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The Non-violent Scientific Study of Birds

BY

J. B. S. HALDANE

(*Based on a lecture given in Bombay on 17 January 1959*)

I am very ignorant about birds, largely because I am unmusical and most British birds are small and inconspicuous, so that their songs and call-notes are more distinctive than their colours or shapes.

In the nineteenth century it was hard to study birds without killing them. The first job of an ornithologist is to identify species; and in order to be sure that we have, for example, three and only three species of kingfisher in the suburbs of Calcutta it is necessary to kill a number, and find that all can be assigned to one of these species. This phase is now fortunately nearly over. One can learn to assign a bird to its correct species without killing it.

What is the next step? It is, I think, to find the distribution of species and subspecies in India at different times of the year, and also their local habitats, names, and so on. Here Ogniev's great Zoology of the U.S.S.R. could be a model. Ultimately we should look forward to a time when there will be an ornithologist for every hundred or so square miles of India capable of enumerating the local species, and a central organization such as the Bombay Natural History Society to make maps showing the distribution of each species in India. As, however, this would require ten thousand or so ornithologists it is not immediately possible. But a start can be made.

The next question to be asked is, perhaps, how many birds of one or more species there are in a given area. At first sight this is a very difficult question, as birds are so mobile. But as eggs they are

extremely immobile. I hope that, if we develop statistical biology at the Indian Statistical Institute, we may make the attempt to enumerate all the nests of some conspicuous species, such as vultures, night herons, and cattle egrets, in an area of ten square miles or so. When this has been done for thirty or so representative areas in India we shall be in a position to estimate, no doubt very roughly, the total population of these species in India.

The total numbers of breeding adults of a few local species are roughly known (see Fisher and Lockley 1954). Thus for the gannet, *Sula bassana*, the number of nests in the East Atlantic area (Britain, etc.) was about 70,000 in 1939 and had risen to 82,000 in 1949. In the West Atlantic (Newfoundland, etc.) it was about 13,000 in 1939. Thus at present there are about two lakhs of mated birds, and perhaps as many juveniles. They live on a small number of precipitous rocks, mostly on small islands. There are fifteen 'cities' of 17,000 to 1200 nests, and fourteen 'villages' of 500 nests or fewer. These numbers are fairly accurately known. James Fisher had counted thousands of nests on cliffs from small boats. He was able to induce the British Naval Air Force (Fleet Air Arm) to photograph many of these sites as part of their training. The exact numbers of nests could be counted at leisure from the photographs, and the results compared with those obtained by cheaper methods. Few of the latter were incorrect by ten per cent.

This 'urbanization' is characteristic of sea birds, and is carried to greater lengths in more numerous species. The extreme example is furnished by *Uria lomvia*, Brünnich's Guillemot, of which there appear to be four or five million on the coasts of Greenland, about half of which breed on a single rock Agpar-s-suit. This is one extreme of bird behaviour. Most small song birds keep a "territory" round their nests private by singing and quarrelling with intruders, even if they are more sociable when not breeding, while others, such as the Indian weaver bird, live in 'villages' of a few tens or hundreds of nests.

Is there any possibility of counting all the breeding members of an Indian bird species? I suggest that the most hopeful targets are the large flamingo *Phoenicopterus antiquorum*, and the smaller species *Phoeniconaias minor*. The former breeds in the Great Rann of Kutch and the latter possibly in the Little Rann. The Lesser Flamingo, which lives on unicellular algae, is not apparently found in many other localities except Sambhar Lake in Rajasthan. The Rann of Kutch is unsuitable for walking but, owing to the absence of trees, it should be possible to photograph nesting birds from

the air. This can of course only be done by the Indian Air Force. In peace time the armed forces have to carry out exercises of various kinds. Their efficiency can be better gauged from their performance against natural forces, for example the rapid replacement of bridges destroyed by floods, or the landing on a difficult coast, than by their prowess against 'enemies' who they know will not hurt them. Hence such co-operation would, I believe, increase the efficiency of our Air Force.

So much for mere populations or densities per square mile. But how do these increase or decrease? Observations on a few hundred or even a few dozen nests of any species will tell us the average number of eggs laid per year. More careful, but not very arduous, watching will tell us how many young birds per nest survive to start flight. On the whole tropical birds produce fewer eggs in a clutch than birds of the same species or a closely related species in a temperate climate. This is at least partly due to the shorter tropical days, which do not give the parents time to feed a large brood. Most of the comparisons have been made by Moreau with African birds, but Lack (1950) points out that in India *Parus major* (the Great Tit) has an average clutch of 3 compared with 10 in England. This difference must be compensated in one of two ways. Either the average number of clutches in India must be greater or the mortality less. There must be a balance because if, for example, the numbers in an area increased by only 10% per year for a century, the density would increase 13,781 times. This can of course happen when a new species occupies a country, but not with established species. In only one case has this balance been directly demonstrated by comparison of statistics. In Switzerland the Starling (*Sturnus vulgaris*, a bird very similar to the myna) lays more eggs than in England, but dies younger. It will be easy to get data on numbers of broods in India, not so easy to get data on mortality. Before I speak about mortality, let me say a few words on the feeding of young.

What do they get to eat? One can of course kill parents and examine their crop contents. Apart from ethical considerations this means that one can only get one piece of information from a bird. Several other methods are available. Lack found that if he caught parent swifts (*Apus apus*) they might desert their young. So he waited until a parent bird fed a baby and departed, and then pressed the baby's throat, getting a pellet containing about 600 insects entangled in the parent's sticky saliva. They were largely flying aphids, so swifts eat insects which compete with men for food plants, and what

is more, eat them while they are moving to new food plants and invulnerable to sprays and other insecticides. Thus swifts seem to be wholly favourable to agriculture, whereas some other bird species live largely on seeds and lower agricultural output, while other insect eating birds eat some insects, such as bees, which assist in the pollination of plants and thus help human horticulture and even agriculture. We should certainly encourage the birds which are helpful to man, even if we do not massacre the others. A second non-violent method has been used in the Soviet Union. The nestlings are replaced by models which, when a watcher pulls a string, open mouths and may emit a suitable noise. The food falls into a bag, and I hope is given to its legitimate owners after the insects, molluscs, seeds, and so on, have been assigned to their correct species.

Do young birds get enough to eat? Lack (1954) found that when the brood size was less than the average, the number of young starlings surviving for a few months was roughly proportional to the brood size. However this was not so when the brood size exceeded the average. Even if the excess young survived to fly, they did not survive much longer. Presumably their parents could give them enough food to fledge, but not enough to get an adequate start in life. The technique consists of ringing nestlings. But of 15,000 starlings ringed in this research, only 346 or 2.3% were recovered, that is to say found dead and the rings returned.

The ringing technique was invented by Mortensen in Denmark to study migration. As you know, several ducks ringed in India have been picked up in Siberia and vice versa, and one German-ringed stork in India. Ringing birds does not harm them. One ringed robin (*Erithacus rubecula*) in Eire lived for eleven years, though nearly two-thirds of all robins die each year, so only about one robin per lakh is expected to live so long. It is a fortunate and peculiar fact that birds' legs are fully grown before they start flying. A metal or plastic ring can therefore be put on a nestling and remain on its leg for life. The rings usually carry a request to send them to a certain address if found. There may be a small reward. In Western Europe population density and literacy are both so high that as many as 15% of the rings on large birds are returned. We cannot yet hope for such good results in India. But we may reach them when our children are educated.

Table I gives data on *Vanellus vanellus*, the lapwing, a British crested bird of about the size of the hoopoe, and which our great British naturalist William Turner thought to be a hoopoe four hundred years ago, since ancient authors of about two thousand years ago had

described only one crested bird of this size. Then he went to Central Europe and saw a hoopoe, which agreed very well with the Latin description. He realised that there were birds in Britain of which the ancients knew nothing, and started to describe them. That was the beginning of scientific ornithology in Britain.

Each ring is recorded on a card in an office at the British Museum of Natural History in London, and I analysed all the cards recording rings put on nestling birds before the year 1940 (Haldane 1955). I made the table in 1954, so, as one bird had lived for fourteen years, if I had included birds ringed, say, in 1950, many would still have been alive. Following a method due to Lack, I omitted all birds picked up in the same year when they were ringed. Their number is large, but it is misleading because a man who has taken the trouble to ring fifty little lapwings will probably notice dead ones in his neighbourhood, and hence the apparent mortality in the first eight months will be too high (Table I). The first column is the year of the bird's life in which it was

TABLE I

x	d_x	xd_x	$\Sigma(d_x)$	Δ	x^2
1	2	3	4	5	6
1	194	194	206.38	−12.38	0.74
2	145	290	136.21	+ 8.79	0.57
3	90	270	89.90	+ 0.10	0.00
4	54	216	59.33	− 5.33	0.48
5	48	240	39.16	+ 8.84	2.00
6	25	150	25.85	− 0.85	0.03
7	24	168	17.06	+ 6.94	2.82
8	9	72	11.25	− 2.25	0.45
9	6	54	7.43	− 1.43	0.28
10	5	50	4.90	+ 0.10	0.00
11	5	55			
12	7 { 1	12			
13	0	0	9.53	− 2.53	0.67
14	1	14			
	607	1785	607.00	0.00	8.04

picked up. Thus if a bird was ringed in 1930 and found dead in 1931 we say that its age $x=1$. d_x is the number of birds found dead in the xth year of their life. For example 54 rings were from birds dying in their fourth year (e.g. birds ringed in 1940 and picked up in 1944). The third column is the product of the first two. Now suppose that in each year a constant fraction m of all birds dies, we

is more, eat them while they are moving to new food plants and invulnerable to sprays and other insecticides. Thus swifts seem to be wholly favourable to agriculture, whereas some other bird species live largely on seeds and lower agricultural output, while other insect eating birds eat some insects, such as bees, which assist in the pollination of plants and thus help human horticulture and even agriculture. We should certainly encourage the birds which are helpful to man, even if we do not massacre the others. A second non-violent method has been used in the Soviet Union. The nestlings are replaced by models which, when a watcher pulls a string, open mouths and may emit a suitable noise. The food falls into a bag, and I hope is given to its legitimate owners after the insects, molluscs, seeds, and so on, have been assigned to their correct species.

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find that 607/1785 (the ratio of the totals of columns 2 and 3) gives us an estimate of m, namely .340 or 34.0%. Now this seems a very simple theory, too simple to be true, for we know that in human beings a bigger fraction die in their sixtieth year than their sixth, in other words m is not constant. If m is constant we expect that 607 m, or 206.38, birds died in their first year, leaving 400.62, and 400.62 m, or 136.21, died in their second year. In this way the expectations in column 4 were calculated. Column 5 gives the differences of columns 3 and 4. If m increased with age, as in man, the values would at first be positive, and later negative. We can make a further test. Dividing Δ^2 by $\Sigma(d_x)$ we get the last column. If m is constant we should expect the total to be 9; it is rather less. There is no reason to doubt the constancy of the mortality. In other words all birds after their first year died of accident. There is no evidence that any small bird dies of old age in nature, for other species have yielded similar results. I dealt in a similar way with the figures for 120 birds ringed from 1940 to 1951. The mathematics are much more complicated, and give m=.372, which is close enough to the former value to give me some confidence in my calculations. The annual mortalities range from about two-thirds for very small song birds to about a tenth or less for large sea birds. But in some ways the results obtained about migration are even more interesting. Dr. Sálim Ali tells me that systematic work is at last being started to map out migration routes between India and Siberia.

How do bird populations change? This could be studied in India as easily as anywhere else. When a species is introduced into a new habitat it may increase very quickly. Figure 1 shows the rate of increase of *Phasianus colchicus* on an island off the American coast. Four pairs were introduced. The biennial census shows the effect of juvenile mortality. The population increased from two to four times annually, and showed some signs of stabilizing, until a very formidable predator, the American soldier, was introduced, and further observations were useless. But the population had increased from 8 to 1325 in five years. Figure 2 of *Parus major* in a British wood is more typical. The increase was due to the installation of nesting boxes. The population increased violently each spring and fell back in autumn. Some birds left the wood each winter, and they or others returned before the nesting season. Similar observations could be made in India, even on the same species.

If there are enough ornithologists in India ten years hence we shall be able to begin observations like those recorded in Fig. 3, which gives the population of herons (*Ardea cinerea*) at a number of

English nesting sites. A very cold winter, such as that of 1947, reduced the number of birds, probably because a great deal of water was frozen. But they regained their original density in two years or so, and showed no tendency to increase indefinitely. If we knew how

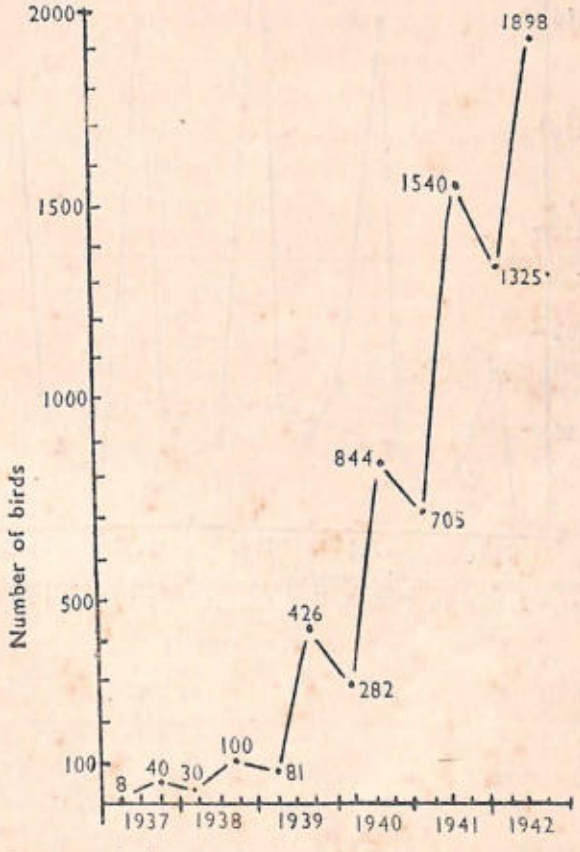

Fig. 1. Increase of pheasants (*Phasianus colchicus*) on Protection Island, Washington, U.S.A. After Einarsen and Lack (1954).

they achieved this stability we human beings might take some hints from them. It seems likely that marriage is postponed where there is a shortage of nesting sites. Other bird populations, especially in northern regions, show cyclical fluctuations with a period of about ten years, but the figures are not very satisfactory.

Such investigations take some time; Dr Sálim Ali may wish me to suggest topics which would give results in a year or two, and thus secure a M.Sc. Bird behaviour offers many such possibilities. One of our English song birds, the thrush (*Turdus ericetorum*), leaves a record of its predations, as it breaks snail shells on stones or tree stumps before giving their contents to its young. Table II is a record

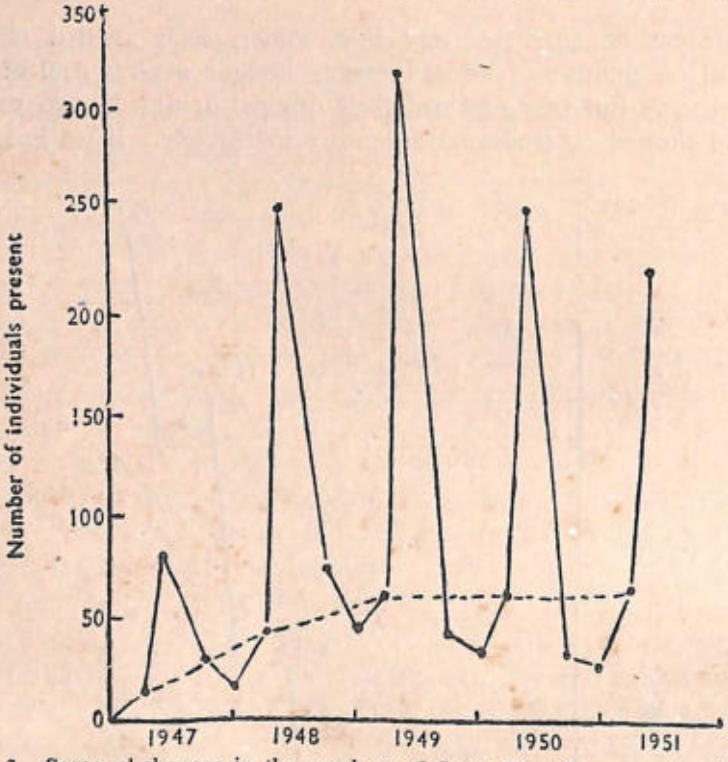

Fig. 2. Seasonal changes in the numbers of Great Tits (*Parus major*) in a 63 acre wood near Oxford, England. After Gibb and Lack (1954).

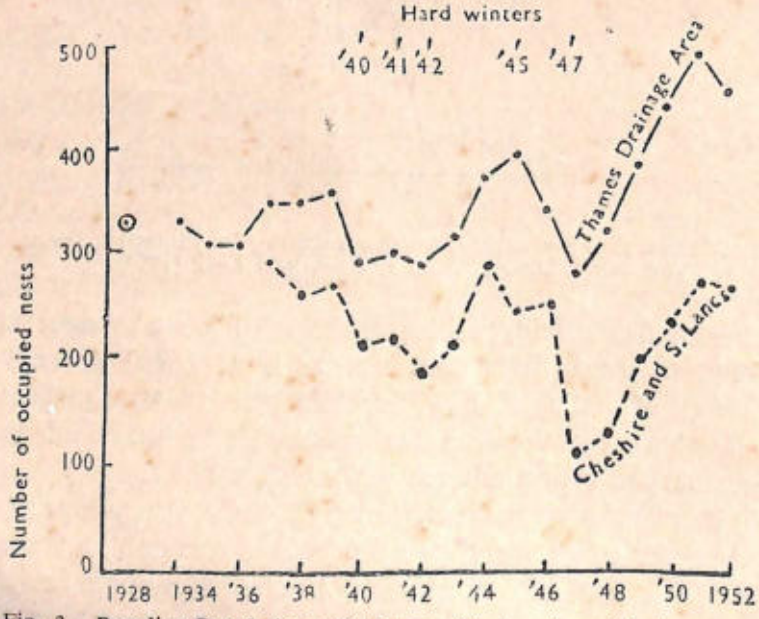

Fig. 3. Breeding Populations of Herons (*Ardea cinerea*) in two areas of England. After Lack (1954).
The 'hard' winters are those in which water was frozen for long periods, rendering fishing difficult.

of its behaviour. The snail species *Cepea nemoralis* has several colour forms, which can be classified as yellow and not yellow, the former being recessive. On a brown background of dead leaves the yellow snails are conspicuous to the human eye, while they are less conspicuous among green leaves. They are also commoner on green backgrounds such as grass which does not dry up in summer, than on

TABLE II

Snails *Cepea nemoralis*, collected by men and killed by thrushes in Marley Wood, near Oxford

Data of P. Sheppard

Date	Yellow	Not Yellow	% Yellow	..
14. 4. 50	80	250	24·2	Human collections
26. 5. 50	57	147	27·9	
6 to 11. 4. 50	3	4	43	Killed by *Turdus ericetorum*
-23. 4. 50	7	10	41	
-30. 4. 50	11	21	34	
- 7. 5. 50	9	25	26	
-19. 5. 50	3	16	16	
-22. 5. 50	1	6	14	
-26. 5. 50	2	12	14	
6. 4. 50 to 26. 5. 50	36	94	27.7	Total bird-killed

brown ones such as the floor of beech woods. Sheppard (1951) made counts of snails killed by thrushes during the breeding season of 1950 in a wood where there were few green leaves in early April, and many in late May. We see that the thrushes collected more of the snails which were conspicuous to the human eye at the times in question. But their overall bag favoured neither type of snail, so it looks as if they were responsible for keeping the observed proportion of yellow snails. This is an example of Natural Selection in action. Similarly Kettlewell (1956) has shown how birds act as agents of natural selection in transforming the colour of the moth *Biston betularia*. I have little doubt that similar studies of choice by birds in nature could be made in India. My colleague Sri K. R. Dronamraju is now making one at Calcutta, but in his case the choosers are butterflies, not birds.

Here is another example of bird behaviour which could and should be studied statistically. Moreau, Purchon, and others, in a series of

papers in the *Proceedings of the Zoological Society of London*, have studied the visits of birds, both in Africa and Europe, to their nests when brooding eggs and feeding their young. Unfortunately they never give all the figures needed for a complete statistical analysis. It is however clear that in several species the time spent on the nest per day rose during incubation, and then fell again as the young demanded more and more food but less and less warmth. The durations of absences were less variable than those of stays on the nest. This can be interpreted as meaning that the parent bird has a strong urge to return after five minutes or so, even if it has found little food, and no strong urge to leave the nest after a standard time. However, it would be most valuable to collect such data in such a way that they could be given adequate statistical treatment. This would mean observation throughout the hours of daylight during a nesting period, which would require the co-operation of at least two men. Moreau however was very satisfied by the performances of illiterate African assistants, and I have no doubt that equally reliable Indians are available. If the data are complete, the Indian Statistical Institute can analyse them.

I am not musical, and cannot detect slight difference in bird songs and calls. Their full investigation demands the rather expensive apparatus used by Thorpe (1955). But this is not essential. Marler (1952) wandered about Britain with no apparatus beyond two ears and a note-book, and found differences in the song of the same species, *Fringilla coelebs*, in five different areas. He also studied it in the Azores islands, while Promptoff had previously done so in two areas of the Soviet Union. The differences were quite marked. The most complicated song, on an average, was sung in Scotland. But the birds of the Thames Valley were more variable, and included the finest songsters. In the Azores where there is no other species with a similar song, and therefore no biological need for a species-specific song, the performance was much simpler and cruder. Similar work could and should be done in India. Are there, for example, Marathi and Gujarati songs in the same bird species?!

From a cursory reading of Tinbergen's (1951) work you might think that birds respond to very crude stimuli. Like men they sometimes do so, but not always. Migratory birds have definite routes which generally avoid long ocean and desert crossings, and often follow coast lines and large rivers. In Scandinavia and Germany most small song birds which winter in tropical Africa follow the Atlantic coast. But *Sylvia curruca*, the Lesser Whitethroat, flies southeast from Germany to Turkey, and then south along the Nile

Valley. They mainly fly at night, and birds in their first year can find the way. How do they 'know' it? I end up by introducing you to one of the most amazing stories in the whole of biology, a story which I hope, but am not certain, is true, though I have the greatest respect for its author. But scientists are human, and even the greatest of them make mistakes. Sauer hatched birds in the laboratory and kept them in cages where they never saw the sky. They became restless at night for two or three weeks at the normal migration times in autumn and spring. If they can see even a part of the sky, they attempt to fly approximately southeast.

Now comes Sauer's (1958) amazing discovery. The birds responded perfectly well in a planetarium, that is to say a dome in which the stars are represented by points of light. Now in such a planetarium we can alter the apparent position of the stars in two ways. We can alter them as they would alter at the same place during one night. For example in Germany in late October Rohini (Aldebaran) was well up in the sky when the stars were first seen after sunset, while Kalpurush (Orion) was just rising. If the planetarium was arranged to show the stars in this position the birds tried to fly southeastwards, as they should. Now the planetarium was altered so that Kalpurush was high in the sky, and Sinha (Leo) rising, in fact the stars as they would be seen about 11 p.m. The birds tried to fly westwards. Now at that moment they would have seen the stars in those positions if they had been near lake Balkhash in Kazakhstan, and their best way to western Turkey would have been to fly west. At intermediate star positions they flew southwest and south. The pole of the planetarium can also be shifted so that the stars appear as they would from another latitude. Sauer changed the apparent position of the stars to that which would be seen at the same time in Egypt. Achernar was shown in the south, the Saptarshi (Ursa Major) were below the northern horizon. The birds flew south, as they would have done in Egypt.

Of course I have over-simplified Sauer's account. Perhaps Matthews's results on solar navigation are equally remarkable, though they are still not universally accepted. But it does appear that some birds have, if not an innate knowledge of astronomy, at least an innate capacity for responding to certain star patterns. Presumably some kind of pattern develops in their brain which corresponds to that of the stars, as of course feather patterns develop on their skins. Probably Matthews's work will be easier to repeat in India, but somehow Sauer's seems to me more exciting, if only because it suggests that birds may have knowledge which has not come to them through their senses. And if birds, why not man?

I must apologize to Dr Sálim Ali for the numerous inaccuracies which I am sure have crept into this lecture. But this is inevitable if I am lured into speaking on a subject to which I have made no serious contributions. I close with the hope that in his old age he may be able to introduce scientific ornithology, to which he has made such notable contributions, into the curriculum of our universities.

REFERENCES

Fisher, J. & Lockley, R. M. (1954): Sea-birds. London, Collins.

Haldane, J. B. S. (1955): The calculation of mortality rates from ringing data. Acta XI. Congr. Int. Orn. Basel.

Kettlewell, H. B. D. (1956): Further selection experiments on industrial melanism in the Lepidoptera. *Heredity* **10**: 287-303.

Lack, D. (1950): Family size in titmice of the genus *Parus*. *Evolution* **4**: 279-290.

——— (1954): The natural regulation of animal numbers. Oxford, Clarendon Press.

Marler, P. (1952): Variation in the song of the Chaffinch (*Fringilla coelebs*). *Ibis* **94**: 458-472.

Sauer, E. G. F. (1958): Celestial navigation by birds. *Scientific American* **199**: 42-47.

Sheppard, P. M. (1951): Fluctuations in the selective value of certain phenotypes in the polymorphic land snail *Cepaea nemoralis* L. *Heredity* **5**: 125-134.

Tinbergen, N. (1951): The study of instinct. Oxford, Clarendon Press.

Thorpe, W. H. (1955): Comments on 'The bird fancyer's delight', together with notes on imitation in the sub-song of the Chaffinch. *Ibis* **97**: 247-251.

The Vegetation of Kodaikanal Grassy Slopes

BY

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INTRODUCTION

Kodaikanal, on the Palni Hills of south India, is situated at an altitude of 6000-7000 ft. Its flora is very rich, as can be made out from the many references in Gamble's FLORA OF THE PRESIDENCY OF MADRAS, and particularly from Fyson's THE FLORA OF THE SOUTH INDIAN HILL STATIONS. Throughout the preparation of this paper, I have made constant use of these two books; but the paper is mainly based on the data that I have collected personally in the field, paying particular attention to the precise dates of flowering and fruiting, the exact distribution, and relative abundance of the various plants studied.

This study is restricted to the angiospermic vegetation of the grassy slopes about Kodaikanal. One full year has been spent in an intense examination of the various species occurring on such slopes and on the phenology of the same.

In the enumeration that follows, lengthy descriptions have been omitted on purpose; interested readers are referred to the standard works just mentioned. The notes given for each plant are meant to bring out the more important features of the same. In this paper the two terms *abundance* and *distribution* are not considered synonymous; a plant is said to be abundant when large numbers of the same occur at a particular spot; on the other hand, a plant is said to be widely distributed when, without regard to the large or small number of specimens, the plant is found to occur in many spots or places within the given area. Such data I consider of importance, particularly when it is a question of plants that may have some economic importance, medicinal or otherwise; this detailed information may materially reduce expenses, should it become necessary at any later time to collect the plant for commercial exploitation.

In this paper 154 species belonging to 114 genera and 47 Families are mentioned. The order of the Families is the same as in Gamble's FLORA; however, a few Families have been split into more uniform

groups following Hutchinson's FAMILIES OF FLOWERING PLANTS. Within the Family both genera and species are given in alphabetical order. The common English names, occasionally mentioned in my list, are mostly taken from Fyson's book.

METHODS OF STUDY

Three plots of land on open grassy slopes were selected for intensive study from March 1956. The plots were all in the neighbourhood of Shembaganur, just below Kodaikanal, at an altitude of about 6000 ft. I identified all the plants in these plots as they appeared, and in my fortnightly visits took careful notes of their phenology. The study was not restricted to these three relatively small plots; comparison was constantly made with other parts of the same hilly slopes, particularly to find out the distribution of the plants and their size and to note differences in their flowering and fruiting seasons, especially as affected by altitude.

SOIL AND CLIMATE

As regards soil, the plateau is made up of a special kind of gneiss, called charnockite, consisting of blue-coloured quartz, felspar, and mica in varying proportions. The soil is mostly yellow composed of bauxite, hematite, magnetite, and aluminous sediments. This soil is almost entirely covered by a layer, 25-60 cm. thick, of compact, water-holding, black mud.

Though Kodaikanal lies within the monsoon zone, its climate is greatly modified by altitude. Among the hill stations of India, Kodaikanal is said to have the lowest maximum temperature in summer and the highest minimum in winter, as may be seen from the following table, which records the monthly average maximum and minimum temperatures in °C. for Shembaganur for the years 1953-1957.

TABLE I

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Max.	17.4	19.8	21.3	22.5	21.9	20.6	19.4	19.2	19.4	19.2	18.4	17.3
Min.	10.2	11.8	13.5	14.5	16.2	15.1	13.9	14.1	13.6	13.7	11.9	10.7

As regards climate, Kodaikanal has four fairly clearly defined seasons: (1) *The Dry Season*, January to March, during which rain is rare and the sun hot, and in consequence tender annuals are often severely damaged. (2) *The Hot Season*, April and May, during which showers are frequent, and annuals thrive. (3) *The South-West Monsoon Season*, June to September: many plants come into bloom, conditions are ideal for most plants; the rainfall is somewhat erratic due to the fact that Kodaikanal lies within the rainshadow region of the Cardamom Hills of Kerala. (4) *The North-East Monsoon Season*, October to December: showers are more regular and frequent than during the rest of the year.

The annual average rainfall of about 185 cm. is more or less distributed throughout the year, and this keeps the vegetation of Kodaikanal fresh without the drastic monsoon and dry season fluctuations that are so striking for most parts of peninsular India. The following table gives the average monthly rainfall in cm. for Shembaganur for the years 1953-1957.

TABLE 2

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
7.25	2.87	8.00	27.15	10.87	10.37	12.72	14.00	18.22	36.1	22.9	12.9	183.35

ENUMERATION OF SPECIES

BERBERIDACEAE

1. **Berberis tinctoria** Lesch. The Common Nilgiri Barberry

An evergreen thorny shrub, about 90 cm. high. The stem is hard, and bright yellow inside. Inflorescence many-flowered; flowers bright yellow. Flowering February-March. Fruits ripe by May: at first green, then red, finally dark blue.

Fairly common on slopes, though never abundant.

VIOLACEAE

2. **Viola patrinii** DC. The Spear-leafed Violet

A perennial herb with a thick rootstock, without runners. Leaves radical, lanceolate; petioles long, winged, sheathing at the base. Flowers solitary, white. The first showers in March bring out an

abundance of flowers; stray ones may be seen almost throughout the year. Capsules common by June, oblong, splitting into 3 boat-shaped valves.

Common and abundant, though not easily noticed, being hidden by grasses.

3. **Viola serpens** Wall. The Common Wood Violet

A perennial, creeping, uniformly pubescent herb. Leaves ovate, on slender petioles 6-8 cm. long. Flowers solitary, 1-2 cm. across, pale blue to white, abundant during May-June; stray ones throughout the year. Capsules globose.

Strictly this is not a plant of open grasslands, but of the 'sholas', where the plant is abundant.

POLYGALACEAE

4. **Polygala bolbothrix** Dunn.

A small, densely pubescent, spreading herb. Leaves alternate, lanceolate-acuminate. Inflorescence few-flowered; flowers drooping, pink. Flowering probably throughout the year.

Abundant in one of the three areas under study, but restricted in distribution. It is more common at lower elevations. Not mentioned by Fyson.

5. **Polygala persicariaefolia** DC.

A thin, scarcely branched herb, 25 cm. high. Leaves narrow-elliptic to linear, 3-4×0.4-0.5 cm. Racemes up to 6 cm. long, mostly lateral. Flowers 6-12 on each raceme, rose-coloured, available from September to January with a peak in October-November; in places not exposed to strong sun, flowers may be had even in March-April. Fruit an oval capsule.

Abundant locally on grass slopes, but not widely distributed; more robust specimens occur at lower elevations. Not mentioned by Fyson.

6. **Polygala rosmarinifolia** Wt. & Arn. The Rosemary Milkwort

An erect, scarcely branched annual, 25-30 cm. high. Leaves linear, 2-3×0.5 cm. Racemes few-flowered, short. Flowers greenish, throughout the year, but abundant from June to August. Pod elliptic; seeds two, black, covered with short white hairs and capped by a conspicuous aril.

Abundant and common. More robust specimens occur at lower elevations.

7. **Polygala sibirica** L. The Common Milkwort

A small herb from a woody, perennial stalk. Branches many, spreading. Racemes short, from the axils of the upper leaves. Flowers purple, seen throughout the year. Capsule winged.

Common along cattle tracks or among low vegetation; this seems to be the lower limit of the distribution of this plant.

HYPERICACEAE

8. **Hypericum japonicum** Thunb. The Marsh St. John's Wort

A slender, erect herb, often tufted, up to 10 cm. high, growing in marsh. Leaves sessile, ovate, entire, more or less reddish brown. Flowers terminal, yellow. Flowering February-October. Fruit a capsule, red; common from November to January.

Abundant in marshy places, rare elsewhere.

9. **Hypericum mysorense** Heyne The Common St. John's Wort

A rough shrub, 90 cm. or more high. Young branches 4-angled; leaves conspicuously decussate. Flowers large, showy, bright yellow, terminal. Flowering October-May, abundant in March-April. Fruit oval, surmounted by 5 persistent styles.

Abundant and common on slopes. During the flowering season, this plant is one of the most conspicuous species on these hill slopes.

10. **Hypericum wightianum** Wall.

A slender herb about 15 cm. high. Stems terete, branches spreading. Leaves ovate, 1.5×0.5 cm., often reddish brown.

Flowering etc. as for *H. japonicum* Thunb.

TILIACEAE

11. **Triumfetta pilosa** Roth.

A perennial undershrub 60-90 cm. high, uniformly hirsute. Lower leaves 3-lobed, upper ones ovate-acuminate, 10×4 cm., coarsely serrate. Inflorescence of 3-10-flowered axillary cymes. Flowers yellow. Flowering September-November. Capsules covered with long, soft spines; common in December-January.

Abundant, often gregarious, along roadsides, in waste land, etc., but not common.

LINACEAE

12. **Linum mysorense** Heyne

A slender, erect annual, 20-40 cm. high. Branches corymbose; leaves sessile, linear. Flowers terminal, yellow, solitary or in racemes

of 3-5. Flowering November-January; in shaded spots flowers may be seen till March-April. Capsules globose.

Abundant in places, but not common.

GERANIACEAE

13. **Biophytum intermedium** Wt.

A small herb, often less than 8.cm. high, with a woody rootstock. Stems unbranched. Leaves 4-5 cm. long, paripinnate; leaflets 10-15 pairs, slightly sensitive. Flowers yellow, small, 5-6 on a peduncle. Fruit an ovoid capsule enclosed in the persistent sepals.

Abundant locally but not common; in crevices of rocks, walls, etc. Flowering more or less throughout the year, but scarce in the cold months.

BALSAMINACEAE

14. **Impatiens goughii** Wt. Gough's Water Balsam

A slender, much-branched annual, 10-25 cm. high. Stems fleshy, reddish. Leaves ovate, opposite, exstipulate; petioles 2-4 cm. long. Flowers pink, corymbose, each on a slender or filiform pedicel 1-1.5 cm. long; usually 3-6 pedicels supported on a peduncle 4-6 cm. long, axillary. Fruit an ovoid capsule.

Abundant on wet rocks, rare elsewhere. Flowers almost throughout the year, with a peak in November.

15. **Impatiens tomentosa** Heyne The Red Liberty Cap

A slender, pubescent, annual marsh herb. Stems red, pubescent, 30 cm. long, rooting at the lower nodes. Leaves narrow, acute, 4×0.8 cm., on short petioles. Flowers pink, 1-3, axillary, on pedicels about 2 cm. long. Flowering September-May; stray flowers throughout the year. Capsules pointed at both ends; seeds 3-5, black.

Abundant in marshes, not seen elsewhere. Gamble reports 70 species for Madras, and Fyson 31 for the south Indian hill stations, but I have noted only about 12 about Kodaikanal.

PAPILIONACEAE

16. **Crotalaria albida** Heyne

A low, diffuse plant, branching abundantly but only from below. Leaves simple, subsessile, 1-1.5×0.5 cm., cuneate, thick, pubescent. Inflorescence of terminal racemes 4-5 cm. long. Flowers yellow, 6-8 in a raceme. Flowering nearly throughout the year with

occasional interruptions. Very few flowers seem to run into fruit. Pods glabrous.

Not abundant but widely distributed.

17. **Crotalaria calycina** Sch. Rabbit's Ears

An erect annual 10-60 cm. high, profusely covered with brown hairs. Stems cylindrical, flexuous. Leaves oblanceolate, 4-6×0.6 cm., densely hirsute on the lower surface. Flowers in loose racemes, distant from one another. Calyx 2 cm. long, densely tomentose. Corolla yellow, not exserted from the calyx. Flowers abundant in September-October; stray ones and pods nearly throughout the year. Pods 2 cm. long, dark brown; seeds over 20.

Fairly abundant and widely distributed. Probably the name "Rabbit's Ears" comes from the two ear-like upper lobes of the calyx.

18. **Crotalaria fysonii** Dunn.

A small, trailing, perennial herb, with a thick rootstock. Upper leaves ovate, lower ones orbicular, all usually pubescent. Racemes terminal, leaf-opposed or erect. Flowers 4-6, showy, yellow. Flowers throughout the year, but few of them seem to run into fruit.

Widely distributed along the slopes, and fairly abundant. There is one form of the plant with perfectly glabrous leaves.

19. **Crotalaria leschenaultii** DC.

An erect, branched undershrub, 90 cm. high, or higher. Leaves oblanceolate-cuneate, glabrous on the upper surface, silky on the lower, 8 cm. long. Racemes many, large, bright yellow tinged with brown, which turn black when dry. Flowering starts in August, and continues for most of the year. Ripe pods 5-6 cm. long.

Common but not abundant.

20. **Crotalaria ovalifolia** Wall.

A low, diffuse, pubescent herb from a perennial rootstock. Branches 20 cm. long, wiry, more or less erect among grasses. Leaves simple, ovate. Stipules broad at the top and decurrent along the stem. Racemes terminal, of 2-3 flowers. Flowering more or less throughout the year, with a peak in September-November.

Common and abundant.

21. **Crotalaria wightiana** Grah.

A conspicuous, pretty shrub, 100-120 cm. high. Leaves 12×9 cm., elliptic-ovate, obtuse at the apex, densely pubescent; stipular wings prominent. Racemes few-flowered. Flowers conspicuous. Flowering June-November. Flowers and pods are seen on the same plant

for most of the year, except perhaps in April-May. Pods 4-5 cm. long.

Common, at times fairly abundant. This seems to be the upper limit of the distribution of this plant.

22. **Desmodium parvifolium** DC.

A low trailer often hidden in the surrounding herbage. Fresh leaves in June-July. Stems thin and pubescent when young, red and glabrous when old; lateral branches many. Leaflets 3, often not more than 0.5 cm. long. Racemes terminal, densely pubescent. Flowers pink. Flowering September-December. Pods from January onwards. Even after dehiscence, the pod persists on the plant, at times even for months.

This is sometimes so abundant as to form the dominant ground vegetation, but not widely distributed. Stray flowers seen even after January in shaded places, but the statement 'Flowers March-October' of Fyson seems to be incorrect.

23. **Desmodium rufescens** DC.

An erect, tall, twiggy shrub, up to 150 cm. high; young parts brown pubescent. Leaflets 3, obovate, the underside covered with silky pubescence. Racemes mostly terminal, 8-15 cm. long. Flowers blue-purple, crowded on the upper part of the raceme. Flowering August-January. Pods and stray flowers from February onwards.

In thickets, in clumps.

24. **Desmodium scalpe** DC.

A shade plant, young parts pubescent. Leaflets 3, the middle one rhomboid, lateral ones oblique. Stipules prominent. Inflorescence up to 30 cm. long, a lax terminal raceme. Flowers brick red, abundant September-January.

Not a plant of the open grassland, but of shaded woods.

25. **Flemingia grahamiana** Wt. & Arn.

An erect shrub, with the fresh leafy branches rising above the surrounding grass by April, after the first showers. Leaflets 3, thick; the terminal one ovate-cuneate, 8×4 cm.; lateral ones oblique, smaller. Flowers in dense axillary spikes; calyx densely covered with red glands; corolla rather yellow than pink. Flowers common from September onwards. The last flowers may be seen from December to January along with pods which are also covered with red glands. Pods may be seen as late as May.

Abundant and common everywhere on grassy slopes.

26. **Indigofera pulchella** Roxb.

A shrub 30-180 cm. high. Leaves imparipinnate, with 11-15 leaflets. Racemes 7-12 cm. long. Flowers purple, appearing before the leaves, September-May. Pods narrow, straight, 4-5 cm. long.

Not abundant but widely distributed. The stem is often covered with galls.

27. **Leptodesmia congesta** Benth.

A perennial, diffuse, trailing herb. Stems thin, young parts pubescent. Leaves abovate, pubescent. Inflorescence a terminal raceme. Flowers crowded in the raceme, which appears whitish on account of the dense pubescence of the calyx. Flowers May-December. Pods common from January onwards.

Abundant in certain places, but not common.

28. **Shuteria vestita** Wt. & Arn.

A slender twiner. Stems thin, pubescent. Leaves pinnately trifoliate, leaflets ovate. Racemes up to 12 cm. long; calyx densely pubescent; corolla purplish. Pods flat, pubescent. Flowers November-January; pods till March.

Common in thickets, not in open grasslands.

29. **Tephrosia tinctoria** Pers.

An undershrub with imparipinnate leaves; leaflets 9 or more, their undersurface pubescent. Racemes mostly terminal. Flowers red, October-December. Pods flat, slightly curved, about 4 cm. long. The empty pods persist on the plant after dehiscence.

Abundant only in certain places; commoner at lower elevations.

CAESALPINEACEAE

30. **Cassia leschenaultiana** DC.

A low, diffuse or decumbent perennial herb. Leaves 3-5 cm. long, paripinnate; leaflets 16-24 pairs. Flowers on pedicels up to 1.5 cm. long, solitary, axillary, yellow. Flowering more or less throughout the year, abundant from August to September. Pods hairy, throughout the year.

Both abundant and common. It is easily distinguished from *C. mimosoides* L., a similar plant, which has 30-50 pairs of leaflets and glabrous pods.

ROSACEAE

31. **Rubus ellipticus** Sm. The Yellow Raspberry

A large gregarious straggling shrub. Stems armed with curved prickles; tender parts covered with white tomentum and red hairs.

Leaves pinnately trifoliate, rugose, obovate; the middle one the largest, 9×7 cm.; lateral ones 6×4 cm.; margins serrate. Flowers white, in terminal or axillary clusters, drooping; abundant in September, less so during the rest of the year. Fruit a globose aggregate of drupes, yellow when ripe. The fruit of this and the two following species are delicious when ripe.

Abundant and common along roads, paths, and edges of forests.

32. **Rubus fairholmianus** Gardn. The Purple Bramble

A large, prickly shrub, about 2 m. high, gregarious. Stems, chiefly the young parts, covered with dense woolly tomentum. Leaves simple, 3- or more-lobed, up to 25×10 cm., rugose, cordate at the base; undersurface tomentose, almost black when dry. Stipules fimbriate. Inflorescence terminal; flowers white, throughout the year. Fruit an aggregate of drupes, dark purple when ripe.

Gregarious, but not common; this seems to be the lower limit of the distribution of this plant.

33. **Rubus niveus** Thunb.

A very prickly straggling shrub, with prickles along the stem, petioles, even along the midrib of the leaf. Leaves of 5-7 ovate-acute, serrate leaflets, covered with dense white tomentum on the under-surface. Inflorescence terminal or axillary; flowers pink, throughout the year with a peak in September. Fruit an aggregate of drupes, purple when ripe.

Often in groups in moist surroundings.

SAXIFRAGACEAE

34. **Parnassia mysorensis** Heyne The Grass of Parnassus of Kodai-kanal

A slender herb with a perennial rootstock, occurring in clusters on wet rocks or in marshes. New shoots by August. Leaves radical, petioles 4-6 cm. long; lamina cordate. Scapes 12-20 cm. long, with a long bract about half way up; flowers white, from November onwards.

Only in moist places. The plant dries up early in January except in shady places, where it may be seen in flowers much later.

CRASSULACEAE

35. **Kalanchoe grandiflora** Wt. & Arn.

A stout, succulent herb, in dense clusters on or near rocks. Stems thick, cylindrical, with prominent leaf-scars. Leaves thick, orbicular-

ovate, 8×5 cm., opposite. Inflorescence terminal, 45 cm. or longer, branched. Flower buds appear by October; dense clusters of yellow flowers are abundant from December to March. Fruits are enclosed in the dry, persistent corolla tubes.

Abundant in clumps, chiefly along the edges of rocks; rare elsewhere.

DROSERACEAE

36. **Drosera burmanni** Vahl The Common Sundew

A herb of moist ground, often concealed by surrounding grass, with a permanent rootstock and no stem. Leaves red, spathulate, with long-stalked glands, forming a rosette on the ground. Scape 8-12 cm. Flowers white, in a scorpioid cyme. Flowers were collected in May, but data insufficient to determine the flowering season.

In moist ground; rare elsewhere.

37. **Drosera peltata** Sm. The Moon-leaf Sundew

A perennial, slender herb. Stems thin, up to 30 cm. long. Leaves peltate, alternate, cauline, dark, fringed by long-stalked glands. Flowers terminal, white; abundant after rains, fewer during the year.

Both common and abundant, especially in damp soil. Stains the paper red when dried for the herbarium.

MELASTOMACEAE

38. **Osbeckia wightiana** Benth.

A well-branched, hardy shrub or small tree. Young parts densely pubescent. Leaves ovate-oblong, 3-8×2-5 cm., silky with white tomentum on the undersurface. Inflorescence of up to 5 flowers; calyx densely pubescent; corolla purple, 2-4 cm. across. Flowering starts by August; flowers abundant till October, persisting occasionally till May.

Abundant and common.

CUCURBITACEAE

39. **Melothria leiosperma** Cogn.

A scabrid climber. Tendrils simple. Leaves very brittle, shallowly lobed. Female flowers solitary, male ones fascicled, yellowish; seen almost throughout the year. Fruit globose, green with white streaks when young, red when ripe.

Common at lower elevations; on rocks, in thickets, etc.

UMBELLIFERAE

40. **Bupleurum mucronatum** Wt. & Arn. The Common Hare's Ears

A slender, branched herb, 60-150 cm. high, with green, knotted stems. Leaves narrow, lanceolate, 6 cm. long. Umbels compound, terminal. Flowers yellow, from May onwards, quite abundant in September, scarce by January when the plant begins to dry up.

Fairly common but never abundant.

41. **Centella asiatica** Urban

A prostrate herb. Stems wiry, reddish, rooting at the nodes. Leaves orbicular with narrow sinus, 2×1 cm., larger in shady places. Umbels simple, peduncles 1-2 cm. long, few-flowered; flowers pink.

Both common and very abundant on any type of soil. The size of the plant varies much according to surroundings.

42. **Heracleum rigens** Wall. The Common Cow Parsnip of Kodaikanal Downs

An erect, branched herb, up to 150 cm. high. Rootstock thick. Stems pubescent, brittle. Leaves large, of 3-5 rounded leaflets with serrate margins. Umbels compound, terminal, spreading. Flowers yellow, June-September. The peduncle elongates much when in fruit. Fruit a double mericarp, elliptic, flat on drying. The plant is dry by November.

Fairly common and abundant.

43. **Pimpinella candolleana** Wt. & Arn.

An erect herb, up to 50 cm. high. Stem unbranched, slender. Basal leaves cordate, petioles 8 cm. long; cauline leaves with sheathing bases, 3-lobed. Umbels compound, terminal. Flowers white, July-November. Fruit papillose.

Common and abundant on slopes.

RUBIACEAE

44. **Anotis leschenaultiana** Wt. & Arn.

A perennial, procumbent herb, rooting at the nodes, densely tomentose throughout. Leaves ovate-acute, 2×1 cm. Inflorescence of trichotomous cymes, terminal. Flowers pink. Flowering August-December; but in moist surroundings, flowers may be seen almost throughout the year. Fruit a capsule.

Abundant in moist soil, especially on rocks, occasionally elsewhere.

45. **Galium asperifolium** Wall. The Indian Bedstraw

A scabrid, wiry climber often seen on shrubs, walls, etc. Stems rough, thin, 4-angled. Leaves opposite, oblanceolate, with 4-6 leaf-

like stipules. Fresh leaves appear in April, flowers are common in July-August and abundant in September. Flowers minute, yellowish. Fruits common in December; by January the plant dries up.

Common and abundant. The 4 or 6 leafy stipules are often mistaken for leaves (Gamble and Fyson). It has been noted that the leaves and stipules dry only after the stem has dried.

46. **Knoxia mollis** Wt. & Arn.

An erect herb, up to 90 cm. high. Stems cylindrical, or slightly 4-angled. Leaves ovate-acute, 6×2 cm., pubescent. Inflorescence in small terminal corymbs. Flowers bluish, abundant March-October. The large ellipsoid fruits, though few, are conspicuous.

One of the commonest and most abundant of the grassland plants.

47. **Oldenlandia herbacea** Roxb.

A small, branched, erect, annual herb, 10-25 cm. high, with small narrow leaves and small white flowers. Flowering October-December, after which the plant dries up.

Gregarious, often on rocks and in wastelands. This seems to be the higher limit of the distribution of this plant. Not mentioned by Fyson.

48. **Oldenlandia swertioides** O. Kuntze The Ground Lilac

A small shrub, up to 60 cm. high. Stem 4-angled, glabrous. Leaves sessile, ovate, 6×2 cm., yellow when dry. Inflorescence mostly terminal, at times axillary; flowers lilac, April-November; later in the year, stray flowers and fruits may be occasionally seen.

As common and abundant as *Knoxia mollis* Wt. & Arn. Conspicuous on slopes, above the surrounding grasses.

49. **Wendlandia notoniana** Wall.

A shrub or small tree. Leaves ternate, elliptic-lanceolate, 9×4 cm., pubescent on the undersurface. Inflorescence in dense, terminal panicles; buds appear by December, flowers are common by February, white, scented. Fruits from May onwards.

Abundant in certain places, but not common; it is much more common at lower elevations.

VALERIANACEAE

50. **Valeriana hookeriana** Wt. & Arn.

A slender, softly pubescent, annual herb. Stems 40 cm. long, often unbranched. Leaves opposite, the radical ones pinnate with

7 leaflets; odd leaflet ovate, lateral ones lanceolate. Inflorescence a profusely branched corymbose panicle. Flowers small, pink-white, April-October, abundant in September. Fruits crowned by white pappus.

Fairly common and abundant on grassy slopes. Young plants are seen from November onwards.

COMPOSITAE

51. **Ageratum conyzoides** L. The Floss Flower

An annual, 30 cm. high. Stems branched, pubescent. Leaves opposite, rugose. Inflorescence a homogeneous head; florets all tubular, light blue or purplish. The protruding purple styles are characteristic. Flowers abundant January-April, less so in the rest of the year. Achenes black.

Abundant but not common. A troublesome weed along roadsides, in wastelands, plantations etc.

52. **Anaphalis aristata** DC.

A viscid, green herb, up to 40 cm. high. Stems woody at the base, supporting many erect, pubescent, flowering branches. Leaves many, close, narrow, acute, clasping the stem with acute auricles; undersurface white. Heads many, homogeneous; bracts pink when young, bleached at the tip when old. Flowering November-January. Plants dry up by February.

In rather dry places; common but not abundant.

53. **Anaphalis beddomei** Hook. f.

A gregarious undershrub. Main stem decumbent, brown, with erect, ascending branches 30-60 cm. high, clothed below with the older leaves. Leaves oblanceolate, thin, 10×2 cm., with a layer of white tomentum on either surface, and with 5 prominent veins. Heads white, corymbose, with the outer peduncles longer so that the corymb is depressed in the centre. Flowering July-November.

Abundant in moist surroundings, especially near rocks, where they occur in groups.

54. **Anaphalis lawii** Gamble

An annual herb, very variable in size, 10-60 cm. high, the size depending on the kind of soil. Stems cottony, unbranched, bases covered with dead leaves. Leaves sessile, oblanceolate, 2-4×0.6-1.4 cm., cottony. Inflorescence in terminal heads, bracts rose-coloured.

Flowers abundant April-September; the dry, bleached bracts persist for a long time.

Not only common and abundant, especially on exposed poor soil, but one of the commonest herbs of the area.

55. **Anaphalis travancorica** Sm.

Resembles *A. beddomei* Hook. f., except for the noticeably larger, closer-set, thicker and silky leaves, and larger inflorescence heads. Flowering November-January.

Occurs in dense clumps on wet rocks and on moist earth banks; occasionally elsewhere.

56. **Artemisia parviflora** Roxb.

A perennial undershrub, 120 cm. high, conspicuous above the surrounding vegetation. New shoots from April onwards. Lower leaves cuneate, upper ones deeply pinnatifid; both with a pair of narrow stipule-like segments each at the base. Buds from July onwards; flowers August-December, on a panicle 30 cm. long. The dry panicles persist till March.

Common but not abundant. This seems to be the higher limit of the distribution of the plant. Gall formation on the stem is characteristic.

57. **Bidens pilosa** L.

An erect herb, up to 60 cm. high. Stem 4-angled, glabrous. Leaves opposite, pinnately trifoliate, leaflets serrate. Inflorescence a heterogeneous head, flat, with yellow discs and conspicuous white ray bracts. Flowers throughout the year. Achenes black, narrow, angled, surmounted by 2 barbed spines.

A very common and abundant wayside weed. Its wide distribution may be accounted for by the barbed spines on the achenes that cause the latter to penetrate into, and adhere to, the clothing of man and the limbs of animals, thus ensuring their dispersal.

58. **Blumea neilgherrensis** Hook. f.

An erect, aromatic herb, 60 cm. high, glandular-hairy all over. Leaves obovate-acute, up to 8×3 cm., smaller below the flowers. Heads without rays, in panicles; florets purple. Flowering April-June, probably at other times also.

Rare in distribution and numbers; always in shady places.

59. **Cnicus wallichii** DC. The Common Indian Thistle

An erect, stout herb, 90-180 cm. high, spiny all over. Stems branched. Leaves sessile, decurrent, variously lobed, margins armed

with sharp spines. Inflorescence terminal, on short, axillary, leafy branches, of homogeneous heads; outer involucral bracts spiny. Flowers June-September; florets purple. Achenes with feathery pappus.

Common, not abundant.

60. **Conyza ambigua** DC.

An erect herb, up to 90 cm. high. Leaves alternate, narrow, linear, up to 6 cm. long. Heads terminal, cylindrical; involucral bracts narrow, green. Florets yellow. Flowers July-March.

A wayside weed, abundant but not common. An introduced plant.

61. **Conyza japonica** Less.

An erect herb, up to 35 cm. high. Leaves sessile, spathulate, coarsely serrate. Heads nearly sessile, in terminal, rounded corymbs. Florets pinkish.

Rare.

62. **Conyza stricta** Willd. The Kodaikanal Groundsel

A branched herb, up to 30 cm. high, pubescent throughout. Leaves numerous, closely-set, entire, oblanceolate, 3-5×0.4-0.6 cm. Heads very numerous, terminal, in corymbs; florets yellow; flowers throughout the year.

One of the commonest plants in the area; occurs even in very poor soil.

63. **Emilia scabra** DC.

A herb with alternate, pinnatifid, basal leaves when young, and leafy throughout the stem when old. Stems 30-75 cm. high. Heads solitary on slender stalks; florets red. Flowers throughout the year.

Common but not abundant.

64. **Erigeron mucronatum** DC. 'Swan River Daisy' (Lloyd, 1909)

A perennial herb with slender branches spreading flat, from a woody base. Leaves narrow, oblanceolate, 2-4 cm., often 3-lobed. Flower heads terminal, often in pairs, peduncles long. Ray florets at first white, turning pink when old. Flowers February-May, fewer later. Stray ones throughout the year.

A very abundant plant all over the area, particularly along the sides of streams, on earth banks, etc. Fyson states that this is originally a Mexican plant, often in south India erroneously confused with *Vittadenia australis* A. Rich., an Australian plant.

The plant is supposed to have been introduced by Sir Vere Levinge, Governor of Madras (Lloyd, 1909).

65. **Eupatorium glandulosum** H. B. & K.

An erect shrub, 50-100 cm. high. Stems branched, reddish, glandular. Leaves opposite, ovate-acuminate, serrate. Flower heads homogeneous, in terminal corymbs. Florets white, scented. Flowering February-April. Achenes black, surmounted by white pappus.

A native of Mexico, now found as an escape, often growing in large numbers along the wayside etc., but not common. Not mentioned by Gamble.

66. **Laggera alata** Sch.

A scabrid, stout herb, up to 60 cm. high. Stems and branches angled and winged. Leaves alternate, oblanceolate, 7×1.5 cm., decurrent, sharply serrate, pubescent above, tomentose beneath. Flower heads drooping in the axils of the upper (smaller) leaves, forming a terminal panicle. Florets purple. Flowering November-April.

Fairly common and abundant, especially at slightly lower elevations. Conspicuous above surrounding grasses. Dry plants with the discs of the heads persist for months after flowering is over, sometimes even till the next flowering season.

67. **Senecio wightianus** DC.

A slender plant, 1 m. high. Stems slender, geniculate, scandent, prominently ribbed, profusely branched. Leaves simple, alternate, hastate, up to 7×3 cm., sharply dentate. Heads 12-20, on axillary corymbs; florets yellow. Flowering January-March. Small achenes with copious pappus.

Abundant in thickets, but not common.

68. **Vernonia fysoni** Calder

A straggling shrub, 120-150 cm. high, with cottony hairs throughout. Leaves elliptic, acute at both ends, 10×4 cm., green on the upper and yellowish on the lower side. Flower heads in terminal corymbs; florets purple. Flowering February-May.

Common but not abundant, on slopes, even in poor soil.

CAMPANULACEAE

69. **Campanula alphonsii** Wall.

A small, wiry, spreading herb, from a perennial rootstock, often on wayside walls. Stems slender, up to 30 cm. long, branched. Leaves obovate, with white tomentum on the undersurface. Flowers

mostly terminal, blue, few. Flowers were collected in December and May, but data insufficient to determine the flowering season.

Rare.

70. **Campanula fulgens** Wall.

An erect herb, up to 60 cm. high. Stems slender, usually unbranched. Leaves mostly crowded at the base, distant higher up the stem, elliptic, narrowed at both ends, serrate, pubescent. Spikes terminal; flowers often in whorls at irregular intervals along the spike. Flower buds start opening from the top. Flowering June-October; stray ones up to January. The colour of the flower varies from purple to almost white. Capsule 5-celled, opening by slits at the side.

Common and abundant on slopes. The opening of the flower buds from the top downwards is usual, but is this so constant as Fyson states?

71. **Wahlenbergia gracilis** DC.

A slender, perennial herb. Stems wiry, sparingly branched, up to 30 cm. high; many from the same perennial rootstock. Leaves linear, 2-3 cm. long, alternate. Flowers terminal on pedicels up to 15 cm. long. The size of the flower varies; the colour is deep blue to pure white. Flowers abundant in March-April after the first showers, less during the rest of the year.

At times one of the commonest and most abundant plants in open grasslands, with poor vegetation.

LOBELIACEAE

72. **Lobelia excelsa** Lesch. The Giant Lobelia

A conspicuous, coarse herb, 1-4 m. high. Stems cylindrical, up to 5 cm. diameter, with soft pith inside. Leaves alternate, serrate, simple, villous, up to 35×5 cm., oblanceolate, persistent on the stem even after drying, giving the plant a shabby look. Flowers purplish brown, in dense terminal, solitary spikes 30-150 cm. long. Flowers December-March. Fruit globose, enclosed in the calyx tube. The dry inflorescence with the fruits and the persistent calyx tubes present an untidy sight, and remain long after the flowering is over.

Common and gregarious along roadsides, shola edges, etc., but is restricted in distribution. A solitary terminal spike is the rule; but if the terminal spike is cut in the bud stage, a dense cluster of smaller spikes spring up from near the apex of the plant.

73. **Lobelia nicotianaefolia** Heyne

Similar to the preceding, but with white flowers. Leaves glabrous, oblong, 12×4 cm.; spikes looser and thicker. Flowering February-March.

Rare at this altitude; more robust specimens at 4000-5000 ft.

ERICACEAE

74. **Gaultheria fragrantissima** Wall.

An erect shrub, 100-120 cm. high. Stems rough, branched, brittle. Leaves simple, alternate, ovate, 6×4 cm., coriaceous; petioles thick and red. Young shoots smooth and red. Flowers small, in axillary racemes, November-May; stray ones during the rest of the year. Calyx persistent as a fleshy coating around the fruit. Corolla white, egg-shaped, fragrant especially when crushed, with 5 small recurved lobes. Fruit a berry, blue when ripe, with a red stalk.

Common at edges of sholas, along waysides, etc., but restricted in distribution.

75. **Rhododendron nilagiricum** Zenk.

A tree 4-6 m. high, with rough and thick bark. Branches very brittle, usually only from the upper half of the stem. Leaves elliptic, 9×3 cm., acute at both ends, coriaceous, dark green on the upper surface, silvery when young and rusty brown when old on the lower; margins recurved. Flowers crowded in dense terminal bunches which are 10 cm. across, red. Flowers abundant December-February; stray ones till May. Capsule oblong, 2×1 cm., woody, opening from the top downwards into the component carpels, but leaving the central axis.

The only tree noted in the area under study. Conspicuous on slopes for the dense clusters of red flowers. Widely distributed.

PRIMULACEAE

76. **Lysimachia deltoidea** Wt. The Creeping Jenny

A slender, pubescent, trailing herb. Stems prostrate, 15-25 cm. long. Leaves opposite, ovate, 2×1 cm. Flowers yellow, solitary; pedicels up to 3 cm. long. Flowers April-July. Fruit a capsule, opening by valves.

Abundant in shaded, moist places; rare elsewhere.

ASCLEPIADACEAE

77. **Ceropegia hirsuta** Wt. & Arn. var. **stenophylla** Hook. f.

A thin, pubescent twiner, with a tuberous rootstock. Stems slender, twining on grasses, 30-40 cm. long. Leaves linear, 5-10×0.2 cm. (the

trinomial *stenophylla* refers to the narrowness of the leaf), pubescent. Flowers in 2-3-flowered axillary, peduncled cymes. Pedicels 1.5-2 cm. long, pubescent. Flowers reddish brown, with purplish spots; corolla 2-2.5 cm. long, narrow in the middle, inflated at both ends; lobes 5, connate by their tips, leaving 5 lens-shaped openings. Flowers August-October. Follicles not seen.

Fairly common on grass slopes, though not easily noticed, except when in flower. This seems to be the higher limit of the distribution of this plant. Not mentioned by Fyson.

78. **Tylophora fasciculata** Ham.

A slender plant with thick, fascicled roots; branches many. Lower leaves elliptic-acute, 5×2 cm.; upper ones lanceolate, 3×1 cm.; all opposite, glabrous. Flowers deep brown, small, crowded in umbelliform cymes, at times axillary, oftener terminal. Flowering April-May. Follicles not seen.

At times fairly common among grasses, though not easily noticed owing to the small size of the plant and flowers. Commoner at lower elevations. Not mentioned by Fyson.

GENTIANACEAE

79. **Exacum wightianum** Arn. The Giant Field Gentian

An erect, branched, leafy shrub, 40-120 cm. high. Stems square, winged, glabrous. Leaves lanceolate, 5-10×3-4.5 cm., 3-nerved, opposite, glabrous. Flowers blue, many, terminal or in the upper axils; pedicels up to 4 cm. long, recurved in fruit. Flowers mostly March-April, stray ones later on.

Gregarious here and there on slopes.

80. **Gentiana pedicellata** Wall. var. **wightii** Kurz.

A perennial herb, 6-12 cm. high. Radical leaves form a rosette on the ground, obovate, 1-1.5×0.5 cm. long. Flowers terminal, solitary, bright blue; common March-April, stray ones for the rest of the year. Fruit a capsule, dehiscing longitudinally into 2 valves, the empty capsule-valves persistent on the plant for some time.

Common everywhere, but plants occurring on moist ground are more robust, with more flowers. Ordinarily the flowers are only 5-6 mm. diameter, but Fyson reports flowers up to 15-20 mm.

81. **Swertia corymbosa** Wt.

An erect herb, with several shoots from a perennial rootstock, 15-45 cm. high. Stems cylindrical, ridged by decurrent leaves. Leaves

opposite, sessile, obovate, acute, narrower and shorter upwards. Flowers in the axils of the upper leaves, in pairs of corymbs. The colour of the flower is of various shades of blue; corolla marked with glands and blue nerves; flowering October-March.

Common and abundant. Very variable in size.

SCROPHULARIACEAE

82. **Calceolaria mexicana** Benth. The Common Slipper Flower

An erect herb with fleshy stems up to 45 cm. high. Stems and leaves covered with glandular hairs. Leaves opposite, deeply serrate, the basal segments even pinnatisect. Flowers axillary; corolla tube short and lips saccate, closed; colour bright yellow. Flowering October-December.

A native of Mexico, naturalized and common along shady banks of streams, as a weed in gardens, sometimes in waste lands. Locally abundant but not widely distributed.

83. **Pedicularis zeylanica** Benth. The Pink Rattle

A perennial herb up to 50 cm. high, often with many shoots from a single rootstock. Leaves alternate, oblanceolate, 2-5×1 cm., the margins variously cut and curved backwards. Flowers in the axils of the upper leaves, 2-lipped, pink; flowering October-December.

Common but not abundant; often found in moist localities, less often in drier areas. The many incisions on the lamina remind one of some fern-fronds. From a distance the inflorescence is often mistaken for that of *Satyrium*.

84. **Sopubia delphinifolia** G. Don

An erect herb up to 80 cm. high. Leaves opposite, the upper ones 1-2 cm. long, simple, linear; the lower ones pinnatisect with 2-4 pairs of filiform segments. Flowers axillary; corolla longer than broad, narrow below, inflated above, pink. Flowers were collected in November, but data insufficient to determine the flowering season.

Occurs in grass fields, a root parasite (Fyson). It is a plant of lower elevations.

85. **Sopubia trifida** Ham.

A pretty herb, 30-50 cm. high. Upper leaves simple, linear, 1.5-2 cm. long; lower ones larger, each with one pair of narrow segments. Flowers axillary, one or more in an axil; corolla broader than long, yellow with a purplish eye. Flowering starts with the first showers in March-April, and continues till December.

Common and abundant in grass fields.

86. **Striga lutea** Lour.

A scabrous herb, parasitic on roots of grasses, 10-15 cm. high. Stems sparingly branched. Leaves narrow, 3-4×0.5 cm., opposite. Flowers in the axils of the upper leaves; corolla yellow or white. Two sets of flowerings have been noticed: one from May to July, the other from November to January, probably depending on the rains.

Common and abundant in grass fields. Plants are more robust at lower elevations. Are the yellow-flowered and white-flowered plants just 2 forms of the same species?

LENTIBULARIACEAE

87. **Utricularia graminifolia** Vahl The Common Blue Bladderwort

A slender water herb, 7-12 cm. high. Leaves linear, from stolons provided with small, dark purple bladders. Scape erect; flowers 1-3, purple, terminal or subterminal. Upper corolla lip obovate, lower one broadly arched in the middle; spur slender, pointing downwards. Flowers nearly throughout the year.

Plentiful in marshy soil, not seen elsewhere.

GESNERIACEAE

88. **Didymocarpus tomentosa** Wt.

A ground herb with radical, broadly elliptical, rugose and densely tomentose leaves. Flowers bluish purple, on a branched, densely tomentose scape. Flowering May-December, depending on the rains. From time to time fresh blossoms have been noticed. Capsules 2 cm. long. The plant dries up by January.

Distribution poor, but abundant on rocks.

89. **Klugia notoniana** A. DC.

An erect herb with fibrous roots. Stems fleshy, smooth, 20-60 cm. high, swollen at the nodes. Leaves alternate, very oblique at the base, pubescent, up to 12×6 cm. Flowers conspicuous, bright blue, in racemes. Capsule spherical.

Found on rocks near streams in the shade; not seen elsewhere.

ACANTHACEAE

90. **Andrographis neesiana** Wt.

A hardy herb, 30-50 cm. high. Leaves ovate-oblong, 10×6 cm. Flowers in one-sided racemes crowding in dense terminal clusters.

Flowering starts in September, reaches a peak in January-March, and may last till June. Corolla purplish, the lips widely separated. Stamens 2, with broad, white filaments and black anthers. Capsules oblong or ellipsoid. By June the capsules dehisce, and the plant dries up.

One of the commonest and most abundant plants in the area, found even on very poor soil.

91. **Justicia simplex** Don

A herbaceous, pubescent, diffuse plant, from a perennial rootstock. Branches procumbent, geniculate. Leaves entire, ovate, pubescent. Spikes terminal, about 5 cm. long. Flowers throughout the year, with a peak in November. Bracts and sepals very hairy; corolla pink. Fruit an elliptic capsule.

Common even on poor soil. The size of the plant varies according to surroundings.

92. **Strobilanthes kunthianus** T. And. The Common Strobilanth of the open hill sides. The Great Blue Flower of the Nilgiris (Robinson, 1935).

A branched, gregarious shrub, 50-150 cm. high, varying considerably in size according to localities. Stem cylindrical in old parts, angular in the younger, swollen at the nodes. Leaves elliptic, acute at both ends, 4-6×2-3 cm., serrate, rough, greenish on the upper and whitish on the lower side. Flowers in dense terminal, usually branched, cone-like spikes, 6-14 cm. long. Corolla pale blue, 2-3×1.5 cm. Stamens 2. Capsule oblong.

Very abundant all over these hills, dominating the slopes along with the bracken. The periodical general blooming, clothing the slopes in blue, renders this plant a favourite of all. The local name of the plant literally means "The Flower of the Hills", and the plant is referred to in one of the Tamil classics. Records of eleven consecutive geneal bloomings at regular intervals of 12 years are at hand: 1838, 1850, 1862, 1874, 1886, 1898 (Robinson, 1935), 1910, 1922, 1934, 1946 (Anglade, unpublished), and 1958. However, stray flowers have been noted almost every year from 1950-1957.

VERBENACEAE

93. **Clerodendrum serratum** Moon.

A robust, scarcely branched shrub, up to 180 cm. high. Stems 4-angled. Leaves ternate, serrate, elliptic, narrow at both ends,

16×6 cm. Inflorescence terminal, 8-12 cm. long. Flowers blue. Flowering April-November; stray flowers throughout the year.

Fairly common, but never abundant. This seems to be the higher limit of the distribution of this plant.

94. **Lantana camara** L. var. **aculeata** Mold. The Lantana

A strongly aromatic, straggling shrub, with recurved prickles along the angles of the stem. Leaves opposite, rugose, cordate, serrate. Flowers in corymbose spikes, pink, or blue and yellow at this altitude (orange-coloured at lower elevations). Flowers more or less throughout the year. Fruit a berry, black when ripe.

Common and abundant in waste land, in masses along the main road.

95. **Lantana trifolia** L.

A pubescent, hispid undershrub, up to 50 cm. high. Leaves subsessile, 8×3 cm., cordate, dentate, often ternate, at times opposite. Spikes terminal, short, or at times up to 5 cm. long. Bracts conspicuous, boat-shaped. Flowers pink, common in June; stray ones throughout the year. The axis of the spike seems to elongate in fruit. Fruit a berry, bright red when ripe, well protected by the boat-shaped, persistent bracts.

Not very common, though abundant in certain places. Not mentioned by Fyson.

LABIATAE

96. **Anisochilus dysophylloides** Benth.

An erect, thick herb, 25-40 cm. high, silky all over, from a perennial rootstock. Leafy shoots appear in September. Stems tomentose, decumbent, branches ascending. Leaves opposite, elliptic, 2-5×1.5 cm., thick, aromatic. Inflorescence a spike, 3-8 cm. long. Flowers purple, strongly-scented, crowded along a cylindrical, erect axis. Flowers November-January; the dry spikes seen even in May.

Gregarious in dry places, on rocks, exposed summits of hills, etc.

97. **Calamintha umbrosa** Benth. The Catmint

A spreading herb. Stems angular, up to 80 cm. long. Leaves ovate, dentate, 3×2 cm., slightly pubescent, petioles 1 cm. long. Flowers purplish, in terminal and axillary whorls. Calyx tomentose, 2-lipped. Corolla with a flat upper lip and 3 spreading lower lobes. Flowers September-December.

Abundant in moist places, borders of sholas, but not common.

98. **Coleus barbatus** Benth.

A tomentose, aromatic, erect herb, up to 45 cm. high, from a perennial rootstock. Leaves alternate, 10×3 cm., lanceolate, slightly oblique. Flowers blue, in whorls on an elongated spike, May-October. Calyx distictly hairy.

Widely distributed, never abundant; commoner at lower elevations.

99. **Leucas linifolia** Spr.

A branched, erect herb, up to 45 cm. high. Leaves entire, linear-lanceolate, 8×0.5 cm. Inflorescence of terminal whorls. Calyx tube with a very oblique mouth, the upper lip conspicuously long and pointed. Corolla white, with a long lower lip.

Often gregarious on rocks, in waste land, etc.; it is a plant of lower elevations.

100. **Leucas ternifolia** Desf.

A branched, often gregarious plant, 30-40 cm. high, from a stout rootstock. Branches and leaves often in threes, covered with a velvety pubescence. Leaves elliptic, 1.5×0.4 cm., strongly one-nerved. Flowers often in 2 whorls about 3 cm. apart. Flowering starts in September, reaches a peak in October, and may last till June.

Common and abundant on slopes.

101. **Leucas vestita** Benth.

A robust herb, 60-120 cm. high, with brown pubescence all over. Leaves elliptic, 7-12×3-5 cm., coarsely serrate, tomentose. Inflorescence of large, spherical whorls, axillary or terminal. Bracts ciliate, 1 cm. long. Calyx slightly shorter. The brown upper lip of the corolla distinguishes this species from all the others. Flowers more or less throughout the year.

Along roadsides, etc. in moist soil. Locally abundant but not common.

102. **Micromeria biflora** Benth. The Lemon-scented Thyme

A strongly aromatic herb with a stout woody rootstock and many ascending wiry stems, 10-15 cm. long. Leaves ovate-acute, subsessile, 0.5 cm. long. Inflorescence normally in 3-flowered axillary cymes; flowers purplish, strongly scented. Flowering starts in February and continues till the rains.

Common, at times abundant, chiefly in grass fields, on walls, etc.

103. **Plectranthus coetsa** Buch.-Ham.

A stout herb, 60-150 cm. high, with densely villous stems. Leaves opposite, ovate-acute, 6×3 cm., densely pubescent, white on the

undersurface. Flowers in crowded terminal compound panicles up to 15 cm. long; flowers blue, October-January.

Abundant along roadsides, streams, but not common.

104. **Plectranthus wightii** Benth.

A pubescent herb, 30-60 cm. high. Leaves 10×6 cm. ovate-acute, dentate. Flowers white, speckled with red spots, arranged in spreading panicles with foliaceous bracts. Flowers December-February.

Abundant in moist areas, rare elsewhere.

105. **Scutellaria colebrookiana** Benth.

An erect, slender herb, up to 35 cm. high. Leaves deltoid, 2.5×2 cm., petioles 2 cm. long. Spikes 8-18 cm. long. Flowers September-November, probably at other times also.

Rare at this altitude; commoner and more robust lower down.

106. **Scutellaria violacea** Heyne

A sparingly pubescent, fleshy herb, 25-60 cm. high. Leaves ovate, crenate, 6×3 cm.; petioles 4 cm. long. Spikes 8-25 cm. long. Flowers white tinged with purple; July-January.

Abundant in shaded and moist places; rare elsewhere.

AMARANTACEAE

107. **Allmania nodiflora** R. Br. var. **angustifolia** Hook. f.

An erect herb, with many sparingly branched shoots from a perennial rootstock. Stems 6-20 cm. long. Leaves alternate, entire, 4×0.3 cm., acute, glabrous, brownish. Flowers in axillary sessile clusters, white; more or less throughout the year.

Common in dry places on rocks etc., but not abundant.

POLYGONACEAE

108. **Polygonum chinense** L.

A rambling stout herb, often semi-scandent along walls or in thickets. Stems reddish, swollen at the nodes; the ochreate stipules 1.5-2 cm. long. Leaves 7-12×3-5 cm., ovate-oblong, finely serrate. Flowers white, with a pinkish tinge, clustered in terminal panicles; nuts enclosed in fleshy perianth; both flowers and nuts seen throughout the year.

Abundant on hedges, at the edges of woods, etc.

THYMELEACEAE

109. **Lasiosiphon eriocephalus** Dcne.

A large, branched shrub, up to 180 cm. high. Leaves linear-oblong, 5×1 cm., entire, glabrous. Flowers in terminal, silky, globular heads; perianth tubular, 1-2 cm. long, densely woolly except for the yellow lobes. Flowers December-May.

Scarce at this altitude; more common and abundant at lower elevations where thickets of this plant dominate the hill slopes.

EUPHORBIACEAE

110. **Phyllanthus gardnerianus** Baill.

A very variable herb, about 15 cm. high at this altitude. Branches slender, numerous. Leaves oblong, 1×0.4 cm., green to brown, subsessile. Male flowers numerous, short pedicelled; female ones fewer, on filiform pedicels 2-3 cm. long. Flowers and capsules throughout the year.

Common and abundant. Though at this altitude the plants are dwarfed, specimens reaching 40-50 cm. high have been collected at lower elevations.

URTICACEAE

111. **Pouzolzia wightii** Benn.

A gregarious herb, 45-80 cm. high. Leaves lanceolate, 5×2.5 cm. strongly 3-nerved, ternate or opposite, gradually passing into floral bracts. Flowers pedicelled, on an axis 25-40 cm. long. Male flowers rounded, flat topped; female ones flask-shaped with a contracted mouth from which the stigma projects. Flowers almost throughout the year except during the cold months, when fruits are common.

Gregarious in cool places.

BURMANNIACEAE

112. **Burmannia coelestis** Don

A slender herb about 10-15 cm. high, occurring in very moist soil. Leaves reduced to ensiform, radical scales. Flowers solitary or a few, blue; were collected in June, August, and January-March. Probably throughout the year.

Only in very moist places, often along with *Utricularia*.

ORCHIDACEAE

113. **Aerides crispum** Lindl. The Common Pink Rock Orchid

A robust, usually epiphytic orchid. Stems stout, 5-25 cm. long. Roots thick, greenish white, clasping the host firmly. Leaves distichous, thick and close-set, 12-18×3 cm., notched into two unequal lobes at the tip. Racemes axillary, 25 cm. long or longer. Flowers large, rose-coloured. Flowering May-June. Once 4 stray racemes were noted in March. Few flowers seem to run into fruit.

This once common orchid has unfortunately practically disappeared from these hills!

114. **Cheirostylis flabellata** Wt.

An inconspicuous ground orchid of shady woods. Stems succulent, greenish and thickened at the base. Leaves 3-5, thin, brownish, ovate-acute, sheathing at the base. Scape 8-16 cm. high, with 5-8 flowers; the bifid, well-fringed lip is characteristic. Flowering January-February.

Abundant in the Eucalyptus forest at Shembaganur.

115. **Coelogyne glandulosa** Lindl. The Plantain Orchid

A ground orchid, the creeping rhizome bearing annually renewed pseudobulbs that carry 2 terminal leaves. Pseudobulbs 6-12×3 cm., green. Leaves 10-30×4 cm., green. Scape almost fully sheathed by bracts; flowers about 6, lasting for about 3 weeks, white, except for an inside yellow patch on the lip. Flowering March-April.

Gregarious on rocks; rare elsewhere.

116. **Eulophia nuda** Lindl.

A ground orchid, with tuberous rhizomes, 45-60 cm. high when in leaf. Leaves from a lateral bud, elliptic, lanceolate 30-40×6-8 cm. appearing after the flowering, and lasting till December. Scape brown, 30 cm. long, bearing a raceme of 6-15 flowers; flowers purple. Flowering March-May. Fruits 4 cm. long.

Gregarious locally, but not widely distributed.

117. **Eulophia pratensis** Lindl. The Yellow Ground Orchid

Vegetative parts and habitat similar to that of *E. nuda* Lindl., but seldom gregarious, and slightly smaller in size. Scape 15-25 cm. long, bearing a raceme of 4-8 yellow flowers. Lip broader than long. Flowering December-February.

More widely distributed than the preceding species. The plant is very variable in size apparently on account of the kind of soil.

118. **Habenaria crassifolia** A. Rich.

A ground orchid with an ellipsoid tuber. Stems slender, up to 30 cm. high, with sheathing, lanceolate bracts. Leaves only 2, fleshy, radical, flat on the ground 2-3.5 cm. diameter. Racemes 12 cm. long with 15-25 flowers; flowers small, 0.6 cm. across; ovary and club-shaped spur 1-1.5 cm. each.

Abundant but restricted in distribution; occurs also in poor soil.

119. **Habenaria digitata** Lindl. var. **travancorica** Fischer

A slender ground orchid, 15-30 cm. high. Leaves spirally arranged; lower ones ovate-acute, 3-4×1.5-2 cm., upper ones narrower and acuminate. Racemes 8-15 cm. long, with 6-20 nearly green flowers, matching in colour with that of surrounding grasses. The plant is easily distinguished by the filiform segments of the petals curving upwards horn-like. Spur shorter than the ovary, both enveloped by a long bract. Flowers August-November.

Abundant in grass fields, and widely distributed.

120. **Habenaria longicalcarata** A. Rich. Elephant's Head

A ground orchid, 30-60 cm. high, from an oblong tuber. Leaves radical, 3-5, oblong-acute, 5-10×1-2 cm., mostly near the ground. Flowers terminal, 3-5 only, white. Spur 10-15 cm. long, green, thick. Flowering June-October.

Common but not abundant; more abundant at lower elevations.

121. **Habenaria longicornu** Lindl.

Plant similar to the preceding species, but smaller (20-35 cm. high), and occurring in clusters. Leaves cauline, 4-8, narrow 3-7× 1-1.5 cm., from near the ground. Flowers more numerous than in the preceding (3-8), lip 3-partite, ivory white, the side lobes finely toothed. Spur up to 10 cm. long. Flowers August-November.

Gregarious, often in thin soil on rocky ground.

122. **Habenaria perrottetiana** A. Rich.

A stout ground orchid, 30-60 cm. high. Leaves elliptic-acute, 4-8×2-3 cm., closely set, gradually passing into floral bracts. Flowers 4-12, yellow, nearly covered by the large foliaceous bracts. Sepals obtuse, concave, 1.5×0.8 cm.; petals erect; lip longitudinally folded. Flowers in November.

A rare plant.

123. **Habenaria rariflora** A. Rich.

A ground orchid, 8-12 cm. high, occurring in large numbers. Leaves basal, 4-5×1-1.5 cm., oblong-lanceolate. Flowers white, 3-4

in a raceme. Petals 2-partite, segments curved backwards. Spur slender, curved, 6-9 cm. Flowering July-September.

In large numbers on thin soil on or near rocks.

124. **Microstylis densiflora** Fischer

A brownish ground orchid, only up to 12 cm. high. Stems slender, bare below the flowering axis. Leaves usually 2, plaited, 6-8×2-3 cm., ovate-acute. Racemes many-flowered, often under 6 cm. long. Flowers purple. Lip reniform, finely dentate. Flowering June-September.

Common, at times gregarious.

125. **Nervilia carinata** Sch.

A low ground orchid, often hidden by grasses, with a single, long-petioled (6-8 cm.), orbicular leaf 4×4 cm., which appears in June after the flowering and remains till December. Flowering April-June. Scape about 10-15 cm. long, bearing 3-5 small, purplish flowers supported by long bracts. Sepals and petals pale green; lip yellow, with purple veins and spots.

