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Keibul Lamjao Sanctuary and the Browantlered Deer—1972 with notes on a visit in 1975

RANJIT SINH¹
(With two plates)

There has been no investigation done of the status of this animal and its unique habitat since E. P. Gee's report of November, 1959 and March, 1960, in this *Journal* (1960). But it is certain that the Manipur stag (*Cervus eldi eldi* McClelland, 1842 is today one of the rarest and the most localised subspecies of the family Cervidae in the world. Zealously protected by the former rulers of Manipur State in the past, the stag was relentlessly hunted by both local people and army personnel once the area came under British hegemony. By 1950 the Manipur subspecies of the browantlered deer was regarded as extinct till located once again in a small area called the Keibul Lamjao at the south-eastern corner of the Logtak Lake. An area of approximately 20 sq miles was formed into a sanctuary in 1954, and was subsequently reduced to 10½ sq miles in 1959. The other subspecies of the browantlered deer or Thamin in the Burmese subspecies (*Cervus eldi siamensis* Lydekker, 1915), the Manipur variety, locally called the *sangai* or occasionally

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sangrai, carries the smallest pair of antlers and has always been confined, even in historical times, to the vale of Manipur. At present, it is restricted to the Keibul Lamjao.

About 20 miles south of Imphal, the Capital of Manipur, lies the Logtak Lake, approximately 25 sq miles in extent, and famous for its fish and migratory waterfowl. There are floating islands or "Phumdi" on the lake, on which live fishermen in temporary huts. It is one of the largest natural lakes in the country, and forms a vast inland drainage area. South of the Logtak Lake and separated from it by the Thanga Hills, lies another low lying swamp called the Keibul Lamjao. Its eastern boundary is the Manipur river which drains the Logtak and indeed the entire vale of Manipur, ultimately joining the Chindwin river in Burma.

To the east of the Manipur river, is another marshy area called the Khoidum Lamjao,—rather larger than Keibul, which had its own population of the deer. This area is now reclaimed and cultivated, and the Sangai have been destroyed, a few of them crossing over into the Keibul sanctuary. To the west of the sanctuary and below the western hills of the Manipur valley was another Sangai area centring around a village called Sangailou (the Sangai paddy fields). Now this region also has been cultivated. In effect, therefore, the Sangai has been now restricted completely to the Keibul Lamjao Sanctuary and even here its habitat has shrunk.

Between 1959 to 1968 the area of the sanctuary was $10\frac{3}{4}$ sq miles. In 1968 a further 3 sq miles of the area north of the Khordak River, which drains the northern portion of the sanctuary, was added to the sanctuary, increasing the total area to $13\frac{3}{4}$ sq miles.

There are three hill features in the sanctuary. The northernmost is the Chingjao Hill, the Pabot Hill with the observation shed being a little to the south of this; and the third, Toya Hill, approximately 3 miles further to the south. There was much more vegetation on the Pabot Hill which I visited, than is shown in the photograph accompanying EPG's report of 1960. This proves that this area at least has been better protected since then. However, there is considerable grazing on Chingjao Hill which has practically no trees left. In fact, the entire portion of the sanctuary a quarter mile from the north-west of Pabot Hill is grazed intermittently, and there is cultivation and habitation on the Khordak River which bisects the northern portion of the sanctuary. These cultivations are illegal. Further to the south, there is a sickle shaped tongue of lowland called Thang-Brel-Maril which practically cuts the entire sanctuary into half. This is a strip about 300 to 500 yards wide, and though there are only about 4 or 5 official patta holders at the western corner of it, illegal encroachments continue to delve deeper and deeper along this strip of land. Though the area has been demarcated and there are boundary pillars, encroachment continues to

spill over these lines. Mostly paddy is grown, and from here cattle sally forth and disturb adjacent regions. South of the Toya Hill and along the Khuga River north of Ithai village, there is more grazing by a substantial number of cattle, and the area is fast degenerating. The effective habitat of the Manipur deer is now confined to an area east and south of the Pabot Hill up to the Thang-Brel-Maril, and another area further south of this strip of cultivation extending up to Toya Hill.

Thus though the total area of the Keibul Lamjao Sanctuary is 13 $\frac{3}{4}$ sq miles, the real habitat of the Manipur deer does not exceed 6 sq miles, and this too is under imminent danger of being divided into two halves. The total world population of the subspecies is now confined to this last tenuous habitat, and at the rate at which encroachment and grazing is increasing, if no urgent steps are taken to reverse this process and to safeguard the sanctuary, the Sangai will be extinct very soon. It is evident that the prime reason for the survival of this unique deer in this heavily populated area is the floating swamp. If the swamp (or phumdi) goes, the deer will vanish with it.

STATUS OF THE SANCTUARY

The Keibul Lamjao Sanctuary is a protected forest today. There is not even a proposal to make it into a reserve forest for the time being. In my opinion this should be done forthwith as it will give the Forest Department the right of removal of any encroachers. The sanctuary has been notified in the gazette in 1966 and its boundaries have been outlined. It is under the Eastern Forest Division of Manipur, with range headquarters at Moirang.

Climate:

The average annual rainfall is approximately 125 cm. The humidity is highest in the month of August at 81 per cent and lowest in March at 49 per cent. The maximum temperature is 35°C and the minimum 1.66°C. Frost occurs during the winter.

Flora:

Apart from the three hills of Pabot, Toya and Chingjao, the remainder of the sanctuary is one vast morass of floating organic matter called the phum or phumdi. A passage of free water for boating up to Pabot Hill, has been cleared. The phumdi is made up of decayed vegetation, and varies in thickness from 1 to 4 feet. It floats upon the water, whose level varies with the season. Thus during the driest months of February and March, some of the phumdi especially along the edge of the sanctuary, rests on the hard ground below. Actually only 1/5th of the phumdi shows above water, the rest being below it. The floating islands are a

growing organic unit and the thickness of the phumdi increases from year to year. This is particularly applicable to the phumdi which during the summer season rests upon the ground. With onset of the monsoon, the major portion of the sanctuary gets covered with water and the animals seek refuge on the hills. Then in approximately three or four days the phumdi which had settled on the ground, sets itself free and once again floats on the top of the water. In 1966, there were heavy floods with the water level rising to an unprecedented height of 2531 feet above msl. The phumdi got carried away with the current and with it went a certain number of the deer.

Walking on the phumdi is a unique experience—as if one was walking on an air-mattress. Where the phumdi is not thick enough to support the weight, one can sink up to one's thigh in the ooze—and this happens every few steps.

The reeds and grasses which grow on the phumdi, and the ratio thereof, are listed in E. P. Gee's account. Since I myself did not carry out a detailed investigation in this regard, Mr. Gee's list is reproduced below:-

"Tou	<i>Phragmites karka</i>	45% of the sanctuary
Singut	(not yet identified)	25%
Khoimum	<i>Saccharum munja</i>	15%
Ishing Kombong	<i>Saccharum latifolium</i>	5%
Pulai	<i>Alpinia allughas</i>	5%
Singnang	<i>Saccharum procerum</i>	2%
Miscellaneous		3%"

The Ishing Kombong (*Saccharum latifolium*) is the favourite food of the Sangai and is relished even by the hind which was in captivity at the Keibul chowki. Secondly, the percentage which it occupied in the sanctuary, if not 5 per cent as E. P. Gee's reports, would certainly not be more than 10 per cent. An adequate supply of the Ishing Kombong grass is essential for the conservation of the deer and the matter becomes more significant when it is realised that it is also a favoured food of the encroaching domestic buffalo.

As has been mentioned above, the phumdi becomes thicker and heavier with the passage of time with more vegetation being added to it each year. This process of annual increase is more evident in the phumdi at the edges of the sanctuary, where it has the opportunity of settling on the ground for the longest period and thereby derives sustenance from the soil below. If for two to three years consecutively, there is no heavy flooding, this bordering phumdi would not be forced to leave the ground to float. It will become a part of the hard ground as humus. The factor of trampling by domestic buffalo during the dry season would also, I am sure, help in pressing the phumdi to the hard

ground below and making it a permanent fixture thereupon. The ultimate result of such a process is that the phumdi at the border becomes hard ground with the passage of time, and the actual area of the floating phumdi decreases. It is this process which decreases the floating phumdi habitat of the sangai in the Keibul Lamjao. Water Hyacinth has made its appearance in the open water areas of the sanctuary, but this being very limited it has not yet reached significant proportions in the sanctuary. The three hills within the sanctuary are not only very important observation points in the sanctuary, but constitute a very significant factor in the eco-system. They are the only hard ground in the sanctuary to which the animals can repair to from time to time. Though the sangai has adapted itself admirably to the phumdi habitat, the alacrity with which the captive sangai move over hard areas and hilly ground and the fact that it used to inhabit other non-phumdi areas is evidence enough that unlike the *sititunga*, the sangai is not exclusively a marsh animal. The fact that they regularly visit the hills is proved by their droppings there. Other animals such as the hog deer also use these hills, which during the floods provide the only refuge for the larger mammals of the sanctuary. All the three hills should be strictly protected from grazing and other exploitation and trees and shrubs should be allowed to grow there. Simul and other indigenous trees like *Salix tetrasperma* may be planted, especially on the now barren Chingjao Hill, but no exotic should be introduced.

Exploitation:

The right of grass cutting is auctioned each year in the months of March and April for approximately Rs. 2,000/-. The *singang* grass is utilised for thatch purposes. Burning occurs during the dry season and is reported to be accidental. However, it is possible that some of these fires, at least on the periphery are caused by graziers to obtain fresh grass.

Grazing:

It is most prevalent in the northern and southern part of the sanctuary and around Keibul village has succeeded in degenerating these lands. Only buffaloes are able to traverse the marsh though a few cows were seen grazing along the periphery. Some buffaloes were observed in the centre of the sanctuary just south of the Pabot Hill in the best sangai area. Though no cutting of trees was noticed, the fact that Chingjao Hill has no trees and that Toya Hill also has rather sparse vegetation, is an indication that there is grazing and cutting on these two hills.

I was informed that approximately 100 people cut grass in the sanctuary every day. Certain plants are collected for consumption as vegetables. Fishing in the open patches is also indulged in, and I saw a number of fish traps along the channel leading to Pabot Hill. Apart from

the grass cutters, fishermen and the graziers, some people pass through the sanctuary on their way to Khordak and the Logtak for purposes of fishing.

Poaching does occur in the sanctuary, especially in the northeastern region. The poachers use shot guns and drive the deer with dogs. A wooden trap which resembles a yoke is also used. The main offenders are from the Muslim community whose population around the sanctuary has increased. To a certain extent poachings is also done by the tribes such as the Kukis who live to the south of the sanctuary. Luckily the Hindu population is mostly vegetarian. However, the Muslim community possess a large number of weapons, and the crop-protection weapons are issued to the land-owners including those occupying land in the Thang-Brel-Maril. Poaching and habitat destruction are the two significant causes for the present precarious status of the sangai. Most of the poaching occurs from March to May during the dry season.

The remains of a young hog deer was found on Pabot Hill, but its cause of death could not be ascertained. A hog deer stag was reported to have been killed by poachers in north-west part of the sanctuary a few days before our arrival.

Fauna:

The browantlered deer:

E. P. Gee had carried out a sample survey of an area of a quarter sq. mile, and from the deer counted in this patch, he had estimated that the total population was 100. I was only able to see one stag from Pabot Hill and was told that I was lucky. A drive was attempted in a small patch at the southwestern corner of the sanctuary close to Thang-Brel-Maril. No deer was put up. Despite the fact that some of the deer which must have then lived in Khoidum-Lamjao across the Manipur river, and which subsequently must have crossed to Keibul Lamjao following the opening of that area for cultivation, the number of sangai today is less than that when E. P. Gee visited in 1960. This was confirmed by Babu Singh the most knowledgeable amongst the staff of the sanctuary. The reason is primarily poaching, and secondly the further shrinking of the habitat due to grazing, cultivation and grass cutting. The floods of 1966 in which the phumdi was swept away from certain areas, must have also contributed to the decimation. The total area which would now be fit for sangai habitation would only be about 6 sq. miles as has been mentioned above, and unless the process reverses, it will shrink still further. The largest number of sangai reported to have been seen together recently is five and the usual number are ones and twos. Though it is not possible to assess correctly the total population in such a habitat, I would certainly put the figure as less than 100. More in the neighbourhood of 50. It is imperative that a census of this animal be carried

out, and the only way it can be done is from a helicopter flying low over the morass.

Hog-deer (*Axis porcinus*) occur in the sanctuary and their droppings were observed on Pabot Hill. Wild pig also exist and raid the surrounding crops. Their droppings were seen. A wild cat locally called "Sadung" was reported in the sanctuary. From its description it appears to be a civet of an indeterminate variety.

Staff:

The sanctuary is under one deputy ranger, three forest guards, one game chaprasi and one boatman, and two daily-wage employees working as boatmen. This very small staff is stationed at three points Keibul to the west, Ithai to the south and Paphu-pat in the east. They have residential accommodation. The staff is wholly inadequate and would have to be greatly augmented.

Residential Accommodation and facilities for Tourists:

There are two rest houses—one at Phubala off the Imphal-Moirang road. It is situated close to the Logtak lake and has 4 rooms with two beds each, quite well furnished. It is under the control of the Publicity Department and the charges are Rs. 3/- per day. There is no catering arrangement. The rest house is electrified but there is no running water. It is a beautifully situated bungalow and could be developed. There is another rest house at Sendra on the Thanga Hills that commands a magnificent view of Logtak Lake as well as the southern aspect of the valley. This also has 4 suites, but was under repairs. There are no vehicles for tourists to hire. The only method whereby tourists can visit the sanctuary is to go up to Keibul by road and then along the water channel in dug-out boats upto Pabot Hill, where there is an observation shed. (Plate I). Usually, mornings and evenings are preferred and if the visitor is lucky he may see from the hill top the deer moving about on the phumdi. The view from here is magnificent but the chance of seeing deer are remote. If driven out by beaters, deer can be seen from the hill tops, but walking on phumdi is very difficult and the villagers are not keen to undertake the job. Besides, such regular drives would be a great factor of disturbance to the deer and should not be normally practised.

The Logtak project:

A coffer dam is being put up below the junction of the Khuga and Manipur rivers, south of Ithai village and approximately half a mile below the southern tip of the sanctuary. The gate of the Ithai dam will be 2525 feet above main sea level. This will therefore, be the height of the water in the Logtak Lake; and since the Logtak is connected with the Keibul Lamjao through two channels running through the Thanga Hills, the water table of the Keibul Lamjao will also be 2525 feet above msl. The surplus water of the Logtak which would have otherwise

spilt over the dam at Ithai, would be diverted through a channel running west-ward from the Logtak. This water will then go through a tunnel in the western range of hills, and a drop of thousand feet, will generate 35 Kw of power.

The height of the water in the Logtak Lake and in the Keibul Lamjao varies from 2518 to 2528 feet above msl. The lowest level is in February-March, the highest of course being during the monsoon. In 1966 the water level of the flood waters rose to 2531 feet above msl as a result of which some phumdi is reported to have been swept away. Now the water level is sought to be retained at 2525 feet constantly. The danger of a flood has been averted as the river is being widened. In the dry season the water level of the Logtak and the Keibul sanctuary would not also go down to 2518.

At the height of 2525 feet above msl, the area under water in the Keibul sanctuary will increase. Since the level is going to be retained at that height, the extent of the phumdi habitat would also theoretically remain constant. The phumdi will not settle on the ground in the dry season and the predilection for becoming heavier and heavier and finally settling on the hard ground would be lessened. The cattle and the poachers will not be able to make their inroads during the dry season to the extent they do now. The total area of the phumdi will increase and its extent would be retained at a contour of 2525 feet msl which is achieved today only during the monsoon and post-monsoon period. On the face of it, therefore, it would appear that maintenance of the water at a given level would prevent further decrease of the sangai habitat and make poaching more difficult. Indeed, it may even be that the habitat of the sangai would be increased with the constant water level at 2525' above msl. However, certain factors will have to be kept in mind. The Logtak Lake and the Keibul Lamjao with which it is connected, are a very complex aquatic eco-system. The disturbance of its ecology may have other complex and unforeseen results. The project is almost nearing completion and it will not be possible and advisable to stop it. But a research be carried out on the ecological aspects of this project, indeed on the ecology of the entire Keibul Lamjao-Logtak complex. If any factor which proves to be adverse to either of the two, the project should be modified to that extent. Perhaps the lowering of the water table from 2525' above msl, if such is proved to be necessary may have to be carried out. Certain other considerations may also have to be investigated. Now that the annual flooding and the lowering of the water table in the summer would not be permitted, what would be the ecological repercussions? The phumdi which settles on the hard ground in the dry season would not now be permitted to do so. Would this have any effect upon its composition, and would the phumdi continue to flourish if it is not allowed to settle on the hard ground? In other words,



Above: View from the Channel of Pabot Hill. *Below:* West view from Pabot Hill.



Above: Deer seen from the Helicopter in 1975. *Below:* Captive deer in the enclosure at the Sanctuary.

is the periodic settling of the phumdi on the hard ground essential for its existence? It may be pointed here that phumdi is unique to the Keibul Lamjao, there being very few phumdi islands on the deeper and larger Logtak Lake close by. Moreover, water hyacinth has invaded the Logtak but not the Keibul Lamjao. There is hardly any open water in the latter. But with the water table at 2525' above msl, would there be more open water and as a consequence more water hyacinth? A very significant and interesting factor is that the peak rutting period is in the month of February and March when the water level is at its lowest and the phumdi has settled on the ground, at least on the fringes. The coinciding of the rut with the dry season is not a coincidence in my opinion. And if this assumption is correct, would maintenance of the water table at 2525' above msl adversely affect the rut. Do the animals mate on the floating phumdi or do they require hard ground.

Lastly, the Logtak project envisages the reclamation of the land between contours 2525 and 2528 feet above msl. This is supposed to be an area of 6000 acres. It must be made very sure that the area which is proposed to be reclaimed for cultivation between these two contours, is not from within the Keibul Lamjao Sanctuary.

Recommendations:

Manipur is the only part of India in which the Browantlered deer is found, and it is in fact the only habitat in the world where this particular subspecies occurs. To focus attention on this unique deer, it is suggested that just as Assam has declared the Rhino as the state emblem, the Manipur Government should declare the 'Sangai' as its state emblem.

2. The Keibul Lamjao Sanctuary should be declared a reserve forest and a National Park. This would not only give the State Forest Department adequate power to conserve this unique habitat, but will also set aside this small piece of territory as an area of national importance in which the State and Central governments could work in harmony to achieve a common goal.

3. An adequate wildlife legislation should be adopted. The Government of India has already approached the Government of Manipur for the adoption of the Central Wildlife Conservation and Management Bill. It is hoped that the Manipur Government will adopt this. The existing manual of "Preservation of Wildlife and Reserve Forest and other parts of Manipur" also needs to be revised.

4. The present staff of the sanctuary is totally inadequate. The following personnel is recommended for the sanctuary. One full time A.C.F., one ranger, 6 foresters, 10 forest guards, three boatmen and three game chaprasis. The A.C.F. with two foresters, two forest guards, one boatman and two game chaprasis, should be at Keibul. The ranger, with one

forester, two forest guards and one boatman, should be at Komla-Khong-north-east of the sanctuary. At Ithai one forester, two forest guards and one boatman be stationed, and at Khordak village one forester, two forest guards and one chaprasi. This staff is absolutely essential to prevent poaching and illicit grazing.

5. *Service rifles*—410 muskets or .303 rifles for which cartridges are only available with the Government and not in the open market needs to be supplied to the Ranger and each of the Forest Guards. The Police Department of the State should make available these weapons, as has been done in some other States.

6. The poaching is done mostly with the help of dogs, and traps, and is usually from the north-east of the sanctuary. This will have to be effectively curbed and the poachers prosecuted. Poaching is most prominent in the dry season and if during this time additional staff is required, they could be provided on a temporary basis, to augment the permanent staff. This would be over and above the staff suggested above. The Forest Department should keep a copy of the license holders on the periphery of the sanctuary, and if anything adverse comes to notice, they could move the Government for the cancellation of the licenses.

7. The incidence of grazing is most from November to May. This must be stopped, specially in the northern region around the Chingjao Hill and to the south near Ithai village. As the grazing is mostly from the western, northern and southern sides, a trench could be dug from Thanga Hills to Ithai village to prevent the ingress of cattle. Not only do the cattle constitute a factor of disturbance but also pose a threat as the carriers of disease. One single epidemic is sufficient to wipe out the total world population of the Manipur stag today. Besides, as has been pointed out above, cattle is the main competitor with the Sangai for the grass Ishing Kombong which constitutes less than 10 per cent of the total grass in the sanctuary.

8. Other factors of human exploitation such as fishing, wood cutting on the hills, grass cutting and transit through the sanctuary, should be totally prohibited. Grass cutting only fetches Rs. 2000/- a year and this must be stopped.

9. No person should be allowed to enter the sanctuary without a valid permit from an official not below the rank of a Ranger.

10. Burning of grass should not be allowed in the sanctuary.

11. Illicit cultivation in the Thang-Brel-Maril should be done away with. If this is not implemented the sanctuary is in danger of being cut into two halves with disastrous results. Illegal settlements on the Khordak river must also be removed.

12. Prophylactic inoculation of peripheral cattle and buffaloes, specially the latter, be carried out intensively. In Pabot Hill it may be worthwhile to experiment by placing rock-salt. I am sure the deer would wel-

come this and apart from providing them with nutrition, it would also result in their being seen more frequently from this observation post.

13. No exotic plants or trees should be introduced or planted in the island or elsewhere in the sanctuary. However, the planting of indigenous trees should be carried out on the Chingjao Hill and to a lesser extent on Toya Hill.

14. A wooden observation tower should be put up at Toya Hill with a canal cut through the phumdi from the west. However, this should only be done when effective protection can be provided to this spot.

15. The A.C.F. to be placed in charge of the sanctuary should receive wildlife training at Dehradun.

16. Since the Keibul Lamjao and the Logtak lake are areas of inland drainage and being a complex aquatic eco-system, are extremely fragile, care should be taken to prevent any action which may endanger the eco-systems. Spraying of insecticides and pesticides which will immediately find their way into the lakes, should be prohibited at all cost, otherwise the entire life including the fish, may be jeopardised.

17. A detailed scientific study of the effects of the Logtak project on the Keibul Lamjao, needs to be started forthwith. The salient features of the investigation have been suggested before in this report. In fact there is urgent need to carry out a research on the ecology of the Keibul Lamjao; on its unique phumdi habitat, the deer and the aquatic life.

18. Since the Keibul Lamjao is today the only habitat of the brow-antlered deer, disease or a radical setback, not to mention the incidence of poaching, could wipe out the entire population of the deer. It is therefore, essential that a second suitable home for this deer should be set up in the valley of Manipur itself. This could be in the Khoidum Lamjao (what now remains of it), or any other suitable habitat in the valley. The Forest Department may make investigations in this regard—where a second sanctuary could be created wherein a small breeding group of the sangai could be released at a later juncture.

However, to augment the present low population of the deer in the sanctuary, to enable research on the deer in at least a semi-captive stage, and to provide an added attraction to visitors, a captive breeding programme of the brow-antlered deer on its own habitat, is imperative. At present there is an enclosure which is behind the Keibul forest office in which a hind is kept. Though this is a fairly large enclosure, there is no phumdi nor marsh in it. An ideal enclosure would be one in which a part of the phumdi is enclosed as well, as a certain portion of the hillside to which the animal could move over when they wish to be on hard ground. Such an enclosure could be situated on the Ching-mei Hill southeast of the Keibul forest beat-office. Here the hind held in captivity could be released, and a herd of two stags and three hinds

could be brought over from the Delhi Zoo for breeding purposes. These deer in the Delhi Zoo are the progeny of the sangai which were captured from the Keibul Lamjao some years back. Browantlered deer breed well in captivity and I am sure if properly looked after, and if attached to a research project, they could form a nucleus for an effective captive breeding project.

THE SANCTUARY IN MARCH 1975

I visited Keibul Lamjao after a lapse of three years in 1975. Considerable progress has been made since my earlier visit at the instance of the Government of India, and due to the keen interest now being evidenced by the Government of Manipur.

I took the opportunity of the presence of the Pre-Investment Survey helicopter in Manipur to carry out an aerial survey of the population of the deer, this being the only feasible way of counting them in the impenetrable floating morass. March being the height of dry season, the "phumdi" had been set on fire by the surrounding villagers and fresh green grass was sprouting. The deer could therefore hide only in the remaining patches of dry grass which made the counting easy (Plate II). I flew low over the Keibul Lamjao for a period of about 45 minutes, and the number of deer revealed was far below even the most pessimistic estimate. *There are only 14 Manipur Browantlered deer left in the wild, 5 stags, 6 hinds and 3 fawns.* This makes the Manipur deer the most threatened animal in the entire sub-continent, and amongst the half a dozen most endangered species in the whole world.

It is fortunate that this species breeds well in captivity and we have a viable herd in the Delhi Zoo, and have given them to other reputable zoos in the country for breeding purposes. However, if the deer are to survive in the wild, and if the captive breeding stock is to be rehabilitated in the wild, it is imperative that the Keibul Lamjao Sanctuary must be preserved at all costs. This is the only suitable habitat left for this deer in the valley of Manipur. I have been advocating the acquisition of a suitable territory for the deer on the other side of the Manipur river where they once lived. This is now in private hands and can be acquired for the deer if the Manipur Government so deems fit. However, the primary task is to preserve absolutely the existing habitat in the Keibul Lamjao Sanctuary.

All grazing and fishing inside the sanctuary must be stopped. I saw more evidence of grazing and fishing in the sanctuary in March, 1975 than was the case in March, 1972. If necessary, this should be done by putting up a physical barrier for which funds have been provided to the Manipur Government, and which have not been utilised so far.

The cultivation within the sanctuary, especially in the Thang-Brel-Maril strip which bisects the sanctuary almost into two, should be prohibited. In case where the property rights have been given over to the cultivators, these lands should be acquired, for which Government of India can meet the cost of acquisition under the scheme of Financial Assistance to Selected National Parks and Sanctuaries, and under which we are already providing funds to the Keibul Lamjao.

No person should be allowed into the sanctuary without a valid permit from the officer in charge, and this would preclude the entry of regular parties of villagers who enter the sanctuary to collect grass and wild vegetables.

Protective staff to be augmented and posted at strategic points on the periphery of the sanctuary. *At least four Home Guards units should be posted on the periphery to patrol the area with the forest staff.*

Weapons given to the villagers on the periphery especially on the eastern side of the sanctuary, are regularly mis-used for the poaching of deer with the help of dogs. All these weapons should be withdrawn and the licenses cancelled.

Repeated prophylactic inoculations should be carried out on the cattle of the periphery for preventing cattle disease from affecting the remnant population.

The sanctuary should be upgraded into a national park and the boundary of this park should be the contour 25 25', which will be the level of the water when the Logtak project is completed, and lastly, as has been discussed above, the raising of the water level due to the Logtak project will have certain obvious advantages. However, if the constant maintenance of the water at the level of 25 25' is to have a deleterious effect on the ecology of the Keibul Lamjao Sanctuary and the formation of the floating islands which are the very *raison d'être* of this sanctuary, the level of the water held by the dam on the Manipur river would have to be manipulated so as to restore the ecological factors prevailing prior to the building up of the dam.

It must be emphasised that the Manipur deer and the Keibul Lamjao Sanctuary on which it is existing, are in a desperate situation and unless the matter is given very urgent priority, there is no doubt that this beautiful deer will become extinct in the wild, in the very near future.

The Mountain Hawk-Eagle¹

S. M. OSMAN²

I was resting on a high stretch of the Theri-Mussoorie road one morning, where it marks the northern boundary of the Motidhar shooting block, when I noticed an eagle spiralling up from the plains. Soon it was flying level with the road and passed so close overhead that I could see each detail. To a falconer it was a real beauty, handsome and very large. Without a single wing-beat, it glided towards a rocky out-crop, perching as delicately as if its huge bulk were without weight. It was not more than a hundred and fifty yards away, and I had to act quickly.

I hissed at my servant to produce the dogaza and live pigeon that always accompany me to out-of-the-way places, and set my trap in a terraced field just below the road. Then we hid and prayed.

Soon the eagle dived in a most spectacular fashion straight into the net, and no mother could have shown greater love or gentleness towards her first-born than I felt towards this tigress from the sky as I freed her from the net. My permit expired that day and I had intended to shoot some more pheasants before catching the last bus at Sahastradhara, but now I decided to head for the taxi-stand at Mussoorie. I had no hood with me, but was able to borrow needle and thread in Soakholi, the first village I came to, and after I had sealed its eyes the eagle was calmer.

Before I proceed to narrate the obstacles my father and I had to overcome before this eagle was trained, and some of the incidents in the six happy years we hunted with her, let me attempt a more general description of the Mountain Hawk-Eagle, *Spizaetus nipalensis*.

In immature birds the head is dark brown, but the feathers on top of the head are edged with light cinnamon. The colour changes to a darker shade with each successive moult, so that in old birds the head is almost black. In addition, dark moustachial stripes are developed. On top of the head is a long crest, the feathers of which are tipped with light cinnamon, or in older birds with almost pure white. The back and upper parts are light chocolate, becoming dark brown after a few years of moulting. The wings are barred with dark chocolate, and the tail-coverts barred with white. The tail pens are of a light olive-grey colour with dark brown bands running across.

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In juvenile birds the general colour scheme is of a light or pale shade. The wing-covert feathers in all such birds have almost white edges. All immature birds have a salmon patch below their chins. In older birds this patch is cleft by a dark brown streak, which tends to broaden with each moult and also to become more and more dark till it appears almost black in birds that are more than six years old. This streak reaches down till it almost touches the crop. The underparts appear to be white or almost so. In such birds the breast is pale cinnamon in colour, and is streaked with light brown feathers that extend to well below the crop. From here downwards, white barrings are found right to the belly. In older birds these broken white bars touch the crop of the eagle, and are well pronounced. Streaks that in immature birds are of a light brown shade change to a dark brown colour after a few moults. In young birds, the tail pens seem to have more numerous and narrower bars running across them.

In an unusually long head, that is very conspicuous in the female birds, is set a black beak. In juvenile birds, the eyes are yellow, but with advancing age the colour changes to a deep orange. The toes are usually of a faded yellow shade, but the colour depends on the food the eagle has been eating, as some birds killed by an eagle are not always as nutritious as rodents such as hares, squirrels and hamsters. Food that is rich in fat and vitamin B₁₂, if fed to the eagle or any hawk for some length of time, will change the colour of the toes of that predator to a bright yellow. This indicates very good health. In these eagles, the feathers on the tarsi not only come down as far as the toe-joint, but grow in between the toes as well. By looking at the extreme limit of the feather range on the tarsi of hawk-eagles it is easy to differentiate between *nipalensis* and *cirrhatus*.

This eagle has the most formidable claws to be seen in birds of its size and weight. On the other hand, its beak is not as broad-based as Bonelli's. This slender beak in no way impairs its efficiency as a big killer of game.

Male birds rarely go above twenty-five inches. Females may measure thirty inches or more at times.

In the Himalayas, *nipalensis* keeps to the higher ranges and prefers forested slopes. Because of snow, and cold, and also because other birds such as pheasants migrate to the foothills during winter, *nipalensis* also is obliged to come down to the plains, when it may be seen as far down as the lower reaches of the Siwaliks. In its winter habitat it still prefers wooded areas, especially where peafowl and junglefowl abound. Beyond the Siwaliks, it has seldom been reported, and on the whole it is seen to prefer the mountain fastness of the mighty Himalayas, where it breeds. It is the most voracious raptor, for its size, that I have seen. It kills a huge variety of game, taking both big and small birds with ease.

It also kills and eats hares, squirrels, an occasional stone marten, and flying foxes the large fruit bats that are found in the Doon Valley. Large birds that are frequently taken are peafowl, chir and monal pheasants, junglefowl, and waterfowl such as the greylag goose. The smaller birds include partridges, wood pigeons and even swift parakeets. Since most of these birds are taken on the wing some idea of the speed this eagle is capable of achieving can be formed. I am convinced, and my conviction is probably shared by quite a number of falconers and naturalists, that *nipalensis* is the fastest eagle on the Indian subcontinent.

In flight it is graceful, showing an enormous degree of manoeuvrability. When our eagle had been fully trained I had ample opportunities of watching her when flown after nightjars. This fly-by-night is no easy prey even for the fast sparrow-hawks, but our eagle would capture it on the wing nine times out of ten. The nightjars, or goatsucker as it is sometimes called, is remarkable for its powers of flight and great speed. It twists and turns in mid air so effortlessly that it is amazing just to watch it perform.

In all my years of wandering in the hills I have come across only three *nipalensis* nests. One of these was not far from a village close to Mussoorie. In early spring I am often gripped by restlessness. At such times I drop whatever work I have on hand, and with rucksack and valise strike for the hills or the forests. Then, after a few days of aimless roaming around in the wilderness, I return home, once again a contented man. In March the hills to the north of Dehra are a veritable paradise, and if you go to the right places you will find the countryside teeming with wild life, especially birds of all kinds, including local migrants that each year return to their old nesting sites. Most of the bird population is busy either courting or building a nest, but the Mountain Hawk-Eagle completes these preliminaries in January, and in March is settling down to the more serious business of incubation and egg-hatching.

The village I am speaking of stood near a terrifying precipice, cocked at such a dizzy angle on the slope of the hill that just to reach it was sufficient to put the fear of God into the heart of any plainsman. Bang on the edge of the precipice, and no more than twenty yards from the cluster of huts that make up the village, there stood a towering pine tree. In the village lived hillmen with their families, buffaloes, and goats, all in the same huts. A rickety cot had been pulled out of one of the huts for me, and as I sat talking to the headman I heard the unmistakable *Kwick Kwick* call of an eagle coming from the direction of the giant pine. Immediately I was on my feet, and in order to get a better look at the nest I climbed up the hill for a hundred feet or so, enough to put me level with the nest. It was about ten feet below the top of the

pine tree, and in full view from where I stood. I watched the male bird leave the nest, and the female eagle, which was the bigger of the two, settle down to incubate the eggs. I sat there for almost an hour in the hope of getting a better glimpse of the contents of that nest, but no amount of shouting or clapping would make the hen bird leave the nest even for a short while. In fact my efforts had just the opposite result, for thereafter she crouched lower in the nest with her head barely showing above the rim. From this behaviour I concluded that there must be eggs, though I did not know how many.

Two months later I returned to the village hoping to see the eaglets in full glory. But I could see no nest and the headman told me that it had been blown down in a terrific storm, some weeks after my last visit. I was inclined to believe this as no one could have molested the nest since the tree stood on the brink of an abyss, and even getting near the pine was enough to make my head reel.

I came across a second nest at a place in Uttar Kashi in the Garhwal hills. Here I had an excellent view of the two eaglets, as they used to stand up in the nest whenever the parents came to feed them. What struck me as odd was that the parent birds were not of the same age. The male eagle was an immature bird, for I could clearly see the white edges of the feathers on its wing-coverts, and I had been under the impression that immature birds did not breed. The female eagle was unusually big, and from the darkness of her colour appeared to be six or seven years old. The chin stripe referred to earlier was most conspicuously drawn under her chin.

I was able to watch the nest to my heart's content for two whole days, and could see not only the eaglets, but the parent birds too as they came with food for their offspring. I was fascinated to see the female bring home sometimes a lizard, sometimes a hill partridge or chukor, and once a blue rock pigeon. It was touching to see the tender care she exercised in feeding the eaglets. The nest itself was an untidy pile of sticks high in a huge tree. I found the eaglets were being fed at all times of the day by the parent birds, and one of these would always be on hand to defend the nest and eaglets against marauders. It was so well guarded that ravens and kites gave it a wide berth. There was quite a lot of wing-flapping and screaming by the eaglets when one of the parents flew home with food.

The third nest was at Binahar in the western Doon valley, about 5000 ft above sea level. As I was walking at dusk across a terraced field I saw an eagle fly out of the only oak tree at the far end. My host told me that there was a nest, and that the eagle could be seen flying in and out of it many times during the day, so next morning I walked over and had got quite close to the tree before the eagle decided to fly away. I was easily able to see she was a female Mountain Hawk-Eagle, some five

years old. The nest was untidy, but not very big, and was placed not more than thirty feet from ground-level. From this I concluded that the nest had not seen many years of tenancy, and must have been built a year or so ago. I did not see the male bird, but I did not stay at the nest site for more than a few minutes, and probably he was either out hunting, or on the other side of the ravine. When I inquired about the nest again, a couple of years later, I was told the oak tree had been cut down.

I have seen these eagles in Naini Tal and am sure they extend over the entire Himalayan range. I don't think they spread into Kashgaria, but they do reach Assam, and on to Burma. A planter friend in Assam once showed me the skin of an eagle he had shot in the hill ranges of southern Bhutan, and on examination I found it to be the skin of a Mountain Hawk-Eagle. Accounts of naturalists engaged in field work over the Arakan Yomas, in western Burma, mention that the eagle has been seen there also.

Now let us return to the bird I had so easily captured. We called her *Kohistani*, which in Persian means mountaineer. I was not at all prepared for the many difficulties and troubles that we had to overcome in training her, and that she was ultimately trained and gave us many happy hours of hunting was made possible only by the inestimable help extended by my father. Single-handed I am sure it would not have been possible for me to achieve much with this particular bird. Even with my father's help it still took almost twice the normal amount of time and labour required for the training of an eagle. Our concentrated efforts and experience had only a very gradual effect in subduing the wild and unpredictable nature of this Himalayan Queen.

To begin with, we found the eagle carried a heavy infestation of mites, which it had probably gathered from the snow pigeons it had been feeding on. And when its mutings were examined under the microscope we found tell-tale traces of tapeworm infestation. In dealing with the external parasites I made my first mistake. When all the old known methods of eliminating the mites had proved unsuccessful, I invoked the assistance of our local veterinary surgeon, who advised me to dust the eagle with Gammexane powder, which is commonly used in this part of the world for ridding poultry of ticks. In spite of the expert advice, as the tin was labelled 'for poultry only' I reduced its strength by mixing it with an equal quantity of wood ash. I hoped in this way to eliminate side effects, and little realised how wrong I could be.

Less than an hour after a liberal application of this mixture of Gammexane and wood ash, *Kohistani* had a very severe attack of convulsions and threw up all the food she had taken earlier in the day. After these epileptical fits had passed off, the eagle sat up very groggily and I was hoping that the worst was over when she got another attack. This time the trouble lasted much longer and was more intense. She fell off

the perch and got hopelessly entangled in her leash. In trying to rescue her, for I did not want her feathers to be broken, my hand came close to her talons, and she gripped the bare and unprotected palm, sending the main back claw right through it. In her delirium the eagle kept up a spasmodic tightening of her grip, every time sending excruciating pain shooting up my whole arm. It was difficult to say how long I could stand this without fainting, but luckily my father had heard me cry out and rushed to my help. Together we managed to free my hand, which mercifully had started to become somewhat numb.

The swabs of cotton-wool saturated with iodine that I squeezed into the hole in my palm did not put me to any great discomfort, but this anaesthetized feeling unfortunately did not last for long and when the circulation was back to normal I found I had not only a swollen but also a throbbing palm.

During the course of the night I recorded nine such fits. By next morning Kohistani had lost the use of her legs, and remained lying on her breast all the time. The intervals between the fits however gradually grew longer and the next night we registered only three fits. On the third day the eagle was able to sit up for short intervals. During these three days she did not eat anything, and as attempts to force-feed her would induce an attack she was left alone in a warm dark place.

From the third day onwards Kohistani showed signs of improvement. During the day she did not suffer a single attack, and in the evening she ate a little meat, the liver of a hare I had shot in the afternoon. After that she never looked back. But the experience had left her in a state of extreme excitability and great nervousness. Any sudden noise would cause intense agitation and excessive distraction. She refused to cooperate, and would only jump to the fist from a very short distance when pressed by hunger. We could not hope to condition her while she was in this plight, so we decided to feed her up, and refrain from handling her until she was once again in the highest health condition.

Gradually the eagle gained weight, and after some time was back to normal. To all outward appearances, she looked as well as any eagle could, yet she never lost her neurotic jumpiness, and the training was an ordeal for both trainer and trainee. For what seemed an endless number of minutes, you would watch her sitting on the perch with my father standing in front of her, extending a welcoming fist with a little meat. He would beckon and beckon the eagle to jump to the fist, but she would not budge. Kohistani would simply look at all this with a tranquil gaze, and remain so still that you could swear she was a stuffed specimen, and not alive at all.

This went on for almost a month. Then she began to jump with less hesitation and soon she was flying to the fist from a distance of eight to ten feet. These flights were always from the ground, or from the block

perch, and hence from a lower to a higher level. By this time my patience was almost exhausted and I was ready to let the eagle go, but my father kept grinding away at the training as though such resistance was only to be expected from our beauty. It is this quality of being able to withstand resistance for longer than the normal man that makes the difference between a good and a mediocre falconer. It is also a sign of stronger character, and I could see this asserting itself on the eagle. The foundations of her resistance were gradually being sapped and she was beginning to cooperate.

In another few days, I was pleased to see her fly to the fist from the branch of a tree that stood some fifteen feet high. During this period of the training, we were not prepared to take any chances so we used a creance. This meant that if during her short flight from the branch to the fist the eagle decided to quit and turned aside, she would be restrained by the long cord attached to her leash. As soon as she started to come when called from distances beyond eighty feet, the creance became redundant. Once an eagle is flying to the fist without hesitation, whenever called, the creance should not be used. It is very liable to get tangled in a bush or branch, and if a bird under training is suddenly brought up short by the creance it is naturally upset and discouraged from further flight.

Kohistani was now doing very well, and within a few days was in yarak. The time had come to fly her at game. I would here once more like to emphasize that the first flight at game for any newly trained hawk is a very important occasion, for should the first few attempts at catching game be unsuccessful, the hawk loses confidence and is much discouraged.

We chose Kersali, a village nestling under a bluff on the right bank of the Song river at its confluence with the Bandall, for Kohistani's first flight after game. A few paddyfields extended from the village to the steep edge of the tableland lying to the west. Pheasants come from the dense cover on the bluff to feed on the paddy left after harvesting. We arrived very early, before the sun had made its appearance. My father had the eagle on his fist and we had not moved far when I noticed pheasants dodging in and out of the patches of bramble, making for the rising ground ahead. I signalled my father to be ready but it was not necessary, for not only had he seen the birds himself, but the eagle also was keenly following their movements. She bated, and my father let her go immediately, but the wily birds had already sensed danger and scurried back into the nearest bramble-patch. Seeing this, the eagle executed a right-hand sweep and flew to the nearest tree overlooking the bush. She perched on the topmost branch, facing the spot where the pheasants had gone to cover. It was now our business to force the cunning birds out into the open. The pheasants were in a thicket of about a dozen bram-

ble bushes, and were all the while trying to break back, as we tried to drive them towards the eagle. Meanwhile the eagle was becoming restive, her bells tinkling as she constantly shifted her position to get a better view of what was going on below.

Perhaps, after running around so many times in a small circle, the pheasants had lost their sense of direction, or maybe they too had become desperate and had decided to take their chance in the open, eagle or no eagle, when at last the cock bird exploded out of cover with a shrill *chirr* and made for the next lot of brambles. The moment it appeared the eagle shot out like a flash of light and the birds met in mid-air with a resounding smack.

The eagle came to earth almost at once, gripping the ill-fated pheasant so powerfully that it could not move at all. For a few seconds it squawked pitifully and then was quiet. You could not have found two happier men than Father and I as we stood watching the eagle bother the dead pheasant.

I always found Kohistani very brave, but she would sometimes ignore game no matter how well the stage had been set. I fear my initial blunder of having exposed her to the toxic pesticide was largely responsible for her changing moods. She showed a special fondness for hares, and always bated hard after them if not slipped. I was one day exercising her by letting her follow me, flying from tree to tree. We usually covered a mile or more like this. We were in the middle of our morning jaunt when a hare sprang from almost under my feet, when the eagle was on a tree more than hundred yards behind me. She must also have seen the hare for I heard the tinkle of bells and knew that she had taken off from the tree, and when I turned round she was quite near, flying like smoke. She flew low, hardly three feet above the ground, and the wind escaping through the slits in the bells made a continuous whistle. In the six years the eagle had been with us, I had often before seen what followed next, but the memory of it even today sets the blood throbbing in my temples. The eagle effortlessly grabbed the hare by the nape of the neck, lifted it clean off the ground and raised it over five feet before coming down to earth with both feet firmly planted in the victim. A falconer's dream.

What I wish to stress is not merely the way in which rodents were dealt with, but also the speed at which these birds can fly. Looking at the Mountain Hawk-Eagle one could never imagine how fast it can travel. It is twice the size of an ordinary goshawk and it would be reasonable to surmise that it is slower. On the contrary, I have substantial proof that the Mountain Hawk-Eagle is able to perform just as well if not better than a goshawk, as well as being five times as powerful. The fact that it can capture such fast and nimble prey as parakeets and pigeons is a clear indication that provided it is above the quarry, it can

fly even faster than a goshawk. In manoeuvrability, it is quite its equal.

I had Kohistani with me for slightly more than six years, and during this period she accounted for more than sixty hares apart from other game. She did not always register a kill, and on some occasions the hares got away with a whole skin, but such instances were few compared to the times when hares were bagged. Whenever a hare escaped, I attributed it to the eagle's changing moods, and remembered her ordeal with the Gammexane powder.

I have mentioned the speed at which these birds can move, and the way they can twist and turn when hot on the heels of the quarry. I have had countless opportunities to witness the performance not only of wild mountain hawk-eagles, but also of tame eagles of this species, under controlled conditions that excluded the chance of any error in judgement. Experiments were repeated again and again, and a stop-watch used for timing. Photographic records of the eagle's flight were also made and all confirmed its remarkable speed and manoeuvrability. I have been an ardent falconer ever since my schooldays, and have been lucky enough to handle many hawks, falcons, and eagles. Therefore I have had many opportunities to observe the relative speed of the different birds of prey. My findings are based on personal experience and keen interest.

Barn Owls are often hunted with sparrow-hawks, merlins and other small hawks such as shikras, and I have frequently succeeded in gathering an owl or two with a Peregrine tiercel. But owls are very cunning and can dodge in and out between the branches with exceeding ease. In all cases the hawks and falcons had to stretch themselves to their maximum capacity to catch their prey. One would not have thought the seemingly ungainly Mountain Hawk-eagle able to compete, but I have time and again captured owls both big and small with Kohistani. Amongst the bigger members of the *Bubo* tribe the Horned Owl was the favourite and the eagle was also very keen on Barn Owls. These screech owls are usually found living by the dozen in a banyan standing isolated from other trees, preferably on the edge of an open field. These stygian creatures love to dwell in such trees, where the thickly overgrown branches give them good protection from enemies during the day. Hollows in the twisting limbs provide excellent tenements for raising a family and it is as difficult to drive the blighters out of this sanctuary as it is to drive a man out of his home. They are always very reluctant to fly, and it takes a lot of shouting and stone-throwing to persuade a novice bird to leave his ancestral abode for the uncertain comfort of the next tree a few hundred yards away.

At such times it was possible to slip the eagle after the retreating owl, and on all such occasions I have witnessed a show magnificent beyond description. The eagle would catch up with the owl in a few determined

wing-strokes and grab it effortlessly. I suppose the mere sight of the monstrous adversary close on their heels made the owls forget how to dodge and swerve. What is surprising is that after the capture of an owl Kohistani always came down to the ground, and did not carry the kill into some tree where it would be difficult for me to get her down. Only when an owl did gain the protection of the next tree, but could not find any convenient hollow to hide in, would the eagle catch it as it sat on the branch. Even then, in nine cases out of ten Kohistani came floating gracefully to the ground with the owl almost hidden in her mighty claws.

As for the bigger owls, *Bubo bubo*, the Great Horned Owl, presented no problem at all. Once it had been located in some ravine its fate was sealed. It never got a chance to get away and its feeble efforts at self-defence were unavailing. There is only one way an owl can outsmart an eagle, and that is if it decides to soar.

Though the Great Horned Owl rarely attempts it, the Turkestan Owl is much given to this sort of escape tactics, and it is great fun to watch these bold fliers hunted by a Saker falcon. Both falcon and owl ascend in what to the observer may appear to be never-ending mounting spirals till they show as mere specks in the azure blue of the sky. Unfortunately for it, the owl is not what may be termed a stayer, and the moment it tires and starts on its downward journey, its fate is sealed. The Saker begins its classic dives and the falconer is rewarded with an astounding series of mid-air strikes. Every time the Saker makes contact with the quarry, feathers explode in the sky as though the owl has been hit by a charge of shotgun pellets.

Towards the close of each hunting season, and just a few days before Kohistani was to be grounded for moulting, I would make it a point to slip her at whatever small game we came across. These last few days of the shikar season always witnessed most intensive hunting, for we bagged all sorts of game, from squirrels, mongoose, and hares, to partridges, bush quail, and neophrons. This was at the start of the hot season, when hunting was possible only during the early morning hours or just before sunset. In spite of the short period at our disposal, we were still able to have an immense amount of sport.

I remember how one day Kohistani killed a mongoose. With a couple of friends, I was out hunting in the morning. The sun was quite warm notwithstanding the early hour—it was hardly 8 a.m.—and we decided to call a few minutes' halt in a mango grove in the shade of the trees that had already started budding. One of my friends was carrying an air-gun and he went ahead to see if he could shoot some bird for Kohistani to be fed upon. Very soon he came charging back to say he had seen a mongoose roving at the far end of the grove. 'Let us try and grab it with the eagle,' I said. But when we reached the spot where my friend had seen the mongoose, we found that it had disappeared. Presuming

it had gone to earth in a nearby warren, we gathered round the hole and were debating what to do next, when all of a sudden the creature poked its head out of the burrow and then shot out as if a posse of devils were after it. I was standing quite close to the hole.

By the time I had unhooded the eagle the mongoose was clear away and was moving at a goodish clip towards the hedge that marked the boundary of the grove. The eagle saw what was happening and hesitated for a fraction of a second, this being her first time at mongoose. Then she launched herself off my fist—I did not cast her after the quarry—and a cheer of exaltation went up from the small crowd as we watched the eagle dodge through the trees and cut out the victim's line of retreat to the boundary hedge. It grabbed its prey with a terrific *woosh* and lifted it clean off the ground. I was horrified to see that Kohistani had gripped her prey by the rump, and that the business end of the protesting quarry was snapping viciously, trying to bite the eagle's hold from its tender behind. Like lightning, the eagle shifted her other foot and firmly nailed the mongoose just behind the ear. All this happened while eagle and quarry were still in the air. After delivering the *coup-de-grace* Kohistani landed not far from where she had first lifted the mongoose from the ground. It was the first mongoose I had ever hunted with Kohistani and I was very happy about her and my achievement.

In dealing with squirrels, she found the going a bit rough. As a matter of fact squirrels are not easy prey even for hawks. The way they can dodge and turn round the branches of a tree would make survival difficult even for a sparrowhawk, if it had to depend solely on catching squirrels for food. During the six years the eagle was with me, however, I managed to get almost a dozen squirrels. A treed squirrel being next to impossible for an eagle to capture, I would try to drive it out into the open by shouting and throwing stones. Meanwhile my father would be waiting, with Kohistani held unhooded and in readiness to be cast off the moment the squirrel touched the ground. There it can never hope to evade an eagle hot on its heels.

Kohistani possessed one unusual quality that enthralled me whenever I witnessed it. Quite unlike some other birds of prey, she never carried game and would always come down to rest on the ground no matter how small the quarry she held in her mighty grip. There was only one exception, when she carried a dead crow up into a tree, but the circumstances were peculiar. One evening, I had gone to a mango garden close to our home with the idea of shooting a crow for Kohistani to eat the next day. I did not have long to wait, for this was a roosting site for crows, and they would come over in huge numbers, cawing, just before dusk. I winged one with the powerful air-gun I was carrying, but unfortunately I had no more pellets with me, and it kept hopping from one branch of the tree to the other, knowing full well that any attempt

to take off would only end in its downfall.

I was thinking of going back for more ammunition when I saw my father approaching with Kohistani. She sat unhooded on my father's fist and was already bating after the wounded crow.

She was unleashed and cast after the crow which was nervously cawing, for it too had seen the eagle. The crow did not have the ghost of a chance, but as Kohistani grabbed it her jess knotted round the twig on which the crow had taken refuge and though she managed to smash loose she flew into another tree some distance away. It had got dark by this time and all we could see was a dark shape moving on the branch where it had alighted and the tinkle of her bells as she shifted her position.

I was under the impression that the eagle was preparing to feather and start eating the crow, but to make sure I dashed home to fetch a powerful torch. When I got back my father told me that the eagle had flown to yet another tree, where the torch's beam showed Kohistani comfortably reposing on a thick branch. There was no trace of the crow, so we had a look in the tree where the eagle had been moving so restlessly and found the crow wedged in the fork of a small branch, ready for Kohistani's breakfast next morning.

We felt sure that she would return to her kill at the first streak of dawn, and feared that, once she had taken her fill, it would be difficult to persuade her to fly to the gloved fist. So we lashed some bamboo poles together, and after some neck-breaking work—for we had to look directly upwards while aiming the long and whipping pole at its target—we managed to topple the dead crow down. Then we left the eagle to sleep in expectation of a marvellous repast the following morning.

Though we came back next day before the sun had risen, we found Kohistani searching the branch where she had stored the crow. When called she flew down obediently to my father's fist, and was perhaps for the first time happy to see us after a night's separation.

On more than one occasion Kohistani followed and robbed other birds of prey of their rightful prize. When the eagle was not taken out hunting she was exercised, and one day, when I had just called her back to fist after letting her follow me, I was about to reward her with a dainty morsel of pigeon meat from my falconer's bag, when a sparrowhawk flew past with a thrush in its claw. This was too great a temptation, and Kohistani immediately took off and with a few sweeping beats of her wings, had caught up with the lesser hawk and claimed her reward. She could have easily killed the sparrowhawk of course but she was on the whole quite kindly disposed towards the weaker birds of prey. I have often left her at home, sitting on the same perch with a Sparrowhawk I had at the time, scarcely a foot apart. And in the presence of other eagles Kohistani behaved very well, maintaining an un-

ruffled, uninterested pose and showing no inclination to fight or quarrel. In one instance, I remember, there was a lot of provocation from another hawk-eagle that would scream, and glare, and try to attack Kohistani. But she would sit quietly on the perch for hours together, while the uncouth hooligan screamed close to her. Her only response to the bad manners of her neighbour was to preen. In spite of her huge size, formidable strength, and undisputed prowess as a killer of game, she was always well-behaved on the perch at home. She was quite indifferent to dogs and did not mind their sniffing at her. She displayed unparalleled bravery when required, but otherwise was as gentle as a lamb.

Funnily enough the sight of a bicycle struck terror in her heart. A motorcycle, a truck, or even a railway engine meant nothing to her, but let her see a bicycle and she would start bating. Sometimes she was so much upset that she lost her appetite. If recently fed, she might even throw up her last meal. What could have been the real cause to trigger all this I was unable to know. I tried very hard to find the origin of this strange behaviour.

I had Kohistani for a little over six years, and found that the most difficult period was just after the moulting season had finished, when she was taken from the mews for a refresher course of training. During the moulting season she was fed on a diet of extra fine delicacies, to assist moulting, and naturally she grew very fat. When the moult finished towards the end of September it was quite warm even in Dehra Dun, and the combination of heat, overweight and a long spell of inactivity perhaps accounts for her dislike of being handled. She bated so much that I feared a return of her epileptic fits. To reduce the risk, her diet was gradually reduced towards the end of the moult, and handling postponed until she had lost a few ounces.

She was very choosy so far as her hoods were concerned. For no apparent reason she would take a liking to one particular hood but would not tolerate another of the same size and pattern, and cut from similar leather. I tried many experiments, using the same pattern and leather but different colours, and found that Kohistani never resisted the clamping on of a hood of orange or deep yellow colour. Other colours were never favoured, and if the hood were of a dark brown shade she would start screaming at the mere sight of it.

Kohistani disliked any newcomer to the mews, particularly if it was a child. Perhaps her instinct told her that children's behaviour was unpredictable and that they were not to be trusted. Another curious antipathy was towards brooms.

Keeping a hawk is always uphill work, but one's troubles are amplified when one decides to keep an eagle. The first consideration is naturally how to procure enough food, especially towards and during the moulting season. Hawks can be fed on mutton or beef occasionally,

but this kind of food is not conducive to the growth of healthy feathers and so must be avoided during the moulting period. During moulting, food rich in carotin, and bird or rodent fat, is essential. Collecting doves or pigeons with an air gun did not appeal to me, for at this season birds also are nesting and rearing their young. I always avoided this method of finding fodder for my eagle. Instead I got four pairs of rabbits, and these proved so prolific that in a short time I had more than twenty bunnies running all over the place. I got so fond of those dear little balls of fluff, that I simply could not steel myself to slaughter any one of them. But at the rate they kept multiplying feeding the rabbits became a big problem and soon I was begging people to come and take them as gifts.

One day about this time I noticed mounds of earth freshly thrown up by the gerbille rats that abound in this part of the country, living in colonies of a hundred or more together. The next evening found me carrying four baited rat-traps, which I left in spots where I thought the rats would come out in the night to feed. The idea proved to be a very good one, for early next morning I found all the traps sprung and four worthies stretched out.

Unlike ordinary field rats, gerbilles are not ugly or dirty. All the rats I trapped were very healthy, and extremely clean. In this way I avoided the unnecessary slaughter of birds, and had no longer to bear the burden of supporting a family of rabbits. Every evening the traps were laid and baited, and early next morning I would go and collect the dead rats. They were disembowelled on the spot and carried home to Kohistani. She liked this kind of fare and grew fat on the rodent meat. It was economical for me too, for I no longer had to buy a pigeon every alternative day to feed the eagle. As a matter of fact it made it possible for me to keep two eagles at a time. It only meant laying out more traps, which was no hardship, as there were colonies not far from my home, and my nocturnal nibblings did not seem to have any visible effect on them. Nevertheless I always moved to the next lot of burrows after having trapped in one area for any length of time.

Kohistani always moulted quite well. She started by shedding the primaries as early as March, and moulting would be completed by the third week of September or slightly earlier. During the first year, when the eagle still had a mantle of juvenile feathers, I noticed that these showed a tendency to break off quite often. I followed the usual practice of dipping a dented feather in nearly boiling water. This straightened it out, but unfortunately the feather was extremely brittle after this hot-water treatment, and would snap off whenever the least pressure was applied. When hares or even pheasants were being hunted, the eagle would have a slight struggle to finish the prey off, which would result in one or two feathers breaking or bending. After her first moult, how-

ever, and when she had had a regular diet of rodent meat for a full season, her new feathers were strong, and could be bent without their snapping. From then onwards, no imping or hot-water treatment was ever called for.

All good things must come to an end, and the time came when circumstances beyond my control compelled me to part with Kohistani. I could have given her to a falconer friend in India or Europe, but decided instead to restore her to the free life of the wild.

In preparation, we kept her in the mews after her moult was completed and continued to feed her on rodent meat. We handled her as little as possible, so that after a few weeks she was quite fat and almost wild. Then Father and I took her to a remote area in the Rajaji Sanctuary, where there was plenty of small game for her to feed on, and released her. I don't suppose she remained there long, for it was the mating season. Soon she must have been gripped by a huge restlessness, and have soared up and crossed the Siwaliks to the Himalayas only twenty miles away, to find a mate and raise a family. I often see her in my dreams and hope that, one fine day, I shall see her in reality.

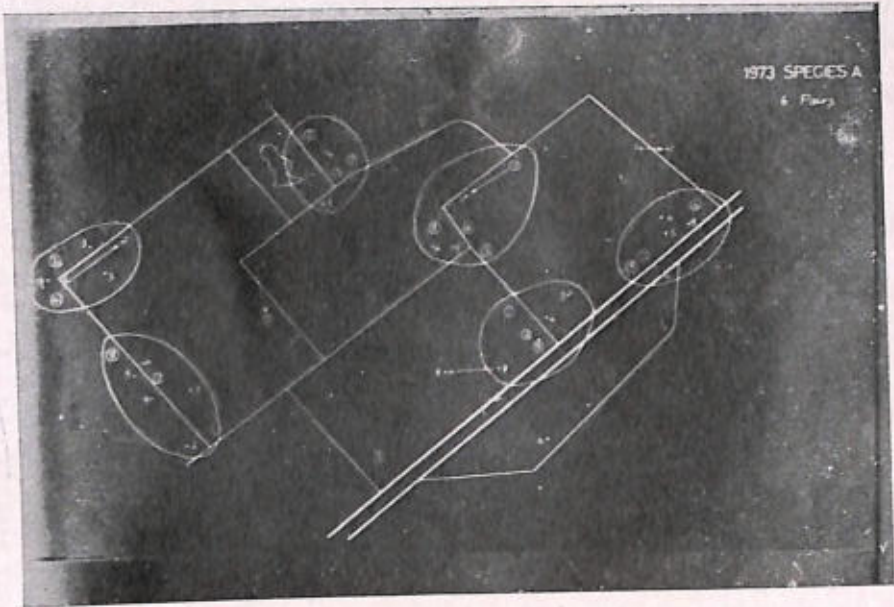


Fig. 1

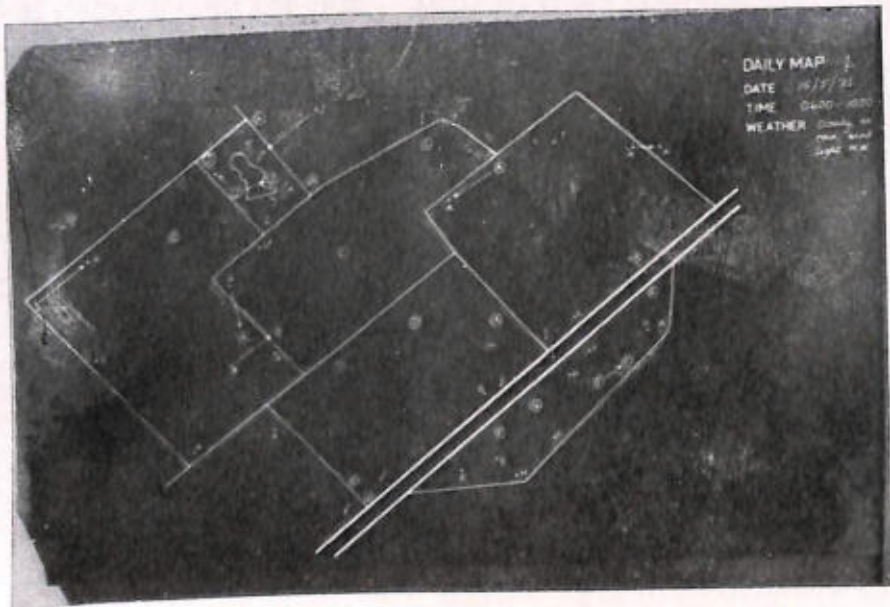


Fig. 2

Fig. 1. Typical visit Map (see p. 276); Fig. 2. Species Map (see p. 277).

Methods for estimating bird populations¹

A. J. GASTON²

(With a plate & two diagrams)

This paper attempts to describe a number of methods for the estimation of bird populations. The kind of method employed will depend on a variety of factors; the purpose for which the estimate is required, the ecology and behaviour of the species concerned, and the degree of accuracy considered necessary.

In the case of an economically important bird pest, causing direct damage to a standing crop it may be sufficient simply to estimate the damage, and assess the reduction in damage resulting from various control measures tested. An example of this kind of situation would be the use of tape-recordings or shots to scare birds away from orchards. The success of the technique can be assessed directly from the decrease in the percentage of damaged fruit, without knowing how many birds are involved.

In situations requiring some estimates either of the actual number of birds involved, or of relative changes in the size of a particular population, a method must be chosen appropriate to the task in hand. Population estimates, in terms of birds/unit area are generally more difficult to achieve than population indices, which allow comparison between different years, seasons, or areas without giving an idea of the actual number of birds involved.

Where a detailed population study is being carried out it is best to employ both estimates and indices. If a number of populations of the same species are examined, and estimates and indices compared then it may become possible to relate the index figures to the estimates so that actual population figures can be derived from the indices, which usually involve less field-work.

COMPARATIVE INDICES

1) *Line transects*. These are performed by one or more observers walk-

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ing or driving through the area of study, and counting all individual birds seen. The observer's route should be selected prior to the start of the transect, and should, if possible, be random with respect to variations in the habitat, though this is not always possible if pre-existing foot-paths or field borders are followed. When comparing population changes with time over a particular area then the transect, one chosen, should be followed exactly on each subsequent visit. If two different areas are being compared for their relative population densities then transects in the two areas should be equal in length, and an equal length of time should be spent on each.

The length of the transect will depend on the abundance of the bird species being censused. If the area is small then there is no theoretical objection to criss-crossing the same ground, or to counting the same bird twice, provided that this is not done knowingly. A transect of 2-3 miles might be sufficient for counting Bulbuls (*Pycnonotus* spp.) in scrub, whereas a suitable transect for Coursers (*Cursorius* spp.) in the desert might involve a jeep ride of 50 miles.

Line transects are usually used in fairly uniform habitat, or in habitat such as mixed scrub and woodland, where the observer can, on any random route, pass through several patches of each of the constituent vegetational types.

The activity, and hence the visibility, of birds varies with season, weather conditions, and time of day. In order to make successive transects comparable it is important that these factors be taken into consideration. Comparison between different habitats by the transect method is very difficult because birds are unlikely to be equally visible in different types of vegetation. In habitats where the vegetation is dense an auditory transect, made by counting the number of calls heard, rather than the number of birds sighted, may be most useful, but it depends on the species being censused having an unmistakable call. Contact calls and alarm calls are more suitable for this purpose than songs, since singing tends to be seasonal, and usually confined to one sex. The auditory transect is particularly useful in tall woodland where most birds are out of sight in the canopy.

In very open habitats, such as flat desert, or counting sea birds at sea, it is necessary to impose some limit on the distance that birds can be counted from the transect line. At sea a limit of 200 metres is suitable but this has to be estimated by eye, and hence tends to introduce a subjective bias.

An advantage of the transect method is that it is simple to carry out, and requires no special apparatus. Also, if it is repeated several times over a short period then the resulting figures can be used to calculate a mean and standard deviation, and these give some indication of the reliability of the method.

2) *Tape recordings.* Many birds can readily be attracted to the tape-recorded calls of their own species. A comparative estimate of density can be obtained for these species by using a transect, and playing suitable calls at intervals along the route. Birds attracted to the calls can be counted as they appear, or calls heard in reply can be counted. This method is particularly useful for shy skulking species.

The kind of call employed will depend on the species involved. For most small passerines the song is best, particularly during the breeding season. For birds like Babblers (*Turdoides*), which do not sing, the contact call or the mobbing call can be used. Care must be taken to ensure that the volume at which the call is played remains constant throughout the census, and only observations made at the same time of day, or season can be compared.

3) *Mist netting.* Mist nets (fine nylon nets which trap birds unharmed when they fly into them without seeing them) can be used to assess changes in the abundance of a particular species in a given locality. The number of birds caught depends on many factors; the activity of the birds, the area of nets deployed, the siting of the nets in relation to the vegetation, the amount of time that nets are deployed. Catches made on two days can only be compared if all these factors remained equal.

The effectiveness of mist nets for trapping resident birds declines steadily from the time that they are erected, and if the nets remain in the same sites for several consecutive days local birds learn to avoid them. Ideally there should be sufficient nets available to be able to allow catching 20 or so of the required species within a few hours. Different sites vary widely in the numbers of birds trapped, without any relation to the density of the population, and for this reason it is only permissible to compare catches when nets have been set in exactly the same sites.

This method is probably highly inaccurate, but it can be used in conjunction with population estimates by "capture-recapture" methods. It cannot be used to compare population densities in different habitats, since the structure of the habitat is bound to affect the ease with which birds are trapped. Young birds seem to be more susceptible to trapping with mist nets than older birds, and estimates of populations containing many young birds cannot, therefore, be compared with older populations.

4) *Random nest searching.* An index of the year to year fluctuations in the size of breeding populations of certain species in a particular area can be obtained from the number of nests found annually by random searching, provided that the same amount of time and effort is expended on each year. This makes no allowances for increases in the efficiency of the searcher, and is best suited to species such as Larks and Partridges, where the nest is usually located by flushing the mother bird off the eggs after a systematic beat.

POPULATION ESTIMATES

1) **Estimation of breeding populations.** These will be treated under four headings, depending on the kind of social structure involved. It has to be borne in mind that the breeding population in any one season is usually substantially smaller than the total population size. In some species breeding is deferred until they are several years old, and in other species birds potentially old enough to breed may be inhibited by social factors. In the Jungle Babbler (*T. striatus*) only about 30 per cent of the population breeds in one year.

At the same time establishing the size of the breeding population may be important in some cases because it relates directly to the possible rate of increase of the total population.

a) *Colonial nesters.* Birds which breed in large colonies tend to occupy the same nesting area every year, and such colonies are usually well known locally. Storks, herons, cormorants, pelicans, vultures, and flamingos all come into this category. During the non-breeding season birds from a single colony may spread out over thousands of square miles, and because of this it is very difficult to assess the area which is served by a particular colony or to derive an idea of birds' density in terms of pairs/unit area.

Counting nests in a large colony is subject to a number of potential errors. Some birds may make more than one nest if their first effort is robbed by a predator. In some cases previous years' nests persist, and in others nests may be built so close together that it is impossible to tell the boundaries of individual structures. Uncertainty is increased by the fact that in mixed colonies, such as a heronry, several different species may be the owners of such adjacent nests.

The timing of the count is important. If it is too early then some pairs may not have begun to nest, if it is too late in the season then many will have abandoned their nests due to predation or accidents to the eggs. Ideally several counts should be made at different stages in the season. In tree nesting colonies each tree can be tagged with a label stating the number of nests it carries, or the trees can be mapped, and the number of nests in each entered on the map. The total breeding population can then be calculated by summing the maximum counts for each tree.

In a few cases, such as flamingos, or sea-birds nesting on open beaches, it may be possible to count occupied nests from aerial photographs. This is only useful when the colony is known to comprise only a single species, because the identification of species from aerial photographs is probably not possible. For tree nesting birds, such as storks and vultures, this method is not appropriate because nests in the tops of the trees are likely to obscure those lower down.

Photography can also be useful in counting colonies of cliff-nesting species, such as Griffon Vultures (*Gyps fulvus*), and bank nesters, such as Sand Martins (*Riparia riparia*), and Bank Mynas (*Acridotheres ginginianus*). Once the colony has been photographed a blow-up can be used by the observer to tick off nest holes or nests which can be seen to be in use. At old colonies of Bank Mynas, for instance, some holes may not be in use, while others may be occupied by sparrows. A few hours spent observing the colony, and ticking off those holes in use, should be sufficient to estimate the population at that time, but counts should be repeated at intervals throughout the breeding season to allow for early and late nesters.

Weaver colonies are more difficult to count than those of hole-nesters. The nests are quite conspicuous but not all of those built are used. In the case of the Baya (*Ploceus philippinus*) nests are usually suspended in palms or other trees and can be scored for occupation by observing them from a distance. Colonies of Blackthroated Weavers (*P. benghalensis*) in tall grass, or Streaked Weavers (*P. manyar*) in reed beds, are more difficult to watch, and in these cases it is necessary to examine each nest in order to ascertain whether it is occupied.

Small passerine birds, which have a relatively short breeding cycle, may nest several times in the course of a year, and only a proportion of the population may be breeding at any one time. If this is so it may be impossible to get an accurate idea of the size of the breeding population from counting nests at any time during the season. Colonial nesters, however, tend to have their nesting fairly well synchronised. In cases where strongly asynchronous nesting is suspected it may be that assessment of breeding populations gives no real indication of the size of the total population, and the method is then useful only for comparative purposes.

b) *Semi-colonial nesters*. These are species which do not exhibit much overt territorial behaviour, and tend to nest in the general vicinity of others of their own species, but which may on some occasions nest alone. Colonies are not necessarily in the same place from year to year, and are often rather spread out. In some cases the aggregation of nests may be due to the clustering of suitable nest sites, rather than any positive gregariousness on the part of the birds.

Birds in this category include Munias (*Lonchura* spp.), Parakeets (*Psittacula* spp.), and Bee-eaters (*Merops* spp.). The last two of these probably aggregate due to the proximity of suitable nest sites. A big old tree with a number of holes may accommodate several pairs of Parakeets, and sandy bank in otherwise flat country may concentrate the nests of Bee-eaters.

Methods for assessing the size of colonies are the same as for colonial species, but the amount of work required to ensure that all colo-

nies are located is much greater. Watching for concentrations of birds, and searching suitable sites, should be sufficient in open country, but the area that can be covered diminishes rapidly in scrub and woodland.

c) *Territorial species*. This category includes most species of passerine birds, as well as many birds of prey, game birds, waders, pigeons, non-parasitic cuckoos, owls, kingfishers, and woodpeckers. A number of methods for assessing breeding populations of territorial species by mapping sightings of individual birds, and particularly of singing males, have been devised for use in temperate regions. The 'Common Bird Census' method used for its national survey by the British Trust for Ornithology, will be described, and its drawbacks in the Indian situation discussed.

Finding nests for territorial species is usually impractical for a population of more than about 20 pairs. Instead it is easier to map the territorial system of the population, and this has the advantage that, while nesting may be sporadic, territories should remain fairly constant throughout the breeding season.

The British Trust for Ornithology method (hereafter known as the BTO method) is based on surveys carried out at weekly intervals throughout the season by observers on foot. A study area of about 300 acres of farmland, or 100 acres of woodland is chosen, and a base map of the area at the scale of 25" to the mile prepared, and duplicated.

If the study area is relatively featureless it may be necessary to erect marker posts or paint numbers on the trees in order that the observer can locate himself accurately at any time.

A separate map is used each time that the study area is visited, and this is carried on a clip-board so that observations can be drawn on it easily. The observer follows a route designed to bring him to within about 50 metres of every part of the study area, and each bird sighted in the course of this walk is plotted on the map, using a code of different letters to denote different species, and symbols to denote whether singing or not.

Fig. 1 shows a typical visit map as it appears at the end of one day's visit. Sightings enclosed by circles denote birds seen in song, dots denote individuals not singing, and an arrow connecting two points indicates that the individuals concerned was seen to move from one spot to the other in the BTO census all species are recorded, but the same method could be applied to a few, or only a single species.

A minimum of about 10 visits are made during the season, for each of which a separate map is used. At the end of the season an individual map is prepared for each species by plotting the points for that species from each daily map in turn. Each point is numbered corresponding to the number of the visit, day 1, day 2, etc. An example of the resulting species map is shown in fig. 2.

Fig. 2 depicts a fairly idealised example, and it can be seen that points tend to fall into 6 clearly defined groups, which presumably center on pair territories, with a few scattered observations outside these which can be ignored. This map, therefore, suggests a population of 6 pairs of this species.

The BTO method has been in use in Britain for more than 10 years and its drawbacks are fairly well known. Species which are best censused by this method are those having a short breeding season during which they sing a lot. Birds which like to perch prominently are particularly suitable.

Care should be taken to distinguish unmated males. These usually appear prominently at the beginning of the season, and then later disappear. In some cases they may continue singing long after the other birds have given up.

Birds which present particular difficulties are semi-colonial species, polygamous species, species living in dense vegetation, and species like larks which sing high above the ground, making mapping very difficult. A good practice with singing larks is to watch them until they return to the ground, and then mark that spot.

Species which might be censused by this method in lowland India include those which perch and sing in obvious places, such as the Pied Bushchat (*Saxicola caprata*), Shrikes (*Lanius* spp.), King Crows (*Dicrurus adsimilis*), Rollers (*Coracias benghalensis*), Flycatchers (*Muscicapa* spp.), Robins (*Saxicoloides fulicata*), Magpie Robin (*Copsychus saularis*), and Purple Sunbird (*Nectarinia asiatica*).

Because song is much less important for tropical birds than for their temperate counterparts this method has usually been thought inapplicable in tropical situations, but with some modification it should prove useful. Certain species tend to sing a lot at particular times of day, and particular season, and this should be taken into account. Robins, for instance, sing most vigorously before sunrise, while Wren-Warblers (*Prinia*) sing particularly after rain.

A lot depends on the density of the population being censused. If birds are very dense, then it becomes impossible to distinguish the boundaries of individual territories. If birds are fairly spread out, however, it may be possible to map the territories even without observing song, particularly if the birds are attached to a few look-out posts, as is usually the case with shrikes.

In a few cases this method can be used to assess wintering populations, where these defend territories. This applies to the Black Redstart (*Phoenicurus ochruros*), and the Lesser Whitethroat (*Sylvia curruca*), although it must be borne in mind that in this case the territories are individual, not pair territories.

Two factors may tend to upset population estimates based on the

BTO method; if there is an unequal sex ratio then an assessment based on singing birds (males) may not give an accurate idea of the number of pairs. For some species there is evidence that males outnumber females, and in this case unmated males may inflate the estimate. Also, if there is a large non-breeding, non territory-holding population this may tend to confuse the estimate by obscuring the pattern of territories.

A technique which can be employed in conjunction with a BTO type mapping survey is colour marking with coloured plastic leg-rings, so that birds can be identified individually. This can be used as a check over a small part of the study area to assess the efficiency of straight-forward mapping.

Plastic rings are commercially available in England in different sizes and colours, but can also be manufactured out of sheets of coloured plastic, cut into suitable lengths and moulded. Birds should be marked with combinations of different colours. If 10 colours are available this gives a possibility of 100 combinations using two rings in either order (i.e. Red/Green and Green/Red). It is usually advisable to use the same combination on both legs so that the bird can be identified even if only one leg is visible.

This method is best for species which can be readily trapped, such as Robins, Tailor Birds (*Orthotomus sutorius*), or Yellow-eyed Babblers (*Chrysomma sinensis*). Once a suitable number of birds have been marked (about 30-40 at least) then mapping can be carried out as for the BTO census, with the advantage that the territory of a particular individual can be distinguished by known sightings inserted or inferred from the grouping of points.

An advantage of the colour marking method is that it enables non-breeding wanderers to be readily detected. A population containing many of these would result in some colour ringed birds being seen repeatedly (the territory holders), and others never, or seldom being seen again after their marking (the wanderers). From the proportion of those judged to be territory holders to those judged to be wanderers it may be possible to assess the actual size of the non-breeding population, but a snag here is that the trapping method may not be equally effective for both categories. Territory holders are usually less susceptible to catching in mist nets, for instance, than non-territory holders.

The main drawbacks of the colour marking method is that it is very time consuming, and it requires an observer with acute colour vision. It provides much more information about the structure of the population, the size of territories, and the movements of individuals than any other method, however, and is probably the best if a really detailed study of the species' biology is required.

d) *Group territorial species*. These are species in which territories are occupied not by pairs, but by groups of birds, ranging in size from 3-30.

These are fairly easily censused because most of these species are strictly resident throughout the year, and also defend their territories year-round. Because of the variation in the size of flocks these can often be identified individually over small areas by the number of birds that they contain, alternatively some members can be colour marked. The flocks can then be mapped in the same way that their territories are mapped. The winter season is probably the most suitable for counting of flocks, because during the breeding season these have a tendency to fragment during the day. At this season flocks are best counted in the evening when they always join up before flying to roost together.

2) **Sampling methods.** These methods are based on the assessment of the total population by capturing and marking a sample, releasing it, and then taking a second sample in order to find the proportion of marked to unmarked birds. This technique is known 'capture-recapture', or Lincoln Index.

Birds can be marked either with plastic rings, aluminium rings, or with painted or dyed marks on the plumage, or even by clipping the toes. The only limiting criterion for the marking is that it should endure the duration of the study, and that it should not impair the normal activities of the bird.

Once a sample has been marked, and a second sample taken, the total population is calculated from the formula

$$P = S_1 \times S_2 / M$$

where P = total population

S_1 = first sample marked and released

S_2 = second sample captured

M = number of marked individuals captured in the second sample

Hence if 30 birds are captured and marked in the first sample (S_1) and 40 captured in S_2 , of which 20 are marked, then the total population is estimated by

$$\begin{aligned} P &= 30 \times 40 / 20 \\ &= 60 \end{aligned}$$

Theoretically there are several conditions which must apply for this calculation to give an accurate approximation. Both samples should be taken from the population entirely at random (i.e. there should be an equal chance of any individual in the population being captured). The first sample should mix completely with the population after being released, and before the second sample is taken. There should be no immigration into, or emigration from, the population between the two samples.

In practice birds do not usually satisfy any of these requirements. Except in isolated cases, such as land birds on an island, or water-birds in a marsh surrounded by arid country, all bird populations are subject

to continual immigration and emigration at the periphery. Even birds which do not hold territory tend to have a preferred range, and this prevents the population from mixing randomly, and in any case there is no trapping method available that can give an entirely random sample of an entire population.

If this method is to be used, then probably the best trapping technique is to use mist nets, but these should be shifted around in such a way as to ensure even coverage of the entire area, both for the first, and the second samples. Baited wire traps cannot be used for this type of calculation as there are always some individuals which repeatedly enter the traps, while others are trap-shy, and never get caught.

This method may be useful when assessing the size of dense roosting flocks, or the population of skulking species inhabiting dense vegetation. It is unlikely to yield an answer better than 50 per cent accurate.

Successive samples can be treated with more elaborate mathematical

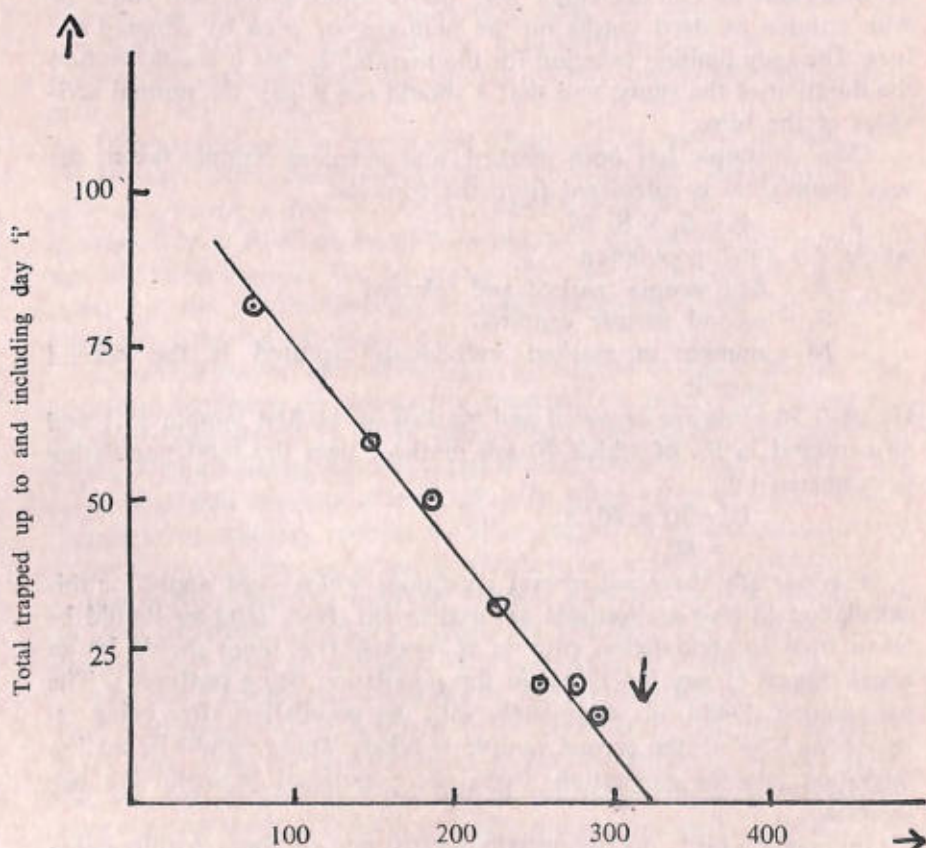


Fig. 1

No. of unringed birds trapped on day 'T'

procedures to yield better estimates but the drawbacks to the method remain the same. These results can also be used in a comparatively simple way, if each successive sample is marked, to yield a population estimate. This is done by plotting the number of unringed birds trapped on any one day against the running total of all birds marked, up to and including that day, on a graph. A sample graph is shown (diagram 1). The x axis shows the total number ringed up to and including day 'i', and the y axis shows the number of unringed birds trapped and ringed on day 'i'. By plotting 3 or more points a line of best fit can be drawn, and extrapolated to meet the x axis. This point (at which no more unringed birds could be caught) gives the total population. This method uses the same assumptions as the capture-recapture method but is easier to calculate for a number of recaptures.

A capture-recapture (Lincoln Index) can also be made using only one day's trapping if the birds are marked in a conspicuous manner. If this is done then, instead of a second trapping, the population can be counted visually for marked and unmarked birds. The resulting calculation is the same as for the usual capture-recapture method, except that in this case S_2 is the number of birds observed on the visual survey, and M is the number of those observed which are marked. A sample calculation, therefore, would be: number of birds captured and marked (S_1) = 50, number seen on a four hour visit to the area the following day (S_2) = 60, of which 15 were marked (M).

Population estimate (P) = $50 \times 60/15 = 200$

3) Roost counting. Many species of birds, outside the breeding season, roost in large flocks during the night, scattering to feed during the day, and flying in to roost about sunset. The size of these roosts can sometimes be estimated by a team of observers counting birds as they arrive at the roost. Most species fly in to the roost in flocks of up to 100 birds and these can be fairly accurately estimated with practice, or in some cases actually counted. At least 4 observers are generally necessary, stationed around the roost, and the sectors covered by each must be clearly defined in order to avoid double counting.

Some water-birds, such as egrets, tend to fly to roost following the line of waterways, and these can be counted by observers sited on these flight lines. Other species which roost communally, and which might be estimated by this method are parakeets, starlings (*Sturnus* spp.), mynas (*Acridotheres* spp.), and crows (*Corvus*).

Roosts can be located by one or more observers moving around by car, and taking compass bearings on the direction taken by flocks flying purposefully just before sunset. Arrows indicating these flight lines can be plotted on a suitable map of the district, and the area at the convergence of the arrows searched on foot to pinpoint the roost. A typical roost-line map is shown (diagram 2).

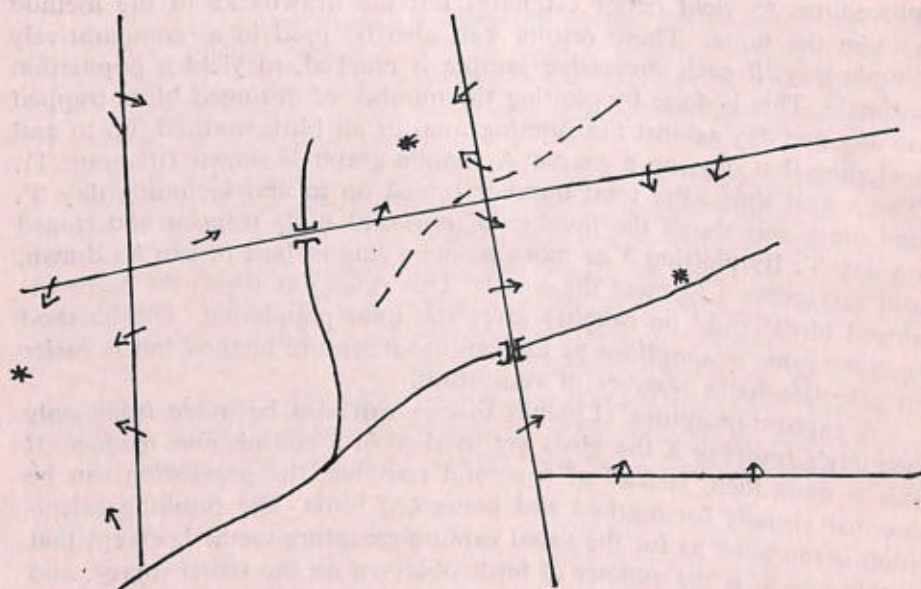


Fig. 2

← Direction of flocks. * Position of roosts. - - - - Boundary between feeding areas of 2 roosts.

Only roosts of moderate size (about 100-10,000) can be counted in this way. Larger roosts are more difficult because individual flocks flying in tend to be too large to estimate accurately.

A few species which form much smaller roosts might be censused in this way. In particular peafowl, which roost high up in tall trees might be susceptible to this method. On a moonlight night the birds are quite conspicuous against the sky, and can be easily counted. In areas where tall trees are only found in patches roosts can be located during the day by searching the ground under each group of trees for peafowl droppings, which are readily recognisable.

Very large roosts of small birds such as wagtails (*Motacilla* spp.) or swallows (*Hirundo*), which tend to fly in to the roost in ones and twos, cannot be counted satisfactorily. In this instance an estimate can be obtained by catching birds with mist nets and using the capture-recapture techniques. It has been shown for some species, however, that individual birds tend to return to the same position in the roost every night. If this is true then a capture-recapture estimate will be badly biased.

Roosting is not only a nocturnal phenomenon, gulls and shore birds often form resting flocks at high tide, and these can be counted either

while fighting in or while leaving. Ducks and geese tend to feed at night, and form roosting flocks during the day on open water, which can be counted provided that the stretch of water is not too large. Those ducks which feed mainly on open water such as *Aythya* spp. are particularly easy to count. Dabbling ducks (*Anas* spp.) are more difficult because they tend to prefer marshes and reed beds to open water.

In Britain all major open waters are counted monthly by teams of volunteers, and when coverage is complete this can yield a valuable estimate of the water bird population. The important thing is that all counts should be made simultaneously because ducks are extremely mobile, and counts made at different localities on different days would almost certainly lead to double counting.

CONCLUSIONS

Every species of bird, every different habitat requires a technique specially adapted to it. The methods described above are not exhaustive, but provide some indication of the approaches available.

A great deal of work in Britain is being carried out with a view to providing population indices of common birds, and the BTO Common Bird Census is the main outcome of this. Interest mainly centres around the idea that bird populations may provide a sensitive indicator of pollution in terrestrial ecosystems, in the same way that fish can be used as an indicator of river pollution.

Though the kind of amateur participation which can be enlisted in Britain is not available in India it seems likely that a small professional team could provide the same kind of information over limited but representative areas. This kind of work could help to assess the impact of new agricultural techniques, particularly the massive application of fertilisers and pesticides, on bird populations in rural areas. This in turn could furnish evidence, and "early warning" about potentially disastrous changes in the ecosystem.

Ecology of Indian Desert; IV— Photoperiods in relation to growth behaviour of two desert species of *Sida*¹

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Varying photoperiods appeared to influence the growth patterns of two desert species of *Sida*. The photoperiod observed for the optimum growth in both the species was 12 hours. However, when compared among themselves, the fresh weight, dry matter accumulation and moisture content in *S. spinosa* were found to be always more than in *S. grewoides*. Flowering was first initiated in 9 and 12 hours photoperiodic exposures in *S. grewoides* and *S. spinosa*, respectively. *Sida grewoides* indicated a preference for longer photoperiod as the seedlings did not survive in less than 9 hours exposures, although in longer ones beyond 12 hours the plants remained only in vegetative state. In *S. spinosa* plants did not die even in 3 hours photoperiodic exposures in the 24 hours cycle, but remained in vegetative state like those in longer photoperiods of 18 and 24 hours.

INTRODUCTION

In the recent past voluminous information has been accumulated on the relation between growth behaviour and photoperiods in a number of plant species. The photosynthetic process in green plants which takes place in light masks the respiratory activity, since in the latter process, the products are broken down, which are produced in the former. The different photoperiods definitely affect the production and growth of new leaves resulting either in a well developed shoot system or a poor one, this in turn affects the productivity. The translocation of extra photosynthetic products to the root affects the growth and morphology of root system. Garner & Allard (1920) stress the importance of the length of the daily light periods as a factor influencing the growth and development of plants. Root growth and its subsequent development has always been recognised as important phenomenon.

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Light energy is one of the important factors affecting a large number of known and unknown biochemical-physiological processes as well as plant size and shape. In many plants the length of the daily photoperiods also regulate the meristematic activities (Kadam-Zahavi & Alvarez-Vega 1968). Flowering is primarily an ecological phenomenon, yet comparatively very little study of the flowering process has been made from purely ecological standpoint (Salisbury 1963). The photoperiods and temperature may act at any of the several stages in the ecological life cycle of any plant species. Several reviews on the physiology of flowering are available. Lang (1952) initiated the series covering photoperiodism and vernalization; whereas Liverman (1955), Doorrenbos & Wellensiek (1959) and Salisbury (1961) emphasised the importance of mainly photoperiodism and plant growth.

Photosynthetic process is of paramount importance with respect to physiological adaptation of the species to the environment. Ketellaper (1965) has shown that dry matter production of tomato and soybean plant responds to variations in the length of the light-dark cycle. It has been earlier proposed that unfavourable cycles are injurious to plant growth (Ketellaper 1960; Tukey & Ketellaper 1963).

Light as the energy source is of primary importance which brings about the most striking changes as compared to other environmental factors. Information on the effects of photoperiods on the root and shoot growth, dry matter production, floral initiation and fruit setting in arid zone plants is extremely meagre. Floral initiation in long day plant and short day plant is determined by a floral stimulus, which is generated in the leaves under the influence of photoproduction and is then translocated to the growing points (Lang 1952). It is generally assumed that scarcity of water leads to the poor development of root and shoot system, but it also leads to early flowering and ultimately fruit setting which is based solely on field observations. To test this assumption, experiments were conducted on varying photoperiods in relation to two desert species of *Sida*.

EXPERIMENTAL METHODS

Five days old seedlings of *S. grewioides* and *S. spinosa* were transplanted in 12 cm wide earthen pots. One seedling per pot was maintained till the experiments were over. The soil in the pots was kept moist by regular watering and they were placed in shade in the beginning to ensure better seedling growth and establishment. After 10 days these experimental pots were exposed to various photoperiods viz., 3, 6, 9, 12 and 18 in the 24 hour cycle and also in continuous light. The extra light duration besides sunlight was supplied by six fluorescent tubelights of

40 watts each from a distance of one meter. One set of plants was kept in total darkness. These experiments were started from 8th August 1969 and the observations were made up to 60 days (8th October 1969). During this period the durations of day and night periods were approximately equal. Three replicates of each set were used for the present study. The observations have been made for growth behaviour of root and shoot, fresh weights, dry matter accumulations, moisture contents, flowering and fruit settings. The temperature during the day remained $32^{\circ} \pm 2^{\circ}\text{C}$ and in the night $24^{\circ} \pm 2^{\circ}\text{C}$.

OBSERVATIONS

(a) *Root and shoot growth*

The growth of the two *Sida* species in the experimental pots remained comparatively poor from those growing in nature, which may be due to edaphic factors. The growth analysis in different photoperiods has been given in tables 1 and 2.

TABLE 1

GROWTH PERFORMANCE OF *S. grewoides* IN DIFFERENT PHOTOPERIODS AFTER 30 AND 60 DAYS OF TREATMENT. ALL MEASUREMENTS ARE IN MM.

Photoperiods in 24 hr cycle	Days	Main shoot length	Main root length	Length of longest lateral root	No. of axillary branches	Total No. of leaves per plant
3 hours	30	80	100	60	—	14
	60	—	—	—	—	—
6 hours	30	120	150	130	—	25
	60	—	—	—	—	—
9 hours	30	220	200	200	5	52
	60	253	310	330	9	98
12 hours	30	220	220	220	8	65
	60	320	480	360	11	113
18 hours	30	180	220	120	—	33
	60	240	310	220	—	54
24 hours	30	140	200	120	—	24
	60	180	240	180	—	44

It would be evident from table 1 that the root system was poorly developed in 3 hours photoperiodic exposures in both the plant species. The number and length of laterals were less when compared with plants in other photoperiodic exposures. *S. grewoides* could not survive in 3 and 6 hours photoperiodic exposures till the end of the experimental period. The growth of the root system was increasingly favoured with

the increase in photoperiodic exposures up to its optimum period of 12 hours in both the species studied. However, the photoperiod beyond 12 hours exposure appeared to inhibit the growth of the root system. The best growth of root system in both the species was found in 12 hours photoperiods (Tables 1 and 2). Further increase in the photoperiodic exposures did not favour the growth of root system. When compared among themselves, the root system of *S. spinosa* was more extensive and better as compared to that of *S. grewiooides*.

Similar to the root system, the shoot system was also poorly developed in 3 hours photoperiod (Tables 1 and 2). The shoot growth was progressively better with the increasing photoperiodic exposures. The best shoot growth in *S. grewiooides* as well as in *S. spinosa* was observed in 12 hours photoperiodic exposures, which was similar to root system. In 12 hours optimum photoperiods these plant species exhibited maximum shoot branches and leaves.

TABLE 2

GROWTH PERFORMANCE OF *S. spinosa* IN DIFFERENT PHOTOPERIODS AFTER 30 AND 60 DAYS OF TREATMENT. ALL MEASUREMENTS ARE IN MM.

Photoperiods in 24 hr cycle	Days	Main shoot length	Main root length	Length of longest lateral root	No. of axillary branches	Total No. of leaves per plant
3 hours	30	180	180	81	—	10
	60	250	200	100	—	22
6 hours	30	370	320	260	18	94
	60	460	380	300	24	205
9 hours	30	400	400	300	20	110
	60	520	460	340	28	254
12 hours	30	550	450	400	26	163
	60	700	550	480	32	318
18 hours	30	380	330	290	8	72
	60	510	480	450	20	147
24 hours	30	290	230	275	4	57
	60	350	410	380	9	88

With respect to longitudinal growth, the data indicated that the length of photoperiods has a qualitative influence on both the species. Under relatively short photoperiods the plants remained stunted. *S. grewiooides* could not survive for 60 days under short photoperiods of 3 and 6 hours. Under longer photoperiods elongation of the main axis as well as lateral branches occurred. Photoperiods longer than the optimum were found to be inhibiting shoot growth. However, *S. spinosa* expressed better growth performance when compared with *S. grewiooides*.

TABLE 3

EFFECT OF DIFFERENT PHOTOPERIODS ON FRESH WEIGHT, DRY MATTER ACCUMULATION AND MOISTURE CONTENT IN ROOT AND SHOOT OF *S. grevioides* AFTER 30 AND 60 DAYS OF TREATMENT. ALL VALUES ARE IN GRAMMES

Photoperiods in 24 hr cycle	Days	Root			Shoot		
		Fresh wt.	Dry matter	Moisture content	Fresh wt.	Dry matter	Moisture content
3 hours	30	0.050	0.035	0.015	0.350	0.050	0.300
	60	—	—	—	—	—	—
6 hours	30	0.120	0.050	0.070	1.020	0.180	0.840
	60	—	—	—	—	—	—
9 hours	30	0.640	0.250	0.390	3.620	0.900	2.720
	60	3.300	0.870	2.430	10.400	2.920	7.480
12 hours	30	0.890	0.330	0.560	3.970	0.920	3.050
	60	3.500	0.940	2.560	10.800	3.070	7.730
18 hours	30	0.240	0.108	0.132	1.800	0.350	1.450
	60	0.840	0.190	0.650	2.500	0.490	2.010
24 hours	30	0.230	0.105	0.125	1.400	0.260	1.140
	60	0.520	0.150	0.370	2.000	0.320	1.680

TABLE 4

EFFECT OF DIFFERENT PHOTOPERIODS ON FRESH WEIGHT, DRY MATTER ACCUMULATION AND MOISTURE CONTENT IN ROOT AND SHOOT OF *S. spinosa* AFTER 30 AND 60 DAYS OF TREATMENT. ALL VALUES ARE IN GRAMMES

Photoperiods in 24 hr cycle	Days	Root			Shoot		
		Fresh wt.	Dry matter	Moisture content	Fresh wt.	Dry matter	Moisture content
3 hours	30	0.070	0.050	0.020	0.740	0.120	0.620
	60	0.170	0.080	0.090	1.500	0.740	0.760
6 hours	30	0.440	0.210	0.230	4.110	0.950	3.160
	60	2.250	0.520	1.730	6.900	2.520	4.380
9 hours	30	1.140	0.510	0.630	5.940	1.620	4.320
	60	2.500	0.730	1.770	8.600	3.370	5.230
12 hours	30	1.920	1.020	0.900	11.250	3.250	8.000
	60	8.790	2.290	6.500	13.800	6.950	6.850
18 hours	30	1.400	0.410	0.990	5.620	1.870	3.750
	60	4.290	1.450	2.840	12.100	6.500	5.600
24 hours	30	0.500	0.230	0.270	4.090	1.020	3.070
	60	1.590	0.390	1.200	6.300	1.920	4.380

(b) *Fresh weight, dry matter accumulation and moisture content*

The experimental plants died after a few days when placed in continuous darkness. The experimental plants of *S. grewoides* under 3 and 6 hours photoperiodic exposures could not survive up to the end of 60 days. The effect of different photoperiods on fresh weights, dry matter accumulations and moisture contents of root and shoot in *S. grewoides* and *S. spinosa* are given in tables 3 and 4.

It would be evident from table 3 that the maximum fresh weight in roots, 0.890 g and 3.500 g in *S. grewoides*; and 1.900 g and 8.790 g in *S. spinosa* in 30 and 60 days respectively, were found in both the species when exposed to 12 hours photoperiods. The maximum fresh weights of shoots in *S. grewoides* were 3.970 g and 10.800 g at the end of 30 and 60 days, respectively. The maximum fresh weights in *S. spinosa* were 11.250 g and 13.800 g at the end of 30 and 60 days, respectively. The fresh weight, dry matter and moisture contents of roots as well as shoots in both the species increased with the increasing photoperiodic exposures till 12 hours of the optimum. Further increase in photoperiodic exposures caused a decline in the fresh weights, dry matter accumulations and moisture contents.

(c) *Flowering and fruiting*

(i) *S. grewoides*—The effect of various photoperiods on flowering and fruiting status of this species at different intervals of time has been studied and expressed in table 5.

TABLE 5

THE FLOWERING AND FRUITING STATUS OF *S. grewoides* AT THE END OF 15, 30, 45 AND 60 DAYS AFTER THE PLANTS WERE EXPOSED TO DIFFERENT PHOTOPERIODS IN A 24 HOURS CYCLE.

No. of days	Photoperiods in 24 hours Cycle					
	3	6	9	12	18	24
15	—	—	fl	—	—	—
30	—	—	fr	fp	—	—
45	+	+	fr	fl	—	—
60	+	+	fr	fr	—	—

— = vegetative; + = plant did not survive; fp = floral primordia; fl = flowering; fr = fruiting.

It would be evident from table 5 that floral initiation in *S. grewoides* is controlled by 9 and 12 hours photoperiods. The first initiation of flowering could be observed as early as after 10 days in 9 hours and after 25-30 days in 12 hours photoperiodic exposures. The plants in other photoperiods remained vegetative.

Plants kept in total darkness did not survive and died within the period of 10 days of starting the experiment. The plants in 3 and 6 hours photoperiods died after 30 and 45 days, respectively. However, the plants under 18 and 24 hours photoperiods remained completely in vegetative state. The earliest fruit setting could be observed only in 12 hours photoperiods during the experimental period.

(ii) *S. spinosa* — The bud initiation to certain extent appeared to be apparently independent of photoperiods, but the formation of complete floral buds and flush of flowering in this species depended on the light exposures of definite periods. The flowering and fruiting status of the plants was estimated when the plants had already received the described photoperiods at the end of 15, 30, 45 and 60 days. The periodic observations for the above mentioned plant species have been tabulated in table 6.

TABLE 6

THE FLOWERING AND FRUITING STATUS OF *S. spinosa* AT THE END OF 15, 30, 45 AND 60 DAYS AFTER THE PLANTS WERE EXPOSED TO DIFFERENT PHOTOPERIODS IN A 24 HOURS CYCLE.

No. of days	Photoperiods in a 24 hours cycle					
	3	6	9	12	18	24
15	—	—	—	fp	—	—
30	—	fp	fl	fr	—	—
45	—	fl	fr	fr	—	—
60	—	fr	fr	fr	—	—

— = vegetative; fp = floral primordia; fl = flowering; fr = fruiting.

It is evident from table 6 that the first floral initiation was observed in 12 hours photoperiods as early as after 7 days of the start of the experiment. After 15 days additional floral initiation were observed in plants exposed to 9 hours photoperiods. Further initiation of flowering was seen later in plants exposed to 6 hours photoperiods. The plants kept in total darkness did not survive and died within 15 days of the start of the experiment. However, no floral initiation could be visualised in plants exposed to 3, 18 hours photoperiods and continuous light. Besides flowering, the first fruit setting was also observed in plants exposed to 6, 9 and 12 hours photoperiods during the experimental period.

DISCUSSION

Information on the effects of photoperiods on the plants of desert

environment is extremely meagre. Hardly any plant species of arid region of India has been classified as to its photoperiodic requirements. *Sida grewoides* and *S. spinosa* appear to be influenced by day lengths. The photoperiods definitely affected the production and growth of new leaves and the magnitude of growth of roots and shoots. The leaves of the plants are perceptrs of the radiant energy. The photoperiodic treatment of the leaves causes the photosynthetic apparatus to stimulate there. This photosynthetic apparatus starts different physiological and biochemical processes in the chlorophyllous organs of the plant.

Ketellaper (1965) showed that variations in the length of light-dark cycle affect the growth behaviour and dry matter production of tomato and soybean. Sharma & Sen (1971) observed that the growth behaviour and dry matter production in *Solanum nigrum* was changed with the different photofractions. Austin (1948) reported that in *Impatiens balsamina* fresh and dry weights of the aerial and subterranean parts were maximum under the 16 hours photoperiods. Root development was proportionally greater under longer photoperiods. The percentage of moisture contents in aerial system was greater under the longer photoperiods. Chawan (1970) has observed that various photoperiods definitely affected the growth behaviour of roots in *Corchorus aestuans* and the short photoperiods were unfavourable for the growth. It has been earlier proposed that unfavourable photofractions are injurious to plant growth (Ketellaper 1960; Tukey & Ketellaper 1963).

Wareing (1956) showed that there is a relation between the length of the optimal light period and the duration of dark period. The initiation of flower buds and their further development has been connected with the auxin production. Chawan & Sen (1971) showed that day length influence the bud initiation, the flush of flowering and specially the fruit setting in *Corchorus aestuans*. The morphological changes in the vegetative parts of shoot and the development of yellow-red pigments appeared to be connected with fruit setting in *C. aestuans*. Halaban (1968) stated that flowering response of *Coleus frederici* and *C. blumei* is dependent on the photoperiods. Both these plant species have a critical day length of about 12 hours. Photoperiodic effects on floral initiation in a wide variety of plants have been thoroughly reviewed in recent years (Chouard 1960; Lockhart 1961; Salisbury 1963).

The growth behaviour, flowering and fruit setting in the two species of *Sida* have been studied from purely ecological standpoint in this study. Short photoperiodic exposures were found to be unfavourable for the plants. Certain photoperiodic exposures were the direct requirements for flower initiation and fruit setting. This may be interpreted as (a) complete absence of floral initiation in plants exposed to certain photoperiods, (b) change in the growth behaviour of root and shoot system, (c) plants not getting sufficient daily photoperiodic exposures

remained vegetative for a long time, when in contrast to those getting the required photoperiods flowered and showed fruit setting in the experimental duration of 60 days.

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REFERENCES

- AUSTIN, J. P. (1948): The influence of length of photoperiod on the vegetative and reproductive development of *Rudbeckia bicolor superba*, *Delphinium ajacis*, *Cosmos sulphureus* and *Impatiens balsamina*. *Amer. J. Bot.* 28: 244-250.
- CHAWAN, D. D. (1970): Ecophysiological observations on arid zone plants with special reference to seed germination and rhizology. Ph.D thesis, Jodhpur University (unpubl.).
- & SEN, D. N. (1971): Photoperiodic influence and floral initiation and fruit setting in *Corchorus aestuans* Linn. (in press).
- CHOUARD, P. (1960): Vernalization and its relation to dormancy. *Ann. Rev. Pl. Physiol.* 11:191-238.
- DOORENBOS, J. & WELLENSIEK, S. J. (1959): Photoperiodic control of floral initiation. *Ann. Rev. Pl. Physiol.* 10: 147-184.
- GARNER, W. W. & ALLARD, H. A. (1920): Effect of relative length of day and night and other factors of the environment on growth and reproduction in plants. *J. Agri. Res.* 18:553-606.
- HALABAN, R. (1968): The flowering response of *Coleus* in relation to photoperiod and the circadian rhythm of leaf movement. *Pl. Physiol.*, 43:1894-1898.
- KADAM-ZAHAVI, A. & ALVAREZ-VEGA (1968): The use of coloured light for agriculture. Final report to Ford Foundation Grant No. A-6/5.
- KETELLAPER, H. J. (1960): Interaction of endogenous and environmental periods in plant growth. *Pl. Physiol.* 35:338-341.
- (1965): Interaction of endogenous and environmental periods in plant growth. *Pl. Physiol.* 38:337-345.
- LANG, A. (1952): The physiology of flowering. *Ann. Rev. Pl. Physiol.* 3:265-306.
- LIVERMAN, J. L. (1955): The physiology of flowering. *Ann. Rev. Pl. Physiol.* 6:177-210.
- LOCKHART, J. A. (1961): Mechanism of photoperiodic process in higher plants. *Encyclopaedia Plant Physiol.* 16:390-438 (ed. W. Ruhland, Springer-Verlag, Berlin).
- SALISBURY, F. B. (1961): Photoperiodism and flowering process. *Ann. Rev. Pl. Physiol.* 12:293-326.
- (1963): The flowering process. Pergamon Press, New York.
- SHARMA, K. D. & SEN D. N. (1971). Photofraction in relation to growth behaviour in *Solanum nigrum* Linn. *Oecol. Plant.* 6:35-42.
- TUKEY, H. B. JR. & KETELLAPER, H. J. (1963): Length of the light and dark cycle and plant growth. *Amer. J. Bot.* 50:110-115.
- WAREING, P. F. (1956): Photoperiodism in woody plants. *Ann. Rev. Pl. Physiol.* 7:191-214.

Observations on the reproductive Biology and early postnatal development of the Panther, *Panthera pardus* L., in captivity¹

J. H. DESAI²

(With three text-figures)

INTRODUCTION

Among the big cats, the panther is the most widely distributed species over the world (Walker 1964). Like the tiger it has been subjected to an increasing hunting pressure and persecution from the last century. In the recent past it has declined noticeably in peninsular India and is mostly found in certain favourable localities such as sanctuaries and is almost rare in many places where it was common formerly (Krishnan 1972). Considerable information regarding its habits, habitat and hunting technique is available from the records of hunters and naturalists, but little is known of its breeding habits in the wild.

Considering the secretiveness of the panther it is little wonder that such information is notably lacking in literature. However, in view of its importance as one of the major predators, a knowledge of the reproductive biology is essential background information. This study was undertaken to provide information (1) on the reproductive behaviour of the panther; (2) to ascertain the duration of oestrus, breeding season, gestation period and size of litter; and (3) to provide comparative data on the early postnatal development of the panther. This paper is based on data collected at the Delhi Zoological Park from 1958 to 1973 and on comparative records available from various other zoos.

MATERIALS AND METHODS

The Delhi Zoological Park was officially opened to the public on

¹ Accepted June 1973.

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1st November 1959 but work on the zoo had started in 1955. In 1956 the zoo received four panther cubs as presents from different sources. The Delhi zoo was successful in breeding panthers for the first time in 1960, when a litter of two cubs was born on 29th May. Until May 1973, 63 panther cubs had been born to nine pantheresses.