Common and abundant about Shembaganur, hidden among grasses. Not mentioned by Fyson.

126. **Peristylus goodyeroides** Lindl.

A ground orchid 20-30 cm. high. Leaves on the lower half of the stem, oblong, 8×3 cm. Spikes 6-10 cm. long, many-flowered; flowers greenish white, small, with characteristic globose spurs. The sepals and the lateral petals form a hood over the rest of the flower. Flowering July-November.

Common, especially in dry places; more common at lower elevations. Not mentioned by Fyson.

127. **Phyllomphax obcordata** Sch. The Common Purple Ground Orchid

A ground orchid, 10-25 cm. high. Stems leafy throughout. Leaves ovate-acute, green with a purplish base, 4×1.5 cm., passing into bracts. Bracts leafy, longer than the ovary. Spikes of 6-12 flowers; flowers vary from purple to white. Spur short and broad. Flowers May-August, with a peak in July-August.

Common and at times very abundant; very variable in the size of the vegetative parts and in the colour, shape, and size of the floral parts, especially the lip.

128. **Phyllomphax obcordata** Sch. var. **jantha** Hk. f.

Similar to the preceding species but a larger plant, up to 35 cm. high, found in cool, moist places. Stems purplish, leaves green with

purplish nerves, and larger flowers. Lip 2.5 cm. across, purple. Flowers June-August.

Less common and abundant than the preceding species.

129. **Platanthera susannae** Lindl.

A robust, leafy, gregarious, ground orchid. Stem leafy, up to 120 cm. high. Leaves ovate-oblong, 6-15×3-8 cm., passing into leafy bracts. Bracts lanceolate 9×3 cm. Flowers 3-6, white, fragrant, 5-9 cm. across; lateral petals linear; lip very large with pectinate side lobes; spur 12-15 cm. long, hidden within the bracts. Flowers September-November.

Poorly distributed. The size of the whole plant and structure of the lip make this a very conspicuous ground orchid.

130. **Satyrium nepalense** Don The Pink Twin-Spur

A ground orchid, 25-60 cm. high. The lowest 2 leaves radical, large, 10-16×6-10 cm., broadly ovate, with a sheathing base, spreading flat on the ground. Spikes stout, 10-25 cm. long, many-flowered; bracts larger than the flowers. Flowers pink to white. Lip erect, with a spur hanging from either side. The ovary is not twisted. Flowers August-November. The dry scape sometimes remains for months.

Common and abundant. A very variable plant, but the variations do not warrant the splitting into varieties.

131. **Spiranthes australis** Lindl.

A slender ground orchid, 15-25 cm. high, with a bulbous rootstock and thick, white roots. Leaves 4-5, clustered at the base of the stem, oblanceolate, 5-10×0.8-1.2 cm. Scape 15-25 cm. high, slender; spike spirally twisted, 6-9 cm. long, bearing 30-35 flowers. Flowers small, white, spirally arranged. Flowering March-June.

Abundant in moist ground, but not well distributed.

HYPOXIDACEAE

132. **Curculigo orchioides** Gaertn. The Yellow Ground Star

A small herb, with a stout, vertical rootstock, with radical, plaited leaves. Leaves lanceolate, 10-14×1.5 cm. Flowers solitary, or a few, bright yellow, stellate, close to the ground. Flowers appear soon after the first showers in March-April. Stray ones throughout the year.

Fairly distributed and abundant. An abundance of flowers with the first showers after the dry months is characteristic.

in a raceme. Petals 2-partite, segments curved backwards. Spur slender, curved, 6-9 cm. Flowering July-September.

In large numbers on thin soil on or near rocks.

124. **Microstylis densiflora** Fischer

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Abundant in moist ground, but not well distributed.

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Fairly distributed and abundant. An abundance of flowers with the first showers after the dry months is characteristic.

LILIACEAE

133. **Disporum leschenaultianum** D. Don The Nilgiri Solomon's Seal

An erect, profusely branched herb, up to 120 cm. high, with a creeping rhizome. Leaves broadly ovate, 7×4 cm., glabrous. Inflorescence often of sessile, terminal umbels. Flowers white, pendulous or drooping from curved pedicels. Flowering May-August. Berries dark blue when ripe, by November.

In moist places, in sholas, but not well distributed.

134. **Iphigenia indica** Kunth.

A wiry herb, up to 20 cm. high, often hidden in the grass. Corms globose, covered with brown scales, 1×0.5 cm. Leaves linear, 12-15×0.5 cm. Flowers terminal, solitary or in pairs; deep purple; perianth segments filiform. Flowers with the first showers in March-April. Fruit an oblong, 3-valved capsule, 1×0.5 cm., ripe by August-September.

Well distributed, but not abundant. Not easily noticed in the grass except when in flower.

135. **Lilium neilgherrense** Wt. The Nilgiri Lily

An unbranched, erect, leafy herb, 60-120 cm. high. The underground bulb sprouts with the first showers in March-April. Leaves lanceolate-acute, 8-10 cm., sessile, glabrous. Flower buds appear by June; flowers 2-4, white, 15×10 cm., terminal, spreading, trumpet-shaped, strongly scented; flowering August-October. Fruit an oblong, loculicidal capsule 6-9 cm. long, dehiscing by January.

Common on slopes, the large flowers render this plant conspicuous.

COMMELINACEAE

136. **Aneilema dimorphum** Dalz.

A decumbent herb, with a non-tuberous rootstock; roots fibrous; the plant spreading by the lateral branching of the rootstock. Stems 10-15 cm. long, leafy at the base. Leaves 4-6×0.5-1 cm. Flowers bluish, regular, in terminal dichotomously branched panicles; from July onwards, with a peak in December; the plant begins drying up by January. In the shade flowers are seen later in the year. Capsule oblong.

Common in moist surroundings.

137. **Commelina clavata** Clarke

A decumbent herb, with slender, geniculate stems. Leaves 4-6×0.6-1 cm., alternate, with sheathing leaf bases which are

noticeably ciliate. Flowers biue, in scorpioid cymes, protected by a spathe. Flowers most of the year, with a peak in August-September. The plant dries up by December. Fruit a 4-angled, oblong capsule.

Common and abundant.

138. **Cyanotis arachnoidea** Clarke The White Spider Legs

A decumbent herb, covered all over with silky pubescence. Stems stout, 25-40 cm. long. Leaves 4-5×0.6-1.5 cm., acute. Flowers bluish, in terminal, subsessile cymes with bracts below. Flowers nearly throughout the year. Fruit an oblong capsule.

Common and abundant even in dry places.

PALMAE

139. **Phoenix humilis** Royle var. **pedunculata** Becc.

A perennial, erect shrub, up to 150 cm. high at this altitude. Stems marked with numerous leaf-scars. Leaves up to 120 cm. long, pinnate; leaflets 30-45 cm. long; spadix yellow, branched, monoecious; fruits orange when young, deep purple when ripe.

This is a plant typically belonging to lower elevations; one flowering was noticed in October. Only 3 plants were noted in the area under study. Not mentioned by Fyson.

ARACEAE

140. **Arisaema leschenaultii** Bl. The Common Cobra Lily

A juicy herb with a tuberous rootstock. Stems 60-90 cm. high, greenish mottled with purple spots. Leaf solitary, palmately compound; leaflets about 9, elliptic-lanceolate, 14×4 cm. The plant sprouts with the first showers in March-April; flowering May-July. Spadix enclosed in the spathe; sterile appendix stout, blunt. Fruits conical, on a fleshy receptacle, at first green, then red.

In shady places.

141. **Arisaema tortuosum** Sch. The Ratstail Cobra Lily

Very similar to the preceding species except for the sterile appendix of the spadix exserted from the spathe, resembling a rat-tail.

Same habitat as the preceding, but is less abundant.

ERIOCAULACEAE

142. **Eriocaulon brownianum** Ruhl. The Black-backed Hatpin Flower

A marsh herb with a thick rhizome. Leaves radical, linear, acute, 12-15×0.5-1 cm., tomentose. Scapes slender, 2-3 per plant, each

25-50 cm. long, tomentose, with a sheath 10-15 cm. long. Flowering March-June; flower heads flat. Involucral bracts appear whitish grey, but actually they are black, covered with silky tomentum.

Gregarious in marshy soil.

CYPERACEAE

143. **Kyllingia cylindrica** Nees

A perennial herb, with a thick rhizome, 2-4 cm. long. Stems 10-15 cm. high. Leaves radical, linear, 5-15 cm. long. Heads of white spikelets terminal on the stem, cylindrical, protected basally by leaf-like bracts. Flowering July-December, after which the plant dries.

Common, and fairly abundant in places.

144. **Mariscus cyperinus** Vahl

A perennial herb, with erect stems 15-25 cm. high. Leaves radical, linear, 15-25 cm. long. Spikes divergent, 2-5 cm. long, with leaf-like bracts at their base. Flowering June-December.

Common and very abundant in places.

GRAMINEAE

145. **Andropogon lividus** Thw. The Purple Grass

Culms usually 25-30 cm. high, smooth, thin but rigid. Leaves radical, linear, acuminate, 5-8 cm., erect. Spikes 2 only, 2-4 cm. long, terminal, divergent, purple; spikelets in pairs. Flowers May-December.

Common and abundant.

146. **Arundinella fuscata** Nees

An erect, stiff, perennial grass, 30-45 cm. high. Leaves mostly basal, narrow, linear 5-15×0.5-1 cm. Panicles 8-10 cm. long with a dense cluster of spikes. Spikes stiff, 3-4 cm., spikelets crowded along one side only of the spike, often in pairs, one spikelet having a longer stalk than the other. Flowering June-September.

Common and abundant.

147. **Brachiaria semiundulata** Stapf

A decumbent, villous grass. Leaves ovate, 1.5-4.5 cm. long, densely pubescent. Spikes 1-2 cm. long, few; spikelets irregularly arranged. Flowers August-November.

A shade weed. Common and abundant.

148. **Chrysopogon orientalis** A. Camus

A tall, handsome grass. Culms slender, up to 90 cm. high, with glabrous nodes. Leaves basal, 4.5-24×1-1.5 cm., acute, pubescent. Panicles 12-18 cm. long, branches ascending, bearing red hairs at the base of the spikelets. Spikelets in threes, middle one sessile and fertile, pale yellow, 0.6 cm. long; lateral ones pedicelled and sterile, 1.2 cm. long, red. The yellow anthers and stigmas against the red glumes, all raised up on a tall culm, make the plant conspicuous on the slopes. Flowers July-December.

Common and abundant.

149. **Eulalia phaeothrix** O. Kuntze The Auburn Tresses

A stout grass; culms 45-60 cm. high, with brown, tomentose, leaf-sheaths crowded at the base. Leaves slender, very sharp at the edges, acuminate, 15-45 cm. long. Spikes 5-10 cm. long, brown. Flowers June-September.

In large clusters near rocks.

150. **Heteropogon contortus** Beauv. The Spear Grass

A gregarious, variable grass; culms about 30-45 cm. high. Leaves from the middle of the culm, distichous, rigid, 3-7×0.4 cm. Spikes grey, 3-6 cm. long, with about 10 pairs of spikelets and a terminal odd sessile one. The spike terminates in a 'spear' made up of many awns twisted together. Flowers nearly throughout the year, with a peak in July.

Common and abundant. A troublesome weed, on account of the sharp and barbed awns which penetrate into the clothing of men and hairs of animals.

151. **Setaria pallidifusca** Stapf

A gregarious grass; culms about 30-40 cm. high. Leaves linear, 14-20×0.5 cm. Spikes cylindrical, usually 6 cm. long, pale yellow to reddish brown; spikelets dense, ovate-elliptic, 0.3 cm. long, deciduous, with about 10 barbed awns. Flowers September-November.

Abundant as a weed in gardens, scarce elsewhere. A fodder grass.

152. **Themeda cymbaria** Hack.

A robust, perennial grass; culms erect, up to 3 m., clothed with broad, coriaceous leaf-sheaths at the base. Leaves linear, up to 120 cm. long. Inflorescence 30 cm. or longer, a decompound spike; the individual spikes have each a spathe-like bract at the base and

consist of 6-11 spikelets. Flowers July onwards. The plant dries up or is burnt by January. Fresh leaves with the first showers.

Common on slopes.

153. **Themeda triandra** Forsk.

An annual, erect grass; culms up to 3 m. tall. Leaves linear. 25-50 cm. long. Spikes crowded, drooping in globose fascicles. Flowers July-November.

Common.

154. **Tripogon bromoides** Roth.

A slender, tufted grass; culms 10-40 cm. high, slender but rigid. Leaves 8-20 cm. long, rolled. Spikes 6-10 cm. long; spikelets 1.5 cm. arranged closely in two rows.

Gregarious near rocks.

Acknowledgements

To Fr. J. Pallithanam, S.J. for the suggestion of the subject, to Fr. J. Vincent, S.J. for the notes on soil and climate, and to Fr. H. Santapau, S.J. for his patient correction of the manuscript, for his constructive criticisms and valuable suggestions for improvement, are due the thanks of the author.

References

Fyson, P. F. (1932) : The Flora of the South Indian Hill Stations. Madras.

Gamble, J. S. & Fischer, C. E. C. (1916-1935) : Flora of the Presidency of Madras London.

Hutchinson, J. (1926, 1934) : The Families of Flowering Plants. London.

Lloyd, E. M. M. (1909) : Guide to Kodaikanal and its History. Kodaikanal.

Robinson, M. E. (1935) : The Flowering of *Strobilanthes* in 1934 (with 8 plates). *JBNHS* **38** : 117-122.

Santapau, H. (1955) : Botanical Collector's Manual. New Delhi.

Wadia, D. N. (1953) : Geology of India. London.

Fishing Methods for the Indian Shad [*Hilsa ilisha* (Hamilton)] in the Indian Region

BY

S. JONES

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PART II

(With 3 text-figures and 7 plates)

(Continued from Vol. 56, page 275)

6. Andhra Pradesh

The most important rivers in Andhra Pradesh where hilsa fishing is carried out are the Godavari and the Krishna. Hilsa is caught from the sea also along the Andhra Coast.

Gill net

Rangoon vala (Rangoon net). This is a drift net introduced from Rangoon, Burma, and is used below the anicuts in the Godavari and Krishna rivers for catching hilsa. In the Godavari, I have seen it being used below the anicuts at Bobberlanka, Maddurlanka, and Bigneshwaram, and I was informed that it is used in a similar manner at Dhowleshwaram also. Each net is 30 metres or more long, about 5 to 5.5 metres broad, and of fine netting with 10 to 13 cm. mesh. The head-line has a series of floats of *Avicennia* roots at regular

intervals while the lower portion is free. At one end of the head-line is a buoy of gourd and the other end is tied to the boat. The boat is manned by two or three persons and one person is in charge of the net. The boat is taken towards the anicut along one side of the river and, on approaching the eddies in the vicinity of the foot of the fall, the buoy is thrown into the river and then the net is paid out, the boat in the meanwhile proceeding to the opposite side trying to keep a course parallel to the anicut. What actually happens is that by the time the whole net is paid out, the boat as well as the net has drifted down a considerable distance. The fish ascending the river towards the anicut get gilled in the net that drifts down in the opposite direction. When the desired distance is traversed downstream, the boat is rowed back towards the opposite shore (from where it first started) hauling in the net and collecting all the gilled fishes. The process is repeated, the catches being more when the flood level is high and the current strong. The whole operation is diagrammatically represented in Plate XVI, fig. 18.

Seines[1]

Pedda ayilu or *Pedda vala.* This is a drag net composed of 6 to 10 pieces, each 30 metres long and 18 metres broad with 2 to 2.5 cm. mesh. The head and ground ropes are made of coir and are provided with wooden floats and brick sinkers respectively. Two six-ton boats pay out the nets simultaneously as they proceed towards the shore describing a semicircle. The end ropes are given to two groups of 30 to 35 men on the bank to be dragged as a typical shore seine. The net is operated in the estuaries of the Godavari River and is reported to bring in heavy catches of hilsa.

Vusa vala. This is a drag net about 460 to 600 metres long and about 3 metres broad with floats about 1.5 metres apart along the head rope. The mesh is about 10 cm. and the ground rope has burnt bricks as sinkers. The net is cast by a couple of boats and then hauled from the bank of the estuary as typical shore seine.

Thelu vala. This is a boat seine about 530 metres long and 2.7 metres broad with 10 to 13 cm. mesh and 350 floats along the head rope and brick weights along the ground rope. It is operated in combination with *kettu vala* below the Godavari anicut when the level of the water begins to fall after the floods. *Kettu vala* is a wall net about 460 metres long and 1.5 metres broad with about

[1] My thanks are due to Mr. I. Ram Mohan Rao, Deputy Director of Fisheries, Andhra, for kindly arranging to furnish the information on the drag nets used for hilsa fishing in Andhra State.

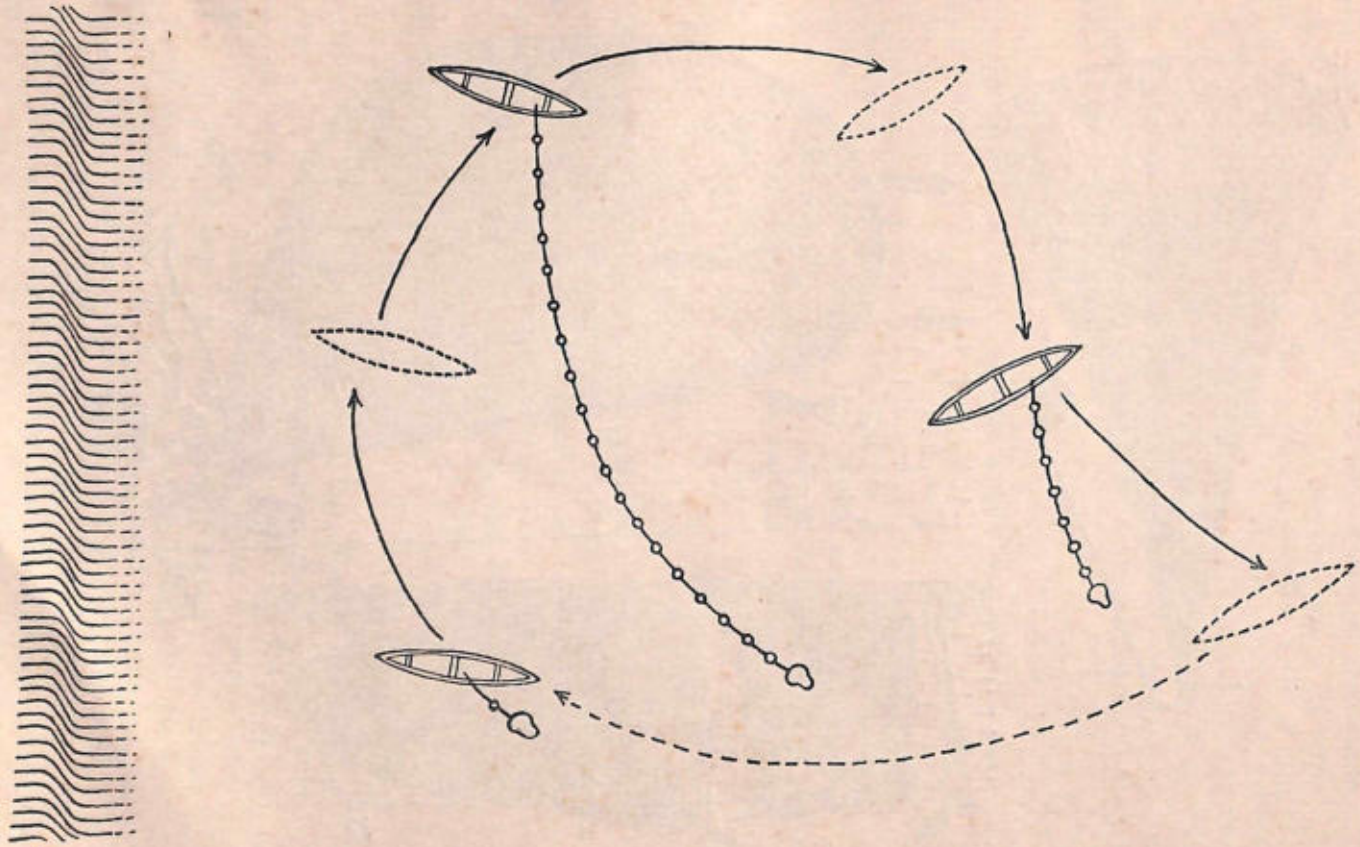


Fig. 18. Diagrammatic representation of the operation of the *Rangoon vala* in the Godavari (Andhra). (By M. Mydeen Kunju).

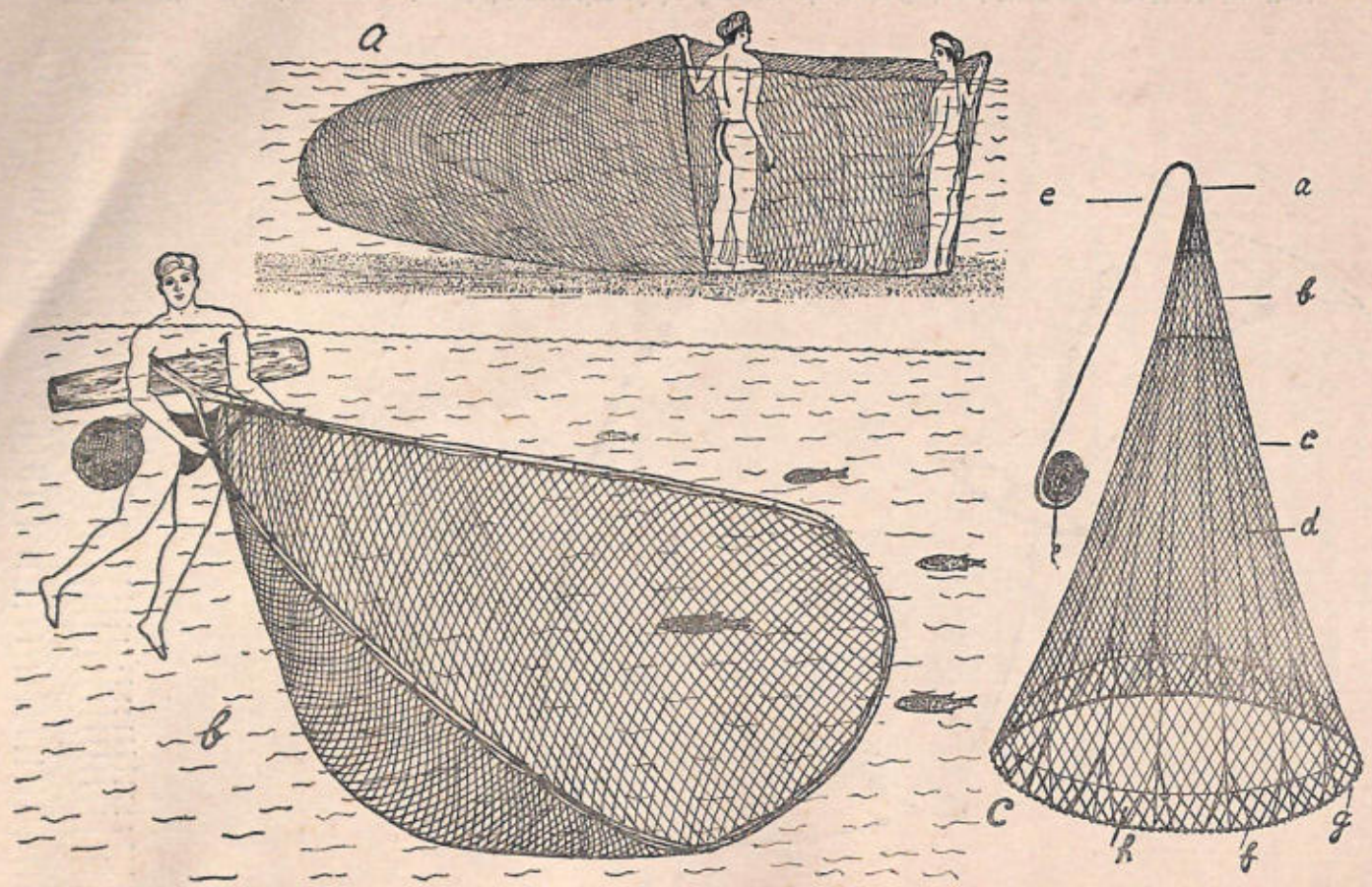


Fig. 19. a.—*Thuri valai* of the Coleroon, Madras. (M. P. Lakshmanan).
b.—*Kappu valai* in the Coleroon, Madras. (Modified from Hornell 1950).
c.—*Veechu valai* of Cauveri Delta. (By M. Kumaran).
a=*Mothiram;* b=*Patsipathal;* c=*Mal;* d=*Vanku-kayir;* e=*Ul-kayir;* f=*Kala-kayir;* g=*Mani;* h=*Velladi.*

10 cm. mesh with coir head rope and ground rope without floats and sinkers. This net is firmly tied to poles fixed across the river below the anicut with the bottom rope close to the river bed. The *thelu vala* is loaded in two boats of 4 to 6 ton capacity with about 6 men in each and is cast some distance away from the *kettu vala* and the two boats proceed towards it making an encircling movement. The *thelu vala* is dragged close to the *kettu vala* and the fish that congregate in the diminishing space are hauled into the boats. The operation is repeated till most of the fish in the particular area are caught.

Pelagic trawl

Iriga vala (Pl. IX, fig. 11 *a*). This has already been described under Orissa (p. 265).

Cast nets

Vessur vala. Two ordinary cast nets are joined together side to side and cast in a circle with the help of two boats. The water is disturbed with bamboo sticks when one side is still open. The nets are then hauled out of water into the respective boats and the fish, if any found inside, is taken out.

7. Madras[1]

The important hilsa ascending river in the Madras State is the Cauveri and its main deltaic branch, the Coleroon. Most of the fishing is done below the lower anicut in the Coleroon. Hilsa is caught during certain months from the sea also. Both *Hilsa ilisha* and *H. toli* occur in the sea off the Coromandel Coast. The *Kappu valai* fishing and the fish drives in the Coleroon have already been mentioned by Hornell (1946 and 1950).

Gill nets

Kanni valai. This is an untanned gill net about 55 metres long and about 3 metres broad. It is made of 14 ply 20 count cotton thread and the mesh is of 3 inches. The head rope has floats of *Calotropis gigantea*, locally known as *erukh* or of *Erythrina indica*. There are 70 floats in all tied at intervals of 12 meshes. The ground rope has weights of burnt clay (5 cm.×2 cm.) at irregular intervals. At one end of the head rope is a long pointed threading peg or

[1] I am indebted to Mr. Ranganathan, Assistant Director of Fisheries, Tanjore, Mr. Balasubramanian, Inspector of Fisheries, Kumbakonam, and Mr. Kesavan, Inspector of Fisheries, Negapatam, for local assistance rendered during my visit to the Cauveri Delta to study the hilsa fishing methods.

korpan-kutchi of the Portia Tree (*Thespesia populnea*) measuring about 50 cm. which is used for gathering the net in folds. The net is held against the current by 8 to 12 persons who stand in a row along the entire length of the net treading on the foot rope. The net portion, known as the *maal*, curves in the form of a bag by the force of the current.

Kettu valai. The *kanni valai* mentioned above is used without the floats and sinkers as a fixed gill net. The head and ground ropes are stouter and these are tied to stakes and fixed in the bed of the river. For a single net about 55 metres long, 8 stakes are fixed equidistant from one another, and the length of one operational unit will depend on the stretch of river to be covered.

Quite often *kanni valai* and *kettu valai* are operated in combination and invariably so at the time of regular fish drives referred to on p. 428.

Rangoon valai or *Ulla valai* or *Ullam valai* or *Kanni valai* (Drift net). This is a drift net of the type used in the Godavari and the Krishna rivers. It is operated in the lower reaches of the Cauveri and its deltaic branches during low tides. Formerly the net was obtained readymade from Rangoon, Burma, and hence the name *rangoon valai*. At present they are made locally from mill-made yarn (equivalent to 10 count 6 ply thread) and is said to be not as effective as the imported ones. The mesh size is 11.5 cm. and an operational unit consists of 6 pieces, each 27 metres long and about 5 metres wide joined together. The head rope has small floats of *Avicennia* roots, 2 metres apart from one another. There are no weights or ground rope. The net is cast across the river and is allowed to drift down with the boat during low tide. Small nets operated in canals are sometimes known as *ulla thundu* or *ullathundu valai*.

Thedachi valai. This is a gill net operated along the Coromandel Coast for all kinds of fishes. During the months of April and May some quantities of hilsa, presumably both *Hilsa ilisha* and *Hilsa toli*, are caught from the sea with this net. In some places including Cuddalore and Pondicherry this is also known as *kanni valai*.

Thedachi valai is a long untanned gill net of 11 cm. mesh made of 3 ply 10 count or 9 ply 20 count cotton yarn. Its length varies from 185 to 460 metres and the breadth is about 3 metres (covered by 24 meshes). The head rope has wooden floats 4 metres apart and the ground rope has stone weights alternating with them. The net is operated from a catamaran with a crew of 3 or 4 persons during night time. After the whole net is paid out, the catamaran is anchored and the fish that get gilled are removed from time to time.

Thuri valai (Pl. XVII, fig. 19 *a*). The net known by this name in the Lower Anicut is quite different from the well-known *thuri valai* of the Coromandel Coast operated in the sea like a pelagic trawl with a pair of catamarans. The *thuri valai* of the Lower Anicut is a simple dome-shaped net of about 7 metres in circumference and shaped into a bag about 1.5 to 2 metres deep when set against the current. It is made of 20 count 12 ply or 10 count 6 ply cotton yarn with a stout cord along the circumference which prevents the net from getting unduly stretched out. The net is held against the current by two persons who tread on the lower margin to keep it close to the bed of the river. It is used close to the anicut and all fishes including hilsa that are carried down by the force of the current get gilled.

Push nets

Kappu valai (Pl. XVII, fig. 19 *b*). This is the simplest type of net in operation and consists of a large oval ring net fixed to the V-shaped (forked) branch of some hardwood tree like *Thespesia populnea*. The height of the net including the handle is from 3 to 3.5 metres and the greatest width from 1.2 to 1.5 metres. The ring is made up of a pair of small bamboos, split or whole as the case may be. The handle is about 46 cm. long and the fork about 30 cm. In some a cross bar is tied across the extremities of the fork to give strength to the frame. The net is made of 20 count 6 ply or 40 count 8 ply cotton thread. The size of the mesh varies from 2.5 to 6 cm., the larger meshed ones being used when operated for hilsa.

The *kappu valai* is used in two ways. When specially used for hilsa at the time of high floods, it is used as drifting push net by a person who floats down the river on a log of wood with the net held in front in which the ascending fish get gilled. The gilled fish are removed and deposited in a palm leaf bag with a detachable lid having a *chevaux de frise* opening which prevents the escape of a fish, or it is killed by biting and threaded on to a cord tied to the waist. After covering some distance the person gets on to the bank, retraces the distance on foot and repeats the process.

It is also used in the manner of a typical dip-net by fishermen who remain standing in the water by the side of open sluices. All varieties of fish including hilsa that congregate in such places are caught.

Cast nets

Veechu valai (Pl. XVII, fig. 19 *c*). This is extensively used in the Cauveri system and perhaps the largest group of fishermen operating

this net is at the Lower Anicut. All kinds of fishes from tiny carp minnows to large sized catfishes are caught with the help of this net. The mesh is quite variable but when mainly used for hilsa large meshed ones are used. The *veechu valai* of the Cauveri Delta is essentially the usual type of cast net of peninsular India. It is made of 20 count 10 ply cotton thread with 6×8 cm. mesh. The depth is about 3 metres and the circumference about 13 to 15 metres. There are about 150 iron weights of about 3 cm. length and 1.5 cm. thickness. Each part of the net has a name and these are indicated in the diagram. It is generally used untanned.

The *veechu valai* is operated in two ways. The commonest method is to remain on the bank or up to waist-deep water close to the shore and cast the net as usual and collect the caught fish in the palm leaf basket hung at the waist. Generally ten to twenty men stand more or less *en echelon* on either side of a pool near the sluice gate and cast the net giving very little chance for any fish in that stretch of water to escape. The other method known as *theppam* veechu (Pl. XVIII, fig. 20) is followed when fishing in deeper waters by a fishing unit of two persons. The fisherman stands on a raft made of about 5 or 6 logs of light wood locally known as *kalyanamaram* (*Erythrina indica*) and another person who wades in the water pushes the raft to the desired place.

Fish drives (Pl. XIX, fig. 21). The fish drives in the Coleroon in the Cauveri delta were events of considerable local importance in former days with the semblance of a *mela* when, unlike as at present, there was greater flow of water and more frequent floods in the river. With the construction of a number of dams and anicuts in the upper stretches of the Cauveri and its tributaries for diversion of water for irrigational purposes, floods are rare and even where they occur are only of very short duration reducing the hilsa fishery to an ephemeral feature.

The method generally adopted is as follows: Stakes are fixed across a selected portion of the river and *kettu valai* is tied to them so as to prevent the escape of fish. A number of *kanni valai* are joined together to cover the width of the river and the whole net is dragged towards the *kettu valai* by a number of fishermen. As hilsa collect together in large numbers in the diminishing space between the two nets, they are removed with the help of dip nets, scoop nets, etc. When the *kanni valai* meets the *kettu valai* the former is lifted up bringing into it most of the remaining fish. Auxiliary nets are brought behind to ensure the capture of the fish that escape from the net in front.

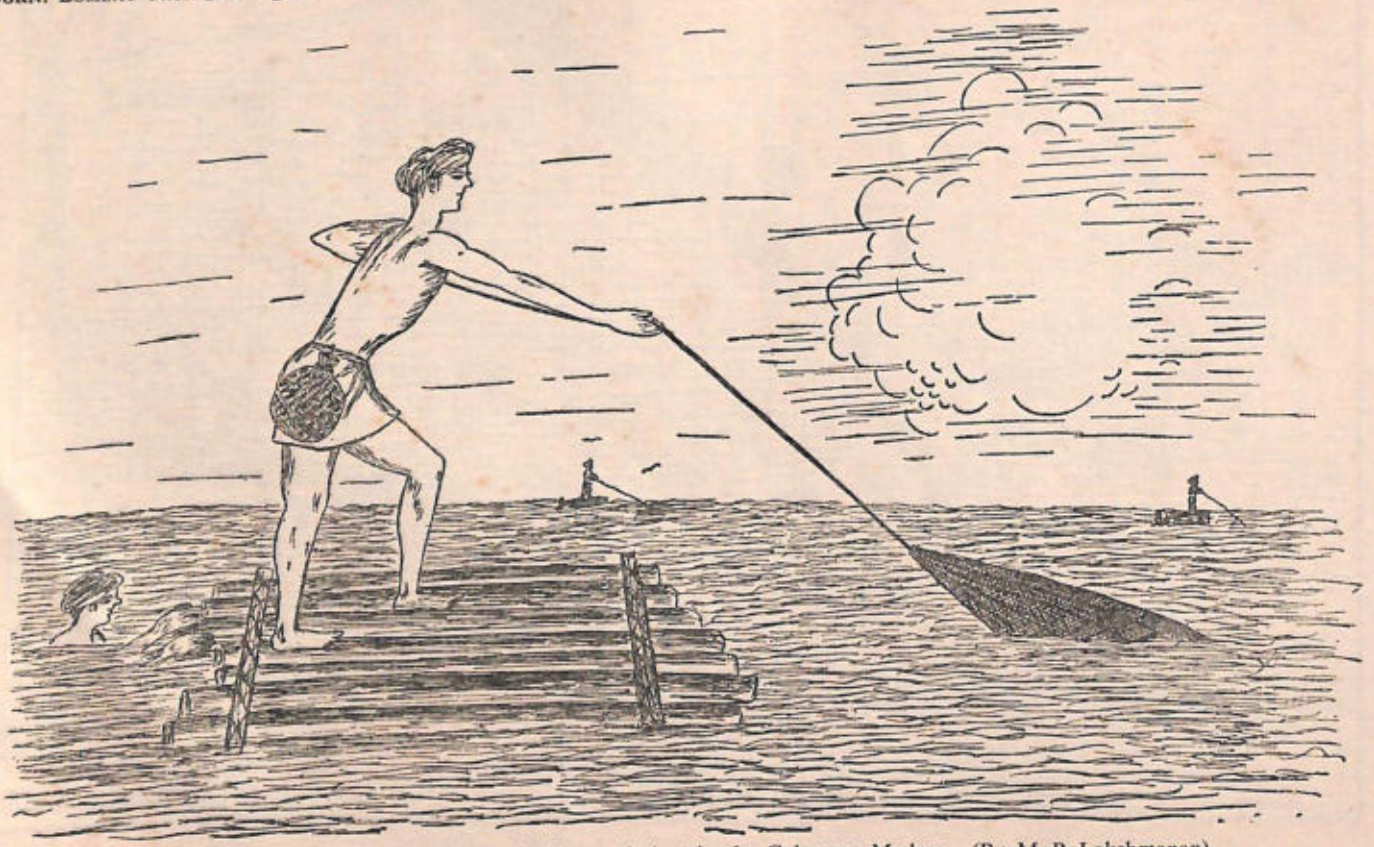


Fig. 20. *Theppam veechu* below the Lower Anicut in the Coleroon, Madras. (By M. P. Lakshmanan).

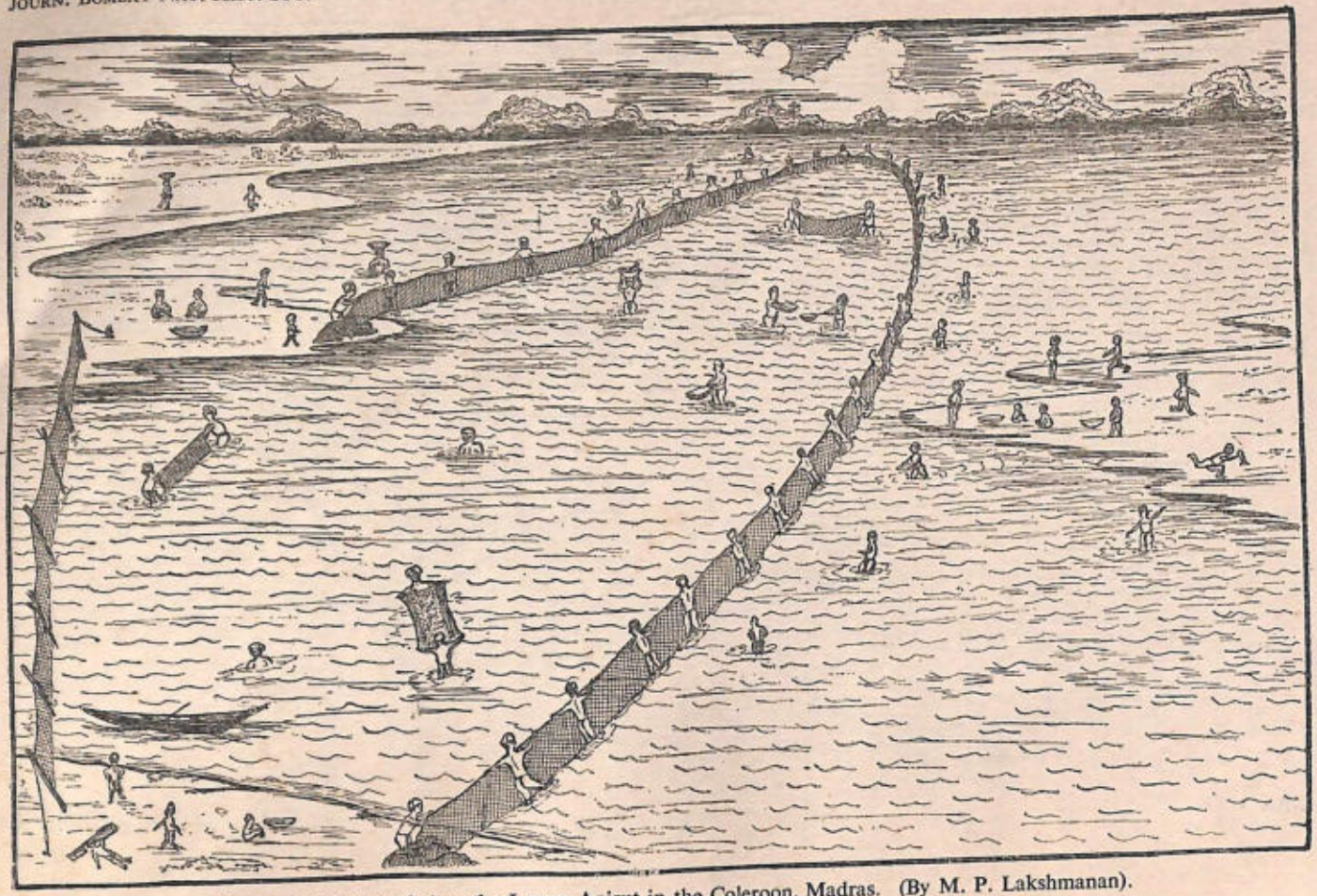


Fig. 21. Fish drive below the Lower Anicut in the Coleroon, Madras. (By M. P. Lakshmanan).

The operation is repeated whenever appreciable quantities of hilsa are known to be present in the river. The fishing rights in the river system are auctioned by the Government and the fish drives are organised by the lessees concerned.

8. Bombay

Kulkarni (1951) has given in fair detail, the methods employed for catching hilsa in Narbada River and its estuary. The fishing methods by the Bhils in the Narbada River have very interesting parallels in the Cauveri and Indus rivers in Madras and Sind respectively.

Gill nets

Budichi jal (Pl. XX, fig. 22 *a*). The fishing done in the Narbada estuary with this sunken drift net has been described by Kulkarni (1951 p. 619) as follows:

'The usual gear employed for large scale capture of hilsa in the Narbada River is sunken drift-nets. They are ordinary drift-nets, but, instead of floating near the surface they are set almost near the bottom and drift at that level. Each piece is about 72 feet long and 7 feet deep. Ten or twelve such pieces are joined together end to end as a single unit and are allowed to drift as a vertical wall. The nets are generally made of twisted hemp with a mesh of 5 inches (stretched mesh). Triangular pieces of burnt clay with a hole in the centre or some other similar articles are tied to the lead line and used as sinkers. About 16 floats, generally made of dry gourds are tied to the cork line (head rope) to keep the entire net erect in the water. The net is similar to the "Palwa jal", or "Hilsa net" described by Pillay (1948), which fishes at the surface. The position of floats on the surface gives the impression that the net is on the surface but actually there is a long string between the floats and the net (text-fig. No. 2). This length is adjusted according to the depth of the water fished so that the net remains in reality near the bottom of the river. In some places the earthen sinkers dangle half a foot below the head line (foot rope), so that the chances of the net getting entangled in bottom debris are reduced.'

'The boats used for the fishing are all flat bottom boats of about a ton in capacity varying from 20 to 30 feet in overall length. Each boat has a crew of three or four, one of whom is a skipper ("tindel") who manages the boat while the others operate the nets. After the net is cast, one end of it is tied to the boat which also drifts along with the net. It is paid out across the stream almost at right angles to the current so that it drifts downwards slowly and the fish swimming

upstream are enmeshed in it. After about half an hour, the net is hauled up to remove the catch and is paid out again for further operations. During spring tide period, these operations are continued day and night, and are suspended only when the catches dwindle towards the end of spring tide period.'

Palwa jal. This net is operated at Kodinar on the Kathiawar coast (Pillay 1948). It is a cotton drift net of 5 cm. to 6.3 cm. mesh made up of 30 to 50 pieces, each piece 28 metres long and 2.7 to 3.7 metres deep with a number of wooden floats tied to the head rope which is about 1.5 cm. thick. The foot rope is thin and without sinkers. The different pieces of netting are tied together by means of the free ends of the head and foot ropes and the composite piece is paid out so as to form a long wall of net drifting with the current. Fishing is carried out in the sea and the net is operated both day and night.

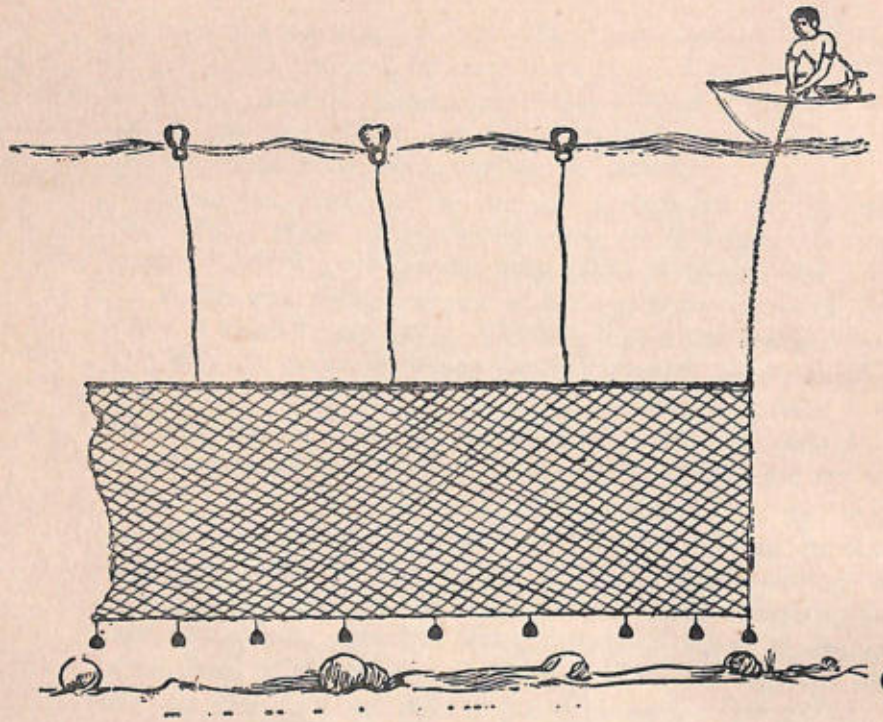
Valli jal[1]. This is a fixed gill net operated in the marine and inshore areas of the Veraval and Porbunder coasts in Kathiawar. The operational net used in the Veraval zone consists of 30 to 40 pieces, each about 31 metres long and 2 metres broad with 10 cm. mesh. The head rope has wooden floats of about 30 cm. long and 7 cm. thick at about 2 metre intervals. The foot rope has no sinkers but the two ends are anchored and buoyed. Yarn of 12 ply 20 counts is used for the net and 12 ply 6 counts for the head line. The fishing season is from August to October and March to May. The net is operated in the early hours of the morning and hilsa is caught along with other fishes.

The *valli jal* of Porbunder zone is a multipurpose drift net operated in the sea from September to November and April to June. Each piece is about 77 to 86 metres long and 3 metres deep with 15 cm. mesh made of 12 ply 20 counts yarn and 7 such pieces are laced together to make one operational net. The head rope has cylindrical wooden floats at 2.5 metres interval.

Khanderi jal[1]. This is a gill net operated during the rainy season in the estuaries and creeks of the Veraval zone. Each piece is about 130 metres long and 3.7 metres deep with 7 cm. mesh made of 6 to 9 ply of 40 to 20 counts yarn. This is also a multipurpose net and hilsa forms one of the catches.

Pankha rach[1]. This is a fixed gill net operated in the estuarine areas of the Jamnagar zone. Each piece is about 29 to 36 metres long and 4.7 to 5.5 metres deep with 9 to 10 cm. mesh and 7 to 8

[1] Information on *valli jal*, *khanderi jal*, and *pankha rach* has kindly been furnished by Mr. K. R. Srivatsa, Director of Marine Products, Rajkot, Saurashtra.



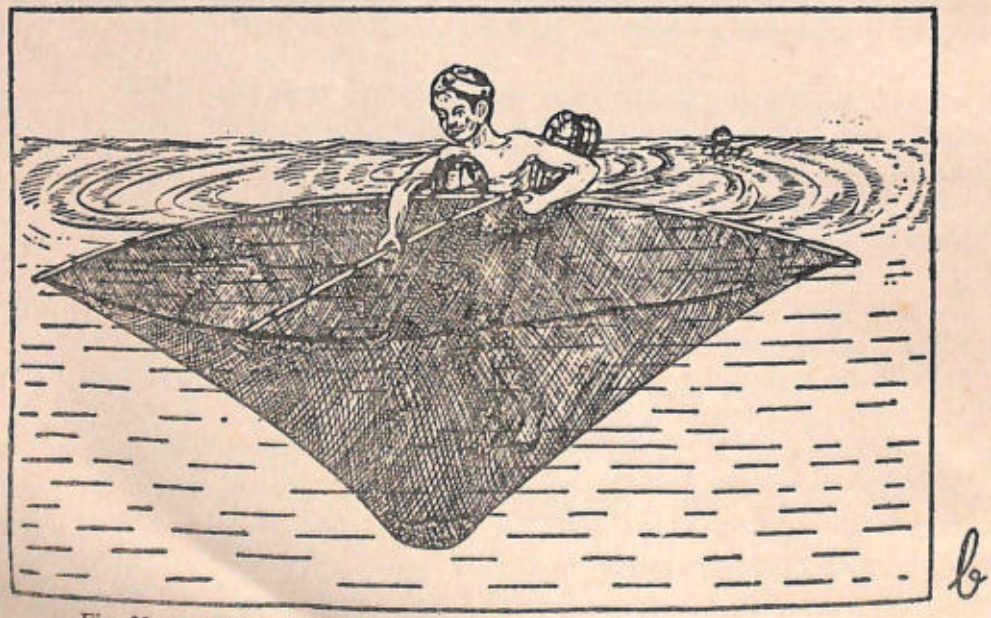


Fig. 22. a.—*Budichi jal* of Bombay. (After Kulkarni 1951).
b.—Operation of the *Jamda jal* of Bombay. (After Kulkarni 1951).

such pieces are laced together and used at a time. The head rope is tied to two poles fixed in the estuary while the ground rope which is provided with sinkers remains pressed against the mud at the bottom. All kinds of fish including hilsa are caught.

Lift net

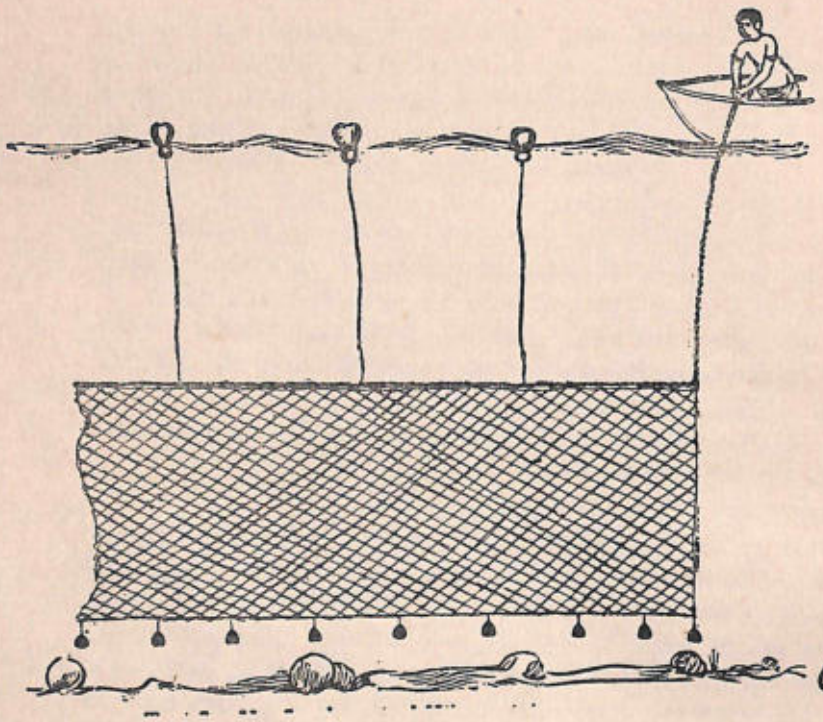
Jamda jal (Pl. XX, fig. 22 *b*). In principle this is similar to the *kappu vălai* fishing by the Cauveri (Madras) fishermen and the *sumbokee* and *matlee* fishing by the Sind fishermen. The fishing has been described in detail by Kulkarni (1951). The 'Bhil' fishermen catch the ascending hilsa with *jamda jal* during high tide when the maximum movement of the fish is expected. The *jamda jal* is a dip net with a loose bag-like net portion and a wooden cross bar across the centre (see Kulkarni op. cit. for particulars). The fisherman with the net in his hands drifts with the current supported on a float of dry gourds encased in a meshwork of coir. As soon as an ascending hilsa strikes the net, it is lifted and the fish is retrieved and secured to a cord with a float at the end tied to the waist of the fishermen. Eight to ten fishermen drift down in a line and cover in one operation a stretch of river about 5 miles long and then walk back to the starting place. Each fisherman gets five to ten fish a day.

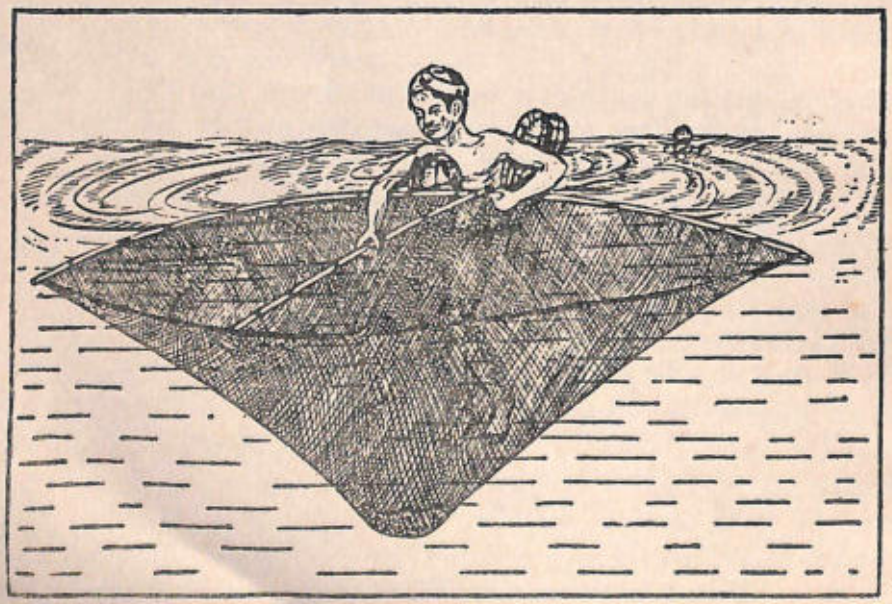
II. PAKISTAN

In Pakistan from the hilsa fishery point of view, East Bengal constituting the eastern wing of the country is the most important while Sind lying in the western wing comes next in order.

1. East Bengal

As stated already under West Bengal the fishing methods employed in the two Bengals are the same in principle as well as in details. All the methods enumerated under West Bengal are employed in East Bengal also, except that in view of the vastness of the fishing areas and greater fishing activity, a number of modified methods are in vogue. Ahmad (1952 & 1954) in recent accounts on the fishing gear of East Pakistan and Hilsa Fishery of East Bengal has described briefly the methods employed there for catching hilsa and the relevant extracts from it are quoted here. The description of the *bundh jal* is based on the information furnished by a fisherman who migrated from East Bengal.





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Clap nets

Kharki jal. See under West Bengal (p. 252). This is known as *sharki jal* in Pabna and the dimensions of the net which vary in different districts (Ahmad 1954 *a*) are given below:

Rajshahi.—3.7 to 5.5 metres by 3 to 3.7 metres, with mesh of 4 cm.
Pabna.—6.7 to 7.3 metres by 4.5 metres, with mesh of 6.3 cm.
Kushtia.—8.2 metres by 1.8 to 4.2 metres with 5 to 7.5 cm. mesh.
Faridpur.—7.3 to 9 metres by 7.3 to 9 metres with 9 cm. mesh.
Dacca.—9 metres by 4.5 metres with 5 cm. mesh.
Tippera.—6 metres by 7.3 metres with meshes from 4.5 to 5.7 cm.

Shangla jal. See under West Bengal (p. 253). This net is known as *khosh jal* in Bakarganj, *hilsa jal* in Mymensingh, and *lawa jal* in Sylhet. The dimensions of the net in the different districts as reported by Ahmad (1954) are as given below.

In Rajshahi it measures 4.5 to 5.5 metres by 3 to 3.7 metres with 4 cm. mesh, in Rangpur 4 to 4.5 metres by 5.5 to 6 metres with meshes from 5 to 6.3 cm., in Pabna 7.3 by 3.7 metres with 5 cm. mesh, and in Khulna 9 metres by 2.1 metres with 2.5 to 4 cm. mesh. In Kushtia it is 6.2 to 8.2 metres by 1.8 to 2.7 metres with 5 to 7.5 cm. mesh, in Tippera 7.3 to 8.2 metres by 3.7 to 4.9 metres, with 2.5 to 6.3 cm. mesh.

Biri jal. This in principle is similar to the *shangla jal.* Ahmad (1954) has described this net which is used in Mymensingh throughout the year for catching small-sized fish. It is 9 metres long and 14 metres wide, the meshes of the upper part of the net being 6.3 cm. while the meshes of the lower part are as small as .3 cm.

Honga jal. 7 metres long, 3 metres in breadth, with 5 to 10 cm. mesh, is used in the district of Sylhet from April to November for catching hilsa and is similar to the *biri jal* (Ahmad 1954).

Gill nets

Apsha jal has weights attached to its lower rope and nets used in Bakarganj measure 274 metres in length, 6 metres in width, with 2.5 cm. mesh. It is used from November to March for fishing hilsa (*Hilsa ilisha*) and some other species. *Apsha jal* is also used in Faridpur.

Barain jal. 9.5 metres long, 7.5 metres deep, with mesh size of 4 cm. This net is employed in the district of Chittagong in September and October for capturing hilsa.

Chhandi jal. See under West Bengal (p. 254) for the description of the net. In East Bengal it is employed for gilling hilsa from May to October in the districts of Chittagong, Noakhali, Bakarganj, Pabna,

Dacca, Tippera, and Faridpur. The net is laid at night and hauled in the morning (Ahmad 1954).

Chapila jal. Measures 150 metres by 27 metres with 1.3 to 2.5 cm. mesh and is used in the district of Mymensingh throughout the year for catching chapila (*Gadusia chapra*), bhangon (*Mugil* sp.), pangas, and hilsa (Ahmad 1954).

Dar jal measures from 5.4 to 9 metres in length, 4.5 to 8 metres in depth, and has meshes from 4 to 5 cm. It is used in the district of Tippera from April to November for catching hilsa (Ahmad 1954).

Dora jal or *Ilish jal.* See under West Bengal (p. 254).

Era jal is made of Sun-hemp and is used in the district of Bakarganj. It measures up to 723 metres in length, 12 metres in depth, with meshes from 9 to 12.5 cm. It is employed for catching hilsa from May to November (Ahmad 1954).

Har jal is used in the district of Bakarganj by joining a number of pieces to form a net 610 metres long and 22.4 metres deep. The meshes of the nets are 5 cm. It is operated for catching hilsa, silond, pangas, etc., from June to November (Ahmad 1954).

Khot jal is 15.2 metres by 4.5 metres with 5 cm. mesh and is used in the district of Bakarganj from June to November for capturing hilsa (Ahmad 1954).

Pye jal. According to Ahmad (1954) this net is used in Bakarganj throughout the year for catching a variety of fishes including hilsa. It is 274 metres by 6 metres with 2.5 cm. mesh.

Tuni jal is used in the district of Tippera for catching hilsa during the months from April to June. It is 13.7 metres by 6.7 metres and has a mesh of 5 cm. (Ahmad 1954).

Seine nets

Bara jal. See *jagat ber jal* under West Bengal (p. 257). According to Ahmad (1954) this net is also known as *jagat ber, gogar* and *maha jal.*

Ber jal. This net is reported to be used both as a drag net as well as a seine net. See under West Bengal (p. 256).

Kona jal or *Bhasha gulli.* See under West Bengal (p. 257). The size of the net differs considerably in the different parts of the country. In Faridpur this net has only one pocket situated at one end. The net alone measures 9 to 10 metres by 6.3 to 11 metres with mesh of 5 cm. (Ahmad 1954).

Chhota ber jal. From the name (*chhota*=small) it means a small *ber jal.* This is used for catching a variety of fishes except in

Bakarganj where this is employed for catching hilsa. The net is about 91 metres by 4.6 metres with mesh of about 4.5 cm.

Dhop jal. This net is used in the district of Bakarganj for catching pangas and hilsa. It is 36 metres by 9 metres with 2.5 cm. mesh and has both floats and sinkers. A number of pieces are joined together for operation and is hauled while still afloat (Ahmad 1954).

Ghai ber jal. This is a very large seine net measuring up to 723 metres long and about 13.7 metres deep with 2.5 cm. mesh used for catching hilsa in the district of Bakarganj from November to April (Ahmad 1954). It has a series of pockets which prevent the fish from escaping.

Gulti jal. The net measures 305 metres in length, 6 metres in depth, and has mesh of 6 cm. It is used in the district of Bakarganj from June to November for catching hilsa. It has both floats and sinkers and has pockets (*ghai*) at the lower end which are formed by doubling up about half metre of the lower margin (Ahmad 1954).

Gultin jal is a hilsa net used in the district of Bakarganj, from April to September for catching hilsa. It is 46 metres long, 13.7 metres deep, with 5 cm. mesh. Like *gulti jal* it has pockets at the lower extremity and is also provided with floats and weights (Ahmad 1954).

Jangla jal. This net is used in the districts of Bakarganj, Pabna, Jessore, and Faridpur. In Faridpur it is 12 metres by 7.3 metres with mesh of 6 cm. and is operated from December to April for catching hilsa and a variety of other fishes. In Pabna the dimensions of the net are 9 metres by 3.7 metres with mesh of 1.3 cm. and the net is used from October to December for catching prawn. A number of pieces of the net are often joined at the time of operation. The lower end of the net is doubled up and is sewn to form pockets. The net is known by the name of *jangalia jal* in Bakarganj. In Pabna the *jangla jal* is used for catching hilsa (Ahmad 1954).

Kochal jal. See under West Bengal (p. 255). 'This net is called *kochal* in Kusthia, Pabna, Rajshahi, Bogra, and Dacca; *dora* and *kochal* in Jessore; and *kochal* and *jangil* in Bakarganj' (Ahmad 1954).

Patan jal. This net is used for catching hilsa in the districts of Pabna and Bakarganj. In Pabna it is 61 metres by 6 metres with 5 cm. mesh and is used from June to August, whereas in Bakarganj it measures 274 metres by 13.7 metres and has 5 cm. mesh. It is used for catching other fishes also (Ahmad 1954).

Tana ber jal. See under West Bengal (p. 256). This net is used in Dacca from September to May for capturing carp and hilsa and measures 152 by 4.6 metres with 5 cm. mesh. It has no sinkers (Ahmad 1954).

Drag nets

Ber jal. See under seine nets (p. 256).

Dara jal. This net measures 274 metres by 4.6 metres and has mesh of 6 cm. and is used for catching hilsa from November to April in the district of Bakarganj (Ahmad 1954).

Trawl net

Jangalia jal. This is a simple type of hand trawl. About a third of a rectangular netting is doubled up and sewn to form a long pocket. The free side of the netting is lashed to a long bamboo pole and sinkers are attached to the doubled up edge which help to keep the mouth of the bag open when the net is operated. Two short ropes with brick weights are tied to the two extremities of the bamboo pole and this helps to keep the upper part of the net at the desired depth when it is pulled along the water. This trawl net is used in Pabna for catching hilsa (Ahmad 1954). It may be recalled here that there is a seine net, a modification of *jangla jal* known by the name of *jangalia jal* in the district of Bakarganj (see p. 434).

Dip nets

Chhakni jal (Fig. 25). This is a small dip net used in the district of Faridpur for capturing hilsa when the fish swims near the banks of rivers (Ahmad 1952).

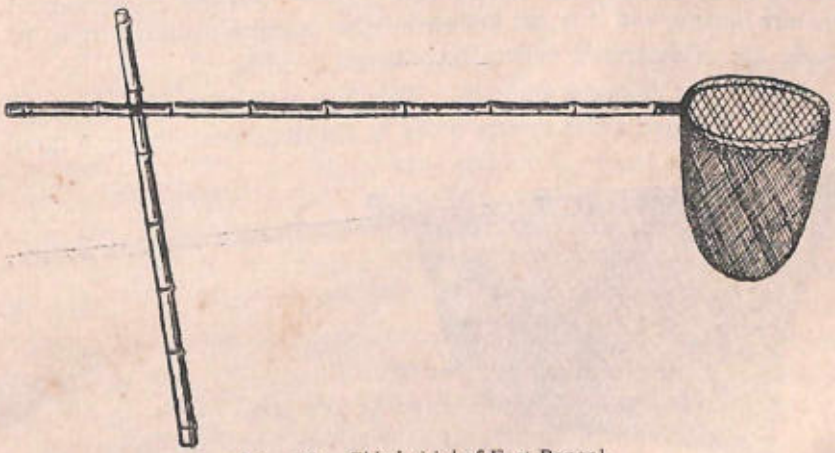

Fig. 25.—*Chhakni jal* of East Bengal.

Bheshal jal or *Khara jal* or *Kadra jal* (Fig. 24). This is a large triangular net with mesh from 1.3 cm. to 4 cm. worked from a bamboo platform erected on the bank of the river or in shallow water.

According to Ahmad (1952) the net is used in Jessore and Tippera for catching hilsa. In principle this is similar to the *gara besal* of West Bengal (p. 260).

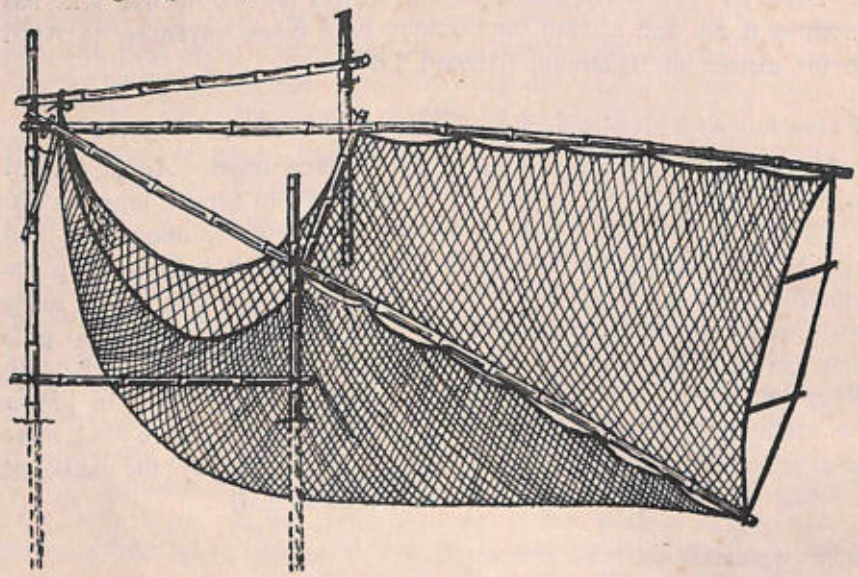

Fig. 24.—*Bheshal jal* of East Bengal.

Hath Bauli jal. This is a small *bhesal jal* of 5 cm. mesh worked by hands from a boat for catching hilsa in the districts of Rajshahi and Pabna during rainy season (Ahmad 1954). Further details about this are lacking and it is not known in what manner it differs from the *nauka bhesal* described under West Bengal p. 261.

Hefa jal or *Hafa jal* (Fig. 26). This is a triangular dip net about 7 metres in length and 3 metres broad at the distal part having a mesh

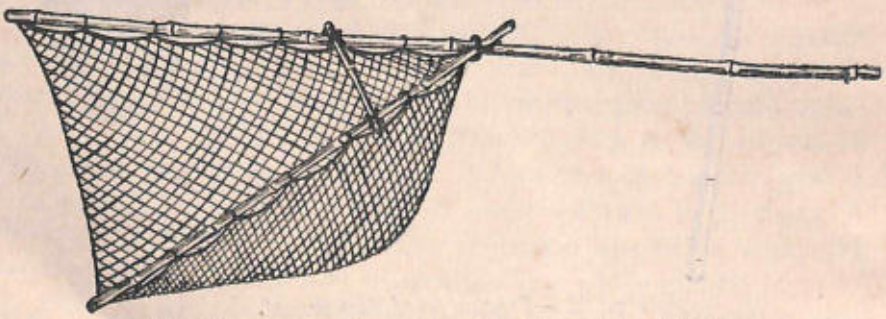

Fig. 26.—*Hefa jal* of East Bengal. (After Ahmad 1954).

of 10 cm. This is used in the district of Sylhet from April to May for capturing hilsa.

Fence net or Pound net

Bundh jal (Pl. XXI, fig. 23[1]). In principle this is somewhat similar to the pound net used for shad in the United States. *Bundh jal* is a fixed net and is generally constructed across large rivers like the Meghna and the Padma. This method of fishing is done from February to May and the most important fish caught in the pound is hilsa. The stakes are removed towards the end of May by which time the effect of monsoon rains begins to be felt in the river.

Long stakes are driven in the form of an arc from one shore across the greater part of the river leaving one side for the passage of boats and launches. In between long stakes shorter ones are fixed and all these are bound together by horizontally placed pieces of sticks. To give additional stability the whole fence is held in position by a series of anchors fixed upstream, their number depending on the force of the current. The end of the fencing away from the shore curves inwards in the form of a circle leaving a small passage for the entry of fish. Close meshed (about 1.3 cm.) netting is fastened to the stakes up to the water line like a wall obstructing the passage of fish either way. Above the water line wide-meshed netting is tied up to a height of about 90 cm. Another wide-meshed netting is tied about 46 cm. above the water line and this is folded over and stretched and attached to distantly placed poles as the chord of an arc leaving a sagging bag-like space in the form of a *verandha* net. The enclosure or the pound at the inner end consists of a single net in the form of a trough with an opening on one side for the entry of the fish. It is open above the water line.

The *bundh jal* is intended to capture fish that migrate upstream against the current. Fishes such as carp, coming against the obstruction, try to overcome it by jumping and get caught in the verandha net. Hilsa on the other hand move along the fence and eventually enter the pound where they remain circling round and round with very little chance of escape through the passage by which they had entered. To remove the fish, the 'pound' is untied from the supporting stakes and the contents emptied into a boat.

Fish drives. Mojumdar (1939) refers to fish drives in the eastern part of the Bay of Bengal during winter months which he describes as follows: 'The other way of catching the hilsa in this part of the country is to drive the shoals into the branch rivers opening in the

[1] The figure is based on a model shown to me by Shri Lakhi Kanth Burman, a refugee fisherman from East Bengal now employed at the Central Inland Fisheries Research Station, Calcutta.

sea by the beating of tins or drums. When they are up in such a *Khal*, their way to the sea is obstructed with nets and they are caught for days together.'

2. Sind

The fishing method for hilsa in the Indus is very similar in principle to that in the Narbada in Bombay and the Cauveri in Madras, but looks somewhat queer and hazardous. The method has attracted the attention of early European travellers as far back as the first half of the 17th century, as is evident from the writings of Sebastien Manrique (Luard and Hosten, 1927) during his travels between 1623-43. In describing the voyage down the Indus to Bakhar he writes:

'We sailed on peacefully in this way, keeping careful watch at night, finding as we advanced on our road an abundance of good cheap provisons in every place we anchored at. In some places, where the stream was shallow, we met many fishermen who furnished us with most excellent shad very cheaply . . . They dispense with the encumbrance of nets and assistants as they go out fishing on large earthen vessels with the circumference of ten to twelve palms in breadth, flattened at the rim, and open at the top in a big, circular aperture just of a size to receive the front of a man's stomach, which being pressed into it checks the ingress of the water. It thus serves as a safe receptacle for the fish as well as a steady base and support for the fisherman, who lies upon it directing his earthen ship with his legs, his hands being busy with the spear, piercing the scaly swimming fishes . . . This abundance of fish was most welcome . . .'

From the above report it appears likely that hilsa was abundant at one time near the surface to be available for spearing and that the water was clear to see the movements of the fish. Spearing is not done now but a modified hand net with a long shaft is used by fishermen who drift on earthen vessels and other floats. Rarely, fishing is also done from boats.

It appears from Day's report (1873) that a triangular type of lave-net known in Sindhi as '*Sumbokee*' which could be closed like a purse net is also in use. He says: 'A species of lave-net is also used and in various ways; their plan of construction is in a triangular frame. In Sind, the fishermen float down the Indus on a gourd or hollow earthen pot, and this net is let down below him; as a hilsa fish, ascending up the muddy stream, strikes against the net, it is

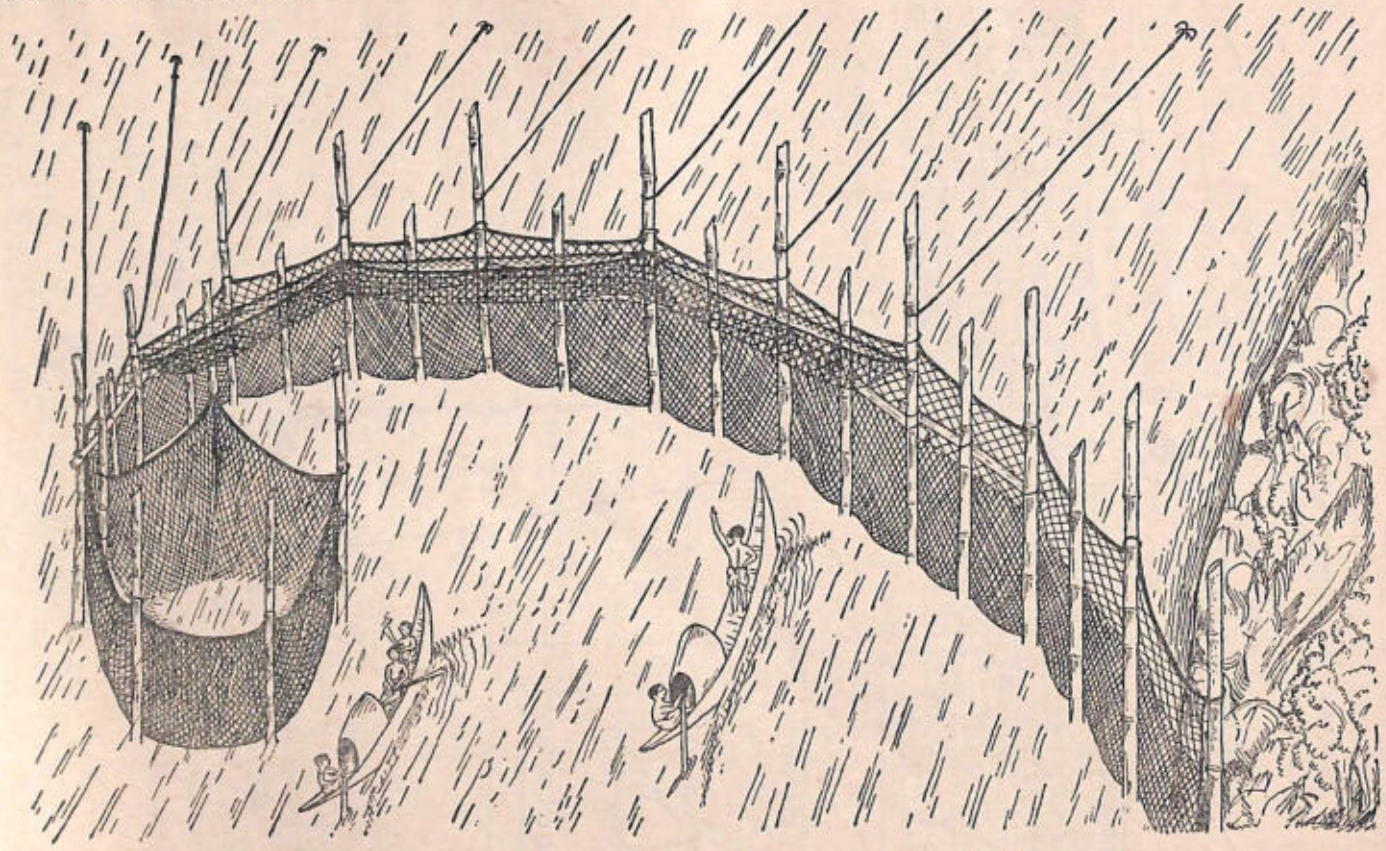

Fig. 23. *Bundh jal* of East Bengal. (By M. Mydeen Kunju).

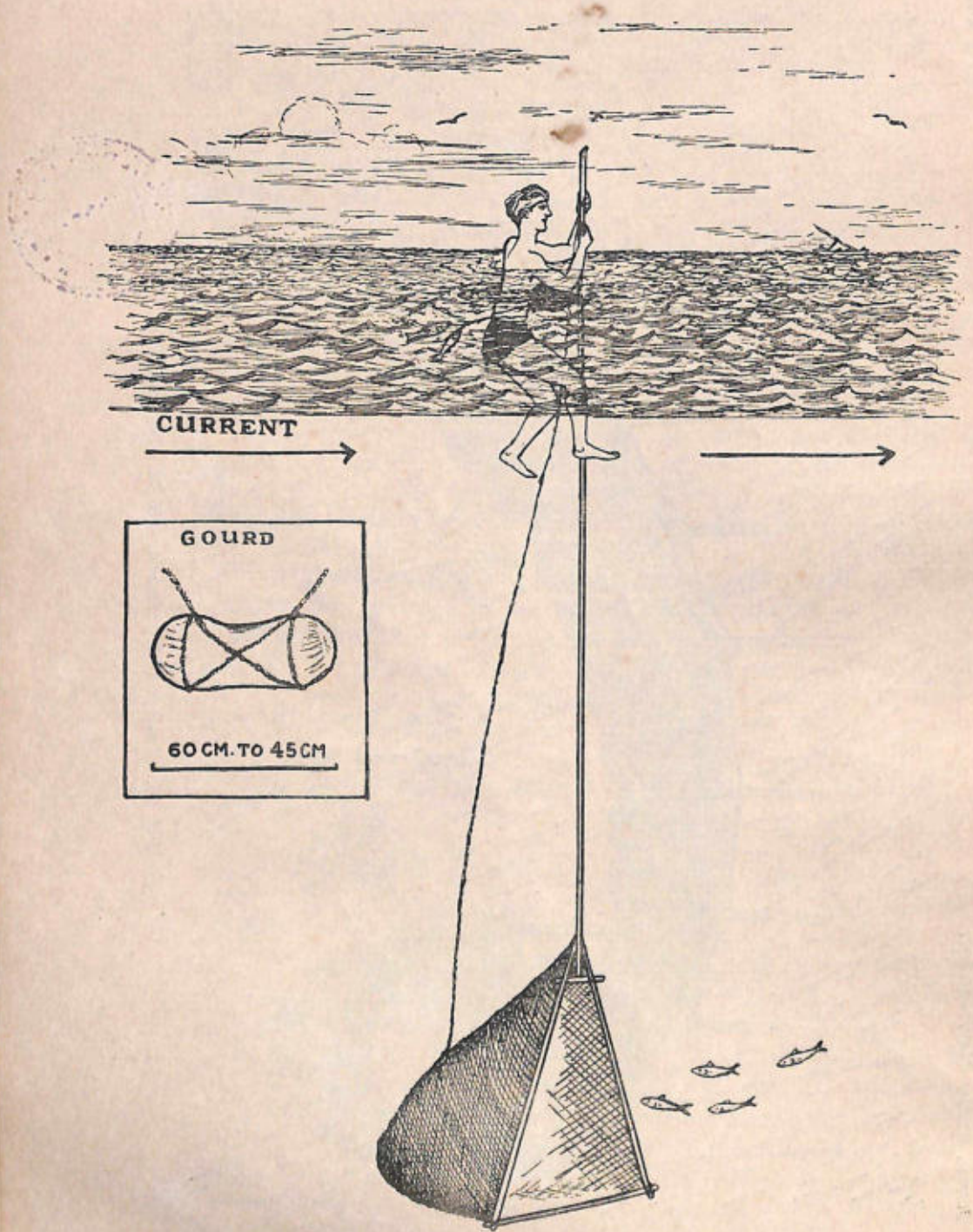

Fig. 27. *Sandh jal* of Sind. (By M. P. Lakshmanan).

made to contract like a purse by means of a string the fisherman holds in his hand.' The observation is repeated in his subsequent account on Indian fish and fishing (Day 1883).

Sandh jal (Pl. XXII, fig. 27[1]). This appears to be the same as the *Sumbokee* referred to by Day (op. cit.). The handle of the net is about 6.5 metres long and each side of the triangular frame is of equal length measuring a little over 2 metres. The mesh size of the net is about 5 cm. The fisherman drifts with the current supporting himself on a dry gourd 45 cm. to 60 cm. in length with the net held almost vertically down. A string tied to the deep bag of the net is held by him and the entry of any fish is communicated through this. By a twist of the handle the fish is imprisoned. The net is lifted up and the captured fish threaded on a string tied to the waist of the fisherman.

Matlee (*Palla pot*). While describing hilsa fishing in the Indus Hornell (1950, p. 109) makes mention of the *palla pot* method. He summarises the fishing activity as follows: 'But the excitement of hilsa-fishing in the Cauveri is as nothing compared with the animated scenes on the Indus, where the Hilsa gives employment to hundreds of fishermen the whole length of Sind. The usual device is a development of the Cauveri one. The net used has grown, however, into the form of a gigantic landing net, with a shaft 20 feet long and with a bag much deeper in proportion. Armed with this the fishermen float downstream, either seated in the bow of a small raft-like punt, or supported by gourds, enveloped in netting and strapped to his back. Or he may, when the fishing reach is short, elect for a third, still more primitive method, and float down the river balanced precariously over the mouth of a great globular chatty or earthenware pot made for the purpose by the village potter. The net is used as on the Cauveri, but in a nearly vertical position. The hilsa, pushing upstream in vehement haste to reach the spawning grounds, blunders into the net and in spite of the extraordinary agility of this fish, man triumphs, being prepared; a sharp twist of the shaft imprisons the fish in the tail of the net and the fisherman, cautiously shortening his grip, finishes it with a knife and consigns it to the bottom of the boat or the depth of the chatty beneath him; if his support is gourds, a needle is passed through the eyes or the gills and

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[1] My thanks are due to Dr. M. R. Khan, Assistant Regional Fisheries Officer, Food and Agriculture Organisation of the United Nations, Bangkok, for having kindly taken the trouble of arranging to get information on hilsa fishing in the Indus, and to Mr. Agha G. Hussain, Deputy Director, Central Fisheries Department, Pakistan, for furnishing a sketch on which Figure 27 in this article is based.

the fish is threaded on a string with the previous victims in tow beside the float.'

'In specially favourable spots, where the river is deep alongside one bank, the fisherman with his net immersed walks downstream along the shore, adjusting his pace to the speed of the current. In the vicinity of towns both the gourd-float and the chatty are preferred to the punt; they give better results and involve practically no expense. The chatty is considered the better killing method, but where the reach within which the fish are caught is long, the fisherman prefers the gourds—their weight is less for the long weary tramp back to his starting-point.'

The *palla pot* has a flattened spheroid shape and is neckless with a comparatively small mouth on which rests the stomach of the fisherman closing it effectively, the latter directing his movements with his hands and legs in a froglike manner. Earthen vessels of smaller size without any opening on which the fishermen float down in a sitting posture is also reported to have been employed (Burns, 1834). The fishermen who cannot afford the 'luxury' of a '*Palla pot*' use a bundle of dry reeds to float down which is discarded on getting water-logged (Wood, 1841). This has the advantage that it need not be carried back but the problem of making a fresh bundle every time remains. A more convenient and perhaps safer alternative commonly employed is the use of a netful of dried gourds strapped to the body. In view of its lightness no serious problem of transportation arises during the trek back to the starting point. The method is very similar to the one followed by the 'Bhil' fishermen of the Narbada.

III. BURMA

Hilsa occurs along the entire coastal waters of Burma from Arakan in the north to the Mergui Archipelago in the south and ascends the rivers for spawning purposes. The information we have on the fishing methods is very meagre and is mainly confined to the observations of Kyaw (1953).

Gill nets

Hmyaw paik[1]. This is a drift net used all round the year in rivers and estuaries of Burma. It is made of cotton yarn and the length varies from 15 to 90 metres and width from 2.7 to 3.7 metres. The mesh is about 10 to 12.5 cm. There are floats along the head rope

[1] The information regarding this net was furnished personally by U Ba Kyaw, Fisheries Officer, Burma.

but no ground rope or sinkers at the bottom. The net is allowed to drift with the current and the gilled fish are periodically removed. Fishes other than hilsa are also caught in this net. It appears that the net is sometimes provided with a ground rope also to which weights of lead pieces and burnt clay are attached, as stated by Khin (1948).

Nga-thalouk paik. This net is reported by Kyaw (1953) as being used in the Mergui Archipelago. Each operational net is about 550 metres long and 11 metres deep consisting of 3 sets laced together, each set having 20 separate pieces of netting of about 9 metres in length. The mesh size varies from 10 to 15 cm. according to the size of the fish available in the different seasons. The net is operated by three open boats with a total crew of 12 persons. Two boats are of 2 tons capacity each and are used as net boats, while the third one is of 6 ton capacity and serves as the mother boat. When a shoal is sighted it is encircled by the net which is paid out simultaneously from the two small boats. After the two ends of the net meet, the boats go about scaring the fish by beating the water with poles. The net is then hauled up into the two small boats which traverse the circle in the reverse direction and the gilled fish are removed. Each operation takes 2 to 5 hours depending on the catch.

SUMMARY

The methods of fishing for the Indian shad, *Hilsa ilisha* (Hamilton), in India, Pakistan, and Burma are described in fair detail. Some of the nets are specially devised for catching hilsa while the others are multipurpose nets in which this fish forms one of the catches. In all, about 102 nets are classified and dealt with, and of these most of the important ones are illustrated. A glossary of local names of fishing gear and tackle is given with explanation.

REFERENCES[1]

Ahmad, Nazir (1952) : Hilsa fishery of East Bengal. *J. Asiat. Soc. (Sci.)* **20** (1) : 7-14 (1954).

— — — (1954) : Fishing-Gear of East Pakistan. *Pakistan J. Sci.***6** (3) : 162-178.

Burns, Alexander (1934) : Travels into Bokhara **3** : 40.

Chacko, P. I. (1952) : Past, present and future of the Hilsa fisheries in the Madras State. *J. Asiatic Soc. (Sci.)* **20** (1) : 55-58 (1954).

Day, F. (1873) : Report on the Freshwater fish and Fisheries of India and Burma, pp. 22 & 23. Calcutta.

— — — (1883) : Indian Fish and Fishing. *International Fisheries Exhibition, Handbooks*, **2**, pp. 488-489.

Government of India (1951) : Preliminary guide to Indian fish, fisheries, methods of fishing and curing. Revised Edition, Marketing Series No. 66. pp. 70, 117, 119, 125 & 127. Delhi.

[1] In addition to those referred to in the text, a few references on the subject not included in the bibliography on Hilsa by the author (Jones, 1952) are also given here.

Hornell, J. (1924*a*) : The Fishing Methods of the Ganges.—*Mem. Asiatic Soc. Bengal* **8**: 223-224, 227-230. Calcutta.

— — — (1924*b*) : Fishing Methods of the Madras Presidency, Part I. Coromandel Coast. *Madras Fish. Bull.* **18** : 59-110.

— — — (1946) : Water Transport : Origins and Early Evolution. Cambridge University Press, pp. 2 & 5.

— — — (1950) : Fishing in many waters. Cambridge University Press, pp. 88 and 108-113.

Jones, S. (1952) : A Bibliography of the Indian Shad, *Hilsa ilisha* (Hamilton), *J. Zool. Soc. India*, **4** (1) : 97.

— — — & Sujansinghani, K. H. (1953) : Fish and fisheries of the Chilka Lake with statistics of fish catches for the years 1948-1950. *Indian J. Fish.* **1** (1 & 2).

Kaushiva, B. S. (1952) : A preliminary note on Hilsa fisheries of Uttar Pradesh. *J. Asiatic Soc.* (*Sci.*) **20** (1) : 45-46 (1954).

Khin, U (1948) : Fisheries in Burma. Govt. Printing and Stationery, Rangoon.

Kulkarni, C. V. (1951) : Hilsa Fisheries in the Narbada River. *JBNHS* **49** (4) : 619-621.

Kyaw, Ba (1953) : Information on Hilsa Fishery of the Mergui District, Union of Burma, *I.P.F.C., Communication.*

Luard, C. Eckford & Hosten, H. (1927) : Travels of Frey Sebastein Manrique. 1629-1643. **2**. pp. 230 & 232.

Mojumdar, C. H. (1939) : Foreshore fishing in the eastern part of the Bay of Bengal. *Sci. & Cult.*, Calcutta, **5** (4) : 219.

Naidu, M. Ramaswami (1939) : Report on a Survey of the Fisheries of Bengal, pp. 8-17. Calcutta.

Pillay, T. V. R., (1948) : Marine Fisheries of Kodinar in Kathiawar. *JBNHS* **48** (1) : 47-61.

Qureshi, M. R. (1952) : Palla of Sind. *J. Asiatic Soc.* (*Sci.*) **20** (1) : 59-63 (1954).

Varma, C. P. (1952) : Hilsa Fishery in Bihar. *J. Asiatic Soc.* (*Sci.*) **20** (1) : 41-43 (1954).

Wood, J. (1841) : Journey to the source of the River Oxus. London.

Glossary of local names

Jal means net in Hindi and other north Indian languages and the term is current in the states of Bengal, Bihar, Uttar Pradesh, Assam, and Bombay in India and in East Bengal and Sind in Pakistan. This is modified into *Jalo* in Oriya (Orissa). *Vala* and *Valai* mean net in Telugu and Tamil in Andhra Pradesh and Madras respectively.

Local name	Page	State or Country	Meaning where known	Explanation
Apsha jal ..	432	East Bengal		Gill net
Ata vala ..	266	Orissa	-	A portion of *Pedda irgali* near the wing
Bada irgali ..	265	Orissa	*Bada*=big	Large conical bag net
Bada jal ..	259	West Bengal	Big net	Stake net
Bandal ..	275	Uttar Pradesh		Method of fishing after blocking with bamboo fencing
Barain jal ..	432	East Bengal		Gill net
Baranda ..	267	Orissa	border	Border meshes of *Tangra jalo*
Bara jal ..	433	East Bengal	big net	Big seine net. Known also as *Jagat ber*, *Goger* and *Maha jal*
Bar jalo ..	263 & 266	Orissa		Long drag net
Baromadi ..	266	Orissa		Bag portion of *Pedda irgali*
Basa jal ..	260	West Bengal		Lift net
Basal jal ..	260	,, ,,		Lift net
Basant jalo ..	264	Orissa		Gill net operated from boat

Local name	Page	State or Country	Meaning where known	Explanation
Batchari jal ..	261	West Bengal		Large sized cast net. Also known as *Othar jal*
Batchari nauka ..	261	,, ,,	*Nauka* = boat	Boat used for the operation of *Batchari jal*
Behunti jal ..	257	,, ,,		Fixed bag net. Also known as *behundi jal*, *bainti jal*, or *bim-jal*
Ber jal ..	256 433	West Bengal & East Bengal		Seine net
Ber jal ..	435	East Bengal		Drag net
Bhahali jal ..	272	Assam		Lift net operated from a drifting boat
Bhasa jal ..	260	West Bengal		Lever dip net operated from a boat
Bhekti Phandi-jalo	263	Orissa	Bhekti = *Lates calcarifer*	Large meshed gill net
Bhesha gulli ..	433	East Bengal		Seine net. Also known as *Kona jal*
Bheshal jal ..	435	East Bengal		Large lever dip net. Known also as *Khedra jal* or *Kedra jal*
Bhido jalo ..	265	Orissa		Gill net. Known also as *Bhida jalo*
Bhiro jalo ..	264	Orissa		Gill net. Known also as *Bheed jalo* or *Ilishi jalo*
Biri jal ..	432	East Bengal		Clap net
Bisari jal ..	274	Bihar		Dip net
Budichi jal ..	429	Bombay		Sunken drift net
Bundh jal ..	437	East Bengal	*Bundh* = embankment	Fence net
Chairon jal ..	272	Assam	Four-finger-meshed net (*Chairon* derived from *char* = which means four)	Clap net
Chapila jal ..	433	East Bengal		Gill net
Char-pata jal or *Char-gherra jal*	262	West Bengal	*Char* = Mud-flat exposed during low water	A type of barrier net
Chawk jalo ..	269	Orissa		Drag net used for fish drive
Chhandi jal ..	254 432	West Bengal & East Bengal		Gill net
Chhandi nauka ..	254	West Bengal	*Nauka* = boat	Boat employed for using *Chhandi jal*
Chhakni jal ..	435	East Bengal		Dip net
Chhanta jal .. or *Chhata jal*	275	Uttar Pradesh		Shore seine net
Chhota ber jal ..	433	East Bengal	*Chhota* = small *Ber* = encircle *jal* = net	Small seine net
Chondi jal ..	264	Orissa		A kind of drift net.

Local name	Page	State or Country	Meaning where known	Explanation
Chondi jalo ..	269	Orissa		Similar to *Chondi jal* used as drag net during fish drives in the Mahanadi
Chotta irgali ..	266	Orissa	*Chotta*=small	Small conical bag net. Known also as *Sanna irgali*
Chouhandra ..	268	Orissa		Small meshed net behind *Satiya jalo* of *Mal jalo*
Cuna jalo ..	268	,,		Free ends of *Mal jalo*. Known also as *Chuna jalo*.
Dandi jal ..	273	Bihar		Gill net. Also known as *Dondi jal*.
Dara jal ..	435	East Bengal		Drag net
Dar jal ..	433	,, ,,		Gill net
Dhop jal ..	434	East Bengal		Seine net
Dinghi ..	253	West Bengal		Round bottomed boat
Dondi jal ..	273	Bihar		Gill net. Known also as *Dandi jal*.
Dongya ..	270	Orissa		Flat bottomed boat
Dora jal ..	433	East Bengal		Gill net. Also known as *Ilish jal*.
Dui-tuni jal ..	272	Assam	Two poled net (*Dui*=two & *tuni*=pole)	Lever type of clap net
Era jal ..	433	East Bengal		Gill net
Erukh ..	425	Madras	*Calotropis gigantea*	Name of a tree. Timber used as floats
Funga jal ..	272	Assam		Clap net
Gai ber jal ..	256	West Bengal		Seine net
Gab ..	252	West Bengal	*Diospyros embryopteris*	Name of a tree, the fruits of which are used for tanning nets
Gara jal or *Gara besal*	260	West Bengal		Lever dip net fixed in the river
Ghai ber jal ..	434	East Bengal	*Ghai*=bag or pocket	Seine net with pockets
Gharia ka ghauch	275	Uttar Pradesh		The term used for the operation of scoop-net from a boat
Ghauch ..	275	Uttar Pradesh		Lift net used in the Bandal method of fishing
Gherua jalo ..	265	Orissa		Hempen gill net
Goolti jal ..	255	West Bengal		Gill net
Gulti jal ..	434	East Bengal		Seine net
Gultin jal ..	434	,, ,,		Seine net
Hadia jalo ..	268	Orissa		A triangular dip net operated by hand
Hafa jal ..	436	East Bengal		Same as *Hefa jal*
Har jal. ..	433	East Bengal		Gill net
Hath bauli jal ..	436	,, ,,	*Hath*=hand	Triangular dip net operated by hand

Local name	Page	State or Country	Meaning where known	Explanation
Hefa jal ..	436	East Bengal		Triangular dip net operated by hand from a boat
Hela jal ..	260	West Bengal		Hand operated push net
Hilsa ..		Bengal	*Hilsa ilisha* (Hamilton)	The Indian shad
Hilsa jal ..	432	East Bengal	Hilsa net	Clap net
Hmyaw paik ..	440	Burma		Drift net. *Paik* which means net in Burmese is written as *Paikgyi* also
Honga jal ..	432	East Bengal		Clap net
Huli ..	269	Orissa		Dug-out canoe
Ilihi ..	271	Assam	Hilsa	
Ilish ..	254	Bengal	Hilsa	
Ilishi ..	263	Orissa	Hilsa	
Ilihi jal ..	271	Assam	Hilsa net	Clap net. Known also as *Kami jal*.
Ilish jal ..	254 & 433	Bengal	Hilsa net	Gill net. Also known as *Dora jal*.
Ilishi phandijalo	263	Orissa	Hilsa net	Fixed gill net. Also known as *Ilishi jalo*
Iriga vala ..	265 & 425	South Orissa & Andhra Pradesh		Conical bag net. Also known as *Irgali* or *Irgal jalo*
Jagat ber jal ..	257	Orissa	*Jagat*=universe *Ber*=enclose or encircle	Long seine net
Jal ..		W. Bengal, E. Bengal, Bihar, Uttar Pradesh, Assam, and Bombay	net	A Hindi term meaning net common throughout north of peninsular India
Jalia dinghi ..	252	Bengal	*dinghi*=small boat	Fishing boat used in the rivers of Bengal
Jalo ..	263	Orissa	net	Common term for net in Oriya
Jamda jal ..	431	Bombay		Purse-like hand net
Jangalia jal ..	435	East Bengal		Hand trawl net
Jangla jal ..	434	East Bengal		Pocketed seine net
Jarul ..	252	West Bengal	*Lagerstroemia flos-reginae*	Name of a tree. Timber used for constructing boats
Joha jal ..	274	Bihar		Seine net
Kala-kayir ..		Madras	*Kala*=bull; *kayir*=rope	Cord along the circumference of the cast net
Kalyanamaran ..	428	Madras	*Erythrina indica*	Name of a tree. Timber used for making rafts
Kamail jal ..	274	Uttar Pradesh		Clap net
Kami jal ..	271	Assam		Clap net. Known also as *Ilihi jal*
Kanni valai ..	425	Madras	Meshed net (*Kanni*=mesh)	Gill net

Local name	Page	State or Country	Meaning where known	Explanation
Kappu ..	427	Madras	fork	Forked branch of tree used for making *Kappu valai*
Kappu valai ..	425	,,	Fork net	Push net
Karal jal ..	255	West Bengal		Gill net
Kephla jal ..	261	,, ,,		Cast net
Kettu valai ..	424 & 426	Madras	Fixed net (*kettu*=tie)	*Kanni valai* without floats and weights
Khanderi jal ..	430	Bombay		Gill net
Kharki jal ..	252	West Bengal		Clap net
Kharki jal ..	432	East Bengal		Clap net. Also known as *Sharki jal*
Khepa jalo ..	268	Orissa		Cast net
Khosh jal ..	432	East Bengal		*Shangla jal* of Bakarganj
Khot jal ..	433	,, ,,		Gill net
Kochal jal ..	255	West Bengal		Fixed gill net
Kona jal ..	257 433	West Bengal & East Bengal		Seine net. Also known as *Bhesha gulli*
Konta jal ..	255	West Bengal		Fixed gill net
Korpan-Kutchi ..	30	Madras	*Korpan*=threading, *Kutchi*=peg	Threading peg
Kosa nauka ..	271	Assam		Small sized fishing boat
Lawa jal ..	432	East Bengal		*Shangla jal* of Sylhet
Maal ..	30	Madras	*Maal*=net	Net portion of cast net
Maha jal ..	274	Uttar Pradesh	Big net (*Maha*=big)	Large bag net
Mal jal ..	262	West Bengal		Barrier net
Mal jalo ..	268	Orissa		Barrier net
Male madi ..	266	Orissa		One portion of *Pedda Irgali* in front of *Baromadi*
Mani ..		Madras		Lead weight of *Veechu valai* of Cauveri Delta
Matlee ..	439	Sind		Earthenware pot used as a float in hilsa fishing
Mela ..	33	'Hindi'	Procession or festival	
Nanhya jalo or *Naya jalo* ..	268	Orissa		Portion of *Mal jalo* near the *Cuna jalo*
Nauka ..	261	West Bengal	boat	Name for boats in general
Nauka-Besal ..	261	,, ,,		Lever not operated from boat
Nga-thaloukpaik	441	Burma	Hilsa net (*Nga-thalouk*=Hilsa, *paik*=net)	Gill net
Odi vala ..	265	Orissa	*Odi*=prevent or obstruct	Drift net. Known also as *Odi jalo*
Othar jal ..	261	West Bengal & East Bengal		Large cast net

Local name	Page	State or Country	Meaning where known	Explanation
Palwa jal ..	430	Bombay	*Palwa*=hilsa Hilsa net	Drift net
Pankha Rach ..	430	Bombay (Gujarati)	*Rach*=net	Fixed gill net
Pansi nauka ..	271	Assam	*nauka*=boat	Large sized fishing boat
Patan jal ..	434	East Bengal		Seine net
Patua jalo ..	267	Orissa	*Patua*=Engraulid	A type of drag net
Pedda ayilu ..	424	Andhra Pradesh	*jalo*=net	Seine net. Also known as *Pedda vala*.
Pedda irgali ..	265	Orissa		Trawl type of net. Also known as *Bada Irgali*
Pye jal ..	433	East Bengal		Gill net
Rangoon vala ..	423 & 426	Andhra Pradesh	Rangoon net	Drift net formerly imported from Burma. Known also as *Ulla* or *Ullam valai* or *Kanni valai*
Sal ..	252	West Bengal	*Shorea robusta*	Name of a tree. Timber used for constructing boats
Sandh jal ..	439	Sind		Dip net
Sangla jal ..	271	Assam		Clap net
Sanna Irgali ..	266	Orissa	*Sanna*=small	Small conical bag net. Also known as *Chotta Irgali*
Sarni-phasi jalo ..	267	Orissa		A combination net of *Sarni jalo* and *Phasi jalo*
Satiya jalo or *Santiya jalo*	268	Orissa		End portion of *Mal jalo*
Shangla jal ..	253 432	West Bengal & East Bengal		Clap net
Sinapu vala ..	266	Orissa	Small meshed net (*Sinapu*=small meshed)	Middle part of *Pedda irgali*
Sumbokee ..	439	Sind		Small hand net
Sungail ..	273	Bihar		Clap net. Also known as *Sungla jal* or *Hilsauri*
Suti jal ..	258	West Bengal		Funnel shaped bag net. Also known as *Soti jal*
Tana ber jal ..	256 434	West Bengal & East Bengal	*Ber*=enclose	Seine net
Tangra jalo ..	266	Orissa		Pocketed drag net. Also known as *Tangna jalo* or *Tangni jalo*
Thedachi valai ..	426	Madras		Gill net
Theppam veechu ..	428	,,	*Theppam*=raft, *veechu*=cast	Casting net from a raft
Thelu vala ..	424	Andhra Pradesh		Drag net

Local name	Page	State or Country	Meaning where known	Explanation
Kappu ..	427	Madras	fork	Forked branch of tree used for making *Kappu valai*
Kappu valai ..	425	,,	Fork net	Push net
Karal jal ..	255	West Bengal		Gill net
Kephla jal ..	261	,, ,,		Cast net
Kettu valai ..	424 & 426	Madras	Fixed net (*kettu*=tie)	*Kanni valai* without floats and weights
Khanderi jal ..	430	Bombay		Gill net
Kharki jal ..	252	West Bengal		Clap net
Kharki jal ..	432	East Bengal		Clap net. Also known as *Sharki jal*
Khepa jalo ..	268	Orissa		Cast net
Khosh jal ..	432	East Bengal		*Shangla jal* of Bakarganj
Khot jal ..	433	,, ,,		Gill net
Kochal jal ..	255	West Bengal		Fixed gill net
Kona jal ..	257 433	West Bengal & East Bengal		Seine net. Also known as *Bhesha gulli*
Konta jal ..	255	West Bengal		Fixed gill net
Korpan-Kutchi ..	30	Madras	*Korpan*=threading, *Kutchi*=peg	Threading peg
Kosa nauka ..	271	Assam		Small sized fishing boat
Lawa jal ..	432	East Bengal		*Shangla jal* of Sylhet
Maal ..	30	Madras	*Maal*=net	Net portion of cast net
Maha jal ..	274	Uttar Pradesh	Big net (*Maha*=big)	Large bag net
Mal jal ..	262	West Bengal		Barrier net
Mal jalo ..	268	Orissa		Barrier net
Male madi ..	266	Orissa		One portion of *Pedda Irgali* in front of *Baromadi*
Mani ..		Madras		Lead weight of *Veechu valai* of Cauveri Delta
Matlee ..	439	Sind		Earthenware pot used as a float in hilsa fishing
Mela ..	33	'Hindi'	Procession or festival	
Nanhya jalo or *Naya jalo* ..	268	Orissa		Portion of *Mal jalo* near the *Cuna jalo*
Nauka ..	261	West Bengal	boat	Name for boats in general
Nauka-Besal ..	261	,, ,,		Lever not operated from boat
Nga-thaloukpaik	441	Burma	Hilsa net (*Nga-thalouk*=Hilsa, *paik*=net)	Gill net
Odi vala ..	265	Orissa	*Odi*=prevent or obstruct	Drift net. Known also as *Odi jalo*
Othar jal ..	261	West Bengal & East Bengal		Large cast net

Local name	Page	State or Country	Meaning where known	Explanation
Palwa jal ..	430	Bombay	*Palwa*=hilsa Hilsa net	Drift net
Pankha Rach ..	430	Bombay (Gujarati)	*Rach*=net	Fixed gill net
Pansi nauka ..	271	Assam	*nauka*=boat	Large sized fishing boat
Patan jal ..	434	East Bengal		Seine net
Patua jalo ..	267	Orissa	*Patua*=Engraulid	A type of drag net
Pedda ayilu ..	424	Andhra Pradesh	*jalo*=net	Seine net. Also known as *Pedda vala.*
Pedda irgali ..	265	Orissa		Trawl type of net. Also known as *Bada Irgali*
Pye jal ..	433	East Bengal		Gill net
Rangoon vala ..	423 & 426	Andhra Pradesh	Rangoon net	Drift net formerly imported from Burma. Known also as *Ulla* or *Ullam valai* or *Kanni valai*
Sal ..	252	West Bengal	*Shorea robusta*	Name of a tree. Timber used for constructing boats
Sandh jal ..	439	Sind		Dip net
Sangla jal ..	271	Assam		Clap net
Sanna Irgali ..	266	Orissa	*Sanna*=small	Small conical bag net. Also known as *Chotta Irgali*
Sarni-phasi jalo ..	267	Orissa		A combination net of *Sarni jalo* and *Phasi jalo*
Satiya jalo or *Santiya jalo*	268	Orissa		End portion of *Mal jalo*
Shangla jal ..	253 432	West Bengal & East Bengal		Clap net
Sinapu vala ..	266	Orissa	Small meshed net (*Sinapu*=small meshed)	Middle part of *Pedda irgali*
Sumbokee ..	439	Sind		Small hand net
Sungail ..	273	Bihar		Clap net. Also known as *Sungla jal* or *Hilsauri*
Suti jal ..	258	West Bengal		Funnel shaped bag net. Also known as *Soti jal*
Tana ber jal ..	256 434	West Bengal & East Bengal	*Ber*=enclose	Seine net
Tangra jalo ..	266	Orissa		Pocketed drag net. Also known as *Tangna jalo* or *Tangni jalo*
Thedachi valai ..	426	Madras		Gill net
Theppam veechu ..	428	,,	*Theppam*=raft, *veechu*=cast	Casting net from a raft
Thelu vala ..	424	Andhra Pradesh		Drag net

Local name	Page	State or Country	Meaning where known	Explanation
Thuri ..	427	Madras	bag	The cod end of a bag net
Thuri valai ..	427	,,	Bag net	Gill net (not the typical *Thuri valai* of the Coromandel coast)
Tisto jalo ..	263	Orissa		Fixed gill net
Toni jal ..	252	East Bengal		A kind of trawl net
Tuni jal ..	433	East Bengal		Gill net
Ul-kayir ..		Madras	*Ul*=inner, *kayir*=rope	Drawing rope of cast net
Ulla-or *Ullam valai*	426	Madras	*Ulla or Ullam*=hilsa	Drift net. Known also as *Rangoon valai* or *Kanni valai*.
Ulla thundu or *Ulla thunduValai*	426	,,	*Thundu*=piece	Small *Rangoon valai* or *Ullam valai*
Vala ..	423	Andhra Pradesh	net	Telugu term for net
Valai ..	425	Madras	net	Tamil term for net
Valli jal ..	430	Bombay		Fixed gill net
Vanku kayir ..		Madras	*Vanku*=receive, *kayir*=rope or coir	Gathering or receiving rope of cast net
Veechu valai ..	427	Madras	Cast net (*Veechu*=cast)	Cast net
Vessur vala ..	425	Andhra Pradesh	Cast net (*Vessur*=cast)	Used as a combination of two cast nets
Vusu vala ..	424	,,		Drag net
Waram ..	266	S. Orissa & Andhra Pradesh	side	Wing portion of *Pedda irgali*. Telugu word.

William Jack, the Botanist (1795-1822)

BY

D. CHATTERJEE

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Botanists and plant-geographers who are interested in plant life and its distribution in Malayasia must have come across the name of Jack in various books. Jack was indeed one of the pioneer naturalists who explored the virgin forests of India, Malaya, and Sumatra. Unfortunately, he died at the young age of twenty-seven years and it is perhaps for this reason that he is not much known to our botanists of today. Yet, from the few scattered papers and memoirs, it was felt that a short biographical account of Jack would perhaps be well worth publication even after such a long period, as it would stimulate the minds of our younger field botanists.

William Jack was born on the 29th January 1795[1] at Aberdeen, Scotland, where his father Dr. William Jack was the principal of a College. Young Jack was unusually intelligent from his boyhood and joined a grammar school at the age of six. While in school, he almost always kept the top position in his class. He soon became a scholar in classics, French, and natural science and commenced the study of medicine at the age of fourteen. He completed his studies and passed the M.A. examination at the age of sixteen. He then wanted to continue his medical studies in Edinburgh but could not do so for a year as he was attacked by scarlet fever. During this time, he taught classics for sometime in his own school, studied Italian and Spanish, and attended classes on Divinity. He came to London in 1811, i.e. before completing his seventeenth year.

In London, he continued his studies in medicine and botany and he soon came in contact with such eminent persons as Sir Joseph Banks, Robert Brown, and G. Anderson. After attending hospitals and lectures in medicine and surgery he appeared for his F.R.C.S. examination and duly passed at the young age of 17. He communicated the good news of passing the medical examination to his father in a letter dated the 1st February 1812. He wrote: 'Yesterday, I passed as Fellow of the College of Surgeons and with flying colours.

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[1] The year of birth given by Burkill (*JBNHS* **51**: 868; 1953), i.e. 1773, is evidently incorrect. The year of birth was, however, correctly given by him in his earlier paper (*Gard. Bull. Str. Settl.* **4**: 125; 1927).

Five days were all I had in which to prepare and go through the previous business. I appeared before my examiners with all the courage I could muster, and having evaded in the best way that I could, the demand for a certificate of age, they agreed after a little consultation to examine me. Sir William Blizard questioned me, and as it was an extra-ordinary meeting, the whole court were judges. My trial was short and they seemed so well pleased with my replies, that Sir William Blizard, said that it was unnecessary to put any more questions as it was evident I understood my subject. Sir James Earle agreed and obligingly declared that not one in five hundred would answer so accurately. I retired for a while, and when I returned, the Master put a few questions as to my period of study etc. and informed me that I had passed. They then congratulated me on my success; one observed that I should be an honour to the Company's service and paid me such compliments as modesty forbids me to repeat.'

Jack then went back to Aberdeen and spent a few months at home with his parents. He returned to London and secured an appointment of a surgeon in the Bengal Establishment of the East India Company and sailed for India on board the Company's ship 'Baring' on his eighteenth birthday, i.e. on 29th January 1813.

On his arrival in India, he was posted as a surgeon in the East India Company's army at various places like Dum Dum (1813), Nepal terai with Ochterlony's army (1814-15), Bettiah (1815), Bechiaco (1816), Dinapore (1816-17), and Calcutta (1818). Jack visited the Botanic Garden at Calcutta on the 19th July 1818, and wrote: 'I have paid a visit to Dr. Wallich at the Botanic Garden, a short distance from Calcutta; he received me with great kindness and warmth, and insists on my coming to stay with him while I remain here. He is not only a good botanist but an excellent physician, and much inclined to assist me in obtaining some situation which may open a field for botanical research and connect me with himself in that department.'

During this time, Sir Thomas Stamford Raffles, Governor of the East India Company's establishment in Sumatra, also visited the Botanic Garden and met Jack at Calcutta. At the request and recommendation of Dr. Nathaniel Wallich, Sir Stamford very willingly agreed to take Jack with him to Sumatra. The party soon sailed in the Company's cruiser 'Nearchus' and, besides Jack, contained two French zoologists. On their way, the party spent a few months in Penang and Jack collected a large number of plants. From this collection, Jack described 130 plants of which about 80 were considered new. In Sumatra, they stayed at the headquarters at Bencoolen. From Bencoolen, Jack made several trips to the interior of Sumatra

including a climb on the Gunong Benko peak. He worked hard and made exhaustive notes and descriptions of these plants, many of which proved new to science.

Sir Thomas Stamford took keen interest in the natural history and social customs of the people of Sumatra. It may be noted that it was mainly due to his interest that the wonder plant *Rafflesia arnoldi* R. Br., which commemorates his and Dr. Joseph Arnold's name was first discovered in 1818 and made known to science. The plant, as is well known, is a root parasite and bears gigantic flowers, about three feet across and the largest in the vegetable kingdom. Since the discovery of this plant, Jack visited the type locality and other areas and collected considerable additional information about this species which was duly published in his *Malayan Miscellanies*. Jack continued his botanical activities in the midst of various official assignments and by March 1822 he had described seventy-five new plants, including fifteen new genera.

Although Jack's indomitable energy continued, his health was not keeping very good. On April 8, 1821 he wrote in his letter to his parents: 'I have lately had a return of the old complaint in my lungs, which laid me up for some time; but by dint of bleeding, blistering and starving, I got over it pretty well, and have now only to recover strength which I shall do very fast, I feel no doubt.' Towards the end of August 1822 Jack returned from a trip to Java, and at that time he was definitely very ill. In view of his failing health, Sir Thomas Stamford Raffles agreed that he should go to the Cape (South Africa) for a change of air. He boarded the ship 'Layton' but unfortunately died the next day (15th September 1822) while the ship was still anchored at Bencoolen. Jack thus died prematurely at the young age of 27 years.

Soon after Jack's death, Sir Stamford Raffles wrote a letter to the East India House in London. An extract of this letter dated the 15th September 1822 was as follows: 'We were to have embarked this morning for Singapore, but the wind has proved foul, and it was ordained that we should remain another day to bury our dear and invaluable friend, William Jack. Poor fellow! a finer head or heart there never was and whether as a bosom-friend or a scientific assistant he was invaluable to me.'

About that time, Dr. Wallich of the Calcutta Botanic Garden was on tour at Singapore. The ship touched there on the 10th October 1822, and Dr. Wallich heard the sad news from Sir Thomas Stamford Raffles. Dr. Wallich was so moved that he thought it fit to send a

letter of condolence to Jack's father. He also agreed to erect a monument in the Calcutta Botanic Garden in memory of Jack.[1] The letter of Dr. Wallich to Jack's father was as follows:

'When I wrote you last, I had hopes of being shortly able to convey to you more welcome intelligence. Alas! it was otherwise ordained, and it has become my lot to condole with you on the untimely departure of your most excellent son, my dear and beloved friend, William! This sudden and most melancholy intelligence was communicated to me by Sir S. Raffles who landed here this morning and who deeply participates in our deplorable loss. Your son's spotless integrity, his excellence of character, and of heart and of universal esteem which he enjoyed here, have now their reward. It is, therefore, only my bitter loss and that of his revered and afflicted parents, that distresses me, and which recent as the shock is, almost overcomes me while I pen these words. Forgive me, therefore, for dwelling in this manner on this sad event. I should endeavour to console you—and I cannot console myself.'

Principal Jack received a similar letter of condolence from Sir Thomas Stamford Raffles. All friends and admirers of Jack were convinced that he was an indefatigable worker and a most zealous contributor to science. His premature death was a great loss to Malayan botany. The major part of his plant collection and various manuscripts and drawings, which were being sent to England after his death and whose posthumous publication would have further added to the magnificent record of Jack's scientific attainments, were unfortunately destroyed. This happened in 1824 when the ship in which Sir Thomas Stamford Raffles was returning home on leave caught fire at sea. Ironically enough, the name of the ship was 'Fame'.

Jack was elected a fellow of the Geological Society of London where he submitted a paper on the Geology of Sumatra for publication. His name was commemorated in the genus *Jackia* in the family Rubiaceae by Dr. Wallich. Blume also honoured him by naming another genus *Jackia* in the family Polygalaceae. *Jackia* Bl., being a later homonym and congeneric with *Xanthophyllum* Roxb., the latter generic name has to be followed.

His other papers were as follows:

(1) *Malayan Miscellanies* 1 & 2, Bencoolen, (1820-22).

Note. In view of the excellence and rarity of the above publication, it was reprinted in various journals, e.g. (*a*)

[1] For some unknown reason this monument was never erected.

Calcutta J. nat. Hist. **4** : 1-62, 160-231, 305-374 (1843). (*b*) Comp. volume to Hooker's *Bot. Mag.* **1**: 147-157, and 253-272. (*c*) Hooker's *J. Bot. Ser.* 2. **1** : 358-380 (1834).

(2) On the Malayan species of *Melastoma*. *Trans. Linn. Soc. Lond.* **14** : 1-22 (1825).

(3) On Cyrtandraceae, a new natural order of plants. *Trans. Linn. Soc. Lond.* **14** : 23-45 (1825).

(4) Account of *Lansium* and some other genera of Malayan plants. *Trans. Linn. Soc. Lond.* **14** : 114-130 (1825).

Besides these Jack prepared a few other memoranda dealing with certain socio-economic aspects about the native people of Sumatra.

Biographical notes on Jack appeared earlier in the following:

(*a*) Comp. Vol. to Hooker's *Bot. Mag.* **1** : 121-147 (1835; (*b*) *Gard. Chron. Ser.* 3; **26** (2): 252-53 (1899; (*c*) *Gard. Bull. Str. Settl.* **4** : 125 (1927); (*d*) *Flora Malesiana* **1** : 256-57 (1950).

Below is reproduced the text of a letter from William Jack to Dr. Wallich, mainly concerning the discovery of *Rafflesia* in Sumatra, together with a photostat facsimile of its last page:

Bencoolen,
1st June, 1820.

'My dear Wallich,

'I have been much disappointed at not having a single opportunity of writing you for a long period and now I have nothing better than the circuitous route of Batavia. I must, therefore, content myself with a few lines and trust that ere long, I shall have some direct opportunity. I am very anxious to hear from you and learn your plans for the ensuing season. The time of your proposed voyage is fast approaching and I am desirous of learning your arrangements regarding it. I do hope on your own account that you will put it in execution, it will relieve you from a great deal of tiresome worrying business, and a year passed in amusement and pleasure in an alpine region like Napaul will be as good as a voyage to Europe and be an epoch from which to date the commencement of a new lease of life. If you could have made a voyage here in place of the Napaul trip, it would have been to me still more delightful. But we are seldom fated to have all we wish in this world and happy is he who looks at the brightest side of the present whatever it be, and takes the honey of every flower he finds without repining that it is not the wished-for rose. I think, there are few people who

have more the means of being independent of circumstances than ourselves and such as like us can turn from any prospect, however dark, to that of nature which is always the same, fresh and bright. But stop, good Mr. Pen, not so fast, as Fielding says, we have got on the top of a hill and how we are to get down again is the question. I believe, he does it by ringing the bell for breakfast and though I have not that resource at hand just now, I must somehow contrive to descend to matters of fact. And first for domestic news; I have a new character to introduce on the stage in the presence of lady Raffles's second son who made his debut about a week ago with great applause. Capt. Watson's lady also presented him with a girl a few days before. In short, increase of population is the order of the day in more ways than one. Sir Stamford's ever indefatigable mind is now turned to the improvement of this place and to drawing forth its resources whatever they may be. It could be too long to give you here a detail of all he has done and all he is doing. Suffice it to say that the very aspect of the place is changed and in spite of all its natural disadvantages, there are good hopes of its rising. Natives and Europeans all seem to awake to the new impulse they receive, and I really think the former more readily and fully than the latter. It is hardly possible to conceive the apathy and *vis inertiae* of the Europeans who have been trained up and imbibed the spirit of the old school of this place. The last 20 years of Bencoolen have been its age of Gothic darkness. It was far better before the time of its old Government but has declined ever since it fell under Bengal. *Nunc vedit ad pristinam dignitatum*, yea it revives in more than pristine splendor.

'I have just concluded the second and longest part of a zoological paper, the Birds. The remainders will not be given so much in detail and will, I hope, be soon finished. Then for botany anew. It has been almost suspended by these and other occupations. I have got numbers of the great flower and have at length satisfied myself upon every point. I have corrected many of the first ideas of it. I mean to send you a specimen. How to send it living is more puzzling. I find, it is parasitic on a species of *Cissus* with quinate and ternate leaves, which I cannot ascertain as yet for want of Roxb. These leaves are serrate and smooth. From the stems of this woody *Cissus* which run either on or under the ground, spring these gigantic flowers at first a round knob, enveloped in a number of calycine or bracteal leaves, which open as the flower enlarges and mostly drop off as it gets ripe. The flowers are unisexual

? *ergo* dioecious. The male has the globular anthers disposed round the margin of the central column as I have already described. The female wants them, but is otherwise similar, and the center of the column is occupied by the minute seeds which are not exactly undulant but disposed on the surfaces of a number of fissures which traverse the substance of the column, without any order or regularity. We get them in numbers from all parts of the country

from all parts of the country so that
they do not appear to be rare. Strange
that they should never before have
been heard of.– They are called by
the natives Pelinum Sekuddé. or the
Devils siribox. or as you would call it
in Bengal Paun box. I like the
name. Poculum Jovis. prov: dub: –
I had a story to tell you of the French
men, but will let it alone just now.
Here break we off at that unhallowed name
Like bards of old when words ill omened came,
Believe me, My Dear Wallich
Thine in saecula saeculorum
William Jack –
P.S. My best regards to Mrs Wallich. and pray
write, write, write.

so that they do not appear to be rare. Strange that they should never before have been heard of. They are called by the natives

Pelimun Sikuddi or the Devil's siribox or as you would call it in Bengal Paun box. I like the name. Poculum jovis. proc. dub.

'I had a story to tell you of the Frenchmen but will let it alone just now.

Here break we off at that unhallowed name
Like bards of old, when words ill-omened came,
Believe me, my dear Wallich,
Thine in saecula saeculorum.

William Jack.

'*P.S.* My best regards to Mrs. Wallich and pray write, write, write.'

Observations on Finn's Baya (*Ploceus megarhynchus* Hume) re-discovered in the Kumaon terai, 1959[1]

BY

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AND

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(*With 2 plates and 5 text-figures*)

CONTENTS

[1] Dedicated with deep admiration to Professor Dr. Erwin Stresemann on his 70th birthday.

I. Introduction

1. Previous knowledge of the Species

In December 1866, 93 years ago, the celebrated ornithologist A. O. Hume obtained from 'Kaladoongee' two examples (both female or male in winter plumage) of a previously undescribed weaver bird which on account of its strikingly massive bill he named *Ploceus megarhynchus* (1869, *Ibis* : 406). In the original description Hume mentioned that his specimens differed from females of the large-billed eastern form of *Ploceus philippinus* from Sikkim terai, East Bengal, and Burma, not only in being larger and darker but in the more rufescent tone of the entire plumage and in other details.

It was not until 1901 that the breeding plumage of the male first became known. Frank Finn, then a Superintendent in the Indian Museum, procured two live birds in the Calcutta market said to have come from below Naini Tal. Finn's description of the breeding male, quoted by Stuart Baker in FAUNA OF BRITISH INDIA, BIRDS **3** : 69, emphasizes the large amount of yellow in the plumage. Finn observed his birds, apparently both males, moult from the bright yellow breeding dress to the dark brown plumage described by Hume earlier. His coloured plate in the *Ibis* (1901 : 29) depicts one of his birds when it was in breeding dress, and the same bird after it had gone off plumage. Curiously enough, during the next 50 odd years practically nothing further was added to our knowledge of the species with the exception of the finding of a breeding colony in the Bhutan duars by C. V. O'Donel in 1912 (NIDIFICATION **3** : 4) the identity of whose owners was refuted by Whistler. Indeed though a few birds turned up from time to time in the Calcutta bird market, their exact provenance was in doubt, and mystery continued to surround the species which was believed to be exceedingly rare. So much so that some 4 years ago the Indian Board for Wild Life entered it on the list of rare and vanishing species whose export, dead or alive, was totally prohibited.

As Humayun Abdulali (1952) has since shown, much of the mystery and confusion that has surrounded this species was due to the unwarranted doubts cast by Whistler and Kinnear (1933) upon the identity of the breeding specimens of *P. megarhynchus* collected by C. V. O'Donel in the Bhutan duars in 1912 which, they maintained, were nothing but the eastern form of the Common Baya, namely *Ploceus philippinus burmanicus* Ticehurst. However, in his MS. notes (now in SA's possession) Whistler himself gives the diagnosis of *P. p. burmanicus* male, as differing from

philippinus in 'the total or almost total absence of yellow on the breast, and no yellow on the mantle; throat variable and may be almost whitish to almost as dark as in *philippinus;* underparts rusty or tawny white. Female, juvenile, and non-breeding male, with more rusty supercilium; underparts and flanks more tawny than in *philippinus.*'

Later Whistler had the opportunity of examining at least one of O'Donel's breeding specimens, a female collected in the Bhutan duars on 25-5-1912 obviously at the very colony referred to by Stuart Baker and upon which the latter's description of the breeding female is based (F.B.I. **3**: 70). On this specimen Whistler reported as follows (personal communication to SA, see *Indian Forester*, June 1935 : 372): 'The crown and nape and sides of the face are olive-brown, strongly washed with yellow and practically unstreaked, these parts contrasting with the rest of the plumage. The chin, throat, breast and flanks are largely canary yellow. In all other respects the bird . . . agrees entirely with the rest of the series (of *burmanicus*), and I have no doubt it is the same form.' In view of his own description of female *burmanicus* as having no yellow on the underparts it is difficult to understand Whistler's conviction that the above specimen was the same form nevertheless!

Humayun Abdulali (1954) has further shown that in view of the good series of undoubted *megarhynchus* recently collected by Dr. Walter Koelz at Agia, near Goalpara in western Assam, Whistler and Kinnear were definitely mistaken in considering O'Donel's breeding birds to be *P. p. burmanicus.* Abdulali draws attention to certain differences in coloration between on the one hand live birds obtained from the Bombay market (said to come from Kumaon terai) together with those recently procured in Calcutta (said to come from Gorakhpur via Bareilly), and on the other O'Donel's specimens from the Bhutan duars together with those collected by Koelz in Assam. If these differences can be sustained on further material it may be worthwhile to recognize an eastern race of *Ploceus megarhynchus.*

2. Rediscovery in Kumaon, 1959

This being the unsatisfactory state of our knowledge, it was felt imperative that a well-organized effort be made to re-discover the species in its natural habitat, and to collect fresh breeding specimens and data on its ecology and habits. One of us (JHC) has been studying the ethology of the Ploceinae in Africa and is now in India to continue his researches on the Indian weavers. We welcomed the opportunity of making a concerted attack on this elusive creature,

Our field trip[1] in the Rampur and Haldwani districts of Kumaon (U.P.) lasted from 10 July to 8 August 1959. One of us (SA) returned to Bombay on 23 July, leaving the other to continue investigations by himself thereafter. While together, our base of operations was Fatehpur (*c.* 10 km. from Haldwani). Later work was done mainly from the Forest Rest House at Lalkua. A car made daily visits to the colonies possible, as also the exploration of an extensive tract of the surrounding terai and bhabar country. We wish to record our thanks to the Chief Conservator of Forests, U.P., for the helpful co-operation and facilities we received during the field work from him and all officers of his department, in particular from Shri S. S. Bahadur, Wild Life Warden, Western Circle.

It may be recalled that as far back as 1934 a special expedition to Kaladhungi[2] to re-discover *Ploceus megarhynchus* had failed to locate the bird or to procure any workable clue concerning its whereabouts. (Ali, Sálim, 1935). In September 1953 Mr. Horace Alexander and one of us (SA) made a second fruitless quest in the terai around Bilaspur (Rampur dist.) where Mr. Alexander had definitely seen 12 to 15 birds while motoring through on 24 June of the same year. Since then correspondence with various residents in the Rampur area had elicited only diffuse vicarious information concerning the species, but all the same it was encouraging that at least professional bird catchers did distinguish a larger 'Pahâri Baya' from the Common, Striated, and Blackthroated species inhabiting the same area, which confirmed the fact that the bird did exist in the locality.

However, were it not for a lucky accident on our very first day while still *en route* from Rampur to Fatehpur, the finding of the bird would not have been quite such a simple affair. When about 40 km. out of Rampur City, and 3 beyond Bilaspur, on the Naini Tal road a largish weaver with conspicuous yellow rump and underparts suddenly flashed past in front of our car and into some tall grassland. A follow-up on foot failed to flush the bird again, but presently a second bird was seen to fly out of the grass and up into the leafless top of a Silk Cotton tree about 10 m. high growing alongside the road. Binoculars revealed this to be a male *megarhynchus* in breeding plumage, and the roughly woven blobs and tangles on the bare branches there to be nests in various stages. Soon several more of the weavers appeared on the tree-top with strips of grass, intertwining them

[1] Aided in part by a Rockefeller grant through the Bombay Natural History Society.

[2] An obscure little village at the foot of the hills on the old Moradabad-Bazpur-Naini Tal road which, by the sensational success of the book MAN-EATERS OF KUMAON has shot into fame as the home of the legendary Col. Jim Corbett. His cottage, now in changed ownership, stands there crumbling in decay.

laconically into the part-built structures. Since this first unexpected discovery and the many other nest colonies thereafter, it is no longer difficult to understand how the bird—which actually proves to be not at all rare or uncommon in this locality—could have been overlooked on previous quests. Indeed, but for the builders in attendance among the tree-top one would have hardly thought of looking for a nest colony in such a situation, or recognized such completely unorthodox structures as nests of an Indian weaver bird.

3. Field Recognition, and Particulars of Specimens collected in 1959

Adult Male (breeding): *Above*, head and nape bright yellow with contrasting dark brown ear coverts. Back and upper parts dark brown, broadly streaked. Rump yellow. *Below*, from chin to vent, including flanks, bright golden yellow (richer and deeper than in the Baya). Beginnings of a dark brown collar or breast-band on sides of neck.

Adult Female (breeding): *Above*, head and nape pale canary yellow, or brownish heavily suffused with yellow. Rest of upper parts rich brown, streaked darker. *Below*, pale canary yellow or yellowish white. First year male in breeding season exactly like female. The latter can be distinguished in the hand by smaller overall proportions, and slenderer bill and tarsus.

First year males in this plumage were observed collecting grasses and weaving them into partly built structures giving the illusion that females also build. We have no evidence that these rough and formless tangles are ever completed or functional.

Specimens collected:

	Wing	Bill	Tar.	Tail
2 ♂♂ ad. (breeding)	78.5–80	22–23*	25	56–60 mm

* Depth of bill at base 15-15.5 mm.

Iris orange-brown; bill blackish horn, paler at base; legs and feet brownish flesh. Testes 10×7, 10×8 mm.

	Wing	Bill	Tar.	Tail
2 ♂♂ (first year)	77–79	21*	25–26	57 mm.

* Depth at base 14-15 mm.

Iris hazel/orange-brown; bill horny brown, paler (whitish) at base and chin; legs and feet brownish flesh. Testes minute *c.* 2×1 mm.

	Wing	Bill	Tar.	Tail
1 ♀ ad. (breeding)	74	20.5*	23.5	54 mm.

* Depth at base 11 mm.

Iris orange-brown, duller than in ad. ♂; bill: upper mandible horny brown, lower pale flesh, brownish at tip; legs and feet brownish flesh.

In this species the tail is rounded and almost fan-shaped.

In non-breeding plumage male and female are alike and separable from *Ploceus philippinus* only by their somewhat larger size, darker coloration and larger bill. Definite field identification, however, is not always possible.

The facts that *P. megarhynchus* builds a type of nest very different from that of any other Indian weaver of the genus *Ploceus*, and that the female is seasonally dimorphic in such marked degree, suggest the need of a deeper study of its proper systematic status.

II. Breeding Ecology

1. Habitat

Finn's Baya inhabits pure terai country in which marshes and extensive stands of sarpat (*Imperata arundinacea*) and munj grass (*Saccharum spontaneum*) are sparsely dotted with isolated trees, particularly *Salmalia malabarica*, and occasionally interspersed with patches under rice or sugar cane cultivation. Nest colonies were found perched in the topmost twigs of trees in limited areas locally distributed within the terai as a whole. The largest number were located along a four mile stretch of road starting just north of Bilaspur and extending to about a mile north of Rudrapur on the main Rampur to Naini Tal highway. Here some twenty colonies were seen, mostly containing some 15-20 nests each, but in a few cases with many more—up to 200 at least in one colony. A further two colonies were found at about 1.5 and 7 km. respectively from Rudrapur on the Bazpur road, and several further colonies were located on the Lalkua-Bareilly road near Kitcha. The latter group lay close to the borderline between the terai and the bhabar country that lies between it and the Himalayan foothills. Several colonies normally occur together but always with wide stretches of intervening country between them and other groups.

It seems certain therefore that, at least in the breeding season, the species is not found in the bhabar. The two females obtained by Hume from Kaladhungi in typical bhabar in December 1866 were therefore probably from the scattering of the birds in the non-breeding season. Alternatively the locality name on the label may have been meant only as a broad indication of the general area in which the birds were shot. After our present experience of the species in the terai it is understandable why the quest for the birds in their published

type locality in 1934 (Ali, 1935) failed. A brief visit to Kaladhungi during our present investigation again failed to reveal the birds. Certainly Stuart Baker (F.B.I. **3** : 70) is quite incorrect in stating that the species breeds up to 3 or 4000 feet. His information is obviously based on O'Donel's breeding record and specimens from the Bhutan duars labelled 300-500 feet, and the Rudrapur area also lies at *ca.* 700 feet elevation only. Kaladhungi itself is not more than 1300 feet.

2. Colony Sites

All the breeding colonies located by us were in tree-tops, almost all of *Salmalia malabarica*, at about 9 or 10 metres from the ground. In a very few cases other trees were favoured and the main observations on behaviour were made on birds building their nests in a *Dalbergia sissoo*. The birds strip the leaves off all the twigs around the nests so that the upper part of the canopy is normally completely denuded and the colonies thus stand out prominently against the skyline. O'Donel in the Bhutan duars found the species nesting 'in a vast area of grass more or less intermixed with scrub'. In Kumaon nest building was also observed in reeds and rushes over standing water, but since most of the birds concerned were first year juvenile males and these reed beds were also roost sites, it is likely that the activity was no more than 'doodling'. The nests observed here were never complete, and may simply be the results of excessive building energy having no certain connection with definitive breeding. Similar observations have been made on this species in Dr. S. C. Law's aviary in Calcutta in 1936 or thereabouts, and on other weavers in captivity. Also on wild first year males of *Ploceus philippinus* in India (Ali, 1931, p. 958) and on *Quelea quelea* in West Africa (Morel & Bourliere, 1957; Crook in press). Thus while nests are certainly sometimes built in reeds it is not yet certain to what extent such sites are actually used for breeding.

The smaller *Salmalia* trees probably provide the birds with some degree of protection from terrestrial predators by virtue of their extremely spiny trunks and branches. It was in fact a major operation to obtain nests and eggs from one of these trees, and the climber had to use every possible caution. Further many of the colonies were situated near water in land which after heavy rain is mostly flooded.

Five out of seven colonies in which birds were observed were built in trees in which a pair of Black Drongos (*Dicrurus adsimilis*) were also nesting. The drongos were extremely alert to all approaching birds, attacking especially crows (*Corvus splendens*) and birds of prey with great effect. They also drove off birds of other species that

approached the tree including Common Mynas, Redvented Bulbuls, Yellow-eyed Babblers, and Rufousbacked Shrikes. There is no doubt that the weavers derive great benefit from the dash and audacity of their neighbours. In all cases noted the young of the drongo were much older than those of the weaver, suggesting therefore that the drongo had occupied the tree site prior to the arrival of the weavers.

3. Breeding Season

On our arrival in Kumaon on 12 July it was at once apparent that breeding was largely completed. Out of the many nest colonies located on the Bilaspur-Rudrapur road only two were fully occupied, and, in the only one that could be closely observed, the birds were already busy feeding young. In two further colonies a few nests were being visited. Later on nest construction and courtship were seen in a fresh colony between 22 July and 5 August. These nests were, however, never finished and pair formation never attained. Ultimately the nests were deserted. At Kitcha a colony with well-incubated eggs was found on 2 August. It is thus clear that Finn's Baya breeds very early in the rainy season well before the main breeding period of the other Ploceines[1] in the area. The colonies found abandoned on 12 July still sat among bare twigs and as it was ascertained that *Salmalia malabarica* puts out new leaves on the defoliated branches within a week of the birds' departure, we can say the colonies could not have been left for longer than that time. We were told that heavy rains fell in the area near the end of May and it is probable that these marked the onset of the birds' breeding. During SA's preliminary enquiries, one correspondent had furnished information obtained from a local bird catcher apparently familiar with the bird under the name of 'Pahāri Baya', that the species breeds twice in the year—in July and again in September, i.e. it has two broods. Our experience indicated that this information is probably quite correct.

4. Flocking, Feeding, and Food

The species is at all times gregarious moving in flocks about the grassland, feeding in company and coming to the colonies and departing therefrom in well integrated groups. The flocks fed in the tall grass and sugar cane stands where insects were apparently taken. Also on ploughed fields and on the roadsides where seeds appeared to constitute the food. Parents were once seen feeding their young on seeds pecked up on the roadside. On the ground the birds walk well, but when moving at speed they hop.

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[1] *Ploceus philippinus*, *P. manyar*, and *P. benghalensis*.

The crops and gizzards of the shot specimens contained entire husked rice grains probably gleaned on the road, other smaller seeds, and brown chitinous insect remains (ants?). One female shot at a nest colony with an insect in her bill for the young had insect remains in the crop.

III. The Breeding Colony

1. Colonies particularly observed

Since we had arrived after the main breeding period it was not possible to observe the development of a colony from its first visitation by a flock throughout reproduction to the departure of the young. It is not possible therefore to assign time periods to the different phases of life in the colony. Thus unfortunately we do not yet know how long it takes to construct the nest, at what stage in its construction the female accepts it and lays eggs, the incubation period, or the fledging period. These must await a further study in which observations should be started by the middle of May. The following account has thus been constructed from notes taken at three different colonies each at a different stage in the reproductive cycle. The colonies observed, in chronological order, were as follows:

(i) A colony in a *Salmalia malabarica* tree on the Bilaspur road, approximately half way to Rudrapur (Plate I).
Here young were in the nest on 12 July; by 25 July only a single nest was still occupied at which a female was feeding well-fledged young. A week later the colony was deserted and the old nests partly obscured by new green shoots. At this colony observations were made on parental care.

(ii) A colony in a *Dalbergia sissoo* tree on the Rudrapur- Bazpur road. Nest construction and courtship were observed between 22 July and 5 August. The colony was ultimately deserted before pair formation occurred.

(iii) A colony in a *Salmalia malabarica* near Kitcha on the Lalkua-Bareilly road in a site difficult of access, on the far side of a river. Here behaviour during incubation was observed on 2 and 4 August.

2. Nest site, Structure, and Building behaviour

The nests of Finn's Baya are unlike those of any other Indian weaver. They are large gobular structures, untidily but firmly woven with long strips of coarse grass, and the entrance is at one side near the top. Often a porch-like projection surrounds the entrance forming

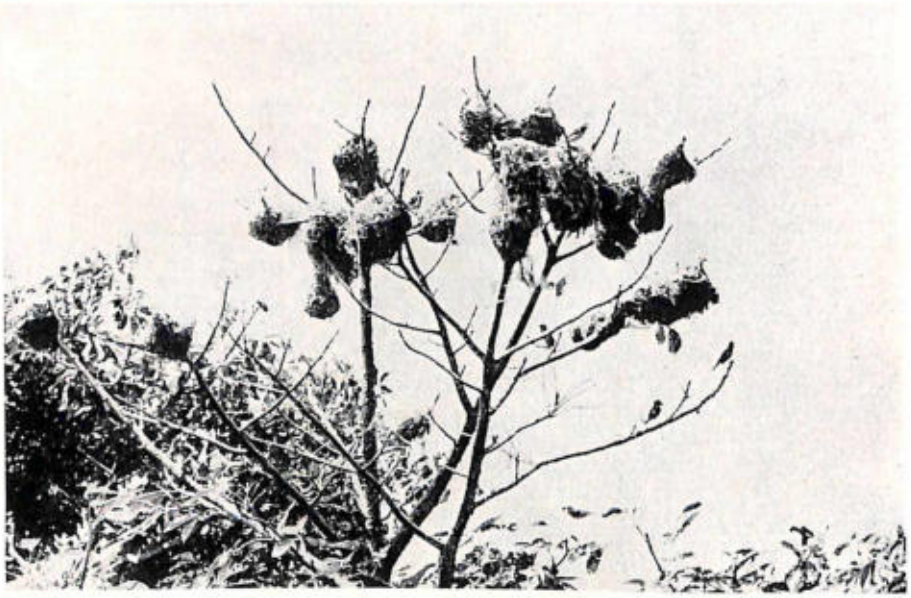
a small papilla as often seen in munias' nests. The structures are usually firmly knotted to upright twigs which are often worked into the fabric and also support the body of the nest from below. Occasionally the nests are slung sideways on to a twig or two so that the nest chamber hangs free below it. In no case, however, are the nests truly suspended from fine single twigs as is normally the case for the Common Baya, *Ploceus philippinus* (Ali, 1940). The nests thus most resemble those of the *Quelea* in Africa (Morel, Morel, & Bourliere 1957) both in form and in the method of attachment to the supporting vegetation, as well as in the progressive stages of construction. Silhouetted against the sky in the distance, a nest colony looks rather like a cluster of honeycombs in the bare tree-top. In Asia the only other species with a comparable nest would appear to be the Golden Weaver (*Ploceëlla chrysaea* Hume) of Burma which, however, builds mostly in small trees and bushes (Stuart Baker, NIDIFICATION 3 : 12). All other Asian species have nests normally slung or suspended from fine twigs (*P. philippinus*) or from grasses or rushes (*P. benghalensis* and *P. manyar*) and with vertical tubular entrances opening below.

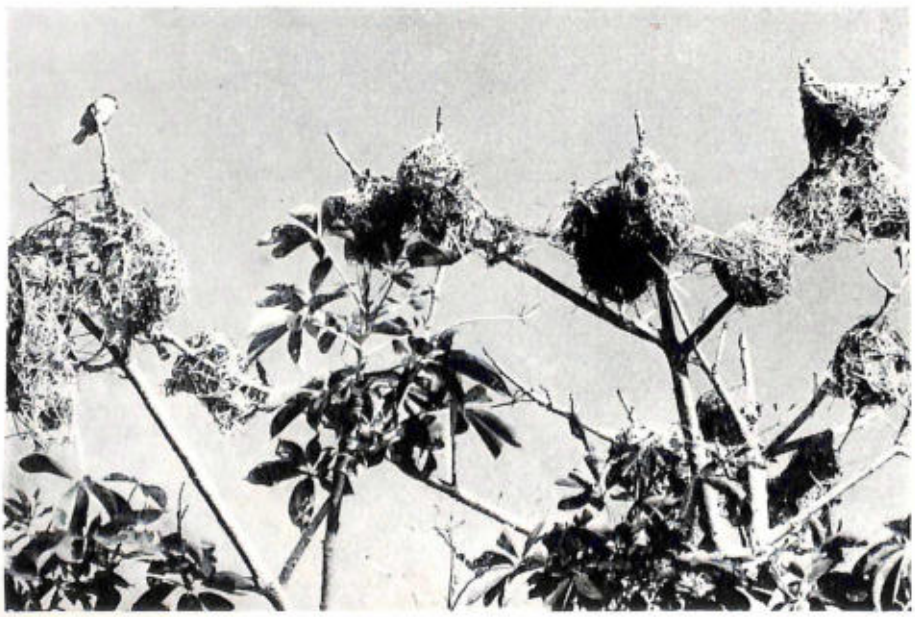
A feature of especial interest is that many of the nests form composite units being linked together with connecting walls or flanges of material, or by long separate strands bound in firmly at each end to different individual nests. Usually these composite structures (2, 3, or 4 nests) belong to a single male, but at the larger nest composites at least two males were often responsible (see below). The linkage of the structures is due to the extreme proximity of the building positions at which the birds begin construction. Loose strands from one nest are thus pulled across into the neighbouring nest and the ends tied in. With repetition of this behaviour, together with indiscriminate building on flanges and sometimes even on a neighbouring male's nest, a partial fusion of the individual nests occurs. This is a rare condition in the Ploceinae the only other recorded case being for *Malimbus rubricollis* in Southern Nigeria (Crook, 1958 *a*) and infrequent cases in *Quelea* colonies. It occurs only in species in which the area defended around the nest during its construction (i.e. its territory) is extremely small (see below) and it appears to mark a half way step in the evolution of the giant fused nesting structures, such as are found in other Ploceidae (*Philetairus socius*, Friedmann 1949; *Bubalornis albirostris*, Crook 1958 *b*).

The individual nests are constructed by the male birds. Building started in the *Dalbergia sissoo* with the tying together of twigs into the shape of a ring (the initial ring, Skead 1947) that forms the foundation of all weaver nests. The birds perch on one twig and repeatedly

Silk Cotton Tree with nest colony at top.

Photo : Sálim Ali





Close-up of the nests.

Photos : Sálim Ali

lean out to grasp another in the beak. This is then pulled close to the body and held under the feet. Many such isolated movements are made until ultimately the twig is bound to the perch by a knot of grass tied around it by movements of the bill. In cases where the twigs are too stiff for bending, as is usual in *Salmalia* trees, separate twigs are simply linked up with knotted strands of material which eventually complete the circular shape of the ring. When the initial ring is finished, it is thickened at the sides by the twining in of fresh grass strands. At the same time separate strands are looped across from one side to the other at any angle and at random so that a kind of trellis-work or net gradually appears. At this stage the bird pushes the material with its beak, head, and breast so that it becomes curved outwards from the usual working position at the base of the initial ring. The horizontal depth of the nest is thus determined by the reach of the bird during the performance of the shaping movements. All the while the bird is actively engaged in snipping off the leaves on the twigs near the nest and these then fall from the tree. Some leaves very close to the developing nest are, however, sometimes incorporated in the structure. The nest now develops by repeated additions of long strands of grass (30-60 cm. in length and up to 1 cm. in breadth) each taken to the site singly held in the beak of the builder. These strands are loosely looped across from side to side of the initial ring or between it and other supporting twigs that are incorporated into the developing walls. Thus on arrival the male first ties the end of a strand to the side of the initial ring by inserting it through the accumulated material, pulling it through and reinserting it several times until it is firmly fixed; the free end is then taken in the beak, twisted once or twice around the various supports and either laid against or interlaced with the developing trellis-work and then, if long enough, tied in again firmly to the far side of the initial ring. After each bout of knotting and twining, a bout of shaping movements usually occurs. The bird then sits on or near the nest titivating with loose pieces of his own nest and those projecting from his neighbours'. Also sometimes he hops on to a neighbouring structure where he performs further in the same way. He may also steal materials and take them to his own nest or take loose ends left hanging from a neighbour's nest and tie them in to his own. In this way the interconnections between neighbouring structures are established. Sometimes one bird alights on its nest with a long strand the end of which hangs temptingly near another builder. The latter then often seizes it and pulls. At once a vigorous tug-of-war ensues, each bird straining to gain the prize. Several times the grass strands broke under

the strain. Curiously enough, these intensely fought competitions never ended in fights, perhaps because the birds always had the full length of the grass between them.

As the framework develops, the strands are pushed downwards and twined around supports below the building position and also to the lower rim of the initial ring itself. The chamber thus begins to bulge below the original ring (fig. I) in a rough kidney shape. As the whole structure is being fitted throughout to supporting twigs, its shape is normally somewhat irregular conforming to the disposition of the various twigs bound into the frame. Further to these movements, wet mud blobs are carried to the nest in the beak and fixed either to the sides of the fabric of the initial ring or amongst the various strands of the chamber walls. Some of these blobs were very large and others were clearly mud-covered lumps of sodden wood. One mud covered twiglet was also used (5-7 cm.). By this time the nest is nearing its definitive shape and the entrance (the initial ring) has come to lie at the side near the top. There are, however, often gaps in the fabric which remain open and the birds occasionally enter by them. Occasionally a bird may sit in such a gap and carry out building and shaping movements from there exactly as if it were the initial ring. When the framework is complete the fabric is thickened by the addition of further strands.

The majority of observations on which this account is based were made on 12 nests in active construction in Colony ii. Since this colony was abandoned it was not possible to see how soon after the completion of the first nest a male begins another. One case was, however, observed in which a well-established ring was abandoned and destroyed and a new one built among twigs a few inches below. The nests were never properly completed and we cannot say how long a nest takes to construct when building motivation is at its maximum earlier in the season.

Females were observed titivating and shaping the nests very actively during their 'inspection' visits to the colony. Often a female would give several nests this treatment before leaving the colony. After egg laying, females were seen bringing soft grass heads (sp. ?) to the nests using them to line the interior. Nests obtained from Colony iii were however not fully lined, the base of the egg chamber and the area near the entrance having received the greatest attention. Apart from these activities the females, as in other weavers, did not take further part in nest construction.

3. Polygamy

Finn's Baya is polygamous and evidently attracts his wives to nests built in succession. As it was not possible to observe the whole process, we estimate the sex ratio of adults breeding in the colony from a few careful counts made in Colonies i and iii.

In Colony i there were 15 units of nests made up of 7 single nests, four units of two joined nests, two units of three joined nests, and two units of four joined nests. At two carefully observed units of two nests each there were single males with two females each. At a unit of four nests there were two males (one for the upper two nests, one for the lower two in the unit) and four females. At Colony iii single males respectively were recorded at three units of four nests each, one unit of three nests and one of two nests all of which had females. In a further twenty nests repeated counts revealed only seven males. Thus at forty-five closely observed nests in the two colonies only 16 males were present to match the 45 female occupants. This gives us an average of 2.8 females and nests to a male. The above observations thus suggest that while cases of single males with only one nest and female, and of males with as many as four females were recorded, the usuai number is probably two or three.

4. Eggs, and Clutch size

Eggs were obtained from six nests cut down from Colony iii. As in other Indian weavers, they were of a plain white coloration. There were four clutches of two eggs and two of three. The egg measurements, taken with a vernier calliper, are given in Table I. In a sample of 12 eggs the mean length was 20.95 mm. (maximum 23.6 mm., minimum 19.8 mm.); mean breadth 15.28 mm. (maximum 15.7 mm., minimum 14.8 mm.). Some of these eggs have been presented to the Bombay Natural History Society together with a group of nests.

IV. Agonistic and Reproductive Behaviour

1. Territorial Behaviour

At a colony under construction the males come and go in groups. On arrival the birds at once separate to their nest sites giving loud songs in a chorus. Approach to the nest by other birds is never tolerated and aggressive behaviour is at once shown. The defended area is however extremely small, at no time consisting of more than the nest site itself and, unlike most other weavers which tend to have their nests well spaced at least at the commencement of breeding, the

TABLE I

Egg measurements of clutches of *Ploceus megarhynchus* obtained near Kitcha on August 3, 1959

Clutch No.	Clutch size	Egg measurements in mm.
I	2 eggs	20.0 × 15.0 19.8 × 14.8
II	2 eggs	20.0 × 15.0 20.7 × 15.4
III	2 eggs	23.1 × 15.4 23.6 × 15.3
IV	2 eggs	Broken
V	3 eggs	20.1 × 15.7 20.9 × 15.6 21.2 × 15.2
VI	3 eggs	20.0 × 15.1 20.7 × 15.4 21.3 × 15.5

sites are so crowded as to be often within the stretching distance of the neighbouring birds. The distance between nest sites is in fact hardly greater than the normal 'individual distance' of the birds in a flock.

(i) *The Lunging Match*

The two factors, extreme crowding of nest sites and intensively aggressive reaction to the approach of other males, produce an unusual form of territorial defence almost all of which occurs on the nest itself, the defenders each perched in his proper nest ring and lunging as hard as possible at each other. These 'Lunging Matches', of which variants are found in many other weaver species, have the following form (see fig. I):

(1) The two combatants turn and face each other.

(2) Both raise wings above back but without at first extending (spreading) them, and begin quivering them at considerable speed. Sometimes the wings are simply raised, and quivering does not develop.

(3) One bird lunges at the other in an attempt to peck the beak or face of the opponent. The latter at once recoils its head into its shoulders and may move the whole body backwards pivoting on the hips. The feet do not change position. Immediately the lunge is completed the opponent at once retaliates with an identical pecking movement and it is now the turn of the first bird to recoil. Alternate lungings and recoilings occur repeatedly until the birds tire and one of them turns sideways and titivates its nest or hops into a different position on its nest or twigs near by. Sometimes the match is again renewed in the changed position.

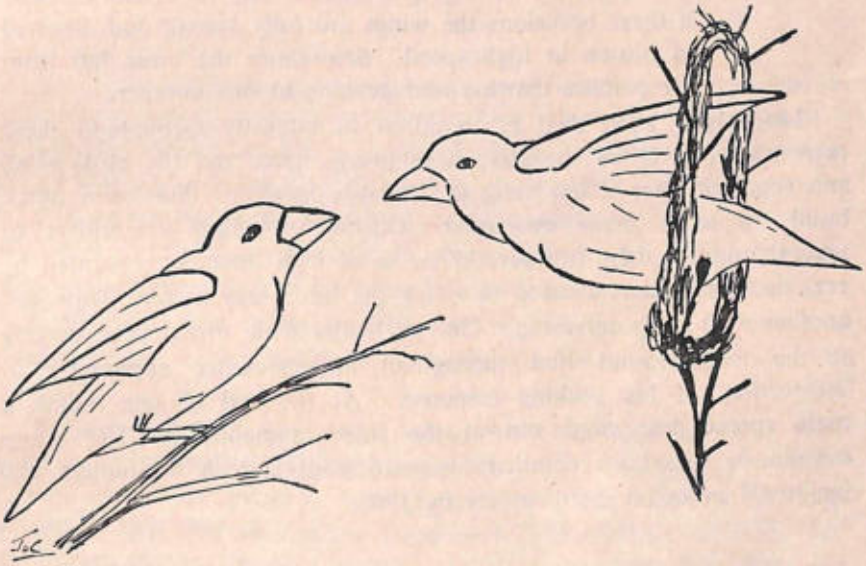


Figure I. Lunging Match between two males, the bird at right being perched in the Initial Ring.[1]

(4) The degree of wing spreading and the amplitude of the movements both increase with the intensity of the encounter. The movement varies from a simple wing quivering in which the wings are raised just above the line of the back and not spread at all, to an intense wing beating with partial wing spreading ('fluttering') in which the amplitude of the movement is greater, the wings moving from a position well above the line of the back to just below back level. Thus the more intense (i.e. longer and

[1] All figures drawn by JHC from sketches in field notebooks.

fiercer) the encounter, the greater is the spread of the wings and the amplitude of the flutter. The wing elevation is also higher. Wing movements of this kind during Lunging Matches have not been recorded previously from other Ploceine species although wing raising is given in the context by *Quelea quelea*.

(5) In the majority of Lunging Matches the combatants were both perched in the rings or on their developing nests. In some cases one of the birds was on a twig near its nest, while in a few further cases both the birds were perched on twigs near their nests.

(6) Occasionally these Lunging Matches lead to actual combat. On these occasions the wings are fully spread and elevated and beaten at high speed. Sometimes the birds fall from their perches clawing and pecking at one another.

There is a good deal of variation in intensity throughout these performances. Often the start is relatively quiet and the birds relax and separate after a few lunges. Usually, however, there is a quick build up to a fierce encounter. During prolonged encounters of several minutes there are several peaks of high intensity separated by periods of partial relaxation in which the birds may merely fixate one another with wing quivering. One particular male would peck fiercely at the twigs round him throughout an encounter apparently in 'redirection' of his pecking response. At the end of one match a male spread his wings out at the sides momentarily. The above account is based on detailed observation of sixteen encounters and incidental notes on many others by JHC.

(ii) *Supplanting*

Males sometimes 'supplant' one another (i.e. one bird fixates another and flies at it normally replacing it on its perch). This occurs particularly when the males follow prospecting females around part of the colony and thus repeatedly approach both one another and each other's nests. Supplanting of prospecting females is also common (see below).

2. Mobbing

The male Finn's Bayas at colonies with eggs and young sometimes perform mobbing attacks on human intruders. The bird concerned starts calling a loud *skeer skeer skeer* on the tree and then flies out repeatedly over the head of the intruder repeatedly calling. We have

no experience of other weavers' behaving towards a human being in this way. The behaviour resembles that of the drongos, who also had nests in the trees concerned, though it lacks the proficiency of the latter. The behaviour was not observed towards birds such as crows, normally so admirably driven away by the drongos.

Once a flock of Common Babblers (*Turdoides caudata*), the pair of drongos in occupation, a Redvented Bulbul (*Pycnonotus cafer*), and a pair of Yellow-eyed Babblers (*Chrysomma sinensis*) began mobbing a snake in a bush near the colony. During the commotion a dozen or so Finn's Bayas flew down into the same tree giving their mobbing call. On the hurried departure of the snake the bayas returned to their nests.

3. Pair formation

As in the majority of colonial weavers, courtship and pair formation are preceded by nest invitation during which the male attracts a prospecting female to his nest, at which he later courts and finally mates with her. From the present field observations a detailed account of nest invitation can be presented. Unfortunately we did not observe sufficient courtship to be sure of the actual details of the process. The greeting behaviour of pair members during brooding was, however, well observed and, since in other species this is often identical to postures seen in courtship, we can suggest the probable course of events.

Females normally first visit a colony when the nests are at an early stage of construction (Colony ii). They arrive singly or in small groups and soon some at least fly off with the males in foraging parties so that they accompany them back to the colony after feeding. In any event the arrival of females in the colony occasions great excitement among the males many of whom cease building and approach the females displaying (see below).

On arrival in the colony a female hops about among the nests in an apparently unconcerned manner although the sleeked plumage and crouched posture indicate a strong tendency to flee. She also avoids all males that approach her. During this exploration she hops on to many of the developing nests and performs shaping movements and titivation or merely examines them closely, peering about in and around the structures. During this activity the owner is in close attendance giving a particularly intense display (see below). Occasionally the female may respond with a little wing quivering, but in all observations she hops out of the nest again after a few seconds and taking no notice of the male proceeds to a further structure. Occasionally

two females approach a nest at the same time, there is then either a brief fight or one bird supplants the other.

The male's response to the approach of a female is an elaborate display with several degrees of performance intensity depending on the female's proximity to his nest. As soon as a female alights near an area of nests, most of the males hop down from their sites and approach her fixating her closely all the while. They finally stop advancing at a distance of one or two feet from her position. All the time they are giving the 'Wing Undulation Display' of the following very variable components:

(1) The bird faces the female fixating her with the body slightly crouched or else leaning forward or upward slightly from the hips in the direction of the female. The plumage is not fluffed except on the crown and nape.

(2) The tail is widely spread and often slightly depressed especially when the wing movements are fastest.

(3) The wings are undulated with a very slow and often irregular rhythm. They are normally fully spread and well elevated above the back. They are beaten through an arc of some forty-five degrees, between 45° and 135° to the dorso-ventral line of the body (see fig. IV); they thus move between a position roughly half elevated above the back to a drooped position at the side of the body. Often during the course of these undulations movement ceases for several seconds and this may happen with the wings either elevated or drooped (fig. II). Often the movements give place to wing quivering following partial closure of the wing. Wing quivering occurs at very low display motivation and often precedes it. Also males just beyond the immediate circle of displaying birds may show some wing quivering without leaving their nest sites.

(4) Song is given (see under Vocalisation, below).

During the performance the males may shift their positions, stop and start the display several times, and frequently change to wing quivering. There is a great deal of excitement and loud singing. The males, having left their nest territories, now frequently pass each other's nests while moving towards the female and this occasions many supplanting attacks. Further two displaying males may approach each other in their excitement, and a brief fight then follows. Every time the female moves there is a great commotion as the quarrelsome males change positions and approach her again. After a time the female flies on to a nest. At once the owner, who has been wing undulating

near it or among the circle of 'admirers' flies up to his site and perching on the exterior near the entrance, at the side of the entrance or on a twig near it, performs the 'High Speed Wing Beating Display' of the following components:

(1) Posture as in Wing Undulating.

(2) Tail widely spread and either straight or slightly depressed, rarely slightly elevated.

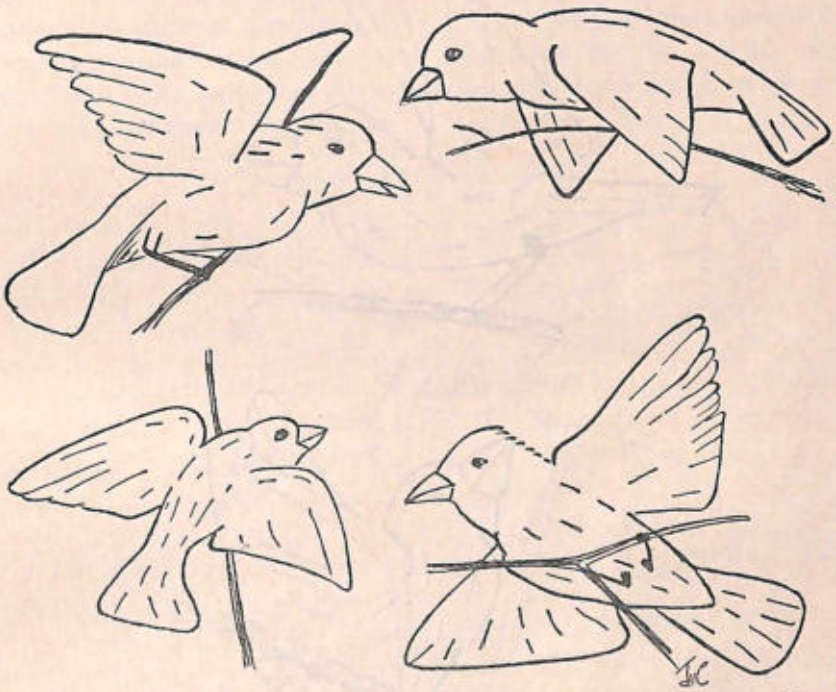


Figure II. The Wing Undulating Display : wings shown in differing positions with performers facing different directions. Top left and bottom right, wings well elevated ; bottom left, wings at the side ; top right, wings drooped. See text.

(3) The wings are fully elevated above the back and beaten at high speed (10 beats in 1.2 secs. mean of four readings, minimum 1, maximum 1.4) through a small arc above 135° to the dorso-ventral line of the body (fig. IV).

(4) Sings loudly at the female. Occasionally at the most intense moments of display a loud *skee skee* termination to the song was heard.

These displays last a few seconds only, the male then hopping to a fresh twig near the nest where he resumes wing quivering or undulating all the while watching the female closely. After several seconds he again flies to the nest and gives the High Speed Wing

Beating Display. This alternation continues until the female leaves the nest or until the male tires and sits near by wing quivering. Occasionally neighbouring males also fly to a twig near the nest and give the High Speed Wing Beating Display. They are at once supplanted by the owner.

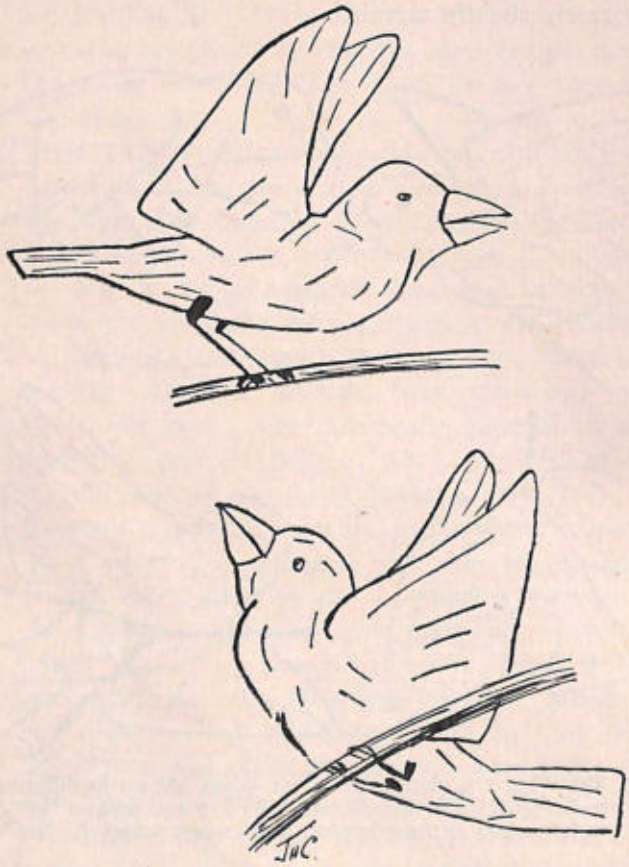


Figure III. The High Speed Wing Beating Display. Bottom bird displays to a female in nest above his position.

The females are not always greeted with display; frequently a male may supplant females approaching his nest and occasionally pursues them for a short distance within the colony tree. More rarely a female lunges at an approaching male away from his nest and forces him to retreat.

128 behaviour sequences shown by the males on the arrival of females among their nests were observed in detail and recorded on tape for later analysis.

The 'Wing Undulation' and 'High Speed Wing Beating' displays are clearly both forms of advertisement and resemble the nest invitation displays of other weavers, particularly the *Quelea* which also displays in an upright posture on a globular nest. However, the female visits nests irrespective of the male's display so that the display probably functions also as part of courtship. The 'High Speed Wing Beating' display in particular resembles a mounting attempt complete with the flutter of wings above the back. During display at the nest several copulation attempts were seen, none of which were however apparently successful, and, at the time, no solicitation by the females was observed. Pair formation was thus never completed in the colony (ii) and the nests never accepted.

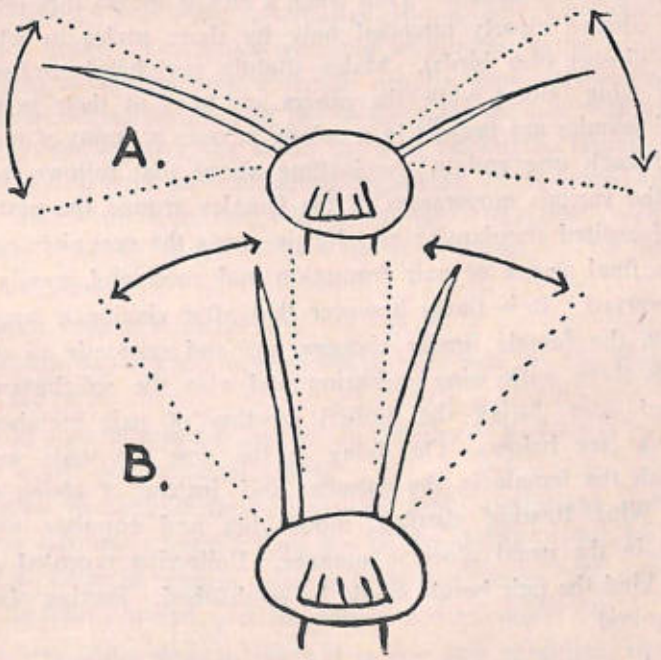


Figure IV. Diagram showing arc and elevation of wing movements in A, Wing Undulation and B, High Speed Wing Beating.