The panthers at the Delhi Zoological Park are kept in spacious enclosures which provide sufficient room for exercise. Each enclosure has small cells at the back where the panthers are shut in during the night. The floors of the cells are cemented but wooden platforms are provided as warm resting places.

The panthers are fed six days in a week on buffalo calf meat and on Friday of each week no food is given. On average, an adult panther is given 5 kg of fresh raw meat with bones daily, but the quantity is adjusted according to the size, age and general condition of the animal.

For the purpose of this study, data have been drawn from my own observations from 1963 onward, supported by the records maintained at the Delhi Zoological Park in the form of individual animal history cards, daily observation reports and Head Animal Keepers' registers.

The measurements of seven newly born cubs were recorded within twelve hours after their birth. The early postnatal growth of one cub was recorded from the time of birth till the age of four months, when it had weaned completely; and that of other two cubs till the age of two months. All the three cubs were raised by their respective mothers.

Comparative data on early postnatal development of the cubs were derived from Zurich zoo (Weillenmann 1963); New York zoo (Crandall 1964) and Sao Paulo zoo, Brazil (Carvalho 1968).

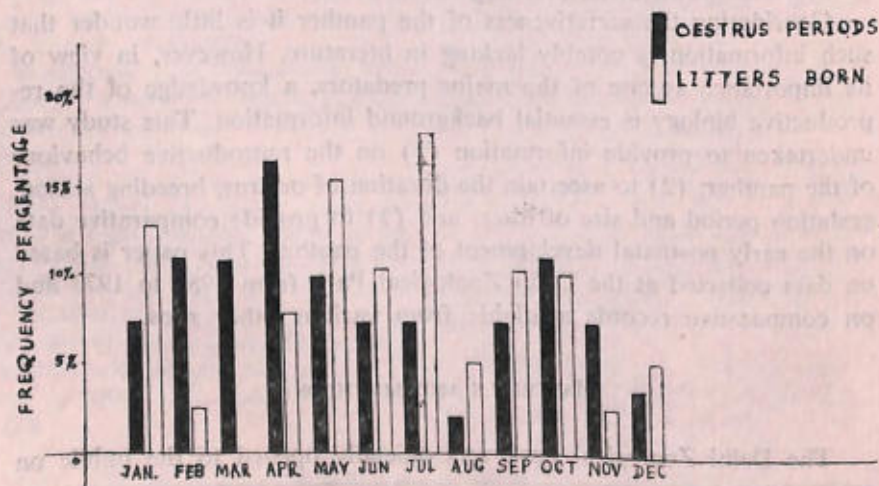


Fig. 1. Frequency distribution of oestrus periods and birth of Panther cubs.

BREEDING SEASON

Panthers breed all the year round (Prater 1971). Between the years 1828 and 1961, panthers had bred during all seasons at Whipsnade and Regent's Park (Jarvis & Morris 1962). It has been stated that in India panther cubs are born between February and March (Blandford 1888-91).

At the Delhi Zoological Park the females come in oestrus during all the months of the year (Fig. 1). From 1958 to 1973, 55 oestrus or heat-periods of nine females have been recorded, during which these females were mated several times by the males and from 1960 to 1972, 63 cubs were born in 39 litters. These data are presented in Table 1.

TABLE 1

BREEDING SEASON OF PANTHER, *Panthera pardus*, IN CAPTIVITY

Months	Number of oestrus or heat-periods	Percentage	No. of litters born	Percentage
January	4	7.3	5 (8)	12.8
February	6	10.9	1 (2)	2.5
March	6	10.9	—	—
April	9	16.4	3 (5)	7.7
May	5	9.9	6 (9)	15.4
June	4	7.3	4 (4)	10.3
July	4	7.3	7 (12)	17.9
August	1	1.8	2 (3)	5.1
September	4	7.3	4 (7)	10.3
October	6	10.9	4 (7)	10.3
November	4	7.3	1 (3)	2.5
December	2	3.6	2 (3)	5.1
Total	55	100	39 (63)	100

Figures in bracket indicate number of cubs.

DURATION OF OESTRUS

Behaviour such as willingness to be stroked by their keepers, increased rubbing on bars and walls of the cages, repeated rolling over on the back indicate that the female is in oestrus (Sadlier 1966). The duration of oestrus was taken as the total number of days on which the above behaviour of a female was recorded and when she permitted mounting and copulation by the males.

Available data on the oestrus periods of 9 adult pantheresses show a wide range of variation (Table 2).

TABLE 2

BREEDING BIOLOGY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	No. of oestrus periods	Range of oestrus (days)	Average oestrus period (days)	Average of last day of oestrus to birth (days) (gestation period)	Average number of cubs/litter
Budhi	9	6-12	9	92.2 (5)	1.6 (6)
Tara	7	4-10	7.4	94.6 (3)	1.7 (4)
Heer	3	5-10	5.0	91.0 (2)	1.7 (4)
Rani	4	7-13	7.5	91.0 (3)	1.6 (5)
Vimla	6	6-12	8.5	93.6 (3)	1.6 (5)
Ganga	3	8-11	10.0	93.0 (2)	1.0 (2)
Kali	7	6-12	8.1	—	—
Meenu	9	7-12	8.0	93.0 (5)	1.6 (11)
Jamuna	7	8-14	10.0	87.5 (2)	1.5 (2)

Figures in brackets indicate number of litters.

SEXUAL MATURITY

Mivart (1881) reports that the domestic cat becomes reproductively mature at the age of one year. The Scottish wild cat breeds first when about 12 months old (Mathews 1941). Sankhala (1967) states that tiger cubs mature at an age between 3½ and 6 years. Young female lions become cyclic at the age of about 3 years, while males appear to require several months longer to achieve sexual maturity (Crandall 1964).

One pantheress (Tara) came into oestrus for the first time at the age of 1 year and 8 months at the Delhi Zoological Park. Another pantheress (Ganga) became cyclic at the age of 2 years 11 months and Heer and Jamuna did so at the age of 3 years 2 months and 3 years 3 months respectively. Two females Meenu and Rani littered for the first time at the age of 2 years 3 months and 2 years 9 months respectively (Table 3). One male Ajay mated for the first time at the age of 2 years.

TABLE 3

OBSERVATIONS ON SEXUAL MATURITY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	Date of birth	Date of first oestrus	Age at which observed in oestrus for the first time	Date on which first litter was born	Age at which littered for the first time
Tara	20.8.56	5.4.58	1 - 8	5.8.60	4 - 0
Ganga	15.4.63	5.3.66	2 - 11	15.6.66	3 - 2
Heer	March 56	24.5.59	3 - 2	29.5.60	4 - 2
Jamuna	15.4.63	3.7.66	3 - 3	—	—
Meenu	27.4.58	Records not available	—	11.7.60	2 - 3
Rani	Oct. 58	Records not available	—	18.7.61	2 - 9
Budhi	24.5.57	10.3.61	3 - 10	18.6.61	4 - 1

MATING BEHAVIOUR

Properly adjusted and well-mated pairs of panthers breed freely in captivity but attempts to introduce mature specimens to each other are not without risks of injury (Crandall 1964). When any female comes in oestrus at the Delhi Zoological Park, a male is put in the adjoining cage from where the two can see and smell each other. If both show signs of compatibility, it is assumed that they will accept each other and subsequently both are introduced to each other in a large enclosure. They approach each other very cautiously. The muscles of both animals remain taut and they continually growl and snarl at each other. After some time they relax and gradually come closer, till they are face to face. They sniff each other. When mutual confidence is established, the female starts rolling on her back in front of the male and presents herself. She sits with her forelimbs extended fully on the ground, her hind limbs remaining half bent. The male approaches from behind and mounts, and his first insertion takes place within 4 to 8 seconds. Actual coition time varies from 10 to 50 seconds. During coition, the animals emit a variety of guttural sounds. As the climax of the act approaches, the male firmly holds the skin of the female's nape between his incisors and both panthers make a high-pitched sound. As soon as copulation is complete, the male dismounts quickly or is thrown off. Sometimes a short scuffle takes place. After each copulation the female lies flat on the ground for some time. After a short interval, the female again approaches the male, and the whole process is repeated.

During the peak of oestrus copulation takes place 5 to 60 times between 8.00 a.m. and 5.00 p.m. At this time the male and female are both unconcerned about any other activity and show no interest even in the food offered to them.

As stated earlier, bringing male and female together in zoos is not without risk. Sometimes the partners behave aggressively and one of them may be seriously injured or even killed by the other. In June 1967, one of the females Rani was introduced to a male Milu. For some time they behaved very well, but suddenly the male, which was heavier and bigger, caught hold of the female, and a serious fight took place. Rani died of injuries two days later.

GESTATION PERIOD

The gestation period of the panther is given as 90 to 100 days or 98 to 105 days by Kenneth (1953). Asdell (1946) records it as being 92 to 95 days and Pocock (1939) notes a gestation period of 102 days for an African leopard at Whipsnade Park Zoo as being exceptional. Cran-

dall (1964) gives one gestation length for a black leopard as 90 days from the middle of the heat period. Sadlier (1966) notes 100 day gestation period for two litters of the Chinese leopard from the second day of oestrus. The longest gestation period of the species is recorded as 112 days, at Prague zoo (Dobroruka 1968). Prater (1971) gives the gestation period as 13 weeks. It is difficult to compare the above data as in most cases the date of conception is defined differently. For purposes of this study, the duration of gestation is estimated as the period from last day of mating to birth, and the mean period was 91.9 days, the extremes being 84 and 98 (Table 2).

LITTER SIZE

Prater (1971) records that two to four cubs are usually produced. Dobroruka (1968) states that over a period of 15 years at Prague zoo, three young have been born on only two occasions. One was born in two instances and two in seven instances. Jobaert (1960) mentions that in the Congo leopards give birth to two or three young. Zuckermann (1953) records one to three young per litter in the Zoological Gardens of London from 1839 to 1937. According to Pushp Kumar (Curator, Nehru Zoological Park, Hyderabad), usually one to two cubs have been born in a litter at the Nehru Zoological Park, three cubs have only been born on two occasions (pers. comm.).

Data on 39 litters at the Delhi Zoological Park indicate that two cubs per litter were born on twenty occasions, one on seventeen occasions and only in two instances were three young born. The average was 1.6 cubs per litter (Table 2).

POSTNATAL DEVELOPMENT OF THE YOUNG

The panther cubs born in the New York and Zurich zoo weighed 0.567 kg and 0.430 kg at birth respectively as recorded by Crandall (1964) and Weillenmann (1963).

The weights and measurements of seven cubs at Delhi Zoological Park indicate that a newly born cub weighs approximately 0.500 kg to 1.00 kg and measures 360 mm to 483 mm from tip of nose to tip of tail between pegs (Table 4). All cubs were born with their eyes closed.

TABLE 4

MEASUREMENTS OF CUBS OF *Panthera pardus*, RECORDED WITHIN TWELVE HOURS AFTER BIRTH

Date of birth	Sex	Weight in kg	Total length in mm	Tail length in mm	Ear length in mm	Forefoot in mm
29.1.66	Male	1.000	483	181	25	103
25.6.66	Male	0.750	360	130	—	75
29.9.66	Female	0.575	420	133	15	95
29.9.66	Female	0.600	430	165	15	102
24.4.67	Female	0.500	360	120	11	80
10.6.67	Female	0.600	370	140	15	90
20.6.67	Male	0.950	432	163	24	108
Average		0.710	407.8	147	15.8	93.2

At birth the panther cub is a helpless little creature as its eyes are closed and the movements of the limbs are uncoordinated and rather random. The skin on nose-tip, paws and perineal area is mostly pink. The fur is short, the spots are faintly developed and the whiskers are black in colour. A cub emits a low cry when hungry or uncomfortable.

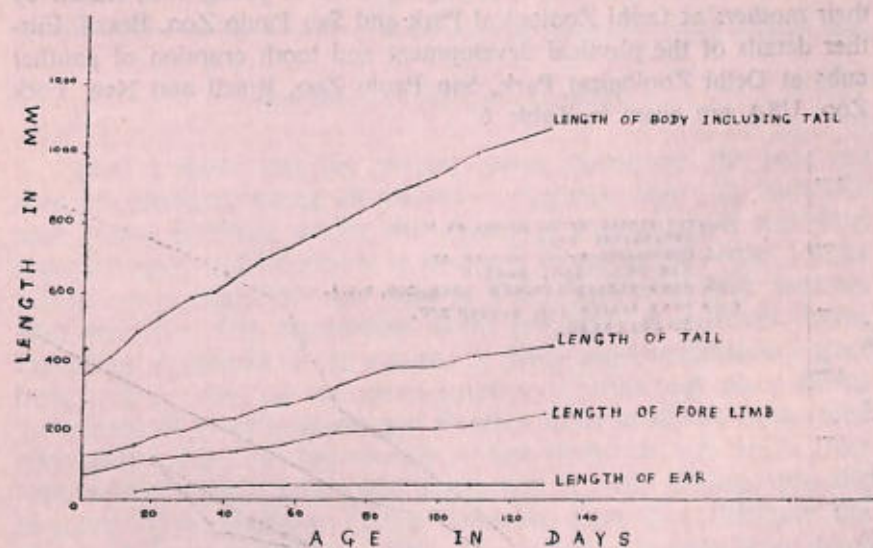


Fig. 2. Growth rate of body parts of cub born at Delhi Zoo (Table 5).

A panther cub born in 15th January 1966 was measured and weighed from birth till the age of 129 days when it was completely weaned and handling was no longer possible. Details of the measurements are given in table 5.

TABLE 5

GROWTH IN WEIGHT AND LENGTH OF PANTHER, *Panthera pardus*, BORN AT DELHI ZOOLOGICAL PARK

Age in days	Weight in kg	Total length in mm	Length of tail in mm	Length of forelimb in mm	Length of ear in mm
0	0.750	360	130	75	—
8	1.000	420	140	90	—
15	1.250	490	160	110	30
21	1.450	530	190	120	35
29	1.550	580	200	130	40
36	1.800	600	230	135	40
43	2.150	640	240	145	43
50	2.400	700	270	155	45
57	2.800	725	280	160	50
64	3.050	760	300	185	50
71	3.250	800	330	200	50
86	4.000	890	390	210	50
98	4.750	940	390	210	50
114	5.600	1010	420	220	50
129	6.250	1080	450	255	50

In Fig. 3, the growth rates of panther cubs hand-reared at Zurich and New York zoos are compared with those of young cubs reared by their mothers at Delhi Zoological Park and Sao Paulo Zoo, Brazil. Further details of the physical development and tooth eruption of panther cubs at Delhi Zoological Park, Sao Paulo Zoo, Brazil and New York Zoo, USA are given in Table 6.

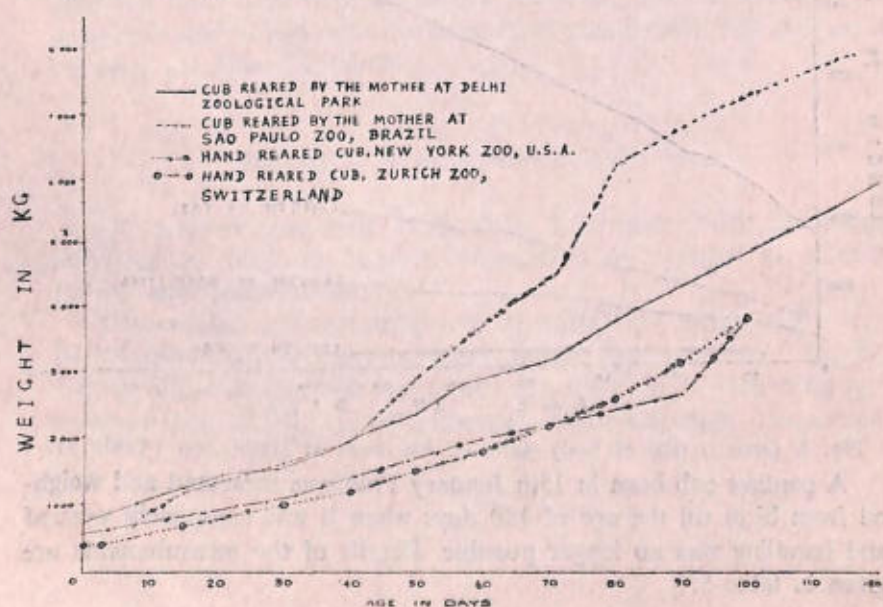


Fig. 3. Growth rate of cubs born at Delhi zoo compared with cubs in other zoos.

TABLE 6

COMPARISON OF PHYSICAL DEVELOPMENT OF PANTHER CUBS BORN AT DELHI ZOOLOGICAL PARK AND OTHER ZOOS

Specimen	Age in days when:					
	eyes open	incisors erupt	1st canine erupts	1st molar erupts	weaned	permanent canine erupts
Born at Sao Paulo Zoo Brazil on 18.7.1966	9	20	—	45	120-125	280
Born at New York Zoo, U.S.A. on 23.2.45	6	—	—	—	—	—
Born at Delhi Zoological Park (India) on 15.6.1966	8	21-29	29	52	114-129	—
Born at Delhi Zoological Park on 29.9.1966	4	22	30	53	—	—

DISCUSSION AND CONCLUSIONS

Figure 1 shows that the panther breeds throughout the year and cubs are produced during all seasons in captivity. However, there is a peak period of births during the months of January, May and July, while February and November show a low percentage of births. During March not a single cub was born at Delhi Zoological Park between 1958 and 1973. This corresponds to the low breeding activities during December. According to the records of Whipsnade and Regent's Park from 1828 to 1961, the maximum number of births took place during the months of March, August and October while minimum births took place during January. The records of San Francisco zoo, USA, from 1929 to March 1967, show a high percentage of births during April and May and a low percentage during November, December, February and March (Reuther & Doherty 1968). The breeding records of panthers at Jaipur zoo indicate that from 1954 to 1963 not a single cub was born during the months of February and November (Sankhala & Desai 1969).

The records of San Francisco zoo and Jaipur zoo compare well with those of the Delhi Zoological Park. The variations in peak periods of

birth may be due to the different climatic conditions and local conditions.

2. All the larger felidae appear polyoestrus in captivity (Eckstein & Zuckermann 1956). Several authors (Asdell 1946; Eckstein & Zuckermann 1956; Sadlier 1966) give seven days as the duration of the oestrus period in lionesses. Sankhala (1967) states that the mating period of the tiger ranges from 3 to 23 days. Sadlier's data (1966) of three female panthers of three different types show mean length of oestrus for the species as 6.7 days.

The duration of oestrus varies from 4 to 14 days, according to the data of nine females at Delhi Zoological Park. There is also a wide range of individual variation among the pantheresses as shown in Table 2. It is not known whether age, physical condition, climate and frequency of copulation are responsible for such variations. The mean length of oestrus calculated from 55 oestrus periods of nine females is 8.1 days.

3. There is much individual variation in the age at which panthers attain sexual maturity. It appears that panthers become sexually mature at an age of between 2 and 4 years. However, no definite conclusion can be drawn from this small sample.

4. Well-adjusted pairs of panthers breed freely in captivity, but the first meeting involves risks of fatal injury. The mating behaviour of panthers is very similar to that of the tiger described by Sankhala (1967). The entire act of copulation lasts from one to three minutes but the actual coition takes only ten to fifty seconds. Mating takes place any time during the day. Panthers may mate five to sixty times in a day.

5. Data on 39 litters born at the Delhi Zoological Park from 1960 indicate a gestation period of 84 to 98 days with an average gestation of 91.9 days. This compares well with the gestation periods given by several authors (Asdell 1946; Kenneth 1953; Crandall 1964 and Prater 1971).

6. The ratio of number of cubs per litter shows that usually one or two cubs are born at a time in captivity. A litter of three cubs is born only occasionally. The average of 39 litters is 1.6 cubs per litter.

7. A newly-born panther weighs on an average 0.710 kg and measures 408 mm (Table 4). Its eyes are closed at birth and open any time from four to nine days later. It has no co-ordination of movements and cannot walk properly or stand upright. During the first four weeks it requires extreme care and nursing by the mother. Infant mortality occurs mostly during the first four weeks. The incisors are cut at the age of 21 to 29 days and the canines erupt at the age of 30 days. It starts licking and biting solid food when it is 52 days old and the first molar is cut. At the age of about 70 days, it starts taking buffalo calf meat or goat meat in captivity. In the beginning, nursing is frequent but the period of suckling at each feeding is reduced. As the cub grows, the fre-

quency of nursing is reduced but the period of suckling at each feeding increases. At the age of 70 days, it suckles only two to three times in a day. It is completely weaned at 114 to 130 days. The growth rate of the cubs reared by their mothers is much better than that of hand-reared cubs. This is evident from the data of cubs reared by their mothers at Delhi Zoological Park and Sao Paulo zoo, Brazil as compared to the hand-reared cubs of New York and Zurich zoos (Fig. 2).

There is much individual temperamental variation. Some mothers take good care of their cubs, others neglect them and some pantheresses even eat their own cubs. Cannibalism although not common, is prevalent among panthers even in well-managed zoos and needs further investigation. As a rule all pantheresses are very possessive and protective of their cubs and become very ferocious if they sense any danger to them.

The panther is one of our most magnificent and graceful animals. It is well adapted for survival in highly variable climates and habitats. Its short gestation period and reproductive potential suggest that under normal conditions it can maintain itself. However, with large-scale destruction of habitat due to industrialization and agriculture, depletion of its prey and indiscriminate poaching, it has a slender chance of survival in the wild. In order to evolve suitable measures for its protection further scientific study of the species in its natural habitat is desirable.

REFERENCES

- ASDELL, S. A. (1946): Pattern of mammalian reproduction. Ithaca, N.Y. Cornell University Press.
- BLANDFORD, W. T. (1888-91): The Fauna of British India including Ceylon and Burma. Mammalia, London.
- CARVALHO CORY, T. D. (1968): Comparative growth rates of hand-reared big cats. *Int. Zoo Yb.* 8:56-59.
- CRANDALL, L. S. (1964): Management of Wild Animals in Captivity. London and Chicago. University of Chicago Press. p. 761.
- DOBRORUKA, L. J. (1968): A note on the gestation period and rearing of young in the Leopard at Prague Zoo. *Int. Zoo Yb.* 8:65.
- ECKSTEIN, P. & ZUCKERMANN, S. (1956): The oestrus cycle in Mammalia, Vol. 1 Part I, Marshall's Physiology of Reproduction. Parks A.D. (Ed.), London: Longmans Green & Co. p. 688.
- JARVIS C. & MORRIS D. M. (1962): The breeding season of mammals in captivity. *Int. Zoo Yb.* 3:292-301.
- JOBAERT, A. J. (1960): Le Leopard. *Zooleo.* 56(5,6):223-230.
- KENNETH, J. H. (1953): Gestation periods. Techn. Conn. 5 Edinburgh: Commonwealth Bureau of Animal breeding and genetics.
- KRISHNAN, M. (1972): An ecological Survey of larger mammals of Peninsular India. *J. Bombay nat. Hist. Soc.* 69(1):26-54.
- MATHEWS, L. H. (1941): Reproduction in the Scottish Wild Cat, *Felis silvestris grampia* Miller. *Proc. Zool. Soc. London* 111:59.
- MIVART, ST. G. (1881): The Cat. London.
- POCOCK, R. I. (1939): The Fauna of British India. I. Mammalia. London: Taylor & Francis.
- PRATER, S. H. (1971): The Book of

Indian Animals: Bombay nat. Hist. Soc., Bombay. p. 263.

REUTHER, RONALD T. & DOHERTY, JAMES (1968): Birth season of mammals at San Francisco Zoo. *Int. Zoo. Yb.* 8:96-101.

SADLER, R. M. F. S. (1966): Notes on reproduction in the larger Felidae. *ibid* 6:184-187.

SANKHALA, K. S. (1967): Breeding behaviour of the tiger in Rajasthan. *ibid* 7:133-147.

SANKHALA, K. S. & DESAI, J. H. (1969): Reproductive pattern of some Indian mammals. *Cheetal—Jr. Wildlife Soc. India.* 12(1):114-129.

WALKER, E. P. *et al.* (1964): *Mammals of the World*: Johns Hopkins Press, Baltimore, USA.

WEILLENMANN, P. (1963): Notes on hand-rearing a Leopard, *Panthera pardus*. *Int. Zoo Yb.* 4:317-318.

ZUCKERMANN, S. (1953): The breeding season of mammals in Captivity. *Proc. Zool. Soc. London*, 122:827-950.

Plant-pest status of root-eating ant, *Dorylus orientalis*, with notes on taxonomy, distribution and habits (Insecta : Hymenoptera)¹

M. L. ROONWAL²
(With three text-figures)

INTRODUCTION

The history of the economic status of the large root-cutting ant, *Dorylus orientalis* Westwood (Hymenoptera: Formicidae: Dorylinae), in the Indian Region has been curiously controversial. The very first record of it as a plant-pest (potatoes) by Barlow (1899) was immediately disputed by Forel (1899) who then, and also later (1923), maintained that the species is exclusively insectivorous. Subsequently, several entomologists recorded it as attacking various plants in India, Sri Lanka and Burma, but Mukerji (1934) again asserted that it is exclusively carnivorous (eating insects and earthworms) and refused vegetable food. Like several other earlier observers, I have personally seen this ant seriously attacking potato tubers, in Dehra Dun, but here again we have the following denial (*in litt.*, 3 November 1971) from so authoritative a source as the Director, Central Potato Research Institute, Simla:

"We have no recorded reference about these ants as pests of potatoes or about the control measures against them."

In view of this confusion and controversy, I have in the present paper examined briefly, from the available records and from personal observations, the economic status of this ant as a pest of plants, and also added some notes on its control, taxonomic status, geographical distribution, habits and biology.

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STATUS AS PLANT-PEST, AND CONTROL

Status as plant-pest. In view of the controversy as stated above, I have given below a summary of the available records regarding the attacks of this ant on plants.

1. Barlow (1899).—Damages potatoes (but see Forel 1899).
2. Forel (1899, 1923).—(i) (1899, p. 198): Doubts Barlow's (1899) record of damaging potatoes; says it eats only insects. (ii) (1923, p. 17): Doubts its herbivorous nature and considers it as entirely carnivorous.
3. Green (1903, p. 39).—Sri Lanka: Its workers live entirely underground and are confirmed vegetarians. It's a serious pest of potatoes, making galleries in tubers. Also attacks tubers of dhalias and roots of sunflower (*Helianthus* sp.); in later case eating off tender bark below collar.
4. Stebbing (1905, p. 683; 1908, p. 73).—India (Calcutta): Attacks potatoes and "cornflour plants".
5. Lefroy (1906-09): India and Sri Lanka: (i) (1906, pp. 231-232): Attacks healthy living plants, e.g., cauliflowers, cabbages, artichokes, etc., just below soil and completely destroys them. (ii) (1907, p. 128): Damages vegetable crops. Sporadic local pest of vegetable gardens. (iii) (1909, p. 238): Attacks plants, eating them below or at soil-level. Workers also attack workers of the harvest ant, *Pheidole indica*.
6. Dutt (1912, p. 247).—Pusa (Bihar): Damages vegetable crops but not seriously.
7. Rutherford (1914).—Sri Lanka: Attacks kohlrabi.
8. Fletcher (1914-20).—(i) (1914, p. 274): South India: Attacks growing plants including young coconut palms. Ceylon: Perforates pods of groundnut and consumes contents; also attacks its roots. Attacks sugarcane. (ii) (1917, p. 281): India (Bihar): Regularly attacks cauliflower seedlings below ground. (iii) (1920, p. 35): India (Bihar and Uttar Pradesh): Attacks underground parts of vegetables (potatoes, cauliflower, etc.) and early-sown groundnuts. Ceylon: Attacks roots of potatoes and other vegetables.
9. [Burma] (1918, p. 52).—Burma: Attacks sugarcane setts.
10. Speyer (1918).—Sri Lanka: Attacks vegetables.
11. Hutson (1919-39).—Sri Lanka: (i) (1919, pp. 276-77): Bores in potatoes. (ii) (1920): A pest of potatoes. (iii) (1933a): Attacks carrots, onions and *Arachis* sp. (iv) (1933b, pp. 276-279): Workers attack underground portions of several vegetables and also some young trees, e.g., citrus. Attack chiefly in May-September. (v) (1936, pp. 293-295): Attacks vegetables, shrubs and trees. (vi) (1937): Attacks ginger rhizomes. (vii) (1939): Severely attacks coconut seedlings; also attacks potato tubers and roots of tree-tomato (*Cyphomandra betacea*).
12. Mukerji (1934).—India (Calcutta): Workers are not vegetarians; seen feeding on live beetle grubs and live earthworms (reared on them in the laboratory); did not eat vegetable food offered.
13. Ghosh (1936, 1940): (i) (1936, pp. 23-24): India: Attacks bee-hives and eats larvae and pupae [attack is presumably by winged males]. (ii) (1940, pp. 130, 138, 141): Burma: Attacks seedlings of trees, cutting roots and killing plants; also attacks potato tubers and seedlings of coconut palms.
14. Beeson (1941; reprint 1961, p. 386).—India and Sri Lanka: "Appears to be entirely herbivorous", and is occasionally a pest in gardens (particularly of vegetables) and in seed-beds in nurseries; bulbs and tubers are hollowed out.
15. Cherian and Ramachandran (1943).—India: Occasionally attacks bee-

hives for honey and pollen, and also destroys bees and brood.

16. Wilson (1964, pp. 442-443).—Sri Lanka: Workers found underground in disturbed forests and cultivated land.

17. Pruthi (1969, p. 466).—India: Attacks plants; is also carnivorous.

18. Unpublished records.—(i) Forest Research Institute, Dehra Dun: (a) West Bengal (Batali, 1830 m. Darjeeling District): Attacking oak, *Quercus lamellosa*. (b) Assam: Jiri Forest, Cachar: Found in decaying climber. (ii) Mr. P. L. Chaturvedi, U.P. Institute of Agricultural Sciences, Kanpur (*in litt.*, 28 August 1971): Attacks potato tubers especially in early stages of growth; also vegetable seedlings of cauliflowers, cabbages, etc. (iii) Director, Central Potato Research Institute, Simla (*in litt.*, 3 November 1971): *Not* known to attack potatoes (*sic!*). (iv) Present author: Serious pest of potato tubers in Dehra Dun (February and April).

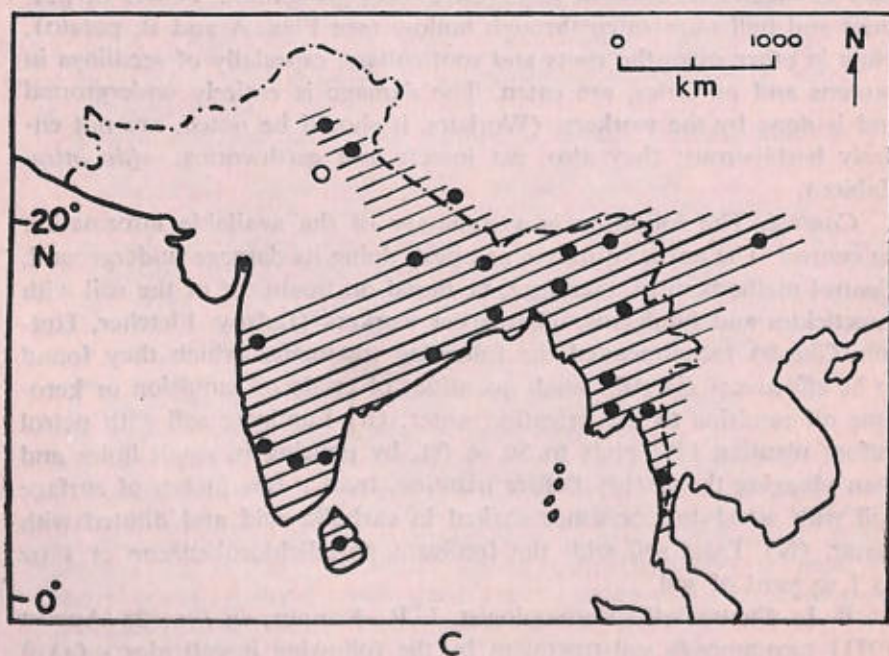
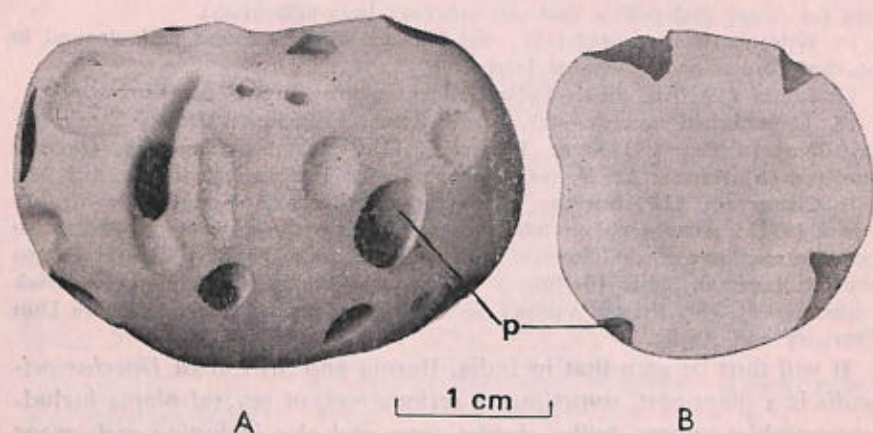
It will thus be seen that in India, Burma and Sri Lanka *Dorylus orientalis* is a plant-pest, sometimes a serious one, of several plants including vegetables, tubers, bulbs, shrubs, trees and also including cash crops such as sugarcane, coconut palm, citrus and groundnut. Tubers of potatoes and bulbs are eaten through hollow (see Figs. A and B, potato), while in other cases the roots and root-collars, especially of seedlings in gardens and nurseries, are eaten. The damage is entirely underground and is done by the workers. (Workers, it should be noted, are not entirely herbivorous; they also eat insects and earthworms, *vide infra*, Habits.)

Control. The following is a summary of the available information on control. The ant is entirely a soil pest, doing its damage underground. Control methods must, therefore, be based on treatment of the soil with insecticides and fumigants. The earlier workers (Lefroy, Fletcher, Hutson, Ghosh) recommended the following treatments which they found to be effective:— (i) Add small quantities of crude oil emulsion or kerosene oil emulsion to the irrigation water. (ii) Fumigate soil with petrol before planting (1-2 pints to 30 sq ft), by pouring in small holes and then plugging them. (iii) Before planting, treat a few inches of surface soil with wood-dust or ashes soaked in carbolic acid and diluted with water. (iv) Treat soil with the fumigant paradichlorobenzene at 1 oz to 1 sq yard of soil.

P. L. Chaturvedi (Entomologist, U.P., Kanpur, *in litt.*, 28 August 1971) recommends soil treatment by the following insecticides:— (a) 3 litres of 30 per cent emulsifiable concentrate (E.C.) of aldrin in 1,000 litres of water. Spray this quantity in root region per acre of potato crop. (b) Heptachlor (2% E.C.). (c) Gamma benzene hexachloride (B.H.C.) (20% E.C., based on lindane). Both to be used as above.

TAXONOMIC STATUS AND DISTRIBUTION

Taxonomic status. The synonymies and the more important taxonomic references are given below:



Dorylus orientalis Westwood

FIGS. (A) and (B): Potato tubers showing damage caused by the workers. Dehra Dun. (A) In surface view. (B) In cross-section. FIG. (C): Map of Indian Region and neighbouring areas, showing the approximate geographical distribution (shaded in diagonal lines). Solid circles indicate the major localities where the species has been found.

p., pits excavated by the workers.

Dorylus (Alaopone) orientalis Westwood 1835

1835. *Dorylus orientalis* Westwood, *Proc. zool. Soc. Lond.*, London, 3, p. 72. "India Orientali".
1840. *Typhlopone curtisi* Shuckard, *Ann. Mag. nat. Hist.*, London, 5, p. 265. Worker.
1840. *Dorylus longicornis* Shuckard, *Ann. Mag. nat. Hist.*, London, 5, pp. 321-322. Bengal.
1881. *Alaopone oberthueri* Emery, *Ann. Mus. Stor. nat. Genova*, Genoa, 16, p. 274. Worker. Calcutta.
1889. *Dorylus fuscus* Emery, *Ann. Mus. Stor. nat. Genova*, Genoa, 27, p. 487. Worker. Rangoon, Burma.
1901. *Dorylus orientalis* Westw. (and *D. curtisi* Sh., *fuscus* Em. and *longicornis* Sh.), Forel, *J. Bombay nat. Hist. Soc.*, Bombay, 13(3), pp. 462-464. Revision.
1903. *Dorylus orientalis*. Westw., *D.o. fusca* Em. and *D.o. longicornis* Sh., Bingham, *Fauna Brit. India, Hymenoptera*, London, 2, pp. 3-5.
1964. *Dorylus (Alaopone) orientalis* Westw., Wilson, *Pacific Insects*, Honolulu, 6(3), pp. 442-443. Revision.

Field diagnosis

Male (winged): Length of head and body 17-25 mm; of forewing 16-18 mm. Brownish yellow, head dark reddish brown.

Female: Unknown.

Worker: Without wings and eyes. Head and body castaneous brown. Antennae with 9-11 segments (Wilson 9, Sri Lanka, Forel 11). Abdomen elongate, flattened dorsally and thus without a distinct waist. Of two forms, major and minor. Total length: Major 5-11 mm, minor 2.5-3 mm.

Illustrations

The illustrations available in the literature are: (1) Emery (1881, p. 274): Worker, head and antenna, *A. oberthueri*. (2) Bingham (1903, p. 5): Good figure of a ♂ and a worker major. (3) Stebbing (1905, p. 683; and 1908, Pl. XXIII): Figure of a ♂ and a worker (the latter wrongly labelled as ♀). Lefroy (1906, p. 232): Good figure of a worker. This is repeated by several authors, e.g., Lefroy (1907, p. 128), Dutt (1912, p. 247) and Ghosh (1936, p. 24; 1940, p. 130).

Geographical distribution. In addition to the records of Forel (1901), Wilson (1964) and others, I have examined examples from the following Indian localities in the collection of the Forest Research Institute, Dehra Dun:— (i) Bernag, 1830 m alt. (Almora District, Uttar Pradesh). (ii) Batasi, c. 1830 m alt. (Darjeeling District, West Bengal), ex "*Quercus lamellosa*". (iii) Jiri Forest (Cachar, Assam), ex "*decaying climber*". The following are the detailed locality records, countrywise:—

(1) INDIA: *Uttar Pradesh*: Dehra Dun, 610 m.; Berenag (Almora Dist.), 1830 m.; "Siwaliks". *Bihar*: Pusa. *Orissa*: "Orissa". *West Bengal*: Calcutta and vicinity (Calcutta, Sibpur, Barrackpore); Darjeeling: Batasi, c. 1830 m.2 (Darjeeling Dist.). *Assam*: Jiri Forest (Cachar

[Silchar] Dist.); Nambour Reserve (Sibsagar Dist.). *Maharashtra*: Poona. *Karnataka*: "Kanara". *Tamil Nadu*: Madras; Coonoor. (2) *NEPAL*: Amlekhganj, 520 m. (3) *BURMA*: Tenasserim; Rangoon; Pegu; Moulmein; Bhamo; Kowkareet; Palon; Carin Cheba; Kabo, 120 m. (4) *SRI LANKA*: Kandy, 600-700 m. (5) *CHINA*: Meitan, Kweichow (southern China).

On this basis the approximate geographical distribution may be summarised thus: India (whole, except the extreme northern and north-western parts); southern Nepal; Sri Lanka; Burma (south to Tenasserim); east to southern China (Kweichow) (Fig. C). Going up to about 1830 m altitude above sea-level.

HABITS AND BIOLOGY

Swarming

Males swarm at night and are attracted to light (females are unknown). In north India they swarm at the end of the cold weather, in late February (Lefroy 1909). But swarming in April also occurs at Dehra Dun (note in Ledger Files in Entomology Branch, Forest Research Institute, Dehra Dun; extract given below):

About 820 examples [presumably winged males] emerged in a 10 × 20 feet outdoor cage in New Forest, Dehra Dun, on 10 April 1928. Cage erected in March 1926, and planted with roots and cuttings of teak in June 1926. Possibly at that time a pair (or more) of this ant was introduced in the cage with the soil adhering to the roots. If so, the time between egg-laying and swarming of next brood is about two years. It is hardly likely that the species got entry into the cage through a tunnel from outside; no swarming occurred in the neighbouring cages or in the vicinity.

Season of damage

The season when the workers cause damage seems to vary with climate. In Dehra Dun I observed them attacking the potato crop in early February and again in April. In Sri Lanka, the attack is chiefly in May and September (Hutson 1933b).

Food habits etc.

Workers have the termite-like habit of living entirely underground and making tunnels and galleries through the soil to reach the plant parts. They are largely vegetarian, eating tubers, bulbs, rhizomes, roots and other underground parts of plants. They also eat animal food such as insects and earthworms, but it is not known whether this is habitual or occasional. In the laboratory, Mukerji (1934) reared workers exclusively on beetle grubs and earthworms; they refused plant food. They also occasionally eat larvae and pupae of bees, as well as pollen and honey from bee-hives (Ghosh 1936; Cherian & Ramachandran 1943).

Sometimes they are also known to attack the workers of the harvest ant, *Pheidole indica*, which are carried to the nest where they are killed and cut into pieces (Lefroy 1909). Males are probably carnivorous but no exact information is available.

The nest is made underground rather deep in the soil but little else is known about it.

It will thus be seen that our knowledge of the habits and biology of this ant is very limited and there is scope for considerable work.

ACKNOWLEDGEMENTS

I am grateful to the following persons for supplying useful information and for other assistance: K. S. Pradhan, Zoological Survey of India, Calcutta; P. K. Sen-Sarma and the staff of the Entomology Branch, Forest Research Institute, Dehra Dun; P. L. Chaturvedi, Entomologist, U.P. Institute of Agricultural Sciences, Kanpur; and the Director, Central Potato Research Institute, Simla.

SUMMARY

1. In view of the controversy about the status of the ant *Dorylus orientalis* as a plant-pest (some authors maintaining that it is exclusively carnivorous), all the available information has been re-examined and fresh observations added.

2. It is established that in India, Burma and Sri Lanka the ant (in the worker stage) is a definite, sometimes serious, pest, attacking the underground portions of several plants including economic ones such as vegetables, potatoes, groundnuts, coconut seedlings, citrus and sugarcane setts.

3. Information on its taxonomic status is summarised. There are four synonyms: *D. curtisi* (Shuckard), *D. fuscus* Emery, *D. longicornis* (Shuckard) and *D. oberthueri* (Emery).

4. The geographical distribution is, India (whole, except N and NW parts), S. Nepal, Sri Lanka; Burma and S. China (Kweichow).

5. Notes on habits and swarming are given.

REFERENCES

- BEESON, C. F. C. (1941): The Ecology and control of the Forest Insects of India and the Neighbouring Countries. p. 1007, sev. figs. Dehra Dun (Vasant Press). Reprint, 1961.
- BARLOW, E. (1899): Notes on insect pests from the Entomological Section, Indian Museum. *Indian Mus. Notes*, Calcutta, 4(4): 180-221. (Also: Note on *Dorylus orientalis* by Forel, p. 198).

BINGHAM, C. T. (1903): The Fauna of British India, including Ceylon and Burma. Hymenoptera Vol. 2. Ants and Cuckoo-wasps. London., pp.1-5.

[BURMA] (1918): Annual Report of the Department of Agriculture, Burma, for the Year ended 30 June 1918. Rangoon (Govt. of Burma). p. 52.

CHERIAN, M. C. & RAMACHANDRAN, S. (1943): Bee enemies. *Indian Fmg.*, Delhi, 4(5):251-253.

DUTT, G. R. (1912): Life-histories of Indian Insects (Hymenoptera). *Mem. Dept. Agric. India (Ent.)*, Calcutta, 4(4):247.

EMERY, C. (1910): Genera Insectorum. Hymenoptera, Fam. Formicidae, Subfam. Dorylinae. Brussels. pp. 14-15.

FLETCHER, T. B. (1914): Some South Indian Insects and other Animals of Importance. Madras. p. 274.

————— (Ed. by) (1917): Cruciferous crops. *Proc. 2nd ent. Meet. (Pusa, Feb. 1917)*, Calcutta, p. 281.

————— (1920): Annotated list of Indian crop-pests. *Proc. 3rd ent. Meet. (Pusa, Feb. 1919)*, Calcutta, 1: 35.

FOREL, A. (in E. BARLOW) (1899): Note on *Dorylus orientalis*. *Indian Mus. Notes*, Calcutta, 4(4):198.

FOREL, A. (1901): Les Formicides de l'Empire des Indes et de Ceylon. Part VIII. *J. Bombay nat. Hist. Soc.* 13(3): 462-577.

————— (1923): *Le Monde Social des Fourmis du Globe*. 5. Geneva. See p. 17.

GHOSH, C. C. (1936): Bee-keeping (3rd Revised Ed.). *Misc. Bull. Imp. Counc. agric. Res.*, Delhi, No. 6, vi + 91 + 8 pp.

————— (1940): *Insect Pests of Burma*. Rangoon (Govt. Press). See pp. 130, 138 and 191.

GREEN, E. E. (1903): Note on *Dorylus orientalis*, West. *Indian Mus. Notes*, Calcutta, 5(2): 39.

HUTSON, J. C. (1919): Quarterly Report of the Entomologist. January-March, 1919. *Trop. Agriculturist*, Peradeniya, 52(5):276-277.

HUTSON, J. C. (1920): Report of Entomologist. Ceylon Dept. Agri., Adm. Rept. for 1919, Peradeniya, pp. C8-C10.

————— (1933a): Report on the work of the Entomological Division (Ceylon Department of Agriculture, 1932). p. 23, typescript. Peradeniya, 1933 (Summary in *Rev. appl. Ent.* (A), London, 21:361-362).

————— (1933b): Pests of garden plants. 1. The root-eating ant (*Dorylus orientalis* Westw.). *Trop. Agriculturist*, Peradeniya, 80(5): 276-279.

————— (1936): Entomological notes. *Trop. Agriculturist*, Peradeniya, 87(5):289-295.

————— (1937): Report on the work of the Entomological Division. Adm. Rept. Dir. Agric. Ceylon, 1936, Colombo, pp. D22-D-28.

————— (1939): Report on the working of the Entomology Division. Adm. Rept. Dir. Agri. Ceylon 1937, Colombo, pp. D37-D42.

LEFROY, H. M. (1906): Indian Insect Pests. Calcutta. pp. 231-232.

————— (1907): The more important insects injurious to Indian agriculture. *Mem. Dept. Agric. India*, Calcutta, 1(2):128.

————— (1909): Indian Insect Life. Calcutta. pp. 227-228.

MUKERJI, D. (1934): On the anatomy of the worker of the ant *Dorylus (Alaopone) orientalis* W. *Zool. Anz., Leipzig*. 105:97-105.

PRUTHI, H. S. (1969): Textbook on Agricultural Entomology. ix + 1 + 977 pp., 92 pls. New Delhi (Indian Counc. Agric. Res.). See p. 466.

RUTHERFORD, A. (1914): Report of the Entomologist. Rept. Ceylon Dept. Agric., July 1, 1912 to December 31, 1913). Colombo.

SPEYER, E. R. (1918): Report on the work of the Entomological Division, including special investigations into shot-hole borer of tea. Ceylon Adm. Repts. for 1917, Dept. Agri., pp. C10-C13.

STEBBING, E. P. (1905): Insect life

in India and how to study it, etc. *J. Bombay nat. Hist. Soc.* 16:683, fig. 86 (male; and worker, wrongly labelled as female).

_____ (1908): A Manual of Elementary Forest Zoology for In-

dia. Calcutta. pp. 72-73 and Pl. XXIII.

WILSON, E. O. (1964): The true army ants of the Indo-Australian area (Hymenoptera: Formicidae: Dorylinae). *Pacific Insects*, Honolulu, 6(3): 427-483.

Sacred groves of India—A plea for continued conservation¹

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INTRODUCTION

The practice of nature conservation is a very ancient tradition in India, so ancient in fact, that its roots go back to the pre-agricultural, hunting gathering stage of the society. The protection accorded to many plant and animal species such as the Peepal and Umber trees and the Langur and Nilgai is well known. There are also instances of entire biological communities such as all aquatic creatures in a rock-pool or all plant life in a patch of forest receiving protection because of their association with some deity. With the weakening of religious beliefs these creatures and communities are now in danger of losing this traditional protection. We are writing this to make a plea that we must not lose our legacies from these ancient practices, but must make every effort to incorporate them in an enlightened approach to nature conservation.

Sacred groves are one of the most valuable of such legacies from the primitive practices of nature conservation. Scattered, presumably throughout India, are tracts of sacred forests which have been completely or nearly completely immune from human interference on grounds of religious beliefs. The nature of religious cults associated with such sacred groves suggests that the practices are very ancient, deriving from the hunting-gathering stages of the society. The composition of the vegetation, corresponding to the climax formation for that region, corroborates the supposition that the sacred groves have been immune from human interference for a very long period of time. These sacred groves may range in size from a clump of trees to as much as twenty hectares in area. Even the smaller groves often harbour some old and

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Above: Sacred grove of goddess Janni at Mangaon, Velhe Taluka, Poona District. *Below:* Sacred grove of the saint Somjibuva at Dhaman Vahal, Mulshi Taluka, Poona District.

magnificent specimens of trees and climbers. The larger groves are a veritable treasure-trove for the naturalist, supporting many species of plants which are rare in the area, and are becoming rarer and rarer with the deforestation which seems to gather pace daily. These sacred groves are also often serving as a last refuge for arboreal birds and mammals especially monkeys, and no doubt for other forest loving animals as well (Plate).

TWO EXAMPLES

We will illustrate the phenomenon of these sacred groves with the help of two examples from Maharashtra; one, a grove of the goddess Janni at Mangaon in Velhe taluka of Poona district and the second, a grove of the goddess Kalkai at Gani in Shrivardhan taluka of Kolaba district. Both are amongst the largest groves that we have visited, being about fifteen hectares in size, and lie along the crestline of the Western Ghats. Both lie in regions which receive about 4000 mm of rainfall during the months of June to September, and consequently support montane subtropical evergreen forests.

Mangaon lies near the southwestern edge of the Panshet reservoir and is at a distance of one km from the motor launch stop at Mangaon. The grove is about three quarters of a kilometre away from the village itself and is situated on a hill slope of about 30° to 40°. About five hectares of this grove was felled in 1948, but this was allowed to grow without further disturbance and is now a good second growth forest. The other ten hectares appear to be in their primaeval condition. This primary forest is composed almost entirely of trees about ten to thirty metres tall with little shrubby or herbaceous undergrowth. The dominating tree species are Yeru (*Dysoxylum binectariferum* Hook. f.), Jamun (*Syzygium cuminii* Skeels) and Anjan (*Memecylon umbellatum* Burm). Particularly remarkable specimens are those of Bhorab (*Sterculia guttata* Roxb.) and Peepar (*Ficus arnottiana* Miq.). The forest is rich in woody climbers notable amongst which are Shikekai (*Acacia rugosa* Ham.) and Ombali (*Gnetum ula* Brong.).

The reigning deity of the grove is a mother goddess, Janni. She is now in the form of a simple icon in a primitive temple. However, even this grandeur is recent. Originally she was in the form of uniconic stone lumps smeared with minium lying out in the open. These stones are still in the temple, along with a stone representing the *mulpurusha* or the founder of the Polekar clan of the Mangaon village. The deity demands animal sacrifice and is supposed to be very ferocious in nature. It is believed that the femininity of the deity indicates that the worship originated in the hunting gathering stage of the society which was still

awed by the miracle of birth and in which there was little of male domination. The fact that the temple is fairly recent, and away from the village also supports the conjecture that the cult originated when the society was not yet settled in permanent dwellings (Kosambi 1962).¹

Removal of any plant material, even of dead wood from the grove is taboo. The villagers seem to respect this taboo with near-complete sincerity even today. Wood from the grove was however occasionally removed in the past with special permission from the deity in case of a disaster such as a major fire in the village. Apart from such, presumably very rare violations, the grove must have been in a completely primaeval condition till 1948. In that year there was a dispute regarding the ownership of the grove between two clans in the village. The dispute was settled by the Government by the entire grove being auctioned for felling. A coal merchant from Poona bought the grove in the auction and commenced felling with the help of imported tribal katkari labourers. The villagers, who were at first unhappy about the destruction of their sacred grove, decided that they should at least make some money if destruction was inevitable. They also felt that it was the merchant who will be subjected to the wrath of the goddess. They therefore refused to let the katkaris do the felling and volunteered to do the felling themselves but on wages higher than those demanded by the katkaris. This dispute lasted for quite a while, but finally the merchant gave in and the villagers completed about five hectares of felling. At this point there was a further dispute which was terminated with the merchant dying a sudden death vomiting blood. The villagers decided that the death was a just punishment meted out by the goddess because of the violation of her sacred grove. Felling was stopped, and the rest of this magnificent grove was saved from disaster. Today, the rest of the region has been completely deforested and the grove of Janni stands as the last refuge of the magnificent vegetation that covered the entire region till only twenty years ago.

Our second example is from Konkan. The village of Gani is about twenty kilometres from Shrivardhan isolated atop a hill plateau. The base of the hill may be reached by a bus, or jeep but one has to climb a distance of five kilometres before reaching the village. The sacred grove of Kalkai lies about half a kilometre from the village itself and is situated on a gentle slope. The grove is about fifteen hectares in area and all of it is in its primaeval state; there has never been any felling in the grove within human memory. The forest is dominated by *Terminalia paniculata* Roth, *Mangifera indica* Linn., *Holegerna grahmi* Hook. f., *Alstonia scholarae* R. Bc. and is about twenty to forty metres in height. There is little shrubby undergrowth, but a rich growth of

¹ KOSAMBI, D. D. (1962): Myth and Reality. Popular Book Depot, Bombay.

climbers of species *Gnetum ula* Brong. *Acacia rugosa* Ham., *Combretum ovalifolium* Roxb. and *Schefflera venulosa* Harms. The most remarkable specimen in the grove is a magnificent tree of Garud (*Ficus* sp.) which has a girth exceeding fifteen metres.

The reigning deity of the grove is like that in Mangaon a mother goddess, Kalkai. She is in an uniconic form and lies open to the sky. She demands blood sacrifice. In all these features as well as in lying at a distance from the village, the cult at Gani resembles the Mangaon cult. Removal of any live wood from the grove is taboo. However the taboo on the removal of dead wood and leaf litter appears to have been relaxed within recent times. As with Mangaon, all the region surrounding the village Gani has been completely deforested. The effects of this deforestation which has been more thorough at Gani, are being felt much more acutely by the villagers. They now have no source of fuel-wood or of leaf litter for preparing the paddy fields except for the grove. Moreover, apart from a village well, the only perennial source of water is a spring in the grove. Deforestation has led to the drying up of all the other perennial springs in the vicinity of the village. The spring in the grove is therefore the only perennial water source for the cattle, or for the people working in the field.

The villagers of Gani are now acutely aware of the crucial role of the grove in their economy. This grove, as many others, is classified as temple land in the revenue records, and therefore cannot be exploited except at the initiative of the temple trust. The villagers, as trustees, have no wish to destroy this last source of fuel and water. It so happened, however, that part of the grove was classified as forest land. As this coupe was due for felling by rotation in 1972, some of the trees from the grove were marked for felling by the departmental personnel. The villagers were very unhappy at this, and on being informed by some forest department official of our interest in the sacred groves wrote to us for help. We visited the grove and were convinced of the merit of the villagers' case. We are very happy to state that the forest department very considerably halted the felling in the grove at our request.

GEOGRAPHICAL DISTRIBUTION

Such sacred groves are a very ancient and widespread phenomenon in the old world cultures. They are mentioned in Greek and Sanskrit classics and are reported to exist today in a number of countries besides India e.g. Ghana, Nigeria, Syria, Turkey. We have not come across any comprehensive account of the sacred groves, and this list based on personal conversations with other naturalists is definitely very incomplete. It appears, however, that this phenomenon is entirely unknown in the

New World (R. E. Schultes, personal communication). In India they have been reported to us from the entire length of the Western Ghats, in Maharashtra, Mysore and Kerala. The reigning deities of the groves in Mysore and Kerala are cobras rather than mother goddesses as in Maharashtra. Aravalli hills in Rajasthan have groves dedicated to a mother goddess Jogmaya (I. Prakash, personal communication). Sacred groves are also found in the hill states of northeastern India, and in fact are notable for harbouring rare species of orchids (A. G. Raddi, personal communication).

The finest sacred groves of India presumably occur in the Sarguja district of Madhya Pradesh (G. G. Takle, personal communication). Here every village in the area has a grove about 20 hectares in extent. What is remarkable is that not only plant, but also animal life receives absolute protection in these groves. The groves therefore serve as sanctuaries for herds of ungulates as well. These groves are locally known as sarana forests, a word which probably derives from the Sanskrit "sharana" or sanctuary.

ECONOMIC SIGNIFICANCE

It is well known that the climax form of vegetation in any locality often tends to be richer in species than the earlier stages of succession. As climax forests, the sacred groves are particularly diverse in species of trees and the life forms dependent for their existence on trees, namely climbers and epiphytes. With the felling of forest all around them, the sacred groves have become the last refuge of many plant species. Many of the plant species which depend for their very survival in the region on the sacred groves are of considerable practical value. A striking example of this was provided by the grove at the village of Tunbad in Shrivardhan Taluka. This rather small grove harboured a magnificent specimen of Garabi or Gaidhari (*Entada phaseoloides* Merr.) a leguminous climber. The local inhabitants use the bark of this climber in treating cattle against snakebite. We were told that this was the only specimen of this species within a radius of 40 kilometres, and people came up from considerable distances to this grove for the medicinal bark. It is certain that many species now preserved in the sacred groves possess such medicinal properties and may prove to be of considerable economic value if properly studied and exploited.

Apart from the preservation of rare species the sacred groves may be serving the function of preservation of biological diversity even in the case of commoner species of trees. Thus we have been told of two groves in Maharashtra which support ancient Teak (*Tectona grandis*) forests although teak has disappeared from the vicinity of those groves

(1) Dhamani in Junnar Taluka of Poona district; (Shri U. K. Mavin-kurve, personal communication) and Dapora in Wani Taluka of Yeotmal district (Shri M. G. Gogate, personal communication). It is very likely that the teak specimens in these groves represent genetic variants which are peculiar to that geographical region. Experience with forest tree breeding programmes in North America has shown that the success of such programmes depends crucially on the availability of abundant genetic variation over the entire geographical range of the species. The genetic variation of species like Teak likely to be preserved in the sacred groves may therefore prove to be of great value in a future forest tree breeding programme in India.

CONSERVATION

Continued conservation of these sacred groves is obviously desirable both from a practical and an aesthetic point of view. Unfortunately, the religious beliefs on which this conservation was based are beginning to weaken at the same time as the need for their conservation is becoming more and more urgent with the deforestation of the surrounding regions. Both the sacred groves described in detail above have been just saved from threats of destruction. Many others have succumbed. The larger, more valuable sacred groves are in fact more susceptible because they can fetch considerable money in the short run for the poor farmers. For example, there were originally four sacred groves of an area greater than five hectares in the Panshet reservoir catchment area. Two of these, one at Shirkoli and the second at Gondekhal, both of fifteen hectares each, were felled in 1956. A third, at Tav is likely to be felled in the next one or two years. That at Mangaon continues to be coveted by charcoal merchants. We were told that just last year a merchant offered the village headman a bribe to agree to bid as a dummy in an auction the merchant was hoping to arrange.

All of this obviously points to the need for immediate measures to conserve all the remaining sacred groves of substantial extent. Most of these are classified as lands reserved for a temple. The land may be owned either by the Government or privately. Where the land is under governmental control the logical measure is to turn it over to the forest department which can classify these groves as preservation plots. It is, however, the privately owned groves that are in more imminent need of protection. Those mentioned above as already felled at Shirkoli and Gondekhal were privately owned, and so is that at Tav likely to be felled very soon. Such privately owned groves could probably be best preserved through the good offices of charity commissioners who regulate the functioning of the religious trusts. This could be accomplished by

the charity commissioners adopting the view that the grove associated with a temple is an important asset that the trustees must preserve. We are also happy to note that the Flora Wing of the Indian Board of Wild Life is considering the possibility of setting up a system of nature preserves to protect the sacred groves of northeastern India. It would be obviously desirable to extend the scope of such a system to embrace all of India.

SUMMARY

Scattered, apparently throughout India, are a large number of forest tracts which have remained immune from human interference because of religious beliefs. As deforestation has been taking place at a rapid rate in many areas, such forests have come to be the only remnants of the original forest in a number of cases. Because of the absence of human interference the sacred forests support the climax vegetation appropriate for their particular locality. Such a climax vegetation is very rich in species of trees, climbers and epiphytes. As such these sacred groves serve the vital function of preservation of plant species which have become very rare or extinct elsewhere. Preservation of these species could be of great economic significance. Some of the species so preserved are already of medicinal significance; others could acquire such a significance in future. Even in the case of species not in any danger of extinction, the sacred forests may serve to preserve genotypes which may be useful in a future forest tree breeding programme. The sacred forests are also of great silvicultural interest as indicators of the natural productivity of the region. It is, therefore, imperative to survey these sacred forests and properly assess their role in nature conservation so that these forests may continue to be preserved even if the religious beliefs associated with them weaken and may disappear.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the willing help received from many officials of the Maharashtra State Forest Department in our survey of the sacred groves of Maharashtra. We would particularly like to mention Shri V. D. Mehendale, Additional Chief Conservator of Forests for Maharashtra, without whose interest this project could not have been pursued. Many others have helped with information and these have been acknowledged in the text. We are also thankful to Drs. G. B. Deodikar and T. S. Mahabale for their encouragement and for generously supporting this research through the facilities of the Maharashtra Association for the Cultivation of Science.

Hunting and feeding in wild dogs¹

MICHAEL FOX² AND A. J. T. JOHNSINGH³
(With a graph)

These observations are based on our preliminary study of the Indian Wild Dog (*Cuon alpinus*) in the Mudumalai Sanctuary, Tamil Nadu.

Wild Dogs at Mudumalai usually hunt in the early hours of the morning between 6 and 8 a.m. They generally avoid strenuous activity during the heat of the day, seeking shade under rocks, dense underbrush or lying in along the banks of a river. This behavioural thermoregulation greatly influences the daily activity and movements of these dogs living in the tropical and subtropical regions. In cooler seasons they may be active and hunt at any time of the day. They rarely hunt at night but are most active on moonlight nights. This implies that they rely greatly on the sense of sight for hunting. But, in fact, all senses including those of sound and smell, are used flexibly without any particular specialization on any one modality.

During our two month study we were lucky to see a vain attack by wild dogs on a gaur calf which was protected by the determined mother and other members of the herd. Yet the agility and tenacity of the wild dogs gave us an idea of how they tackle a large prey such as the spotted deer or sambar. Further, four fresh kills were discovered before the vultures and other scavengers had arrived to remove everything. They were in varying degrees of mutilation and by the various signs that the dogs had left it was possible to piece together how the prey is brought down and dismembered.

It is highly probable that one of the dogs seizes the deer by the nose, which, like a twitch on a horse, must greatly inhibit its movements. Other dogs attack the hind end, biting the thighs, buttocks and flanks. One dog may secure a hold on the tail and with the other on the nose, one or two dogs on the ears and the rest of the pack pulling at the prey's flanks and hind quarters, a tug-of-war ensues. The prey is pulled down and if it is a fawn it is literally torn apart. There is no killing bite as in the big cats to dispatch the prey swiftly. The wild dogs, although they

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have powerful jaws, have relatively short canine teeth which could not be used to serve the spinal cord of larger prey. These shorter canine teeth, aided by the outer upper incisors which are curved and have evolved into a pair of secondary canines, enable the wild dog to secure a hold on the prey. The sight of several dogs securely attached to the prey and pulling, twisting and tearing at it, has shocked many a hunter who sees the wild dog as bloody killers. They are indeed messy, having no clean and efficient way of killing their prey.

When the flanks are torn open, the prey may be eviscerated as it struggles or is dragged along the ground by other dogs at the head end. The liver, kidneys and the lungs may be eaten and some sections of the intestines except the stomach and rumen which are torn out and left untouched. Similarly with the wildpig, the stomach was untouched by the dogs. The dogs may eat portions of the animal that are torn off as it struggles. Hence the frequent observation that the wild dog will even eat their prey while it is still alive.

The eyelids and eyes may also be eaten. It has been said that the dogs bite out the eyes of the deer and blind them first. Considering the difficulty a wild dog would have in seizing the eyeball, retracted deep into the orbit by retractor oculi muscles as a defensive reflex, this interpretation is unlikely. Rather the dogs remove the eyes when the prey is dead or immobilized in shock, prior to death.

In the absence of a killing bite, what physical stimulus kills the prey? Young fawns suffering from multiple bite injuries have been rescued from wild dogs and they have recovered; others have 'played dead' (the tonic immobility reaction) and suffering from less extensive injuries, were able to run off, once the dogs were chased away. (Davidar: personal communication). Presumably the prey goes into a state of shock, death ensuing rapidly after evisceration, this latter not being the major physical stimulus that kills the prey. In the absence of evisceration, the onset of shock may be prolonged and wild dogs would have to fight with the prey longer and, possibly, sustain injuries themselves during the attack. What more efficient method then, in the absence of more effective weapons, than to disembowel the prey? An understanding of these facts will hopefully give to the hunter and naturalist a clearer understanding of why the wild dogs seem to be such bloody killers.

Analysis of wild dog faeces shows the presence of fur, skin, hooves, and teeth of fawns and large quantities of digested bone, which has the consistency of fine chalk. It would be highly adaptive for the wild dogs to ingest fur to protect the alimentary tract from possible injury, especially from the extremely sharp bone spicules from small mammals. It was often with much difficulty that we were able to remove the matted fur that formed tight wads and balls around these splinters of bone. Clearly, if carnivores in captivity are fed on small mammals such as

hares, the carcass should not be skinned but left intact so that the ingested fur may be used to form a protective bolus around any fragments of ingested bone.

The composition of successive stools passed by one dog reflected even more of their eating habits. Some stools contained little or no hair, but mainly dark digested meat protein and occasional strips of partially digested muscle and tendon. Other stools contained fur and a lower proportion of digested protein and bones. Bone fragments were never found in those stools that contained no hair. From this we may conclude that the dogs either purposefully ingested quantities of hair when they also crushed and swallowed bones or in the process of digestion the fur aggregates around the bone fragments and are usually voided together and separate from the meat portion of the meal. Fragments of skull, teeth, claws and ocular lenses embedded in fur attested the fact that small mammals were eaten whole.

A high proportion of sambar remains included ingested grass (*Iseil-ema prostratum*). One faecal sample contained only grass and twigs; this dog was probably sick since the stool was liquid. The only other vegetable matter ingested in a significant amount was the fruit of *Zizyphus*, which was present in one sample. This fruit is commonly eaten by langur, bonnet macaque, porcupine, spotted deer, pigs and bear. Some fragments of grass, seeds, twigs and bamboo leaves were found in many of the faeces and their presence was probably accidental since a wild dog eating its prey on the ground is bound to pick up such material.

There is no satisfactory answer as to why carnivores eat grass. Like fur it may be an anti-irritant. Grass may also be an important source of vitamins and trace elements not available in the all meat diet, since the stomach contents of chital and pig were not eaten. We were not able to ascertain whether or not the wild dog eviscerated small mammals before eating them but this was certainly the case with the deer and the wild pig.

To determine the predation by wild dog on the deer population of our study area we collected the pelvises and lower jaws of deer. Of the sixty-three pelvises collected fifty-six were chital and the remaining seven sambar. Sex ratios were 23 male to 33 female chital and 5 female to 1 male sambar. (One fragment of pelvis could not be sexed).

In order to gain some insight into the degree of maturity of these kills pelvic index was taken by measuring the distance from the top (anterior rim) of the acetabulum or hip joint and the bottom of the obturator foramen. This index was chosen since it was the most intact region—the ilium and ischium usually being chewed and splintered by the dogs (text figure).

From the figure, it appears that pelvises with an index less than 7.5 cm would be ingested entirely by the wild dogs, since no remains were

found in the field (with the exception of a 2-3 month old fawn killed by three dogs near our camp). This conclusion may not be warranted since a pelvis of 7.5 cm index would be well ossified especially at the region of the acetabulum and could not therefore be easily ingested. It is quite possible then, that wild dogs do not kill many sub-adult fawns with a pelvic index of 6.5-7.5 cm. But this conclusion also may not be warranted, since the field samples were taken in the spring and most fawns would not attain this pelvic index until late summer or autumn. The absence of such remains in the spring collection in this study is an open question. We do not know how long moderately calcified bones remain intact. Their half life may be as short as 2-3 months, since many scavengers, notably porcupines and small rodents, will ingest such bones which constitute a rich source of mineral salts essential to their diet.

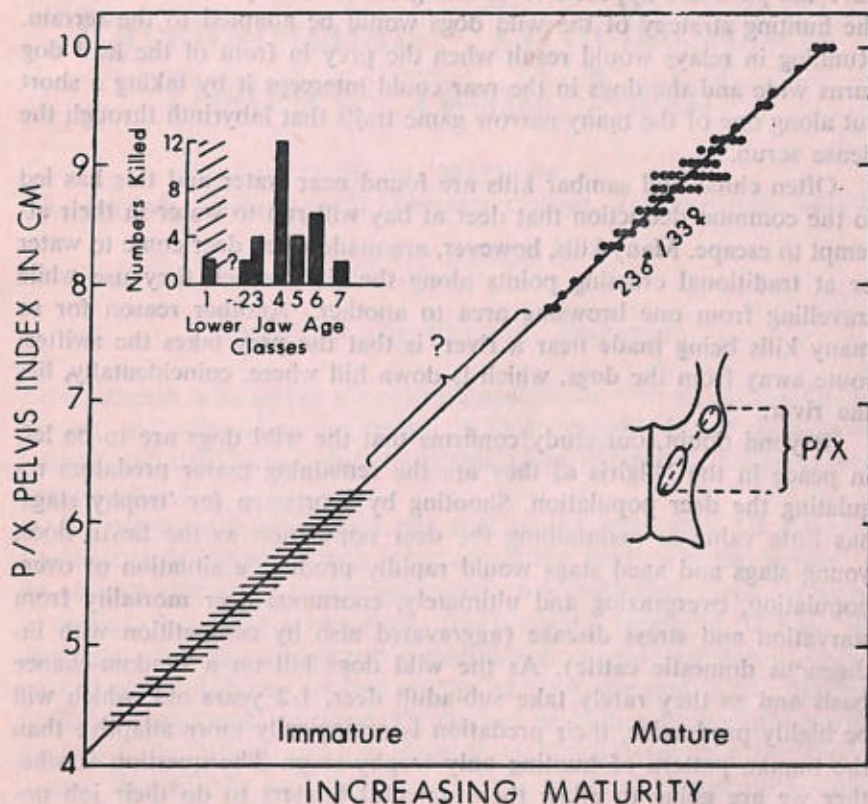
A similar age gap was found in the samples of lower jaws. The same arguments posed above hold for the absence of sub-adult jaws in the collection. Interestingly enough the greatest proportion of kills was in the 4-6 year (prime) age group. This may not be an indication that the wild dogs selectively kill animals of this age, but rather that the majority of animals in the herds fall (with the exception of the large annual fawn crop) within this age group. This conclusion is supported indirectly by the Nilgiri Game Association records of the number of chital shot each year. The numbers have increased greatly over the last few years, indicating that there must be more individuals in the herds which fall into this highly productive age range.

The age classes of kills identified from lower jaws are shown in the figure and this follows Schaller's (1967) age classification based on the wear on various teeth. Class I represents the fawns and in most of these kills the jaws are eaten by the dogs, since we found only two specimens. Classes 2 and 3 are yearlings and young adults and classes 4, 5 and 6 represent prime adults. Class 7 is past prime. Interestingly no really aged specimens were found, indicating that chital in the Nilgiris rarely live over 8 or 10 years of age.

Only eight lower jaws of the Sambar were collected in contrast to 31 lower jaws of the chital and all of these were subadults. Analysis of faeces confirmed the fact that the chital was the most commonly killed prey during the period of study. We were wary about collecting too many faecal samples from the packs because this might have had some effect on their marking behaviour since the faeces were deposited mainly at communal dunging areas.

The ratio of chital to sambar remains found in the faeces was very close to the ratio of chital to sambar pelvises that were collected in the field (approximately 10:1.5 or for every twenty chital killed three sambar). This ratio accords with the lower population of sambar and with the fact that these deer are very large and powerful and difficult for the

wild dogs to bring down. Presumably the wild dogs kill mainly fawns and subadult sambar since no adult lower jaws were found in the study area.



Graph showing age classes of lower jaws and pelvises.

With greater expertise we might have been able to distinguish between the fur of chital fawns, subadults and adults but this was not possible. Judging from the number of faeces containing digested calcium (from the bones of ingested fawns) the ratio of fawns to adults during the period December-February in the samples was in the ratio of 2:1. A complete tail of a fawn, many small tarsal and carpal bones and undigested hooves were commonly found in these faeces.

It has been said that on a long chase the wild dogs run after the prey in relays and this may be a misinterpretation of canid hunting behaviour and has been clarified somewhat by Hugo & Jane van Lawick's observations of cape hunting dogs in their book *THE INNOCENT KILLERS*. As the prey zig-zags in front of the pack it comes closer to some dogs than to others; the closest dog takes up the chase until the prey

again turns wide and another dog closer to it will take over. The open plains of Serengetti where the cape hunting dog lives is very different from the jungle habitat of the wild dog, although a few small clearings have the park-like appearance of this great African plain. Consequently the hunting strategy of the wild dogs would be adapted to the terrain. Running in relays would result when the prey in front of the lead dog turns wide and the dogs in the rear could intercept it by taking a short cut along one of the many narrow game trails that labyrinth through the dense scrub.

Often chital and sambar kills are found near water and this has led to the common deduction that deer at bay will run to water in their attempt to escape. Many kills, however, are made when deer come to water or at traditional crossing points along the river which they use while travelling from one browsing area to another. Another reason for so many kills being made near a river is that the prey takes the swiftest route away from the dogs, which is down hill where, coincidentally, lies the river.

Beyond doubt, our study confirms that the wild dogs are to be left in peace in the Nilgiris as they are the remaining major predators regulating the deer population. Shooting by sportsmen for 'trophy stags' has little value in maintaining the deer population as the fawn, does, young stags and aged stags would rapidly produce a situation of overpopulation, overgrazing and ultimately, enormous deer mortality from starvation and stress disease (aggravated also by competition with indigenous domestic cattle). As the wild dogs kill on a random-chance basis and as they rarely take sub-adult deer, 1-2 years old, which will be highly productive, their predation is ecologically more adaptive than the human pattern of hunting only trophy stags. The question is whether we are going to allow these graceful hunters to do their job undisturbed.

REFERENCE

- SCHALLER, G. B. (1967): *The Deer and the Tiger*. University Press, Chicago.

A contribution to the Flora of Pacchaimalais, Tiruchirapalli District, Tamil Nadu¹

K. M. MATTHEW

The Rapinat Herbarium, St. Joseph's College, Tiruchirapalli 620 002

(With a map)

SITUATION AND PHYSICAL FEATURES

Tiruchirapalli is an inland district of Tamil Nadu, with an area of 14,281 sq km, and comprising the taluks of Tiruchirapalli, Karur, Kulithalai, Lalgudi, Musiri, Perambalur, Udayarpalayam, Alangudi, Kulathur and Thirumayam.

Forests occupy less than 7 per cent of the total area. Of this, the Pacchaimalais ('green hills') lying along the north-western border of the district and rising to 950 m account for the larger share. Irregular in outline, they have a maximum (north-south) length of 32 km. "In plan, the range has a very rude resemblance to an hour-glass in shape, being nearly cut in two by two ravines of great size and depth, opening to the northeast and southwest. Of the two parts thus formed, the north-western is the larger, and has generally a higher level than the south-eastern. Besides the rambling shape of the range, the most noteworthy and striking feature is the great steepness of the western slopes compared with those of the east, which are rarely precipitous, and are broken by sundry long buttress-like spurs, projecting far into the low country" (King & Foote 1864). The total area is 480 sq km of which 274 are in the Tiruchirapalli district, and 206 in the Salem district. The entire southern slopes and parts of the eastern and western slopes fall within the Musiri taluk of the Tiruchirapalli district. The Pacchaimalais of the Tiruchirapalli district are separated from the Kollimalais of the Salem district by the narrow Thammampatty valley.

Situated 70 km from the town of Tiruchirapalli and at the foothills of the Pacchaimalais is the small village of Sobanapuram. At the centre of the plateau of the Pacchaimalais is the village of Top Sengattupatty, with an Inspection Bungalow the only place suitable for camping on the

¹ Accepted March 1971.

plateau. The two villages are connected by a 10 km bridle path, now being replaced by a motorable road.

Soil: The rocks are gneissic, with pockets of cretaceous sedimentary deposits. The soil varies in texture from sandy loam to loam. On the slopes it is dry, stony, poor in humus, and even less than 1 m deep, while the plateau has deep sandy loam with a good admixture of humus. There has been considerable erosion, accelerated by various forms of mismanagement like overexploitation, overgrazing, or even destruction of forests for shifting cultivation.

Climate: Whereas the district as a whole is characterized by a warm climate with low humidity, the Pacchaimalais have a relatively moderate climate owing to altitude and vegetation.

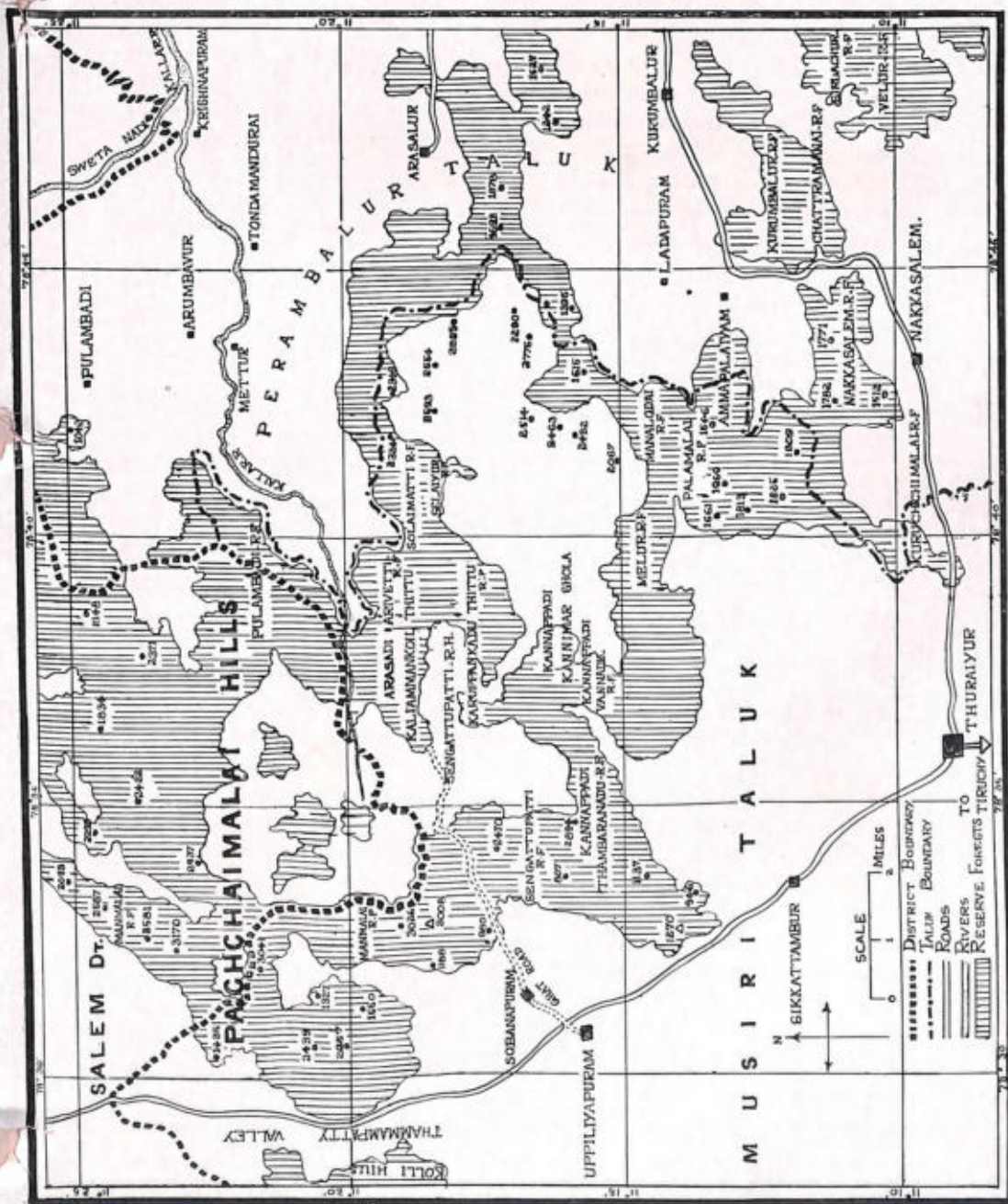
More than half of the mean annual rainfall of about 130 cm is received during the northeastern monsoon in October-November. The southwest monsoon is generally light; occasional summer showers also occur. The plateau is said to be malarial.

People: The portion of the Pacchaimalais within the Tiruchirapalli district has three *nadus* or groups of villages—Vannadu with 19 villages, Tanparanadu with 16 and Kambainadu with 13. The inhabitants are 'Malaiyalees' ('hill men'). Agriculturists of the hills (cultivating just the mere essentials of subsistence like cereals and pulses), sparsely dressed, speaking a dialect of Tamil, these people are a well-knit group, with their own family, social and religious customs and agricultural practices. Education or anything like modern amenities have scarcely reached them; their only contact with the outside world is the weekly trek down the hills to the plains for marketing. The general shyness of these people hides a great store of unassumed friendliness. Sociologists will find the habits, customs and community organization worth study.

Vegetation: The forests are of the *Southern Tropical Dry Deciduous* (Champion 1961) type. Below 450 m the forests, within easy access of the villages around, are much degraded owing to heavy grazing or random fellings. The vegetation is rather sparse and regeneration poor. Among the more dominant species are *Acacia leucophloea*, *Chloroxylon swietenia*, *Dichrostachys cinerea*, *Erythroxylon monogynum*, *Zizyphus leucopyrus*, *Tamarindus indica*, *Randia dumetorum*, *Memecylon edule* and *Dodonea viscosa*.

On the upper slopes, however, the forests are denser owing to better growth conditions and less interference; besides the species mentioned, are *Maba buxifolia*, *Murraya koenigii*, *Carissa spinarum*, *Elaeagnus indica*, and *Scutia circumcissa*. Sandalwood is the main item of forest revenue in these forests. Bamboos are occasionally present; the few climbers are large and woody; ferns and epiphytes are scarce except at the higher altitudes.

Patches of *Southern Subtropical Hills Forests* occur in the plateau



Map of the Pachchaimalai Hills.

areas of Karuppankadu Thittu and Sholamadevi, where annual rainfall exceeds 120 cm, and trees exceed 20 m tall, with a lower shrubby, mostly evergreen, layer.

There has been considerable human interference in the form of destruction of forests for shifting cultivation. One obvious consequence is the invasion of *Lantana camara* var. *aculeata* and *Dodonea viscosa*. *Stachytarpheta urticaefolia* is the most conspicuous weed of neglected gardens, where they form dense masses. Exotic ornamental species are scarce. The first plant colonizers on the motor road under construction are *Tridax*, *Vernonia*, *Tephrosia*, *Corchorus*, *Dolichos*, *Ipomoea*, *Sida* and several species of grasses.

The crops of the plateau consist of cereals like *Oryza sativa*, *Pennisetum typhoides*, *Sorghum vulgare*, *Eleusine corocana*, *Setaria italica*, *Panicum miliare*, *Paspalum scrobiculatum*; pulses and vegetables like *Dolichos lablab*, *Vigna sativa*, *Phaseolus mungo*, *Phaseolus radiatus*, *Dolichos biflorus*, *Brassica juncea*, *Capsicum annuum*; and cash crops like *Sesamum indicum*. Coconut and bananas are seen around habitations.

The presence of some very old trees of *Terminalia* spp., *Artocarpus heterophyllus*, *Ficus bengalensis*, *Diospyros* spp. suggests that certain tracts of the interior have not been tampered with; even in the villages themselves, the scarcity of introduced species, of economic or aesthetic value, is noteworthy.

The Scope of the Present Exploration

The Pacchaimalais have so far not been exhaustively explored (Sebastine & Henry 1961) though the region does show certain interesting features. There are several species of restricted distribution that verge on the endemic; many more species are new records to the Tiruchirapalli district.

Ethnobotanical studies have considerable scope here on account of the intimate knowledge of plants possessed by the Malaiyalees. Deprived of modern medical amenities, these people depend on plants for medicines. The fact that each family seldom has more than a child or two, may suggest that the people depend on some plant of contraceptive value. Certain individuals in every village are known for their intimate knowledge of plants—in fact the author realized that such a Malaiyalee companion was indispensable for good field work. The local names and uses of plants given below are largely taken from data given by such a field assistant.

The distributional notes under each species are given under one of three headings: 'at the foothills' (chiefly around Sobanapuram), ('on the slopes' (ghats), and/or 'on the plateau' (chiefly at Top Sengattupatty, Karuppankadu Thittu, Kalamankovil Thittu, Masimalaiyan

Thittu and Kannimar Shola). The notes refer to the actual places of collection *without* suggesting anything about the overall distribution of the species on the Pacchaimalais. The paper summarises the work of two collection trips—in December 1969 and July 1970. It is of a preliminary nature, reporting the first attempts towards an eventual *Flora* of the district.

Identification of the plants was done personally by me at the Madras Herbarium, Coimbatore. The collections are preserved in the Rapinat Herbarium, St. Joseph's College, Tiruchirapalli. The following enumeration consisting of 349 species from 269 genera belonging to 82 Families follows Gamble & Fischer (1956) for the order of the Families; genera and species are given in alphabetical order. Nomenclature has been brought up to date as far as possible; Tamil names, given in brackets closely following the botanical name, have generally been collected or verified in the field, failing which they have been taken from Seshagiri Rao & Krishnaswamy (1941).

ENUMERATION OF SPECIES

RANUNCULACEAE

Clematis gouriana Roxb. ex DC.

An extensive climber; leaves highly variable in shape; flowers white, in dense axillary or terminal panicles; common on the plateau.

Naravelia zeylanica DC.

On the upper slopes and on the plateau; usually spreading on thickets, etc.

MENISPERMACEAE

Cissampelos pareira L. (Appatta)

A tomentose climber; on the plateau.

Cyclaea peltata (Lamk.) Hook. f. & Th.

A climbing shrub with peltate leaves; on the plateau.

Diploclisia glaucescens (Bl.) Diels

A woody climber with small yellow flowers on the old stem; on the plateau.

Stephania japonica (Thunb.) Miers

A climber with small flowers in axillary umbels; on the plateau.

CAPPARACEAE

Capparis sepiaria L. (Thoratti)

A large straggler with hooked thorns and small white flowers; the petals fall early; on the upper slopes and on the plateau.

VIOLACEAE

Hybanthus enneaspermus (L.) F. Muell. (Orilalthamarai)

(*Ionidium suffruticosum* Ging)

A small herb with solitary pink flowers; along the slopes.

BIXACEAE

Flacourtia indica (Burm. f.) Merr. (Sothaippallu; Sottaikala)

(*F. sepiaria* Roxb.)

A dense shrub with small green flowers; fruits said to be harmful to teeth; abundant on the plateau.

Scolopia crenata Clos.

An armed tree up to 8 m tall; flowers small, white, with spreading stamens and thick styles; abundant on the plateau.

PITTOSPORACEAE

Pittosporum floribundum Wt. & Arn. (Kattusampangi)

A tree up to 12 m tall, with white flowers in terminal panicles; on the plateau in the forests.

POLYGALACEAE

Polygala javana DC.

Several branches from a woody base; flowers relatively large, pink; plants seldom seen entire owing to grazing; common on the slopes.

MALVACEAE

Hibiscus vitifolius L. (Manithuthi)

A shrub with yellow flowers; on the plateau, near habitations.

Malvastrum coromandelianum Garcke

A weed of wastelands on the plateau.

Pavonia procumbens Boiss.

An undershrub with white flowers; on the slopes and on the plateau.

Pavonia zeylanica Cav. (Mammatti)

An undershrub with pinkish flowers; on the slopes.

Sida rhombifolia L. (Tenacham)

A shrub with yellow flowers; on the slopes and on the plateau.

Urena lobata L. (Ottati)

A weed of wastelands; flowers pinkish.

STERCULIACEAE

Helicteres isora L. (Valambiri)

A tree up to 10 m tall, with red flowers and spirally twisted follicles; on the plateau.

Pterospermum obtusifolium Wt. (Mulipolavu)

A small tree on the slopes; reported to be scarce by Gamble.

Pterospermum xylocarpum (Gaertn.) Sant. & Wagh (Odupai)

(*P. heyneanum* Vahl)

A tree of the plateau forests; numerous seedlings as undergrowth.

Waltheria indica L.

An undershrub with reddish stems and yellow flowers; one of the first colonizers on the freshly cut road.

TILIACEAE

Corchorus ? olitorius L. (Sanal; Peratti)

Robust specimens seen along the newly cut ghat road; not seen elsewhere.

Corchorus tridens L.

Same as above.

Grewia disperma Rottl. ex Spreng. (Anaikkatimaram)

A small tree; fruit conspicuously 2-lobed, covered with golden tomentum.

Grewia emarginata Wt. & Arn.

A large shrub with leaves whitish on the undersurface.

Grewia flavescens Juss. (Karichili)

A small tree with yellowish flowers; on the slopes.

Grewia orientalis L.

A shrub with long arching branches and white flowers; throughout the range.

Grewia rhamnifolia Heyne

A tree; throughout the range.

Grewia tiliifolia Vahl (Thadachi)

A tree of the plateau forests.

Grewia umbellifera Bedd.

A shrub up to 4 m tall; on the plateau.

LINACEAE

Hugonia mystax L. (Moithirakkanni)

A straggling shrub with extensive branch system spreading on the trees; flowers bright yellow, showy, aggregated at the apices of branches; fruits red when ripe; on the slopes.

Erythroxylon monogynum Roxb. (Sembulichai)

A spreading shrub up to 3 m tall; flowers yellow; ripe fruits red; throughout the range.

MALPIGHIACEAE

Hiptage madablota Gaertn. (Kurukathi)

A woody straggler; leaves said to be used for smoking by the local people; on the plateau.

GERANIACEAE

Oxalis corniculata L. (Puliyarai)

A diffuse creeper with yellow flowers; common on the plateau.

RUTACEAE

Atalantia monophylla Correa (Kattu Elumichi)

An armed tree up to 12 m tall; on the plateau.

Chloroxylon swietenia DC. (Vamparai)

A large shrub or small tree with pinnate leaves; the dehisced capsules persist for long; throughout the range.

Clausena dentata (Willd.) R. & S. (Aanai)

C. willdenovii Wt. & Arn.

A large shrub or small tree; aromatic leaves said to hasten the ripening of fruits like bananas in storage; on the plateau.

Evodia lunu-ankenda (Gaertn.) Merr. (Kattushanbagam)

A densely foliaceous tree over 20 m tall, with copious flowers; on the plateau.

Feronia limonia (L.) Swingle (Vilamaram)

F. elephantum Correa

Occasional trees on the plateau.

Glycosmis cochinchinensis Pierre (Kulapanai)

A large shrub or small tree up to 5 m tall; on the slopes and on the plateau.

Murraya koenigii (L.) Spr. (Karuveppilai)

A shrub with aromatic leaves used in cooking; one of the most dominant species on the plateau.

Pleiospermium alatum (Wall. ex Wt. & Arn.) Swingle

Limonia alata Wt. & Arn.

A densely foliaceous tree with winged leaves; throughout the range.

Toddalia asiatica Lam. (Milagaranai)

A prickly straggler with greenish flowers; on the plateau.

OCHNACEAE

Ochna ? squarrosa L. (Kalkuruvi)

A large shrub or small tree with yellow flowers; on the plateau.

BURSERACEAE

Commiphora caudata (Wt. & Arn.) Engl. (Pachaikkiluvai)

A large shrub or small tree, the thin bark flaking off exposing the green bark; on the slopes.

MELIACEAE

Aglaia elaeagnoidea (Juss.) Benth. (Chokla)

A. roxburghiana Hiern.

A tree over 15 m tall, in the forests of the plateau.

Cipadessa baccifera (Roth.) Miq. (Savattuchedi)

A shrub of the forest margins on the plateau.

Soyimida febrifuga Juss. (Somadanam)

A tree over 12 m tall with large, ovate, woody capsules; planted at the Top Sengattupatty Rest House.

OLACACEAE

Olax scandens Roxb. (Kadalranchi)

A thorny shrub with arching branches and yellowish flowers; at the foothills.

OPILIACEAE

Cansjera rheedii Gmel.

An armed shrub with arching branches and dark green leaves; on the plateau.

Opilia amentacea Roxb.

A straggler with pendulous racemes and oblong drupes.

CELASTRACEAE

Celastrus paniculata Willd. (Manjakadi)

A straggler with crenulate leaves, and white flowers in pendulous panicles; throughout the range.

Elaeodendron glaucum Pers. (Kanniramaram)

A tree of the plateau forests.

Maytenus emarginata (Willd.) Ding Hou

Gymnosporia emarginata Laws.

A common shrub of the plateau; the thorns on the apical portions of shoots are longer, and bear leaves and flowers.

Maytenus heyneana (Roth.) Raju & Babu

Gymnosporia heyneana Laws.

A woody shrub with woody thorns up to 3 cm long on the older stem; on the plateau.

RHAMNACEAE

Sageretia filiformis (Roth.) Don

S. parviflora R. Br.

A shrub with arching branches; on the slopes.

Scutia circumcissa (L.f.) Druce (Kokkimullu)

S. myrtina Kurz

A strongly armed shrub abundant on the slopes.

Ventilago maderaspatana Gaertn. (Vennyangodi; Karadikkodi)

A climbing shrub; on the plateau.

Zizyphus oenoplia Mill. (Kattu Elanthai; Churaimullu)

A large, very thorny shrub; throughout the range.

Zizyphus xylopyrus Willd. (Kottai Ilanthai)

A tree of the foothills with velvety leaves when young and large fruits.

VITACEAE

Cayratia pedata (Vahl) Gagnep. (Kattupirandai)

A scandent shrub with pubescent leaves; on the plateau.

Cissus quadrangularis L. (Perandai)

The leaves are notably persistent; on the slopes.

Cissus vitiginea L.

A trailing shrub along the slopes.

Leea crispa L.

A shrub usually at the borders of forests, on the plateau.

SAPINDACEAE

Cardiospermum canescens Wall.

Mature capsules globose, not winged; on the plateau, not common.

Cardiospermum halicacabum L. (Modakkathan)

Mature capsules elongated, winged; at the foothills and on the slopes.

Dodonea viscosa L.

Abundant in the forest clearings on the plateau.

Filicium decipiens Thw. (Athadali)

A densely foliaceous tree of the plateau forests.

Sapindus emarginatus Vahl (Naikottai)

A tree yielding fruits which are locally used as substitute for soap; throughout the range.

Schleichera oleosa (Lour.) Oken.

S. trijuga Willd.

A large tree over 30 m tall; on the plateau.

ANACARDIACEAE

Rhus mysorensis Heyne (Chippamaram; Sappula)

An armed, dense shrub with numerous arching branches and small, yellowish flowers.

MORINGACEAE

Moringa oleifera Lamk. (Murungai)

Planted near habitations on the plateau.

PAPILIONACEAE

Alysicarpus ? longifolius Wt. & Arn.

A stout undershrub with prominently veined leaves; along the slopes.

Alysicarpus vaginalis (L.) DC. var. **nummularifolia** Baker

A herb of unweeded gardens, pasture lands, etc.; on the plateau.

Atylosia albicans Benth.

A twiner noted for the whitish foliage and large yellow flowers; abundant on the plateau.

Canavalia ensiformis DC. (Valavarai)

A twiner from the woody base; flowers purple; along the slopes and on the plateau.

Crotalaria medicaginea Lamk.

A low herb with rather showy yellow flowers; throughout the range.

Crotalaria nana Burm.

A prostrate herb with small, yellow flowers; on the plateau, in pasture lands.

Dalbergia paniculata Roxb. (Porapatchalai)

A tree on the slopes; not common.

Desmodium gangeticum (L.) DC. (Pulladi)

An erect undershrub with lilac-tinged flowers; on the plateau.

Desmodium triflorum (L.) DC. (Sirupulladi)

A profusely branched creeping herb, rooting at the nodes, forming dense mats on the ground; flowers purple; on the plateau.

Dolichos falcatus Klein ex Willd.

A wiry twiner on the slopes and on the plateau; flowers yellow.

Indigofera colutella (Burm. f.) Merr.

I. viscosa Lamk.

A branched subshrub along the slopes; flowers red.

Indigofera cordifolia Heyne

A prostrate herb conspicuous for the silky white foliage; abundant at the foothills.

Indigofera linifolia Retz.

A prostrate, well-branched herb; abundant at the foothills.

Mucuna atropurpurea DC. (Kakkavali)

A woody climber; pods covered with yellow to brown irritant bristles; pods 2-seeded; on the plateau.

Pongamia pinnata (L.) Pierre (Pungu)

P. glabra Vent.

A densely foliaceous tree, with tubercled bark; on the plateau.

Tephrosia hirta Ham.

An erect subshrub of the foothills and slopes.

Tephrosia tinctoria Pers.

A pubescent subshrub from a woody stock; flowers red; on the plateau.

Zornia gibbosa Span.

Z. diphylla (L.) Pers.

A diffuse herb with yellow flowers and prickly pods; foothills and slopes.

CAESALPINIACEAE

Bauhinia racemosa Lamk. (Athi)

A deciduous tree up to 10 m tall; common at the foothills.

Caesalpinia crista L. (Kalachikkai)

A very thorny, massive straggler with yellow flowers; along the slopes.

Caesalpinia decapetala (Roth.) Alst. (Putthadukki)

C. sepiaria Roxb.

A very pubescent thorny shrub ascending to several metres along nearby trees, etc.; flowers yellow; on the slopes and on the plateau.

Cassia auriculata L. (Aavaram)

A shrub less than 1 m tall; flowers bright yellow; common in open ground at the foothills. Plants in the areas are notably smaller than elsewhere in the district.

Cassia fistula L. (Sarakkonnai)

Stray trees on the plateau; apparently less luxuriant than in the plains.

Cassia occidentalis L. (Ponnavarai; Thagarai)

In wastelands near habitations on the plateau.

Cassia siamea Lamk. (Manjakkonnai)

A tree with bright yellow flowers and coppery pods; on the plateau.

Delonix regia (Boj.) Raf. (Valnarayanamaram)

Stray trees near habitations on the plateau.

Pterolobium indicum A. Rich. (Karu Indu)

A very thorny straggler with white flowers and reddish young pods; really abundant at the foothills and along the slopes.

Tamarindus indica L. (Puli)

At the foothills, as an avenue tree.

MIMOSACEAE

Acacia chundra (Roxb.) Willd. (Karungali)

A. sundra DC.

A tree with copious yellowish flowers; very abundant at the foothills.

Acacia pennata (L.) Willd. (Vellai Indu)

A very thorny straggler with white flowers; common and abundant at the foothills.

Albizia amara Boiv. (Usil)

A deciduous tree up to 10 m tall, with whitish flowers; foothills and slopes; pods used as substitute for soap.

Dichrostachys cinerea Wt. & Arn. (Vidathalam)

A thorny shrub or tree with spicate flowers pink below and yellow above; common at the foothills.

Mimosa pudica L. (Thottalsurungi)

Common wayside weed on the plateau.

Mimosa rubicaulis Lamk. (Kattusikkai)

A very thorny straggler, near fences; flowers pink.

CRASSULACEAE

Bryophyllum pinnatum Kurz. (Ranakkalli)

In moist, shady ground rich in humus; on the plateau.

COMBRETACEAE

Anogeissus latifolia Wall. (Vellainagai)

A large, deciduous tree; on the plateau.

Terminalia arjuna Wt. & Arn. (Vellamaruthu)

A large, usually buttressed tree, over 30 m tall; on the plateau, near rivulets.

Terminalia chebula Retz. (Kadukkai)

A large tree over 30 m tall, common in the forests of the plateau; fruits yield a local tanning material.

Terminalia paniculata Roth. (Pulavaimaram)

A large tree over 35 m tall, with dark corrugated bark, heavy horizontally spreading branches, and brown, winged fruits; on the plateau.

MYRTACEAE

Psidium guajava L.

Planted on the plateau.

Syzygium cumini (L.) Skeels (Navalmaram)

S. jambolanum DC.

A large tree over 25 m tall; near streams on the plateau.

LECYTHIDACEAE

Careya arborea Roxb. (Aamimaram)

A densely foliaceous tree up to 15 m tall; on the plateau.

MELASTOMATACEAE

Memecylon edule Roxb.

A large shrub or small tree with blue flowers and dark purple fruits; on the plateau.

Memecylon umbellatum Burm. f. (Kasamaram)

A shrub with yellowish leaves and small, yellow berries.

LYTHRACEAE

Ammannia baccifera L. (Neermael Neruppu)

In paddy fields; on the plateau.

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven

Jussiaea suffruticosa L.

An erect, pubescent undershrub, with green stems; in marshy places on the plateau.

Ludwigia perennis L. Roxb.

L. parviflora

A decumbent, glabrous herb with purple stems, reddish leaves and yellow flowers; in the marsh on the plateau.

PASSIFLORACEAE

Passiflora calcarata Mast.

Along thickets, etc., on the plateau.

CUCURBITACEAE

Melothria heterophylla (Lour.) Cogn. (Pulivanji)

A climber with polymorphic leaves and striped fruits; on the plateau.

Momordica charantia L. (Pavai)

Near habitations on the plateau.

BEGONIACEAE

Begonia malabarica Lamk.

A branched, succulent herb up to 1 m tall, with white flowers, in the crevices of rocks in the shade, at higher altitudes on the plateau.

AIZOACEAE

Mollugo pentaphylla L. (Parpadagam)

On the slopes and on the plateau. This is the only species of the genus collected on these hills.

UMBELLIFERAE

Centella asiatica (L.) Urban (Vallarai)

On the plateau, in pasturelands.

ARALIACEAE

Schefflera racemosa Harms. (Kanagi)

A large tree of the forests on the plateau.

Schefflera stellata Harms.

A straggler or a tree near rocks in the forests on the plateau.

ALANGIACEAE

A small tree, at times spinous; on the plateau.

Alangium salvifolium (L.f.) Wang. (Azhingimaram)

RUBIACEAE

Adina cordifolia (Roxb.) Hook. f. ex Brandis (Manjakkadambai)

A tree of the plateau forests.

Borreria articulata (L.f.) F.N. Will. (Nathaichuri)

B. hispida (K. Schum.); *Spermacoce hispida* L.

A hispid, procumbent herb of pasturelands; throughout the range.

Borreria ocymoides DC.

An erect herb with small white flowers; at the foothills.

Canthium dicoccum (Gaertn.) T. & B. (Naluvai; Nallamandaram)

Plectronia didyma Kurz

An evergreen tree with shining leaves; on the plateau.

Knoxia sumatrensis (Retz.) DC.

K. corymbosa Willd.

An erect herb with lilac flowers; on the plateau; rather scarce.

Oldenlandia corymbosa L.

An erect herb with white flowers on long pedicels; in pasturelands on the plateau.

Pavetta indica L. var. *montana* Thw. (Kuttippilathi)

A large, bushy shrub with white flowers; good fodder for calves and lambs; on the slopes and on the plateau.

Pavetta indica L. var. *tomentosa* Hook. f.

In the forests of the plateau.

Plectronia parviflora Bedd. (Mullukkarai)

A thorny shrub; galls often present; on the plateau.

Randia dumetorum Lamk. (Karai)

A thorny shrub with white flowers; abundant at the foothills.

Randia malabarica Lamk. (Sirukarai)

An erect thorny shrub with fragrant, white flowers and red fruits;

on the slopes.

Tarena asiatica (L.) Alst. (Therani)

(*Chomelia asiatica* Kze.)

A large shrub with shining leaves, drying black; on the plateau.

Xeromphis spinosa (Thunb.) Keay

(*Randia brandisii* Gamb.)

A large shrub with prominently veined leaves; mature fruits 4 cm across; on the plateau.

COMPOSITAE

Acanthospermum hispidum DC. (Multhulasi)

A weed of wastelands, especially near habitations; on the plateau.

Ageratum conyzoides L. (Poompillu)

A gregarious herb in unweeded gardens; heads white or violet; on the plateau.

Bidens pilosa L.

A weed of cultivation; on the plateau.

Blainvillea acmella (L.) Philipson

(*B. rhomboidea* Cass.)

A scabrid subshrub with white heads; on the plateau.

Blumea bifoliata DC.

A bushy herb in wasteland near habitations; rays yellow; on the plateau.

Blumea lacera DC. var. **glandulosa** Hook. f. (Narakkarandai)

A glandular hairy herb, abundant in unweeded gardens; heads yellow; on the plateau.

Eclipta prostrata (L.) L.

(*E. alba* Hassk.)

A herb of moist places; heads white; on the plateau.

Emilia sonchifolia (L.) DC. (Mulsevi)

A soft-pubescent herb of pasturelands, etc.; on the plateau.

Erigeron bonariensis L.

(*E. linifolius* Willd.; *Conyza ambigua* DC.)

An erect, sparsely branched herb of unweeded gardens; on the plateau.

Notonia grandiflora DC.

A robust shrub over 1 m tall, with yellowish heads; on the slopes, near rocks.

Siegesbeckia orientalis L.

A weed of wastelands near habitations.

Tridax procumbens L. (Vettukayachedi)

An abundant weed near cultivated places; throughout the range.

Vernonia cinerea (L.) Less.

A common weed; heads pink turning white; throughout the range.

Vicoa indica (Willd.) DC. (Mookkuthippondu)

In unweeded gardens; heads yellow; on the plateau.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb. (Manipudpam)

A large shrub with coriaceous, shining leaves; in the plateau forests.

Embelia basaal DC.

A large shrub with arching branches covered with numerous, large lenticels; on the plateau.

SAPOTACEAE

Madhuca longifolia (L.) Macbr. (Nattu Iluppai)

(*Bassia longifolia* L.)

A large and densely foliaceous tree over 40 m tall; on the plateau.

EBENACEAE

Diospyros ebenum Koenig

A medium-sized tree with woody fruits; in the plateau forests.

Diospyros ovalifolia Wt. (Vedukanari)

A small tree of the plateau forests.

Maba buxifolia Pers. (Kattuthovarai)

A shrub or small tree from half way up the ghats; one of the most abundant species of the plateau; occasional shrubs at the foothills.

OLEACEAE

Jasminum auriculatum Vahl (Udigai)

A climbing shrub with dense clusters of white, fragrant flowers; on the plateau.

Jasminum rigidum Zenk. (Oosimalligai)

In the forests of the slopes and of the plateau; flowers white.

Jasminum ? trichotomum Heyne

A woody straggler; flowers white; throughout the range.

Ligustrum perrottetii DC.

A large shrub with white flowers; on the plateau.

Ligustrum roxburghii C. B. Cl.

A shrub up to 5 m tall, with white flowers; on the plateau.

Linociera intermedia Wt. (Musiladi)

A tree with white, fragrant flowers; on the plateau.

APOCYNACEAE

Carissa spinarum L. (Sirukila)

A shrub with white flowers on the ziz-zag branches; one of the do-

minant species throughout the range.

Catharanthus pusillus (Murr.) Don (Milagaippoandu)

(*Vinca pusilla* Merr; *Lochnera pusilla* K. Schum.)

A glabrous annual herb with white flowers; in cultivated places on the plateau.

Catharanthus roseus (L.) Don (Kallaraippoo)

(*Vinca rosea* L.; *Lochnera rosea* Reichb.)

On the plateau; the white-flowered plants are far more numerous than the pink-flowered ones.

Ichnocarpus frutescens R. Br. (Manippilangodi)

A profusely branched, climbing shrub with rusty-tomentose branches; on the plateau.

Plumeria rubra forma *acuminata* Sant. & Irani ex Shah

(*P. acuminata* Ait.; *P. rubra* forma *acutifolia* (Ait.) Woods.)

Planted near a shrine on the plateau; petals white, with shades of yellow.

Wrightia tomentosa R. & S. (Tondampalai)

A small tree, tomentose on the younger branches; on the plateau.

ASCLEPIADACEAE

Asclepias curassavica L.

Stray plants along a stream on the plateau.

Cosmostigma racemosum Wt. (Vattuvalli)

A climber with yellowish flowers; on the plateau.

Cryptolepis buchanani R. & S.

A profusely branched shrub with copious latex, yellowish flowers and green pods; on the plateau.

Cryptolepis grandiflora Wt.

A climber; on the slopes.

Cynanchum pauciflorum R. Br.

A climber; on the plateau.

Dregea volubilis (L.f.) Benth. ex Hook. f. (Kudasappalai)

(*Marsdenia volubilis* (L.f.) Cooke)

A woody climber with green flowers; on the plateau.

Gymnema hirsutum Wt. & Arn.

A climber with spirally twisted stems; on the plateau.

Gymnema sylvestre (Retz.) Schult. (Sirukurinji)

A woody climber; on the slopes.

Hemidesmus indicus (L.) Schult. (Nannari)

At the foothills; flowers yellow.

Sarcostemma acidum (Roxb.) Voigt (Kodikkalli)

(*S. brevistigma* Wt. & Arn.)

The succulent green branches seen in masses on thickets, etc.; flo-

wers noted only at the foothills, not above.

Secamone emetica R. Br. (Aatangodi; Angaravalli)

A well branched, wiry twiner in dense masses from a woody base; on the plateau.

? **Telosma pallida** (Roxb.) Craib.

A twiner with watery latex; on the plateau.

Toxicarpus kleinii Wt. & Arn.

A slender, villous, twiner with yellowish flowers.

LOGANIACEAE

Strychnos ? potatorum L.f. (Thethankottai)

A densely foliaceous tree with numerous fruit-like galls; on the plateau.

GENTIANACEAE

Exacum pedunculatum L.

A herb up to 15 cm tall; in moist ground; at the foothills.

BORAGINACEAE

Cordia evolutor Gamb.

A tree up to 6 m tall, with yellow drupes; on the slopes.

Cordia wallichii Don (Namavirai)

A tree up to 10 m tall; fruits yellowish; on the plateau.

Cynoglossum furcatum Wall.

A herb up to 1 m tall with bluish flowers on slender, elongate racemes.

Ehretia ? laevis Roxb. (Aadali)

A tree up to 10 m tall; flowers white; on the slopes and on the plateau.

CONVOLVULACEAE

Argyrea kleiniana (R. & S.) Raiz.

(*A. bracteata* Choisy)

A large climber noted for the showy, pink flowers and masses of persistent bracts; on the slopes and on the plateau.

Evolvulus alsinoides L. (Vishnukiranthi)

Common in open ground on the plateau.

Ipomoea obscura Ker.-Gawl. (Thalikodi)

A twining herb with delicate, yellowish corolla 1 cm across; on the slopes and on the plateau.