Comparing the two displays with those of other species, the 'Wing Undulation' seems homologous with the many other Wing Beating advertisement displays while 'High Speed Wing Beating' completes and terminates the display in a similar manner to the 'Wings rigid' postures with which it may be homologous (Crook, 1958 *a*, and in preparation). The motivation of these various postures will be further analysed (by Crook) in a later comparative publication.

In several highly colonial weavers, for instance *Ploceus cucullatus* in Africa and *Ploceus philippinus* in India, the performance of nest advertisement displays is highly contagious so that if one male displays to a female a large number of birds, if not all of them, will fly to their nests and display in the same way (i.e. social facilitation). In the present species however this does not happen. Only the males in the vicinity of a female display to her, and they only fly to their nests for the performance of the 'High Speed Wing Beating' after her arrival there. The female is, moreover, very rarely chased (a common occurrence in other species) either within or beyond the colony and as soon as she leaves one area of nests the males return to building and titivating on them while a neighbouring group of males begins displaying to the female. Thus when a female moves through a colony she is always closely attended only by those males to whose nests she is closest (4-6 birds). Males slightly peripheral to her position merely wing quiver while the others are busy at their nests. When several females are present in a colony at once a group of males forms around each one and in the jostling about that follows, consequent upon the various movements of the females around the nests, a great deal of excited supplanting and lunging near the nest sites occurs.

The final stages of pair formation and successful copulation were not observed. It is likely however that after visiting a large number of nests the female finally chooses one and responds to the male's displays there with wing quivering and also the solicitation posture observed later during the mutual greeting of pair members during brooding (see below). On flying to the nest the male would then approach the female in the entrance and, instead of giving the 'High Speed Wing Beating' display, mount her and copulate with wings beating in the usual ploceine manner. Following repeated sequences of this kind the pair bonds would be established. Further observations are required.

4. Behaviour during brooding

At Colony iii incubation was well advanced by the time of the observations on 2 and 4 August. The males sat about their nests occasionally titivating on them and bringing in new grass strands which were added to the exterior. These fresh green strands were not observed at nests with young inside in Colony i. The birds came and went in groups as before, producing loud twittering choruses on arrival and departure. The females were very active about the nests; some were incubating and others flew to and fro transporting flowery grass

heads into the nest. They confined their attentions now to their own nests.

The males showed lunging behaviour only very occasionally and it was clear that this had largely ceased. They frequently trespassed on one another's nests, however, but a brief supplant sufficed to remove an intruder and no fighting was seen. The males also occasionally supplanted females who had perched on a nest other than their own. Usually the males welcomed females returning to their nest groups by turning to face them and wing quivering. Only rarely were some Wing Undulation movements seen, and there was none of the displaying so characteristic of the pre-mating period. Sometimes when a female had entered a nest the male flew to the entrance wing quivering and sang loudly into it. When wing quivering, a male may advance towards a female and sing, whereupon she usually disappears into the nest in a hurry. The males were not seen entering the nests.

On arrival at the nest unit a female usually wing quivers intensely to the male who may be greeting her in the same manner. Both birds then wing quiver together for a few seconds before the female passes to her nest (cf. *Quelea quelea*, Crook in press). Frequently however the female may show a posture which, through comparison with other weavers, can only be called a 'Solicitation Posture'. This has the following components:

(1) Body crouched on perch.

(2) Wings are slightly spread out at the side of the body and quivered.

(3) Tail slightly raised (*circa* 30° to the line of back) and tremored in the dorso-ventral plane.

From time to time during certain of these posturings a further more intense posture is given. This has the following further features:

(1) The body is closely squatted on the perch. The head is suddenly raised and the bill is pointed upwards.

(2) At the same time as the bill raising and squatting, the wing quivering suddenly ceases and the wings are spread out at the side of the body in a slightly drooped position (figure V).

(3) The tail remains slightly raised or is yet further raised above the back and the tremoring is continued.

This posture usually occurs during a spell of wing quivering or ordinary solicitation, and may recur three or four times before the female flies to the nest. Occasionally it is given without prior wing quivering or solicitation. Some females seemed more disposed to give the postures than others.

In other weavers this type of greeting behaviour closely resembles sexual behaviour prior to copulation, and we thus have every reason to suppose that these solicitation postures also occur prior to copulation in this species. The particularly intense form of the posture probably accompanies mounting itself. During brooding the postures probably prevent the expression of aggressive responses by the male on the female's approach. The male in fact was never seen to respond to

Figure V. The female ' Solicitation Posture ' in the intense form with momentary sideways spreading of the wings in a slightly drooped position.

these postures with any behaviour other than wing quivering, but the occasional supplant and the approach to the nest with loud song indicate the infrequent activation of a tendency to attack the approaching bird.

5. Care of Young

Although both sexes feed the young in the nest and also remove faeces, the females are the more active. The males spend much time simply sitting near their nests singing and driving off females (other than their own) that come near them, and in occasional supplants against neighbouring males. When a male alights at a nest containing young he frequently sings, and he also wing quivers (as above) when a female alights there with food. No complex 'greeting' behaviour with female solicitation was however observed during this phase, the females merely showing occasional wing quivering on arrival with their tails slightly raised. The food appeared to be mainly insects carried in the beak.

After the young have left the nests they follow their parents. On 3 successive mornings a group of adults, both male and female, were seen on a roadside, each adult followed closely by one, two, or three full fledged young, wing-shivering and begging food. The adults were picking seeds from the road surface and giving them to the young. At least on these occasions regurgitation was not recorded.

6. Behaviour of First year Juveniles

We observed many first year juveniles (males?) in company with some adult males building nests (or perhaps merely 'doodling'?) in rushes and reeds at two different night roosting sites. The nests were all at a very early stage in construction being either rings or partially developed chambers, or just formless tangles. The birds were seen bending down leaves of rush and tying their ends into the structure. The standing reed stems are tied together with grass strands transported to the site by the builders. As in the definitive tree-top colonies the nests were often only a few inches apart and Lunging Matches were seen at the sites. The whole behaviour was however irregular with individuals frequently building actively on several nest sites, and at any one site several birds may come and build. No females were seen visiting these nests. This type of irregular building activity together with failure to complete the nests and an absence of clearly defined ownership and territorial defence is characteristic of reproductive behaviour at low motivation in several weaver species. In particular it has been recorded for *Quelea* at a midday roosting site in the Senegal in the month preceding actual breeding (Crook, in press). First year juveniles of *Ploceus cucullatus* and *Ploceus philippinus* while yet in 'sparrowy' plumage also build nests, that are inadequately completed and never occupied by females. Whether actual breeding colonies of *P. megarhynchus* here are also sited among reed beds, as recorded from the Duars, remains to be ascertained.

7. Vocalisation

The voice of Finn's Baya is louder, harsher, and more 'nutty' than that of *Ploceus philippinus*. We heard the following cries uttered, some of which have been recorded on tape for further analysis:

(i) A twittering cry given on take-off and alighting. This is particularly noticeable during group flights and appears to play a role in flock integration.

(ii) The *skeer skeer* (or *tseer tseer*) mobbing calls. (p. 472)

(iii) A high pitched alarm note.

(iv) The song given by the male during Wing Undulation, High Speed Wing Beating displays, and Lunging Matches, and also when sitting still in the territory. The majority of birds utter the song as a continuation of the twittering upon arrival in the colony during nest construction (Colony ii), and thereafter it recurs in sporadic choruses, the song of one bird starting the others singing. The song

may be rendered: *twit-twit-tit-t-t-t-t-trrrrr wheeze whee wee we*. The complete phrase is not always given. Occasionally a high pitched *seep seep* either followed the song or occurred during the High Speed Wing Beating displays.

V. Summary

Due to lack of knowledge about its ecology and habits since first described in 1869, *Ploceus megarhynchus* was hitherto considered one of the rarest Indian birds, a notion that now proves to be erroneous. Previous quests for it had failed mainly because of the false scent laid by the published type locality 'Kaladoongee' which is actually situated in the forested country of the Kumaon bhabar at the base of the W. Himalayan foothills, whereas the bird is restricted to the vast swampy grasslands of the terai at a lower elevation. The present investigation first discovered the bird's true habitat by accident, thus removing the major obstacle in its field study. Paucity of correct information may also be due in part to the difficulty of distinguishing this species in the field from the Common Baya in non-breeding plumage.

Unlike all other Indian members of the genus, *Ploceus megarhynchus* builds untidy coarsely woven globular nests in colonies among the topmost twigs of Silk Cotton (*Salmalia*) and other trees which are deliberately denuded of foliage. Incomplete nests were also found among marshy reed beds. In form and details of progressive construction the nests resemble those of *Quelea quelea* of Africa.

Ploceus megarhynchus differs from other Indian Ploceinae also in the fact that the female, in addition to the male, is seasonally dimorphic and acquires a distinct yellow breeding dress, but which is less bright than the male's.

Its general breeding biology resembles that of the Common Baya, *Ploceus philippinus*. The males, wholly responsible for nest building, are successively polygamous having from 1 to 4 females each. The eggs are white, and two or three constitute a normal clutch. Both parents, but chiefly the female, feed the young in the nest and later outside.

Some incomplete observations are recorded on voice, courtship, pair formation, and other behaviour.

REFERENCES

Abdulali. Humayun (1952) : Finn's Baya (*Ploceus megarhynchus* Hume). *JBNHS* **51** : 200-204.

——— (1954) : More notes on Finn's Baya (*Ploceus megarhynchus*). *JBNHS* **52** : 599-601.

Ali, Sálim (1931) : The Nesting Habits of the Baya, *Ploceus philippinus* (L.). *JBNHS* **34** : 947-964.

——— (1935) : Mainly in quest of Finn's Baya (*Ploceus megarhynchus* Hume). *Indian Forester* **41** : 365-374.

——— & Ambedkar, Vijaykumar C. (1956) : Notes on the Baya Weaver Bird, *Ploceus philippinus* Linn. *JBNHS* **53** : 381-389.

——— ——— (1957) : Further Notes on the Baya Weaver Bird, *Ploceus philippinus* Linn. *JBNHS* **54** : 491-502.

Baker, Stuart E. C. (1926) : Fauna of Brit. India, Bds. **3** : 66-77 (Ploceinae).

——— (1934) : The Nidification of the Birds of the Indian Empire **3** : 1-13 (Ploceinae).

Crook, J. H, (1958a) : Studies on the comparative Ethology and Social Organization of the Weaver Birds. Ph. D. thesis. Cambridge University Library.

Crook, J. H. (1958b) : Etudes sur le comportement social de *Bubalornis a. albirostris* (Vieillot). *Alauda* **26** (3) : 162-192.

——— (in press) : Studies on the social behaviour of *Quelea q. quelea* (Linn.) in French West Africa.

Finn, F. (1901) : On the Specific Validity of *Ploceus megarhynchus* Hume. *Ibis*: 29-32.

Friedmann, H. (1949) : The breeding habits of the Weaver Birds. A study in the biology of Behaviour Patterns. Smiths. Inst. Ann. Report : 293-316.

Hume, A. O. (1869) : *Ibis* : 356.

Morel, G., Morel, Y., and Bourliere, F. (1957) : The Blackfaced Weaver Bird or Dioch in West Africa. An ecological study. *JBNHS* **54** : 811-825.

Skead, C. J. (1947) : A study of the Cape Weaver (*Hyphantornis capensis olivaceus*). *Ostrich* **18** : 1-42.

Whistler, H. & Kinnear, N. B. (1933): The Vernay Scientific Survey of the Eastern Ghats (Ornithological Section). Part vi. *JBNHS* **36** : 832-833.

The Great Indian Rhinoceros (*R. unicornis*) in Nepal[1]

Report of a fact-finding Survey, April-May 1959

BY

E. P. GEE, M.A., C.M.Z.S.

(*With 3 plates and 3 maps*)

CONTENTS

I. INTRODUCTION

Chitawan and neighbouring areas of Nepal have long been famous for their abundance of big game, including the Great Indian One-horned Rhinoceros, *Rhinoceros unicornis*, which is now one of the vanishing species of the world. For many years this part of southern central Nepal was the strictly guarded shooting preserve of the rulers of that country; but with the advent of democracy and unsettled political conditions in 1951, the exact status of the area and of the rhinoceros in it has not been clear to the outside world. Reports were in circulation of alarming slaughter by poachers in recent years, especially in the year 1958-59; but lack of authentic information prompted the Survival Service Commission of the International Union for the Conservation of Nature to ask me to investigate the distribution and status of the Rhinoceros in Nepal, and to suggest measures for the preservation of this species in Nepal.

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[1] The Bombay Natural History Society, as a token of its deep concern in the reportedly serious plight of the rhinoceros in Nepal, had contributed towards the expenses of Mr. Gee's survey promoted by the Survival Service of the International Union for the Conservation of Nature and Natural Resources. This report, first published in *Oryx*, the journal of the Fauna Preservation Society, is here reproduced by courtesy of the editor, the IUCN, and the author.—EDS.

As it was not possible for me to visit the area concerned until the end of March, 1959, which is the start of the hot weather, when dust, heat, and flies render camping difficult, and as facilities for investigating the problems were somewhat restricted due to the short notice given, the duration of the survey was not extensive. Sufficient time was, however, found to spend two and a half weeks in the Rapti Valley, to traverse almost the whole area, to visit typical localities within the rhinoceros area, both inhabited and uninhabited by rhinoceros, and to obtain first-hand information about the administrative and ecological aspects of the problem.

Having had considerable experience of the Great Indian Rhinoceros and its preservation in Assam and Bengal, I found it most interesting to study the same animal and its habitat in Nepal—where conditions turned out to be very different from those in India.

II. General Review and Summary of Report

The rhinoceros area in Nepal covers approximately 1250 square miles, comprising the valleys of the rivers Narayani, Rapti, and Reu. Although it is *dun* country, it contains most of the sub-tropical vegetation usually associated with *terai* country, and can roughly be divided into (1) riverain, (2) grassland above flood level, and (3) *sal* forest. The hills are almost entirely under *sal* (*Shorea robusta*), a valuable hardwood.

During the cold weather months from November to April, the rhinoceros live mostly in the thick tree and scrub forest of the riverain tracts, whereas in the rainy season from June to September, many of them move away from the partly flooded riverain tracts into grassland or forest. Competition between human settlers and wild life for the grassland area has reached a critical stage, in which wild life has retreated further and further into the unexploited parts of the area and into the thick riverain scrub forest.

As the result of many years of being shot both by sportsmen and poachers and of being driven by villagers from cultivated areas, the rhinoceros of Nepal has adopted a mode of existence and a temperament different from those observed in north-east India where, during the present century, rhinoceros have been strictly protected in their natural habitat. In Nepal they have become nervous, frightened of the sight of human beings, and almost entirely nocturnal. A number of years of strict protection and the allocation of 'living space' in riverain and grassland tracts are needed to enable them to settle down to a normal and peaceful existence.

Poaching remains a serious problem, although the rhinoceros receive much protection from the thick cover, which is not their real habitat, and from the Rhinoceros Protection Department. But a more serious problem is that of increased and increasing influx of both authorized and unauthorized human settlers from the hilly regions of Nepal into the plains which form the rhinoceros area.

I consider that the position is not nearly so hopeless as recent reports had made it out to be, and that in spite of poaching, the number of rhinoceros is in the region of 300.

The Nepal Government has wisely constituted a national park and has plans for a wild life sanctuary. But, unfortunately, the national park in its present form is not an ecological unit in which the animals would have full scope to behave normally, nor is it of sufficient area to include a reasonable amount of rhinoceros habitat and their lines of seasonal and local migration. Apparently the wild life sanctuary now proposed by Government would not enjoy the permanency so necessary for nature conservation. While immediate human needs of land for cultivation and grazing are paramount, the essential long-term need for water and soil conservation and for a specified area to be set apart for the preservation of wild life in its natural habitat, as a wise form of land-use, must not be lost sight of. It is not too late for these very necessary steps to be taken. The area proposed in Section VIII of this Report, to be added to the present national park, contains the greatest possible number of rhinoceros in their natural habitat. At the same time it is almost entirely free from human occupation and consequently there would be a minimum of administrative work.

III. History of the Rhinoceros Area

The present rhinoceros areas of Nepal, in fact the whole of that country, have been up till recent times a closed book to foreigners. Visits by outsiders were discouraged, even forbidden. Perhaps the first foreigner to tour in the Nawalpur, Chitawan, and Reu Valley areas was Mr. E. A. Smythies who, during World War II was Forest Adviser to the Nepal Government. In the course of his duties Smythies visited almost all the submontane tracts along the 500 mile *sal* belts of the Nepal *terai*.

There is some historical evidence that the Rapti Valley, as Chitawan is usually known, was once much more thickly populated than at the beginning of this century, and it is possible that malaria was the chief reason for any subsequent depopulation of the area.

The Rapti Valley has remained closed even to most prospective Nepali settlers, not only because of malaria, but because it was strictly protected as the special shooting preserve of the rulers of Nepal, whose huge camps and elephant beats were known the world over. Up till recent years almost the only people living in the area were simple 'Plains Nepalis'—the Tharus, who appear to have become immune to malaria and who incidentally provide practically all the elephant drivers of that country. These people also provided the labour required for making rough cross-country tracks in the dry cold-weather months and for preparing shooting camps.

A special department of armed men has existed for many years to protect the rhinoceros, tiger, and other game. At the time of my visit it consisted of: 1 Commander (Captain), 1 Assistant (Lieutenant), 4 Subedars, 24 Havildars, and 122 Rhino Guards.

Mr. E. A. Smythies in his book, BIG GAME SHOOTING IN NEPAL (1942), and his wife Olive, in her TIGER LADY (1953) speak in glowing terms of their trips to the Narayani, Rapti, and Reu valleys in the years 1941-1945. They found that, whereas in the rest of the Nepal *terai* there was practically no game left, here was still a sportsman's paradise, with uncounted numbers of rhinoceros and other big game, and comparatively unspoiled habitat.

In 1951 as a result of the political upheaval in which the Rana regime came to an end and democracy came into being, the area underwent a change. Poaching increased to an alarming extent—in fact this seems to have been the peak year for illegal slaughter of rhinoceros.

From 1951 onwards the weakening of protection in the big game reserve meant that malaria was now the main, if not the sole, deterrent to settlers coming from the hills into the Rapti Valley. It was not possible in such a mountainous country as Nepal to prohibit indefinitely the influx of human settlers into grasslands suitable for cultivation of crops. 'Hills Nepalis,' Gurungs, Magars, and others, started to come down into the Rapti Valley unofficially; and officially the Rapti Valley Multi-purpose Development Project began in 1955 to settle cultivators from the hills in the western portion of Chitawan south of Narayangarh, at the rate of 2500 persons a year. By March, 1959, 12,000 persons had been settled on grasslands once occupied only by rhinoceros and other species of wild life, and 52½ square miles had been thus opened up and developed. It is proposed to settle a further 25,000 persons in the Rapti Valley in the near future.

A new gravelled road from Hitaura to Bharatpur and Narayangarh has been constructed jointly by the United States Operations Mission

and the Nepal Government, and this was completed by March 1959, except for a bridge and the big causeway near Hitaura. It was claimed that recent malaria control measures had succeeded in making the valley considerably safer for human occupation.

Besides the 12,000 persons officially settled by the R.V.M.-P. Development Project, a large unspecified number of people from the hills have settled unofficially in various parts of the Rapti Valley during the last few years. It is obvious that if the influx of human settlers continues unchecked wild life will ultimately disappear from this renowned place.

The Nepal Government has been aware of this danger, and during the winter of 1957-58 steps were taken to allot a part of the north of the valley as a national park. In January, 1959, the Mahendra Mriga Kunja (Mahendra Deer Park), or Mahendra National Park, of 68 square miles was formally opened by King Mahendra. It is proposed that a 'Wild Life Sanctuary' (possibly for 10 years only, after which it may revert to shooting blocks) shall be created south of the national park to include most of the rhinoceros area as well as cultivation and grazing areas. Another area has been allotted as 'King's Reserve' and another as 'Shooting Blocks' (see map No. 2).

IV. Geography and Ecology

The present rhinoceros area comprising the valleys of the rivers Narayani, its tributary the Rapti, and the Rapti's tributary the Reu, is often loosely spoken of as part of the Nepal *terai*. *Terai* in northern India and Nepal is, strictly speaking, moist country a few miles from the base of the Himalayas, below the *bhabar*, which is dry country with a subsoil of boulders right at the foot of the Himalayas. Chitawan, or the Rapti Valley, is a *dun*—a plateau or flat valley inside the foothills of the Himalayas; its altitude is between 900 and 1000 feet above sea-level, and it has most of the typical vegetation of the *terai* which is usually at 350 to 600 feet.

The *dun* of the Rapti Valley is approximately 40 miles long from east to west, and varies from 4 miles wide at Ramoli at the eastern end, to about 16 miles at its widest, in the west near the Narayani River. This is the main rhinoceros area, bounded on the north by range upon range of the Mahabharat (Himalayas) and on the south by the Churia Range (Siwaliks). Another area with similar vegetation lies west of the Narayani River and down the bank of that as far west as Tamashpur. A third area is the Reu Valley which is divided from the Rapti Valley by a ridge of the Churia Range. The scenery,

Sal trees in the *dun* of the Rapti Valley, with Himalchuli (25,800 ft.) in the distance.

The River Narayani (or Gandak) near Deoghat in the Mahendra National Park.

Photos : E. P. Gee

Indian rhinoceros in typical grassland habitat in Nepal.

Cow and calf rhinoceros in typical grassland habitat in Nepal.

Photos : E. P. Gee

climate, and vegetation of the Rapti *dun* is very similar to that of the beautiful Corbett National Park of Uttar Pradesh in India.

Records of rainfall for this area are scanty, and have only been kept during the past three years. It appears that 65-70 inches, falling mainly between June and September, is the normal rainfall of Bharatpur at the western end of Chitawan.

The terrain of these three valleys can be conveniently divided into riverain, grassland, and timber forest:

1. Riverain, comprising all the low-lying strips along the river beds as well as the islands in the river beds.

2. Grassland, above flood level, most of which is either being or is about to be occupied, cultivated, and grazed by human settlers.

3. Timber forest, mainly on the higher undulating portions of the *dun*, and covering most of the hills of the area.

Riverain

The Narayani (or Gandak) is a huge river, and occasionally washes a live rhinoceros down into India. In this area it widens out to a mile or two and has islands (*tapoos*). To get over it one often has to cross three, four, or five channels as well as the islands in between, and this takes about half a day. In addition to this mile or more of channels and islands, there runs along each bank a strip of riverain forest and savannah which varies in width up to a mile or more. The low lying islands in the river, which could be classed as sand banks, become flooded during most of the rainy season, June to September. The higher islands and most of the low-lying strips of forest and savannah along the banks get flooded during peak floods of the monsoon. All this area is excellent rhinoceros habitat, containing the water, grasses, reeds, and forest cover they need—particularly during the dry weather, November to May.

The Rapti River is small compared with the Narayani, and in the dry weather can be crossed by jeep at many places where its shingly bed widens out. It too has islands, particularly in its lower reaches, and strips of riverain forest and savannah on either bank, varying in width from a furlong to a mile or so. The Reu, main tributary of the Rapti, is much the same as the Rapti but very much smaller, and the valley very much narrower.

The vegetation of the riverain tracts consists of tree forest and savannah.

Tree Forest.—The trees are mainly of flood resisting species such as *simul* (*Salmalia malabarica*), *sheesham* (*Dalbergia sissoo*), and

khair (*Acacia catechu*). There is a tangled mass of undergrowth, much of which is evergreen and much of which is also thorny, affording the fullest shelter for rhinoceros during the day time, especially in the dry weather.

Savannah.—The vegetation of the savannah varies a great deal according to whether it is above or below the river level of normal rains. It consists mainly of the reeds and grasses usually found in this part of the world, viz. *ekra* (*Erianthus* spp.), *khagri* (*Phragmites karaka*), *nal* (*Arundi donax*), and *thatch* (*Imperata cylindrica*). Frequently there is an intermingling of forest and savannah, forming dense scrub thickets with plenty of cover.

Nearly all the savannah areas of the riverain tracts are burnt off annually by the local villagers to improve the grazing for their cattle —and incidentally, for the wild herbivorous animals. This has been taking place, at least to some extent, for thousands of years, and has become part of the ecological pattern.

Whenever a small stream, known locally as a *khola*, flows out of the hills, or through grassland into a river, there is to be found a small riverain tract usually thickly forested, of varying width according to the size of the tributary. These *kholas* provide corridors for movement of game away from the main rivers as well as thick cover during day time.

Hardly any of the riverain tracts of the three rivers contain houses or even cultivation, as they are liable to flooding during the monsoon months. Practically all of them are made use of by villagers for firewood-cutting, thatch-cutting, and grazing. The thickest of the tree forest and scrub forest areas are seldom interfered with, due to thorns and impenetrability.

Grassland

On leaving the low-lying riverain tracts one finds flat grasslands above flood level stretching for a furlong or two in the Reu Valley, for a mile or two on the west bank of the Narayani River at Sandhna, and for anything up to seven or eight miles in the *dun* north of the Rapti River. These grasslands contain the same reeds and grasses as the savannahs of the riverain tracts, with the addition of other high-ground vegetation which is not flood resistant. The soil is richer and more suitable for the growing of crops at the eastern end than at the western end, where it is lighter and more sandy in composition.

Nearly all the grasslands of the whole rhinoceros area have either been occupied by human settlers for cultivation or grazing, or are

just about to be, with the notable exception of the south bank of the Rapti from Jaimangala village westwards past Darbar (a disused shooting lodge built for King George V when he visited Nepal in 1911) towards the junction of the Reu River and southwards to the Churia range. This is so far mostly unspoiled by human settlers.

Of the grasslands which have for some time been occupied by settlers, in some places the effects of continuous annual burning, overgrazing, cattle-tread, and exposure to increased evaporation, are becoming evident from decreased fertility and increased desiccation.

Timber Forest

In this area the sub-montane timber forest is mainly *sal*, which is to be found growing on some of the well-drained higher grassland, as well as on most of the surrounding hills. It is a tree of great beauty of form and colour, and contributes much to the aesthetic enjoyment of the place, especially when the snows of the Himalayas some 50-80 miles away are visible. The *sal* forests of the area are mostly virgin and contain some of the best trees of this species in the world, rising to 160 feet, especially in the north of the Rapti Valley, in what is now the Mahendra National Park. The *sal* is being exploited by the Forest Department only in the east towards Hitaura. At present there is no exploitation west of Debichor, except some cutting by new settlers.

Most if not all of the *sal* forests are under the jurisdiction of the Forest Department, and are regarded as Reserved Forests. Unfortunately, however, it appears that the boundaries of some of these Reserved Forests have not been clearly demarcated, and unauthorized persons are said to be settling in parts of them with the usual accompaniment of felling and burning for cultivation and grazing. If this is true, it deserves the urgent attention of the authorities, especially as there are so many parts of these forested hills which, forming the catchments of the streams and rivers, need careful conservation in order to avoid soil erosion and desiccation.

V. Administrative and Political

Administration will be considered only as far as the rhinoceros and its preservation are concerned. Three different divisions of the Forest Department are involved. The Rapti Valley is under the Divisional Forest Officer of Chitawan residing at Hitaura; the Nawalpur area (west of the Narayani River) is under the D.F.O of that district residing at Parasi, a journey of some distance from the rhinoceros area with

no roads for travelling; the Reu Valley is under the D.F.O. of Birganj. From the rhinoceros preservation aspect it is unfortunate that this area of Nepal should fall under the jurisdiction of three different D.F.Os., under two separate Circle Conservators, with no means of communication between them except via Kathmandu. The D.F.O., Chitawan, residing at Hitaura, is in charge of the whole Rhinoceros Protection Department which operates in all the three areas; but he is unable officially to visit the Nawalpur or the Reu Valley areas except by arrangement with the D.F.O. of the district concerned. All this is not a criticism of the Forest Department: it merely states the position as it happens to be today. The Narayani River is possibly too great a physical barrier for both sides of it to be under one D.F.O.

Poaching of Rhinoceros

The Rhinoceros Protection Department, the personnel of which has already been given, mans 42 *chowkis* (posts), 26 in the Chitawan area, nine in the Reu Valley, and seven in Nawalpur. Poaching, as has been said, was probably at its peak during 1951. Accounts differ as to the intensity of poaching during the years 1952-58: some people informed me that the position was static, becoming no better and no worse, while others said that during the last three years there has been a slight improvement. Probably official statistics do not give a true picture of the actual amount of poaching during any particular year.

I was told that in 1958, 60 rhinoceros were officially listed as poached: 52 in Chitawan, 6 in Reu Valley, and 2 in Nawalpur. Of these 60 rhinoceros killed by poachers, 24 horns were recovered, and 13 persons arrested and gaoled. In 1959, twelve cases had been detected by the end of March—Chitawan 6, Reu Valley 2, and Nawalpur 4. Of these eight horns had been recovered and seven men arrested.

I had discussion with many people, particularly with the Divisional Forest Officer of Chitawan, who had been for four years in charge of that division, and with Captain Gyan Bahadur Basnayt who had been for two years in charge of the Rhinoceros Protection Department, and there appears to be no evidence of any real organization behind the poachers. Most of the poachers of the Nawalpur area are said to come from the hills, while many of the poachers of Reu Valley and Chitawan come from the south, including India. Some of the poachers are also said to be new settlers from the hills in the Rapti Valley. Magars, Gurungs, and others. The Tharus, 'plains Nepalis', and original inhabitants of this area, are mostly simple and innocent folk,

Cow rhino with her newly born calf in the Rapti Valley, Nepal.

Rhino guard stands near the carcase of a rhinoceros killed by poachers. (Note the skull with horn removed.)

Photos : E. P. Gee

and are believed not to be involved to any great degree in the poaching of rhinoceros.

Most of the rhinoceros poachers in Nepal take refuge first of all in the hills, and then make their way to India, where the horns probably pass through the port of Calcutta to the Far East, particularly to China. The possession and sale of rhinoceros produce is illegal in India—if the place of origin is Bengal or Assam. But if the origin is Nepal, it is probable that its transit through and export from India would not be considered illegal under existing laws and rules. I therefore recommended, while in Kathmandu, that the Government of Nepal should try to effect greater co-ordination of protective measures with the Government of India, in order to prevent this traffic. I now suggest also that the Excise Posts on the India-Nepal border should be kept constantly on the watch for the same purpose.

Development

The last bridges and causeways of the fine gravelled motor road from Hitaura in the east to Bharatpur and Narayangarh in the west are nearing completion. Apart from this there are no all-weather roads. In the dry weather (November to May) all villagers and even isolated houses are connected by bullock-cart tracks which are motorable for jeeps and other high-clearance vehicles.

Since 1955 the Rapti Valley Multi-Purpose Development Project has opened up 53½ square miles of grassland, formerly the home of rhinoceros and other wild life, for 12,000 human settlers, mostly from the hills (see Map No. 2). The implementation of the proposal to settle a further 25,000 persons in the Rapti Valley, combined with the influx of unauthorized settlers, if allowed to continue at its present rate, would mean that hardly any part of this once famous big-game preserve will be left for wild life.

The Mahendra National Park

In its present size and shape, this national park contains about 50 square miles of hills and almost virgin *sal* forest, with a few *kholas* which are dried up in their middle reaches from March till June, and about 18 square miles of mixed evergreen and deciduous forest and grassland with plenty of water in the *kholas* and swamps.

There are villagers with their houses, cultivation, and cattle at Narayangarh, Tikoli, Jirwan, and Jurpani, who still have to move from the national park to alternative sites, with promised assistance from Government. The D.F.O. informed me that he was experiencing some difficulty in enforcing this order, and that the matter was

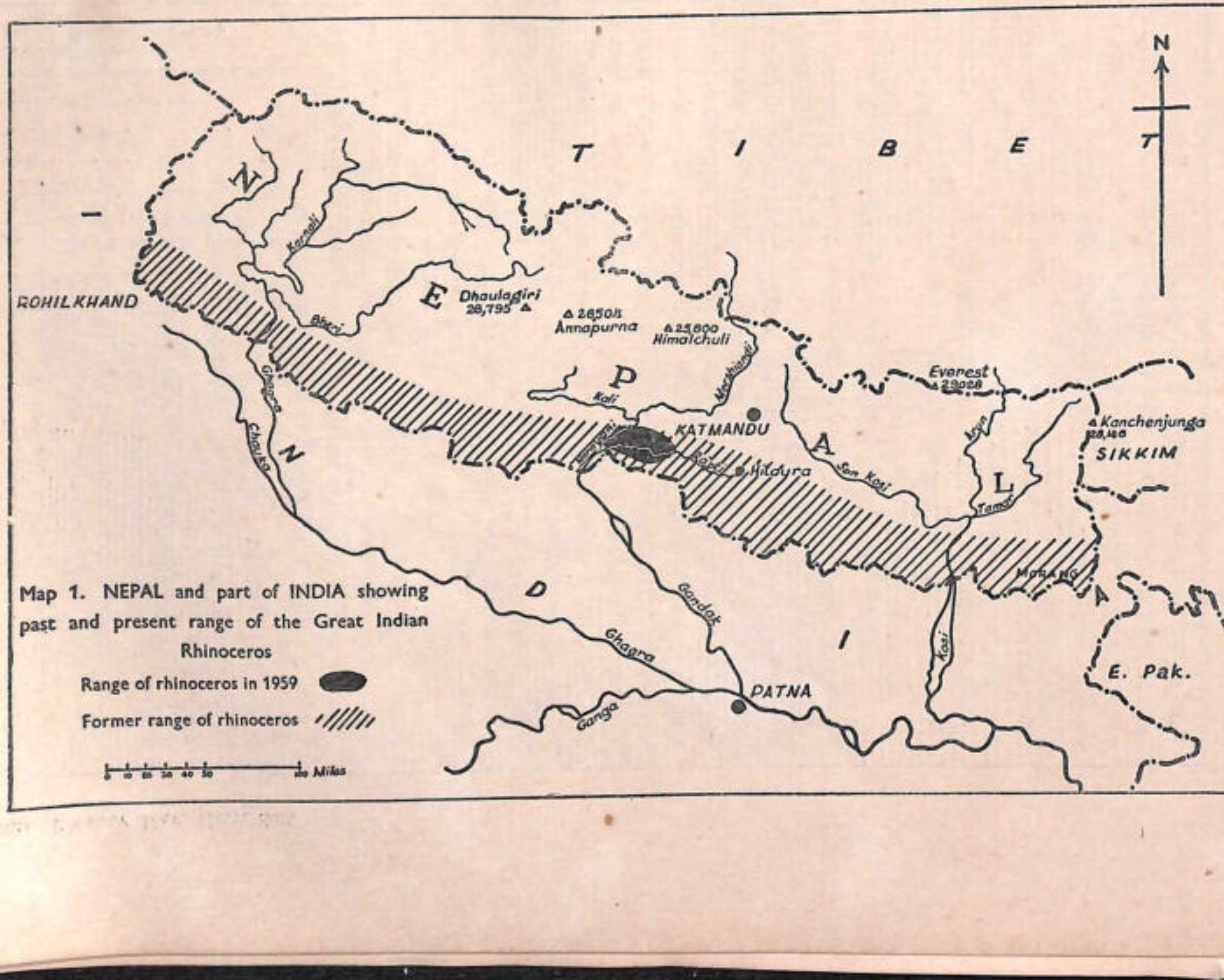
urgent in view of the approaching season for seed-sowing. While I was there the Tikoli villagers expressed their willingness to leave the park area if they were given some of the areas to be re-settled near by. I duly passed on this information to the authorities on my return to Kathmandu.

Necessary additions to the Park.—North of Narayangarh up to Deoghat, the road runs along the river bank from which the mountain and river scenery is very beautiful. When I was there the red-flowering bush *Woodfordia floribunda* was in full bloom, as were several flowering trees; and the *kusum* tree, *Schleichera trijuga*, was in new leaf, shimmering in pale mahogany—all these as well as the *sal* trees in their transition stage from old to new foliage added to the beauty of the scene. But the majestic and unspoiled sal-forested mountains on the opposite bank west of the Narayani and north of the confluence of the rivers Kali Gandaki and Mershiandi, although they contain numbers of gaur, deer, and other wild life, have not been included in the national park. As these parts are mountain and virgin forest almost totally unoccupied by human settlers, they would make a very fine addition to the park without the difficulty of removing human inhabitants.

South of the park, from where the new road forms the southern boundary at Tikoli, there is a four to six mile wide strip of comparatively unspoilt *sal* forest and grassland along the Khagri Khola stream down to the Rapti River, where the majority of the rhinoceros are. This strip forms a natural corridor for local seasonal migration of rhinoceros and other animals—but it has not been included in the park.

Without these two additions—the southward corridor for wild life movement along the Khagri Khola to and from the Rapti, being far the more important—the national park is not a viable ecological unit. But if this corridor be included, then it is only one step further to extend it southwards, to include both some of the best rhinoceros country south of the Rapti River and also the upper reaches of the Reu Valley. If this were done, a large percentage of Nepal rhinoceros population would be included in the national park (see Map No. 3). A further advantage of this north-south extension, fully protected under national park rules, would be that wild life could move into it, as the land to the east and west becomes occupied by settlers.

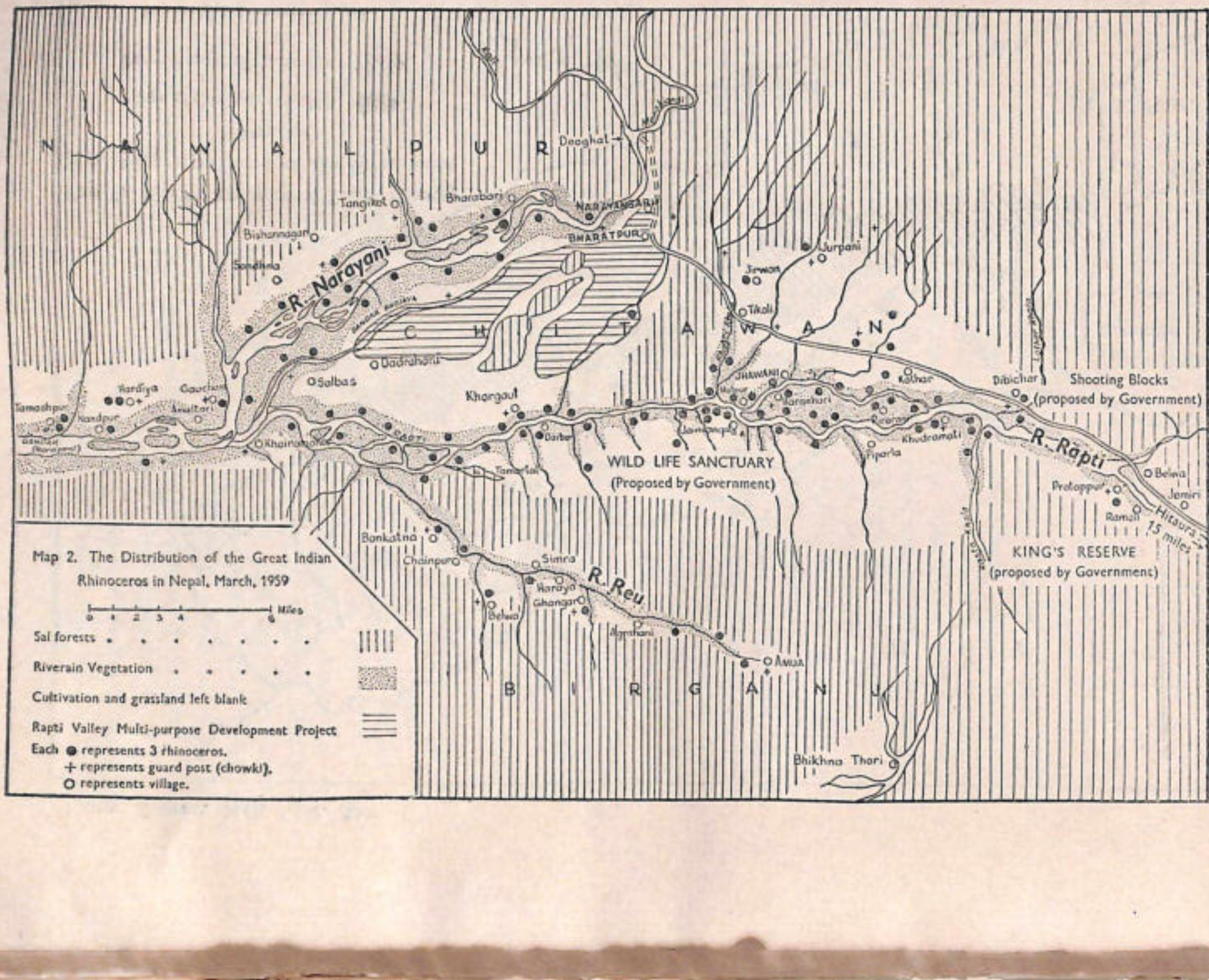
The 'Wild Life Sanctuary' which the Government of Nepal proposes to establish south of the Mahendra National Park (see Map 2) cannot be regarded as a potentially true sanctuary, for a considerable amount of it is already under human occupation, cultivation, or



Map 1. NEPAL and part of INDIA showing past and present range of the Great Indian Rhinoceros

Range of rhinoceros in 1959

Former range of rhinoceros



Map 2. The Distribution of the Great Indian Rhinoceros in Nepal, March, 1959

0 1 2 3 4 6 Miles

Sal forests . . . .

Riverain Vegetation . . . . .

Cultivation and grassland left blank

Rapti Valley Multi-purpose Development Project

Each ● represents 3 rhinoceros.
+ represents guard post (chowki).
O represents village.

grazing. Moreover, it is proposed in some quarters that this area be a sanctuary for ten years only, after which it is to be opened up again as shooting blocks. Thus during the ten years as a 'sanctuary' it would merely have the dubious status of shooting blocks temporarily closed to shooting. If the best and unspoilt portion of this proposed sanctuary were added to the present national park in order to make a viable unit, then after allowing for reasonable belts of country on either side, as buffer belts where grazing and firewood or thatch cutting are allowed, but in which no settlement or shooting except bona fide crop protection is permitted, the rest of the area might be opened as shooting blocks under strict control with full protection for rhinoceros and other rare species.

Shooting Blocks and King's Reserve

The area north of the Rapti at its eastern end, which the Government proposes should become 'Shooting Blocks', consists mainly of foothills of the Mahabharat Range, and is under *sal* forest. The area south of the Rapti proposed as 'King's Reserve' is part of the Churia Range, and also forested with *sal*. Both these propositions appear reasonable (see Map No. 2). They contain a few rhinoceros at their western extremities, under the protection of the Rhinoceros Protection Department.

A project believed to be in the blue-print stage is to divert the water of the Khagri Khola from a point about one mile north of Tikoli in the Mahendra National Park, and also the water of certain other streams in the vicinity, to irrigate part of the newly-settled grassland south of Bharatpur. If this were done, some of the rhinoceros area in the south of the present Mahendra National Park would dry up. Moreover, the only stream in the 'corridor' needed for extending the present park southwards to the Rapti river, would cease to flow in the dry weather. This project is a serious threat to nature and wild life preservation; it is to be hoped that it will be shelved or modified.

VI. General Account of the Survey

After a brief halt in Calcutta to discuss with Dr. Roonwal (Director of the Zoological Survey of India and Secretary-General of the Indian Board for Wild Life) ways of assisting Nepal to stop any possible traffic of rhinoceros produce through India, I arrived at Kathmandu by air on 15th March. There I spent six days before going into camp in the rhinoceros areas, which are a day's journey

by road. This period was very usefully employed in making contact with officials and non-officials, and in obtaining information of every description. These contacts included: General Kiran, S.J.B.R. (Shumshere Jung Bahadur Rana), who is the present authoritative and acknowledged leader in all matters pertaining to sport and wild life in Nepal; Field Marshal Kaiser, S.J.B.R., who, though he has not visited the rhinoceros area since 1933, has a vast store of knowledge of *shikar* and natural history; Mr. Balarama Paul Baidya, Chief Forest Officer; Major Lok Bikram, in charge of elephants (Government and others). Captain Tej Jung Thapa, Circle Conservator; Colonel and Mrs. Proud of the British Embassy; Mr. N. Pal, Adviser on Forests, India Aid Mission; and Mr. Boris Lissanevitch, of the Hotel Royal, who knows the rhinoceros area.

This period of six days was also necessary to procure permits and letters of introduction to officials in the rhinoceros area—without these it would not have been possible to proceed.

On 22nd March I motored along the Tribhuvan Raj Path, the new road built by the Indian Army, over the Simbanjong Pass (8162 feet above sea-level), to Hitaura at the eastern end of the area. Here I met Mr. Sudhir Jung Thapa, the Divisional Forest Officer in charge of the Chitawan (Rapti Valley) Division, with whom I was to spend most of the subsequent sixteen days touring.

The following day we jeeped westwards along the new Rapti Valley road, with the proposed King's Reserve on our left and the proposed Shooting Blocks on the steep hills on our right, both mainly under *sal* forest. Here in the upper reaches of the Rapti the riverain strip is narrow. After crossing the gravelly bed of the Rapti River at the tiny villages of Ramoli and Pratappur we made two tours into the forest along rough forest roads used by timber contractors. This gave me an idea of the terrain of the King's Reserve, at the western end of which about six rhinoceros are believed to exist. Rhinoceros wander far afield during the monsoon months, even into the town of Hitaura, I was told.

On 24th March we went into camp at Tikoli, which is at the south-eastern point of the newly-constituted Mahendra National Park, and a convenient centre for seeing the area where the rhinoceros density is greatest—Jhawani and neighbourhood. Here we were joind by Captain Gyan Bahadur Basnayt and Lieutenant Gaj Raj Joshi of the Rhinoceros Protection Department. Although our food, luggage, and camping equipment had not yet arrived, I took an elephant out in the afternoon southwards along the Khagri Khola stream towards the Rapti. To the east of the Khagri Khola all is

cultivation and villages, while to the west of the stream it is mainly unspoilt *sal* forest with patches of savannah. We saw tracks and dung of rhinoceros and found two of them in a secluded wallow in the thick scrub forest of the riverain tract of this stream. On our approach they immediately made off into cover.

Shortly after arrival at Tikoli, I opened up a large map of the area, and questioned the two officers of the Rhinoceros Protection Department about the numbers of rhinoceros at each *chowki* (post), sometimes at each part of each *chowki*. After explaining to them that conservative figures were required, I compared their figures place by place with those given by the D.F.O., and then reduced them in all cases. I also obtained from them all the information I could on the types of terrain, localities of cultivation, grazing, and unspoiled grassland or forest. Then I was able to re-plan my tour programme so that I could visit a sample of each rhinoceros area, and a sample of each type of terrain. So my tour was not a 'conducted one'—in fact, I often later insisted on going to a spot other than that recommended for finding the greatest numbers of rhinoceros.

On the morning of 25th March we went to the Chitawan *hatisar* (elephant station) and took two elephants southwards to the Rapti River, to a riverain area near Malpur and Haranhari. Here we located six rhinoceros, including a cow and young calf, all of which appeared very frightened. On 26th March we again went to the *hatisar* and proceeded with three elephants to another area west of Haranhari. Here we found 10 rhinoceros, including 2 cows and young calves, also 3 young two-year-olds in a 'school' of their own. Rhinoceros of this age are usually found still with their mothers, and I presume that these three had been driven off by their mothers when new calves were born. Nearly all these 16 rhinoceros were in dense scrub riverain forest, which is not the real habitat of this species. They were in thick cover even in the early morning. Although most of the grasslands had been burnt off, and although the young shoots were coming up—so palatable to herbivorous animals—no rhinoceros were found grazing in the open grassy areas, as one would have found in Kaziranga and other sanctuaries of Assam. There were also many fewer mud or water wallows than I expected. This might have been partly due to the sandy nature of the soil, and partly to the fact that a wallowing rhinoceros falls an easy victim to poachers. The rhinoceros in Nepal appeared to be very much more nocturnal than those in Assam, and very much more shy of human beings. Their droppings were scattered in small heaps or as single droppings

instead of the large heaps found in Assam, where they lead a more natural and peaceful life.

As all the villagers of the area build *tands* (look-out towers for frightening away crop-raiding rhinoceros) both in their fields and also actually in their village vegetable gardens—in Assam the similar *tongis* are only built in the fields near a sanctuary—and as rhinoceros ditches are built round most vegetable gardens, it was abundantly clear that the rhinoceros roamed far and wide over cultivated areas during the night, and lay up in hiding during the day. This was borne out by reports from the villagers, and from fresh rhinoceros tracks and dung seen near the villages.

The riverain forest in places is very thick, often with thorny and evergreen bush, providing ideal, though unnatural, cover for the rhinoceros. Visibility was very limited. Consequently numbers of rhinoceros we observed depended largely on the number of elephants we could muster on each visit. An observer on a single elephant could only find rhinoceros within a strip of country extending sometimes ten, sometimes twenty, yards on each side of him during a traverse in such forest. A party with three elephants could naturally traverse an area about three times as great. It is, therefore, not only for display that the rulers of Nepal have always employed a great number of elephants, over fifty at a time, for their shoots: a large number of elephants is actually required to locate and drive the game in such thick country.

Incidentally, the last of the big shoots, in January 1959, had taken place in this very area, and over fifty elephants had driven a different square mile on three consecutive days in order to catch rhinoceros calves for foreign zoological gardens. They circled 5, 7, and 13 rhinoceros respectively on these three occasions. Although this year no cow rhinoceros were shot, as has been done in previous years in order to obtain the calf, the disturbance and fright caused to the rhinoceros of this particular place must have been considerable.

Several participants of this shoot informed me that between 50 and 60 different rhinoceros had been counted in the area covered by the shoot, which was spread over some 40 square miles (about 4 miles north to south by 10 miles west to east) between the Khagri Khola and Kathar.

The Mahendra National Park

While in camp at Tikoli, I was able to pay three visits to the Mahendra National Park. In the afternoon of 25th March, we went by jeep via Jurpani across the *kholas* and back by Narayangarh. The

chowki (post) at Tandkhola was a very beautiful site with a fine view of *sal*-forested hills, but there was no water in the stream. In fact, there was no water in any of the four bouldery and sandy *kholas* we crossed, although there reportedly had been during previous months. I was informed that there was a little water higher up, and that it runs underground at this point, to reappear again lower down in the rhinoceros area of the national park. One or two water-holes provide water for gaur, sambar, chital, and other animals in this northern portion of the park.

In the afternoon of 26th and in the morning of 27th March, I made two extensive trips on an elephant into the south-east part of the park, where there were reported to be 12-30 rhinoceros. Although I found a few fresh tracks and droppings, I could find no rhinoceros on either of these trips, but on my return to camp I was informed that many were to be found here during the rains, though I could get no exact information about local or seasonal migrations. As this was ideal rhinoceros habitat with plenty of grassland as well as water and cover, I was puzzled as to why they should have migrated southwards to the Rapti, where there was less grazing and more human interference. My elephant on these two trips had been greatly worried by large horse-flies or gad-flies (locally known as *dans*), and possibly this may at least partly provide the answer to this puzzle.

The D.F.O. assured me that the previous year he had visited the area in the middle of April and had seen rhinoceros; and both the lieutenant and the havildar of the Rhinoceros Protection Department said that a considerable number of rhinoceros come here in the monsoon months. I therefore became convinced that a corridor for migration of rhinoceros between the national park and the Rapti River was urgently needed, and that the national park could well be extended southwards to make it. An extract from my diary reads: 'As there is forest and little or no cultivation west of the Khagri Khola, the national park could be extended southwards in a corridor about four miles wide, to include the Rapti area (near Jhowani) . . . and then southwards to the Siwalik Hills, possibly to include the rhino of the Reu Valley.' As my tour progressed, I became more and more sure that the above measure was urgently necessary if the rhinoceros of Nepal were to be preserved.

I was disappointed with my first three visits to the national park, but on 27th March, I visited Deoghat after visiting Mr. Malla, Chief of the Rapti Valley Multi-Purpose Development Project. Motoring from Narayangarh along the bank of the Narayani, I was much

impressed by the magnificent river and mountain scenery. The *kusum* trees were coming into new leaf and were a blaze of pale mahogany colour, and the bright red of the *Woodfordia floribunda* was much in evidence, both adding to the beauty of the *sal* trees now in their transitional stage. It then occurred to me that the forested mountains to the west of the Narayani River and also those north of the confluence of the two rivers at Deoghat, almost totally uninhabited as I was told, could well be added to the national park. I also found that the national park idea seemed to have caught on in the district, and frequent references were made to the 'national park' rather than to the 'mriga kunja'. I think that this should be encouraged, and that Mahendra National Park should be this park's permanent name.

Shortly after midday the D.F.O. returned to Hitaura, and I went with the officers south-westwards through the recently settled area to Dadrahani, in order to cross the Narayani River to Sandhna in Nawalpur District. Very few people ever go to this 'remote' and inaccessible area. It took us half a day to cross the different channels and islands of the river, and we reached our camp site long after dark, having travelled by truck, dug-out boat, elephant, bullock-cart, and on foot.

On the 29th we visited the riverain forest near Sandhna with one elephant, and found one rhinoceros in thick cover. Then we crossed to Bandar Bhojaya *tapoo* and found 4 rhinoceros in a wallow, including a cow and tiny calf. This cow charged us twice in the thick forest. During the second charge my elephant tried to bolt and my hat and lens hood were knocked off. After we had dismounted to look for the lens hood, back came the irate rhinoceros for a third charge! In the afternoon we visited more riverain forest, and saw 3 rhinoceros. None of these 8 rhinoceros had been listed by us on the map at Tikoli.

On 30th March plans were made for me to visit an area south-west of camp, where they were anxious to show me a great number of rhinoceros. After my three recent visits to riverain tract of the Narayani, I was able to take their word for that and we visited instead the *sal* forest and hills to the west, to see that kind of terrain. Here I found tracks and droppings of rhinoceros in the *kholas*, and saw one animal. In this range of hills there are patches of grassland, *kholas* with water, and a belt of swampy ground all along the base between the hills and the 1½ mile wide strip of cultivation. This was useful information, proving that these hills could and did hold rhinoceros, and that during monsoon floods they migrated to the higher hilly region.

Having made a sample survey of the comparatively 'unknown' Nawalpur area, I re-crossed the wide Narayani River back into the Chitawan District, to camp at Dadrahani. In the afternoon I took an elephant into the mile-wide riverain strip on the east bank of the Narayani, and saw tracks and droppings of rhinoceros. Six, including two cows and calves, were said to be here. The D.F.O. had rejoined us from Hitaura. On 1st April I went to see the area at the junction of the Rapti and Narayani rivers, and also the *tals* or small lakes on the south side of the Rapti. All round here is magnificent thick rhinoceros habitat, and we saw fresh tracks and droppings, though no rhinoceros. The *tals* turned out to be small and disappointing—no comparision with the *bheels* of Kaziranga where so many rhinoceros and other species are to be seen grazing out in the open.

On 2nd April we jeeped through cultivated land, through a belt of unspoilt *sal* forest, and through more cultivated land to camp at Khargaul. This *sal*-forested portion of the *dun* contains some unspoilt country with swamp deer, chital, pig, and other animals. As it apparently contains no rhinoceros in the dry weather, I have not included it in my recommendations, but the Nepal Government could well consider creating a small wild life sanctuary here.

After a night at Sandhna of unexpected and unseasonal rain, the snows of the Himalayas were a magnificent spectacle—this was the only day on which they were clearly visible in a cloudless and hazeless sky. Only a tiny peak of Dhaulagiri (26,795 feet) was visible behind a nearer range, but the whole massifs of Annapurna (26,504 feet) and Himalchuli (25,800 feet) towered in splendour before our eyes—more than ample compensation for being washed out two nights before.

I particularly wanted to see the country round Darbar, and also another and larger lake called Tamortal, and the connecting corridor through the Churia Range from the Rapti to the Reu Valley. The riverain forest and grassland near Darbar are comparatively unspoilt and ungrazed, but I saw no wild life. The *tal*, set in the midst of *sal* forest, was also disappointing, but north of the Rapti on our way back to camp on three elephants we found 4 rhinoceros within half a mile of our tents, a not unusual phenomenon as both in Nepal and north-east India rhinoceros seem to prefer the vicinity of villages and cultivation to unspoilt country.

The cart track from Darbar, past Tamortal, leads from the Rapti Valley into the Reu Valley; and while at Tamortal we were only a few miles from the Reu river. I would have liked to have had the time to visit the Reu Valley, but this could not be done. I was,

however, informed by the D.F.O. that he went there as recently as November 1958, and saw 8 rhinoceros. He described to me all the conditions of the place—similar to those in the Rapti and Narayani valleys, only on a smaller scale.

The next morning we took two elephants—one had broken loose during the night and disappeared into the forest—and traversed some more riverain country north of the Rapti, finding two rhinoceros. In the afternoon I took one elephant, the 'escaped' one which had been recaptured, into the riverain belt near the camp, and photographed 2 rhinoceros.

Having seen a sample of the country round Darbar, both north and south of the Rapti, I said I would like to drive through the middle of the belt of *sal* forest and grassland that would, if approved of by the Nepal Government, be such a useful addition as a corridor to the Mahendra National Park. I also wanted to see the country to the south of this corridor, south of the Rapti. Accordingly on 4th April, we jeeped through this corridor at a point where it must have been about 6 miles wide. It consisted of comparatively unspoilt *sal* forest with patches of grassland, swamps, water holes, and of course the Khagri Khola on the eastern side. It proved to be ideal habitat for rhinoceros, deer, and other animals.

Eventually we arrived at Jaimangala and camped there, in spite of the fact that cholera and smallpox were in epidemic form near by. In the evening we took out four elephants and within one mile of camp found 9 rhinoceros. I personally saw 5, including 2 cows with young calves, and I have no reason to doubt the veracity of the others who saw an additional 4; for, on the following day I saw different rhinoceros on this very same spot. While trying to photograph a rhinoceros cow and calf, our four elephants at one time were encircling 4 rhinoceros, 1 sambar stag, 2 hog deer, and 2 bears. From Jaimangala westwards, most of the country appeared to be unspoilt and unoccupied by villagers, confirming my opinion that this area should be included in a southward extension of the national park.

On the following day we explored, on three elephants, the area westwards on the south bank of the Rapti, and returned along the north bank through the corridor. On the way out in the early morning I inspected and photographed the carcases of 2 rhinoceros shot this year by poachers. I was told that the poachers themselves might have been shot had not 7 rounds of ammunition fired at them failed to go off.

Although we had seen 9 rhinoceros near the camp on the previous day, yet in this wilder country further away from the camp we saw

nothing—until finally we came across a cow rhinoceros defending her pink, newly-born calf against a tiger. Our approach apparently frightened away the tiger. The rhinoceros with characteristic lack of gratitude then charged my elephant two or three times. Photography was rendered very difficult by the fact that in Nepal the elephants are trained to charge back at a rhinoceros. In spite of this commotion, and in spite of the waving arms of the excited and gesticulating elephant-driver, I managed to secure some photographs of the newly-born calf with its mother—they must be unique.

On our return along the north bank of the Rapti, we suddenly saw, peering out of the tangle of unburnt grass, the head and horns of a solitary bull gaur (*Bos gaurus*), which immediately made off. We then searched without success for rhinoceros in two *kholas*, which had water and evergreen forest suitable for these animals. When we were near camp I dismounted from the elephant, stalked and photographed on foot 5 of the rhinoceros seen by us on the previous day, as they lay in their wallows. There were also four sambar hinds within a mile of the village.

In the evening I visited a riverain area north-east of the camp with one elephant, and found 4 rhinoceros including a cow and a young calf. Three of these were in thick grass within one furlong of our tents. The experience of this day in this area, as in all the other areas I visited, shows that rhinoceros and other wild animals prefer the vicinity of villages and cultivation to the unspoilt forests and grasslands. The existence of thick cover in the form of evergreen and thorny scrub forest enables them to do this. The probable reasons are firstly and mainly a predilection for man-grown crops, secondly a certain amount of safety from predators, both human and feline.

On the morning of 6th April, we struck camp and proceeded to the house of the captain of the Rhinoceros Protection Department, where I was shown some of the rhinoceros horns and personal possessions recovered from poachers. Thence back to the main road and eastwards past the proposed 'Shooting Blocks' and 'King's Reserve' to Hitaura. After discussions with the D.F.O., I returned the following day over the Simbanjong Pass to Kathmandu. There I spent three days discussing my observations in the rhinoceros area, with the people whom I had met earlier. Finally I flew from Nepal to India on 11th April.

VII. Status, Distribution and Future of the Rhinoceros in Nepal

It is difficult to obtain accurate information about the former range and distribution of rhinoceros in Nepal. W. T. Blanford, in THE FAUNA OF BRITISH INDIA, MAMMALIA, Part II (1891), wrote of it as being found in 1850 '. . . . along the base of the Himalayas in Nepal and as far west as Rohilcund' (a district of India near the border of West Nepal). From information obtained in Kathmandu it appears that the last rhinoceros in the Morang District of south-eastern Nepal was shot at the turn of the present century, and that the last rhinoceros in the area immediately east of Chitawan was killed in 1927. It would be safe to say that about 100 years ago rhinoceros were found all along the southern border of Nepal. Since 1930 they have been confined to the area covered by this Report.

Referring to the rhinoceros population of Nepal in 1942, E. A. Smythies wrote: 'It is estimated that at present the total number is between 300 and 400.' In 1953 the Forest Department of Nepal estimated that there were 1000 rhino, and in 1957, 600. Considering the extent of the rhinoceros area and the thick cover of the riverain tracts into which the rhinoceros can and do retreat, these estimates are not beyond the bounds of probability. Unfortunately, however, no serious attempt ever seems to have been made to estimate the numbers scientifically by sample surveys, by studying seasonal migrations, and so forth. A census is not possible owing to the density of the riverain scrub forest.

In a Miscellaneous Note published in the *Journal of the Bombay Natural History Society* in August 1957, P. D. Stracey, who is Director of Forest Education in India and had been on an official visit to Nepal in April of that year, gives an estimate in the region of 400. He based this figure on a brief visit to the area and on talks with Forest Officers and others. It appears to have been a reasonable figure, though the 'rhinoceros area' map supplied to him was inaccurate.

In Kathmandu, before my tour, I noted down the estimates of rhinoceros population made by various people. These included:

General Kiran, S.J.B.R. ...	... 250-300
Chief Forest Officer ...	... 300-400
Captain Tej Jung Thapa ...	... 320

On arrival at the rhinoceros area, I was given the following estimates:

Divisional Forest Officer ...	... 320
Captain Gyan Bahadur Basnayt	... 530
Lieutenant Gaj Raj Joshi ...	... 380

On the 13 elephant trips on which I saw rhinoceros, the number of elephants taken out averaged 2.15. This is important, as the larger the number of elephants used in such thick country, the more chance there is of rhinoceros being encountered. On these 13 trips I personally counted 43 rhinoceros, of which 9 were young calves. On the same trips, other members of the party on other elephants saw an additional 14, bringing the total to 57 rhinoceros seen, including 12 young calves. Visibility varied from between 5 and 20 yards in the thicker forest to between 20 and 100 yards in the more open areas; so the actual ground covered in each traverse was not great and I do not believe I actually saw one-tenth of the ground inhabited by rhinoceros.

From the detailed information supplied to me by the D.F.O., Chitawan, and by the officers of the Rhinoceros Protection Department and others, which I checked in sample surveys on 18 elephant trips in different parts of the rhinoceros area, I estimate that there are now about 300 rhinoceros in Nepal. I have marked their approximate distribution as in March-April 1959 by black dots on Maps 2 and 3, each dot representing 3 rhinoceros. Should my figure of 300 be an overestimate—I do not think that it is—or an underestimate, which is quite possible, the numbers represented by each dot can be adjusted. The pattern of distribution would remain, subject to seasonal local migrations.

It will be noticed that the distribution of rhinoceros when I was there, the dry season of March and April when the burnt-off grassy areas were beginning to appear green with young shoots, was almost entirely in or very near the riverain tracts. This, I consider, was not so much due to scarcity of water and grazing in other areas, as to the thick cover provided by the evergreen and thorny scrub forest in these tracts. It will also be seen that rhinoceros in Nepal, as in NE. India, show a marked predilection for man-grown crops and vegetables, and therefore choose a habitat as near as possible to villages and cultivation. They do not object to sharing their grazing with domestic buffaloes and cattle, though it appears that in Nepal these common grazing grounds are grazed by domestic beasts by day and rhinoceros by night. In Kaziranga Sanctuary of Assam also, the regions of greatest density of rhinoceros population are nearest to the largest areas of cultivation and villages. It is an inescapable fact that whatever areas of unspoilt country may be set aside for rhinoceros preservation, they will probably continue to inhabit those riverain tracts which are nearest to cultivated land. The presence of *tands* (look-out

towers) and rhinoceros ditches in the fields and vegetable gardens over the whole area considered in this Report would alone prove the presence of rhinoceros—if such proof were needed in addition to tracks, dung, and the animals themselves.

With regard to movements of rhinoceros, I was informed that there has been a noticeable shift from the area now being settled by the Rapti Valley Multi-purpose Development Project to the Nawalpur district and to other parts of the Rapti Valley. From all accounts, the grasslands south-west of Bharatpur down to Salbas, along the east bank of the Narayani River, used to be the best tracts for rhinoceros; but they are no longer so. There is little or no information to be had on local migrations, though this seasonal movement is bound to take place each monsoon as the riverain tracts become partly or wholly flooded. The general direction of this movement would be away from the rivers towards the grassy tracts and *kholas* at the foot of the *sal*-forested hills. The most important line of migration, as has already been pointed out, is along the Khagri Khola and the belt of unspoilt country on its western bank. It is very desirable that local officers should study these seasonal movements.

The great danger to rhinoceros from poachers, on account of the horns which are sold and commercialized as an aphrodisiac, exists and will continue to exist. It is being dealt with by the Rhinoceros Protection Department which is doing good work in difficult circumstances. In fact, it is surprising that more rhinoceros are not shot by poachers. The officers in charge possess no maps, and appear to have no instructions to observe or study the habits, distribution, numbers, or movements of rhinoceros. Many of the rhinoceros guards (sepoys) have received no training. The service conditions of these guards, Rs. 30 per month Nepal currency (£1 7*s.* 0*d.*) with no rations, no uniform and no accommodation, are inadequate and are below those enjoyed by the *hatisar* personnel. Some of the ammunition does not 'go off'. No rewards or promotions appear to be awarded for good work, such as the capture of poachers or recovery of horns. As the value of these horns is very high—as much as Rs. 3135 Indian currency (£235) was paid to a poacher for a horn obtained in the Reu Valley—and the temptation to a lowly-paid guard very great, a system of promotion and rewards would have a stimulating effect.

But a danger to the rhinoceros of Nepal greater than that from poachers has arisen in the development and settlement of the grasslands of the Rapti Valley. As there is now increased competition for

grasslands between human occupants and wild life, a decision will have to be made by the Government as to whether settlement of human population is going to occupy all the available land of the Rapti Valley, or whether water and soil conservation and wild life preservation will have their rightful place in development schemes. It is confidently to be hoped that as a matter of wise land-use the authorities will set apart the appropriate areas for these urgently necessary requirements.

The habits of the rhinoceros of Nepal have been affected by two main factors. Firstly, rhinoceros have been shot for sport as well as by poachers for a very long time, if not since time immemorial. Secondly, they have been pushed further and further back from their habitat and feeding grounds, particularly during the past four years, by the influx into the grasslands of both authorized and unauthorized settlers. Consequently they have become more and more hunted and persecuted, and like an outlawed political party have 'gone underground', taking refuge in the thick scrub forest of the riverain tracts. They have become very scared, and if encountered in their hiding places frequently charge before rushing away to another hiding place. They have become very much more nocturnal than rhinoceros in India, and are rarely if ever to be found grazing in the open during day time. Their dung often consists of individual droppings, or very small dung heaps instead of the large dung heaps found in Assam, and this is probably due to their more furtive existence. Though Jungle Mynas (*Aethiopsar fuscus*) settle on rhinoceros in Nepal, Cattle Egrets (*Bubulcus ibis*) are never found in their company, though they are always so found in Assam; and this also is probably due to the rhinoceros' nocturnal habits and furtive existence.

The fact that so many rhinoceros cows were seen with young calves (12 young calves out of 57 rhinoceros seen by my party) goes to show that the rhinoceros of Nepal have become accustomed to the new conditions in which they have to live and are actually thriving.

The average horn I saw in Nepal was very much smaller than in Assam, and I saw no old rhinoceros. Both sportsmen and poachers look for large horns; furthermore the older rhinoceros (often with large horns) are the more easily shot.

At the present moment the position of the rhinoceros in Nepal is very insecure, especially considering the impending influx of 25,000 more authorized settlers, and an unknown number of unauthorized ones, into the Rapti Valley. An irrigation scheme also is proposed which would lead off the water of the Khagri Khola and other streams

to the newly-settled area. If this is put into effect, it will drain to a dangerously low level the rhinoceros habitat in the region of Tikoli and southwards to the Rapti.

It is not too late even now to allocate certain areas in the catchments of the rivers and streams for strict protection as a necessary and urgent measure of water and soil conservation; to demarcate clearly the boundaries of Reserved Forests and to prevent indiscriminate cutting and burning within them; and to allocate sufficient areas for rhinoceros and other wild life to live in safety and security alongside human settlers.

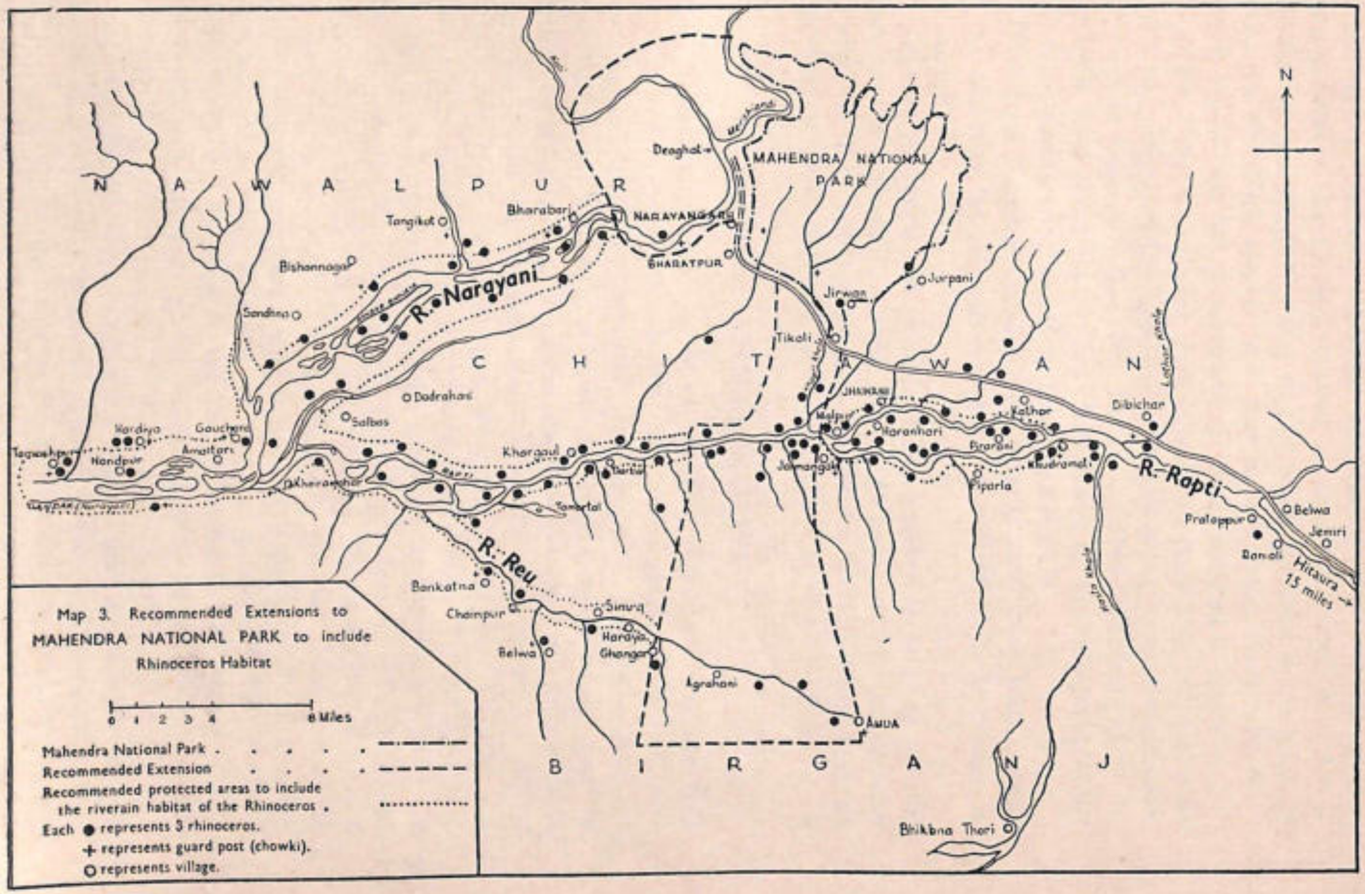
Owing to the various pressures and peculiar circumstances affecting the status of rhinoceros in Nepal it is recommended that the policy governing the administration of the national park and wild life preservation in general be a flexible one. While adhering as far as possible to the principles accepted by leading nature conservationists in the world, it is possible that certain departures from these principles might prove advantageous for the preservation of the rhinoceros. For instance, this species' partiality for a habitat near villages might indicate that a few carefully selected and strictly controlled 'forest villages' inside the national park could be allowed, in which rhinoceros guards would have assistance and protection in their operations against poachers. Also the fact that tigers prey on very young rhinoceros might render it advisable to control the numbers of tigers in the rhinoceros inhabited areas, should they become excessive. Any wild life management policy would naturally have to be based on ecological study.

VIII. Recommendations (see Map 3)

The following recommendations are made:

(1) That the present Mahendra National Park be enlarged and extended (*a*) southwards to include the migration routes and rhinoceros areas as far as the Reu valley, and (*b*) north-westwards to include the scenic area in the north-west. See Sections V and VI and Map 3. And that this national park be fully protected with buffer belts where possible.

(2) That the riverain tracts of the Narayani, Rapti, and Reu rivers which contain rhinoceros be designated as National Park Extension Areas or Protected Areas, with rights of local villagers for grazing, cutting firewood, and cutting thatch to continue as before, but to remain free of settlement and cultivation.



Map 3. Recommended Extensions to MAHENDRA NATIONAL PARK to include Rhinoceros Habitat

(3) That a wild life sanctuary or national park be created in a suitable area in the Morang District of southeast Nepal in order to preserve the few remaining wild buffalo there; and that a few pairs of rhinoceros be re-introduced into that area so that there will be a second locality for the preservation of the rhinoceros in Nepal.

(4) That the Rhinoceros Protection Department be strengthened, chiefly by reorganization and by improvement of service conditions, as noted in Section VII. And that a suitably qualified officer be appointed, who could assume complete charge of wild life preservation in the rhinoceros area, including the national park.

(5) That a Nepal Board for Wild Life be constituted which would be the authority for all matters pertaining to wild life preservation in the country.

(6) That education and publicity be undertaken in order to develop consciousness among the people of the cultural and economic value of wild life and nature conservation, and to develop tourism as an important economic factor in support of wild life preservation.

IX. Acknowledgements

In conclusion, I must record my deepest appreciation of the help given to me in Nepal by officials and non-officials. First and foremost, to General Kiran Shumshere Jung Bahadur Rana who gave me his fullest moral support and advice as well as much information; to the Chief Forest Officer, Mr. Balarama Paul Baidya, who kindly made his departmental information available to me and allotted an officer to take me round the rhinoceros area; to Circle Officer Captain Tej Jung Thapa, an experienced sportsman and naturalist; to Major Lok Bikram, who helped me to obtain elephants in the Rapti Valley; to Mr. K. B. Malla, Chief of the Rapti Valley Multi-Purpose Project, who kindly allowed me camping facilities and transport to Dadrahani; to Mr. Boris Lissanevitch, of the Hotel Royal in Kathmandu, who very kindly made available to me some camping equipment as well as much information; to Colonel and Mrs. Proud of the British Embassy, Mr. Sen of the Indian Embassy, and Mr. N. Pal of the India Aid Mission, all of whom showed much interest in my mission.

In particular I want to offer my thanks and appreciation to Mr. Sudhir Jung Thapa, Divisional Forest Officer of Chitawan, who accompanied me during most of my tour in the rhinoceros areas, and without whose patient help and never-failing supply of information my work could not have been successful. To Captain Gyan Bahadur

Basnayt and Lieutenant Gaj Raj Joshi, officers in charge of the Rhinoceros Protection Department, I owe my gratitude for making all the local arrangements, including camping, elephant trips, etc.

REFERENCES

BLANFORD, W. T. (1891) : The Fauna of British India, Mammalia, Part II.

SHEBBEARE, E. O. (1953) : Status of the Three Asiatic Rhinoceros. *Oryx* **2** (3) : 141-9.

SMYTHIES, E. A. (1942) : Big Game Shooting in Nepal.

SMYTHIES, Olive (1953) : Tiger Lady.

STRACEY, P. D. (1957) : The Status of the Great Indian Rhinoceros (*R. unicornis*) in Nepal. *JBNHS* **54** : 763-6.

Biology and Ecology of Oriental Termites (Isoptera)

No. 4.* The Dry-wood Termite, *Coptotermes heimi* (Wasm.), in India.

BY

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(*With* 3 *Plates*)

CONTENTS

I. INTRODUCTION

Coptotermes heimi (Wasmann) (synonym : *C. parvulus* Holmgren) (Fam. Rhinotermitidae, Subfam. Coptotermitinae) is one of the three species of termites which are most destructive to timber in houses and elsewhere in India, the other two species being *Heterotermes indicola* (Wasmann) and *Odontotermes feae* (Wasmann).

It is interesting to note that although *Coptotermes heimi* is a species occurring commonly throughout the Indian region, it is not (except in Lahore, West Pakistan) the common species to be found attacking the experimental pieces of timber buried in the ground (*vide* Beeson, 1934, p. 3). Beeson stated that the species occurring in the experimental wood-cubes treated with wood-preservatives and buried in the ground in Lahore was *C. heimi*, but in corresponding tests done elsewhere in India and

*Earlier numbers are as follows:
No. 1. *JBNHS* (1954), **52** (2 & 3): 459-462, 1 pl.
No. 2. *ibid.*, (1954), **52** (2 & 3): 463-467, 1 pl.
No. 3. *ibid.*, (1955), **53** (2) : 234-239, 2 pls.

Ceylon the species were different, thus: at Pusa (Bihar), *Microtermes obesi* Holmg. [=*M. anandi* Holmg.]; at Calcutta, *Odontotermes feae* (Wasm.); at Bangalore (S. India), *O. horni* (Wasm.); at Dehra Dun (U.P.), *O. bangalorensis* Holmg.; and in Ceylon, *O. horni* (Wasm.), *O.* (*Hypotermes*) *obscuriceps* (Wasm.), *O. redemanni* (Wasm.), and *Coptotermes ceylonicus* Wasm.

Information on the biology of *Coptotermes heimi* is limited and widely scattered. Some new information on its biology is presented here, and the existing knowledge summarised for easy reference.

In the course of a systematic revision of the Indian species of genus *Coptotermes* Wasmann, a large amount of material, consisting of over 63 lots and nearly 150 separate vials, was examined from all over India (including a few from the western Punjab, in West Pakistan). This material contained the original data of the collectors relating to dates and time of swarming, the names of the hosts attacked, and other valuable information on the biology of the species. The data are summarised below. Some of these specimens, e.g. from Calcutta, Kharagpur, and Allahabad, collected during 1907-1910, bore previous but wrong determination labels as *Coptotermes travians* (Haviland), and it is likely that they may have been referred to in the literature under that name. Besides this material, some data on nests became available during recent field surveys, and from other sources.

The data discussed here concern the following particulars: Geographical distribution; host-material; nature of damage; swarming; nests; duration of life; etc. The limited information available in the published literature on the species has also been discussed. Authors in whose papers information on biology and ecology is available are the following:

Annandale (1923): Swarming; nest construction, etc.

Assmuth (1913): Nature of damage to wood; nest-structure; swarming. (Accounts of *C. heimi* and *C. parvulus* were mixed up and not mentioned separately; most of the remarks refer to '*Coptotermes*'.)

Beeson (1934) : Nature of damage.

Beeson (1941) : Summary of biology.

Holmgren, K. & Holmgren, N. (1917): Swarming.

Holmgren, N. (1912): Swarming.

Margabandhu (1934): Summary of known information.

Rattan Lal & Menon (1953) : Literature on biology and systematics. [Mixed with *C. travians* (Haviland), with which they synonymise *C. heimi* (Wasm.)]

Roonwal (1954): Ecology.

Besides these, Assmuth (1915), Silvestri (1923), Dover (1931), and Dover & Mathur (1934) make casual mention of *C. heimi.*

The nomenclative position of the species is summarised below:

Coptotermes heimi (Wasmann, 1902)

(Synonym: *Coptotermes parvulus* Holmgren, 1913)

1902. *Arrhinotermes heimi* Wasmann, *Zool. Jb.* (*Syst.*), Jena, **17** (1), p. 104, Pl. 4, Fig. 1. (India: Wallon, Ahmadnagar Dist., Bombay State).

1911. *Coptotermes heimi*, N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), p. 73.

1913. *Coptotermes parvulus* N. Holmgren, *J. Bombay nat. Hist. Soc.*, Bombay, **22** (1), p. 104; and *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2), p. 73. (In both cases: Anand and Vadtal, Bombay State.)

1953. *Coptotermes travians* (Havil.), Rattanlal & Menon, *Catal. Indian Ins.*, No. 27, *Isoptera*, Delhi, p. 27. (Erroneously synonymise *C. heimi* (Wasmann) with *C. travians* Haviland.)

Bugnion (1910, *Ann. Soc. Ent. Fr.*, Paris, **79**, p. 137) also wrongly determined *C. heimi* specimens as *C. travians*.

Where no source is mentioned, the data given in the following account are original.

I am indebted to Shri M. Srinivasan, Curator, Industrial Section, Botanical Survey of India, Calcutta, for kindly checking the correct botanical names of the host-plants.

II. Geographical Distribution

Coptotermes heimi occurs all over India and parts of West Pakistan (Punjab). The present material studied by me is from the following localities:

India

Andhra Pradesh: Adoni.
Assam: Gauhati.
Bihar: Ankura (Saranda Div.); Pusa.
Bombay State: Bombay city and environs.
Madhya Pradesh: Khandwa; Sillari (near Nagpur); Balaghat.
Mysore State: Dharwar; Sidapur (Coorg); Bellahunisi, Kottur; Siriguppa.
Orissa: Barkuda Is. (Chilka Lake); Angul; Sambalpur; Balukhand (Puri Dist.).
Punjab: Hoshiarpur; Sri Hargobindapur (Gurdaspur Dist.); Jullander.
Rajasthan: Bariganga near Jodhpur.
Uttar Pradesh: Dehra Dun and vicinity (alt. *ca.* 610 m.); Kalsi (Dehra Dun Dist.); Chakrata (alt. *ca.* 2100 m.); Kanpur; Allahabad; Mirzapur; Rampur; Gopalnagar (Bijnor Dist.); Pathargarh (Najibabad Dist.); Lucknow; Biharigarh (Saharanpur Dist.); Haldwani.
West Bengal: Calcutta and environs; the 24-Parganas (the Sundarbans); Bankura; Kharagpur; Sam Sing.

WEST PAKISTAN

W. Punjab: Chichawatni; Lahore.

'*C. parvulus* Holmg.' has been recorded from India and West Pakistan as follows:

Anand and Vadtal in Bombay State. (type localities.) (Holmgren, 1913 *a*, *b*.)

Barkuda Is. (Chilka Lake, Orissa.) (Annandale, 1923; Silvestri, 1923.)

Karachi (Sind, W. Pakistan). (Assmuth, 1913.)

III. HOST-MATERIAL, ETC.

Coptotermes heimi appears to be polyphagous and occurs in dead wood and under bark of numerous host-plants as well as in constructional timber in houses, railway coaches, bobbins, packing cases, old sleepers, and in insulated electric wire. It has also been recorded from 'mud tunnels' (apparently cemented excreta tunnels) on walls, and in one case '*ex* mound' (Angul, Orissa) but it is not clear whether the mound was built by the *Coptotermes* itself or by some other species—species of *Coptotermes* are not known to be mound-builders in India, though an Australian species, *C. lacteus* (Frogg.), does build mounds. In another case it was recorded '*ex* nest in a tree', and here again it is not clear whether it was a nest of the *Coptotermes* itself or of some other termite or even an ant.

1. List of Host-plants

About 35 different species, belonging to a wide assortment of families, have been recorded as hosts, as follows:

Acacia arabica Willd., Babul, Fam. Leguminosae. (From rotten log).

Acacia sp., Fam. Leguminosae. (From dead plant).

Albizzia sp., Fam. Leguminosae. (Under bark).

Avicennia sp. (*A. alba* Linn. or *A. officinalis* Linn.), Baen, Fam. Verbenaceae. (Nest found in dead log).

Bamboo, Fam. Gramineae, Tribe Bambuseae. (From dry splints).

Bauhinia vahlii W. & A., Fam. Leguminosae. (From dead log).

Boswellia serrata Roxb., Salai, Fam. Burseraceae.

Cactus sp., Fam. Cactaceae.

Carica papaya Linn., Papaya, papita, Fam. Caricaceae.

Casuarina equisetifolia Forst., Fam. Casuarinaceae. (Under bark).

Cedrela toona Roxb., Toon, Fam. Meliaceae. (From dead portion of green standing tree; and dead stump).

Euphorbia nivulia Ham., Thor, Fam. Euphorbiaceae.

Excaecaria agallocha Linn., Fam. Euphorbiaceae. (From pole).

Ficus benghalensis Linn., Banyan, Fam. Urticaceae (Moraceae according to some authors). (From dead stump. Nests also found in dead trunks).

Garuga pinnata Roxb., Fam. Burseraceae.

Heritiera fomes Buch.-Ham. (synonym: *H. minor* Roxb.), Sundri, Fam. Sterculiaceae. (From pole).

Jatropha curcas Linn., Fam. Euphorbiaceae.

Lagerstroemia parviflora Roxb., Fam. Lythraceae. (From half-dead tree).

Lannea coromandelica (Houtt.) Merr. [synonyms: *Lannea grandis* (Dennst.) Engl. and *Odina wodier* Roxb.], Fam. Anacardiaceae. (From pole in soil).

Mangifera indica Linn., Mango, Fam. Anacardiaceae. (From rotten stump; roots; and under bark).

Moringa pterygosperma Gaertn. [synonym: *M. oleifera* Lamk.], Fam. Moringaceae.

Morus alba Linn., White mulberry, Fam. Moraceae. (From fallen logs).

Palm leaves, Fam. Palmae.

Pinus longifolia Roxb., Chir Pine, Fam. Pinaceae. (Sometimes wrongly referred to as *P. roxburghii* Sarg.).

Prunus persica Bth. & Hook., Peach, Fam. Rosaceae.

Pterocymbium tinctorium Merr. [synonym: *Heritiera tinctoria* Blanco], Fam. Sterculiaceae.

Rhizophora conjugata Linn., Fam. Rhizophoraceae. (From rafters).

Salmalia malabarica Schott & Endl. [synonym : *Bombax malabaricum* DC.], Simal, Silk Cotton tree, Fam. Malvaceae.

Shorea robusta Gaertn. f., Sal, Fam. Dipterocarpaceae. (From pole; and under bark).

Saccharum officinarum Linn., Sugarcane, Fam. Gramineae. (From stump and crushed pieces).

Swietenia floribunda Griff., Fam. Meliaceae.

Tamarindus indica Linn., Imli, Fam. Leguminosae. (From stump; and packing case).

Tamarix gallica Linn., Fam. Tamaricaceae.

Tectona grandis Linn., Teak, Fam. Verbenaceae. (From dead portion of green standing tree; and log).

Xylocarpus gangeticus Parkin. [synonym: *Carapa moluccensis* var. *gangeticus* Prain], Fam. Meliaceae. (From pole).

2. Other Material

Besides the host-plants listed above, *C. heimi* has also been recorded as infesting the following materials:

Paper and books; wood-work in houses; wooden packing cases; wooden floor; wooden barrels; chemically treated wood blocks ('graveyard cubes'); pipe line and wood casing containing electrical wire; insulated electric wire; old wooden sleepers; wood-work of railway coaches; 'feeding on bobbin having cotton thread'; and below cow dung.

IV. Economic Importance and Nature of Damage

As stated above, *Coptotermes heimi* is economically one of the three most important termites which infest the wood-work of buildings in India. Apart from buildings, it attacks wood-work in railway coaches, wooden packing cases, stored timber, wooden sleepers, and papers and books. There are records of it having been taken from 'insulated electric wire' and 'pipe line and wood casing containing electric wire', this damage sometimes leading to the leakage of electric current.

The 'feeding pattern' is characteristic (Pl. 1, fig. 1). The termite eats away the softer parts of the wood along the fibres, leaving the outer surfaces of constructional timber intact. The harder parts of the wood, such as the heartwood, knots, etc., are generally not destroyed, but may be tunnelled through when necessary. Thus, longish, narrow oval cells are constructed whose long axis is along the similar axis of the wood-fibres. The thin partition walls are plastered with excrement. The cavities so formed are filled with a tough, mottled brown to bluish-black deposit (Pl. 1, fig. 2), the so-called 'fillings' of Assmuth (1913), 'formed in an irregular spongy or stringy network resembling superficially fungus combs' of certain termites (Beeson, 1941, p. 543). Assmuth (1913) believed that such plastering was done on all surfaces, including the surfaces of glass bottles, in order to facilitate walking. According to Annandale (1923), however, the plastering with excrement, which is done by the workers during nest-construction also, is for the strengthening of the thin partition walls.

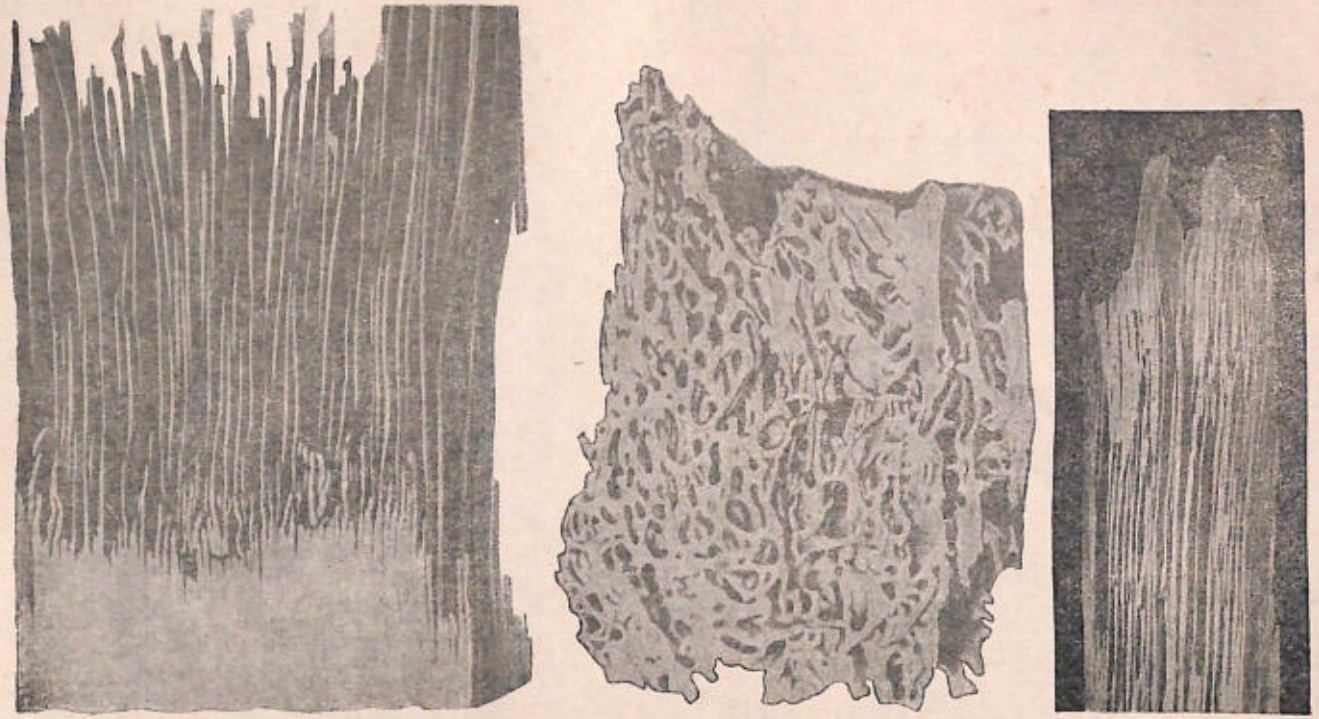
A similar feeding pattern occurs in *Heterotermes indicola* (Wasm.), another important dry-wood termite of India (Pl. 1, fig. 3).

V. Swarming

Swarming of *Coptotermes heimi* was observed in India in Uttar Pradesh (various parts), West Bengal (Calcutta), Orissa (Barkuda Is., Chilka Lake), and Bombay city.

1. Season of swarming

The following are the recorded dates, years, and locality of swarming, arranged chronologically under each month:



1 2 3

The pattern of damage to wood caused by *Coptotermes heimi* (Wasm.) and *Heterotermes indicola* (Wasm.).
Fig. 1.—A piece of softwood (chir pine) damaged by *Coptotermes heimi*. Enlarged.
Fig. 2.—The 'fillings' which fill the cavities in the wood damaged by *Coptotermes heimi*. Enlarged.
Fig. 3.—A piece of softwood (chir pine) damaged by *Heterotermes indicola* (Wasm.)

'*January to March*'

Beeson (1941, p. 544) stated: '*C. heimi* swarms at sunset during the dry season and especially in January to March.' This statement needs confirmation with regard to January.

February

2. ii. 1912. Coimbatore.

March

6. iii. 1910. Calcutta.
7. iii. 1908. Calcutta.
15. iii. 1911. Bombay. (Same material as in Holmgren, 1912, pp. 777-778.)
20. iii. 1910. Calcutta.

April

No record.

May

13. v. 1923. Barkuda Is. (Chilka Lake, Orissa).
25. v. 1907. Kharagpur (West Bengal).

June

8. vi. 1911. Pusa (Bihar). (Holmgren & Holmgren, 1917, pp. 144-145.)
11. vi. 1955. Dehra Dun (U.P.), alt. *ca.* 610 m.
12. vi. 1950. —do.—
15. vi. 1953. —do.—
16. vi. 1950. —do.—
19. vi. 1940. —do.—
21. vi. 1955. —do.—

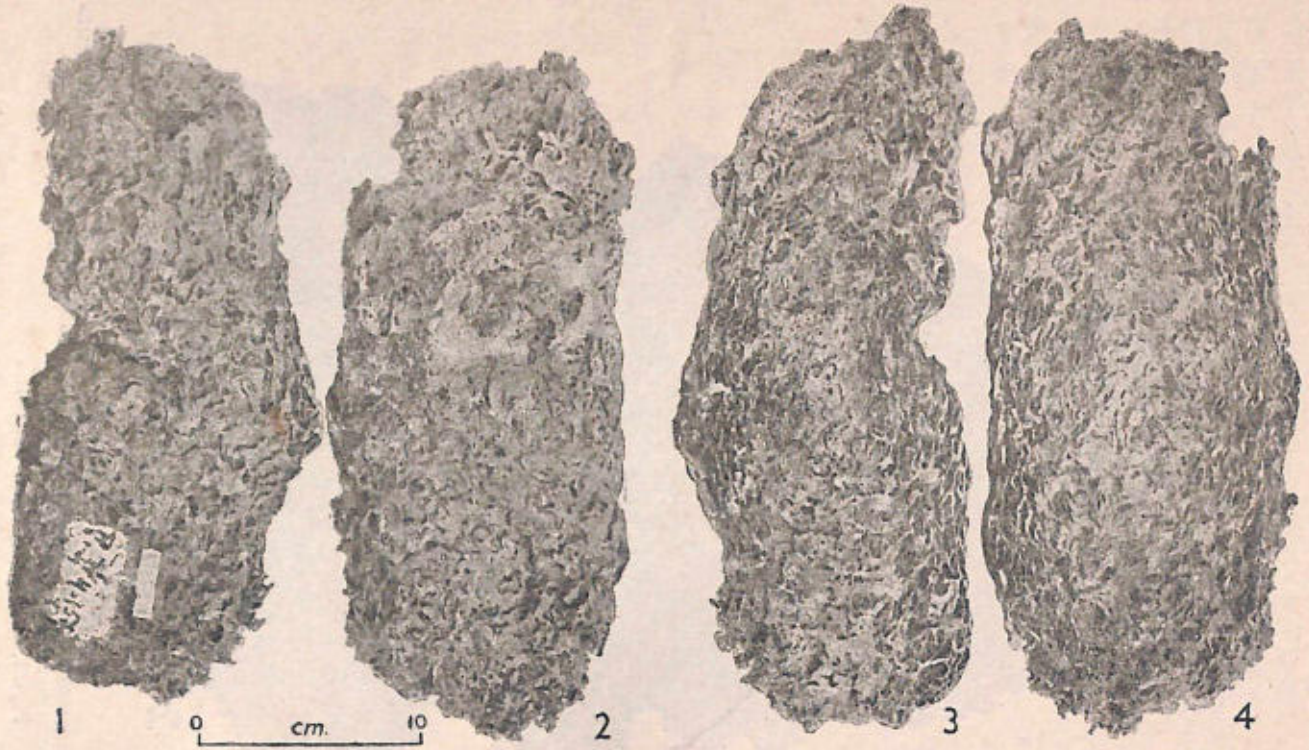
July

1. vii. 1907. Allahabad (U.P.).
3. vii. 1941. Dehra Dun and Kanpur (U.P.).
5. vii. 1955. Dehra Dun (U.P.).
6. vii. 1952. Kalsi (Dehra Dun Dist., U.P.), alt. *ca.* 800 m.
15. vii. 1935. Dehra Dun (U.P.), alt. *ca.* 610 m.

August

6. viii. 1930. Dehra Dun (U.P.). (Only one imago collected.)

From these data it appears that swarming generally occurs from early March to early August. It seems to happen in the spring and early summer (March-May) in the warm and more humid parts of the country



Nest of the termite *Coptotermes heimi* (Wasmann), from the Sundarbans, 24-Parganas District, West Bengal, India (Narayanpur village, Namkhana Forest Range, Sundarbans Forest Division), found in a log of the 'baen' tree, *Avicennia* sp. (Family Verbenaceae), lying on the ground. *M. L. Roonwal* coll., 4th January 1954. (Coll. No. R3/4-1-54)

Figs. 1 and 2. Outer view of the nest which has been cut in two halves.

Figs. 3 and 4. Ditto. Inner view of the same two pieces of the nest.

VI. Nests and their Structures

(Plates 2 and 3)

Coptotermes heimi nests in dead logs of wood (Annandale, 1923, pp. 250-251; and Roonwal, present account), as well as in the soil (Beeson, 1941, p. 544). A nest has also been found between the wooden boards of a railway carriage in north-western India (Pl. 2). Either nests or swarming (*vide* above) of winged adults (which indicates breeding) have been recorded from logs or dead standing trees of the following species :

Avicennia sp.—Nest found (*vide infra*).

Cedrela toona Roxb.—Swarming from dead stump.

Ficus benghalensis Linn.—Nests in dead trunks (Annandale, 1923).

Lannea coromandelica (Houtt.) Merr. [synonyms : *L. grandis* (Dennst.) Engl. and *Odina wodier* Roxb.].—Probably nesting. (Swarming from hole in ground near pole of *Lannea*; soldiers taken from the pole).

Mangifera indica Linn.—Swarming from rotten mango stump.

Tectona grandis Linn.—Swarming from dead portion of green standing tree.

Annandale (1923, Pl. V, figs. 5 and 5*a*) reproduced photographs of small portions of a nest collected in the Barkuda Island (Chilka Lake, Orissa). I reproduce here photographs of two complete nests : (i) A nest found between the wooden boards of a railway carriage in north-western India (Pl. 2), (ii) A nest found in a dead log of 'baen' tree, *Avicennia* sp. (Fam. Verbenaceae) found on the ground in the Sundarbans, West Bengal (Pl. 3).

The nest usually consists of a somewhat flattened, porous structure of dark grey-brown colour, and composed of a network of strands, probably made partly of the harder wood-fibres left over during the process of eating away the wood and partly of the termite excrement cemented together by the insect and plastered over the wood fibres. There are irregular chambers of varying sizes, and the whole nest presents an appearance rather like the fungus combs of a mound-building termite such as *Odontotermes obesus* but with the chambers more flattened. The central portion of the nest is rather more compact than the superficial parts, where the chambers are larger. No royal chamber could be found.

The West Bengal nest was about 30 cm. in maximum length, 15 cm. in maximum width, and 12.5 cm. in maximum height. It was found in a log of 'baen' 60 cm. long and 30 cm. in diameter lying on the ground; the log itself showed no external indication of damage inside. The railway carriage nest was about 40 cm. in length and 15 c.m. in the large diameter.

For '*C. parvulus*' (which is a synonym of *C. heimi*, see above) Beeson, 1941, p. 544 wrote as follows : '*Coptotermes parvulus* makes a simple nest of small extent underground whence it tunnels into logs on the ground and ascends the trunks of trees in the bark in galleries covered in with earth.'

The only other observations on the nest of *C. heimi* are those of Annandale (1923, pp. 250-251) made on the Barkuda Island, Chilka Lake. The nests were found in the moist portions of logs and trunks of the banian, *Ficus benghalensis*. Several nests may occur in a single log and are confined to those parts of it that remain damp. During the hot weather the insects retire to the heart of the trunk, but in the rains they may be found immediately under the bark. The nest- structure has a superficial resemblance to the spongy excretory and woody material (the 'fillings' of Assmuth, 1913) with which the termite fills the cavities it creates inside the wood it feeds on, but can be distinguished from the latter by its more fragile and papery structure. According to Annandale : 'The chambers in this nest are eaten out from the wood by little bodies of workers, which crowd together for the purpose and are apparently so intent on their work that they can be dissipated only by violence. As they eat away the wood they secrete some substance that dyes it black to a depth of about a millimetre. Possibly this substance may guide another body working independently from the other side of the partition, by means of some flavour or of a peculiar consistency it imparts to the wood. The excrement must be spread on the walls in a liquid or semi-liquid condition after they are completed. The flattened pellets can be distinguished by the naked eye.'

Assmuth (1913) stated that the workers of *C. heimi* spread their excrement on any body including glass surfaces, over which they crawl, and that this layer may form an easy pathway for the workers. Annandale (1923), however, was of the opinion that the real function of this layer of excrement is to strengthen the walls of the cells of the nest etc., for 'the partitions between the cells are often so fragile, especially where the wood is rotten, that they would collapse unless strengthened'.

In a nest opened in April, Annandale found some of the cells, always at a considerable distance from those occupied by living individuals, filled with the dead and shrivelled bodies of workers and soldiers. No particular royal chamber could be distinguished. The occupied cells always contain large numbers of soldiers and workers, including immature individuals.

Annandale further noticed that the nests of *Microcerotermes annandalei* seem to be precisely like those of *Coptotermes heimi*, and he considered it possible that the former species merely occupies deserted nests of the latter.

VII. Some other biological Data

1. Duration of life

From observations in the Barkuda Island (Chilka Lake), Annandale (1923, p. 237) concluded that in *Coptotermes heimi* the individuals in a colony die early and probably do not live beyond a year. He wrote : '. . . the sexual individuals of those species in which the winged adults are small live for a shorter period than those in which they are large, and, indeed, probably survive for only one year. I base this conclusion on the fact that in *Capritermes obtusus*, *Coptotermes heimi* and *Eurytermes assmuthi* only very young wingless males and females were found in nests examined shortly after swarming time. In all these species it is probable that more than one pair of adults inhabits each nest.'

For workers and soldiers, he stated : 'That many die off in the latter part of the dry season I have no doubt . . . In a nest of *Coptotermes heimi* opened in April I found many dead and shrivelled corpses of workers and soldiers in chambers somewhat remote from those occupied by living individuals.'

2. Proportion of the various Castes

The only observations are those of Roonwal (1954, p. 465) who stated that in Sillari, Madhya Pradesh, the soldiers constituted about 33 per cent of a soldier-worker population in a dead tree of 'salai', *Boswellia serrata*.

3. Ecological Adjustment with other Species of Termites

Coptotermes heimi seems to live in peaceful ecological adjustment with several other species of termites. Thus, on the Barkuda Is. (Chilka Lake) Annandale (1923, p. 250) found that in a dead trunk of the banyan tree, *Ficus benghalensis*, no less than five species of termite were living : *Odontotermes feae*, *Odontotermes obesus*, *Microcerotermes annandalei*, *Microtermes anandi*, and *Coptotermes heimi*. Similarly, in the Sillari forest in the Nagpur-Wardha Forest Division in the Bombay State (formerly in Madhya Pradesh) Roonwal (1954) found that in a recently dead standing tree of the 'salai', *Boswellia serrata* Roxb. (Fam. Burseraceae), two species, namely *Coptotermes heimi* and *Odontotermes redemanni* (Wasm.), were living. *O. redemanni* fed on the surface of the sapwood not going deeper than about one centimetre from the surface both on the bole and the root stock, while *C. heimi* was confined to the core of bole which it had completely hollowed out and filled with a hard spongy whitish excretory material.

4. Secretion of Whitish Fluid by Soldiers

The soldiers of *C. heimi* share with other members of the genus *Coptotermes* the habit of ejecting a whitish milky fluid in the form of a droplet from the opening of the fontanelle on the dorsum of the head. The fluid, which on exposure to air quickly hardens to a gummy solid, is secreted by a large gland which extends from the head into the abdomen.

VIII. Summary

1. *Coptotermes heimi* (Wasmann) (Isoptera, Rhinotermitidae, Coptotermitinae) [synonym *C. parvulus* Holmgren] is one of the three termite species which are most destructive to timber in houses and elsewhere in India.

2. The available data on its biology and ecology are limited and widely scattered. In the present paper, while providing new biological data on swarming, nest-structure, host-material, etc., the existing data are summarised for ready use.

3. The nomenclative position of the species is briefly given, and *C. parvulus* Holmgren is regarded as a synonym of it. Some authors have, without justification, synonymised *C. heimi* (Wasm.) with *C. travians* (Haviland).

4. Geographical distribution. The species has been recorded from all over India and parts of W. Pakistan (W. Punjab). It does not occur in Ceylon.

5. Host-plants, etc. The species is polyphagous and feeds on dry constructional timber as well as on dead and semi-rotten wood, logs, and trunks of dead standing trees of a large number of host-plants. About 35 such species, belonging to a wide assortment of families, have been recorded. In addition, it has been recorded as damaging packing cases, wooden sleepers, papers, books, and woodwork in electrical installations, etc.

6. The economic importance of the species and the nature of damage it causes, i.e. its 'feeding pattern' in the wood, is discussed.

7. Swarming. Swarming occurs from March to August, at dusk or in the early part of the night. Statements of winter swarming (January and February) need confirmation.

8. Nests, etc. Nesting occurs in small colonies in logs of wood of several species (at least six such species have been recorded), in soil in the ground, and between the wooden boards of railway carriages. Several nests may occur in the same trunk. The nest made by the workers is a flat suboval structure, about 30 cm. in length and 15 cm. in the long diameter, composed of a network of narrow, flattened, suboval cells, constructed out of the wood left after eating, and with the walls plastered with termite excrement.

9. Some other biological data, such as the duration of life, the proportion of individuals of the various castes, ecological adjustments with other termite species, and the secretion by the soldiers of a whitish milky fluid from the dorsum of the head, are discussed.

IX. REFERENCES

ANNANDALE, N. (1923): The habits of the termites of Barkuda. *Rec. Indian Mus.* **25** (2) : 233-251.

ASSMUTH, J. (1913): Wood-destroying white ants of the Bombay Presidency. *JBNHS* **22** (2) : 372-384, 4 pls.

— — — (1915): Indian wood-destroying white ants. (Second contribution). *JBNHS* **23** (4) : 690-694.

BEESON, C. F. C. (1934): Introduction Pp. 1-3 [*in* C. DOVER & R. N. MATHUR: Methods of testing the susceptibility of timbers to termite attack. *Indian For. Rec. (Ent.)* **20** (7) : 1-20]

— — — (1941): The Ecology and Control of the Forest Insects of India and the Neighbouring Countries.—2 + ii + 1007 pp., 202 figs. (several on whole pages). Dehra Dun.

DOVER, C. (1931): Some methods of testing the comparative durability of Indian timbers in relation to termite attack. *Indian Forester* **57** (7) : 341-351.

— — — & MATHUR, R. N. (1934): Methods of testing the susceptibility of timbers to termite attack. (With an Introduction by C. F. C. Beeson, pp. 1-3.)—*Indian For. Rec. (Ent.)* **20** (7) : 1-20.

HOLMGREN, K. & HOLMGREN, N. (1917): Report on a collection of termites from India.—*Mem. Dept. Agric. India (Ent.)* **5** (3) : 137-171.

HOLMGREN, N. (1912): Termites from British India (Bombay) collected by Dr. J. Assmuth. *JBNHS* **21** (3) : 774-793.

— — — (1913*a*): Termites from British India (near Bombay, in Gujarat and Bangalore) collected by Fr. J. Assmuth, S.J. *JBNHS* **22** (1) : 101-117, 3 pls.

HOLMGREN, N. (1913*b*): Termitenstudien. 4. Versuch einer Systematischen Monographie der Termiten der Orientalischen Region,—*K. Sv. Vet. Akad. Hadl.*, Stockholm & Uppsala, **50** (2) : 1-276, 8 pls.

MARGABANDHU, V. (1934): An annotated list of Indo-Ceylonese termites. *JBNHS* **37** (3): 700-714.

RATANLAL & MENON, R. D. (1953): Catalogue of Indian Insects. 27. Isoptera. 4 + 94 pp., Delhi (Govt. of India).

ROONWAL, M. L. (1954): Biology and ecology of oriental termites (Isoptera). No. 2. On ecological adjustment in nature between two species of termites, namely, *Coptotermes heimi* (Wasmann) and *Odontotermes redemanni* (Wasmann) in Madhya Pradesh, India. *JBNHS* **52** (2 & 3) : 463-467, 1 pl.

— — — & CHHOTANI, O. B. (1960): Monograph on the Indian species of the termite genus *Coptotermes* Wasmann (Isoptera: Rhinotermitidae). Indian Counc. Agric. Res., Delhi. In press.)

SILVESTRI, F. (1923): The fauna of an island in the Chilka Lake. Part II. No. 1. The termites of Barkuda Island. *Rec. Indian Mus.* **25** (2) : 221-232.

VISHNOI, H. S. (1957): The swarming of termites in Delhi. *JBNHS* **54** (3) : 792-793.

A Study of the Vegetation of Ajit Sagar Bundh, Rajasthan

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(*With a sketch map*)

INTRODUCTION

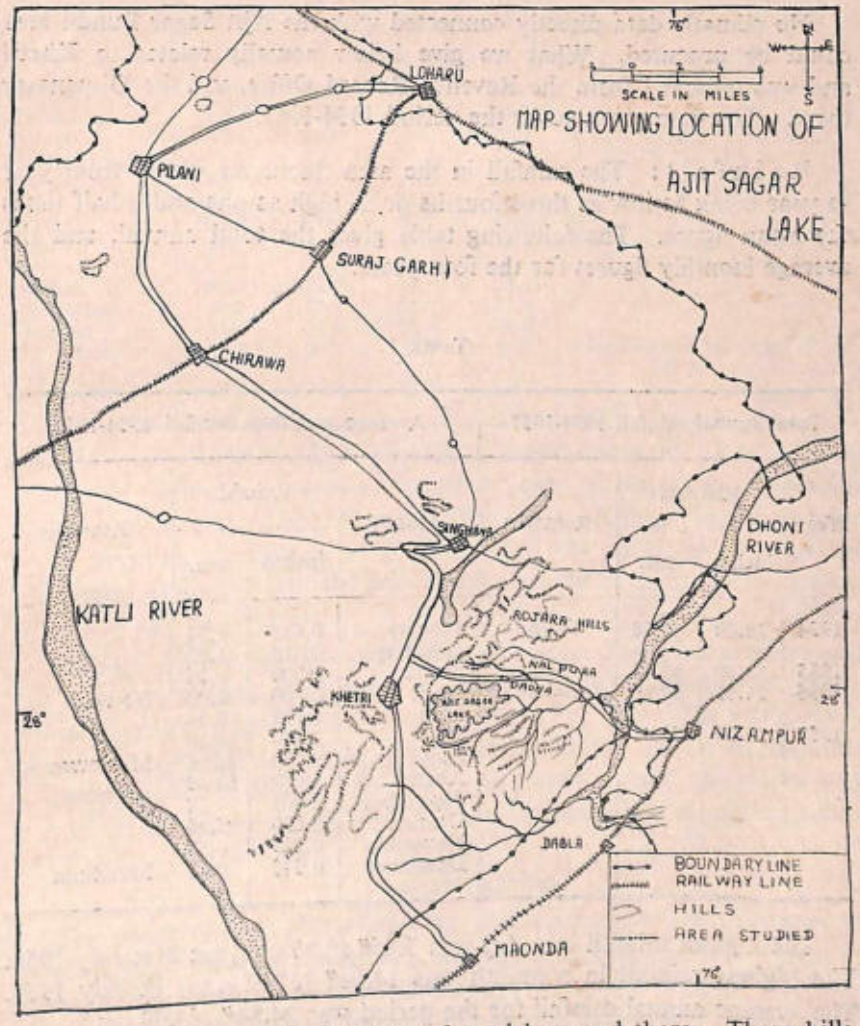
The present work deals with the vegetation of Ajit Sagar Bundh and the surrounding hills covering an area of about eighteen sq. miles. The work was undertaken because there is no information about the vegetation of the area. Another purpose of the study was to evaluate the suggestions of Drude, supported by Blatter and Hallberg (1918-1921) and Biswas and Rao (1953), that the line of demarcation between the Indo-malayan and Perso-arabian flora ranges from the Gulf of Cambay northwards along the Aravallis.

The study was commenced in December 1956 and was spread over eighteen months. The time at our disposal was very short. However, to make the study intensive, the area was visited at least twice a month which helped to give a preliminary knowledge of the phenology of each plant, the life cycle of herbaceous plants, and the relative abundance and distribution of such species in different parts of the year. Fresh specimens were brought to the laboratory for identification, which was confirmed by comparison with specimens in the Herbarium of The Forest Research Institute, Dehra Dun. The sheets are deposited in the Herbarium of Birla College, Pilani.

TOPOGRAPHY AND PHYSICAL FEATURES

Ajit Sagar Bundh (27°60′N., 75°51′W.) is about 8 miles north-east of Khetri town (see map). The Bundh was founded by C. K. M. Walter in 1859 and was named after Ajit Singh, the ruler of the time. It is situated at an elevation of 1200 ft. above sea-level close to the villages Dhada, Fatehpura, and Tonda on the Khetri-Nizampur road. The unique position of the lake, fringed on all sides by hills (except the south-east where it is almost level ground), adds to its beauty and grandeur. The highest hill in the surroundings is Rojhra (2009 ft.).

One of the important physiographic factors on the hills is the gully erosion. Rain water flows down the slopes making small channels, as a result of which the rocky substratum has become exposed. The rains erode the surface of the hills and consequently the surface remains



rocky and bouldery with deposits of sand here and there. These hills, which are a part of the Aravalli system, represent an ancient crystalline complex and have contributed several metallic minerals, the most important among them being copper and iron.

There is a good orchard close by (½ mile) irrigated by water from the lake, which is conducted through a narrow channel paved with stones for more than one-third of its length. Due to improper levelling, there

are a number of puddles on either side of the narrow irrigation canal and a large marshy area of about 100 sq. yds.

Climatic Factors

No climatic data directly connected with the Ajit Sagar Bundh area could be procured. What we give below actually relates to Khetri and was obtained from the Revenue Record Office, and the Dispensary there. The data given cover the period 1954-1957.

Rainfall: The rainfall in the area fluctuates widely from year to year being as low as three-fourths or as high as one and a half times the mean figure. The following table gives the total annual, and the average monthly figures for the four years:

Table I

Total annual rainfall 1954-1957				Average monthly rainfall 1954-1957			
Year	Rainfall		Remarks	Month	Rainfall		Remarks
	inches	cm.			inches	cm.	
1954	18.20	46.28	Minimum	January	0.685	1.74	
				February	0.718	1.82	
1955	24.60	62.48		March	0.300	0.76	
1956	31.61	80.29	Maximum	April	0.000	0.00	No rain
				May	0.175	0.44	
1957	24.96	63.41		June	2.440	6.20	
				July	9.020	22.86	Maximum
				August	5.670	14.40	
				September	2.865	7.28	
				October	2.890	7.34	
				November	0.225	0.57	
				December	0.040	0.10	Minimum

The highest rainfall in a day was 3.25″ (8.25 cm.) on 21st July 1956. The highest rainfall in a month was 14.68″ (37.28 cm.) in July 1956. The average annual rainfall for the period was 24.84″ (63.09 cm.).

Temperature: The highest temperature recorded during the period 1954-1957 is 112°F. (44.4°C.) on 26th May 1954; the lowest 46.00°F. (7.78°C.) on January 1955. The range of daily temperature for the summer months was 12.0°F. (6.7°C.) and for winter 16.0°F. (8.9°C.). The following table gives the mean monthly maximum and minimum temperatures in F. and C.:

TABLE II

Mean monthly maximum and minimum temperature in °F. and °C.

Month	Mean maximum		Mean minimum		Remarks
	°F.	°C.	°F.	°C.	
January	69.9	21.0	54.9	12.7	
February	77.7	25.4	57.7	14.3	
March	87.9	31.0	70.1	21.2	Mean yearly temperature 81·0°F. (27.2°C.)
April	95.5	35.3	81.8	27.7	
May	104.7	40.4	91.7	33.2	
June	103.8	39.9	90.7	32.6	
July	94.7	34.8	83.5	28.6	Mean maximum temp. 87.4° F. (30.8°C.)
August	93.5	34.2	82.5	28.1	
September	90.2	32.3	81.7	27.6	
October	81.7	27.6	72.7	22.6	
November	76.5	30.3	65.5	18.7	Mean minimum temp. 74.7°F. (23.7°C.)
December	73.1	28.4	55.9	13.3	

The water table in the surrounding areas seems to be only 30-40 feet deep. This is in contrast to other parts of Rajasthan where the water table is very much deeper. The water holding capacity of the rocky surrounding hills is very limited and the major portion of the rain water drains off into the lake where a depth of 25-30 feet is always present in the deeper spots.

Soil: A few spots in the Nizampur road have loose sandy soil but they do not form the rippled dunes characteristic of adjacent places. Table III gives a survey of the soil samples of the area. The soil is fairly rich in silt and humus in the sloping banks of the lake. The hillocks are gritty, and the soil is thin. Due to human agency the soil is very rich in the garden area. In the plain ground the soil is sandy but stable and fertile.

BIOTIC FACTORS

The biotic factors disturbing the vegetation here are the same as in other hilly parts of Rajasthan, namely the grazing and browsing by sheep, cattle, hares, and other mammals, and the felling of trees and bushes, and scraping up of ground vegetation by humans. The indirect effect of all this on the habitat is highly devastating.

VEGETATION

1. Vegetation along the road leading to the lake.

During the hot months the plants found along the roadside are mostly hardy perennial shrubs and trees indigenous to the area. These

TABLE III

Character of soil samples from different places in Ajit Sagar

Locality	Depth of the soil taken	Physical Nature		Chemical Nature					
		Colour	Texture	Chloride	Carbonate content	Nitrate content	Reductivity	pH	Remarks
1. Plains ..	5 cm.	Brown	Sandy	++	—	++	—	7.0	Neutral
	10 ,,	Brown	Sandy	+	—	++	—	7.0	Neutral
2. Bank of the lake ..	5 ,,	Grey	Smooth	++	—	+++	+	8.5	Alkaline
	10 ,,	Black	Smooth	+++	—	+++	+	7.5	Alkaline
3. Slopes of hills ..	5 ,,	Reddish	Gritty	+++	++	+++	—	7.0	Neutral
	10 ,,	Brown	Gritty	+++	+	++	—	8.5	Alkaline
4. Top of hills ..	5 ,,	Red	Gritty	++	—	++	—	7.5	Alkaline
	10 ,,	Red	Gritty	++	—	+	—	7.5	Alkaline
5. Garden area ..	5 ,,	Blackish	Clayish	++	+	++++	+	8.0	Alkaline
	10 ,,	Brownish	Clayish	+++	++	+++	+	7.5	Alkaline

include *Prosopis spicigera*, *Calotropis procera*, *Zizyphus* spp., *Grewia populifolia*, *Sida veronicaefolia*, and *S. grewioides*. Among introduced species, the following are found on either side of the road : *Prosopis juliflora*, *Albizzia lebbeck*, *Lawsonia* sp., *Punica granatum*, *Kigelia pinnata*, etc. During the rainy season there is a luxuriant growth of herbaceous plants, such as *Tribulus terrestris*, *Cleome viscosa*, *Vernonia cinerea*, *Cassia tora*, *Phyllanthus niruri*, *Tridax procumbens*, *Boerhavia diffusa*, *Trianthema pentandra*, *Indigofera* spp., *Tephrosia purpurea*, etc. The plants seen in the cold months are *Justicia* spp., *Cnicus wallichii*, *Argemone mexicana*, and *Indigofera* spp. *Pergularia daemia* and *Merua arenaria* are climbers found generally on *Acacia arabica*, *A. senegal*, and *Euphorbia nivulia*.

2. Vegetation in the plains.

The vegetation in open stabilized soil, soon after the rains, is abundant in grasses and other species of *Polycarpaea*, *Euphorbia*, *Leucas*, *Justicia*, *Indigofera*, *Tridax*, *Borreria*, *Digera*, *Mollugo*, *Boerhavia*, *Tribulus*, etc. Under the shade of shrubs and trees are found *Commelina benghalensis*, *Corchorus* spp., *Pupalia lappacea*, *Achyranthes aspera*, *Riccia* spp., and mosses. A few fungal species such as *Agaricus*, *Lycoperdon*, and *Ravenalia* were observed. *Ravenalia* was found to be in an epidemic form on *Albizzia*. Most of the above plants die away in winter and a few new plants such as *Solanum nigrum*, *Psamogeton biternatum*, *Argemone mexicana*, *Justicia* spp., *Cnicus wallichii*, *Launaea* spp., etc. come up. The ground is barren in summer except for a few plants such as *Phyllanthus niruri*, *Solanum xanthocarpum*, *Corchorus* spp., etc. The trees and shrubs that constitute the permanent vegetation are distinguished into the following associations :

(a) *Prosopis-Capparis* association.—This is the principal association of the area. The elements present are : *Prosopis spicigera* (d)[1], *Capparis decidua* (c), *Gymnosporia spinosa* (r), *Balanites aegyptiaca* (r), *Ephedra foliata* (r), *Acacia senegal* (r), *A. leucophloea* (r), *Mimosa hamata* (r), *Tecomella undulata* (r), *Zizyphus* spp. (c), and *Clerodendrum phlomidis* (r).

(b) *Acacia-Salvadora-Prosopis* association.—This is the second prominent association of the area and is constituted by *Acacia arabica* (d), *A. senegal* (c), *Prosopis spicigera* (c), *Salvadora oleoides* (f), *S. persica* (r), *Balanites aegyptiaca* (r), *Securinega leucopyrus* (r), *Lycium europeum* (r), *Zizyphus* spp. (c), *Gymnosporia spinosa* (r), *Coccinia cordifolia* (c), and *Saccharum munja* (r).

(c) *Acacia-Balanites-Capparis* association.—This is a little denser than the above two associations and occurs only at two spots. The

[1] d dominant, c common, f frequent, r rare,

constituents are : *Acacia senegal* (d), *Balanites aegyptiaca* (c), *Capparis decidua* (c), *Salvadora oleoides* (r), *Anogeisus pendula* (r), *Clerodendrum phlomidis* (r), *Zizyphus xylopyra* (c), *Saccharum munja* (r), *Gymnosporia spinosa* (r), *Coccinia cordifolia* (c), *Ephedra foliata* (r), and *Securinega leucopyrus* (r).

(d) *Capparis-Gymnosporia-Clerodendrum* association.—This association comprises *Capparis decidua* (c), *Gymnosporia spinosa* (d), *Zizyphus* spp. (r), *Clerodendrum phlomidis* (c), *Grewia tenax* (r), *Calotropis procera* (c), and *Boerhavia verticillata* (r).

Near temporary ponds tree species such as *Anogeisus pendula*, *Acacia arabica*, *Salvadora oleoides*, etc. were found to be very vigorous. On the slopes of these ponds an association of grasses such as spp. of *Cenchrus*, *Dactyloctenium*, *Cynodon* and species of *Cyperus*, *Phyllanthus*, *Polygonum*, *Glinus*, *Heliotropium*, *Amaranthus*, *Euphorbia*, etc. is found. When the ponds dry up *Polygonum plebejum* and *Glinus lotoides* are found in abundance. In loose sandy areas has been found an association of *Calligonum polygonoides*, *Saccharum munja*, etc.

3. Vegetation of the lake area.

(a) Inside the lake. A large number of algae, mostly filamentous, are collected in the lake soon after the rains and as the climate becomes hotter they decay and produce a very foul smell. The phanerogamic hydrophytes found in the lake include *Vallisneria spiralis*, *Hydrilla verticillata*, *Potamogeton indicus*, etc. As the water margin recedes, in the hotter months, these plants are forced to deeper zones while those on the margin die away and add to the silt after shedding seeds. This process may be regarded to be a very important factor in raising the substratum of the lake. By the onset of rains regeneration of the plants takes place.

(b) On the water margin. The vegetation on the bank of the lake close to the water margin shows a well-marked seasonal succession. As soon as the monsoon sets in the water margin shows a luxuriant growth of *Dentella repens*, *Coldenia procumbens*, *Glinus lotoides*, *G. oppositifolius*, *Cynodon dactylon*, *Eclipta prostrata*, *Alternanthera triandra*, *Phyla nodiflora*, and *Verbascum coromandalinum*. At places pure associations of *Dentella* and *Coldenia* in the form of thick carpets are also found. The aerial parts of the above mentioned plants assume a reed swamp stage, the underground parts spreading, anchoring the plants in the extremely mobile substratum, and contributing towards the stabilization of silt. By October all these plants except *Eclipta*, *Alternanthera*, and *Cynodon*, which flourish throughout the year, complete their life cycle and may perish or perennate by hardy root stocks. As the water level recedes in the hotter months the perennial ones encroach on the

deeper regions of the lake. *Coronopus didymus* and *Potentilla supina* found in abundance during the colder months perish by the onset of summer.

(c) On the slopes of the lake. On the sloping banks of the lake are found the following associations :

(i) *Prosopis-Securinega* association.—This is found on the gravelly slopes. The plants that constitute this association are : *Prosopis spicigera* (d), *Securinega leucopyrus* (c), *Grewia tenax* (f), *Zizyphus xylopyra* (r), *Cordia dichotoma* (r), *Gymnosporia spinosa* (r), *Calotropis procera* (r), *Dipteracanthus patulus* (r), etc. The ground vegetation is abundant in *Vernonia cinerea, Heliotropium supinum, Glinus lotoides, Celosia* spp., *Indigofera* spp., *Tephrosia purpurea,* and species of *Cyperus, Cynodon, Cenchrus,* etc. Most of the above plants except *Vernonia, Glinus,* and *Heliotropium* are found throughout the year. At one or two places, where silt has accumulated, a few trees of *Acacia arabica* were found to grow luxuriantly. During the rainy season when the lake is full these trees have more than one-third of their body under water.

(ii) *Saccharum-Grewia* association.—This association is found on the bundh side. The top of the levelled muddy bundh is almost dry throughout the year. The members constituting this association are : *Saccharum munja* (d), *Grewia tenax* (c), *Calotropis procera* (f), *Securinega leucopyrus* (r), *Rhus mysorensis* (r), *Pavonia zeylanica* (r), *Hibiscus micranthus* (r), *Sida grewoides* (c), *Capparis decidua* (r), etc.

4. Vegetation of the irrigation canal.

There is a permanent flow of water from the lake through the narrow and shallow canal. On the banks of the canal are found *Polygonum barbatum, Saccharum munja, Sida* spp., *Glinus lotoides, Cyperus* spp., *Ficus glomerata, Prosopis juliflora, Typha angustata, Bacopa monnieri,* etc.

5. Vegetation in marshy puddles.

The vegetation in puddles is almost a pure association of *Typha angustata.* On the banks of these marshes close to the water margin are found *Bacopa monnieri, Cyperus eleusinoides, C. arenarius, Fimbristylis diphylla, Panicum* spp., and *Zeuxine sulcata* in different seasons of the year. In puddles were observed *Hydrilla, Vallisneria, Potamogeton, Aponogeton,* and *Chara.*

6. Vegetation on the hills and hillocks.

During the dry months the herbage of the hills is almost inconspicuous and the rocky boulder-strewn slopes appear barren to a casual observer. On closer scrutiny, small trees, mostly or completely devoid of foliage, are seen to be scattered on the hill-sides. By the onset of

monsoon there is a grand flush of plant growth and innumerable number of plants formerly dry becomes recognizable while others not distinct before spring up. The small trees that dot the stony hills and were devoid of leaves become green and conspicuous. The most remarkable changes are seen in the annual and perennial herbaceous plants, the most dominating of them being *Cardiospermum halicacabum*, *Orygia decumbens*, species of *Indigofera*, *Tephrosia*, and *Justicia*. The whole hill-side becomes green. These herbaceous plants grow in the pockets and crevices of rocks where some soil has accumulated.

On the steep slopes, where run-off is excessive and soil erosion is at a maximum, the vegetation is very sparse and shows pure association of *Euphorbia nivulia*, *Opuntia dillenii*, and *Rhus mysorensis*. *Striga gesneroides* grows invariably on the roots of *Euphorbia nivulia*. On the gently sloping sides, where there are greater opportunities for soil accumulation, relatively thick growth occurs and the following associations have been distinguished :

(a) *Euphorbia-Grewia* association.—*Euphorbia nivulia* (d), *Grewia tenax* (c), *Cocculus laeba* (c), *Dipteracanthus patulus* (c), *Barleria prionitis* (r), *Securinega leucopyrus* (r), *Sida grewioides* (r), *Abrus precatorius* (c).

(b) *Acacia-Prosopis* association.—*Acacia senegal* (c), *A. arabica* (d), *Prosopis spicigera* (c), *Gymnosporia spinosa* (r), *Capparis decidua* (r), *Balanites aegyptiaca* (r), *Euphorbia nivulia* (r).

(c) *Acacia-Balanites* association.—*Acacia senegal* (d), *Balanites aegyptiaca* (c), *Capparis decidua* (c), *Grewia tenax* (r), *Securinega leucopyrus* (c), *Anogeisus pendula* (r), *Cocculus laeba* (r).

(d) *Rhus-Gymnosporia* association.—*Rhus mysorensis* (c), *Gymnosporia spinosa* (d), *Calotropis procera* (c), *Grewia tenax* (r), *Euphorbia nivulia* (r), *Barleria prionites* (r), *Dipteracanthus patulus* (c), *Orygia decumbens* (r).

LIST OF PLANTS

(The name given after the botanical name and author is the vernacular name. The number in parenthesis is the number of the hebarium sheet.)

ANONACEAE

1. **Anona squamosa** Linn. Cultivated.

2. **Polyalthia longifolia** B. &. H. Ashok. Planted. Bark used in medicine.

MENISPERMACEAE

3. **Cocculus pendulus** (Forst.) Diels.=*C. leaeba* DC. (2,3,229). Common.

4. **Tinospora cordifolia** Miers. Said to be flowering in the hot months but we have not seen the flowers. Root and stem used as an antidote for snake bite.

PAPAVERACEAE

5. **Argemone mexicana** Linn. Satyanashi. (7). Common. Fls. Jan.-May. Sometimes found even in Sept. near temporary ponds.

CRUCIFERAE

6. **Coronopus didymus** (Linn.) Sm.=*Senebiera pinnatifida* DC. In cold season.

7. **Capsella bursa-pastoris** Medick. A weed of cultivated places. Fls. Dec.-Feb.

The following plants are cultivated: 8. **Brassica oleracea** L. var. **botrytis**. 9. **B. caulorapa** Forsk. 10. **B. campestris** Linn. 11. **B. juncea** Hf. & T. 12. **B. rapa** Linn. 13. **B. oleracea** var. **capitata** L. 14. **Raphanus sativus** Linn. 15. **Iberis umbellata** Linn.

CAPPARIDACEAE

16. **Cleome viscosa** Linn. (135,136). Common in the plains after the rainy season. Fls. Jul.-Nov.

17. **C. brachycarpa** DC. (307). Similar except pubescence and in having six stamens. Very rare.

18. **Capparis decidua** (Forsk.) Pax. Fls. Oct-Nov. and March-April. Common in plains and hillocks. Near temporary ponds it forms pure associations.

19. **Merua arenaria** Hk. f. (330). A perennial woody climber with leathery leaves. Fls. greenish white. Dec.-Feb.

VIOLACEAE

20. **Viola (stocksii** Boiss.?) (160). A small puberulous herb branched from root-stock. Dehiscence of the fruit, white seeds, apetalous flower, and scarious stipules are characteristic. Fls. Sept.-Nov. Very rare on hills.

21. **Viola (cinerea** Boiss.?) (164,224). Perennial herb of about 1 ft. Branching dichotomously. Flowers violet, polypetalous. Calyx hairy. Fls. Oct.-Nov.

Note: The above sheets could not be compared with any of the sheets in F.R.I. herbarium.

POLYGALACEAE

22. **Polygala erioptera** DC. (132,173). A common herb with margins of keel and wing yellow. Fls. Jan.-Mar.

CARYOPHYLLACEAE

23. **Spergula pentandra** Linn. (13). A common herb of winter in the plains, has fleshy leaves which are not grooved as in *S. arvensis*.

24. **Polycarpaea corymbosa** Lamk. (267,268). Common in open places. Fls. Sep.-Jan.

PORTULACACEAE

25. **Portulaca oleracea** Linn. (343). A fleshy annual with yellow flowers opening in the morning. Fls. Sept.-Dec.

26. **P. quadrifida** Linn. (342). Differs in the prostrate habit and long stipular hairs. Flowers bigger.

27. **P. grandiflora** Linn. Cultivated.

TAMARICACEAE

28. **Tamarix dioica** Roxb. Farans. As plantations.

MALVACEAE

29. **Sida grewioides** Guill. & Perr. Kharenti. (245). A perennial under shrub. Fls. Sept.-Jan.

Note: Blatter and Hallberg reported white flowers also from W. Rajasthan. The flowers observed by us were all yellow.

30. **S. veronicaefolia** Lamk. (93). A shade-loving low herb of the plains. Fls. Sept.-Jan.

31. **S. cordifolia** Linn. (92). A hairy undershrub. Fls. Aug.-Sept Rare.

32. **Abutilon bidentatum** A. Rich. (204). An erect downy shrub of about 4-5 feet. Leaves leathery. Pedicels shorter than the petiole. Ovary contains about 15 carpels. On slopes of hills. Fls. Oct.-Jan.

33. **A. fructicosum** Guill. & Perr. (31,32). Similar except in being woody and hairy, and having leathery leaves and lesser number of carpels (10 or less). Fls. Oct.-Dec. Common.

34. **Pavonia zeylanica** Cav. (14,203). A tall herb with pink flowers. Common after the rainy season.

35. **Hibiscus micranthus** Linn. (195,280,290,110,111). A small undershrub with rosy flowers. Common in stony and rocky places. Fls. Jul.-Dec.

36. **H. gibsonii** Stocks. (169,188). A trailing herb with palmately lobed leaves and long coiled epicalyx. Rare during monsoon.

37. **H. (lobatus** O. Ktze. = *H. solandra* L. ?). (92). An erect herb with pale hairy, serrate, cordate leaves. Corolla yellow. Fls. Aug.-Nov. Only one plant could be seen in the area surveyed.

38. **Malvastrum tricuspidatum** A. Grey. (109). A hairy undershrub. Fls. Sept.-Dec. Weed of cultivated and moist places.

39. **Abelmoschus esculentus** (Linn.)=*Hibiscus esculentus* Linn. Moench. Cultivated.

40. **Salmalia malabarica** (DC.) Schott. & Endl.=*Bombax malabaricum* DC. Plantations. Fls. Jan.-Mar.

TILIACEAE

41. **Grewia tenax** (Forsk.) Fiori.=*G. populifolia* Vahl. Common. Fls. Aug.-Nov.

42. **G. oppositifolia** Roxb. A small tree cultivated for fruits.

43. **Triumfetta cana** Bl. (50). A small undershrub. Fruit oval, spiny. Fls. Aug.-Dec. Very rare.

44. **T. bartramia** Linn.=*T. rhomboidea* Jacq. (193). An undershrub, leaves variable and bigger than in the above species. Frequent. Fls. Aug.-Nov.

45. **T. pentandra** A. Rich.=*T. neglecta* W. & A. (195). Differs from the above species in having rugose, oval, acute leaves. Frt. oval with armed hooks. Rare, in higher altitudes. Fls. Sept.-Nov.

46. **Corchorus depressus** (Linn.) Stocks.=*C. antichorus* Roeusch. (201) Perennial prostrate undershrub forming carpet on the gravelly and hard ground. Fls. and frt. Sept.-Jan.

47. **C. tridens** Linn. (210). An annual herb, capsule 1-2″ long, common in plains. Fls. and frt. Sept.-Dec.

48. **C. aestuans**. Linn.=*C. acutangulus*. (208,247). Capsules 1″ long, broader and winged, three-ridged. Fls. and frt. Aug.-Dec. In hard ground.

49. **C. trilocularis** Linn. (209). Stouter herb. Capsules 2-3″ long, cylindrical with short erect beaks. Fls. and frt. Aug.-Nov.

ZYGOPHYLLACEAE

50. **Tribulus terrestris** Linn. Gokhru. (28,122,123). A common plant of the plains during the rainy season. Frt. Dec.

51. **Fagonia cretica** Linn.=*F. arabica* Linn. (219,176). A spiny perennial herb. Flowers all round the year but more profusely in cold season.

GERANIACEAE

52. **Oxalis corniculata** Linn. (37,228). A yellow-flowered herb of shady moist places. Fls. and frt. Aug.-Feb.

53. **Averrhoa carambola** Linn. Kamrach. Cultivated.

RUTACEAE

The following plants are cultivated: 54. **Citrus aurantium** Linn. 55. **C. sinensis.** 56. **C. medica** var. **media.** 57. **C. medica** var. **acida** Roxb. 58. **C. medica** var. **limonum** Wall. 59. **C. medica** var. **limetta** DC. 60. **C. decumana** Linn. 61. **Feronia limonia** (Linn.) Swingle.=*F. elephantum* Correa. 62. **Aegle marmelos** Correa. Bel.

SIMAROUBACEAE

63. **Balanites aegyptiaca** Linn.=*B. roxburghii* Planch. (308). Fls. March-April. The greasy pulp of the fruit is used medicinally.

64. **Ailanthus excelsa** Roxb. Cultivated.

BURSERACEAE

65. **Commiphora mukul** (Hook. ex Stocks.) Engl. Gugul. Fls. Sept.-Dec. Common on the dry Maonda Hills. Gum is used medicinally.

MELIACEAE

As plantations: 66. **Melia azedarach** Linn. 67. **Azadirachta indica** Juss.

CELASTRACEAE

68. **Gymnosporia spinosa** (Forsk.) Fiori.=*G. montana* Benth. (27,240). Common. Fls. and frt. Oct.-Feb.

RHAMNACEAE

69. **Zizyphus nummularia** W. & A.=*Z. rotundifolia* Lamk. (121). A common bush. Fls. and ft. Aug.-Dec.

70. **Z. xylopyra** Willd. (269,270). Amedium-sized tree. Leaves and fruits bigger. Fls. and frt. Aug.-Dec.

71. **Z. mauritiana** Lamk.=*Z. jujuba* Lamk. non Mill. Cultivated.

VITACEAE

72. **Cayratia carnosa** Gagnep.=*Vitis trifolia* L. A twiner. Fls. and frt. Sept.-Oct.

SAPINDACEAE

73. **Cardiospermum halicacabum** Linn. Balloon vine. (27). Common herbaceous climber of the bushes. Fls. and frt. Sept.-Dec.

74. **Dodonaea viscosa** Linn. Common hedge plant.

ANACARDIACEAE

75. **Rhus mysorensis** Heyne. Dansar. (172,309). A spiny shrub. Fls. Aug.-Sep.

76. **Mangifera indica** Linn. Cultivated. Fls. April.

MORINGACEAE

77. **Moringa oleifera** Lamk.=*M. pterigosperma* Gaertn. Sainjna. Cultivated.

LEGUMINOSAE

78. **Crotalaria medicaginea** Lamk. (205,206). Undershrub. Fls. Oct.-Jan.

79. **C. burhia** Hamilt. (310). A diffuse erect herb with slender branches. Common in plains only. This plant was never seen to fruit. Fls. Sept.-Oct. Stray flowers are seen throughout the year.

80. **Cyamopsis tetragonoloba** (Linn.) Taub.=*C. psoralioides* DC. Guar. (116). Commonly cultivated, but as an escape at many places.

81. **Indigofera linifolia** Retz. (231,232). A small prostrate herb. Leaves lanceolate. Fls. and frt. Sept.-Feb.

Note: Leaves in our specimens were broader than those found at Pilani.

82. **I. cordifolia** Heyne. (118,141). Broader leaves with more pubescence. Common in crevices of rocks. Fls. and frt. July.-Nov. and Feb.-March.

83. **I. enneaphylla** Linn. (243,260). Diffusely branched prostrate herb. Leaves 5-9 foliate. Common in plain ground. Fls. and frt. Sept.-Feb.

84. **I. argentea** (non Linn.) Burm. (281). An undershrub with yellowish flowers. Leaves 5-7 foliate. Rare; fls. and frt. Sept.-Jan.

85. **I. tinctoria** Linn. (225,254). Bigger shrub. Leaves 11 foliate frequent all over the area. Fls. and frt. Sept.-Feb.

86. **Rhynchosia minima** DC. (175,256,273). A common climber with 3-4 seeded pods. Fls. and frt. Sept.-Feb.

87. **Tephrosia purpurea** Pers. (136,186). Has a good number of variations. Fls. Aug.-Feb.

88. **T. pumila** Pers.=*T. purpurea* var. *pumila* Pers. (191). Rare.

89. **T. petrosa** Blatt. & Hall.=*T. spinosa* Pers. (120,88). Fls. solitary, axillary, from Jul.-Dec.

90. **T. pauciflora** Grah.=*T. purpurea* var. *pauciflora* Grah. (185). Frequent.

91. **T. candida** DC. (150,279). Flowers white. Racemes 15 cm. long. Frequent on the hills. Pods 6-7 cms. long.

92. **T. multiflora** Blatt. & Hall.=*T. senticosa* Pers. (322). Rare.

93. **T. incana** Grah.=*T. villosa* Pers. var. *incana*. (49). Diffused undershrub. Common in rainy season.

94. **Abrus precatorius** Linn. Chimri. A rare climber on bushes.

95. **Sesbania sesban** (Linn.) Merr. var. **picta** Santapau=*S. aegyptiaca* var. *picta* Prain. (223). A common shrub of waste places. Leaves 25-30 cm. long. Corolla with black dots. Fls. and frt. Sept.-Dec.

96. **Alysicarpus vaginalis** DC. (161,283). A small herb with hairy leaves. Upper leaves lanceolate, lower roundish. Fls. red, frt. jointed and 8-chambered. Fls. July-Feb.

97. **Phaseolus trilobus** Ait. (71,283). Fls. Sept.

98. **Zornia diphylla** Pers. (189). Common. Fls. and frt. Aug.-March.

99. **Dalbergia sissoo** Roxb. Sisom. A roadside plantation. Some times self sown.

100. **Butea monosperma** (Lamk.) Taub. Palas. Very rare. We have not seen this plant in flowering state.

The following are cultivated: 101. **Pisum sativum** Linn. 102. **Trigonella foenum-graecum** Linn. Often runs wild. 103. **Cicer arietinum** Linn. 104. **Phaseolus mungo** var. **radiatus** Linn. 105. **P. aconitifolius** Jacq. Mott.

106. **Cassia occidentalis** Linn. (140). In barren places. Fls. Aug.-Jan.

107. **C. tora** Linn. (65). A small shrub. Fls. Aug.-Dec.

108. **C. pumila** Lamk. (187). Prostrate herb with flat pods. Fls. Jul.-Dec.

109. **Parkinsonia aculeata** Linn. Introduced, almost naturalized.

110. **Tamarindus indica** Linn. Cultivated.

111. **Delonix regia** Boj.=*Poinciana regia* Boj. In gardens.

112. **Prosopis spicigera** Linn. Common. Fls. May. Frt. stored and eaten.

113. **P. juliflora** DC. An Australian tree almost naturalized.

114. **Mimosa hamata** Willd. (26,311). A straggling shrub. Pod flat, 5 cms., recurved sutures, prickly; heads globose, axillary, pink turning white. Fls. and frt. Aug.-Feb. Common in plains.

115. **Acacia arabica** Willd. A common tall tree of the area. Pod medicinal.

116. **A. senegal** Willd. Khair. (159,264). A small tree of the area. Spines hooked in threes, abundant on the hills; pod much flattened, 2-3 chambered. Fls. Oct.-Dec.

117. **A. leucophloea** Willd. A small rare tree with terminal inflorescence and long spines. Fls. white, Aug.-Nov.

118. **Albizzia lebbeck** Benth. A roadside plantation, often infected by *Ravenalia sessilis* during Dec.-Jan.

ROSACEAE

119. **Potentilla supina** Linn. (346). A prostrate herb of winter, near water margin of the lake. Leaflets 5, deeply lobed. Fls. solitary, axillary, minute, yellow, from Jan.-March. The only other report of the plant in Rajasthan is from Mt. Abu.

120. **Rosa indica** Linn., 121. **Prunus communis** Linn., and 122. **Quisqualis indica** L. are cultivated.

COMBRETACEAE

123. **Anogeissus pendula** Edgw. Dhau. (57,177). A tall tree, branches pendulous. Common particularly near ponds and on the hills. Fls. Aug.-Jan.

124. **Terminalia arjuna** Bedd. Fls. April-May. Probably planted. Rare.

MYRTACEAE

The following species are cultivated: 125. **Psidium guajava** Linn. 126. **Syzygium cumini** (Linn) Skeels.=*Eugenia jambolana* Lamk. 127. **Eucalyptus** sp.

LYTHRACEAE

128. **Ammannia baccifera** Linn. (99). A small decumbent herb with red solitary axillary flowers. Fls. and frt. Oct.-Feb.

129. **Nesaea lanceolata** Koehn. (36). A small herb with minute flowers in Nov.-Dec. This is a new record for Rajasthan.

The following are cultivated: 130. **Punica granatum** Linn. 131. **Lagerstroemia indica** Linn. (15). 132. **Lawsonia inermis** Linn. (147).

ONAGRACEAE

133. **Trapa bispinosa** Roxb. Singhara. Cultivated.

CARICACEAE

134. **Carica papaya** Linn. Cultivated. May be dioecious or polygamous.

CUCURBITACEAE

135. **Momordica dioica** Roxb. A climbing herb, dioecious. Fls. after rains.

136. **M. balsamina** Linn. (340). Common climber on bushes. Fls. Aug.-Jan.

137. **Cucumis callosus** (Rottl.) Cogn.=*C. trigonus* Roxb. Common in bushes.

138. **Citrullus colocynthis** Schrad. Tumba. (178). A common herb.

139. **Blastania fimbristipula** (Fenzl). Kotschy. & Perr.=*Ctenolepis cerassiformis* Naud. (207,220,278). A monoecious climber with stipuliform bracts. Fls. and frt. Jul.-Dec.

140. **Melothria maderaspatana** Cogn. (226). Common during rainy season.

141. **Coccinia cordifolia** (Linn.) Cogn.=*Coccinia indica* W. & A. A climber with tuberous roots and large white flowers. Fruit edible.

The following species are cultivated: 142. **Momordica charantia** Linn. 143. **Lagenaria vulgaris** Ser. 144. **Cucurbita moschata** Duch. 145. **C. maxima** Duchesne. 146. **Cucumis melo** Linn. 147. **C. sativus** Linn. 148. **Luffa cylindrica** (Linn). Roem.=L. *aegyptiaca* Mill. 149. **L. acutangula** var. **amara** Clarke. 150. **Citrullus vulgaris** Schrad. 151. **C. vulgaris** var. **fistulosus** Stocks.

CACTACEAE

152. **Opuntia dillenii** Haw. (333). A common plant on gravel. Fls. Nov.-Dec.

MOLLUGINEAE

153. **Trianthema portulacastrum** Linn.=*T. monogyna* Linn. (171). Procumbent annual herb. Carpel single. Stamens 15. Fls. red, Aug.-Dec.

154. **T. decandra** Linn. (325). Carpels 2, fls. white.

155. **T. triquetra** Willd. ex Rottl.=*T. crystallina* Vahl. (313). Carpel 1, stamens 5, a rare plant in plains only. Fls. July-Oct.

156. **Mollugo cerviana** Ser. (259). On sandy soil. Fls. and frt. Oct.-Feb.

157. **M. nudicaulis** Lamk. (261). Common in open places.

158. **Glinus oppositifolia** (L.) DC.=*Mollugo oppositifolia* Linn. (170). A prostrate glabrous herb. Flowers greenish. Common.

159. **G. lotoides** Linn.=*Mollugo hirta* Thunb. (331). A stellate, woolly herb very common in winter and spring. Stamens 10.

160. **Orygia decumbens** Forsk.=*O. triantha* Vicary. (17,18). Fls. Sept.-Dec.

UMBELLIFERAE

161. **Psamogeton biternatum** Edgw. (320). A small herb with much dissected leaves. Umbels of silvery pink flowers. Rare, fls. Feb.-March.

The following are cultivated: 162. **Foeniculum vulgare** Mill. 163. **Coriandrum sativum** Linn. 164. **Trachyspermum ammi** (Linn.) Sprague. =*Carum copticum* Benth. 165. **Cuminum cyminum** Linn. 166. **Daucus carota** Linn.

RUBIACEAE

167. **Dentella repens** Forsk. (142,143). A small prostrate herb rooting at nodes. Flowers solitary, axillary, white. According to Hooker (F.B.I.) the flowers are $1 \times 12''$ only but in our collection they were $\frac{1}{2}''$ long. Fls. and frt. Sept.-Dec. This plant is a new record for Rajasthan.

168. **Oldenlandia corymbosa** Linn. (169) Common after rains.

169. **Borreria hispida** (L.) Schum.=*Spermacoce hispida* Linn. 214,286). An erect or prostrate annual herb. Fls. and frt. Sept.-Feb.

170. **B. stricta** (L.) Schum.=*Spermacoce stricta* Linn. (67). Fls. Aug. Nov.

COMPOSITAE

171. **Erigeron canadensis** Linn. (238). An annual herb with ribbed stem. Fls. all tubular, dirty white, Oct.-Jan. Common on hillocks.

172. **Vernonia cinerea** Less.=*V. patula* W. & A. (61,242). Very common herb with pinkish heads.

173. **V. conyzoides** Wight.=*V. candolleana* W. & A. (55). A bigger plant very variable for its leaf and colour of the flower. Fls. Aug.-Jan.

174. **Pulicaria crispa** Benth. (130). A small pubescent herb. Heads minute, leaves toothed. Fls. Dec.-April.

175. **P. wightiana** Clarke. (263). Profusely branched herb, fls. throughout the year.

176. **Eclipta prostrata** Linn.=*E. alba* (L.) Hassk. Common. Fls. July-Jan.

177. **Blainvillea acmella** (Linn. f.) Philipson.=*B. rhomboidea* Cass.=*B. latifolia* L. (66,155). A common herb on the banks of the lake Leaves very variable. Fls. during rainy season.

178. **Glossocardia bosvallea** DC.=*G. linearifolia* Cass. (179). A small prostrate annual herb with much dissected leaves. Fls. Sept.-Nov. Rare.

179. **Bidens biternata** (Lour.) Merr. & Sherff.=*B. pilosa* Linn.=*B. wallichi* DC. (70). An erect herb with much-lobed leaves. Fls. Aug.-Dec.

180. **Tridax procumbens** Linn. (4,58). Fls. throughout the year.

181. **Sonchus asper** Hill. (53). Fls. Nov.-Dec.

182. **Launaea nudicaulis** Hk. f. (219). A perennial undershrub. Fls. Sept.-Feb.

183. **Cnicus wallichii** DC. (73,334). A common spiny herb on the slopes of the hills. Head a cottony ball of 1-1½" diam. Fls. Dec.-May.

PRIMULACEAE

184. **Anagallis arvensis** Linn. (29). A small herb with fleshy leaves. Fls. Jan.-Apr.

OLEACEAE

185. **Jasminum multiflorum** (Burm. f.) Andr.=*J. pubescens* Willd. Ornamental.

SAPOTACEAE

186. **Achras sapota** Linn. Chikku. Cultivated.

SALVADORACEAE

187. **Salvadora persica** Linn. Fls. March-June. Rare.
188. **S. oleoides** Decne. Fls. Feb.-June.

APOCYNACEAE

189. **Lochnera pusilla** K. Schum.=*Vinca pusilla* Murr. (62,63,287). A small herb with white hypocrateriform corolla. Fls. Aug.-Sept. Very rare.

190. **L. rosea** Reichb.=*Vinca rosea* var. *alba* Linn. Ornamental, runs wild.

191. **Nerium indicum** Mill. In gardens. A few plants were observed near marshy locality. Appears to be self sown.

Other cultivated species include, 192. **Thevetia peruviana** (Pers.) K. Schum. 193. **Plumeria rubra** Linn. forma **acutifolia** (Poir.) Woodson. 194. **Carissa carandas** Linn. 195. **Ervatamia coronaria** Staf.

ASCLEPIADACEAE

196. **Calotropis procera** R. Br. Common.

197. **Pergularia daemia** (Forsk.) Chiov.=*Daemia extensa* R. Br. (335). A perennial climber. Flowers yellowish green, tinged pink at base. Oct.-Feb.

198. **Leptadenia pyrotechnica** (Forsk.) Decne.=*L. spartium* Wight. Khimp. Common.

199. **Ceropegia bulbosa** Roxb. (183). Common. Fls. Sept.-Feb.

200. **Cryptostegia grandiflora** R. Br. Common.

BORAGINACEAE

201. **Cordia dichotoma** Forsk. f.=*C. myxa* Linn. (38,44). A small tree with white clustered flowers Aug.-Dec. On gravelly soil.

202. **C. rothii** Roem. Goyandi. (339). Planted. Fls. hot season. Frt. edible.

203. **Coldenia procumbens** Linn. (14,16). An annual grey, hairy herb, procumbent, close to water margin of the lake. Fls. from July-Sept.

Note: Nairne (1894) described it to be common weed of the cold season in western India. But in the area under consideration they are abundant in rainy season. In cold season they die away.

204. **Heliotropium subulatum** Hochst. (237). An erect annual hispid herb. Leaves sessile, lanceolate, 2″ long spike, branched. Fls. sessile, Oct.-Nov.

205. **H. paniculatum** R. Br. (129). An erect herb, leaves 1½″ long, linear. Fls. pedicellate. Spikes 2″ long terminal.

206. **H. strigosum** Willd. (128). A small procumbent, hispid herb. Leaves minute, ½″ long, linear. Fls. shortly pedicellate; nutlets 4, hairy.

207. **H. eichwaldii** Steud. (172). An erect herb, branching from base. Leaves oval thick. Spikes 2″ long, helicoid, terminal.

208. **H. supinum** Linn. (332). A villous herb, spreading, densely clothed with soft hairs. Flowers in short, axillary silky spikes; on the sloping banks of the lake. Fls. Jan.-Mar.

209. **Trichodesma indicum** R. Br. (59). Much-branched erect herb. Flowers pale blue. Leaves gland-dotted.

210. **T. amplexicaule** Roxb. (60). A smaller herb with brownish white flowers and longer lanceolate thicker leaves. Fls. Aug.-Oct.

CONVOLVULACEAE

211. **Cuscuta reflexa** Roxb. (42). A common parasite of *Adhatoda*. Fls. Sept.-Jan.

212. C. **hyalina** Roth. (113,115). Parasatic on *Tephrosia*, *Trianthema*, *Tribulus*, *Amaranthus*, *Acalypha*, and *Commelina*. Common after the rains.

213. **Evolvulus alsinoides** Linn. (105,106). A diffused perennial herb, branches many, villous. Fls. blue. Corolla subrotate. Fls. Aug.-Dec.

214. **Convolvulus pluricaulis** Chois. var. **macra** Clarke (304). A diffused hairy herb, branches suberect, densely silky. Fls. solitary or in groups of threes, white with rosy tinge. Fls. twice a year.

215. **Ipomoea pilosa** Sweet. (152). A hairy climber ; flowers pink,

the lower surface of the leaf white and upper brown and silky. Fls. Sept.-Oct.

216. **I. nil** (Linn.) Roth. J.=*I. hederacea* auct. non. Jacq. (151). A twining herb sparsely hairy. Leaves deeply 3-lobed. Peduncle 1-flowered. Fls. blue tinted pink.

217. **I. pes-tigridis** Linn. (215). Twining pubescent herb. Frt. enclosed in densely hairy calyx. Leaves deeply five-lobed. Common after rainy season. Fls. white.

218. **I. rumicifolia** Chois. (217). Suberect herb, leaves hastate, petioles 2″ long, Corolla campanulate ½″ or some times more in diameter.

The cultivated members include, 219. **I. pes-caprae** (Linn.) Sweet.= *I. biloba* Forsk. 220. **I. batatas** Poir. 221. **Argyreia** sp.

SOLANACEAE

222. **Solanum xanthocarpum** S. & W. (26,140,227). Spiny shrub with purple corolla, stamens yellow.

223. **S. nigrum** Linn. Makoi. (323). A common weed. Fls. white, Dec.-Mar.

224. **Physalis minima** Linn. (157). Common in rainy season.

225. **Datura metel** Linn. var. **alba** Clarke. A common shrub.

226. **Lycium europaeum** Linn. (249,251). A thorny shrub, 8-10 ft. Fls. Oct.-Dec.

227. **Withania somnifera** Dunal. Aswagandh. A common undershrub. Fls. almost throughout the year.

The following species are cultivated: 228. **Lycopersicum esculentum** Mill. 229. **Nicotiana tabacum** L. 230. **Capsicum frutescens** L. 231. **Solanum melongena** L. 232. **Cestrum nocturnum** L. 233. **Petunia** sp.

SCROPHULARIACEAE

234. **Anticharis linearis** Hochst. (264). A small herb, appears to be perennial, fls. purple, in Aug.-Oct. and Feb.-March.

235. **Verbascum coromandalinum** (Vahl.) Ktze.=*Celsia coromandalina* Vahl. (174,236). An annual shrub with yellow, spurred flowers. Common on the bank of the lake and moist places during the rainy season.

236. **Striga gesneroides** (Willd.) Vatke.=*S. orobanchoides* Benth. (74). A root parasite on *Euphorbia nivulia*. Common after the rains up to Dec.

237. **Kickxia ramosissima** (Wall.) Janchen.=*Linaria ramosissima* Wall. (137). A prostrate herb. Common in crevices of rocks. Fls. Nov.-Jan.

238. **Lindenbergia indica** (L.) Ktze.=*L. urticaefolia* Lehm. (89,90). In gravelly ground and old mud walls of the villages. Flowers during rainy season; very rare in cold months.

239. **L. machrostachya** Benth. (91). A small herb, branching from the rootstock. Leaves reddish and smaller than the previous species. Fls. Aug.

240. **Bacopa monnieri** (L.) Pennel.=*Herpestris monniera* Benth. (205, 206). Succulent herb near water-logged areas. Fls. Jul.-Dec. rarely Feb.-Mar.

BIGNONIACEAE

241. **Tecoma undulata** G. Don=*Tecomella undulata* Seem. Fls. March-Apr.

242. **Kigelia pinnata** DC. and 243. **Millingtonia hortensis** Linn. are cultivated.

PEDALIACEAE

244. **Martinia annua** Linn.=*M. diandra* Glox. (146,148). A shrub known for its characteristic fruit. Leaves very large, more than a foot in length. Generally found on rubbish heaps. Fls. Aug.-Sept.

245. **Sesamum indicum** DC. (68,69). A common herb. Fls. and frt. Aug.-Oct. Cultivated and wild.

ACANTHACEAE

246. **Dipteracanthus patulus** (Jacq) Nees.=*Ruellia patula* Jacq. (11, 47). A small shrub on gravelly soil. Common. Fls. Aug.-Dec.

247. **D. prostratus** (Poir.) Nees=*Ruellia prostrata* Poir. var. *dejecta* Clarke. (144). An undershrub with longer internodes. Fls. Aug.-Dec.

248. **Andrographis echioides** Nees. (163). Fls. Jul-Nov.

249. **Barleria prionitis** Linn. (98,183). A spiny undershrub with long internodes and yellow flowers. Common in gravelly places, road sides, and hills. Fls. Sept.-Feb.

250. **B. acanthoides** Vahl. (336). Smaller herb with short internodes and broad oval leaves. Fls. Dec.-Jan.

251. **Lepidagathis hamiltoniana** Wall. (143). A spiny undershrub with spherical heads at lower nodes. Fls. Nov.-Jan.

252. **Justicia simplex** D. Don. (21). An erect herb with small linear leaves. Fls. Sept.-March.

253. **J. diffusa** Willd. (22,75,76). Common after the rainy season.

254. **Peristrophe bicalyculata** Nees. (43). A shrubby weed. Common after the rainy season. Fls. Oct.-Dec.

255. **Adhatoda vasica** Nees=*Justicia adhatoda* L. (6). Common in hills. Fls. Nov.-March. Generally attacked by *Cuscuta reflexa*.

VERBENACEAE

256. **Phyla nodiflora** (Linn.) Greene.=*Lippia nodiflora* Mich. (18, 139). A diffusely branched prostrate herb, rooting at nodes. Heads globose. Abundant on the water margin. Fls. Oct.-Jan.

257. **Lantana indica** Roxb. (329). Fls. Jan.-Feb. Rare, on hills.

258. **Clerodendrum phlomidis** Linn. A rare plant. We could not find this plant in flowering.

LABIATAE

259. **Ocimum basilicum** Linn. Marva. (337). Ornamental.

260. **O. sanctum** Linn. Cultivated and self-sown.

261. **O. americanum** Linn.=*O. canum* Sims. Bapchi. (104,124,125). An undershrub. Most common on the slopes of the hills, after the rainy season.

262. **Leucas urticaefolia** R. Br. (194,196). A small annual herb. Leaves 1″ broad, toothed. Fls. Sept.-Dec.

263. **L. cephalotes** Spreng. (199). Diffusely branched herb. Leaves longer 3″. Flower head bigger; on slopes of hills.

264. **L. ciliata** Benth. (200). A small hairy herb with woody base.

265. **L. aspera** Spreng. (197). Leaves linear, 2″ long. Bracts provided with bristles. Common in plains.

266. **Salvia aegyptiaca** Linn. (97,171). A small undershrub. Aug.-Jan.

NYCTAGINACEAE

267. **Boerhavia diffusa** Linn. (12,154). Fls. Aug.-March.

268. **B. repanda** Willd. (277,282). A glabrous herb. Rare.

269. **B. verticillata** Poir. (153). A decumbent sometimes climbing shrub, leaves broader than the above two species. Perianth white. Fls. Sept.-Jan.

The garden plants include: 270. **Mirabilis jalapa** Linn. 271. **Bougainvillea spectabilis** Willd.

AMARANTHACEAE

272. **Celosia argentea** Linn. (20,22). Spikes very variable.

273. **Digera muricata** (L.) Mart.=*D. arvensis* Forsk. (244). Rare.

274. **Amaranthus spinosus** Linn. Common in waste places and near ponds.

275. **A. gangeticus** Linn. An erect stout herb. Stem grooved. Bracts membranous exceeding perianth. Stamens three only.

276. **A. viridis** Linn. (235). A much-branched glabrous herb. Leaves notched at the apex. Bracts shorter than the perianth. A common weed. Leaves eaten.

277. **A. polygamus** Linn. var. **angustifolia.** (16). Common prostrate weed, leaves 2-lobed at the apex, rigid, stamens 3. Frt. ovoid. Fls. Nov.-March.

278. **Aerua javanica** (Burm. f.) Spreng.=*A. tomentosa* Forsk. (234). Common.

279. **Achyranthes aspera** Linn. (23). A common monsoon weed in bushes. Fls. after rainy season.

280. **Alternanthera triandra** Lamk.=*A. sessilis* (L.) R. Br. (52,56). Common on the water margin.

281. **Pupalia lappacea** Moq. (25). Common in bushes. Fls. Aug.-Jan.

CHENOPODIACEAE

282. **Chenopodium album** Linn. Bathua. (13). Common herb of winter.

283. **C. murale** Linn. (15). Common in cold season. Spikes shorter.

284. **Beta vulgaris** Linn. 285. **Spinacia oleracea** Linn. and 286. **Basella rubra** Linn. are cultivated.

POLYGONACEAE

287. **Calligonum polygonoides** Linn. Phog. A common leafless shrub of the plain ground. The bushes are covered with pinkish-white flowers in April.

288. **Polygonum plebejum** R. Br. var. **brevifolia** (10). A prostrate herb. Rootstock woody, branches grooved. Internodes very short concealed by leaves and stipules. Flowers sessile, Jan.-May.

289. **P. indicum** Heyne=*plebejum* var. *indica* (54). Branches spreading all round. Internodes shorter than the leaves, 2-3 flowers in the axils.

290. **P. effusum** Meissn.=*P. plebejum* var. *effusa* (9). A slender herb, internodes longer, fls. pedicellate, Dec.-Feb. Common near ponds.

291. **P. barbatum** Linn. (38,39). A stout annual herb. Stipules strigose, mouth with cilia exceeding the tube. Common in marshes and ditches.

292. **Antigonon leptopus** Hook. and 293. **Rumex hastatus** D. Don. are cultivated.

ARISTOLOCHIACEAE

294. **Aristolochia bracteata** Retz. (134,202). A decumbent or very rarely climbing glabrous herb. Fls. solitary. Perianth tube cylindric with trumpet mouth, dark purple. Common in bushes. Fls. Aug.-Nov.

EUPHORBIACEAE

295. **Euphorbia parviflora** Linn.=*E. hypericifolia* L. var. *parviflora* Prain. (119,257). A decumbent herb, branching at base. Leaves glabrous on both sides. Fls. Aug.-Nov. and Feb.-Apr.

296. **E. hirta** Linn.=*E. pilulifera* L. (41,130). A common ascending herb clothed with yellowish hairs. Stem 4-angled, leaves dark green above, pale beneath. Flowers greater part of the year.

Note: Blatter, McCann, & Sabnis (1929) listed *E. hirta* and *E. pilulifera* as two separate species.

297. **E. thymifolia** Linn. (17). A small prostrate hispid herb with a copper-tinged stem. Leaves obtuse, near each other. Common in gravel.

298. **E. microphylla** Heyne. (343). Stems spreading from the root and dichotomously branched; pale and brittle. Leaves as long as broad stipules minute styles deeply bifid.

299. **E. clarkeana** Hk. f. (325). Leaves longer, stipules larger, seeds rugose pale brown. Common.

300. **E. nivulia** Buch.-Ham. A large shrub. Branches fleshy and cylindrical with pairs of sharp spines. Common. Fls. Feb.-March.