Ipomoea staphylina R. & S. (Ononkodi)

A massive climber with white flowers, dark purple in the tube; on

the slopes.

Rivea hypocrateriformis Choisy

A twiner on wayside thickets, etc.; at the foothills.

SOLANACEAE

Datura fastuosa L. (Oomathai)

Stems dark purple, somewhat succulent; in wastelands near habitations on the plateau.

Physalis peruviana L.

Plants found as new colonizers along the newly made ghat road.

Solanum giganteum Jacq.

A large shrub, white tomentose on the younger parts; flowers white; on the plateau.

Solanum khasianum Cl. var. **chatterjianum** Sengupta

A wayside subshrub; on the plateau.

Solanum nigrum L.

An annual herb with small, white flowers; on the plateau.

Solanum torvum Swartz (Sundai)

A shrub of open places on the plateau; flowers white.

Solanum verbascifolium L. (Malaichundai)

A large shrub or small tree, usually along fences; flowers white; on the plateau.

SCROPHULARIACEAE

Bacopa monnieri (L.) Penn. (Neerpirami)

(*Moniera cuneifolia* Michx.)

In marshy land on the plateau; flowers violet; opening by 9.30 a.m.

Ilysanthes oppositifolia Urban

In perennially moist ground on the plateau; flowers violet.

Limnophila ? **rugosa** (Roth.) Merr.

Notably robust specimens gregarious in marsh on the plateau; corolla purple.

Lindernia ciliata (Colsm.) Penn.

(*Ilysanthes serrata* Urban)

Abundant in marsh on the plateau; corolla purplish with a yellow blotch on the lower lip.

Lindernia crustacea (L.) F. Muell.

(*Vandellia crustacea* Benth.)

In pasturelands and unweeded gardens on the plateau.

Striga angustifolia (Don) Sald.

(*S. euphrasioides* (Vahl) Benth.)

Parasitic on *Pennisetum typoides*; flowers white; on the plateau.

Striga asiatica (L.) Kze.

Stray plants along the slopes; flowers white.

LENTIBULARIACEAE

Utricularia caerulea L.

In perennially moist ground; flowers purplish.

Utricularia ? graminifolia Vahl

On moist rocks along a stream on the plateau; flowers violet.

ACANTHACEAE

Andrographis alata (Vahl) Nees

An erect herb on the floor of the plateau forests; stems angular, almost winged at the apices.

Andrographis elongata T. And.

A herb with white corolla and purple stamens; at the foothills and on the slopes.

Asystasia gangetica T. And. (Meddaikkeerai)

A straggling and spreading herb along thickets, etc.; flowers purplish, on the plateau.

Barleria pilosa Wall.

An undershrub of the slopes with large crowded bracts.

Barleria prionitis L. (Kattu Kanagambaram)

An armed shrub with yellow flowers; very common along the ghats.

Dicliptera cuneata Nees

A branched herb with pink flowers; on the plateau.

Dipteracanthus prostratus (Poir.) Nees (Pottakanchi)

(*Ruellia prostrata* Poir.)

A diffuse, spreading subshrub with axillary flowers; corolla violet, falling off easily; on the plateau.

Ecbolium viride (Forsk.) Alst.

(*E. linneanum* Kurz)

A shrub with bluish flowers, and bracts purple along the margins; along the slopes.

Eranthemum capense L.

(*E. montanum* Roxb.)

A shrub up to 1 m tall, with blue flowers; on the plateau.

Justicia glauca Rottl.

A herb rather variable in size; flowers pink; on the slopes.

Justicia quinqueangularis Koen.

An undershrub with ascending branches; along bunds of paddy fields on the plateau.

Justicia simplex Don

A pubescent herb with small pink flowers; along the bunds of paddy fields on the plateau.

Phlebophyllum ? versicolor (Wt.) Brem.*(Strobilanthes ? cuspidatus* T. And.)

A gregarious shrub over 1 m tall; leaves white, on the undersurface; flowers not seen; sparse on the slopes, abundant on the plateau.

Strobilanthes ? micranthus Wt. (Korakkuthazhai)

An erect shrub with leaves green throughout; flowers not seen; gregarious in patches in the plateau forests.

Thunbergia fragrans Roxb. var. *vestita* C. B. Cl.

A tomentose twiner with white flowers 3 cm across; on the plateau.

VERBENACEAE

Gmelina asiatica L. (Nilakkumil)

An erect shrub with golden yellow flowers; at the foothills.

Lantana camara var. *aculeata* (L.) Mold. (Arippu; Unni)

Only stray plants along the slopes; on the plateau it is almost non-existent in the forest, whereas it forms dense masses in the cleared areas; flowers pinkish; generally in fruit in July.

Lantana indica Roxb.

An erect shrub over 1 m tall with pinkish flowers; on the plateau.

Phyla nudiflora (L.) Greene (Poduthalai)*(Lippia nodiflora* Mich.)

A prostrate herb rooting at the nodes; on the plateau in pasturelands.

Premna corymbosa Rottl. & Willd. (Munnaikkeerai)

A shrub over 1 m tall with spreading branches; on the plateau.

Premna tomentosa Willd. (Podaganari)

A small tree, densely tomentose on the younger parts; on the plateau.

Stachytarpheta urticaefolia (Salisb.) Sims (Seemainayuruvi)*(S. indica* Vahl)

Stray plants on the slopes, over 50 cm tall; abundant and gregarious in unweeded gardens on the plateau but the plants are smaller; flowers blue to purple; one of the most abundant weeds of the plateau.

Svensonia hyderabadensis (Walp.) Mold. (Naranjedi)*(Bouchea hyderabadensis* Walp.)

Plants even up to 3 m tall, with pink flowers; at Masimalaiyanthittu, inside forests, on the plateau; said to be restricted in distribution.

Symphorema involucreatum Roxb.

A shrub with arching branches; on the plateau.

Vitex altissima L. f. (Mayiladi)

A tree over 20 m tall, with violetish flowers; fairly common in the forests of the plateau.

Vitex negundo L. (Nochi)

A shrub with purple flowers; along streams, near villages, etc.; on the plateau.

LABIATAE

Anisomeles indica (L.) Kze. (Vattapeimarutti)

Shrubby, over 1 m tall; at the foothills.

Leucas biflora R. Br. var. **procumbens** Gamb.

On the floor of the forests of the plateau; less on the slopes; flowers white.

Leucas lanata Benth.

Erect shrub with branches spreading to over 1 m; on the plateau, in thickets.

Leucas lavandulaefolia Rees

(*S. linifolia* Spr.)

An erect herb of wastelands; particularly abundant near cultivated places; on the plateau.

Ocimum adscendens Willd.

A branched herb; flowers with purple calyx and white corolla; along the slopes.

Orthosiphon glabratus Benth.

A branched herb; along the slopes.

NYCTAGINACEAE

Boerhaavia diffusa L. (Sattaranai)

Several procumbent branches from a stout rootstock; along the slopes.

AMARANTHACEAE

Amaranthus viridis L. (Kuppaikkeerai)

In wastelands near habitations; on the plateau.

Celosia argentea L. (Pannaikkeerai)

An erect herb up to 1 m tall, near cultivation; flowers pinkish; on the plateau.

CHENOPODIACEAE

Basella rubra L. (Sirupasali)

A glabrous, succulent twiner, with reddish spicate inflorescence; on the plateau.

Chenopodium ambrosioides L.

In wastelands near habitations; plants strongly scented; on the plateau.

ARISTOLOCHIACEAE

Aristolochia indica L. (Isuramuli)

A perennial twiner; perianth with shades of yellow and green, tinged purple; on the plateau.

PIPERACEAE

Peperomia dindigulensis Miq.

A succulent herb with pinkish stems; on moist rocks in the shade, on the plateau.

Piper attenuatum Buch.-Ham.

On the plateau.

LAURACEAE

Cassytha filiformis L. (Erumaikkottam)

At the foothills; parasitic, without any host specificity.

Cinnamomum ? iners Reinw.

A tree with large, coriaceous, shining leaves; on the plateau.

Litsaea deccanensis Gamb.

A tree with grey branches and rusty tomentose buds; on the plateau.

ELAEAGNACEAE

Elaeagnus indica Ser.

A straggler with arching branches; undersurface of leaves white-tomentose; common, even abundant, in and around the forests on the plateau.

LORANTHACEAE

Dendrophthoe falcata (L. f.) Etting (Pulluruvi)

(*Loranthus longiflorus* Desv. var. *falcatus* Kurz)

A densely branched parasite with yellow perianth and reddish stamens; at the foothills; on a variety of hosts.

Helicanthus elastica (Desr.) Danser (Andagan)

(*Loranthus elasticus* Desv.)

Perianth white at the base, green on the lobes; filaments red; on the plateau.

Loranthus ? courtallensis Gamb.

On the plateau.

Loranthus ? recurvus Wall.

On the plateau.

Scurrula cordifolia (Wall.) Don

(*Loranthus cordifolius* Wall.)

A massive parasite with rusty-tomentose foliage and orange-yellow flowers with short perianth tube; on the plateau.

Viscum orientale Willd.

On the plateau; no host specificity.

Viscum ramosissimum Wall. (Ottu)

Parasitic on *Dendrophthoe falcata* itself parasitic on *Zizyphus*; at the foothills.

SANTALACEAE

Santalum album L. (Santhanam)

The most important source of forest revenue from the district, the bulk of which comes from the Pacchaimalais; several trees are affected by the "spike" disease; throughout the range.

EUPHORBIACEAE

Acalypha fruticosa Forsk. (Chinni)

A well branched shrub; along the slopes.

Antidesma zeylanicum Lamk. (Nolaidali)

A tree up to 8 m tall, with the tender parts rusty-tomentose, and fruits red.

Bridelia roxburghiana Gehrm.

A tree of the plateau forests.

Cleistanthus collinus (Roxb.) Benth. ex Hook. f. (Oduvan)

A large shrub or small tree up to 5 m tall with capsules up to 3 cm across; one morsel of ground leaves or the rind of the capsules said to be lethal; said to be used for suicide by the hill tribes; throughout the range.

Dalechampia indica Wt.

A twiner with large bracts and glandular calyx; on the slopes.

Emblica officinalis Gaertn. (Nellikkaimaram)

Occasional trees on the plateau; fruits few.

Euphorbia hirta L. (Ammanpaccharisi)

In the pasturelands; throughout the range.

Givotia rottleriformis Griff. (Boothalai)

A tree over 20 m tall; leaves densely white tomentose on the under-surface; fruits with a hard shell, covered with fluffy tomentum; on the slopes.

Jatropha curcas L. (Kattamanakku)

Along hedges; throughout the range.

Kirganelia reticulata (Poir.) Baill. (Neerpalai)

A shrub, usually near streams; on the plateau.

Mallotus philippinensis (Lamk.) Muell.-Arg. (Kapilapodi)

In dense groups in cleared lands where it seems to be a colonizer; on the plateau.

Melanthesa turbinata (Koen. ex Roxb.) Oken

(*Brevnia patens* Rolfe)

A shrub over 1 m tall; on the plateau.

Phyllanthus fraternus Webster (Keezhanelli)

(*P. niruri* auct., non L.)

A delicate herb in wastelands; throughout the range.

Phyllanthus gardnerianus Baill.

Several branches from a woody rootstock; in pasturelands on the plateau.

Phyllanthus maderaspatensis L.

A decumbent herb; at the foothills.

Phyllanthus polyphyllus Willd. (Keelanelli)

A tree resembling *Embllica officinalis* in habit; on the plateau.

Phyllanthus urinaria L. (Shivappunelli)

A herb with creeping branches; leaves and fruits reddish; on the plateau.

Sebastiania chamaelea Muell.-Arg.

A weed of pasturelands; fruits reddish.

Securinega virosa (Roxb. ex Willd.) Pax & Hoffm. (Pula; Veppulathi)

(*Fluggea virosa* Baill.)

A large shrub with minute flowers; on the plateau.

Tragia involucrata L. (Canchori)

A twiner with stinging bristles; on the plateau.

ULMACEAE

Celtis wightii Planch. (Vellaithovarai)

A densely foliaceous tree up to 10 m tall, with solitary fruits; on the slopes and on the plateau.

Holoptelea integrifolia (Roxb.) Planch. (Aavili)

A tree up to 12 m tall; on the plateau.

Trema orientalis (L.) Bl. (Amparuthi)

A tree of the plateau forest borders.

MORACEAE

Artocarpus heterophyllus Lamk. (Pila)

(*A. integrifolia* L.)

Found in cultivation, and probably also wild.

Ficus benghalensis L. (Aalamaram)

Occasional trees throughout the range.

Ficus hispida L. f. (Peiyathi)

A tree up to 10 m tall, without aerial roots; tender parts hispid; throughout the range.

Ficus ? luscens Bl. (Malai Ichi)

(*F. ? infectoria* Roxb.)

A large tree over 30 m tall, with heavy, horizontal branches; near

habitations, on the plateau.

Ficus mysorensis Heyne (Kal Aal)

A large tree with copious foliage; on the plateau.

Plecosperrum spinosum Trec. (Koratti)

A large shrub with numerous arching branches, with conspicuous thorns all over; on the slopes and on the plateau.

Streblus asper Lour. (Parungu; Piramaram)

A large shrub or small tree; on the plateau; said to be locally used for decorations on festive occasions.

Streblus taxoides (Heyne ex Roth.) Kurz

(*Phyllochlamys spinosa* Bur.)

An armed shrub up to 3 m tall; very abundant in the forests of the plateau.

GNETACEAE

Gnetum ual Brongn. (Karunjaraikkodi)

Fairly common in the forests of the plateau; the vernacular name refers to the use of the stems as ropes.

ORCHIDACEAE

Cymbidium aloifolium Sw.

Epiphytic; flowers brownish red; on the plateau.

Eulophia epidendracea Fischer

Terrestrial; perianth green but for the white lip; on the slopes.

Habenaria plantaginea Lindl.

Terrestrial; leaves 3-4, spreading on the ground; flowers white; in moist, shady ground on the plateau.

Habenaria viridiflora R. Br.

In marshy ground; flowers green; on the plateau.

Hetaeria ? ovalifolia Benth.

Terrestrial; abundant in moist, shady places, in humus; on the plateau.

Vanda parviflora Lindl.

Epiphytic; on the plateau.

Vanda spathulata Spreng.

Usually terrestrial initially, but epiphytic later; shoots showing up conspicuously above the thickets, especially during flowering; on the plateau.

HYPOXIDACEAE

Curculigo orchioides Gaertn. (Nilappanai Kizhangu)

An acaulescent, ground herb with bright yellow flowers; very abundant in pasturelands on the plateau.

DIOSCOREACEAE

Dioscorea ? esculenta Burk. (Musilamvalli Kizhangu)

A climber from a tuberous rootstock, found all over the plateau; the rhizomes are eaten, even raw, by the local people.

LILIACEAE

Asparagus ? racemosus Willd. (Seemai Sadaveri)

On the plateau.

Gloriosa superba L. (Kalappai Kizhangu)

Throughout the range; not too common.

Sansevieria roxburghiana Schult. f. (Marul)

Acaulescent; rootstock creeping; flowers white, along a scape up to 1 m tall; at the foothills.

Scilla hyacinthina (Roth.) Macbr. (Sirunari Vengayam)

(*S. indica* Baker)

A scapigerous herb with tunicate bulbs and leaves with black blotches; flowers purple; at the foothills.

Smilax zeylanica L. (Malaithamarai)

On the plateau.

PONTEDERIACEAE

Monochoria vaginalis Presl.

In marsh, paddy fields, etc.; flowers blue; on the plateau.

COMMELINACEAE

Commelina benghalensis L. (Kanavazhai)

In shady places, along the bunds of paddy fields, etc.; perianth blue; on the plateau.

Commelina paludosa Bl.

(*C. obliqua* Ham.)

The uniformly white perianth seems to be characteristic of the plateau.

Commelina palcata Hassk.

On the plateau; perianth blue.

TYPHACEAE

Typha angustata Bory & Chaub. (Jambu)

Plants stunted, scarcely exceeding 1 m tall; along a rivulet at Sobanapuram, at the foothills.

ARACEAE

Acorus calamus L. (Vasambu)

Gregarious in marsh at Sembur, on the plateau.

Colocasia esculenta (L.) Schott.

(*C. antiquorum* Schott.)

Gregarious, in marsh; petioles dark purple; leaves up to 50 × 50 cm; spathe yellow.

CYPERACEAE

Bulbostylis barbata Kunth

On the slopes.

Cyperus eleusinoides Kunth

Robust plants in marsh on the plateau.

Cyperus haspan L.

Culms even over 1 m tall; in stagnant water on the plateau.

Cyperus sanguinolentus Nees

In marshy land; spikelets green; on the plateau.

Fimbristylis bisumbellata Bub.

In marshy ground; on the plateau.

Fimbristylis dichotoma Vahl

On the plateau, in marshy land.

Fimbristylis miliacea Vahl

On the plateau, in marshy land.

Fimbristylis spathacea Roth.

On the plateau.

Fimbristylis tetragona R. Br.

Culms ash-coloured, in dense clusters in marshy ground; on the plateau.

Kyllinga sp.

Along the bunds of paddy fields; on the plateau.

Pycnus globosus Reichb.

On the plateau in wastelands.

Pycnus puncticulatus Nees

On the plateau.

Scirpus erectus Poir.

Gregarious in marshy places on the plateau.

GRAMINEAE

Apluda mutica L.

(*A. aristata* L.)

Culms exceeding 1 m tall, scrambling along thickets; on the plateau.

Arachne racemosa (Heyne) Ohwi

(*Eleusine verticillata* Roxb.)

Robust specimens along the freshly cut ghat road.

Aristida depressa Retz.

Robust specimens along the freshly cut ghat road.

Bambusa arundinacea (Retz.) Willd. (Perumungil)

On the slopes; young culms yellow.

Brachiaria ramosa (L.) Stapf (Puliampullu)

Along the slopes.

Chrysopogon fulvus (Spreng.) Chiov. (Cholappullu)

(*C. montanus* Trin.)

At the foothills; spikelets with conspicuous yellow anthers.

Eleusine corocana (L.) Gaertn. (Kael Varagu)

An escape from cultivation; along the freshly cut ghat road.

Eragrostiella bifaria (Vahl) Bor (Shernaipullu)

(*Eragrostis bifaria* Wt. ex Steud.)

At the foothills, in open ground.

Eragrostis tenella (L.) Beauv. ex R. & S.

[*E. plumosa* (Retz.) Link]

On the plateau.

Eragrostis uniolooides (Retz.) Nees ex Steud.

In marshy ground; spikelets purple.

Hackelochloa granularis (L.) Kze

On the plateau; cultivated.

Heteropogon contortus (L.) Beauv. ex R. & S. (Oosippullu)

At the foothills.

Panicum repens L. (Injippullu)

In moist ground, along bunds of paddy fields, etc.; on the plateau.

Perotis indica (L.) Kze

At the foothills; recognized by the long, purple, feathery awns.

Setaria verticillata (L.) Beauv.

Along the freshly cut ghat road.

Themeda cymbaria Hack. (Sadumpullu)

Culms robust, over 2 m tall where ungrazed; a good fodder.

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REFERENCES

- CHAMPION, H. G. (1961): A preliminary survey of the forest types of India. *Indian For. Rec.* 1(1):1-204.
- GAMBLE, J. S. & FISCHER, C. E. C. (1956): Flora of the Presidency of Madras (reprint). Calcutta.
- KING, W. & FOOTE, R. B. (1864): On the geological structure of parts of the districts of Salem, Trichinopoly, Tanjore and South Arcot in Madras Presidency. *Mem. Geol. Surv., India* 4(2):1-152.
- SÉBASTINE, K. M. & HENRY, A. N. (1961): Vascular plants of the Pachaimalais. *Bull. bot. Surv. India* 3:55-65.
- SESHAGIRI RAO, V. S. & KRISHNASWAMY, M. H. (1941): List of the more important trees, shrubs, climbers and herbs occurring in the forests of the Madras Presidency with their local names. Madras.

Biology and fishery of *Pseudosciaena sina* (C.) at Ratnagiri, South Maharashtra¹

B. V. BHUSARI²

(With five text-figures)

Sciaenids constitute 3 per cent of the total marine catch in India contributing nearly 26,000 m tonnes per annum (on average for 10 years). In Maharashtra the percentage of sciaenids is 4.6 per cent (9,111 m tonnes) (on average for 10 years) per annum on total marine catch and 35 per cent of the total sciaenid catch of India.

Ratnagiri is an important fishing centre in southern Maharashtra and sciaenids contribute nearly 22 per cent of the total trawl catch. Fourteen species of sciaenids have been recorded, and among these *Pseudosciaena sina* predominates, contributing nearly 38.5 per cent to the total trawl catch.

MATERIAL AND METHODS

Fishes required for the purpose of this study were collected regularly from the trawl catches landed at Ratnagiri. The trawlers operate in an area (arc) about 20 miles north and south of Ratnagiri and land their catches at different landing centres in Ratnagiri, i.e. Kalbadevi, Mirkarwada and Rajiwada. As the trawling and shore seine operations are suspended during the monsoon season specimens were obtained from the catches of cast nets and hook and line, brought to Ratnagiri fish market. In all 600 specimens were measured to the nearest millimetre and weighed to the nearest gramme. For the study of food and feeding habits the specimens were cut open and measurements of the component parts of the alimentary canal were taken. The relative length of intestine (RLI) and relative length of the gut (RLG) were noted. Qualitative analysis of food was done in both adults and juveniles whereas the quantitative analysis of food items was done by displacement method for the adults only.

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For determining the minimum size of maturity in the female fifty specimens were examined. As the sexes cannot be distinguished in sizes below 7 cm, fishes of 8 cm and above only were examined for the different maturity stages in females. The colour of the ovary and its extension in the body cavity were taken into consideration for measurements of ova diameter. Ovaries were preserved in 5 per cent formalin for 8-10 days. About 700 ova were measured from each ovary. The ova were separated by testing out a portion of the posterior region of the ovary on a glass slide and were measured by means of eyepiece micrometer.

Ova measuring less than 5 md (1 md = 0.03 mm) were not considered as these were present in the ovaries in all stages of maturity (De Jong 1939, Clark 1934). Fecundity was estimated by weighing one gram sample of the ovary and counting the number of eggs contained in it. The number of eggs in the ovary was computed by taking into consideration the total weight of the ovary. The maturity scale adapted by ICES (Wood 1930) was followed for studying the progression of ova towards maturity. The spawning in this species was determined by studying the different stages of the ovary occurring in each month. The percentage of occurrence of males and females was observed for the sex ratio.

The fishery of the species was estimated from random samples of c 10 kg once every ten days for analysis. For studying the length frequency distribution, 1500 specimens were measured within a period of 3 months.

Food and feeding habits

Earlier works [Gopinath (1942), Mookerjee *et al.* (1946), Chacko (1949), Kow (1950), Jacob (1948) and Rao (1964)] indicate that adult sciaenids consume a variety of food consisting mainly of crustaceans, fishes, molluscs, polychaetes and echinoderms and are thus carnivorous and benthic. During this investigation it was found that juveniles ranging in total length from 5.6 to 7 cm mainly feed on planktonic copepods, *Lucifer*, *Mysis*, *Acetes*, small prawns and polychaetae larvae.

The following items of food were seen in the gut contents of *Pseudosciaena sina*—

- 1) Teleosts — Sole fish, *Leognathus* sp., young of sciaenids.
- 2) Crustaceans — *Penaeus* sp., *Metapenaeus* sp., crustacean larvae, crabs, *Mysis*, *Squilla*, hermit crabs and Amphipods.
- 3) Echinoderms — Sea urchins.
- 4) Polychaetes — Nereid worms.
- 5) Molluscs — Bivalves.

Fluctuations in the composition of the main food items consumed by adults of *Pseudosciaena sina* in different months are shown in table 1.

It will be seen from table 1 that crustaceans form the most do-

TABLE 1
 PERCENTAGE COMPOSITION OF IMPORTANT FOOD ITEMS DURING DIFFERENT MONTHS
 IN THE YEAR AUGUST 1962 TO JULY 1963 IN *Pseudosciaena sina*

Months	No. of specimens examined	Fishes	Prawns	Squilla	Acetes	Other crustaceans	Total crustaceans	Salps	Polychaetes	Molluscs	Misc.
1. August 1962	60	6.95	48.10	—	41.87	3.12	93.09	—	—	—	—
2. September	86	6.70	30.02	3.63	18.55	40.18	92.38	—	0.92	—	—
3. October	33	15.62	56.25	12.50	7.80	3.12	79.65	—	—	—	4.68
4. November	31	33.35	27.87	36.36	2.42	—	66.65	—	—	—	—
5. December	44	28.55	23.27	49.87	—	—	73.14	—	—	—	—
6. January 1963	29	26.66	36.65	33.32	—	—	69.97	3.33	—	—	—
7. February	29	70.00	30.00	—	—	—	30.00	—	—	—	—
8. March	72	5.55	18.03	65.21	—	1.38	84.61	6.93	—	2.76	—
9. April	23	—	8.16	86.00	—	—	94.16	—	—	6.00	—
10. May	35	3.93	35.43	3.93	25.19	—	64.05	—	—	—	31.49
11. June	17	7.40	25.90	25.90	40.70	—	92.50	—	—	—	—
12. July	24	17.77	17.77	17.77	13.33	33.30	82.17	—	—	—	—

minant group as its food. Among crustaceans, prawns, *Squilla*, *Acetes* are the most common items.

Prawns: Prawns are taken practically throughout the year. The percentage of prawns as food in the gut contents varies from 8.16 to 56.25. The average percentage of prawns in August, September and October was 45. The percentage of prawns during these three months in the fishery is also high and its average percentage is 70 during this period.

***Squilla*:** *Squilla* in the food was observed during whole year except in the months of August and February. The percentage of *Squilla* in the food was observed to be more in the month of December (50%), March (65%) and was maximum in the month of April (86%).

Fish: This is the third important item. Fish as food was observed throughout the year with maximum in February (70%) and minimum in May (3.93%). The average percentage of fish in food in the months of November, December, January and February was 40.

***Acetes*:** *Acetes* was commonly observed from May to November in food. Maximum percentage was in June (41%) and August (42%) whereas it was minimum in November (2.42%).

The absence of *Acetes* in food from December to April in spite of their presence in the locality and availability indicates that the fish prefers prawns, *Squilla* and fish. The presence of benthic animals like prawns, *Squilla*, molluscs, crabs in the gut contents indicates its bottom feeding habits.

Maturation and Spawning

Description of the ovary

Until the fish attains 7 cm in total length it is difficult to distinguish females from males. The gonads in both the sexes are thread-like and whitish in colour. The ovaries in specimens over 7 cm appear slightly swollen compared to testes of corresponding size. Different stages of ovarian maturity as determined from external appearance of the ovary and its extension in relation to the body are given below:

- 1) Immature Ovary — The ovary is transparent with reddish appearance and extends to about $\frac{1}{2}$ of the body cavity.
- 2) Maturing Ovary — The ovary is yellowish in colour. The ova are granular in nature and are also visible to the naked eye. The ovary extends to nearly $\frac{3}{4}$ of body cavity.
- 3) Mature Ovary — The ovary is similar in appearance to the maturing ovary but is more swollen and extends the entire length of the body cavity.
- 4) Ripe Ovary — The ovary at this stage is fully swollen occupying the entire body cavity. Ova are transparent.

- 5) Spent Ovary — The ovary is flaccid, blood-shot and wrinkled, and extends $\frac{1}{2}$ of the body cavity or more.

Size at first maturity

To study the minimum size of maturity in the females a number of specimens were examined. As already stated sexes are not clearly distinguishable below 7 cm and, as such specimens ranging from 8 to 14 cm were only considered. From the data plotted in Fig. 1, it will be seen that 15 per cent of the fish matured in the 11.2 cm groups, and 48 per cent in the 12.5 cm groups. Nearly 50 per cent of the females of *Pseudosciaena sina* reached first maturity at a length of 11.2 to 12.5 cm. This is, therefore, considered as the minimum size of first maturity. The fishes measuring 13 cm and above were 100 per cent mature.

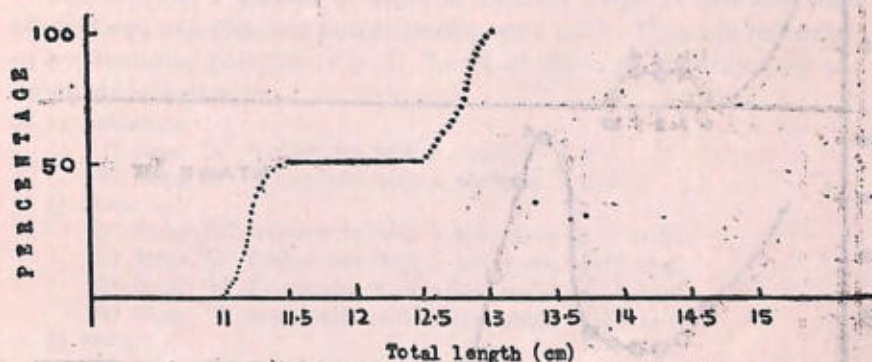


Fig. 1. Size at first maturity in *Pseudosciaena sina*.

Development of Ova

An ovary in advanced maturity was selected for studying the maturation stages of the ova. A sample of ova from this ovary was taken and ova diameter measurements were made. The ova were classified in micrometer division groups and a percentage frequency polygon was drawn.

First batch

Ova ranging in size from 0 to 5 m d. in diameter. The ova are transparent and the nucleus is clearly visible. Such ova are present throughout the year and represent the general stock of eggs.

Second batch

Diameter 6 to 10 m d. These ova are also transparent with nucleus and protoplasmic layer visible.

Third batch

Diameter 11 to 15 m d. Ova granular and yellow in colour and with yolk.

Fourth batch

Diameter 16 to 20 m d. Ova granular, round, and yellow in colour.

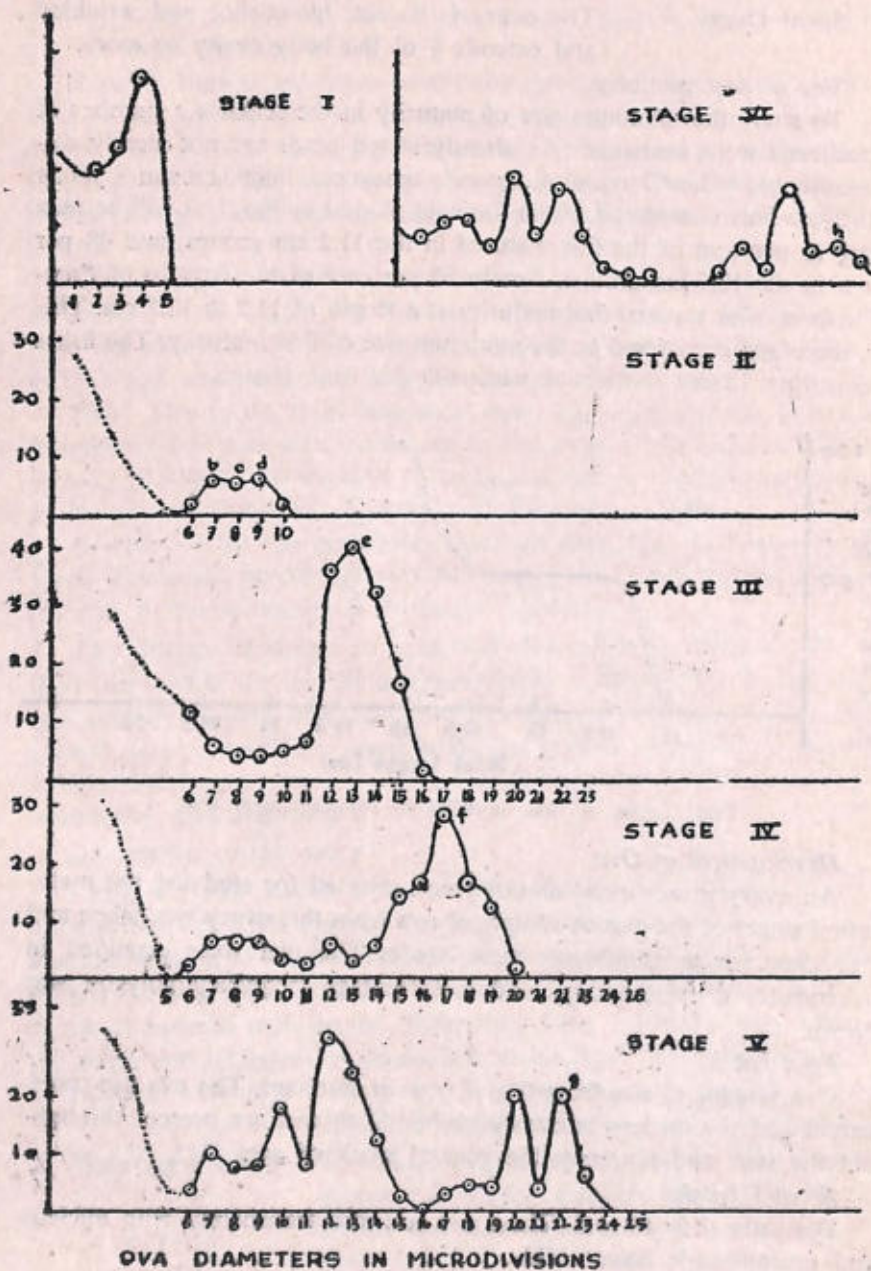


Fig. 2. Different stages of Maturation in *Pseudosciaena sina*.

Fifth batch

Diameter 21 to 25 m d. Ova round and transparent with a single oil globule. This is perhaps the spawning stage of the ovary.

To determine the growth of the ovary from immature to spent stage, it is necessary to arrange the data in chronological order starting from the month in which immature ovaries are observed until the period when spent ovaries occur.

However, when the observations on the condition of the ovary were undertaken, it was found that fish in different stages of maturity occurred in any sample indicating that all the fish do not mature simultaneously. It was, therefore, decided to group the data on the basis of largest mode in diameter frequency percentage of ova.

Accordingly, a number of fishes in different stages of maturity were selected and ova diameter measurements were made. They are represented by frequency polygons (Fig. 2). In all 10 stages of maturity were encountered. They are:

1) *Immature*

- i) Stage "a" frequencies with a mode at 3 m d.
- ii) Stage "b" frequencies with a mode at 5 m d.

2) *Maturing*

- iii) Stage "c" frequencies with a last mode at 7 m d.
- iv) Stage "d" frequencies with a last mode at 10 m d.
- v) Stage "e" frequencies with a last mode at 12 m d.
- vi) Stage "f" frequencies with a last mode at 15 m d.

3) *Mature*

- vii) Stage "g" frequencies with a last mode at 17 m d.
- viii) Stage "h" frequencies with a last mode at 20 m d.

4) *Ripe*

- ix) Stage "i" frequencies with a last mode at 25 m d.

5) *Spent*

- x) Stage "j" frequencies with a last mode at 5 m d.

More than seven stages of maturity could be described in *Pseudosciaena sina* but as per standards of the International Council of exploration of Sea (Wood 1930) the stages examined are:

Stages in <i>Pseudosciaena-sina</i>	Ova diameter range in m d.	Stages described by I.C.E.S.
Stage "a" & "b"	0 to 5	I
Stage "c" & "d"	5 to 10	II
Stage "e" & "f"	10 to 15	III
Stage "g"	15 to 17	IV
Stage "h"	17 to 20	V
Stage "i"	20 to 25	VI (Spawning)
Stage "j"	Less than 6	VII (Spent)

Fishes with ovaries in all these stages of maturity were observed nearly throughout the year.

However, to study the spawning season, the data from 400 specimens were converted into frequency percentage of stages of maturity for each month (Fig. 3).

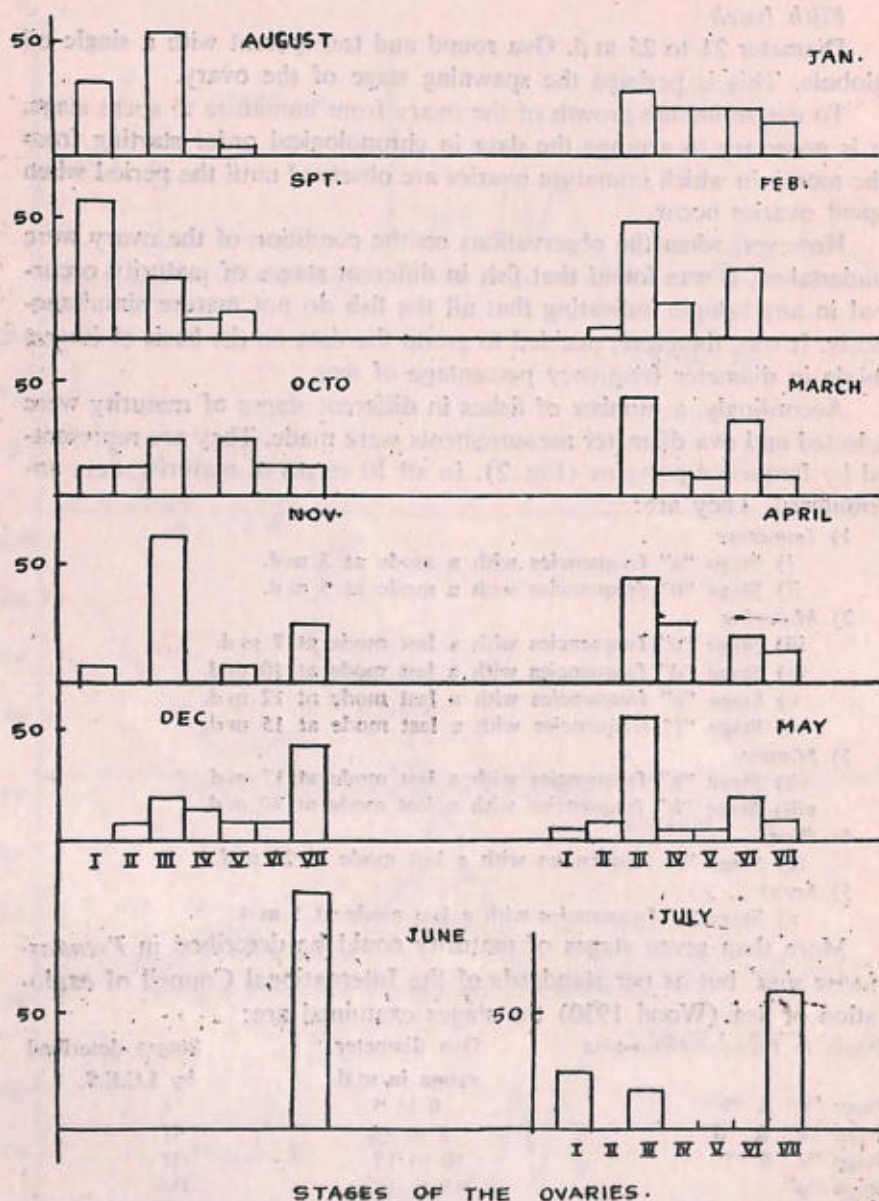


Fig. 3. Percentages of different stages of maturity in *Pseudosciaena sina* in different months.

From the histograms it is seen that fishes in stages III, IV and V of maturity are very common, forming 50 to 80 per cent. During the study period few fishes in stage VI of maturity were observed.

There is no information on the eggs and larvae of *Pseudosciaena sina*. Attempts to collect these were also not successful. In the absence of any information on eggs and larvae it is difficult to fix up a definite spawning period. The fishes in stages IV and VI of maturity are available from October to May, and fish in spent condition (VII stage) from October to July. Nearly 85 per cent spent ovaries were encountered in the months of June and July.

Frequency of spawning

The multiplicity of modes in the ova diameter frequency curves shows that the size range of ova is large and there is a continuous gradation, indicating several batches of eggs in all stages of maturity. Thus, it appears that the production and withdrawal of eggs is a continuous process and the species spawns more than once over a greater part of the year. The presence of fish in advance states of maturity IV, V, VI and spent individuals over a greater part of the year seems to corroborate this inference. The availability of these fishes in large quantities in trawl catches at Ratnagiri also supports the above findings.

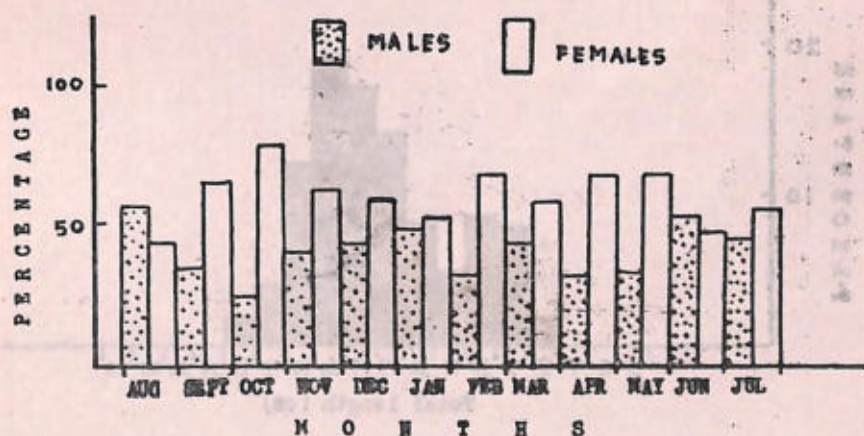


Fig. 4. Percentage of occurrence of Males and Females.

Fecundity

The ova count of this species shows that ova produced by individuals of the same length showed variation. The fecundity varies between 32,174 to 60,840 eggs.

	Weight of the ovary in gm	No. of eggs
i)	9.420	60,840
ii)	6.900	47,140
iii)	5.530	46,610
iv)	4.640	40,620
v)	2.550	32,174

Since specimens of the same length show variation, it is probable that there is a prolonged spawning period, and that the spawning is intermittent and that the eggs are spawned in batches.

Sex Ratio

From Fig. 4 it is evident that the female of *Pseudosciaena sina* predominates in the commercial catches throughout the year.

Fishery

As already stated, the trawl catch landings of sciaenids, the *Otolithus* and *Pseudosciaena sina* together contribute nearly 83 per cent of the total sciaenid catch at Ratnagiri. To analyse the length frequency distribution 1,500 specimens were measured at random for a period of three months, i.e. October, November and December, when fishing season is in full swing at Ratnagiri. The catch analysis shows (Fig. 5)

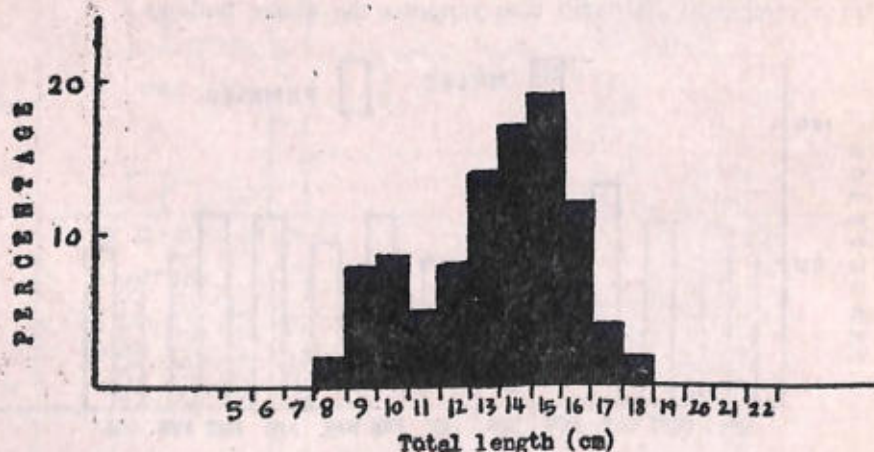


Fig. 5. Length frequency distribution in *Pseudosciaena sina*.

that fishes ranging in size from 12-13 cm in total length are most common and dominant in the trawl catches and form the major group in the fishery at Ratnagiri. It has been observed that these fish mature for the first time at this length and are caught in trawl without giving any chance to spawn even for the first time; probably this is detrimental to the sustained yield of sciaenid fishery. Attention should be drawn to the fact that the catches of sciaenids have been going down during the last ten years. Vellappan Nair *et al.* (1969) found the average annual landing of sciaenid catches in India to be 36,320 M. tonnes (1950-1962)

whereas the 1962-1971, average is 26,000 M. tonnes and that of Maharashtra 13,570 M. tonnes (1960-62) and 9,111 M. tonnes (1962-71).

ACKNOWLEDGEMENTS

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Studies on Indian Crickets (Orthoptera: Insecta), Part—III¹

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(With eighteen text-figures)

This paper deals with 13 species of Indian Crickets comprising of six genera of the subfamily Gryllinae, of which *Gryllopsis rajasthanensis* Bhowmik, female of *Turanogryllus dehradurensis* Bhowmik, immature stages of *Turanogryllus rufoniger* (Chopard), and male genitalia of *Stephoblemmus humbertiellus* Saussure (which is also a new record from India) and of *Coiblemmus compactus* (Chopard); *Gryllopsis jammuensis* Bhowmik (1967) has been described and transferred to the genus *Turanogryllus*.

INTRODUCTION

This paper is the third in the series on Indian Crickets (Gryllidae) and is a portion of the unpublished material of the thesis submitted for the award of doctorate degree of the Calcutta University. Additional information on the morphology, abundance and nomenclatural changes of 13 species belonging to the subfamily Gryllinae are described. In order to avoid duplication in respect to references etc. only those which have been omitted by Chopard (1969) are included here.

Genus *Gryllopsis* Chopard, 1928

Gryllopsis Chopard, 1928, *Rec. Ind. Mus.* 30:13.

Diagnosis: The genus is characterized by large rounded head and nearly cylindrical body; usually perfectly developed, very wide elytra in males; females may be apterous or may bear very short elytra which sometimes may be reduced to only pads; internal tympanum absent on anterior tibia; subgenital plate with conical or rounded apices; absence of styli-form process in male genitalia.

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Remarks: The genus *Gryllopsis* had been thought so far as one of the very widely distributed genera of oriental crickets. But recent studies based on male genitalia show that this genus and the genus *Turanogryllus* Tarbinskii (1940) though they have in common many morphological characters are readily distinguishable from each other by the presence or absence of styliform process in the male genitalia. It is found that quite a few species described previously as *Gryllopsis* possess styliform process in the genital structures like those of *Turanogryllus*. In the fitness of things those *Gryllopsis* possessing styli in genitalia, *inter alia*, are transferred to the latter genus.

***Gryllopsis furcata* (Saussure)**

1877. *Grylloides furcatus* Saussure, *Mé'm. Soc. phys. Hist. nat. Geneve*, 25: 399-400.

Additional characters: FEMALE: Apterous, testaceous brown or rufous brown, pubescent insect with very stout cylindrical body. Head spherically convex, the pale lines on occiput and vertex usually very obscure; in rare exceptions they have four distinct testaceous light lines (specimen from Mysore); arched posterior band about thrice as wide as anterior band, connects the eyes and is brown or dark brown; anterior band also arched and connects only the antennal sockets; frontal rostrum about four times as wide as the first antennal segment; facial shield prominent, convex and with a median suture; clypeofrontal suture almost straight. Pronotum transverse and so convex that it appears saddle shaped, both anterior and posterior margins straight but sides parallel; lateral lobes square shaped, the inferior margin being horizontal. Ovipositor large, strong, shorter than posterior femora, apical valves with acute apices but the superior valves are longer than their corresponding inferior valves. The valves remain wide open at rest. Subgenital plate with truncated apex. Anterior tibia with an oval, elongated tympanum at external face only. Posterior femur very stout and wide, rufous brown, striations on it hardly recognizable but knee is distinctly dark brown; posterior tibia with variable number of spines, usually the inner ridges with four or five spines and the external ridges with five to six spines but specimens from Mysore show four external and five internal spines in both sexes; supero-internal spurs almost subequal to the intermediate internal spurs; posterior metatarsi with four to five internal and four to six external denticles on each margin.

MALE: Differs from female in having well developed brownish or dark brown elytra with three oblique veins extending up to about two-thirds of abdomen; diagonal vein short, straight and bifurcated at base; mirror much obliquely disposed, wider than long, divided by a curved vein and united with the first chord by a veinlet; apical field very short,

usually with three much obliquely disposed veins and a false vein and with distinct but irregular areolae; triangle intercale distinguishable; anal vein almost broken at right angle, and the scantily reticulated field with five regularly spaced, feebly curved veins; mediastinal vein with one branch only.

Measurements (in mm): Male: Length of body 16.25-17; length of pronotum 4.25-4.55; width of pronotum 5.25-5.5; clytra 6.75-8; posterior femora 11.5-12; posterior tibiae 8-8.75.

Female: Length of body 16.25-20; length of pronotum 4.75-5; width of pronotum 5.25-6.25; posterior femora 14-15.75; posterior tibiae 9.9-10.5; ovipositor 7-14.25.

Material examined: 1 male, 1 female from Mysore city; 1 female from Coimbatore; 2 females from Rajpur (Dehra Dun); 2 males, 2 females from Nagarjunkonda (Andhra Pradesh).

Remarks: This species can easily be distinguished from all other species of the genus by its strongly cylindrical body, besides its rounded head with two transverse bands and open type of ovipositor.

Gryllopsis rajasthanensis Bhowmik (Figs. 1 & 2)

1967. *Gryllopsis rajasthanensis* Bhowmik, *Proc. Ind. Sci. Cong. Assoc. Benaras*, Part B: 491.

Description: FEMALE: Small, body cylindrical, yellowish and densely pubescent. Head as wide as the pronotum in front, yellowish, with two transverse brown bands and of these anterior one connects the bases of antennal sockets and the posterior one the inter-ocular sockets; occiput and vertex with five very indistinct longitudinal brownish lines. Lateral ocelli brownish, anterior ocellus very small and yellowish. Frontal rostrum almost twice as wide as the first antennal segment and parallel sided. Labrum broad, rounded at apex and partially trilobed; clypeus partially divided by a median longitudinal suture; clypeofrontal suture strongly arcuate. Eyes black, very prominent and oval. Pronotum pale yellowish and transverse, anterior margin being slightly concave and posterior margin nearly straight, both margins ciliated, sides a little convex at the middle; disc convex, densely pubescent, with a median longitudinal suture and two triangular lobes brown, rest yellowish, inferior margins ascending posteriorly. Abdomen yellowish but mottled with brownish spots on dorsum. Ovipositor yellow, straight, long, apical valves acute. Legs yellow. Anterior tibia with a long oval tympanum at its external face only. Posterior femora very stout, longer than abdomen, indistinctly striated at external face; posterior tibia with four external and five internal spines; posterior metatarsi with seven external and five internal brownish denticles.

Elytra extending up to the middle of abdomen, yellow, these overlap on

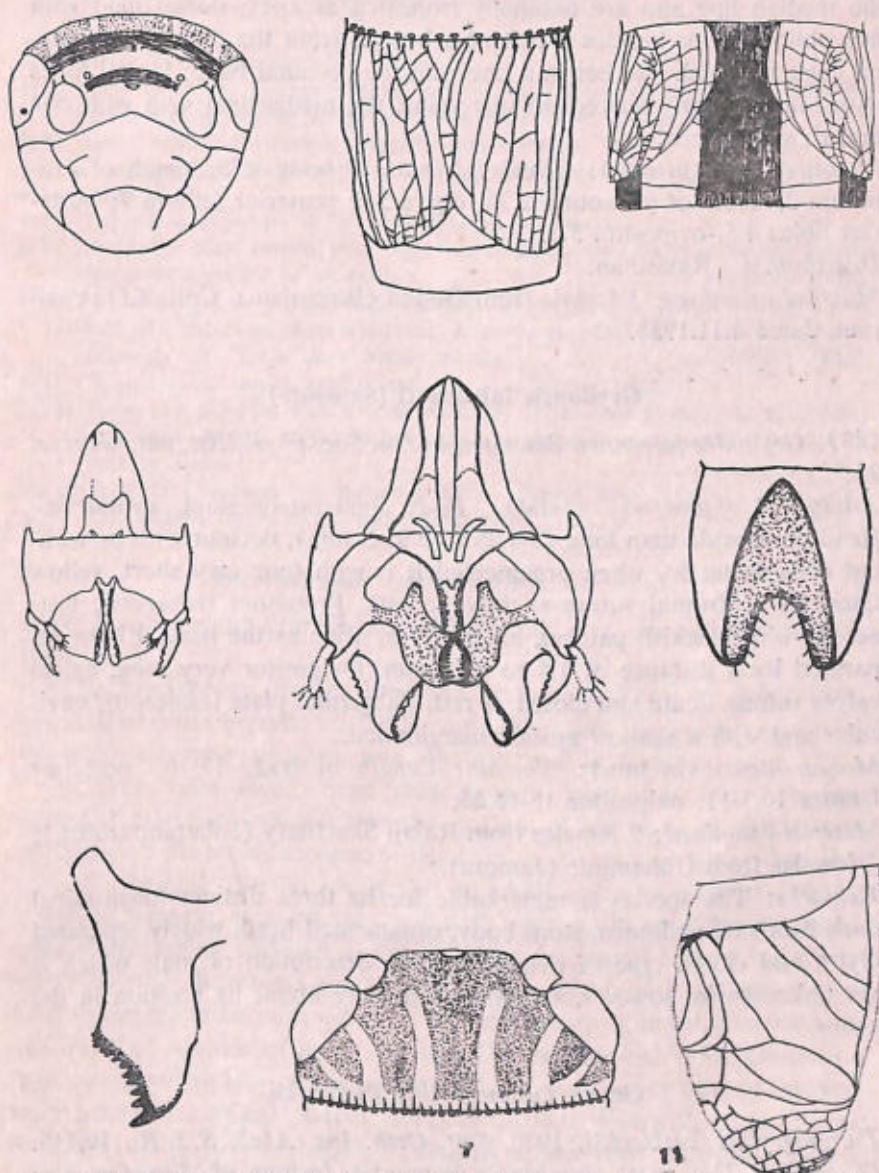


Fig. 1. *Gryllopsis rajasthanensis*, female head, dorsal view. x 17; Fig. 2. *ibid.*, elytra. x 15; Fig. 3. *Turanogryllus rufoniger*, male genitalia, dorsal view. x 18; Fig. 4. *ibid.*, male genitalia, ventral view. x 18; Fig. 5. *ibid.*, apical end of ventral lobe of ectoparamere. x 55; Fig. 6. *ibid.*, subgenital plate of an advanced nymph. x 20; Fig. 7. *Turanogryllus jammuensis*, female head, dorsal view. x 17; Fig. 8. *ibid.*, pronotum and elytra. x 15; Fig. 11. *Turanogryllus histrio*, male elytra. x 15.2.

the median line and are obliquely truncated at apex; dorsal field with five oblique veins besides a sort of a branch from the discoidal; humeral edge brownish and lies in a line with the pronotal band; lateral lobes with four regularly spaced oblique veins; the mediastinal vein with one branch at the apex.

Measurements (in mm): Female: Length of body 9.75; length of pronotum 2; width of pronotum 2.75; clytra 2.6; posterior femora 7; posterior tibiae 4.5; ovipositor 5.7.

Distribution: Rajasthan.

Material examined: 1 female from Gudha (Rajasthan), Coll. T.G. Vazirani, dated 4.11.1958.

***Gryllopsis falconneti* (Saussure)**

1877. *Grylloides falconneti* Saussure, *Mé'm. Soc. phys. Hist. nat. Geneve*, 25: 230.

Additional characters: FEMALE: *Body* moderately stout, cylindrical. Head more wide than long (5-5.25 to 2.95-3 mm), occiput with or without ornamentation, when ornamented it is with four very short, yellow lines. Clypeofrontal suture slightly arcuate. Pronotum transverse, testaceous with blackish patches, anteriorly as wide as the head. Elytra separated by a distance of 1.5 to 2.25 mm. Ovipositor very long, apical valves rufous, acute and closed at rest. Subgenital plate testaceous, navicular and with a shallow apical emargination.

Measurements (in mm): Female: Length of body 13-16; posterior femora 10.5-11; ovipositor 18-18.25.

Material examined: 2 females from Rajaji Sanctuary (Saharanpur dist.); 2 females from Udhampur (Jammu).

Remarks: The species is remarkable for its three distinct longitudinal dark bands on abdomen, stout body, ornamented head, widely separated elytra and closed type of ovipositor. The description of male which is yet unknown is, however, essential to be sure about its position in the genus.

Genus *Turanogryllus* Tarbinskii

Turanogryllus Tarbinskii, 1940, *Salt. Orth. Ins. Azeb. S. S. R.*, 19, 115.

Diagnosis: The most important diagnostic feature of *Turanogryllus* is the presence of styli on the posterolateral extremities of epiphallus. Spherically convex head, quite lateral lobiform female elytra, triangular and strong, longitudinally sulcated male supra anal plate often with two spinules, somewhat bilobed subgenital plate in both sexes and externally visible dorsal lobes of ectoparameres are also remarkable.

Distribution: Russia; Africa; Western Asia; Pakistan and India.

KEY TO INDIAN SPECIES¹

- 1(4) Elytra as long as the abdomen
 2(3) Body cylindrical; clypeofrontal suture moderately arcuate; head blackish brown with four distinct yellow lines on occiput*quadri-lineatus* (Bh.)
 3(2) Body rather depressed; clypeofrontal suture indistinct, straight; head strongly rounded and without any ornamentation*dehradurensis* (Bh.)
 4(1) Elytra shorter
 5(8) Clypeofrontal suture more or less strongly arcuate
 6(7) Pronotum dark brown with light impressions; two oblique veins; female elytra rudimentary or absent*virgulatus* (Bol.)
 7(6) Pronotum brown varied with blackish brown spaces; female elytra short, obliquely truncated and separated from each other by a short distance; abdomen with three dark brown bands*jammuensis* (Bh.)
 8(5) Clypeofrontal suture almost straight or a little arcuate
 9(10) Pronotum fulvous with a wide posterior brown band; three to four oblique veins; female elytra longer than the metanotum, separated by a very narrow space*rufoniger* (Ch.)
 10(9) Pronotum without any posterior band; clypeofrontal suture a little arcuate; female elytra short, widely separated*histrion* (Sauss.)

***Turanogryllus dehradurensis* Bhowmik**

1969. *Turanogryllus dehradurensis* Bh., *Zool. Anz.*, Bd. 182, Heft 1/2: 143-144.

The species was described on the male only. Since its publication, new material has become available from Bihar and the Punjab and from the latter a female specimen was obtained, and is described here.

FEMALE: Size large, head dark brown, pronotum and abdomen generally rufous brown whereas the dorsum of abdomen is dark brown variegated with brownish spaces; head rather larger and wider than that of male; frontal rostrum about two and half times as wide as the first antennal segment; post clypeus yellowish white as in male from Panipat. Pronotum slightly widened at anterior margin; lateral lobes almost concolorous with the pronotum. Elytra oblique, as long as the mesonotum and separated from each other by a width which is more than the dorsal width of any one of them and with five longitudinal veins. Ovipositor rufous brown, as long as the length of body, moderately curved upwards and with acute apical valves; subgenital plate yellowish with distinct concave apex, thus giving it a bilobed appearance. Posterior femora stout, shiny rufous brown throughout; rest of the posterior legs yellowish; posterior metatarsi with five brownish denticles on each margin. *Measurements* (in mm): Female: Length of body 18.5; length of pronotum 4.5; width of pronotum 6; elytra 2.75; gap of elytra at base 2.5; posterior femora 13.25; posterior tibiae 9.5; ovipositor 19.5.

¹*T. babaulti*, *T. maculithorax* & *T. fascifrons* described in the fauna by Chopard (1969) are not included in the key.

Material examined: 1 male from Hazaribagh (Bihar); 1 male and 1 female from Panipat, Karnal dist. (Punjab).

Turanogryllus quadrilineatus Bhowmik
(vide 1969. *Zool. Anz.*, 182, 1/2: 144-145)

Additional material of this species is not available for study.

Turanogryllus rufoniger (Chopard) (Figs. 3, 4, 5 & 6)

1925. *Grylloides rufoniger* Chopard, *Ann. Soc. ent. France*, 94: 292.
1963. *Paragryllopsis rufoniger* Chopard, *Bull. Res. concil Israel*, 11B: 169.

*1967. *Turanogryllus rufoniger* Chopard, *Orth. Cat.*, 10.

Additional characters: MALE: Head deep brown with six distinct testaceous lines on occiput and vertex; clypeofrontal suture appears straight but effaced at the middle; a longitudinal suture extends from anterior ocellus to the extremity of anteclypeus. Pronotum almost parallel sided or slightly widened at posterior end but in the specimens from Dehra Dun the anterior end narrowed while the posterior end gradually widens; inferior margin of lateral lobes of pronotum straight, with angles almost rounded. Knees of posterior femora brown; posterior tibia with five to six internal and six external spines. Elytra testaceous brown and cover the abdomen; mirror oblique, rounded anteriorly, divided by a distinct curved vein, more than one and half times as wide as long, connected to first chord by one or two veinlets; oblique vein varies from three to four, in one example the last oblique being biforked; three chords of which first two strongly curved; apical field short, with four clear veins and with rectangular areolae; lateral field testaceous, with seven regularly spaced, moderately curved veins, mediastinal vein trimargous. Subgenital plate bilobed at apex. Genitalia typical for the genus, the posterior emargination of epiphallus penetrating up to about half of the entire length and with a V-shaped projection in the middle; the dorsal lobe of ectoparameres with a lateral process which is digitiform (three to four digits) on its inner face, apical end of the ventral lobe with twelve denticles.

FEMALE: Completely tallys with Chopard's (1925) original description. *Immature stages*: Immature stages of the species are readily recognizable but some minor variations are found in colour pattern, elytra and genital apparatus etc.

In two immature females (length of body 12mm, ovipositor 3mm) abdominal dorsum not entirely black but with two lateral and one median longitudinal blackish brown bands; elytra present as lateral pads only.

In four immature males (length of body 8 mm to 13 mm and width

about 1.5 mm long, overlapping elytral pads) and in one female (length of body 11 mm) the colour bands are on lateral margin of pronotal disc and not on anterior and posterior borders.

Measurements (in mm): Male: Length of body 13.5-14; length of pronotum 3-3.3; width of pronotum 5-5.5; elytra 8-9.5; posterior femora 10-11; posterior tibiae 7-7.25.

Female: Length of body 14.75-16.25; length of pronotum 5.25-5.8; elytra 3.25-3.75; posterior femora 10.75-11.5; ovipositor 12.9-13.6.

Material examined: 2 males, 2 females from Mysore city (University campus); 1 female from Gagret forest, Dist. Hoshiarpur (Punjab); 1 male from Hispana river, Dehra Dun.

Remarks: The species is readily identifiable by its particular colour pattern of head and of pronotum.

Turanogryllus jammuensis (Bhowmik) (Figs. 7, 8 & 9)

1967. *Gryllopsis jammuensis* Bhowmik, *Proc. Ind. Sci. Cong. Assoc. Benaras*, Part B: 491.

1969. (?) *Gryllopsis pakistana* Chopard, *Fauna Ind. Grylloidea*, 2:75.

Description: FEMALE: Size medium. Body moderately cylindrical, sparsely pubescent and testaceous varied with brown. Head rounded, dark brown, shiny and with six distinct yellow longitudinal lines, the lateral two of which are united at base and end near the eyes; front slightly flattened; frontal rostrum nearly twice as wide as the first antennal segment. Face yellow; clypeofrontal suture moderately arcuate. Eyes black, prominent and oval. Pronotum transverse, slightly narrowed both in front and behind, with both anterior and posterior margins straight; disc somewhat convex, varied with brown to blackish brown spaces, sparsely pubescent; lateral lobes yellowish except the extreme superior margins which are deep black, rounded at anterior angle, inferior margin slightly ascending posteriorly. Abdomen thinly hairy with a very prominent longitudinal median and two lateral blackish bands on the dorsum, ventrum yellowish. Ovipositor long and straight, inferior apical valves a little shorter than the superior ones. Legs testaceous. Anterior tibiae with a long oval tympanum at their external faces only. Posterior femora moderately stout, striated with brown at external faces, tibiae with six internal and seven external spines, the first external being very small. Elytra about 3 mm long and separated from each other by less than 1 mm distance, obliquely truncated; dorsal field shiny brown with four complete and slightly oblique veins, the venation is confused in the space between the fourth vein and the second discoidal; lateral lobes yellowish, with six regularly spaced veins, the mediastinal having a small branch at apex.

Measurements (in mm): Female: Length of body 12; length of pronotum 3; width of pronotum 4; elytra 3; posterior femora 10; posterior tibiae 7; ovipositor 11.

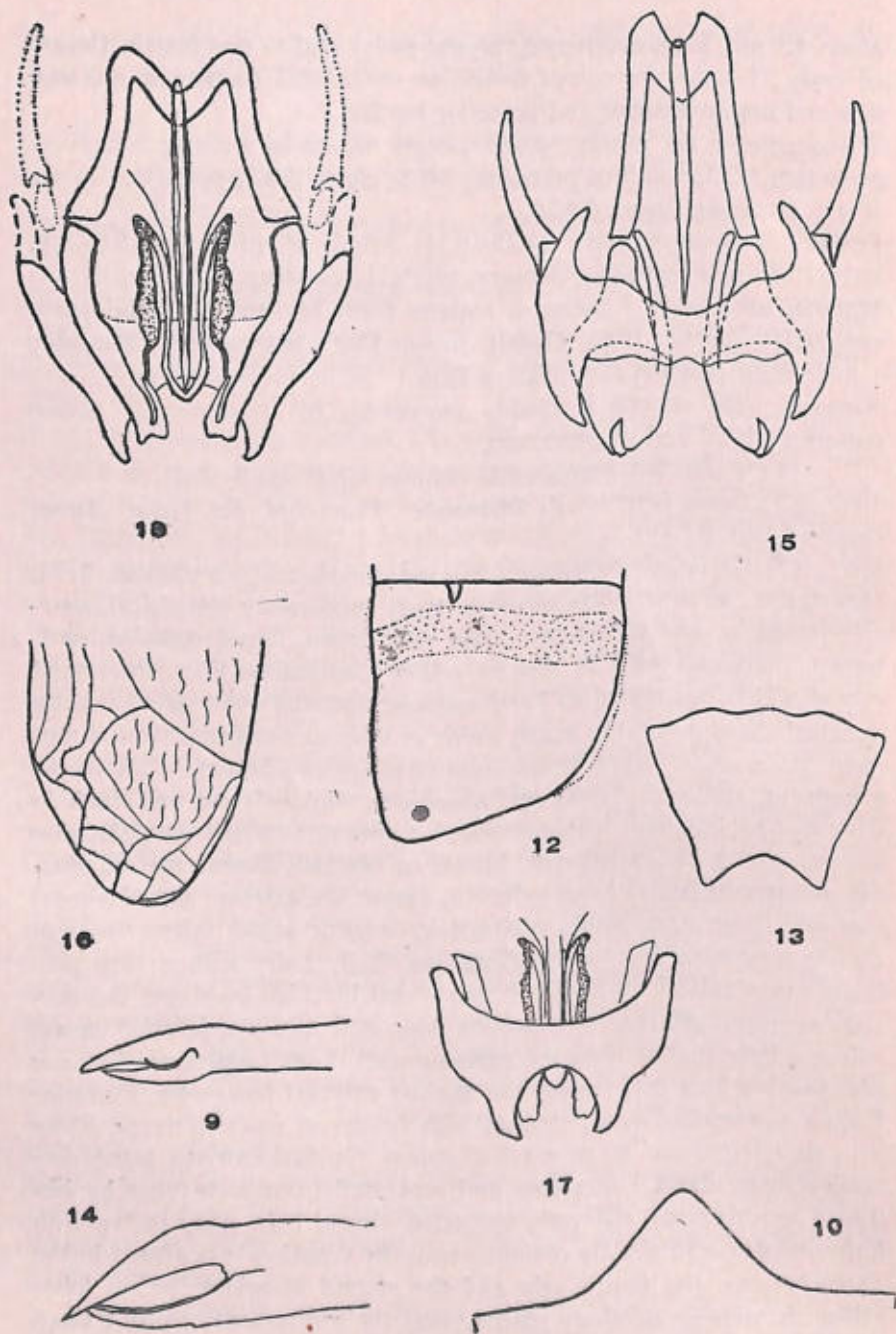


Fig. 9. *Turanogryllus jammuensis*, ovipositor. x 25; Fig. 10. *Turanogryllus virgulata*, male clypeofrontal suture. x 15; Fig. 12. *Turanogryllus histrio*, lateral pronotal lobe. x 22; Fig. 13. *ibid.*, subgenital plate. x 25; Fig. 14. *ibid.*, ovipositor. x 25; Fig. 15. *Coiblemmus compactus*, male genitalia, ventral view. x 20; Fig. 16. *Stephoblemmus humberthilli*, male elytron, apical portion. x 10; Fig. 17. *ibid.*, male genitalia, dorsal view. x 20; Fig. 18. *ibid.*, male genitalia, ventral view. x 20.

Material examined: 1 female from Jhajjar (Jammu & Kashmir), coll. R. Tilak, dt. 5. 10. 1964.

Remarks: The species somewhat resembles *T. rufoniger* in its general aspect and coloration but can be easily separated by its longer elytra and their close approximation, sparse pubescence etc. Male yet unknown.

The description of the species shows that it is very close to the female of *G. pakistana* Ch. (1969) and the latter may turn to be a synonym. At present it has been provisionally included in the synonymy list.

***Turanogryllus virgulatus* (Bolivar) (Fig. 10)**

1900. *Grylloides virgulatus* Bolivar, *Ann. Soc. ent. France* 68:797.

1933. *Gryllopsis virgulatus* Chopard, *Rev. Suiss. Zool.*, 40:163.

1963. *Paragryllopsis virgulatus* Chopard, *Bull. Res. Council, Israel*, 11 B:169.

1964. *Turanogryllus virgulatus* Randell, *Canad. Ent.*, 96:1571; Chopard, 1967, *Orth. Cat.*, 10.

Additional characters: MALE: General coloration dark brown, shiny. Head strongly rounded, glossy, without ornamentation; frontal rostrum strongly convex, about twice as wide as the first antennal segment; facial parts testaceous rufous. Pronotum concolorous with head, anterior margin slightly concave, posterior margin straight, nearly parallel sided or very indistinctly narrowed at anterior end; disc convex with two pyriform brownish impressions at the middle; inferior margin of lateral lobes testaceous rufous while the superior margin concolorous with the pronotum and with the anterior angle nearly rounded and the posterior angle a little ascending. Dorsum of abdomen dark brown while the ventrum concolorous with facial parts, no incision on metasternal plate. Legs hairy, testaceous. Anterior tibia with an oval external tympanum. Posterior femora stout, posterior tibia with five internal and six external spines, the supero internal spurs equal in length to supero intermediate ones; posterior metatarsi with five to six brown denticles. Elytra cover the abdomen; two curved oblique veins; mirror more wide than long, postero-inferior angle broadly rounded, divided by a curved vein at the middle and united to the first chord by one veinlet; apical field very small and reduced to a few irregular areolae where two oblique veins and one false vein are recognizable.

FEMALE: Differs from male in being apterous and in having the colour of head, pronotum, abdominal dorsum much darker and size bigger; ovipositor remains open at rest, testaceous, straight, apex very acute. In one specimen from Mt. Stuart, Madras, the posterior tibiae with seven internal and six external spines; subgenital plate a little concave at apex but not bilobed as in other species of the genus.

Measurements (in mm): Male: Length of body 10.5-10.75; length of

pronotum 2.75-3; width of pronotum 3.5-3.8. Female: Length of body 12-16; length of pronotum 2.75-3.5; width of pronotum 4-4.25; ovipositor 8.5-10.

Material examined: 2 males, 1 female from Mysore city; 1 female from Nilgiri Hills (alt. 2628 m); 1 female from Mt. Stuart (Madras).

Remarks: The species is readily recognizable by its blackish appearance, somewhat depressed shape of female with its open type of ovipositor. It is only known from south India.

Turanogryllus histrio (Saussure) (Figs. 11, 12 13 & 14)

1877. *Gryllodes histrio* Saussure, *M'em. Soc. phys. Hist. nat. Geneve*, 25:397.

1963. *Paragryllopsis histrio* Chopard, *Bull. Res. Council Israel*, 11B: 169.

*1967. *Turanogryllus histrio* Chopard, *Orth. Cat.*, 10.

Additional characters: MALE: Head spherical and convex; occiput and vertex with six yellowish light lines; frontal rostrum wider than first antennal segment. Clypeofrontal suture slightly arcuate. Fourth segment of maxillary palpi shorter than third, fifth largest, widened apically and obliquely truncated. Pronotum transverse; lateral lobes with rounded angles. Elytra a little shortened or as long as the abdomen; mirror almost transversely disposed, undivided; three oblique veins; apical field with somewhat irregular areolae. Anterior tibia with a long, oval internal and a very small rounded external tympanum; first external spine of posterior tibia denticle like. Supra anal plate with two spinule like projections. Subgenital plate more or less bilobed and projected much beyond the supra anal plate.

FEMALE: Differs from males in having reduced elytra which are widely separated, and with long, slender ovipositor with narrow and lanceolate apical valves.

Measurements (in mm): Male: Length of body 8-9.5; elytra 4.25; posterior femora 7-7.25.

Female: Length of body 11.5; posterior femora 8; ovipositor 7.

Material examined: 1 male from Kaziranga (Assam); 1 male, 1 female from Noorpur forest range, Dist. Gurdaspur (Punjab).

Remarks: The species is remarkable for its cylindrical, slender body with a brown band on the extreme superior margin of each pronotal lobe and two brown, prominent, spots near the postero median margin of pronotal disc.

Genus *Gryllodes* Saussure, 1874

Gryllodes sigillatus (Walker)

1869. *Gryllus sigillatus* Walker, *Cat. Derm. Salt. Br. Mus.*, 1:46.

1877. *Gryllodes sigillatus* Saussure, *Me'm. Soc. phys. Hist. Nat. Geneva*,

25: 210; B. Bienko, 1933, *Bol. Soc. Esp. Hist. nat.*, 33:325; Randell, 1964, *Canad. Ent.*, 96:1588.

Additional characters: MALE: Pale yellowish to testaceous in colour. Body depressed. Head as wide as the pronotum anteriorly; front yellowish and sloping; frontal rostrum a little narrower than the first antennal segment with lateral sides characteristically dark brown. Pronotum transverse with silky pubescence, anterior margin slightly concave, posterior margin straight and with a characteristic irregular dark transverse band continuing on either side up to the lateral margin of the lateral lobes; disc flat, a little widened in the middle, with a longitudinal suture at the middle and with two pyriform colour impressions at the superior part. Elytra extend beyond half of abdomen (leaving last five tergites free); mirror obliquely disposed, antero-internal and postero-external angles somewhat rounded but the other two angles more or less angulated, divided by a curved vein at the middle and united to the first chord by one or two veinlets; diagonal straight, bifurcated at base and sometimes united with the first chord by a veinlet; anal field very sparsely reticulated; lateral field with four regularly spaced slightly curved veins; mediastinal vein with a short apical branch. Posterior femora rufous brown, stout, longer than posterior tibiae and with indistinct dark oblique striations on external faces; posterior tibiae with five spines on each margin.

FEMALE: Differs from male in having the elytra reduced to very small lateral pads. Ovipositor slender, subequal to posterior femora, with acute apical valves.

Immature stages: Females are apterous with reduced ovipositor while the males are with imperfectly developed elytra without clear neuration.

Measurements (in mm): Male: Length of body 12-14; length of pronotum 2.25-2.5; width of pronotum 3.75-4.25; elytra 4.75-5.5; posterior femora 9.5-11; posterior tibiae 7-7.5.

Female: Length of body 15.25-16; length of pronotum 2.5-3; width of pronotum 4.25-4.75; posterior femora 10.5-11.5; posterior tibiae 7.25-8; ovipositor 10.5-11.5.

Material examined: 1 male from Banisaugh (Jammu); 3 males, 21 females from Ambala (Punjab); 1 female from Dhaukhand Forest Range, Dist. Saharanpur; 3 males, 3 females from Dehra Dun; 2 males from Sahastna Dhara Hills, Dehra Dun; 1 female from Timli Forest Range, Dehra Dun; 1 female from Rajpur (Madhya Pradesh); 1 male from Santal Parganas (Bihar); 1 male from Subhasgram (W. Bengal); 5 males, 9 females from Calcutta; 1 male from Nagarjunsagar (Andhra Pradesh); 2 males, 1 female from adjoining area of Mysore city; 1 male from Couriaghat (south Andaman Island); 1 male from Mallaca vilage (Car Nicobar).

Remarks: The species is readily recognizable by its general appearance

and colour pattern and is commonly seen in undisturbed places in houses.

Genus *Itaropsis* Chopard, 1925

***Itaropsis tenellus* (Walker)**

1869. *Gryllus tenellus* Walker, *Cat. Derm. Salt. Br. Mus.*, 1:37.

Additional characters: FEMALE: Head shiny dark brown, with or without four indistinct brownish light lines on posterior head. Clypeofrontal suture almost straight. Pronotum almost parallel sided, both anterior and posterior margins straight; disc with two rufous brown pyriform impressions and with a median longitudinal suture. Elytra cover the abdomen in one specimen, in another, they are slightly shorter; dorsal field with four to five obliques, somewhat regularly spaced veins and one to two branches from the discoidal.

Measurements (in mm): Female: Length of body 11.5-12; clytra 8-9; posterior femur 8.5-9; posterior tibia 4.5-5.

Material examined: 1 female from Dehra Dun, coll. S. Lal, dt. 9-5-1961; 1 female from Mussoorie (Uttar Pradesh), coll. R. P. Mukherjee, dt. 5-12-1961.

Remarks: Female of this species is unique among the Gryllidae for its rudimentary ovipositor which is represented by a styliform process almost enclosed by the subgenital plate.

Genus *Coiblemmus* Chopard, 1936

***Coiblemmus compactus* (Chopard) (Fig. 15)**

1928. *Homaloblemmus compactus* Chopard, *Spol. Zeyl.*, 14:201.

Additional characters: MALE: Head slightly wider than pronotum. Frontal rostrum almost twice as broad as the first antennal segment. Lateral field of elytra yellowish and with four somewhat parallel and equidistant veins; the mediastinal vein with a branch originating either from its very base or at most from its basal half and also with a small apical branch. Male genitalia: Epiphallus roughly H-shaped when viewed dorsally, the anterior margin moderately emarginate, the emargination is maximum at the middle; the posterior margin roughly U shaped and also emarginate, posterior lobes become evenly pointed and are curved inwards. Ectoparamere, when viewed ventrally, appears as a stout and simplified structure, its posterior margin having the corners produced, pointed and curved dorsally, basal half of ectoparamere divided into two processi of unequal width, the anterior internal process being thinner and rod like, a little curved outwards and comparatively longer than the external one. The courses of mesal lobes cannot be completely seen. Endoparameres, on profile somewhat C shaped, basal union of two endoparameres greatly expanded and with inwardly angulated lateral

processi. Virga unspecialized, moderately long and quite narrow.

Measurements (in mm): Male: Length of body 14-14.8; length of pronotum 3.2-3.5; elytra 7.8-8.25; posterior femora 10.25-10.6; posterior tibiae 6.9-7.25.

Material examined: 2 males from Mysore city (University campus), coll. S. Vasantha, dt. 1964.

Remarks: This monotypic genus is widely distributed in Ceylon and less commonly in Tamil Nadu. The male genitalia has been described elaborately for the first time.

Genus *Stephoblemmus* Saussure, 1877

Stephoblemmus humbertiellus Saussure (Figs. 16, 17 & 18)

1877. *Stephoblemmus humbertiellus* Saussure, *Mem. Soc. Phys. Hist. nat. Geneve*, 25:428.

Additional characters: The specimen at hand tally in majority of characters with the description and diagrams given by Saussure (1877) but some minor variations are also found viz., the mediastinal vein in left elytron with two branches at apex and in the right one with one branch; lateral field with three prominent but irregular and slightly curved veins, the middle one biforked apically in left lateral field; apical field comprised of a few irregular but distinct areolae; anterior tibiae with a small internal and a moderately long, oval external tympanum in each; posterior tibiae with five internal and six external spines in each.

Male genitalia: The genitalia in general resembles that of genus *Miogyryllus* Saussure and thus it should be placed in the subtribe *Sciobiina* Bolivar (Vide Randell 1964, *Canad. Ent.*, 96:1589).

Epiphallus: Distinctly H shaped in dorsal view, emargination of anterior border rather very broad and relatively deep, reaching up to one third the length of epiphallus; emargination of posterior border noticeably narrower but reaching still deeper; the bridge formed by the two emarginations is about one third the entire length; anterior internal apodemes moderately long. Ectoparameres almost rod like, slightly incurved structures with spine like projections at apices and each is bent on itself. Mesal lobes remarkably prominent in the form of a double ribbon, the external process very thin, irregular but comparatively broader and connected with the spine like projection of the ectoparamere by a thread like connection which can be seen only on profile, the internal process descends downwards as a narrow process, one on each side of the virga and ultimately united with each other forming a V shaped projection just on the medio-posterior emargination of epiphallus and is visible both dorsally and ventrally. Endoparameres J shaped on profile and with the antero-ventral edge weakly expanded. Virga long, narrow, and unspecialized; basal portion connected by the expanded bases of the endoparameres; the apical portion being visible dorsally

in between the apices of the mesal lobes. Rami simple, rod shaped, a little expanded and shallowly divided at their dorsal extremities. Ramal plates cannot be traced.

Measurements (in mm): Male: Length of body 10; clytra 5.25; wings 14; posterior femora 7.25; posterior tibiae 5.25; width of frontal lamellar process 5.2.

Material examined: 1 male from Rajaji Sanctuary, Dist. Saharanpur (Uttar Pradesh), Coll. T. D. Soota, Dt. 13-7-1963.

Remarks: This species of the monotypical genus is reported for the first time from India. The species is rare since the specimen dealt with here is the third one known so far.

ACKNOWLEDGEMENTS

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REFERENCES

- BEY-BIENKO, G. Y. (1933): Records and descriptions of some Orthoptera from U.S.S.R. *Bol. Soc. esp. Hist. nat.* 33:317-341.
- BHOWMIK, H. K. (1967): Six new genus of Gryllidae from India. *Proc. 55th Ind. Sc. Cong. Part 3*:491-492.
- (1969): Studies on Indian Crickets (Orth.: Insecta), Part I. *Zool. Anz. Bd. 182, Hefl. 1/2*:143-152.
- BOLIVAR, I. (1900): Les Orthoptères de St. Joseph's College à Trichinopoly (Sud de l'Inde) 2^{me} partie. *Ann. Soc. ent. France* 68:761-812.
- CHOPARD, L. (1925): Descriptions de Gryllides nouveaux (Orthoptères). *Ann. Soc. ent. France* 94:291-332.
- (1928): Revision of the Indian Gryllidae. *Rec. Ind. Mus.* 30:1-36.
- (1928): Additional notes on the Gryllidae of Ceylon. *Spol. Zeyl.*, 14:197-208.
- (1933): Gryllidae de l'Inde méridionale. *Rev. Suiss. Zool.* 40(5):161-167.
- (1963): Notes sur la faune des Orthoptéroïdes d'Israël et de quelques régions limitrophes (Blattodea, Gryllacridoidea, Grylloidea). *Bull. Res. Council. of Israel* 11B:161-176.
- * ————— (1967-68): Orthopteroïdes Catalogus, 10 & 12.
- (1969): The fauna of India and the adjacent countries, Grylloidea, Calcutta, 2:421, (1964).
- RANDELL, R. L. (1964): The male genitalia in Gryllinae (Orth. Gryllidae) and a tribal revision. *Canad. Ent.* 96:1565-1607.
- SAUSSURE, H. DE (1877-78): Melanges Orthopterologiques, Vme. Fascicule, III Gryllides (I & II partie). *Mé'm. Soc. phys. Hist. nat. Gene've*, 25:169-504, 509-836.
- *TARBINSKII, S. P. (1940): Pryigayushchiye pryamokriliye nasyekomiye. Azyerbaidjandkoi S.S.R. (Muscow and Leningrad).
- WALKER, F. (1969): Catalogue of the specimens of Dermaptera Saltatoria in the collection of the British Museum, London 1:225-423.
- * Denotes references not seen in original.

Crop preference of rodents at Ludhiana¹

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Rodents are the most destructive vertebrate pests of field crops in the Punjab. The loss from rodents to wheat, groundnut and sugarcane crops were reported by Bindra & Prem Sagar (1968). However, relatively little is known about the preference of different species for different field crops.

MATERIALS AND METHODS

Capture, mark, release and recapture method (Davis 1964) using 2 types of wonder traps (Deoras *et al.* 1969) to avoid cannibalism was employed. In one type, the entrance was only 4 × 2 cm, so that *Bandicota bengalensis* (Gray) and *Tatera indica* (Hardwicke) could not enter, and the pressing-disc was so adjusted that the animal weighing as little as 5 gm could enter. In the other type, the pressing disc was so adjusted that the animals weighing less than 20 gm could not enter. A mixture of husked rice, *bajra* (Pearl-millet) and wheat was used as bait. The traps were laid in different crops at a distance of 100 m from one another in a 53 ha cultivated area of the Punjab Agricultural University Farm, Ludhiana. This study was conducted during December 1970 to November 1972 for a 10-day period in the first fortnight of each month.

The preference was determined by using the following preference categories.

Categories of crop preference based on the number of specimens per species per trap per day ($\times 10^3$).

Species	Highly preferred	Moderately preferred	Less preferred
<i>Mus musculus bactrianus</i> Blyth	200-650	100-199	0-99
<i>Mus booduga</i> (Gray)	100-450	10-99	0-9
<i>Rattus meliada</i> (Gray)	100-650	10-99	0-9
<i>Tatera indica</i> (Hardwicke)	100-158	10-99	0-9
Total	600-975	300-599	0-299

RESULTS AND DISCUSSION

The observed preferences by different species are given in Table 1, and are discussed below briefly.

¹ Accepted January 1974.

Species	Season	Highly preferred	Moderately preferred	Less preferred
<i>Mus musculus bacirianus</i>	Rabi	Fenugreek, Potato, radish, spinach and tomato.	Barley, <i>sarson</i> and <i>sarson</i> + Egyptian clover	<i>Ber</i> orchard, cauliflower, Egyptian clover, lentil, lucerne, oat, pea, <i>toria</i> and wheat.
	Kharif	Fodder, groundnut and sugarcane.	Brinjal, cluster-bean, cow-pea, <i>desi</i> cotton, <i>janitar</i> , pearl-millet, sorghum and soybean.	American cotton, bitter-gourd, bottle-gourd, carrot (seed), chickory, citrus orchard, green-gram, <i>kaahi</i> , mango orchard, maize, musk-melon, Napier- <i>bajra</i> hybrid, onion (seed), pigeon-pea, squash-melon sweet-potato, turmeric and water-melon.
<i>Mus booduga</i>	Rabi	Radish and <i>sarson</i> + Egyptian clover.	potato, tomato, <i>toria</i> , Fenugreek, lentil, oat, ^{yequm pure} <i>sarson</i> and spinach.	Barley, <i>ber</i> orchard, cauliflower, Egyptian clover, lucerne, pea, <i>sarson</i> and spinach.

Species	Season	Highly preferred	Moderately preferred	Less preferred
	<i>Kharif</i>	Groundnut.	American cotton, Citrus orchard, chickory, cluster-bean, <i>desi</i> cotton, fodder, green-gram, <i>jantar</i> , maize, mango orchard, musk-melon, pearl-millet, sorghum, soybean and sugarcane.	Bitter-gourd, bottle-gourd, brinjal, cow-pea, <i>kaahi</i> , Napier- <i>bajra</i> hybrid, onion (seed), pigeon-pea, squash-melon, sweet-potato, turmeric and water-melon.
<i>Rattus melitada</i>	<i>Rabi</i>	Cauliflower and onion.	<i>Bar</i> orchard, Egyptian clover, lentil, oat, potato, <i>sarson</i> , <i>sarson</i> + Egyptian clover, tomato, and wheat.	Barley, fenugreek, <i>metha</i> , pea, radish, spinach, and <i>toria</i> .
	<i>Kharif</i>	cow-pea, fodder, groundnut, pearl-millet, and soybean.	American cotton, bitter-gourd, black-gram, bottle-gourd, brinjal, citrus orchard, cluster-bean, <i>desi</i> cotton, green-gram, <i>jantar</i> , maize, mango orchard, musk-melon, Napo potato and water-melon. <i>piet-bajra</i> hybrid, pigeon-pea, radish (seed), sorghum, sugarcane, sweet-	carrot (seed), chickory, <i>kaahi</i> , okra, onion (seed), squash-melon, and turmeric.

Species	Season	Highly preferred	Moderately preferred	Less preferred
<i>Tatara indica</i>	Rabi	<i>Metha</i>	Lentil, onion, <i>sarson</i> and <i>toria</i> .	Barley, <i>ber</i> orchard, Egyptian clover, lucerne, oat, potato, <i>sarson</i> + Egyptian clover, tomato and wheat.
	<i>Kharif</i>	Brinjal	American cotton, chick-ory, cluster-bean, <i>desi</i> cotton, fodder, green-gram, <i>jantar</i> , maize, Napier- <i>bajra</i> hybrid, okra, pearl-millet and sorghum.	Black-gram, bottle-gourd, citrus orchard, mango orchard, musk-melon, squash-melon, pigeon-pea, radish (ssed), soybean, sugarcane, sweet-potato and water-melon.

TABLE 1
CROP PREFERENCE BY DIFFERENT SPECIES OF RODENTS DURING DECEMBER 1970-NOVEMBER 1972 ON THE PAU FARM,
LUDHIANA

Crop	Number of rodents per trap per day (x 10 ³)								
	M.m.b.	M.b.	M.p.	R.m.	B.b.	G.e.	T.i.	Total	
1	2	3	4	5	6	7	8	9	
CEREALS									
Barley	100(1+1)	0(1+1)	0(2+2)	1(2+2)	0(1+1)	0(2+2)	0(1+1)	101	
Oat	58(3+1)	17(3+1)	39(9+3)	64(9+3)	0(6+2)	0(9+3)	4(6+2)	182	
Maize	59(9+9)	16(9+9)	1(21+21)	34(21+21)	4(12+12)	0(21+21)	21(12+12)	135	
Pearl-millet	186(3+1)	14(3+1)	5(5+6)	140(5+6)	0(2+5)	0(5+6)	12(2+5)	357	
Wheat	86(15+15)	20(15+15)	1(38+39)	35(38+39)	5(23+24)	1(38+39)	6(23+24)	154	
PULSES									
Black-gram	0(0+0)	0(0+0)	0(1+0)	67(1+0)	0(1+0)	0(1+0)	0(1+0)	67	
Green-gram	89(3+3)	28(3+3)	0(6+6)	86(6+6)	0(3+3)	0(6+6)	11(3+3)	214	
Lentil	22(0+1)	67(0+1)	0(0+2)	11(0+2)	0(0+1)	0(0+2)	22(0+1)	122	
Pigeon-pea	13(3+3)	0(3+3)	1(8+8)	25(8+8)	0(5+5)	0(8+8)	0(5+5)	39	
Soybean	100(1+0)	33(1+0)	0(3+0)	178(3+0)	0(2+0)	0(3+0)	0(2+0)	311	
OILSEEDS									
Groundnut	300(1+0)	450(1+0)	25(1+0)	200(1+0)	0(0+0)	0(1+0)	0(0+0)	975	
Sarson	100(1+1)	0(1+1)	0(3+3)	16(3+3)	0(2+2)	0(3+3)	39(2+2)	155	
Toria	67(1+1)	17(1+1)	0(3+3)	6(3+3)	0(2+2)	0(3+3)	17(2+2)	107	

M.m.b. = *Mus musculus bactrianus*, M.b. = *Mus booduga*, M.p. = *Mus platythrix*, R.m. = *Rattus meliata*, B.b. = *Bandicota bengalensis*, G.e. = *Golunda ellioti*, T.i. = *Tatera indica*.

TABLE 1 (contd.)

Crop	M.m.b.	M.b.	M.p.	R.m.	B.b.	G.c.	T.i.	Total
1	2	3	4	5	6	7	8	9
SUGAR CROPS								
Sugarcane	25(2+2)	27(2+2)	1(4+4)	68(4+4)	14(2+2)	6(4+4)	0(2+2)	368
Sweet-potato	80(1+0)	0(1+0)	0(3+1)	35(3+1)	7(2+1)	0(3+1)	7(2+1)	129
FODDER								
Cow-pea	100(1+0)	0(1+0)	0(1+0)	650(1+0)	0(0+0)	0(1+0)	0(0+0)	750
Egyptian clover	56(0+4)	6(0+4)	4(0+7)	29(0+7)	0(0+3)	0(0+7)	0(0+3)	95
Lucerne	57(3+2)	7(3+2)	0(5+5)	45(5+5)	5(3+2)	13(5+5)	2(3+2)	129
Napier- bajra hybrid	48(2+3)	4(2+3)	6(4+6)	45(4+6)	10(2+3)	5(4+6)	44(2+3)	162
Sarson + Egyptian clover	188(0+4)	150(0+4)	71(0+7)	71(0+7)	0(0+3)	0(0+7)	0(0+3)	480
Sorghum	175(1+0)	75(1+0)	25(3+0)	92(3+0)	25(2+0)	0(3+0)	13(2+0)	405
Fodder*	358(5+5)	58(5+5)	44(11+11)	105(11+11)	21(6+6)	7(11+11)	40(6+6)	633
SUMMER VEGETABLES								
Bitter-gourd	25(1+1)	0(1+1)	0(1+1)	25(1+1)	0(0+0)	0(1+1)	0(0+0)	50
Bottle-gourd	86(2+2)	0(2+2)	0(3+3)	33(3+3)	14(1+1)	0(3+3)	0(1+1)	133
Brinjal	152(3+4)	5(3+4)	0(5+6)	42(5+6)	0(2+2)	0(5+6)	158(2+2)	357
Musk-melon	50(2+2)	25(2+2)	0(3+3)	17(3+3)	17(1+1)	0(3+3)	0(1+1)	109
Okra	0(0+0)	0(0+0)	0(2+2)	8(2+2)	0(2+2)	0(2+2)	50(2+2)	58
Squash-melon	50(0+1)	0(0+1)	0(1+1)	0(1+1)	50(0+1)	0(1+1)	0(0+1)	100

* (mixture of pearl-millet, cow-pea, cluster-bean and sorghum)

TABLE 1 (contd.)

Crop 1	M.m.b. 2	M.b. 3	M.p. 4	R.m. 5	B.b. 6	G.c. 7	T.i. 8	Total 9
Water-melon	88(2+2)	0(2+2)	0(3+3)	58(3+3)	0(1+1)	0(3+3)	0(1+1)	146
WINTER VEGETABLES								
Cauliflower	0(1+1)	0(1+1)	0(1+1)	183(1+1)	0(0+0)	0(1+1)	0(0+0)	183
Carrot (seed)	25(1+1)	0(1+1)	0(1+1)	0(1+1)	0(0+0)	0(1+1)	0(0+0)	25
Fenugreek	550(0+1)	50(0+1)	0(0+1)	0(0+1)	0(0+0)	0(0+1)	0(0+0)	600
Onion	0(0+0)	0(0+0)	0(1+1)	117(1+1)	0(1+1)	0(1+1)	17(1+1)	134
Onion (seed)	25(1+1)	0(1+1)	0(1+1)	0(1+1)	0(0+0)	0(1+1)	0(0+0)	25
<i>Metha</i>	0(0+0)	0(0+0)	0(0+1)	0(0+1)	0(0+1)	0(0+1)	100(0+1)	100
Pea	50(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	50
Potato	340(1+1)	20(1+1)	0(3+3)	87(3+3)	0(2+2)	0(3+3)	0(2+2)	447
Radish	650(1+0)	300(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	950
Radish (seed)	0(0+0)	0(0+0)	0(1+0)	67(1+0)	0(1+0)	0(1+0)	0(1+0)	67
Spinach	200(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	200
Tomato	248(4+3)	57(4+3)	3(6+5)	73(6+5)	0(2+2)	0(6+5)	8(2+2)	389
FRUIT TREES								
Ber	17(3+3)	3(3+3)	1(9+9)	14(9+9)	0(3+3)	0(9+9)	0(3+3)	35
Citrus	51(6+6)	24(6+6)	7(9+9)	40(9+9)	0(3+3)	0(9+9)	1(3+3)	123
Mango	50(3+3)	24(3+3)	6(9+9)	54(9+9)	6(6+6)	1(9+9)	1(6+6)	142
MISCELLANEOUS								
American cotton	24(3+3)	38(3+3)	1(8+8)	18(8+8)	0(5+5)	0(8+8)	13(5+5)	94
Desi cotton	150(1+1)	42(1+1)	25(2+2)	75(2+2)	0(1+1)	0(2+2)	67(1+1)	359
Cluster-bean	147(6+4)	90(6+4)	7(12+8)	93(12+8)	3(6+4)	0(12+8)	10(6+4)	350

TABLE 1 (contd.)

Crop	M.m.b.	M.b.	M.p.	R.m.	B.b.	G.c.	T.i.	Total
1	2	3	4	5	6	7	8	9
<i>Jantar</i>	144(3+0)	22(3+0)	11(5+1)	33(5+1)	11(2+1)	0(5+1)	33(2+1)	254
Chickory	67(1+0)	33(1+0)	0(2+0)	0(2+0)	0(1+0)	0(2+0)	33(1+0)	133
<i>Kaathi</i>	33(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	33
Turmeric	3(0+1)	0(0+1)	0(0+1)	0(0+1)	0(0+0)	0(0+1)	0(0+0)	3
After harvesting of different crops*	16	0	1	10	1	0	0	
Ploughed fields before sowing*	34	32	0	44	0	0	20	

Parenttheses are the number of traps used during December 1970-November 1971 and those during December 1971-November 1972.

* Total number of rodents trapped.

The pooled data of all the species of rodents shows their preference for cow-pea, fenugreek, fodder (mixture of pearl-millet, cow-pea, cluster-bean and sorghum), groundnut and radish, and followed by brinjal, cluster-bean, *desi* cotton, pearl-millet, potato, *sarson* + Egyptian clover, sorghum, soybean, sugarcane and tomato than the other crops (Table 1).

All the species, except *Tatera*, were found more in the closely-spaced crops. This difference might be due to the hopping type of movements of *Tatera*.

The frequent tillage operations that caused lack of weeds and dis-

However the rodents were found in a variety of crops, but the disturbed the habitat during early stages of growth of vegetables could explain the lower incidence of rodents during early stages than during later stages. Also, in fodder crops, absence of tillage operations might be responsible for the high incidence of rodents.

bers in which they were observed in different crops suggest that they exhibit preference for different crops. For instance, *Rattus* preferred onion, cauliflower and soybean; *M. hooduga* preferred groundnut and radish; *M. m. bactrianus* preferred fenugreek, radish, spinach, tomato and potato; *M. platythrix* preferred oats; *Bandicota* preferred bottle-gourd, musk-melon, squash-melon, lucerne and wheat; *Golunda* preferred lucerne and *Tatera* preferred *metha* and brinjal. It would be desirable to examine as to whether these preferences are on the basis of the olfactory or gustatory stimuli presented by the crops.

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REFERENCES

- BINDRA, O. S. & PREM SAGAR (1968): Study on the losses to wheat, groundnut and sugarcane crops by the field-rats in Punjab. *Proc. International symp. binomics control rodents Kanpur*. Sept. 20-Oct. 2, 1968. p. 28-31.
- DAVIS, D. E. (1964): Manual for analysis of rodent population. The Pennsylvania State Univ. Pennsylvania 82 p.
- DEORAS, P. J., RENAPURKAR, D. M. & CHATURVEDI, G. C. (1969): Importance of baiting and trapping. *Pesticides* 3:41-42.

The cocoon spinning behaviour and fecundity of *Stegodyphus sarasinorum* Karsch (Araneae: Eresidae) from India¹

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(With seven text-figures)

Observations on the sequence of cocoon spinning behaviour and fecundity of the social spider *Stegodyphus sarasinorum* Karsch (Eresidae) are given.

INTRODUCTION

In the genus *Stegodyphus*, cocoons have been observed by Marshall (1898), Jambunathan (1905), Millot & Bourgin (1942), Phanuel (1960) and Bradoo (1972a), but the mechanism of cocoon spinning in *Stegodyphus* has not been investigated before. The cocoon spinning behaviour among spiders affords a good example of a succession of instinctive responses controlled by both internal and external stimuli. The spinning activity is so organised that no stage can be omitted and no stage repeated. The different stages of this behaviour follow one after the other as in a chain automatic behaviour.

This paper, describes the sequence of cocoon spinning behaviour and fecundity of the social spider *S. sarasinorum* Karsch, common in Kerala, south India.

METHODS OF STUDY

The cocoon spinning behaviour of *S. sarasinorum* Karsch, was studied in seven batches that were established in the laboratory. Each batch

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contained 5 to 10 gravid females placed within a loosely closed glass jar. After a few days of nest construction inside the jar, the females make their cocoon on the nest surface or on the web around the nest. As the cocoon spinning is a nocturnal activity in this spider, a dim torch light was used during the course of these observations.

The complete sequence of cocoon spinning behaviour was observed only seven times in the laboratory and the duration for each stage in the sequence, was recorded. The later stages of this sequence were also observed in several field colonies of this species that were regularly examined during the breeding season.

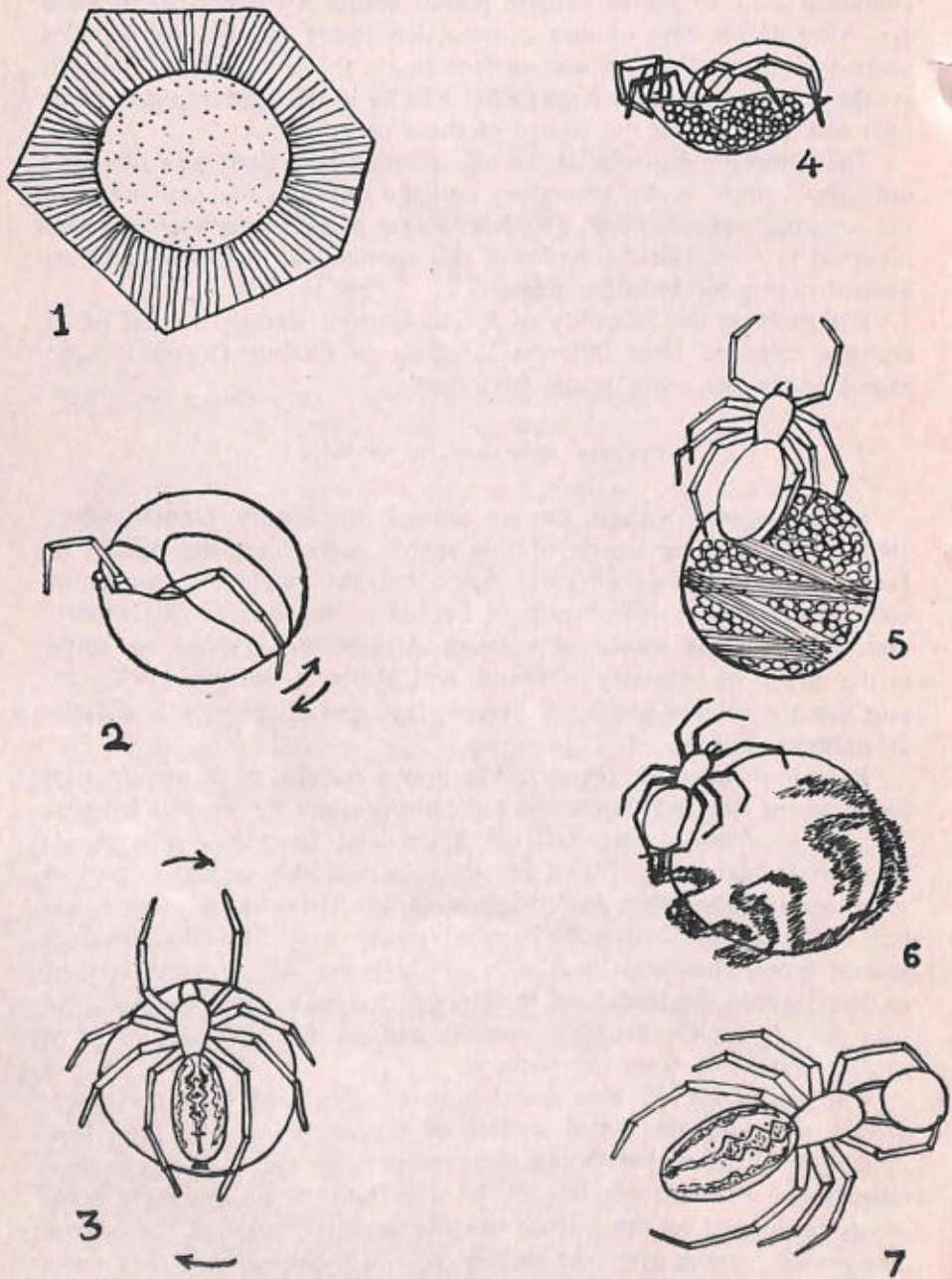
For studying the fecundity of *S. sarasinorum* Karsch, a total of 41 cocoons collected from different localities in Calicut (Kerala), were examined for egg count in the laboratory.

COCOON SPINNING BEHAVIOUR

S. sarasinorum Karsch, has an annual life history (Jambunathan 1905). The breeding season of this spider starts from the middle of January and continues till early April, but the maximum number of cocoons are made in the month of February. Marshall (1898) reports that the egg-laying season of a South African *Stegodyphus* sp. starts in the month of February or March and Millot & Bourgin (1942) report that the solitary species, *S. lineatus* lays eggs in the month of June, in southern Europe.

Behaviour of gravid females. The gravid females of *S. sarasinorum* are larger in size and they move more slowly than the normal females. The gravid females bear well developed and functional silk glands (Bradoo & Majupuria 1973), but they do not take an active part in snare construction. They feed on prey, captured mostly by other members of the colony. During the breeding season, gravid females construct several brood chambers lined with soft cribellar silk for storing their cocoons, within the tunnels of their nest. This makes the nest architecture suitable for the breeding purpose and for the new generation of spiders that hatch from the cocoons.

The gravid females also spend most of their time in 'toilet movements', grooming the dorsal surface of the abdomen with hind legs, upper side of the cephalothorax with anterior legs and they groom their appendages with one another. Such toilet movements are more commonly performed by the mature and the gravid females of the colony. The gravid females also take part in colony foundation, as they leave their nest, individually or in groups of few individuals and then they establish new breeding nests, close to the parent nest (Bradoo 1972b). Each gravid female makes a total of 2 to 4 cocoons during the breeding season.



The Cocoon spinning behaviour of *S. sarasinorum* Karsch.
 Fig. 1. Platform with the central disc; Figs. 2 and 3. Construction of the receiving valve; Fig. 4. Oviposition; Fig. 5. Concealing the egg-mass; Fig. 6. Spinning of Cribellar silk around the cocoon; Fig. 7. Transportation of the cocoon.

In *S. sarasinorum*, the cocoon spinning behaviour normally involves ten stages in the following sequence:

1. *Construction of the Platform*: The first step in cocoon spinning behaviour is the construction of a loose silken platform (Fig. 1) consisting of numerous closely arranged silk threads, placed side by side, close to the nest surface. The spinning of the platform is finished within about 9 to 15 minutes. The finished platform appears as an oblique or horizontal thin sheet of smooth supporting silk, on the upper middle surface of which the cocoon is spun.

The construction of the platform starts normally after midnight, when the other members of the colony are busy, either spinning cribellar silk on the web or feeding on some ensnared prey. The spinning of the platform indicates the start of the cocoon spinning behaviour and if the spider is disturbed at this stage, she at once retreats into her nest and never returns back to resume the work on the platform. The cocoon spinning is also suspended, as and when the spider receives strong web-signals from other members of the colony, rushing to their nest due to some disturbance in the surroundings. Undisturbed and calm surrounding is hence essential for the successful completion of the platform. After the platform is ready, the spider examines it by palpal contacts and quickly shakes her abdomen sidewise and this releases the next phase of the spinning behaviour i.e. the construction of the receiving valve.

2. *The Receiving Valve*: The receiving valve is made by rubbing the mid and hind spinnerets over the upper middle surface of the platform. During this process, the spider taps (dabs) her abdomen up and down, adding silk over the platform and at the same time, she changes her orientation, turning clockwise or anticlockwise. Such dabbing movements continues, for a short time till the platform shows a thin smooth pinkish-white circular disc (Fig. 1), that later becomes the cup-like receiving valve of the cocoon. After the formation of this disc, the spider then thickens only the margin of the disc by making two types of spinning movements on the upper side of the disc. These movements include, (i) a short sidewise movement of the abdomen, resulting in the repeated brushing of the spinnerets along the margin of the disc. This results in the gradual thickening of the periphery of the disc that becomes the receiving valve (Fig. 2). (ii) The second type of movement involves the rotation of the spider (clockwise or anticlockwise) over the same upper side of the receiving valve. This results in a uniform thickening of the margin of the receiving valve so that a shallow depression is gradually formed in its middle (Fig. 3).

The above mentioned two spinning movements continue simultaneously, as the spinnerets add silk over the receiving valve. During this spinning activity, the spider receives tactile stimuli through the palps,

that are constantly kept in contact with the margin of the valve and it is accompanied by a slight arching of the abdomen. The palpal contact is necessary for the continuity of the spinning movements. A single rotation of the spider over the valve is completed in an average of one and a half minutes and such rotations continue for about 25 to 40 minutes, after which the construction of the receiving valve is complete. The receiving valve is supported by the platform.

3. *Rest*: The completion of the receiving valve is always followed by about 4 to 5 minutes rest. During this period, the spider remains motionless over the receiving valve without making any visible movements. This duration may be necessary for the eggs to move down from the ovaries into the basal part of the oviducts for deposition.

4. *Oviposition*: The rest stage is followed by certain characteristic movements of the cephalothorax and up and down movement of the abdomen, accompanied by quick shivering of the legs. The spider remains flat and then adjusts her epigynal furrow over the receiving valve and within 2 or 3 minutes, she starts depositing her eggs. During this process, the spider again remains motionless, the anterior pair of legs remain deflexed beneath the cephalothorax. Some fluid is also secreted along with the eggs that keeps them glued into a single yellowish egg-mass as also reported in *S. lineatus* by Millot & Bourgin (1942). The completion of oviposition is followed by the next stage, provided the spider is not disturbed at this stage.

In some field colonies of *S. sarasinorum*, sometimes after oviposition, the spider suspends her further spinning activity due to some external disturbances and leaves her incomplete cocoon so that the egg-mass finally shrivels.

5. *Concealing the Egg-mass*: The eggs deposited within the receiving valve are immediately covered by loose thin silk threads taken out quickly from the spinnerets. In this process, the spider moves her abdomen sidewise, brushing her spinnerets very quickly over the surface of the egg-mass (Fig. 5) which is concealed in about 4 to 7 minutes. With each stroke of the abdomen, the spinnerets produce many straight silk threads extending from one to the other margin of the valve (Fig. 5). This phase is then followed by spinning of the covering valve.

6. *The Covering Valve*: The spinning of the covering valve is brought about by the repeated brushing of the spinnerets all over the concealed egg-mass, in a haphazard manner. The spider always changes her direction during this spinning activity. The spinning movements of this phase are exactly similar to those made at the start of the formation of the receiving valve. The covering valve is completed in about 40 to 50 minutes, after which it appears as a thin whitish papery cover over the eggs.

After the completion of the covering valve, the smooth double convex white cocoon is looked after by the mother. Even if disturbed, she

does not leave her cocoon now, but firmly holds it with her palps and legs. My observations revealed that it is mainly the size and the tactile stimuli from the cocoon surface that she responds to, as an empty cocoon from another nest of its kind would also be accepted by the mother, and looked after like her own cocoon. The gravid females, that have not oviposited, do not show maternal care, although they may accept cocoons temporarily.

These observations show that the maternal care in *Stegodyphus* starts shortly after the oviposition and completion of the covering valve of the cocoon and that this behaviour shown by the mother is instinctive, released probably by both internal and external stimuli. The internal stimulus probably comes from the brain while the external stimulus involves mainly the tactile stimuli received from the cocoon surface. That the central nervous system of spiders contain certain neurosecretory cells, has recently been reported by Legendre (1954a, 1954b, 1958) and Sasira Babu (1965).

With the completion of the covering valve of the cocoon, the spider continues the next phase of her behaviour.

7. *Removal of some supporting threads*: The completion of the covering valve is followed by the removal of a few supporting silk threads present around the cocoon. The mother slowly cuts only a few of these silk threads of the platform by the help of her chelicerae within 2 to 5 minutes and this results in a slight tilt in the original flat position of the cocoon. The cocoon becomes slightly free along one side. This is followed by the next phase, the spinning of the cribellar silk.

8. *Cribellar silk*: For the first time in cocoon spinning behaviour, the spider starts spinning sticky cribellar silk over the cocoon surface and along the margin (Fig. 6). This provides a firm attachment between the two valves of the cocoon. The spinning of cribellar silk is a slow process for which both the hind legs are used by the spider and this stage lasts for about 35 to 49 minutes. Like *Stegodyphus*, other cribellates also cover their cocoons with cribellar silk and this has certain advantages. Norgaard (1941) reports that the cocoons of *Eresus niger* Pet. are covered with cribellar silk and many foreign bodies like sand grains, remains of prey and plant matter are also added to camouflage the cocoon. Bradoo (1972b) found a *Uloborus* spider covering her bag-like cocoon with cribellar silk, that is useful to a great extent for preventing the ovipositional activity of its egg parasite. In *S. sarasinorum* the cribellar silk not only unites the two valves of the cocoon but it also provides a rough surface for convenient transportation by the mother. The adhesive cribellar silk also protects the cocoon from ants that sometimes raid the nests of social spiders (Bradoo 1972a).

9. *Separation of the Cocoon*: After adding some cribellar silk over the cocoon surface, the mother cuts all the remaining supporting threads

of the platform in about 10 minutes around the cocoon. The cocoon becomes free from the platform and the spider then removes the cocoon that may be covered with additional sticky cribellar silk before it is carried to the nest.

10. *Transportation*: This is the last phase of the cocoon spinning behaviour. The cocoon after it is completely free, is carried by the mother within 1 to 3 minutes towards her nest. The method of transportation of the cocoon is different from the method used in transport of prey. The prey is practically dragged by several spiders towards the nest, but the cocoon is held by the palps and one or two anterior legs (Fig. 7), and is carried by the female into the brood chamber of her nest. The mother remains with the cocoon and she is often observed adding more cribellar silk on the surface of the cocoon. At times, she takes the cocoon out through a nest exit and exposes it to the rays of the sun. This behaviour has also been reported by Millot & Bourgin (1942) in *S. lineatus*, who believe that it is necessary for receiving the warmth from the sun.

The duration of different stages of cocoon construction is given in table 1. Each cocoon measures 6 to 8 mm in diameter.

The different silk glands involved in the construction of the cocoon in this social spider has been described in detail by Bradoo & Majumuria (1973). In addition to cribellar silk, produced by different glands, at least two types of silk glands, namely, cylindrical glands and tubular glands are involved in cocoon construction. These two kinds of glands are characteristic of females only.

TABLE I
DURATION IN MINUTES OF TEN STAGES IN COCOON SPINNING BEHAVIOUR OF
S. sarasinorum KARSCH

Stages	Dates of observation						
	Jan. 21	Feb. 8	15th	16th	25th	Mar. 5th	9th
Platform	11	13	12	15	14	9	13
Receiving valve	31	40	29	30	35	32	25
Rest	5	5	5	5	5	4	5
Oviposition	2	3	2	2	3	2	2
Concealing	5	7	5	5	6	4	5
Covering valve	40	50	46	43	41	48	45
Removal of supporting threads	2	3	5	2	2	3	2
Cribellar silk	45	37	46	35	40	49	45
Separation	6	4	5	7	9	7	9
Transportation	1	2	1	2	2	3	1
Total duration	148	164	156	146	157	161	152

FECUNDITY

Each female *S. sarasinorum* makes a total of 2 to 4 cocoons during her lifetime. The total number of eggs contained in a cocoon varies from 60 to 115, as found in 41 cocoons opened in the laboratory (Table 2). The average number of eggs deposited in each cocoon varies from 67 to 93. The total number of eggs deposited by a single female in her life time varies from 164 to 280. Millot & Bourgin (1942) found that each cocoon of *S. lineatus* contained 150 to 250 eggs. The immature individuals of *S. sarasinorum* that attain maturity late, deposit only few eggs and generally make a single cocoon. A female of this species made a cocoon on 18th January, 1965 in the laboratory, that contained 122 eggs and when this spider was shortly dissected in the laboratory, its ovaries contained 65 more eggs in different sizes within the two ovaries.

TABLE 2

NUMBER OF EGGS IN 41 COCOONS OF *S. sarasinorum* KARSCH, IN 1965

S. No.	Date	No. of Cocoons	No. of Eggs	Average No.
1.	29th Jan.	4	71-115	67
2.	9th Feb.	4	62-115	82
3.	25th Feb.	6	60-114	84
4.	26th Feb.	4	73- 95	87
5.	2nd Mar.	9	77-105	88
6.	10th Mar.	10	66-111	93
7.	23rd Mar.	4	61- 98	83
Total		41	60-115	67-93

REFERENCES

- BRADDOO, B. L. (1972a): Some observations on the Ecology of social spider *S. sarasinorum* Karsch (Eresidae) from India. *Oriental Ins.* 6(2): 193-204.
- (1972b): Life history and bionomics of *Idris* sp. (Scelionidae: Hymenoptera) egg parasite of *Uloborus*, a commensal on the web of *S. sarasinorum* Karsch. *Zool. Anz. Leipzig*, 188(1/2):43-52.
- & MAJUPURIA, T. C. (1973): Studies on the anatomy of social spider *S. sarasinorum* Karsch (Eresidae) Part—I: Spinnerets and Silk glands. *ibid.* 190(1/2):67-73.
- JAMBUNATHAN, N. S. (1905): The habits and life history of a social spider *Stegodyphus sarasinorum* Karsch. *Smiths. Misc. Coll.* 47:365-372.
- LEGENDRE, R. (1954a): Sur la presence de cellules neurosecretrices dans

le systeme nerveux central des Araneids. *C. R. Acad. Sci.* 238:1267-1268.

————— (1954b): Donnes anatomiques sur le complexe neuroendocrine retrocerebral des Araneids. *Ann. Sci. Nat. Zool.* 16:419-426.

————— (1958): Contributions A L'etude du systeme nerveux des Araneids. (Summary D.Sc. thesis Paris Univ.). *Ann. Biol.* 34(5-6):193-223.

MARSHALL, G. A. K. (1898): Notes on: south African social spiders (*Stegodyphus*). *Zoologist.* 688(2):417-422.

MILLOT, J. & BOURGIN, P. (1942):

Sur la biologie des *Stegodyphus* solitaires. *Bull. Biol. France et Belg.* 76: 299-314.

NORGAARD, E. (1941): On the biology of *Eresus niger* Pet. *Ent. Medd. Kopenh.* 22(2/3):150-179.

PHANUEL, G. J. (1960): Unusual nest site of a social spider *S. sarasinorum* Karsch. *J. Bombay nat. Hist. Soc.* 57(3):686-688.

SASIRA BABU, K. (1965): Anatomy of the central nervous system of Arachnids (Ph.D. thesis, Sri Venkateswara Univ.). *Zool. Jb. Anat. Bd.* 82:1-154.

TABLE I

NUMBER OF EGGS IN 100 EGGS OF 21 SPECIES OF *Stegodyphus* IN 1965

No. of Eggs	No. of Clusters	No. of Clusters	No. of Clusters
1	100	100	100
2	100	100	100
3	100	100	100
4	100	100	100
5	100	100	100
6	100	100	100
7	100	100	100
8	100	100	100
9	100	100	100
10	100	100	100
11	100	100	100
12	100	100	100
13	100	100	100
14	100	100	100
15	100	100	100
16	100	100	100
17	100	100	100
18	100	100	100
19	100	100	100
20	100	100	100
21	100	100	100
22	100	100	100
23	100	100	100
24	100	100	100
25	100	100	100
26	100	100	100
27	100	100	100
28	100	100	100
29	100	100	100
30	100	100	100
31	100	100	100
32	100	100	100
33	100	100	100
34	100	100	100
35	100	100	100
36	100	100	100
37	100	100	100
38	100	100	100
39	100	100	100
40	100	100	100
41	100	100	100
42	100	100	100
43	100	100	100
44	100	100	100
45	100	100	100
46	100	100	100
47	100	100	100
48	100	100	100
49	100	100	100
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REFERENCES

————— (1965): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 111: 1-15.

————— (1966): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 112: 1-15.

————— (1967): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 113: 1-15.

————— (1968): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 114: 1-15.

————— (1969): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 115: 1-15.

————— (1970): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 116: 1-15.

————— (1971): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 117: 1-15.

————— (1972): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 118: 1-15.

————— (1973): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 119: 1-15.

————— (1974): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 120: 1-15.

————— (1975): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 121: 1-15.

————— (1976): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 122: 1-15.

————— (1977): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 123: 1-15.

————— (1978): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 124: 1-15.

————— (1979): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 125: 1-15.

————— (1980): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 126: 1-15.

————— (1981): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 127: 1-15.

————— (1982): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 128: 1-15.

————— (1983): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 129: 1-15.

————— (1984): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 130: 1-15.

————— (1985): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 131: 1-15.

————— (1986): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 132: 1-15.

————— (1987): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 133: 1-15.

————— (1988): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 134: 1-15.

————— (1989): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 135: 1-15.

————— (1990): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 136: 1-15.

————— (1991): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 137: 1-15.

————— (1992): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 138: 1-15.

————— (1993): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 139: 1-15.

————— (1994): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 140: 1-15.

————— (1995): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 141: 1-15.

————— (1996): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 142: 1-15.

————— (1997): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 143: 1-15.

————— (1998): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 144: 1-15.

————— (1999): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 145: 1-15.

————— (2000): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 146: 1-15.

————— (2001): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 147: 1-15.

————— (2002): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 148: 1-15.

————— (2003): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 149: 1-15.

————— (2004): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 150: 1-15.

————— (2005): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 151: 1-15.

————— (2006): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 152: 1-15.

————— (2007): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 153: 1-15.

————— (2008): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 154: 1-15.

————— (2009): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 155: 1-15.

————— (2010): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 156: 1-15.

————— (2011): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 157: 1-15.

————— (2012): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 158: 1-15.

————— (2013): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 159: 1-15.

————— (2014): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 160: 1-15.

————— (2015): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 161: 1-15.

————— (2016): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 162: 1-15.

————— (2017): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 163: 1-15.

————— (2018): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 164: 1-15.

————— (2019): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 165: 1-15.

————— (2020): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 166: 1-15.

————— (2021): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 167: 1-15.

————— (2022): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 168: 1-15.

————— (2023): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 169: 1-15.

————— (2024): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 170: 1-15.

————— (2025): A study of the biology of social spiders in the Bombay region. *Bull. Biol. France et Belg.* 171: 1-15.

Notes on South Indian Hepaticae—1¹

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(With seventeen text-figures)

INTRODUCTION

The bryological flora of south India, a territory luxuriant in liverworts both in frequency and variety, has not received adequate attention. Stray references to some liverworts from this area occur in some publications (reviewed by Pandé & Bharadwaj 1952; Udar 1975).

The leafy genera belonging to acrogynous Jungermanniales, which form the bulk of the hepatic vegetation of south India, have not been studied much. The present paper gives an illustrated taxonomic account of the genera *Trichocolea* and *Notoscyphus*. It is interesting that both these taxa are also commonly found in the eastern Himalayas.

DESCRIPTIONS

1. ***Trichocolea tomentella*** (Ehrh.) Dumort., Corr. Nees, *Naturg. Eur. Leberm.* 3:105 (1838). (Figs 1-8).

**Jungermannia tomentella* Ehrhart, *Beitrage zur Naturkunde*, 2:150. (1788).

Trichocolea tomentella Dumort., *Comment. Bot.* 113. (1822).

Thricolea tomentella Dumort., *Sylog. Jungerm.* 67. (1831).

Tricolea tomentella Dumort., *op. cit.* p. 99.

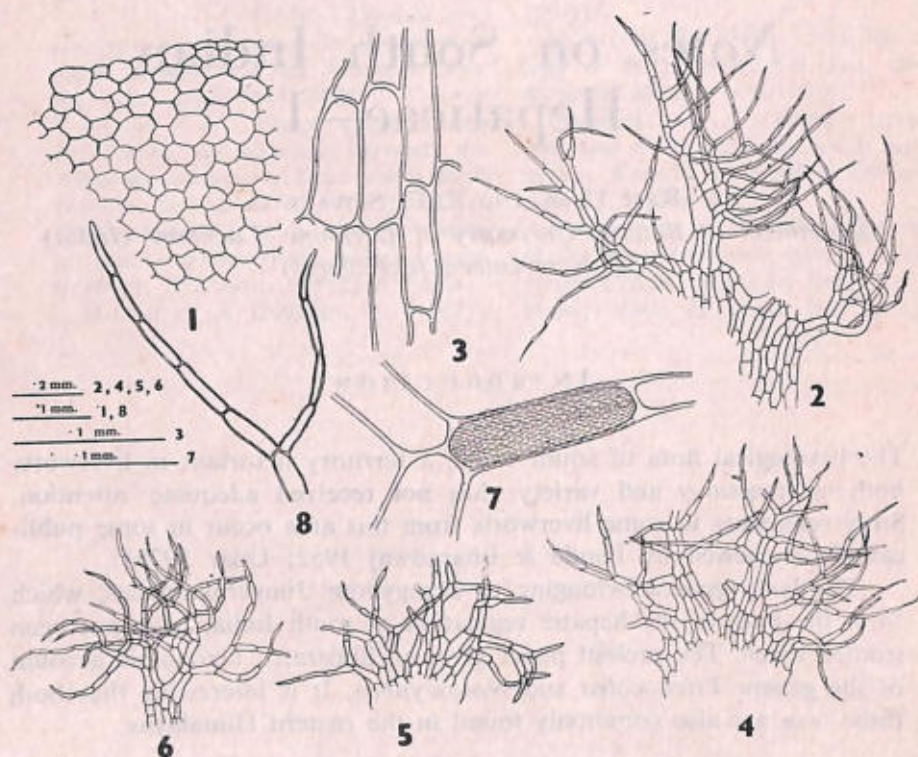
Tricholea tomentella Dumort., *Rec. d'Observ. Jungerm.* 20. (1835).

Trichocolea biddlecomiae. Austin, *Bot. Gaz.* 3:6. (1878).

Plant whitish green becoming yellowish on drying; stem about 10 cm or more in length, regularly bi-tri-pinnate, dorsally covered with paraphyllia (in the form of simple or branched filamentous cilia), 23-30

¹ Accepted July 1971.

* Synonymus adopted from Hatcher (1957).



Trichocolea tomentella

Fig. 1. Cross section of stem (a portion magnified); Fig. 2. Leaf of the main axis; Fig. 3. Cells of the leaf lamina; Fig. 4. Underleaf of the main axis. Fig. 5. Leaf of a branch; Fig. 6. Underleaf of a branch; Fig. 7. Cells of the cilia magnified; Fig. 8. Branched paraphyllium.

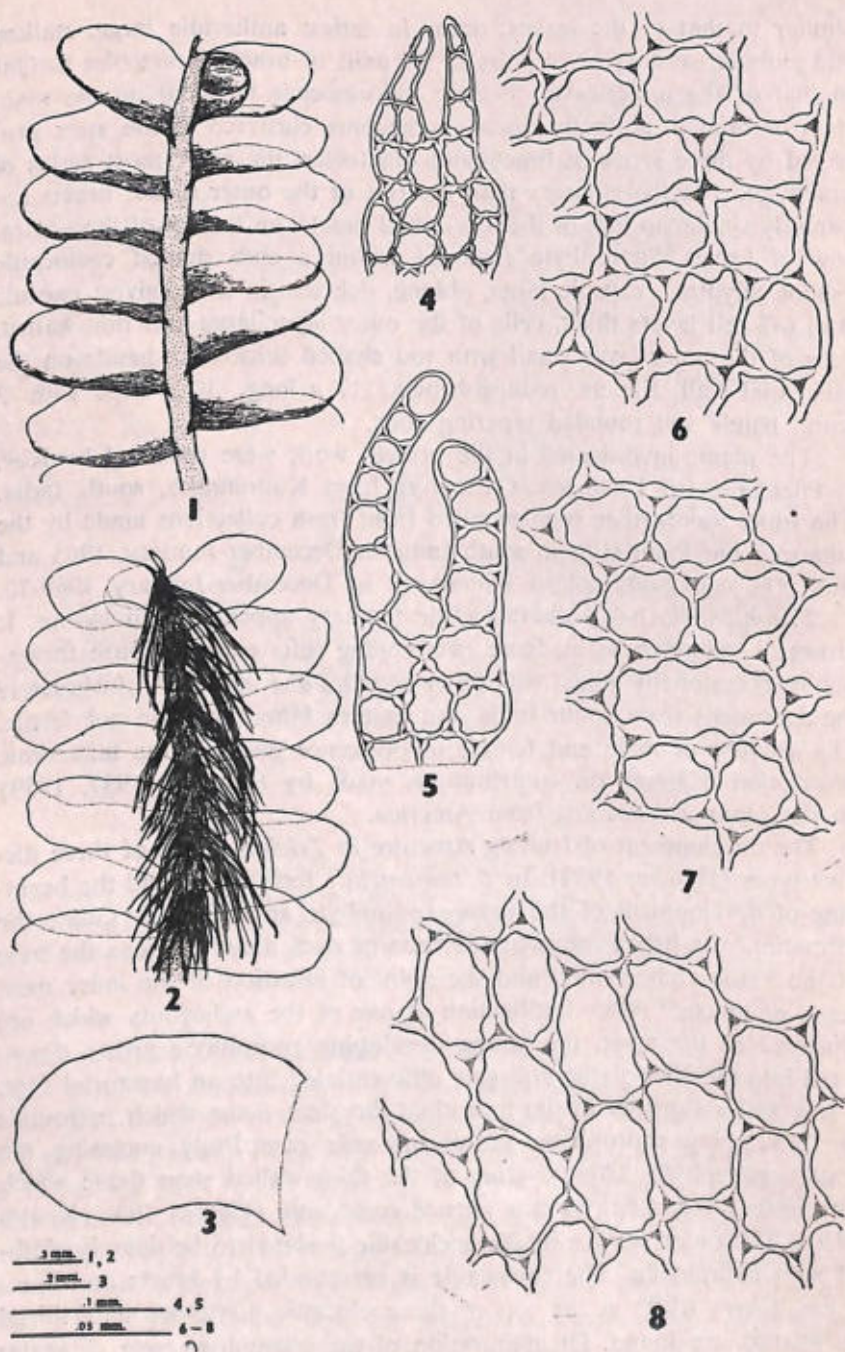
cells across diameter, cells differentiated into cortex and medulla, cortical cells $9.6-38.4 \mu$ in diameter, with slightly thickened walls, medullary cells not thickened, $24-52.8 \mu$ in diameter. Leaves in three rows, two lateral and one ventral, lateral leaves alternate, about 1.5 mm or less long, (from the base to the apex of the cilia), 1.7 mm broad, deeply divided into 6-8 (usually 6) segments with simple or branched cilia, cells of the cilia $57.6-105.6 \mu$ long, $9.6-24.0 \mu$ broad, cuticle striolate-papillose; cells of the undivided lamina $67.2-124.8 \mu$ long, $19.2-28.8 \mu$ broad; underleaves smaller than the leaves, c. 1 mm long, 1.5 mm broad, bifid, each lobe further divided into 4-6 simple or branched cilia similar to those of the leaves. Male inflorescence branched, antheridial branches similar to that of the vegetative branches; bracts concave,

similar to that of the leaves, occur in series; antheridia large, stalked and globose, solitary or in pairs in the axils of bracts; bracteoles similar to that of the underleaves. Female inflorescence terminal on the main stem or branch, perianth absent, archegonia clustered at the apex protected by three series of bracts and bracteoles, the inner most series of bracts and bracteoles larger than the rest of the outer series; bracts apparently similar to that of the leaves and bracteoles to that of the ventral row of leaves. Sporophyte enclosed within a club shaped coelocaul (shoot calyptra), capsule large, oblong, dehisces in to 4 valves; capsule wall 6-7 cell layers thick, cells of the outer layer large and thin-walled, cells of the inner layer small with rod shaped thickening bands on the tangential wall. Elaters reddish-brown 117μ long, 10μ wide with 2 spiral bands and rounded tapering ends.

The plants investigated in the present work were collected by Rev. I. Pfeleiderer (of Esslingen, Germany) from Kudremukh, south India. The study was further supplemented from fresh collections made by the authors from Palni Hills in south India in December-January, 1965 and from Darjeeling in eastern Himalayas in December-January 1969-70.

T. tomentella has a characteristic feathery appearance in nature. It grows on moist rocks in dense overlapping tufts either in pure formation or occasionally mixed with other hepatics and mosses. Unfortunately the specimens from south India and eastern Himalayas are not fertile. The account of male and female inflorescence given in the taxonomic description is based on contributions made by Hatcher (1957, 1959) on the genus *Trichocolea* from America.

The development of fruiting structure in *Trichocolea* is of three distinct types (Hatcher 1959). In *T. tomentella* "fertilization and the beginning of development of the young sporophyte apparently stimulate the formation of a broad meristematic zone of stem tissue between the base of the fertile archegonium and the point of insertion of the inner most series of bracts." After fertilization of one of the archegonia which are clustered at the apex, the young developing sporophyte grows downward into the stem tissue and gets differentiated into an haustorial foot, a seta and a capsule. In the meantime the stem tissue which surrounds the developing sporophyte, grows upwards completely enclosing the young sporophyte. This covering of the thick-walled stem tissue which surrounds the sporophyte was termed coelocaul (Goebel 1930; Knapp 1930). The outer surface of the coelocaul is stated to be densely clothed with paraphyllia. The coelocaul is surrounded by bracts and bracteoles below, while at the top of the coelocaul numerous unfertilized archegonia are found. On maturation of the sporophyte, seta elongates and the tip of the coelocaul ruptures irregularly by the emergence of the large, oblong capsule. The spores in this genus are reddish-brown, $30-35 \mu$ in diameter, oval to rounded, smooth or minutely punctate.



Notoscyphus lutescens

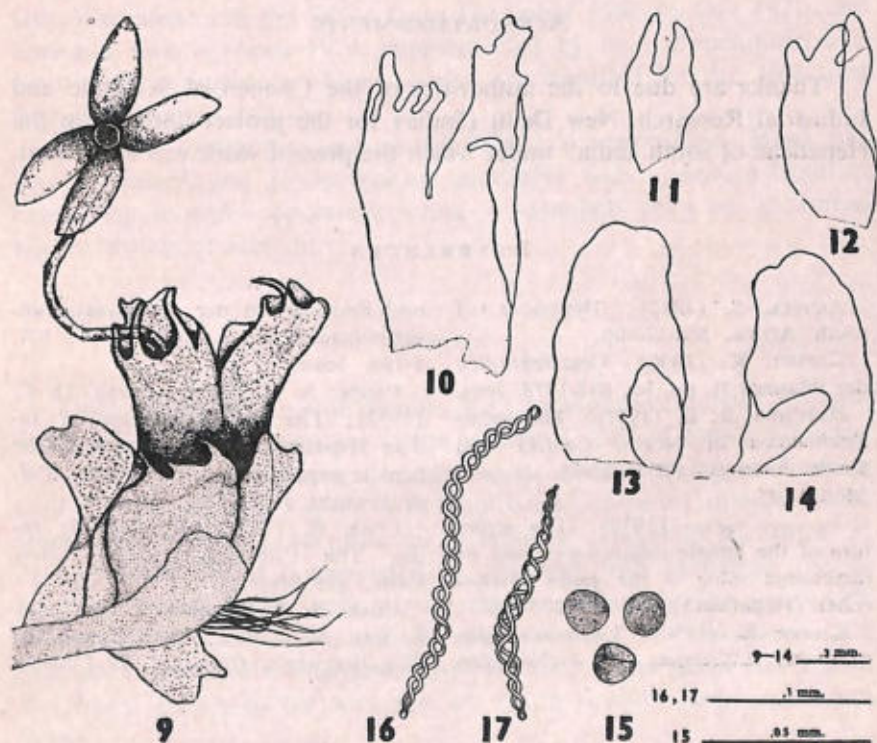
Figs. 1-2. Dorsal and ventral view of the plant respectively; Fig. 3. Leaf; Figs. 4-5. Underleaves (amphigastria); Figs. 6-8. Marginal, middle and basal cells of the leaf respectively.

2. *Notoscyphus lutescens* (L. et L.) Mitt. Fl. Viti, p. 407, 1862. (Figs. 1-17).

**Jungermannia lutescens* L. et L., Pug. IV p. 16 (1932).

Gymnomitrium lutescens G., Syn. Hep. 4 (1844).

Plants small 10-18 mm or so long, prostrate, green to yellowish-green, rarely branched; rhizoids ventral, arising in fascicles from the base of the amphigastria. Leaves in three rows, two lateral and one ventral; lateral leaves simple, succubous, entire, unistratose, cells with conspicuously bulging trigones, oil bodies in fresh leaves 2-4 per cell, elliptical, prominently granular with rough outline, apical cells of the leaf $19.2-28.8 \times 38.4-48.0 \mu$, middle cells $19.2-28.8 \times 24.0-57.6 \mu$ and basal cells $24.0-38.4 \times 28.8-48.0 (52.8) \mu$; underleaves minute, bifid, c. 264.0μ long, 100.8μ broad, cells with conspicuously developed trigones. Dioecious. Antheridia in the axils of the bracts, bracts sac like in two



Notoscyphus lutescens

Fig. 9. Magnified view of the perianth with elongated seta and dehiscent capsule; Fig. 10. A portion of the perianth; Figs. 11-12. Female bracts; Figs. 13-14. Male bracts; Fig. 15. Spores; Figs. 16-17. Elaters.

* Synonyms adopted from Arnell (1963).

alternate rows enclosing a single antheridium in each. Archegonia apical, enclosed within the perianth, bracts and bracteoles bifid, sporophyte differentiated into foot, seta and capsule, seta elongated bearing a spherical dark-brown capsule, capsule dehiscence into 4-valves, capsule wall multi-stratose, cells with thickening bands; spores unicellular, more or less spherical c. 12.0-14.4 μ in diameter; elaters tapering at both ends, usually bispirate, rarely with a tendency to become trispirate, 67.2-249.6 μ long and 9.6-14.4 μ broad in the middle.

The plants were collected by us from Kodaikanal (alt. 6500 ft, Palni Hills), south India in December-January 1965-1966. This species also grows abundantly in east Himalayan territory. The study of the oil-bodies was completed from the specimens collected from Darjeeling during December-January 1969-70 (Udar *et al.* 1970).

ACKNOWLEDGEMENTS

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REFERENCES

- ARNELL, S. (1963): Hepaticae of south Africa. Stockholm.
- GOEBEL, K. (1930): Organographie der Pflanzen II. pp. i-x, 643-1378. Jena.
- HATCHER, R. E. (1957): The genus *Trichocolea* in North, Central and South America—(Hepaticae). *Lloydia* 20:139-185.
- (1959): The structure of the female inflorescence and its taxonomic value in the genus *Trichocolea* (Hepaticae). *ibid.* 22:208-214.
- KNAPP, E. (1930): Untersuchungen über die Hüllorgane um Archegonien und Sporogonien der Akrogynen Jungermaniaceen. *Bot. Abhandl.* 16: i-iv, 1-168. Jena.
- PANDE, S. K. & BHARADWAJ, D. C. (1952): The present position of Indian Hepaticology with a note on the hepatic vegetation of the country. *Palaeobotanist* 1:368-381.
- UDAR, R. (1975): Bryology in India. The *Chronica Botanica*, New Delhi. (in press).
- UDAR, R. & SRIVASTAVA, S. C. & KUMAR, D. (1970): Oil-bodies in Indian liverworts. *Curr. Sci.* 39:458-459.

The Terrestrial Mammals of Bahrain¹

MICHAEL GALLAGHER² AND DAVID L. HARRISON³
(With a map)

INTRODUCTION

A summary is given here of 13 species of terrestrial mammals which occur in Bahrain, in the Persian (Arabian) Gulf, based upon the identification by Harrison of specimens collected by Gallagher during the latter's residence on the island from December 1968 to July 1971, and during a visit in April 1974, supplemented by field observations and reports in the literature. Eight species are recorded for the first time from the Bahrain Islands.

No other systematic account of Bahrain's mammalian fauna has been published, and as changes are inevitable under pressure from an expanding human population future assessments may be measured against this brief account.

BAHRAIN

The independent State of Bahrain is an archipelago of about 30 small desert islands at the entrance to the V-shaped Gulf of Salwa (*Dowhat al Salwa*) mid-way along the Arabian shore of the Persian or Arabian Gulf. The largest of the group is Bahrain Island, some 30 miles in length from north to south, 10 miles at its broadest and with its centre at 26°03'N, 50°33'E. It is connected by causeway with Muharraq Island, on which is the international airport, and by a short bridge and a new causeway with Sitra Island and its oil terminal. Other islands on the east side include Nabi Salih and, near the shore of the Qatar peninsular, the Howar group; on the west side are Umm Nassan, Jidda and Umm Saban.

The greater part of Bahrain and its satellite islands is a desert of

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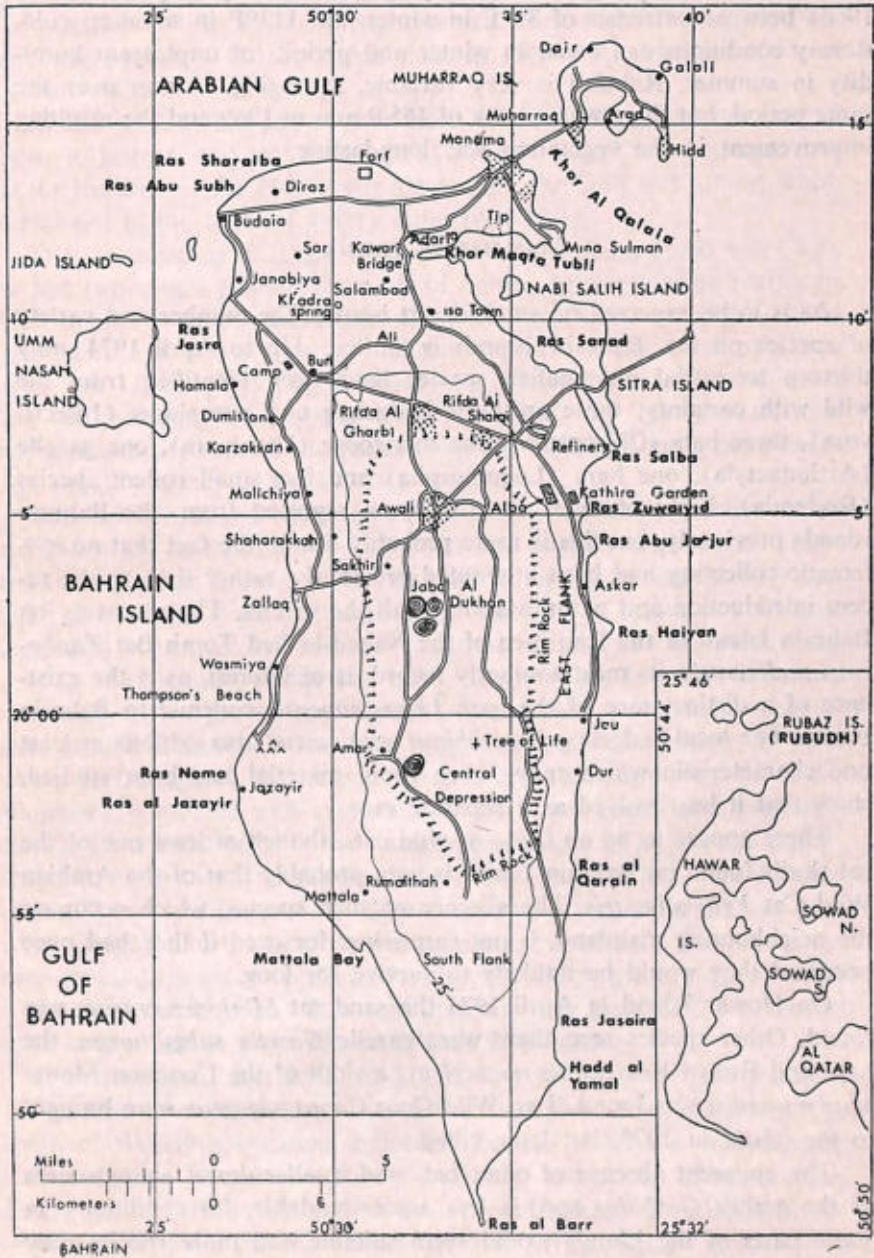
sand, stones and rock. Bahrain Island itself is an elongated dome, principally of Eocene limestone, parts of which have slumped and eroded to form dusty depressions bordered by low cliffs and hills. The Jebel al Dhukhan, at 440 feet the highest surviving part of the original dome, stands in the central, saucer-like depression. The stony flanks slope outwards and downwards to the peripheral extension of recent deposits, mostly of sabkha (salt mud flats) but also of silt, blown sand and raised beaches; only in one place (at Ras Noma, south of Zallaq on the west coast) is there an area of medium-sized dunes, though this is not extensive. In some of the larger wadis (dry water courses) cut in the west flank, deposits of windblown sand against the wadi walls produce near dune conditions, with rocks, bushes and sand hummocks in the wadi bed. There are some caves and many niches and crevices in the limestone sheets, hills and cliffs.

Howar Island, the largest of the group 13 miles south east of the southern tip of Bahrain Island, is 12 miles from north to south but only 3 miles at its broadest. It is uninhabited except for half a dozen policemen who live in the fort near a deserted fishing village at the north west tip and have one landrover, but it is occasionally visited by fishermen, and also by picnic parties who stay at the guest house near the north east tip. It consists mainly of an uneven limestone plateau, which slopes up from raised beach flats in the west to end as 30 foot cliffs on the east side. Some variety on this bleak desert island is provided by much flotsam cast up on the north and west coasts, by two small elongate hills with eroded niches used by animals for shelter, by sand-filled wadis and shallow depressions and by traces of old cultivation.

Vegetation occurs over most of the islands (Good 1954, 1955 and Wiltshire 1964), but in all except the irrigated part of the northern cultivated zone it consists of hardy xerophytic and sub-halophytic species, improved and supplemented by carpets of ephemerals after heavy rain. There are numerous plant species suitable for herbivores, but these are patchy in distribution.

Cultivation, mostly in date gardens, is restricted by the availability of water to a narrow discontinuous belt which stretches in an arc from near Zallaq on the west coast of Bahrain Island to Sitra on the east, and to parts of Muharraq, Sitra and some smaller offshore islands. Most of the available water seeps slowly along pervious strata from Saudi Arabia in the west and is tapped by hundreds of artesian wells or emerges as land and submarine springs; it is supplemented by some water which accumulates from local rains. The salinity increases and the static head decreases from the north-west to the south-east and supplies are dwindling rapidly and becoming more saline. The lowering of this water table has, over the years, caused some springs to cease or reduce their flow and the ancient subterranean aqueducts (*qanat* in Bahrain and Iran,

the equivalent of *falaj* in Oman) to dry up. Nevertheless there are still some brackish wells in use in the southern part of the island for the watering of domestic animals. On Howar Island there are at least three cisterns for the collection of rain water; these were full in April 1974



Map of Bahrain Island,

but only one has an access for animals. The domestic oil town of Awali, in the desert, has its own water supply and flora.

The harsh desert climate is modified by the surrounding sea and the prevailing north-westerly wind (*Shimaal*) and is less severe than on the Arabian mainland, temperatures varying (in the 20-year period 1947-1966) between extremes of 39°F in winter and 113°F in summer; cold, stormy conditions can occur in winter and periods of unpleasant humidity in summer. Rainfall is very variable, averaging 75 mm over the same period, but there was a peak of 165.9 mm in 1969 and the resulting improvement in the vegetation was long-lasting.

MAMMALIAN FAUNA

As is to be expected on small desert islands, the number and variety of species on the Bahrain islands is limited. Up to April 1974 only thirteen terrestrial mammalian species have been identified from the wild with certainty; these are: one hedgehog and one shrew (Insectivora), three bats (Chiroptera), one mongoose (Carnivora), one gazelle (Artiodactyla), one hare (Lagomorpha) and five small rodent species (Rodentia). Eight of these had not been reported from the Bahrain islands previously, but this is more probably due to the fact that no systematic collecting had been attempted previously, rather than to the recent introduction and naturalisation of all the species. The discovery on Bahrain Island of the Iraq race of the Naked-bellied Tomb Bat *Taphozous nudiventris*, its most southerly record, is of interest, as is the existence of a distinct race of the hare *Lepus capensis* endemic to Bahrain Island. The local hedgehog *Paraechinus aethiopicus* also exhibits at least one characteristic which may, when more material has been studied, show that it has evolved as a separate race.

There appear to be no foxes or wild cats, though at least one of the cat skulls found on Bahrain Island is very probably that of the Arabian Wild Cat *Felis silvestris*. The absence of such species, which occur on the neighbouring mainland, is not surprising, for even if they had once occurred they would be unlikely to survive for long.

On Howar Island in April 1974 the sand rat *Meriones crassus* was found. Other species seen there were gazelle *Gazella subgutturosa*, the hare and Brown Rat *Rattus norvegicus*; a skull of the Common Mouse *Mus musculus* was found. Two Wild Goat *Capra aegagrus* were brought to the island in 1973, but later killed.

The apparent absence of other bats and smaller desert animals such as the gerbils *Gerbillus* spp. is less understandable, for conditions in some parts of the islands would seem suitable and more species may well be found.

ORIGINS

The Bahrain Islands began emerging from the sea near the close of the middle Miocene, and further local uplift in the late Miocene and Pliocene, followed by much weathering, gave the islands their present configuration (Willis 1967), though the sea level at the end of the Pliocene was probably 150 m higher than at present (Fairbridge 1961, *in* Kassler 1973).

Kassler (1973) has shown that from about 80,000 years ago the sea began to retreat, and that from about 70,000 to 17,000 years ago, during the maxima of the Pleistocene glaciations, the Gulf was almost wholly exposed in the form of a very large river valley.

The sea returned in stages to its present level about 5,000 years ago, the last two stages entered the Gulf of Salwa, cutting marine platforms at 18 m and 9 m present depth, approximately 8,000 and 7,000 years ago. There are, however, some marine deposits in the Gulf of Salwa which are 11,000 years old. Bahrain was therefore probably connected with the mainland from about 80,000 to 11,000 (or 7,000) years ago, during which time vertebrate fauna from the mainland must have occupied suitable niches in the Bahrain ecosystem.

The Bahrain Islands now lie wholly within the 18 m depth contour and are joined to the mainland of Qatar and Saudi Arabia by a narrow structural feature, known as the Bahrain Ridge, over which the water depth is less than 9 m. To the south in the Gulf of Salwa is a shallow depression in the sea bed formed by subsidence early in the Pleistocene period. The Bahrain Ridge has been rising in the last few thousand years and marine growth and deposits have caused very shallow conditions around Bahrain. It has been suggested (A. J. Standring, *in pers. comm.* to Gallagher) that it is not impossible that temporary shoal development, combined with exceptionally low tides, could have produced short lived connection with the mainland sufficient to permit the migration of some species after the flooding of the Gulf of Salwa. The distance (some 20 miles to Qatar from Bahrain Island across the shallower part of the Ridge), and the tidal regime, would seem to make this only a remote possibility, except perhaps for gazelle, which are known to wade in search of marine algae. It is said that it is now possible for a man to wade at low tide to some Howar islands from Qatar.

It is considered that 2,000 to 3,000 years would have been required for the hare to have developed its distinct morphological characters; the length of Bahrain's isolation indicated above would have provided the necessary time. The shrew *Suncus murinus*, mongoose *Herpestes edwardsi*, gazelle and some rodents have probably been introduced or re-introduced by man, but the hedgehog, hare, jerboa *Jaculus jaculus* (not *Meriones* as given by Wiltshire) and many reptiles (Gallagher 1971)

have probably been present since Bahrain became isolated. Wiltshire (loc. cit., p. 121) also says that the presence of the *Uromastyx* lizard and the jerboa "suggest that Bahrain was formerly united with the mainland and has never been entirely submerged, to the detriment of its desert fauna, since that union".

THREATS AND CONSERVATION

The increase in the human population (to over 216,000 in April 1971, representing an increase of nearly 3 per cent annually since the previous census in 1965), and the continued improvement in living standards, have led to greater mobility; to a spread of urbanisation, of factories and of roads; to the neglect of some plantations, and to an increased demand upon the natural resources of the island, such as oil, gas, water, stone and sand for construction, and generally wider facilities for recreation. These factors have increased the pressure upon the countryside and, to a greater or lesser degree, upon the fauna and flora.

It is pleasing to be able to report that H H the Amir has continued to deny the general public access to the southern half of the island unless special permission is obtained. This was formerly the reserve for the hunting by the ruling family, by falcon or Saluki hound, of game birds, particularly the Houbara *Chlamydotis undulata*, the hare and possibly the gazelle. Due probably to the scarcity of the first two such hunting is now rarely practised, but the area is regularly traversed by staff of the Bahrain Petroleum Company (BAPCO) as it lies over the oil and gas fields; fishermen and weekend picnic parties are occasionally permitted to enter and to drive anywhere.

The killing of gazelle and hare is forbidden everywhere, but the shooting of hare is known and both these and other species, such as the jerboa and mongoose (and the lizard *Uromastyx microlepis*) are killed by traffic, particularly in Spring. However, such species as the rats *Rattus* spp., Common Mouse and shrew will probably benefit from further urbanisation.

Apart from Man the predators of mammals probably include feral dogs and cats; some birds, mostly migratory (Rogers & Gallagher 1973), and the resident terrestrial snakes (Gallagher 1971). In 1974 tracks of large feral dogs were seen in the desert which would indicate an extension of their range.

SYSTEMATIC LIST

Order Insectivora

Family ERINACEIDAE

Paraechinus aethiopicus Ehrenberg, 1833. Ethiopian Hedgehog

1 ♀, 21 March 1970, near Zallaq.

1 ♀, 29 July 1970, between Nuwaidrat and Malamir.

In or near cultivated or well vegetated areas, including Muharraq Island, but rarely seen. Reported in January, March, April and July, usually on roads, so it is probably active throughout the year.

This is the first record of the species on Bahrain (Harrison 1972). The sides of the carapace of the two specimens are noticeably whiter than other examples of this species from Arabia in the Harrison collection and described in Harrison (1971). These specimens may well represent a local race, but more material is required to determine the constancy of this character.

Family SORICIDAE

Suncus murinus Linnaeus, 1766. House Shrew or Grey Musk Shrew

1 ♀, 18 April 1970, near Manama

1 ♂, 2 ♀ ♀, 6 May 1970, " "

2 ♂ ♂, 2 ♀ ♀, 5 June 1970, " "

1 ♂, 1 ♀, 1 September 1970, " "

1 ♂, 1 ♀, 29 September 1970, " "

1 ♀, 20 May 1970, Awali.

The first record of *Suncus* in Bahrain was a very small female, found dead by T D. Rogers on the soil covering the municipal rubbish tip near Manama. Despite many subsequent searches both here and elsewhere only the larger, more common form was found. The very small size and the different dentition of the first specimen make it probable that either the smaller form represents an additional introduction from the Orient or that *S. murinus* is a polymorphic species.

Almost entirely nocturnal, it was very common and noisy on the rubbish tip in May 1970, but was rather less common at other times and it seemed to be absent in the cold months. It also occurs quite commonly in and around some houses and gardens near Manama, where it has been recorded climbing the creeper on houses, and it has also been recorded at Awali. Also called the Blind Rat, and known by some Iranians on Bahrain as *musha*, some locals believe them to be poisonous.

Order Chiroptera

Bats were seen in the cultivated zone of Bahrain and Muharraq

Island most of the year. Three species were indented, but the roosts of only two were found and these could not be checked regularly.

Family EMBALLONURIDAE

Taphozous nudiventris magnus Wettstein, 1913. Naked-bellied Tomb Bat

5 ♂♂, 1 ♀, 10 June 1970, Qala'at al Bahrain.

1 ♀, 12 July 1971, near Tubli.

These specimens are the first record of this species on Bahrain and the most southerly record of the Iraq race (Harrison 1972).

The largest bat seen on Bahrain, they usually fed in the clearings between date plantations. Only one roost was found, in the roof of a tower of the Qala'at al Bahrain (the "Portuguese fort") on the north coast; no other species were seen to share this roost, which was not occupied all the year; very few were present there in April 1974.

Family HIPPOSIDERIDAE

Asellia tridens Geoffroy, 1813. Trident Bat

4 ♂♂, 6 ♀♀, 5 July 1970

4 ♂♂, 3 ♀♀, 17 November 1970

2 ♂♂, 2 ♀♀, 15 January 1971

A fairly common species, of which three roosts were found. The first, on 5 July 1970, was of about 20 bats in a subterranean aqueduct (*qanat*) near the village of Malichya, at the foot of the west flank. These *qanat* have open man-holes reaching to the surface, like wells, every 20 metres or so, through which the bats fly. Very little dung was present, indicating that this roost is not in regular occupation; no bats were present on 10 December 1970, 26 April 1974, nor on some other occasions.

The second, on 17 November 1970, was in a series of caves reached by a very small tunnel leading from the south face of the historic fortified hill near the settlement of Amar, in the centre of the southern half of Bahrain Island. About a hundred bats seen before they fled down other passages. A huge bank of dung and a very strong smell were evidence of undisturbed occupation over a long period.

The third roost was in a natural cave in the limestone of the east flank, about two kilometres south of the village of Askar. The mouth of the cave was partly walled round, suggesting that it was used as a cistern to collect rain water. The large outer cave is connected to some smaller ones, and in a hollow about 3 metres by 2 metres in one of these about 60 bats were found on 15 January 1971, but only about six bats were present on 27 May 1971.

Although a widely distributed species and known from neighbouring

Qatar and from Hufuf, eastern Saudi Arabia, these were the first records from Bahrain (Harrison 1972, p. 627).

Pipistrellus kuhli ikhwanius Cheesman and Hinton, 1924. Kuhl's Pipistrelle

1 ♀, 4 May 1971, near Manama.

This specimen was taken by T D Rogers at 8 p.m. from amongst many small bats flying in clearings between date gardens at the edge of the marshes near Manama. Small bats, possibly this species, were widespread in the cultivated zone of Bahrain and Muharraq islands, and they were said to be found occasionally on trees as well as buildings.

A widespread species, it was known from Bahrain previously from two specimens in the Cox-Cheesman collection and collected on 9 April 1921 (Cheesman & Hinton 1924, and Harrison 1964, p. 155).

Order Carnivora
Family VIVERRIDAE

Herpestes edwardsi ferrugineus Blanford, 1874. Common Mongoose

1 ♀, 2 November 1969

1 ♂, 30 March 1970

1 ♀, 4 June 1970 (skull only) Malichiya

A successful species, presumably introduced from Iran or India, and known from the cultivated zone, where it is widespread and even occurring in the capital (Mandaville 1971) and once at Awali, where at least one was kept in captivity and later released (I W Hanwell, in pers. comm.).

They live in burrows, drain pipes, holes in the wall etc., and are active throughout the year, foraging singly or in family parties in and near gardens and digging in lawns. The food includes snakes, chickens, eggs and young birds (Belgrave 1953) as well as Coleoptera larvae and possibly rodents, the Marsh Frog *Rana ridibunda* and the eggs of the Terrapin *Clemmys caspica*.

Copulation was reported only at the end of January and in February, though in India the species breeds throughout the year (Prater 1971).

Both specimens were found by Mrs C Stroud killed by traffic on the north coast road. These are the first mongooses to be recorded from Bahrain (Harrison 1971).

Family FELIDAE

Felis spp.

1 ♀, 12 July 1970 (skull only), Ras al Qarain.

1 ♀, 15 January 1971 (skull only), near Askar.

There is no certain record of wild cats having existed on Bahrain.

However, two very large cat skulls were found, one near the beach about 6 km south of the almost deserted village of Durr on the east coast, and the other with some remains of the animal in the bat cave near Askar. They are not *F. margarita*, but they are quite possibly genuine Wild Cat *F. silvestris*. The first could just possibly be from a feral animal, but the second skull and teeth closely match other specimens of *silvestris* in the Harrison collection; it is however, impossible to be certain without the skin.

One of these might be from a "*Felis lybica* (= *F. silvestris*) from the Ethiopian frontier and released by a friend" in 1969 (R W B Izzard, in pers. comm.).

Mr L D Josephson (later of BAPCO) said, in pers. comm. in 1971, that "a lair of two wild cats in the Bahrain desert was reported in the *Bahrain Islander* (a BAPCO journal) about 15 years ago", but this report has not been traced. Some residents in 1974 said that they had seen large cats, but these animals may be feral domestic cats, of which there must surely be a number.

Order Artiodactyla Family BOVIDAE

Gazella sp.

Gazelle, apparently all *Gazella subgutturosa* (see later), wander freely over the southern part of Bahrain Island and they have been recorded as far north as Hamala Camp. They often frequent the coasts, usually leaving early in the morning; they also visit Jebel al Dhukhan when water and vegetation is available. The maximum number seen together was 27 (on 13 August 1971, west of Amar, by M C Jennings, in pers. comm.). Young have been seen with adults in spring and a freshly dead juvenile was found in July 1971. Formerly hunted with Saluki hounds and falcons, they are now protected but are occasionally killed by traffic. Some have been reported being drowned in the sea after bolting to escape from helicopters.

Their origin and present status is not clear. Even if there was an indigenous stock it must have been increased by gifts to the Amir and by escapes from the small captive herds kept by some sheikhs.

Gazelle on Howar Island could have been introduced or might have waded from the mainland of Qatar at very low tide. Seven were seen on Umm Nassan Island on 18 April 1970, where there was also a large Blackbuck *Antelope cervicapra* on 27 December 1970, no doubt introduced. About twenty gazelle are said to have been introduced to Umm Nassan from India by Sheikh Hamad, the grandfather of the present Amir. Two Wild Goat were introduced briefly to Howar Island in 1973.

Gazella subgutturosa marica Thomas, 1897. Rhim Gazelle

1 ♂, 12 July 1970, Ras al Qarain

1 ♂, 26 July 1971, Ras Noma

1 ♂, 28 July 1971, Wasmiya, Zallaq

This race was represented from Bahrain by a single specimen in the British Museum (Natural History) collected in 1922. The head from the whole mummified remains of a very immature gazelle, found behind the beach crest on the south east coast, was therefore the first example of this species obtained on Bahrain for nearly fifty years.

Two other young gazelle of this species were found dead on the road near Zallaq on the west coast but, as for the first specimen, only the skulls were retained.

About ten gazelle are said to survive on Howar Island, where at least three were seen regularly at a water cistern and vegetation near the Police Fort in April 1974; resting places were found under rock ledges in the jebels near the centre of the island. The skull of one found dead in a cistern by J H Clingly in 1973 proved to be this sub-species. Mr Clingly says that he believes that it is they that make the small excavations to be seen along the beach crest, and it is presumed that this is in a search for the basal tubers of *Cistanche lutea* (Orobanchaceae) which flower there after Spring rains.

Order Lagomorpha

Family LEPORIDAE

Lepus capensis atallahi Harrison, 1972. Bahrain Hare

1 ♀, 14 April 1971, near Isa Town

1 imm. ♂, 29 July 1970, Khadra. BM (NH) No. 1970.2035

1 ♂, 12 May 1971, Ras Noma

This very small hare, distinguished from all other Arabian hares by its remarkably short ears, was first described (Harrison 1972) from a specimen found dead on the road near Isa Town by T D Rogers. A leveret, found alive by M C Jennings on 29 July 1970 and killed by a dog on 5 August, is in the British Museum (Natural History) spirit collection, and another leveret, taken in the dunes at Ras Noma on 12 May 1971 by Capt D M Dever, is in the Harrison collection.

With the rapid spread of urbanisation and main roads the hare is not as widespread and as common as it was (Belgrave 1953). However, it is still present in most desert areas, including Jebel al Dhukhan, as far north as Isa Town, as far south as the southern tip and on the east and west coasts. One was also seen on Umm Nassan Island on 27 December 1970 and it was present on Howar Island in 1974. Hunted formerly with Saluki hounds it is now protected, but is occasionally shot, and also killed by traffic.

It is mainly crepuscular or nocturnal, and avoids the heat of day by

lying in a shallow form under a bush or rock, or in a burrow of about its own length dug into the sand at the base of a bush, from which it will tend not to move unless approached very closely.

The specimen found on 14 April was host to the sucking lice (Phthiraptera) *Haemodipsus setoni* group Anophira: Hoplopeuridae, the first recorded example from this species.

Order Rodentia

Family DIPODIDAE

Jaculus jaculus vocator Thomas, 1921. Lesser Three-toed Jerboa

- 1 ♂, 7 February 1969, Sakhir
- 1 ♂, 23 March 1969, Central desert
- 1 ♀, 1 December 1969, Central desert near Awali
- 1 ♂, 12 February 1970, Central desert
- 1 ♂, 22 August 1970 (skull only) Wasmiya
- 1 ♀, 20 November 1970, Central desert
- 1 ♂, 20 February 1971 (skull only), near Malichiya
- 1 ♂, 3 March 1971 (skull only preserved), Sitra

Widespread in desert and semi-desert, and occurring as far north as Budaia. It is active during all but the cold months, though it may not be seen so frequently in mid-summer.

The burrow is not easily found, presumably because it is usually on flat open ground and the animal usually seals it from within. At Rifa'a boys are said to catch them after pouring water down the burrow. After heavy rain one jerboa was found dead outside a small burrow 10 metres up on a small hillside near Sakhir. Most other specimens have been found killed by traffic on the roads.

One previous specimen from Bahrain is in the British Museum (Natural History) collection (Ellerman 1948).

Family MURIDAE

Rattus rattus Linnaeus, 1758. Black Rat

- 1 ♂, 13 February 1970, Jufair, near Manama
- 1 ♂, 25 February 1970, near Manama
- 1 ♂, 3 March 1970, near Manama
- 1 ♂, 8 March 1970, Manama
- 1 ♀, 22 August 1970, coast at Ras Jazayir
- 3 ♂♂, 18 September 1970, Khadra
- 1 ♀, 25 September 1970, Nakhil Lozi, near Buri
- 1 ♂, 9 November 1970, Jufair
- 1 ♀, 5 April 1971, Budaia

Widespread in habited and vegetated areas and in semi-desert. Specimens, all of the pale form, have been seen in most parts of the northern

half of Bahrain and on Muharraq Island; tracks, probably of this species, were found on Jebel al Dukhan and on all beaches, so that it may exist over the southern half also. They commonly climb trees by day and night. The specimen on 5 April was found in the gut of a snake *Coluber ventromaculatus*.

Two specimens were host to the Sucking Louse (Anoplura) *Polyplax spinulosa* (Burmeister 1838) and one to a tick *Hyalomma* sp. (probably *impeltatum*).

Earlier specimens from Bahrain are in the British Museum (Natural History) collection (Harrison 1972, p. 460).

Rattus norvegicus norvegicus Berkenhout, 1769. Brown Rat

1 ?o, December 1968, (skull), Ras abu Jarjur

1 ♀, 23 August 1969, Jufair, near Manama

1 ♂, 25 August 1969, Jufair, near Manama

1 ?o, 30 August 1969, Ras Noma

1 ♂, 1 January 1970, near Manama

1 ♂, 7 November 1970, Muharraq causeway

1 ad. ♀, 1 imm. ?o, 16 April 1974, Howar Island (skulls retained)

It occurs around the harbour and habited areas of Muharraq Island and of Bahrain Island, certainly as far south as Sitra and Ras Noma.

The specimens collected are the first to be recorded from Bahrain (Harrison 1971, and 1972, p. 465).

Discovered for the first time on Howar Island near the old village and police fort. Skulls were also found in bird pellets from the centre of the island, and burrows were seen in debris and dry seaweed along the west coast.

The Howar specimens were host to the mite *Laelaps nuttali* Hirst.

Mus musculus gentilulus Thomas, 1919. Common Mouse

Very common and widespread over most of the islands, where it has been taken in domestic areas, under vegetation, in pure desert and on beaches. The burrows are in or at the base of sand hummocks, under vegetation or on flat ground (as on some beaches); some are sealed from within. Entirely nocturnal.

One had been swallowed by a snake *C. ventromaculatus*, and one on 31 May contained four embryos. The skull of one was found in an old pellet of a predatory bird on Howar Island in April 1974.

An earlier specimen from Bahrain is in the British Museum (Natural History) (Harrison 1972, p. 474).

Family CRICETIDAE

Meriones crassus crassus Sundevall, 1842. Sundevall's Jird

2 ♂♂, 17 April 1970, Howar Island, Bahrain

These specimens came from burrows under rocks on the plateau at

the north of the island. Others were seen in a colony of burrows in sandy hummocks and soft ground under bushes near the west coast, and other rodent burrows, possibly of this species, were in rocky and sandy ground in other parts of the island.

In subsequent searches of similar ground on Bahrain Island the lizard *U. microlepis* was found to occupy most likely sites. However, *Meriones* may yet be found to occur in parts of that island also.

These are the first specimens from the Bahrain Island. The nearest previous examples came from Al Khobar, 26 miles west of Bahrain Island. The specimens resemble series of the typical form from Sharjah, on the mainland, in all essential respects.

These specimens were host to the mites *Androlaelaps longipes* (Bregetova); an association with *Meriones* species was noted by Bregetova (1952) in USSR and Costa (1951) in Israel.

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REFERENCES

- BELGRAVE, J. H. D. (1953) 1968: Welcome to Bahrain. London: Augustan Press.
- BREGETOVA, N. G. (1952): New species of mites of the genus *Haemolaelaps* (Gamasoidea: Laelaptidae) parasitizing rodents. *Zool. Zh.* 31:860-882.
- CHEESMAN, R. E. & HINTON, M.A.C. (1924): On the mammals collected in the desert of central Arabia by Major

R. E. Cheesman between November 1923 and March 1924. *Ann. Mag. nat. Hist.* (9) 14:548.

COSTA, M. (1961): Mites associated with rodents in Israel. *Bull. Brit. Mus. nat. Hist.* (Zool.). 8:1-70.

ELLERMAN, J. R. (1948): Key to the rodents of south-west Asia in the British Museum collection. *Proc. Zool. Soc.* (London) 118:765-816.

GALLAGHER, M. D. (1971): The amphibians and reptiles of Bahrain. Bahrain: Oriental Press.

GOOD, R. D.'O. (1954): The Bahrain Islands and their desert flora. *Biology of Deserts. Proc. Sympos. Biol. Hot & cold deserts*: 45-55. London.

————— (1955): The flora of Bahrain. In Dickson, V. *The wild flowers of Kuwait and Bahrain*, London: Allen & Unwin.

HARRISON, D. L. (1964): The mammals of Arabia, Vol. 1. Insectivora, Chiroptera, Primates. pp. 1-192. London: Benn.

————— (1971): Observations on some notable Arabian mammals, with the description of a new

gerbil (Gerbillis, Rodentia: Cricetidae). *Mammalia* 35(1):111-125.

————— (1972): The mammals of Arabia. Vol. 3. Lagomorpha, Rodentia. pp. 383-670. London: Benn.

KASSLER, P. (1973): The structural and geomorphic evolution of the Persian Gulf in The Persian Gulf, Ed. Purser, B. H. Berlin, Heidelberg and New York: Springer.

MANDAVILLE, J. P. (JR.) (1971): Notes and records. *Arabian nat. Hist. Assoc.* 1:8-9.

PRATER, S. H. (1971): *The Book of Indian Animals*. (3rd ed.) Bombay Natural History Society, Bombay.

ROGERS, T. D. & GALLAGHER, M. D. (1973): Birds of Bahrain, [an unpublished, stencilled, annotated check list deposited at the British Museum (Natural History)].

WILLIS, R. P. (1967): *Geology of the Arabian Peninsula—Bahrain*. Geological survey, professional paper 560-E. Washington: US Government Printing Office.

WILTSHIRE, E. P. (1964): The Lepidoptera of Bahrain. *J. Bombay nat. Hist. Soc.* 61(1):119-141.

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REFERENCES

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- BREGETOVA, N. G. (1952): New species of mites of the genus *Haemolaelaps* (Gamasoidea: Laelaptidae) parasitizing rodents. *Zool. Zh.* 31:860-882.
- CHEESMAN, R. E. & HINTON, M.A.C. (1924): On the mammals collected in the desert of central Arabia by Major

Food-habits of water-birds of the Sundarban, 24 Parganas District, West Bengal, India—V¹

Lapwing, Sandpiper, Stint, Tern, Kingfisher

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Zoological Survey of India, Calcutta

(With three text-figures)

(Continued from Vol. 71(2):200)

Vanellus indicus indicus (Boddaert), The Red-wattled Lapwing

The Red-wattled Lapwing, *Vanellus indicus indicus* (Boddaert), is a common bird of the Sundarban area. It is generally met with singly or in pairs. In the reclaimed area it is found in cultivated fields especially after harvesting, on elevated bunds between such fields when these are inundated, as well as in fallow lands, edges of freshwater pools, tanks, etc. In forested area, it is sometimes seen on exposed mud-flats of tidal rivers and forest fringes, and sometimes near pools of water in the interior.

About the food-habits of the Red-wattled Lapwing, Jerdon (1864, p. 648) remarked that it feeds on various insects, shells, and worms. Mason & Lefroy (1912, p. 265) examined the food of nine examples at Pusa (Bihar) and stated: "Of 118 insects taken by 9 birds, 51 are injurious; 6 birds took injurious insects, 4 neutral and 4 injurious. One bird took a prawn, 1 shell and 2 vegetable matter". Baker (1929, p. 188) writes that its food consists of worms, grubs, insects of all kinds as well as freshwater mollusca, tiny crayfish, etc. Ali (1955, p. 92) found that it fed on insects, grubs, molluscs, etc.

On an examination of the stomach-contents of 69 specimens of the European Lapwing, *Vanellus, v. vanellus* (Linnaeus), Collinge (1927, p. 234) found that of the total food consumed during the year 89 per cent was animal food. Of this, injurious insects formed 60 per cent, neutral insects 4 per cent, slugs and snails 10 per cent, earthworms 10 per cent, and miscellaneous animal matter of a neutral nature 5 per cent.

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- R. E. Cheesman between November 1923 and March 1924. *Ann. Mag. nat. Hist.* (9) 14:548.
- COSTA, M. (1961): Mites associated with rodents in Israel. *Bull. Brit. Mus. nat. Hist.* (Zool.). 8:1-70.
- ELLERMAN, J. R. (1948): Key to the rodents of south-west Asia in the British Museum collection. *Proc. Zool. Soc.* (London) 118:765-816.
- GALLAGHER, M. D. (1971): The amphibians and reptiles of Bahrain. Bahrain: Oriental Press.
- GOOD, R. D.'O. (1954): The Bahrain Islands and their desert flora. Biology of Deserts. Proc. Sympos. Biol. Hot & cold deserts: 45-55. London.
- (1955): The flora of Bahrain. In Dickson, V. The wild flowers of Kuwait and Bahrain, London: Allen & Unwin.
- HARRISON, D. L. (1964): The mammals of Arabia, Vol. 1. Insectivora, Chiroptera, Primates. pp. 1-192. London: Benn.
- (1971): Observations on some notable Arabian mammals, with the description of a new gerbil (Gerbilles, Rodentia: Cricetidae). *Mammalia* 35(1):111-125.
- (1972): The mammals of Arabia. Vol. 3. Lagomorpha, Rodentia. pp. 383-670. London: Benn.
- KASSLER, P. (1973): The structural and geomorphic evolution of the Persian Gulf in The Persian Gulf, Ed. Purser, B. H. Berlin, Heidelberg and New York: Springer.
- MANDAVILLE, J. P. (JR.) (1971): Notes and records. *Arabian nat. Hist. Assoc.* 1:8-9.
- PRATER, S. H. (1971): The Book of Indian Animals. (3rd ed.) Bombay Natural History Society, Bombay.
- ROGERS, T. D. & GALLAGHER, M. D. (1973): Birds of Bahrain, [an unpublished, stencilled, annotated check list deposited at the British Museum (Natural History)].
- WILLIS, R. P. (1967): Geology of the Arabian Peninsula—Bahrain. Geological survey, professional paper 560-E. Washington: US Government Printing Office.
- WILTSHIRE, E. P. (1964): The Lepidoptera of Bahrain. *J. Bombay nat. Hist. Soc.* 61(1):119-141.

Only 11 per cent of the food was of vegetable nature, 6 per cent of which consisted of weed seeds and 5 per cent of miscellaneous vegetable matter. He thus concluded that 70 per cent of its food was of a beneficial nature and 30 per cent neutral.

The detailed analysis of the stomach-contents of 174 adult specimens of *Vanellus i. indicus* that I collected in the Sundarban is given in Table 18.

TABLE 18

ANALYSIS OF THE STOMACH-CONTENTS OF THE RED-WATTLED LAPWING

N = Number of specimens.

Weight = Total weight (in gramme) of examples of all species under a Class.

Length of fish = Its standard length.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Phylum Chordata				
Class Reptilia				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
<i>Ptyas mucosus</i> (Linnaeus)	6			Common in cultivations. Parts of head, and body partly digested.
<i>Xenochrophis piscator</i> (Schneider)	2			Common in paddy-fields.
<i>Amphiesma stolata</i> (Linnaeus)	4			Common on tidal mud-flats, partly digested.
Total:	12	120	1.96	
Phylum Mollusca				
Class Gastropoda				
Order Archaeogastropoda				
Family NERITIDAE				
<i>Nerita (Odontostomia) lineata</i> (Dillwyn)				
	31			Complete shells.
Order Mesogastropoda				
Family VIVIPARIDAE				
<i>Viviparus bengalensis</i> (Lamarck)				
	56			Freshwater form. Mostly complete shells.
Family PILIDAE				
<i>Pila</i> sp.	10			-do-
<i>Littorina melanostoma</i> Gray	21			-do-
<i>Digonistoma</i> sp.	10			-do-
<i>Melanoides tuberculatus</i> (Müller)	85			-do-

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
<i>Melanoides (Plotia) scabra</i> (Müller)	17			-do-
Order Basommatophora				
Family LYMNAEIDAE				
<i>Lymnaea acuminata</i> (Lamarck)	40			-do-
Family PLANORBIDAE				
<i>Indoplanorbis exustus</i> (Deshayes)	22			Land-snail.
Shell fragments				Not identifiable.
Total:	292	1830	27.91	

Phylum Arthropoda

Class Insecta

Order Orthoptera

Family LOCUSTIDAE

Heiroglyphus banian

Fabricius

81

Paddy-pest. In fragments.

Attractomorpha sp.

25

Pest of tobacco and vegetables.

Oxya sp.

31

Pest of paddy.

Chrotogonus sp.

82

Pest of cotton.

Acrotylus sp.

22

Pest of paddy nurseries.

Heteropternis sp.

19

-do-

Locusta danica Linnaeus

35

-do-

Pyrgomorpha sp.

6

-do-

Lefroya sp.

27

Coptotettix sp.

8

Family TETTIGIDAE

Acrydium sp.

21

Scelimena sp.

16

Pest of cultivated plants.

Family GRYLLIDAE

Gryllus sp.

35

Pest of roots of paddy, etc.

Liogryllus sp.

45

-do-

Acheta bimaculata

(De Geer)

30

-do-

Brachytrypes sp.

23

-do-

Family GRYLLOTALPIDAE

Gryllotalpa africana

Beanvois

91

Mostly parts of body.

Gryllotalpa sp.

27

-do-

Orthopteran fragments

Not identifiable.

Order Dermaptera

Family LABIDURIDAE

Labidura sp.

Family LABIIDAE

Labia minor (Linnaeus) 17

Family CHELISOCHIDAE

Chelisoches morio (Fab.) 3

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Family FORFICULIDAE				
<i>Forficula</i> sp.	12			
Forficulid claspers and fragmentary remains				Not identifiable.
Order Isoptera				
Family TERMITIDAE				
<i>Odontotermes</i> sp. ?	26			Partially digested. Therefore identification doubtful. Pest of Sugarcane and other Gramineae.
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
<i>Ischnura</i> sp. ? (Naiads)	40			Aquatic form.
<i>Coenagrion</i> sp. ? (Naiads)	32			-do-
Suborder Anisoptera				
Family AESCHNIDAE				
<i>Anax</i> sp. ? (Naiads)	20			-do-
<i>Aeschna</i> sp. (Naiads)	27			-do-
Family LIBELLULIDAE				
<i>Pantala</i> sp. (Naiads)	6			-do-
<i>Crocothemis</i> sp. (Naiads)	9			Aquatic form.
Odonata fragments				Not identifiable.
Order Hemiptera				
Family PENTATOMIDAE				
<i>Nezara viridula</i> Linnaeus	25			Pest of vegetables.
Family COREIDAE				
<i>Leptocoris</i> sp.	80			Pest of paddy-shoots.
Family PYRRHOCORIDAE				
<i>Dysdercus cingulatus</i> (Fabricius)	32			Pest of cotton, etc.
Family JASSIDAE				
<i>Nephotettix</i> sp.	100+			Rice leaf-hopper, pest.
Family GERRIDAE				
<i>Halobates</i> sp.	6			Aquatic form.
<i>Gerris</i> sp.	9			-do-
Family BELOSTOMATIDAE				
<i>Belostoma</i> sp.	7			Aquatic form, body in parts.
Family NEPIDAE				
<i>Ranatra</i> sp.	10			Aquatic form.
<i>Nepa</i> sp.	13			-do-
Family NOTONECTIDAE				
<i>Notonecta</i> sp. ?	21			-do-
Family CORIXIDAE				
<i>Corixa</i> sp.	8			
Order Lepidoptera				
Caterpillars				Partially digested. Not iden- tifiable.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Coleoptera				
Family CICINDELIDAE				
<i>Cicindela</i> sp.	6			
Family RUTELIDAE				
<i>Anomala elata</i> (Fabricius)	81			Pest of garden plants.
Family COCCINELLIDAE				
<i>Epilachna</i> sp.	27			Elytra only.
Family TENEBRIONIDAE				
<i>Opatrum</i> sp.	38			Pest of potato-tubers, etc.
Family MELOIDAE				
<i>Mylabris pustulata</i> Thunberg	26			Pest of earheads of paddy.
<i>Gnathospastoides rouxi</i> Castalenu	14			-do-
<i>Cylindrothorax ruficollis</i> (Fabricius)	14			-do-
<i>Cylindrothorax ? tenuicollis</i>	19			-do-
<i>Epicauta</i> sp.	28			-do-
Family CHRYSOMELIDAE				
<i>Podagria</i> sp.	6			Pest of <i>Hibiscus</i> .
<i>Sagra</i> sp. ?	3			Pest of <i>Dolichos lablab</i> .
<i>Oides affinis</i> Jacoby	7			Pest of paddy.
<i>Haltica cyanea</i> Weber	13			-do-
<i>Diclidispa armigera</i> (Olivier)	19			-do-
Family CURCULIONIDAE				
<i>Episomus</i> sp.	5			Pest of foliage of cultivated plants, especially pulses.
<i>Myllocerus</i> sp.	18			Pest of paddy.
<i>Atactogaster</i> sp.	10			Pest of cotton, vegetables, etc.
<i>Alcides</i> sp.	7			Pest of indigo, agathi, etc.
<i>Pempherus affinis</i> Fabricius	11			Pest of cotton.
Family SCARABAEIDAE				
<i>Heliocopriss bucephalus</i> (Fabricius)	16			
<i>Catharsius</i> sp.	12			
Family DYTISCIDAE				
<i>Dytiscus</i> sp.	9			Aquatic form.
Family GYRINIDAE				
<i>Gyrinus</i> sp.	8			-do-
Family HYDROPHILIDAE				
<i>Hydrocharis</i> sp. ?	7			-do-
<i>Berosus</i> sp.	6			-do-
Coleoptera larvae				Mutilated beyond identification.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Hymenoptera				
Family FORMICIDAE				
<i>Dorylus orientalis</i>				
Walker	108			Pest of sugarcane, but I have found it on jute also.
<i>Solenopsis geminata</i>				
Fabricius	92			Pest of brinjal.
<i>Oecophylla smaragdina</i>				
Fabricius	62			Pest of mango and other trees.
<i>Camponotus compressus</i>				
Fabricius	188			Pest of various plants.
<i>Phidole</i> sp.	30			
Miscellaneous insect fragment				Not identifiable.
Total:	2017	3750	63.21	
Class Arachnida				
Order Araneae				
Family ARGYOPIDAE				
<i>Argyope</i> sp.	100+			
<i>Cyrtophora</i> sp. ?	100+			In bush.
<i>Leucage decorata</i> (Blackwall)	100+			Common in paddy and grass.
<i>Araneus</i> sp.	50+			Common, in bush and paddy.
<i>Cyclosa</i> sp.	10+			Common in bush.
Family TETRAGNATHIDAE				
<i>Ecuta javanica</i> Thorell	100+			Very common in paddy and grass. Invariably found in stomachs.
Family LYCOSIDAE				
<i>Lycosa</i> sp.	10+			Common in ground and in grass. Invariably present in stomachs.
<i>Hippasa</i> sp.	20+			-do-
Family OXYOPIDAE				
<i>Oxyopus</i> sp. ?	30+			
Miscellaneous spider fragments				
Total:	520+	345	5.63	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
<i>Pheretima</i> sp.	10+			In bits. Invariably present in stomachs.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
<i>Perionyx</i> sp.	10+			
<i>Eutyphoeus</i> sp. ?	5			Partially digested. Identification doubtful.
Family NAIDIDAE				
<i>Chaetogaster</i> sp. ?	6			Partially digested. Identification doubtful.
Family TUBIFICIDAE				
<i>Limnodrilus</i> sp.	10+			Tangled mass.
Miscellaneous Oligochaeta (bits)				Not identifiable.
Total:	41+	75	1.22	

The diet of this bird is solely of animal nature (Fig. 1). Of the total food consumed by 174 birds, 63.2 per cent represent insects, comprising 2017 examples belonging to 72 species. Of these 1683 examples representing 45 species are crop and vegetable pests; the rest are predators or neutral. The other items are mostly freshwater Mollusca (27.91%), spiders (5.63%), snakes (1.96%) and Oligochaeta (1.22%).

From the analysis it is seen that the Red-wattled Lapwing is a very useful bird, feeding on injurious insects that affect agriculture.

Tringa glareola Linnaeus, The Spotted Sandpiper

The Spotted Sandpiper, *Tringa glareola* Linnaeus, is a bird of the open marshes. It frequents freshwater bogs, inundated paddy-fields, flooded parts of the reclaimed area and tidal swampy forests. It moves in parties from one mud-flat to another pecking and probing for food on the exposed muddy banks during the ebb tides and at the edge of shallow water. It is a winter visitor.

Very little information is available about the food-habits of this bird. In India, Mason & Lefroy (1912, p. 268) analysed the stomach-contents of 24 examples and stated: "Of insects eaten by 24 birds, 9 are injurious, 3 beneficial and 43 neutral. Of 12 birds that contained insects, 4 took beneficial, 9 neutral and 6 injurious. Sixteen contained shells, 1 a prawn, 1 a shrimp, 3 a feather and 6 vegetable matter". Ali (1955, p. 94) stated about this and *Tringa ochropus* Linnaeus, that: "They run along on the squelchy mud picking up tit-bits or probe with their bills for food: insects, larvae, worms and molluscs". In Europe, Voous (1960, p. 97) found that the food consisted predominantly of small water and marsh insects; also worms and small molluscs outside the breeding season.

The detailed analysis of the stomach-contents of 38 adult specimens that I collected in the Sundarban is given in Table 19.

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS.

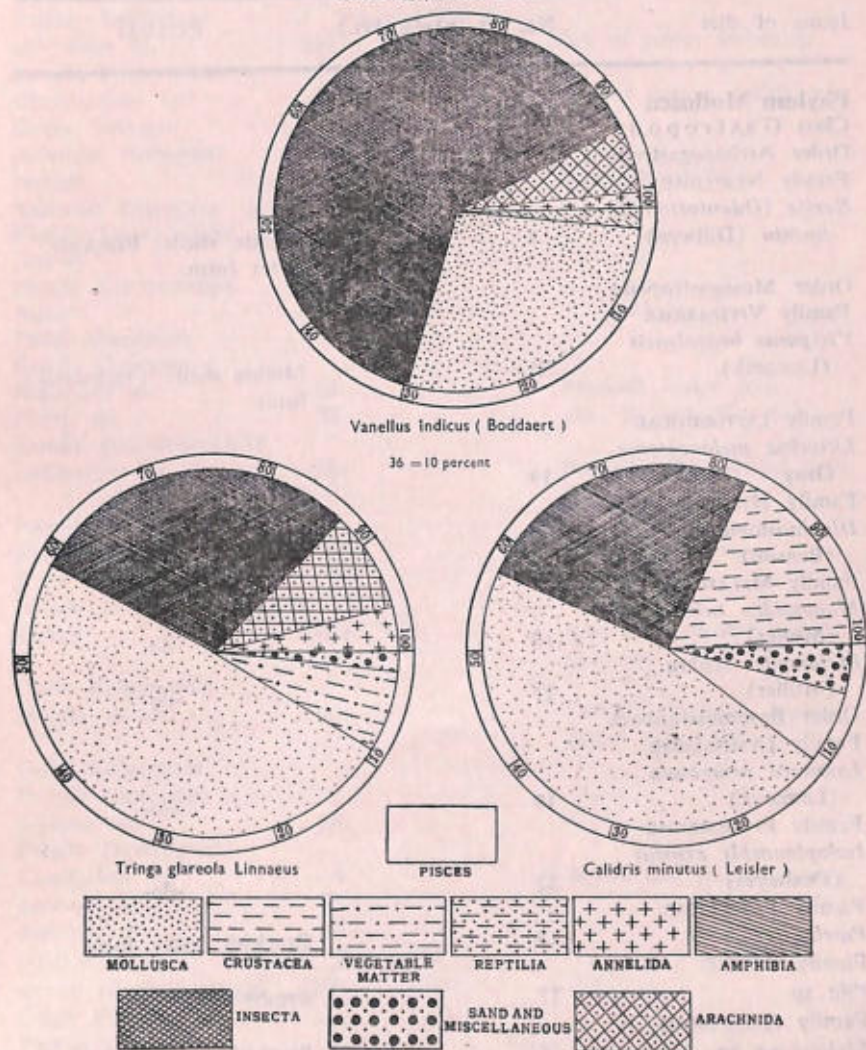


TABLE 19

ANALYSIS OF THE STOMACH-CONTENTS OF THE SPOTTED SANDPIPER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Archaeogastropoda				
Family NERITIDAE				
<i>Nerita (Odontostomia)</i>				
<i>lineata</i> (Dillwyn)	8			Minute shells. Brackish water form.
Order Mesogastropoda				
Family VIVIPARIDAE				
<i>Viviparus bengalensis</i> (Lamarck)				
	21			Minute shells. Freshwater form.
Family LITTORINIDAE				
<i>Littorina melanostoma</i> Gray				
	19			-do-
Family HYDROBIIDAE				
<i>Digoinostoma pulchella</i> (Benson)				
	6			-do-
Family MELANIIDAE				
<i>Melanoides tuberculatus</i> (Müller)				
	18			-do-
<i>Melanoides scabra</i> (Müller)				
	27			-do-
Order Basommatophora				
Family LYMNAEIDAE				
<i>Lymnaea acuminata</i> (Lamarck)				
	19			-do-
Family PLANORBIDAE				
<i>Indoplanorbis exustus</i> (Deshayes)				
	32			-do-
Family PATELLIDAE				
<i>Patella</i> sp. ?				
	15			Brackish water form.
Family PILIDAE				
<i>Pila</i> sp.				
	17			Freshwater form.
Family GALEODIDAE				
<i>Melongena</i> sp. ?				
	6			Brackish water form.
Class Bivalvia				
Family ARCIDAE				
<i>Arca</i> sp.				
	3			Brackish water form.
Miscellaneous molluscan fleshy pulp and shell-fragments				
				Not identifiable.
Total:	191	720	49.03	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Arthropoda				
Class Insecta				
Order Orthoptera				
Family TETTIGIDAE				
<i>Acrydium</i> sp.	165			Pest of paddy nurseries.
Family LOCUSTIDAE				
<i>Chrotogonus</i> sp.	26			Pest of cotton, paddy, etc.
Order Odonata				
Suborder Anisoptera				
Naiads				
	25+			Mostly mutilated.
Suborder Zygoptera				
Family LIBELLULIDAE				
Naiads	40			-do-
Family COENAGRIIDAE				
Naiads	35			-do-
Order Hemiptera				
Family GERRIDAE				
<i>Halobates</i> sp.	60			Brackish water form.
<i>Gerris</i> sp. ?	78			-do-, partially digested.
Family GELASTOCORIDAE				
<i>Limnocois</i> sp. ?	18+			Partially digested and mostly in fragments.
Family NEPIDAE				
<i>Ranatra</i> sp.	35			Freshwater form.
<i>Nepa</i> sp.	28			-do-
Family JASSIDAE				
Jassids				
	100+			Invariably present in stomachs.
Order Ephemera				
Mayfly naiads				
	100+			Partially digested. Identification not possible.
Order Coleoptera				
Family GYRINIDAE				
<i>Gyrinus</i> sp.	16			
Family DYTISCIDAE				
<i>Canthydrus</i> sp.	6			Elytra and parts of body.
<i>Laccophilus</i> sp.	35			-do-
<i>Bidessus</i> sp.	40			-do-
<i>Hydratictus</i> sp.	3			-do-
<i>Eretes stictus</i> Linnaeus	100			
Order Diptera				
Family CULICIDAE				
Larvae & pupae	1000+			Partially digested.
Family CHIRONOMIDAE				
Larvae	100+			
Miscellaneous insect fragments				
				Not identifiable.
Total:	2010+	425	29.10	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Class Arachnida				
Order Araneae				
Family ARGYOPIDAE				
<i>Tetragnatha</i> sp.	100+			Invariably present in stomachs.
Family OXYOPIDAE				
<i>Oxyopes</i> sp. ?	100+			
Family HERSILIDAE				
<i>Hersila</i> sp.	50+			
Miscellaneous spider fragments				Not identifiable.
Total:	250+	130	8.94	
Phylum Annelida				
Order Oligochaeta				
Family TUBIFICIDAE				
<i>Limnodrilus</i> sp.	100+			Tangled mass.
Family MAGASCOLECIDAE				
<i>Pheretima</i> sp.	6			
<i>Perionix</i> sp. ?	7			
Order Polychaeta				
Family SERPULIDAE				
<i>Mercierella</i> sp.	10+			Brackish water form. In bits.
<i>Ficopomatus</i> sp. ?	10+			-do-
Miscellaneous Annelida				Partially digested. Not identifiable.
Total:	133+	60	4.10	
Vegetable matter				
Fragments of aquatic plants and weed seeds:				
Total:		100	6.84	Partially digested. Not identifiable.
Sand				
Total:		25	1.57	

The food of the Spotted Sandpiper is composed of 91.59 per cent of animal matter, 6.84 per cent of vegetable matter and 1.57 per cent of sand (Fig. 1) which is found mixed with the food. The animal matter is comprised of 49.08 per cent Mollusca in the form of minute shells and 29.10 per cent insects. Except three species of terrestrial grasshoppers, the other 20 species of insects found in the stomachs are immature aquatic forms representing naiads of dragon- and damselflies and, larvae and pupae of mosquitoes, chironomids, etc., and a few adult bugs and beetles. Spiders constitute 8.94 per cent of the diet, and Annelida which are represented by freshwater Oligochaeta and brackish water

Polychaeta, only 4.10 per cent. The vegetable constituents of the food is made up of fragments of aquatic plants and wild seeds to the extent of 6.84 per cent.

Since the bird destroys many harmful aquatic Diptera, such as larvae and pupae of mosquito and chironomid, it is certainly beneficial. The agriculturists are also benefitted by this bird as it devours some grasshoppers and leafhoppers.

Calidris minutus (Leisler), The Little Stint

The Little Stint, *Calidris minutus* (Leisler), is a winter visitor to the Sundarban area from early December to the end of March. It is a social bird, often mixing with other stints and other waders, forming flocks, sometimes of considerable size. It inhabits freshwater marshes as well as the salt marshes of the estuaries, and prefers broad mud-flats of tidal rivers keeping close to the edge of the water. During the ebb tide, it searches in the silt for minute creatures and follows the water as it recedes. With the high tide it moves up to the bank and finally to the freshwater mud-flats in the interior.

Very little information is available about the food-habits of this bird. In India, Mason & Lefroy (1912, p. 270) examined the stomachs of three specimens at Pusa and found 15 neutral insects and shells. Whistler (1928, p. 364) mentions that it collects minute insects, Crustacea, worms, and the seeds of various aquatic plants. According to Baker (1929, p. 236) its food consists of insects, tiny worms, mollusca, beetles and sometimes seeds. Ali (1955, p. 96) mentions that it picks up tiny insects, crustaceans and molluscs. In Europe, Voous (1960, p. 101) found that its food consists of mainly small insects, including large quantities of mosquitoes and their larvae; and outside the breeding season large numbers of small crustaceans and snails are also taken.

The detailed analysis of the stomach-contents of 86 adult specimens that I collected in the Sundarban is given in Table 20.

TABLE 20

ANALYSIS OF THE STOMACH-CONTENTS OF THE LITTLE STINT

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family LITTORINIDAE				
<i>Littorina melanostoma</i>				
Gray	61			Some complete and some broken shells.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Basommatophora				
Family LYMNAEIDAE				
<i>Lymnaea acuminata</i> (Lamarck)	32			Mostly complete shells.
Family PLANORBIDAE				
<i>Indoplanorbis exustus</i> (Deshayes)	19			-do-
Class Bivalva				
Family ARCIDAE				
<i>Arca</i> sp. ?	6			Part of opercula.
Miscellaneous shell fragments				Not identifiable.
Miscellaneous Mollusca pulp				Not identifiable.
Total:	118	425	46.18	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
<i>Macrobrachium</i> sp.	27			Mostly in parts. Freshwater form.
<i>Macrobrachium rude</i> (Heller)	35			-do-
<i>Palaemon styliferus</i> (Milne-Edward)	29			-do-
Family PENAEIDAE				
<i>Metapenaeus</i> sp.	18			Brackish water form.
Family GRAPSIDAE				
<i>Varuna litterata</i> (Fabricius)	33+			Brackish water form, partially digested. Not identifiable.
Miscellaneous crustacean fragments				
Total:	142	172	17.70	
Class Insecta				
Order Orthoptera				
Family TETTIGIDAE				
<i>Acrydium</i> sp.	9			Semi-aquatic and ground- hopper.
<i>Scelimena</i> sp.	13			-do-
<i>Loxilobus</i> sp.	7			-do-
Order Dermaptera				
Family LABIIDAE				
<i>Labia</i> sp.	3			
Miscellaneous earwigs				Claspers and parts of body.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Ephemera				
Family EPHEMERIDAE				
Naiads	5			Partly digested.
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Naiads	8			-do-
Suborder Anisoptera				
Family AESCHNIDAE				
<i>Aeschna</i> sp. ? (naiads)	2			-do-
Miscellaneous dragon- & damselflies larvae				Not identifiable.
Order Hemiptera				
Family GERRIDAE				
<i>Gerris</i> sp.	17			Aquatic form. Partially digested.
<i>Halobates</i> sp. ?	9			
Family NAUCORIDAE				
<i>Laccocoris</i> sp.	6			-do-
<i>Limnocoris</i> sp.	4			-do-
Family NEPIDAE				
<i>Ranatra</i> sp.	3			Aquatic form.
Order Coleoptera				
Family DYTISCIDAE				
<i>Laccophilus</i> sp.				
<i>Eretes stictus</i>				
Linnaeus	17			Aquatic form.
Family GYRINIDAE				
<i>Dineutes</i> sp.	4			Aquatic form. Elytra and parts of body. Mostly mutilated.
<i>Gyrinus</i> sp. ?	7+			
Family JASSIDAE	100+			Digested beyond identification.
Order Diptera				
Family CULICIDAE				
Larvae	100+			In tangled mass. Partially digested.
Miscellaneous insect fragments				Not identifiable.
Total:	314+	230	25	
Vegetable matter:				
<i>Panicum</i> sp. ? (seeds)				
Grass and leaves (bits)				
Total:		55	6	
Sand	Total:	40	4.35	

The food of the Little Stint consists of 89 per cent of animal matter and 6 per cent of vegetable matter, the balance (4.35%) being made up by sand (Fig. 1). The animal matter comprises of minute molluscs (46.18%) which are generally taken complete with shells; arthropods represented by freshwater and brackish water crustaceans (17.70%), and insects (25%) of mostly aquatic and a few terrestrial species. The crustaceans are of commercial value.

Since the bird consumes some crustaceans of commercial value, it does not appear to be completely a harmless bird, but its adverse effect on fishery is too little to warrant branding it as a injurious bird.

Chlidonias hybrida indica (Stephens), The Indian Whiskered Tern

The Whiskered Tern, *Chlidonias hybrida indica* (Stephens) is a common bird of the freshwater and brackish water marshes of the Sundarban area. It frequents open water bordered by dense vegetation and reedbeds. It is a winter visitor and is commonly seen in parties consisting of half a dozen to a dozen individuals, circling over drying pools and *gheries* diving from time to time to collect food.

About the food-habits of the Indian Whiskered Tern, Jerdon (1864, p. 837) stated: "This tern is exceedingly abundant in India, frequenting marshes, tanks and rivers, usually preying on aquatic food, not unfrequently hunting over fields, beds of reeds, and marshy ground, where it captures grasshoppers, caterpillars and other insects". Whistler (1928, p. 373) recorded: "Dragonflies and their larvae appear to be their staple food, but water beetles and other aquatic insects are freely taken". Baker (1929, p. 112) writes that it lives principally on water insects and larvae, dragonflies, grasshoppers, etc., and also on fish and tadpoles. Ali (1955, p. 91) states that the food comprises of tiny fishes, tadpoles, crabs, grasshoppers and other insects. The allied European subspecies *C. h. hybrida* (Pallas) takes all sorts of small animals living on or near the water's surface, such as small fish, frogs, dragonflies, and other aquatic and marsh insects (Voous, 1960, p. 131).

The detailed analysis of the stomach-contents of 13 adult specimens of the Indian subspecies that I collected in the Sundarban is given in Table 21.

TABLE 21

ANALYSIS OF THE STOMACH-CONTENTS OF THE INDIAN WHISKERED TERN

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Class Amphibia				
Order Anura				
Family RANIDAE				
Tadpoles	10			Partially digested beyond identification.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
<i>Rana limnocharis</i>				
Boie	2			Subadult.
<i>Rana tigerina</i> Daudin ?	1			Subadult.
Miscellaneous frogs				Mutilated beyond identification.
Total:	13	20	6.66	
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
<i>Chela</i> sp.	7			Partly digested.
<i>Puntius</i> sp.	14			Length 30-40 mm. Invariably present in stomachs.
Family CLARIIDAE				
<i>Clarius batrachus</i> (Linnaeus)	1			Length 50 mm.
Family BAGRIDAE				
<i>Mystus</i> sp.	8			Length 30-40 mm. Partially digested.
Order Perciformes				
Family ANABANTIDAE				
<i>Anabas testudineus</i> (Bloch)	2			Length 40-50 mm.
Miscellaneous fish remains				Not identifiable.
Total:	32	50	20	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
<i>Macrobrachium</i> sp.	19			Invariably present in stomachs.
<i>Palaemon styliferus</i> (Milne-Edward)	6			
Family ATYIDAE				
<i>Caridina gracilipes</i> de Man	10+			Fragmentary remains. Partially digested.
Miscellaneous crustacean fragments				Not identifiable.
Total:	35	50	20	

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
<i>Hieroglyphus banian</i>				
Fabricius	6			Pest of paddy.
<i>Locusta migratoria</i>				
(Reiche & Fairmaire)	4			Pest of paddy.
<i>Attractomorpha</i> sp.	5			Pest of paddy, vegetables, etc.
Family GRYLLIDAE				
<i>Brachytrypes</i> sp.	3			Pest of roots of crop, etc.
Miscellaneous orthopteran fragments				
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Naiads				
	25			Partially digested beyond identification.
<i>Ceriagrion</i> sp.	4			Wings and parts of body.
<i>Ischneura</i> sp.	8			-do-
Suborder Anisoptera				
Family LIBELLULIDAE				
<i>Crocothemis</i> sp.	16			-do-
<i>Brachythemis</i> sp.	13			-do-
Order Hemiptera				
Family NEPIDAE				
<i>Nepa</i> sp.	8			Aquatic form.
Family BELOSTOMATIDAE				
<i>Belostoma</i> sp.	4			Elytra and fragments of body.
Order Coleoptera				
Family DYTISCIDAE				
<i>Laccophilus</i> sp.	9			Aquatic form.
Family GYRINIDAE				
<i>Gyrinus</i> sp.				
Miscellaneous coleopteran fragments				
Order Hymenoptera				
Family VESPIDAE				
<i>Vespa orientalis</i>				
Linnaeus	7			Mutilated body.
Miscellaneous insect fragments				
				Not identifiable.
Total:	87	170	53.33	

The Whiskered Tern subsists solely on animal food (Fig. 2), of which 6.66 per cent consists of tadpoles and frogs; 20 per cent of small fishes (30-70 mm standard length) of commercial value; 53.33 per cent

of insects (mostly aquatic, some immature dragon- and damselflies, a few adult bugs and beetles), and some terrestrial grasshoppers which are pests of cultivated plants; the crustaceans taken are in small proportion (20%) and are of commercial value.

From the economic point of view the bird does not appear to be beneficial since 40 per cent of food consists of fishes and crustaceans of commercial value. This is far from compensated by the few insect pests of agriculture that it destroys.

***Ceryle rudis leucomelanura* Reichenbach, The Pied Kingfisher**

The Pied Kingfisher, *Ceryle rudis leucomelanura* Reichenbach, is a common bird of the tidal rivers and creeks, inland pools and inundated fields of the Sundarban. It has not been observed in the interior of forests, and it appears to be more common in the creeks and rivers than in inland waters.

Regarding the food of the Pied Kingfisher, both Jerdon (1863, p. 234) and Blanford (1895, p. 120) state that it feeds entirely on fish. Mason & Lefroy (1912, p. 167) analysed five stomachs and concluded that the birds fed entirely on fish. Whistler (1927, p. 232) stated: "Its diet consists entirely of small fish". Baker (1927, p. 248) mentioned: "Its food is entirely aquatic and principally small fishes, though it will also eat water-insects, tadpoles, tiny prawns or very small frogs". Ali (1955, p. 56) lists fish, tadpoles, frogs and aquatic insects as its food.

The detailed analysis of the stomach-contents of 299 adult specimens that I collected in the Sundarban is given in Table 22.

TABLE 22

ANALYSIS OF THE STOMACH-CONTENTS OF THE PIED KINGFISHER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
<i>Puntius</i> sp.	122			Freshwater form.
<i>Chela</i> sp.	29			Quite common in stomachs.
Family BAGRIDAE				
<i>Mystus</i> sp.	187			-do-
Order Scopeliformes				
<i>Harpodon nehereus</i> (Hamilton)				
	18			Brackish water form.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
<i>Oryzias melastigma</i> (McClelland)				
	51			

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Mugiliformes				
Family MUGILIDAE				
<i>Rhinomugil corsula</i> (Hamilton)	17			Length 35-45 mm.
<i>Mugil parsia</i> (Hamilton)	117			Brackish water form.
<i>Mugil tade</i> Forskal	6			Quite common in stomachs.
Order Polynemiformes				
Family POLYNEMIDAE				
<i>Polynemus paradiseus</i> Linnaeus	12			Length 30-60 mm.
Order Perciformes				
Family AMBASSIDAE				
<i>Ambassis</i> sp.	126			Freshwater form. Quite common in stomachs.
Family SCIAENIDAE				
<i>Pseudosciaena</i> sp.	10			
<i>Johnius</i> sp.	18			Length 45-55 mm. Brackish water form.
<i>Pama</i> sp.	6			-do-
Miscellaneous fish remains				Not identifiable.
Total:	719	2246	57.0	

Phylum Arthropoda

Class Crustacea

Order Decapoda

Family PALAEMONIDAE

Macrobrachium lamerrei
(Milne-Edward)

81

Freshwater form. Quite common in stomachs.

Macrobrachium rude
(Heller)

17

Palaemon styliferus
(Milne-Edward)

12

Freshwater form.

Family ATYIDAE

Cardina gracilipes
de Man

62-

Partly digested.

Family PENAEIDAE

Metapenaeus brevicornis
(Milne-Edward)

109

Brackish water form. Quite common in stomachs.

Metapenaeus monoceros
Fabricius

61

-do-

Miscellaneous crustacean
fragments

Not identifiable.

Total: 342 680 17.0

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Class Insecta				
Order Hemiptera				
Family BELOSTOMATIDAE				
<i>Belostoma</i> sp.	69+			Freshwater form. Quite common in stomachs.
Family NOTONECTIDAE				
<i>Notonecta</i> sp.	32			Some in fragments.
Family CORIXIDAE				
<i>Corixa</i> sp.	63			
Order Coleoptera				
Family DYTISCIDAE				
<i>Laccophilus</i> sp.	28			Freshwater form.
<i>Bidessus</i> sp.	26			
<i>Eretes stictus</i> Linnaeus	75			-do-. Quite common in stomachs.
Family GYRINIDAE				
<i>Gyrinus</i> sp.	50			Freshwater form. Quite common in stomachs.
Miscellaneous insect fragments				
				Not identifiable.
Total:	343	1040	26.0	

The bird consumes wholly animal food comprising of 57 per cent fishes, 26 per cent aquatic insects and 17 per cent crustaceans (Fig. 2). The fishes and crustaceans, which form the major bulk are of commercial value. Most of the fishes are brackish water forms but a few are freshwater species. These fishes measure 30-60 mm in standard length. The crustaceans on the other hand are mostly freshwater species with a few brackish water forms.

Since as much 74 per cent of its diet consists of fishes and crustaceans of commercial value, it may be regarded as a bird destructive to pisciculture.

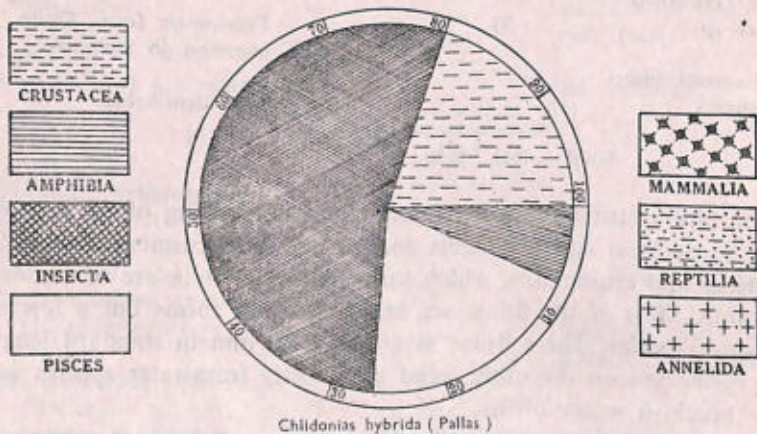
Halcyon smyrnensis fusca (Boddaert), The Whitebreasted Kingfisher

The Whitebreasted Kingfisher, *Halcyon smyrnensis fusca* (Boddaert), is mainly a bird of the plains of India. In the Sundarban area during the wet season, it is found near about freshwater ponds, jheels, waterlogged areas along the embankments and inundated or dry fields. It is rare in tidal creeks and rivers. It dives from its perch to capture its prey from either the edge of tanks or very shallow water. During dry season, however, it does not depend upon water for its food, and it disperses over a wide area perching on poles, horizontal wires across fields, trees standing in dry land and even enters thin forests in search of food. It has also been found sometimes to remain close to Cattle Egrets or graz-

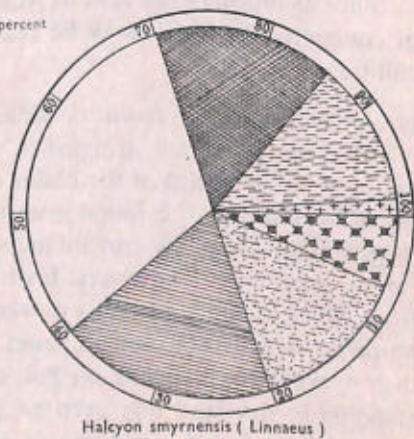
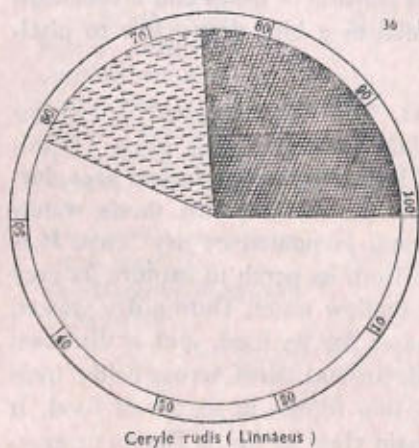
ing cattle by flying from perch to perch, and insects disturbed them are picked up by it.

The food of this kingfisher is of varied nature. Jerdon (1862, p. 225) mentions that it is composed of land-crabs, mouse, lizard, grasshoppers and other insects; and near water, fish, tadpoles and water-insects. Blandford (1895, p. 132) states that though it occasionally but rarely catches fish by plunging after them, it lives chiefly on insects and small lizards and sometimes on mice and land-crabs. Mason & Lefroy (1912, p. 168) observed the bird taking grasshoppers at Pusa and Chindwara, and once eating a lizard at Pusa. Baker (1927, p. 270) wrote: "Its principal article of diet are undoubtedly grasshoppers and locusts, but it will eat almost anything not too large to swallow. Frogs, small lizards, worms, etc., are all thankfully taken and eaten; I have seen it taking cicadae from the

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS.



36 10 percent



trunk of trees, whilst prawns, small crabs, etc., are taken in preference to fishes when it haunts streams". Whistler (1928, p. 235) stated: "This very typical kingfisher is mainly a land-bird and feeds largely on insects, lizards, frogs and such small fry, which it captures after the manner of a Roller, flying down to them on the ground from an elevated perch. It is said very occasionally both to plunge into water after fish and to take insects on the wing". Ali (1955, p. 57) mentions fish, tadpoles, lizards, grasshoppers and other insects, young birds and mice as its food.

Gibson Hill (1951) mentions that the principal constituent of the diet of the allied form, *H. s. prepulchra* Madarasz, in Singapore is undoubtedly insects, mostly grasshoppers and other Orthoptera. Often these are taken in the larval stage. It also eats a number of lizards, chiefly skinks. He examined eight stomachs which yielded the remains of three skinks, *Mabuya* sp., feathers and head of *Munia* sp., some 15 grasshoppers and mantids, four beetles, three bees, four large black ants, a small scorpion, *Isometrus maculatus*, and two centipedes, *Scolopendra subspinipes*. There was no trace of fish or crustacea.

The detailed analysis of the stomach-contents of 192 adult specimens that I collected in the Sundarban is given in Table 23.

TABLE 23

ANALYSIS OF THE STOMACH-CONTENTS OF THE WHITEBREASTED KINGFISHER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Class Mammalia				
Order Rodentia				
Family MURIDAE				
<i>Mus</i> sp.	12			Partially digested.
Family SCIURIDAE				
<i>Funambulus pennanti</i> Wroughton	7			Mutilated, young.
Total:	19	180	6.92	
Class Reptilia				
Order Lacertilia				
Family AGAMIDAE				
<i>Calotes</i> sp.	31			
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
<i>Ptyas mucosus</i> (Linnaeus)	11			

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
<i>Natrix</i> sp.	13			
Miscellaneous Reptilia (mutilated)				Mostly small lizards. Not identifiable.
Total:	55	360	13.84	
Class Amphibia				
Order Anura				
Family RANIDAE				
<i>Rana</i> sp. (tadpoles)	200+			Partially digested.
<i>Rana</i> ? <i>limnocharis</i> Wiegmann	21			Some mutilated.
<i>Rana tigrina</i> Daudin	6			
Family BUFONIDAE				
<i>Bufo melanostictus</i> Schneider	9			
Miscellaneous tadpoles				Digested beyond identification.
Total:	236+	496	19.07	
Series Pisces				
Class Teleostomi				
Family CYPRINIDAE				
<i>Puntius</i> sp.	60			Length 10-20 mm. Freshwater form.
Family BAGRIDAE				
<i>Mystus</i> sp.	82			Length 10-25 mm. Partly digested.
Order Perciformes				
Family ANABANTIDAE				
<i>Anabas testudineus</i> (Bloch)	42			Length 20-40 mm.
Total:	184	812	31.23	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
<i>Macrobrachium</i> sp.	71			Freshwater form.
<i>Macrobrachium rude</i> (Heller)	26			-do-
<i>Palaemon styliferus</i> Milne-Edward	18			-do-
Family POTAMONIDAE				
<i>Paratelphusa</i> sp.	9			Parts of body.
Miscellaneous Crustacea fragments				Not identifiable.
Total:	124	292	11.23	

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
<i>Hieroglyphus</i> sp.	21			Paddy pest.
<i>Attractomorpha</i> sp.	15			Pest of tobacco and vegetables.
Family TETTIGIDAE				
<i>Acrydium</i> sp.	22			
Family GRYLLIDAE				
<i>Gryllus</i> sp.	5			Pest of paddy-roots.
<i>Achaeta</i> sp.	9			-do-
<i>Brachytrypes</i> sp.	19			-do-
Family GRYLLOTALPIDAE				
<i>Grylotalpa</i> sp.	36			-do-
Miscellaneous orthopteran fragments				Not identifiable.
Order Dermaptera				
Family LABIDURIDAE				
<i>Labidura</i> sp.	6			
Family CHELISOCHIDAE				
<i>Chelisoches</i> sp.	4			
Forficulid claspers and fragmentary remains				Not identifiable.
Order Hemiptera				
Family BELOSTOMATIDAE				
<i>Belostoma</i> sp.	6			Aquatic form.
Family PYRRHOCORIDAE				
<i>Dysdercus cingulatus</i> Fabricius	4			Pest of cotton and vegetables.
Order Lepidoptera				
Miscellaneous larvae				Partially digested beyond identification.
Order Coleoptera				
Family DYTISCIDAE				
<i>Eretes stictus</i> Linnaeus	12			Aquatic form.
Family DYNASTIDAE				
<i>Oryctes rhinoceros</i> Linnaeus	3			Pest of coconut palm.
<i>Phyllognathus dionysius</i> (Fabricius)	11			Pest of paddy-ears.
Family RUTILIDAE				
<i>Anomala elata</i> (Fabricius)	16			Underground stem-and root-feeder of cultivated plants.
Family MELOIDAE				
<i>Epicauta</i> sp.	27			Pest of paddy-ears.
Family CICINDELIDAE				
<i>Cicindela</i> sp.	9			
Miscellaneous Coleoptera (elytra)				Not identifiable.

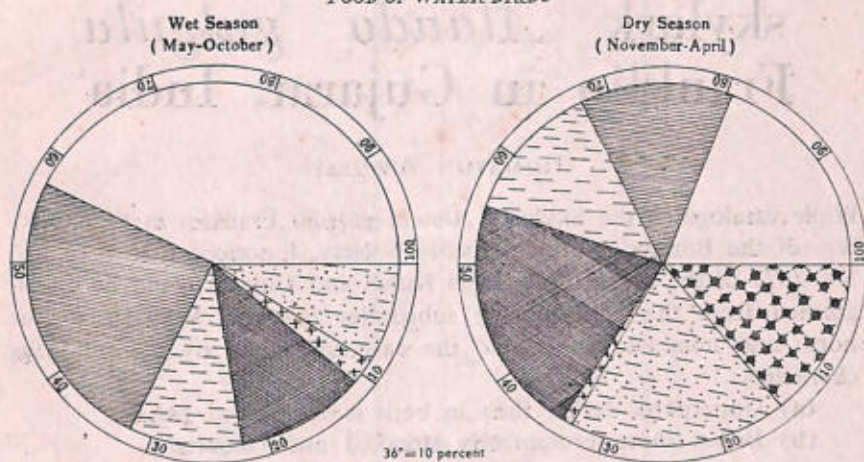
Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Hymenoptera				
Family FORMICIDAE				
<i>Dorylus</i> sp.	4			Pest of sugarcane, jute, etc.
<i>Solenopsis</i> sp.	6			Pest of brinjal.
Miscellaneous insect fragments				Not identifiable.
Total:	235	420	16.15	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
<i>Pheritima</i> sp.	13+			Partially digested.
Miscellaneous earthworms (bits)				Not identifiable.
Total:	13+	40	1.53	

The entire food of the Whitebreasted Kingfisher consists of animals. It is composed of 31.23 per cent of fishes which are small fry of commercial freshwater species, 19.07 per cent of Amphibia (tadpoles, frogs and toads), 13.84 per cent of reptiles (snakes and lizards), 6.92 per cent of mammals (mouse and squirrel), 11.23 per cent of Crustacea of commercial value; 16.15 per cent of Insecta, and 1.53 per cent of Annelida represented by moist soil earthworms (Fig. 2). The insects taken by the bird have been found to be mostly pests of crops and vegetable. Out of the 235 examples representing 20 species recorded from the stomachs, 198 examples representing 14 species have been found to be injurious to crops, two predators and four neutral.

The food of this bird during the rainy (wet) season varies to some extent from that of dry season. During the wet season (May to October) when the water level is much higher and the whole area is largely inundated, the birds live more on aquatic animals, such as tadpoles, fishes, shrimps, prawns, aquatic insects and annelids; while during the drier months from November to April it consumes more of land organisms.

Out of the 192 specimens of the bird studies, 109 were collected during the wet period and 83 during the dry season. Analysis of their stomach-contents reveals the following seasonal variation (Fig. 3):

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF
FOOD OF WATER BIRDS



Halcyon smyrnensis (Linnaeus)



Animal groups:	Wet season: (food percentage)	Dry season: (food percentage)
Mammalia	—	14.10
Reptilia	8.84	18.74
Amphibia	25.00	13.14
Pisces	42.96	19.40
Crustacea	10.00	12.46
Insecta		
Terrestrial	3.00	16.00
Aquatic	8.14	5.16
	<hr/> 11.14	<hr/> 21.16
Annelida	<hr/> 2.06	<hr/> 1.00

From the data presented above it may be generalised that during the wet season this bird is not beneficial since it consumes fish fry and shrimps of commercial value which constitute more than half (52.96%) the total bulk of its food. On the other hand, in the dry season it does immense service to the agriculturists by consuming insect and rodent pests of agriculture, which together form 35.26 per cent of its diet.