301. **Phyllanthus niruri** Linn. (218). An erect glabrous herb. Stems angular, leaves sub-sessile, flower axillary. Common weed of cultivated places.

302. **P. urinaria** Linn. (13,19). A weed herb. Branches very few at the top; leaves sessile, pale beneath. Rare.

303. **Emblica officinalis** Gaertn.=*Phyllanthus emblica* Linn. Cultivated.

304. **Securinega leucopyrus** Willd.=*Flueggea leucopyrus* Willd.=*Securinega obovata* (Willd.) Pax & Hoffm. (265). Common. Fls. Sept.-Nov.

305. **Acalypha ciliata** Forsk. (1,115). A stout herb. Branches few, leaves finely serrate, petiole longer than blade, bracts crowded. Fls. Aug.-Oct.

306. **Ricinus communis** Linn. Cultivated and wild.

MORACEAE

307. **Ficus glomerata** Rox. Gular.

308. **Morus alba** Linn., 309. **Ficus benghalensis** Linn., 310. **F. religiosa** Linn., 311. **F. carica** Linn., and 312. **F. krishnae** C. are cultivated.

HYDROCHARITACEAE

313. **Vallisneria spiralis** Linn. (48,239). Common hydrophyte. Leaf size very variable. Fls. Nov.-Dec.

314. **Hydrilla verticillata** Presl. (33,34,101,102,108). A submerged water plant; leaf very variable in shape and size.

315. **Lagarosiphon roxburghii** Benth. (328). Submerged herb, stem filiform, upper branches floating. Leaves sessile, opposite. Common in lake.

ORCHIDACEAE

316. **Zeuxine sulcata** Lindl. (327,328). An erect fleshy terrestrial herb of marshy places, 6-8" high, leaves sessile, linear, acuminate, 2½" long, flowers white in dense raceme, Jan.-Feb.

SCITAMINAE

317. **Canna indica** Linn. (35), 318. **Zingiber officinale** Rosc., and 319. **Musa sapientum** Linn. (two varieties) are cultivated.

AMARYLLIDACEAE

320. **Crinum asiaticum** Linn., and 321. **Agave** spp. are cultivated.

DIOSCOREACEAE

322. **Dioscorea bulbifera** Linn. Cultivated.

LILIACEAE

323. **Asparagus racemosus** Willd. Satavar. (133). On hills. Fls. hot months.

324. **Asphodelus tenuifolius** Cav. Fls. Feb.-March.

325. **Allium cepa** Linn., 326. **A. sativum** Linn., and 327. **Aloe barbadensis** Mill.=*A. vera* Linn. are cultivated.

COMMELINACEAE

328. **Commelina benghalensis** Linn. (149,258). A glabrous herb. Fls. Sept.-Nov.

329. **C. obliqua** Buch.-Ham. (61,288).

330. **C. wightii** Raizada=*C. glabra* Clarke. (85,284). Narrow lanceolate leaves, fls. solitary, axillary, pale brown. Aug.-Sept.

331. **C. suffructicosa** Bl. (86). Very rare.

332. **C. salicifolia** Roxb. (285). Becomes dark brown on drying. Fls. Sept.-Dec.

333. **C. nudiflora** Linn. (180,230,274). Frequent.

334. **Cyanotis axillaris** Schult. (158). Leaves pink, fls. solitary axillary.

PALMAE

335. **Phoenix sylvestris** Roxb. Cultivated.

PANDANACEAE

336. **Pandanus tectorius** Soland. ex Parkinson=*P. odoratissimus* Roxb. Cultivated.

TYPHACEAE

337. **Typha angustata** Chaub. (127). A herb 5-6 feet, nearly half beneath water. Monoecious; catkins very large, upper bigger half male yellowish, lower half female brownish. Abundant in marshy places and irrigation canals.

ARACEAE

338. **Pistia stratiotes** Linn. A few plants floating in ponds and puddles, leaves broadly rounded retuse. In cold months they were found decaying; flowers could not be observed.

339. **Colocasia** sp. Cultivated.

NAIADACEAE

340. **Potamogeton indicus** Roxb. Common in lake and puddles.

341. **Aponogeton monostachyon** Linn. Rare.

CYPERACEAE

342. **Cyperus arenarius** Retz. (82). A small sub-erect herb of plains and moist places, branching from the rootstock. Fls. Dec.-Feb.

343. **C. niveus** Retz. (126). Many white spikes gathered in the form of a star on a one foot long peduncle. Common around lake.

344. **C. eleusinoides** Kunth. (84,289). 1½-2 ft. high stem arising from a perennial rootstock, 3-angled. Many axillary spikes arise at the top. Abundant in marshy places along with *Typha*. Fls. Aug.-Dec.

345. **C. rotundus** Linn.

346. **C. compressus** Linn. (331). A small herb in the form of tufts. In moist places. Fls. Dec.

347. **Fimbristylis diphylla** Vahl var. **annua** Clarke. (211,306). Herb 1 ft. high. Spikes ¼", red, oval. Fls. Aug.-Oct.

348. **F. squarrosa** Vahl. (349). Annual. Leaves about half the length of the stem, ligule squarrose. Style 2-fid, base with many long hairs.

349. **Kylinga triceps** Roxb. (77). A sub-erect herb, 6″, many stems arising from a bulbous rootstock. Inflorescence 3-lobed, with 3 linear leaves.

GRAMINEAE

350. **Bothriochloa pertusa** (Linn.) A. Camus = *Andropogon pertusus* Willd. var. *insculptus*. (338). An erect annual grass, nodes bearded, 3-4 purple spikes in a spathe silky. Awn of 4 glumes ½″ long.

351. **Cenchrus setigerus** Vahl = *C. biflorus* Roxb. (81). An erect grass 6″ long. Inner bristles of the flower short. Common in plains.

352. **C. barbatus** Schum. = *C. catharticus* Del. A tufted grass, leaf sheath inflated, inner bristles long and spinescent.

353. **C. prieurii** (Kunth.) Maire. = *Pennisetum prieurii* Kunth. (346). Spikes short, similar to *P. cenchroides* but leaves long with filiform tip.

354. **Setaria verticillata** Beauv. (72). An annual grass.

355. **Paspalum paspaloides** Camus. = *Panicum paspaloides* Pers. A tall grass, rachis flat. Spikelets biseriate, glabrous. Spikes longer than internodes.

356. **Bracharia ramosa** (L.) Stapf. = *Panicum ramosum* Linn. (75). Stem ascending from a creeping base. Rachis narrow, first glume shorter than the 3rd, five-nerved.

357. **B. reptans** (L.) Gard. & Hubbard = *Panicum prostratum* Lamk. (75). Similar, with shorter leaves, 1st glume only ¼ of the third glume. Stems branching at most of the nodes.

358. **Paspalidium punctatum** (Burm. f.) A. Camus = *Panicum punctatum* Burm. (321). Perennial erect grass. Inflorescence 6-12″ long, spikes 20, fls. ovoid, pale. Common in wet places.

359. **P. antidotale** Retz. Tall branching panicle large, spikelets short ovoid, clustered.

360. **Rhynchelytrum villosum** Chior. = *Tricholaena teneriffae* Parlat. (78). Leaves convolute rigid, spikes open, spikelets ¼″, purplish white, silky with spreading hairs.

361. **Digitaria sanguinalis** Scop. (339). Rare annual. First glume ciliate.

362. **Melanocenchrus royleana** Nees var. **plumosa** Raizada & Jain. (83). A tufted annual grass, spikelets 2-flowered. Fls. Dec.-Feb.

General Conclusion

The vegetation of the hill presents a very striking life form consisting of spiny *Euphorbia nivulia* and other thorny plants such as *Balanites aegyptiaca, Acacia senegal, Gymnosporia spinosa, Zizyphus* spp., *Barleria* spp., etc. Therefore this may be called a thorny scrub.

The vegetation on steep slopes of the hills is very sparse, whereas on the gentler slopes it is rich. This marked difference in the nature of the vegetation of the hills emphasises the importance of edaphic (soil depth) and topographical factors. Based on the rainfall Biswas and Rao (1953) divided Rajputana into three zones: the desert zone, the arid zone, and the semi-arid zone. The Aravalli ranges with their comparatively dense vegetation, when compared with the rest of Rajasthan, fall in the semi-arid zone. Mt. Abu, the highest peak in the Aravallis, receives a higher rainfall (62.49″ =158.72 cms.) than the rest of Rajasthan and the vegetation is richer in both density and number of species than western Rajasthan (cf. Blatter & Hallberg, 1918-1921; Mahabale & Kharadi, 1946), Harsh Nath (Nair & Nathawat, 1957), and the hills at Ajit Sagar. Mt. Abu with its high altitude favours the growth of some of the Himalayan species of the families Rosaceae, Salicaceae, Berberidaceae, and Ranunculaceae. These elements and the species characteristic of peninsular India, found at Mt. Abu, such as species of *Diospyros, Sterculia, Holarrhena, Plumbago, Spondias*, etc. are not found in Harsh Nath and the area under consideration. However the vegetation in Harsh Nath is much denser than Ajit Sagar. The difference may be attributed to several factors, primarily the water-supplying capacity of the soil. Where a shallow soil cover lies over a porous and strong substratum drought is felt almost all round the year and if the rainfall is low a dry scrub develops as in Ajit Sagar hills which are dry almost eight months of the year so that only those species which can withstand drought can grow. Therefore the plants growing there develop characters designed to meet the environmental conditions and it may not be surprising, then, that a large number of plants growing there have similar characters that enable them to pass readily the adverse conditions. This may account for the predominance of thorny scrub on the hills. Where the soil is deeper and less rapidly depleted of soil moisture or the loss of water is compensated in the form of occasional rains the incidence of drought may be seasonal and a forest can develop as in Mt. Abu. These considerations lead to the conclusion that the distribution of vegetation in the different parts of Aravalli ranges is controlled by soil moisture, which, of course is affected by climate, soil, and topography. They can therefore be described as edaphoclimatic climax. The influence of biotic factors also cannot be overlooked. The plant coverage and their gregariousness are affected by grazing and cutting.

It has been considered at various quarters that the simpler vegetation not only of the Aravallis but the whole of Rajasthan is the deterioration product of a rich vegetation. There has been some speculations as to whether the degradation is due to increasing climatic adversities or operations in the past of the various factors resulting in the deterioration of richer communities. According to Wadia (1954) the whole of Asia is undergoing dessication. He states that Rajasthan was a fertile tract with rich vegetation about 2500 years ago. The main reason he considers for the desertification is the change in climate leading to a very low rainfall. Joshi (1956) considers that the luxuriant growth of vegetation during the rainy season supports the hypothesis of Wadia. The following observations will be of interest in this connection: (a) The richer communities of eastern Rajasthan gradually become thinner and thinner towards the west. (b) The simpler communities could be derived by the elimination of a few species characteristic of complex ones. (c) Simpler communities show occasional occurrence of species of complex ones. (d) The vegetation of the southern region of the Aravalli ranges is more complex than those in the north. These considerations bear testimony to prove that the simpler associations are the deterioration product of a climatic climax vegetation.

The families having five or more genera are Malvaceae (5), Asclepiadaceae (5), Solanaceae (5), Cucurbitaceae (6), Scrophulariaceae (6), Acanthaceae (7), Amaranthaceae (7), Compositae (11), Leguminosae (14), and Gramineae (15). The last three families are the most dominating as is also the case in Pilani, Chirawa, Harsh Nath, and western Rajasthan. The Cyperaceae which occupy the fourth place in W. Rajasthan are poorly represented as is also the case in E. Rajasthan. The families having five or more species are Asclepiadaceae (5), Polygonaceae (5), Labiatae (6), Solanaceae (6), Cucurbitaceae (7), Scrophulariaceae (7), Commelinaceae (7), Mollugineae (8), Convolvulaceae (8), Tiliaceae (9), Boraginaceae (9), Cyperaceae (8), Malvaceae (10), Acanthaceae (10), Amaranthaceae (10), Euphorbiaceae (10), Compositae (13), Gramineae (22), and Leguminosae (29). The families Leguminosae, Gramineae, Compositae, Euphorbiaceae, Amaranthaceae, and Malvaceae constitute about two-fifths of the flora.

The various genera are poorly represented. The largest genera having 5 or more species are *Indigofera* (5), *Heliotropium* (5), *Cyperus* (5), *Euphorbia* (6), *Commelina* (6), and *Tephrosia* (7). The relatively good representation of *Commelina* is remarkable.

In general 3 distinct elements, namely western (African-Persian), eastern (Malayan), and Indian can be distinguished in the flora of Ajit Sagar. Of the three elements western is represented by 83 and eastern by 33 species. The eastern is a little more than one third of the western. In western Rajasthan the eastern element is only one seventh

of the western. This shows the greater proportion of eastern element in Ajit Sagar. Blatter and Hallberg (1918-1921) and Biswas and Rao (1953) supported the suggestions of Drude that the line of demarcation between the Indo-malayan flora and the Perso-arabian flora ranges from the Gulf of Cambay northwards along the Aravallis. If it is true, one would expect a mingling of western and eastern elements in equal proportions. The dominance of western elements in Lohargal, Harsh Nath, and Ajit Sagar indicates that the line of demarcation should be sought more towards the east. However, more intensive studies of the various parts of the Aravallis are necessary before a final conclusion can be arrived at.

Summary

The various associations found around Ajit Sagar lake area are described. The vegetation on the hills is regarded to be a thorny scrub. The poor vegetation is attributed to the limited water supplying capacity of the soil, and the existing vegetation is considered to be the deterioration product of a climatic climax vegetation.

Of the 384 plants listed, 379 are angiosperms which include 126 cultivated and 253 indigenous plants. Leguminosae, Compositae, and Gramineae are the most dominating families. The largest genera include *Indigofera*, *Helliotropium*, *Cyperus*, *Euphorbia*, *Commelina*, and *Tephrosia*.

Three elements, western, eastern, and Indian, can be distinguished in the flora. The western element predominates over the eastern element. The eastern type is only a little more than one-third of the western.

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References

Biswas, K. & Rao, R. S. (1953): Rajputana desert vegetation. *Proc. Nat. Inst. Sci. India* **19** : 411-421.

Blatter, E. & Hallberg, F. E. (1918-1921): The flora of the Indian desert. *JBNHS* **26** : 210-246, 525-531, 811-818; **27** : 40-47, 270-279, 507-519.

— —, McCann, C., & Sabnis, T. S. (1929): The Flora of Indus Delta. Indian Bot. Soc. Madras.

*Drude, O. (1890): Handbuch der Pflanzen Geographie. Stuttgart.

— — —, (1913): Die Oekologie der Pflanzen. Brunswick.

Hooker, J. D. (1875-1897): Flora of British India I-VII. London.

Joshi, M. C. (1956): Plant ecology of Bikaner and its adjacent areas in comparison with rest of western Rajasthan. *J. Indian Bot. Soc.* **35** : 495.

Mahabale, T. S. & Kharadi, A. (1946): Some ecological features of the vegetation of Mount Abu. *Proc. nat. Acad. Sci. India* **16** : 13-23.

Nair, N. C. & Nathawat, G. S. (1952): Vegetation of Harsh Nath, Aravalli Hills. *JBNHS* **54** : 281-301.

Nairne, A. K. (1894): The Flowering Plants of Western India. Bombay and London.

*Wadia, D. N. (1954): Deserts of Asia—their origin and growth in the late pleistocene time. Birbal Sahni Inst. Paleobotany 1-10.

*Not seen in original.

On the Parakeet *Psittacula intermedia* (Rothschild) [Aves : Psittacidae]

BY

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Psittacula intermedia was described by Rothschild (1895) on a single trade skin shipped to him from Bombay. He accepted it as an Indian bird. Later, he obtained six more specimens from one Mr. Dunstall, a plumassier of London. Hartert (1924, p. 126) in his account of these specimens stated that these six skins were selected from a greater number of these birds.

Owing probably to the rarity and uncertain locality *Psittacula intermedia* did not receive the attention it deserves in Indian ornithology. Both Rothschild's and Hartert's papers had apparently been overlooked by subsequent workers on Indian ornithology, and the species found no place in any work of such eminent ornithologists as Blanford, Stuart Baker, Ticehurst, and Whistler. Nevertheless, we find it resuscitated, without locality, by Peters (1937, p. 246).

The problems created by this bird are many and somewhat intriguing. I have made an attempt here to determine its status, its affinities, and the possible place of its occurrence.

Rothschild (loc. cit.) pointed out that *Ps. intermedia* is somewhat intermediate between *Ps. schisticeps* (=*himalayana*[1]) and *Ps. cyanocephala*[2]. There appear then two possibilities as to its status:

(1) that it is a hybrid between *Ps. himalayana*/*Ps. finschi* and *Ps. cyanocephala*/*Ps. roseata*, produced by nature or by man; and

(2) that it is a genuine species wild at some unknown locality.

Regarding the possibility of its being hybrid, Rothschild (loc. cit.) has expressed the opinion that it is not a hybrid, and Hartert (loc. cit.) has stated: 'If it were a hybrid, so many specimens would not very

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[1] *Psittacula himalayana*, as hitherto understood, has recently been shown by Husain (1959) to be composed of two separate species, *Ps. himalayana* and *Ps. finschi*.

[2] *Psittacula cyanocephala* has subsequently been shown by Biswas (1951, pp. 1-6) to be composed of two species, *Ps. cyanocephala* and *Ps. roseata*.

likely have come at the same time, and one would expect them to vary, but they are all alike.' Indeed, I have independently come to the same conclusion after an examination of all these specimens. Besides, if they were man-made hybrids, they would necessarily have been cage birds. But the character of their toes does not indicate this. *Psittacula intermedia* may, therefore, be regarded as a genuine wild species.

It is necessary to record here a few words about the known specimens of *Ps. intermedia.* Including the type only seven specimens of the species are believed to exist, and they are all housed in the Rothschild Collections of the American Museum of Natural History, New York. None of the specimens is sexed but, from coloration, six of them appear to be exceedingly similar adult males, while the seventh (A.M.N.H. No. 621545) is an immature specimen, being green all over, and its sex cannot be guessed. Incidentally, it may be added that this specimen has as long a wing as that of the longest-winged male specimen, and it matches well with immature examples of *Ps. himalayana,* both in coloration and in size. I am thus led to consider it an immature specimen of *Ps. himalayana,* which brings down the total number of known specimens of *Ps. intermedia* from seven to six.

All the specimens are in more or less fresh plumage. In one (A.M.N.H. No. 621544) the central tail feathers still show the sheaths at their bases. The post-juvenile moult in another specimen (A.M.N.H. No. 621542) is almost finished. Its body feathers are all very fresh, its wings and tail are in moult, and its head has new red and blue feathers with some greenish towards their centres. A third specimen (No. 621543) is a trifle different from the other specimens in having very little yellow on the tips of its central rectrices, and more green than verdigris on the rump.

As has already been stated by Rothschild and by Hartert, *Ps. intermedia* is intermediate between *Ps. himalayana*/*Ps. finschi* and *Ps. cyanocephala*/*Ps. roseata.* A careful comparison of the five species shows that *Ps. intermedia* shares characters with the four other species as presented in Table 1. It would appear from the above that if coloration alone is considered *Ps. intermedia* is closer to *Ps. cyanocephala*/*Ps. roseata* than to *Ps. himalayana*/*Ps. finschi* (*contra* Rothschild). However, taking into consideration the size factor (Table 2) also, I am inclined to agree with Rothschild that *Ps. intermedia* is nearer *Ps. himalayana*/*Ps. finschi.* Furthermore, the conglomeration of characters among the five species, as presented in Table 1, suggests that they are genetically related.

TABLE 1.

SHARING OF CHARACTERS AMONGST THE MALES OF *Psittacula roseata*, *Ps. cyanocephala*, *Ps. intermedia*, *Ps. himalayana*, AND *Ps. finschi*.

	Ps. roseata	*Ps. cyanocephala*	*Ps. intermedia*	*Ps. himalayana*	*Ps. finschi*
Ps. roseata	A″, b, d	g, h, i	E, F	c, E, F	c
Ps. cyanocephala	g, h, i	A, e, f	B, C, D	B, D	B, D, e
Ps. intermedia	E, F	B, C, D	A′	B, D, E, F, G, H, I	B, D, G, H, I
Ps. himalayana	c, E, F	B, D	B, D, E, F, G, H, I	a	a, B, c, d, G, H, I
Ps. finschi	c	B, D, e	B, D, G, H, I	a, B, c, d, G, H, I	F/f

Explanation of symbols :

Crown : rich lilac (A), pale lilac (A″), intermediate (A′), slaty (a) ; verdigris collar : present (B), absent (b) ; rump : verdigris (C), green (c) ; under wing-coverts : verdigris (D), green (d) ; wing patch : darker red-brown (E), lighter red-brown (e) ; tips of central tail feathers : yellow (F), white (f), yellowish white (F/f) ; mandible : yellowish buff (G), blackish (g) ; wing size : large (H), small (h) ; bill size : large (I), small (i).

As to the place of occurrence of *Ps. intermedia*, nobody knows for certain where it occurs. Nor has any ornithologist ever seen this bird alive in nature. Rothschild thought that it occurs somewhere in the 'Western Provinces' of India, meaning western Himalayas, because

TABLE 2.—MEASUREMENTS IN MILLIMETRES OF *Psittacula roseata*, *Ps. cyanocephala*, *Ps. intermedia*, *Ps. himalayana*, AND *Ps. finschi*.

		Wing	Tail	Bill from cere
Ps. roseata Sikkim, northern Bengal, Assam, Burma (except Tenasserim)	30 ♂	135–150 (142.3)	152–198 (178.5)	16–20 (18.4)
	21 ♀	132–143 (138.0)	140–179 (157.7)	16–18.5 (18.0)
Ps. cyanocephala Himalayas from the Punjab to northern Bengal	15 ♂	143–150 (146.0)	195–253 (218.7)	18–19 (18.4)
	13 ♀	139.5–144 (143.2)	190–200 (196.3)	17–18 (17.6)
Ps. intermedia "India. Nat. Skim." TYPE	1 (♂)	157	—	20.5
"India." Other specimens	5 (♂)	148, 155, 155+156, 158	185, 202, 221	19, 20, 20, 21, 21
Ps. himalayana Himalayas from Kashmir to Nepal.	23 ♂	162–174 (167.1)	172–270 (232.5)	21–23.5 (22.2)
	10 ♀	155–166 (162.2)	175–231 (202.0)	20.5–22.5 (21.3)
Ps. finschi	16 ♂	148–156 (153.0)	244–270 (256.5)	22–23 (22.3)
Assam, upper Burma	5 ♀	143–149 (145.5)	225–251 (240.1)	21.5–23 (22.1)

Figures in parentheses represent average measurements.

along with the type 'came two skins of *P. schisticeps*' (=*himalayana*). Hartert believed that it 'evidently came from some part of the Himalayas, as it was accompanied by other Himalayan birds', and hinted at the possibility of its occurrence in the western Himalayas. On the label (Rothschild's Tring Museum label) of the type specimen, however, we read: 'India Nat. Skim.' This may be a slip meaning either 'native skin (a skin collected by a native) from India', or 'India, Native Sikim'—as present Sikkim used to be called by the British authorities in olden days to distinguish it from British Sikkim= Darjeeling district. In the latter case, it is impossible to know now whether the change in the locality of the type label was merely a

clerical error or written under instruction. It is possible that either Rothschild or Hartert, or both, had reasons to change their earlier opinion on the probable place of occurrence of the bird, but there does not appear to be any published account to corroborate this assumption. The labels of the other specimens simply bear 'India' as the locality.

Four species of *Psittacula*, namely *Ps. eupatria*, *Ps. krameri*, *Ps. cyanocephala*, and *Ps. himalayana*, occur in the western Himalayas (west of Kumaon), while as many as seven species, i.e. the four above-named species plus *Ps. roseata*, *Ps. finschi*, and *Ps. alexandri*, are found in the eastern Himalayas (Kumaon eastward). Competition among the species of *Psittacula* would, therefore, seem to be greater in the eastern Himalayas. However, the fact that the wing, tail, and bill are larger in *Ps. intermedia* than in *Ps. cyanocephala* and *Ps. roseata* may perhaps indicate that the former ranges to an altitude higher than the latter, and nearly as high as *Ps. himalayana*/*Ps. finschi*. Along the whole length of the Himalayas, in the altitudinal zone of approximately 1800-2400 metres, the only species of *Psittacula* known to occur are *Ps. himalayana* and *Ps. finschi*. Possibly, *Ps. intermedia* co-exists with either or both of them in this altitudinal belt where obviously competition among them is expected to be comparatively less than it is elsewhere. It is likely that the species has escaped the notice of ornithologists so far because of its probable localized distribution. Furthermore, great portions of the Himalayas, particularly the Assam Himalayas, remain yet to be faunistically explored.

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References

Biswas, B. (1951) : Revisions of Indian birds. *Amer. Mus. Novit.*, No. 1500 : 1-12.

Hartert, E. (1924) : Types of birds in the Tring Museum. *Novit. Zool.* **31** : 112-134.

Husain, K.Z.(1959): Taxonomic status of the Burmese slaty-headed parakeet. *Ibis* **101** : 249-250.

Peters, J. L. (1937) : Check-list of birds of the World, Cambridge, Mass. **3** : 246.

Rothschild, W. (1895) : On a new parrot. *Novit. Zool.* **2** : 492.

Some New Isopod Parasites on Fishes

BY

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(With two plates)

INTRODUCTION

In a preliminary investigation on the Isopod fauna of Bombay, the presence of three new species of parasitic Isopods was noted. A detailed description of their morphological features with suitable illustrations is given below.

1. **Argathona muræneae** sp. n.

Family: Corrallinidae.
Genus: *Argathona* Stebbing.
Host: *Muræna tessellata.*
Date: August 1956.
Collection: 9 females.

DESCRIPTION

Body ovate. Colour violet. Surface setose. Thoracic segments without any tubercles. Convex along the mid-dorsal line. Less than half as broad as long.

Cephalon and its appendages: (Pl. I, Fig. 1). The cephalon is more or less a triangular plate, though slightly broader than long. The base of the cephalon is comparatively straight while the lateral sides are broadly rounded and meet anteriorly in a very small rostral projection covering the base of the antennae. The surface of the cephalic segment is setose but not as thickly as the other body regions. Moderate eyes situated wide apart at the postero-lateral sides of the head.

Antennae (Pl. I, Figs. 2 and 3) are well developed. The first pair (Pl. I, Fig. 2) is extensible as far as the posterior margin of the first

thoracic segment. Its peduncle is well defined with three segments, and the flagellum with eleven to thirteen segments. Each segment of the flagellum carries a pencil of brush setae along the mid-anterior margin on the ventral aspect. The terminal segment, however, bears brush setae at its apex.

The second antenna (Pl. I, Fig. 3) is long and slender. It extends to the posterior margin of the third segment of the thorax. The peduncle and flagellum of the second antenna are well defined. First two joints of the peduncle are small, the third slightly longer but atrophied on the inner side, thus giving it a triangular appearance. The fourth and fifth articles are as long as the combined length of the first three articles and are more or less sub-equal to each other. The flagellum of the second antenna consists of thirty to thirty-four articles or segments. Each segment bears a thin pencil of setae on the ventral side. The terminal segment bears setae at the apex.

Mandibles (Pl. I, Fig. 4 *a* and 4 *b*) are strong, and their cutting edges thickly chitinised, retaining their brown colour even in permanent preparations. Left mandible (Fig. 4 *a*) is represented by a thin blade-like projection which is not serrate.

First maxilla (Pl. I, Fig. 5) has the outer joint strong, chitinised unguis, and a hook-like spine at the base.

Second maxilla (Pl. I, Fig. 6) is simple, short and lobe-like.

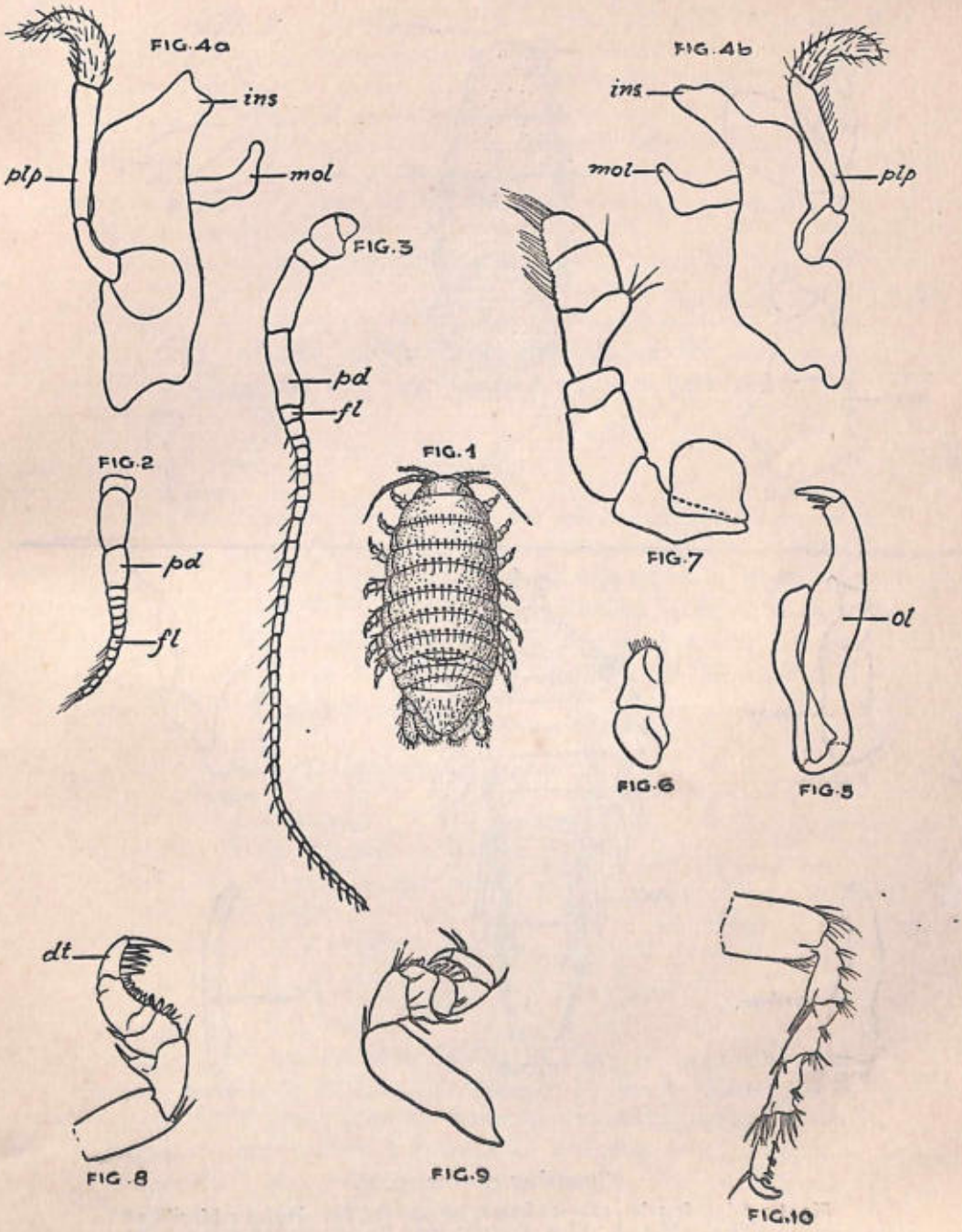
Maxillipeds (Pl. I, Fig. 7) with the last two joints setose along their inner margin towards the apex.

Thorax and its appendages: (Pl. I, Figs. 1, 8, 9, 10). Thorax is long and broad. Its surface is uniformly setose. The first thoracic segment is the longest of all. The second, third, and fourth segments are sub-equal and slightly shorter than the first. The fifth, sixth and seventh are shorter, the seventh being the shortest. The breadth of the thoracic segments goes on increasing up to the fourth thoracic segment which is broadest. Succeeding segments are slightly narrower.

Epimeral expansions of the thoracic segments are well defined, excepting those of the first one. The second and third segments have their epimera developed but not as much as in the succeeding segments.

First thoracic leg exhibits a dentate dactylus on the inner side, in addition to a strong terminal spine (Pl. IV, Fig. 8). The succeeding two legs are also dentate but on a smaller scale. Others are strong and thickly setose (Pl. IV, Fig. 9).

Abdomen and its appendages: (Pl. I, Fig. 1). Due to the bent nature of the body, the first abdominal segment is totally



Argathona muraeneae sp. n.

Fig. 1 : Adult female. Fig. 2 : First antenna, *fl*—flagellum, *pd*—peduncle. Fig. 3 : Second antenna, *fl*—flagellum, *pd*—peduncle. Fig. 4a 4b plp—plp : Left and right mandibles, *ins*—incisor, *mol*—molar. Fig. 5 : First maxilla, ol—outer lobe. Fig. 6 : Second maxilla. Fig. 7 : Right maxilliped. Fig. 8 : First thoracic leg. Fig. 9 : Second thoracic leg. Fig. 10 : Seventh thoracic leg.


FIG. 4

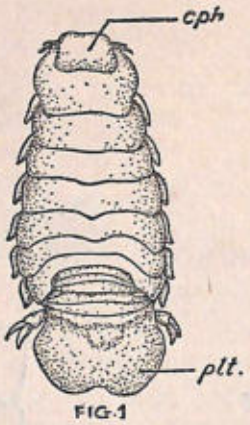


FIG. 1

FIG. 5

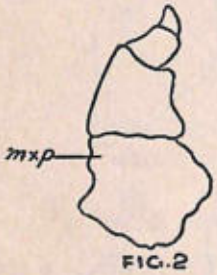


FIG. 2

FIG. 3

SHIRGAONKAR

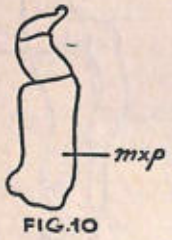


FIG. 10

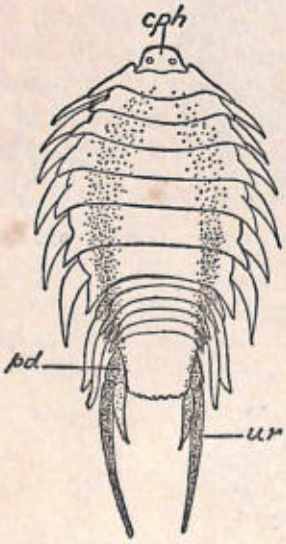


FIG. 6

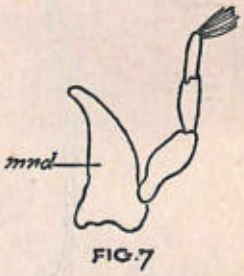


FIG. 7

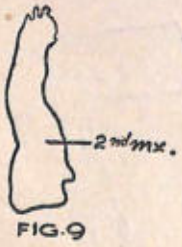


FIG. 9

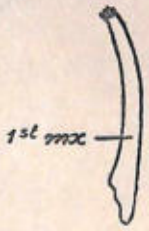


FIG. 8

SHIRGAONKAR

Cymothoa cinerea sp. n.

Fig. 1 : Adult female—*cph*—cephalon, *plt*—pleotelson. Fig. 2 : Maxilliped, *mxp*—maxilliped. Fig. 3 : First thoracic leg. Fig. 4 : Second thoracic leg. Fig. 5 : Seventh thoracic leg.

Nerocila pigmentata sp. n.

Fig. 6 : Adult female, *cph*—cephalon, *pd*—peduncle, *ur*—uropod. Fig. 7 : Right mandible, *mnd*—mandible. Fig. 8 : 1st *mx*—First maxilla. Fig. 9 : 2nd *mx*—Second maxilla. Fig. 10 : *mxp*—Maxilliped.

covered by the seventh segment of the thorax. Likewise, the second abdominal segment is also partially covered. The third is nearly as broad as the seventh thoracic segment. The fourth, which is equally broad, covers the fifth segment laterally. Excepting the first and the covered portion of the second, all the abdominal segments are setose.

Epimeral expansions of the abdominal segments are not defined but they can be recognised by their backward projections on the third and fourth segments.

The last abdominal (pleotelsonic) segment is bulged on each side of the mid-dorsal line in the anterior region. The telsonic region is triangular with rounded apex posteriorly. The telson is not thickly setose. The posterior margin of the telson and of the uropods is dentate with long and fine setae, sprouting out from the depression of the dentary.

Remarks

The gills and the buccal cavity of the fish *Muræna tessellata* was found infested with the aforesaid species of isopods. Their general appearance and body colour resembled the description of *Argathona normani* (Stebbing, 1905). However, they differed from it by their apparent parasitic habitat and the non-tuberculate nature of the thoracic segments and the telson. In view of this, this species is named here as *Argathona muræneae*.

2. **Nerocila pigmentata** sp. n.

Family: Cymothoidae.
Genus: *Nerocila* Leach.
Host: *Opithopterus turtoor* (dorsal side).
Date: May 1956.
Collection: Two ovigerous females.

Description

Body ovate and compact; broad (13 mm.) in the middle and broadly converging at the ends (length 21 mm.). Body colour beautiful yellow-grey. Presence of lateral dark violet bands running almost throughout the length of the body; becoming faint, sparse, and broad on the thoracic region, and deeply pigmented on the abdomen, peduncle of uropod, and its outer-ramus.

Cephalon (Pl. II, Fig. 6). Cephalon or head is broader than long and subquadrate. Its anterior margin is broadly rounded and

posterior trilobed. The median lobe is large and rounded and the side ones are small and angled. Eyes, situated in the postero-lateral angles of the head, are small. First pair of antennae does not reach the middle of the first thoracic segment and the second extends to the middle of the segment. Mandibles, maxillae and maxillipeds show the characteristic structure of the genus *Nerocila* (Richardson, 1905) (Pl. II, Figs. 8, 9, 10).

Thorax (Pl. II, Fig. 6). The length of the thorax is almost equal to its breadth at the 6th segment. First thoracic segment is 2½ times broader than long. Its anterior margin is trisinuate and posterior uniformly curved. The postero-lateral angles of this segment are very prominent and extend nearly to the posterior margin of the second segment. Epimera of the first segment are not visible. The second, third, and fourth segments are subequal in length but narrower than the first. The posterior margin of these segments is broadly rounded in a convex manner. The postero-lateral angles of the second segment are abruptly short as compared to those of the first, and gradually elongated in posterior segments. The epimeral expansions of the second segment are slender, acute, and extend almost to the posterior extremity of the third segment. Those of the third and fourth are also slender but slightly more elongated. The fifth segment of the thorax is broad and long. At the sides, it exhibits anteriorly a pair of sutures demarcating the anterior portion, from which the epimeral expansions arise. Its posterior portion extends laterally backwards, to form well-developed postero-lateral angles of the segment. The epimera of the fifth segment are well developed, with a broad base, sloping into a fine acute point, reaching the lateral sutures of the succeeding segment. The sixth and seventh segments are broad, the former being the broadest. They are also longer than the rest but are subequal. The posterior margin of the 6th segment is almost straight, and of the seventh concave. The lateral sutures of these segments are prominent. Their epimeral expansions are robust and long. Postero-lateral angles of these segments are very well developed.

The first five thoracic legs are prehensile and closely situated. The sixth is slightly posterior to the middle of the body and wide apart from the fifth. The seventh leg is also situated far off from the sixth. All the legs are similar to each other in structure but they increase in length abruptly in the posterior pairs, the seventh being the longest.

Abdomen (Pl. II, Fig. 6). The abdomen is slightly immersed in the thorax. Its five free segments are well defined. The lateral

angles of the first four segments are well developed and elongated. The epimera of the first two abdominal segments are slender, acute, elongated, reaching the distal end of the peduncle of the uropod. Epimera of the other segments are not visible. The pleotelson is more or less a rectangular plate, with its angles broadly rounded, the inner margin of which is almost straight as compared to the outer. The peduncle of uropod is distinct. The outer distal angle of the uropod is extended. Peduncle and outer ramus of the uropod are deeply coloured. Both the rami of the uropod are elongate, terete, slender, and acute. The outer ramus is double the length of the inner, and is darkly pigmented. The inner ramus has a slightly broader base.

Remarks

The significant features like long acute arrow-like epimeral expansions of the posterior segments of the thorax, broadly rounded telson, the presence of beautiful dark violet bands on the sides on the body and the long slender uropod region make this species strikingly different from the other known species of the genus *Nerocila* (Richardson, 1905; Barnard, 1940). Therefore, the species is named as *Nerocila pigmentata* owing to its dark pigmentation of the sides of the body and uropods.

3. **Cymothoa cinerea** sp. n.

Family: Cymothoidae.
Genus: *Cymothoa* Fabricius.
Host: *Stromateus cinereus* (in the buccal cavity).
Date: September 1956.
Collection: Two females.

Description

Body stout oblong 44 mm. long and 19 mm. broad at 4th thoracic segment. Colour brown-yellow. Thoracic segments punctate. Abdominal segments not smooth.

Cephalon and its appendages: (Pl. II, Figs. 1 and 2). *Cephalon* (Pl. II, Fig. 1 cph.) is large with its posterior margin straight. Laterally, the posterior angles are straightly curved into a rounded margin. The lateral margins of the cephalon are also straight but not parallel to each other; instead they slope anteriorly

posterior trilobed. The median lobe is large and rounded and the side ones are small and angled. Eyes, situated in the postero-lateral angles of the head, are small. First pair of antennae does not reach the middle of the first thoracic segment and the second extends to the middle of the segment. Mandibles, maxillae and maxillipeds show the characteristic structure of the genus *Nerocila* (Richardson, 1905) (Pl. II, Figs. 8, 9, 10).

Thorax (Pl. II, Fig. 6). The length of the thorax is almost equal to its breadth at the 6th segment. First thoracic segment is 2½ times broader than long. Its anterior margin is trisinuate and posterior uniformly curved. The postero-lateral angles of this segment are very prominent and extend nearly to the posterior margin of the second segment. Epimera of the first segment are not visible. The second, third, and fourth segments are subequal in length but narrower than the first. The posterior margin of these segments is broadly rounded in a convex manner. The postero-lateral angles of the second segment are abruptly short as compared to those of the first, and gradually elongated in posterior segments. The epimeral expansions of the second segment are slender, acute, and extend almost to the posterior extremity of the third segment. Those of the third and fourth are also slender but slightly more elongated. The fifth segment of the thorax is broad and long. At the sides, it exhibits anteriorly a pair of sutures demarcating the anterior portion, from which the epimeral expansions arise. Its posterior portion extends laterally backwards, to form well-developed postero-lateral angles of the segment. The epimera of the fifth segment are well developed, with a broad base, sloping into a fine acute point, reaching the lateral sutures of the succeeding segment. The sixth and seventh segments are broad, the former being the broadest. They are also longer than the rest but are subequal. The posterior margin of the 6th segment is almost straight, and of the seventh concave. The lateral sutures of these segments are prominent. Their epimeral expansions are robust and long. Postero-lateral angles of these segments are very well developed.

The first five thoracic legs are prehensile and closely situated. The sixth is slightly posterior to the middle of the body and wide apart from the fifth. The seventh leg is also situated far off from the sixth. All the legs are similar to each other in structure but they increase in length abruptly in the posterior pairs, the seventh being the longest.

Abdomen (Pl. II, Fig. 6). The abdomen is slightly immersed in the thorax. Its five free segments are well defined. The lateral

angles of the first four segments are well developed and elongated. The epimera of the first two abdominal segments are slender, acute, elongated, reaching the distal end of the peduncle of the uropod. Epimera of the other segments are not visible. The pleotelson is more or less a rectangular plate, with its angles broadly rounded, the inner margin of which is almost straight as compared to the outer. The peduncle of uropod is distinct. The outer distal angle of the uropod is extended. Peduncle and outer ramus of the uropod are deeply coloured. Both the rami of the uropod are elongate, terete, slender, and acute. The outer ramus is double the length of the inner, and is darkly pigmented. The inner ramus has a slightly broader base.

Remarks

The significant features like long acute arrow-like epimeral expansions of the posterior segments of the thorax, broadly rounded telson, the presence of beautiful dark violet bands on the sides on the body and the long slender uropod region make this species strikingly different from the other known species of the genus *Nerocila* (Richardson, 1905; Barnard, 1940). Therefore, the species is named as *Nerocila pigmentata* owing to its dark pigmentation of the sides of the body and uropods.

3. **Cymothoa cinerea** sp. n.

Family: Cymothoidae.
Genus: *Cymothoa* Fabricius.
Host: *Stromateus cinereus* (in the buccal cavity).
Date: September 1956.
Collection: Two females.

Description

Body stout oblong 44 mm. long and 19 mm. broad at 4th thoracic segment. Colour brown-yellow. Thoracic segments punctate. Abdominal segments not smooth.

Cephalon and its appendages: (Pl. II, Figs. 1 and 2). *Cephalon* (Pl. II, Fig. 1 cph.) is large with its posterior margin straight. Laterally, the posterior angles are straightly curved into a rounded margin. The lateral margins of the cephalon are also straight but not parallel to each other: instead they slope anteriorly

to meet the anterior truncate margin. This gives the cephalon a trapezoidal appearance. The anterior half of the trapezoidal cephalic plate is slightly depressed in the middle. Small, more or less rounded eyes are placed a little behind the middle of the head or cephalon.

First antenna is smooth and robust with nine articles. The apical articles are slenderer than the basal. It reaches the projected latero-anterior angles of the first thoracic segment.

Second antenna is smooth but much more slender than the first. It consists of eight articles and almost touches the posterior lateral angles of the first thoracic segment when stretched.

Maxillipeds possess cilia-like projections on the inner border of basal segment (Pl. II, Fig. 2).

Thorax and its appendages: (Pl. II, Figs. 1, 2, 4, 5).

The first thoracic segment is the longest and the fifth the broadest. The antero-lateral angles of the first thoracic segment nearly extend up to the middle of the cephalon. The second, third, fourth, and fifth thoracic segments are equal in length, while the length of the succeeding two segments is less, the last being the shortest. The anterior margin of the first segment is emarginate and that of the succeeding segments is covered by the preceding segments. The posterior margin of all the thoracic segments is not straight but is projected mid-dorsally into a small curved protrusion. This curved projection is more prominent in the fourth and fifth segments.

The lateral epimeral plates of the thoracic segments are not attached to the entire length of the segment, but are attached only to the anterior half. In the posterior segments this attachment can be easily distinguished by the presence of a prominent transverse notch in the middle of the segment. The first three pairs of thoracic legs (Pl. II, Figs. 3, 4) have long strong dactyli nearly as long as those of the following pairs. The last four pairs have strongly developed carinae on the femora. The femur of the seventh pair is (Pl. II, Fig. 5) broad and long.

Abdomen and its appendages: (Pl. II, Fig. 1).

The abdomen is nearly $\frac{1}{2}$ the length of the body and is conspicuously immersed in the thorax. The fifth abdominal segment is broader than the preceding ones. Each of the abdominal segments has four to five small tubercles on the anterior half, arranged in an inconspicuous row. The remaining portion of the segment is smooth.

The pleo-telson (Pl. II, Fig. 1, *plt.*) is broader than long. The anterior margin has irregular tubercles on the top. Its anterior side has conspicuous depression on the mid-dorsal region. The postero-

lateral margins are broadly rounded. The posterior margin has a wide notch on the mid-dorsal line.

REMARKS

The presence of such a large specimen in the buccal cavity of *Stromateus cinereus* is very interesting. Its study shows a close resemblance of shape and body form to that of the known parasite *Cymothoa stromatea*, parasitic on *Parastromateus niger* (Pillai, 1954). However, the present species differs from *C. stromatea* in possessing longer thorax, shorter and tuberculated abdomen, and slightly punctate sides of the body. Hence it is named after its host.

REFERENCES

Barnard, K. E. (1940) : *Ann. S. Afri. Mus.* **32** : 381.

Pillai, N. K. (1954) : *Bull. Central Research Inst. Univ. Travancore, Trivandrum.* Ser. (C), **3** (I) : 1.

Richardson, H. (1905) : A monograph of the Isopods of North America. *Bull. U.S. Nat. Mus.* No. 54.

Stebbing, T. (1905) : Ceylon pearl oyster fishery Reports, 4. Suppl. Rep. 1.

An Ornithologist revisits West Nepal (March 21-25, 1959)

BY

ROBERT L. FLEMING

After an interval of seven years, we found ourselves again at Sanauli, the check-post north of Gorakhpur on the Nepal border. Nothing much had changed—motor lorries were all older. In 1949 we knew nothing of the bird life but collected there twice (1949, 1951). Armed only with binoculars, note-book, and some local ornithological experience, we now had a good chance to check again on birds along the road to Tansen and around Pokhara.

The bus apparently would be delayed for some time, so we ranged out from the station. There were several common birds about—House Crows, Common Mynas, Black Drongos on a dead tree. A Crimsonbreasted Barbet called from a mango grove. Out in cut-over grain fields were many Pied Mynas, more plentiful here than in any other place we have visited in Nepal. Indian Rollers sat on bounds between fields; this species became less frequent or not seen at all until we reached Pokhara where they were positively numerous. A frequent roadside bird was the pink-legged Indian Pipit with its speckled breast. From a large almost leafless tree came the metallic chirp of the Yellowthroated Sparrow. Two of these occupied a special branch which was apparently an 'apartment'. I had only found this sparrow twice before. A Grey Partridge called from a distant hedge. Jungle Crows here may have been either the Indian or Himalayan race. There was a species of dove, identity undetermined.

No sign of the departure of any bus, therefore we set out on foot to observe what we could before being overtaken. The road ran westward with large, white boundary posts at intervals on our left. A pair of Ashycrowned Finch-Larks crouched in the dust of the road. The male flew upward for five or six wing-beats, then plummeted down a short distance on folded wings only to rise again and repeat the performance to the accompaniment of a sweet little song. Large white egrets stood near a distant pond. We have collected *Egretta alba modesta* (Gray) but are still looking for the smaller bird, *E. intermedia*. Overhead wheeled a number of birds like martins—black above, white below with light gray, almost whitish throats. On a

bound of a field rested a White-eyed Buzzard which turned its head and blinked its eyes. When we tossed a clod in its direction, it flew low over the ground, then suddenly ascended into a low tree. An Indian Bush Chat sat on the top of a shrub on the far side of the field.

We looked back but could see no activity at the distant check-post. Soon we reached a stream near a camp. The Indian Pond Herons were here as well as a pair of Redwattled Lapwings. From a mango grove darted a Green Bee-eater showing a metallic sheen as it flattened its wings, wheeled and glided back to the same twig. Overhead a flight of Roseringed Parakeets flashed by, 'clacking' as they went. At the water's edge a White Wagtail, possibly *Motacilla alba dukhunensis* Sykes, restlessly searched for insects. A single sandpiper ran along the edge of the water [*Actitis hypoleuca* (L.) ?]. A Blackheaded Shrike flew with heavy flight from a small tree. This species is common from the terai to 8000 feet and beyond. Several days north of Kathmandu we found *Lanius schach tricolor* to be very common. In May, at 7500 feet they were breeding. Colonel Richard Proud, who went on through the Gosainkund Pass at 14,500 feet into Langtang Valley, saw only the black-headed bird on this side, and immediately on the other side only the grey-headed race *L. s. erythronotus* (Vigors). A group of Common Babblers moved among trees above a cactus hedge. This was the first glimpse of this common bird in Nepal. Many Redvented Bulbuls were here and in the foothills. The Kite of this area was much darker than those at Tansen and Pokhara.

Our bus finally caught up with us. From here to Butwal, about twenty miles, we spotted several more familiar birds. Neophrons circled through the air at Bhairahwa town. House Sparrows were in holes in brick buidings, while an Indian Hoopoe with its rose-tinted breast, dropped into a tree in front of a shop.

Again on the road we saw a group of Cattle Egrets feeding in company with buffaloes. Some say egrets pick ticks off animals' backs but careful examination of stomachs in Egypt have not confirmed this. They apparently take insects which are stirred up by grazing herds. A Wiretailed Swallow rested on a concrete bridge we crossed—a species we have not yet taken in Nepal. A brown vulture with white on its back sat upright on a nest-platform in a tall tree. A Bank Myna scurried between the legs of cattle, reminding me of the first one I tried to collect which did the same thing. Occasional Pied Bush Chats perched on shrubs in open meadows while the Common Kingfisher sped over patches of water beside the road. On

a larger stream we caught a glimpse of the Pied Kingfisher poised on hovering wings.

In the distance a forest of tall trees loomed up. A pair of Sarus Cranes as well as Lesser Adjutant Storks stood in one of the last clearings. What appeared to be a Yellowbreasted Babbler popped out of the dry grass next to the road. As we entered the forest we were hemmed in for the next few miles and saw nothing. Not that the area was empty for we crossed the very stream where we found Conover's Green Pigeon (sp. nova) and the Great Grey Woodpecker (*Mulleripicus*)—the only place we've ever seen it. We finally completed our twenty mile trip in a little over four hours and reached Butwal (900 feet), at the foot of the Siwalik Range, where we stayed over night.

Next morning Purple Sunbirds were calling from trees heavy with mistletoe. Here was the only Brownbacked Indian Robin we saw, in the same place we collected it ten years before. We struck out northward along the rocky trail which leads through a defile up the Tinau River bed. The Whistling Thrush now became common along the stream. Whitecapped Redstarts skimmed from rock to rock; soon they would be nesting on mountain streams at 12,000 feet. The *too-lee, too-lee* of the Tailor Bird now followed us much of our way. Here we heard the loud, metallic *cluk* of the Indian Grackle. This species is very common farther east where, at Hitaura and Amlekhganj below Kathmandu, young birds are sold in the bazaar for a rupee or two. A hunting party in the taller trees contained several willow warblers, the Chestnutbellied Nuthatch, and a small pied woodpecker, possibly *Dendrocopos canicapillus mitchelii* (Malherbe). Near a village was a small dove about the size of the little Red Turtle Dove. The Whitecheeked Bulbul as well as the little White-eye with its plaintive *teer* became frequent.

The road, a series of stone ledges, now wound through a forest with a ravine on our right choked with creepers and shrubs. I didn't see the Green Magpie, Redheaded Trogon, nor Red Junglefowl of other years, but the Brownbacked Pied Shrikes were in their place, flitting from limb to limb, and also the Greyheaded Flycatcher with its cheery notes. Bulbuls like each other's company for the Blackheaded Yellow, the Black (really grey with a black crest and coral beak), and the Browneared, which we call 'the musical bulbul', were all together. The little Bronzed Drongo hawked insects from a dead branch in the same tree where he had been before.

Rani Bas, 'the place where the Queen sat', was the spot on the way to Tansen which was 'bursting' with birds. The Green Pigeon there

may have been the thick-billed species. The first class songster of the ravine was the Indian Shama. And the first class mimic, in almost every tree was the Orangebellied Chloropsis. The Blackbreasted Sunbird was in the same sunny nook next to the village near some dark green Willow Warblers. A bit higher the forest was full of barbet calls. There was the Bluethroated, the two-note *whe—lp* of the Goldenthroated, and the piercing *pir-au* of the Himalayan Great Barbet. The second is only occasionally found while there are many of the other two. The sketchy little song of the Whitebrowed Fantail Flycatcher came from dense cover where it sat on lower branches swaying from side to side. On the ridge above the village Hodgson's Striated Swallows skimmed the treetops while a party of Whitecrested Laughing Thrushes filled the air with their hollow mockery. Then something rustled at our feet. After a moment out stole a Streaked Laughing Thrush which fluttered down the hill followed by a second one. The Mussoorie race is very much more common than its Nepal cousin (*setafer*). The soft *chir* of the Redbilled Babbler revealed a small party of these birds in dense undergrowth. Although it was mid-forenoon a Barred Owlet suddenly unleashed a ripple of notes. Greyheaded Flycatcher-Warblers worked energetically in the trees, singing as they went while their duller relatives, the Blackbrowed Flycatcher-Warblers, worked near the ground in a more deliberate manner.

We climbed a narrow defile, crossed a bridge, and passed a number of thatched Nepali houses neatly trimmed in two-toned cream and terra cotta. On the cut-over hillside Hodgson's Rustycheeked Scimitar Babblers sent forth a duo: *pick—puck, peak*. In this rather narrow valley we came across a considerable number of Verditer Flycatchers which seemed to be moving northward in a compact group for we hadn't seen them before nor did we see or hear them later. The Dark-grey Cuckoo-Shrike with its three descending notes, called at intervals. A flock of Scarlet Minivets flew across the valley and filled the air with their conversation. Just overhead a tiny Fire-breasted Flowerpecker rummaged about in a cluster of leaves. A pair of Crested Buntings sat on the edge of a field. For the first time we met the Magpie Robin, so very common in Pokhara, Tansen, and Kathmandu.

The road led steeply upward for a thousand feet to Marsain (4000 feet) beyond which we could see the white buildings of Tansen, seven miles distant. We had to drop down fifteen hundred feet to a stream and rice fields. In a secondary growth of jungle we came across a party of Yellowcheeked Tits, escorting leaf warblers,

Velvetfronted Nuthatches, and others. Here the Indian Sunbird gave a vivid view of his brilliant red and green breast and abdomen. A flock of Longtailed Minivets, with their mellow *tweet—tweet*, flew through the trees.

We reached the bottom of the steep descent and passed out into rice fields. Redbilled Blue Magpies sent their grating notes down from the slopes above. Then followed the *tidilly—aye—kok* of the Himalayan Tree Pie which flew above us with laboured wing-beats and drooping tails. The common Hawk-Cuckoo screamed *brain fever* in rising crescendo. A Whitebreasted Kingfisher sat at the edge of a stream, but we missed his brown-headed stork-billed cousin which we had collected here seven years before.

We still had three or four miles to go and a climb from 2500 to 4500 feet. We followed the survey route of the new motor road to run from Butwal to Pokhara. Sal forest and some pine covered the hills. We saw several uniformly grey-brown flowerpeckers and near them a party of Greenbacked Tits. A Crested Serpent Eagle screamed overhead, displaying bands of white on outstretched wings. A single Collared Bush Chat along the roadside appeared to be the darker Turkestan species. Just below Tansen the Haircrested Drongo, with its upturned tail feathers flew from one tree to another ahead of us. In and around Tansen we noted Barn Swallows, and Hodgson's Munias which buzzed off with a plaintive *tik*. A Black Vulture circled above the town in company with several Griffon Vultures. Along the path to Bussaldara where the Mission Hospital is being built, a Kestrel flew from a rock below the road and glided down to a similar vantage point. Its back seemed rather dark like that of the Himalayan race. Just then a magnificent golden-headed Bearded Vulture swiftly cut through the air, a common bird here but not farther east. Our host and hostess at the Mission Hospital were Dr. and Mrs. Carl Friedericks.

Next morning we were up early to visit old haunts in Srinagar forest behind Tansen. Much to my dismay, many of the trees had been lopped and much of the bird population had disappeared. A pair of Pine Martens (*Martes flavigula*) ranged over the hillside, also accounting for the scarcity of birds. However, I did add a dozen more species to my list. The Upland Pipit, everywhere common, called *teacher, teacher* from several directions. Numerous Tree Pipits flew from shady forest floors. Tree Sparrows had a nest in a hole of a hospital building; they had completely replaced House Sparrows. On the northern slope were both Greenfinches and Dark-grey Bush Chats. Then we heard a Spiny Babbler. It was in a small tree

across a ravine and was soon joined by another, remaining there several minutes before disappearing. The Little Blue-and-White Flycatcher sat in one of the larger trees; its white supercilium was quite distinct. Near the ridge were several Nepal Grey Tits. A Barred Owlet puffed itself out and sat silently in the early morning sunshine. Several Blackthroated Thrushes flew from wild pear trees bordering the old firing range. Nepal House Swifts careened over grassy slopes. In the last grove before we reached the hospital was a leaf warbler, greenish grey in colour with a large bill and pink lower mandible, probably *Phylloscopus magnirostris*.

Next afternoon, on the way back to Butwal, a forktail was near the stream below the road. As darkness overtook us the Jungle Owlet called, followed by the *haw-ek* of the Hawk Owl. We heard from three to five deliberate notes of a nightjar, possibly *Caprimulgus macrurus albonotus*. Along the Tinau River at Butwal came the high-pitched *chait, chait* of Franklin's Nightjar.

After a restful night we attempted to get to Bhairahwa to catch the plane to Kathmandu. It took us six hours to get twenty miles and we missed our connection. A shuttle plane took us as far as Pokhara where we had the good fortune of being stranded two days! The pilot invited us into the cockpit. It was like magic to look down on that rough, steep road we had covered three times by foot and to know you could sit back and get to Pokhara in minutes. We saw Tansen, the Kali Gandak gorges and river, and had glimpses of Annapurna up ahead.

Our impromptu stop in Pokhara, in a valley at 3000 feet and only fifteen miles south of the Annapurna Range, was most pleasant, made so by Dr. and Mrs. F. Okada of the American Museum, New York City. They introduced me to Captain Gibson, Gorkha tele-communication officer from Malaya, who accompanied me to the low ridges north of the parade ground. Some of the birds were the same as those near Tansen but there were additions. The Koels held noisy conversations throughout the valley; we hadn't heard them since we left the plains of India. Flocks of Greyheaded Mynas in large numbers reminded us of a similar distribution in central Nepal from 1000 to 3000 feet. We picked out a buzzard in a tree at the edge of rice fields. Sand Martins lined the telephone wire over open cultivation. Several Blue Rock Pigeons flew out of the Seti River gorge, while light coloured kites above us were probably *Milvus l. lineatus*. A Spiny Babbler, one of a party of two or three, called from the scrub jungle on the ridge above the rice fields and Captain Gibson watched one through the glasses. We had to turn back because of

an on-coming storm. As we did so, we heard still other Spiny Babblers at a spot a little to the west and exactly where I had collected one almost ten years before.

A brilliant dawn broke over a glorious array of snow-capped mountains next morning. The air had been washed and this was the day for pictures—but no camera! As we started out for the wooded ridge to the south of the town, bordering Phewa Tal, I could not keep my eyes off that Himalayan grandeur. En route we met numbers of old bird friends[1] but there were others which made the trip exciting. Some of the most common species around Pokhara were the Bengal Tree Pie which we hadn't seen since leaving India, the Spotted Dove, and Jungle Mynas which outnumber Common Mynas. On a wooded hillside we came upon a natural bath in a large rock, filled by the rain of the night. A pair of Eastern Redbreasted Flycatchers, a Greywinged Blackbird (the only one we saw), and tits were taking full advantage of this provision for their needs. The Large Himalayan Cuckoo-Shrike flew into a leafless tree at the top of the ridge; its loud *per-lee* indicated its presence before we could see it. The Blacknaped Woodpecker also frequented the same ridge. A Shikra swooped into a tree ahead of us and stayed several minutes, showing the vermiculated breast of an adult bird.

We looked down from the top of the ridge on to the lake below. Phewa Tal had lost about a fourth of its water but a new dam will restore it. A rest house now rose from the water's edge, recently put up for Their Majesties. We walked toward a cultivated field in the centre of which was a large, old mango tree. We were surprised to see a male Maroon Oriole in glistening plumage. There was a commotion to our left; four Haircrested Drongos pursued a fifth into a tree. In the next few minutes we counted six others. Beyond the field a Black Partridge sent out his *chuck—pān, biri, cigarette*! Back down in the fields we saw a pair of Whitenecked Storks in deliberate flight towards town. Along one of the streets a European Cuckoo sent his familiar call from the top of a bare tree. Then on one of the wide, shaded avenues I had a real surprise. There was a Redthroated Thrush which I had never seen before, hopping around on the ground in front of me. It looked and acted just like its black-throated cousin. After a few minutes it flew up into a tree.

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[1]Dr. O'Hanlon and we watched a pair of Barn Swallows feeding their four young in the rafters of a house at the Mission Hospital. First one fledgling, more hungry than the others, pushed forward and received food four or five times in succession. Then it slumped back into the nest for a rest while the next one monopolized the feeding for several minutes. The second gave place to the third, and so on.

That evening we went back to the place on the terraced hillside north of the parade ground where we had heard the second group of Spiny Babblers. Ten years before the hillside was covered with scrub jungle, but now there was nothing left except a small tree or two and a tangle of brush and ferns around a neglected spring—a place now quite easy to find. A Crimsonbreasted Barbet flew on outspread wings out of a neighbouring pipal tree, after flying ants. Meanwhile two or three Spiny Babblers were carrying on an animated conversation just ahead of us. One came out of the tangle near the ground toward me but soon darted back to shelter. Another one flew out the far side of this patch. One, however, mounted a small bush and put on a full concert: *There, chir, chir; we we*, then with rising notes, *right here, right here, right here* followed by a loud *tee-ter, tee-ter, teeter, tee-ter, tee-ter, tee-ter*, the second syllable two notes below the initial one. There followed several mimic calls like *pwink* of a bulbul and *chip, chip* of a Blackthroated Thrush. Again a loud series of *tee-ters*, a descending *pookil, pookil, pookil* augmented with a *chupu, chupu*, then fresh introductory gurgles, the *tee-ter* refrain concluding with more gurgles and trills. When disturbed it gave a low *chur-r-r-r*. By now it was almost dark.

The following day we had a long wait at the airport so we visited the Mission Leprosarium near by. We crossed the Seti River to get there. A pair of Neophrons had a nest in the gorge. They would fly on to the ground some distance away, then come wheeling back with something in their beaks. One after the other they would disappear into the wall crevice, come out about twenty seconds later, and be off again.

Several kestrels also flew about this spot, possibly the paler European bird. When we returned a couple of hours later we could only see one. It was perched on an overhanging branch eating a snake. It worked away for about ten minutes, then picked up the long tail and tried to swallow it whole. The tail stuck in its throat so the falcon placed the tail of the snake between its talons and pulled at it for several more minutes. Again the bird tried to swallow the lot with same result. A third try—no luck. Finally the kestrel gathered the morsel, flew to a rock, placed it behind a projection and glided away. The reptile may have been a keelback (*Natrix*). Back to the airport the plane finally came from Dang and we reached Kathmandu at dusk after a memorable visit again to Tansen and Pokhara.

BIRD LIST FOR TANSEN-POKHARA, 1959

Indian Pond Heron. *Ardeola grayii* (Sykes).
Cattle Egret. *Bubulcus ibis coromandus* (Boddaert).
Eastern Large Egret. *Egretta alba modesta* (Gray).
Intermediate Egret. *Egretta intermedia* (Wagler).
Whitenecked Stork. *Dissoura episcopus episcopus* (Boddaert).
Smaller Adjutant Stork. *Leptoptilos javanicus* (Horsfield).
Blackwinged Kite. *Elanus caeruleus vociferus* (Latham).
Pariah Kite. *Milvus migrans govinda* Sykes.
Large Indian Kite. *Milvus lineatus lineatus* (J. E. Gray).
Shikra. *Accipiter badius dussumieri* (Temminck).
Japanese Desert Buzzard. *Buteo buteo burmanicus* Hume.
White-eyed Buzzard. *Butastur teesa* (Franklin).
Black Vulture. *Sarcogyps calvus* (Scopoli).
Himalayan Griffon. *Gyps himalayensis* Hume.
Indian Whitebacked Vulture. *Pseudogyps bengalensis* (Gmelin).
Bearded Vulture. *Gypaetus barbatus L.*
Indian Crested Serpent Eagle. *Spilornis cheela cheela* (Latham).
European Kestrel. *Falco tinnunculus tinnunculus* L.
Himalayan Kestrel. *Falco tinnunculus interstinctus* Horsfield.
Black Partridge. *Francolinus francolinus asiae* Bonaparte.
Northern Grey Partridge. *Francolinus pondicerianus interpositus* Hartert.
ndian Sarus Crane. *Grus antigone antigone* (Linnaeus).
Redwattled Lapwing. *Lobivanellus indicus indicus* (Boddaert).
Common Sandpiper. *Actitis hypoleucos* L.
Thickbilled Green Pigeon. *Treron curvirostra nipalensis* (Hodgson)
Indian Blue Rock Pigeon. *Columba livia intermedia* Strickland.
Indian Spotted Dove. *Streptopelia chinensis suratensis* (Gmelin).
Indian Red Turtle-Dove. *Oenopopelia tranquebarica humilis* (Temminck).
Eastern Roseringed Parakeet. *Psittacula krameri borealis* (Neumann).
Common Hawk Cuckoo. *Cuculus varius* Vahl.
European Cuckoo. *Cuculus canorus* L.
Koel. *Eudynamys scolopacea scolopacea* (L.)
Jungle Owlet. *Glaucidium radiatum radiatum* (Tickell).
Western Himalayan Barred Owlet. *Glaucidium cuculoides cuculoides* (Vigors).
Indian Brown Hawk-Owl. *Ninox scutulata lugubris* (Tickell).
Long-tailed Nightjar. *Caprimulgus macrurus albonotus* Tickell.
Franklin's Nightjar. *Caprimulgus affinis monticolus* Franklin.
Pied Kingfisher. *Ceryle rudis leucomelanura* Reichenbach.
Common Kingfisher. *Alcedo atthis bengalensis* Gmelin.
Whitebreasted Kingfisher. *Halcyon smyrnensis smyrnensis* (L.)
Indian Roller. *Coracias benghalensis benghalensis* (L.)
Indian Hoopoe. *Upupa epops orientalis* Stuart Baker.
Green Bee-eater. *Merops orientalis orientalis* Latham.
Assam Great Barbet. *Megalaima virens magnifica* Baker.
Goldenthroated Barbet. *Megalaima franklinii franklinii* (Blyth).
Bluethroated Barbet. *Megalaima asiatica asiatica* (Latham).
Crimsonbreasted Barbet. *Megalaima haemacephala indica* (Latham).
Blacknaped Woodpecker. *Picus canus sanguiniceps/gyldenstolpei.*
North Indian Pigmy Woodpecker. *Dendrocopos moluccensis nanus* (Vigors).
Ashycrowned Finch-Lark. *Eremopterix grisea* (Scopoli).
Common Swallow. *Hirundo rustica rustica* L.

Hodgson's Striated Swallow. *Hirundo daurica nipalensis* Hodgson.
Indian Sand Martin. *Riparia paludicola chinensis* (Gray).
Indian Wiretailed Swallow. *Hirundo smithii filifera* Stephens.
Scarlet Minivet. *Pericrocotus flammeus speciosus* (Latham).
Western Longtailed Minivet. *Pericrocotus ethologus favillaceus* Bangs & Philips.
Brownbacked Pied Shrike. *Hemipus picatus capitalis* (McClelland).
Dark Grey Cuckoo-Shrike. *Coracina melachistos melachistos* (Hodgson).
Large Himalayan Cuckoo-Shrike. *Coracina novaehollandiae nipalensis* (Hodgson).
Black Drongo. *Dicrurus macrocercus albirictus* (Hodgson).
Bronzed Drongo. *Dicrurus aeneus aeneus* Vieillot.
Haircrested Drongo. *Dicrurus hottentotus hottentotus* (L.)
Maroon Oriole. *Oriolus trailii traillii* (Vigors).
? Himalayan Jungle Crow. *Corvus macrorhynchos intermedius* Adams.
? Indian Jungle Crow. *Corvus coronoides levaillanti* Lesson.
Indian House Crow. *Corvus splendens splendens* Vieillot.
Redbilled Blue Magpie. *Kitta erythrorhyncha occipitalis* (Blyth).
Bengal Tree Pie. *Crypsirina vagabunda vagabunda* Latham.
Himalayan Tree Pie. *Crypsirina formosae himalayensis* (Blyth).
Nepal Grey Tit. *Parus major nepalensis* Hodgson.
Greenbacked Tit. *Parus monticola lepcharum* Meinertzhagen.
Yellowcheeked Tit. *Parus xanthogenys xanthogenys* Vigors.
Chestnutbellied Nuthatch. *Sitta europaea almorae* Kinnear & Whistler.
Velvetfronted Nuthatch. *Sitta frontalis frontalis* Swainson.
Hodgson's Rustycheeked Scimitar Babbler. *Pomatorhinus erythrogenys ferrugilatus* Hodgson.
Redbilled Babbler. *Stachyris pyrrhops* Blyth.
Yellowbreasted Babbler. *Macronous gularis rubricapilla* (Tickell).
Spiny Babbler. *Turdoides nipalensis* (Hodgson).
The Common Babbler. *Argya caudata caudata* (Dumont).
Whitethroated Laughing Thrush. *Garrulax albogularis albogularis* (Gould).
Whitecrested Laughing Thrush. *Garrulax leucolophus leucolophus* (Hardwicke).
Nepal Streaked Laughing Thrush. *Garrulax lineatus lineatus* (Vigors).
Orangebellied Chloropsis. *Chloropsis hardwickii hardwickii* Jardine & Selby.
Blackheaded Yellow Bulbul. *Pycnonotus flaviventris flaviventris* (Tickell).
Whitecheeked Bulbul. *Pycnonotus leucogenys leucogenys* (Gray).
Bengal Redvented Bulbul. *Pycnonotus cafer bengalensis* Blyth.
Browneared Bulbul. *Microscelis flavalus flavalus* (Hodgson).
Magpie Robin. *Copsychus saularis saularis* (L.).
Indian Shama. *Copsychus malabaricus indicus* (Stuart Baker).
Whitecapped Redstart. *Phoenicurus leucocephalus* Vigors.
Plumbeous Redstart. *Phoenicurus fuliginosus fuliginosus* Vigors.
Greybacked Forktail. *Enicurus schistaceus* (Hodgson).
Indian Bush Chat. *Saxicola torquata indica* (Blyth).
Turkestan Bush Chat. *Saxicola torquata przewalskii* (Pleske).
Western Dark Bush Chat. *Saxicola ferrea* Gray.
Brownbacked Indian Robin. *Saxicoloides fulicata cambaiensis* (Latham).
Himalayan Whistling Thrush. *Myiophoneus caeruleus temminckii* Vigors.
Greywinged Blackbird. *Turdus boulboul* (Latham).
Blackthroated Thrush. *Turdus ruficollis atrogularis* Temminck.
Redthroated Thrush. *Turdus ruficollis* Pallas.
Blackbrowed Flycatcher-Warbler. *Seicercus burkii burkii* (Burton).
Greyheaded Flycatcher-Warbler. *Seicercus xanthoschistos xanthoschistos* (Gray).
Green Leaf Warbler. *Phylloscopus inornatus humei* (Brooks).

Himalayan Leaf Warbler. *Phylloscopus proregulus chloronotus* (Gray).
? Largebilled Leaf Warbler. *Phylloscopus magnirostris* Blyth.
Crowned Leaf Warbler. *Phylloscopus reguloides reguloides* (Blyth).
Burmese Tailor Bird. *Orthotomus sutorius patia* Hodgson.
Beavan's Wren-Warbler. *Prinia hodgsonii rufula* Godwin-Austen.
Eastern Redbreasted Flycatcher. *Ficedula parva albicilla* (Pallas).
Verditer Flycatcher. *Muscicapa thalassina thalassina* Swainson.
Greyheaded Flycatcher. *Culicicapa ceylonensis calochrysea* Oberholser.
Whitebrowed Fantail Flycatcher. *Rhipidura aureola aureola* Lesson.
Indian White Wagtail. *Motacilla alba dukhunensis* Sykes.
Northern Tree Pipit. *Anthus hodgsoni yunnanensis* (Uchida & Kuroda).
Indian Pipit. *Anthus richardi rufulus* Vieillot.
Upland Pipit. *Oreocorys sylvanus* (Blyth).
Blackheaded Shrike. *Lanius schach tricolor* (Hodgson).
Indian Grackle. *Gracula religiosa intermedia* Hay.
Greyheaded Myna. *Sturnus malabaricus malabaricus* (Gmelin).
Pied Myna. *Sturnus contra contra* L.
Common Myna. *Acridotheres tristis tristis* (L.).
Jungle Myna. *Acridotheres grandis fuscus* (Wagler).
Bank Myna. *Acridotheres ginginianus* (Latham).
Purple Sunbird. *Nectarinia asiatica asiatica* (Latham).
Black-breasted Sunbird. *Aethopyga saturata saturata* (Hodgson).
Indian Scarletbacked Sunbird. *Aethopyga siparaja seheriae* (Tickell).
Tickell's Flowerpecker. *Dicaeum erythrorhynchum erythrorhynchum* (Latham).
Firebreasted Flowerpecker. *Dicaeum ignipectus ignipectus* (Blyth).
Indian White-eye. *Zosterops palpebrosa palpebrosa* (Temminck).
House Sparrow. *Passer domesticus indicus* (Jardine & Selby).
Tree Sparrow. *Passer montanus malaccensis* Dubois.
Yellowthroated Sparrow. *Gymnorhis xanthocollis xanthocollis* (Burton).
Hodgson's Munia. *Lonchura striata acuticauda* (Hodgson).
Greenfinch. *Carduelis spinoides spinoides* Vigors.
Crested Bunting. *Melophus lathami* (Gray).

(The subspecific designations are based on material previously collected and identified. Nomenclature from *Birds from Nepal*, Rand and Fleming, 1957 and THE BIRDS OF BURMA, Smythies, 1953).

Albinism and Partial Albinism in Tigers

BY

E. P. GEE

(*With a plate*)

By kind permission of the Maharaja of Rewa, I was recently able to visit and photograph the famous white tigers which are in captivity in that former princely State. A white tiger, which had been captured as a cub in the jungles of Rewa, had been mated with a normal-coloured tigress which was its own offspring as the result of a previous litter by an ordinary tigress. This experiment of inbreeding had produced four white cubs which appeared to be identical in coloration with the father, and a striking contrast to the mother.

Before proceeding to give the details of this unique event, it would perhaps be advisable to explain that the terms 'albino' and 'white' are often rather loosely used in reference to light-coloured tigers in India. Varying degrees of 'whiteness' are to be found, from light-coloured specimens with dark brown stripes (sometimes known as 'red' tigers), and cream-coloured ones with dark brown or dark grey stripes, to the Rewa type which have ashy-grey stripes on an almost white background.

Incidentally, when examining tiger skins caution must always be exercised due to the fact that, after lapse of time and exposure to light, all normal-coloured tiger skins fade from their true colour to a cream background with dark brown stripes. Only freshly-cured skins, or those which have been carefully and correctly preserved, can be accepted as giving an accurate picture of what the live animal looked like.

Nearly all the lighter-coloured 'white' tigers which are often described as 'albinos' are only partial albino, for to be a true albino a specimen must have white hair (or feathers in the case of a bird) with no pigmentation, and pink eyes with no pigment in the iris.

As far as I can ascertain, there has only been one case of true albinism in tigers. This was in 1922 in the former state of Cooch Behar in north-east India, reported in a Miscellaneous Note in the *Journal of the Bombay Natural History Society* [**28** (4) : 1124] by Victor N. Narayan. He wrote: 'We sent our head Jemadar to

reconnoitre and he came face to face with 4 tigers, 2 of which he reported as being of a very light colour. Three days later we shot 4 tigers out of the same jungle . . . We thought we had bagged all the tigers, but on examination found that two were full-grown cubs, and two about three-quarters grown. The two full-grown cubs, were of the ordinary colour and markings of a tiger, 1 male and 1 female. Measurements about 6'-6". The three-quarters grown cubs, were unique and to me seemed pure albinos. They had pink eyes and were evidently in very bad condition because before being shot at they only trotted along like big dogs, whilst the other two galloped hard. Another peculiarity was the long neck, quite unlike that of any other tiger or leopard I have ever seen; one was a male and one a female. As it was dark we could not beat any more but two days later got the mother, a fine beast in the prime of life and condition. Measurement 8'-9". I forgot to mention the measurement of the freaks viz. 6'-0". Such beasts have never been known of, or seen here, nor during the many shooting excursions my father (the late Maharaja Uripendra of Cooch Behar) made into Assam.'

Whereas there is some doubt as to whether black tigers or white leopards have ever existed, black leopards are commonly found in the wetter regions of south and north-east India and in other parts of south-east Asia. It would be expected that white tigers would be found only in the drier regions, but in fact they are found also in Assam which has a high rainfall with very thick forests, as well as in a large area of central India which is now in the re-organized States of Madhya Pradesh and Bihar. This area includes the Bilaspur and Mandla districts of the old Central Provinces, and old Rewa State, and parts of Bihar.

Cases of white tigers, which have not been true albinos and which appear to have been of varying degrees of creaminess and whiteness, are many. Richard Lydekker in THE ROYAL NATURAL HISTORY records that 'a white tiger, in which the fur was of a creamy tint, with the usual stripes faintly visible in certain parts, was exhibited at the old menagerie at Exeter Change about the year 1820'. A record of a white tiger from Poona was published in the *Proceedings of the Zoological Society of London* in 1891.

Messrs. Rowland Ward in their RECORDS OF BIG GAME record a number of white tigers shot in India, of which one was shot in Rewa State and presented by the Maharaja to King George V, and is now in the Natural History Museum in South Kensington, London. A male white tiger from the Lechuar Jungles of Bihar is exhibited in the

The white tiger in the courtyard of the palace. A large and fine beast.

The normal-coloured mother with her four white cubs, in a separate courtyard.

Photos : E. P. Gee

Indian Museum, Calcutta, of which the ground colour is cream, stripes light brown, and (glass) eyes normal-coloured.

The Bombay Natural History Society recorded no less than seventeen cases of white tigers shot in India between the years 1907 and 1933. One of these was shot in the Dhenkanal State, Orissa, in 1909 and was described as follows: 'The ground colour was pure white and the stripes were of a deep reddish black colour' [*JBNHS* **19** (3)]. Another was shot in the Bilaspur District of the then C.P. in 1910 and is described in the *Journal* [**24** (4)] as 'cream coloured throughout but paler on the head and the stripes were chocolate brown'. Another was shot in the district of Bhagalpur in Bihar, and was described [*JBNHS* **32** (3)] as: 'pure white with black stripes on her body and russet brown ones on the tail. The taxidermists to whom the trophy was sent report that during the year 1926 they received three white tiger skins including mine (mine was shot on December 6, 1926), but my skin is the only pure white one, the other two being cream coloured.' As recently as 1958 a white tiger was shot near Hazaribagh in Bihar, and the skin was on view at a Calcutta taxidermist's.

A number of white tigers have from time to time been reported from Assam. In March 1889 one was shot in upper Assam and is recorded by Lydekker. Lt.-Col. F. T. Pollok in his book WILD SPORTS OF BURMAH AND ASSAM published in 1879 wrote: 'Mr. Shadwell, Assistant Commissioner in the Cossyah and Jyntiah Hills, also had two skins quite white, but when turned about in a strong light just a faint mark or two could be seen to indicate that they belonged to a tiger at all . . .'. Boga-bagh Tea Estate in upper Assam is so called from the two white tigers found there at the beginning of this century, and one of them had 'a lemon-coloured patch on the back of the neck, otherwise it was white with faint stripes'. The two light-coloured tigers shot by W. G. Forbes of Hathikuli Tea Estate in 1929 were described at the time of curing by Messrs. Van Ingen as 'red tigers'.

Now back to the Rewa white tigers. There have been eight cases of a white tiger in this old State during the last 50 years, during which time diaries have been kept at the palace. These include a two-year-old male captured near Sohagpur in December 1915 and kept for some years in captivity. H. E. Scott of the Indian Police saw this animal five years later (December 1920) and described it in a Miscellaneous Note in the *Journal* [**27** (4)] as follows: '*Body colour:* pure white. No cream colour was visible. *Stripes:* indistinct or light black: while some of the stripes, particularly the face markings, are quite black, the majority are ash-coloured owing to white hairs being

mixed with the black. *Nose:* mottled grey-pink (instead of pure pink as in normal tigers). *Lips:* grey-black on hair line but quickly merge to pink (instead of being quite black and gradually merging to pink well inside the mouth as in normal tigers). *Eyes:* the colourings of the eyes are very indistinct. There is no well-defined division between the yellow of the comex and the blue of the iris. The eyes in some lights are practically colourless, merely showing the black pupil on a light yellow background. *Eyelids:* pinkish-black. *Ears:* practically normal in colour and markings. The ground black is however slightly ashy. *General description:* the tiger is of course underdeveloped owing to years of captivity, but in height he is probably slightly above normal and in a wild state would undoubtedly have been an exceptionally large animal.'

The former Maharaja of Rewa shot a white tigress in 1937. In 1946 a white tigress was shot by the Administrator and when skinned was said to have been found to have six unborn cubs—described as white, but I believe this was not substantiated. The present Maharaja shot a white tiger in 1947—the last one to be shot in this area. At this stage I must record my gratitude to Shri Arimardan Singh, Private Secretary to the Maharaja of Rewa, who not only personally conducted me to see the tigers but also gave me much valuable information about their history and so on.

The white tiger now in captivity in the old disused summer palace at Govindgarh, twelve miles from Rewa town, was captured on May 27, 1951 when it was believed to be about nine months of age. A tigress and four cubs came out in a beat. The mother and three cubs were shot, while the fourth cub which was white and bigger and stronger than the others was later captured in a cage with water placed in it (in a dry place at the dry time of the year). Since then no more reports of a white tiger have been received in the area which used to be Rewa State. On February 27, 1952, a normal-coloured tigress was captured in this area and was kept with the white tiger. Two male normal-coloured cubs were born on September 7, 1953, and of these one was given to Bombay and the other went to a Calcutta dealer.

The second litter of four normal-coloured cubs was born on April 10, 1955, consisting of two males and two females. A male and a female cub of this litter went to a Calcutta dealer, and one male cub was given to the Ahmedabad Zoo—where it still is. A female cub was kept at Rewa (now the mother of the litter of four white cubs). A third litter was born to the white tiger and the normal-coloured tigress on July 10, 1956. Of the four cubs one died on

the first day. Two female cubs were presented to the President and the Prime Minister of India, and went to the Zoological Park in New Delhi. A male cub along with its mother was given to the Ahmedabad Zoo. Ever since then the female cub of the second litter was kept with the white tiger, its father.

On October 30, 1958, the present litter of four white cubs was born, consisting of three females and one male. One cub was weak, but the mother looked after it very well and suckled it first in a corner before feeding the others, and soon this cub became as strong as the others. When I saw the family on April 13 the cubs were said to be fully weaned, and I saw them feeding on pieces of meat. I spent two busy hours in trying to photograph the family, both in colour and in black-and-white, and had little opportunity of closely observing or noting down the exact details of their coloration.

But generally speaking the tiger appeared to be an exceptionally large and powerful beast, with a fine coat and ruff, with ground colour of almost pure white or off-white. There seemed to be no trace of brown, lemon, or even cream colour. The stripes were ash-coloured. The eyes appeared to be icy-blue, and the pads of the paws pink. It behaved in a manner which one would have expected from a typical tiger—it crouched in the shade at the far end of its courtyard and glared at its human visitors as they stood on a safe balcony above. Then it rose, advanced with dignity, and then charged with a shattering roar across the sunlit courtyard. Then it strode back to the furthest shady corner. This demonstration was repeated several times—a spectacular and most impressive sight.

In an adjoining courtyard the normal-coloured tigress and her four white cubs were playing. The cubs appeared to be exact replicas of the father, and therefore need no description. All appeared to be in perfect health, and a striking contrast to their richly-coloured mother. All five animals behaved as would be expected of tame animals in a zoo.

The history of the breeding of these four white cubs poses some interesting problems of genetics. I am personally not competent to express an opinion on this point, but I have found that my Siamese cat when crossed with her own 'tabby-coloured' son (she had mated with a non-Siamese 'tabby-coloured' cat near by produced pure-looking Siamese kittens. Also there is the case of the famous white bull American bison named Big Medicine of the Moiese National Bison Range in the U.S.A.: when crossed back with its own normal-coloured mother, the latter produced a white offspring which was a pure albino with pink eyes and even white hooves.

According to some notes made by me some years ago from a scientific work by Professor J. B. S. Haldane, one of the world's leading geneticists, albino mated with albino produces albinos, while albino crossed with normal almost always produces 'normals' to look at. (I am using inverted commas to distinguish between the different types of normal offspring.) But such a 'normal' crossed with a similar 'normal' would produce $\frac{1}{4}$ albinos and $\frac{3}{4}$ "normals", and "normal" crossed with "normal" would also produce $\frac{1}{4}$ albino and $\frac{3}{4}$ "normals". (Other possibilities of crossing are: 'normal' with normal, "normal" with normal, "normal" with 'normal', and albino with "normal".)

In the case of the Rewa white cubs now under review, this has been the result of crossing an albino (if we use the term loosely: more correctly it is a partial albino) with 'normal'. It would be interesting to see if the same crossing repeated would again produce a complete litter of white cubs, for Professor Haldane in a letter to me recently has expressed the opinion that we are dealing with a 'recessive mutant' and that whiteness being presumed to be a recessive character one would expect equal numbers of white and normal-coloured ("normal") cubs from such a mating between the white tiger and its normal-coloured ('normal') daughter. He considers (provisionally) that the chance of getting a 'run' of four white cubs was 1/16, like getting four tails running on spinning a coin. More information on the family history of the Rewa white tiger and its various offspring is required before a complete study of the case can be made.

The white tigers of Rewa and adjacent districts appear to have usually been of great size in their wild state, and the present captive Rewa tiger certainly is a large beast. A number of sportsmen and naturalists have from time to time wondered if there existed a separate breed or variety of white tiger in the forests, and whether a wild white tiger would prefer a white mate to a normal-coloured one. Possibly this will never be decided now, owing to the decline in their numbers—no white tigers have been heard of in old Rewa State since 1951.

But now at the Govindgarh palace zoo history appears to have been made, and a distinct breed of white tigers has begun to be established. It should not be difficult now for the white tiger to be again crossed with his normal-coloured ('normal') daughter and more white cubs to be produced; and when the present four white cubs grow up, one hundred per cent white cubs should definitely result

from a crossing between the females and the male, or between the father (also grandfather) and the female cubs.

Caution would have to be exercised against overdoing this kind of inbreeding, although it does seem to take place in the wild state without too much deterioration of stock. The 'normal' and "normal" normal-coloured cubs of the family could also be used in a scientifically planned and properly managed breeding programme.

Such a white breed of tiger, if firmly established in India, would give this country a considerable amount of prestige in the zoological world, as well as provide a fillip for tourism and at a later date a possible economically valuable item of export to foreign countries.

[A few words of explanation may bring out the genetical significance of the case. The white male tiger captured in 1951 genetically carries the double recessive mutant for white (nn). The normal tigress with which it was first mated carried the double dominant for normal colour (NN). The offspring of a cross between nn ♂ × NN ♀ will always be normal-coloured but genetically heterozygous, i.e. will be Nn.

Theoretically a cross between the old white tiger (nn) and a heterozygous normal-coloured female (Nn) may give rise to 50% Nn, normal-coloured heterozygous, and 50% nn, white coloured homozygous. The latter carries factors nn only, and generally speaking any cross between the old white tiger (nn) or any white ♂ descendant and a ♀ white tigress (nn) will only produce white offspring. The white race of tiger may thus become permanently established; however the possibility of a reversion to normal colouring through mutation is not to be discounted.—EDS.]

A brief account of the Flora of Visnagar, N. Gujarat, and its environs

BY

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INTRODUCTION

The importance of flora work has often been stressed, and with the establishment of the Botanical Survey of India it has assumed national importance.

The FLORA OF BOMBAY PRESIDENCY was published by Cooke (1901-08) more than fifty years ago. E. Blatter and C. McCann (1926-34), Saxton and Sedgwick (1918-22) have done considerable work on the 'Bombay Grasses' and on the 'Flora of North Gujarat' respectively. Recently Father H. Santapau (1945) has contributed enormously by his detailed and painstaking work on 'Flora of Khandala', 'Flora of Gir and Dang Forest'. Phatak and Joshi (1955) have to their credit an account of the 'Flora of the University Campus', Baroda.

It was with an idea of advancing the knowledge of the vegetation of Gujarat and thereby helping to build the flora of India that the present work was undertaken.

TOPOGRAPHY

Visnagar is a Taluka in the Mehasana District of north Gujarat. It is 56 miles north of Ahmedabad on the Ahmedabad-Taranga Hill railway line. It is situated on 72° 42′ E. and 23° 42′ N. The general climatic conditions are similar to those of semi-desert areas. The average rainfall is 15″ to 30″; the temperature Max. 117°F. and Min. 48°F. The soil salinity, though present in excess in a few patches of the land, is much lower than that of the semi-desert areas. The general texture of the soil is sandy, though the percentage of clay present is much higher than in the sandy semi-desert areas. The Visnagar taluka is especially rich in sub-soil water. There is sufficient well irrigation, and hence in winter and summer the climate is comparatively more humid.

COLLECTIONS

As a first step the vegetation in the area within a radius of two miles surrounding the M.N. College, Visnagar, was studied. This served as a background for a more thorough exploration of Visnagar and other

talukas near about. Some plants are from Varetta and Balaram, the collections of which were made on botanical excursions, when the author was attached to M.N. College, Visnagar. In all 215 plants have been collected and described from about 62 families.

RANUNCULACEAE

1. **Clematis gouriana** Roxb. (Morvel).

Hab. An extensive climber with grooved stem. *Fl.* (Oct.-Dec.) Yellowish white. *Loc.* Wild near Hanuman temple.

ANONACEAE

2. **Polyalthia longifolia** Bth. & Hk.f. (Asopalav).

Hab. A tall handsome tree. *Fl.* (Mar.-May) Yellowish green. *Loc.* College garden.

3. **Anona squamosa** L. (Sitaphal).

Hab. Shrubby plants to small trees. *Fl.* Noted in leaf only. *Loc.* Botanical Garden.

MENISPERMACEAE

4. **Tinospora cordifolia** Miers (Galo).

Hab. An extensive climber with corky grooved bark and adventitious aerial roots. *Fl.* (Apr.-May) Yellowish green. *Loc.* On hedges. Common.

5. **Cocculus villosus** DC. (Vevadi).

Hab. A straggling scandent twiner with soft hairs covering the leaves. *Fl.* (Dec.-Jan.) Small, green. *Loc.* On hedges. Common.

NYMPHAEACEAE

6. **Nymphaea lotus** L. (Poyna).[1]

Hab. Rhizome stout, horizontal with floating leaves. *Fl.* White. *Loc.* Along railway lines. Vadnagar.

7. **Nelumbium speciosum** Willd. (Kamal, Padmakamal).

Hab. Large aquatic herb, with creeping stems. *Fl.* White or rosy. *Loc.* Vadnagar.

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[1] The real *N. lotus* L. is an Egyptian plant, not found wild in India. What this plant may be we are unable to tell without actual specimens at our disposal.—EDS.

PAPAVERACEAE

8. **Argemone mexicana** L. (Darudi).

Hab. A prickly herb with spreading branches. *Fl.* (Dec.-Feb.) Yellow. *Loc.* Common in waste places.

CAPPARIDACEAE

9. **Gynandropsis pentaphylla** DC. (Thanamani).

Hab. Annual, erect branched hairy herb. *Fl.* (Jul.-Sept.) White or pale pink. *Loc.* Growing wild in waste places.

10. **Capparis aphylla** Roth (Kerandu).

Hab. A straggling glabrous herb. *Fl.* (Nov.-Mar.) Reddish brown. *Loc.* Common, grows wild.

11. **Capparis sepiaria** L. (Kanther).

Hab. A much branched, woody climber. *Fl.* (Feb.-May) White. *Loc.* Common as a hedge.

12. **Cadaba indica** Lane. (Khordu).

Hab. A straggling, much branched shrub. *Fl.* (Nov.-Mar.) Greenish white. *Loc.* Along the border of fields.

PORTULACACEAE

13. **Portulaca oleracea** L. (Ghol).

Hab. An annual succulent, prostrate herb. *Fl.* (Sept.-Dec.) Yellow. *Loc.* Wild on ground in moist places.

14. **Portulaca grandiflora** Lam.

Hab. A small, hairy herb with fleshy leaves. *Fl.* (May-Jul.) Red. *Loc.* Botanical Garden.

MALVACEAE

15. **Sida veronicifolia** Lam. (Bhoybala).

Hab. A perennial, much branched prostrate herb. *Fl.* (Oct.-Nov.) Yellow. *Loc.* College grounds.

16. **Abutilon indicum** Sweet. (Kansaki).

Hab. A small shrub, hairy. *Fl.* All the year, yellow. *Loc.* Wild in Bot. Garden.

17. **Hibiscus rosa-sinensis** L. (Jasud).

Hab. A garden plant known for its conspicuous red flowers.

18. **Hibiscus schizopetalous** L. (Latkanjasud).
Hab. A garden plant with pendulous flowers; petals divided.

19. **Thespesia populnea** Soland. (Parasbhendi).
Hab. A small tree. *Fl.* (Oct.-Jan.) Yellow with purple base, and black centre. *Loc.* Bot. Garden.

BOMBACACEAE

20. **Adansonia digitata** L. (Choramlo).
Hab. Noted as a small tree. *Fl.* Not flowering. *Loc.* Bot. Garden.

21. **Bombax malabaricum** DC. (Ratoshimlo).
Hab. Noted as a small tree, not flowering. *Loc.* Bot. Garden.

STERCULIACEAE

22. **Guazuma tomentosa** H.B. & K. (Badok).
Hab. A small tree. *Fl.* (Aug.-Sept.) Yellow, fragrant. *Loc.* Bot. Garden.

TILIACEAE

23. **Grewia asiatics** L. (Phalsa).
Hab. A small tree, young parts hairy. *Fl.* (Mar.-Apr.) Yellow. *Loc.* Bot. Garden.

24. **Corchorus trilocularis** L. (Kadavi chenchadi).
Hab. Annual hairy herb. *Fl.* (Sept.) Yellow. *Loc.* In fields, common.

ZYGOPHYLLACEAE

25. **Tribulus terrestris** L. (Gokru).
Hab. Branching prostrate herb, usually silky. *Fl.* (Sept.-Dec.) On pseudoaxillary peduncles. *Loc.* College grounds.

RUTACEAE

26. **Murraya koenigii** Spreng. (Mitolimdo).
Hab. Noted as a small tree not flowering. *Loc.* Bot. Garden.

27. **Citrus medica** var. **limonum**. (Pahadilimdo).
Hab. A small tree. *Fl.* (Aug.-Oct.) White. *Loc.* Bot. Garden.

28. **Feronia elephantum** Corr. (Kotu).

Hab. A big tree armed with spines. *Fl.* (Mar.-May) Dull red. *Loc.* Bot. Garden.

29. **Aegle marmelos** Corr. (Bel).

Hab. A small thorny tree. *Fl.* (Apr.-May) Greenish white. *Loc.* Along roadsides and Bot. Garden.

Simarubaceae

30. **Ailantus excelsa** Roxb. (Arduso).

Hab. Lofty trees with glandular hairy leaves. *Fl.* (Dec.-Mar.) Small, polygamous. *Loc.* Common. Near fields.

31. **Balanites roxburghii** Planch (Shnoria).

Hab. A small tree, branches ending in very strong sharp ascending spines. *Fl.* Green in small axillary cymes. *Loc.* Bot. Garden.

Meliaceae

32. **Melia azedarach** L. (Bakan limdo).

Hab. Medium-sized tree. *Fl.* (Apr.-May) Lilac. *Loc.* Common. Along roadsides.

33. **Azadirachta indica** A. Juss. (Limdo).

Hab. A large tree. *Fl.* (Mar.-May) White. *Loc.* Common. Everywhere.

Celastraceae

34. **Gymnosporia marginata** Roth

Hab. A shrub with stout zig-zag branches profusely armed with spines. *Fl.* (Aug.-Jan.) White with reddish tinge and in fascicles. *Loc.* Along railway lines.

Rhamnaceae

35. **Zizyphus jujuba** Lamk. (Bor).

Hab. A small thorny tree. *Fl.* (Sept.-Oct.) Greenish yellow. *Loc.* Common in Visnagar. Wild in Balaram.

36. **Zizyphus lotus** Lamk. (Khareki bor).

Hab. A small thorny tree. *Fl.* (Sept.-Oct.) Greenish-yellow. *Loc.* Vadnagar.

37. **Zizyphus rotundifolia** Lamk. (Chanibor).

Hab. A small much branched shrub, armed. *Fl.* (Sept.) Small, greenish. *Loc.* Balaram. Wild.

38. **Zizyphus oenoplia** Mill. (Burgi).

Hab. A small thorny shrub. *Fl.* (Sept.) Green. *Loc.* College road.

VITACEAE

39. **Vitis quadrangularis** Wall. (Had sankal).

Hab. Stem winged, climbing by tendrils. *Fl.* (July) Green. *Loc.* Bot. Garden.

40. **Vitis repanda** Wt. & Arn. (Gandovelo).

Hab. Stems hairy, woody. *Fl.* (Mar.-Apr.) Greenish. *Loc.* In fields.

41. **Vitis trifolia** L. (Ratakhat katumbo.)

Hab. Stem fleshy, hairy. *Fl.* (Aug.-Sept.) *Loc.* Fields, hedges. Common.

SAPINDACEAE

42. **Cardiospermum halicacabum** L. (Karoliyo).

Hab. Annual and perennial, slender delicate climber. *Fl.* (Sept.-Dec.) White. *Loc.* Common on hedges in Bot. Garden.

43. **Sapindus laurifolius** Vahl. (Arita).

Hab. A tree. *Fl.* (Oct.-Dec.) Dull white. *Loc.* Bot. Garden.

44. **Dodonaea viscosa.** L. (Jakmi).

Hab. A shrub. *Fl.* (Jan.-Feb.) Greenish yellow. *Loc.* As a hedge in College garden.

ANACARDIACEAE

45. **Mangifera indica** L. (Ambo).

Hab. A large tree. *Fl.* (Jan.-Feb.) Orange coloured, odorous. *Loc.* Field near railway station.

46. **Anacardium occidentale** L. (Kaju).

Hab. A small crooked tree. *Fl.* (Jan.-Mar.) White with red stripes. *Loc.* Varetta gardens.

47. **Semecarpus anacardium** L. (Bilama).

Hab. A small tree. *Fl.* (May.-Jul.) Greenish white. *Loc.* Varetta gardens.

MORINGACEAE

48. **Moringa pterigosperma** Gaertn. (Sargavo).

Hab. A small, soft-wood tree. *Fl.* (Sept.-Dec.) White. *Loc.* Bot. Garden.

PAPILIONACEAE

49. **Heylandia latebrosa** DC. (Godhadi).

Hab. A prostrate herb. *Fl.* (Aug.) Yellow. *Loc.* College grounds.

50. **Crotalaria juncea** L. (Shan).

Hab. Erect hairy shrub. *Fl.* (Aug.-Sept.) Bright yellow. *Loc.* Fields.

51. **Indigofera lineafolia** L. (Gali).

Hab. Scandent herb in sandy soil. *Fl.* (Aug.-Sept.) Pink. *Loc.* College grounds.

52. **Indigofera enneaphylla** L. (Bhuiguli).

Hab. Prostrate, trailing hairy herb. *Fl.* (Aug.-Jan.) Bright red. *Loc.* College grounds.

53. **Indigofera tenuifolia** L.

Hab. Same as above. *Fl.* (Aug.-Dec.). *Loc.* College grounds and in fields.

54. **Sesbania grandiflora** Poir. (Agathiyo).

Hab. Small soft-wood tree. *Fl.* (Aug.-Dec.) White, large. *Loc.* Bot. Garden.

55. **Sesbania aegyptica** Poir. (Shevari).

Hab. Small shrub. *Fl.* Throughout the year. *Loc.* Common, as a hedge.

56. **Abrus precatorius** L. (Chanoti).

Hab. A wiry perennial twiner. *Fl.* (Aug.-Sept.) White with pink tinge. *Loc.* Balaram.

57. **Butea frondosa** König. (Khakaro kesudo).

Hab. A small tree, young parts hairy. *Fl.* (Feb.-Mar.) Bright red. *Loc.* Bot. Garden.

58. **Zornia diphylla** L. (Galgivi).

Hab. Small diffuse herb. *Fl.* Small, yellow. *Loc.* Fields.

59. **Clitoria ternatea** L. (Garani).

Hab. A twining herb. *Fl.* (Jul.-Sept.) Blue and white. *Loc.* On hedges on College road.

60. **Canavalia ensiformis** DC. (Tarvardi).

Hab. Twiner. *Fl.* (Aug.-Sept.) Pink. *Loc.* On hedges in college compound.

61. **Alhagi maurorum** Fisch. (Jawasa).

Hab. Low shrub with green branches and strong hard thorns. *Fl.* (Aug.-Nov.) small, red. *Loc.* College playgrounds.

62. **Pongamia glabra** Vent. (Karanj).

Hab. A small tree. *Fl.* (Apr.-Jun.) White and purplish in dense racemes. *Loc.* Along roadsides. Common.

63. **Melilotus officinalis** Willd.

Hab. An annual herb. *Fl.* (Dec.-Apr.) Pale yellow. *Loc.* Common in waste places.

CAESALPINACEAE

64. **Caesalpinia pulcherrima** Swartz. (Galtoro).

Hab. A small unarmed shrub. *Fl.* Throughout the year ; yellow and red. *Loc.* Bot. Garden.

65. **Poinciana regia** Bojer. (Gulmohor).

Hab. A big tree. *Fl.* (Apr.-Jun.) Red. *Loc.* Bot. Garden.

66. **Cassia fistula** L. (Garmalo).

Hab. A small tree. *Fl.* (Mar.-Jun.) Yellow. *Loc.* Bot. Garden.

67. **Cassia occidentalis** L. (Kasundaro).

Hab. Small annual shrub, fetid when rubbed. *Fl.* (Sept.-Nov.) Yellow. *Loc.* Common in waste places.

68. **Cassia tora** L. (Povadio).

Hab. A small herb. *Fl.* (Aug.-Oct.) Yellow. *Loc.* Common as a weed in waste places.

69. **Cassia auriculata** L. (Aval).

Hab. A much branched shrub. *Fl.* All the year round; light yellow. *Loc.* College compound.

70. **Cassia grandis** L.

Hab. A small tree. *Fl.* (Mar.-Sept.) Rose coloured. *Loc.* Bot. Garden.

71. **Tamarindus indica** L. (Amli).

Hab. A large tree. *Fl.* (May-Jul.) Yellow with pink strips. *Loc.* College road and a few trees inside the city.

72. **Bauhinia variegata** L. (Kanchan).

Hab. Medium-sized spreading tree. *Fl.* (Feb.-Jun.) Pink. *Loc.* Bot. Garden.

73. **Bauhinia racemosa** Lamk. (Asondaro).

Hab. Small crooked tree. *Fl.* (Mar.-June) White. *Loc.* Wild along road going to Balaram.

MIMOSACEAE

74. **Prosopis spicigera** L. (Khijdo).

Hab. Armed small tree infested with insect galls. *Fl.* (Dec.-Mar.) Yellow. *Loc.* Common. Along railway lines towards Mehsana.

75. **Acacia arabica** Willd. (Baval).

Hab. Small armed tree with fissured bark. *Fl.* (Jul.-Feb.) Yellow. *Loc.* Common. Grows wild.

76. **Acacia catechu** Willd. (Kher).

Hab. A small tree, leaves with glands. *Fl.* (Aug.-Sept.) Pale yellow. *Loc.* Common.

77. **Albizzia lebbek** Benth. (Kaliosaras).

Hab. Unarmed deciduous tree. *Fl.* (Mar.-May) White, fragrant. *Loc.* Bot. Garden.

78. **Pithecolobium dulce** Benth. (Vilayati ambli).

Hab. A small armed tree. *Fl.* (Dec.-Mar.) White. *Loc.* Varetta gardens. Few trees in Visnagar.

79. **Parkia biglandulosa** Wt. & Arn. (Chandufal).

Hab. An unarmed big tree. *Fl.* (Jan.-Mar.) White. *Loc.* Bot. Garden.

CRASSULACEAE

80. **Bryophyllum calycinum** Salisb. (Dhamari).

Hab. A succulent herb. *Fl.* (Jan.-Feb.) Reddish purple. *Loc.* Bot. Garden.

81. **Kalanchoe cylindrica** DC.

Hab. A succulent herb, leaves with small bulbils. *Fl.* Not flowering.

COMBRETACEAE

82. **Terminalia catappa** L. (Deshi badam).

Hab. Small tree with whorled horizontal branches. *Fl.* (Aug.-Sept.) Greenish white. *Loc.* Bot. Garden.

83. **Terminalia belerica** Roxb. (Baheda).

Hab. A tree. *Fl.* (Mar.-May) Upper flowers male; lower female. *Loc.* Bot. Garden.

84. **Combretum coccineum** Wall.

Hab. A large climbing shrub with slender stems. *Fl.* (Feb.-Apr.) Bright crimson in brush-like spikes. *Loc.* Bot. Garden.

85. **Quisqualis indica** L. (Rangoon vel).

Hab. A scandent climbing shrub. *Fl.* (Mar.-Sept.) Different shades of red or white. *Loc.* Professors' quarters.

MYRTACEAE

86. **Eugenia jambolana** Lamk. (Jambu).

Hab. A big tree with exfoliate bark. *Fl.* (Feb.-Apr.) White. *Loc.* Outskirts of Visnagar.

87. **Psidium guayava** L. (Jamfal).

Hab. A very small tree, bark white, peeling off. *Fl.* (Apr.-May) White. *Loc.* Common.

88. **Eucalyptus globulus** Labill.

Hab. A large straight growing tree, bark white, peeling off. *Fl.* (Nov.-Feb.) White. *Loc.* Varetta gardens.

LYTHRACEAE

89. **Lawsonia alba** Lamk. (Mendhi).

Hab. Much branched shrub. *Fl.* Throughout the year. Fragrant, white. *Loc.* As a hedge on College road.

90. **Lagerstroemia indica** L. (Chinaimendhi).

Hab. A small shrub. *Fl.* (May-Jul.) Pink. *Loc.* Bot. Garden.

PUNICACEAE

91. **Punica granatum** L. (Dadam).

Hab. A small shrub. *Fl.* All the year. Reddish-crimson. *Loc.* Common.

ONAGRACEAE

92. **Trapa bispinosa** Roxb. (Singoda).

Hab. Aquatic floating herb with swollen petioles. *Fl.* (Jul.-Sept.) White. *Loc.* Very common in tanks ; is grown for its fruit.

CARICACEAE

93. **Carica papaya** L. (Papayu).

Hab. A tree of medium height. *Fl.* (Sept.-Nov.) Unisexual, yellow white. *Loc.* Bot. Garden and Sardarji's garden. Common.

CUCURBITACEAE

94. **Trichosanthes cucumerina** L. (Ranpadval).

Hab. Annual, monoecious climber. *Fl.* (Sept.-Dec.) White. *Loc.* On hedges and in rice fields.

95. **Momordica dioica** Roxb. (Kankoda).

Hab. Perennial, dioecious tuberous-rooted climber. *Fl.* (Sept.-Dec.) Yellow. *Loc.* On hedges in fields.

96. **Luffa acutangula** var. **amara** C. B. Clarke (Kadava turiya).

Hab. Annual, monoecious climber. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Near Randala station.

97. **Cucumis trigonous** Roxb. (Kotembra).

Hab. A monoecious scabrid climber. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Wild on hedges in gardens and fields.

98. **Coccinia indica** Wt. & Arn. (Ghiloda).

Hab. A perennial, dioecious tuberous-rooted climber. *Fl.* (Aug.-Jan.) White. *Loc.* Bot. Garden.

99. **Melothria maderaspatana** Cogn. (Charate).

Hab. An annual, monoecious climber with simple tendrils. *Fl.* (Aug.-Jan.) Light yellow. *Loc.* On hedges in Bot. Garden.

100. **Blastania garcinia** Cogn.

Hab. An annual, monoecious climber. *Fl.* (Sept.-Dec.) Yellow, small. *Loc.* Bot. Garden.

101. **Citrullus colocynthis** Schrader. (Mota indravarana).

Hab. A perennial, monoecious creeper on ground. *Fl.* (Aug.-Dec.) Yellow. *Loc.* In fields.

RUBIACEAE

102. **Ixora parviflora** Vahl. (Nevari).

Hab. A small evergreen shrub. *Fl.* (Jan.-Apr.) Crimson. *Loc.* Bot. Garden.

103. **Spermacoce hispida** L. (Madhurijadi).

Hab. A small procumbent herb. *Fl.* (Sept.-Jan.) White. *Loc.* College playgrounds.

104. **Hamelia patens** Jacq.

Hab. A small shrub, stem reddish, square. *Fl.* (Jun.-Jan.) Orange red. *Loc.* Bot. Garden.

COMPOSITAE

105. **Vernonia cinerea** Less. (Sahadevi).

Hab. An annual herb, stem hairy. *Fl.* (Oct.-Jan.) Pinkish violet. *Loc.* Common; in waste places.

106. **Ageratum conyzoides** L. (Makadmari).

Hab. An annual hairy herb. *Fl.* (Nov.-Mar.) White or pale blue with bad odour. *Loc.* Bot. Garden.

107. **Sphaeranthus indicus** L. (Gorakh mundi).

Hab. A small much branched glandular hairy herb. *Fl.* (Nov.-Jan.) Reddish purple. *Loc.* As a weed in fields and waste places.

108. **Caesulia axillaris** Roxb. (Maka).

Hab. A succulent sub-erect herb. *Fl.* (Sept.-Jan.) Axillary heads pale blue. *Loc.* Common in waste places; near College hostel.

109. **Xanthium strumarium** L. (Gadriyu).

Hab. A small unarmed herb with short hairs. *Fl.* (Nov.-Feb.) Monoecious, unisexual heads. *Loc.* Common in moist places.

110. **Tridax procumbens** L. (Pardeshibhangro).

Hab. A small straggling procumbent perennial herb, hairy. *Fl.* All the year round. Yellow. *Loc.* Common as a weed.

111. **Echinops echinatus** Roxb. (Shuniyo).

Hab. A much branched rigid spiny herb with white cottony hairs. *Fl.* (Oct.-Jan.) In big white spiny balls. *Loc.* Near Rajput boarding, common near wet places.

112. **Eclipta alba** Hassk. (Bangro).

Hab. A rough annual erect or prostrate herb. *Fl.* All the year. Heads small, white. *Loc.* Common as a weed.

113. **Adenostemma viscosum** Forst.

Hab. An erect annual, viscidly pubescent. *Fl.* (Sept.-Mar.) Heads in dense panicles. *Loc.* Common as a weed.

114. **Launaea pinnatifida** Cass.

Hab. Perennial glabrous herbs. *Fl.* All the year. Heads fascicled, yellow. *Loc.* Common weed.

115. **Tricholepis glaberrima** DC.

Hab. Annual, branched glabrous erect stem. *Fl.* (Sept.-Feb.) Heads solitary, purple. *Loc.* Common weed.

SAPOTACEAE

116. **Bassia latifolia** Roxb. (Mahudo).

Hab. A large tree with rounded crown. *Fl.* (Mar.-Apr.) In dense fascicles. *Loc.* Outskirts of Visnagar.

117. **Mimusops elengi** L. (Borsali).

Hab. A small evergreen tree. *Fl.* (Dec.-Apr.) Light brown or white; fragrant. *Loc.* Dosabhai garden.

118. **Mimusops hexandra** Roxb. (Rayan).

Hab. Large evergreen tree. *Fl.* (Sept.-Nov.) White. *Loc.* Varetta gardens.

119. **Achras sapota** L. (Chiku).

Hab. A small evergreen tree with milky juice. *Fl.* (Apr.-Oct.; May-June) White. *Loc.* Bot. Garden.

OLEACEAE

120. **Nyctanthes arbor-tristis** L. (Parijatak).

Hab. A small tree. *Fl.* (Sept.-Jan.) Yellow with white lobes. *Loc.* Bot. Garden.

121. **Jasminum grandiflorum** L. (Chameli).

Hab. A shrub, scandent. *Fl.* (Jan.-May) White, fragrant. *Loc.* Bot. Garden.

SALVADORACEAE

122. **Salvadora persica** L. (Piludi).

Hab. A tree with drooping branches. *Fl.* (Jan.-Mar.) Small, functionally unisexual. *Loc.* Common.

APOCYNACEAE

123. **Carissa carandas** L. (Karmada).

Hab. Large armed shrub with twin stout thorns. *Fl.* (Jan.-Apr.) White, odorous. *Loc.* Bot. Garden.

124. **Vinca rosea** L. (Sadaphuli).

Hab. A small shrub. *Fl.* All the year round, pink. *Loc.* Cultivated in gardens.

125. **Vinca rosea** var. **alba** L.

Hab. A small shrub. *Fl.* All the year ; white. *Loc.* Cultivated in gardens.

126. **Nerium odorum** Sol. (Kaner).

Hab. A shrub with milky juice and verticillate leaves. *Fl.* All the year; pink, red, white. *Loc.* Cultivated in gardens.

127. **Cerbera thevetia** L. (Pilikaner).

Hab. A small tree with milky juice. *Fl.* All the year; yellow. *Loc.* Near temples and women's hostel.

128. **Plumeria acutifolia** Poir. (Khadchampo).

Hab. A deciduous tree with milky juice. *Fl.* (Feb.-Oct.) White with golden centre. Fragrant. *Loc.* Bot. Garden.

129. **Plumeria rubra** L.

Hab. A smaller tree than above. *Fl.* (Feb.-Oct.) Petals red, centred with rich yellow; fragrant. *Loc.* Bot. Garden.

130. **Wrightia tinctoria** R. Br. (Mito indrajav).

Hab. A deciduous tree of moderate size, with milky juice. *Fl.* (Mar.-May) *Loc.* Bot. Garden.

131. **Tabernaemontana coronaria** R. Br. (Chandani).

Hab. A small shrub with milky juice. *Fl.* (Jul.-Sept.) Snow white. *Loc.* Bot. Garden.

ASCLEPIADACEAE

132. **Calotropis procera** R. Br. (Nanoratoankado).

Hab. A small shrub, young parts with cottony hairs. *Fl.* (Nov.-Feb.) Pink. *Loc.* Common; in waste places.

133. **Asclepias curasavica** L. (Kakatundi).

Hab. A small perennial herb with milky juice. *Fl.* (Aug.-Sept.; Jan.-Feb.) Crimson. *Loc.* Bot. Garden.

134. **Leptadenia reticulata** Wt. & Arn. (Nanidodi).

Hab. A twiner. *Fl.* (June-Aug.) Small greenish yellow. *Loc.* Common; on hedges and in Bot. Garden.

BORAGINACEAE

135. **Cordia sebestena** L.

Hab. A small evergreen shrub. *Fl.* (Sept.-Mar.) Scarlet or orange red with sooty calyx. *Loc.* Bot. Garden.

136. **Heliotropium supinum** L. (Ghedeo okhrad).

Hab. A prostrate softly hairy herb. *Fl.* (Dec.-Mar.) Small. *Loc.* College playgrounds and common near wet places.

137. **Cordia rothii** R. & S. (Nanagundha).

Hab. A small deciduous tree. *Fl.* (Mar.-Jun.) White, small. *Loc.* Bot. Garden.

CONVOLVULACEAE

138. **Cuscuta reflexa** Roxb. (Amarvel).

Hab. A parasitic twiner; pale greenish yellow. *Fl.* (Nov.-Feb.) White in clusters. *Loc.* Common in villages.

139. **Evolvulus alsinoides** L. (Shankavali).

Hab. A small prostrate wiry herb; hairy. *Fl.* (Aug.-Dec.) Light blue. *Loc.* Common; on sandy soil.

140. **Jacquemontia violacea** Choisy (Jakshini).

Hab. A perennial twiner with slender stems. *Fl.* (Dec.-Jan.) Bright blue. *Loc.* Dosabhai garden.

141. **Argyreia speciosa** Sweet. (Samudrashok).

Hab. A huge climber, stems stout, hairy, white. *Fl.* (Aug.-Sept.) Large rose purple; bracts large white. *Loc.* Dosabhai garden.

142. **Ipomoea aquatica** Forsk. (Jalgamini).

Hab. A floating aquatic plant with hollow stem, and rooting at nodes. *Fl.* (Oct.-Apr.) Pale purple. *Loc.* Common in tanks.

143. **Ipomoea batatas** Poir. (Shakkaria).

Hab. Creeping plant, rooting at nodes. *Fl.* Noted in vegetative condition only. *Loc.* Bot. Garden.

144. **Ipomoea quamoclit** L. (Kamlata).

Hab. An annual, slender twiner with pectinate leaves. *Fl.* (Sept.-Dec.) Scarlet. *Loc.* Bot. Garden and Professors' quarters.

SOLANACEAE

145. **Solanum xanthocarpum** S. &. W. (Bhoyringani).

Hab. A spiny prostrate perennial herb. *Fl.* (Oct.-Mar.) Yellow. *Loc.* Common; in waste places.

146. **Withania somnifera** Dunal (Ghodakun).

Hab. A small hairy undershrub. *Fl.* (Sept.-Nov.) Yellowish green. *Loc.* Common; in wet places.

147. **Physalis minima** L. (Popti).

Hab. A small herb with toothed or lobed leaves. *Fl.* (Aug.-Nov.) Yellow. *Loc.* Common; in wet places.

148. **Datura fastuosa** L. (Kalodhaturo).

Hab. A small shrub with purplish and white spotted branches. *Fl.* (Sept.-Jan.) White or tinged with purple. *Loc.* Common; near marshy places.

149. **Cestrum nocturnum** L. (Ratanirani).

Hab. A small scandent shrub. *Fl.* (July-Nov.) Yellowish green. *Loc.* Sardarji's garden.

SCROPHULARIACEAE

150. **Herpestis monnieria** H.B.K. (Bam, Jalnevari).

Hab. A small succulent creeping aquatic herb, rooting at nodes. *Fl.* (Jan.-May) Pale blue. *Loc.* Near Talav.

151. **Striga orobanchioides** Benth. (Ratoagiyo).

Hab. A small erect herb parasitic on roots of Bajari; stem reddish purple. *Fl.* (Oct.-Nov.) Pink with white spot at the base of each lobe. *Loc.* In fields, along railway lines.

152. **Russelia juncea** Zucc. (Raseeli).

Hab. A much branched phylloclade with thick nodes; whorled pendulous branches. *Fl.* All the year. Red. *Loc.* College garden.

153. **Lindenbergia urticifolia** Link & Otto.

Hab. A small hairy glandular herb. *Fl.* (Aug.-Dec.) Yellow. *Loc.* Near wet places, and on wet old walls.

154. **Angelonia grandiflora** L.

Hab. A small perennial herbaceous plant, with glands secreting sticky fluid. *Fl.* (Sept.-Jan.) Of peculiar shape with characteristic smell. *Loc.* Bot. Garden.

BIGNONIACEAE

155. **Tecomella undulata** Seem. (Ragatrohido).

Hab. A small tree with drooping hairy branches. *Fl.* (Dec.-Apr.) Orange-yellow. *Loc.* Varetta gardens, and behind College garden.

156. **Millingtonia hortensis** L. (Akashneem).

Hab. A large straight evergreen tree with corky covering on stem. *Fl.* (Sept.-Dec.) White; sweet scented. *Loc.* Bot. Garden.

157. **Spathodea campanulata** Beauv.

Hab. Noted as a small tree. *Fl.* (Dec.-Feb.) Orange-scarlet. *Loc.* Bot. Garden.

158. **Kigelia pinnata** DC.

Hab. Noted as small trees in Bot. Garden; not flowering.

159. **Tecoma stans** L.

Hab. A large shrub. *Fl.* (Sept.-Dec.) Bright yellow. *Loc.* Common along hedges in Bot. Garden.

ACANTHACEAE

160. **Thunbergia grandiflora** Roxb.

Hab. A large, woody climber. *Fl.* (Feb.-Sept.) Bluish. *Loc.* Grows extensively, covering the green house in Bot. Garden.

161. **Barleria prionitis** L. (Pilokantasholiyo).

Hab. A small shrub, much branched, very prickly. *Fl.* (Oct.-Jan.) Yellow. *Loc.* Grows wild in Bot. Garden.

162. **Lepidagathis trinervis** Nees. (Harancharo).

Hab. A very small diffuse herb much branched. *Fl.* (Nov.-Mar.) Purple. *Loc.* Common.

163. **Asteracantha longifolia** Nees. (Echaro).

Hab. A herb with reddish brown stems with yellow straight spines in the axil of leaves. *Fl.* (June-Jan.) Purplish blue. *Loc.* Common by the side of tanks.

164. **Ruellia tuberosa** L.

Hab. A small herb with fasciculated tuberous roots. *Fl.* (Aug.-Oct.) Purplish blue. *Loc.* Common in Bot. Garden.

165. **Adhatoda vasica** Nees. (Ardusi).

Hab. A much branched shrub. *Fl.* (Aug.-Jan.) White with rose-coloured streaks in the throat. *Loc.* Common as a hedge plant.

VERBENACEAE

166. **Lantana camara** L. var. **aculeata** Mold. (Indra danu).

Hab. A shrub, stems with many recurved prickles. *Fl.* All the year. Of various colours. *Loc.* Bot. Garden. Does not grow wild.

167. **Gmelina hystrix** Schutt.

Hab. A large spinous shrub. *Fl.* (Aug.-Dec.) Yellow in pendulous panicles. *Loc.* Bot. Garden.

168. **Vitex negundo** L. (Nagodi).

Hab. A small tree, stem square, white and hairy. *Fl.* All the year. Bluish purple. *Loc.* Bot. Garden.

169. **Clerodendron inerme** Gaertn. (Vanvai).

Hab. A shrub with climbing habit. *Fl.* (Aug.-Jan.) White. *Loc.* College garden; as a hedge.

170. **Clerodendron serratum** Spreng.

Hab. A small shrub with branches spreading at base. *Fl.* (Aug.-Jan.) Pink. *Loc.* College garden.

LABIATAE

171. **Ocimum sanctum** L. (Tulsi).

Hab. An annual, much branched herb; hairy purplish. *Fl.* (Sept.-Dec.) Purplish. *Loc.* Common.

172. **Ocimum gratissimum** L. (Avachibavchi).

Hab. A small shrub. *Fl.* (Jul.-Dec.) Pale greenish yellow. *Loc.* Near tennis court.

173. **Ocimum basilicum** L. var. **thyrsiflora** Benth. (Sabjo).

Hab. A small herb, much branched, purple hairy. *Fl.* (Aug.-Nov.) Pink with long white hairs. *Loc.* College garden.

174. **Leucas aspera** Spreng. (Kubo).

Hab. An annual herb, stem square and hairy. *Fl.* (Oct.-Nov.) White. *Loc.* Common; in wet places.

NYCTAGINACEAE

175. **Boerhavia diffusa** L. (Punarnava).

Hab. A creeping herb, stem purplish. *Fl.* (Sept.-Dec.) Dark pink. *Loc.* Common; grows wild.

176. **Boerhavia repanda** Willd. (Satodo).

Hab. A small herb with long internodes. *Fl.* (Oct.-Dec.) Pink. *Loc.* In hedges in Bot. Garden; and along railway lines.

177. **Bougainvillea spectabilis** Willd. (Rativel).

Hab. An extensive climber. *Fl.* (Aug.-Jan.) Rosy-purple bracts. *Loc.* College and Dosabhai garden.

AMARANTHACEAE

178. **Celosia** sp.

Hab. A small, annual erect herb with grooved stem. *Fl.* (Sept.-Jan.) In small terminal spikes. White. *Loc.* Common on waste land.

179. **Digera arvensis** Forsk. (Kanejaro).

Hab. A small erect annual herb. *Fl.* (Sept.-Dec.) Perianth rose-coloured. *Loc.* Common; in fields.

180. **Amaranthus spinosus** L. (Kantalodambo).

Hab. A small annual erect herb with grooved stem, bearing axillary spines. *Fl.* (Aug.-Nov.) Green. *Loc.* A common weed.

181. **Achyranthes aspera** L. (Andhadi).

Hab. An annual erect herb with square stem. *Fl.* (Nov.-Jan.) Greenish white. *Loc.* Common in waste places.

182. **Pupalia lappacea** Moq. (Dhologipto).

Hab. A large hairy herb. *Fl.* (Aug.-Dec.) Perianth woolly. *Loc.* In hedges, common.

183. **Gomphrena globosa** L. (Batan).

Hab. A small annual herb, stem dichotomous, purplish. *Fl.* (Sept.-Apr.) Purplish red. *Loc.* In gardens, often growing as an escape.

CHENOPODIACEAE

184. **Basella rubra** L. (Pothi).

Hab. A perennial large twiner, stem red with thick leaves. *Fl.* (Oct.-Jan.) Red. *Loc.* Bot. Garden.

POLYGONACEAE

185. **Polygonum plebejum** R. Br. var. **indica** Hook.

Hab. A much branched prostrate herb. *Fl.* (Dec.-Mar.) Pink. *Loc.* College grounds.

186. **Polygonum glabrum** Willd. (Ragatrohido).

Hab. A tall shrub, slightly branched and reddish below. *Fl.* (Oct.-Mar.) Pink. *Loc.* On margins of tanks.

ARISTOLOCHIACEAE

187. **Aristolochia bracteata** Retz.

Hab. A herb; almost spreading on the ground. *Fl.* (Aug.-Jan.) Dark purple. *Loc.* Near Kadarpur railway station.

EUPHORBIACEAE

188. **Euphorbia neriifolia** L. (Thor).

Hab. A large fleshy much-branched shrub. *Fl.* (Aug.-Apr.) Involucres forming shortly pedunculate solitary or twin cymes. *Loc.* As a hedge along fields and gardens.

189. **Euphorbia tirucalli** L. (Kharsadi thor).

Hab. A small, unarmed, much-branched tree. *Fl.* (Mar.-May) Involucre rose-coloured. *Loc.* As a hedge in Bot. Garden.

190. **Euphorbia splendens** Boj.

Hab. A small armed shrub. *Fl.* (Sept.-Mar.) Cyathia dichotomous. Involucre crimson or scarlet. *Loc.* Dosabhai and Bot. Gardens.

191. **Euphorbia heterophylla** L.

Hab. A small annual herb with floral leaves. *Fl.* (Sept-.Feb.) Green. *Loc.* P.W.D. garden.

192. **Phyllanthus niruri** L. (Bhoyamli).

Hab. A small annual herb. *Fl.* (Aug.-Nov.) Yellowish green, very small. *Loc.* Common as a weed.

193. **Putranjiva roxburghii** Wall. (Putravanti).

Hab. A small evergreen tree with drooping branches. *Fl.* (Mar.-May) Dioecious. *Loc.* Bot. Garden.

194. **Jatropha glandulifera** Roxb.

Hab. A small tree, glandular. *Fl.* (Jan.-May) Greenish yellow. *Loc.* Bot. Garden.

195. **Croton tiglium** L. (Napalo).

Hab. A large evergreen shrub. *Fl.* (Sept.-Dec.) Monoecious. *Loc.* Gardens.

196. **Ricinus communis** L. (Erandi).

Hab. A large annual or perennial shrub. *Fl.* (Dec.-Mar.) Monoecious. *Loc.* Bot. Garden and cultivated in fields.

MORACEAE

197. **Ficus religiosa** L. (Pipalo).

Hab. A large tree. *Fl.* Receptacles in pairs; dark-purple when ripe. *Loc.* College garden and near temples.

198. **Ficus bengalensis** L. (Vad).

Hab. A very large tree, with aerial roots. *Fl.* Receptacles in pairs, red. *Loc.* College garden.

199. **Ficus carica** L. (Anjir).

Hab. A small tree. *Fl.* Receptacles solitary; basal bracts reddish purple when ripe. *Loc.* Bot. Garden.

200. **Morus alba** L. (Shetur).

Hab. A large deciduous shrub. *Fl.* (Feb.-Mar.) Monoecious. *Loc.* Bot. Garden.

URTICACEAE

201. **Pilea microphylla** Lieb.

Hab. Small perennial herb. *Fl.* (Sept.-Oct.) Monoecious. *Loc.* Bot. Garden.

MONOCOTYLEDONS

HYDROCHARITACEAE

202. **Hydrilla verticillata** Presl. (Bam).

203. **Valisneria spiralis** L. (Prangavat).

Hab. Submerged plants; abundant in Talav.

AMARYLLIDACEAE

204. **Crinum asiaticum** L. (Nagdaman).

Hab. A herb with tunicated bulb. *Fl.* (Aug.-Oct.) White. *Loc.* Dosabhai garden.

AGAVACEAE

205. **Agave americana** L. (Ketaki).

Hab. A large perennial herb. *Fl.* Any time of the year ; yellowish green. *Loc.* Bot. Garden.

LILIACEAE

206. **Asparagus gonoclados** Baker. (Satavri).

Hab. A much branched armed small weak undershrub with nodular roots. *Fl.* (Dec.-Jan.) White. *Loc.* Bot. Garden.

207. **Dracaena goldieana** Bull.

Hab. An erect woody plant with crowded leaves. *Fl.* Not in flower. *Loc.* Bot. Garden.

208. **Gloriosa superba** L. (Vachnag).

Hab. A large annual herbaceous climber, with solid and white tuberous rootstock. *Fl.* (Aug.-Oct.) Orange and scarlet. *Loc.* Along railway lines in hedges. Wild.

209. **Asphodelus tenuifolius** Cav. (Dungro).

Hab. A small annual herb with fibrous roots. *Fl.* (Dec.-Mar.) White with red tinge. *Loc.* In wheat and bajri fields.

210. **Aloe vera** L. (Eliyo).

Hab. A small herb with fleshy leaves. *Fl.* (Aug.-Jan.) Orange-scarlet. *Loc.* Bot. Garden. Grows extensively.

COMMELINACEAE

211. **Commelina nudiflora** L. (Shishmuli).

Hab. A small diffuse glabrous herb rooting at nodes. *Fl.* (Sept.-Dec.) Dark purple. *Loc.* Grows wild after rains everywhere.

PALMACEAE

212. **Phoenix sylvestris** Roxb. (Khajuri).

Hab. An unbranched plant, the stem covered with petioles of fallen leaves. *Fl.* (Jan.-Mar.) Dioecious. *Loc.* Bot. Garden.

PANDANACEAE

213. **Pandanus furcatus** Roxb.

Hab. A small tree with aerial roots. *Fl.* Not flowering. *Loc.* Bot. Garden.

POTAMOGETONACEAE

214. **Potamogeton indicus** Roxb. (Jalpupodi).

Hab. An aquatic herb. *Fl.* (Dec.) Spike; dense flowered. *Loc.* In tanks along railway line.

CONIFERAE

215. **Thuja orientalis** L. (Morpankhi).

Hab. A small compact evergreen plant. *Fl.* Monoecious, minute. *Loc.* Bot. Garden.

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Reviews

1. THE ROYAL BOTANIC GARDENS, KEW. By W. B. Turrill, D.Sc., F.R.S., London: Herbert Jenkins, 1959. 22×14 cm.; pp. 256, map, 26 half-tone illustrations. Price 25*s*.

This year the Royal Botanic Gardens, Kew, celebrate the second centenary from their foundation in the eighteenth century; this book is a fitting tribute to the work that has been done and is being done in the various branches of Horticulture and Botany. It is appropriate, too, that Dr. Turrill should write this story; in the words of Dr. G. Taylor, the present Director, who introduces the book to the public, 'the book is in good measure a jubilee commemoration of his (Dr. Turrill's) half-century's devotion to Kew. His is a splendid record of loyal service which has brought great credit to the institution.' When I first knew him, Dr. Turrill was the Curator of the Herbarium; and it was thanks to his great kindness that this reviewer and many others like him could appreciate the treasures housed in the various departments of the Royal Botanic Gardens.

To the professional gardener or botanist, Kew is a hallowed place, the mere name of which seems to inspire reverence and love; it certainly does this to me. Both the gardens and the herbarium and library, and the various laboratories now established in Kew, owe much to the inspiration and energy of such giants in the botanical world as the two Hookers (Sir William and Sir Joseph Dalton), to Bentham, to Col. Prain, and others, to speak only of those that have gone to their reward. Their example seems to be animating the present staff with their boundless energy and enthusiasm.

Dr. Turrill has delved into the archives of the Royal Botanic Gardens, and has as a result produced a book that reads like a story; in simple and non-technical language he tells of the development of a Royal Garden of but about 9 acres into the magnificent establishment of today with over 250 acres of ground. After many vicissitudes as a private Royal Garden, Kew developed into one of the world's leading botanical institutions from the appointment of Sir William Hooker in 1841, when Sir William became the first director officially appointed by government; from that moment practically every year has seen new additions to the Gardens, new facilities for research. The Herbarium, housed in three large galleries, numbers over 6,000,000 specimens; among them there is a most valuable number of type sheets; the Indian

collection is the best in the world, both in numbers and in type materials. As for the Gardens themselves, William Aiton, one of the first Curators, in 1789 listed 5500 species under cultivation in Kew; in the last few years, I heard from the then Director, Sir Edward Salisbury, that over 45,000 different species of plants were being cultivated in the gardens, in the open air or under glass in the various hot-houses.

Dr. Turrill describes in detail the gardens and the various houses. Among the latter the Palm House is probably the most striking structure in Kew; it happens to be also one of the oldest houses. It was completed in 1848; its length is 362 ft., its width 100 ft., its height 66 ft. The Palm House stood as originally built until the Second World War, when much of the glass was destroyed by enemy action; in spite of this most of the plants could be saved, and are now housed again in the rebuilt Palm House.

Another showy detail of Kew is the orchid house. 'The main orchid house at Kew is a new construction built in 1958. There are, connected with this, a number of orchid "pits" that is special smaller houses where orchids are raised from seed and by vegetative propagation and are kept till ready for public exhibition.' The collection of living orchids at Kew is an astonishingly large one, it is also a very showy one. One of the details mentioned by Dr. Turrill when speaking of orchids may be of interest to our readers: orchids are known to produce very large numbers of minute seeds; the record for Kew is a specimen of *Cynorchis chlorochilon*, one single fruit or capsule of which contained 3,770,000 seeds!

At the end of the book there is a large-scale map of the Gardens, with the help of which it is easy to locate any of the various details discussed in the book.

The subjects dealt with in the various chapters are the following: History from the beginning to 1958; scientific research at Kew; economic botany and the various museums; detailed description of the gardens, of the green houses, etc.; Kew in spring, summer, autumn, and winter. There is an interesting chapter on Wild Life at Kew, where many of the birds, insects, etc. seen at Kew are mentioned. The appendices and indexes are of particular help to scientific readers.

One of the great attractions of Kew is that every season of the year seems to bring out a beauty of its own. Bluebells cover the ground in early spring, soon to be followed by daffodils; a little later the sides of the Broad Walk are a riot of colour with the finest combination of massed tulips; by Easter time the Japanese cherry trees with their profuse flowering are a great attraction to visitors, with Rhododendrons

and Azaleas also at their best. All through summer roses, geraniums, and other colourful plants are the delight of countless visitors that flock to the Gardens. Kew is visited annually by over a million persons, and all seem to find there something to delight and interest them. Merely as a picnic spot there is no better place in the world!

It is but natural that such a large institution should be costly to run; it is also natural that the government and the country should expect some tangible return for the money spent. Kew has repaid the money spent many times over; perhaps this has not been done directly to the British treasury, it has certainly been done through the Commonwealth. It was through Kew that India and the East obtained their quinine plants from the high ranges of the Andes in South America; it was also through Kew that southeastern Asia received the *Para* rubber seedlings from which the rubber plantations of Ceylon, Malaya, and other eastern countries have been developed.

To the professional botanist the world over, Kew is known for its many botanical publications, among which *Index Kewensis* stands out signally; two large volumes and twelve supplements of this monumental work have so far been published; in this index all the seed-bearing plants of the world are listed; beginning with Linne's *Species Plantarum*, published in 1753, every plant that has been described or published in any scientific work to the present day is listed with the appropriate reference to the original publication. If the Royal Botanic Gardens, Kew, had done nothing but to sponsor the publication of this book and its supplements, Kew would still deserve a high place in the esteem and gratitude of all the botanists of the world. But it has done much more than that: some of the finest botanical gardens, at least in the British Commonwealth in general and in India in particular, owe their inspiration to Kew. India owes a special debt of gratitude to Kew, in that the FLORA OF BRITISH INDIA and the more important provincial floras have been compiled by the staff of the Kew Herbarium.

The printing of the book is an honour to the British printing trade; the many fine illustrations are well selected to give an idea of the history, activities, and beauty of Kew. The book is clearly a work of love. On this bicentenary occasion the reviewer, remembering the happy years spent in Kew, sends hearty wishes; may the Royal Botanic Gardens of Kew continue for many centuries to flourish and prosper. *Floreat Kew!*

H. SANTAPAU

2. BIRD WATCHING AS A HOBBY. By W. D. Campbell, M.B.O.U. 114 pp. (18.5×12 cm.). With photographic illustrations by H. A. Thomson. Stanley Paul, London, 1959. Price 10*s*. 6*d*. net.

This is an excellent little introduction to Bird Watching written interestingly and in simple language by an experienced devotee of the hobby. It is intended for the young and the novice, but its comprehensive coverage should make its appeal to the general reader with even a passing interest in his natural surroundings.

The chapter headings are descriptive of the contents: Bird watching as a Hobby; Structure; The Bird's Voice; Reproduction; The Food of Birds; Migration; Classification; Recognition and Identification; Man and Birds; From Bird Watcher to Ornithologist. The text is enlivened by good photographs and by illustrative anecdotes from the author's personal experiences of over a quarter century of bird watching.

The general reader will find the chapters on Migration and Man and Birds of particular interest. At the end of the latter are given some particulars concerning the Protection of Birds Act of 1954 which, even in its toned-down form as passed by the British Parliament, is in many respects exemplary. Suitably adapted to local needs and conditions, it could serve as a model for similar legislation in other countries, including our own. The chapter on Recognition and Identification gives useful hints on what, where, and how to observe and record, which, if persistently and intelligently followed, will without special effort transform the man who starts bird watching as a hobby into a competent scientific ornithologist as it has done the author of the book.

S. A.

3. POULTRY KEEPING IN INDIA. By P. M. N. Naidu. Pp. xviii+293 (24.5×18.5 cm.). 21 coloured plates, 192 black-and-white photographic and line illustrations. Published by the Indian Council of Agricultural Research, New Delhi, 1959. Price Rs. 19.80.

At the outset it may be pointed out that 'poultry' in the title is evidently used here in a restricted sense to cover only domestic fowls. Ducks, geese, turkeys, and guinea fowl which are normally also included in the term are not dealt with. They are perhaps intended to form the subject of a future volume.

India was the centre of domestication of the indigenous Red Junglefowl, believed to be the progenitor of all the existing domestic

breeds. Man's primary quest seems to have been for a good fighting bird, and though fowls were doubtless also used as food, domestication for this purpose was apparently only a secondary consideration. Little attention seems to have been paid in India through the ages to poultry keeping as an economic undertaking, or developing suitable breeds as a source of food supply for the community. Even today as an industry it is far less exploited or popular than its potentiality as a food resource would warrant in a country like ours, for ever striving to make the ends of food production and food consumption meet.

No ventures in poultry farming have so far been undertaken here on a scale comparable with the gigantic industry into which it has developed in western countries, especially the U.S.A. But in a small way poultry keeping has always flourished as a cottage industry or for domestic consumption in villages throughout the countryside. No traveller in India can be unfamiliar with the tough and stringy dak bungalow chicken and the diminutive pigeon-like eggs which are the produce of that bird. That seemingly no effort should have been made to improve the size of the egg and the quality of its layer is strange, but understandable in the absence of official encouragement for scientific experimentation and selection for better breeds. The few fanciers and well-meaning reformers who from time to time tried to introduce foreign strains of egg-layers or meat-producers to improve the indigenous stock had not long to wait before having their entire flocks wiped out by one or other of the numerous poultry diseases which are the bane of the poultry keeper, especially in the tropics, but against which the hardier local breeds have developed some measure of immunity.

It is only now, with the encouragement and facilities provided to poultry keepers by the Central and State Governments through prophylactic inoculations of the birds and competent scientific advice, that poultry farming is gaining in popularity and becoming a practicable proposition for the villager and man of modest means, and gradually transforming its erstwhile speculative character into a steady profit-earning industry.

Poultry keepers as well as all concerned over the food problem in India will welcome this timely publication of the Indian Council of Agricultural Research. From time to time the Council had put out a number of pamphlets on poultry keeping, but the need of a comprehensive book providing practical knowledge in a handy form was acutely felt. The author Shri P. M. N. Naidu has done his job admirably, and deserves to be complimented. That the book

provides just the sort of information poultry keepers needed will be evident from its list of contents. The chapters cover every aspect of the industry, from the history and economics of poultry keeping in India, and the choosing of breeds for different purposes, through the practical techniques of breeding, feeding, and care, to marketing. In the reviewer's opinion, the chapter on Diseases and their Control, in the light of past disappointments and failures, should prove of the greatest practical usefulness and go a long way to reassure the many poultry keepers who have suffered through the ravages of these epidemics and been compelled to abandon their enterprise and enthusiasm.

The book is well printed and attractively got up, and the illustrations are chosen with care, although the colour rendering in some of the plates is not all that can be desired. Considering the high cost of art paper and colour printing, the price is not unreasonable, though unfortunately still rather beyond the reach of the ordinary small man who might be induced to take up poultry farming not only to augment the family income, but also as a service to the community in producing more food. An official publication like this, to carry its message to the widest circle of would-be beneficiaries and produce practical results, needs to be heavily subsidized by government.

S. A.

4. A GUIDE TO FRESHWATER INVERTEBRATE ANIMALS. By Dr. T. T. Macan. Pp. x+118 (18.5×13 cm.). With 202 line drawings. Longmans, Green & Co., Ltd., London, 1959. Price 11*s*. 6*d*.

The scope and organisation of this book are well set in its introduction. It has been the intention of the author to provide such practicable keys as would enable young naturalists or beginners interested in freshwater animal life to identify their captures to the nearest group.

The author, in this work, has devoted 111 pages to four keys—a painstaking work for identifying freshwater invertebrates and then in the end contributes a short account, comprising only four pages, on parasites and epibionts. Of the four keys, the first helps to identify all the freshwater invertebrates up to phyla, and animals belonging to Protozoa, Sponges, Coelenterata, and minor phyla up to their groups. The remaining three keys deal with Mollusca, Worms, and Arthropoda

respectively. More than half of the book is devoted to the identification of freshwater insects.

Literature on animal taxonomy, generally speaking, is too often not readily comprehended by a general student of freshwater animal life. Sometimes also the unfortunate attitude that only an expert is capable of identifying animals correctly has discouraged many a promising beginner from attempting field work. But a book of this type can help any one to readily identify the more common freshwater invertebrates with reasonable accuracy up to a group if he is prepared to follow up the keys given here.

The book is, therefore, recommended for those who have developed interest in identifying freshwater invertebrates, and it will also form a useful addition to biological libraries.

DR. KEWALRAMANI

5. FISHERY SCIENCE, ITS METHODS AND APPLICATIONS. By George A. Rounsefell and W. Harry Everhart. Pp. xii+444 (15×23.5 cm.). With a frontispiece, one coloured plate, and 106 text-figures. John Wiley & Sons, Inc., New York. Price $ 7.50.

The unprecedented activities in the development of fisheries science in this country during the last ten years has opened up a new field for post-graduate training and research in fishery biology, management, and technology in many Indian Universities. However, as in most countries in the tropics, the science is still in its infancy not having progressed beyond the exploratory stage and hence it will be a long time before a comprehensive text-book on the subject specially pertaining to this region is available for the guidance of students and researchers. On the other hand, in the waters of the temperate regions fishery science offers a wealth of practical knowledge made possible mainly by the pioneering and inspiring works of John Murray, Michael Sars, W. Thompson, W. Herdman, J. Johnstone, C. G. Joh. Pettersen, J. Hjort, and many others and carried on through the last few decades in many parts of the world, notably the North Sea, the Baltic, the Sea of Azov, the Atlantic and Pacific coasts of North America, and the fresh waters of the Holarctic. Among the more recent books a long list may be cited as being both informative and instructive to the student and researchers, but there are practically none which have attempted a synthesis and common interpretation of the methodology and principles employed for both freshwater and marine fishery biology in such a way as to be equally applicable to

the research, conservation, and management of fishery resources regardless of where the fish occur. Although six years have elapsed since its publication we are pleased to make known to our readers the availability of such a book in FISHERY SCIENCE, ITS METHODS AND APPLICATIONS.

The book, which is divided into eleven sections, has 25 chapters, each having at its end a list of references which is heavily weighted to North American works. The opening chapter 'How do we produce knowledge?' is an appropriate one and worthy of reading by all biologists engaged in preparing research papers whether of an applied or fundamental nature. The remaining chapters deal with principles of fishery management in general, and as pertaining to streams and ponds; methods of estimating population size, abundance, and limiting factors; habitat improvements; varied types of gear and their uses; tagging; age and growth studies; fishery statistics, stream and lake surveys; fishery regulations, etc.; and conclude with one on fishery problems needing immediate and greater attention, such as abundance; genetics in relation to increased annual harvest; natural balance; role of nutrients; estuarine ecology; interspecific relations, and the like. This is followed by an appendix giving a list of scientific journals exclusively dealing with fishery science or in which the majority of the articles pertain to fishery research and once again there is a partiality to North American publications. The book concludes with a useful six-page glossary of scientific terms and a thirty-page author and subject index.

Fishery problems are varied both from place to place and from species to species and the ever increasing output of research material is also accompanied by constant refinements of existing methods and techniques. Naturally to expect one book to elucidate all would seem an impossibility. One basic requisite for anyone specializing in fishery biology and management is a good grasp of the principles of ecology as applicable to this field and a working knowledge of the problems, methodology, and applications of the allied subjects of limnology, oceanography, marine biology, and ichthyology. To rationalise, the user of this book is expected to have some training in these subjects. Although lagging, fishery science in tropical waters has its own specialities as regards some of the problems, methods, and its applications, and a chapter or two on this aspect would have greatly enhanced the usefulness of this book as an international reference work on the subject. Nevertheless many of the principles and methods treated by the authors are equally applicable to tropical situations, both freshwater and marine. The treatment of the various

topics dealt with is concise, but in some places only passing references are made to topics worthy of more detailed treatment which would necessitate looking into other references also. Indeed, this is a drawback. For instance in a text-book discussion meant to be an aid to students one would expect to find also a reference to Graham, M. (1929): Studies on Age-determination in Fish. Parts 1 & 2, *Fish. Invest. Min. Agri. Fish. Ser.*, II, Vol. 11, Nos. 2 & 3 for the subject on scales and age-determination (Chapter 18), or to Hynes, H. B. N. (1950): *J. Anim. Ecol.*, 19 (1): 36-58 for the section on 'Methods of stomach analysis' (p. 356), and so on. More recent researches on the dynamics of fish populations will necessitate some changes in chapters 6 and 7.

Prediction, judicious management, and conservation are the goal of fishery science and this book will give some idea of the immense amount of systematic and consistent work necessary to attain these ends. On the whole the book is well written, well illustrated, and the production is excellent. Many of the principles of value find a place in it thus making it a worthy text-book and source of reference. The omissions and suggestions are minor when compared to the many useful qualities of the book and at its present standard a life of many editions is assured. The book can be confidently recommended as an aid to post-graduate teaching as well as a guide to researchers through the pages of which a wide knowledge of the methods and applications of fishery science as specially pertaining to the piscine world can be gained.

E. G. SILAS

6. DIVERSIONS OF A DIPLOMAT IN CEYLON. By Philip K. Crowe. Pp. x+318 (21.5×14.5 cm.). Line drawings by P. E. P. Deraniyagala, and a map. London, 1957. Macmillan & Co. Ltd. Price 30*s*. net.

As a keen shikari the author has travelled widely in Ceylon and picked up from many sources interesting items of natural (and sometimes unnatural) history. The identity of the devil bird, the blood-sucking vampire bat, and the singing fish of Batticaloa Harbour still appears to be uncertain and the author refers to a new species of red bear described from Ceylon in 1815. There is an extraordinary account of the discovery, in company with Major W. W. A. Phillips, of a red-wattled lapwing sitting on a clutch of Kentish Plover eggs . . . 'an hour later the Kentish plover mother was back on the job. Undoubtedly the lapwing was a paid egg-sitter!'

As in India, the Ceylon authorities no doubt have headaches with the matter of game preservation, but it is strange that they have not yet outlawed some of the commonest offences, e.g. shooting deer and junglefowl from cars and killing of stags in velvet. Perhaps it is prohibited, but if so the fact that a person of the standing of the author has indulged in these practices implies that little publicity has been given to the law which, as in many parts of India, is nobody's concern.

Unfortunately the author has been a little too free in the identification of birds and animals mentioned by him. Upon enquiry it was discovered that the apparent additions of the Pintailed Duck, the Green Pigeon, and the rabbit to the fauna of the Maldives could not be vouched for!

The book is, however, very readable and is just the kind which arouses interest and discussion among naturalists and shikaris.

H. A.

7. THE TIGER OF RAJASTHAN. By Colonel Kesri Singh. Pp. 197 (22×14 cm.). With twelve plates. London, 1959. Robert Hale Ltd. Price 18*s*.

In the foreword, the meaning of the word 'Kesri' is given as 'tiger'. 'Kesri' is really a mutilated form of the Sanskrit word Kesari meaning the 'maned one'. In the preface the author has expressed gratification on his good fortune of being able to select his favourite occupation as his profession. He claims to having been in constant touch with, and studied wild animals for over thirty-seven years. The book is the result of his experiences during this time. The reader therefore is naturally expectant to learn something new about the tiger, but is disappointed to find that the book is largely a chronicle of how innumerable tigers were slaughtered by the author himself or beaten out for slaughter by others. Interlarded are anecdotes, some curious, some interesting, some merely to point a moral or adorn a tale. The photographs on the whole are poor. Many of them are of doubtful authenticity, and some quite obviously posed.

Col. Kesri Singh has a great reputation in Rajasthan as a tiger slayer, and an even greater reputation for knowledge of tiger lore.

Perhaps it is this reputation that is responsible for the disappointment the reviewer feels on laying down the book!

B. BASU

8. COLLECTING, PRESERVING AND STUDYING INSECTS. By Harold Oldroyd, M.A., F.R.E.S. Pp. 327 (23.5×15.5 cm.). 15 monochrome plates and numerous line dawings. Hutchinson and Co. Ltd., London, 1958. 25*s*.

One basic prerequisite towards becoming a skilled insect collector is to learn the habits and life-history of your quarry. By understanding the reactions of various insects towards light, warmth, food, moisture, and shelter you can learn to anticipate their movements and know where to look for them.

This seemingly simple knowledge, which in some cases can become almost instinctive, leads some entomologists to capture rare or unusual insects, while other unobservant collectors at the same time and place are securing only the most commonplace species.

A fundamental wisdom and personal humane awareness permeates this practical and thoughtful book on identifying, collecting, and preserving insects. The author Harold Oldroyd sets forth a large amount of accumulated details. His strong sense of humour and individuality as well as a clear and fluid style set this book apart, and makes interesting reading to the neophyte amateur as well as informative matter to the professional entomologist.

The work describes many established as well as up-to-date aspects of entomology, such as practised methods of killing, preservation, mounting, photography, identification, classification, and methods of recording new facts and describing new species. Each phase is thoroughly discussed, with an ample supply of directions, explanations, lists, diagrams, and plates to make each point quite clear. Further aids are given at the back of the book with an appendix of useful chemical formulae and reagents; a glossary of entomological terms; a list of references; and some 'useful addresses' for materials, books, and new and second-hand cabinets in London.

The field of entomology offers many unexplored possibilities, for considerable work has yet to be done in the way of international classification, unification, study, and collection of insects in various parts of the world. Very little is known about Indian insects, for instance—with the possible exception of those injurious to specific crops or responsible for human diseases. Mr. Oldroyd mentions the fact in particular that the fauna of decaying rot-holes in trees has not yet been completely explored, especially in the tropics where some rare and beautiful insects have yet to be fully investigated. 'No opportunity of collecting them should be missed,' he succinctly points out.

In many ways this book offers a challenge. With detailed information packed into this book, and new fields for exploration pointed out, a person could be aided and inspired to promote further study and offer solid contributions to the present knowledge of entomology.

B. J. TUFTY

9. KERALATTILE PAKSHIKAL—(in Malayalam). By Induchúdan. Pp. xiii+638+indexes 2 unnumbered (21×14.5 cm.). 10 colour plates and 169 line drawings. Kerala Sáhitya Academy, Trichur. 1958. Price Rs. 8.50.

This is the book form of the series of articles contributed in the last few years to the illustrated Malayalam weekly, the *Matrubhumi*, by Induchúdan, the assumed name of the author, Sree K. K. Neelakantan, who is now Professor of English Literature in the Women's College at Trivandrum.

The book contains detailed descriptions of 115 or more of the commoner birds occurring in the State of Kerala. There are additional chapters for general topics, such as a historical sketch of Ornithology in India, hints to bird watchers, and a list of suggested reading which includes two books already published in Malayalam.

The descriptions are well written and largely supplemented by the author's own observations. They reveal his keenness for birds and competence as an observer. He writes intimately and sympathetically of his subjects which makes the book eminently readable.

The reported occurrence of the Common Hornbill, *Tockus birostris* (Scop.) in the Valluvanád and Palghat Taluks of the District of Malabar, where it is common, is interesting. The bird has not so far been found in Travancore or Cochin. But it may be pointed out that it is listed in the Malabar birds given as appendix iv of THE MANUAL OF THE MALABAR DISTRICT by W. Logan (1906). The author's discovery of Peafowl living in the wild state is also interesting, though he has not disclosed where, out of fear for their safety.

The format of the book is pleasing. The colour plates, from blocks borrowed from the Bombay Natural History Society, have reproduced well and the line drawings, in most cases, are good. But the printer's errors, from which Malayalam publications are seldom free, outnumber the 41 items already listed in the errata and are offending to the sensitive reader. At least the mistakes in spelling of the English and scientific names of birds in the first table of the opening chapter should have been avoided.

It would have been a great convenience to the reader, if the scientific names of birds were also included in the chapter headings, which now contain their Malayalam names only. Similarly, the scientific names of the different trees and plants associated with birds mentioned in the book are also desirable.

These are only minor matters in an otherwise excellent book and the author deserves to be congratulated not only for his painstaking studies, but also for doing a real service to all Malayalam readers by giving them a reliable handbook of their birds.

N. G. P.

Miscellaneous Notes

1. MUSK SHREWS FEEDING ON LEECHES

Commenting on B. K. Behura's note [*JBNHS* **55** (3): 552] on a musk shrew (*Suncus murinus*) attacking a keelback (*Natrix stollata*), the editors of this journal mentioned the widely varied dietary of the musk shrew, which includes besides cockroaches and other insects which are its normal food being an Insectivore, various other animals like scorpions, toads, bull-frogs, suckling guinea pigs, as well as vegetable matter like roots, grain ?, and bread, etc. Elsewhere, Deoras and Gokhale have recorded [*JBNHS* **55** (3): 459] baby rats and mice also in the dietary of the musk shrew.

Recently, I have observed rather an odd item in their dietary. While keeping for experimental purposes over a hundred live leeches (*Foraminobdella heptamerata*) in a wide-mouthed open earthenware vessel, I was noticing a conspicuous dwindling in their numbers every morning, but no dead ones could be seen in the container. Unfortunately, I was neither aware of the presence of two musk shrews in my house nor of their nocturnal pilferings of my leeches till one evening, when I noticed them at dusk getting up the vessel in my very presence, poking their snouts right into the water, snatching the leeches, and rushing off with them to the nearest retreat.

In about a week's time nearly eighty leeches were knocked off this way. Sometimes I noticed dead leeches floating, with cuts on their body, probably the shrew-bites. These dead and stinking ones seem to attract the shrews more, because, when the vessel was removed to concealment, the shrews could easily scent their way up.

It is rather unlikely in nature for leeches to come within reach of musk shrews, which normally inhabit human surroundings, but I wonder whether the shrews would resort to hunting after this strange food, if they happen to live in the vicinity of leech infested waters.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE,
TAMBARAM, SOUTH INDIA,
September 19, 1959.

P. J. SANJEEVA RAJ

2. PRESENT STATUS OF THE TWO-HORNED RHINOCEROS, *DIDERMOCERUS SUMATRENSIS* (FISCHER) IN THE SHWE-U-DAUNG RESERVE, BURMA

U Tun Yin of Rangoon has sent us a recent draft report on the Shwe-U-Daung Reserve by Mr. Oliver Milton who, together with Mr. R. D. Estes, is presently engaged on a survey of wild life in Burma. This report is of a preliminary nature and covers the period of one month (July-August) when the monsoon was at its worst making it difficult to find, follow, and identify rhino tracks. More than half the Reserve, i.e. over 60 sq. miles, was sampled including some 25 sq. miles in which grew abundantly two sources of food particularly favoured by rhinoceros, namely Kyansa (*Toddalia aculeata*) and Kyein (*Calamus* sp.), where the rhinoceros were expected to be found. From all the evidence obtained, both directly and by questioning the locals, it appears that there are now only two rhinos living in this area (some believe 3) confined to the upper reaches of the streams in the remotest parts of the Reserve.

Considerable depletion of wild life took place in the Reserve during and since the last war until about 1956, anti-government elements having made protective control by the Forest Department impossible. From local evidence it seems that since about 1940 at least 17 rhinos have been killed. This figure may represent only a part of the total destruction. What an attractive commercial proposition a dead rhino can be to the poacher is shown by the values attached to the various parts of its body, given as under:

Dried blood	5 kyats	=$1.05 U.S.	per half ounce
Fresh blood	500 kyats	=$105 ,,	per 1 viss (=3.65 lb.)
Bone	50 kyats	=$10.5 ,,	per viss
Skin	100 kyats	=$21 ,,	per viss

Horn varies from 500 kyats ($105) to 1000 kyats ($210) per inch.

The survey will be resumed in March/April 1960 after which a further report will be submitted by the investigators, with their comments and suggestions.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
September 27, 1959.

EDITORS

3. THE SHOU OR 'SIKKIM STAG'

In the *Journal* for December 1958 (**55**: 556) Mr. Gee appeals for information regarding the status of the 'Shou' (*Cervus affinis* Hodgs.) in Bhutan and Tibet. I have visited all the areas in which this animal is said to occur, and my experience of it may be of interest despite the fact that it is not up-to-date.

Western Tibet

I do not think the Shou has ever occurred in recent times in the vicinity of Mt. Kailas and the Manasarowar Lake. The fact that an antler was found in a monastery near the lake means nothing. All sorts of queer objects such as python skins, stuffed monkeys, crocodile heads, etc., are to be found in these monasteries—presents from pious pilgrims. Western Tibet is a barren, elevated country, totally devoid of forest, and suitable only to such animals as the yak, kiang, gazelle, and antelope which are specially adapted to the rigours of life on the great Plateau. The Shou could never exist under such conditions.

Chumbi Valley

When I was in Gyantse from 1923 to 1926 a few Shou inhabited the Chumbi Valley in the vicinity of a little plain called Lingmothang. In the winter of 1925 I saw three hinds in this area, but no stags. The Shou was also reported to occur at this time in the upper reaches of the Ha Valley in Bhutan, but even at this early date the animal was said to be on the verge of extinction, and in later years Raja Dorje, who owned the Ha Valley, told me he was convinced that all had been exterminated. In 1933 and 1949, in company with Major G. Sherriff I traversed Bhutan from west to east keeping for the most part to the temperate zone under the eaves of the Great Himalayan Range. Burhel were plentiful, also musk deer and barking deer, and in certain valleys takin, but I saw no Shou nor did I hear of any, though the country seemed eminently suited to their needs.

SE. Tibet

In 1936, 1938, and again in 1946-47, Major Sherriff and I made extensive journeys in SE. Tibet. We visited the provinces of Takpo, Kongbo, and Pome, and explored the great Tsangpo Gorge, and the valleys of the Po Yigrong and Po Tsangpo. In none of these areas did we see or hear of Shou, except in the district of Tsari. Tsari is holy ground wherein no life may be taken. Mt. Takpashiri, a place of pilgrimage, is as sacred in the eyes of the Tibetans as Mt. Kailas

in western Tibet. But Tsari unlike western Tibet is densely forested, and here the Shou at the time of our visits occurred in fair numbers. At the village of Chikchar the inhabitants informed us that it descended in winter to feed amongst their cattle. We were told, however, that even in this holy sanctuary the deer were often harried in late autumn by barbaric Dafla tribesmen who ascend the Subansiri to trade, and slay the animals with arrows tipped with deadly aconite. In proof of this we found Shou heads in the vicinity of Chikchar with horns still attached to the skull.

Lhasa

During the war, in 1942-43, I was stationed in Lhasa and in the summer of 1942 I sent my Kashmiri servant to a place called Reting, 60 miles north of the city, to collect plants. He was given a letter of introduction to the Reting Rimpoche, a lama of high rank who acted for a time as regent of Tibet after the death of the 13th Dalai Lama. My servant was well and hospitably received and allowed to wander wherever he wished. He returned to Lhasa in the autumn with a fine collection of plants, and confirmed the reports I had heard that the Reting district was a fertile and well-wooded area. He was most enthusiastic about the country, and said it closely resembled Kashmir and that it contained a large number of Shou which he called 'bara singh', which were strictly preserved by the Reting Rimpoche. In addition to the Shou, he said there were numbers of bear, leopard, and burhel. The fact that Shou occurred in the Reting area was also corroborated by Lhasa officials whom I consulted on the matter. It is certain, therefore, that the Shou enjoyed sanctuary in this Reting area until the end of the war. Unfortunately, after the war, the Reting Rimpoche got into serious trouble. He was arrested for a political crime, and imprisoned in a Potala dungeon where he is said to have died. Shortly after this China invaded Tibet. In view of the Chinese belief that the horns of deer in velvet possess aphrodisiac qualities, it is extremely doubtful if the Shou at Reting any longer enjoy the protection afforded them by the late Reting Rimpoche.

Information on this point could probably be obtained in Kalimpong.

BRITISH MUSEUM (NATURAL HISTORY).
CROMWELL ROAD.
LONDON, S.W.,
March 3, 1959.

F. LUDLOW

4. A TRUSTING CROW

Yesterday while I was sitting reading on the veranda of my house, a common crow (*Corvus splendens*) flew in and alighted quite close to me. This unusually deliberate act on its part made me curious. On examining, I was able to find that the crow had a small metal ring pressed around the lower half of its beak, quite close to its base, causing slight bleeding and preventing it from closing the beak. I approached the crow, which made not the least sign of fear, and holding it by hand removed the ring. Without any delay the crow flew out. I wonder whether there is any other record of this kind. A probable explanation is that, by long association with man, the crow has come to believe in his essential dignity; at least it is fascinating to think so.

MARINE BIOLOGICAL LAB.,
TRIVANDRUM-7. P. RABINDRA NATH
July 11, 1959.

5. SPINY BABBLERS IN KATHMANDU VALLEY

On our day off last week, my wife and I headed for the haunts of the Spiny Babbler [*Turdoides nipalensis* (Hodgson)]. We picked up Dr. Das in Kathmandu, drove past the King's palace, and seven miles northward to Buda Nilkantha Narain with its new white-washed walls trimmed with terra cotta. There we made a right angle turn toward the west and zigzagged for three miles up through a pine forest and scrub jungle to Tokha Sanatorium and the doctor's bungalow. From his lawn we looked down from our 5800 feet to the Kathmandu Valley below. The Sanglakhola on the right meandered through lush, green rice fields to meet the Vishnumati on our left and disappeared behind familiar landmarks of modern Kathmandu—Bhim Sen Tower, the Tundikhel, and Phurtli Sarak.

By mid-morning, monsoon clouds lay above and below us. Armed with binoculars and vasculum and accompanied by our little white Tibetan apso 'Jhapu', we paused at the end of the terrace to get direction. Yes, the 'Spinys' were calling both to the right and to the left, so we picked our way down through a grove of young pines (*Pinus longifolia*), past corn fields, to a hill-side of scrub *Symplocos*, *Rhododendron*, and laurel, shrubs of *Phyllanthus* and *Osbeckia*, over patches of grass brightened with yellow *Hypoxis* and beds of *Selaginella*.

Half way there we came upon an improvised shrine beside a

running brook. A *pujari* was chanting before a platform of large, multi-coloured dahlias, supported by rows of fruit. A group of villagers sat around him, many of whom grasped scrawny chickens.