(to be continued)

On a new subspecies of the skylark *Alauda gulgula* Franklin in Gujarat, India¹

HUMAYUN ABDULALI

While cataloguing the Skylarks *Alauda gulgula* Franklin in the collection of the Bombay Natural History Society, I noticed that 7 (4♂♂ 1♀ 2o?) of the 8 specimens from Kutch and Gujarat could be distinguished from the neighbouring subspecies *punjaubi* Whistler to the north and nominate *gulgula* to the east and south by the following characters:

- (a) Upperparts darker than in both *punjaubi* and *gulgula*.
- (b) Breast more prominently streaked and coloured.
- (c) Larger bill and hind claw, as per table of measurements attached.

On these differences, I separate them as:

***Alauda gulgula dharmakumarsinhji* subsp. nov.**

Holotype: ♂ collected by R. S. Dharmakumarsinhji at Bhavnagar, Gujarat, on 26 April 1953, bearing No. 21279 in the collection of the Bombay Natural History Society.

Paratypes: ♂♂ Nos. 21276, 21277 and unsexed 21278 and 21378 collected at Bhavnagar, Gujarat, by R. S. Dharmakumarsinhji on 26 April and 17 June 1953; and ♂ No. 9058 from Saiat, Kaira District, Gujarat, on 12 December 1945, and ♀ No. 9057 from Mandvi, Kutch, on 8 March 1944, both by Sálím Ali.

On the last date another skylark was obtained at the same place, which I have placed with *punjaubi*. One or the other was an immigrant or straggler.

This bird is named after R. S. Dharmakumarsinhji of Bhavnagar, the author of *BIRDS OF SAURASHTRA* and well known in ornithological circles in India. He sent the birds to the Bombay Natural History Society in two lots in 1953 but no correspondence other than the covering letter is now traceable and I do not know if they were ever carefully examined by anybody before.

It may also be of interest to mention that in the course of my work, I have examined some 580 sexed specimens of different species of larks, of which 65 per cent are males, the preponderance in some groups, as in the present instance, being more pronounced.

¹ Accepted December, 1974.

Alauda gulgula dharmakumarsinhjii subsp. nov.

TABLE OF MEASUREMENTS

		Wing	Bill from feathers	Tail	Hind claw
♂	<i>dharmakumarsinhjii</i>	(4) 91,92,93,95	12.2*,15,15.4,-	47,51,52,56	17.5-24* av. 20.2
♂	<i>punjaubi</i>	(9) 93-100 av. 97.3	11.8-14 av. 13	50-56 av. 54.5	12-17 av. 14.5
♂	<i>gulgula</i>	(13) 86-95 av. 90	13.2-14.9 av. 14.2	46-52 av. 49.6	11.3-17.3 av. 13.9
1 ♀	2o? <i>dharmakumarsinhjii</i>	(3) 90,92,92	14.6,13.7,14	52,48,50	19,18,2,22.3
♀	<i>punjaubi</i>	(6) 87-99 av. 91.5	13-13.6 av. 13.3	47-53 av. 51	11.2-15 av. 13.6
♀	<i>gulgula</i>	(2) 85,88	13,13.1	46,50	13.3, 14.1

* No. 9058 from Saiat, Kaira District has a small bill but the longest claw.

Algae of Vidarbha, Maharashtra¹

N. D. KAMAT²

Botany Department, Institute of Science, Nagpur 1

In this paper 636 taxa belonging to Chlorophyceae, Euglenophyceae, Xanthophyceae, Dinophyceae and Cyanophyceae are recorded from 25 different places in Vidarbha.

During the years 1964 to 1969, I collected 2538 vials of algae from Khamgaon, Mehkar and Lonar (Buldhana District), Akola, Karanja and Malegaon (Akola District), Amravati (Amravati District), Yeotmal (Yeotmal District), Pavnar, Wardha (Wardha District), Katol, Satnavri, Vena Dam, Dahegaon, Umred and Mansar (Nagpur District), Gondia, Tumsar, Tiroda, Bhandara Road, Bhandara, Jawahar Nagar and Sakoli (Bhandara District), Warora and Chandrapur (Chandrapur District). The collections were made mainly from ponds and lakes used for pisciculture. All these collections were preserved in 4% formalin. Camera lucida diagrams of all these algae have been drawn.

Vidarbha region consisting of eight districts, forms the north-eastern part of Maharashtra State. The maximum and minimum temperatures for the region are 50°C and 8°C. The rainfall varies from 70 to 125 cm for the different places of collections. The soil is mostly black and clayey.

So far *Chara brachypus* Br., *C. corallina* Willd., *C. zeylanica* Willd., *Lychnothamnus barbatus* (Meyen) Leonhardi and *Nitella hyalina* (De Cond.) Agardh from Ambazari lake, Nagpur (Kamat 1967) and *Pediastrum boryanum* (Turpin) Meneghini, *P. tetras* (Ehr.) Ralfs and *Tetraedron minimum* (A. Br.) Hansgirg from ponds in Nagpur (Phillipose 1967) have been recorded from this region.

In this paper 391 taxa of Chlorophyceae, 96 taxa of Euglenophyceae, 2 taxa of Xanthophyceae, 11 taxa of Dinophyceae and 136 taxa of Cyanophyceae are included. Members of Charophyceae and Bacillariophyceae and the algae of Nagpur proper are still under study and hence not included in this paper. Many algae could not be identified for the lack of mature reproductive parts.

Rich collections were made from Vadali lake at Amravati and Ram-

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sagar lake at Tiroda while very few algae were found in Januna lake at Khangaon and Rishi lake at Karanja. The algal flora was negligible in ponds with a dense floating vegetation particularly of species of *Azolla*, *Wulfia*, *Lemna* and *Pistia* occurring either alone or in combinations.

The pH of the water of the collection spots when studied, is given in the bracket immediately after the collection spot. The pH was found out by studying at least three samples of water from three different places of the collection spot, by using B.D.H. Universal indicator. The pH of the collection spots ranged from 7.2 in Ramsagar to 11 in a lake at Lonar.

Common algae of this region are *Coelastrum cambricum* Archer v. *intermedia* (Bohlin) G. S. West, *Ankistrodesmus falcatus* (Corda) Ralfs, *Scenedesmus bijuga* (Turpin) Lagerh. v. *alternans* (Reinsch) Hansg., *Rhizoclonium hieroglyphicum* (Ag.) Kuetz., *Pithophora oedogonia* (Mont.) Wittr., *Closterium diana* Ehreb., *Cosmarium auriculatum* Reinsch, *Euastrum spinulosum* Delp., *Trachelomonas hispida* (Perty) Stein em. Defl., *T. volvocina* Ehrenb., *Aphanothece pallida* (Kuetz.) Rabenh., *Merismopedia glauca* (Ehrenb.) Naeg., *Spirulina major* Kuetz. ex Gomont, *Oscillatoria okeni* Ag. ex Gomont and *O. splendida* Grew ex Gomont.

Only the important works referred for the identification of these algae are given in the references.

CHLOROPHYCEAE

Chlamydomonas globosa Snow

In a puddle, Amaravati (18-10-64). In a pond (8.2), Katol (8-12-68).

C. snowii Printz

In a small pond, Akola (16-10-68).

Gonium pectorale Muell.

In a pool, Khangaon (13-10-67). In Mendhe lake (9.5), Bhandara (19-10-68). In Abkari lake (7.5), Bhandara (9-12-68).

Pandorina morum (Muell.) Bory

In ponds, Umred (30-11-64), Mansar (13-12-64). In pools, Amravati (18-10-68). In Mendhe lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

Eudorina elegans Ehrenberg

In Abkari lake (7.5), Bhandara (28-12-68).

Sphaerocystis schroeteri Chodat

In Abkari lake (7.5), Bhandara

(29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

Gloeocystis ampla (Kuetz.) Lagerh.

In a pond, Umred (30-11-64).

G. gigas (Kuetz.) Lagerh.

In Vadali lake, Amravati (18-10-64).

Tetraspora gelatinosa (Vauch.)

Desvaux

In a lake (8), Yeotmal (14-11-68).

T. lacustris Lemm.

In Abkari lake (7.5), Bhandara (28-11-68).

Elakatothrix viridis (Snow) Printz

In paddy fields, Amravati (13-10-64). In newly constricted cement cisterns, Khangaon (13-10-67), Akola (13-10-68), Bhandara (12-1-69).

Microactinium pusillum Fresen.

In Khamb lake (9), Bhandara (28-12-68).

Dictyosphaerium pulchellum Wood

In Nursery pond (8), Bhandara (21-12-68).

Dimorphococcus lunatus A. Br.

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (28-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

Schroederia indica Philipose

Planktonic in a bodhan, Amravati (18-10-64).

S. robusta Korsh.

Planktonic in a pool, Wardha (14-10-65).

S. setigera (Schroeder) Lemm.

Planktonic in a bodhan¹, Amravati (18-10-64). Pyrenoids present.

Korshikoviella gracilipes (Lamb.)

Silva

Planktonic in a pool, Amravati (18-10-64).

Pediastrum boryanum (Turpin)

Meneghini

In a lake (8.2), Dahegaon (27-12-64). In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

P. duplex Meyen

In a pond, Mansar (13-12-64). In a lake (8), Yeotmal (24-11-68). In Nave lake (9.5), Bhandara (19-1-69).

P. duplex Meyen v. **clathratum** (A. Br.) Lagerh.

In Abkari lake (7.5), Bhandara (28-12-68).

P. duplex Meyen v. **cohaerens**

Bohlin

In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

P. duplex Meyen v. **gracilimum** West et West

In a pond (8.5), Bhandara Road (19-1-69).

P. integrum Naeg. v. **perforatum** Racib.

In Ramsagar lake (7.2), Tiroda (2-2-69). Cells broader up to 35 μ .

P. muticum Kuetz.

In ponds, Mansar (13-12-64).

P. simplex Meyen

In Vadali lake, Amravati (18-10-64). In droppings of birds near Vena dam (1-2-69). In a pond, Bhandara (3-3-69).

P. simplex Meyen v. **duodenarium** (Baily) Rabenh.

In Vadali lake, Amravati (3-3-65). In a pond (8.5), Bhandara Road (19-1-69).

P. tetras (Ehrenb.) Ralfs

In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

P. tetras (Ehrenb.) Ralfs. v. **tetraedron** (Corda) Hansg.

In Pavnar dam (27-10-64).

Sorastrum americanum (Böhlin) Schmidle

In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

S. americanum (Bohlin) Schmidle v. **undulatum** G. M. Smith

In Vadali lake, Amravati (3-3-65).

S. spinulosum Naeg.

In paddy fields, Amravati (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (19-12-68).

Coelastrum cambricum Arch. v. **intermedium** (Bohlin) G. S. West

In Vadali lake, Amravati (18-10-64; 3-3-65). In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-64). In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. microporum Naeg.

In Sarkari lake (7.2), Tumsar (29-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. reticulatum (Dang.) Senn

In Abkari lake (7.5) Bhandara (29-12-68).

Westella botryoides (W. West) De Wild.

In a nursery pond (8), Bhandara (28-12-68).

¹ Bodhan = Buffalo wallow.

Nephrocystium hydrophilum (Turn.) Wille

In Vadali lake, Amravati (3-3-65).

N. obesum West et West

In paddy fields, Amravati (13-12-64).

Trochiscia reticularis (Reinsch)

Hansg.

In ponds, Mansar (13-12-64).

Oocystis borgei Snow

In Pavnar dam (27-10-64). In Zarp stream, Chanda (1-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Nursery pond (8), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. elliptica W. West

In ponds, Umred (30-11-64). In Vadali lake, Amravati (3-3-65).

O. gigas Arch.

In Vadali lake, Amravati (18-10-64).

O. macrospora (Turn.) Brunnth.

Rare. In a pond, Mansar (13-12-64).

O. pusilla Hansg.

In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

O. solitaria Witttr. v. *major* Wille

In a pond, Mansar (13-12-64).

Gloeotaenium loitsbergianum Hansg.

In Vadali lake, Amravati (18-10-64; 3-3-65). In Abkari lake (7.5), Bhandara (19-1-69).

Ankistrodesmus convolutus Corda

In Mendhe lake (9.5), Bhandara (19-1-69).

A. falcatus (Corda) Ralfs

In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

A. falcatus (Corda) Ralfs v. *acicularis* (A. Br.) G. S. West

In a cement cistern, Amravati (18-10-64). In Nursery pond (8), Bhandara (28-12-68).

A. falcatus (Corda) Ralfs v. *mirabilis* (West et West) G. S. West

In Vadali lake, Amravati (3-3-65).

A. falcatus (Corda) Ralfs v. *tumidus* (West et West) G. S. West

In paddy fields and in cement cisterns, Amravati (18-10-64).

A. spiralis (Turn.) Lemm.

In ponds, Umred (30-11-64). In Abkari lake (7.5), Bhandara (26-12-68).

Selenastrum bibraianum Reinsch

In a pond, Umred (30-11-64).

Kirchneriella lunaris (Kirchn.) Moebius

In Mendhe lake (9.5), Bhandara (19-1-69).

K. lunaris (Kirchn.) Moebius v. *irregularis* G. M. Smith

In ponds, Umred (30-11-64).

K. subsolitaria G. S. West

In Mendhe lake (9.5), Bhandara (19-1-69).

Cells sometimes bigger in size, up to 6.5 μ broad and 20 μ long.

Tetraedron hastatum (Reinsch)

Hansg.

Very rare. In a bodhan, Amravati (13-10-64).

T. minimum (A. Br.) Hansg.

In Vadali lake, Amravati (3-3-65).

T. pentaedricum West et West

In Khamb lake (9), Bhandara (28-12-68).

T. pusillum (Wall.) West et West

In Nursery pond (8), Bhandara (12-1-69).

T. trigonum (Naeg.) Hansg.

In Vadali lake, Amravati (3-3-65). In Nursery pond (8), Bhandara (28-12-68).

Scenedesmus arcuatus Lemm. v. *platydisca* G. M. Smith

In a pool, Satnavari (18-10-64). In ponds, Umred (30-11-64). In Mendhe pond (9.5), Bhandara (19-1-69).

S. bijuga (Turp.) Lagerh.

In a pond (8.5), Bhandara Road (19-1-69).

S. bijuga (Turp.) Lagerh. v. *alternans* (Reinsch) Hansg.

In ponds, Umred (30-11-64), Mansar (13-12-64). In Zarp stream, Chanda (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

- S. bijuga** (Turp.) Lagerh. v. **alternans** (Reinsch) Hansg. f. **parvus** G. M. Smith
In pools, Wardha (14-10-64). In Zarpat stream, Chanda (1-11-65).
- S. denticulatus** Lagerh.
In Abkari lake (7.2), Bhandara (29-12-68).
- S. denticulatus** Lagerh. v. **australis** Playf.
In Abkari lake (7.2), Bhandara (29-12-68).
- S. dimorphus** (Turp.) Kuetz.
In Zarpat stream, Chanda (1-11-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In a pond (8.5), Bhandara Road (19-1-69).
- S. hystrix** Lagerh.
In Abkari lake (7.2), Bhandara (28-12-68).
- S. longus** Meyen
In ponds, Umred (30-11-64).
- S. longus** Meyen v. **minutum** G. M. Smith
In Abkari lake (7.2), Bhandara (29-12-68).
- S. obliquus** (Turp.) Kuetz.
In Sarkari lake (7.2), Tumsar (22-12-68). In Nursery pond (8), Bhandara (22-12-68).
- S. quadricauda** (Turp.) De Breb. v. **longispina** (Chodat) G. M. Smith
In a pool, Satnavri (18-10-64). In Zarpat stream, Chanda (1-11-64).
- S. quadricauda** (Turp.) De Breb. v. **maximus** West et West
In a gutter, Wardha (27-10-64). In Sarkari lake (7.2), Tumsar (22-12-68). In a pond (8.5), Bhandara Road (19-1-69).
- Crucigenia rectangularis** (Naeg.) Gay
Rare. In Vadali lake, Amravati (18-10-64).
- Tetrallantos lagerheimii** Teiling
In a pond, Umred (30-11-64).
- Ulothrix aequalis** Kuetz.
In a pond, Umred (30-11-64).
- U. cylindricum** Prescott
In a pool, Wardha (27-10-64).
- U. subconstricta** G. S. West
In a pond, Umred (30-11-64).
- U. tenerrima** (Kuetz.) Kuetz.
In a drying bodhan, Satnavri (18-10-64). In a pond, Umred (20-11-64). In Vadali lake, Amravati (3-3-65). In a pond (8.2), Tumsar (22-11-68).
- Cylindrocapsa oedogoniodes** Randhawa
In a pond, Mansar (13-12-67).
- Stigeoclonium attenuatum** (Hazen) Collins
In a pond, Umred (30-11-64).
- S. hubneri** Heering
In Sarkari lake (7.2), Tumsar (22-12-68).
The alga is characterized by long, multicellular hairs.
- S. lubricum** (Dillw.) Kuetz.
Adhering to the stones in a streamlet, Amravati (18-10-64).
- S. nanum** Kuetz.
In ponds, Umred (30-11-64), Mansar (13-12-64).
- Chaetophora pisciformis** (Roth) Agardh
Common. In puddles, pools, Mansar (20-9-64).
- Coleochaete irregularis** Pringsheim
Epiphytic on *Chara* sp. in Sarkari lake (7.2), Tumsar (22-11-68).
- C. orbicularis** Pringsheim
Epiphytic on aquatic plants in ponds, Mansar (13-12-64). In Vadali lake (9), Amravati (18-10-69). In Sarkari lake (7.2), Tumsar (22-12-68).
- C. scutata** De Breb.
Epiphytic on *Ipomoea* sp. in Sarkari lake (7.2), Tumsar (22-12-68). Epiphytic on grass in Ramsagar (7.2), Tiroda (2-2-69).
- C. soluta** (De Breb.) Pringsheim
Epiphytic on grass in Ramsagar lake (7.2), Tiroda (2-2-69).
- Protococcus viridis** C. A. Agardh
On moist earthen pots, Amravati (18-10-64).
- Fritschiella tuberosus** Iyengar
On moist soil near Gaon lake, Sakoli (5-10-69).
- Chaetosphaeridium globosum** (Nordst.) Klebahn
In Ramsagar lake (7.2), Tiroda (2-2-69).

C. pringsheimii Klebahn f. *conferta* Klebahn

In Abkari lake (7.5), Tumsar (29-11-68).

Gomontia holdenii Collins

In mucilaginous masses of other algae, in a pond, Umred (30-11-64).

Rhizoclonium hieroglyphicum (C. A. Ag.) Kuetz.

Common. In a streamlet, Amravati (18-10-64). In Pavnar dam (27-10-64). On dripping rocks, Amravati (3-3-65). In cement cisterns, Khamgaon (13-10-67), Bhandara (12-1-69), Amravati (2-3-69), Wardha (4-4-69). On dripping stone and brick walls near Gaumukh, Lonar (24-10-68), Khamb lake (9), Tiroda (2-2-69). On shaded moist soil, Akola (6-3-69).

The alga shows variation in size. Usually there is no branching and when it is present, the branches are very short and one to two-celled.

Pithophora oedogonia (Mont.) Wittr.

Common. In small pools, puddles, cement cisterns and at the shore of ponds, Amravati, Dahegaon, Katol, Khamgaon, Gondia, Sakoli, Wardha, Tiroda (August-March).

Cladophora glomerata (L.) Kuetz.

Attached to the sides of cement cisterns, Amravati (18-10-64). Epizoic on snails in ponds, lakes, Amravati, Gondia, Lonar, Sakoli and Yeotmal (October-March).

Oedogonium aster Wittr. ex Hirn

In Vadali lake, Amravati (3-3-65).

O. australianum Hirn

In a pond, Mansar (13-12-64).

O. autumnale Wittr. ex Hirn

In ponds, Umred (30-11-64).

O. calvum Wittr. ex Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

O. cardiacum (Hass.) Wittr. ex Hirn f. *interjectum* Hirn

In Abkari lake (7.5), Bhandara (29-11-68).

O. crispum (Hass.) Wittr. ex Hirn

In a pond, Umred (30-11-64).

O. elegans West et West v. *americanum* Jao

In a pond, Ramtek (13-12-64). In

Ramsagar lake (7.2), Tiroda (2-2-69).

The alga from Ramsagar lake has longer vegetative cells—up to 80 μ long.

O. ellipsoideum Jao

In a pond, Mansar (13-12-64). Oogonia slightly longer—up to 81 μ long.

O. flexuosum Hirn

In a lake (8), Yeotmal (24-11-68).

Hirn (1900), Tiffany (1930) and Gemeinhardt (1939) describe the alga as incompletely known. In Yeotmal material male filaments are also present. Vegetative cells 19-22 μ broad, 21-23 (-24.5) μ long; antheridia in series of 4-12, 16.2-17.4 μ broad, 6.5-12.2 μ long.

The alga is heavily calcium incrustated.

O. inconspicuum Hirn

In a pond, Mansar (13-12-64).

O. inframediale Jao

In a pond, Mansar (13-12-64).

O. obesum (Wittr.) Hirn

In Nave lake (9.5), Bhandara (12-1-69).

O. obtruncatum Wittr. ex Hirn v. *ellipsoideum* Wittr. ex Hirn

In Abkari lake (7.5), Bhandara (29-11-68).

O. plagiotomum Wittr. ex Hirn v. *gracilis* Wittr. ex Hirn

In Khamb lake (9), Bhandara (28-12-68).

O. poecilosporum Nord. et Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

O. porrectum Nordst. ex Hirn

In a pond, Mansar (13-12-64).

O. pringsheimii Cramer: Wittr. ex Hirn v. *nordstedtii* Wittr. ex Hirn

In Nave lake (9.5), Bhandara (19-1-69).

Male filaments not observed. Female filament cells slightly capitate.

O. pseudospirale Nygaard

In Nave lake (9.5), Bhandara (19-1-69).

O. pusillum Kirchn. ex Hirn

In paddy fields, Vadali lake, Amravati (18-10-64). In Sarkari lake

(7.2), Tumsar (22-12-68).

O. santurcense Tiff.

In a pond, Umred (30-11-64). In Abkari lake (7.2), Bhandara (28-11-68).

O. subaerolatum Jao

In paddy fields, Amravati (18-10-64).

O. tapeinosporum Wittr. ex Hirn

In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. undulatum (Breb.) Al. Braun; Wittr. ex Hirn

In Vadali lake, Amravati (18-10-64, 3-3-65). In a pond, Umred (30-11-64). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69). In a pond, Wardha (15-10-69).

O. urbicum Wittr. ex Hirn

In Nave lake (9.5), Bhandara (19-1-69).

O. virceburgense Hirn

In paddy fields, Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Bulbochaete diamesandria Nordstedt ex Hirn

In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

B. lagoensis Wittr. ex Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

B. varians Wittr. ex Hirn

Very rare. In Vadali lake, Amravati (3-3-65).

Netrium digitus (Ehrenb.) Itzig. et Roth v. **lamellosum** (Breb.) Gronbl.

In Ramsagar lake (7.2), Tiroda (2-2-69).

Cylindrocystis americana West et West v. **minor** Cushman.

In a pond (7.8), Mansar (9-10-69).

Gonatozygon aculeatum Hast.

In a pond (8), Mansar (9-10-69).

G. kinahani (Arch.) Rabenh.

In a pond, Mansar (13-12-64).

G. monotaenium De Bary

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Gaon pond (8), Sakoli (7-1-

69). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

G. pilosum Wille

In a pond, Mansar (13-12-64).

Pleurotaenium baculoides (Roy et Biss.) Playf.

In a streamlet, Satnavri (18-10-64). In a pond, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Zygospores are present in Tiroda material. They are ellipsoid, 56-62 μ broad, 80-84 μ long, with spiny outer wall.

P. chrenbergii (Breb.) De Bary

In Sarkari lake (7.2), Tumsar (22-12-68).

P. elatum (Turner) Borge v. **subundulatum** Hirano

In a rock pool, Satnavri (18-10-64).

P. indicum (Grun.) Lund

In Abkari lake (7.5), Bhandara (29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

P. inermium (Moeb.) Hirano

In a pond, Umred (30-11-64). In Ramala lake, Chandrapur (1-11-65). In Nave lake (9.5), Bhandara (19-1-69).

P. ovatum Nordst.

In a streamlet, Satnavri (18-10-64). In a pond, Mansar (13-12-64). In Ramala lake, Chandrapur (1-11-65). In Nave lake (9.5), Bhandara (19-1-69).

P. simplicissimum Gronbl.

In Sarkari lake (7.2), Tumsar (22-12-68).

P. simplicissimum Gronbl. v. **semiundulatum** Hirano

In a pond, Umred (20-10-64). In Ramala lake, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

P. subcoronulatum (Turn.) West et West

In a pond, Mansar (13-12-64).

P. trabecula (Ehrenb.) Naeg.

In Vadali lake, Amravati (18-10-64). In Motha lake, Umred (30-11-

64). In Sarkari lake (7.2), Tumsar (22-12-68).

Curved semicells are commonly found in Tumsar material.

P. trabecula (Ehrenb.) Naeg. f. **clavata** (Kuetz.) West et West

In a pond, Mansar (13-12-64).

Occasionally cells longer—up to 615 μ long.

P. trabecula (Ehrenb.) Naeg. v. **maximum** (Reinsch) Roll f. **constrictum** Scott et Prescott

In Nave lake (9.5), Bhandara (19-1-69).

P. trabecula (Ehrenb.) Naeg. v. **rectum** (Delp.) West et West

In a pond, Umred (30-11-64). In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), and Belati pond (7.5), Tiroda (2-2-69).

Closterium acerosum (Schrank) Ehrenberg

In a pond, Umred (30-11-64).

C. acerosum (Schrank) Ehrenb. f. **rectum** Scott et Prescott

In Zarpal stream, Chandrapur (1-11-65).

C. aciculare West et West

In Vadali lake, Amravati (3-3-65).

C. acutum Breb.

In ponds, Umred (30-11-64), Mansar (13-12-64), and in Nursery pond (8), Bhandara (28-12-68).

C. acutum Breb. v. **variable** (Lemm.) Krieger

In a rock pool, Satnavri (18-12-64). In Nave lake (8), Sakoli (5-1-69).

C. calosporum Wittr.

In a puddle, Wardha (3-4-65).

C. calosporum Wittr. v. **brasiliense** Borg.

In a pond, Umred (30-11-64).

C. cornu Ehrenb.

In a streamlet, Satnavri (18-10-64). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

The Yeotmal alga agrees with form *alfa* of Croasdale (1955).

C. cornu Ehrenb. v. **upsaliense** Nordst.

In a pond, Umred (30-11-64).

C. cynthia De Not

In a pond, Umred (13-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69). Striations 6-8 in 10 μ .

C. dianae Ehrenb.

In a pond, Umred (30-11-64). In a lake (8.2), Dahegaon (27-12-64). In Vadali lake, Amravati (3-3-65). In Abkari lake (7.2), Bhandara (29-12-68). In a pond (8.2), Jawahar Nagar (12-1-69). In Mendhe lake (9.5), Bhandara (19-1-69).

C. ehrenbergii Menegh.

In a pond, Umred (30-11-64).

C. gracile Breb.

In bodhans, Amravati (18-10-64). In Zarpal stream, Chandrapur (1-11-65).

C. idiosporum West et West

In a lake (8), Yeotmal (24-11-68).

C. incurvum Breb.

In a streamlet, Satnavri (18-10-64). In Vadali lake, Amravati (18-10-64, 3-3-65). In a lake (7.2), Sakoli (14-1-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. jenneri Ralfs

In a streamlet, Satnavri (18-10-64). In a pond (8.2), Dahegaon (27-12-67). In Mendhe lake (9.5), Bhandara (19-1-69).

C. jenneri Ralfs v. **tenue** Croasdale

In a pond, Umred (30-11-64). In Mendhe lake (9.5), Bhandara (19-1-69).

C. kuetzingii Breb.

In a pond, Umred (30-11-64).

C. lanceolatum Kuetz.

In a pool, Satnavri (18-10-64). In bodhans, Amravati (18-10-64). In ponds, Umred (30-11-64).

C. leibleinii Kuetz.

In puddles, Mansar (13-12-64).

C. libellula Focke

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. lineatum Ehrenb.

In a pond, Mansar (13-12-64).

C. littorale Gay

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara

(28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. macilentum Breb.

In Sarkari lake (7.2), Tumsar (22-12-68). In Gaon lake (7.2), Sakoli (5-1-69).

C. parvulum Naeg.

In a streamlet, Satnavri (18-10-64). In a pond, Umred (30-11-64). In Ramala lake, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

C. setaceum Ehrenb.

In a pond, Umred (30-11-64).

C. sinense Lutkem.

In a streamlet, Satnavri (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. tumidulum Gay

In Vadali lake, Amravati (3-3-65, 18-10-69). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

C. tumidum Johnson

In a pond, Mansar (13-12-64).

C. venus Kuetz.

In a pond, Mansar (13-12-64). In a pond (8), Jawahar Nagar (12-1-69).

C. venus Kuetz. v. **incurvum** (Breb.) Krieger

In Vadali lake, Amravati (3-3-65).

Cosmarium abbreviatum Racib.

In Nave lake (9.5), Bhandara (19-1-69).

C. abbreviatum Racib. f. **pygmaea** Messik.

In Vadali lake, Amravati (18-10-64, 3-3-65).

C. amoenum Breb.

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68).

C. angulosum Breb. v. **concinuum** (Rabenh.) West et West

In a pond (8), Jawahar Nagar (12-1-69).

C. auriculatum Reinsch

In a pool, Satnavri (18-10-64). In Vadali lake, Amravati (18-10-64). In Zarpal stream, Chandrapur (1-11-65). In ponds, Mansar (10-12-65). In Sar-

kari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

Cells slightly shorter up to 48 μ long and cell wall finely punctate.

C. bengalense (Grun.) Turn.

In a pond, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

Bhandara alga is slightly bigger—up to 49 μ broad, 82 μ long.

C. biloculatum Breb. v. **subpunctulatum** Krieger et Gerloff

In a pond, Umred (30-11-64). In Nave lake (9.5), Bhandara (19-1-69).

C. binum Nordst.

In a pond, Umred (30-11-64).

C. botrytis Menegh.

Rare. In Vadali lake, Amravati (3-3-65).

C. ceylanicum West et West f. **minus** Scott et Prescott

In a pond, Mansar (13-12-64).

C. connatum Breb.

In paddy fields, Amravati (18-10-64).

C. contractum Kirchn.

In a pond, Umred (30-11-64).

C. contractum Kirchn. f. **jacobsenii** (Roy) West et West

In paddy fields, Amravati (18-10-64). In ponds, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. contractum Kirchn. v. **ellipsoideum** (Elfv.) West et West

In Vadali lake, Amravati (18-10-64). In a pond, Mansar (13-12-64).

C. contractum Kirchn. v. **minutum** (Delp.) West et West

In a pond, Mansar (13-12-64).

C. contractum Kirchn. v. **norvegicum** Racib.

In a pond (8), Jawahar Nagar (12-1-69).

C. cucurbitinum (Biss.) Lutkem.

In a pond, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. cucurbitinum (Biss.) Lutkem. v. **grande** Gronbl.

In paddy fields, Amravati (18-10-64).

C. depressum (Naeg.) Lund v. **intermedium** (Gutw.) Messik.

In the scum on submerged stones in Kapsi lake (8.2), Akola (18-10-68).

The cells much smaller, 21-25 μ broad, 22-27 μ long, isthmus 6-7 μ broad.

C. difficile Lutkem. v. **dialatum** Borge

In ponds, Mansar (13-12-64).

C. dispersum Johnson

In Abkari lake (7.5), Bhandara (29-12-68).

Cells slightly broader.

C. dispersum Johnson v. **truncatum** (West et West) Krieger et Gerloff

In Abkari lake (7.5), Bhandara (22-11-68).

C. dubicum Borge

In Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. dybowskii Gutw.

In Mendhe lake (9.5), Bhandara (19-1-69).

C. elegantissimum Lund f. **minor** West

In ponds, Mansar (13-12-64).

C. exiguum Arch.

In a pond, Umred (30-11-64).

C. freemanii West et West

In a pond, Umred (30-11-64).

C. furcatospermum West et West v. **koreana** Skv.

In cement cisterns, Amravati (18-10-64).

C. fuscescens Hirano

In a pond, Mansar (13-12-64). In scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68).

Present alga is bigger than the type — 13-15 μ broad, 10-20 μ long.

C. garrolense Roy et Biss. v. **crassum** Jao

In paddy fields, Amravati (18-10-64).

C. granatum Breb.

In Vadali lake, Amravati (18-10-64).

C. hammeri Reinsch v. **homaloderum** (Nordst.) West et West

In Mendhe lake (9.5), Bhandara (19-1-69).

C. hammeri Reinsch v. **protuberans** West et West

In Vadali lake, Amravati (18-10-64).

C. impressulum Elfv.

In Vadali lake, Amravati (18-10-64). In Zarpat stream, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

C. impressulum Elfv. v. **octangularis** Hirano

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. inconspicuum Arch.

In Vadali lake, Amravati (18-10-64).

C. infirmum Gronbl. v. **minus**

(Gronbl.) Krieger et Gerloff

In a pond (8), Jawahar Nagar (12-1-69).

C. laeve Rabenh.

In Vadali lake, Amravati (18-10-64). Adhering to the rocks near Gandhi ghat, Pavnar (27-10-64). In a pond, Umred (30-11-64).

C. laeve Rabenh. v. **depressum** Croasdale

In Vadali lake and nearby paddy fields, Amravati (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68).

The alga is sometimes slightly bigger, 10.5-10.8 μ broad, 14.5-15 μ long. It agrees well with the figures given by Croasdale (1956) but not with the figures given by Krieger and Gerloff (1969), pl. 44, f. 7a) though the figures are reproduced from Croasdale, the sinus being shown differently.

C. lagenarioides (Roy) Lutk.

In Mendhe lake (9.5), Bhandara (19-1-69).

C. lunatum Wolle v. **sparsum** (Turn.) Krieger et Gerloff

In a pond, Mansar (13-12-64).

The present alga is bigger in size, 40-42 μ broad, 28-29 μ long, isthmus 10-10.5 μ broad.

C. lundellii Delp. v. **circulare** (Reinsch) Krieger

In Vadali lake, Amravati (3-3-65). In the scum on the submerged stones

in Kapsi lake (8.2), Akola (16-10-68).

C. lundellii Delp. v. **corruptum** (Turn.) West et West

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. lundellii Delp. v. **ellipticum** West

In a pond, Mansar (13-12-64). In Nave lake (9.5), Bhandara (19-1-69). In Nave lake (8), Sakoli (12-1-69). In a pond (8), Jawahar Nagar (12-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. maculatum Turn.

In a pond, Umred (21-11-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. mansangense West et West

In Sarkari lake (7.2), Tumsar (22-12-68).

C. margaritatum (Lund) Roy et Bisset

In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In a pond (8), Jawahar Nagar (12-1-69).

C. margaritatum (Lund) Roy et Bisset f. **minor** (Boldt) West et West

In a pond, Umred (30-11-64). In a pond (8), Jawahar Nagar (12-1-69). In Mendhe lake (9.5), Bhandara (19-1-69).

C. moniliforme (Turp.) Ralfs v. **pan-duriforme** (Heimerl) Schmidle

In Abkari lake (7.5), Bhandara (29-12-68).

C. nymannianum Grun.

In a pond (8.2), Dahegaon (27-12-64).

C. nymannianum Grun. v. **brevis** (Wille) Krieger et Gerloff

In a pond, Umred (30-11-64).

C. obsoletum (Hantzsch) Reinsch v. **sitvense** Gutw.

In a pond, Umred (30-11-64).

C. obtusatum Schmidle

In a dam, Pavnar (27-10-64). In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

C. orthostichum Lund

In a lake (8), Yeotmal (24-11-68).

C. orthostichum Lund f. **subpolonica** Messik.

In a lake (8), Yeotmal (24-11-68).

C. phaseolus Breb. v. **achondrum** Boldt

In Sarkari lake (7.2), Tumsar (22-12-68).

C. polonicum Racib.

In Sarkari lake (7.2), Tumsar (22-12-68).

C. polygonum (Naeg.) Arch.

In a pond, Mansar (13-12-64).

C. portianum Arch.

In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. portianum Arch. v. **nephroideum** Wittr.

In Vadali lake, Amravati (18-10-64, 20-10-69).

C. pseudadoxum Jao

In Chattri lake, Amravati (18-10-64).

C. pseudoconnatum Nordst.

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. pseudohexagonoides Bruhl et Biswas

On the stone wall of Vadali, Amravati (18-10-64).

C. pseudopyramidatum Lund

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. pseudopyramidatum Lund v. **borgei** Krieger et Gerloff

In Abkari lake (7.5), Bhandara (29-2-68). In Sarkari lake (7.2), Tumsar (22-12-68).

C. pseudopyramidatum Lund v. **car-niolicum** Lutk.

In a lake (7.5), Tumsar (22-12-68). In a pond (8), Jawahar Nagar (12-1-69).

C. pseudopyramidatum Lund v. **lenti-ferum** Taylor

On submerged soil in Vena dam (1-2-69).

C. pseudopyramidatum Lund v. **rot-undatum** Krieger et Gerloff

In Painganga river (8.5), Mehkar (20-10-68).

C. pyramidatum Breb.

In paddy fields, Amravati (18-10-64). In a lake (8.2), Dahegaon (27-12-64). In Vadali lake (9), Amravati (18-10-69).

C. pyramidatum Breb. v. **convexum** Krieger et Gerloff

In Vadali lake (9), Amravati (18-10-69).

C. quadratum (Gay) De Toni

In a dam, Pavnar (27-10-64).

C. quadratum Ralfs

In Ramsagar lake (7.2), Tiroda (2-2-69).

Krieger and Gerloff (1969) include *C. quadratum* f. *major* Irene Marie in *C. quadratum*. The present alga agrees with f. *major* in size.

C. quadratum Ralfs f. **willei** West et West

In Vadali lake, Amravati (3-3-65).

C. quadrum Lund

In Mendhe lake (9.5), Bhandara (19-1-69).

C. quinarium Lund

In Nave lake (9.2), Bhandara (19-1-69).

C. ralfsii Breb. v. **alpinum** Racib.

In Vadali lake, Amravati (18-10-64).

C. ralfsii Breb. v. **montanum** Racib.

In a pond, Umred (30-11-64).

C. rectangulare Grun. v. **africanum** West et West

In a pond, Umred (30-11-64).

C. regnellii Wille

In a lake (8.2), Dahegaon (27-12-64).

C. regnellii Wille v. **kerguelense**

Krieger et Gerloff

In paddy fields, Amravati (18-10-64).

C. reniforme (Ralfs) Arch.

In a pond (8), Jawahar Nagar (12-1-69).

C. repandum Nordst. f. **minor** West et West

In Nave lake (8), Sakoli (5-1-69).

C. retusiformae (Wille) Gutw.

In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. sexangulare Lund

In Vadali lake (9), Amravati (18-11-68).

C. sexangulare Lund f. **minimum** Nordst.

In Vadali lake (9), Amravati (18-11-68). In Abkari lake (7.5), Bhandara (25-11-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. sikhimense Turn.

In the mucilaginous mass of *Gloetrichia* sp. floating in Vadali lake, Amravati (18-10-64).

C. speciosum Lund v. **incrassatum** Insam et Krieger

In a pond (8), Jawahar Nagar (12-1-69).

The present alga differs from the type in having rounded apex as shown by Croasdale (1956).

C. striolatum Naeg. v. **nordstedtii** (Moeb.) Krieger

In ponds, Umred (30-11-64).

C. subacutangulum Gronbl.

In a pond (8), Jawahar Nagar (12-1-69).

C. sublatere-undateim West et West

In a pond, Umred (30-11-64).

C. subreinschii Schmid v. **ocellatum** West et West

In Vadali lake, Amravati (3-3-65).

C. subtransiens Croasdale

In Ramsagar lake (7.2), Tiroda (2-2-69).

The alga differs from the type in having 12 undulations instead of 10.

C. subtumidum Nordst.

In Vadali lake (9), Amravati (18-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

C. subtumidum Nordst. f. **minor**

Krieger

In Vadali lake, Amravati (18-10-64).

C. subtumidum Nordst. v. **rotundum** Hirano

In a pond (8), Jawahar Nagar (12-1-69).

C. supraconnatum (Turn.) Krieger et Gerloff

In Abkari lake (7.5), Bhandara (29-11-68).

- C. striolatum** Naeg.
In Nave lake (9.5), Bhandara (19-1-69).
- C. trachydermum** West et West
In a streamlet, Satnavri (18-10-64).
- C. trachypleurum** Lund v. **nordstedtii** Gutw.
In Ramsagar lake (7.2), Tiroda (2-2-69).
- C. trafalgaricum** Wittr.
In a cement water passage in a garden, Wardha (12-3-68).
- C. trilobatum** Reinsch v. **printzii** Messik.
In a pond, Umred (30-11-64).
Umred alga agrees with Skuja's Westonian island form (Hirano 1957).
- C. triplicatum** Wolle
In Sarkari lake (7.2), Tumsar (22-12-68).
- C. tryolicum** (Nordst.) Krieger et Gerloff
In Vadali lake (9), Amravati (18-11-68).
- C. tuddalense** Strom
In Nave lake (8), Sakoli (5-1-69).
- C. tumidum** Lund
In Ramsagar lake (7.2), Tiroda (2-2-69).
- C. undulatum** Corda ex Ralfs
In a pond, Umred (30-11-64).
- C. undulatum** Corda ex Ralfs v. **crenulatum** (Naeg.) Wittr.
In a pool, Wardha (27-10-64).
- C. undulatum** Corda ex Ralfs v. **minutum** Wittr.
In Vadali lake, Amravati (18-10-64). In a dam, Pavnar (27-10-64). In Abkari lake (7.5), Bhandara (29-12-68). In a pond (8), Jawahar Nagar (12-1-69).
- C. undulatum** Corda ex Ralfs v. **wollei** W. West
In Ramsagar lake (7.2), Tiroda (2-2-69).
- C. variolatum** Lund v. **rotundatum** (Krieger) Messik.
In a pond (8.5), Bhandara Road (19-1-69).
- C. venustum** (Breb.) Arch. v. **brevis** Bernard
In a pool, Satnavri (18-10-64).
- C. virde** (Corda) Josh. f. **minor** W. West
In small ponds, Wardha (27-10-64).
- C. virde** (Corda) Josh. v. **hibernicum** (W. West) Krieger et Gerloff
In Nave lake (9.5), Bhandara (19-1-69).
- C. wittrockii** Lund
In Vadali lake, Amravati (18-10-64).
- Euastrum bidentatum** Naeg.
In a pond, Umred (30-11-64).
- E. binale** (Turp.) Ehrenb. v. **korcana** (Skv.) Okada
In a pond, Umred (30-11-64).
- E. binale** (Turp.) Ehrenb. v. **sectum** Turn.
In a lake (8.2), Dahegaon (27-12-64).
- E. ceylanicum** (West et West) Krieger
In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69).
- E. denticulatum** (Kirchn.) Gay
In a lake, Mansar (13-12-64).
- E. divergens** Josh. v. **ornatum** (Borge) Schm.
In Abkari lake (7.5), Bhandara (28-12-68).
- E. elegans** (Breb.) Kuetz. v. **pseudelegans** (Turn.) West et West
In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65).
- E. inerme** (Ralfs) Lund
In Ramsagar lake (7.2), Tiroda (2-2-69).
- E. insulare** (Wittr.) Roy
In Vadali lake (9), Amravati (18-11-68). In Abkari lake (7.5), Bhandara (29-11-68). In a pond (8), Jawahar Nagar (12-1-69).
- E. irregulare** Gonz. et Gang.
In a puddle, Satnavri and in Vadali lake, Amravati (18-10-64). In pools near a dam, Pavnar (27-10-64).
- E. turneri** West
In Abkari lake (7.5), Bhandara (29-11-68).

E. lutkemuelleri Duc. v. **carniolicum** (Lutkem.) Krieger

In a pool, Mansar (13-12-64).

E. platycerum Reinsch

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

E. spinulosum Delp.

Common in Vadali lake, Amravati (18-10-64, 3-3-65, 18-11-68). In a pond, Umred (30-11-64). In puddles, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (29-11-68). In Nave lake (8), Sakoli (5-1-69). In a pond (8), Jawahar Nagar (12-1-69). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

E. spinulosum Delp. v. **bellum** Scott et Prescott

In a pond (8), Jawahar Nagar (12-1-69).

E. subamoenum Schmidle

In Abkari lake (7.5), Bhandara (28-12-68).

E. sublobatum Breb.

In Vadali lake, Amravati (3-3-65).

E. sublobatum Breb. v. **obtusatum** (Gutw.) Krieger

In ponds, puddles, Mansar (13-12-64). In Vadali lake, Amravati (3-3-65).

E. turneri West

In Abkari lake (7.5), Bhandara (9-11-68).

Micrasterias crux-melitensis

(Ehrenb.) Hass.

In Sarkari lake (7.2), Tumsar (22-12-68).

M. foliacea Bailey

In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

M. mahabuleshwariensis Hobs. v.

chauliodon Scott et Prescott

Very rare. In a pond, Mansar (13-12-64).

M. pinnatifida (Kuetz.) Ralfs

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

M. pinnatifida (Kuetz.) Ralfs v. **pseudoscitans** Gronbl.

In Sarkari lake (7.2), Tumsar (22-12-68).

M. radians Turn.

In ponds, Umred (30-11-64), Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-11-68).

M. zeylanica Fritsch

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (28-12-68).

M. zeylanica Fritsch v. **rectangularis** Scott et Prescott

In Abkari lake (7.5), Bhandara (28-12-68).

Xanthidium antilopaeum (Breb.)

Kuetz. v. **canadense** Joshua

In a pond, Mansar (13-12-64).

The present alga is smaller than the type—30-34 μ broad, 40-44 μ long, isthmus 20-21 μ broad.

X. antilopaeum (Breb.) Kuetz. v. **hebridarum** West et West

In a pond, Mansar (13-12-64).

X. burkillii West et West v. **alternans** Skuja

In a pond, Mansar (13-12-64).

X. hastiferum Turn.

In a pond, Mansar (13-12-64).

Arthrodesmus convergens Ehrenb.

In ponds, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Zygotes are present in Mansar alga. They are spherical to ellipsoidal with smooth, thick outer wall, 29-31 μ in diameter, 30-34 μ long.

A. curvatus Turn.

In a pond, Mansar (13-12-64).

A. curvatus Turn. v. **latus** Scott et Prescott

In a pond, Umred (30-11-64). In Nave lake (8), Sakoli (5-1-69).

Staurastrum anatinum Cooke et

Wille v. **curtum** Smith

In a Gaon lake (7.2), Sakoli (5-1-69).

S. arcuatum Nordst.

In a pond, Mansar (13-12-64).

S. brebissonii Arch. v. **truncatum** Gronbl.

In Abkari lake (7.5), Bhandara (28-12-68).

- S. brevispinum** Breb. v. **retusum** Smith
In Vadali lake, Amravati (18-10-64).
- S. dejectum** Breb.
In ponds, Umred (30-11-64), Mansar (13-12-64). In Abkari lake (7.5), Bhandara (28-12-68).
- S. dickiei** Ralfs
In a pond, Mansar (13-12-64).
- S. gladiosum** Turn.
In a pond, Umred (30-11-64).
- S. gracile** Ralfs
In Ramsagar lake (7.2), Tiroda (2-2-69).
- S. hantzii** Reinsch v. **japonicum** Roy et Bisset
In a pond, Mansar (13-12-64).
- S. indentatum** West et West f. **minus** Scott et Prescott
In a pond, Umred (13-12-64).
- S. iotantum** Wolle v. **longatus** Hirano
In a pond, Mansar (13-12-64).
- S. iotantum** Wolle v. **tortum** Teiling
In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).
- S. leptodermum** Lund v. **capitatum** Hirano
In ponds, Mansar (13-12-64).
- S. longispinum** (Bail.) Arch. v. **bidetatum** (Wittr.) West
In a pond, Mansar (13-12-64).
- S. megacanthum** Lund
In a pond, Mansar (13-12-64).
- S. orbiculare** Ralfs
In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In Ramsagar lake (7.2), Tiroda (2-2-69).
- S. orbiculare** Ralfs. v. **depressum** Roy et Bisset
In Vadali lake, Amravati (18-10-64). In Nave lake (9.5), Bhandara (19-1-69).
- S. orbiculare** Ralfs v. **ralfsii** West et West
In Sarkari lake (7.2), Tumsar (22-12-68).
- S. perundulatum** Gronbl.
In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68).
- S. pinnatum** Turn. v. **subpinnatum** (Schm.) West et West f. **robustum** Krieg.
In a pond, Umred (30-11-64).
- S. polymorphum** Breb. v. **pygmaeum** Gronbl.
In Abkari lake (7.5), Bhandara (28-12-68).
- S. punctulatum** Breb.
In puddles, Umred (30-11-64). In Vadali lake, Amravati (3-3-65).
- S. quadricornutum** Roy et Bisset
Rare. In Vadali lake, Amravati (3-3-65).
- S. retusum** Turn. v. **boreale** West et West
In Vadali lake, Amravati (3-3-65).
- S. saltans** Josh. v. **javanicum** Scott et Prescott
In a pool, Umred, (30-11-64).
- S. sexangulare** (Bulnh.) Lund
In a pond, Umred (30-11-64).
- S. sexangulare** (Bulnh.) Lund v. **crassum** Turn.
In a pond, Umred (30-11-64).
- S. tohopekaligense** Wolle
In a pool, Mansar (13-12-64).
- S. tohopekaligense** Wolle v. **insigne** West et West
In puddles, Mansar (13-12-64).
- S. unguiferum** Turn.
In ponds, Umred (30-11-64), Mansar (13-12-64).
- Sphaerosozoma punctatum** West et West
In a pond, Umred (30-11-64).
- S. vertebratum** (Breb.) Ralfs
In ponds, Umred (30-11-64).
- Spondylosium nitens** (Wall.) Arch. f. **majus** Turn.
In a pond, Umred (30-11-64).
- S. planum** (Wolle) West et West
In ponds, Umred (30-11-64), Mansar (13-12-64).
- Onychonema laeve** Nordst. v. **latum** West et West
In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
- O. laeve** Nordst. v. **micracanthum** Nordst.
In a pond, Umred (30-11-64).

- Hyalotheca dissiliens** (Smith) Breb.
In Vadali lake, Amravati (3-3-65).
- H. indica** Turn.
In Ramsagar lake (7.2), Tiroda (2-2-69).
- H. mucosa** (Mert.) Ehrenb.
In a pond, Umred (30-11-64).
- H. undulatum** Nordst.
Rare. In Vadali lake, Amravati (13-12-64).
- Desmidium aptogonum** Breb.
In Vadali lake, Amravati (3-3-65).
- D. aptogonum** Breb. v. **ehrenbergii** Kuetz.
In paddy fields, Amravati (18-10-64). In Ramala lake, Chandrapur (1-11-64). In Nave lake (9.5), Bhandara (19-1-69).
- D. pseudostreptonema** West et West
Common in ponds, Umred (30-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
Aplanospores are observed in material from Ramsagar lake. They are globose, 16 μ broad, with smooth wall.
- D. quadratum** Nordst.
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Streptonema trilobatum** Wall.
In ponds, Umred (30-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
Zygotes are observed in Ramsagar material. Zygotes are 33-35 μ broad, 50-53 μ long, ellipsoid in shape and with smooth walls.
- Mougeotia bangloreensis** Iyengar
In paddy fields, Vadali lake, Amravati (18-10-64).
Aplanospores are also present.
- M. calcarea** (Cleve) Witt.
In a puddle, Amravati (18-10-64).
- M. floridana** Transeau
In Kapsi lake (8.2), Akola (16-10-68).
- M. maltae** Skuja
In Ramsagar lake (7.2), Tiroda (2-2-69).
- M. microspora** Taft
In a pond, Mansar (13-12-64).
- M. reinschii** Transeau
In a pond, Amravati (18-10-64).
- M. sphaerocarpa** Wolle
In Sarkari lake (7.2), Tumsar (22-12-68).
- M. transeau** Collins
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Zygnema czurdae** Randhawa
In Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
- Z. gangeticum** Rao
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Z. globosum** Czurda
In Vadali lake, Amravati (3-3-65).
- Zygnemopsis minuta** Randhawa
In Vadali lake, Amravati (3-3-65).
The present alga is provisionally kept here as the zygospores and azygospores differ from the type in having smooth walls and horned zygospores not observed.
- Z. sphaerospora** Randhawa
In Abkari lake (7.5), Bhandara (29-12-68).
Vegetative cells bigger—up to 21 μ broad, 150 μ long.
- Spirogyra azygospora** R. N. Singh
In Khamb lake (8), Tiroda (2-2-69).
- S. bichromatophora** (Randhawa) Transeau
In Kapsi lake (8.2), Akola (16-10-68).
- S. bififormis** Jao
In a pond, Wardha (12-3-68).
Lateral conjugation only observed.
- S. corrugata** Transeau
In Ramsagar lake (7.2), Tiroda (2-2-69).
- S. diluta** Wood
In a streamlet, Satnavri (18-10-64).
- S. fennica** Cedercreutz
In Ramsagar lake (7.2), Tiroda (2-2-69).
Chloroplast makes four turns.
- S. fuellebornei** Schmidle
In a dam, Pavnar (27-10-64).
- S. smithii** Transeau
In Zarpal stream, Chandrapur (1-11-65).
- S. weberi** Kuetz.
In paddy fields, Amravati (18-10-64).

EUGLENOPHYCEAE

Euglena acus Ehrenb.

In bodhans, Chandrapur (1-11-65).

In a pond, Umred (30-11-66).

E. acus Ehrenb. v. **hyalina** Klebs

In a gutter, Khamgaon (13-10-67).

E. acus Ehrenb. v. **oyei** Defl.

In a bodhan, Amravati (18-10-64).

E. acus Ehrenb. v. **rigida** Hubner

In a foul smelling pool, Chandrapur (1-11-65).

E. allorgei Defl.

In a bodhan, Akola (10-10-68).

E. caudata Hubner

In a bodhan, Akola (18-10-68).

E. charkowiensis Swir.

In a pool near a gutter, Chandrapur (1-11-65). In a bodhan, Akola (16-10-68). In Mendhe lake (9.5), Bhandara (19-1-69).

E. charkowiensis Swir. v. **minor** Skovortz.

In Zarpat stream, Chandrapur (1-11-65).

E. chortes Schiller

In a pond, Umred (30-11-64). In Nursery pond (8), Bhandara (28-12-68).

E. gaumeri Allorge et Lefevre

In a bodhan, Amravati (18-10-64).

E. gracilis Klebs

In a bodhan, Umred (30-11-64). In a pool, Khamgaon (13-10-67).

E. ignobilis L. P. Johnson

In a bodhan, Akola (16-10-68).

E. limnophila Lemm.

In a pool, Satnavri (18-10-64).

E. mucifera Mainx

In a pond, Umred (30-11-64).

E. multiformis Schiller

In a bodhan (8.4), Akola (16-10-68).

E. oxyuris Schmarda

In a pond, Umred (30-11-64). In a gutter, Khamgaon (13-10-67).

E. pusilla Playfair

In a pond, Umred (30-11-64).

E. spirogyra Ehrenb.

In a pond, Umred (30-11-64).

E. spirogyra Ehrenb. v. **suprema** Skuja

In a puddle, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

E. tripteris (Duj.) Klebs

In a puddle, Umred (30-11-64).

Phacus acuminatus Stokes v. **indica** (Pochm.) Huber-Pestalozzi

In a bodhan, Amravati (18-10-64).

In a pool, Umred (30-11-64).

P. acuminatus Stokes v. **variabilis** Lemm.

In bodhans, Amravati (18-10-64).

Umred (30-11-64), Mansar (13-12-64).

P. angulatus Pochm.

In Nursery pond (8), Bhandara (28-12-68).

P. caudatus Hubner

In a pond, Umred (30-11-64).

P. circumflexus Pochm.

In a pond, Umred (30-11-64).

P. contortus Bourr.

In a puddle, Umred (30-11-64).

P. curvicauda Swir.

In bodhans, Amravati (18-10-64), Wardha (27-10-64), Umred (30-11-68).

P. sphippion Pochm.

In Ramala lake, Chandrapur (1-11-65).

P. longicauda (E.) Duj. v. **major** Swirenko

In a pool, Umred (30-11-64).

P. longicauda (E.) Duj. v. **rotunda** (Pochm.) Huber-Pestal.

In bodhans, Amravati (18-10-64), Chandrapur (1-11-64), Akola (16-10-68). In Ramala lake, Chandrapur (11-10-68). In Sarkari lake (7.2), Tumsar (22-12-68).

P. mangini Lef.

In a bodhan, Akola (16-10-68).

P. minutus (Playf.) Pochm.

In a pool, Satnavri (18-10-64). In Khamb lake (9), Bhandara (28-12-68).

P. orbicularis Hubn.

In a pond, Umred (30-11-64). In Januna lake (8.2), Khamgaon (13-10-67). In Mendhe lake (9.5), Bhandara (19-1-69).

- P. pekinensis** Skvortz.
In Januna lake (8.2), Khamgaon (13-10-67).
- P. platatea** Drez.
In bodhans, Amravati (18-10-64), Umred (30-11-64), Mansar (13-12-64), Akola (16-10-68), Bhandara (22-12-68). In Nursery pond (8), Bhandara (28-12-68).
- P. pleuronectes** (O.F.M.) Duj.
In Motha lake, Umred (30-11-64).
- P. pseudonordstedtii** Pochm.
In a puddle, Umred (30-11-64).
- P. stokesii** Lemm. f. *minor* Conrad
In a pond, Wardha (27-10-64).
- P. swirenkoi** Ekvortz.
In a pool, Wardha (27-10-64).
- P. thrombus** Pochm.
In a pool, Umred (30-11-64).
- P. tortus** (Lemm.) Skv.
In a bodhan, Amravati (18-10-64). In Nursery pond (8), Bhandara (28-12-68).
- Trachelomonas allia** Drez. em. Defl.
In a streamlet, Satnavri (18-10-64). In a pond, Umred (30-11-64). In Mendhe lake (9.5), Bhandara (19-1-69).
- T. armata** (E.) Stein
In a pond, Umred (30-11-64).
- T. armata** (E.) Stein v. *longispina* Playf.
In a puddle, Umred (30-11-64).
- T. armata** (E.) Stein v. *steinii* Lemm. em. Defl.
In Vadali lake, Amravati (18-10-64). In a streamlet, Satnavri (6-12-64). In a puddle, Mansar (13-12-64). In Nursery pond (8), Bhandara (28-12-68).
- T. bacillifera** Playf.
In a bodhan, Chandrapur (1-11-65).
- T. bacillifera** Playf. v. *minima* Playf.
In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).
- T. bernardinensis** W. Vischer em. Defl.
In a bodhan, Akola (16-10-68).
Tests bigger—22 to 26 μ broad, 55 to 58 μ long.
- T. conica** Playf.
In Ramala lake, Chandrapur (1-11-64).
- T. cylindrica** E. sec. Playf. v. *decolata* Playf.
In a bodhan, Amravati (18-10-64).
- T. dubia** Swir. em. Defl. v. *lata* Defl.
In a puddle, Mansar (13-12-64).
- T. dybowskii** Drez.
In a pond (8.5), Bhandara Road (19-1-69).
- T. globularis** Lemm. (Awer.) v. *boyeri* (Palmer) Conr.
In a pond, Mansar (13-12-64). In Abkari lake (7.5), Bhandara (28-12-68).
- T. hispida** (Perty) Stein em. Defl.
In paddy fields, Amravati (18-10-64). In Vadali lake, Amravati (18-10-64, 3-3-65). In bodhans, Chanda (1-11-64), Umred (30-11-64), Mansar (13-12-64), Malegaon (16-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).
- T. hispida** (Perty) Stein em. Defl. f. *recta* Defl.
In Abkari lake (7.5), Bhandara (29-12-68).
- T. hispida** (Perty) Stein em. Defl. v. *coronata* Lemm.
In paddy fields, Amravati (18-10-64).
- T. incertissima** Defl.
In bodhans, Amravati (18-10-64). In Vadali lake, Amravati (3-3-65).
- T. intermedia** Dangeard
In a pond, Mansar (13-12-64). In a pond (8.5), Bhandara Road (19-1-69).
- T. klebsii** (Klebs) Defl.
In Vadali lake, Amravati (3-3-65). In bodhans, Akola (10-10-68). In Khamb lake (9), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).
- T. lacustris** Drez.
In a bodhan, Malegaon (11-10-68). In Sarkari lake (7.2), Tumsar (22-12-68).

T. mangini Defl.

In Nursery pond (8), Bhandara (28-12-68).

T. mucosa Swir. v. *hyalina* Skv.

In a bodhan, Chandrapur (1-11-65).

T. oblonga Lemm.

In a bodhan, Akola (16-10-68). In a pool, Malegaon (20-10-68). In a bodhan, Mansar (20-11-68). In Khamb lake (9), Bhandara (28-12-68). In a pond (8.5), Bhandara Road (19-1-69).

T. oblonga Lemm. v. *australica* Playf.

In a bodhan, Chandrapur (1-11-64). In a pond, Mansar (13-12-64).

T. oblonga Lemm. v. *major* Kamat

In a pond, Umred (30-11-64).

T. oblonga Lemm. v. *truncata* Lemm.

In a bodhan, Warora (2-11-65). In a pond, Mansar (12-11-67).

T. obtusa Palmer

In a pond, Umred (30-11-64).

T. perforata Awering

In Nursery pond (8), Bhandara (28-12-68).

T. piscatoris (Fischer) Stokes

In a bodhan, Chandrapur (1-11-65.)

T. playfairi Defl.

In ponds, Umred (30-11-64).

T. pulcherrima Playf. v. *minor* Playf.

In a bodhan, Amravati (18-10-64). In a pond, Mansar (13-12-64).

T. raciborskii Wolosz.

In Abkari lake (7.5), Bhandara (19-12-68).

T. robusta Swir. em. Defl.

In Mendhe lake (9.5), Bhandara (19-1-69).

T. scabra Playf.

In a bodhan, Amravati (18-10-65).

T. scabra Playf. v. *ovata* Playf.

In bodhans, Amravati (18-10-64).

T. similis Stokes

In Nursery pond (8), Bhandara (28-12-68).

T. superba Swir. em. Defl.

In Sarkari lake (7.2), Tumsar (22-12-68).

T. sydneyensis Playf.

In Abkari lake (7.5), Bhandara (29-12-68).

T. varians Defl.

In a pond, Umred (30-11-64). In Nursery pond (8), Bhandara (28-12-68).

T. volvocina Ehrenb.

In bodhans, Amravati (18-10-64), Wardha (22-10-64), Umred (30-11-64), Mansar (13-12-64), Chandrapur (1-11-65), Gondia (5-3-67), Khamgaon (13-10-67). In Nursery pond (8), Bhandara (28-12-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69). In a pond (8.5), Bhandara Road (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

T. volvocina Ehrenb. f. *minuta* Fritsch

In a bodhan, Amravati (18-10-64).

T. volvocina Ehrenb. v. *derephora* Conrad

In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

T. volzii Lemm. v. *cylindrica* Playf.

In a pond, Umred (30-11-64).

T. volzii Lemm. v. *pellucida* Playf.

In pools, Umred (30-11-64).

T. wermelii Skv.

In Nursery pond (8), Bhandara (28-12-68).

T. woycickii Koczwar v. *bombayensis* Kamat

In a pond, Mansar (13-12-64).

T. woycickii Koczwar v. *pusilla* Drez.

In a bodhan, Amravati (18-10-64). **Strombomonas fluviatilis** (Lemm.) Defl.

In Nursery pond (8), Bhandara (28-12-68).

S. maxima (Skv.) Defl.

In a bodhan, Chandrapur (1-11-64).

S. napiformis (Playf.) Defl. v. *brevicollis* (Playf.) Defl.

In Nursery pond (8), Bhandara (28-12-68).

S. ovalis (Playf.) Defl.

In a bodhan, Chandrapur (1-11-65). Wall finely punctuate.

S. urceolata (Stokes) Defl.

In a bodhan, Amravati (3-3-65).

Lepocinclis glabra Drez. f. *minor*
Prescott

In a bodhan, Amravati (18-10-64).

L. marssonii Lemm. em Conrad

In Sarkari lake (7.2), Tumsar (22-

12-68).

Menoidium gracile Playf.

In a puddle, Umred (30-11-64).

Anisonema acus Duj.

In a pond, Mansar (13-12-64).

XANTHOPHYCEAE

Ophiocytium elongatum West et
West

In a puddle, Umred (30-11-64).

Botrydium granulatum (L.) Greville

On the moist soil of a drying

puddle, Satnavri (18-10-64). On moist
soil near a pond, Gondia (5-3-67).

On the moist soil of a drying pool,
Sakoli (15-12-68).

DINOPHYCEAE

Cystodinium iners Geitler

In a pond, Mansar (13-12-64).

Massartia stigmatica (Linden)

Schiller

In Vadali lake, Amravati (3-3-65).

In Ramsagar lake (7.2), Tiroda (2-2-
69).

Gymnodinium neglectum (Schill.)

Lind.

In a puddle, Mansar (13-12-64).

G. rotundum Klebs

Planktonic in Khamb lake (9),
Bhandara (28-12-68).

Glenodinium gymnodinium Penard

Planktonic in a pond (8.2), Katol
(24-11-68).

G. quadridens (Stein.) Schiller

Planktonic in Khamb lake (8),
Tiroda (2-2-69).

Peridinium bipes Stein

In Sarkari lake (7.2), Tumsar (22-
12-68).

P. cinctum (Muell.) Ehrenb.

In Ramala lake, Chandrapur (1-11-
65).

P. palustre (Lindem.) Lef. v. *racibors-
skii* (Wol.) Lef.

In Abkari lake (7.2), Bhandara
(29-11-68).

P. penardiforme Lindem.

In Ramsagar lake (7.2), Tiroda (2-
2-69).

P. pusillum (Penard) Lemm.

In a cement cistern, Amravati (18-
10-64).

CYANOPHYCEAE

Microcystis aeruginosa Kuetz.

Planktonic in a pond (9.2), Tum-
sar (22-12-68). In Nursery pond (8),
Bhandara (28-12-68). In Khamb lake
(8.5), Tiroda (2-2-69).

M. flos-aquae (Wittr.) Kirchn.

Planktonic in ponds, Gondia (5-3-
67), Mehkar (20-10-68), Tumsar (22-
12-68).

Aphanocapsa grevillei (Hass.)

Rabenh.

On stones in pools, Satnavri (18-
10-64). On submerged soil at the
shore of Vena dam (1-2-69).

A. testacea Naeg.

In Ramsagar lake (7.2), Tiroda (2-
2-69).

The alga is free floating and the
cells are spherical and never ellip-
soid as in the type.

Aphanothece castagnei (Breb.)

Rabenh.

In cement cisterns, Khangaon (13-
10-68). In Nave lake (9.5), Bhandara
(28-12-68).

A. heterospora Rabenh.

In Ramsagar lake (7.5), Tiroda (2-
2-69).

A. microscopica Naeg.

Adhering to sides of cement cisterns, Amravati (18-10-64). In Ram-ala lake, Chandrapur (1-11-64). In Nave lake (9.5), Bhandara (19-1-69). In Rasmagar lake (7.2), Tiroda (2-2-69).

A. pallida (Kuetz.) Rabenh.

In Vadali lake and on moist soil, Amravati (18-10-64). In paddy fields, Umred (30-11-64). On moist soil and in ponds, Mansar (13-12-64). On moist soil in a garden, Chandrapur (1-11-65). On moist soil and in cement cisterns, Khamgaon (13-10-67). On moist soil of a drying pool, Akola (16-10-68). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

Firm, globular to elongate, yellowish mucilaginous masses, 3-8 cm broad, were present in large numbers in paddy fields in Umred.

In some collections, cells with sheaths—*Gloeotheca* like cells were present.

Gloeocapsa muralis Kuetz.

Adhering to the sides of a cement cistern, Amravati (18-10-68).

Gloeotheca geoppertiana (Hilse)

Forti

In a cement water passage, Wardha (12-3-68).

G. rupestris (Lyngby.) Born.

In a pool, Khamgaon (13-10-67).

G. samoensis Wille

In a cement cistern, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Chroococcus minor (Kuetz.) Naeg.

In cement cisterns, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. minutus (Kuetz.) Naeg.

In a streamlet, Satnavri (18-10-64). In pools, puddles, Wardha (27-10-64), Khamgaon (13-10-67).

C. minutus (Kuetz.) Naeg. v. **obliteratus** (Richt.) Hansg.

In the scum on the stones submerged in Kapsi lake (8.2), Akola (16-10-68).

C. pallidus Naeg.

In a puddle, Wardha (27-10-64).

C. spelaeus Ercegovic

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turgidus (Kuetz.) Naeg.

In a pond, Wardha (27-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turgidus (Kuetz.) Naeg. v. **maximus** Nygaard

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turicensis (Naeg.) Hansg.

In cement cisterns, Amravati (18-10-64). In a lake (8.2), Dahegaon (27-12-64). In Januna lake (8.2), Khamgaon (13-10-67).

C. westii (W. West) Boye-Pet.

In a lake (8), Yeotmal (27-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69).

Merismopedia elegans A. Br.

In puddles, Wardha (27-10-64), Mehkar (20-10-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

M. glauca (Ehrenb.) Naeg.

In a streamlet, Satnavri (18-10-64). In cement cisterns, Amravati (18-10-64), Wardha (27-10-64). In a pond (8.5), Jawahar Nagar (12-1-69). In a side pool of Vena dam (1-2-69). In Khamb lake (8.5), Tiroda (2-2-69).

M. punctata Meyen

In a dam, Pavnar (27-10-64). In Zarpal stream, Chandrapur (1-11-64). In a pond, Wardha (10-11-65). In Painganga river (8.2), Mehkar (20-10-68). In Nave lake (8), Sakoli (15-12-68).

M. tenuissima Lemm.

In cement cisterns, Amravati (18-10-64).

Colonies usually consisting of 4-8 cells. Cells broader—up to 3 μ broad.

Synechococcus cedrorum Sauv.

In cement cisterns, Amravati (18-10-64).

S. aquatilis Sauv.

In a pool, Amravati (18-10-64).

S. crassa Woronic.

In a cement cistern, Amravati (18-10-64).

S. sallensis Skuja

In a cement cistern, Amravati (18-10-64).

Myxosarcina burmensis Skuja

In Abkari lake (7.5), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

M. spectabilis Geitler

In a pond, Umred (30-11-64).

Chamaesiphon sideriphilus Starm. v. **glabra** C. B. Rao

In a lake (8), Yeotmal (24-11-68).

Calcium impregnation is not present.

Borzia trilocularis Cohn

In cement cisterns, Amravati (18-10-64). Khamgaon (13-10-67).

Spirulina major Kuetz. ex Gomont

In Vadali lake, Amravati (18-10-64). In a pool, Satnavri (18-10-64). In Pavnar dam (27-10-64). In a puddle and in a gutter, Wardha (27-10-64). In Ramala lake, in a pool and in a bodhan, Chandrapur (1-11-64). In a pond, Gondia (5-3-67). In a lake (11), Lonar (24-10-68). In Zarpat stream, Chandrapur (12-10-69). In a lake (8), Yeotmal (24-11-68). In Khamb lake (8.5), Tiroda (2-2-69).

S. meneghiniana Zanard

In a pond, Wardha (27-10-64). In a lake (11), Lonar (24-10-68).

S. princeps West et West

In Sarkari lake (7.2), Tumsar (22-12-68).

S. subsalsa Oerst.

In a rock pool, Wardha (27-10-64).

S. subsalsa Oerst. v. **crassior** Virieux

In a lake (11), Lonar (24-10-68).

Spirals up to 4 μ broad only.

Arthrospira platensis (Nordst.) Gomont

In a lake (8), Yeotmal (24-11-68).

A. tennis Bruhl et Biswas

In a bodhan, Amravati (18-10-64).

Trichomes usually much longer, with 10 spirals.

Oscillatoria agardhii Gom.

In a pond, Gondia (5-3-67).

O. amphibia Ag. ex Gom.

In a dirty water passage, Wardha (27-10-64). In ponds, Mansar (13-12-64), Gondia (5-3-67), Tumsar (22-12-

68). At the shore of a lake (11), Lonar (24-10-68).

O. angusta Koppe

In a streamlet, Satnavri (18-10-64).

O. annae van Goor

In a puddle, Wardha (27-10-64).

O. boryana Bory ex Gom.

In a lake (8), Yeotmal (24-11-68).

O. brevis (Kuetz.) Gom.

In gutters and side pools, Akola (16-10-68), Khamgaon (13-10-67). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. chalybea (Mertens) Gom.

In a pond, Amravati (18-10-64). In a pond (8), Akola (16-10-68). In a lake (11), Lonar (24-10-68).

O. claricentrosa Gardn.

In the mucilaginous masses of other algae in a pond, Umred (30-11-64).

O. cortiana Menegh.

In a gutter, Wardha (27-10-64).

O. cortiana Menegh. v. **minor** Kamat

In a puddle, Chandrapur (1-11-65).

O. decolorata G. S. West

In a pond, Umred (30-11-64).

O. formosa Bory ex Gom.

In a cement cistern, Amravati (18-10-64).

O. geminata Menegh. ex Gom.

In a lake (8.2), Katol (8-12-68).

Trichomes narrower up to 2 μ broad.

O. jasorvensis Vouk

In Ramsagar lake (7.2), Tiroda (2-2-69).

O. mougeotii Kuetz.

In a streamlet, Satnavri (18-10-64).

In a pond and in gutters, Umred (30-11-64). In gutters, Akola (16-10-68), Karanja (17-10-68), Mehkar (22-10-68). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

O. nigro-viridis Thwaites

On moist soil near a gutter, Wardha (12-3-68).

O. okeni Ag. ex Gom.

In Pavnar dam (27-10-64). In a gutter and in Januna lake (8.2), Khamgaon (13-10-67). On the shore of a lake (11), Lonar (24-10-68). In a lake (8), Yeotmal (24-11-68). In

Sarkari lake (7.2), Tumsar (22-12-68).

O. ornata Kuetz. ex Gom. v. *crassa*
C. B. Rao

In a pond, Wardha (27-10-64). In Zarpot stream, Chandrapur (1-11-64). In a pond, Gondia (5-3-67).

O. princeps Vauch.

In a rock pool, Wardha (27-10-64).

O. proboscoidea Gom.

In a bodhan, Satnavri (18-10-64).

In a pool, Wardha (27-10-64).

O. profunda Kirchn.

In a pond, Gondia (5-3-67). On moist soil near Vena dam (1-2-69). In a road side puddle, Tiroda (2-2-69).

O. pseudogeminata G. Schmid

In a puddle, Amravati (18-10-64).

In a streamlet, Satnavri (18-10-64).

O. pseudogeminata G. Schmid f. *longa* Kamat

In a pool, Satnavri (18-10-64). In Zarpot stream, Chandrapur (1-11-64). On moist soil near a pond and in Kapsi lake (8.2), Akola (16-10-68). In a lake (11), Lonar (24-10-68). In Khamb lake (8.5), Tiroda (2-2-69).

Occasionally the trichomes are broader—up to 2.8 μ broad.

O. quadripunctulata Bruhl et Biswas

Embedded in the mucilaginous masses of *Gloeotrichia* sp. in Gaon lake (7.2), Sakoli (5-1-69).

O. quadripunctulata Bruhl et Biswas v. *unigranulata* R. N. Singh

In a streamlet, Satnavri (18-10-64).

O. quadripunctulata Bruhl et Biswas v. *unigranulata* R. N. Singh. f. *ahmedabadensis* Kamat

In paddy fields, Umred (30-11-64). On the shore of Vena dam (1-2-69).

O. raciborskii Wolosz.

In Nursery pond (8), Bhandara (28-12-68).

Trichomes slightly broader—up to 10 μ broad.

O. rubescens D. C. ex Gomont

In gutters, Amravati (18-10-64), Umred (30-11-64), Akola (16-10-68), Mehkar (20-10-68), Yeotmal (24-11-

68). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. schultzei Lemm. v. *cylindrica* Kamat

On moist soil near a pond, Wardha (27-10-64). In Zarpot stream, Chandrapur (1-11-64).

Trichomes slightly broader—up to 3.5 μ broad.

O. simplicissima Gom.

In Sarkari lake (7.2), Tumsar (22-12-68).

O. splendida Grev. ex Gom.

In a pool, Satnavri (18-10-64). In Gaon lake (7.2), Sakoli (7-1-69). In Ramsagar lake (7.2), and Belati pond (7.5), Tiroda (2-2-69).

Belati pond alga is broader—up to 3.6 μ broad.

O. splendida Grev. ex Gom. v. *attenuata* West et West

On moist soil near Vena dam (1-2-69).

O. subuliformis Kuetz. ex Gom.

On drying soil near a lake (11), Lonar (24-10-68).

Trichomes broader—up to 7.5 μ broad.

O. tambi Woron.

In a bodhan, Amravati (18-10-64). In a lake (11), Lonar (24-10-68).

Amravati alga has slightly constricted trichomes while Lonar alga has narrower trichomes (\approx 2.9 μ broad).

O. tenuis Ag. v. *tergestina* Rabenh.

In a lake (8), Yeotmal (24-11-68).

O. ulrichii Prat

Planktonic in a bodhan, Gondia (5-3-67).

Phormidium corium (Ag.) Gom.

In Vadali lake, Amravati (18-10-64). In a streamlet, Satnavri (18-10-64).

P. crossbyanum Tild.

On cement flooring near a water tap, Tiroda (2-2-69).

P. foveolarum Gom.

In Zarpot stream, Chandrapur (1-11-64).

P. frigidum Fritsch

On the sides of cement cisterns, Amravati (18-10-64).

P. jenkelianum G. Schmid

In a streamlet, Satnavri (18-10-64).

P. molle Gom.

In Vadali lake, Amravati (13-10-64). In a pool, Wardha (27-10-64).

P. mucicola Huber-Pest. et Naumann

Embedded in the mucilage of *Microcystis* colonies in Nursery pond (8), Bhandara (28-12-68), in a pond (9), Tumsar (22-12-68), in Khamb lake (8.5), Tiroda (2-2-69).

P. stagnina C. B. Rao

On dripping rocks, Chandrapur (1-11-64). Near a water tap, Wardha (2-3-68).

Lynghya allorgei Frey v. **granulata** Kamat

On stones in a streamlet, Satnavri (18-10-64).

Filaments are narrower, 3-3.2 μ broad and the cells sometimes longer—up to 5 μ long.

L. birgei G. M. Smith

In Sarkari lake (7.2), Tumsar (22-12-68).

L. confervoides Ag.

Adhering to cement drain, Wardha (12-3-68).

L. endophytica Elenk. et Hollerb.

In mucilaginous masses of *Aphanathece* in paddy fields, Umred (30-11-64).

L. gandhii Kamat

In a fountain reservoir, Amravati (18-10-64).

L. hieronymusii Lemm.

In a pond, Umred (30-11-64).

L. holsatica Lemm.

Floating masses in a pond, Wardha (27-10-64).

L. lachneri (Zimm.) Geitler

In a cement cistern, Amravati (18-10-64). In a lake (8), Yeotmal (22-11-68). In Nave lake (9.5), Bhandara (19-1-69).

L. lachneri (Zimm.) Geitler v. **minor** Geitler

On cement flooring near a water tap, Tiroda (2-2-69).

L. limnetica Lemm.

In Ramsagar lake (7.2), Tiroda (2-2-69).

L. majuscula Harvey ex Gomont

In a streamlet, Satnavri (18-10-64). In Pavnar dam (27-10-64).

L. martensiana Menegh. ex Gomont

In a streamlet, Chandrapur (1-11-64).

Trichomes slightly narrower—up to 5.8-6 μ broad.

L. shackletoni West et West

On cement flooring near a water tap and in Ramsagar lake (7.2), Tiroda (2-2-69).

L. spiralis Geitler

In a bodhan, Satnavri (18-10-64).

Microcoleus chthonoplastes Thuret ex Gomont

On moist soil near Nave lake, Sakoli (5-1-69).

Anabaenopsis arnoldii Aptek. v.**indica** Ramnathan

Planktonic in a lake (11), Lonar (24-10-68).

Spores not observed.

A. circularis (G. S. West) Wolosz. et Miller

Planktonic in a puddle, Mehkar (20-10-68).

Heterocysts are conical and not spherical as in the type. Granules and/or gas-vacuoles are not observed.

A. raciborskii Wolosz.

Planktonic in ponds, Gondia (5-3-67), Mehkar (20-10-68).

Trichomes are slightly constricted in both the collections, which agree with the description given by Geitler (1932). Desikachary (1959) describes the trichomes as not constricted though his figure (Pl. 63, f. 7) shows slight constrictions at some cross walls.

Raphidiopsis mediterranea Skuja

Planktonic in ponds, Mansar (13-12-64), Gondia (5-7-67), Katol (8-12-68).

Cylindrospermum licheniforme

Kuetz. ex Born. et Flah.

In Vadali lake, Amravati (3-3-65).

C. majus Kuetzing ex Born. et Flah.

In paddy fields, Amravati (18-10-64).

- C. muscicola** Kuetz. ex Born. et Flah.
In Nave lake (9.5), Bhandara (19-1-69).
- C. stagnale** (Kuetz.) Born. et Flah.
In Vadali lake, Amravati (3-3-65).
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Anabaena fuellebornii** Schmidle
In Sarkari lake (7.2), Tumsar (23-12-68).
- A. inaequalis** (Kuetz.) Born. et Flah.
In a pond, Umred (30-11-64).
- A. orientalis** Dixit
In Sarkari lake (7.2), Tumsar (22-12-68).
- A. sphaerica** Born. et Flah.
Planktonic in a puddle, Mehkar (20-10-68).
- A. volzii** Lemm.
In paddy fields, Amravati (13-10-64). In a small pond, Wardha (27-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
- Nodularia spumigena** Mertens
In a lake (11), Lonar (24-10-68).
- Nostoc microscopicum** Carm. ex Born. et Flah.
In Nursery pond (8), Bhandara (28-12-68).
Spores not observed.
- N. paludosum** Kuetz. ex Born. et Flah.
In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68).
- N. rivulare** Kuetz. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).
- Aulosira fertilissima** Ghose v. *tenuis* C. B. Rao
In Vadali lake and in paddy fields, Amravati (18-10-64). In Kapsi lake (8.2), Akola (16-10-68).
- A. implexa** Born. et Flah. v. *crassa* Dixit
In Vadali lake, Amravati (18-10-64). In a streamlet, Warora (30-10-65). In a pool, Chandrapur (1-11-65).
- Camptylonemopsis pulneyensis** Desik.
In Sarkari lake (7.2), Tumsar (22-12-68).
Filaments up to 16 μ broad; spores are cylindric, 12-14 μ broad, 16-20 μ long, with smooth walls.
- Scytonema chiastum** Geitler
In paddy fields, Amravati (18-10-64).
- S. cookei** W. et G. S. West
On moist soil, Amravati (18-10-64).
- S. simplex** Bharadw.
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Forticia bossei** (Fremy) Desik.
In a streamlet, Amravati (18-10-64; 20-11-68).
Spores broader up to 6.5 μ broad, the shape of the spores also different being always rectangular, and not rounded at the angles.
- Calothrix clavatooides** Ghose
Epiphytic on *Hydrilla* leaves in a cement cistern, Akola (6-3-69).
- C. epiphytica** West et West
In Sarkari lake (7.2), Tumsar (22-12-68).
- C. karnatakensis** Gonz. et Kam. v. *major* Gonz. et Kam.
Epiphytic on aquatic plants in Vadali lake, Amravati (3-3-65).
- C. marchica** Lemm.
In Abkari lake (7.5), Bhandara (29-12-68).
- C. wembaerensis** Hieron et Schmidle
In Sarkari lake (7.5), Tumsar (22-12-68).
- Dichothrix orsiniana** (Kuetz.) Born. et Flah.
On dripping rocks, Amravati (18-10-64).
- Gloeotrichia intermedia** (Lemm.) Geitler v. *kanwanensis* C. B. Rao
In Ramala lake, Chandrapur (1-11-64). In Abkari lake (7.5), Bhandara (29-12-68).
- G. natans** Rabenh. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).
Cells and heterocysts are slightly broader.
- G. pilgeri** Schmidle
Epiphytic on aquatic plants in ponds, Umred (30-11-64), Vadali lake, Amravati (18-10-64), Mansar (13-12-64), Nave lake (9.5), Bhandara (19-1-69).

- G. raciborskii** Wolosz. In Vadali lake, Amravati (18-10-64).
Planktonic in Gaon lake (7.2), Sakoli (5-1-69).
- G. raciborskii** Wolosz. v. **kashiense** C. B. Rao
- Hapalosiphon baronii** West et West In a pond, Mansar (13-12-64).
- H. hibernicus** West et West In a pond, Mansar (13-12-64).

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REFERENCES

- BRUNNTHALER, J. (1915): Protozoococcales. In A. Pascher's, Die Süsswasserflora Deutschland, Osterreichs und der Schweiz. Jena.
- CHODAT, R. (1926): *Scenedesmus*. Etude de genetique, de systematique experimentale et d'hydrobiologie. *Rev. Hydrol.* 3:71-258.
- COLLINS, F. S. (1928): Green Algae of North America. New York.
- CROASDALE, H. (1955): Freshwater Algae of Alaska. I. Some desmids from the interior. *Farlowia* 4(4):513-565.
- (1956): Freshwater algae of Alaska. I. Some desmids from the interior. Part 2. *Actinotaenium*, *Micrasterias* and *Cosmarium*. *Trans. Amer. microsc. Soc.* 75:1-70.
- DESIKACHARY, T. V. (1959): Cyanophyta. New Delhi.
- FOREST, H. S. (1954): Handbook of Algae. Knoxville.
- GEITLER, L. (1925): Cyanophyceae. In A. Pascher's, Die Süsswasserflora Deutschland, Osterreichs und der Schweiz. 12. Jena.
- (1932): Cyanophyceae. In Rabenhorst's Kryptogamenflora von Deutschland, Osterreich und der Schweiz. 14. Leipzig.
- GEMEINHARDT, K. (1939): Oedogoniales. In Rabenhorst's Kryptogamenflora von Deutschland, Osterreich und der Schweiz. 12. Leipzig.
- GOJDICS, M. (1953): The genus *Euglena*. Madison.
- GOMONT, M. (1892): Monographie des Oscillariees (Nostocacees homocystees) I & II. *Ann. Sci. nat. Bot. Ser.* 15(7):263-368; 16(7):91-264.
- GONZALVES, E. A. & GANGLA, K. S. (1947): A new asymmetrical species of *Euastrum*. *J. Indian bot. Soc.* 26: 9-12.
- & KAMAT, N. D. (1959): The Myxophyceae of the Karnatak III. *J. Univ. Bombay* 28:28-41.
- HAZEN, T. F. (1902): The Ulotrichaceae and Chaetophoraceae of the United States. *Mem. Torrey bot. Cl.* 11(2):135-250, pls. 20-42.
- HIRANO, M. (1955-1956-1957-1959): Flora Desmidiarum Japonicarum. *Contr. Biol. Lab. Kyoto Univ.* 1955 (1):1-56; 1956(2):57-106; 1957 (4 & 5):107-225; 1959(7 & 9): 226-386, pls. 1-52.
- HIRN, K. E. (1900): Monographie und Iconographie der Oedogoniaceen. *Acta Soc. Sci. fenn.* 27:1-395, pls. 1-64.
- HUBER-PESTALOZZI, G. (1938-1950-1955): Die Binnengewasser. Bd. XVI.

Teil 1, 3, 4. Das Phytoplankton des Susswassers. Stuttgart.

IRENEE-MAIRE (FR.) (1939): Flore desmidiale de la region de Montreal. La prairie.

IAO, CHIN-CHIH (1937): New Oedogonia collected in China. IV. *Sinensia* 8(3-4):299-313.

KAMAT, N. D. (1963): The Algae of Kolhapur, India. *Hydrobiologia* 22: 209-305.

————— (1963a): The Oscillatoriaceae of Ahmedabad, India. *J. Univ. Bombay* 31(3 & 5):20-27.

————— (1964): The Euglenophyceae of Bombay. *J. Biol. Sci.* 7(1):8-14.

————— (1967): Dispersal of Charophytes by the Pintails. *Curr. Sci.* 36:134.

KOLKWITZ, R. & KRIEGER, H. (1944): Zygnematales. In Rabenhorst's Kryptogamenflora von Deutschland, Osterreich und der Schweiz. 13, part 2.

KRIEGER, W. (1937): Die Desmidiaceen. In Rabenhorst's Kryptogamenflora von Deutschland, Osterreich und der Schweiz. 13, part 1.

KRIEGER, W. & GERLOFF, J. (1962-1965-1969): Die Gattung *Cosmarium*. Lieferung 1, 2, 3, 4. Stuttgart.

PHILIPPOSE, M. T. (1967): Chlorococcales. New Delhi.

POCHMANN, A. (1942): Synopsis der Gattung *Phacus*. *Arch. Protistenk.* 95:81-252.

PRESCOTT, G. W. (1951): Algae of the Western great lake area. Michigan.

PRINTZ, H. (1964): Die Chaetophorales der Binnengewasser. *Hydrobiologia* 24(1-3):1-376.

RAMNATHAN, K. R. (1964): Ulotrichales. New Delhi.

RANDHAWA, M. S. (1959): Zygnemataceae. New Delhi.

SCOTT, A. M. & PRESCOTT, G. W. (1961): Indonesian desmids. *Hydrobiologia* 17:1-132, pls. 1-63.

SKUJA, H. (1949): Zur Susswasserfauna Burmas. *Nova. Acta Soc. Sci. Upsal.* ser. 4, 14:1-188, pls. 1-37.

SMITH, G. M. (1916): A monograph of the algal genus *Scenedesmus*, based upon pure culture studies. *Trans. Wisc. Acad. Sci. Arts Lett.* 18: 422-539, pls. 25-33.

————— (1920): Phytoplankton of the Inland lakes of Wisconsin. part I. *Wis. Geol. nat. Hist. Surv. Bull.* 57:1-243, pls. 1-51.

TIFFANY, L. H. (1930): The Oedogoniaceae, a monograph. Ohio.

————— & BRITTON, M. E. (1952): The algae of Illinois. Chicago.

TRANSEAU, E. N. (1951): The Zygnemataceae. Ohio.

WEST, W. & WEST, G. S. (1904-1905-1908-1912): A monograph of the British Desmidiaceae. Vols. 1-IV. London.

—————, —————, & CARTER, N. (1923): A monograph of the British Desmidiaceae. Vol. V. London.

A Catalogue of the Birds in the Collection of the Bombay Natural History Society—18

(Eurylaimidae, Pittidae, Alaudidae)

HUMAYUN ABDULALI

[Continued from Vol. 72(1): 131]

843 specimens of 81 species and subspecies, up to No. 909 in INDIAN HANDBOOK and registered No. 23957 are covered by this part.

EL *Cymbirhynchus macrorhynchus siamensis* de Schauensee & Ripley (Pran, south-west Siam) Black-and-Red Broadbill

1 ♂? Tenasserim Town, Burma. Wing 97; bill 23; tail 77

The subspecific identification of this and the next is based on the distribution in Peters's CHECK-LIST, Vol. 7, p. 7.

EL *Cymbirhynchus macrorhynchus malaccensis* Salvadori (Malacca)

1 ♂? Malacca. Wing 96; bill 24.5; tail 86

The subspecific identification is as mentioned under the last.

864 *Serilophus lunatus rubropygius* (Hodgson) (Nepal) Nepal Col-
lared Broadbill 3:470

11 : 4 ♂♂ (1 juv.) 6 ♀♀ 1 ♂? juv.

1 Rajhatkhawa, Jalpaiguri dt., W. Bengal; 2 Margherita, 1 Dening, Lohit Valley, 1 Roopchena, 1 Hungum, N. Cachar, Assam; 2 Melok R., below Wamakan 500 ft; 1 Rasa, 1 Mansum, Chindwin Exp., Burma; 1 no data (ECSB).

	Wing	Bill	Tarsus	Tail
3 ♂♂	82,84,85	13,14(2)	18(2),19	62,64,66
6 ♀♀	81-83 av.82	14-15	17-19	62-67 av. 64
(1H ♂♀	83-88	from skull 15-17	c.21	66-71)

Specimen No. 9834 marked ♂ shows white-tipped feathers on either side of the neck. The two juveniles (?) lack these spots as also the grey sheen on the lower plumage. There is a slight wash of rufous on the upperparts, but I cannot see 'the rufous of the rump extending further on to mantle' as stated by Ticehurst (*JBNHS* 39:559).

865 *Psarismus dalhousiae dalhousiae* (Jameson) (Northern India, probably near Simla) Longtailed Broadbill 3:472

14 : 5 ♂♂ 8 ♀♀ 1 ♂?

1 Longview T.E., 1 Darjeeling, 1* Kurseong, W. Bengal, 1 Berrick, 2 Singtam, Teesta Valley, 1 Martam, Rongni Valley, 1 Rinchinpong, Sikkim; 1 Margherita, Assam; 1* Dalu, 1* Tawmaw, 1* Nanyaseik, 1* Mansum, Chindwin Exp., Burma, 1* no data.

These birds can be divided into two groups, eight with underparts greenish, and six (2♂♂ 4♀♀) bluish. They show no differences in size, but the latter* (12 January to 31 March) are from Kurseong (1), and Chindwin (4), while the green (western ?) birds are dated between 26 November and 26 January. The eastern birds show slight traces (as do the others) of the character on which Hume separated *assimilis* from *Thayetmyo*, Burma, i.e. a small patch of blue on the nape after the black. This is usually concealed by the black feathers and its visibility is largely dependent on the make-up of the skin.

The specimens measure:

	Wing	Bill	Tarsus	Tail
♂♂	99-102 av. 100	17-19	27-29	120(2),125,127
♀♀	99-103 av. 101	18-19	26-28	110-130 av. 119
(♂♀)	99-107	17-18	27-28	95-136)

The material available shows no difference in wing length between the sexes as suggested in IND. HANDBOOK (4:250) where there is no mention of the number measured.

866 *Pitta nipalensis nipalensis* (Hodgson) (Nepal) Bluenaped Pitta 3: 444

14: 8♂♂ (1 by pl.) 6♀♀ (2 by pl.)

1 Darjeeling, W. Bengal; 1 Sikkim; 2 Margherita, 1 Tezu, Lohit Valley, 1 Gusyong, 1 Heogagul, 1 Cachar, Assam; 2 Dalu, 1 Hpala, Chindwin; 1 Man, Yasu Valley, Pakokku; 1 Aka, Chin Hills, Burma, 1 no data.

In series, the females have paler underparts than the males, which also vary among themselves. Three males obtained by the Chindwin Expedition show dark centres to the scapulars and are slightly smaller than the others, including an unsexed bird in male plumage (No. 9075) from Man, Yasu Valley, Pakokku, Burma, further south.

	Wing	Bill	Tarsus	Tail
♂♂	115-124 av. 120	26-28	52-53	50-58 av. 53.8
Chindwin				
♂♂	115,118,119	26(2),27	50,51,52	49,50,55
♀♀	118-122 av. 120	26-28	51-56 av. 53.6	50-60 av.52.5
(♂♀)	116-129	22-26	51-59	61-68)

867 *Pitta brachyura brachyura* (Linnaeus) (Ceylon) Indian Pitta

28: 7♂♂ 10♀♀ 11 o?

1* Kalka, 1* Simla Hills; 2† Bombay, 2 Khandala, 1 Ratnagiri, 1* Wamanpalli, Chanda, Maharashtra; 1 Alanki, 2* Karwar, N. Kanara, 1† Tekkadi, 1† Peermade, Periyar, 2† Shembaganur, 2† Kodaikanal, Palnis, 2 Travancore, Kerala; 1 Anuradhapur, Ceylon; 1† Pt. Calimere, 1 Kurumbapatti, Salem, Tamil Nadu; 1† Vizagapatnam Dt., A.P., 1* Baghowni, Tirhut, Bihar; 1* Kumaon, Naini Tal, 1* Sikkim, 2 no data.

Many years ago I had noticed some colour differences in the Pittas available in the Bombay collection and though additional material and opinions were obtained, it was not possible to take any definite decision. The present re-examination reveals the same differences, and while

unable to offer any definite results, I am placing them on record for somebody else to follow up as and when opportunity offers.

They fall into 3 separate groups, all of which include specimens with dark streaks on the back:

(a) 7*: 1 ♂ 4 ♀ 2 o?

These differ from both the other groups in having pale underparts, greyer and less brown lateral crown streaks, and bluish green backs. They share a shiny, pale blue rump with (c).

They include all the Himalayan specimens, the southernmost being from Karwar (July) and Chanda (27 May) and were all taken between 20th May (Sikkim) and 16th October (Kumaon).

After the migrations and breeding seasons are determined, Koelz's name *pulchra* (Bhadwar, Kangra, Punjab) may be applicable to the northern population.

(b) 9†: 1 ♂ 4 ♀ 4 o?

These share the darker underparts etc. with (c) but are separable from both (a) and (c) by the *darker* blue of the rump.

The northernmost are from Bombay and Vizagapatnam dist. (both Oct.) and there appears to be a concentration in the south-western hills. During my earlier examination in 1955, a bird borrowed from Ceylon was also included in this group, as is suggested by its capture, presumably on migration at Pt. Calimere. This and six of the others were taken in October, with one each in January and March.

(c) 12 (unmarked): 5 ♂ 5 ♀ 2 o?

Resemble group (a) in the pale blue of the rump, but otherwise similar to (b).

The distribution overlaps that of group (b) including Ceylon, now accepted as the type locality of nominate *brachyura*. Specimens were taken in January, February (2), April (2), May, July and October (2).

The southernmost breeding record is from near Bombay, while they are known to nest regularly in Dhulia, West Khandesh and near Mhow in Central India, south and north of the Satpura Range, in June and July. No breeding specimens are available to permit any attempt at localising the separate (?) groups.

The sexes show no differences in size nor do those with the colour differences.

	Wing	Bill	Tarsus	Tail
♂♂	102-107 av 105	21-23	35-38	30-37 av. 34
♀♀	101-109 av. 105	20-22	35-38	30-37 av. 34
(IH ♂♀)	101-111	from skull 22-26	35-39	36-40)

868 *Pitta moluccensis megarhyncha* Schlegel (Banka) Larger Blue-winged Pitta 3: 452

IND. HANDBOOK (4:254) refers to a single record from Barisal, E. Pakistan (now Bangladesh) but in the same year (1970) Paynter, *Bull.*

B.O.C. 90:118) said it was conspicuous in the Sunderbans in April, had enlarged gonads, and was probably breeding.

EL *Pitta moluccensis moluccensis* P.S.L. Müller (Tenasserim) Lesser Bluewinged Pitta 3 : 450

3 ♂?

1 *Myingyan, Upper Burma* (24 May 1902), 1 *S. Irawaddy, 1 Copah, Malay Peninsula* (6 Oct. 1880).

Wing 119, 120, 123 (118-127): bill —, 22, 25.5 (24-26 *contra* 29-34 in *megarhyncha*); tarsus 39(2), 40 (20-24); tail 36, 39, 41 (42-45).

The measurements of the tarsus in FAUNA are no doubt in error, but accepting those of the culmen, these birds would both be of the nominate race. They show very little red on the lower belly and undertail coverts cf. Pl. xiii in the BIRDS OF BURMA (Smythies, 1953).

869 *Pitta sordida cucullata* Hartlaub (Malacca) Hooded or Green-breasted Pitta 3 : 455

1 ♂ Simla, NW. Himalayas.

Measurements under 870.

870 *Pitta sordida abbotti* Richmond (Nicobars) Nicobar Hooded or Greenbreasted Pitta 3 : 457

3 : 2 ♂ ♂ 1 ♀ Campbell Bay, Great Nicobar

	Wing	Bill	Tarsus	Tail
1 ♂ <i>cucullata</i>	115 (109-119)	23.5 (20-22)	37 (38-42)	37 (39-42)
2 ♂♂ <i>abbotti</i>	108, 110	22.5, 23	40, 40	32, 35
1 ♀ <i>abbotti</i>	109	22	37	34
(♂ ♀)	103-110	22	40	39)

These birds have the green upperparts suffused with olive *contra* clear green in No. 869. The head is darker, the white patch on the primaries smaller, and compared with the single specimen of *cucullata*, the blue on the belly more prominent.

EL *Pitta gurneyi* Hume (South Tenasserim) Gurney's Pitta 3 : 457

1 ♀ *Bankachon, S. Tenasserim*

Wing 98 (97-102); bill 22 (20-22); tarsus 39 (40-42); tail 43 (46-54).

EL *Pitta caerulea caerulea* Raffles (Sumatra) Giant Pitta 3 : 447

1 ♂ (by plumage) *Bankachon, S. Tenasserim*

Wing 153 (138-155); bill 34 (32-35); tarsus 58 (54-59); tail 51 (61-67).

871 *Pitta cyanea cyanea* Blyth (Arakan) Blue Pitta 3 : 448

1 ♂ *Lower Thoungyin Forest, Burma-Siamese Border.*

Wing 116 (106-116); bill 23 (22-24); tarsus 42 (43-45); tail 56 (57-62).

872 *Mirafra javanica cantillans* Blyth (Bengal) Singing Bush Lark 3 : 334

4 : 2 ♂ ♂ 1 ♀ 1 ♂?

1 Bhimasar, Nakhtrana dist., Kutch; 1 Nadiad Town environs, Gujarat;

1 Dodi, Malwa Plateau, c. 1700 ft, Bhopal State, C.I.; 1 Cawnpore (cage bird).

The males (4 Sept. and 9 Dec.) from Kutch (with developed gonads) and Gujarat and the cage bird from Cawnpore are paler and less distinctly marked than the female, both above and on the breast.

873 *Mirafra assamica assamica* Horsfield (Assam) Bengal Bush Lark 3 : 336

6 : 4 ♂♂ 1 ♀ 1 ♂?

2 Jagadhri, Ambala, Punjab; 1 Baghowni, Tirhut; 1 Rajputee Saran, Bihar; 2 Kaziranga, Assam.

The grey upperparts, and the markings on the head are quite distinct from those in *M. assamica affinis*. The birds from the Punjab are paler and less richly coloured than the others.

Measurements under No. 874a.

874 *Mirafra assamica affinis* Blyth (Southern part of the peninsula of India) Madras Bush Lark 3 : 339

23 : 12 ♂♂ (1 juv.) 8 ♀♀ 3 ♂♂

(a) 1 Kalai, Trichinopoly, 2 Pt. Calimere, 2 Chitteri Range, 1 Kurumbapatti, 2 Harur, Tirthamalai, Salem District, Tamil Nadu; 3 Palkonda Hills, 1 Seshachalam Hills, 2 Koduru, Cudappah, 1 Kavur Taluka, Nellore District, A.P.; 1 Golapalli, Bastar.

(b) 2 Baramba, 1 Talchar, 2 Barkul, Chilka Lake, Orissa, 1 Nilgiri.

The birds in group (b) (except those collected in 1902 and badly foxed) have dark upperparts, with little or no trace of rufous. They are quite different from the dark grey of nominate *assamica* but resemble them in their noticeably heavy bills, and represent an intermediate population between *affinis* and *assamica*, closer to the former.

Birds from further south show more rufous on the upperparts, a character which is more pronounced in ♀ No. 9187 from Trichinopoly. Jerdon also said that specimens from the Carnatic have a redder tinge than others from Midnapore and Ceylon. Specimens from the extreme south and southwest hills are under *ceylonensis* (q.v.).

Measurements under 874a.

874a *Mirafra assamica ceylonensis* Whistler (Colombo, Ceylon) Ceylon Bush Lark

9 : ♂♂

1 Wadakkancheri, 3 Malakku, Kumdukadru, Trichur, Cochin; 2 Kutiani (Kutyani), 1 Thattakad, Kerala, 1 Cassimode, south(?) Travancore (J.P. Cook), 1 Aramboli, Cape Comorin.

I have already referred (in press) to the validity of this large-billed race, with and without rufous underparts, occurring in Ceylon and in a very restricted area in southernmost India.

		Wing	Bill	Tail
<i>assamica</i>	♂♂	82,84,85 (2)	13.5-14.7 av.13.8	45,46(2), 47
	♀	81	13.6	43
	(♂♀)	82-84	c. 13-14	45-50)
<i>affinis</i>	(a) ♂♂	83-87 av. 84.6	12.2-13.5 av, 13	44-48 av. 45.8

	Wing	Bill	Tail
(b) ♂♂	78-85 av. 82	12.5-14 av. 13	41-46 av. 44.3
(IH)	77-88	from skull 15-18	42-52)
<i>affinis</i> (a) ♀♀	—	—	—
(b) ♀♀	75-82 av. 78.7	12.5-15 av. 13	39-44 av. 41
(IH)	75-82	13-17	39-45)
<i>ceylonensis</i> ♂♂	81-88 av. 84	13.1-14.7 av. 14	42-48 av. 45
<i>microptera</i> ♂	76	13	43
(♂♀)	67-77	12-13	40-45)

EL **Mirafra assamica microptera** Hume (Thayetmyo) Burmese Bush Lark 3 : 340

1 ♂ Paukkaung, Prome District, Burma.

The single specimen is small but washed rufous above, resembling *affinis* from around Madras and agreeing with Hume's original description of *microptera*, *contra* three others from Mandalay (U.S. Nat. Mus. Nos. 44982/4) which are also small but greyer above and purer white below.

Measurements under 874a.

875/6 **Mirafra erythroptera sindiana** Ticehurst (Karachi, Sind) Sind Redwinged Bush Lark 3 : 342

16 : 14 ♂♂ 2 ♀♀ (1 juv.)

4 Ambala, 1 Chandigarh, Punjab; 3 Delhi; 2 Bulandshar, 3 Meerut, 3 Cawnpore, U.P.

Koelz's *furva* from Sihor, Kathiawar, is synonymised with *sindiana* in IND. HANDBOOK (5:7) but the lack of topotypes of both races only permits a recording that specimens from the Punjab and Delhi have wider pale margins to the feathers of the back, and are in series paler than those from further south. Those from Uttar Pradesh are old and badly prepared and are perhaps best left together.

The others which are placed under nominate *erythroptera* show differences of colour, but are in series darker.

No. 18228 from Ambala, marked "juvenile" is darker above. A juvenile from Cawnpore (No. 9152) has the head streaks broken into spots, and the rufous on the primaries extends much further towards the tips, than in adults.

The measurements are under 877.

877 **Mirafra erythroptera erythroptera** Blyth (Northern Deccan) Redwinged Bush Lark 3 : 341

21 : 17 ♂♂ 2 ♀♀ 2 ♂♂

2 Bhuj, 2 Kharirohar, 1 Chadva, 1 Kutch; 2 Vaghjipur, 1 Deesa, Palanpur, 1 Dalkhania, Amreli, Gujarat; 2 Narwer Fort, 1 Bhind, 1 Bhadarwar, Gwalior, 1 Dodi, Malwa Plateau, 1 Sanchi, Bhopal; 1 Jabalpur; 1 Poona, 1 Kannad, Aurangabad, 2 Mukher, Nanded District, Maharashtra.

	Wing	Bill	Tarsus	Tail
<i>sindiana</i>	♂♂ 72-83 av. 80	12-13	21-24	45-53 av. 50.5
	1 ♀ 70	—	20	44
	(1H ♂♀ 73-84	from skull 13-15	21-23	46-56)
<i>erythroptera</i>	♂♂ 75-82 av. 80	12-14	21-24	46-53 av. 50
	(1H ♂♀ 75-84	from skull 13-15	21-23	47-55)

In *sindiana* the birds from Delhi and westwards have their wings average 81 mm *contra* 77.5 in the eastern birds.

The preponderance of males in both groups is noticeable and inexplicable.

As already indicated under 875, these birds show differences in colour. The southernmost is from Poona and it is unfortunate that the only specimens available from Point Calimere in Tamil Nadu where several *erythroptera* are said to have been handled by the Ringing Camps (JBNHS 68:458) are *M. assamica*.

EL. *Lullula arborea pallida* Zarudny (Hills of Transcaspia) Wood Lark

1 ♂: *Amara, Iraq.*

Wing 100; bill 12.7; tail 52.

The subspecific identification is based on the locality.

878 *Eremopterix grisea* (Scopoli) (Gingee, S. Arcot) Ashycrowned or Blackbellied Finch Lark 3: 353

67: 43 ♂♂ (2 pull., 2 juv.) 19 ♀♀ 5 ♂?

1 Rawalpindi; 1 Thanessa, Karnal District; 1 Bhong, Indus River, 1 Bahawalpur, Punjab; 6 Delhi; 2 Meerut; 2 Bhinmal, 1 Pali, Jodhpur; 3 Jaithari, Bhopal; 1 Chadva, Bhuj, Kutch; 1 Radhanpur, 2 Patan, Mehsana district, 1 Pariaji, Kaira district, Gujarat; 1 Deolali, 1 Nasik, 1 Shil, Thana; 7 Santa Cruz, 1 Pali Hill, Bandra, 1 Bombay, 3 Panchgani, 2 Satara; 1 Bargi, 1 Karwar, 1 Shirgunji, S. Kunta, 1 Kanara, 1 Talewadi, Belgaum; 1 Wadakkancheri, 1 Trivandrum, 1 Trichinopoly, 1 S. Arcot, 1 Madras; 7 Cumbum Valley; 1 Koduru, S. Cuddapah; 4 Godavery Delta; 1 Nayagar State, Orissa; 2 Purulia, Manbhum, 1 Madhubani, 1 Baghowni, Tirhut, Bihar.

IND. HANDBOOK accepts no subspecies from over the wide range of this species, but the specimens/series from different areas show differences, which if supported by additional material would probably justify separation. Among the males, birds from Satara, Karwar and Kerala, are darkest above, while others from Bhong, Bahawalpur, Bhopal and Delhi, are the palest, several of the latter being marked *siccata* by Whistler. A single bird from Talewadi, Belgaum, has the upperparts brown and the upper surface washed with rufous, a character on which other subspecies have been described from the same area. When at the Yala Sanctuary in Ceylon (July 1967), I noted that they "appeared different from Indian birds".

The females show other differences. The two from Delhi are outstandingly palest.

	Wing	Bill	Tarsus	Tail
♂♂	73-79 av. 75	10-11	16-18	37-45 av. 41.5
(IH)	74-80	from skull 11-13	15-17	37-44)
♀♀	72-76 av. 74.5	10-11	15-18	36-42 av. 39.5
(IH)	72-79	11-13	15-17	37-44)

879 *Eremopterix nigriceps affinis* (Blyth) (Karachi) Black-crowned Finch Lark 3: 355

9 : 6♂♂ 3♀♀

4 Karachi, 1 10 m off Karachi (?); 3 Phalodi, Jodhpur State; 1 Kuar Bet, Kutch.

The two males and two females from Karachi, all collected by C.B. Ticehurst in 1918 have their upperparts paler than in the others. Shivrajkumar (*JBNHS* 66:625) refers to flocks and individuals seen in different parts of Gujarat and suggests migratory movements.

	Wing	Bill	Tarsus	Tail
♂♂	79-85 av. 81.5	10-11	17-19	48-52 av. 50
♀♀	74,75,78	10(3)	17,17,18	45,47(2)
(IH)	♂♀ 78-83	from skull c.12	16-17	46-51)

EL *Ammomanes dunni eremodites* Meinertzhagen (Sheikh Othman, Aden Protectorate, Arabia)

4 : 2♀♀ 2♂♂? *Siyahad, Arabia* (St. John Philby, March 1940).

Wing 83, 88, 95(2); bill 12.5, 13.2, 13.5(2); tail 49, 51, 53 56.

No. 9394, wing 95, was identified at the Smithsonian Institution by Mr. Bond, who informs me that accepting *Siyahad* as at 25°38'N., 47°05'E., these records extend the accepted range of the species into eastern Arabia.

Ammomanes deserti

Most of the extra-limital part of the collection has been gone over by Ticehurst (?) and trinominally named, but it is not possible to link the identifications with any paper nor to confirm the groupings, particularly of *iranicus* and *phoenicuroides*, and I am not disturbing the identifications (except for three specimens of *orientalis* from Meshed, North Persia) and am only referring to the differences.

EL *Ammomanes deserti cheesmani* Meinertzhagen (Shatt-el-Adhain, Iraq) Desert Finch Lark

2♂♂? *Shatt-el-Adhain, Iraq*.

The two topotypes can be picked out from the others from Samara not very far away by the greater amount of pink on the upperparts.

Wing 96, 99; bill 12(2); tarsus 21, 22; tail 65, 66.

EL *Ammomanes deserti isabellinus* (Temminck) (Deserts of Aquaba, Arabia)

4 : 1♂ 1♀ 2♂♂

2 *Bait-al-Khalif, 1 Samara, Iraq*; 1 mile 30, 1200' *Kal Kerim*(?), *Persian Gulf* (C.E. Capito 14-1-25).

These are similar to *cheesmani* but less pink above. They are marked *fraterculus* ? which is synonymised with *isabellinus*, in Peters's CHECK-LIST.

Wing 94, 96, 100, 101; bill 12(2), 13,-; tarsus 20, 22, 23,-; tail 63, 64, 68(2).

EL *Ammomanes deserti iranicus* Zarudny (Hurmuck, Persian Baluchistan)

6 : 4 ♂♂ 2 ♀♀

2 *Amirabad*, 2 *Kalat Yussuf*, 1 *Birjand*; 1 *Tigat 4000'*, eastern Persia.

These birds are in series browner and less grey than those marked *phoenicuroides*.

All were collected by LaPersonne in December 1926 (2), January (1) and March 1927 (3).

	Wing	Bill	Tarsus	Tail
♂♂	106,109 (3)	12-13.2	23-24	70,72,73,-
♀♀	101,102	12.5,13.5	22,23	68 (2)

Meinertzhagen (*Ibis* 1920:143) identified birds from Quetta as of this subspecies.

EL *Ammomanes deserti orientalis* Zarudny and Loudon ("lower mountains of southwestern Bukhara..... Kushka River, sporadic in northwestern corner of Persia; around the middle Amu Darya..).

3 : 2 ♂♂ 1 ♀ *Meshed, North Iran.*

The birds collected by LaPersonne in February 1927 are slightly paler and sandier than *iranicus* and larger than *isabellinus* and may well be *orientalis* as indicated by Vaurie in BIRDS OF PAL. FAUNA p. 24. Paludan 1959, ON THE BIRDS OF AFGHANISTAN p. 141 refers to those from North Afghanistan as *orientalis* but says they are even paler than *cheesmani* from Salehabad and Kulmabad (?) in S.W. Iran. The topotypes of *cheesmani* available for comparison (*supra*) are however distinctly paler.

	Wing	Bill	Tarsus	Tail
♂♂	104,108	12.12	23,25	71,72
♀	103	10.5	24	68

880 *Ammomanes deserti phoenicuroides* (Blyth) (Kashmir) Indian Desert Finch Lark 3 : 352

23 : 11 ♂♂ 9 ♀♀ 3 ♂?

1 *Gudar-i-Ghichi*, 3000', 2 *Aliabad*, 1 2000' *Bandan*; 1 *Bali Komh*, 2 *Kunik*, 3500' *Seistan & Kain*; 3 *Kaidasht Pass*, 7000', *Kain*, 1 *Ab-i-Kahugan*, 44 m. s.e. of *Khawash*, 4700' *Persian Baluchistan*; 1 *Lokh*, 100 m. south of *Kalat*, 1 *Korak (Pelar)*, (180 m. s. by w. of) *Kalat, Baluchistan*; 1 *Malkand*, 1 *Risalpur*, N.W.F.P.; 2 *Taxila*, 1 *Campbellpur*, Punjab, 2 *Manthar*, *Cholistan*, 2 *Bahawalpur Town* environs, *Bahawalpur*.

Individuals from scattered areas, show differences in size and colour. According to Vaurie the birds from Seistan and Persian Baluchistan should be *iranicus* but they are marked *phoenicuroides* by Ticehurst and agree better with them. ♂ No. 9374 from *Gudar-i-Ghichi*; *Bandan*,

in Seistan, is dark above and shows a heavier bill than most of the others. Another ♂ No. 9373 Korak (Paler) 180 m. south by west of Kalat in Baluchistan resembles *orientalis* in colour but has a small 94 mm wing.

Among the others, two from Manthar, Cholistan, Bahawalpur, collected by Sálím Ali on 21 and 25 February 1939 are very pale above and approach *isabellinus/cheesmani*, except that they lack the pinkish tinge and have less rufous on the upper tail-coverts. Another (No. 9388) from the same place (27 February) is darker, while two more from Bahawalpur Town environs may well be included in the range of variation in others under *phoenicuroides*. Whistler (*JBNHS* 42:731) makes no reference to these differences, but in the course of the report Sálím Ali draws attention to the fact that Manthar falls into a part of the Great Indian Desert known as Rohi Cholistan, a distinct biotope separated from Bahawalpur town "by a depression known as the Hakra, the ancient bed of a bygone river". Two more specimens obtained here are not now available, but there appears little doubt that an examination of these differences, particularly in the field, would be of interest.

881 *Ammomanes cincturus* Zarudny and Hartert (Mujnabad, eastern Iran) Blacktailed Finch Lark 3 : 351

3 : 1 ♂ 2 ♀ ♀ Duzdap, 5000', Seistan, Iran (October 1926)

	Wing	Bill	Tarsus	Tail
♂	99	10	23	56
♀ ♀	94,94	-,10	21,22	53,55
(♂ ♀	97-102 Hartert, 92,93 FAUNA)			

In IND. HANDBOOK (5:13) this is referred to as a race of *phoenicurus*, but they appear to be very different and are perhaps better placed in a separate species as in Peters's CHECKLIST.

882 *Ammomanes phoenicurus phoenicurus* (Franklin) (Between Calcutta and Benares) Indian Rufoustailed Finch Lark 3 : 350

36 : 22 ♂ ♂ 11 ♀ ♀ 3 o?

2 Bhuj, Kutch; 1 Sanchi, Bhopal; 1 Kuno, Gwalior; 1 Harisal, Berar; 1 Bodeli, Baroda, 1 Dohad, Gujarat; 2 Sinnar, Nasik, 4 Bassein, Thana, 2 Dharamtar Creek, 1 Nagotna, Kolaba, 2 Panchgani, 1 Satara, 3 Ratnagiri; 6 Cumbum Valley; 3 Jabalpure, 1 Saugar, 1 Gondia, 1 Bhanupratapur, Kankar; 2* Orissa (* No. 18375 missing).

The material available shows differences of colour and the birds along the western side from Kutch southwards to Kolaba District appear slightly darker both above and below. The chins in the eastern birds appear distinctly paler. Two from Vengurla (the third is an old and dilapidated skin) maintain the darkness and differ in having the scapulars washed and tipped with rufous, a character absent in all the others.

In the absence of any birds from south of the Cumbum Valley, it is not possible to comment upon the validity of the next form *testaceus*.

♀ No. 9355 from Harisal, Berar, dull brown all over, paler on the underparts and with almost no markings on the breast, is presumably a juvenile. The outer webs of all the primaries are bright rufous, distinguishing this from the others.

	Wing	Bill	Tarsus	Tail
♂♂	99-106, one 111, av. 104.5 (IH 100-110)	12.5-15 av. 13.5 from skull 15-17	22-24 21-24	58-65 av. 61 57-64
♀♀	93-105 av. 99 (IH 98-104)	12.5-14.5 from skull 15-16	22-24 21-23	53-60 av. 57.6 52-63

883 *Ammomanes phoenicurus testaceus* Koelz (Salem, Madras)
Southern Rufostailed Finch Lark
nil.

884 *Alaemon alaudipes doriae* (Salvadori) (Iran) Large Desert Lark
3 : 304

15 : 6♂♂ 7♀♀ (1 juv., 2 imm.) 2 ♂?

3 *Shaiba*, Iraq; 3 *Lab-i-Baring*, *Hamunk*, 1 *Khwaja Ahmed*, *Seistan*, Iran;
4 Karachi; 1 *Khorda*, *Pachaw*, 1 *Kharirohar*, 1 *Nir*, Great Rann, *Kutch*;
1 *Yazman*, *Bahawalpur*.

According to Peters (1960, 9:39) and Vaurie (1959), all these should be of the same race but two of the three from Iraq are paler above and have a pale rufous wash which immediately separates them from the others. They also differ in the irregularity and almost complete absence of the dark bar across the white of the secondaries, a character shared with the third from the same place, which is very worn and does not exhibit the rufous.

The juvenile from Karachi has no spots on the breast and very pale upperparts which are not barred with blackish brown as required in both the FAUNA and IND. HANDBOOK. The two immature females (Nos. 8882 and 8887) are less heavily spotted on the breast than the adults.

♂ No. 8881 from *Khwaja Ahmed* has the largest (137 mm) wing but is not larger than Iraqi or Indian birds in other respects, and they are all measured together.

	Wing	Bill	Tarsus	Tail
♂♂	131-137 av. 133 (IH 126-137)	27.5-30 from skull 30-35	36 34-37	89-98 av. 94.5 79-99
♀♀	115, 118, 120, 125 (IH 116-119)	24.5, 25, 26, 28.5 from skull c. 27	31, 32 (2), 33 30-32	78, 89, 90, 92 c. 75)

EL. *Calandrella cinerea brachydactyla* (Leisler) (Montpellier, France)
Short-toed Lark

1 ♂? : 1800' *Siyahad*, *Arabia* (St. John Philby, 17 March 1940)

Wing 97; bill 12, tail 60.

The specimen No. 9397 was identified by Mr. Bond.

The white outer tail feathers, the smaller bill and the brown rather than rufous upperparts immediately separate this from *Ammomanes* with which it lay unnamed for many years.

The original label is marked "in flock of 20/30".

EL **Calandrella cinerea hermonensis** Tristram (Mt. Hermon, Lebanon) Short-toed Lark

1 ♂? *Shatt-el-Adhain, R. Tigris, Mesopotamia.*

No. 9067 collected by C. R. Pitman on 16 October 1917 and marked *brachydactyla* has the upperparts more rufous than in any other and appears to be *hermonensis*.

Wing 89; bill 10; tarsus 20; tail 59.

885 **Calandrella cinerea longipennis** (Eversmann) (Sangora, Dzungaria) Yarkand Short-toed Lark 3:325

42 : 23 ♂ ♂ 14 ♀ ♀ 5 ♂? (1* pull.)

1 *Mohamedabad*; 1 *Robot-i-Mahi, 5 Maina, near Turbat*; 1 *Kidri near Kain, Iran*; 1 *Rekchak Hambar, Kolwa, Baluchistan*; 4 *Chitral Drosh, 4 Jagadhri, 1 Ambala*; 3 *Manthar, Cholistan, 1 Harunabad, 2 Yazman, 1 Chachran, 1 Bhong, Bahawalpur*; 1 *Bhinmal, 3 Jolar, Jodhpur*; 1 *Santawara, Gwalior*; 1 *Ratlam, C.I.*; 2 *Bhuj, 1 Mandvi, Kutch*; 1 *Patan, 1 Vagjipur, Mehsana, 1 Radhanpur, 1 Cambay City environs, 1 Deesa, Palanpur*; 1* *Tso Mori, Tibet*; 1 *Tarning Bashi, Pamirs.*

The whole series shows considerable variation in colour, size and shape of bill, but those from Bahawalpur, Kutch, Gujarat, etc., have been marked *longipennis* either by Sálím Ali or Whistler, and with the material available, I am unable to suggest any amendment.

Some from Maina, near Turbat, paler above and with larger and flatter bills may be *artemesiana*.

Three from 4000', Chitral, collected by Capt. H. S. Fulton in October 1902 have a pronounced rufous wash on the upper surface, but their bills are not as heavy as in *dukhunensis*. Another (No. 9069) from Chitral Drosh dated 2 April 1903 does not show the rufous wash. No. 9104 ♂ from Tarning Bashi, Pamirs, collected by A. Sheriff was named *C. a. acutirostris* by Whistler.

The inner secondaries reach the tip of the wing in only 14 of the 40 adults and this is not a useful species character as suggested in IND. HANDBOOK (5:19). In both *longipennis* and *dukhunensis*, the fourth primary is distinctly shorter than the first three (as per FAUNA) and this appears to be a more reliable index.

Measurements under 886.

886 **Calandrella cinerea dukhunensis** (Sykes) (Dukhun) Rufous Short-toed Lark 3:326

18 : 10 ♂ ♂ 6 ♀ ♀ 2 ♂?

2 *Ghoti, Nasik, 2 Thana, 7 Salsette, 1 Poona*; 1 *Karupadanna, Cochin*; 1 *Godavery Delta*; 1 *Bhasandapur, Chilka Lake, Orissa*; 1 *Rajputtee Chupra, Bihar*; 2 *Calcutta Market.*

There is some variation in colour but they are distinguished by (1) the heavier and darker streaking on the upperparts, each feather fringed with rufous, (2) the fulvous wash on breast and underparts being more

distinct than in *longipennis* and (3) the thicker bill.

Though both this and the last (885) are winter migrants from the north, all the northern specimens are *longipennis*, and the southern ones of this form!

♂ No. 19651 from Ghoti, Nasik, in worn plumage does not show the dark markings on the upper surface, but is identified on the basis of another obtained on the same day and place.

The specimens measure:

		Wing	Bill	Tarsus	Tail
<i>longipennis</i>	♂♂	86-97 av. 92.3 (IH 95-100	10-12 from skull 12-15	20-23 20-21	50,55-62 av. 58.5 54-65)
<i>dukhunensis</i>	♂♂	92-103 av. 97 (IH 95-103	10-12 from skull 13-14	20-22 20-21	52-61 av. 57 59-60)
<i>longipennis</i>	♀♀	84-92 av. 88 (IH 88-94	10-12 from skull 12-14	19-21 20-21	49-56 av. 49.4 53-59)
<i>dukhunensis</i>	♀♀	86-99 av. 91 (IH 92-98	10-12 av. 10.5 from skull 13-14	20-21 20-21	50-56 av. 53.5 51-56)

Only three have the inner secondaries reaching the tip of the wing.

887 *Calandrella acutirostris acutirostris* Hume (Balakchi, upper Karkash Valley, north of Sughet Pass, Karakoram) Karakoram or Hume's Short-toed Lark 3 : 327

8 : 4♂♂ 4♀♀

3 Chitral; 1 Darazpur, Punjab; 3 Satanwara, 1 Surwaya, Gwalior.

In series, these have darker upperparts and less pure white on the outer webs of the two outermost tail-feathers than those under *tibetana* (888).

Measurements under 888.

888 *Calandrella acutirostris tibetana* Brooks (Tibet, beyond Sikkim) Tibet Short-toed Lark 3 : 328

9 : 5♂♂ 1♀ 3o? (1 juv.)

1 Darazpur, Punjab; 1 Debring, 1 Kashmir; 5 *Tingri* 14,000'; 1 *Gyanka* 13,500', *South Tibet*.

The juvenile from *Tingri*, South Tibet, collected by A. F. R. Wollaston on 27 June 1921, has pale whitish tips to all the feathers of the upperparts and tail, and rufous wash over the same area, most accentuated on the rump, and on the edges of the wing feathers.

		Wing	Bill	Tarsus	Tail
<i>acutirostris</i>	♂♂	90,91,92,94 (IH 89,96	11,12(3) -	20,21,22 (2) ex Paludan)	58,60,61,65
<i>tibetana</i>	♂♂	88-97 av. 91.2 (IH 98-100	11(4),12 from skull 13-15	20,21(3),22 19-22	53-65 av. 57.8 54,58-65)
<i>acutirostris</i>	♀♀	85,87,89,93 (IH 84-90	11(2),12(2) -	20,21,22(2) ex Paludan)	55(2),59,61
<i>tibetana</i>	♀	87 (IH 85-92	10 from skull 13-14	21 19-21	58 54-60)

888a *Calandrella rufescens persica* (Sharpe) (Niris, Iran) Persian Short-toed Lark 3 : 332

3 : 2 ♂♂ 1 ♀

2 *Lab-i-Baring, Lutak, Seistan Delta, Iran.*

	Wing	Bill	Tarsus	Tail
♂ ♀	96,98,94	10,11,10	20,21,21	61,61,60

EL *Calandrella rufescens seebohmi* (Sharpe) (Central Asia from Yarkund and Kashgar to Mongolia)

1 o? *Khotan, 4400'.*

Wing 88; bill 10; tarsus 21; tail 60.

The bill is noticeably smaller than in both *persica* and *heinei*

EL *Calandrella rufescens heinei* (Homeyer) (Volga region) Lesser Short-toed Lark

16 : 2 ♂♂ 1 ♀ 13 o?

10 *Shait-al-Adhain, 1 Bait-al-Khalifa, Samarah, 1 Twin Canals, 1 Zubier, 2 Felujah, 1 Tigris, Mesopotamia.*

	Wing	Bill	Tarsus	*Tail
2 ♂♂	95,96	10,10	20	61,62
1 ♀	94	10	20	58
13 ♂♀	91-100 av. 97	10-11	20-21	56-64 av. 60

No. 9125, 9127 and 9131 collected on 26th and 31st (2) Oct. 1917 have slightly paler upperparts and tend towards *seistanica* which are however yet paler.

889 *Calandrella raytal adamsi* (Hume) (Agore Valley, Hazara) Indus Sand Lark 3 : 331

17 : 12 ♂♂ 2 ♀♀ 3 o?

1 Jammu State; 1 Attock, 3 River Jhelum, 1 River Sutlej, 3 Ambala, 4 Bahawalpur, Punjab; 1 Karachi; 3 Delhi.

	Wing	Bill	Tarsus	Tail
<i>adamsi</i> ♂♂	78-88 av. 83	10-13	19-21	46-52 av. 49.5
(IH)	80-89	from skull 11-13	19-20	48-56)
<i>krishnakumarsinhji</i> ♂♂	78,80,65	11(3)	19(2),21	46(2),53
(Vaurie ♂♀)	76-85	from skull 12-13	-	42-50)
<i>adamsi</i> ♀♀	77,82	12(2)	19,21	43,46
(IH)	77-82	from skull 11-13	19-20	46-50)
<i>krishnakumarsinhji</i> ♀♀	75,77,78,79	10,11,(2),12	19,20,21,-	43,44,45,46

The single specimen from Karachi (1903) is very rufous, a character not shown in others equally old.

890 *Calandrella raytal krishnakumarsinhji* Vaurie & Dharmakumarsinhji (Bhavnagar) Saurashtra Sand Lark

9 (details below)

(a) 5 : 1 ♂ 2 ♀♀ 2 o? Bhavnagar.

(b) 4 : 2 ♂♂ 2 ♀♀ 1 Kakhart, 1 Kandla, 2 Kharirohar, Kutch.

Group (b) from Kutch is intermediate between topotypes from Bhavnagar and *adamsi/raytal* but the heavier markings on the upperparts as well as on the breast are strikingly different from the paler, less

marked races and better placed with *krishnakumarsinhji*.
Measurements under 889.

891 **Calandrella raytal raytal** (Blyth) (Lucknow) Ganges Sand Lark
3 : 329

5 (details below)

(a) 2 : 1 ♂ 1 ♀

1 Bulandshar, 1 Cawnpore, U.P.

(b) 3 : 1 ♂ 1 ♀ 1 ♂?

1 *Kyithe*, *Prome Dist.*; 1 *Yebauk*, 1 *Henzada*; *Lower Burma*.

The two Indian specimens are in very poor condition, but the bills are flatter and do not show the thickness and curve visible in the two western subspecies.

The three from Burma, one marked "adult", have their heads spotted rather than streaked, and are slightly smaller.

	Wing	Bill	Tarsus	Tail
(a) ♂	81, ♀ 76	12, -*	19,19	52, -
(b) ♂	80, ♀ 73, ♂? 75	-, 13, 12	19,19,19	47,43,44
(♂ ♀)	74-83	c.11-12	19-20	41-47

* The female has a deformed bill, the lower mandible measuring 14 mm and projecting beyond the upper which is only 9 mm.

EL **Melanocorypha calandra calandra** (Linnaeus) (Pyraenees) Calandra Lark

1 ♀ *Shustar*, *Southwest Iran* (February 1918)

Wing 120; bill 14.6; tail 60.

The specimen is smaller and the upperparts are darker without the yellow/rufous wash present in *psammochroa*. The bill is smaller than suggested by the length.

EL **Melanocorypha calandra psammochroa** Hartert (Dur-Badour, Khorasan, Iran) Calandra Lark

6 : 4 ♂ ♂ 1 ♀ 1 ♂?

1 *Hawi Plain*, 4 *Samarra*, 1 *Twin Canal*, *Mesopotamia*.

	Wing	Bill	Tarsus	Tail
♂ ♂	130,134,135,136	15,16(2),17	27 (2),29 (2)	65,67,68,69
♀	132	18	28	60

These birds though originally correctly identified were found with *M. bimaculata*. Apart from their larger size and the additional characters of more white both on the outer tail feathers and the inner secondaries, the white supercilium is shorter and less distinct than in *bimaculata*.

EL **Melanocorypha leucoptera** (Pallas) (Baraba Steppes, Siberia)

1 ♂ No. 8949, *Peking, China*, (cage bird) 17-1-1901.

Wing 112 (106-126, BIRDS OF U.S.S.R., Vol. 5); bill 17; tarsus 27, tail 55.

EL **Melanocorypha bimaculata bimaculata** (Menetries) (Mountains near Talysh, Transcaucasia) Bimaculated Lark.

1 *Tekkret Tigris, along Samarra-Tekret Railway, Iraq.*
Wing 124; bill 17; tarsus 27; tail 56.

892 *Melanocorypha bimaculata torquata* Blyth (Afghanistan) Eastern Calandra Lark 3 : 312

19 : 12 ♂ ♂ 5 ♀ ♀ 2 o?

5 *Meshed*, 1 *Kidri*, 1 *Birjand*, *E. Persia*; 2 Chitral, N.W.F.P. 1 Campbellpur, Attock, 1 Jagadhri, 2 Ambala, 1 Danturi Karnal, Punjab; 2 Phaladi, Jodhpur; 1 Badu, Mandvi, Kutch; 2 Calcutta Market.

	Wing	Bill	Tarsus	Tail
♂♂	112-122	15-18	26-28	54-58 av. 56
♀♀	114-121	16-17	26-27	50-53 av. 51.6
(H)	116-126	from skull 17-18	26-27	50-61)

♂ No. 8942, one of several from Meshed, with a small bill and wing (112), shows a rufous wash on the upperparts and on the breast.

The 9 from eastern Persia and Jodhpur are on the underside much whiter than all the others, and are not only a tribute to the skinning of LaPersonne, then Assistant Curator of the Society, but also a striking example of the colour transformations which can be brought about in the process of skinning.

893 *Melanocorypha maxima holderi* Reichenow (Kloster Shinse, Kansu) Ladakh Longbilled Calandra Lark 3 : 311
nil.

894 *Melanocorypha maxima maxima* Blyth (borders of Sikkim) Sikkim Longbilled Calandra Lark 3 : 311

3 : 2 ♀ ♀ 1 o? (juv.) *Tinki Deong, South Tibet.*

	Wing	Bill	Tarsus	Tail
Adults	142,150	22,22	29,30	75,81
Juv.	141	18	30	72
♂ ♀	143-154	21-24	29-30	83-93

EL *Eremophila bilopha* (Temminck) (Deserts of Aqaba, Arabia) Temminck's Horned Lark

3 : 2 ♂ ♂ 1 ♀ *Baitul Khalifa, Samarra, left bank of R. Tigris, Mesopotamia.*
Wing ♂ ♂ 97, 101, ♀ 96; bill 11.7, 11.6; tail 60, 67, 61.

895 *Eremophila alpestris albigula* (Bonaparte) (Russian Alps, restricted to Hissar Mountains by Meinertzhagen, 1928, *Ibis*: 523) Pamir-Horned Lark 3 : 307

35: Distinguished by the black of cheeks being linked with that on breast.
(a) 24 : 10 ♂ ♂ 14 ♀ ♀

1 *Asadabad Pass*, 4 *Kapi Kelen Pass* 6000', 2 *Najmabad Pass*, 2 *Turbat-i-Haidari* 5000', 1 *Turmal*, 1 *Meshed* 4500', 1 *Sehdan*, 1 *Amirabad*, 2 *Birjand*; 2 *Mud* 4300', 4 *Kaidasht Pass* 7000', 2 *Tigab*, 1 *Kain*, Eastern Iran.

	Wing	Bill	Tail
7 ad. ♂♂	115-122 av. 117.5	12.1-14.2 av. 13.7	72-80 av. 73.4
(IH 112-119 Ludlow & Kinnear;	116-124 Paludan	from skull 15-17)	
14 ♀♀	103-111 av. 108.3	12.4-13.9 av. 13.2	65-74 av. 68.8
(IH 105-109; 104-116		from skull 15-16)	

The 7 immature females are included in the measurements. If separately measured their wings, bills and tails average 2.7 mm, 0.1 mm and 1.7 mm respectively shorter than in adults with white foreheads.

All these birds from eastern Iran are very similar and are marked *albigula* by a previous worker (Ticehurst?) though the type locality is a long way north. They are all distinguished by their short bills. Most of the males show a fawnish tinge on the upperparts, while those lacking this tinge are slightly smaller and no doubt immature. The immature females also show slight differences in the colour of the upperparts and the absence of white on the forehead is presumably a sign of immaturity. ♀ No. 8913 collected at Kaidasht, Kain, on 7th December has a yellowish forehead but this may be due to staining.

(b) 2 : 1 ♂ 1 ♀ *Elburz Mts. near Tehran, Iran.*

Wing ♂ 119, ♀ 104; bill 15.5, 12.2.; tail 69, 66.

Vaurie (1951: 490) quotes Stresemann (1929 *Jour. f. Orn.* 76:361) that *albigula* is the race in the Elburz mountains. I can see no trace of yellow in either bird, either on the forehead or on the underparts, but the single ♂ has a bill appreciably larger than in those under (a) and the white band on the forehead is also narrower. The ♀ has very indistinct white on the forehead, *contra* pure white in adult (a). It may be worth mentioning that Trott (*JBNHS* 46:695) notes both *albigula* (Feb.-March) and Gould's *penicillata* (July) from the neighbourhood of Tehran.

(c) 3 : 2 ♂♂ 1 ♀ all Gilgit

	Wing	Bill	Tail
♂♂	121(2), ♀ 109	12.7, 12.9, 12.4	71,80,66

The tucked-in necks and poor condition of the specimen makes it difficult to determine whether the black of the checks and breast are confluent but a white collar is suggested. The bills are also smaller than in those under (a). All three specimens show differences in colour. ♂ No. 8931 a very old skin but without date or collector's name is very pale and may be a migrant *pallida* q.v. No. 21483 ♀ (obtained by Bidulph in February 1879) has gray, and not white checks. They are left in this group in accordance with the fact that birds from Gilgit have been so identified.

(d) 6 : 5 ♂♂ 1 ♀ 3 Chitral 1400'; 3 Chitral Ghairat

	Wing	Bill	Tail
♂♂	117-122 av. 119.2	14.2-16.7	72-80 av. 75
♀	117	13.3	75

Three each were obtained by Fulton (July) and Perreau (Feb.),

and while the black cheek-stripe appears connected with the black on the breast in all the specimens, the bills are much longer than in *albigula* and show a tendency towards *longirostris*. They are no doubt resident in the area and do not agree with any description available to me. They were marked *diluta* by ? but are quite different from topotypes of this subspecies from Kashgar (see below).

896 ***Eremophila alpestris longirostris*** (Moore) ('Neighbourhood of Agra' corrected to Kulu and restricted to Rohtang Pass) Longbilled Horned Lark 3 : 309

14 : details below:

(a) 11 : 5 ♂♂ 4 ♀♀ 2 o? (juv.)

1 *Sassirla Pass*, 15000' *Karakoram*; 3 Debring, Ladakh, 1 Rungdum Valley 12000', 1 Doha Gugma 15000', 1 Futi Runi 15000', Lahul; 1 Lasar 13000', 1 Kioto, Spiti; 2 Kashmir.

No. 20568 from *Sassirla Pass*, *Karakoram*, 15,000 ft is very pale and the bill is not as long as in the others, representing no doubt an intermediate population. Vaurie lists specimens from Debring, Ladakh, as intermediate with *elwesi*. ♂ No. 18280 from this place (the other two are juvenile) has the smallest wing and bill in the measurements below*.

(b) 3 : 2 ♂♂ 1 ♀ *Deosai Plateau* 13500' *Kashmir* (all Sept.)

All three are in fresh plumage and have their upperparts paler and almost unmarked, making them very different from those under (a). The latter are however all in worn plumage and it is not possible to comment on the validity of *deosai* Meinertzhagen, which is now generally synonymised with *longirostris*.

	Wing	Bill	Tail
♂♂ (a)	124*-130 av. 127.6	14.8*-17.5 av. 16.3	79-84 av. 81
(b)	127, mltg.	15.7, 16.4	77,84
(IH)	125-131	from skull 17-20	85-92)
♀♀ (a)	121,121, 123	15.7, 16.5(2)	76,79(2)
(b)	114	15.5	72
(IH)	115-124	from skull 18-20	76-85)

In both (a) and (b) the bills (except in the single pale bird from *Sassirla Pass*) are very distinctly larger than in the *elwesi*, *argalea* and *albigula*, (excluding those from Chitral).

897 ***Eremophila alpestris elwesi*** (Blanford) (*Kongra Lama Pass*, Sikkim) Sikkim or Elwes's Horned Lark 3 : 310

5 : 2 ♂♂ (1* by pl. & imm.) 2 ♀♀ 1 o? (juv.)

1 *Shushol*, 1 *Sasar Pass* 15-16000' *Ladakh*; 2 *Tso Morari, Tibet*; 1 *Chunthong*, Sikkim.

The adult ♂ from Sikkim has a distinct black band at the base of the bill while No. 18284* immature ♂ (by plumage) from *Tso Morari* shows traces of black both on the crown and the forehead suggesting that it is of this race, and I am for the moment leaving them together. Ticehurst (*JBNHS* 32:352) refers to *elwesi* extending as far west as *Tso Morari*.

	Wing	Bill	Tail
♂♂	116*, 120	12.4*, 13	75*, 79 *imm.
(IH)	114-123	from skull 13-15	76-89)
♀♀	110, 112	12.5, 14.2	72, 75
(IH)	109-112	from skull 13-15	73-87)

The large 14.2 mm bill of ♀ 18285 from Sasar Pass, Ladakh is an indication of the trend towards *longirostris*.

EL *Eremophila alpestris diluta* Sharpe (Central Asia, Kashgar)

3 : 3 ♂♂ 2 Kashgar, 1 *Yelpaktesh* (Chinese Turkestan).

These birds collected in January and June have their upperparts much paler than in others. Though synonymised with *albigula* they are very different in colour from the large series under 895 (a) above, and probably represents a valid subspecies.

	Wing	Bill	Tail
	120, 120, -	11.9, 14, 14	75, 76, 81

EL *Eremophila alpestris argalea* (Oberholser) (Sughet Pass, Kuen Lun Mountains)

7 : 4 ♂♂ (1* by plumage) 2 ♀♀ 1 o? (pull.)

1 *Chasha*, 1 *Khamba Dzong*, 4 *Tingri*, 15000' *Tibet*, 1* n. of *Suget Pass*, *Karakoram Range*.

Six of these were collected by A. F. R. Wollaston in July 1921 on the way to the first assault on Everest. Though marked *elwesi* (also Hingston *JBNHS* 32:325) the 3 adult males are immediately separable by the fine white streak (*contra* wider white band in *elwesi*) across the forehead. Though very distinctive, its range of distribution appears encircled by *elwesi*, as at present accepted(?).

	Wing	Bill	Tail
♂♂	117, 119(2)	12.4-13.8	70, 74, 81
♀♀	111(2)	11.8, 12	70(2)

The pullet has a yellowish wash on the chin.

No. 8930 from north of Suget Pass was collected by Stoliczka on the Forsyth Expedition in October 1873; the feathers of the forehead having fallen off, the extent of the white band cannot be determined, but it is very pale above and shows much yellowish on the white parts, both of which may be due to the age of the specimen. It is in very poor condition and no measurements are possible.

EL *Galerida cristata cristata* Linnaeus (Vienna) Crested Lark

2 ♂♂ : 1 *Dinnyes*, *W. Hungary*; 1* *Kunfeherto*, *S. Hungary*.

Wing 110, 112*; bill 16.2, 17.6*; tarsus 23.5, 25*; tail 62*, 64.

Vaurie (1959) includes *tenuirostris* C. L. Brehm (*Sarepta*, Lower Volga) with the nominate race, but No. 23428* from *S. Hungary* is so marked, and has a more slender bill than the other.

EL *Galerida cristata* subsp.

4 : 2 ♂♂ 1 ♀ 1 o? 3 *Muscat*, 1 *R. Tanhat*, *Arabia*.

Wing 105, 106, 110, 112; bill 19.1, 19.2, 20.4; tail 62, 63, 64, 65.

These specimens are very similar to *subtaurica/magna* (*infra*) but the bills are larger in series. They were taken in March (3) and April (11th) and may be migrants. Ripley has described *thomsi* from Bebel Akhdar, Muscat, as a very dark race, but that name cannot apply here, and they also appear to be out of the accepted range of *altirostris*.

EL *Galerida cristata leautungensis* Swinhoe (Talienwan, Liautung Peninsula, Manchuria)

1 ♀ Peking, China. Wing 102; bill 16.3; tarsus 23; tail 58.

Sp. No. 20570 is very old and in poor condition. The bill is shorter and stouter and the upperparts slightly browner than in *magna*.

EL *Galerida cristata subtaurica* (Kollibay) (Eregli, Taurus)

10 : 6 ♂♂ 1 ♀ 3 o?

1* Kazimain, Baghdad, 1 Felujah, R. Euphrates, 1* Nahr-Umar, 1 Basra dist.; 1 Shustar, S. Persia, 1* Mishan, S. W. Persia, 1* Hassanabad, 1 Meshed, 1 Mohmiabad, near Kain, Iran; 1* Panjgur, Baluchistan.

Subtaurica and *magna* can both be separated from Indian birds by their longer wings and tails and heavier bills, but there is considerable variation in colour and overlap in size, and the two forms are barely distinguishable. Five of them (marked*) have however been identified as *weigoldi* (= *subtaurica*) by Meinertzhagen (?) and the others have been included only because they appear indetical. Three others marked *weigoldi* have been listed under *magna* (a) for they agree more closely with those tinged with rufous.

The upperparts are slightly darker but this character is not satisfactory for in more than one instance, one of two birds taken at the same place (and once on the same day) is *subtaurica* and the other *magna* (Basra dist., no dates and Mishan, S. W. Persia, 21st Sept.).

Subtaurica does not appear to have been recorded in Baluchistan.

	Wing	Bill	Tail
♂♂	108-112 (110.5)	17.3-19.8 (18.1)	60-65 (62.5)
♀	111	18.4	64
o?	108, 112, 116	18.8, 19(2)	-61, 68

898 *Galerida cristata magna* Hume (Yarkand) Yarkand Crested Lark 3 : 345

53 : details below.

As indicated above, it is barely possible to separate *magna* from those under *subtaurica* and they are again divisible into three groups:

(a) 15 : 9 ♂♂ 1 ♀ 6 o? Large and rufous above.

1* Baitul Khalifa, Samarra, 1* Sheik Saad, 2 41 m. n.e. of Kut, right bank of Tigris, 1* Basra dist., Mesopotamia; 1 Mishan, S.W. Persia, 1 Shustar; 1 nr. Meshed; 1 Gurid, 1 Kain, 1 Chah-i-Mirza Khan, 1 Lab-Baring, Seistan; 1 Duzdap, Iran; 2 Kashgar, China.

Three* skins included here were marked *weigoldi* by Meinertzhagen (?).

♂ No. 9282 from Kashgar (Bailey, 20th June 1918) has the longest wing (118) and the bill (19) and tail (69) are also among the largest. The others all taken between 21st Sept. and 4th February may well be migrants.

(b) 28 : 12♂♂ 10♀♀ 6♂? Similar to (a) but not rufous.

1 *Felujah*, R. Euphrates, 1 *Sheik Saad*, Mesopotamia; 1 *Meshed*, 2 *Rabat-i-Mahi*, Khorasan, 3 *Turbat*, nr. *Meshed*, 1 *Amirabad*, 1 *Birjand*; 2 *Naugab*, near *Kain*, 3 *Kain*, 1 *Kidri*, nr. *Kain*, 2 *Afzalabad*, 3 *Duzdap*, 1 *Bunjar*, 3 *Chah-i-Mirza Khan*, *Seistan Delta*; 2 *Farghana-Baghdad*, *Uzbekistan*, U.S.S.R.; 1 *Bunji*, *Gilgit*.

The two unsexed birds from Farghana, Uzbekistan, obtained in June, have their upperparts greyer than in the others. They measure: Wing 111, 113; bill 15.7, 18.8; tail 64, 69.

(c) 10 : 8♂♂ 2♀♀

1 *Kain-i-Daud*, 15 m. n.w. of *Dizak*, *Persian Baluchistan*; 1 *Chaman*, 1 *Quetta*, 1 *Kalat*, *Baluchistan*; 1 *Wana*, N.W.F.P.; 3 *Campbellpur*, *Punjab*; 1 *Delhi*; 1 *Chini*, *Larkana*, *Sind*.

Nos. 9233 *Persian Baluchistan* (29th July) and 18348, *Chaman* (August) were presumably on their breeding grounds. The others from northern India, all obtained in winter, may be migrants. They differ from those under *chendoola* in their slightly larger wings and bills; in some the bills are not as stout as in *magna* and they are separated on the basis of their longer tails—an apparently consistent character of *magna* and others.

	Wing	Bill	Tail
♂♂			
(a)	106-114, one 118 (111.2)	16.3-19.5 (18.3)	62-69 (65)
(b)	104-115 (111)	16.3-20 (17.7)	62-69 (64.6)
(c)	102-107 (105.3)	16.1-17.9 (17.3)	59-64 (60.7)
(H)	109-116	from skull 20-22)	
♀♀			
(a)	102, 105	17, 17.2	61-62
(b)	100-112, one 117 (105.4)	16.1-17.5, one 19.1 (16.7)	57-63, one 69 (61.2)
(c)	102, 103	16.3, 17.8	61-62
(H)	106-109	from skull 20-22)	

The three from Campbellpur have a narrower band of spots across the breast and the same applies to No. 18342 from the same place which I have placed under *chendoola* for its shorter tail.

No. 9237 is an exceptionally large female (*Rabat-i-Mahi*, *Khorasan*, 20th Jan. Wing 117, bill 19.1, tail 69). Is it possible that the largest birds are *magna* while all the others, including some under *subtaurica* represent an intermediate population, which is also migratory?

899 *Galerida cristata chendoola* Franklin (Between *Calcutta* and *Benares*) *Indian Crested Lark*

36 : details below:

3 : 343

(a) 27 : 10♂♂ (juv.) 13♀♀ 4♂? (1 juv.)

1 Jammu, Kashmir; 1 Campbellpur, 1 Lahore, 1 Murakpur, near Ambala, Punjab; 1 Bhong, 1 Harunabad, Bahawalpur; 2 Delhi; 1 Tilwara, Jhunni R., Jodhpur; 4 Meerut, 2 Kanpur, 1 Fatehpur, U.P.; 2 Bhagowni, Tirhut, 1 Rajputtee, Saran, 1 Hanowshi, Samastipur, Bihar, 1 Radhanpur, 1 Jamnagar, 1 Dwarka, Okhamandal, 1 Khari Rohar, 2 Kharaghoda, 1 Mandvi, Gujarat.

Some of the specimens from Gujarat are grey on the upperparts, approaching the colour of the nominate race and quite equal to that of the single *lynesi* available. Fresh material is required to permit the adjustments which appear necessary.

(b) 9 : 4♂♂ 3♀♀ 2♂♂?

1* Kalo Karim, 1 Shiraz, 1 Charbar, Iran; 1 Geh, 1 Gusht, Dizak, Persian Baluchistan; 2 Chitral Drosh, 1 Kilia Drosh, 1 Wana, N.W.F.P.

While the small difference in size would not warrant a subspecific separation from *chendoola*, these specimens are much paler on their upperparts and it is not possible to decide if this difference is natural or due to fading. No. 9216 ♂ from Kalo Karim, Fars, obtained by Capito was recorded as *magna*, but the small 102 mm wing and 56 mm tail, together with the other similar specimens, leave little doubt that either *chendoola* or another small subspecies is resident through southern Baluchistan and Iran, as far west as Shiraz (July). As in northern India, the position is confused by larger winter migrants visiting the same areas, and the fact that the majority of specimens has been collected in the cold weather. Though unable to offer any very definite results, I have the impression that the individual variation in size is not so random as suggested by earlier workers and that sufficient material and study would fit them into more compact groups.

	Wing	Bill	Tail
(a) ♂♂	97-101 (99.2)	16.2-17.9 (17.2)	54-57 (55)
(M)	98-105	from skull 19-23	54-63
(a) ♀♀	93-101 (96.3)	15.7-17.5 (16.7)	51-56 (54)
(M)	92-98	—	51-55
(b) ♂♀	97-104 (101.1)	15-17-16.2)	53-58, one 61 (57)

♂ 9273 from Chitral Drosh obtained on 14th April has a 61 mm tail, but all the others have them under 60 mm including ♀ 9274 (56 mm) obtained at the same place on the same day.

Group (c) under *magna* (898) is separated by the longer tail but may perhaps represent this population. Some of the more recent skins, particularly from Gujarat have the grey of the underparts approaching that of the nominate race, and more distinctive than in the single *lynesi* available.

900 *Galerida cristata lynesi* Whistler (Gilgit) Gilgit Crested Lark

1♀ 4900' Gilgit, Kashmere, 12th June 1928.

Wing 96; bill 16.4; tail 55.

This specimen is not distinguished from Gujarat under *chendoola* (a).

901 *Galerida malabarica* (Scopoli) Malabar Crested Lark 3 : 348

29 : 15 ♂♂ (1 juv.) 11 ♀♀ 3 o? (1* juv., 1* chick)

6 Salsette, Bombay; 1* Bhiwandi, 1 Belapur Road, 2 Murbad Road, Kalyan, Thana; 1 Panvel, 1* Kihim, 1 Nagotna, Kolaba; 1 Walwan, Poona; 1 Panchgani, Satara; 2* Rajapur, 1 Ratnagiri, 1 Bhatkal, 1 Gotegole, 1 Manki, 1 Karwar, 1 North Kanara; 2 Talewadi, Belgaum, 2 Mercara, Coorg; 1 Honametti, Mysore; 1 Kethi, 6700', Nilgiris.

	Wing	Bill	Tail
♂♂	89-102 (96)	13-6-16 (14.8)	46-55 (51.2)
(IH)	98-105	from skull 16-18	54-63
♀♀	90-98 (93.5)	14-14.6 (14.7)	47-55 (50)
(IH)	91-94	from skull 16-17	46-52

In the present series, the northernmost birds from Bombay and surrounding areas (which are the freshest) can be distinguished from others from North Kanara and southwards by the purer white of the underparts, particularly the lower belly; but it is not possible to determine to what extent this difference is natural or due to foxing/staining. Sp. No. 23886, Bhiwandi, Thana, which had a soft skull has the breast-spots on a background which is darker than the chin and belly, and which forms a distinct patch across the breast. Similar bands are visible in other specimens and may be an indication of immaturity. The material available does not support Koelz's *propinqua* (1939) from Londa, N. Kanara which was said to have the breasts paler and less prominently marked than those from the south.

902 *Galerida deva* (Sykes) (Dukhun) Sykes's Crested Lark 3 : 347

26 : 17 ♂♂ (2* juv.) 7 ♀♀ (1* juv.) 2 o?

1 Mandvi, 1 Padhar, 2 Chaduva, Bhuj, 1 Kutch; 1 Dalkhania, 1 Amreli, 1 Kodinar, S. Kathiawar, 1 Sait, Kaira, 2 Dohad; 2* Devlali, 2 Dindori, 3 Nasik, 1 Aurangabad, 1 Khangaon, Poona; 1* Ratlam, 1 Sardarpur, Gwalior, 1 Dodi, Malwa Plateau, Bhopal, 1* Mandu, Dhar State, C.I.; 1 Cawnpore, 1 Agra (cage bird).

	Wing	Bill	Tarsus	Tail
♂♂	83-91 (85.3)	12-14	20-21	48-52 (50.6)
(IH)	84-92	from skull 13-15	20-21	46-54
♀♀	78-83 (80.8)	11-13	20-21	45-49 (47)
(IH)	76-86	from skull 13-15	20-21	43-50

Some have more rufous underparts than others but this is probably due to foxing. A few have their breasts more heavily marked.

903 *Alauda arvensis dulcivox* Brooks (Himalayas and plains of northwestern Punjab amended to Djarkent, Russian Turkestan) West Siberian Skylark

11 : 4 ♂♂ 7 ♀♀

1 Sheik Saad, 1 Amara, Mesopotamia; 1 Majas, Persian Baluchistan; 1 Wana, Waziristan; 2 Rawalpindi, 1 Karnal, 4 Ambala, Punjab.

In series, these are slightly paler and more rufous than the other skylarks, but all are old specimens and the amount of overlap makes it

impossible to separate *dulcivox*, *cantarella* and *intermedia*(?). They were however examined by Ticehurst and the grouping is on the basis of his identifications on the labels.

	Wing	Bill	Tail
♂♂ <i>dulcivox</i>	115,116,118,121	12,12.6,13,13.6	65,69,70 (2)
(IH)	114-120	from skull 15-16	66-76)
<i>cantarella</i>	115,116,122	12.9,13.5,-	66,68,72
(IH)	115	from skull 15	70)
<i>intermedia</i> (?)	109,113,114,118	11.7,11.9,12.1,12.8	65 (3),66
<i>pekinensis</i>	101,109	11,11.7	60,63
<i>nominate arvensis</i>	117	13.1	69
♀♀			
<i>dulcivox</i>	104-112 (107.5)	11.3, 12.3 (11.9)	60-66 (63)
(IH)	104-120	from skull 14-16	61-70)
<i>cantarella</i>	106,107,115	12,12.8 (2)	74
(IH)	108	from skull 14	67)
<i>intermedia</i> (?)	108,109,119	11.8,12.3 (2)	64 (2),73
<i>pekinensis</i>	107,114	10.7,11.1	62,65
<i>nominate arvensis</i>	111,112	11.2 (2)	60 (2)

903a *Alauda arvensis cantarella* Bonaparte (Central Italy) Caucasian Skylark

14 : 3♂♂ 3♀♀ 80?

4 *Hawi plains, Samarra, 1 Sheikh Saad, 2 Shatt-el-Adhain, 2 Feluja, 1 Mosul*
1 *Kazimain; 2 Bhong, Indus Riverain, Bahawalpur, Punjab, 1♀ no data.*

These are slightly darker than *dulcivox*, but see remarks and measurements under 903.

♂ No. 8964 from Mosul with a 122 mm wing and heavy bill is very rufous.

EL *Alauda arvensis intermedia* (?)

7:4♂♂ 3♀♀ 1 *Gorid 7000', Kain, 5 Amirabad, 1 Birjand, Eastern Persia.*

These specimens have their upperparts slightly paler than in *cantarella* and the breasts also appear more clearly spotted than the others. But all were obtained by LaPersonne and the differences may well be due to the high standard of his skinning to which I have referred. The subspecific name, scribbled in pencil, on the label does not bear the author's name and with the transfer of the type locality of the subspecies *intermedia* to Shanghai it is difficult to guess what subspecies was meant. It is significant that Ticehurst does not refer to *intermedia* in the *Birds of Mesopotamia* but in a subsequent note (1926, *JBNHS* 31:96) while referring to some fresh specimens he apparently synonymises *intermedia* with *dulcivox*, while Vaurie (1959:56) indicates that the name has been used by authors "other than Swinhoe, for Zaleshi's *kiborti*." The present specimens were all obtained in December-January and one label is marked "in large flocks".

EL *Alauda arvensis arvensis* Linnaeus (Sweden) Skylark

3 : 1♂ 2♀♀ *St. Catherine's Lighthouse, U.K.*

The specimens show a rufous wash on the upperparts, more pro-

nounced than in the others, except *pekinensis* (q.v.).

Measurements under 903.

EL *Alauda arvensis pekinensis* Swinhoc (Pekin, now Peiping)
Chinese Skylark

5 : 2♂♂ 2♀♀ 1♂?

4 Peking, 1 Foochow, China.

All are over 70 years old and the resemblance to nominate *arvensis* may be due to foxing. They have noticeably smaller bills.

Measurements under 903.

904 *Alauda gulgula inconspicua* Severtzov (Turkestan) Turkestan
Small Skylark

2♂♂ :

1 (No. 21413) Karahalpak Village Ferghana, Tuya-Kurgan region; 1 (No. 8985) 10,000 ft Chitral.

The Turkestan specimen dated 13th June 1937 has small, fine streaks on the breast and the upperparts are very faintly marked. Though the latter character may be included in the variations among Indian birds, the bill and tail are noticeably larger, and I am prompted to leave northern Indian resident birds as *punjaubi* (q.v.). The second is included here for its wing and tail are larger than in *punjaubi*, and having been collected on 2nd July was no doubt resident in the neighbourhood.

Measurements under 907.

904a *Alauda gulgula punjaubi* Whistler (Ferozepur, Sutlej River)
Punjab Skylark

17 : details below:

Except for a statement by an unnamed reviewer of Sálím Ali's BIRDS OF TRAVANCORE AND COCHIN (*Ibis* 1937, p. 189) I can find no authority for synonymising *punjaubi* with *inconspicua* as has been done in INDIAN HANDBOOK (5:44).

The *inconspicua* (No. 21213) from almost the type locality has a larger bill than any of the specimens from northern India, and the tail (61 mm) is also larger than in most. With this material, *punjaubi* appears to be distinct and I am listing them separately. The eastern birds from the United Provinces are old and faded, and though in all probability identical, I am listing them separately under the same name.

(a) Fresh western birds: 8 : 2♂♂ 4♀♀ 2?

1 Jagadhri, Ambala, 1 Karnal, 2 Daulatpur, 1 Chacharan, Bahawalpur, 1 Mandvi, Kutch; 1 Satanwara, Gwalior; 1 Sarsava, near Saharanpur, U.P.

Nos. 9056 ♂ from Mandvi, Kutch, and 9055 ♀ Gwalior are in worn plumage, with the upperparts showing a pattern different from that of the others. The former (8th March) is from the range of the newly-described *dharmakumarsinhji* and is no doubt a migrant into the area.

(b) Eastern and faded (?): 9 : 7♂♂ 2♀♀

3 Meerut, 6 Kanpur, U.P.

Both groups, (a) and (b) are slightly larger than nominate *gulgula* and have the underparts white rather than buffish.

Measurements under 907.

905 *Alauda gulgula lhamarum* R. & A. Meinertzhagen (Ladak = *guttata* Brooks) Kashmir Skylark 3 : 318

9 : 4♂♂ (1 by size) 4♀♀ 1♂?

1 Srinagar, 1 Chasm Sharif, 1 Sooknas, Kishtwar, 1 Cashmir 7000', 1 Kashmere; 1 Fagu, Keonthal State, 2 Simla Hills, 1 Darazpur, Ambala.

Distinguished from *punjaubi* by the more prominent rufous on the breast which is marked with heavy spotting. The chin is also irregularly and faintly spotted, a character missing in the neighbouring subspecies, but specifically said to be absent in *lhamarum* by Dementiev *et al.* (1970 para 535). There is some variation in the colour of the upperparts and all the specimens are not identical. The birds from Simla and Darazpur were collected in November/December and bear notes suggesting that they are migrants to the area, but with the data available, there is no alternative but to leave them all together. It may be mentioned that Stuart Baker (FAUNA 8:663) has drawn attention to the type being a carbo-lized specimen in immature plumage.

Measurements under 907.

906 *Alauda gulgula inopinata* Bianchi (Tibet) Tibetan Small Skylark 3 : 316

2♂♂ *Tingri, S. Tibet* (July 1921, A.F.R. Wollaston).

Breast well streaked but on white background. The wings (101 and 105) are smaller than indicated in Vaurie "averaging about 109".

Measurements under 907.

907 *Alauda gulgula gulgula* Franklin (The Ganges between Calcutta and Benares) Indian Small Skylark 3 : 319

17 : 13♂♂ 3♀♀ 1♂?

1 Jabalpure, M.P.; 1 Rajapur, Ratnagiri; 2 Karwar, N. Kanara; 8 Godavari Delta; 1 Chilka Lake, Orissa; 1 Manjhaul, Monghyr, Bihar; 2 Dibrugarh, Assam; 1 *Shurdaung, Prome, Burma.*

When describing *punjaubi* (JBNHS 38:767) Whistler changed the type locality of *gulgula* from between Calcutta and Benares "to the Ganges between Calcutta and Benares". As Vaurie (1951) has already pointed out, this is no improvement for in the same place he stated that *punjaubi* extended as far east as Dinapur, which is on the Ganges between Calcutta and Benares!

	Wing	Bill	Tail
♂ ♂			
<i>inconspicua</i>	97,102	13.6,14	60,61
<i>punjaubi</i> (a)	93,97	13.9,14	54,55
<i>punjaubi</i> (b)	95-100 (98)	11.8-13.8(12.8)	50-56 (54.6)
(IH)	90-101	from skull 16-17)	
<i>lhamarum</i> (4)	96-103 (100)	12.6-13.7 (13.1)	55-62 (58.7)
(IH)	98-108	from skull 13-16)	
<i>inopinata</i>	101,105	12.6, -	59,61
(IH)	102-108	from skull 15-16	60-68)
<i>gulgula</i>	86-95 (90)	13.2-14.9 (14.2)	46-52 (49.6)
(IH)	87-93	from skull 14-16	49-56)
<i>australis</i>	90,92,94,96	12.5,13.3,13.7,14.2	48,50,51,53
(IH)	90-102	from skull 14-17	49-56)
<i>dharmakumarsinhjii</i>	91,92,93,95	12.2,15,15.4,-	47,51,52,56
♀ ♀			
<i>punjaubi</i> (a)	87.92	13-13.3	49-53
<i>punjaubi</i> (b)	89,99	13.6,13.6	47,53
(IH)	90-101	from skull 16-17)	
<i>lhamarum</i> ° (4)	92-98 (94.5)	11.8-13 (12.4)	53-59 (55)
(IH)	93-97	from skull 14-15)	
<i>gulgula</i>	85,85,88	13,13.1,13.6	46,48,50
(IH)	82-88	from skull 13-15	49-51)
<i>australis</i>	84,87,95,96	12.6,14(2),14.4	46,47,50,52
(IH)	82-88	from skull 13-15	49-51)

907a *Alauda gulgula dharmakumarsinhjii* Abdulali (Bhavnagar)
Longclawed Skylark

7:4 ♂♂ 1♀ 2♂? (Type and paratypes)

1 Mandvi, Kutch, 1 Saiat, Kaira district, 5 Bhavnagar, Gujarat.

This has been separated on the basis of the long hind claw and other differences (*JBNHS* 72(2):448.

Measurements under 907.

908 *Alauda gulgula australis* Brooks (Ootacamund, Nilgiris) Nilgiri
Skylark 3 : 320

9 : 5 ♂♂ 4 ♀♀

2 Avalanche, Nilgiris, 1* Wadakancheri 400' Cochin, 1 Camp Deramalai, Panthalam Hills, 1 Santhanpara, Cardamom Hills, 1 Perumalmai, 1 Peer-made, 1 Munnar, 1* Travancore.

The two marked (*) are very similar to *gulgula* and may indicate a connection at the base of ghats, restricting *australis* to the hills.

♂ 2908 from Ratnagiri, south of Bombay, is dark above and would have been included in this subspecies were it not for two pale (and old) specimens from Karwar which have probably faded. This requires further examination.

Alauda gulgula subsp. ?

4 : details below.

(a) 2 ♀♀ Nos. 20206 and 20641 from Kalat, and Sultanabad, 64 m south of Kalat, Baluchistan.

Wing 92, 92; bill 12.4, 12.4; tail 52, mltg.

Both have the juvenile characters of a rufous wash all over and rounded pale-margined feathers on the head and I cannot improve upon Ticehurst who left them subspecifically undetermined.

(b) 2♂ Mt. Victoria, 7000 ft, Pakokku Hill Tracts, Central Burma.
Wing 94, 95; bill 12.5, 13; tail 49, 51.

These birds were collected on 9th and 16th May 1906 by K. C. Macdonald, and the latter is marked as shot off nest with 3 set eggs. 'In notes on some birds recorded from Burma', Garthwaite and Ticehurst (*JBNHS* 39:558) refer to two larks by Col. Rippon on Mt. Victoria which were first named *arvensis*. This name was scratched out and changed to *japonicus* by Oates, and they thought that these specimens had served to create the erroneous records of *Anthus japonicus* and *Alauda japonicus*, and decided that they were really *A. gulgula weigoldi* Hartert (Hamkow, Hupeh, Yangtze Valley) which was found in Szechwan, S. E. Tibet and N. Yunnan, being more rusty and darker than *A. g. coelivox* (Southeastern China to Central Annam).

The skins show a lot of foxing but they are too dark to be nominate *gulgula* and the measurements, particularly of the tail, do not agree with those of any of the northern races.

909 *Alauda gulgula vernayi* Mayr (Changyinhku, Burma-Yunnan border) Yunnan Skylark

I have also examined 15 skins from Bhutan which are not yet registered, obtained in recent years by Sálím Ali. They fall into two distinct groups:

- (a) 9 : 6♂♂ . 1♀ 2♂? Gyitsa 10,000 ft. and Bumthang, Central Bhutan.
(b) 6 : 4♂♂ . 2♀♀ Eastern Bhutan

The western birds have fewer but longer streaks on the breast and there is considerable difference in the intensity of rufous on the breast. They show very distinct pale edges to most of the feathers of the upper surface presenting a very different appearance. Their bills are also much shorter. In both, the streaks at the sides of the upper breast, have coalesced into black blotches, a character mentioned in *IND. HANDBOOK for lhamarum*. The specimens which I have grouped under *lhamarum*, mostly from Kashmir, do not show this character and I am afraid that with the descriptions available, I am unable to decide if either of them is *vernayi*.

	Wing	Bill	Tail
(a) ♂♀	96-107 av. 103	11.8-12.7 av. 12.2	59-67 av. 61.1
(b) ♂♀	102-105 av. 104	12.4-13.7 av. 13	59-64 av. 61.2

After these notes were completed, the Bhutan birds were sent to Dr. B. Biswas who has identified group (a) as *inopinata* and (b) as *vernayi*. The former differ from the two specimens from Tingri, South Tibet, named *inopinata* by me above, in having a shorter and more

conical bill, a longer but slender hind claw (6 ♂♂ 15.5-18.8 av. 17.4) and more rufous above. The last may be due to the Tingri birds being in worn plumage but the other characters appear consistent.

There appears to be little doubt that the geographic variations in this Skylark are not yet fully understood, and more material and work is necessary. The key to the species in IND. HANDBOOK (5:41) refers to the 5th primary of *arvensis* falling short of tip of wing by more than 5 mm, and by less than 5 mm in *gulgula*. In the specimens handled, all *arvensis* show a large gap between the 5th primary and tip of wing and while this is an excellent character for separating the two species, the gap in most *gulgula* is over 5 and nearer 10 mm and the latter figure would serve as a more reliable index.

(to be continued)

Field Guide to the Amphibians of Western India

PART 3

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(With two plates)*

[Continued from Vol. 60(3): 702]

This part of the Field Guide has been long overdue but owing to other preoccupations, I was not able to compile my notes earlier. The first two sections namely Introduction and Families Caecilidae & Bufonidae as part 1, and Family Microhylidae as part 2 appeared in Vol. 60, pp. 415-438 and 690-702, (1963) of this *Journal*. This section describes a part of the Family Ranidae. The next and concluding section will describe the remaining ranid species and the tree frogs of the Family Rhacophoridae. The assistance given by Miss S. Isaac, Research Assistant at the Society is gratefully acknowledged.

Family RANIDAE: Frogs

The family Ranidae includes the "true frogs" and is after the family Bufonidae the most widely distributed of amphibian families, occurring in all the zoogeographical regions of the world except the Australian. Though the distribution of the family extends nearly to the arctic circle, the majority of the species are tropical in distribution. Aquatic and semiterrestrial forms predominate; a few are semi-arboreal. The skin is moist and frogs require a humid environment. The species of the family can be distinguished from all other Indian amphibia, except the tree frogs of the Family Rhacophoridae, by the presence of teeth on the upper jaw and the bifid tip of the tongue. One genus of Ranidae, the *Ooeidozyga*, is an exception in having the tongue entire and not bifid. This genus has not been reported from western India. The Rhacophorid tree frogs differ from the ranid frogs in having an additional cartilagenous phalange between the penultimate phalanges of their toes (*see* fig. 13 of Pt. 1 of this series, Vol. 60:426).

Four genera of the family Ranidae occur in western India. They can be distinguished by the following key.

KEY TO THE GENERA IN WESTERN INDIA OF THE FAMILY RANIDAE

- 1 Pupil horizontal or roundish-subtriangular 2
- 1 Pupil vertical 3
- 2 Vomerine teeth present (see fig. 9 in pt. 1, Vol. 60, p. 423) *Rana*
- 2 Vomerine teeth absent *Micrixalus*
- 3 Skin wrinkled, toes webbed *Nyctibatrachus*
- 3 Skin smooth, toes free *Nannobatrachus*

Nyctibatrachus and *Nannobatrachus* are endemic to the Western Ghats. The genus *Nyctibatrachus* occurs as far north as Matheran near Bombay. *Nannobatrachus* is rare and is so far known only from the Tirunelveli Hills in Tamil Nadu.

The majority of the species of the family are of the genus *Rana*. Four subgenera of the genus *Rana* occur in western India. These can be distinguished by the following key.

Genus *Rana* Linn. 1766

KEY TO THE SUBGENERA IN WESTERN INDIA OF THE GENUS *Rana*

- 1 Discs of toe tips if present without groove 2
- 1 Discs of toe tips with a crescentic or horse-shoe shaped circum-marginal groove (see fig. 14 in pt. 1, Vol. 60, p. 426) 3
- 2 Outer metatarsals separated by web up to base or at least in the distal half (see fig. 12a in Pt. 1, Vol. 60, p. 425) *Rana*
- 2 Outer metatarsals united completely or feebly separated at the distal end (see fig. 12b, in Pt. 1, Vol. 60, p. 425). Inner metatarsal tubercle enlarged usually shovel shaped or crescentic *Tomopterna*
- 3 Tongue with a long pitted papilla (see fig. 7b in Pt. 1, Vol. 60, p. 423) *Discodeles*
- 3 Tongue without a papilla; outer metatarsals usually separated by web to the base *Hylorana*

The following species of the four subgenera have been recorded from western India.

Subgenus <i>Rana</i>	<i>Rana (Tomopterna) dobsonii</i>
<i>Rana (Rana) hexadactyla</i>	Subgenus <i>Discodeles</i>
<i>Rana (Rana) cyanophlyctis</i>	<i>Rana (Discodeles) beddomii</i>
<i>Rana (Rana) tigrina</i>	<i>Rana (Discodeles) leithii</i>
<i>Rana (Rana) crassa</i>	<i>Rana (Discodeles) semipalmata</i>
<i>Rana (Rana) verrucosa</i>	<i>Rana (Discodeles) leptodactyla</i>
<i>Rana (Rana) limnocharis</i>	<i>Rana (Discodeles) diplosticta</i>
<i>Rana (Rana) brevipalmata</i>	<i>Rana (Discodeles) phrynoderma</i>
<i>Rana (Rana) malabarica</i>	Subgenus <i>Hylorana</i>
Subgenus <i>Tomopterna</i>	<i>Rana (Hylorana) curtipes</i>
<i>Rana (Tomopterna) rufescens</i>	<i>Rana (Hylorana) aurantiaca</i>
<i>Rana (Tomopterna) breviceps</i>	<i>Rana (Hylorana) temporalis</i>

Subgenus *Rana*

Aquatic and semi-terrestrial species Many are widely distributed and occur different habitats. All commercially exploited species of

Indian amphibia belong to this subgenus. The species occurring in western India can be separated by the following key.

KEY TO THE SPECIES OF *Rana* (*Rana*) OCCURRING IN WESTERN INDIA

- 1 Toes completely webbed (see fig. 12a in pt. 1, Vol. 60, p. 425) 2
- 1 Toes incompletely webbed 5
- 2 Skin of back with longitudinal folds (see fig. 4 in pt. 1, Vol. 60, p. 422) 3
- 2 Skin of back smooth or with tubercles and warts 4
- 3 Inner metatarsal tubercle strongly compressed, crescentic (see fig. 12f in pt. 1, Vol. 60, p. 425); Heels do not overlap when legs are folded at right angles to the body (see fig. 11b in pt. 1, Vol. 60, p. 424) *crassa*
- 3 Inner metatarsal tubercle comparatively smaller, blunt; heels overlap when the legs are folded at right angles to the body *tigerina*
- 4 Size large; skin of back smooth, 2 rows of porous warts on flanks (see fig. 5 in pt. 1, Vol. 60, p. 422); snout flat, obtusely pointed *hexadactyla*
- 4 Size smaller up to 60 mm; skin warty; a single row of porous warts on flanks; snout rounded; inner metatarsal tubercle fingerlike ... *cyanophlyctis*
- 5 A distinct dorso-lateral glandular fold from above tympanum to vent (see fig. 2 in pt. 1, Vol. 60, p. 422); back between the glandular folds, bright orange or yellowish red or red crimson *malabarica*
- 5 Dorso-lateral glandular fold absent; no distinctive colour pattern 6
- 6 Toes 3/4th webbed, 2 phalanges of 4th toe free; outer metatarsals separated by web nearly to base. Tibiotarsal articulation reaches nostril or tip of snout (see fig. 10, in pt. 1, Vol. 60, p. 424) *verrucosa*
- 6 Toes 1/2 webbed, 3 phalanges of 4th toe free; outer metatarsals united in the basal half; Tibiotarsal articulation reaches nostril *limnocharis*
- 6 Toes feebly webbed, web not reaching 2nd phalange of toes; outer metatarsals separated by web nearly to base. Tibiotarsal articulation reaches tip of snout or beyond *brevipalmata*

***Rana hexadactyla* Lesson 1834: Indian Pond Frog**

Diagnosis. Size large. Females reach 130 mm in snout to vent length. The flattish snout with indistinct canthus rostralis, the absence of longitudinal folds on the back and the web of the toes reaching the tip of toes distinguishes it from *Rana tigerina* and *Rana crassa* of equivalent size. Tympanum distinct, equal to or slightly less than diameter of eye. First finger longer than or equal to second. Toes fully webbed. A strong dermal fringe on the outer toes. Outer metatarsals separated nearly up to base by web. Tibio-tarsal articulation reaches tympanum or eye when the leg is held along the body. A small but prominent inner metatarsal tubercle.

Skin smooth above, warty on the flanks, anal area, and throat. Pustular on thighs. Two curved series of closely arranged porous warts from behind the shoulder to the groin and from the axilla to the groin distinct during the breeding season. A U-shaped line of warts above the anus and occasionally extending up the flanks. A glandular fold from behind the eye to the shoulder.

Colour. Bright grass green or olive green above, with or without a pale yellow vertebral line from snout to vent. A black streak along the eye to the shoulder fold. Behind the thighs patterned in black and white or yellow. Ventrally and on flanks white or yellowish white. Throat occasionally stippled with brown.

The juvenile has bars or spots of dark green and black on the back. Thighs with horizontal bars of black and white which may extend up to the abdomen. The largest specimen with this distinctive coloration in the *BNHS* collection measures 52 mm from snout to vent.

Distribution. South and east India up to Calcutta, along the east coast. In the Peninsula its northern limits are not definite. McCann (1934, 1940)^{1&2} records this species from Bombay. The specimens are not in the *BNHS* collections. While it is likely that the species occurs in the Bombay area, it has not been since collected in and around Bombay. There is a record from Punjab. Along the west coast, the *BNHS* collection has specimens from as far north as Goa.

Breeding. The male has external vocal sacs and acquires nuptial pads on the outer aspect of the first and second fingers at breeding time. Call unknown.

The season commences with the monsoon and perhaps even during the premonsoon showers spawning might happen as suggested by juveniles in the *BNHS* collection obtained from Palghat, Kerala from March to June. In areas which receive both the southwest and northeast monsoons, two broods occur. At Trivandrum, Kerala, Ferguson (1904)³ records the breeding season as lasting from July to September, while I have collected gravid females in October and just metamorphosed juveniles in January from the same area. The breeding habits are not fully known. Ferguson (op. cit.) states that the eggs are laid in paddy fields. Juveniles were collected by me from decaying vegetation in a drying pond. Gravid females contain 2,000+ eggs of less than a millimetre. Bhaduri (1944)⁴ describes the tadpoles collected in the environs of Calcutta as olive green above with darker blotches and whitish below, the anterior portion being transparent. Teeth rows in mouth disc five but usually two are lost. Metamorphosed young with a rudiment of the tail range from 17 to 27 mm in snout to vent length but within

¹ McCANN, C. (1934): Occurrence of the Si-toed Frog (*Rana hexadactyla* Lesson) in the Bombay Presidency. *J. Bombay nat. Hist. Soc.* 37:742.

² ——— (1940): A reptile and amphibian miscellany. *ibid.* 42:57.

³ FERGUSON, H. S. (1904): A list of Travancore batrachians. *ibid.* 15:499-509.

⁴ BHADURI, J. L. (1944): Further locality records of *Rana hexadactyla* Lesson in Bengal with brief notes on its tadpoles. *ibid.* 44:484.

this size range specimens with completely absorbed tail have also been collected.

Habits. The preferred habitat of this frog, perhaps the most aquatic of Indian amphibia, is ponds with dense aquatic vegetation where, while resting on the surface, its colour merges with the green of the plants. I have also seen the frog resting among brown drying weeds where its colour stood out in startling contrast! The frog keeps clear of open water. The preference for vegetation is probably related to the protection it may receive from aerial and aquatic predators. A wild caught specimen contained dragonfly larvae and snails. In captivity they take insects and smaller frogs. The species is common in the ponds and weed grown stretches of water along the east coast of the peninsula in Tamil Nadu. It is probably more widespread than its recorded distribution suggests and is possibly often confused with the Indian Bull Frog *Rana tigerina*. It is reported to be eaten in the Madras area (Annandale in Boulenger 1920)⁵ and would form a part of the commercial catches from Tamil Nadu and other areas in the south.

***Rana cyanophlyctis* Schneider 1799: Skipper Frog**

Diagnosis. Medium sized frogs. Large females rarely exceeding 60 mm in snout to vent length. Male much smaller. Distinguished from *Rana hexadactyla* by its smaller size, colour, and by the following characters: Snout rounded, first and second fingers more or less equal in length. Tibio-tarsal articulation reaches up to either between the nostril and eye or the eye or the tympanum when held against the side of the body. Toe tips swollen and rounded. A single line of porous warts on flanks, from behind the shoulder to the groin. Inner metatarsal tubercle finger-like.

Skin dorsally warty. A strong fold from behind the eye to the shoulder. An U-shaped line of warts above the anus as in *Rana hexadactyla*. Ventrally smooth.

Colour. Grey, olive, brown or blackish above with darker spots or marblings dorsally. A dark-edged white band on the back of the thighs. Ventrally white, often spotted, vermiculated or marbled with black. The black on the belly is commoner and more widespread in the larger females.

Distribution. Throughout the Indian Peninsula from the Himalayas southwards, Iran, South Arabia, Sri Lanka, Nepal and Thailand.

⁵ ANNADALE, N. In BOULENGER (1920): Monograph of the South Asian, Papuan, Melanasian and Australian frogs of the Genus *Rana*. *Rec. Indian Mus.* 20:1-223.

Breeding. While calling the vocal sacs of the males project through slits on the floor of the mouth. The inflated sacs are bluish white in colour hence the name *cyanophlyctis* for the species. The call is distinctive and easily recognised. McCann (1932)⁶ compares it to the low pitched rattle of castnets. The call, though more often heard during the rainy season, is heard at other times of the year also and I believe is the only frog call heard near permanent water throughout the year.

The eggs are laid in a frothy mass in standing water though I have collected tadpoles from a fairly large stream, these were possibly a secondary introduction. Tadpoles brown in colour with darker blotches on the tail. Mouth disc with three rows of teeth, one on the upper and two on the lower lip. Beak heavy, black. A black palatine plate inside the mouth. Tadpoles vary considerably in size. McCann's (op. cit.) largest specimen with fully developed hind limbs measured 44 mm, whereas I have collected specimens in the same developmental stage measuring 74 mm in length. Tadpoles from Arabia are larger exceeding 100 mm in length (Anderson 1895).⁷ The tadpoles are larvivorous (McCann, op. cit.). Juveniles at metamorphosis measure 17 to 19 mm and resemble the adult in colour and pattern.

Habits. The commonest and most easily seen of Indian frogs, inhabiting all biotopes of the country. It prefers still waters where it can float placidly on the surface. Most ponds, rain puddles and other stretches of water usually have one or two floating on the surface and several squatting along the edges. The ability of this species to skip over the surface of the water like a ricocheting stone was first remarked upon by Emperor Babar in the 16th century. In association with this habit this frog, unlike other species, does not let the hind legs dangle but has them parallel to the surface of the water permitting the quick flurry of strokes necessary for the skipping get away. After skipping for some distance the animal may remain on the surface, or make a short dive and return to the surface or dive and scramble into the mud at the bottom depending on the extent of its alarm. The distance covered in the skipping alarm flight depends on whether the frog had taken off from land or water. The skipper is both diurnal and nocturnal and during the rainy season wanders considerably on land at night. Where permanent water is available it is seen throughout the year. In other areas it aestivates. Annandale (*in* Boulenger 1920) records seeing them at Quetta (Pakistan) floating sluggishly on the surface of a well whose sides were frozen. It is fairly tolerant of brackish water as well as water

⁶ McCANN, C. (1932): Notes on Indian Batrachians. *J. Bombay nat. Hist. Soc.* 32:152-180.

⁷ ANDERSON, J. (1895): Reptiles and Batrachians from Aden. *Proc. Zool. Soc. London.* p. 600.

polluted by industrial effluents. The food consists of insects and small vertebrates.

***Rana tigrina* (Daud.): Indian Bull Frog**

Diagnosis. Size large; adult females occasionally exceeding 160 mm in snout to vent length. Males smaller. Snout obtusely pointed, projecting beyond the mouth. Tympanum distinct, equal to or slightly smaller than the diameter of the eye. First finger longer than second. Toes fully webbed but the web does not reach the tip of the third toe. Fifth toe with an outer fringe of web. Outer metatarsals separated by web nearly to the base. An obtuse inner metatarsal tubercle. Tibio-tarsal articulation reaches the eye or between the eye and the nostril. Heels overlap when folded at right angles to the body.

Skin smooth or granulate above with distinct longitudinal glandular folds. A fold from behind the eye to the shoulder. Ventral skin, smooth.

Colour. Olive green or brown above with darker markings. A light coloured vertebral streak from snout to vent often present. Limbs barred or spotted.

The juvenile is dark green above with dark brown markings and a black line along the side of the head.

Secondary Sex Characters: Male with external vocal sacs which are bright blue during breeding season. Forelimbs thick. The inner side of the first finger with a horny pad, velvety in texture, and greyish brown in colour. Males at breeding congregations in the Bombay area are bright yellow. This colour which is evident at breeding congregations changes to a sober brown if the animal is removed elsewhere.

Distribution. Throughout the Indian Subregion; Sri Lanka; Burma to Indo-China; South China; Formosa.

Breeding. As in the majority of Indian amphibia, the season coincides with the arrival of the monsoon rains. A detailed account of the breeding habits of the species in the Bombay area has been given by McCann (1932) and is summarised below. The first heavy showers of the monsoon bring frogs out of their aestivation retreats. The males in their lemon yellow livery congregate in rain water pools and ditches. Croaking loudly they alertly await the females which are fought over, the nearest male usually succeeds in holding on to the female and fending off competitors by kicking strongly with the hind legs. The spawn is laid in rain water pools and other transitory water. The eggs which float when laid, later sink to the bottom where they hatch. The tadpole is omnivorous and is usually a bottom feeder, only occasionally coming to the surface. According to McCann they are larvivorous.



Above: *Rana tigerina*; Below: *Rana cyanophlyctis*.
(Photos: R. Whitaker)



Above: *Rana breviceps*; Middle: *Rana malabarica* (Photos: R. Whitaker);
Below: *Rana limnocharis* (Photo: S. R. Nayak) Male, Calling at night.

Habits. The largest of the Indian amphibia, the Bull Frog is widely distributed from the fringes of the deserts to c 2000 m elevation in the hills. Though not as aquatic as *Rana hexadactyla*, every spread of permanent or semi-permanent water has its complement of members of this species hiding in the grass or hollows at the very edge of the water, ready to dive in at the least sign of danger. Usually they blend so well with their habitat that it is difficult to locate them. In the non-breeding season they are silent but at the beginning of the rainy season their call, a deep toned, *oong awang* can be heard throughout the night, each new shower being welcomed with a fresh uproar. Another sound heard only when the frog is caught by a predator is an almost human scream. The frog sometimes gives out a chukle-like *kut kut kut* when caught by hand.

In the absence of permanent water in areas where there is a definite and prolonged dry season, the frog aestivates, singly or several together. In sandy areas they follow the falling water table; instances are on record of specimens being collected at depths of 6 to 9 metres. It is, however, a hardy species able to withstand considerable desiccation.

The diet is catholic and anything in movement which can be swallowed is swallowed, the hands being used to thrust in the unwieldy sections of the prey. In addition to the normal diet of insects which varies with seasonal abundance of the prey species and is not selective, the Bull Frog is reported to have taken mice, shrews, birds up to the size of the Pitta (*Pitta brachyura*), snakes upto a metre in length, Spiny tailed Lizard (*Uromastyx*), toads, other frogs including smaller sized frogs of its own kind, land crabs etc. It is in turn fed on by waterfowl aquatic animals from fishes to crocodiles and various land animals. There is now heavy commercial exploitation of this species, the legs being exported. The rate of exploitation with selective collection of the larger forms is a serious drain on the breeding population and will affect the status of the species as well as its commercial importance unless reasonable safeguards are legislated. One of the adverse effects of removal of the frog now noticed in agricultural areas, is the increase in the number of land crabs and the consequent damage to wet land crops.

Rana crassa Jerdon 1853: Jerdon's Bull Frog

Diagnosis. Very closely resembles *Rana tigerina* but can be distinguished by its shorter leg; the tibio-tarsal articulation reaches only to the tympanum or the eye. The heels do not overlap when the legs are folded at right angles to the body. The inner metatarsal tubercle is distinctive being crescentic and nearly one to one and a half times the length of the inner toe.

Colour. Grey, brown, or green with darker markings. White below, occasionally with black spots on the throat.

Breeding. This species has been confused with *tigerina* and information on its larval stages are not reliable. The breeding habits need to be studied particularly with regard to the characters responsible for reproductive isolation from the closely allied *Rana tigerina*.

Distribution. Peninsular India and the Gangetic Plain. In the west coast upto Malabar. In the east up to Calcutta. Sri Lanka.

Habits. Apart from the fact that it is an excellent burrower unlike *tigerina* no separate records are available of its habits from those of *tigerina*, with which species it has been confused till recently. The young like those of *Rana tigerina* are seen in temporary rain water pools. I have collected adults near tanks in Tamil Nadu. The ecology and behaviour of the sympatric *Rana crassa* and *Rana tigerina* are excellent problems for investigation.

***Rana verrucosa* Gunther 1875**

Diagnosis. Medium sized frogs (up to 61 mm in snout to vent length). Snout obtuse, tympanum distinct nearly the size of the eye. First finger longer than second. Tibio-tarsal articulation reaches nostril or tip of snout; heels strongly overlap when folded at right angles to the body. Toes fully webbed except the fourth which has two phalanges free. A dermal fringe to the fifth toe. Outer meta-tarsals separated nearly to the base. Two meta-tarsal tubercles, the inner larger. A short tarsal fold.

The skin of the back is extremely warty hence the name *verrucosa*. A fold from eye to shoulder. Ventrally smooth.

Colour. Dark grey or brown above with darker markings. A light vertebral streak if present interrupted by the markings on the back. Limbs and lips barred. Sides of the thigh patterned in black and yellow. Ventrally white.

Secondary sexual characters. Male with internal vocal sacs. Pads on the inner aspects of the first finger well developed and base of thighs granular in the male.

Breeding. Call not recorded. Breeding habits unknown. The tadpoles collected from a forest pool in Kerala in September has been described by Annandale (1915).⁸ The mouth disc has five rows of teeth, a marginal row followed by an interrupted row in the upper and three

⁸ ANNANDALE, N. A. (1915): Some undescribed tadpoles from the hills of southern India. *Rec. Indian Mus.* 15:17-23.

unbroken rows in the lower lip. A gravid female was collected in south Kerala in November suggesting that there may be two breeding seasons in some areas.

Distribution. Hill forests of Kerala and Tamil Nadu up to 2000 metres.

Habits. Little known. I have collected this species from the side small fast flowing hill streams overhung with vegetation in the hill forests of south Kerala. Ferguson (op. cit.) reported them from similar situations. Annandale (op. cit.) records that "It is very abundant in the Travancore Hills" and that the species avoids small springs and pools and is usually found at the edge of streams and reservoirs. The coloration is to a certain extent cryptic.

***Rana limnocharis* Boie in Wiegmann, 1835: Indian Cricket Frog**

Diagnosis. Small sized frogs, the majority of specimens seen hardly exceeding 35 mm in snout to vent length. Maximum size recorded, ♂ 51 mm, ♀ 64 mm. Breeding commences at a much smaller size, 20 mm ♂ and 23 mm ♀. Distinguished from other ranids by the smaller size and the brief webbing of the toes, usually half webbed with three phalanges of the fourth toe free. The tibio-tarsal articulation reaches the nostril when the leg is held along the body. Outer metatarsals united in the basal half or third. An inner and an outer metatarsal tubercles present. First finger longer than the second.

Skin warty above often with longitudinal glandular folds, short and interrupted. A strong fold from eye to above shoulder. Smooth below.

Male with a median subgular external vocal sac. The vocal sac area becomes black in the breeding season. A strong pad appears on the inner aspect of the first finger of the breeding male.

Colour. Usually grey or brown with darker markings. Lips and legs often with darker bars. A vertebral band of varying width often present. Ventrally white.

Distribution. East Asia from Pakistan to Japan. Apart from the typical form, three races have been named from India, namely *nilagrica* from the Nilgiri Hills in Tamil Nadu; *syhadrensis* from the western ghats near Bombay; and *andamanensis* from the Andaman group. The races are not readily distinguishable.

Breeding. Specimens in a ready to breed condition have been collected from March to August and October to January. The breeding season coincides with the monsoon rains and in areas like Trivandrum which receive both monsoons there are two distinct breeding seasons. However the occurrence of frogs in breeding condition in March and again in October-December at Mahableshwar in Satara Dt., Maharashtra,

which receives only the SW Monsoon cannot be easily explained. The species apparently does not have a fixed breeding season if conditions suitable for breeding are continuously available.

I have located and collected males calling from under the soil during the breeding season. McCann (1932) compares the call to the loud clatter of castanets and according to Minton (1966)⁹ the call is "a series of loud staccato notes often delivered in bursts suggesting telegraphy". I would compare the call to that of the cricket.

***Rana brevipalmata* Peters 1871**

Diagnosis. Medium sized frogs (snout to vent length 47 mm) closely resembling *Rana limnocharis* but can be separated by the longer hind limbs and shorter web between the toes. Snout pointed, tympanum distinct, first finger longer than second, hind limbs long the tibiotarsal articulation reaching the tip of the snout or beyond; heels strongly overlapping when the legs are folded at right angles to the body. Toes slender, feebly webbed, web not reaching to second phalange of toe. Outer metatarsals separated nearly to the base by web. Inner metatarsal tubercle prominent, half or more the length of the inner toe. A small outer metatarsal tubercle. Skin warty above, smooth below.

Colour. Greyish above with darker markings. White below.

Distribution. Malabar (Kerala); Nilgiris (Tamil Nadu).

Breeding. Male with a pair of vocal sacs and a strong pad on the side of the first finger. Breeding habits and tadpole unknown.

Habits. Unknown.

***Rana malabarica* (Bibr.) 1838: Fungoid Frog**

Diagnosis. Medium sized frogs, the largest in the BNHS collection has a snout to vent length of 81 mm. Adults easily recognised by their distinctive coloration. Snout obtuse, projecting slightly beyond the mouth. Tympanum very distinct, slightly less or equal to the diameter of the eye. Tips of fingers and toes swollen. First finger longer than second. Tibio-tarsal articulation reaches the tympanum or the eye when the leg is held along the body. Heels overlap feebly when the legs are folded at right angles to the body. Toes feebly webbed, two or three phalanges of the fourth toe free. Subarticular tubercles on fingers and toes and inner and outer meta-tarsal tubercles large and prominent.

Skin smooth or granular above with a distinct dorso-lateral glan-

⁹ MINTON JR., SHERMAN, A. (1966): A contribution to the herpetology of West Pakistan. *Bull. American Mus. nat. Hist.* 134:55.

dular fold from above the tympanum to the groin. A shorter fold terminating in a large gland below the tympanum or is continued as a line of glands along the flanks. Ventrally granulate on belly and the underside of the thighs.

Colour. Back bright orange red, yellowish red, or crimson, from the tip of the snout to vent, distinctly separated from the black of the flanks along the canthus rostralis, upper eyelid, and the dorso-lateral fold. Upper lip white and the colour may extend along the line of glands on one sides. Ventrally white, uniform or spotted or marbled with black. Throat and chest often wholly brownish black or black. Legs brown or black barred or marbled with yellowish white. The barring in some of the young specimens (19 mm snout to vent length) resemble stripes.

Juvenile collected in May were greyish or yellowish white above instead of red (snout to vent length 14 mm).

Distribution. The Western Ghats and the lowlands west of the Ghats from Kasara Ghat in Nasik Dist., Maharashtra to Edanad, Chenganur Dist., Kerala. It is possible that the range extends further south but I have not seen it in the Trivandrum area nor has Ferguson (op. cit.) included it in his list of Travancore batrachia. The species is known from the Nilgiris and has been reported from Jagdalpur, Bastar, M.P. (J. C. Daniel & Selukar 1964).¹⁰ It is possible that it may occur in suitable biotopes in other areas of the Eastern Ghats and perhaps in other areas of Peninsular India.

Breeding. Male with feebly developed external vocal sacs and a velvety pad on the inner aspect of the first finger at the breeding season and a glandular area on the anterior portion of the arm.

The breeding season commences with the onset of the monsoon and the northward extension of the rains along the range of the species. Females collected in Edanad, Kerala in March had enlarged ovaries with granular developing ova while the ovaries of specimens collected at Kanheri Caves, Bombay in the same month were dormant. In May females from Talewadi, N. Kanara were spent and just metamorphosed young were noticed. Females from the Bombay area collected in May and early June were gravid. McCann (1940) records a female with eggs in July and Chari (1962)¹¹ collected tadpoles of different stages

¹⁰ DANIEL, J. C. & SELUKAR, T. G. (1964): Occurrence of the fungoid frog *Rana malabarica* (Bibr.) at Jagdalpur, Bastar District, M.P. *J. Bombay nat. Hist. Soc.* 60:743-744.

¹¹ CHARI, V. K. (1962): A description of the hitherto undescribed tadpoles of, and some field notes on the Fungoid Frog, *Rana malabarica* Bibron. *J. Bombay nat. Hist. Soc.* 59:71-76.

in August and the first week of September which supports McCann's observation that the species is a late breeder in the Bombay area. However it is possible that the species has an extended breeding season. The difference in size between the sexes is not very apparent but the largest specimen collected was a female.

The species breeds in still water, preferring shallow pools holding weeds or grass in forest or open country. The call which is given out by the male with sitting at the edge of such pools has been syllabilised by Abdulali (*in* Chari, *op. cit.*) as *wack, wack, wack*. My own observations support a treble version of this syllabilisation. However, McCann (1940) compares the call to the noise made by a tin rattle.

Chari (*op. cit.*) has shown that Boulenger's (*op. cit.*) description of the tadpole was based on misidentification. The tadpole according to Chari is straw yellow in colour and has the head and body blotched with brownish black and tail speckled with black. Mouth disc has one row of teeth on the upper lip and two, the inner interrupted, on the lower lip. Occasionally a short third row. Largest tadpole was 48 mm in total length. Metamorphosis was completed in two months and 18 days after collection of tadpoles. The period is perhaps less in nature.

Habits. This species prefers forested land though it has been recorded in open country particularly in the breeding season. McCann (1936) notes that it is semi-arboreal and may often be seen at considerable heights on trees. When on trees the red coloration of the back is said to resemble red bark fungus and the oblitative pattern of the rest of the body breaks the outline of the body merging the animal into the background; hence the trivial name "Fungoid Frog". McCann (1964) records that a powerful fungoid odour was given out under excitement by a specimen he caught at Tansa Lake near Bombay in May. Abdulali (*op. cit.*) records the odour of a specimen he collected in the same area as resembling burnt rubber. The frog is not as agile as other species and is easily caught and perhaps the coloration is apsomatic. I have seen them mainly at night though McCann (1932) states that they are diurnal. Later (1940) he noted that several specimens that lived in his house were nocturnal. In summer months a large number may gather in moist areas. Such congregations have been observed in the moist cisterns of Kanheri Caves at Bombay and P. B. Shekar (*Per. Communication*) who collected the species at Edanad in Kerala reports that he saw over 30 frogs inside a well in March sitting on the sides above the water. As noted by Abdulali (*op. cit.*) the species does not breed in such areas but in rain water pools. A land frog it is reluctant to enter water and avoids doing so except for breeding.

Subgenus *Tomopterna*: Burrowing Frogs

The species of this subgenus are usually seen only during the breeding season when they surface to breed. In appearance they resemble the burrowing microhylids but have a much larger head. The inner metatarsal tubercle is much enlarged, crescentic in shape and in most species exceeds the inner toe in length. It is the main burrowing tool. The food is ants and other subterranean insects. Three species occur in Western India.

KEY TO THE SPECIES OF *Rana* (*Tomopterna*) IN WESTERN INDIA

- 1 An outer metatarsal tubercle present; Tibiotarsal articulation reaches tympanum or posterior border of eye *rufescens*
- 1 Outer metatarsal tubercle absent; tibiotarsal articulation does not reach beyond shoulder 2
- 2 Snout shorter than eye in length; toes 1/4 to 1/2 webbed *breviceps*
- 2 Snout as long as eye; web toes rudimentary *dobsoni*

***Rana rufescens* (Jerdon) 1854: Rufescent Burrowing Frog**

Diagnosis. Medium sized frogs, the largest specimen in the BNHS collection has a snout to vent length of 43 mm. Head broader than long with rounded snout and distinct tympanum about half or slightly over half the diameter of the eye. First finger much longer than the second, third equal to or slightly longer than the first. Tibio-tarsal articulation reaches tympanum or posterior border of the eye. Heels slightly overlapping when legs are folded at right angles to the body. Toes feebly webbed. One phalange of 1st and 2nd toes free; 2 phalanges of 3rd and 5th toes and 3 phalanges of 4th toe free. Sub-articular tubercles of fingers and toes prominent. Inner meta-tarsal tubercle large, nearly one-third the length of the inner toe and is compressed and crescentic in shape. A small outer meta-tarsal tubercle.

In the field it can be easily confused with *Rana limnocharis* but can be distinguished by the size and shape of the meta-tarsal tubercle and the much more rounded snout.

Skin with numerous warts above and two glandular ridges forming an inverted open V between the shoulders. A glandular fold from the eye to the shoulder. Ventrally smooth except on the back of the thighs where it is granular.

Colour. Brown above with darker spots and marblings. Occasionally a crossbar between eyes. Lips and limbs barred. Most specimens have patches of varying shades of red on them and in some almost the whole dorsal surface may be brick red.

Distribution. Salsette Island, Bombay, southwards along the Western Ghats to Malabar.

Breeding. The male has external vocal sacs appearing as blackish folds on the sides of the throat in the breeding season. A strong pad on the first finger. Call not recorded. Females collected in June at Kanheri Caves, Salsette Island, Bombay and at Gersoppa, North Kanara were gravid. Gravid and spent females have been collected in the Koyna area in July. Abdulali (1962)¹² records a pair in copula in June at Kanheri Caves. The tadpole has not been described so far.

Habits. Little known. It is an uncommon frog. A burrower, it is mainly seen during the early monsoon months, when juveniles and adults have been collected near water and in grass. Adults have been seen at other times of the year in forests under logs and stones.

Rana breviceps Schneider 1799: Indian Burrowing Frog

Diagnosis. Medium sized frogs. Adults in the BNHS collection average 56 mm (range 43 to 65 mm) females and 48 mm (range 41 to 56 mm) males in snout to vent length. Snout short, less than the diameter of eye in length, rounded. Tympanum distinct, approximately three-fifth the diameter of the eye. First finger considerably longer than second, equal to or a little shorter than the third. Tibio-tarsal articulation reaches the shoulder. Heels do not meet when the legs are folded at right angles to the body. Web on toes does not reach the last phalange of the first to third and the fifth toes. Two phalanges of the 4th free. Outer metatarsals bound together. Sub-articular tubercles prominent. Inner metatarsal tubercle, large, compressed, crescentic and more than the inner toe in length. No outer tubercle.

A small circular tubercle occurs on the tarso-metatarsal joint in some specimens from south India. The presence of this tubercle was first noticed in specimens collected at Trivandrum in Kerala (Bhaduri & Kirpalani 1954)¹³ and the occurrence of this tubercle was recorded in specimens from Sri Lanka and India south of c. 17°. Specimens from the range of the species north of 17° latitude lack the tubercle. However specimens without tubercle also occur south of latitude 17°. While collecting at Trivandrum the specimens studied by Bhaduri & Kripalani, I was struck by their remarkable resemblance to species of the Microhylid genus *Uperodon* rather than the *Rana breviceps*. I was familiar with in the Bombay area. The colour too was markedly different being greyish with darker markings instead of the uniform brown of the back in specimens from the Bombay area. It is possible that the southern

¹² ABDULALI, H. (1962): An account of a trip to the Barapede Cave, Talewadi, Belgaum District, Karnataka State, with some notes on Reptiles and Amphibians. *J. Bombay nat. Hist. Soc.* 59:228-237.

¹³ BHADURI, J. L. & KIRPALANI, MIRA, (1954): Notes on the frog *Rana breviceps* Schneider. *J. Bombay nat. Hist. Soc.* 52:620-623.

form with the tarsal tubercle may be a sibling species but more information is needed on the ecology and behaviour of the frog for a conclusion.

Skin smooth or finely granular on the back and coarsely granular on the belly and underside of the thighs. Throat and chest smooth. Occasionally glandular folds and warts on the back. A glandular fold from behind the eye to the shoulder.

Colour. Uniform light or dark brown or grey above, occasionally spotted or marbled with yellow or white. Ventrally white. Throat sometimes brownish. Lips barred. Thighs ventrally marbled with yellow or white. A yellow vertebral streak often present. A black canthal (snout) streak often present, particularly in juveniles. Lip white in some specimens from Bombay.

Distribution. Throughout the Indian Peninsula from the Himalayas to the Cape, Nepal, Burma, Sri Lanka.

Breeding. Males with vocal sacs forming folds on the sides of the throat. Some specimens with an additional fold across the throat in front of the shoulder. Throat black in breeding males. The throat and chest of breeding males granular and present a finely speckled appearance from the presence of pustules.

The call is a soft *awang* which can be heard at a good distance. The breeding season commences with the onset of the monsoon. There is no particularly preferred site for the spawning. I have collected tadpoles in cisterns, rain water pools, pools in quarries, in small hill streams and in shallow and fairly deep water with and without weeds. Females with gravid and spent ovaries have been collected in June and July suggesting that individuals mature at different times. Tadpoles at various stages of development have been collected from the beginning of June to end of July in the Kanheri Caves area of Salsette Island, Bombay, and in May at Talewadi, Karnataka. At Trivandrum, tadpoles were collected in October. Apparently there are two breeding seasons at Trivandrum coinciding with the two monsoons. The tadpole is a bottom feeder and the time of development is 18 to 20 days (C. R. N. Rao 1915).¹⁴

The juvenile measures 8 to 10 mm at metamorphosis. Juveniles have been collected in June and July in the Bombay area and at Surat Dangs. I found the juveniles to be very numerous around rock quarry pools at Tuticorin in Tamil Nadu, in January. These were pale brown with darker spots and resembled young *Rana crassa* found in the same area but could be separated by the shorter webbing of the toes.

¹⁴ RAO, C. R. N. (1915): Notes on some south Indian Batrachia. *Rec. Indian Mus.* 11:31-38.

Habits. A burrowing species, there is little information on their habits. They are seen only during the early monsoon months when they surface to breed. The juveniles are commonly seen for a short period after they metamorphose hopping around the pools from which they emerged.

Rana dobsonii Boulenger 1882: Dobson's Burrowing Frog

Described on the basis of two females collected at Mangalore, south Kanara, measuring 55 mm and 57 mm in snout to vent length. The species differs from *Rana breviceps* only in the snout being equal to the eye in length and the web the toes being rudimentary. I have not seen this species.

(to be continued)

Miscellaneous Notes

1. NOTES ON THE STATUS OF THE NOSELEAF BAT, *HIPPOSIDEROS SPEORIS PULCHELLUS* ANDERSEN (MAMMALIA: CHIROPTERA: RHINOLOPHIDAE)

While preparing a catalogue of Chiroptera in the collections of the Zoological Survey of India, Calcutta, specimens of *Hipposideros speoris speoris* (Schneider) and *H. speoris pulchellus* Andersen presented some difficulty in separation. An attempt is made in this paper to settle the problem. Notes on geographical distribution of the species are also included.

MATERIAL: 1 ♀, Baroda, Gujarat: 19 ♂, 13 ♀, Coorg, Kanara, Bellary (Vijayanagar), Gadag, Belgaum and Deccan, Karnataka: 6 ♂, 4 ♀, Trivandrum, Kerala: 2 ♂, 6 ♀, 1 (unsexed), Salem, Nagercoil and Tiruchirapalli, Tamil Nadu: 2 ♂, 1 ♀; Cuddapah and Palkonda Hills, Andhra Pradesh: 10 ♂, 2 ♀, 5 (unsexed); Sri Lanka.

TABLE

MEASUREMENTS (IN MM) OF *Hipposideros speoris* (SCHNEIDER) FROM THE DISTRIBUTIONAL RANGE OF *H. s. speoris* AND *H. s. pulchellus*

	Mysore (Bellary)	Peninsular India (excluding Bellary)	Ceylon
EXTERNAL:	7 ♂, 6 ♀	23 ♂, 15 ♀	10 ♂ 2 ♀
Length of forearm:	47-52 (50.1)*	49-54 (51.4)	50-54 (52.1)
Length of tibia:	20-23 (21.8)	19.5-25 (21.7)	19-24 (21)
Length of foot including Claws:	8-9 (8.7)	7-10 (8.4)	7.5-9.5 (8.8)
SKULL:	2 ♂, 4 ♀	12 ♂, 5 ♀	4 ♂, 2 ♀
Total length:	18-19 (18.3)	18.1-19.2 (18.4)	18-19 (18.6)
Zygomatic width:	10.3-11.5 (10.8)	10.3-11.7 (10.9)	10.6-11.4 (11.1)
Cranial width:	8.5-8.8 (8.7)	8-9.7 (8.4)	8.2-8.9 (8.5)
Length of upper tooth row ($c-m^2$):	7-7.4 (7.1)	6.8-7.3 (7.1)	7-7.5 (7.3)
Length of lower tooth row (c_1-m_3):	7.5-8.2 (7.7)	7.2-8 (7.8)	7.5-8.3 (7.9)
Length of mandible:	12.6-13.5 (13)	12.5-13.5 (13.1)	12.8-13.5 (13.2)

* Average measurements given in parentheses.

Andersen (1917) separated *pulchellus* (Bellary population) from *speoris* only on average measurements: skull length 18-19.8 mm (18.8) vs. 19-20.3 mm (19.7) and forearm 45.8-51 mm (49.5) vs. 49.8-54 mm (52). From a study of the material of the species from the range of the two 'subspecies', I find that there is no difference in their external or cranial measurements (Table), as mentioned by Anderson (1918). I would therefore, treat *H. speoris pulchellus* Andersen as a synonym of *H. speoris speoris* (Schneider).

The species has hitherto been known to range from Peninsular India, Sri Lanka east to Java, Sumatra and Timor. Brosset (1962) mentioned its absence in Gujarat but one specimen examined by me from Baroda (Gujarat) belongs to this species.

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DESERT REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JODHPUR (RAJASTHAN),
July 10, 1973.

Y. P. SINHA

REFERENCES

- ANDERSEN, K. (1918): Diagnosis of new bats of the families Rhinolophidae and Megadermatidae. *Ann. Mag. nat. Hist.* (9) 2:374-384.
- BROSSET, A. (1962): The bats of Central and Western India. II. *J. Bombay nat. Hist. Soc.* 59:583-624.

2. A NOTE ON ECOLOGY OF THE GOLDEN LANGUR (*PRESBYTIS GEEI* KHAJURIA)

INTRODUCTION

A survey of Manas Sanctuary was undertaken to investigate the distribution of the fauna and to ascertain the present position of the Golden Langur (*Presbytis geei* Khajuria) in the Sanctuary area. The period of survey was from 8th to 18th January 1974. The area within and around the sanctuary were covered by Jeep, on foot, by boat and on elephant back. This report also includes findings of 4 surveys in Garo Hills area pertaining to *Presbytis geei*.

DISTRIBUTION

Gee (1961) gave the distribution of the species as the areas east of River Sankosh and west of River Manas in north west Assam. Further, he presumed (1961, 1964) from reports of sportsman and animal dealers that Golden Langur is present in small numbers in Garo Hill district of Meghalaya and foot hill areas of Khasi Hills although he himself could not spot a single one in these areas. Initiated by a report to the Bombay Natural History Society and a request from the Society to undertake a survey in Garo Hill a serious search was started by Eastern Regional Station, Zoological Survey of India and in February 1970 a party headed by Dr. G. M. Yazdani (10 Feb.-28 Feb. 1971) surveyed certain areas of Garo Hills (Tikrikillah, Tura, Baghmara, Rongdong, Dudhnai) but could not spot a single *P. geei*. A second survey was undertaken in 1971, led by Dr. R. S. Pillai (7th April-16 April 1971) in those areas (Dudhnai, Damra, Darugiri) where Golden Langur was reported but the result was negative. Later in April 1973 and November 1973 two more extensive surveys were made, headed by one of the authors (S. Biswas) in Garo Hill district including areas e.g., Dhudhnai, Dainadubi, Bangshi, Wageasi, Rongjeng, Songsok, Rongrengiri (4 April-24 April 1973) and Bajengdoba, Anogiri, Rongram, Songsok and Damra (3 Nov.-24 Nov. 1973) but no Golden Langur could be observed. It may further be added that the junior author (S. Biswas) had also surveyed Goalpara district of Assam adjoining Garo Hills but failed to notice any Golden Langur in the area.

The present survey confirms Gee's (op. cit.) observation that Golden Langurs are not found on east bank of Manas, as a survey in the areas extending from Mathonguri via Falaguri to Kahitama did not reveal any Golden Langur. It also supports earlier observation of its occurrence in west bank of Manas in Bhutan Forest areas as on 4 different dates troops of Golden Langur were observed only in a part (10 sq km) of this evergreen forest.

STUDY AREA

The present survey included an area of 50 km on each side of river Manas from Mathonguri to Kahit and 10 km on the west bank of Manas in the forested hills of Bhutan. The Golden Langur, as already stated, was seen only in the Bhutan side; this area has steep hills covered by evergreen forest with a gentle slope near Manas river. The forest in study area in the foothill has tall trees such as *Lagerstroemia parviflora* Roxb. [Assamese: Sida], *Salmaalina malabarica* DC. (Schat & Eudl.) [Assamese: Simul], *Dalbergia sissoo* Roxb. [Assamese: Sisoo],

Amoora wallichii King [Assamese: Amaril], *Trewia nudiflora* Linn. [Assamese: Bhelkor], *Ficus* and *Terminalia* spp. besides some shrubby undergrowth.

In the area two troops of Golden Langurs observed, no solitary male was seen. The home range of the troops during the survey appeared to be 3×2 km each with an overlapping region.

TROOP ORGANISATION

Both troops had only one adult male but more than one adult female and adolescent animals of various age groups. In troop 1 only one female with infant was seen whereas in troop No. 2, two females with infants were observed. Troop 1 consisted of 9 members including one adult male, one adult female, 2 subadults and 1 infant and troop 2 consisted of 6 members 1 adult male, 1 subadult male, 2 adult females, 2 infants.

FEEDING BEHAVIOUR

Gee (1961) listed nine trees on which the Golden Langurs were seen feeding (Buds, leaves, flowers and fruits); in the present study the langurs were observed feeding on flowers of *Salmalia malabarica*, (and this appears to be the most preferred food), and fruits of *Amoora wallichii* and *Trewia nudiflora* the last two food plants were not included in Gee's (op. cit.) list. The langurs pick up flowers of *Salmalia* in quick succession and throw the petals down after eating the calyx; while eating fruits of *Amoora* and *Trewia* they were never seen to eat the whole and often after eating a part throw the rest to the ground. Tall branches of trees were always selected for eating and movement from tree to trees or branches was always swift and together. The feeding time varied from 8.30-9.30 a.m., 11.30 a.m. to 1 p.m., 1.30-2.00 p.m. and it appeared that feeding usually coincided with bright sunshine as on the second and third day mentioned earlier, the sky was overcast till noon.

MOVEMENT

Golden langurs appear to prefer tall trees for movement and during the present survey they were never seen below 8 m. They never seemed to be bothered by our observation and even looked down at us from tall trees. They are facile in their movement from one tree to other or from a higher to lower branch, always seen to leap straight and hardly missing the next target. When disturbed, the troop moves very

fast from one tree to the next and continues moving till they reach a suitable tree with foliage cover.

RESTING, AGRESSION, VOCAL COMMUNICATION

The resting langurs usually groom each other. The infant sticks close to the breast of mother and the adult male usually sits on a higher branch looking around.

Only on one day (15-1-1974) was an adult male seen chasing a subadult male on two different occasions and hitting him, when the subadult and the females, screeched. The loud joyous sounding whoops so often made by the common langur [*Presbytis entellus* (Dufresne)], was never heard.

Mating activity was not observed during the present study.

RELATIONSHIP WITH OTHER ANIMALS

The Common langur [*P. entellus* (Dufresne)] and the Capped langur (*P. pileatus* Blyth) present otherwise in Manas Sanctuary area were never seen in association with the Golden Langur.

The only animal which was observed to share food from the same tree with the golden langur was the Malayan giant squirrel *Ratufa bicolor* Sparrmann, and the langur did not seem to object to the presence of these animals.

COLOUR

The colour of different members of the troops vary considerably. The young as also the females appear to be silvery white to light golden whereas the adult male always showed rich golden colour in most part of its fur. Gee (op. cit.) stated that cream or white colour was seen in warm weather and the rich golden to chestnut colour was restricted to colder months but our observations reveal colour differentiation in age and sex groups.

DISCUSSION

During the present study it became obvious that the west bank of Manas in Bhutan forest region has become much less dense than during Gee's earlier observation period and consequently when the golden

langurs come to the fringe areas of forest near the elephant track III, they can be more easily observed. Due to complete protection these animals appear to have become accustomed to human beings.

The infants seen with the troops seemed to be 1-2 months old and as such the young must have been born during November. As reported by the Divisional Forest Officer in charge of Gauhati Zoo, the langur in captivity does not seem to have any particular mating period but the two babies born in captivity were during July and August.

The existence of Golden Langurs in Garo hill district is still to be proved. Gee's (op. cit.) personal attempt as well as four extensive surveys made from this station did not yield a single evidence so far. The definite area of distribution remains between Sankosh and Manas, in a strip of country along the Bhutan border.

The migration of these langurs to the high hills during summer has yet to be investigated but the Divisional Forest Officer of Bhutan forests informed the senior author that he has seen Golden Langurs upto 1600 m on Bhutan Hills on west bank of Manas, during summer months.

Besides the two troops seen during the present study, it is reported that two other troops exist on the Bhutan side of Manas within an area of 15-20 sq km and future studies may well provide data from 4 troops in the study area. The elephant track in the Bhutan forest offers excellent opportunity to track these animals.

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EASTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
SHILLONG 3,
April 16, 1974.

A. K. GHOSH
S. BISWAS

REFERENCES

- GEE, E. P. (1961): The distribution and feeding habits of Golden Langur, *Presbytis geei* (Khajuria, 1956). *J. Bombay nat. Hist. Soc.* 58 (1):1-12.
- GEE, E. P. (1964). The wild life of India. Collins. London. p. 192.

3. A NOTE ON THE BREEDING HABITS OF FOUR-HORNED ANTELOPE (*TETRACERUS QUADRICORNIS*) IN CAPTIVITY

Specimens of the Fourhorned Antelope or Chowsingha have been received from different parts of Orissa and exhibited at Nandankanan Biological Park, Orissa from time to time. Some notes on the breeding habits of this species observed in this Park are presented here.

So far eleven young have been produced in six births including five twins with an average of 1.83 young per litter. Out of these, 4 were males and 7 were females. The sex ratio of males to females was 1:1.75. The six births were distributed as follows: January, 3; March, 2; and April, 1.

The weight and size at birth of seven young born during 1973 and 1974 were as follows: Weight—from 0.75 to 1.2 kg with an average of 1.04 kg; length from tip to tip—from 42 to 45 cm an average of 43.5 cm and the shoulder height—from 24.5 to 27 cm with an average of 25.2 cm. The one young which weighed 0.75 kg and measured 42 cm at birth died on 13th day.

One female born here on 15-iv-1972 has given birth to a single young for the first time on 12-i-1974 at the age of 1 year, 8 months and 29 days or say 1 year and 9 months. This remained with an adult male throughout this period. Another female received in this Park on 13-v-1971 at an estimated age of about one month gave birth to twin young for the first time on 19-i-1973 at an estimated age of about 1 year and 9 months. This had remained with an adult male from the estimated age of about six months. Taking the gestation period as 8 to 8½ months (Prater 1971) the age of sexual maturity of these two females can be said to be about one year to one year and one month.

One female gave birth thrice during the period from April, 1972 to January, 1974 i.e. 15-iv-1972, 29-iii-1973 and 9-i-1974. So the interparturition interval observed twice in this animal was 347 days and 285 days respectively.

The breeding season is in the hot weather and rains and young are born from October to February (Prater loc. cit.). Asdell (1964) states that in the London Zoo three births had taken place in February and others in May and June and twins were produced in three of the five births. According to Walker *et al.* (1964) mating takes place during the rainy season and the young, one to three in number, are born in January or February.

At birth a fawn of fourhorned antelope weighed 2¼ pounds, measured 15 inches in length and the shoulder height was 10 inches (Shull 1958). The average weight of four young of this species was 1.081 kg, the average length was 46.3 cm and the average shoulder height was 27 cm at birth (Acharjyo & Misra 1972).

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CUTTACK 1 (ORISSA),
March 16, 1974.

R. MISRA

REFERENCES

- ACHARJYO, L. N. & MISRA, R. (1972): Cheetal—Journal of Wild Life Preservation Society of India, Vol. 15, No. 2, pp. 64-67.
- ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, p. 581.
- PRATER, S. H. (1971): The Book of Indian Animals, Third (Revised) Edition, Bombay Natural History Society, Bombay pp. 271-272.
- SHULL, E. M. (1958): Notes on the Fourhorned Antelope *Tetracerus quadricornis* (Blainville). *J. Bombay nat. Hist. Soc.* Vol. 55, No. 2, pp. 339-340.
- WALKER, ERNEST P. (1964): Mammals of the World, Vol. II, The Johns Hopkins Press, Baltimore, p. 1422.

4. OBSERVATIONS ON CONFLICT AMONG MALES OF BLACK RAT *RATTUS RATTUS FRUGIVORUS*

Incidence of mortality in conflict among males of black rat *Rattus rattus* L. is supposedly very low (Barnett 1958). Evidence presented herein, however, suggests that in sub-species *Rattus rattus frugivorus* deaths in such interactions may not be unusual in some situations.

OBSERVATIONS

(1) In aggressive rodents caught together males often fight until one is killed by the time traps are collected (Spillet 1968). The same was observed twice in a total of 132 trappings with multiple-catch wonder traps. An apparently senile male with grey hairs and pathological testis (weight 218 gm) was killed in the trap by a younger male (wt. 192 gm) while on another occasion a healthy male (wt. 146 gm) was found to have died in a fight with one of its own age (wt. 152 gm). This

TABLE 1

Colony	Weight of resident <i>alpha</i> gm	Weight of interloper gm	Mortality in days	Final weight of interloper	Wounding
Bisexual	160	146	0.08	143	Superficial
		166	1	162	Superficial
		122	2	114	Superficial
		117	3	108	Testis & viscera pulled out
Bisexual	190	200	1	194	Superficial
		180	1	176	Superficial
		157	5	143	Superficial
		135	6	105	Superficial
		106	1	101	Superficial
		70	2	-	Testis & viscera pulled out
		212	1	201	Superficial
Bisexual	156	160	0.12	158	Superficial
		117	3	102	Superficial
Bisexual*	142				
Bisexual*	175		5	113	Superficial
All-male	196	119	3	107	Superficial
		132	-	-	Superficial
		172	-	-	Superficial

* Housed in cages. All others in pen.

reflects that such mortality among males is not unusual in natural environment.

(2) High rate of mortality was recorded for males released in bisexual colonies maintained in pens ($9 \times 5 \times 4'$). Mature males of good condition were killed by the resident males sooner than weaker ones which wasted away over a period of several days (Table 1). One resident male killed all the six females introduced into its pen. Its behaviour was consequently adjudged as atypical. It was also killed on being released in another colony.

Agnostic interactions in pens were not quantitatively evaluated but there was apparently much jumping and chasing before the interloper was caught by the residents. To escape pursuit the rats often waded into drinking water kept in a tray. Recovered later, when dead, they were often found wet with swollen feet. Body injuries otherwise were superficial except in case of two young males (wts. 70 & 117 gm) whose testes and viscera were pulled out.

(3) 12 interlopers were released in as many bisexual colonies housed in cages ($32 \times 18 \times 18''$). Only two males died after six days while the rest survived the period of observation extending to three weeks. Threatened by resident males, the interlopers invariably hung to the side or roof of the cage. When chased they ran and jumped frantically disturbing the nest box, water tray and also the females in the process. This seemed to 'displace' the aggressive drive of the resident males. The interlopers were thus not pursued with vigour and the survivors accordingly did not show any serious injury. The fur coat was, however, generally thin.

(4) Likewise only a few interlopers were killed in all-male colonies. Their introduction invariably triggered a general fight in the colony which was surmised as the absence of social stability in it. It was clear thus that the interlopers were released before any one male and established its social ascendancy.

(5) A number of males were introduced into cages housing a lone male. None of the interloper was killed in the following eight days. But the condition of some of them had apparently deteriorated. Had the period of observation been extended some deaths might have been recorded. This, however, could not be done.

Individual weights of all the interlopers were compared to that recorded later at the time of autopsy. Maximum decrease in weight (10 to 20%) was shown by the rats which appeared to have wasted away after release. The loss of weight in case of other rats killed as also of the survivors was only marginal.

DISCUSSION

The slender and lightly built black rats climb well. Simulated labo-

ratory facilities for studying their agnostic behaviour needs to be spacious with even surfaces to ensure perpetual contact between the combatants. This was possible in the pens but not quite so in the cages. This may have created the difference in mortality recorded for the same situations in the two set ups.

Resident males attacked the interlopers in all situations to defend their territory against strange males. The intensity of attack on them was particularly heightened by the presence of females. Thus the incidence of male mortality recorded in bisexual colonies housed in pens equalled that reported for more aggressive species as *Rattus norvegicus* (Barnett 1958; *et al.* 1968). Otherwise it was comparatively insignificant.

The interlopers which lost weight rapidly and died slowly in pens and cages can be classified as the 'omega' males (Barnett 1958). Accordingly others able to maintain their weights in cages or killed with marginal loss of it in pens were the 'beta' males. Thus males of this species are also stratified in three social ranks—dominant alphas (residents) and the sub-ordinate betas and omegas. The distinctions between them, however, may not be very sharp like that noted among males of brown rat *Rattus norvegicus* (Barnett 1958).

Death of the residents following successive fights with interlopers shows that the general capacity of the males of this species to tolerate stress of agnostic interactions is very limited. Implied in this are some general facts about the aggressive behaviour of this species e.g. (1) it is less aggressive, (2) any one male fails to dominate several others, as in all-male colony and (3) that it restricts the size of social units. Only a few males thus may succeed in co-existing and the number of females associating with them would obviously depend on their ability to cover them. In any case then the total number of rats in the colony would be limited.

Apparently the behaviour of the species requires analysis in detail. This is being attempted in my laboratory.

ACKNOWLEDGEMENT

I am thankful to Prof. S. M. Alam, Head, Zoology Department, AMU, for facilities and encouragement.

ZOOLOGY DEPARTMENT,
ALIGARH MUSLIM UNIVERSITY,

ALIGARH,

April 4, 1973.

JAMIL AHMED KHAN

REFERENCES

- BARNETT, S. A. (1958): Analysis of social behaviour in wild rats. *Proc. Zool. Soc., London* 130:107-152.
- BARNETT, S. A., EVANS, C. S. & STODDART, R. C. (1968): Influence of females on conflict among wild rats. *J. Zool.* 154:391-396.

5. NOTE ON A COLLECTION OF RATS FROM GOREGAON-MALAD IN BOMBAY

It has been noticed that the species frequency in the rat population from the City of Bombay has changed (Deoras 1966). During a survey of the rats in Bombay it was observed (Joshi 1961) that *Rattus rattus* predominated in former suburbs like Dadar. As urbanisation increased the field rat was found to predominate even in the heart of Bombay, when it was only 2 per cent in the total collection in 1910 (Deoras 1966). During the studies in the eastern suburbs of Bombay it was noticed that the house rat still predominated in the fields of Bhandup (Joshi 1966). But the ex-ratio of both *Rattus rattus* and *Bandicota bengalensis* in the collection was different than that erstwhile found in the heart of Bombay or its suburbs like Dadar (Prasad 1967). The area around Bhandup is becoming heavily industrialised even though there are fields surrounded by a rural type of housing. The western suburbs of Bombay have fields, hills and forest vegetation and it has not yet been heavily industrialised. The frequency of different species in the rat population and the sex-ratio had not been seen for the western suburbs. The present studies were started with this idea, in December 1972 and this note gives an idea of the frequency of species in the rat population in Goregaon-Malad as compared with the collections from the heart of Bombay, and other suburbs (Table 2).

Table 3 gives the percentage of species of rats collected in this area, wherein *Rattus rattus* is 69 per cent and *Bandicota* 13.9 per cent. In both species the females predominate; a phenomenon similar to that seen in the heart of Bombay as well as the erstwhile suburbs. Both figures are just the opposite of what was seen in 1967 at Bhandup. Table 1, gives the percentage of *Rattus rattus* and *B. bengalensis* collected in the entire Bombay, in the suburbs only and their sex-ratio in the heart of Bombay, and erstwhile suburbs as compared to what was available at Bhandup.

The second point of interest is that at Goregaon-Malad *Rattus rattus* continuously dominates for all the six months as opposed to *B. bengalensis* in the entire Bombay. However the *R. rattus* predominance is common to both the suburbs i.e. Bhandup and Goregaon-Malad.

Thirdly *R. norvegicus* is not seen the suburbs and the various spe-

TABLE 1

COMPARATIVE ACCOUNT OF THE PERCENTAGE OF *R. rattus* AND *B. bengalensis* COLLECTED IN ENTIRE BOMBAY, SUBURBS ONLY, GOREGAON-MALAD, BHANDUP ONLY; AND THEIR SEX RATIO FOR THE WARDS AS WELL AS LAST TWO AREAS, 1973.

Percentage of <i>R. rattus</i> in entire Bombay	Percentage of <i>B. bengalensis</i> in entire Bombay	Percentage of <i>R. rattus</i> from suburbs only	Percentage of <i>B. bengalensis</i> from suburbs	Percentage of other rats in the collection (entire)
22.5	46	67.1	13.1	<i>R. norvegicus</i> 17.7 <i>B. indica</i> 0.4 <i>Mus. musculus</i> 3.9 <i>Suncus caeruleus</i> 9.6
Heart of Bombay (Tardeo, Kamathipura and Naggada) <i>R. rattus</i>	Heart of Bombay Percentage of <i>B. bengalensis</i>	Erstwhile suburbs (Dadar, Mahim and Dharavi) Percentage of <i>R. rattus</i>	Erstwhile suburbs Percentage of <i>B. bengalensis</i>	
M. 14.7 F. 34.0 55.6	M. 43.4 F. 39.6 49.2	M. 25.2 F. 32.0 56.5	M. 48.2 F. 35.0 52.7	
Percentage of <i>R. rattus</i> from Goregaon-Malad	Percentage of <i>B. bengalensis</i> from Goregaon and Malad	Percentage of <i>R. rattus</i> from Bhandup (Fields only) 1966-67	Percentage of <i>B. bengalensis</i> from Bhandup (Field-Area) 1966-67	Percentage of other rats collected at Bhandup (Field-Area) 1966-67
M. 69.5 F. 36.5 57.5	M. 13.9 F. 38.83 51.35	M. 26.43 F. 69.0 30.0	M. 19.9 F. 75.0 24.6	<i>B. indica</i> 0.52 <i>Laggada niagarum</i> 45.3 <i>B. gigantea</i> 6.3 <i>Golunda gujerati</i> 1.6

M: Male F: Female

TABLE 2

COMPARATIVE PERCENTAGE OF COLLECTION OF RATS FROM THE ENTIRE BOMBAY AND THE WESTERN SUBURBS OF GOREGAON AND MALAD

	<i>R. rattus</i>		<i>B. bengalensis</i>	
	Entire Bombay	Goregaon and Malad	Entire Bombay	Goregaon and Malad
December, '72	23.6	68	44.5	—
January, '73	25.4	69.3	43.9	12.7
February, '73	23.6	69.3	46.2	14.5
March, '73	21.7	69.4	48.8	16.7
April, '73	19.5	71.05	50	14.11
May, '73	19.3	71.7	47.9	14.57
June, '73	20.4	70	48.1	10.77

TABLE 3

DETAILS OF DIFFERENCES IN THE *R. rattus*, *B. bengalensis* COLLECTIONS AT GOREGAON AND MALAD

(A) Total all rats collected:		16,623	
<i>Rattus rattus</i> sp. in this collection:		8,777	
Percentage of <i>R. rattus</i> in the collection:			69.5%
<i>Rattus rattus rufescens</i> Grey:		8,657	
	Males	2,791	32%
	Females		57%
	Immature		11.2%
<i>R. rattus wroughtoni</i> Hinton:		141	
	Males		58%
	Females		83%
<i>Rattus rattus (rufescens)</i> Grey:			
With white patches on the pectoral region:		6	
	Males		50%
	Females		50%
(B) Total <i>Bandicota</i> Collected:		Nos. 1,479	
Percentage of <i>B. bengalensis</i>			73.86%
	Males		38.83%
	Females		51.35%
Percentage of <i>B. indica</i>			26.13%
	Males		35.93%
	Females		52.44%
Total <i>B. indica</i> collected		Nos. 384	
Percentage of <i>B. indica malabarica</i> collected in the total of <i>B. indica</i>			17.00%
	Males		36.60%
	Females		63.39%

cies of rats (Table 1) found at Bhandup are not represented at Goregaon-Malad.

The studies are being continued and the detailed results would be soon published.

We are extremely thankful to the University Grants Commission for the grant to the Senior Author; to Bombay Municipal Corporation for permitting the collections; and to the Principal, S.S. & L.S. Patkar College for giving facilities to continue the work at Goregaon.

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S.S. & L.S. PATKAR COLLEGE,
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December 6, 1974.

P. J. DEORAS
MANORAMA MITTAL
M. S. PRADHAN

6. THE INDIAN MOORHEN (*GALLINULA CHLOROPUS*) BREEDING IN KERALA

Sálím Ali says in the BIRDS OF KERALA that the breeding of the Indian Moorhen has not been recorded in Kerala. M. C. A. Jackson, too, does not seem to have found it breeding. In April 1974 two Zoologists and I watched Moorhens with chicks at Munnar, the High Ranges, Kerala State.

On 7-iv-1974 Sri S. Satheesh Chandran Nair, Research Scholar in Zoology, Kerala University, and I were watching birds near the Ramaswami Iyer Head Works of the Kerala Electricity Board. At 17.30 hrs, in the stagnant waters of the stream above the spillway, we found an Indian Moorhen with two tiny, jet black chicks. While the parent swam about near the thick growth of reeds on the Park-side bank, the young ones walked about on the floating mat of dead and broken reeds at the edge of the reed-bed. The young could swim, though they did so only when they had to cross a gap in the mat of reeds. Half an hour later in a different part of the pool we came across the same or another pair of Moorhens with two chicks of the same age and colour as the first.

On the 14th we were again at the same spot at 1745 with Sri V. S. Vijayan, Research Scholar working under Dr. Sálím Ali, and we saw a single pair of Moorhens only. They had two chicks with them, but these were more than double the size of those seen a week earlier. Moreover these had the throat and the underparts whitish. The fact that no other pair of Moorhens could be found on the 14th makes me wonder whether there were, after all, only this one pair in the area. If that sus-

picion is correct, the rate of growth of juvenile Moorhens is quite remarkable.

UNIVERSITY COLLEGE,
TRIVANDRUM,
May 28, 1974.

K. K. NEELAKANTAN

7. UNUSUAL BEHAVIOUR OF *PSITTACULA KRAMERI* *BOREALIS*

Over the past two months I have noticed what I believe to be rather unusual behaviour by the Common Green Parakeet.

We are quite accustomed to seeing these birds in large flocks feeding on the various varieties of *ficus*. We have a large *Ficus bengalensis* on our own compound which, when in fruit, is full of parakeets.

This year they have taken to feeding on *Acacia auriculiformis* stripping first the young shoots, and then the mature phyllodes and bark, leaving the tree completely denuded, and all terminal branches absolutely bare of bark.

We have a number of these trees in the campus and the surprising thing is that instead of large flocks, and they come in their hundreds, descending haphazardly and feeding indiscriminately, these birds behave in an entirely systematic manner and appear to be almost controlled.

From early morning the flocks descend upon a single tree and remain feeding there, in their customary wasteful fashion, until about 0800 IST, when they leave *en masse*. If disturbed they rise and circle to return to the same tree when the cause of their alarm has disappeared.

In two or three days, dependent upon size, the tree will have been stripped to its bare frame and then only do the flocks move on to the next tree, which in many cases may be as little as ten yards away.

In this systematic manner these birds have now denuded a dozen trees, which I am pollarding in an attempt to save them.

I should be interested to learn if this behaviour pattern has been reported elsewhere.

TEA RESEARCH ASSOCIATION,
TOCKLAI EXPERIMENTAL STATION,
JORHAT 8,
July 25, 1974.

J. TESSIER-YANDELL

8. NOMENCLATURE OF THE ASIAN PALM SWIFT

(With a plate)

Brooke (1972) has given reasons for separating the African Palm Swift *Cypsiurus parvus* (Lichtenstein) from the Asian, which he designated by the name *Cypsiurus batasiensis*. Although aware that the original spelling of the species-name was *balasiensis*, Brooke (op. cit., p. 219) considered that "sound nomenclature is best served" by retaining this emendation, which was originally proposed by Baker (1927, p. 336).

The name *balasiensis* was first published by J. E. Gray in Griffith & Pidgeon (1829, p. 60), as the following brief entry:

Balasian Swift. Lath. *Cyp. Balasiensis*

Dull brown, with the outer toe versatile. India.

The indicated authority for the English name is John Latham, who described the bird in greater detail under the title 'Balassian Swift' (Latham 1823, pp. 329-330). Because of its general interest and relevance to the argument that follows, Latham's entry is reproduced in facsimile (*see* plate).

The first named of Latham's two sources is certainly Francis Buchanan (who adopted the name Hamilton in later life), a medical officer in the service of the East India Company from 1794-1815 (Stephen & Lee 1908). Dr Buchanan (Hamilton) was a naturalist of wide interests. His published works included reports of travels in parts of India and Nepal, and a treatise on the fish of the Brahmaputra. It is apparent that he also wrote an unpublished manuscript on Indian birds. Such a manuscript was undoubtedly available to Horsfield & Moore, in whose catalogue (1854, p. 108), Dr. F. (B.) Hamilton is cited as the source of the vernacular names for the Palm Swift ('*Putta-Deuli*, Hind., *Batassia*, Beng., and *Ababil*, of the Mussulmans'), and also as the author of 'MS. I, p. 82', quoted as follows:

This bird inhabits Bengal at all seasons, and is a nocturnal bird, appearing at sunset and going to rest at sunrise. It builds its nest in the fronds of the TAL (*Borassus flabelliformes* Linn.). The Bengalese name signifies a bird resembling wind, and is bestowed on account of its swift flight.

The similarity between the phraseology of this passage and the sentences in Latham's (1823) account is sufficiently marked to establish that the author was indeed the same man, and to suggest very strongly that the compilers in both cases had before them the same document.

There can be little doubt that the common source consulted by these authors was an untitled manuscript describing animals and birds at Barrackpore, now in the India Office Library, registered no. MSS Eur. D. 541. The second volume of this work (reg. no. MSS Eur. D. 94) forms part of the Buchanan-Hamilton Collections, and it is reason-

able to assume that the Doctor was the author of both. Pages 82-83 of the first volume are devoted to the palm swift. Since this description is evidently an important primary source, it is transcribed in full below:

Hirundo Apus Batassia B
 Abavir of the Musulmans.
 Batassia of the Bengalese.
 Putta deuli of Hindustan proper.

The Bengalese name signifies a Bird resembling wind, and is bestowed on this species, on account of its swift flying. It inhabits Bengal at all seasons, and is a nocturnal bird, appearing at sun set, and going to rest at sun rise. It builds in the folds of the leaves of the Tal, or *Borassus flabelliformis* Linn.: The length from the point of the bill to the end of the tail is four inches and six tenths. The wings, when shut, are two tenths of an inch longer than the tail; and, when opened, extend ten inches. The tail is two inches and three quarters in length. The toes reach very little beyond its root. The bill is very short, and much depressed, sharp, and rather incurved at the point. The nostrils are oblong, and naked. The feathers of the frontlet are reversed. The irides are brown. The crown, neck, and back are brownish. All the under parts, sides, rump, upper tail coverts, and the wing coverts next the body are ash-coloured. The wing coverts most remote from the body, and the under wing coverts are dusky. The wings are very much acuminate, the secondary quills being very short. The quills are sharp pointed, black on the upper side, and dusky beneath. The tail is much bifurcated, and consists of ten acuminate feathers, dusky above, and tsh coloured beneath. The legs above are feathered to the toes, and behind are naked. The toes are black and four in number, two turned to one side, and two to another. The claws are as long as the toes, and are much hooked.

The history of these has been discussed in detail by Dawson (1946). On the General's death, his collection passed to the British Museum, and the illustrations of biological interest, sorted into systematic order, mounted and bound, are now divided between the Botanical and Zoological libraries of the British Museum (Natural History). The pictures numbered 114-116 in Volume VI (catalogue no. 10979) show adult and juvenile palm swifts, and a nest, attached to a palm frond, containing three young. These drawings are the originals (copied carefully, but appearing as mirror images in the publication) of the representations grouped in Plate 35 of Gray & Hardwicke's *Illustrations of Indian zoology*, part 2, where they are named 'Balassian Swift *Cypselus palmarum* n.'. In the original drawings, the adult male is localised and dated 'Cawnpore June 1800'.

Griffith & Pidgeon's translation of Cuvier, in which Gray's name *balasiensis* appeared, is dated 1829 on the title page. The plates are also individually inscribed with the dates on which each was made. The latest plates are dated October 1829, showing that the completed book must have appeared at the very end of that year. Part 2 of the *ILLUSTRATIONS OF INDIAN ZOOLOGY*, containing the name *Cypselus palmarum*,

66.—BALASSIAN SWIFT.

LENGTH between four and five inches, breadth ten. Bill short, incurved at the point, and much depressed; nostrils oblong, dusky; iridés brown; plumage above ash-coloured, not unlike that of the Sand Martin; beneath paler; quills sharp-pointed, black above, dusky beneath; the wings much acuminate, the second quills being very short, and for the most part dusky; tail much bifurcated, consisting of ten feathers, in colour like the quills; in length two inches and three quarters; the latter, when closed, are a trifle longer than the tail; legs feathered before to the toes, which are four in number, two turned on one side, and two on the other, claws long, and the toes much hooked, and reach very little beyond the root of the tail.

Inhabits India: is the Abavir of the Mussulmans; Balassia of the Bengalese; and Putta deuli of Hindustan Proper. The Bengalese name signifies a bird resembling wind, and is bestowed on this species, on account of its swift flight. Found at Bengal at all seasons; is a nocturnal bird, appearing at sun-set, and going to rest at sun-rise. It builds in the folds of the leaves of the Tol, or *Borassus flabelliformis* of Linnæus.—Dr. Buchanan.

This is figured in General Hardwicke's drawings, dated Cawnpore, June, 1800; length five inches.—A male.

was published in March 1830 (Kinnear 1925). Gray thus published, within a few months, two names for the same species, both based (in the one case directly, and in the other case indirectly through reference to Latham's work) on the same set of drawings of specimens from Cawnpore (i.e., Kanpur) made in 1800.

T. C. Jerdon (1840), following Gray (1830), referred to the species as the Balassian Swift *Cypselus palmarum*. Shortly thereafter, the priority of *balasiensis* was recognised. G. R. Gray (youngest brother of J. E. Gray) in 1844 (p. 54) gave *Cypselus balasiensis* as the valid name, with *Cypselus palmarum* as a synonym. Blyth (1849, p. 86) also used the name *Cypselus balasiensis* for this swift, listing *C. palmarum* in synonymy.

The first emendation of the spelling was introduced by Horsefield & Moore (1854, p. 108) who called this bird *Cypselus batassiensis*, adding a footnote: *Balassiensis, Auct. corrigend.* The 'corrected' name *batassiensis* was subsequently in general use in ornithological literature for several decades; see, for instance, Jerdon (1862), Sclater (1865), Blyth (1866), Holdsworth (1872) Blanford (1895).

A second modification was proposed by Baker (1927, p. 336), who evidently made only superficial research of the problem, writing:

The name of this little swift was first written *balasiensis* but the name is derived from the Bengali name *batassia* and is obviously a misprint and the amended name *batasiensis* must be accepted.

Gray, in using the Bengali name, may be inferred to have applied it to the Bengali bird and the type-locality can therefore be restricted to Calcutta, thus leaving the name *palmarum* free for the paler Western form depicted in Hardwicke's *Illustr. of Ind. Zool.*

Peters (1940, p. 256) reverted to Gray's original spelling, listing the Indian population of palm swift as *Cypsiurus parvus balasiensis*. Despite this lead from a careful taxonomist, Baker's emendation has continued to be used in various combinations by most authors including recently, Ripley (1961) and Ali & Ripley (1970).

CONCLUSION

J. E. Gray's original description, although brief, satisfies provisions (a), (b), (c) and (g) of Article 11, and Article 12 of the International Code of Zoological Nomenclature. Moreover, the consistency of English and Latin names is evidence that Gray's spelling of *balasiensis* was deliberate, and not a copyist's or printer's error. By Article 32 (a) (ii), this spelling is therefore to be retained. Emendation is not justified because Gray chose to use a single 's', nor because his indicated source (Latham 1823) apparently misread or wrongly or carelessly transcribed the Bengali name according to Buchanan.

The name *palmarum*, published a little later, was recognised by contemporaries to be a synonym. As shown above, the documentary evidence does not support Baker's (1927) argument for selecting Calcutta as the type locality, and it is probable that his restriction should be corrected (International Code: Recommendation 72E). Fortunately Whistler & Kinnear (1935) and Brooke (1972) have in independent contributions rejected the separation of eastern and western races on morphological grounds, and consequently the problem of subspecific nomenclature does not arise. Following Brooke's (1972) definition of the species, and taking distributions from Ali & Ripley (1970), the palm swift occurring through most of India is evidently correctly known as *Cypsiurus balasiensis balasiensis*, and the South-east Asian race which apparently reaches Assam is *C. balasiensis infumatus*.

ACKNOWLEDGEMENTS

I am grateful to Mrs A. Datta of the Library, British Museum (Natural History), and to Dr R. J. Bingle of the India Office Library and Records, for their assistance in tracking down Buchanan-Hamilton's manuscript. All other sources were consulted in the libraries of the British Museum (Natural History) or the Zoological Society of London, and it is a pleasure to acknowledge the kind cooperation of staff of both institutes.

GREAT GLEHAM HOUSE,
SAXMUNDHAM, SUFFOLK,
UNITED KINGDOM,
May 11, 1973.

LORD MEDWAY

REFERENCES

- ALI, S. & RIPLEY, S. D. (1970): Handbook of the birds of India and Pakistan 4. Bombay.
- BAKER, E. C. S. (1927): The fauna of British India. Birds 3. London.
- BLYTH, E. (1849): Catalogue of birds in the Museum Asiatic Society. Calcutta.
- (1866): The ornithology of India. A commentary on Dr. Jerdon's 'Birds of India' (part). *Ibis* 2 (2): 336-376.
- BROOKE, R. K. (1972): Geographical variation in palm swifts *Cypsiurus* spp. (Aves: Apodidae). *Durban Mus. Novit.* 9: 217-231.
- DAWSON, W. R. (1946): On the history of Gray and Hardwicke's Illustrations of Indian zoology, and some bibliographical notes on General Hardwicke. *J. Soc. Bibl. nat. Hist.* 2: 55-69.
- GRAY, G. R. (1844): Genera of birds 1. London.
- GRAY, J. E. (1830): Illustrations of Indian zoology; chiefly selected from the collection of Major General Hardwicke, F.R.S. (2). London.

GRIFFITH, E. & PIDGEON, E. (1829): The class Aves arranged by the Baron Cuvier with specific descriptions. The additional species inserted in the text of Cuvier by John Edward Gray 2. London.

HOLDSWORTH, E. W. H. (1872): Catalogue of birds found in Ceylon. *Proc. zool. Soc., Lond.* 1872:404-483.

HORSFIELD, T. & MOORE, F. (1854): A catalogue of the birds in the Museum of the Hon. East-India Company 1. London.

JERDON, T. C. (1840): Catalogue of the birds of the Peninsula of India (part). *Madras J. Lit. Sci.* 11:207-239.

————— (1862): The birds of India, being a natural history of all the birds known to inhabit continental India 1. Calcutta.

KINNEAR, N. B. (1925): The dates of publication of the birds in Gray

and Hardwicke's Illustrations of Indian zoology, with a short account of General Hardwicke. *Ibis* 1925: 484-490.

LATHAM, J. (1823): A general history of birds 7. Winchester.

PETERS, J. L. (1940): Check-list of birds of the world 4. Cambridge.

RIPLEY, S. D. (1961): A synopsis of the birds of India and Pakistan. Bombay.

SCLATER, P. L. (1865): Notes on the genera and species of Cypselidae. *Proc. zool. Soc., Lond.* 1865 (39): 593-617.

STEPHEN, L. & LEE, S. (eds.) (1908): Dictionary of national biography. London.

WHISTLER, H. & KINNEAR, N. B. (1935): The Vernay scientific survey of the Eastern Ghats (11): *J. Bombay nat. Hist. Soc.* 38:26-40.

9. THE BLUECHEEKED BEE-EATER *MEROPS SUPERCILIOSUS*, ITS STATUS IN KUTCH AND SAURASHTRA

The Durbar Saheb of Jasdand and myself had the pleasure of visiting the Flamingo City in the Great Rann of Kutch and some of the Bets beyond towards the border of Sind. We saw a party of about six of these large bee-eaters at Nir on 9th June. On the 11th on our return from the Flamingo City we rested during the heat of the day at Nir before going on to the Bets and after imbibing several glasses of lime juice we strolled around the water course. All the time we heard the bee-eaters calling as they sailed around. Following the winding nullah we came across a ten foot high embankment riddled with bee-eater holes, all large and fresh. There were some eighty such holes and by their size we surmised them to belong to *M. superciliosus* and their appearance suggested that they had been in recent habitation. The presence of the birds in the area confirmed our surmise. Later we again saw these fine bee-eaters on Kuar Bet. They were in magnificently fresh plumage. Sálím Ali, in both his *BIRDS OF KUTCH* and the 'Birds of Gujarat' (*J. Bombay nat. Hist. Soc.* 52:2 & 3) mentions it as an autumn passage migrant. It may be noted that in the *HANDBOOK OF BIRDS OF INDIA AND PAKISTAN* Volume 4, Ali & Ripley mention Dharmakumarsinhji's report of the species regularly breeding on the Bhavnagar coast, where incidentally it is a regular breeding bird and I myself have seen them

around the aerodrome in August. I might mention here that one of my earliest memories of this fine bird is as a boy when I watched at close range three pairs excavating nest holes near Jasdán. This year I have heard them over Rajkot in late May and they have been heard at Jasdán and so they must have been breeding in the area, or possibly passing onto their breeding location near Bhavnagar.

14, JAYANT SOCIETY,
RAJKOT 360 004,
June 16, 1974.

LAVKUMAR J. KHACHER

10. A DAY AT A NEST OF THE GREAT BLACK
WOODPECKER (*DRYOCOPUS JAVENSIS*)
(With two plates)

On a five-day visit to the Periyar Wild Life Sanctuary during the second week of January, 1974, I concentrated on a search for the Great Black Woodpecker which had so far eluded me. On the second day I ran into Mr Robert Horwich, an American researcher on primate behaviour, who said that he had seen a Black Woodpecker almost at that very spot earlier in the morning. Still, in spite of spending three more days at Thekkady I had to leave without so much as a glimpse of the Black Woodpecker.

About a fortnight later Mr Nanu Nair, Wild Life Preservation Officer, Thekkady, informed me that Mr Horwich had found an occupied nest of the Black Woodpecker close to the Picnic Spot. So, at 17.45 hrs on the 2nd of February I was back at the place where Mr Horwich and I had first met on 12-i-1974. There Mr Nanu Nair pointed out a giant tree, quite dead and devoid of all bark, just 20 feet away. At a height of *c.* 20 m and very near the top was the woodpecker's nest, with the female peeping out. It was on the southern side of the tree, just below a large, shallow, irregular cavity. We were to discover the next day that almost all day the sun fell directly on the nest.

The tree stood in the midst of a good stand of medium sized deciduous trees and dense, thorny underground on a narrow strip of land between the road and an arm of the lake. Hardly a stone's throw from the road, it was exposed to all the noises of busy traffic, loud talk and other evidences of flourishing tourism.

That evening we were able to watch the nest for 55 minutes only (1745 to 1840 hrs). At 1805 hrs the male came and alighted on a tree trunk *c.* 10 m ESE of the nest. While hopping up he uttered a few very low *quack* notes. The moment the male alighted on the nest tree, the female flew out with a smooth glide, quite noiselessly. The male entered the nest at 1807 hrs after thrusting his bill smartly 3 or 4 times into

the cavity. Almost all the time between 1807 and 1840 hrs he was looking out of the nest. A minute after he had got in, a pair of Hill Mynas (*Gracula religiosa*) alighted on the horizontal branch below the nest and went on calling. They then flew to a tree close by, and one of them was seen flying into some hollow on the northern side of the woodpeckers' tree. The mynas never approached the woodpeckers' nest and the woodpecker seemed to ignore them. Mr Horwich, however, said that on some days he had seen Hill Mynas going to the woodpeckers' nest and being chased away by the woodpecker.

On 3-ii-1974 I watched the nest for a total of 8 hours and 15 minutes (0750 to 1300, 1500 to 1700, and 1740 to 1845 hrs). Mr Horwich who had kindly agreed to take photographs for me was with me all forenoon and again during the last session (with Mr Nanu Nair as well). The photographs were taken with a Nikkormat camera and a 400 mm telephoto lens.

A brief account of what I saw during the day follows:

0750 to 0915: Nest appeared to be unoccupied, but in fact the female was in.

0915—7 to 8 dull taps (low *dok-dok-dok*) from the east, repeated 3 times. Two minutes later the male came from the east and alighted on the trunk of a tree east of the nest tree. At 0921 he flew to the nest tree alighting 6 feet below the hole and began hopping up. The moment he had alighted on the nest tree, the female thrust her head out, uttered a number of 'chyank's' in quick succession and at 0923 flew off to the east. The male entered and remained till 1235 hrs.

At 1220 came a series of dull taps from inside the nest, 5 to 8 taps at a time, repeated thrice. This was followed by a rapid series of dull du-du-du-du notes (drumming?).

At 1230 hrs the female alighted on the trunk of a teak NW of the nest tree and began hopping up quite silently. She then uttered a number of low *quacks* to which the male replied with feebler notes. She flew to the nest tree at 1235, alighting just below the nest. The male flew off at once and his place was taken by the female.

The nest was not watched between 1300 and 1500 hrs. At 1500 hrs the female was in the nest, peeping out. Ten minutes later she withdrew her head. At 1520 she began looking around and withdrew into the hole only at 1534. The male came from the south at 1550 to a tree SSE of the nest. Simultaneously the female peeped out. To a few low *chyup* notes of the male the female responded with a few dull taps on the wall of the nest. The male flew to the nest tree and the female flew off at once. He went into the nest and turned a somersault so that his head appeared where his 'forked' tail had been a moment ago.

At 1608 a flock of 4 or 5 Hills Mynas flew past the woodpecker tree, landed on another 11 m away and went on uttering an amazing

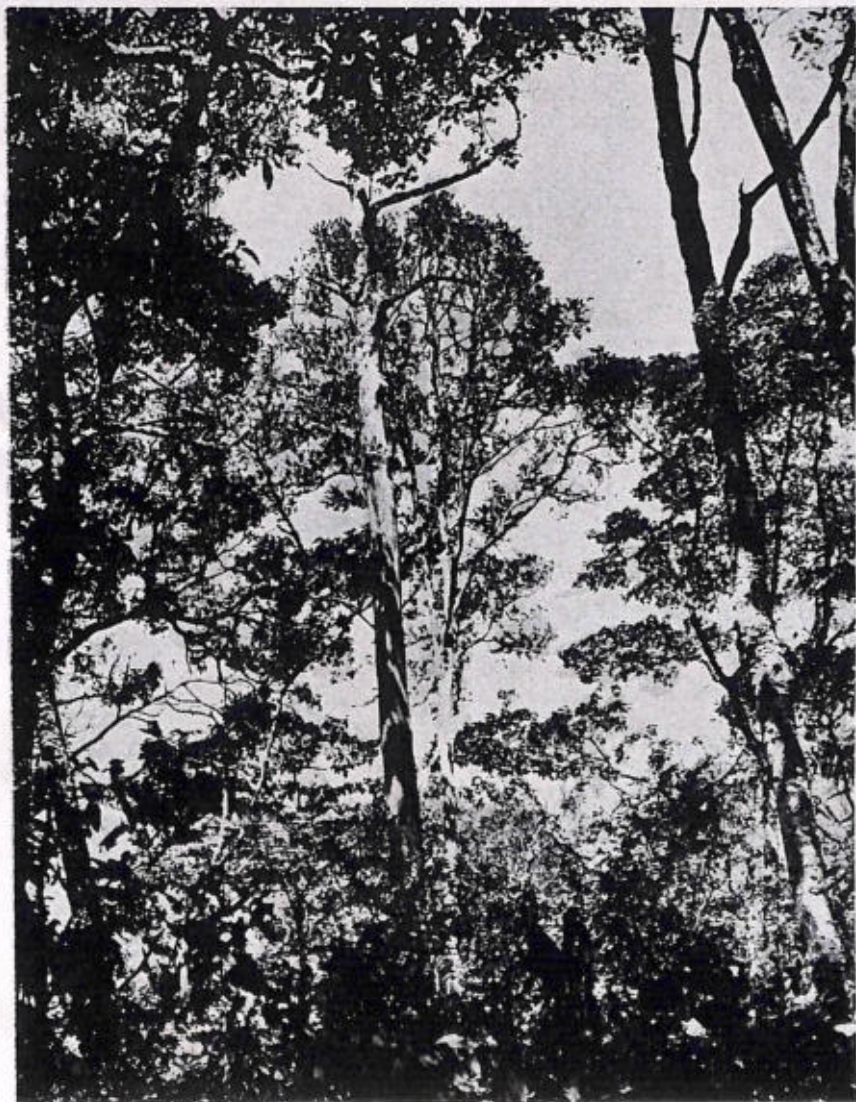
variety of calls. The woodpecker did not react to all this, but he seemed to look around nervously when some Bluewinged Parakeets flew past with their harsh calls, when a dog barked and again when someone banged lustily on a wooden picnic table.

The male woodpecker began to produce a series of dull taps from within and then peeped out, looking in all directions. He repeated this a number of times during the next two minutes, each series of taps being louder and more rapid than the preceding. Between 1635 and 1638 he not only played a tattoo on the inner wall, but seemed to throw something out with smart flicks of the bill after a spell of tapping. At 1638 the hammering became louder though the rate was lower. The last series of taps, a rapid *chug-chug-chug-chug* was at 1639, after which for 20 minutes, he was inactive.

From 1700 to 1740 hrs we were away and on our return found the male looking out and a Hill Myna calling loudly from the branch below the nest. At 1743 the myna left. The female woodpecker arrived at 1753, flying from the south straight to the nest tree. As she began hopping up, the male beat a tattoo of dull taps from within and then flew off to the south. The female entered the nest and remained hidden within till 1802 hrs when a pair of Hill Mynas alighted on the branch below the nest. Even then the female woodpecker did not peep out. Five minutes later one of the mynas flew to the top of the tree from where it uttered various screeches, whistles and croaks. At 1813, before we knew what was happening, the female woodpecker had come out and was chasing the mynas. She pursued them from tree to tree without uttering any call notes and, quite as suddenly as she had come out, went into her nest leaving the mynas on two different trees. The mynas went on calling loudly.

At 1814 hrs a loud but dull drumming came from the east. The mynas returned to the branch below the nest and were very noisy. A couple of Southern Tree Pies had appeared meanwhile and were contributing their mite to the clamour.

At 1822 hrs the woodpecker shot out of the nest and again drove the mynas away. After chasing them around for a minute, she returned and went straight into the nest. One of the mynas flew at 1825 into the hollow on the nest tree into which a myna had gone the previous day. The other myna went on calling from a tree close to the nest. At 1828 the appearance of the female woodpecker's head at the nest entrance coincided with a loud drumming from the east. The second myna also disappeared into the hollow behind the nest at 1830. Just then the male woodpecker alighted on a tree SE of the nest (these woodpeckers did not seem to have a definite 'route' to the nest) and male and female held a duet of low *chiank-chiank-chiank* notes. Uttering the same low sounds, the male flew to the nest tree at 1837, his arrival



The nest tree.
(Photo: Robert Horwich)



The female (?) leaving ~~the~~
(Photo: Robert Horwich)

coinciding with the female's departure to the south. The male dipped his head five times into the nest, entered, reversed, and began peeping out. By 1845 it was dark. I left the spot at 1900 hrs and left Thekkady early the next morning wondering whether I could afford to go again to see the young being fed.

General remarks

1. The male presumably spent the night in the nest on both days. Though no evidence could be adduced, the fact that the birds never left the nest unoccupied and remained within for periods of roughly 3 hours at a time during the day suggested that there were eggs in the nest. If the presumption is correct, we may conclude that both male and female incubate the eggs. (See Sálím Ali & Ripley: HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. 4, p. 209).
2. The HANDBOOK (same page) says, "Very sensitive to disturbance by humans, soon forsaking localities where lumbering is in progress or the forest has been felled." This pair, at any rate, seem to have gone out of their way to select a spot where human activity and noises were no less than at a lumbering camp. Did the attractions of the dead tree outweigh the drawbacks of the place where it stood?
3. On the 2 days when we observed them the birds were remarkably unobtrusive. They never uttered any loud calls and their wings too did not produce the rattling sound often heard when the goldenbacked woodpeckers fly. The movements of these large woodpeckers were so quick and quiet that only chance could have betrayed their presence. In coming and going they preferred to fly quite a distance through the thickest part of the wood before crossing open ground. That the brooding sessions were often 3 hours long also helped to prevent their being noticed in the neighbourhood of the nest.
4. Between 1745 on 2-ii-1974 and 1900 on 3-ii-1974 the change-over at the nest was observed six times. It was not accompanied by any elaborate display. Towards the close of a brooding session, the bird in the nest tapped on the nest wall. This could have been a sign of impatience or a summons to the mate (though whether the tapping could have been heard by the mate unless it were close by is very doubtful).

Postscript

A few days after my return to Trivandrum I heard from Mr Nanu Nair that Mr Horwich feared that the woodpeckers had deserted. Curiously enough it looked as though the mynas did not take over the cavity. Why then did the mynas come to the nest tree, and why did the woodpecker resent their visits? It is not improbable that the mynas were using the hollow on the northern side of the tree to roost in and

that their visits were only at roosting time. Their noise could have got on the nerves of the female woodpecker and made her try to shoo them off. If the mynas had been planning to usurp the nest, they should have paid some visits earlier in the day as well. Also, they would certainly have taken possession of the cavity as soon as the woodpeckers had left.

The photographs illustrating this note were taken by Mr Robert Horwich at my request. I am gratefully obliged to him for sparing the time taken up by the photography as well as for his company. To Mr K. Nanu Nair, Wild Life Preservation Officer, Thekkady, my indebtedness is even greater, for without his enthusiastic co-operation I would not have heard of this nest or watched it in such comfort and style. I am also grateful to Mr D. Vaidyanath, Photographer, Trivandrum Museum, for processing the negatives and printing the photos.

UNIVERSITY COLLEGE,
TRIVANDRUM,
May 6, 1974.

K. K. NEELAKANTAN

11. ON THE OCCURRENCE OF *LANIUS EXCUBITOR* *AUCHERI* BONAPARTE IN PUNJAB

Stuart Baker (FAUNA 2:288) said that *Lanius excubitor aucheri* Bonaparte extended in winter into the plains of the Punjab and NW. Frontier Province, but Ali & Ripley (1972, IND. HANDBOOK 5:82) restrict it as a winter visitor to N. Baluchistan and central and coastal Makran.

In 1941, in 'The Birds of Bahawalpur (Punjab)' (*J. Bombay nat. Hist. Soc.* 42:717) Sálím Ali referred to a ♀ grey shrike collected in Bahawalpur town environs on 29 January 1939 and named it *Lanius excubitor lahtora* (Sykes). Upon re-examination I make this *aucheri*, which identification is confirmed by Mr Bond at Smithsonian Institute.

75, ABDUL REHMAN STREET,
BOMBAY 400 003,
July 31, 1974.

HUMAYUN ABDULALI

12. CHANGE OF IRIS COLOUR DURING THE POST-FLEDGING PERIOD IN THE COMMON BABBLER (*TURDOIDES CAUDATUS*)

INTRODUCTION

During the course of ringing operations in an area of mixed *Prosopis/Acacia* woodland and *Zizyphus* scrub adjacent to New Delhi notes were kept on the colour of the iris and the state of moult among Com-

mon Babblers. During the period between fledging, and the completion of the post-juvenile moult Common Babblers were found to undergo two changes of iris colour, and at close range these enable birds to be aged in the field up until four or five months old.

Methods

About 200 Common Babblers were trapped between August-November 1971, and between July-November 1972, of which 70 were birds in their first year which had not yet completed their post-juvenile moult. Juvenile birds could be identified by the blunt, rounded tips to their primaries, particularly the 10th, as mentioned by Naik & Andrews (1966) for the Jungle Babbler (*Turdoides striatus*).

The state of moult was recorded for each bird according to the system used by Newton (1966), where each new or growing primary feather is assigned a rank score from 0 (feather missing) to 5 (growth complete). Secondary moult was scored in the same way, and the state of moult in the retrices, wing coverts, and body tracts was noted in general terms. The colour of the iris was also noted.

During 1972 a number of nestlings were ringed, and six of these were retrapped during the post-juvenile moult. A total of 13 birds in the two seasons, were trapped two or more times during the course of their post-juvenile moult, and from these the mean rate of post-juvenile moult was calculated in points/day. This rate was then used to calculate a date of commencement for the post-juvenile moult of the six birds ringed as nestlings, and hence find the mean length of time between fledging and the onset of post-juvenile moult.

Results

The course of post-juvenile moult is fairly similar to that of the adult moult, which in turn resembles that of the adult Jungle Babbler described by Naik & Andrews (1966). In contrast to the adult moult, however, the moult of the greater coverts usually begins before the onset of the primary moult, and the moult of the retrices lags behind that of the primaries so that birds are found with a complete set of adult primaries, but most, or in some cases all, of the juvenile retrices. Because of the abrasion the juvenile retrices tend to become hard to identify after a few months and do not provide much help in ageing.

The mean rate of the post-juvenile moult in points/day was found to be 0.95 ($n = 13$, 95% confidence limits 0.61-1.29), giving a mean length of primary moult of 105 days (95% confidence limits 77-164 days).

Using the six individuals for which the date of fledging was known, and the mean rate of primary moult, the periods between fledging and

the commencement of the primary moult were calculated as 30.5, 31.5, 36.5, 39.5, 47, and 47 days (mean = 38.7 days). Thus the mean duration of the period between fledging, and the completion of the primary moult is about 144 days.

The colour of the iris in the adult *Turdoides caudatus* was found to be invariably a dark, warm brown, sometimes with a narrow white marginal rim. No birds in juvenal plumage, or in post-juvenal moult, showed exactly this colour of iris. Table 1 shows the different categories into which irides could be classified, and the number of birds at each stage of post-juvenal moult recorded in each class.

TABLE 1

RELATIONSHIP OF IRIS COLOUR TO PRIMARY SCORE DURING POST-JUVENAL MOULT

Iris colour	Number of individuals trapped in each moult score category						
	0	1-19	20-39	40-59	60-79	80-99	100
1. Dark grey with olive tinge (nestlings and birds with juvenal remiges not fully grown)							
2. Dark grey		4	(all moulting greater coverts)				
3. Pale hazel brown		3	12	9	12	7	4
4. Dark brown at centre, grading to hazel at margin				1	2	1	1
5. Dark brown with traces of hazel at the margin						2	7

The majority of birds trapped during the course of the post-juvenal primary moult (88%) showed a pale hazel iris. The coincidence of the hazel iris with the duration of the post-juvenal moult suggests that the changes in iris colour might be linked to the same hormones that initiate and control the course of the moult.

A few birds reared late in the season do not commence the post-juvenal moult until the following spring, but in these birds the juvenal iris colour is lost, and the iris changes to hazel, although the exact timing of this change was not observed. One bird, reared in early October, was still in juvenal plumage the following February, and had a hazel iris at 120 days old. Another, reared in September, showed arrested moult at P₃ when trapped in February and had a hazel iris at 150 days old.

The occurrence of the transitional stages between hazel and the adult colour in only 14 out of the 59 birds trapped in post-juvenal moult suggests that this change probably takes less than a month. The transition from the juvenal colour to hazel must be even more rapid, since transitional individuals were seen at all.

In the field a bird which has not yet started the post-juvenal moult can be easily recognised by the yellow, fleshy gape. This usually disappears soon after the onset of the post-juvenal moult, and during this period the hazel iris provides a useful guide to the age of the bird at close range, since it is much paler than the adult iris.

Discussion

Among the Indian species of the genus, the Common Babbler is the only one to have a dark iris when adult. In the Jungle Babbler (*T. striatus*), the Rufous Babbler (*T. subrufus*), the Whiteheaded Babbler (*T. affinis*), Ceylon Rufous Babbler (*T. rufescens*), Spiny Babbler (*T. nipalensis*), and the Slenderbilled Babbler (*T. longirostris*) the adult iris is white, and in the Large Grey Babbler (*T. malcolmi*) and the Striated Babbler (*T. earlei*), bright yellow (Ali, Sálím & S. D. Ripley 1971). The colour of the nestling and early juvenal iris is very dark grey throughout the genus. It would seem likely that the dark adult iris of the Common Babbler has been evolved lately, and that the pale hazel iris which appears during the post-juvenal moult represents a recapitulation of the former adult colour.

In the Arabian Babbler (*T. squamiceps*) the female iris colour is similar to that of adult Common Babbler, but the adult male iris is off-white, and similar in colour to that of the Common Babbler during post-juvenal moult. The colour of the nestling and early juvenal iris is the same as that of the rest of the genus.

The Arabian Babbler is extremely similar to the Common Babbler in general morphology, differing from it mainly in its larger size. Since the western races of the Common Babbler are larger than the eastern ones, it seems possible that the Arabian Babbler may represent the speciation of the western end of a former cline, running from peninsular India to the Near East.

In bill colour, adult male Arabian Babblers resemble first year birds of both sexes, whereas the bill changes colour in adult females, and in this respect the adult male character may be considered neotonous (A. Zahavi, pers. comm.). If this is the case then it seems likely that sexual dimorphism in the Arabian Babbler must have evolved through retention of the juvenal iris colour in the male.

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DEPT. OF ZOOLOGY,
SOUTH PARKS ROAD,
OXFORD, ENGLAND,
April 5, 1974.

A. J. GASTON

REFERENCES

NAIK, R. M. & ANDREWS, M. I. (1966): Pterylosis, Age Determination, and Molt in the Jungle Babbler. *Pavo* 4(1 & 2):22-47.

NEWTON, I. (1966): The Molt of the Bullfinch *Pyrrhula pyrrhula*. *Ibis* 108:41-67.

13. OCCURRENCE OF THE PURPLE COCHOA *COCHOA PURPUREA* HODGSON, NEAR MUSSOORIE, U.P.

During a recent collection trip to Mussoorie, we obtained a specimen of a male Purple Cochoa (*Cochoa purpurea* Hodgson) at Dhanaulty, c. 2318 m, approximately 21 km east of Mussoorie on 9th July 1974. According to Blanford & Oates (1890, FAUNA OF BRITISH INDIA 2) and Sálim Ali & Ripley (1973, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN 8) the western-most limit of this species is Almora/Nainital, but Baker (1924, FAUNA OF BRITISH INDIA 2) includes Simla within its range (approximately 114 km northwest of Mussoorie).

This specimen was one of a pair seen along with Greywinged Blackbirds [*Turdus bouboul* (Latham)], in dense undergrowth at the edge of a vast clearing on a hillside slope. Though a considerable area around the spot is cleared to bring under potato cultivation, the thick vegetation along the ravines on the lower slopes might provide this bird enough cover to breed in this area. This rare and shy bird skulks in dense patches and is seldom seen. Ripley (1950, *J. Bombay nat. Hist. Soc.* 49: 386) presumably saw it in Bhimphedi, Nepal, where later Biswas (1961, *ibid.* 58:665) collected a single male. Smythies (1950, *ibid.* 40:515) mentions of a record of this species at Sheopuri, Nepal. The present specimen is the second in the Society's collection, the first was obtained by Dr. Sálim Ali at Gedu, c. 2000 m central Bhutan on 15th October 1968.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
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S. A. HUSSAIN

DEPT. SYSTEMATICS AND ECOLOGY,
UNIVERSITY OF KANSAS,
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September 29, 1974.

ROBERT C. WALTNER

14. SOME SYSTEMATIC NOTES ON THE YELLOW-BREASTED TIT (*PARUS FLAVIPECTUS*)

1. *On the Azure Tit in Chitral*

In July, 1902, H. T. Fulton collected five Azure Tits "in the dense scrub of stunted willow, juniper and birch" in a river bed at an altitude

of about 3000 m at Shost in Chitral. Though his note (1904, *antea 16*) suggests that the tits were rather numerous then there is no later record of an Azure Tit in Chitral or elsewhere in Pakistan or India. Possibly, Fulton merely had met with an occasional wandering flock from the Pamirs or Afghanistan but more probably the tit bred (or still breeds) in the montane forests of Chitral.

Fulton who compared the birds with European *P. caeruleus* but not with *P. (cyanus) flavipectus* from neighbouring Turkestan concluded they were *P. cyanus tianschanicus* Menzbier. At that time, the distribution of the azure tit forms was only rather poorly known. Actually, the western limit of *tianschanicus* runs from the mountains west of Lake Issyk-kul (Kirghiz Range) through Naryn, western Kashgaria and the Tashkurgan Range to the Khalastan but more probably farther west through the Sarykol Range to Hunza where the white-breasted form (*tianschanicus*) has been found near Misgar in October (Ludlow & Kinnear 1933). Yellow-breasted tits (*flavipectus*) occur in the Pamirs eastward to about 73°E (Ivanov 1969).

Thus, one might infer that the Chitral birds belong to *flavipectus* rather than to *tianschanicus*. Stuart Baker (1922), Hellmayr (1929), Hartert & Steinbacher (1933), however, followed Fulton in considering them to be the latter form. This is doubted by Vaurie (1957, 1959) on the basis of Snow's notes who had compared three of the Chitral tits in the British Museum and found they were "far too much yellow" to be typical *tianschanicus*. Contrary to this statement, Snow later (1967, in the Check-List) includes Chitral in the range of *tianschanicus**. Vaurie (1957) concedes that hybrids may occur but thinks it "probable that the population of Chitral is *flavipectus*"—if there is one at all.

Mr. Humayun Abdulali sent me one of the two Chitral birds in the collection of the Bombay Natural History Society for examination. Through the courtesy of the authorities of the British Museum (by sending three of Fulton's skins), the Zoological Museum of the Moscow University, the Zoological Institutes in Leningrad and Halle I was able to compare four specimens from Chitral and a good number of *tianschanicus* and *flavipectus*.

A series of 15 young *flavipectus* (including *carruthersi*; mostly from Ferghana and Tadzhikistan) differs very clearly from 13 young *tianschanicus* (from northern Mongolia, eastern Tian Shan in Chinese Turkestan and southern Kazakhstan) in the tinge of the greyish upper parts: it is distinctly, sometimes even strikingly yellow in *flavipectus*, and pale bluish (fresh skins) or brown, sometimes with a faint pinkish wash (older, foxed skins) in *tianschanicus*. The Chitral birds share the yellow tinge above and below of *flavipectus* and, hence, belong to this

* There, page 117, line 17: for "Altai" read "Alai".

form (if they are closer to *flavipectus* s. str. than to *carruthersi* is discussed below). They differ, however, from either subspecies by being somewhat paler above. The Bombay specimen is less pale and differs in having a brownish rather than greenish tint on the back. This is clearly the effect of foxing; the nuchal band in some young *carruthersi* show some brown, too, and many young *tianschanicus* have a brownish wash above, most distinct in a bird collected in 1876.

The yellow of the under parts is rather pale about as in one juvenile *tianschanicus* from the eastern Tian Shan and paler than in nearly all *flavipectus* and *carruthersi* before me. In just one bird (Brit. Mus. 1904.12.5.14) it is as deep as in average *carruthersi*. This might be one of the birds believed by Fulton to be young (while he thought those with less bright yellow under parts were full-grown individuals). The material is too poor to allow a judgement if the coloration of the Chitral birds is due to individual variation, distinctness of a local (isolated) population or intergradation though the latter is not very probable. The problem has been discussed by Vaurie (1957), and there is no further evidence. It should be stated here that the birds collected by Fulton are clearly not *P. cyanus tianschanicus*.

How the breeding range of the Yellow-breasted Tit is shared among the two subspecies is still unclear. Voyinstvenski (1954), Portenko (1954) and all authors dealing with the birds of Middle Asia ignore the geographic variability within this form. Vaurie (1959) includes the populations of the Alai mountains, the (western) Pamirs and (central) Tadzhikistan in *flavipectus* whereas Stepanyan (1972) says they belong to *carruthersi*, grading into *flavipectus* in "the eastern parts of the Alai Range (specimens from Gulcha)". I did not see any material from these regions. The birds from Chitral are not helpful in this issue since they match *carruthersi* in showing less yellow above and below while they are closer to *flavipectus* in the tail pattern (5 rectrices with white spots).

The taxonomic rank of *flavipectus* (and *berezowskii*) will not be discussed here. Recently, Stepanyan (1972) has reappraised the evidence and considers *flavipectus* to be a distinct species.

2. Description of the young

The juvenile plumage of *carruthersi* has not yet been described. Voyinstvenski (1954) and Portenko (1954) merge this subspecies in *flavipectus* and (like Menzbier 1895) do not even describe the young of the latter, a full description of which evidently has never been published. Hartert (1905) said they are duller on the upper parts than young *tianschanicus* (which he does not describe, to be sure), with a more or less perceptible greenish wash and light sulphur-yellow below. Vaurie (1959) oversimplifies this by saying the young were "deeply

tinged with yellow throughout the entire plumage". This plumage may be described as follows:

Juvenile *flavipectus*.—(Upper parts) fore-head and stripe around crown pale yellow to yellowish white; crown and hind-neck dull grey, the crown often lighter, with a faint bluish tinge; rest of upper parts including upper tail coverts yellowish olive-grey; (sides of head) dark grey line through lores and behind eye, cheeks and ear-coverts like under parts pale to rather bright lemon-yellow; tail, primaries, secondaries, primary-coverts as adult; greater coverts dull grey with broad yellowish-white tips and some bluish on the outer webs; median and lesser coverts slate-grey.

Juvenile *carruthersi*.—Differs from the preceding in being somewhat less vividly tinged yellow on the average (in the specimens examined by me, almost throughout and independent of wear) on the back and less brightly yellow on the under parts, throughout distinctly paler than the breast of the adult. In tail pattern, same difference as in adults.

Hartert & Steinbacher (1933) claim that the juvenile *P. cyanus tianschanicus* "has a yellowish breast and, therefore, apparently has sometimes been taken for *flavipectus*". Vaurie (1959) found *tianschanicus* only "occasionally very faintly tinged with yellow below". Neither is fully correct. Of the 13 juvenile *tianschanicus* before me one shows pale though very distinct yellow colour throughout the under parts, two a slight (ochraceous-) yellowish tinge, one patchy pale yellow over most of the under side, and five a very faint yellowish wash, all these being from northern Mongolia (see Piechocki & Bolod 1972) and Chinese Turkestan; three from Kazakhstan and one from the Mongolian Altai are practically white beneath. Hellmayr (1929) mentions two or three young tits from Chinese Turkestan (Tekes valley) with a "slight suggestion of a pale yellowish prepectoral band" and two similar birds, collected by N. Zarudny in June, 1899, in the adjacent region of Jarkent (now Panfilov).

On the upper parts, young *tianschanicus* are less blue on the back than the adult and much darker grey on the crown. They have a sooty grey nuchal band and grey lesser wing coverts; these parts are ultramarine in the adult.

3. Some remarks about the moult

There are very few data on the moult of the Azure and Yellow-breasted Tits. According to Voyinstvenski (1954), Portenko (1954) and Ivanov (1969) the adults have a complete postnuptial moult July to September; juvenile birds moult at the same time but are said (by Voyinstvenski) to renew only the body plumage. This latter is open to doubt since the four Chitral birds exhibit on growing primary each,

though in one wing only (nos. 5, 5 or 6 as numbered from the carpal joint), all grown to about three quarters. Possibly, the juvenile moult includes the renewal of some distal primaries (see Stresemann 1966, p. 425).

Among the young Yellow-breasted Tits I found some in body moult. Apparently, the flank feathers are the first to be replaced (in one bird as early as June 14, while one from July 22 shows no sign of moult). This is followed by the cheeks and the lower back and rump. About at the same time, the ultramarine lesser wing coverts appear (4 specimens obtained between July 29 and August 7). A bird collected August 18 near Lake Iskander-kul shows that the feathers of the pectoral band are moulted prior to those of belly and lower breast centre. In this bird the greater (secondary) coverts are growing while the back centre is still greenish grey.

UNIVERSITY OF BERLIN,
BERLIN,
September 24, 1973.

G. MAUERSBERGER

REFERENCES

- BAKER, E. C. STUART (1922): Fauna of British India, Birds 1:81. London.
- FULTON, H. T. (1904): Notes on the Birds of Chitral. *J. Bombay nat. Hist. Soc.* 16:44-64.
- HARTERT, E. (1905): Die Vögel der paläarktischen Fauna 1:354. Berlin.
- & STEINBACHER, F. (1933): ditto, Ergänzungsband: 183. Berlin.
- HELLMAYR, C. E. (1929): Birds of the James Simpson—Roosevelts Asiatic Expedition. *Field Mus. Nat. Hist. Publ.* 263, Zool. Ser. 17/3: (86-87).
- IVANOV, A. I. (1969): The Birds of the Pamiro-Alai. Leningrad. (In Russian).
- LUDLOW, F. & KINNEAR, N. B. (1933): A Contribution to the Ornithology of Chinese Turkestan. pt. II. *Ibis* (13) 3:440-473.
- MENZBIER, M. A. (1895): The Birds of Russia. Vol. 2. Moscow. (In Russian).
- PIECHOCKI, R. & BOLOD, A. (1972): Beiträge zur Avifauna der Mongolei. Teil II. Passeriformes. *Mitt. Zool. Mus. Berlin* 48:41-175.
- PORTENKO, L. A. (1954): The Birds of the USSR. Vol. 3. Moscow and Leningrad.
- SNOW, D. W. (1967): Family Paridae in R. A. Paynter (ed.): Check-List of Birds of the World. Vol. XII. Cambridge.
- STEPANYAN, L. S. (1972): On the Systematic Position of the Yellow-breasted Tit [*Parus flavipectus* Severtzov (Paridae, Aves)]. *Nauchn. dokl. biol. nauki* 2:11-16. (In Russian).
- STRESEMANN, E. & V. (1966): Die Mauser der Vögel. *J. Orn.* 107: Suppl.
- VAURIE, C. (1957): Systematic Notes on Palearctic Birds. No. 26. Paridae: the *Parus caeruleus* Complex. *Amer. Mus. Novit.* 1833.
- (1959): The birds of the Palearctic Fauna. Order Passeriformes. London.
- VOYINSTVENSKI, M. A. (1954): [Family Paridae in] G. P. Dementyev & N. A. Gladkov (ed.): The Birds of the Soviet Union. Vol. 5. Moscow (In Russian).

15. OCCURRENCE OF REDTHROATED PIPIT *ANTHUS CERVINUS* (PALLAS) IN BHAVNAGAR

On 8 April 1973 I saw a pair of redthroated pipit *Anthus cervinus* (Pallas) feeding beside Gaurishankar Lake in Bhavnagar, Gujarat. The presence of cinnamon colour on throat and breast make the identification unmistakable and separates it from the closely related *Anthus roseatus*. There was no pinkish or vinous tinge. One of the birds had a brighter throat and upper breast. Subsequently, I saw more of this species.

So far this species has been known from Gujarat only through a single record from Baroda (Sálim Ali, 1955, *J. Bombay nat. Hist. Soc.* 52:777) and hence the present record is of interest.

DIL BAHAR,
BHAVNAGAR,
April 9, 1974.

R. S. DHARMAKUMARSINHJI

16. REFLECTED GLOW FROM THE EYES OF THE GHARIAL

Abdulali (1957)¹ reported that the eyes of the Gharial (*Gavialis gangeticus*) do not reflect torch-light as do the eyes of the marsh crocodile (*Crocodylus palustris*). Oliver (Abdulali 1957) states that the eyes of the Gharial do reflect light, but not in the same fashion as other crocodilians as the "colour is a much fainter glow", and that "there was only a small area in which light could be reflected".

Recently, with the help of Mr. Romulus Whitaker, I examined six Gharial in the collection of the Sri Chamarajendra Zoological Gardens, Mysore, Karnataka. These included five young adults of unknown sex, and a female of one metre. During the course of the examination torch-light was shone at the eyes of the Gharial, at night, and the reflected glow was found to be of the same colour and brightness as that of other crocodilians. However it was observed that the area capable of reflecting light was much larger than in other crocodilians owing to the protruding nature of the eyes.

It was found that to perceive the reflected glow that the torch had to be held at eye level, and that the eyes would not reflect light from a distance of less than four metres. This has also been observed for other species of crocodilians.

¹ ABDULALI, HUMAYUN (1957): Reflected Glow from the Eyes of the Gharial [*Gavialis gangeticus* (Gmelin)]. *J. Bombay nat. Hist. Soc.* 54(3):769-770.

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MADRAS SNAKE PARK AND
CONSERVATION CENTRE,
GUINDY DEER SANCTUARY,
MADRAS 22, TAMIL NADU,
July 19, 1974.

CHARLES A. ROSS

17. SOME NOTES ON GHARIAL [*GAVIALIS GANGETICUS*
(GMELIN)] IN CAPTIVITY
(With a plate)

In view of the very limited information available regarding the food and habits of the Gharial [*Gavialis gangeticus* (Gmelin)] the following notes on captive specimens in Nandankanan Biological Park, Orissa, may be of interest.

Since 1963, sixteen baby gharials have been received, 1 in March, 2 each in June, July and October, and 3 each in August, September and November. All were accidentally captured in fishing nets in the river during floods.

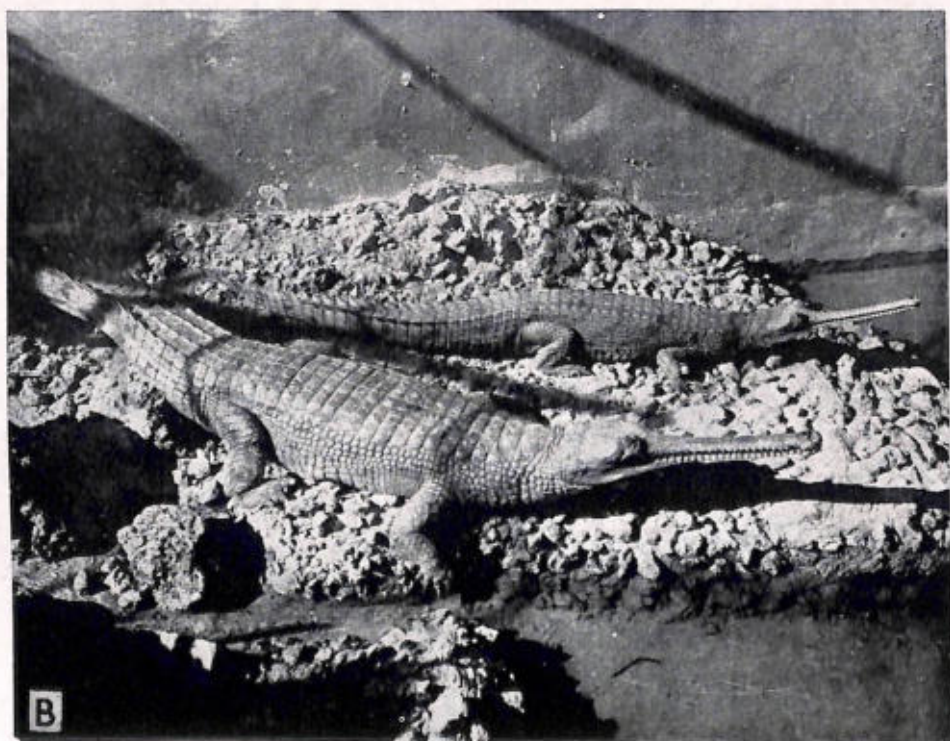
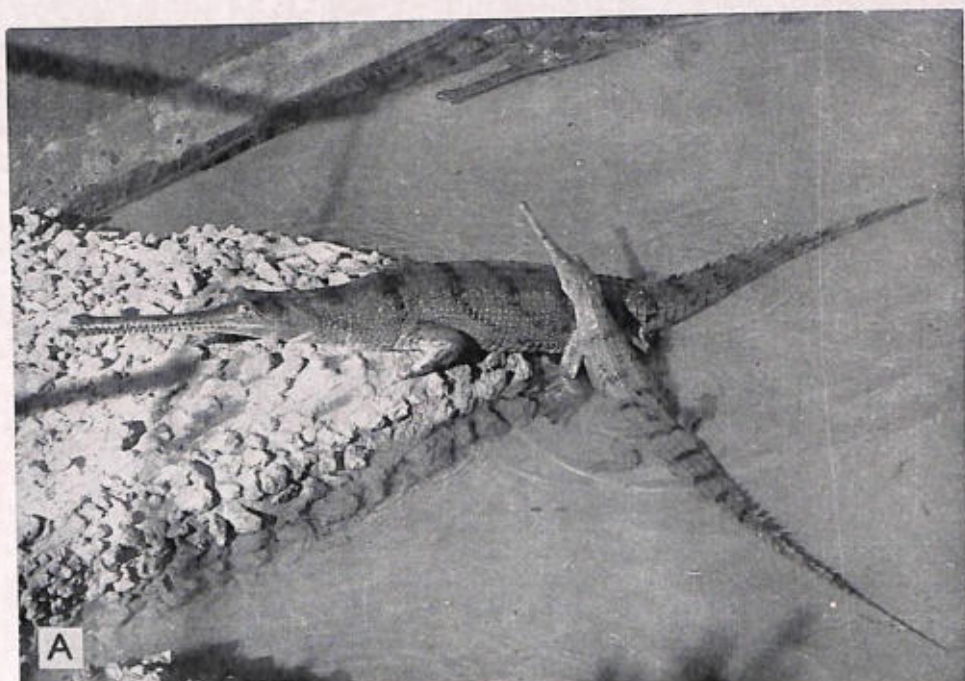
At present three gharials (1♂ 2.56 metres; 2♀♀ 2.45 and 2.48 metres) and two crocodiles [*C. palustris* Lesson (one 3 metre and the other 2 metre)] are kept together in an artificial cement tank of water with irregular sides, of an area of about 750 square feet and a depth of about 3½ feet. The shore is sandy in places and covered with laterite stones in others. The water is changed two or three times every month.

About 20 kgs of live fish, mostly *Channa gachua* (Ham.), *Channa marulius* (Ham.), *Channa punctatus* (Bloch), *Channa striatus* (Bloch), *Heteropneustes fossilis* (Bloch), *Clarias batrachus* (Linn.) *Notopterus notopterus* (Pallas), are dropped into the pond once a week, usually in the evening. The replenishment is guided by the number left and determined at the time of clearing the tank. The surviving fish suggest that *Heteropneustes fossilis* and *Anabas testudineus* are least favoured. Generally dead fish are ignored.

Once the bigger crocodile jumped out of water and caught a monkey sitting on a branch overhanging the tank.

The gharial catches a swimming fish across the middle, raises its entire snout above the surface of the water and then with 2 or 3 snaps turns the fish, bringing it deeper into the mouth and gulps its head first. These jerks of floating gharial often synchronise with a similar movement of the tail outside the water. Fish fingerlings were fed to the gharials when first received and the size increased in proportion with the growth of the gharials.

A baby gharial weighing about 600 gm and measuring about 70 cm



A. Two gharials are just coming out of water. The black bars on the body are clearly visible.

B. Same gharials are returning to water after staying sometime on the land. The black bars on the body have almost disappeared.

was released into the tank on 15th August 1970 and immediately swallowed by one of the crocodiles. Though care had to be taken with the young animals, grown-up gharials and crocodiles lived peacefully together in the same tank. Three turtles [*Lissemys punctata granosa* (Schoepff)] also lived in the same tank for several years being unharmed by the gharials or crocodiles and helped to clean the tank of dead fish and other material.

If not disturbed by visitors, the saurians in winter spent most of the day basking in the sun on the sand. They were also seen out of water sometimes on winter nights.

During summer, they left the tank for some time early in the morning and late in the evening and during the hottest part of the day remained submerged in water.

At times a sort of hissing sound was produced in the process of exhalation.

The specimens have become very tame and can be approached and examined at close quarters.

At 8 a.m. on 31st January 1974, the larger of the two females was resting on the border of the cemented tank with the front portion of the body outside the water. During one hour of observation, the male approached this female three times. He first rubbed his snout and body on her body. On the second occasion he placed his snout over her body, rested for some time and then went away. The third time he placed himself over the body of the female with his snout reaching over her head. It was also observed that the male often followed this female in water, while the other rested quietly on the sand. This was presumably sex play and may well be the commencement of the season for Prasad (1914) found matured eggs in the oviduct in March, and local evidence indicates that they lay in April, May and June.

On the same day (31st January 1974), we approached one of the female gharials lying outside the water. Until we were two metres away, there was no response, but it then opened its eyes for a moment and then closed them again probably because it did not suspect any danger. A female resting at the angle of the tank suddenly jumped into the water on hearing a bus passing at a distance of about 6 metres.

Coloration: The general colour of a fully-grown gharial when out of water is olive of various shades, the head and snout being darker. Numerous indistinct black spots are scattered over the body. When it is swimming in the water, the black spots *expand or disperse* and form 8 or 9 distinct wide black bands across the dorsal surface of the body (Pl., A). When in water, these bands appear more prominent due to the refractive index of the water but gradually disappear when it comes out of the water to the sun (Pl., B). This is due to the contraction of black pigment in the melanophores. The colour of the ventral side also

varies from greenish-olive to yellow-white and this change of colour may be influenced by temperature and sunlight.

When cleaning the tank, a number of teeth of both gharials and crocodiles were found, mostly of the former. Empty spaces in the jaws and growing teeth of varying sizes were observed in the open mouths of the gharials at close quarters. It would appear that the teeth are periodically shed and regrown, one or two at a time. Its teeth are also longer, narrower and more pointed at the tip than those of the crocodile. Those of the crocodile can be easily distinguished by their stoutness, shortness, and the greater number of striations thereon.

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R. MISRA

18. HEMIPENAL STRUCTURE IN *ELAPHE RADIATA* SCHLEGEL WITH A DIAGNOSTIC KEY BASED ON HEMIPENIS

The structure of the hemipenis is poorly known in most of the Indian species of snakes and the available information is from M. A. Smith, (1935, *Fauna. Brit. India*, Vol. III); who has himself pointed out '...descriptions considerably vary in pattern and need revision' (op. cit. p. 11). Structure as a systematic tool has been first utilised by Cope, E. D. (1893) whose classification was later modified by Dunn, F. R. (1928) but most comprehensive account of the structure is of Dowling, H. G. & Savage, J. M. (1960). An attempt has been made in this paper to prepare a diagnostic key on the basis of Smith (op. cit.) and certain observations on lepidosis variation in relation to the structure.

Hemipenis in *Elaphe radiata* Schlegel

Hemipenis extends to 24th caudal plate and the spinose area is nearly $\frac{1}{4}$ th of the organ. Spines are of three types: (i) distal spines, 3-4 mm long, pointed with shallow canaliculate depressions and arranged 5-7 each in 9-10 quite distinct horizontal rows; (ii) medial spines, 5-7 mm long with blunt somewhat curved and each having a fairly marked spatulate canal (larger ones around the sulcus); (iii) proximal

spines, 2-3 mm long, pointed and arranged 5-7 each in horizontal rows.

Above description based on the specimens from north India show variation from the description of Smith (op. cit.) in that the hemipenial structure extends to 24th caudal plate and not up to 10th plate.

DIAGNOSTIC KEY

Hemipenis extending upto:

1. Upto 8th caudal plate
Spines short pointed and throughout
Proximals few large ones *E. porphyracea*
2. Upto 9th caudal plate
Spines pointed hard and not throughout
Proximals all large
i) a loreal *E. prasina*
ii) no loreal *E. frenata*
3. Upto 10th caudal plate (upto 24th plate)
Var. I. Calyses deeply scalloped
Spinose area extensive, rows horizontal
Proximals short pointed *E. radiata*
Var. II Other characters same upto 24th caudal plate *E. radiata*
Calyces calyculate at tip spinose area
extensive, rows longitudinal
Proximals few large ones *E. leonardi*
4. Upto 13th caudal plate
Calyces small pointed
spinose area relatively small (at distal $\frac{1}{2}$)
rows longitudinal with abrupt transition *E. hodgsoni*
5. Upto 14th caudal plate
i) Cups deeply scalloped spinose area half,
calyses calyculate distal spines few, proximals in
2 small rows (with papilla like process) *E. mandarina*
ii) No cups
spinose area more than half, calyses
small uniform, proximals few large *E. flavolineata*
Spinose area half or less (other characters same) *E. helena*
6. Upto 17th caudal plate
Calyces deeply scalloped
spines blunt, proximals short stout *E. cantoris*
7. Upto 21st caudal plate
Calyces not scalloped but large thick,
spinose area short, spines few very large
Proximals short more in numbers *E. oxycephala*
8. Upto 27th caudal plate
Other characters same as in S. No. 5 *E. taenura*
9. Upto 28th caudal plate
Calyces small and scalloped,
spinose area wide, spines uniform *E. mollendorffi*

The significance of the structure in diagnosis appears quite clear. Of the 14 species distributed over India, Burma, Sri Lanka, Pakistan,

Indo-Chinese and Malayan regions, the closest resemblance is between *E. prasina* and *E. frenata* in the orientation of the hemipenal structure. This may be due to closer affinity as also nearly overlapping distribution. There also appears a relation in distribution and length of the structure. Himalayan species (*E. prophyracea*, *E. prasina*, *E. frenata*, *E. radiata*, *E. flavolineata* and *E. cantoris*) comprise one group having structure from 8 to 17 (24 in a var.) caudal scutes. In the group of species distributed in western Himalayas, the hemipenal length is upto 13 to 14 caudal scute; while in species of eastern Himalayas the length of the structure is shorter—with the exception of *E. radiata* which has a overlapping distribution (Bhatnagar 1969). Within Chinese species the aspect deserves further study as neither clear descriptions nor good material is available for study. Within Burmese and Malayan species we find that shorter penis length character repeats but there is an upward trend. However, only a large series of specimens can elucidate the character correctly. Similar situation appears to be within Indo-Chinese species and deserves study in large series.

Himalayan species show a close range of maxillary teeth numbers; number of costals with exception amongst *E. hodgsoni* and *E. cantoris*; ventral scute count variation is 190-236; caudal scute variation from 52-145 and labial count variation appears negligible.

It thus appears that systematic studies on Indian Ophidians deserve a closer study particularly in light of hemipenis character and correlation with lepidosis with distribution. The aspect appears so far neglected.

ACKNOWLEDGEMENTS

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30 SOUTH PATEL NAGAR,
NEW DELHI 110 008,
July 16, 1973.

R. K. BHATNAGAR

REFERENCES

- BHATNAGAR, R. K. (1969): Extension of range of Copperhead Snake *Elaphe radiata* Schlegel (Ophidia: Colubridae) to Doon Valley & Doon Siwaliks. *J. Bombay nat. Hist. Soc.* 66(2):383.
- COPE, E. D. (1893): Prodromous of a new system of the non-venomous snake. *American Nat.* 27 (317):477-483.
- DUNN, E. R. (1928): A tentative key and arrangement of the American genera of Colubridae. *Bull. Antivenin Inst. America* 2:(1):18-24.

- DOWLING, H. G. & SAVAGE, JAY M. (1960): A guide to the Snake hemipennis: a survey of basic structure and systematic characteristics. *Zoologica*, Zoological Society, New York 45(1):17-27.
- SMITH, M. A. (1945): *Elaphe radiata* Schlegel in Faun. Brit. India, Reptilia & Amph., Vol. III, pp. 146-148. Taylor & Francis, London.

19. *ECHIS* IN TAMIL NADU

In a 2 m × 2 m × 1½ m concrete sided pit we had been housing about 30 *Echis carinatus* with pond, rocks, cacti and grass. When dry, the smooth pit walls are the barriers that we know from experience will safely contain "all" snakes under a certain length. When the walls are wet from rain however, we were surprised to see that *Echis* are able to slowly edge their way up the sheer wall. It seems that the suction created by their numerous ventral scales allows smaller and thinner (light) *Echis* to climb the 1½ metre wall in about 1 hour. This not to suggest that *Echis* habitually climbs smooth walls (i.e. houses etc.) as they will certainly follow the easiest route of travel.

Though *Echis* is essentially a ground viper and is collected in its northern range in India under rocks etc., in the south they seem to spend a large part of their time up in thorn bushes, cacti, century plants, in palmyra bark and even casurina trees and thatch roofs. This climbing trend is especially obvious during the rains when we find 80 per cent above ground in bushes and 20 per cent in and under stones, grass tufts, and very rarely in holes.

Echis are common in almost any part of Tamil Nadu that is dry and rocky and/or sandy. They are found in no forests except scrub jungle areas. The average length of *Echis carinatus* in the south is under 250 mm and is lighter in colour, more yellowish than the northern race or sub-species. Though bites are common (we treated 14 cases in the 3 months of July, August, September in a small rural area south of Madras in 1970) fatalities are very rare due to the snakes small size and effectiveness of antivenom serum.

MADRAS SNAKE PARK,
GUINDY DEER PARK,
MADRAS 22,
August 1973.

R. WHITAKER

20. ON THE FISHES OF THE GENUS *CTENOPS* McCLELLAND (1845)

During a study of the fishes of north Bihar (India) a well preserved specimen of *Ctenops nobilis* McClelland, from the collections of Zoological Survey of India, was noted. On comparison with the identified

material in Z.S.I. it revealed some distinct differences but as a solitary specimen it is not possible to give it a separate specific or subspecific status at present. A thorough examination of the material of the genus was done in this connection, and a detailed description of the species is given as the description given by McClelland (1845) is very brief.

McClelland (1845) proposed the genus *Ctenops* for an elegant anabantid fish from the rivers of Sikkim passing on northern frontiers of Bengal and described under it a species *C. nobilis*. Day (1877) synonymised *Ctenops* of McClelland with genus *Osphronemus* (Commerson) Lacépède (1801), changed the spelling of *Osphronemus* to *Osphromenus*. Day (1877), and Regan (1909) considered *Trichopsis* (Kner) Contestrini (1860), as a junior homonym of *Ctenops* McClelland, (1845) and other authors put *T. vittatus* under genus *Ctenops*.

However, Myers (Herre & Myers 1937) pronounced that the *C. nobilis* and *C. vittatus* have generic differences and proposed to retain genus *Trichopsis* (Kner) Contestrini for the latter. This taxonomic change has also been adopted by Smith (1945) and Forselius (1959) who thought it more appropriate to describe the Indian genus *Ctenops* as monospecific.

In the classification of the Teleostean fishes, Regan (1909) and Weber & deBeaufort (1922) placed anabantoidei as a suborder of the order Labyrinthici. Berg (1940) and Greenwood *et al.* (1966) considered the association of these two groups as unnatural and their resemblance as due to convergence and transferred Anabantoidei as a Suborder of order Perciformes.

Genus *Ctenops* McClelland

1845. *Ctenops* McClelland, *Calcutta J. nat. Hist.* 5, p. 281. (Type Species: *C. nobilis* McClelland).

Description

Body oblong, compressed. Head acute. Snout equal or longer than the diameter of the eyes; lower margin of the enlarged lacrimal and the angle and lower margin of preopercle denticulated; premaxillaries and denture with bands of small teeth; no teeth on the vomer and palatine; peripheral teeth enlarged; upper jaw protrusible; dorsal with 4-7 spines and 6-8 rays and inserted almost above the middle of soft anal; anal with 4-5 spines and 23 to 28 rays; median fins scaly at the base; ventrals inserted a little in advance of the pectorals, each with a strong spine and 5 rays, the first ray produced into a filament; scales arranged in regular rows. Those on body ctenoid while the one on head may or may not be ctenoid. Lateral line vestigial. The swim bladder extends into caudal region of the body.

Distribution: Confined to Assam, Bengal and Bihar.

***Ctenops nobilis* McClelland**

1845. *Ctenops nobilis* McClelland, *Calcutta J. nat. Hist.*, 5, p. 281, pl. 21, fig. 1.
(Type Loc.—Rivers of Sikkim passing on N. Frontiers of Bengal)
1849. *Trichopodus nobilis* Cantor, *J. Asiat. Soc. Bengal*, 18, p. 211.
1869. *Osphromenus nobilis* Day, *Proc. zool. Soc.*, London, p. 519.
1877. *Osphromenus nobilis* Day, *Fishes of India*, p. 372, pl. LXXVIII, fig. 5.
1909. *Ctenops nobilis* Regan, *Proc. zool. Soc.*, London, II, p. 777.
1922. *Ctenops nobilis* Weber & deBeufort, *Fish. Indo-Aust. Archpel.* 4, p. 1352.
1937. *Ctenops nobilis*, Shaw & Shebbeare, *J. Asiat. Soc. Bengal* 3, p. 113, fig. 118.

MATERIAL

- a) Z.S.I. Regn. No. Cat. 333, Purnea, Bihar, Dr. Jerdon, one example 53 mm. Standard Length.
- b) Z.S.I. Regn. No. Cat. 334, Dacca, Mus. Collector, One example 57 mm. S.L.
- c) Z.S.I. Regn. No. 1565, Assam, Purchased from Dr. F. Day (original of Pl. LXXVIII, fig. 5 of *Fishes of India*), one example, 60 mm. S.L.
- d) Z.S.I. Regn. No. 13343-45. Jessore Jheel, E. Pakistan, J. Wood Masson & Alcock, 3 exs. 41-66 mm. S.L.
- e) Z.S.I. Regn. No. 7866-67. Dibrugarh, Dr. S. W. Kemp, 2 exs., 42-56 mm. in S.L.
- f) Z.S.I. Regn. No. F 11425/1, Siliguri, N. Bengal, Messrs C. E. Shaw & E. O. Shebbeare, One exam., 60 mm. S.L.
- B, VI, D. 4-6/6-8, P. 13, V. 1/5, A. 4-5/23-28, C. 16, Ll. 28-34. Ltr. 6/12.

A small elegant anabantid with body laterally flattened. Dorsal profile rises immediately behind the nape to the origin of the dorsal after which it descends down to the base. Ventral profile likewise descends sharply from the mandibular edge to the origin of the anal fin after which it ascends gradually up to the base of the caudal. Head length 2.62 to 3.0 in the standard length. Eyes prominent lateral. Diameter of eyes 3.2 to 3.8 times the length of the head. Snout longer than diameter of eye. Snout dorsally convex and anteriorly flat and blunt. Diameter of eye 0.75 to 0.98 times snout length. Interorbital space almost flat and width more than length of snout. Nostrils paired, separated by a flat internarial membrane, nearer to eye than tip of the snout; gape wide. Lower jaw elongated to form a somewhat pipe shaped mouth. Lower jaw longer than upper; upper jaw portrusible.

Day (1877) and Weber & deBeufort (1922) stated that the end of intermaxillaries (premaxillaries) extends opposite to front border of the orbit. The intermaxillaries (premaxilla) do not extend to opposite the front border of the orbit in any of the examples studied here. The premaxillaries form the upper jaw and are broadened medially and narrow distally. The broad medial ends are produced backward into a rod like bony process; the two processes of either side lie opposed to each other

and conjointly form a medio-posterior process of the upper jaw and help in the protrusion and retraction of the upper jaw. These processes lie beneath the nasals. The underside of the premaxillaries bears a wide band of villiform teeth which are enlarged on the periphery. Maxillaries are toothless. Distal ends of the premaxillaries and the maxillaries lie close to each other, that of maxillary being on the outside. The distal tip of maxillary is flattened.

The whole of maxillary and the distal part of the premaxillaries lie in a groove formed below the enlarged lachrymal (Preorbital of Day 1877, Regan 1909, and Weber & deBeufort 1922). The outer border of the lachrymal is toothed. The toothed band on the mandibles is of a similar nature as that of the upper jaw and has a series of enlarged peripheral teeth. The groove below the lachrymal extends on underside of the mandibles but the two sides do not meet below the mandibles. The lower lip is enlarged on the lateral side where it covers the retracted parts of the maxillaries.

Dorsal short, its origin lies about nearly the middle of the soft portion of the anal. Length of the base of the dorsal lies 4.4 to 6 times in the St. length whereas that of the anal base is 1.7 to 2.1 times.

Length of pectoral equal to half that of head or in some examples even somewhat less. Pelvics inserted a little in advance of the pectorals. Spine of the ventral strong and the outermost ray prolonged to varying lengths in all the examples studied here. Length of pelvic spine lies 2.0-2.48 times in length of head.

Except the naked part of the upper lip and the ventral side of the lower jaw, the whole body is covered by scales. The scaly sheath extends onto the basal part of the median fin. The lateral line is but slightly visible and irregularly pierces the scales. The scales of the body are more or less rectangular with the posterior margin convex and beset with ctene. The scales on the head may be smooth edged or minutely ctenoid. There are 28-34 scales along the lateral line while six above it and 12 below.

Coloration:

Colour in spirit brownish. A white band extends from behind the posterior border of orbit and runs uninterrupted below the lateral line upto opposite end of spiny portion of anal fin and thereafter to the base of the caudal in the form of white patches. Another interrupted white band originates from the area between the bases of the pectoral and pelvic fins and extends upto the middle of the soft portion of the anal. A third similar band extends upto the middle of the soft portion of the anal. At the upper part of the base of caudal there is a light edged dark brown ocellus. The ventral side of the head and abdomen are banded alternatively brown and white.

Ctenops sp.

The solitary specimen collected from Bettiah, Bihar, resembles *C. nobilis* in general but shows a few important differences as shown in the table below. It has been compared with specimens of similar length from Dibrugarh (Assam), Jessore Jheel (Bangladesh) and the differences are constant. The main differences being in the depth of body, the height of head at occiput and the length of the pelvic spine.

<i>Ctenops</i> sp.	<i>Ctenops nobilis</i> McClelland.
The depth of the body is less than the length of the head. (Being 1-2 times).	The depth of body either equal or more than the length of head. (Being 0.88-1 times).
The depth of body 3.4 times in standard length.	The depth of body is 3 or less than 3 times in standard length.
The height of body at caudal base lies 1.8 times in height of body.	The height of body at caudal base lies 2-2.6 times in the height of body.
The height of head at occiput is 1.1 times of the depth of body.	The height of head at occiput is 1.3 to 1.9 times in depth of body.
The length of pelvic spine goes 1.87 in length of head.	The length of pelvic spine goes 2.0-2.78 times in head length.
Snout is not longer than eye.	The snout is longer than eye.

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REFERENCES

- BERG, L. S. (1940): Classification of fishes, both recent and fossil. *Trav. Inst. Zool. Acad. Sci., U.S.S.R.*, 5(2): 87-517.
- DAY, F. (1877): The fishes of India, pp. 371-372.
- FORSELIUS, S. (1957): Studies of Anabatid fishes. I. *Zool. Bidr.*, 32: 93-302.
- GREENWOOD, P. H., ROSEN, D. E., WEITZMAN, S. H. & MYERS, G. S. (1966): Phyletic Studies of Teleostean

fishes with a provisional classification of Living forms. *Bull. Amer. Mus. nat. Hist.*, 131(4):341-455.

HERRE, A. W. C. T. & MYERS, G. S. (1937): A contribution to the ichthyology of the Malay Peninsula. *Bull. Raffles Mus.*, 13:5-75, pls. 1-7.

MCCLELLAND, J. (1845) Description of four-species of fishes from Rivers at foot of Boutan Mountain. *Calcutta J. nat. Hist.*, 5:274-282.

REGAN, C. T. (1909): The Asiatic

fishes of the family Anabantidae. *Proc. zool. Soc., London*, 2:767-787.

————— (1909): The classification of Teleostean fishes. *Ann. Mag. nat. Hist.*, 8(3):75-86.

SMITH, H. M. (1945): The freshwater fishes of Siam or Thailand. *Bull. U.S. nat. Mus.*, 188:1-622.

WEBER, M. & DE BEUFORT, L. F. (1922): The fishes of the Indo-Australian Archipelago, 4:350-352.

21. AN INTERESTING CASE OF FISH SPAWNING IN AN OVERCROWDED NURSERY POND

Dubey & Tuli (1961) were the first to record the spawning of Indian major carps in standing water without any flow in two wet bundhs, namely Nagda and Bilaoli reservoirs, of Madhya Pradesh on sandy-clay and stony embankments respectively. Alikunhi *et al.* (1964) recorded major carps spawning in Neorapahari Tallaiya, an ordinary 0.08 ha pond with rocky embankments and sandy-silt bottom, near Nowgong (M.P.). The breeders were stocked in this pond from a nearby tank for induced breeding experiments about 10 days after the accumulation of fresh rain water. They also reported the spawning of catla, rohu and mrigal, soon after fresh rain water had collected, in two typical nursery-cum-rearing ponds (0.08 ha) at Jagatsagar (Nowgong, M.P.) with sandy substratum. There was no flow of water in any of these ponds. A similar case of spawning in a nursery pond, with standing water, at the Experiment Station, Adhartal Lake, Jabalpur, is reported here.

The 0.04 ha nursery pond (25 × 16 × 1.5 m) has been in use for fry rearing for over ten years in connection with the fisheries development programme in the Adhartal Lake (16 ha). This nursery normally dried up during summers but after the 1968 fry rearing season was over, some 500 rohu and 200 mrigal fingerlings, left behind in the nursery, continued to be reared in the pond, with the idea of raising a stock of breeders in the nursery itself. The nursery was filled with lake water at least thrice between February and June each year for the continued rearing of this stock. Between October 1969 and June 1971, the pond was stocked with common carp (*Cyprinus carpio* var. *communis*; 110 mm/25 gm), grass carp (*Ctenopharyngodon idella*, 82 mm/8gm), silver carp (*Hypophthalmichthys molitrix*, 118 mm/11 gm), prawns (*Macrobrachium malcolmsonii*, 55 mm) and mahseer (*Tor tor*, 100 mm) fingerlings. Wild spawning of common carp was recorded in the pond

in November, February-March and July-August each year on marginally growing para grass (*Brachiaria mutica*). Common carp also spawned when water was taken to fill this nursery from Adhartal Lake even in April-May when the air temperatures were as high as 35°-38°C.

Besides the fingerlings listed above, 25 catla (6-15 Kg), 6 rohu (2-4 Kg) and 6 mrigal (1-2 Kg) were further stocked in the nursery between October 1971 and June 1972 with a view to using them as breeders for hypophysation. These large-sized catla and rohu, however, did not mature nor was there any reduction in their mesenteric fat (Tripathi 1972).

The water of the pond was throughout highly turbid and the plankton density extremely poor (traces/50 l). The pH of the pond water varied from 7.5 to 8.2. The pond bottom had about 200-300 mm of loose muck. It often emitted a foul smell and bubbles of gas appeared on the water surface, especially on cloudy days.

During the 1972 monsoon season, mrigal and rohu breeders from this pond were used for hypophysation; the entire induced breeding work was done in the main lake. However, a dry spell from 10th July to 7th August affected the condition of mrigal breeders but rohu breeders continued to respond well to hypophysation even after 7th August 1972. There were heavy rains on 14th/15th August 1972 with 125 mm rainfall. The water level in the nursery, which stood at 442 mm in July, went up to 919 mm on the 15th August. Though there were sporadic rains between 16th and 29th August 1972, the water level in the pond had fallen to 634 mm. Heavy rains were again recorded on 29th August afternoon and it continued raining the whole night (29th/30th Aug.). It was the season's maximum record of rainfall on one day, the details of rainfall and temperature on 29th, 30th and 31st August are given below:

Date	Temperature (°C)		Rainfall (mm)
	Maximum	Minimum	
29-viii-72	23.3	23.3	78.7
30-viii-72	23.0	21.4	304.8
31-viii-72	24.2	21.4	19.3

The water level in the pond went up from 634 to 1164 mm on the 30th August. The dilution on the two occasions (15th and 30th Aug., 1972) could be said to be twice each time.

Despite a heavy downpour from about 2 p.m. onwards on 29th August, rohu breeders from this pond were collected and injected at 5.30 p.m. and about 2.97 lakhs eggs obtained on 30th August morning. Since it was very windy and fixing the hapas in the lake was difficult, breeders were not injected on 30th August evening. On 31st August, when rohu breeders were again collected for hypophysation it was found that they had already bred in the nursery. Though actual

breeding in the pond was not observed it is surmised that it took place in the early hours of 30th morning. A number of hauls were made and several breeders examined. The males were found to be oozing thin milt and the females gave out loose eggs on slight pressure on the abdomen as is commonly observed in case of spent breeders. Several hauls were then made with a plankton net but not a single egg or hatching was obtained. Since common carp, of all sizes, predominated in the pond, it is possible that they had completely destroyed the eggs while those that survived had probably hatched out by the time the search was made and being few in number could not be collected by the plankton net. The season's fish breeding programme thus came to an abrupt halt.

Hauls made subsequently after a month on October 6, 1972, for the presence of small fry, if any, confirmed that spawning had taken place in the nursery. Six fry (35-40 mm) were collected in two hauls with a fine-meshed drag-net. Since large-sized catla and rohu were also present in the pond, further hauls with this drag-net were not made.

An analysis of the soil and water conditions of the pond after spawning (31st August '72) is given below:

Soil

Sand 63.75%, Silt 8.75%, Clay 27.50% Tex class Scl (Sandy-clay-loam).

Water

pH 7.9, K 6 (ppm), Na 18 (ppm), P 0.10 (ppm), Conductivity 200 (micromhos/cm), Total sol. salts 128 (ppm), Titrable alkalinity 2.3 (me/l).

Analysing the factors influencing the spawning of carps, Hora (1945) observed heavy monsoon floods to be the primary factor acting as a triggering mechanism for spawning. However, other workers have laid emphasis on topographical (David 1959), chemical (Mookerjee 1945; Saha *et al.* 1957) and physical (Khan 1945 and David 1959) conditions. Within the ranges encountered, it has been seen that pH, DO, free CO₂, total alkalinity and turbidity have not noticeable effect on spawning. Dasen (1945) considered monsoon floods from the hills as an indispensable factor as it has, besides, special physical and chemical, certain electromagnetic, properties apart from a peculiar smell or fragrance. Recently, Lake (1967), based on a series of experiments, has postulated that fish are stimulated by some factor resulting from inundation of dry ground or from water entering a pond or river after flowing over dry ground. In the present case, the question of fish getting stimulated by water entering the pond after flowing over dry ground cannot be considered as the bundhs and side slopes of the nursery could not be taken as "dry ground" towards the end of the mon-

soon season. It being a typical nursery there was no catchment area too. Rainwater had already entered the nursery on several occasions during the current season as also during the 1970 and 1971 monsoon season but with no effect.

Swingle (1953) has reported that spawning of fish is inhibited due to the presence of a hormone like excretion or secretion from fish that acts as a repressive factor. Though common carp spawned naturally in this pond during July-August, November and February-March, its breeding was noted on several occasions whenever the nursery was refilled with water from the main lake. It is possible that the dilution required to nullify the inhibiting effect of the factor for common carp is different than that for catla, rohu or mrigal. Swingle (1953) has further observed that "the repressive factor may be specific for a particular species or may affect other species". As already noted above, common carp bred profusely in this pond after a heavy shower on 16th August 1972 but perhaps this dilution was not enough for rohu. Rohu itself, however, bred on 30th August when the repressive factor specific for it was considerably diluted. It may be mentioned that spawning of any of the Indian major carps has never taken place in this nursery ever before and this is the first time that rohu have spawned in this pond.

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REFERENCES

- ALIKUNHI, K. H. *et al.* (1964): Observations on the breeding of carps in bundhs near Nowgong, Madhya Pradesh, during July-August, 1964. *Bull. cent. Inst. Fish Educ., Bombay* (1):32.
- DASEN, S. (1945): Symposium on the factors influencing the spawning of carps. *Proc. nat. Inst. Sci. India* 11(3):325.
- DAVID, A. (1959): Observations on some spawning grounds of the Gan-

getic major carps with a note on carp seed resources in India. *Indian J. Fish.* 6(2):327-341.

DUBEY, G. P. & TULI, R. P. (1961): Observations on the breeding of major carps in Madhya Pradesh. *J. Bombay nat. Hist. Soc.* 58(1):81-91.

HORA, S. L. (1945): Analysis of factors influencing spawning of carps. *Proc. nat. Inst. Sci. India* 11(3):303-312.

KHAN, H. (1945): Observations on the spawning behaviour of carp in the Punjab. *ibid.* 11(3):315-320.

LAKE, J. S. (1967): Rearing experiments with five species of Australian freshwater fishes. I. Inducement to spawning. *Aust. J. mar. Freshwat. Res.* 18(2):137-153.

MOOKERJEE, H. K. (1945): Factors influencing the spawning grounds of principal carp of India. *Proc. nat. Inst. Sci. India* 11(3):324-327.

SAHA, K. C. *et al.* (1957): Studies on the factors influencing spawning of Indian major carps in bundh fisheries. *Indian J. Fish.* 4(2):284-294.

SWINGLE, H. S. (1953): A repressive factor controlling reproduction in fishes. *Proc. Eighth Pac. Sci. Congr.* (3) A:865-871.

TRIPATHI, S. D. (1972): Hypophy- sation of Indian major carps at the Experiment Station, Adhartal Lake, Jabalpur, Madhya Pradesh. In Silver Jubilee Symposium on "Aquaculture as an industry". *Symp. No. 3, November 25-28, 1972, Barrackpore (Abs):* p. 10.

22. INTRODUCTION OF INDIAN TROUT IN LONAVALA WATERS

(With a photograph)

In 1926 Mr. F. V. Evans, a Vice Patron of the Bombay Natural History Society reproduced in the Society's *Journal* (Vol. 31, p. 828) a letter published in 1831-32 in the *Oriental Sporting Magazine*, recording occurrence of a remarkable fish known as Indian trout, in great abundance, near Neemuch in the present Madhya Pradesh where officers of the army stationed at that place enjoyed the enviable treat of catching dozens of Indian trout in a couple of hours on artificial fly in the Chambal and Banas rivers. The letter also quotes a record of "the enormous number of 51 dozen of fine trout" caught in a day's fishing by three anglers. On another occasion 19 dozen per head were landed by two anglers. Being impressed by this attractive record and taking into consideration the altitude of Neemuch and Lonavala, Evans suggested introduction of this excellent game fish into Lonavala waters. Sir Reginald Spence, Hon. Secretary of the Society in 1932 and Mr. Prater, the then Curator, in their booklet *THE GAME FISHES OF BOMBAY PRESIDENCY* (1932) followed Evans in their recommendation of introducing the fish in Lonavala and stated "its introduction into some of the perennial streams of the Deccan would be a great acquisition". However, they regretted that no quotations were forthcoming for the supply of fingerlings of this fish for this purpose.

The recommendation of Evans, Spence and Prater went unattend-

ed for years because of the emphasis placed on the culture of rapidly growing food fishes in India in recent years. However, I had noted with interest the significance of transplantation of this outstanding game fish. Hence, when opportunity arose, efforts were made during the past two years to locate the source of fingerlings and arrange their collection. Fortunately, with the cooperation of Dr. G. P. Dubey, the Director of Fisheries, M.P. and Shri S. N. Chatterjee, Deputy Director, Gandhi Sagar Dam, 150 fingerlings were collected from a stream Gambhirlala, near the town of Jawad, about 30 km from Neemuch in Mandasor Dist. of M.P. The Gambhirlala meets Banas river and the latter joins Chambal near Sawai Madhopur in Rajasthan. (Incidentally, this Banas is different from the Banas which joins Sabarmati in Gujarat). About 115 of these fingerlings were brought to Bombay by train on November 11, 1974 and released into Tata Electric Company's fish farm and 65 grown up individuals released into Walwhan lake at Lonavala as an addition to the existing sport fish fauna of the lake.



A pair of *Raimas bola* Indian trout (juveniles).

The Indian trout, *Raimas bola* formerly, *Barilis bola* (Ham.) though it has no taxonomic relationship with the real trout of the salmon family, is commonly honoured with that suffix, largely because of the close similarity in the shape of body and coloration. Another happy analogue that attracts is its remarkable ability to take fly or fly spoon as avidly as the true trout, thus claiming a reputation as a splendid game fish. It also matches the trout in elegance and agility. To perpetually highlight these fine qualities the anglers preferred to call it the "Indian trout".

Day (1878) reported occurrence of Indian trout in Bengal, Orissa, Assam and N.W. Province and Burma but its distribution in Madhya Pradesh in the tributaries of the Chambal and in the lakes and streams of Rajasthan was not recorded till its mention by Evans (1926). 'Bola'

the specific name of the fish is derived from its Bengali local name; Hindi and Oria equivalents being *Buggarah* and *Buggnah*. In Assam it is called *Korang* or even '*Rajahmas*'. Recent enquiries indicate that fishermen at Jawad and also at Rampura on the Gandhi Sagar reservoir call the fish '*gallar*'. Day (op. cit.) reports capture of this fish in Assam weighing 5 lbs. This weight is on the high side but McDonald (1948) confirms having caught fish up to 3 lbs in Burma. Some of the adult specimens caught in the shallow streams near Jawad on November 9, 1974 measured about 30 cm and weighed 600 gms, though the fisherman of Rampura affirm that the fish attains a weight of 1 kg in the adjoining Gandhi Sagar reservoir constructed in 1962 (265 sq. miles) across the main Chambal river.

The present account places on record introduction of this fish into Lonavala waters of the Peninsular India where it did not occur in the past and fulfills one of the Society's recommendations. Practical significance of this introduction is to make available to the local anglers and tourists a most popular sporting fish. Many eminent anglers had wished to have the real trout into the Deccan waters but were disappointed to know that the real trout lived only in cold water like those in Kashmir and Ootacamund and would not thrive in the warm waters occurring elsewhere. But this '*gallar*' (Indian trout) though it has all the necessary attributes of the real trout, does not suffer from the disability of requiring cold water for thriving healthily. The fish thus fulfills the need of the fly fishing sportsmen. However, since it is a riverine fish it is to be seen whether it would thrive in the lacustrine conditions of lakes.

It has, as will be evident from the illustration, an elegant, streamlined body, tapering at both ends. These features are clearly indicative of fast and active movement and in the field, it was seen actively darting and chasing small live fish. These lightning-like movements may sometimes excel even those of the celebrated Mahseer. Further it has undoubtedly been found to be a piscivorous fish as a number of fish specimens were seen in its stomach which has only a short double coiled gut, typical of a carnivorous habit. In this respect it has to be seen whether it would be a welcome addition into the piscicultural sphere, though no doubt, its propensity would be limited because of its small size. However, in large lakes it would certainly serve as an effective control of weed fish. Being a popular sport fish as well as good eating, its practical value in large lakes is fairly high. These factors have to be weighed carefully before spreading it into other habitats. Nevertheless, in the controlled conditions obtaining in the Walwhan lake, its introduction would be of considerable importance to anglers. It is further observed that the Indian trout which was, at one time, so abundant in the streams near Neemuch is now available only in small numbers,

a well grown three pounder being almost scarce. Inquiries reveal that it is met with very rarely in the commercial catches or in the markets in Bengal or Orissa. Even in the collections specially made in the Rajasthan waters, its occurrence is sporadic. Thus, these preliminary observations tend to point out that this one-time abundant game fish is now considerably reduced in its population largely due to apathy and ignorance about its value as a sporting stock. Serious efforts are, therefore, necessary to locate populations of Indian trout and to collect detailed information about its life history and possibilities of survival before it is too late to avoid its becoming extinct. Fishery Biologists in addition to their concern for food fishes should pay particular attention to this fine game fish.

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REFERENCES

- DAY, F. (1878): Fishes of India. London.
 EVANS, F. (1926): Fishing in Lonavala. *J. Bombay nat. Hist. Soc.* 31: 828-830.
 McDONALD, A. S. J. (1948): Circumventing the Mahseer and other sporting Fish in India and Burma. Bombay Natural History Society, Bombay.
 SPENCE, R. & PRATER, S. H. (1932): Game Fishes of Bombay, the Deccan and the neighbouring Districts of the Bombay Presidency. *J. Bombay nat. Hist. Soc.* 36:29-66.

23. SOME INTERESTING METHODS OF FISHING FOR THE GIANT FRESHWATER PRAWN IN KERALA

(With two text-figures)

The giant freshwater prawn (*Macrobrachium rosenbergii*) known locally as *Konchu*, is in high demand and fetches handsome prices. Attracted by the high returns, people have been fishing for the species from every possible location in the backwaters, rivers and channels in central Kerala, adopting various ingenious methods.

Since some of the methods can be adopted with advantage in other parts of the country for catching the same or related species of prawns, a fairly detailed account is given.

Excepting the mode of fishing while the paddy fields are drained for cultivation or that adopted for catching the prawns hiding among submerged mangrove vegetation, in all other cases baits either dropped loose or suspended from floats are invariably used.

1. "Koti Kuthi Veechu" (Cast net fishing with marking poles and baits): This is the commonest method used in the Kuttanad area in Kerala. The gear used is a cast net¹ and baits dropped loose in water marking their position with long poles or *Koti*. The pole is usually the mid rachis of coconut leaves pointed at the base to facilitate fixing in mud and with a few leaflets at the free end to make it visible at night from a canoe, with a hurricane lamp fixed at its front end. Sometimes bamboo poles with a sheaf of leaves tied to the tops are also used as 'Koti'. The poles are four to five metres in length. A dug-out canoe, two men (one for rowing and the other for operating the cast net) and a cast net constitute a fishing unit (Fig. 1). About 12 to 15 marking

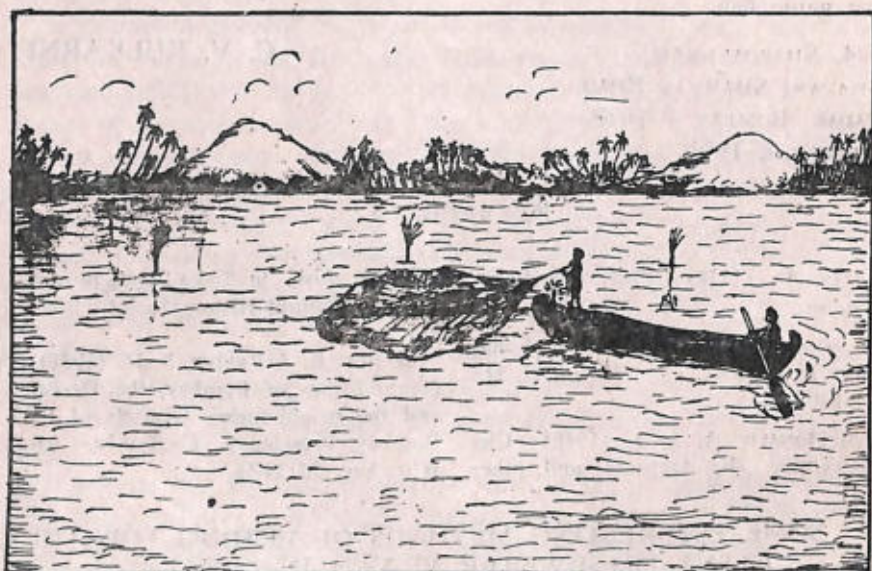


Fig. 1. Cast net fishing with marking poles and baits.

poles are used at a time and they are stacked inside the canoe or hung with sling ropes along the sides if the canoe is small. Raw tapioca (*Manihot utilissima*) or coconut oil-cake is used as bait. The latter is dropped as small pieces whereas the former is made into a coarse powder with the help of a grater made by perforating a tin plate with closely set nail holes. The paste made from the grated tapioca is rolled into small balls by hand. Like coconut oil-cake this has the advantage of spreading slowly when dropped to the bottom. The marking poles are planted in a row about 10 to 15 m apart after selecting a suitable stretch

¹ The measurements of cast net in common use are: mesh size - 1", radius of the net 14-15' and a circumference of about 60-65'.

of the river or backwater with depths varying from 3 to 4 m and without any strong currents or eddies. The bait is dropped loose on one side of the pole at a convenient distance so as to allow sufficient space for operating the net. Baits are always put on the same side of all the poles in the row so that the canoe can be directed straight along one side while fishing. After allowing sometime for the prawns to approach the baits the net is cast above the baits. When the catch is quite good from an area, baits are dropped again and the net operated at the same spot without removing the poles from their original position. Sometimes fishing is done even without dropping the baits a second time. This type of fishing is carried out usually during the small hours of the morning when the prawns come out for feeding. Some fixed points along the shore or permanent structures in the water such as electric poles, pillars of jetties etc., are also used as land-marks for dropping baits.. Tapioca has been found more effective than coconut oil-cake in attracting prawns. One night's catch may be anything between 1 and 12 kg.

2. *Fishing with baits and floats*: This type of fishing is practised in deeper areas where the depth may be 6 to 8 m. Solid baits (boiled pieces of tapioca or coconut kernal) are tied to one end of a rope or string and a float or *Ponthu* (usually cut pieces of banana stem) to the other. A stone of suitable size is tied to the bait as a sinker to keep the bait a little above the bottom and to anchor it at a spot. A number of such baited sets are dropped at intervals of 7 to 10 m in a row. The floats in this case serve also as markers. But where there is a surface current the float will be drifting to one side and the net is cast taking into account the direction of the current and the position of the bait in relation to the float. In still and shallow waters the net is cast right over the float. This type of fishing is done during the day time.

3. *Fishing with "Ottal"*: Another type of gear used is "Ottal".² This is a contrivance made of fine bamboo strips lashed together in the form of a truncated cone open at both ends. This is the same as *Thapa* (Plunge basket) described by Chauhan (1946) and as *Poluha* or *Polo* (cover basket) by Job & Pantulu (1953). These are used in shallow areas especially in the flooded paddy fields where the depth may not exceed 1 m. Here again solid baits, usually boiled tapioca or coconut kernal are used. The flesh of freshwater apple snail, *Pila globosa* is also commonly used. These are tied to small floats made of cut pieces of the stalk of banana leaf. A small stone is tied for anchoring and keeping the bait a little above the bottom (Fig. 2 inset). The fisherman

² The measurements of *Ottal* commonly used in this area are: Upper opening diameter—18 cm, lower diameter—7.5 cm, slanting side length—9.5 cm. The bamboo strips are also closely bound together so that the gaps between them may not exceed a few mm.

carries the *Ottal* and the floated baits in a canoe and drops the baits at regular intervals (Fig. 2). The float wobbles up and down when

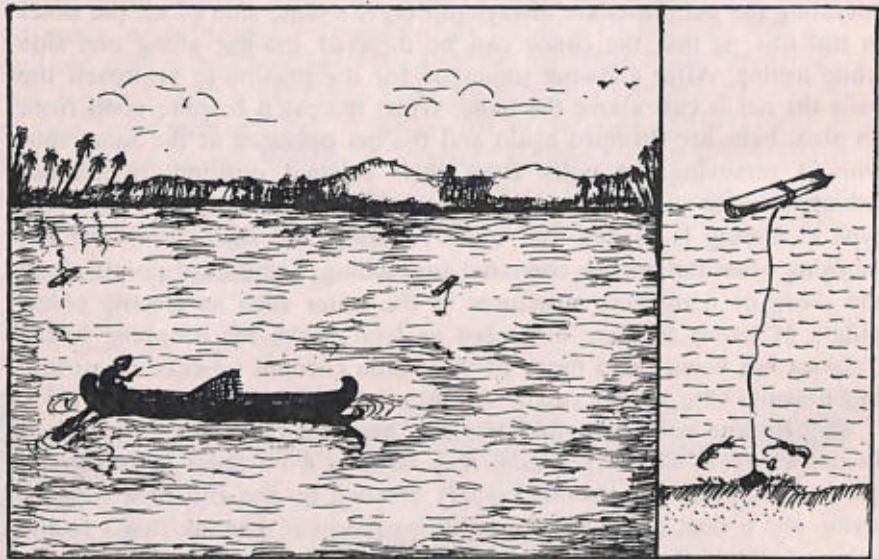


Fig. 2. Fishing with 'Ottal'.

a prawn nibbles at the bait and when the prawn gets at the bait with its pincers one end of the float remains dipped. Since this type of fishing is carried out during day time, movement of the float can be seen from a distance and the fisherman quietly approaches it in his canoe and plunges the *Ottal* over it. Prawns are taken out with hands or even with the legs where the depth is more.

4. "*Vativala*" and "*Vattavala*": *Vativala* is a drag net with a rectangular mouth across which sticks are attached transversely to keep it open and the net is operated by two men holding to the side sticks which are stouter than the others. This net is operated in shallow areas. *Vattavala* is a pouch net with a semi-circular mouth fitted with a bamboo frame of similar shape and is operated by two men in shallows, especially among submerged mangrove vegetation. The net is set near the vegetation and the water disturbed in such a way that the prawns hiding among the plants while trying to escape will get caught in the net. These vegetation are also encircled by the drag net *Vativala* and all the hiding prawns caught by disturbing the plants. *Vattavala* is also used for catching fishes and prawns from paddy field when the water is pumped out in preparation for cultivation.

Though these prawns are caught occasionally in stake nets and chinese dip nets during their sojourn in the backwaters they do not

form a major item in their catches at any time.

M. rosenbergii is also taken by hook and line in some areas of Vembanad lake between Vaikom and Cochin especially during their breeding season. It is also common practice to catch them from their hide-outs inside the crevices of stones and bunds by means of long metallic hook or pin. The prawns are impaled and taken out.

Evolving new baits by mixing some flavour or fish meal with the baits to attract the prawns easily and also studies on the relative efficiency of the various types of baits are lines of work worth considering in view of the great economic importance of the fishery.

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REFERENCES

- CHAUHAN, B. S. (1945): Fish and fisheries of Patna State, Orissa. *Rec. Indian Mus.* 45 (II & III): 267-282.
- GOPINATH, K. (1953): Some interesting methods of fishing in the backwaters of Travancore. *J. Bombay nat. Hist. Soc.* 51:466-471.
- JOB, T. J. & PANTULU, V. R. (1953): Fish trapping in India. *J. Asiatic Soc.* 19(2):175-196.
- JOHN, M. C. (1957): Bionomics and life history of *Macrobrachium rosenbergii* (de Man). *Bull. Cent. Res. Inst. Univ. Trivandrum Ser. C.* 5(1): 93-102.
- RAMAMURTHY, S. & MUTHU, M. S. (1969): Prawn fishing methods. *Bull. Cent. Mar. Fish. Res. Inst.* 14:235-258.
- RAMAN, K. (1967): Observations on the fishery and biology of the giant freshwater prawn, *Macrobrachium rosenbergii* de Man. *Proc. Symp. Crustacea, Mar. Biol. Ass. India, Part II:* 649-669.

24. FOULING ORGANISMS ON FIBREGLASS COATED HULL OF A BOAT IN AN ESTUARINE ENVIRONMENT

(With two text-figures)

Fouling organisms collected from the fibreglass coated hull of the research vessel MLV TARINI which was used in an estuarine environment for 9 months from May 1970 to February 1971, revealed the nature and extent of settlement and the abundance of fouling fauna in the estuarine environment.

INTRODUCTION

This study deals with the settling of fouling organisms on the submerged portion of the fibreglass coated wooden hull of the research vessel MLV TARINI of the National Institute of Oceanography, at Panjim, Goa.

While the 15 m boat was in dry dock at Bombay, about 21 sq m area of its wooden hull was coated with fibreglass sheathing up to about 15 cm above the water line. The submerged portion of the hull formed about 18 sq m of the area. After making the boat sea worthy and equipped for oceanographic work, it was launched in early May 1970 and was brought to Panjim immediately for use in oceanographic studies in estuarine and nearshore waters of Goa region. The boat moved little during the peak southwest monsoon period from June to September, when it was anchored along-side a cement concrete jetty on the Mandovi estuary. From September to February the boat was extensively used in the estuarine and near shore waters of Goa. During the period a heavy settlement of fouling organisms was noted on the hull of the boat which necessitated scrapping in dry dock. This offered a chance to study the settlement of fouling communities on the fibreglass coated hull of the vessel which was used in an estuarine environment for nine months.

METHODS

Random samples in duplicate, each representing a unit area of 1 sq m were scrapped from the bow, stern, starboard and port sides. Wet weight and volume of each sample was recorded. The constituents were sorted, identified as far as possible up to species, and were weighed separately to estimate their percentage composition.

OBSERVATIONS AND COMMENTS

Experimental reports on the settling of fouling organisms on various wooden materials as well as those with different protective coat-

ings are numerous from different environments *in situ* (Kuriyan 1952; Nagbhushanam 1960; Nair 1961; Nair 1965; Balasubramanian *et al.* 1968; Karande 1969 and Balasubramanian 1971). However, nothing is known about fouling organisms in the estuarine and nearshore waters around Goa.

The average weight of settlement per square metre was highest on the starboard side (600.80 gm/sq m) of the submerged portion of the hull, whereas the portside of the hull harboured second highest weight of settlement (439.70 gm/sq m). The stern side and bow side indicated average weight of settlement as 251.50 gm/sq m and 189.40 gm/sq m respectively.

An approximation of values of average settlement per sq m on different sides of the hull gives an average total settlement of about 1983 Kg of fouling organisms on 18 sq m submerged area of MLV TARINI in nine months from May 1970 to February 1971.

All the major fouling organisms namely cirripedes, molluscs, annelids, bryozoans, coelenterates as well as their associates were encountered in the samples collected from the hull.

Among the fouling organisms, the barnacles (cirripedia) were most abundant (Fig. 2B) and their percentage of composition all over the hull, was consistently high and varied from 53.63 per cent to 66.59 per cent per sq. m (Fig. 1). The settlement was so intense that the barna-

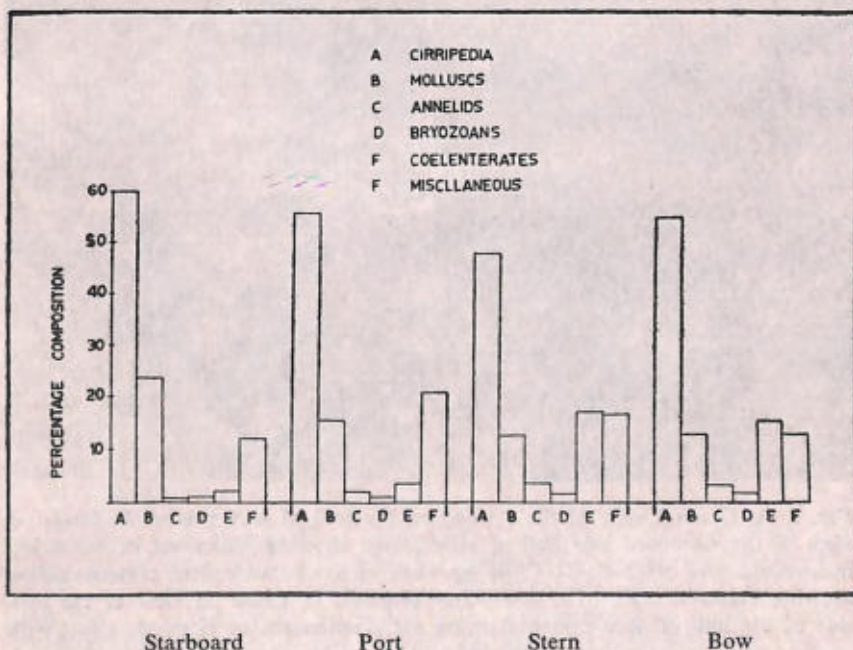


FIG. 1. Diagrams showing the percentage composition of various fouling organisms on different sides of the hull of MLV TARINI.

cles were observed to have grown in 3 tiers or more, with the basal layer of dead shells. Another interesting feature was, the observed preference of site by bigger barnacles, *B. tintinnabulum tintinnabulum* which were congregated on the stern side whereas they were totally absent on other sides of the hull.

The molluscs, by their percentage ranging between 13.79 per cent and 26.57 per cent per sq m were second highest in composition on all the sides of the hull. The occurrence of shell settlement was highest on starboard side compared to that on portside. (Fig. 1). The starboard side being always exposed, offers an easily accessible surface for settlement than the sheltered portside. Oysters and mussels were the main molluscan foulers (Fig. 2C).

The oysters were observed to settle on barnacle shells and not directly on the surface of the hull. Mussels occupied the major portion of the submerged surface, mainly because of their entangling byssus apparatus which, in turn harbours associates such as amphipods, isopods and crabs. Few specimens of *Scapharca* and *Martesia*, were also observed.

Annelids and Bryozoans formed a minor component of the fouling fauna and were found in consistently low percentage ranging

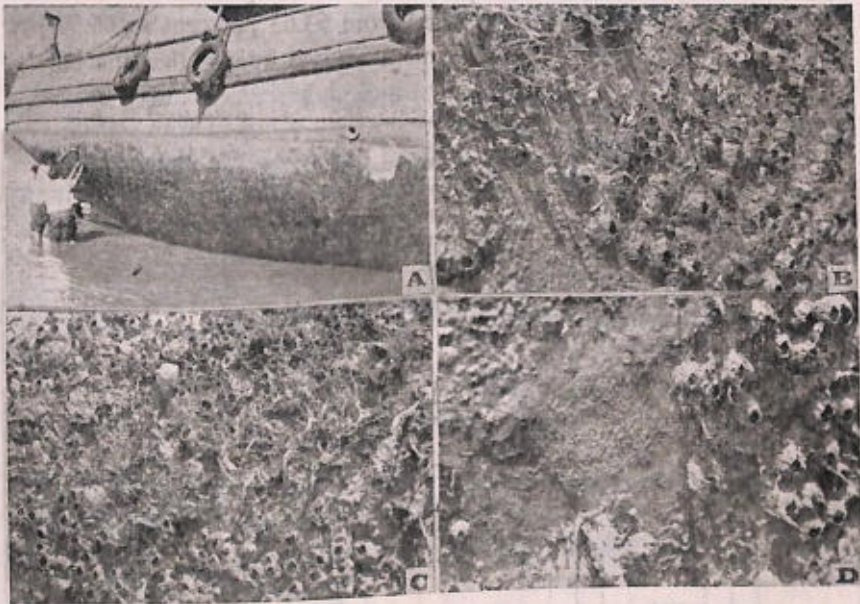


FIG. 2. A. General view of the fouling on the hull of MLV TARINI; B. Close up view of the starboard side hull of MLV TARINI showing settlement of barnacles, hydrozoans and bivalves; C. Close up view of the portside hull of MLV TARINI showing barnacles, crab, hydrozoans and annelids; D. Close up view of the bow side of the hull of MLV TARINI showing early settlement of cirripeds along with barnacles and annelids.

between 0.86%-4.06% and 0.99%-1.86%, respectively. Sessile forms dominating among the annelid-bryozoan component.

Coelenterates, especially hydrozoans appear to be a major fouling element in Goa waters as their settlement was dense and rich at places (Fig. 2D).

Of special interest is the selectivity of the hydrozoan settlement largely on the bow and stern sides as indicated by markedly high percentage of their occurrence in these area, (77% per sq m at stern and 16.1% per sq m at bow) compared to that on the side flanks (Fig. 1). Maximum turbulence at the stern area due to propeller action and the action of the current due to cutting of water at the bow area appear to be conducive factors for such predominant settlement on specific sites.

Hydrozoans are reported (Karande 1969) to cause considerable damage to the protective coating on the hull of the boats. However, the fibreglass coating on the hull of MLV TARINI did not show any apparent deterioration whatsoever.

Miscellaneous components consisting of animal associates, viz. amphipods, isopods, decapods and algal matter were found scattered along with ample silt and debris on all sides of the hull, and formed 13 per cent to 23 per cent per sq m of the average settlement. The highest concentration of miscellaneous constituents was recorded on the portside. The high percentage of miscellaneous constituents were probably the result of heavy precipitation in the waters of estuarine environment in Goa region (Dehadrai 1970). Passive settlement of silt and detritus which is characteristic of estuarine environment may not be considered among the fouling organisms, but it is of consequence as it thus enlarge the burden by constituting a sizeable part of the total settlement on the hull of the boat.

LIST OF FOULING SPECIES

CIRRIPEDIA

1. *Balanus amphitrite communis*
2. *B. a. variegatus*
3. *B. tintinnabulum tintinnabulum*

MOLLUSCS

4. *Ostrea madrasensis*
5. *Mytilus viridis*
6. *Modiolus trailli*
7. *Martesia* sp.
8. *Scapharca* sp.

ANNELIDS

9. *Hydroides* sp.
10. *Sabellid* sp.

11. *Spirobis* sp.

COELENTERATES

12. *Anemonia indicus*
13. *Cribrinopsis robertii*
14. *Actinia* sp.
15. *Sertularia* sp.
16. *Pennaria* sp.

BRYOZOANS

17. *Membraniopora* sp.
18. *Acanthodesia* sp.
19. *Electra* sp.
20. *Bugula* sp.

ISOPODS

21. *Ligia exotica*

AMPHIPODS

22. *Gammarus* sp.

DECAPODS

23. *Dotilla myctiroides*24. *Uca* sp.

ALGAE

25. *Enteromorpha* sp.

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REFERENCES

- BALASUBRAMANYAN, R. (1971): Experiments with fibreglass sheathing as a protection against marine woodbor-ing organisms. *Fish. Tech.* Vol. VIII, No. 1:60-65.
- , RAVINDRAN, K., NAIR, N. UNNIKRIISHNAN & PILLAI, A. G. GOPALKRISHNA (1968): Protec-tion against borers, foulers and cor-ro-sion through the use of aluminium alloy sheathing in a marine environ-ment. *2nd International Congress on Marine Corrosion and Fouling. Athens*: 1-7.
- DEHADRAI, PADMAKAR V. (1970): Changes in the environmental features of the Zuari and Mandovi estuaries in relation to tides. *Proc. Indian Acad. Sci.* 72(2) B:68-79.
- KARANDE, A. A. (1969): Field and laboratory investigations on some ma-rine fouling and boring organisms in Bombay Harbour. *Bull. Natn. Inst. Sci. India* 38(1):612-622.
- KURIYAN, G. K. (1952): Notes on the attachment of marine sedentary organisms on different surfaces. *J. Zool. Soc. India* 4:157-171.
- NAGBHUSHANAM, R. (1960): Resist-ance of Indian Timbers to attack of marine borers. *Tim. Dryers' a. Pres. Assoc. India* 6(1).
- NAIR, N. BALAKRISHNAN (1961): Some aspects of marine borer prob-lem in India. *J. Sci. Industr. Res.* 20 A (10):555-610.
- NAIR, N. UNNIKRIISHNAN (1965): Marine fouling in Indian waters. *J. Sci. Industr. Res.* 24(9):483-488.

25. THE GENUS *DELIAS* HUBN. FROM THE PLAINS OF ASSAM

I was interested to read Messrs Varshney & Nandi's note [69(3): 667-668] regarding the absence of the genus *Delias* from the plains of In-

dia. In Assam the genus is quite definitely not confined to the hills. In the plains of Sibsagar Dt. *Delias aglaia* (L.) and *descombesi leucantha* (Fruh) were two of our very common butterflies. They were succession brooded, the larvae feeding, as usual, on *Loranthus* spp. The following species were also taken in the plains from time to time:

agostina (Hew.) Occasional, Sibsagar Dt. and Margherita. Two only from Naga Hills.

hyparete hierte (Hub.) Sibsagar Dt. Not seen in Naga Hills.

thysbe pyramus (Wall). Sibsagar Dt. Not seen in Naga Hills.

As none of these was common in the neighbouring Naga Hills it would be unsafe to conclude without definite evidence of breeding habits that they were merely wanderers from the hills. The common Naga Hills spp. were *belladonna lugens* (Jord.) and *berinda berinda* (M.). These two I never saw in the plains.

THE OLD RECTORY,
WINTERBORNE HOUGHTON,
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26. DANAID BUTTERFLIES ATTRACTED TO *HELIOTROP- IUM INDICUM* (BORAGINACEAE), AN ALKALOID CONTAINING PLANT

(With a plate)

While on a survey to locate Bonnet macaque troops around Tulsi lake, on 22nd May, 1974, in company with Mr. P. Kannan, Curator for Animals, Borivli National Park, Maharashtra State, I observed a number of Danaid butterflies (*Danaus limniace* and *Euploea core*) clustered on a *Heliotropium indicum* plant which was in flower. At first I assumed that the butterflies were feeding on the flowers, but closer inspection revealed that all of them were clinging to, and feeding on, a dead and decaying inflorescence drooping from the plant.

On a subsequent occasion, on 4th September, 1974, I noticed 5 *Danaus limniace* hovering around, and intermittently settling upon, some newly flowering branches of a *Heliotropium indicum* growing on the bank of the pond near the offices of the Borivli National Park. I decided to find out whether they could be attracted away from this site to another *H. indicum* plant growing about 8 feet away. I crushed an inflorescence bearing few flowers of this latter plant, sufficient to extract the plant juice without distorting its rigidity, and waited. In a few minutes all the 5 specimens of *D. limniace* transferred their attention

to this plant and within seconds of arrival settled and avidly fed on the bruised portion of the plant. While I prepared to take a colour photograph of this group two more members of the same species joined them, making a total of seven. When I passed by the same path about an hour later a few *D. limniace* (perhaps new arrivals?) and 1 *D. chrysippus* were feeding on it.

A few days later, on 8th September, 1974, accompanied by my wife, I observed the same phenomenon on the road verges near the Aarey Milk Colony. Four specimens of *D. limniace* and four of *D. chrysippus* were feeding on some dead and withered branches of a *H. indicum* plant. I took a black-and-white photograph of this assemblage and observed that in spite of the disturbance we had caused in the area the butterflies repeatedly settled on the same branches to feed, so strongly did they seem to be attracted to this plant. We succeeded in capturing 3 specimens of the *D. limniace* (2 males and 1 female) and 1 specimen of *D. chrysippus* (1 male), determined their sex by examining for presence or absence of abdominal brushes ("hair-pencils") and hind wing pouches, and then released them.

The observations on the apparently unusual feeding behaviour recorded here resemble similar behavioural traits reported in Australian butterflies of the family Danaidae. Edgar, Culvenor and Robinson (1973) have reported from Queensland the attraction of *Danaus chrysippus petilea* (Stoll) to *Heliotropium amplexicaule* which is known to contain pyrrolizidine alkaloids. (Bull, Culvenor & Dick 1968). It has also been reported that Australian adult male danaid butterflies are strongly attracted to, and sometimes feed on, dead and withering plants containing pyrrolizidine alkaloids (Edgar, Culvenor & Robinson 1973). Furthermore, Edgar and Culvenor (1974) have pointed out the remarkable fact that danaid butterflies require pyrrolizidine alkaloids, which they possibly obtain from some of their food plants, and that these alkaloids may undergo metabolic alteration into compounds which are found in the hair-pencils of the abdominal brushes of male butterflies. Their suggestion is based on chemical investigations on extracts of hair-pencils of two species of Australian danaids. *D. hamatus* (Macleay) and *Euploea tulliolus tulliolus* (Fabricius) both of which contain pyrrolizidine alkaloids in their hair-pencils. It is pertinent too that the male courtship pheromone found in the hair-pencils of the American danaid, *D. gilippus herenice*, has been identified as a pyrrolizidine compound (Pliske & Eisner 1969). A neotropical danaid, *Lycorea ceres ceres*, is also reported to contain a pyrrolizidine compound in its hair-pencils (Meinwald, Meinwald, Wheeler, Eisner & Brower 1966).

Many species of *Heliotropium* found in India contain pyrrolizidine alkaloids, as also plants belonging to the genus *Crotalaria* (Legumin-



Danaid butterflies feeding on withering *Heliotropium indicum* inflorescences.
(Photo: Author)

osae), *Senecio* (Compositae), etc. (Watt & Breyer-Brandwijk 1962; Chopra, Chopra & Varma 1969; Chopra, Badhwar & Gosh 1965). *Heliotropium indicum* is reported to contain pyrrolizidine alkaloids, the major component being made up of Indicine (Mattocks *et al.* 1961; Mattocks 1967). It seems reasonable to suppose that acquisition of these alkaloids from food sources by danaid butterflies from vastly differing habitats and widely separated biogeographic areas may be a universal phenomenon. Thus it seems likely that the feeding behaviour of danaids, specifically attracted to *Heliotropium indicum*, described in this report is related to their requirement of pyrrolizidine alkaloids. Further studies on the inter-relations between such alkaloid-bearing plants and Indian butterflies belonging to the family Danaidae are in progress.

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REFERENCES

- BULL, L. B., CULVENOR, C. C. J. & DICK, A. J. (1968): The Pyrrolizidine Alkaloids. North-Holland, Amsterdam.
- CHOPRA, R. N., BADHWAR, R. L. & GHOSH, S. (1965): Poisonous Plants of India. Vol. II. Poisonous Plants Agricultural Research, New Delhi, India.
- CHOPRA, R. N., CHOPRA, I. C. & VARMA, B. S. (1969): Supplement to Glossary of Indian Medicinal Plants. Publications and Information Directorate. New Delhi, India.
- EDGAR, J. A. & CULVENOR, C. C. J. (1974): Pyrrolizidine ester alkaloid in danaid butterflies. *Nature* 248:614.
- ROBINSON, G. S. (1973): *J. Aust. ent. Soc.* 12:144.
- MATTOCKS, A. R. *et al.* (1961): Indicine: The Major Alkaloid of *Heliotropium indicum* L. *J. Chem. Soc. Part IV*: 5400.
- MATTOCKS, A. R. (1967): Minor Alkaloids of *Heliotropium indicum* L. *J. Chem. Soc. C. Org.* 329.
- MEINWALD, J., MEINWALD, Y. C., WHEELER, J. W., FISNER, T. & BROWER, L. P. (1966): Major Components in the Exocrine Secretions of a Male Butterfly (*Lycorea*). *Science* 151:583.
- PLISKE, T. E. & EISNER, T. (1969): Sex pheromone of the Queen Butterfly: Biology. *Science* 164:1170.
- WATT, J. M. & BREYER-BRANDWIJK, MARIA G. (1962): The Medicinal and Poisonous Plants of Southern and Eastern Africa. E. and S. Livingstone, Edinburgh and London.

27. NEW RECORD OF ARMY WORM *PSEUDOLETIA SEPARATA* WALKER (LEPIDOPTERA: NOCTUIDAE) AS A PEST OF RAGI IN INDIA

During May-December, 1972, observations on pest of ragi (*Eleusine coracana* L.) in some ragi fields of the Main Research Station, University of Agricultural Sciences, Hebbal revealed moderate infestation by a lepidopterous pest feeding on the foliage and the earheads. The pest was later indentified as *Pseudaletia separata* Walker.

The army worm is well known to infest a variety of food plants of cereal and millet groups. Ghosh (1924) reported it on sorghum, maize, paddy, wheat, oats and other millets. In addition to the above, pulse and vegetable crops were also found to be infested (Lefroy 1909; Fletcher 1914, and Ramchandra Rao 1924). Bindra & Rathore (1965) recorded it as a very destructive and sporadic pest of sorghum, maize, wheat and sugarcane. It was reported to cause severe damage to high yielding varieties of rice at the ripening stage of the crop by feeding on leaves and earheads (Kalode *et al.* 1972). In Mysore it is known to be a severe pest of sorghum and maize.

The present report of the damage by army worms to ragi crop from Mysore, therefore, is a new record of the pest on this host from India.

A brief account of the nature of injury by caterpillars to leaves and earheads, is given below.

The caterpillars, in the pre-earhead period, were found damaging the leaves during night making irregular cuts. The young caterpillars, in the laboratory rearings, were found to escape the leaves causing white membranous patches. The caterpillars hid below the loose soil around the base of the plant or in leaf sheath during day time. Their presence could be made out by the presence of faecal pellets strewn round the base of the plant or inside leaf sheath. About 47 per cent to 53 per cent of plants were infested. The number of larvae per clump varied from one to eight. The observations, continued till the harvest of the crop, revealed that the pest persisted and attacked the earhead in its various stages of development. They fed on the milky and later developed grains after dusk and concealed themselves by coiling at the base during daytime. The earhead thus damaged always had the faecal pellets and often with the caterpillars. The latter pupated in soil at the base of the plant or rarely inside leafsheath and in the earhead.

Further observations on its incidence and biology on ragi crop are in progress.

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REFERENCES

- BINDRA, O. S. & RATHORE, Y. S. (1965): Chemical control of army worm (*Pseudaletia unipuncta* How) on *Sorghum vulgare* at Jabalpur. *Indian J. Ent.* 27(2):223-224.
- FLETCHER, T. B. (1914): Some south Indian insects and other animals of importance. Govt. Press Madras. p. 564.
- GHOSH, C. C. (1924): A note on the occurrence of *Cirphis unipuncta* (Haw.) in the role of army worm. *Rept. Proc. 5th Ent. Meeting, Pusa.* pp. 90-91.
- KALODE, M. B., PRAKASA RAO, P. S. & VARMA, A. (1972): Toxicity of some modern insecticides to paddy cut worm, *Pseudaletia separata* Walker. *Indian J. Ent.* 34(1):84-85.
- LEFROY, H. M. (1909): Indian insect life. Thacker, Spink and Co., Calcutta, p. 796.
- RAMCHANDRA RAO, Y. (1924): Notes on pests investigated in Madras during the year 1921-22. *Rep. Proc. 5th Ent. Meeting, Pusa:* 110-112.

28. OBSERVATIONS ON THE BIOLOGY AND HABITS OF
SYCANUS AFFINIS REUT. (HEMIPTERA: REDUVIIDAE)
AND ITS STATUS AS A PREDATOR

Sycanus affinis Reut. is a commonly occurring predator in Orissa and is found in fairly large numbers in coconut groves located in and around Bhubaneswar. The nymphs and adults of this species attack a large number of surface feeding lepidopterous larvae. So far nothing is known about the biology of this predator. However, Hoffman (1934)¹ has studied the life history of a closely related species, *Sycanus croceovittatus* Dohrn. An attempt was, therefore, made to investigate its life history and habits in order to assess its potentiality as an affective predator.

Laboratory cultures of *S. affinis* were maintained in insect cages. Ten pairs of one day old adult males and females were kept in each cage and these were supplied with full-grown larvae of *Corcyra cephalonica* S. The egg masses laid in cages were removed and kept in petri-

¹ HOFFMAN, W. E. (1934): The life-history and economic status of *Sycanus croceovittatus* Dohrn. (Hemiptera: Reduviidae). *Lengran Sci. J.* 13(3):503-515.

dishes having a lining of filter paper. The date of egg laying was recorded. Ten nymphs, just after hatching, were transferred to a glass rearing jar of 15 × 10 cm size. The open end of the jar was covered with muslin cloth and held in position by rubber bands. Observations on the life history, feeding habits, host preference, preying potentialities of the different nymphal and adult stages were recorded. Five sets of such experiments were carried out in the laboratory. Three extra nymphs were reared in each set to serve as substitutes, the records of which were used in the event of unnatural death of any of the original ten nymphs. The laboratory temperature under which the biology of the predator was studied varied between 23.4 and 32.8°C.

Freshly emerged adult took 7 days to commence copulation. The egg mass contained a single layer of eggs arranged neatly in hexagonal shape. The female took about 3 minutes to lay each egg. The eggs were glued to the bottom with a sticky thread produced by the mother which soon dried up. An egg mass contained 24 to 152 eggs with an average of 100 eggs per cluster. The pre-oviposition period was 3 days and oviposition period varied from 6 to 37 days. The interval between two egg laying ranged from 5 to 10 days. The females were very prolific. A single female could produce a maximum of 807 eggs in confinement (Table 1).

The egg is brown, elongate, slightly bent in the middle, measures 2 mm in length, broad at the base (0.6 mm) and narrow at the top (0.4 mm). The anterior end has a white cap-like operculum. A black transverse line is present on the border between the operculum and the chorion. The chorion is smooth excepting the area lying beneath the black border line which contains a large number of punctuations. The incubation period varied from 14 to 24 days with 17.4 days on the average (Table 2). The per cent hatch ranged from 94.8 to 99.3. During eclosion the fully developed embryo pushed open the operculum. The nymphs took 30 to 40 minutes to extricate themselves from the chorion. Just after hatching, the nymphs sat upon the egg mass for about 10 minutes, stretched their legs, moved to the vicinity and remained congregated for some time.

There were five nymphal instars. Freshly moulted nymphs appeared light red. Their body coloration slowly changed from deep pink to black. The total body length from the clypeal end to the tip of the abdomen of the first, second, third, fourth and fifth instar nymphs was 3 mm, 5 mm, 7 mm, 11 mm and 18 mm respectively. The maximum body width of the nymphs was recorded at the third abdominal tergite. In all the nymphal instars there were three cone-shaped raised structures in the second, third and fourth abdominal tergites on the mid-dorsal line. Excepting the first nymphal instar, the rest of the instars contained four continuous, longitudinal white streaks, two lateral and two sub-

ventral, on the abdominal sternites.

The development period of the different nymphal instars and the total duration of life cycle are presented in Table 2. The table shows that the duration of the fifth nymphal instar is the longest (44.5 days) in April-May (Temp. Min. 28.8°C, Max. 35.5°C, Average 31.4°C and 69% R.H.) and the shortest (17.7 days) in June (Temp. Min. 28.8°C, Max. 35.5°C, Average 32.3°C and 75% R.H.). Egg masses laid during the first fortnight of December completed the life cycle in 152.4 days whereas those laid in the first fortnight of March needed only 81.7 days for completing development. The preimaginal mortality was mostly observed among the fifth instar nymphs. Under conditions of crowding and food scarcity cannibalism was observed mainly during the time of moulting.

The adult is dark in colour. The labium is three segmented, the apical segment is the smallest and contains a few sensory hairs at the tip. The mandibular and maxillary stylets are strong. The former contains backward projecting barbs. The triangular scutellum contains in the centre a rosethorn-shaped spine projecting anteriorly. In the hemelytron, basal region of the corium and clavus of the coreaceous area are black whereas the apical halves contain a light yellow patch. The abdomen is boat-shaped containing 7 tergites and 6 sternites in the male while there are 8 tergites and 6 sternites in female. The total length of the female is 24 mm and that of the male 23 mm. In the female the tip of the abdomen is pointed whereas in male it is blunt. There is a preponderance of males, the male and female ratio being 5.5:4:5.

The adults are very long-lived and hardy. They could withstand extremes of temperature ranging from 15°C to 40°C. Under average laboratory temperature of 30.0°C the males lived longer (85.1 days) than the females (69.3 days). At 15.0°C the males lived for 16 days and females for 14 days whereas both males and females succumbed in two days at a constant temperature of 40°C. Adults lived without food for a period of 28.1 to 33.2 days in summer. Different nymphal instars lived for 8.6 to 41.2 days without food (Table 3) but the fourth nymphal instars survived for the maximum period.

The nymphs and adults are general predators. They were found to predate on a large number of larvae namely those of *Nepantis serinopa* M., *Sesamia inferens* W., *Prodenia litura* F., *Amsacta albistriga* W., *Acherontia styx* W., *Cirphis albistigma* M., *Papilio demoleus* L. and *Anomis sabulifera* G. Besides, nymphs of grasshoppers and cockroaches, white ants and aphids were also attacked. Larvae which were surface feeders were preferred most by nymphs and adults of the reduviid, those of the larvae which remained concealed e.g., in leaf galleries, leaf webbings, leaf case etc. were attacked by the adults only. Likewise, naked pupae and pupae in cocoons, were attacked by the

TABLE I
 FECUNDITY OF ADULT FEMALES OF *S. affinis* UNDER LABORATORY CONDITIONS
 (AVERAGE OF FIVE INDIVIDUALS IN EACH TEST)

Period of observation		Duration (days)			Number of egg masses laid per individual	Total number of eggs laid per individual	Hatch ability percentage
From	To	Pre-oviposition period	Oviposition period	Interval between two consecutive egg layings			
14-3-72	19-4-72	3	37	5-9	6	807	97.9
24-4-72	11-5-72	3	18	7-10	3	194	96.3
5-7-72	10-7-72	3	6	5	2	105	94.8

TABLE 2
 MEAN DURATION OF VARIOUS STAGES IN THE LIFE-CYCLE OF *Sycanus affinis* UNDER LABORATORY CONDITIONS
 (AVERAGE OF 10 INDIVIDUALS IN EACH TEST)

Test No.	Period of observation		Temp. in °C during the developmental period		Egg period	Duration (days)					Total duration of life cycle	Adult longevity (days)			
	From	To	Min.	Max. Aver. age		Nymphal period						Male	Female		
						I	II	III	IV	V				Total	
1.	5-12-71	10-5-72	23.3	34.4	26.4	21	15.3	18.1	20.6	23.5	28.2	105.7	126.7	103.0	85.5
2.	13-12-71	16-6-72	23.3	35.5	29.8	24	17.8	18.0	22.1	26.0	44.5	128.4	152.4	88.6	72.5
3.	14-3-72	10-6-72	27.7	35.5	32.9	14	6.0	9.5	11.3	19.1	21.8	67.8	81.7	75.3	68.3
4.	19-3-72	3-7-72	27.7	35.5	32.0	14	10.0	10.4	17.8	18.5	20.3	77.0	91.0	84.2	70.0
5.	2-4-72	4-7-72	28.8	35.5	32.1	14	11.3	13.3	14.1	15.2	17.7	71.6	85.6	79.4	50.2
Mean						17.4	12.1	13.8	17.2	20.4	26.5	90.1	106.9	86.1	69.3
Range						14-24	5-26	7-27	11-27	12-30	15-56	52-163	64-187	75-103	50-85

adults. When the attack was made on the pupae in cocoons, the adult pierced its stylets from a distance as otherwise the claws often got entangled in the webbings of the cocoons. Larvæ and pupæ remaining in stems and fruits were not attacked. The females were more virulent than the males with regard to the attack of the host. More than one nymph and adult may attack simultaneously a single host. The nymphs were observed sucking the body content of the host for 3 to 4 hours at a stretch. And adult female could overpower a larva of sphinx moth which was 37.2 times as heavy as the predator itself.

From a study to ascertain the maximum number of larvae eaten per day per individual, it was observed that the first four nymphal instars utilized less than one full grown larva of *C. cephalonica*. Once their appetite was satisfied, the nymphs did not attack the larvae even though the latter were in close proximity. However, the fifth instar nymphs and the adults sucked up the larvae at the rate of 1 and 5 respectively per day.

ACKNOWLEDGEMENT

We express our sincere thanks to the Director, Commonwealth Institute of Entomology, London for identifying the insect.

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November 22, 1972.

29. ON THE OCCURRENCE OF *HOMEOCERUS TAPROBANENSIS* DIST. (HEMIPTERA: COREIDAE) FROM POONA WITH A NOTE ON THE SCUTELLAR LEVIGATE LINE

Distant (1902)¹ while describing the species *Homoeocerus taprobanensis* had observed the presence of a central levigate line on head, pronotum and scutellum with the remark that it was obsolete on head. While studying some specimens from Poona I observed that the central levigate line to be well marked and continuous from head to the apex of scutellum in eight specimens, but in four others it was faint and slightly interrupted in the middle, in the region of scutellum. *Homoeocerus taprobanensis* was originally described from Sri Lanka and there is no further report available regarding its distribution.

¹ DISTANT, W. L. (1902): The Fauna of British India, Rhynchota 1:365-366.

Other characters: Lateral margins of pronotum pale levigate, convexium piceous with ochraceous spots, membrane piceous, sternum punctate.

Locality: Agricultural college, Poona, 8-ii-62. S. N. Chaubey, 12 exs.

ACKNOWLEDGEMENT

I thank Dr. B. K. Tikader, Dy. Director, Western Regional Station, Poona, for facilities offered.

WESTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
POONA 5,
December 26, 1972.

K. RAMACHANDRA RAO

30. A PREDACIOUS PENTATOMID BUG, *CANTHECONIDEA FURCELLATA* (WOLFF) ATTACKING *LATOIA LEPIDA* (CRAMER) ON MANGO NEAR BANGALORE

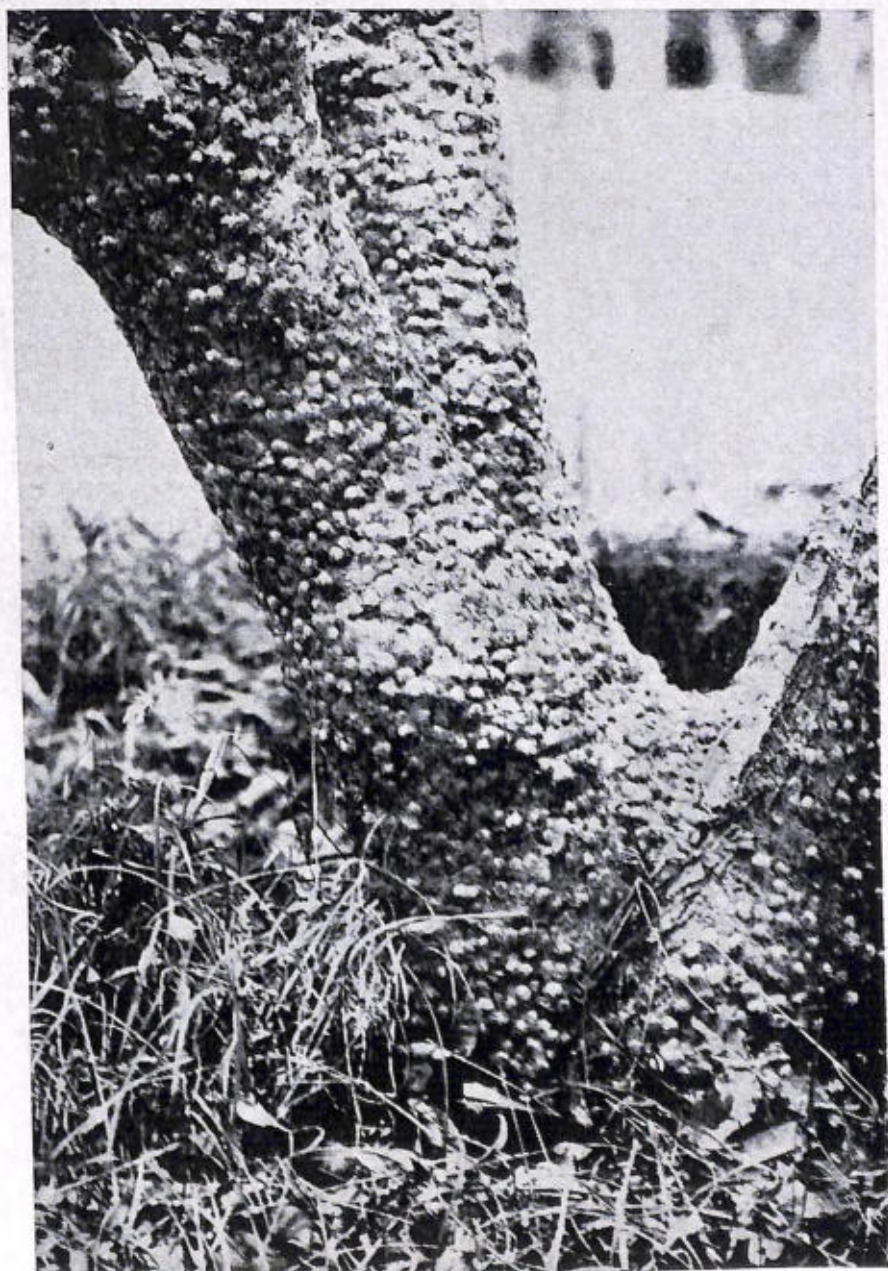
(With three plates)

Our indigenous insect predators of crop pests have not received as much attention as have the parasites and very little information is available on them (Narayanan *et al.* 1967). Except for the more important predatory groups like the Coccinellidae for example, which have been fairly well studied, other equally useful groups—among whom may be mentioned the Mantodea, Reduviidae, Pentatomidae (Asopinae), Neuroptera, Carabidae, Asilidae, Syrphidae (Syrphinae), Chamaemyiidae and particularly the very abundant Spiders (Arachnida: Araneae)—have been overlooked in India.

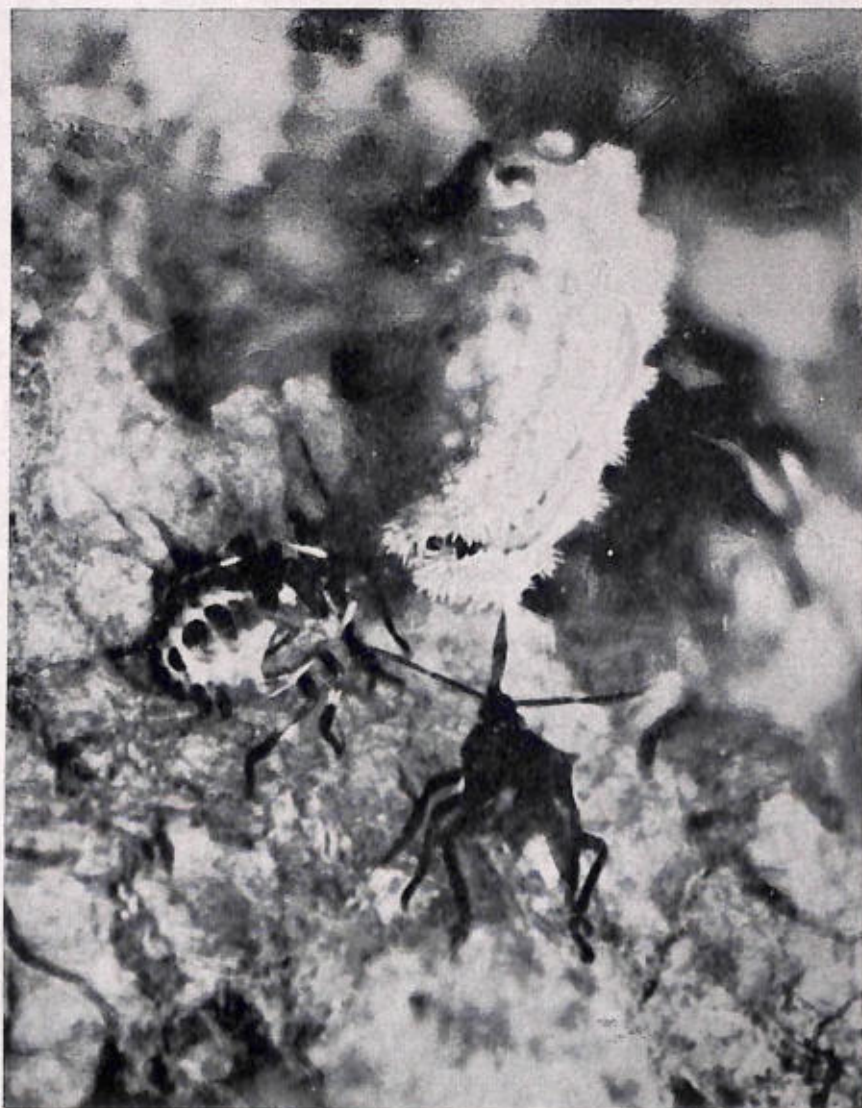
During the course of my field surveys connected with studies on the Coccinellidae and Syrphidae, I came across a serious infestation of the slug caterpillar *Latoia* (= *Parasa*) *lepida* (Cramer) [Lepidoptera: Limacodidae] on some mango trees on a farm near Bangalore. On closer observation, several groups of the nymphs of *Cantheconidea*¹ *furcellata* (Wolff) [Hemiptera: Pentatomidae: Asopinae] were noticed on the cocoon-covered trunks (see plate I). The red and black coloured nymphs in all stages of development and the brownish adult bugs were observed attacking all instars of the host larvae including recently pupated ones.

The bug approached its prey stealthily, with rostrum extended, the

¹The generic name is sometimes misspelled *Cantheconidia* by authors.



Mango tree trunk covered by cocoons of *Latoia lepida* (Cramer).
(Photo: Author)



Caterpillar of *Latoia lepida* (Cramer) being attacked by adult (left) and nymph (right) of *Cantheconidea furcellata* (Wolff).
(Photo: Author)

tip of which was thrust into the body of the slug caterpillar at any accessible point (see plate II). The injected toxin quickly immobilised the caterpillar which, on being attacked, had swayed its anterior end vigorously from side to side as an apparent defensive reaction. The completely sucked caterpillar turned almost black in colour and consisted of nothing more than the outer integument stuck flat to the substrate on account of the internal contents of the caterpillar having turned into a black, sticky substance as a result of the action of the toxin. Several such skins were noted attached to all parts of the trees (see plate III) and lying on the ground below them. The immature bugs are peculiarly gregarious in nature, especially in the earlier instars and even if a single individual actually initiates the attack, one or more others join it not much later. Each group of 2-4 bugs took about 20-60 minutes to fully suck dry a single caterpillar and my observations indicate that from 2-6 larvae were destroyed by one such group in a single day. From laboratory studies, Pant (1960) observed that nymphs consumed 7-8 larvae of *Earias* spp. each during their development (through 5 instars) and adult bugs fed upon 4-8 larvae each day. Gadd (1943) however, reported that one nymph of *Cantheconidea robusta* (Distant) destroyed 28 larvae of another limacodid on tea, *Natada nararia* Moore, in the course of its nymphal life and that a single adult bug killed 101 larvae in six weeks.

This is the first record of *C. furcellata* as a predator of *Latoia lepida* and only the second report of any predator of this limacodid. Ramakrishna Ayyar (1929) mentioned the association of a pyralid caterpillar, *Euzophera* (= *Phycita*) *dentilinella* (Hampson), with the larvae and pupae of *L. lepida* and thought it was predacious on the slug caterpillar. Radha & Rangarajan (1970) later recorded this pyralid as predacious on a lymantriid *Lymantria serva* Fabricius defoliating *Ficus bengalensis* Linnaeus near Coimbatore. They also mention that this pyralid predator was collected as early as 1914 on *L. lepida*. Thompson & Simmonds (1964) did not list any predators of *L. lepida* in their catalogue.

Cantheconidea furcellata however, is polyphagous and a large number of hosts, mainly lepidopterous larvae, are recorded by the following workers: Thompson & Simmonds (1965), Cherian & Brahmachari (1941), David & Basheer (1961), and Pant (1960). One very old host record in Distant (1902), overlooked by all these workers, gives *Hyalaea puera* Cramer and *Antheria paphia* Linnaeus (Tassar Silkworm) as two other prey species. The stink bug itself has very few recorded natural enemies, only one egg-parasite *Microphanurus seychellensis* Kieffer (Hymenoptera: Proctotrupeoidea) being reported (Cherian & Brahmachari 1941). The total life cycle of the bug from egg to adult took 18-21 days (Cherian & Brahmachari 1941) and the adult longevity

was 15-20 days. In *C. robusta* the longevity was 51 days (Gadd 1943). Pant (1960) however, gives only 8-9 days as longevity of adult *C. furcellata* but De Jong (1931) records 28 days for the same species at Java. Present observations indicate that the life cycle varies from 15-18 days (from first instar nymph to adult, eggs not having been found or laid) and the maximum longevity of adult 12 days, in the laboratory.

C. furcellata has a wide distribution throughout the Oriental region, being recorded from India, Ceylon, Burma, Malaya, Sumatra, Java, Formosa and also Japan (Distant 1902). Although this species is capable of exercising fairly good natural control, it seems to be dependent on the presence of a sizeable host density to be really effective as observed in the case under report and by David & Basheer (1961). This being so, considerable damage is already done by the host insect concerned to the crop and as in coccinellids and, admittedly, in most predatory groups, the value of the predator is considerably reduced. However, since the bug is capable of producing favourable results, further studies on its potentialities in checking several lepidopterous pests and on possible means of its mass production would repay study.

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December 21, 1972.

REFERENCES

- CHERIAN, M. C. & BRAHMACHARI, K. (1941): Notes on three predatory Hemipterons from south India. *Indian J. Ent.* 3:115-119.
- DAVID, B. V. & BASHEER, M. (1961): Mass occurrence of the predatory Stink Bug, *Cantheconidia* (*Canthecona*) *furcellata* (Wolff) on *Amsacta albistriga* Walk. in south India. *J. Bombay nat. Hist. Soc.* 58:817-819.
- *DE JONG, J. K. (1931): *Cantheconidea furcellata* as a natural enemy of caterpillars in Tea plantations. *Arch. Theecultuur Ned.-Ind.* 1931, no. 1, pp. 17-24. ([*Rev. appl. Ent.* (A) 19:517].
- DISTANT, W. L. (1902): The Fauna of British India, Rhynchota. Volume 1 (Heteroptera). Taylor and Francis, London. pp. xxxviii + 438.

*References not seen in original.



Completely sucked caterpillar of *Latoia lepida* (Cramer) stuck to mango tree branch.

(Photo: Author)

*GADD, C. H. (1943): Report of the Entomologist for 1942. *Bull. Tea Res. Inst. Ceylon* no. 24, pp. 32-36. [*Rev. appl. Ent. (A)* 32:249].

NARAYANAN, E. S., RAO, V. P. & SUBBA RAO, B. R. (1967): Advances made in Insect Parasitology and Biological Control of pests in India—A Review in Agricultural Entomology Reviews. I.C.A.R., New Delhi. pp. 205-246.

*PANT, C. P. (1960): Some aspects of the Bionomics of *Earias* spp. at Kanpur. *Agra Univ. J. Res. (Sci.)* 9 (1):31-40. [*Rev. appl. Ent. (A)* 50:36].

RADHA, N. V. & RANGARAJAN, A. V. (1970): Occurrence of a Lymantriid pest, *Lymantria serva* F. on *Ficus ben-*

galensis L. and Record of a Pyralid predator, *Euzophera dentilinella* H. *Sci. & Cult.* 36:232-233.

RAMAKRISHNA AYYAR, T. V. (1929): Notes on some Indian Lepidoptera with abnormal habits. *J. Bombay nat. Hist. Soc.* 33:669-675.

THOMPSON, W. R. & SIMMONDS, F. J. (1964): A Catalogue of the Parasites and Predators of Insect Pests. Section 3. Predator Host Catalogue. Reprint edition. Commonwealth Agricultural Bureaux, England. p. 204.

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(1965): op. cit. Section 4. Host Predator Catalogue. Reprint edition. Commonwealth Agricultural Bureaux, England. p. 198.

31. ON THE MODE OF PREYING OF A GIANT WATER BUG (*BELOSTOMA INDICUM* LE PELETIER & SERVILLE, 1775) ON A FROG (*RANA TIGERINA* DAUDIN, 1903)

The giant water bug's (Insecta: Hemiptera: Belostomatidae) habit of feeding on other fresh water fauna is well known. It is a menace to fishery owing to its predacious habit. Dimmock (1886) found some species of giant water bug that were destroying the young fishes in the state fish hatcheries of Massachusetts. No information, however, is available in the literature as to the exact mode by which it kills its large vertebrate preys like frogs, toads, salamanders and so on. Green (1901), who studied the biology of these bugs in aquaria, mentioned that large insects and other organisms falling on water constitute the main food of these bugs; and that, they also feed on frogs when they are able to catch them. Rankin (1935) used damaged tadpoles and pieces of young frogs to feed the nymphs of *Lethocerus americanus* in the culture he made for studying the life history of the species. It is, therefore, worthwhile to record here an observation on the exact mode of preying by one of such giant water bugs, namely *Belostoma indicum* on a frog, *Rana tigerina* in its natural habitat.

On August 23, 1972, I observed, while on a faunistic survey, near Kushnapur village (c. 4 km N.E. of Ghatgaon), Keonjhar district, Orissa, a tug-of-war between a nymph of *B. indicum* and a subadult *R. tigerina* in a temporary water pool, located in a paddy field. The bug had mounted on to the back of the frog and had tightly grabbed its gular region by the fore pair of legs, which are short and raptorial.

The frog often moved deep into water but immediately came up to the surface being unable to get rid of its predator. Such movements of the frog continued for 3-4 minutes. The bug, however, struck firmly to the back of the frog and tightened its grip further and further. Ultimately, the frog did not show any sign of movement and floated on the surface of the water while the bug still clung to its back. With the help of a water net both were brought ashore and even during this process the bug did not leave its prey. It was then forcibly removed from the frog, which had by then succumbed. The frog was examined thoroughly and no mark of injury in the form of puncture or otherwise was detected on its body. Even after rigorous squeezing no trace of blood could be detected on any region of body. In all probability the frog was strangled to death by the tight grip of the fore legs of the bug around its gular region.

Distant (1906) mentioned: "Its proboscis is capable of producing a very painful puncture", of which he himself had the experience from the South African giant water bug, *B. niloticum*. On the contrary, *B. indicum* (at least at its nymphal stage) appears not to rely on its proboscis for killing its prey and instead uses its fore pair of raptorial legs for strangling its large vertebrate prey to death.

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA 16,
December 6, 1972.

S. K. MITRA

REFERENCES

- DIMMOCK, G. (1886): Belostomatidae and some other fish-destroying bugs. Annual Report of the Fish and Game Commissioners of Mass. 1886.
- DISTANT, W. L. (1906): The fauna of British India, Rhynchota. 3:37.
- GREEN, E. E. (1901): Biologic notes on some Ceylonese *Rhynchota*. *Entomologist*. 34:113-116.
- RANKIN, K. L. (1935): Life history of *Lethocerus americanus* (Leidy) (Hemiptera: Belostomatidae). *Kansas Univ. Sci. Bull.* 22:479-491.

32. DEATH OF CERTAIN INSECTS ON SHRUB *BIDENS PILOSA*

From a survey of literature it appears that not much information is available on insect ecology and associated plants. Recent studies on various groups of life forms including birds (Weed dispersal etc.—Bombay Natural History Society's Seminar on Economic Ornithology) have thrown light on various related factors deserving attention.

During field studies in Dehra Dun a fatal (to insects) relation between a shrub of the family compositae—*Bidens pilosa* Linn. with butterflies, dragonflies and damselflies was observed. The distribution of this shrub is throughout India. It was observed that at the time of seed dehiscence the seed spikes project around the dried flower. At the tip of each seed spike are 1-2 mm V-shaped spines having backwardly directed micro spines. Any winged insect sitting on these is unable to fly off as the recurved spines hook on to its body or wings resulting in the death of the insect thereon. In Dehra Dun region this has been observed along the river Badal in Sahasdhara Hills and in Siwalik forests where often quite a few insects are seen dead on this shrub. However, there is no carnivorous relationship between the plant and the insects.

Incidentally it may be pointed out that it is this plant whose spikes are often found stuck on clothing during trek in the forests.

ACKNOWLEDGEMENTS

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30-SOUTH PATEL NAGAR,
DEHRA DUN, (U.P.),
February 20, 1974.

R. K. BHATNAGAR

33. NOMENCLATURAL NOTE ON *MIMUSOPS ELENGI* LINN.

In view of the taxonomic studies carried out by Lam (1925, 1927, 1932) and Van Royen (1952) on the genus *Mimusops* Linn., it has become necessary to put forward this note for the benefit of Indian botanists.

Van Royen (1952) considers *Mimusops elengi* Linn. an extremely variable species thereby leaving no room for distinguishing varieties or forms of Lam. But in the western parts of the Archipelago the leaves are larger up to 18 cm long and towards the east these decrease in size to 6 cm length, ending in the smaller leaves of *Mimusops parvifolia* R. Br.

The synonymy, in detail, is as follows:

Mimusops elengi Linn. Sp. Pl. 349, 1753; Lam in Bull. Jard. Bot. Bzg. sér. 3, 7:234, 1925; sér. 3, 8:479-480, 1927; and in Nova Guinea 14, 4:568, 1932; Van Royen in Blumea 6(3):594, 1952.

M. parvifolia R. Br. Prodr. 531, 1810; Lam in Bull. Jard. Bot. Bzg. sér. 3, 7:235, 1925.

M. elengi Linn. var. *typica* (*elengi*), var. *parvifolia* (R. Br.) Lam, var. *brevifolia* Lam and *M. elengi* Linn. var. *typica* (*elengi*), forma *longepedunculata* (Blume in Burck) Lam in Bull. Jard. Bot. Bzg, sér. 3, 7:235-238, 1925.

GENERAL EDUCATION CENTRE,
MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA,
BARODA 2,
March 25, 1974.

G. M. OZA

34. NOCTURNAL POLLINATION IN *ANTIRRHINUM MAJUS* LINNAEUS BY *XYLOCOPA RUFESCENS* FABRICIUS

INTRODUCTION

In many regions of the World there exist a class of plants which blossom at night. This 'Nocturnal pollination system' has evolved in different plants of unrelated as well as related families. The study of the evolutionary aspect of night pollination has received very little attention so far. One of the most interesting aspects of night pollination is the role played by insects and other pollinators and the way these have become adapted along with the evolution of the plants. In this communication, some observations on the pollinating mechanism of the Snap-dragon (*Antirrhinum majus* L.) is presented.

The plants are cultivated at a height of 4400 ft (c. 1340 m) in the Biligirirangan Hills, near buildings. It was possible to study the pollinator and its plant for several hours at night. Such careful and prolonged observations have excluded all other possible methods of pollination.

DESCRIPTION

The plant, commonly called 'snout flower' or 'snap dragon' (anti = like, rhin = snout) belongs to the family Scrophulariaceae. It is usually cultivated in gardens. The flowers are mildly fragrant and have an uncommon structure. They are borne on long spikes. The corolla tube is rather large and saccate at the base. There are two prominent and curiously shaped lips. On pressing these lips gently between the thumb and the forefinger, they open wide apart due to an intricate mechanism and reveal the variegated throat. The upper lip is erect and the lower lip spreading. The middle lobe is smaller than the side lobes with a large bearded palate. The flowers are of various shades of pink, rose, apricot, orange, crimson, carmine, yellow, white and many gradients of

colours varying from white to shades of light pink salmon, pale maroon and many other attractive combinations of hues in one flower, have been evolved due to intensive floriculture.

Its pollinator, *Xylocopa rufescens* Fabr. (commonly called the 'carpenter bee'; *Xylocopa* = wood cutter) belongs to the family Xylocopidae of the order Hymenoptera. *Xylocopa* are the giants of the bee world and are solitary bees. They have a heavy and stout black coloured body without the pollen baskets on the hind legs. Mouth parts are of 'chewing and lapping' type. Tongue long and slender. These bees bore energetically into dead branches and trunks of trees, and enter buildings where they bore into posts and rafters. They are nuisance not only on account of the damage done to rafters and beams, but also on account of wood dust and other refuse dropped out. They are usually present in forest rest houses and wooden bungalows. This species is strictly a nocturnal Indian carpenter bee. Tunnels are more or less cylindrical, an inch to 1.5 inches in diameter, up to 8 inches long, with short side branches. In this, a series of cells are constructed and each cell contains an egg along with bee bread and pollen (Tsing-Chao Ma 1938; Beeson 1938).

POLLINATION MECHANISM

The female carpenter bee starts its activity at about 7 p.m. in the evening. The bee appears to locate *Antirrhinum* at night purely by sight alone. It was found to visit white flowers more frequently than variegated ones, as possibly the white flowers are more easily seen during night. The shape of the flower fits neatly to the landing posture of the insect body. The insect with a high humming noise alights on the lower lip which goes down due to the weight thus applied and the insect inserts its head into the saccate tube. *Xylocopa* being chiefly a pollen collecting bee, assumes a pendent position under the anthers and by vibrating its wings slightly shakes out of the anthers the dry pollen grain on to the back of its body. When the insect happens to visit another flower, the stigma of that flower comes in contact with the back of the bee and is thus pollinated.

DISCUSSION

'Failure' on the part of some species of flowering plants to compete with the innumerable day bloomers is believed to be the chief cause for the origin of nocturnal pollinating system in angiosperms. Presumably, the evolution of successful night bloomers should have been from

a stock of late day and dusk bloomers. From the latter would have evolved a line of night bloomers eventually through failure to withstand intense competition from the vast array of strictly day bloomers. A similar and a parallel changeover in the pollinating activity must have taken place among certain species of pollinators as is indicative in the *Antirrhinum-Xylocopa* type, where the co-adapted system is very clear. The nocturnal pollinating system in its infancy must have consisted of only a few species of night bloomers and their pollinators. But, now the pollinating system has reached a high density and has developed advanced stages of specialization.

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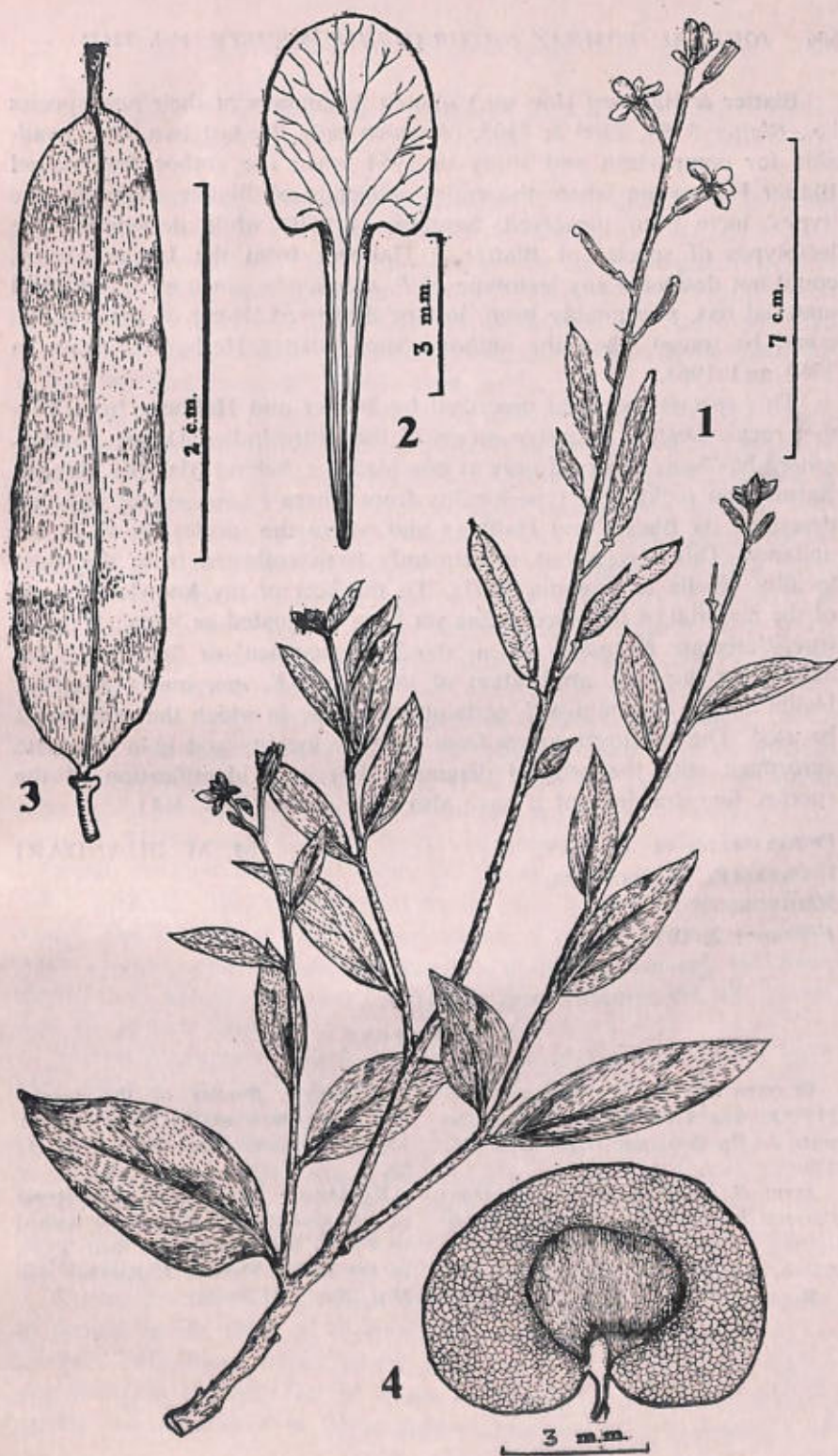
REFERENCES

- BEESON, C. F. C. (1938): Carpenter species of the genus *Xylocopa*. *Rec. Bees. Indian Forester* 64:735-737. *Indian Mus.* 40:265-329.
TSING-CHAO MA (1938): The Indian

35. NEOTYPE OF *FARSETIA MACRANTHA* BLATT. & HALLB. (CRUCIFERAE)

(With four text-figures)

Farsetia macrantha which Blatter & Hallberg (1918) described as a new species from the Indian Desert, has been put in the synonymy of *Farsetia jacquemontii* Hook. f. & Thoms. by Jafri (1957), although he, in his own words "could not examine any material of *F. macrantha* Blatt. & Hallb., but from the measurements given in the specific description (*F. macrantha*) it fits easily within the limits of the same group" (i.e., *F. jacquemontii* sub sp. *jacquemontii*). While a detailed study, whether *F. macrantha* is conspecific with *F. jacquemontii*, is under progress, a search has been made for the type of *Farsetia macrantha*.



Farsetia macrantha Blatt. & Hallb. FIGS. 1. a flowering branch; 2. a petal; 3. a silique; 4. a winged seed (based on Bhandari 507).

Blatter & Hallberg (loc. cit.) quoted 3 numbers of their new species i.e., *Blatter* 5785, 7300 & 7305, of which only the last two were available for comparison and study in 1954 when the author first visited Blatter Herbarium where the entire collection of Blatter, including the 'types' have been preserved. Santapau (1959) while designating the lectotypes of species of Blatter & Hallberg from the Indian Desert, could not designate any lectotype of *F. macrantha*, since all the original material has, presumably been, lost or destroyed. None of these sheets could be traced when the author visited Blatter Herbarium again in 1960 and 1963.

This species has been described by Blatter and Hallberg from Barmer rocks. Despite extensive survey of the entire Indian Desert, *F. macrantha* has been observed only at one place i.e. behind Mataji's Temple, Barmer, on rocks—the type locality from where *F. macrantha* was first described by Blatter and Hallberg and where the species grows in abundance. This species has subsequently been collected from the same locality (Rolla & Kanodia 1962). To the best of my knowledge none of the material of this species has yet been designated as 'type'. I, therefore, designate *Bhandari* 507 a 'standard specimen' or "neotype", exemplifying the true application of the name *F. macrantha* Blatt. & Hallb. and to ascertain with certainty the sense in which the same must be used. The specimen comes from the type locality and is in complete agreement with the original diagnosis. For easy identification of the species, line drawings of it have also been given (Figs. 1-4).

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February 2, 1974.

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REFERENCES

- BLATTER, E. J. & HALLBERG, F. (1918): The Flora of the Indian Desert. *J. Bombay nat. Hist. Soc.* 26: 220.
- JAFRI, S. M. H. (1957): The genus *Farsetia* in Pakistan, India and Afghanistan. *Notes Roy. Bot. Garden Edinb.* 22:210.
- ROLLA, S. R. & KANODIA, K. C. (1962-1963): Studies of the vegetation and Flora of Jodhpur division, Rajasthan State. *Ann. Arid Zone*, 1: 24.
- SANTAPAU, H. (1959): Lectotypes of the species and varieties described by Blatter and Hallberg in their 'Flora of the Indian Desert'. *J. Bombay nat. Hist. Soc.* 56:276-281.

36. *CUSCUTA REFLEXA* ROXB.—A RIVAL TO *DENDROPHTHOE FALCATA* (L.F.) ETTINGSH IN HOME GARDENS

Among the phanerogamic parasites, *Dendrophthoe falcata* Ettingsh has received considerable attention. *Cuscuta* belonging to N.O. Convolvulaceae is not so well known. The number of species of the genus *Cuscuta* has been reported as 7 (Hooker 1885), 5 (Gamble 1956 reprint) and 8 (Shareefuddin Khan 1951). Data on parasitism has been provided by Narayan 1956; Chavan & Sabnis 1960, and some contributions regarding its host range have also been made.

During 1971, 1972 due to unknown factors *Cuscuta reflexa* Roxb. suddenly started spreading in the Deccan from Hyderabad to Bangalore showing itself as yellowish green, leafless, tendril like growth having a coverage and spread. This alarmed orchard and garden owners. Frequently *Cuscuta reflexa* has been confused with *Cassytha* Linn. species belonging to N.O. Lauraceae which is also a complete flowering parasite. The two species however can be easily differentiated from each other. The stem tendrils of *Cassytha* are smaller in diameter, dark green to rusty orange, not easily breakable (fibrous), and overall, the parasite is not as much conspicuous as *Cuscuta*. *Cuscuta reflexa*, on the other hand, is light yellowish (or greenish yellow) to orange, more succulent and easily breakable, very conspicuous and may completely cover the host plant. Frequently the vines turn self parasitic on other branches of the parasite *Cuscuta* or on the same branch itself. As regards the flowers and fruits, the flowers of *Cassytha* are yellow to cream coloured, the fruit is glabrous, upto the size of a pea enclosed in a succulent perianth tube, and crowned by its limb, with a mono-carpellary ovary. The flowers of *Cuscuta reflexa* are white in cymose or paniculate clusters, shortly pediculate, capsules globose to conical, apiculate, seeds 1-2. It also appears that *Cassytha* is more common on wild plants than on garden plants.

Several attempts at citing the host range of *Cuscuta reflexa* have been made by earlier workers and Kaushik (1970) has mentioned that there are 90 different hosts of this parasite belonging to Angiosperms, Gymnosperms and Pteridophytes. In addition, he added 14 new hosts to the host range. When compared to the host range of *Dendrophthoe falcata* which is nearly 330, this figure appears very small indeed. Probably clear distinction between *Cassytha* and *Cuscuta* and more elaborate search of hosts might bring in many more unknown hosts.

During 1971 and 1972 when the appearance of *C. reflexa* became so prolific in the cities of Hyderabad and Bangalore we came across several hosts, among which, as far as is known to us, the following 18 are new host records. Out of these, 13 are plants which are usually grown and maintained in home gardens and one is cultivated for oil

extraction (*Ricinus communis*).

TABLE

No.	Host species	Natural order	Degree of infestation
1.	<i>Aristolochia bractata</i> Retz.	Aristolochiaceae	Light
2.	<i>Argyrea speciosa</i> Sw.	Convolvulaceae	Light
3.	<i>Bougainvillea spectabilis</i> Willd.	Nyctaginaceae	Very heavy
4.	<i>Casurina equisetifolia</i> L.	Casurinaceae	Very heavy
5.	<i>Citrus decumana</i> L.	Rutaceae	Medium
6.	<i>Citrus medica</i> L. var. <i>acida</i>	Rutaceae	Medium
7.	<i>Cryptostegia grandiflora</i> R. Br.	Asclepiadaceae	Medium
8.	<i>Diospyros melanoxyton</i> Roxb.	Ebenaceae	Medium
9.	<i>Duranta plumieri</i> Jacq.	Verbenaceae	Heavy
10.	<i>Ervatamia divaricata</i> (L.) Burkill (Syn. <i>Taberina- montana coronaria</i> R. Br.)	Apocynaceae	Medium
11.	<i>Grewia subinaequalis</i> DC.	Teliaceae	Medium
12.	<i>Jasminum grandiflorum</i> L.	Oleaceae	Very heavy
13.	<i>Leptadinia reticulata</i> W.A.	Asclepiadaceae	Very heavy
14.	<i>Millingtonia hortensis</i> Linn.	Bignoniaceae	Very heavy
15.	<i>Ormocarpum sennoides</i> DC.	Leguminosae	Heavy
16.	<i>Ricinus communis</i> L.	Euphorbiaceae	Medium
17.	<i>Thevetia neriiifolia</i> Juss.	Apocynaceae	Very heavy
18.	<i>Zizyphus oenoplia</i> Thuill	Rhamnaceae	Light

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REFERENCES

- CHAVAN, A. R. & SABNIS, S. D. (1960): On *Cuscuta chinensis* Lamk. —Preliminary observation on parasitism. *Sci. & Cult.* 25:544.
- GAMBLE, J. S. (1956): Flora of Madras Presidency. Vol. II, p. 654.
- HOOKE, J. D. (1885): Flora of British India IV, p. 225.
- KAUSHIK, J. P. (1970): On *Cuscuta reflexa* Roxb. in Gwalior, M.P. *J. Bombay nat. Hist. Soc.* 66(3):663-665.
- NARAYAN, H. S. (1956): Diffused type of parasitism in *Cuscuta hyalina*. *Sci. & Cult.* 21:447-450.
- SHAREEFUDDIN KHAN, M. (1951): Forest flora of Hyderabad, p. 281. Govt. Press, Hyderabad.

37. NEW PLANT RECORDS FOR INDIA FROM
KASHMIR—II

(With two text-figures)

Based upon the occasional collections made during 1968-1973 throughout the Kashmir valley, I reported *Phacelia tanacetifolia* Benth. and *Sideritis montana* Linn. as two new records for India (See *J. Bombay Nat. Hist. Soc.* 69:229, 1972). This paper adds two new composites for India namely: (1) *Aster pilosus* Willd. var. *demotus* Blake recorded as "escape from cultivation, chakrah 7000 ft on 29-ix-1936" on a specimen deposited at KEW and (2) *Chrysanthemum parthenium* (Linn.) Bernh. of which one specimen collected by Falconer (1864) from Kashmir is deposited at Kew.

The fresh specimens of these plants have been deposited at Royal Botanical Gardens, Kew, and Blatter Herbarium, Bombay.

Aster pilosus Willd. var. **demotus** Blake in *Rhodora* 32:139, 1930.

A. ericoides Auct. (non Linn. Sp. pl. 875, 1753). [Fig. 1].

Annual herbs: Stem suberect to decumbent, upto 75 cm branched, leafy, slightly angled towards the base, downy greyish or tomentose towards the apices. Leaves simple, linear, filiform, upto 3.7 cm long, tips acute; crowded towards the apices; alternate, light green, somewhat downy or tomentose. Flower heads white with purplish tinge, generally solitary on a short leafy branch, panicled. Involucral bracts 2-3 seriate; outer ones a bit smaller up to 5 mm long; inner ones up to 7 mm long, obovate to linear, margins membranous, slightly downy and persistent. Flowers heterogamous; ray florets 2-4 seriate, ligule up to 1 cm, entire or bifid near the apex, female, fertile, style half as long as the ligule with 2 small diverging arms near the apex; disc florets purplish, *alpha*-seriate, corolla tube 4-5 fid, stamens 5, anthers with obtuse bases coming out of the tube at maturity, style similar to that of ray florets. Receptacle small, simple and naked. Achenes elongated upto 1 mm, whitish, tapering towards the base, finely hirsute; pappus white, almost 3 times the length of achenes.

Distribution: A native of America and introduced into Kashmir.

Specimens examined: Kaul RRL 19727 (21-x-1970) Badgam Orchards, Rare. Kaul RRL 19801 (31-x-1970) Gulmarg Forests.

Chrysanthemum parthenium (Linn.) Bernh. Syst. Verz. Erf. 145, 1800; Aitch. in *J. Linn. Soc.* 18 : 69, 1880; Kitamura in *Fl. Afghanistan* 402, 1960; Polunin in *Fls. Europe* 443, 1969. *Pyrethrum parthenium* (Linn.) Smith in *Fl. Britannica* 2 : 900, 1800. [Fig. 2].

Perennial branched herbs with a somewhat creeping root stock. Stem woody below erect up to 60 cm, branched, light green, ribbed, finely tomentose towards the apex. Leaves pinnate up to 8 cm long,

with 3-7 oval leaflets, each further divided into narrow, oval, toothed or lobed segments, strongly aromatic; lower cauline leaves stalked, stalk slender, as long or shorter than the leaf; upper ones pinnatifid to pinnatisect, sessile to subsessile, glabrous or minutely pubescent. Flower heads long, stalked, forming subcorymbose compound heads. Involucral bracts ovate, 1-2 seriate, downy with membranous margins. Ray florets



FIG. 1. *Aster pilosus* Willd. var. *demotus* Blake (A flowering shoot). a. an involucral bract; b. a disc floret; c. a ray floret; d. an achene.

in a single outer row, ligules white, 3-5 fid, female, fertile or even sterile. Disc florets many, yellowish, compact in the centre; corolla tube 3-5 fid, stamens with linear anthers, style truncate. Achenes whitish, somewhat cuneate, tapering towards the base, glabrous or minutely hispidulous. Receptacle naked.

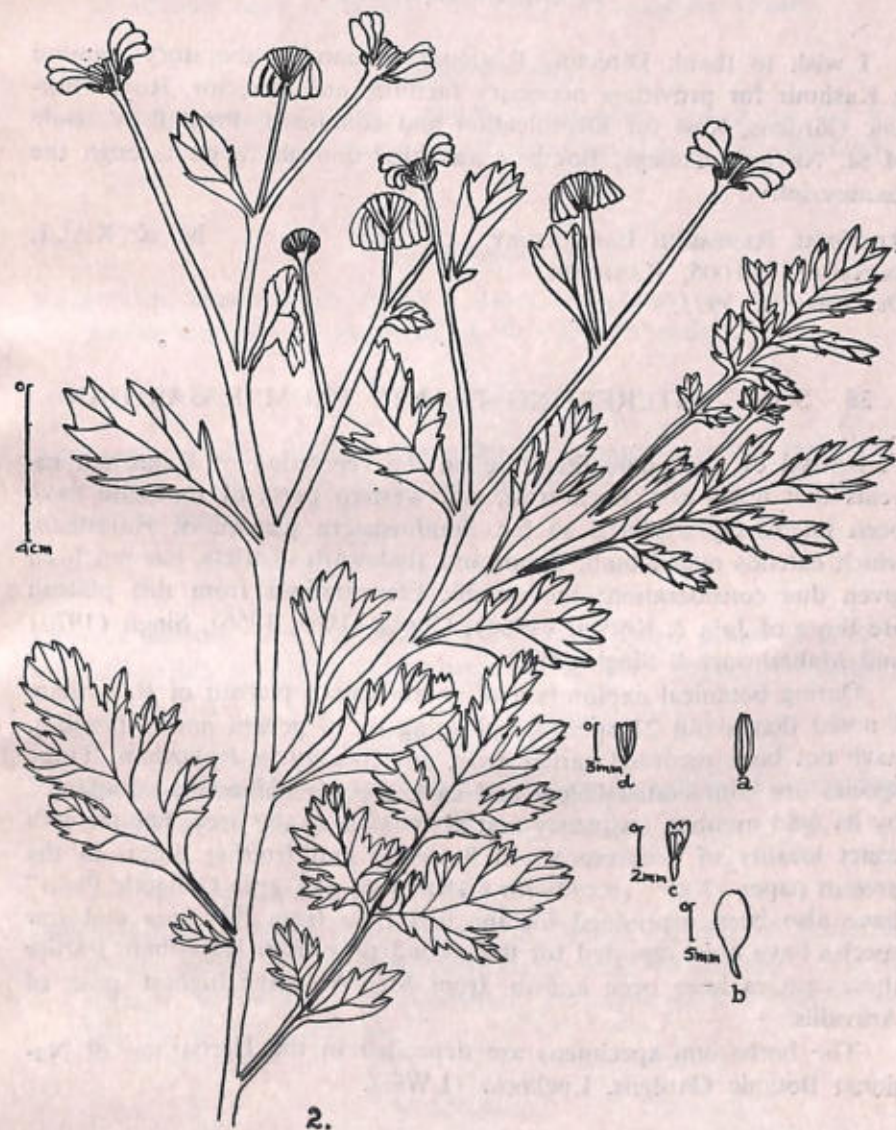


FIG. 2. *Chrysanthemum parthenium* (Linn.) Bernh. (A flowering shoot). a. an involucre bract; b. a ligule; c. a disc floret; d. an achene.

DISTRIBUTION: Europe, Transcaucasia, Caucasus, Asia minor, Afghanistan.

Specimens examined: Kaul RRL 19706 (15-x-1970) Majid Bagh, Srinagar.

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38. SOME INTERESTING PLANTS FROM RAJASTHAN

A perusal of up-to-date literature on the vegetation of Rajasthan reveals that north-east, north-west, and western parts of the state have been intensively explored so far. South-eastern plateau of Rajasthan, which extends over Kotah, Bundi and Jhalawarh districts, has not been given due consideration; the notable contributions from this plateau are those of Jain & Kotwal (1960), Gupta (1965, 1966), Singh (1970) and Maheshwari & Singh (1972).

During botanical exploration of south-eastern plateau of Rajasthan, I noted that about 21 species, belonging to 19 genera and 9 families, have not been recorded earlier from any locality in Rajasthan. These species are enumerated below and each specific name is accompanied by its field number, frequency and abundance in the area, habitat with exact locality of occurrence and flowering and fruiting times. In the present paper 17 new records for "The Flora of Upper Gangetic Plain" have also been mentioned for the first time from this area and few species have been reported for the second time from Rajasthan. Earlier these species have been known from Mt. Abu, the highest peak of Aravallis.

The herbarium specimens are deposited in the Herbarium of National Botanic Gardens, Lucknow (LWG).

POLYGALACEAE

***Polygala erioptera* DC. var. *vahliana* (DC.) Chodat (90504).** Rare; occurs in dry, rocky wastelands near Kotah. This variety differs

from nominate species in the characters of pubescence and hairiness. *Fl. & Fr.*: August-October.

ELATINACEAE

Bergia capensis Linn. (83733). Abundant on sandy and marshy banks of streams near Jhalawarh. *Fl. & Fr.*: August-November.

RHAMNACEAE

Ventilago denticulata Willd. (74408). Occasional; found on the hill-slopes in deciduous forests at Kotah-Dam. *Fl. & Fr.*: December-April.

CAESALPINIACEAE

Hardwickia binata Roxb. (91020). Rare; few plants found in the teak forests near Atru village. *Fl. & Fr.*: December-July.

UMBELLIFERAE

Ammi majus Linn. (74009). Rare; found in patches in wet and shady places in the evergreen forests of Sitabari (Kelwara). *Fl. & Fr.*: March-April.

SOLANACEAE

Physalis minima Linn. var. **indica** Cl. (90376). Rare; found in gardens and fields near Chhabra village. *Fl. & Fr.*: September-January.

PLANTAGINACEAE

Plantago pumila Willd. (90850). Rare; weed of cultivated fields near Baran. *Fl. & Fr.*: January-March.

EUPHORBIACEAE

Chrozophora parvifolia Klotz. ex Schfth. (83831, 90953). Common in drying ponds and ditches, particularly near Darah and Chhabra villages. Plants grow in association with *Gnaphalium pulvinatum* Del. *Fl. & Fr.*: April-July.

GRAMINEAE

Arthraxon hispidus (Thumb). Makino f. **muriculatus** Hook. (74608). Rare; found in dry habitats on the hills near Darah. *Fl. & Fr.*: August-October.

- Brachiaria eruciformis** (J. E. Smith) Griseb. (74498, 83770). Common in dry habitats near Hindoli and Jhalarpatan. Plant is distinguished by its raceme and leaf-blades which are at right angle of leaf-sheaths. *Fl. & Fr.*: October-May.
- B. reptans** (Linn.) Gard. & Hubb. (83655). Common on wet or marshy banks of ponds and rivers and as a weed of cultivation near Manoharthana. *Fl. & Fr.*: July-November.
- B. setigera** (Retz.) Hubb. (74834). Common on the hills at low elevation in wet and shady habitats near Darah. *Fl. & Fr.*: August-November.
- Dimeria connivens** Hack. (83741). Occasional; found in grasslands and in the forests near Jhalawarh. Sometimes confused for *Dichanthium* Will. or *Bothriochloa* O. Ktze. *Fl. & Fr.*: August-November.
- Dichanthium aristatum** (Poir.) Hubb. (90131). Rare; found in dry wastelands near Kotah. *Fl. & Fr.*: August-November.
- Eragrostis papposa** (Duf.) Steud. (83633). Occasional; found in dry sandy or rocky grounds near Nenwa village. Branches, branchlets and glumes are tinged with purple. *Fl. & Fr.*: June-August.
- Ischaemum pilosum** (Klein ex Willd.) Wight (83729). Common; found in waste, sandy or rocky grounds near Jhalawarh and Kotah-Dam. The rhizomes are extensive and the plant can be used in soil conservation. *Fl. & Fr.*: August-December.
- Oropetium villosulum** Stapf ex Bor (83617). Rare; found in dry habitats, chiefly in rock crevices near Darah. *Fl. & Fr.*: August-October.
- Pennisetum polystachyon** (Linn.) Schult. (74456, 83778, 90153). Native of tropics of old world. Common in dry wastelands, particularly near Manoharthana, Atru and Kotah-Dam. *Fl. & Fr.*: Major part of the year.
- Setaria pallide-fusca** (Schumach.) Stapf (74481 74827). Occasional, abundant near ponds and ditches near Kotah-Dam, Manoharthana and Darah. Very close to *S. glauca* Beauv. which has, however, keeled upper lemmas. *Fl. & Fr.*: August-November.
- Sorghum purpureo-sericeum** (Hochst. ex A. Rich.) Aschers. (83684). Occasional; grows in dry habitats, chiefly at the foot of hills near Eklara. *Fl. & Fr.*: August-October.

Besides these, *Cassia phyllodinea* R. Br. (Caesalpiaceae), a native of S. Australia, has been collected from the Central Arid Zone Research Institute, Jodhpur (*Maheshwari* 74176 LWG.). *Glossostigma spathulatum* (Hook. ex Wight) Arn. ex Benth. (83753; locality: Atru

village) and *Ranunculus sceleratus* Linn. (90997; locality: Kotah) growing in the present area have not been reported from any part of Rajasthan except Mount Abu. This indicates close affinity of the flora of area with Mt. Abu, the highest peak of Aravallis.

Duthie (1903-29) included the present area in his "Flora of Upper Gangetic Plain", but has not recorded the occurrence of plants from these districts. A perusal of literature on the vegetation of Gangetic Plain reveals that following 17 species have not been previously reported in the flora of Upper Gangetic Plain from this area; these species are: *Ammi majus* Linn., *Plantago pumila* Willd., *Eragrostis papposa* (Duf.) Steud., *Sporobolus tenuissimus* (Schrank.) Ktze., *Oropetium villosulum* Stapf, *Pennisetum polystachyon* (Linn.) Schult., *Brachiaria eruciformis* (Smith) Griseb., *B. setigera* (Retz.) Hubb., *Sorghum purpureo-sericeum* (Hochst.) Aschers., *Ischaemum pilosum* (Klein ex Willd.) Wight, *Dichanthium aristatum* Poir., *Arthraxon hispidum* (Thunb.) Makino, *Vernonia albicans* (Wall.) DC. (74614; locality: Kotah), *Argyrea sericea* Dalz. (74664; locality: Kotah Dam), *Nicotiana alata* Link & Otto (74010; locality: Bundi), *Fleurya interrupta* (Linn.) Gaud. (90522; locality: Kotah) and *Cassia phyllodinea* R. Br. which has been very recently introduced in this country.

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REFERENCES

- BLATTER, E. & HALLBERG, F. (1918-1921): The Flora of Indian Desert (Jodhpur and Jaisalmer). *J. Bombay nat. Hist. Soc.* 26:218-246, 526-551, 811-818, 968-987; 27:40-47, 270-279, 506-519.
- GUPTA, R. S. (1965): A Contribution to the Flora of Rajasthan. *Ind. For.* 91:428-439.
- (1965): Vegetation of Kotah and Neighbourhood. *Trop. Eco.* 6:63-71.
- (1966): A study of Hydrophytes and Marshland Plants of Kotah and Environs (India). *Trop. Eco.* 7:153-163.
- JAIN, S. K. & KOTWAL, N. N. (1960): On the Vegetation of Shahabad in Rajasthan. *Ind. For.* 86:602-608.
- MAHESHWARI, J. K. & SINGH, V. (1972): *Soliva anthemifolia* (Juss.) R. Br. ex Less. (Compositae): An adventive species in Rajasthan. *J. Bombay nat. Hist. Soc.* 69(2):452-453.
- PURI, G. S. *et al.* (1964): Flora of Rajasthan. *Rec. Bot. Surv. Ind.* 19: 1-154.
- SINGH, V. (1970): Occurrence of *Ceratopteris thalictroides* (Linn.) Brongn. in Rajasthan. *J. Bombay nat. Hist. Soc.* 67(2):354-355.

39. DESMIDS OF MARATHWADA, MAHARASHTRA

The algae of Marathwada division of the Maharashtra State have not been studied so far. I collected 327 vials of algae from Aurangabad, Pali, Bhir, Osmanabad, Parbhani and Nanded from Marathwada region during October 1969. The rainfall for the different places of collections varies from 50 to 150 cm. The pH of the water of the collection spots was determined by using B.D.H. Universal indicator and is mentioned in the bracket immediately after the collection spots in the habitats. Camera lucida diagrams of all these algae have been drawn.

In this note, sixty-one desmids belonging to the genera *Gonatozygon*, *Pleurotaenium*, *Closterium*, *Cosmarium*, *Euastrum* and *Staurastrum* are recorded for the first time. *Closterium leibleinii* Kuetz., *Cosmarium formosulum* Hoff., *C. laeve* Rabenh., *Euastrum spinulosum* Delp. and *Staurastrum gracile* Ralfs are the common taxa in this region.

Gonatozygon monotaenium de Bary

In Moti talao (8.5), Jalna.

The cells are sometimes bent.

Pleurotaenium trabecula (Ehrenb.)

Naeg. v. *rectum* (Delp.) W. et G. S. West

In Moti talao (8.5), Jalna. Common in a pond (8.8), Osmanabad. In a puddle (8.4), Nanded.

Closterium incurvum Breb.

Rare. In Harsool lake (8.5), Aurangabad.

C. kolhapurensis Kamat v. *minus* Kamat

In side pools, Khadkali stream (8.7), Pali.

C. leibleinii Kuetz.

In a side pool, Khadkali stream (8.7), Pali. In Bindusara stream (8.7), Bhir. In Harsool lake (8.5), Aurangabad. In a pool (8.4), Nanded.

C. littorale Gay

In Harsool lake (8.5), Aurangabad.

C. parvulum Naeg.

In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In Kundlika stream (8.3), Jalna. In a streamlet (8.2), Parbhani.

C. subulatus (Kuetz.) Breb.

In a pond (8.8), Osmanabad.

C. tumidulum Gay

In Moti talao (8.5), Jalna. In Kundlika stream (8.3), Jalna. In Bhogavati stream (8.4), and in a pond (8.8),

Osmanabad. In a puddle (8.2), Parbhani.

C. venus Kuetz.

In Moti talao (8.5), Jalna. In a dirty water pool (8.4), and in Harsool lake (8.5), Aurangabad.

Cosmarium abbreviatum Racib.

In a ditch (8.6), and in Bhogavati stream (8.4), Jalna.

C. abbreviatum Racib. f. *pygmaea* Messik.

In Harsool lake (8.5), Aurangabad.

C. angulosum Breb.

In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. angulosum Breb. v. *concinnum* (Rabenh.) W. et G. S. West

In Bindusara dam (8.7), Bhir.

C. auriculatum Reinsch

Common in Moti talao (8.5), Jalna.

C. connatum Breb.

In Moti talao (8.5), Jalna.

C. contractum Kirchner v. *minutum* W. et G. S. West

Common in Harsool lake (8.5), Aurangabad.

C. formosulum Hoff.

Common. In Moti talao (8.5) and in Kundlika stream (8.3), Jalna. In Bhogavati stream (8.4), Osmanabad. In Harsool lake (8.5), Aurangabad. In Bindusara stream (8.7), Bhir. In a pool (8.4), Nanded.

C. garrolense Roy et Bisset

In Moti talao (8.5), and in Kundlika stream (8.3), Jalna. In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In a pool (8.4), Nanded.

C. geometricum W. et G. S. West

In Moti talao (8.5), Jalna.

C. hammeri Reinsch

In Khadkali stream (8.7), Bhir.

C. hammeri Reinsch v. **protuberance**

W. et G. S. West

Common in Harsool lake (8.5), Aurangabad.

C. hammeri Reinsch v. **subbinale**

Nordst.

Rare in Moti talao (8.5), Jalna. Common in a pond (8.8), Osmanabad.

C. inmpressulum Eflv. v. **alpicolum** Schmidle

In a cement cistern (8.6), Aurangabad.

C. incertum Schmidle f. **consociatum** Croadale

Common in Harsool lake (8.5), Aurangabad. In Moti talao (8.5), Jalna.

C. laeve Rabenh.

Very common in streams, pools, puddles, ponds (8.3-8.8), Jalna, Bhir, Pali, Aurangabad, Nanded, Parbhani, Osmanabad.

C. laeve Rabenh. v. **depressum**

Croasdale

In Bindusara dam (8.7), Pali.

The cells are 10-10.5 μ long, 10 μ broad and isthmus 3-3.2 μ broad.

C. laeve Rabenh. v. **pseudooctangulare** Fritsch et Rich

In Khadkali stream (8.7), Pali.

C. latereprotractum Playfair

In Moti talao (8.5), Jalna.

C. majae Strom

In Moti talao (8.5), Jalna.

C. margaritatum (Lund) Roy et Bisset

In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. meneghinii Breb.

In Kundlika stream (8.3), Jalna.

C. moniliforme (Turp.) Ralfs v.**limneticum** W. et G. S. West

In a puddle (8.5), Aurangabad.

C. muelleri Schmidle

In Kundlika stream (8.3), and in Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad. In a puddle (8.4), In Harsool lake (8.5), Aurangabad. In a puddle (8.2), Parbhani.

C. nitidulum de Not

In Harsool lake (8.5), Aurangabad.

C. obtusatum Schmidle

In Bindusara stream (8.7), Bhir.

C. orthostichum Lund

In Harsool lake (8.5), Aurangabad.

C. pardalis Cohn

In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. portianum Archer

Rare in Moti talao (8.5), Jalna.

C. pseudobroomei Wolle

In Moti talao (8.5), Jalna.

C. pseudoexiguum Racib. v. **retusum** Hirano

Rare in Harsool lake (8.5), Aurangabad.

C. quinarium Lund

In Kundlika stream (8.3), Jalna.

C. regnellii Wille

Common in Harsool lake (8.5), Aurangabad.

C. regnellii Wille f. **minima** Eichl. et Gutw.

In Harsool lake (8.5), Aurangabad.

C. regnellii Wille v. **kerguelense** Krieger et Gerloff

Common in Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In a puddle (8.4), Nanded.

C. sexangulare Lund

In a pond (8.8), Osmanabad.

The present alga is slightly bigger up to 45 μ long.

C. speciosum Lund v. **simplex** Nordst.

In Moti talao (8.5), Jalna. In Bhogavati stream (8.4), Osmanabad.

C. spinuliferum W. et G. S. West

In a pond (8.8), Osmanabad.

C. subglobosum Nordst.

(= *Actinotaenium subglobosum* (Nordst.) Teiling)

Very common in Bhogavati stream (8.4), Osmanabad.

C. subtumidum Nordst.

Rare in a pond (8.8), Osmanabad.
In Moti talao (8.5), Jalna.

C. submamillatum W. et G. S. West

In Harsool lake (8.5), Aurangabad.

C. subspeciosum Nordst.

Very common in cement cistern (8.5), Aurangabad.

The zygospores are globose (32-34 μ in diameter) with short blunt projections.

C. subspeciosum Lund. v. **validius** Nordst.

In a side pool of Khadkali stream (8.7), Pali.

C. transiens Gay

Common in Bindusara stream (8.6), Bhir.

C. triplicatum Wolle

In Moti talao (8.5), Jalna.

C. undulatum Corda ex Ralfs v.**minutum** Wittrock

Common in Harsool lake (8.5), Aurangabad.

Euastrum spinulosum Delp.

Common. In Moti talao (8.5), and in Kundlika stream (8.3), Jalna. In Bindusara stream (8.7), and Bindusara dam (8.7), Pali and Bhir. In puddles (8.4-8.6), Aurangabad, Nanded and Parbhani.

Staurastrum gracile Ralfs

In Moti talao (8.5), Jalna. In Harsool lake (8.5), Aurangabad. In puddles (8.4-8.6), Parbhani, Nanded and Aurangabad.

S. iotantum Wolle v. **tortum** Teiling

In Kundlika stream (8.3), Jalna.

S. muticum Breb.

Common in a ditch (8.5), Jalna.

S. punctulatum Breb. v. **ellipticum** Lewin

In a pond (8.8), Osmanabad.

N. D. KAMAT¹

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
NAGPUR,
July 28, 1973.

40. ON THE OCCURRENCE OF *URTICA URENS* LINN. IN INDIA

While making plant collections from Patiala district (Punjab), I noticed on 24-iii-1971 some small plants growing by the wayside in Baradari Gardens, Patiala. The mild sting caused by the plant while uprooting it gave a hint of the identity of the family (Urticaceae) to which the plant belongs. The genus was identified as *Urtica*. Some plants were again collected on 21-iii-1973 from the lawns of the same locality. The species was identified as *Urtica urens* Linn. at Central National Herbarium, Howrah. To the best of my knowledge the plant has not been reported earlier from India and is a new record for this country. The plant makes its appearance in the lawns and waste places in Baradari Gardens, Patiala during spring. Specimens collected (M. Sharma 2283 and M. Sharma 3543) have been deposited in the Herbarium of Punjabi University, Patiala.

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Urtica urens Linn. Sp. Pl. 984, 1753; Bentham, Handbook of the British Flora 464, 1858; Hooker, The Student's Flora of the British Islands 350, 1878; Boissier, Flora Orientalis 4: 1146, 1879; Moss, The Cambridge British Flora 2: 100, t. 108, 1914; Butcher, A New Illustrated British Flora (Pt. 1) 945, 1961; Clapham, Tutin & Warburg, Flora of The British Isles 561, 1962.

Erect, little-to much-branched annual; stems about 10-60 cm long, glabrous except for the stinging hairs. Leaves opposite, stipulate, long petioled, petiole about 1.5-2.0 cm long; lamina ovate-oblong or elliptic-ovate, rounded or truncate at the base, about 3.0-4.5 cm long and about half as broad, deeply and often irregularly serrate, teeth few, terminal oblong, acute. Inflorescence branched from the base, branches usually in pairs and shorter than petioles, ascending or spreading; male and female flowers intermixed in small, loose, almost sessile clusters on the branches; the female more numerous than the male. Male: Perianth 4-partite, lobes concave, imbricate in bud; stamens 4; anthers reniform. Female: Perianth 4-partite, segments unequal, flat. Stigma subsessile, penicillate. Fruit compressed and embraced by the persistent perianth.

Specimens collected by me differ from the normal description in being unbranched. This is probably due to the dry and unfavourable conditions in which the plants were growing.

In FLORA OF BRITISH INDIA 5:548, 1888, J. D. Hooker has described 3 species of *Urtica*. All are perennial and occur on hills above 1,500 m. Out of these *U. dioica* Linn. is dioecious. *U. parviflora* Roxb. is a much taller plant, 90-150 cm in height with larger 5-10 cm \times 2.5-6 cm leaves. Moreover, flower clusters are on the branches of loosely spreading panicles. The third species, *U. hyperborea* Jacq. is much likely to be confused with *U. urens* Linn. due to the similar size of the branches and leaves, and short crowded cymes. But the former is an alpine plant reported from Tibet occurring at the altitude of 4 to 5000 m and can be easily separated from the latter by its low, tufted branches woody below and pubescent between the stinging hairs, and subsessile leaves which are glandular-puberulous beneath.

Common Name: Small stinging Nettle (Britain).

DISTRIBUTION: Europe, N. Africa; Siberia, W. Asia. Introduced in N. America. The plant is a native of Britain.

Flowers and Fruits: March-April.

ACKNOWLEDGEMENTS

I am grateful to Prof. S. S. Bir for providing facilities. Thanks are also due to U.G.C. for providing travel grant to visit Calcutta and to Deputy Director, Central National Herbarium, Howrah for providing herbarium facilities.

DEPARTMENT OF BOTANY,
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PATIALA, (PUNJAB),
August 7, 1973.

M. SHARMA

41. SOME NOTEWORTHY PLANT SPECIES FROM GORAKHPUR

During our study of the flora of Gorakhpur district, we came across a number of species which are new to the area. Of these, the following ten species are new records for the flora of Upper Gangetic Plain.

Cleome rutidosperma DC. Prodr. 1 : 241, 1824 :

= *C. ciliata* Schum. & Thonn. Dansk. Vidensk. Selsk. Skr. Nat. Mat. Afh. 4:68, 1829, ex Char.

Crotalaria pusilla Heyne ex Roth, Nov. Sp. Pl.: 335, 1821; Fl. Brit. India 2 : 70; Bot. Bihar & Orissa: 231.

Dentella serpyllifolia Wall. ex Airy shaw in Kew Bull.: 289, 1932.

= *D. repens* (Linn.) Forst. in Fl. Brit. India 3:42, 1880, pro parte.

Dysophylla stellata Benth. in Wall. Pl. As. Rar. 1:30, 1829; Fl. Brit. India 4:640; Cook, Fl. Bombay 2:540.

Hypis suaveolens (Linn.) Poit. in Ann. Mus. Par. 7:472, t. 29. f. 2, 1806; Fl. Brit. India 4:630; Bot. Bihar & Orissa 4:736.

= *Ballota suaveolens* Linn. Syst.: 1100, 1759.

Bulbostylis capillaris (Linn.) Clarke in Fl. Brit. India. 6:652; Bot. Bihar & Orissa 5:924.

= *Scirpus capillaris* Linn. Mant.: 312, 1771.

Cyperus cyperoides (Linn.) Kuntze, Rev. Gen. Pl. 3 (2): 333, 1898.

= *Scirpus cyperoides* Linn. Mant.: 181, 1771.

= *Mariscus sieberianus* Nees ex Clarke in Fl. Brit. India 6:622, 1893; Bot. Bihar & Orissa 5:909.

Cyperus thomsoni Boeck. in Linnaea 46:295, 1870; Fl. Brit. India 6:608; Bot. Bihar and Orissa 5:899.

Eleocharis congesta D. Don, Prodr. Fl. Nep.: 41, 1825; Fl. Brit. India 6:630; Bot. Bihar and Orissa 5:913.

Rhynchospora hookeri Boeck. in Linnaea 37: 621, 1873; Fl. Brit. India 6:671; Bot. Bihar and Orissa 5:930.

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M. O. SIDDIQUI

DEPT. OF BOTANY,
UNIVERSITY OF GORAKHPUR,
U.P.,
August 26, 1970.

S. N. DIXIT

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UNIVERSITY OF MICHIGAN
ZOOLOGICAL MUSEUM

- C. muscicola** Kuetz. ex Born. et Flah.
In Nave lake (9.5), Bhandara (19-1-69).
- C. stagnale** (Kuetz.) Born. et Flah.
In Vadali lake, Amravati (3-3-65).
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Anabaena fuellebornii** Schmidle
In Sarkari lake (7.2), Tumsar (23-12-68).
- A. inequalis** (Kuetz.) Born. et Flah.
In a pond, Umred (30-11-64).
- A. orientalis** Dixit
In Sarkari lake (7.2), Tumsar (22-12-68).
- A. sphaerica** Born. et Flah.
Planktonic in a puddle, Mehkar (20-10-68).
- A. volzii** Lemm.
In paddy fields, Amravati (13-10-64). In a small pond, Wardha (27-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
- Nodularia spumigena** Mertens
In a lake (11), Lonar (24-10-68).
- Nostoc microscopicum** Carm. ex Born. et Flah.
In Nursery pond (8), Bhandara (28-12-68).
Spores not observed.
- N. paludosum** Kuetz. ex Born. et Flah.
In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68).
- N. rivulare** Kuetz. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).
- Aulosira fertilissima** Ghose v. *tenuis* C. B. Rao
In Vadali lake and in paddy fields, Amravati (18-10-64). In Kapsi lake (8.2), Akola (16-10-68).
- A. implexa** Born. et Flah. v. *crassa* Dixit
In Vadali lake, Amravati (18-10-64). In a streamlet, Warora (30-10-65). In a pool, Chandrapur (1-11-65).
- Camptylonemopsis pulneyensis** Desik.
In Sarkari lake (7.2), Tumsar (22-12-68).
Filaments up to 16 μ broad; spores are cylindric, 12-14 μ broad, 16-20 μ long, with smooth walls.
- Scytonema chiasmum** Geitler
In paddy fields, Amravati (18-10-64).
- S. cookei** W. et G. S. West
On moist soil, Amravati (18-10-64).
- S. simplex** Bharadw.
In Ramsagar lake (7.2), Tiroda (2-2-69).
- Forticia bossei** (Fremy) Desik.
In a streamlet, Amravati (18-10-64; 20-11-68).
Spores broader up to 6.5 μ broad, the shape of the spores also different being always rectangular, and not rounded at the angles.
- Calothrix clavatooides** Ghose
Epiphytic on *Hydrilla* leaves in a cement cistern, Akola (6-3-69).
- C. epiphytica** West et West
In Sarkari lake (7.2), Tumsar (22-12-68).
- C. karnatakensis** Gonz. et Kam. v. *major* Gonz. et Kam.
Epiphytic on aquatic plants in Vadali lake, Amravati (3-3-65).
- C. marchica** Lemm.
In Abkari lake (7.5), Bhandara (29-12-68).
- C. wembaerensis** Hieron et Schmidle
In Sarkari lake (7.5), Tumsar (22-12-68).
- Dichothrix orsiniana** (Kuetz.) Born. et Flah.
On dripping rocks, Amravati (18-10-64).
- Gloeotrichia intermedia** (Lemm.) Geitler v. *kanwanensis* C. B. Rao
In Ramala lake, Chandrapur (1-11-64). In Abkari lake (7.5), Bhandara (29-12-68).
- G. natans** Rabenh. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).
Cells and heterocysts are slightly broader.
- G. pilgeri** Schmidle
Epiphytic on aquatic plants in ponds, Umred (30-11-64), Vadali lake, Amravati (18-10-64), Mansar (13-12-64), Nave lake (9.5), Bhandara (19-1-69).