A hundred yards beyond, a 'spiny' began to sing and was immediately answered by birds in two other directions. We came to a little rise and scanned the bushes and young trees across a ravine. Sure enough, there sat our bird near the top of a twelve-foot pine tree, facing us. He would tilt his head back, hold his tail fairly still and warble for several seconds. He would bend forward, flicking his head and tail slowly from side to side, then straighten up and sing again. There were really two parts to his song: the first was quiet and confidential, the second loud and clear. Initially he seemed to imitate a bulbul, a streaked laughing thrush, and a kestrel, his notes were so varied. But as he swung into the emphatic part of his refrain, the notes were more characteristically 'spiny'.

After the song had been in progress for about three minutes, a second bird flew into the lower branches of the same tree. Its attitude was like that of a Whitethroated Laughing Thrush [*Garrulax albogularis albogularis* (Gould)], with tail bent down and wings flopping open as the head and tail jerked from side to side. It soon 'branch-hopped' upward and sat close to the first bird which flared open its tail and shivered for an instant. The breast of the newcomer was of a distinctly darker shade. The second bird moved about continually, sidling out and back along the branch while the first bird kept his original place. Finally the second one seemed to persuade the first they had an engagement elsewhere, so one after another they 'branch-hopped' vertically downward to the lowest limb of the tree and flew with rapid wing beats to a bush farther into the ravine. We heard two or three calls before all was quiet.

On our way back up the hill we stood at the edge of a corn field and heard still other 'spinys' a quarter of a mile away. We saw brown crickets, tan dragonflies, and a black-and-white day moth with a red body among the foliage. Coral and gill mushrooms lined the path while silver lip (*Cheilanthes farinosa*) and lady ferns (*Athyrium pectinatum*) lined overhanging banks. Along a water course grew a single lily-of-the-valley (*Ophiogopon*) hedged about with Christmas ferns (*Polystichum squarrosum*). Rocks of quartz lay among loose earth glinting with mica.

As we came back past the shrine, four small children played among the debris. The flowers were splashed with blood while the hillside was strewn with fresh feathers, but the fruit was gone. A

kite (*Milvus l. lineatus*) slowly wheeled about the spot where the villagers had sacrificed to 'Ban-Kali', Goddess of the Forest, for rain and a good harvest.

A ray of sun broke through white clouds and lit up the rice fields. Another spiny called from the spur to the east. It was strange that no one had recorded this bird from the Valley for 114 years until we found it first at Nagarjung, then on Sheopuri, Negarkot, and Lele. It is the common babbler of the scrub jungle on the hills surrounding Kathmandu.

SHANTA BHAWAN,
PATAN, KATHMANDU,
NEPAL,
July 25, 1959.

R. L. FLEMING

6. COMMUNAL NEST-FEEDING IN BABBLERS

In a Miscellaneous Note on the parasitic habits of the Pied Crested Cuckoo in Volume **40**, p. 125, I remarked on a case of four members of a gang of Jungle Babblers feeding young in one and the same nest. I thought I had enlarged on this elsewhere but do not seem to have done so. At one particular moment I could see a babbler flying away from the nest having just fed the young, another was now on the rim parting with food, a third was waiting near by in a nim tree, the fourth arrived on the roof of the bungalow a short distance away. I waited till Nos. 3 and 4 had also fed the young. This was in Bareilly, but I have seen three of these babblers feeding the young in a nest as far away as Madras.

In the Pied Crested Cuckoo note I referred to Jungle Babblers feeding two young cuckoos moving about together and wondered whether the young cuckoos were out of the same or different nests—they looked the same age incidentally—of the same party of babblers. However, I think this is the place to point out that I never succeeded in finding two nests of the Jungle Babbler in use at the same time, that is, in an area in which I could say they belonged to the same gang. In fact I have a strong suspicion, supported by a certain amount but insufficient evidence for certainty, that the pairs in a gang nest consecutively and not concurrently. If I am right, this is not a negation of the synchronized nesting idea but merely an adaptation of it which might well be of considerable value in the case of these gregarious birds. I would also add that I have no reason at all to believe that two or more females ever lay their eggs in the same nests as Mr.

Malcolm Macdonald suggests. It should not be too difficult with the help of colour-ringing for someone with the necessary time and patience to elucidate these points.

HAYBARN,
THURSLEY,
SURREY, ENGLAND,
July 26, 1959.

R. S. P. BATES,
Lt.-Col., I.A. (Retd.)

[A. Skutch (1935, *Auk* **52** : 267) found in the Central American Bush Tit, *Psaltriparus melanotis*, where males outnumber females by 4-6 : 1, that unmated bachelor males help the mated pair to feed the young. At three nests 1, 1, and 3 extra males were sharing in this duty.

Out of the 12 young fledged from these three nests, all seemed to be males! But sex was not determined by dissection, so there is a possibility of error.

It would be of great interest to determine the sex ratio in babbler 'sisterhoods'.—EDS.]

7. TWO DEAD SWALLOWS IN A NEST

On 15th September 1959 we went to Changalra (Bhuj) for netting birds under the B.N.H.S. Migration Study Scheme, and in the shooting box there Dr. Sálim Ali found a nest of the Redrumped Swallow, *Hirundo daurica erythropygia* (Sykes), with one dead bird blocking the entrance tube of the nest. On further examination of the nest after the entrance was broken open we found one more dead swallow inside with the shells of its eggs. It appears that the birds had completed the nest, and one of them was incubating the eggs while the other one must have been busy putting the finishing touches to the structure. The only plausible explanation for this rather unusual mishap seems to be that one of the birds must have taken the last few pellets of mud late in the evening, and thereafter on entering the nest to roost it must have tried to complete the day's work. The result of this last-minute constructional alteration was that the entrance hole became too narrow and the birds thus unwittingly entrapped themselves. As some of the mud must have dried up and become hard set during the night, it must have become impossible for the poor swallows to get out of the narrow entrance the next day, and eventually they starved to death.

The two dead swallows were found in a completely dry state and hence it appeared that this little tragedy must have taken place at least a month ago. It is likely that the eggs were broken by the birds during their struggle to escape from the nest; or the other possible explanation for the broken eggs might be that the starving birds helped themselves to the contents?

This unusual incident also throws some light on the roosting habits of this swallow. It would seem, at least in some cases, that the male roosts in the nest while the female incubates the eggs.

BHUJ,
KUTCH,
September 20, 1959.

M. K. HIMMATSINHJI

8. THE DIFFERENT CALLS OF THE GREY PARTRIDGE *FRANCOLINUS PONDICERIAÑUS* (GMELIN)

Generally people are under the impression that the call of the Grey Partridge, commonly heard in our countryside, is uttered by the male alone, but in actual fact in eight cases out of ten it is the combined calls of both the cock and the hen which one hears. I have kept partridges as pets, and thus have had the opportunity to study their different calls at close quarters. These I shall now try to describe.

There are mainly two types of calls which are uttered by the male. Generally they are preceded by low clucks or chuckles uttered several times at intervals of a few seconds, each successive cluck rising in intensity. This is followed by the high-pitched *kili ka ka ka kili ka ka ka* or *kila kila kila* repeated in quick succession. While fighting or challenging, rival males also utter a sharp *pila . . . pila . . . pila* at intervals of two to three seconds. The female sometimes utters low chuckles also, but these are not as sharp as those of the male. The usual call of the female is a very high-pitched mono-syllabic *tee tee tee* repeated several times. She also says *kila kila kila* like the cock, but this call, though similar, is softer and more sharp in comparison. Normally, when the male calls the female joins him and combines her *tee tee* with his *kili kaka* or *kila kila*; and so when they call in unison it sounds like *kiliaak killak killaak* or *kateela kateela kateela*. In the former call, i.e. *kiliaak*, the first syllable of the male's call is uttered simultaneously with the *tee* of the female followed by the *likaka*, while in the latter, i.e. *kateela*, the *tee* of the female is uttered a fraction of a second after the *ki* of the

male, and hence this combined call sounds like *kateela kateela kateela.*

Apart from the above calls there is also a very sharp and high-pitched alarm call which sounds like *tirrr tirrr tirrr* repeated quickly when partridges are flushed by a bird of prey or any animal. When danger is suspected, *chirrr . . . chirrr . . . chirrr* is repeatedly uttered at intervals of between two to eight seconds. This short alarm call is usually continued to be sounded by the birds until they are satisfied that the danger, whether real or imaginary, has passed. When partridges have young chicks with them the above calls are uttered more often. As soon as the parents sound the alarm notes the young ones rush for cover, and they remain quite still until called out by the parent birds with a soft *kunva kunva kunva* which is answered by the shrill *ti ti ti . . . ti ti ti* of the chicks, audible at some distance. These calls of the parent birds are repeated, and the little ones also continue with their tiny calls until the whole family is re-united. Young males sometimes make their first attempt to call when they are between three to eight weeks old.

BHUJ,
KUTCH, M. K. HIMMATSINHJI
September 28, 1959.

9. THE OCCURRENCE OF THE WHITENECKED STORK [*CICONIA EPISCOPA* (BODDAERT)] IN THE KASHMIR VALLEY

Early in the morning of May 15 1959, when I was walking along the Dal Lake in Srinagar, a solitary Whitenecked Stork was observed opposite to Oberoi Palace Hotel (altitude about 5200 ft.).

The occurrence of the Whitenecked Stork in the Valleys is noteworthy since it marks an extension of its distributional as well as as altitudinal range. THE BOOK OF INDIAN BIRDS mentions that it occurs up to an altitude of 3000 ft. above sea-level. Osmaston (Notes on the Birds of Kashmir, 1927, *JBNHS* **32**) does not record it, neither do Bates & Lowther in their THE BREEDING BIRDS OF KASHMIR.

174, KASBA PETH,
POONA 2, V. C. AMBEDKAR
October 20, 1959.

[The Whitenecked Stork occurs in the Salt Range area of the Punjab and has once been recorded in Sind. As far as we are aware, the above is the first published record for Kashmir.—EDS.]

10. LARGE CLUTCH OF NAKTA EGGS

K. S. Shivbhadrasinhji informed me that he had found a nest of a Nakta duck (*Sarkidiornis melanotus*) containing a large quantity of eggs on 21st August 1959 at his farm at Hathab, Gohilwad District, about 18 miles from Bhavnagar.

So on 25th August 1959 he and I went to see the nest. The nest-hole was in a bifurcated trunk of a mango tree. There were two mango trees close to each other, one of which contained the hollow in which the eggs were laid. The trees were situated in open grassland with clusters of other mango trees here and there. A small pond of dirty rain water, the only suitable pool in the neighbourhood, was 300 yards from the nest-hole. The nest-hole was 70 inches from the ground, the diameter of the entrance was 9 inches and the hollow 45½ inches deep. The bottom of the nest-hole was slightly wider, had a separate narrow exit leading upwards to a broken stump, the width at the base being 6 inches. The nest-hole was mostly lined with soft down mixed with sand debris and contained 54 (fifty-four) eggs. We consider this to be an unusually large number, perhaps a record for one nest, the product of at least three or more females. A. Anderson found a nest with 40 eggs, and Livesey in Kotah, Rajasthan, found one with 47 (Baker, NIDIFICATION **4**: 490). The latter thought that it was the product of two or more females.

Taking into account other observations in the vicinity of the nest-hole within a week, we saw one male Nakta and four females, and one day the drake had with him five ducks. We made a search of the neighbouring trees for nests but could not find any and the one which contained the eggs appeared to us as the most suitable site for the Naktas. Therefore, a communal nesting appears to be the obvious answer when suitable nest-sites are wanting. Later, owing to human disturbance, we found the Naktas had deserted the nest and a few of the eggs were cracked and smelly.

DIL BAHAR,
BHAVNAGAR, R. S. DHARMAKUMARSINHJI
August 27, 1959.

[This, as far as we know, is the largest number of eggs recorded in a single Nakta nest.—EDS.]

11. ADDITIONS TO THE BIRDS OF KUTCH

During recent field work in the neighbourhood of Bhuj (15-30 September) in connection with the Society's project of ringing birds for migration study, the following species were recorded as new for Kutch:

1. **Locustella naevia straminea** Seebohm: The Eastern Grasshopper Warbler.

Winter migrant from northwestern central Asia to practically all India. Previously recorded from Gujarat and Saurashtra.

2. **Phragamaticola aedon** (Pallas): The Thickbilled Warbler.

Winter migrant from Siberia from Tomsk to Manchuria, and N. China. An unexpected find as hitherto known only as a visitor to NE., E., & S. India, presumably migrating from the eastern side.

Two specimens were taken in mist nets near Bhuj on 26 and 29 September. Since it has never before been recorded in NW. or W. India it needs to be ascertained whether these two examples were merely vagrants—in some way under pressure of the phenomenally heavy monsoon in Kutch, Saurashtra, and Gujarat this year—or whether the species has consistently evaded collection or observation in the past. It may be mentioned that but for the fact of their getting caught in the mist nets the birds would most certainly have been overlooked or mistaken for the Great Reed Warbler, *Acrocephalus stentoreus brunnescens* (Jerdon), to which it bears a close superficial resemblance.

3. **Ploceus benghalensis** (Linnaeus): The Blackthroated Weaver Bird.

A specimen taken in the nets, 16 September 1959 (preserved but unfortunately destroyed by a cat).

Not recorded from Saurashtra or Sind; nearest from the Baroda and Kaira districts of Gujarat. This was the only specimen (in female plumage) taken during a fortnight amongst 220 *philippinus*. It is possible that small numbers may be resident (?), or may visit Kutch under favourable conditions produced in years of heavy rainfall. Before the specimen was obtained I had observed (on September 7) two nests (this year's) presumably abandoned owing to flood. They were typical of this species both as to structure and site, but no birds were present to confirm their identity.

33 PALI HILL,
BANDRA,
BOMBAY 20,
October 30, 1959.

SÁLIM ALI.

12. ADDITIONS TO THE BIRDS OF TAMBARAM, (CHINGLEPUT DISTRICT, S. INDIA)

Alice M. Barnes has recorded (*JBNHS* **40** : 467-476 and 744-747) eighty-four species of birds noticed in and around Tambaram during the years 1932-1939. During my stay here since 1945, I have noticed some more birds, the addition of which to the bird list of Tambaram may be of interest to bird watchers in this locality:

1. **Dicrurus caerulescens** (Linn.) The Whitebellied Drongo.

Often seen in the college estate either singly or in pairs from October to December. Habits very much like the Black Drongo's. Sometimes noticed in the company of other insectivorous birds like bee-eaters and shrikes. One was observed lying in wait and snatching away a mole cricket scratched out of a gutter side by a domestic hen.

2. **Anthus rufulus** Vieillot The Indian Pipit.

Observed only once late in the evening on 12-10-1957 feeding in the grasslands adjacent to the Selaiyur tank bed.

3. **Crocopus phoenicopterus** (Latham) The Common Green Pigeon.

One was seen in the garden one evening in March 1957.

4. **Sterna aurantia** Gray The River Tern.

Common from February to April when the surrounding tanks begin to dry up. Can be seen flying overhead in flocks of 2-12, but are known to alight only at the larger Agaram tank.

5. **Himantopus himantopus** (Linn.) The Blackwinged Stilt.

Common on all the local tanks from February to April, feeding in the shallow receding waters.

6. **Phalacrocorax niger** (Vieillot) The Little Cormorant.

Only one, probably an accidental visitor, was once captured in 1946 on the Kadaperi tank.

7. **Ardea cinerea** (Linn.) The Grey Heron.

Observed twice on the Selaiyur tank. Once in July 1957 and later on 24-3-1959. Usually single, right in the middle of the tank, rather late in the evenings.

8. **Egretta intermedia** (Wagler) The Smaller Egret.

Noticed only once on 4-2-1958 on the drying up tank at Amruthapuram near the Tambaram Sanatorium station.

9. **Nycticorax nycticorax** (Linn.) The Night Heron.

Never seen them alighting on the local tanks but groups of 2-6 can be seen flying overhead every day at dawn and at dusk from January to April.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE, P. J. SANJEEVA RAJ
TAMBARAM,
July 14, 1959.

[Since the above two more species have been added to the Tambaram list by Mr. Gift Siromoney of the above college as follows:

1. **Dumetia hyperythra** (Franklin) The Rufousbellied Babbler.
A small flock in the garden on 16-9-1959.

2. **Motacilla indica** Gmelin The Forest Wagtail.
A group of 5 on 25-9-1959 and a single on 27-9-1959.

He also gives the description of a bird which was evidently

Lanius cristatus Linn. The Brown Shrike.
Single on wires on 19-10-1959.—EDS.]

13. SOME BIRDS OF CHINGLEPUT DISTRICT, MADRAS

I send here a note on a few birds seen recently around here which are not very commonly observed:

1. Laggar Falcon: *Falco jugger*. Once seen by A. Krebs and myself near the hills south of this town (Chingleput) and again near the western foot of the same hills in early December. On this occasion it stooped very fast from a height and struck down a myna near the bank of a channel. It dragged its victim on to the bank below the bund on which I was standing, and plucking it proceeded to make a meal. Its large size and powerful build and the distinctive colouring easily visible at such a short distance were clear guides to its identity.[1] (Only 2 records—one Chingleput District and one Wynaad.)

[1]The records in brackets are from The Vernay Scientific Survey of the Eastern Ghats, Ornithological Section, by H. Whistler and N.B. Kinnear, and The Birds of Mysore, by Sálim Ali, published in previous volumes of *JBNHS*.

2. Small Indian Swallow-Plower or Pratincole *Glareola lactea*. A dozen of these small plovers drew my attention as they moved on the sandy bed of the Palar River SW. of Chingleput, and thinking they were Ring Plovers I was puzzled by the lack of rings. As more flew in bands of 30 or 40 their almost tern-like long wings, black-tipped tail, and general appearance showed them to be something quite different. The problem of their identity was solved the next day (25th Dec.) when I saw the fine coloured plate in Henry's BIRDS OF CEYLON.

On the sand the birds nestled low or stood, occasionally moving forward in little spurts. The general appearance of the bird is grey with the dark stripe from beak to eye very conspicuous, the chest sandy or buff in colour. At close quarters the white ring round the eye is very conspicuous. Even when at rest the dark tips of the long wings stand out, while in flight the dark primaries and dark-tipped tail contrasting with the white tail coverts prevent false identification.

I estimate that more than 100 were gathered when the light faded. A few days later none were to be seen.
('Godaveri Delta', Mysore, 'Mangalore'.)

3. The Tufted Duck: *Aythya fuligula*. A small party of 9 of these were seen by me on the P. V. Kalathur tank near here on 1-1-59. They were fortunately unusually close to the bund when we appeared. They then paddled off very smartly for the middle of this large tank. Their tubby form, large head (only some had crests), prominent eye, and the striking black and white of the drakes were immediately recognisable, though my last view of these ducks was on a pond in Edinburgh. They have apparently only once been recorded in Ceylon and I myself have not seen them before in these parts. ('North Coimbatore, Vizag, Godaveri, Kistna, Chingleput, Chittore, and Bellary', Mysore.)

4. Spottedbilled Pelican: *Pelecanus philippensis*. On 13-3-59, the watcher at Vedanthangal informed me that no pelicans had been seen this season. Half an hour later, at 5.30 p.m., one appeared and after circling round for a while settled in a tree well in the middle of the tank.

CHURCH OF SCOTLAND MISSION,
CHINGLEPUT,
S. INDIA,
March 14, 1959.

REV. E. O. SHAW, M.A.

14. BIRDS EATING POISONOUS FRUIT OF YELLOW OLEANDER (*THEVETIA NERIIFOLIA*)

Earlier, Krishnan has reported in the *Journal* (**50**: 943-944 and **52**: 207) the Koal (*Eudynamys scolopaceus*) and the Common Myna (*Acridotheres tristis*) eating the fleshy mesocarp of the fruit of the Yellow Oleander. Subsequently, Neelakantan (*JBNHS* **51**: 738) has noted the same habit in the Common Grey Hornbill (*Tockus birostris*) also.

About the end of August, ripe fruits were dropping to the ground from a single Yellow Oleander in front of my house and, for two days alone, I was noticing the Redvented Bulbuls (*Molpastes cafer*) and the Whitebrowed Bulbuls (*Pycnonotus luteolus*) frequenting the plant for the fruit. These birds are abundant in the surrounding 300-acre scrub jungle of the college estate. Only on a single occasion, did I see a Redvented Bulbul pecking at a fruit on the plant, otherwise, they seemed to prefer the ripe ones fallen on the ground underneath. Each bird would eat about half of the fleshy part of the fruit which it pecked at and tore off with its beak. Sometimes while in fear of intruders, it carried off the fruit to safety in a near-by hedge. I noticed several Common Mynas also approaching the ripe fruit but, strangely enough, none of them touched it.

I feel that the preference shown by birds for the ripe fruits is probably due to the lesser amount of latex they contain than the raw ones. Even then it is not every bird, but only an occasional individual that relishes the fruit. Unfortunately, we have no evidence of the effects of eating such poisonous fruit on the birds concerned, either good or bad.

DEPARTMENT OF ZOOLOGY,
MADRAS CHRISTIAN COLLEGE,
TAMBARAM,
S. INDIA,
September 22, 1959.

P. J. SANJEEVA RAJ

15. *CALOTES* LIZARD OCCUPYING BIRD'S NEST

At Jodhpur there was a small nest of a bird (?) in a *Capparis aphylla* bush which was being searched for snakes and small mammals at midnight. The net was examined and found to be occupied

by a lizard, *Calotes versicolor*. It was carefully captured, identified, and marked with indelible ink. Next evening it was released near the bush. The nest was again examined late in the night and found to be occupied by the same lizard. During the day the nest, which appeared to be abandoned by the owner, was always found vacant. It was only a nightly resort of the *Calotes*, which was observed living there for about a week after which it disappeared.

DEPARTMENT OF ZOOLOGY,
MAHARAJA'S COLLEGE,
JAIPUR,
May 1, 1959.

ISHWAR PRAKASH

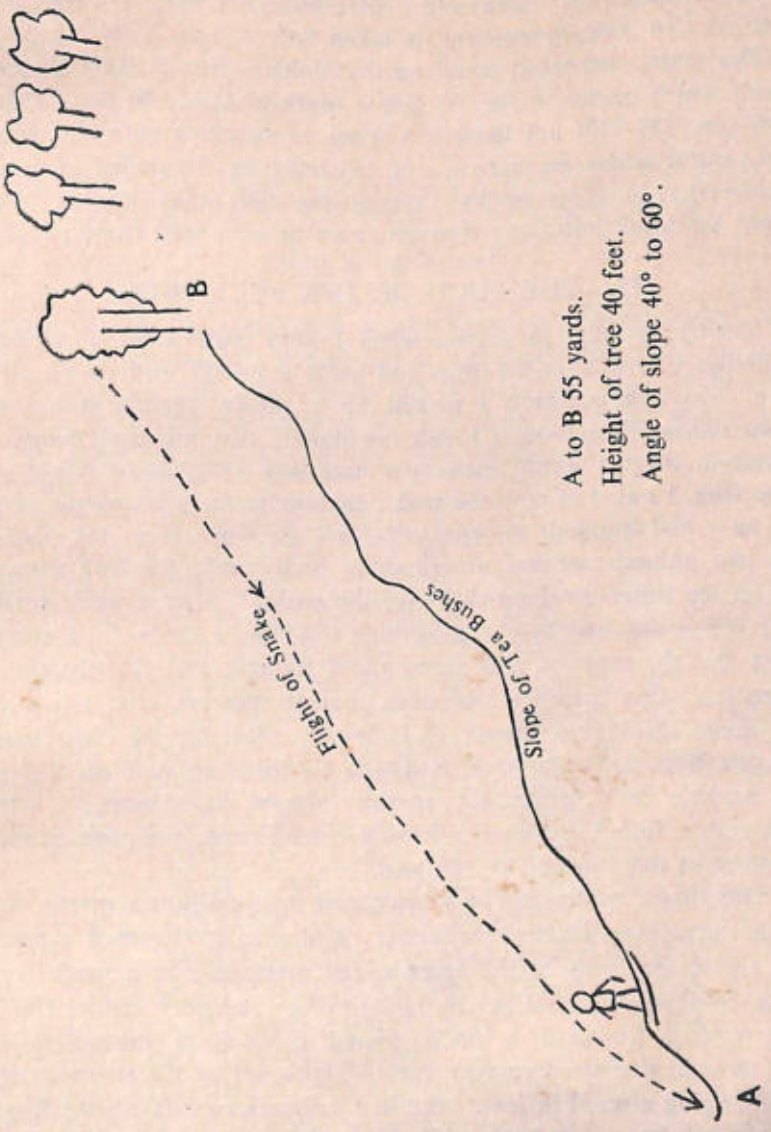
16. FLYING SNAKES

(*With a text-figure*)

I have to report an extraordinary occurrence which happened to me on 16th June 1959.

While walking along a path on my tea estate I saw a snake hurtling through the air towards me on a diagonal trajectory from right to left. When I first saw it, it was about 20 feet above ground level and appeared to have launched itself from a rosewood tree on the slope of 30° above me and some 50 yards away. It came with a furious swimming motion keeping itself perfectly horizontal, and as I drew back whipped past about five feet in front of me at chest level and landed below me between two tea bushes and some five yards away. It lay on a heap of weeds perfectly still, and I was able to observe that it was about 2½ feet long, thin, and coloured yellowy brown with red, black, and white markings on its back. After a few minutes I clambered down the bank to kill it but at the first blow with my stick, which landed towards its tail, it shot off into the bushes. I was unable to observe its head which was in the shadow and behind a branch.

I have never heard of a 'flying snake' or one that could launch itself such a distance and at such a height and anyhow why should it do it? On the other hand if it had been dropped by a bird of prey it would have fallen straight down and not been trajected across my line of vision?



This estate is in the South Wynaad and the average elevation is about 3000 feet.

CHEMBRA ESTATE,
CHEMBRA P.O.,
VIA MEPPADI,
MALABAR,
June 17, 1959.

K. H. VAUGHAN-ARBUCKLE

[Elaborating the note our correspondent sent us the above sketch drawn from measurements taken later.

The snake concerned could be the Golden Tree Snake *Chrysopelia ornata* which occurs in the W. Ghats south of Goa. In the *P.Z.S.* for 1906 (pp. 227-230) are described some experiments with this species. The ventral scales are narrow and the belly can be pulled in to show a concavity in cross section thus giving the snake leaping from a height the same buoyancy through space as of a split bamboo.—EDS.]

17. THE FOOD OF THE BULL FROG

During my stay in Poona, when I kept quite a lot of snakes in captivity, I used to catch frogs and toads regularly to keep the snakes alive. On one occasion I picked up a rather gigantic specimen of *Rana tigrina*, and though I had my doubts that my pet Dhaman (of 8 feet in length) would make the necessary exertion to swallow the huge frog, I put it in with the snake anyhow to see what would happen.

As I had thought, the snake did not even try to eat the frog, and the two animals seemed to get along pretty well, the frog sitting all day in the water bowl provided for the snake. After a week, realising that the snake had to eat something anyhow, I threw in a sparrow. Next day the sparrow was gone, and I thought that the dhaman had eaten it. After three or four days another sparrow, and then a third. All down the snakes throat, so I thought. But for the third sparrow I came back after an hour, and was surprised to find no 'bump' in the snake's belly where the sparrow should have been. I thought that rather funny, because a freshly eaten sparrow always showed a swelling in the stomach in the past.

This time I waited a whole week, and then brought a sparrow along to the large glass-fronted snakebox. And then I witnessed a nauseating sight. As soon as the sparrow fell into the box it made for the glass, thinking it would get through, and at that very instant the huge frog made a frantic dive for it, missed, dove again, missed again. I first thought that the frog was merely frightened by the sparrow and so was jumping around in fear. But in the fourth or fifth try the frog had the sparrow caught in between its jaws, and then using both its forelegs like hands it just shoved the bird into its mouth, pushing first left and then right, left and right, till the bird was entirely within the mouth and throat. Then with an awful effort it gave a mighty swallow, and down went the bird.

CATHOLIC CHURCH,
RAJ-ANANDPUR, BIHAR,
July 27, 1959.

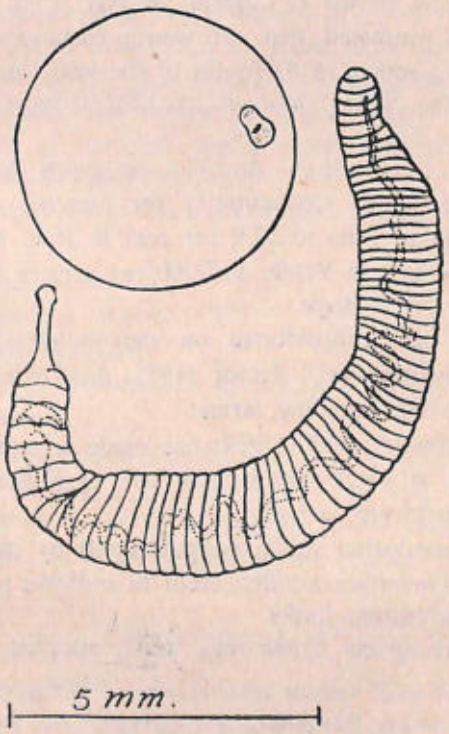
RICHARD LANE SMITH, S.J.

[Several notes have appeared in the *Journal* from time to time on the exceedingly varied nature of the bull frog's dietary. Reference is invited to p. 213 of Vol. **52** (1) where some of the foods previously recorded have been summarized.—EDS.]

18. A PRELIMINARY NOTE ON THE CULTURE AND DEVELOPMENT OF INDIAN EARTHWORMS

(With a text-figure)

The role of the earthworm is controversial. Some regard it as beneficial, whereas others consider it a pest and recommend measures for its elimination. Thus, about three years ago, the Smithsonian Institution recorded the invasion of the eastern United States by a 'Plague' *Pheretima lupeinsis* or the green earthworm.



Pheretima houlleti 24 hrs. after hatching, with capsule.

One reason for the controversy is perhaps the fact that there are many types of earthworms, some beneficial and some otherwise. Hence, the cultivation and breeding of a few selected types has been

undertaken abroad. In India, this aspect has barely received attention, though others are fairly well represented. Thus the monumental work of the late K. N. Bahl deals mainly with Systematics & Anatomy, while J. V. Bhat, N. V. Joshi, and others have concentrated on the intestinal microflora. Shrikhande & Pathak in Kanpur, and Nijhavan & Kanwar in Ludhiana have studied the physico-chemical properties of earthworm castings and the latter team has compared them to those of other insects. Such studies are of the greatest importance in India where nitrogen, in particular, is in short supply and its addition to the soil in the inorganic form is subject to losses by way of leaching, base exchange, and volatilization. The cultivation and breeding of a few select types of earthworms which may produce good manure is thus important to our agronomy.

Work along these lines has advanced so much in other countries that the following can be only a very sketchy review of the same.

Thus, according to the U.S. Dept. of Agr. Exp. Sta. Record **27**, No. 6 (2), it is estimated that earthworm castings deposited during an active growing season of 6 months of the year (in the valley of the White Nile in the Sudan) amount to 239,580 lb. (119.79 tons) per acre.

Wolney has found from direct experiments in culture boxes that the ratio of higher production in the presence of worms varied from 2.6 per cent in Oats to 63.9 per cent in Rye, 135.9 per cent in Potatoes, 140 per cent in Vetch, and 300 per cent in Field Pea to 733 per cent in the case of Rape.

Bafile (1950) has concentrated on the industrial production of humus by earthworms, and Grant (1955) has expanded upon the subject of earthworm breeding farms.

In our own country Joshi (1954) has made a beginning by noting the improvement in black cotton soils due to increased nitrification resulting from earthworm activity.

Experiments conducted so far (unpublished) by the junior author, with castings of *Pheretima houlleti* seem to indicate a fair amount of ammonification in culture flasks.

The procedure given below has been adapted, in part, from Barrett:

Earthworm Culture

Wooden boxes (11″×7″×8″) are filled with garden soil, cowdung, and straw in equal quantities (by volume) and topped up by an inch-thick layer of dried leaves. The upper surface of the leafy layer is then covered by gunny cloth. The boxes are supported on two bricks in a metal tray containing water to prevent attacks from insect

predators like red ants. A population of 250 mature earthworms can be supported by a box of this size. Accordingly they are collected and after preliminary screening, 250 healthy specimens are distributed per box. The boxes are to be watered at regular intervals, avoiding water-logging. (A two-inch layer of crocks and pebbles arranged in the bottom of the box prior to filling up provides good drainage).

The contents are examined at monthly intervals. If a few cocoons are detected then the examination is repeated every week in order to collect the full quota of cocoons. If on the other hand, many young ones are observed then the cocoons can be taken to have hatched during the interval. If allowed to remain, the cocoons will produce young worms in the course of time. If embryological studies are in view then the following method is recommended.

10-12 cocoons are distributed over layers of moist filter or blotting paper kept in the bottom of 8″ petri dishes. The sheets are moistened with a weak watery extract of soil from the earthworm box. The young worms can be maintained for a few days, at least, on a diet of moist filter paper only. This, incidentally, suggests a method for studying the food habits of worms by impregnating the filter-paper with various kinds of artificial media. The excreta can then be subjected to chromatographic analysis.

The following is a list of the earthworms cultured by the method described.[1]

1. *Pheretima posthuma.*
2. ,, *houlleti* (Perrier, 1892).
3. *Pontoscolex corethurns.*
4. *Hoplochoetella khandalensis* (Stephenson, 1924).
5. *Perionynx* sp.

It may here be mentioned that *H. khandalensis* could not be maintained successfully for long periods. *P. posthuma* and *P. houlleti* were selected for further study in pure cultures. Their choice was due to their importance as types for undergraduate courses.

Observations

1. *P. posthuma* prefers more organic matter than *P. houlleti.*

2. *P. posthuma* produces cocoons after a period of four weeks from maturity, whereas *P. houlleti* requires three weeks.

3. The cocoons of *P. posthuma* are brown in colour, oval in outline, and with two projections at either end of the long axis. The

[1]We are indebted to Dr. G. E. Gates, U.S.A., for the identification.

cocoon is deposited deep within the burrow. *P. houlleti*, on the other hand, produces cocoons which are white, round, and slightly larger than those of *P. posthuma*. They are distinct from the soil and can be easily separated.

4. The hatching period for *P. posthuma* is about 30-37 days under petri dishes, while *P. houlleti* requires 25-30 days depending on the temperature and humidity. If the temperature is lowered below 28° C. and 50% relative humidity, the cocoons take a longer time to hatch, about 45-50 days.

5. Both the worms are surface casters.

6. A newly hatched animal has same segments as the adult.

7. About 20% of the cocoons do not develop; probably they are unfertilized.

In brief, it is hoped that the technique presented here will enable workers to contribute towards elucidating the role of the earthworm in agronomy. The animal is also interesting from the zoological as well as the biochemical point of view. Regeneration, respiration, and the nitrogen content of the excreta are some other aspects of importance. Lastly, it will enable teachers to provide live specimens for dissection throughout the year.

Acknowledgements

The authors wish to thank Dr. D. V. Bal, Director, Institute of Science, and Prof. Mrs. E. Gonzalves, Prof. of Botany, Institute of Science, for the facilities provided and for their constant encouragement.

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August 8, 1959.

References

Bafile, M. (1950): Industrial production of humus and artificial raising of earthworms. *Italia Agric.* **87** (6): 372-381.

Barrett, T.J. (?): Harnessing the Earthworm.. London, Faber & Faber Ltd.

Grant, W.C., Jr. (1955): Earthworm breeding Farms. *Science* **121** (3134): 107-108.

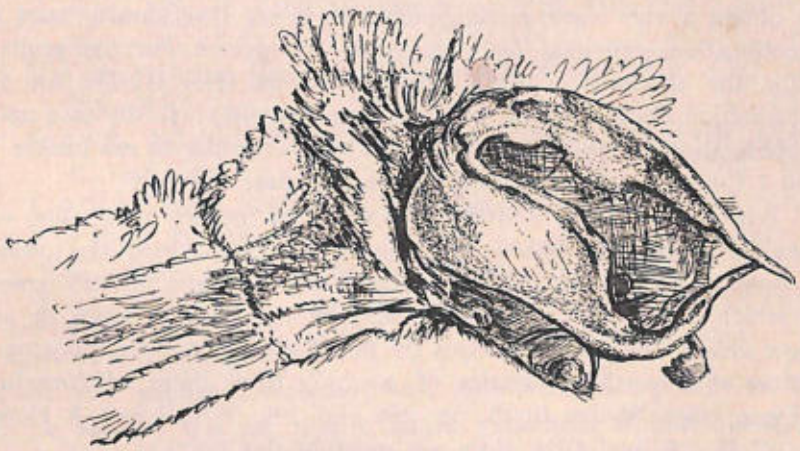
Joshi, N.V. (1954): Investigations on Microbiology of Soils. Proc. of the Symp. on ' Soil Research in India '. *Bull. Nat. Inst. Sci. India* **3**; 115-121.

19. APPEARANCE OF *NACADUBA PACTOLUS CONTINENTALIS* FRÜH., (LEPIDOPTERA: LYCAENIDAE) AT LONAVLA, WESTERN GHATS

(*With a text-figure*)

In October and December 1956, and in November 1957 and 1958, I was fortunate in encountering this rare Line-blue butterfly on the outskirts of Lonavla, (2300 ft.) on the main line between Bombay and Poona.

I took one male only, on 12-12-1956, and a female on 14-10-1956. The next female was caught on 30-11-1957; seven on 5-10-1958, and one each on 15-10, 12-20, and 2-11-1958. There were also two females in November 1958 from which I tried to get eggs.



Clasps of *Nacaduba pactolus continentalis* Früh. (ventro-dorsal view)

All the specimens occurred in a small jungle, only about 200 by 50 yards in area, next to the Christian cemetery. I believe the vegetation here is in the climax stage; a remarkable fact in itself, for the place lies between the bazar and a region of bungalows. But the ground dips suddenly into a hollow, and so man has not cared to spoil it much. I know of no other place in the district where, at most seasons, butterflies are so thick on the ground.

I am unable to give a proper account of the plants; a complete list, eventually, may prove to be the only way of getting at the food-stuff of *pactolus*; at present I can only mention a few which I have learnt to recognize through their known connections with the Lycaenidae. The undergrowth includes a great deal of the leguminous

Mezoneurum cucullatum, the tenacious hooks of which are a great nuisance to the collector. There are also some grand full grown *Entada scandens* (Leg.). On young shoots of young plants of this species I have found larvae of the common *Nacaduba beroe gythion* Früh. Other under-plants are *Cylista scariosa* (Leg.), *Acacia* sp., and *Dioscorea* sp. Among the trees are *Pongamia glabra* (Leg.), growing only on the edge of the wood, apparently not more than six feet high, and without flowering—a botanist's problem. *Terminalia* sp. (Combret.), and *Eugenia jambolana* (Myrt.) conclude this inadequate summary of the plants.

On the identity of the butterfly I am on firm ground. I am much indebted to Mr. T. G. Howarth of the British Museum for checking the identity of the only male I caught. The clasps of the genitalia are distinctive, being in shape rather like the head and bill of a cormorant (see text-figure). It is worth emphasizing how easy it is to obtain a view such as this, sufficient to see the characteristics for identification, provided one remembers to squeeze out the genitalia while the specimen is fresh (see *JBNHS* **54** (1): 212-215 for full information about methods of examining genitalia). In the case under consideration I wanted to remove one clasp in order to see further in. But I found I must wait until I have had more practice.

When I saw Mr. Howarth I had only one female; his opinion was that this should be linked with the male. This helped me towards a confident decision on the fairly large catch of females in 1958, several of which are in excellent condition. But all, whether worn or not, show clearly the darkened veins on the disc of the upper forewing, a feature distinguishing females of *pactolus* from those of *Nacaduba hermus*. (See Wynter-Blyth, pp. 296 and 299; Woodhouse & Henry, pp. 87-88. Evans, 1931, does not mention this point.)

The following is a summary of all the data and records I have been able to get together. I am most grateful to those in charge of the major collections for so kindly easing my way both by letter and personally.

British Museum:

Type from Sikkim, Godwin Salvin Coll., 1908.
Burma: Ataran Valley, Maymyo, E. Pegu, Upper Burma, Nagas.
Assam: Khasis, Angralong.
S. India: Coorg, 9-4-1929, J. H. Yates.
'India': Coll. Hewitson.

Bombay Natural History Society:

Sikkim: Tista Valley, March, April, October, November 1949 and 1950.

Assam: Sibsagar, July 1952. All above in Souter Coll.
S. India: N. Kanara, Karwar, March and May 1920 and 1921, T. R. Bell.

Zoological Survey of India:

Sikkim: 19-10-1884, de Nicéville Coll.
„ undated „
Assam: Sibsagar, undated, Peal Coll.
Tenasserim: Dawnat, undated, de Nicéville Coll.
Bhutan: Buxa, undated, Mus. Coll.

Hope Department of Entomology, Oxford:

Standing under the name of *Nacaduba macropthalma* Fldr. are the following specimens:

1 ♂ Nilgiris 3000 ft. July 4th 1896 A.G. Cardew.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 5th 1918 Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 11th 1918 Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 6th 1919, Coll. C. Donovan.
1 ♂ SE. Nilgiris 6000 ft. Coonoor, May 18th 1919, Coll. C. Donovan.
1 ♂ South India. Palni Hills, 6000 ft. Kodaikanal May 27th 1919. Coll. C. Donovan.
S. India: Coorg, Urti, 28-10-1926, female.
Coorg, Sampaje Ghat, 22-4-1929, male. Both Coll. Winkworth, and labelled *N. pactolus continenlalis.*

The only published records I have been able to find are:

A. *JBNHS* Vol. **35**, p. 105, where Yates tells of four males he took on one short stretch of road on the Sampaje Ghat in Coorg. He then thought his specimens were the first for S. India, until he saw the female in Col. Winkworth's collection. Evidently he did not know of Bell's, Cardew's, and Donovan's specimens.

B. *JBNHS* Vol. **50**, p. 287. F. M. Bailey took a single specimen at Kathmandu in Nepal on 4-10-1937. This is the most northerly record so far.

C. *JBNHS* Vol. **51**, p. 52. Sir Keith Cantlie mentions that it is not rare in the Cherra State, Khasi Hills, Assam, where it occurs from March, and in the autumn.

D. Wynter-Blyth, p. 296, mentions that there are records from the Nilgiris.

There ought to be more data obtainable from private collections, and these, with further research into the literature, would be of great use in filling out the scanty information given above.

The butterfly does seem to be rare, but the available data point to its being even more rarely noticed. Yates was of the opinion that the vast jungles of Coorg had not been thoroughly 'combed'. This I think applies too to the diminishing jungles farther north on the same ghats. An insect which is apparently not continuous-brooded can easily escape notice. Also, as with most Lycaenids, it cannot be identified until caught; and, as everyone who has tried it knows, there is usually at least one butterfly, in the course of a day's catching in thick and thorny jungle, about the identity of which one can only philosophize. One's difficulties are increased with *pactolus*, because where it does occur, it seems to keep to a very restricted area. It certainly seems to do this at Lonavla. Yates's information (see A. above) points this way. Earlier in the same article (*JBNHS* **34**: 1054) he notes that the Coorg specimens are subsp. *continentalis*, and not *ceylonicus* as might have been expected. If the species is as sedentary as it seems, it may even be that further geographical races remain to be sorted out.

The fact that I caught only one male may simply be due to some limitation in myself. At the same time, this may point to the males covering a wider area than the females, which would be normal, but in a rare species would reduce one's chances of getting them. Probably, in my case, they were sitting on leaves high up while I was catching their females down below. Or they may have been at water or damp patches; there is a good spot for this just outside the wood. Woodhouse and Henry (loc. cit.) say that the males have this convenient habit.

At Lonavla the females were flying around in a small patch of filtered sunlight at the bottom of a dell; they could be taken without great difficulty when once they settled for a moment, never for long, on leaves low down. When I missed one, it shot up to the higher levels, probably to an *Entada* creeper; after which no others were seen for a quarter-hour of precious time. Such corporate wariness could well be developed by insects living in close colonies. I only saw them between 11 and 1 in the forenoon, the usual egg-laying time for the season, if *N. beroe* is a guide.

As a matter of fact, the first female I saw in 1958 was probably looking for a place to lay. I caught it, saw it was a four-line *Nacaduba*, and realised that if it was *pactolus* I had lost a chance of discovering its unknown foodplant; which needless to say did not occur

again. I did what I could, marking the spot with a scrap of blue cloth—which is still there. The likeliest plants were: a bushy growth of *Mezoneurum* about four feet high under which the specimen had been fluttering; a poor shoot of *Entada*, trying to grow under the *Mezoneurum* bush; and a scandent *Acacia* not far away. I failed to find any eggs or larvae. I brought two live females home to Poona, and tried without success to get them to lay on a potted *Entada* seedling. At least they lived three days. I hope this will not be the end of the story.

It would be good to hear the experiences of others in this difficult matter of persuading captive butterflies to lay. There must be means of overcoming their well-known reluctance in India. It is specially important to perfect the technique for Lycaenidae, because the gaps in our knowledge of the early stages of this family in India are very large. Wynter-Blyth (pp. 496-499) gives an excellent table, comprising the whole of our present knowledge of Lycaenid foodplants, that is of only 87 out of the 438 species of the Indian region. And many of this large remainder are nothing like as rare as *Nacaduba pactolus*.

This note may fittingly conclude with a spur to our efforts. The great T. R. D. Bell knew at least something about the early stages of this butterfly, though the knowledge probably died with him. His specimens in the Bombay Natural History Society's collection have their pupa case below on the pin. They are dated 1920-21; it was two years before this that he had included notes on some of the *Nacadubae* in his series on Indian butterflies in this journal. He only mentions *N. pactolus* in passing, under the synonym *macrophthalma*, and implies that the early stages are unknown. I am indebted to Mr. Wynter-Blyth for pointing this out; he believes that Bell reared most of the butterflies he presented to the Society's collection. We cannot presume to blame Bell, who published so much, and is still our fullest authority on the habits and growth of Indian butterflies, for not having managed to publish records of the pupa, and probably of the other stages of *pactolus*. It is even possible that the information exists in MS. somewhere. Are any of his note-books still available? Meanwhile, in our fumbling way, those of us who have contracted butterfly fever, and proud of it, must go on trying.

ACKNOWLEDGEMENTS

My grateful thanks are due to the authorities of the British Museum, especially to Mr. T. G. Howarth; to Dr. Varley, and members of the staff at the Hope Department of Entomology, Oxford; to Dr. Kapur of the Zoological Survey of India, to the Hon Secretary and other officers of the Bombay Natural History Society, in particular

Dr. E. J. Silas; and to the staff at the Prince of Wales Museum, Bombay.

ST. JOHN'S MISSION HOUSE,
PANCH HOWD,
POONA 2,
June 22, 1959.

A. E. BEAN

REFERENCES

Bell, T.R.D. (1918) : The Butterflies of the Plains of India, *JBNHS* **25** : 653.

Evans, W.H. (1931) : The Identification of Indian Butterflies.

Wynter-Blyth, M.A. (1957) : Butterflies of the Indian Region.

Woodhouse, L.G.O., and Henry, G.M.R. (1942): Butterfly Fauna of Ceylon.

20. A NEW VARIETY OF THE BUTTERFLY *RAPALA NISSA RANTA* SWINHOE

Rapala nissa ranta var. **bifida.** var. nov.

Two males taken at Sadon, N. Burma in June 1926, in the Tytler collection in the British Museum (Natural History).

In colour and markings these are typical *nissa* of the form that lacks the orange patch on the upper side of the forewing and would, according to the nomenclature used in the Museum arrangement described in paragraph 2 below, be called *nissa ranta* f. *ranta.* I dissected them because at that time my knowledge was confined to the mistaken statement in Evans's IDENTIFICATION OF INDIAN BUTTERFLIES that all *nissa* in Burma had orange patches and were *nissoides.* The cleft between the conjoined clasps of the Sadon specimens extends to half way down the clasps; in other words the total length of the clasps is double the depth of the cleft. In all forms of *nissa* hitherto known the length of the clasps is three and a half times the depth of the cleft. The difference is very noticeable to the eye. Corbet in *Proc. Roy. Entom. Soc.* (B) **8** (6), June 1939 figures clasps of some species and relies on the fixity and constancy of differences of depth of cleft between the species. The cleft of *nissa* is shallower than that of other species except *buxaria*—now called *rectivitta,* for which see below—but is not actually so shallow as is shown in the figure in Corbet, who selects the form *nissoides* as his example.

I hesitate to treat these two specimens as a new species on this evidence alone, so describe them merely as a variety. If more be found they may prove then to be a distinct species.

2. The subspecific name *ranta* is used according to the present arrangement of *nissa* by Corbet in the British Museum. The name

rectivitta Moore was applied by Evans to the Common Flash of Sikkim and Assam, but Corbet has reverted to the view of Swinhoe in LEPIDOPTERA INDICA that *rectivitta* is the older name for the Shot Flash which de Nicéville called *buxaria*. The type of *rectivitta* is not now discoverable in the Museum though Swinhoe wrote that he saw it there. But in the Museum drawer is a specimen of the Shot Flash from the Swinhoe collection with a label '*rectivitta* compared with the type' in the handwriting of Swinhoe.

In the British Museum collection the species *R. rectivitta* Moore 1879 (=*buxaria* de Nicéville, 1888) is separated from *R. nissa* Kollar 1848 by *R. rosacea* de Nicéville 1888 (easily distinguished by its vinous red underside). *R. nissa* is divided into two subspecies:

(1) *R. nissa nissa* Kollar. Confined to NW. Himalayas,

(2) *R. nissa ranta* Swinhoe, 1897. Sikkim, Assam, Burma.

The various varieties of ssp. *ranta* are recognisable as follows: If there be no orange path on the forewing upperside, the name is *nissa ranta* form *ranta*; if there be an orange patch the name is *nissa ranta* form *maculata*. (*Maculata* is a name taken from Seitz 1910 applicable to any *nissa* of any ssp. with an orange patch). In Burma those with a very large orange patch, all being from Hsipaw and Yenwentang, Shan States, are labelled *nissa ranta* form *nissoides* Swinhoe 1910. Those with an orange patch, sometimes very faint, of moderate or small size, are *nissa ranta* form *maculata*. Those from Burma without an orange patch are labelled *nissa ranta* form *ranta*. The existence of any form in Burma except *nissoides* was unknown to Evans in 1932. Most were got by Tytler, and I have found more from Loimwe and Kalaw in his material. Dissections exhibit the depth of cleft normal for *nissa*; only the two from Sadon show a deep cleft.

(3) The use of the term *ranta* should be explained. Swinhoe in LEPIDOPTERA INDICA 1897 thought *nissa* with or without an orange patch extended from the NW. Himalayas to Burma. He got three specimens from the Jaintia Hills (Assam) without orange, differing somewhat in colour and strength of markings, and named them *Rapala ranta*. In Corbet's arrangement *nissa nissa* is confined to the NW. Himalayas and *ranta* is taken as the subspecies occurring from Sikkim to Burma embracing those without and those with an orange patch, these being further distinguished by the form names *ranta* and *maculata* respectively.

5, UPPER WIMPOLE ST.,
LONDON W. 1,
August 26, 1959.

KEITH CANTLIE

21. INFESTATION OF BANYAN TREE BY CATERPILLARS OF THE MOTH *HYPSA FICUS* FABR.

In the first week of April 1959, I noticed that a large *Ficus bengalensis* ('Bargat') tree was covered with caterpillars eating the young leaves. It would seem that the caterpillars emerged from their eggs about March 28th. It was noted that the shoots started sprouting, growing light green leaves on this tree and others near by, about March 12th. At that time weather conditions were hot and close: rain followed on the 30th March, 0.48 inches, and on the 31st March, 0.42 inches. Frass was falling all around the spread of the tree, some 120 feet in diameter.

Large caterpillars started moving off the tree about April 13th. At this time a type of dipterous fly was found hovering over the caterpillars most of the day. The largest, sluggish caterpillars were unable to stop this fly from making a temporary stop at one side of the body, but the younger caterpillars, at the approach of a fly, were able to wag the top half of their bodies violently which kept the flies off and they promptly moved on elsewhere.

Eventually all but the mid-rib of the leaves which were able to grow to some size before the caterpillars became large fell off in 4 or 5 days' time after the leaf had been eaten. Except for one or two Magpie-Robins (*Copsychus saularis*) which seemed to take a few caterpillars early morning, birds were not interested. At this time Mynas [*Aethiopsar* ?] were around in great numbers, migrating uphill.

The larger caterpillars started pupating about mid-April, most down around the roots of the banyan. Many entered the verandah and outer rooms of a near-by cottage. The chrysalids were to be found in rough nests made by the caterpillars of paper, cotton, blanket, gunny-sack 'wool'. Other chrysalids were found uncovered and plain in tins and boxes.

The caterpillars were about 45 mm. long at the final moult. They had hair over the body which was marked by a yellow central band and with two black bands along the two sides. The chrysalis was nearly 20 mm. long and of a dark brown colour. Moths emerged about April 24th. The moth was about 20 mm. long from head to tail, with a wing-spread of from 50 to 60 mm. The upper-forewings are coloured brown/grey with thick light-coloured veins. The wing-cells and head/body are coloured yellow with white patches containing black dots. The underforewings are light brown with a yellow

and white patch nearer the body. The hind-wings were of a light grey colour having a yellow patch near the body.

The moth has been identified by the Bombay Natural History Society as above.

The pupa of the dipterous fly was about 7 mm. long while from head to tail the length of the fly is near 6 mm. with a wing-spread of about 12 mm. The specimen sent for examination was identified as a wasp of the genus *Brachymeria* but, as it was damaged, the species could not be determined. This parasite has apparently not been recorded from *Hypsa ficus* before.

The tree stands at some 2000 feet elevation, at the foot of the first Himalayan range, some 3 miles east of Kathgodam, NE. Rly., Naini Tal District, Kumaon, U.P. It was not until about 9th May that the tree started to sprout young fresh shoots which developed slowly, giving only about 25% of the usual shade it gave at this time of the year, mid-May.

Since writing the above, I noticed that another large tree, some half-mile away in the orchards, also had its young leaves eaten by the same type of caterpillar. Villagers mentioned that some other trees about half a mile further from the village were also attacked.

Most banyan trees in the forest near by were not attacked, as also one near the cottage—a seven year old banyan—and another larger and older tree with a spread of about 150 feet. This is the first time in about 25 years that I have found caterpillars feeding entirely off such banyan trees.

During the last four years there had been much extraction of timber, sal, haldu, jaman, etc., with the burning of charcoal in this area by the Forest Department. It could be that some new crops recently introduced, not usually grown hereabouts in the past, such as Sunn hemp or Arhar dal, attracted this pest. Perhaps egg-laying moths may have come down from the flora of the hillside above, the top ridge of which is about 2000 ft. higher. The main crops grown by the farmers within a three mile radius are wheat and rice.

THE ALLEN ORCHARD ESTATES,
BHOWALI P.O.,
KUMAON, U.P.,
July 20, 1959.

P. R. SHERRED

22. IDENTITY OF THE LADYBEETLE, *EPILACHNA IMPLICATA* MULSANT, FROM INDIA (COCCINELLIDAE: COLEOPTERA)

(*With two figures*)

The ladybeetle, *Epilachna implicata* Mulsant, was first described in 1850 from India by Mulsant who regarded it as allied to *Epilachna vigintioctopunctata* (Fabr.) and superficially resembling a variety of the latter. He, however, pointed out the differences in respect of the disposition and sizes of the black elytral spots by which the two species could be distinguished from each other. In view of the almost infinite variation of spots in *E. vigintioctopunctata*, Crotch (1874) considered *E. implicata* to be a mere variety of the latter. This nomenclatorial status of *implicata* has ever since remained unchanged in literature, as may be seen in the works of Mader (1927) and Korschefsky (1931). Although Dieke (1947) gave a monographic account of *Epilachna* (*sens. lat.*) in Asia, Europe, and Australia, he made no reference to *implicata* either as an independent species or as a variety of *E. vigintioctopunctata* of which he gave an extensive account from India and elsewhere under the name *Epilachna sparsa* (Herbst).

Mulsant (loc. cit.) described *E. implicata* from the material in the collections of Germar and Schaum, Hope, Reiche, and Westermann. As was generally the practice in those days, he did not designate any single specimen as the 'type' or the 'holotype'. Consequently all the examples of *E. implicata* in the above-mentioned collections are syntypes. The one in Prof. Hope's collection at the Oxford University Museum was lately obtained on loan through the kindness of Prof. G. C. Varley. It tallies in the main with Mulsant's description and has, on detailed examination (including that of its genitalia), proved to be quite distinct from *E. vigintioctopunctata* or any of its known varieties. I have since designated this example as the 'lectotype' and give below a brief redescription of the species. The lectotype bears the locality label 'Mysore' and is a female.

Through the courtesy of Dr. M. Puttarudhriah, Government Entomologist, Department of Agriculture, Mysore State, I was also able to obtain some material of *Epilachna* spp. from Bangalore and found in it a series of nine examples of *E. implicata* collected from the cucurbit *Coccinia indica*. The material of *E. vigintioctopunctata* was on the other hand collected from solanaceous plants like the brinjal and potato. As both the males and females were represented in the above-mentioned series of *E. implicata*, a study was also made of the

male genitalia with a view to give further distinguishing characters of the species.

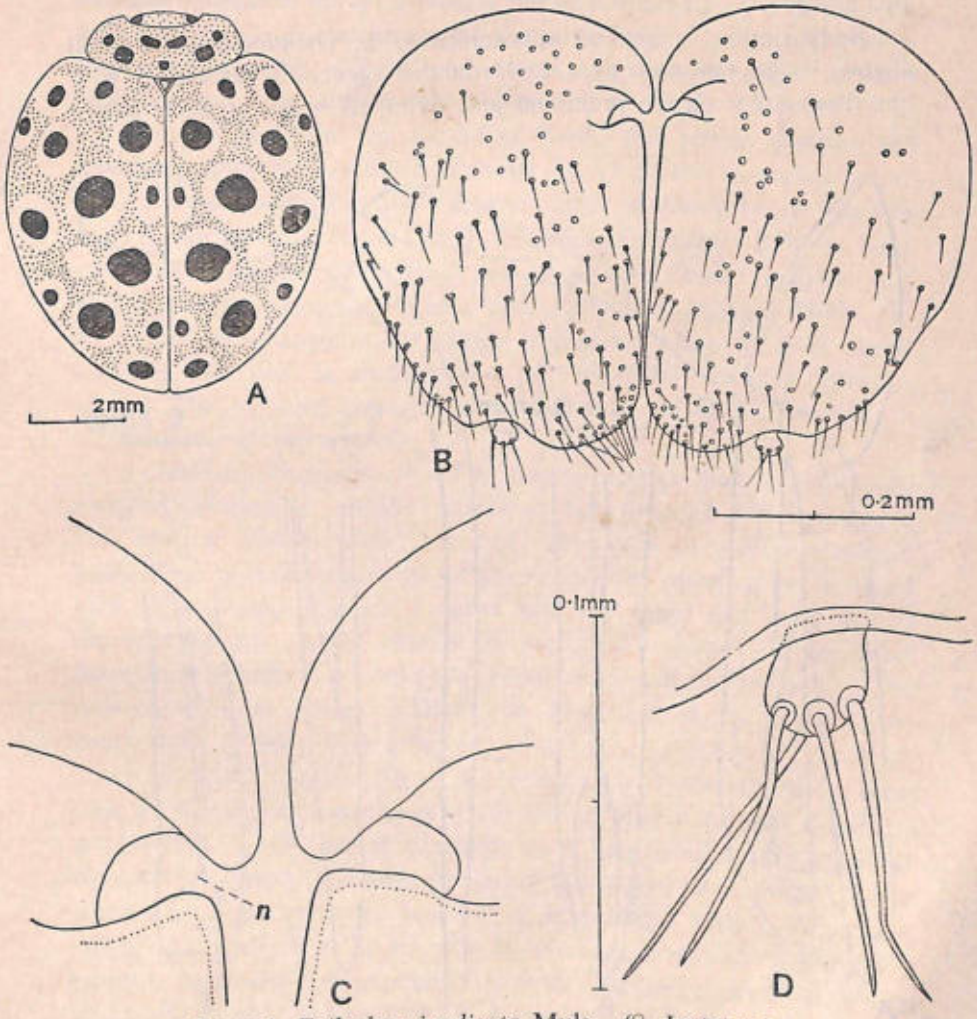


Figure 1. *Epilachna implicata* Muls. (♀, Lectotype).

A. Outline of body and pattern of markings. *B*. Female genital plates (ix sternite). *C*. Inner notches of the genital plates, much enlarged. *D*. Stylus of the genital plate, much enlarged.
0.1 mm. scale for figures C & D.

On account of the harmful association of *E. implicata* with *Coccinia indica*, the fruits of which are used as a vegetable, this ladybeetle is likely to feature in literature on economic entomology. It seems desirable, therefore, that its systematic position be clarified and its possible confusion with *E. vigintioctopunctata* avoided.

Epilachna implicata Mulsant

1850. *Epilachna implicata* Mulsant, *Ann. Soc. Agric. Lyon* **3**, pp. 837-838.

Body similar in general appearance to *E. vigintioctopunctata* but slightly larger, more convex and rounded; generally testaceous with the black spots on the pronotum and elytra of the lectotype as shown

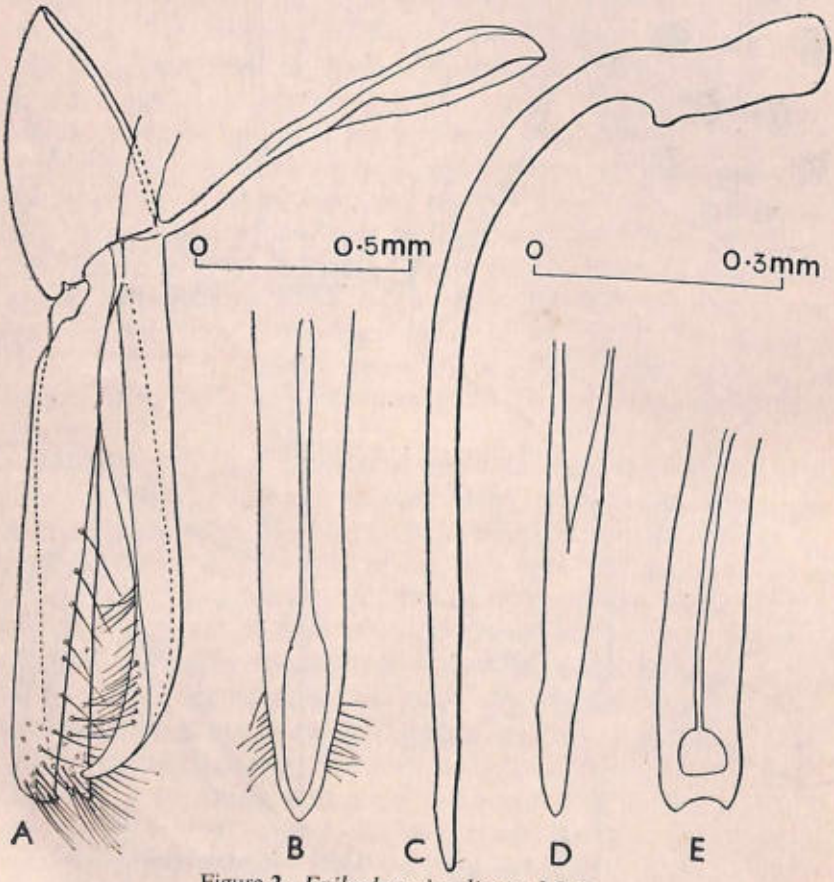


Figure 2. *Epilachna implicata* Muls.

A. Lateral view of external male genitalia except sipho. *B*. Outline of median lobe as seen from below. *C*. Sipho, lateral view; *D*. Apex of the same much enlarged; *E*. Apex of sipho seen from below, much enlarged. 0.5 mm. scale for figures A—C; 0.3 mm. scale for figures D & E.

in Figure 1, A; each elytral black spot invariably surrounded by a light yellow ring. In certain other examples instead of the seven pronotal spots as seen in the lectotype, only five (as a result of the coalescence of the central three spots into one) or six (as a result of

fading away of the posterior central spot) are present. Likewise instead of the thirteen black spots on an elytron, as in the lectotype, certain examples may have fourteen black spots, but in such cases the relative size and position of the spots remain almost unchanged. Underside with a pair of small, piceous spots on the metasternum and median three abdominal sternites. The lateral margins of pronotum are rounded anteriorly but gradually become subparallel in the posterior half. In *E. vigintioctopunctata*, on the other hand, the lateral margins are uniformly rounded. Another character by which the two species may be easily distinguished is that the apical angle of the elytron is rounded in *E. implicata* and distinct in *E. vigintioctopunctata*. It may, however, be mentioned that there are also other Indian species, e.g. *Epilachna dodecastigma* (Wied.) and *Epilachna septema* Dieke, in which the apical angle of the elytron is rounded. Caution must therefore, be exercised in distinguishing *E. implicata* on this character alone. The external genitalia offer the most reliable characters in identification of the species.

♀ *genitalia* (Lectotype): The female genital plates (Fig. 1, B) rounded proximally, slightly narrowed but rounded distally; length 0.44 mm., maximum width 0.31 mm.; the notch on the inner margin fairly deep, subrounded, with a narrow, slanting opening; an enlarged view of the same (Fig. 1, C) shows both the upper and lower lips of the opening (*n*). In the case of *E. vigintioctopunctata*, on the other hand, the notch in the genital plate is wide and the upper lip absent. The pear-shaped stylus (Fig. 1, D) at the distal end of the genital plate bears three or four long setae.

♂ *genitalia:* Sipho (Fig. 2, C) gently curved near the base, from then on straight and gradually narrowed distally to a point if seen in profile (Fig. 2, D). In this respect it is very similar to that of *E. vigintioctopunctata*, but can be easily distinguished from the latter when seen from below on account of its flattened surface and widely emarginate apex (Fig. 2, E). In *E. vigintioctopunctata* the apex of sipho is narrowed and pointed all round. Parameres and basal piece are nearly similar to those of the latter but the median lobe is quite distinctive; when seen in profile (Fig. 2, A). the underside of median lobe is straight in the basal two-thirds of its length and gently curved up to a pointed apex in the apical one-third; the upper side is with a narrow vertical blade-like ridge which starts at the base of the parameres and is gradually narrowed distally to end at the middle of the length of the median lobe; the distal half of the latter bears two rows of long hairs. Seen from below (Fig. 2, B) the median lobe looks like a closed and gradually narrowing tube with the seam along the

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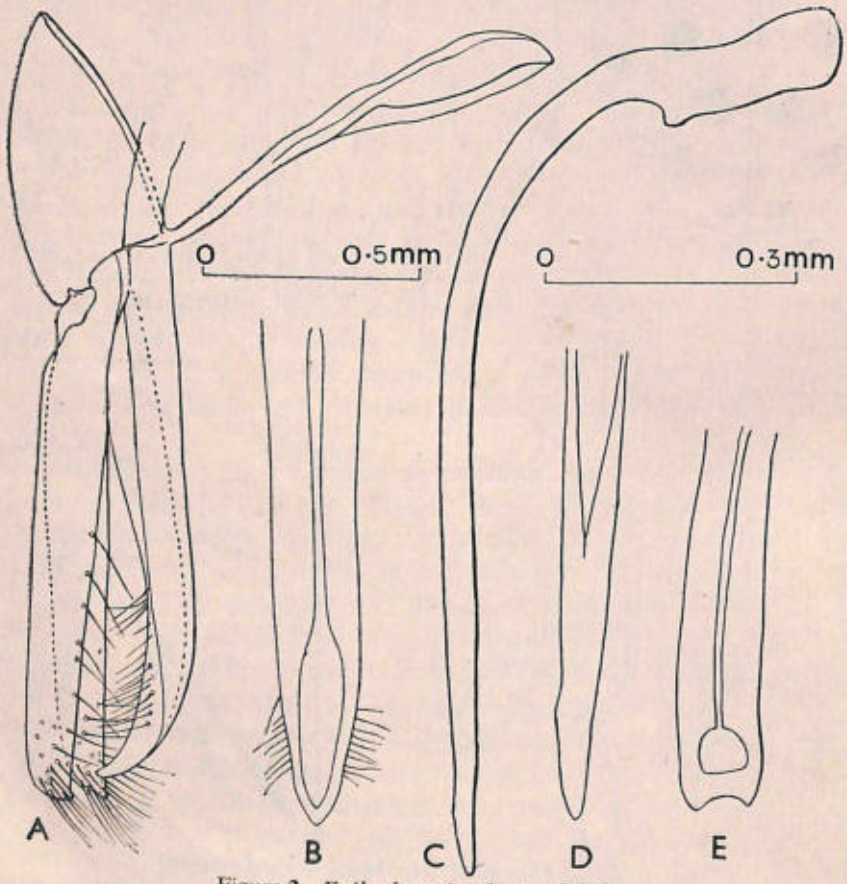

Figure 2. *Epilachna implicata* Muls.

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middle in the basal two-thirds of its length and an elongate-oval orifice in the distal one-third. In *E. vigintioctopunctata*, on the other hand, the median lobe, when seen in profile, is slightly emarginate at a little distance below the middle and then curved upwards into a hook at the apex; the blade-like ridge is also broader; seen from below the orifice of the median lobe is smaller and more or less diamond shaped.

The two species are thus easily distinguished from each other by several reliable characters and should be regarded as distinct.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA, A. P. KAPUR, PH.D., D.I.C.
September 28, 1959.

REFERENCES

1. Crotch, G.R. (1874) : A revision of the coleopterous family Coccinellidae : 87. (E.W. Janson, London).
2. Dieke, G.H. (1947) : *Smithson. misc. Coll.*, Washington, **106** (15) : 1-183.
3. Korschefsky, R. (1931) : *Coleopt. Cat., Berl.* **16** (118), : 26.
4. Mader, L. (1927) : *Evidenz der palaearktischen coccinelliden* (1926) : 34, pl. 1, fig. 32.
5. Mulsant, E. (1850) : *Ann. Soc. Agric. Lyon*, **3** : 837-838.

23. APHIDS OF CALCUTTA AND SUBURBS (WEST BENGAL)

INTRODUCTION

The first records of aphids from West Bengal were by Cotes (1896). Later van der Goot (1916, 1917) added some more species. It was not till 1955, however, that these insects received attention in this part of India and Banerjee and Basu recorded 13 species. In the same year in a review of the Entomological section of the Department of Agriculture, Government of West Bengal, a list of 26 species of aphids including the previous 13 was published.

Of the species so far known from West Bengal, 15 are found in Calcutta and suburbs including 2 new records, one of which has very recently been published by Ray Chaudhuri and Ghosh (1958). A list of such species with a preliminary key for some of them, is given below.

LIST OF SPECIES

Aphis L.

1. **A. craccivora** Koch—320 apterae, 5 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 18-10-52, 25-10-52, 27-1-53, from Cucurbitaceae; Dalhousie Square,

Calcutta, on 10-10-52, 24-10-52, 25-1-53, from Labiatae, Urticaceae, & Scitaminaceae; Curzon Park, Calcutta, on 30-1-53, from Nyctaginaceae; Bishop's Garden, Calcutta, on 3-11-53 from Leguminosae.

2. **A. gosspii** Glov.—10 apterae, 12 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 26-10-52, 1-11-52, & 2-11-52 from Euphorbiaceae and Leguminosae; Curzon Park, Calcutta, on 30-11-52 & 4-12-53, from Amarantaceae and Malvaceae; Dalhousie Square, Calcutta, on 22-10-53, from Araliaceae.

3. **A. nerii** Boyer.—35 apterae, 9 alatae.

Locality & Host plant family: Science College Garden, Calcutta, on 6-11-57, from Asclepiadaceae.

Liphaphis Mordvilko

4. **L. erysimi** (Kalt.).—38 apterae, 17 alatae.

Locality & Host plant family: Dalhousie Square, Calcutta, on 1-10-52, from Araliaceae; Eden Garden, Calcutta, on 11-11-57, from Cruciferae.

Longiunguis van der Goot

5. **L. sacchari** (van der Goot).—37 apterae, 20 alatae.

Locality & Host plant family: Dum Dum, Calcutta suburbs, on 6-1-58, from Graminaceae.

Rhophalosiphum Koch

6. **R. maidis** (Fitch.)—4 apterae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 22-9-53, from Graminaceae.

7. **R. nymphaeae** L.—56 alatae.

Locality & Host plant family: Cossipore Club, Calcutta, on 20-12-52, from Caesalpinioideae.

8. **R. rufiabdominalis** (Sasaki).—7 alatae.

Locality & Host plant family: Behala, Calcutta suburbs, on 4-12-52, from Chenopodiaceae.

Schizaphis Börner

[1]9. **S. graminum** (Rond.).—1 alata.

Locality & Host plant family: Eden Garden, Calcutta, on 28-10-53, from Solanaceae.

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[1] This species is recorded for the first time in West Bengal.

Toxoptera Koch

10. **T. aurantii** (Boyer).—20 apterae, 5 alatae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 10-2-52, from Moraceae.

Macrosiphonellia Del Guercio.

11. **M. sanborni** L.—10 apterae.

Locality & Host plant family: Eden Garden, Calcutta, on 26-10-55, from Compositae.

Myzus Pass.

12. **M. persicae** (Sulz.).—25 apterae, 3 alatae.

Locality & Host plant family: Agri-Horticultural Society, Calcutta, on 4-2-53 & 10-2-53 from Acanthaceae & Malvaceae.

Pentalonia Coq.

13. **P. nigronervosa** Coq.—13 apterae.

Locality & Host plant family: Hoogly, Calcutta suburbs, on 10-1-54, from Leguminosae.

Myzocallis Pass.

14. **M. kahawaluokalani** Kirk.—2 apterae, 8 alatae.

Locality & Host plant family: Curzon Park, Calcutta, on 16-10-52, from Lythraceae.

Tetraneura Hartig

15. **T. hirsuta** (Baker).—2 alatae.

Lacality & Host plant family: Behala, Calcutta suburbs, on 3-12-51 & 4-1-52, from Cruciferae and Solanaceae.

APHIS L.

KEY TO THE APTEROUS VIVIPAROUS FEMALES

1 (2) Processus terminalis $4\frac{3}{4}$-5, 2/5 times as long as base of same segment, equal to, or $1\frac{1}{2}$ times as long as, IIIrd antennal segment. Hairs on first tarsal joints 3, 3, 3. Cauda with 7-9 hairs.

A. nerii Boyer

2 (2) Processus terminalis 2-$2\frac{1}{2}$ times as long as base of the same segment, $\frac{3}{4}$ of, or at most equal to, IIIrd antennal segment. Hairs on first tarsal joints 3, 3, 2. Caudal hairs 1-6.

3 (4) Body pear shaped. Dorsum of the abdomen with honeycomb pattern. Hairs on abdominal tergites with acuminate or furcated apices.

A. craccivora Koch

4 (3) Body elongated. Dorsum of the abdomen without such pattern. Hairs on the abdominal tergites with acute or acuminate apices but never with furcated ones.

A. gossypii Glov.

KEY TO ALATE VIVIPAROUS FEMALES

1 (2) Processus terminalis 4-5,1/5 times as long as the base of the same segment. IIIrd antennal segment usually with 8-12 rhinaria not placed in a row and IVth antennal segment without or with at most 3 rhinaria. Hairs on first tarsal joints 3, 3, 3. Cauda usually with 9 hairs.

A. nerii Boyer

2 (1) Processus terminalis twice or at most up to thrice as long as base of same segment. IIIrd antennal segment usually with 4-7 rhinaria always in a row and IVth antennal segment never with any rhinarium.

3 (4) Abdomen broadly oval. Basal diameter of siphunculi nearly or at most twice as thick as the middle of the hind tibiae; the middle of siphunculi at most 1½ times as thick as the middle of hind tibiae. Middle of hind tibiae never more than 1½ times as basal diameter of IIIrd antennal segment. Apices of femora and tibiae black. Siphunculi black.

A. craccivora Koch

4 (3) Abdomen elongated oval. Basal diameter of siphunculi never less than 2½ or may be up to 2¾ times as thick as the middle of hind tibiae; middle of siphunculi never less than 1½ times and may be almost twice as thick as middle of hind tibiae. Middle of hind tibiae always more than 1½ times and may be up to almost twice as thick as the basal diameter of IIIrd antennal segment. Apices of femora and tibiae pale brown; Siphunculi yellowish brown.

A. gossypii Glov.

ROPHALOSIPHUM Koch

KEY TO ALATE VIVIPAROUS FEMALES

1 (2) Antennae 5-jointed. IIIrd antennal segment. 1, 2/5-1, 3/5 times as long as IVth antennal segment. Longest hair on segment III, $1\frac{1}{2}$ to twice as long as the basal diameter of the segment. Processus terminalis 5, 1/5-6, 3/5 times as long as the base of the same segment. Siphunculus slightly swollen at its middle, and which may extend up to distal 2/3 portion, imbricated from base to apex.

R. rufiabdominalis (Sasaki)

2 (1) Antennae 6-jointed. IIIrd antennal segment 2, 3/5-3, 1/10 times as long as IVth antennal segment. Longest hair on segment III, $\frac{1}{2}$ the basal diameter of the same segment. Processus terminalis 3, 3/5-3, 4/5 times as long as the base of the same segment. Siphunculi bagpipe like, imbricated only at its $\frac{1}{2}$-2/3 portion.

R. nymphaeae L.

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November 27, 1958.

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REFERENCES

1. Banerjee, S.N. & Basu, A.N. (1955): Aphididae of West Bengal *Curr. Sci.* **24** (2) : 61.
2. Cotes, E.C: (1896) : Miscellaneous Notes. *Indian Mus. Notes*, **3** : 54.
3. Das, B. (1918) : The Aphididae of Lahore. *Mem. Indian Mus.* **6** : 135.
4. Doncaster, J.P. (1954) : Notes on genus *Liphaphis* Mordvilko 1928 and description of a new species *Proc. R. ent. Soc. London.* **23** (B) t 83.
5. ——— (1956) : The Rice root aphid. *Bull. ent. Res.* **47** : 7.
6. Goot, P. van der (1916) : On some undescribed aphids from collections of the Indian Museum. *Rec. Indian Mus.* **12** (1) : 1-4.
7. ——— (1917) : Notes on some Indian aphids. *Rec. Indian Mus.* **13** (4) : 175-183.
8. Mukerji, D. & Behura, B.K. (1949) : Observations on the biology of *Aphis nerii*. *JBNHS* **46** : 68.
9. Ray Chaudhuri, D. N. & Ghosh. A.K. (1958) : A note on aphids of Calcutta and suburbs with special reference to the newly recorded host plant families for some of the species. *Curr. Sci.* **27** (10) : 402.
10. Takahashi, R. (1931) : Aphididae of Formosa, Pt. 6 : 1-127.
11. Anon. (1948-1955) : Systematic study on the Aphididae of West Bengal. A brief review. Entomology section, Department of Agriculture, Government of West Bengal.

24. INSECT PESTS OF MAIZE IN RAJASTHAN

The region, south-east of the Aravalis, is the chief maize growing area of Rajasthan. About 60 per cent of the total area under the crop falls in this region, which is one of the most important maize producing tracts of India. The cultivation of this crop has of late years become of so much national importance as well as domestic interest that the farmers are anxious to obtain maximum yields.

The crop is sown in June-July and harvested in September-October. It has been observed that, out of the many adversities that maize cultivation has to face, the damage caused by insect pests is by far the worst. To the misfortune of the farmers, practically no information exists on the insect pests of this crop in Rajasthan. An intensive survey was, therefore, undertaken to investigate the insects injurious to maize and elucidate points in their biology which would help in suggesting and developing control measures against them.

It has been found that maize crop is attacked by many kinds of insects. No part of the plant escapes injury. Although no specific determinations have been made of the losses occasioned by insect pests, it is quite evident that at a very conservative estimate 10 to 15 per cent of the produce is lost annually in this region on account of the insects alone. Furthermore, insect attack weakens the plant, which may later succumb to unfavourable weather conditions, encroachment of weeds, or other causes.

A list of the insects noticed to cause economic loss to maize crop is arranged under the different parts of the plants damaged, together with short notes on their biology and nature of damage for the more important ones. The pests recorded in this paper were collected and identified, and as far as possible reared in the entomological laboratory of the College. Wherever necessary, specimens were sent to different entomological institutes for identification. In preparing this report the works published by Sen-Gupta and Behura from Orissa (1), Srivastava from Uttar Pradesh (2), and Trehan and Pingle from Bombay (3) have been of great help.

Insects attacking Roots

1. White ants, *Odontotermes* sp. and *Microtermes* sp. (Termitidae).

Major pests under unirrigated conditions. Infestation may begin soon after germination and also occurs at any stage of growth of the crop.

Leaf Feeders

A. *Chewing*

1. Kharif grasshopper, *Hieroglyphus banian* Fb. (Acrididae).

A major pest, usually active during the months of July to October. Adults and nymphs feed on the leaves and there is only one generation in a year.

2. Surface grasshopper, *Chrotogonus trachypterus* (Bl.) (Acrididae).

A minor pest; injurious to the young crop during June and July.

3. Hairy caterpillar, *Amsacta moorei* Butl. (Arctidae).

A major pest. The caterpillars defoliate the plants. There is only one generation during June-July, the pupa of the second brood hibernates in the soil. Sometimes the infestation is very serious during the early growth of the crop. The caterpillars feed voraciously on the seedlings and the damage increases as the caterpillar grows, so much so that in certain years all the seedlings in a field are often wiped out, thus necessitating resowing of the crop which may be too late.

4. Army worm, *Cirphis unipuncta* H. (Noctuidae).

A major pest; attacks the crop at all its stages of development. As soon as the crop germinates the larvae are attracted to and feed on the leaves mostly at night, while during the day they remain hidden in the clods underground. In severe cases of attack they completely defoliate the seedlings as is done by the hairy caterpillars. When the crop is somewhat advanced in its growth and the internodes have been formed, the worms attack the growing shoot and remain hiding singly or more frequently in groups of 2 or 3 in the whorl. When the injured leaves unfold they present a ragged and unsightly appearance. Such damage results in stunted growth of the crop and reduced grain production. There are 2 to 3 generations from June to October and then it hibernates as pupa in the soil.

5. Lucerne caterpillar, *Laphygma exigua* (Hb.) (Noctuidae).

A minor pest; feeds on the leaves during July and August along with the hairy caterpillar and the army worm.

B. *Sucking*

1. Aphids, *Aphis maidis* Fitch. (Aphididae).

A minor pest. Infestation usually occurs from August to September.

2. Stem bug, *Pundaluoya simplicia* Dt. (Fulgoridae).

A minor pest found on the tender shoots. Nymphs and adults are active during September and October.

Stem Borers

1. Maize borer, *Chilo zonellus* (Swin.) (Pyralidae).

A major pest. The newly hatched larvae, after feeding for sometime on the tender leaves, bore into the stem and produce dead heart in the young crop. When the plants are sufficiently grown they tunnel into the stem causing reddening of the stems and yellowing of the leaves. The pest is active from June to November. There are about four generations in a year and the caterpillar hibernates in stubble. Early planted crop is severely damaged in summer.

2. Pink borer, *Sesamia inferens* (Wlk.) (Noctuidae).

A major pest; occurs along with the maize borer, but its first generation appears after the first generation of the maize borer is over. This pest is active from July to March and there are 6 generations in a year. The tunneling by one borer in a stalk does not always cause appreciable damage, but when two or more are present within the same stalk, as frequently happens, it becomes reduced to a mere shell and is filled with fragments of the frass or castings of the borers. It has been noticed that maize plants suffering from severe borer injury ripen much earlier than the healthy ones.

Attacking Tassels and Cobs

1. Army worm, *Cirphis unipuncta* Haw. (*vide* leaf feeders).

A serious pest of cobs. When tassels appear the worms immediately attack them, but this feeding rarely results in serious injury. As soon as the silks and ears appear the larvae leave all other parts of the plant and turn their attention to them. They feed upon the silks as long as these are fresh, and such feeding is within the protection of the shunk. The young larvae crawl to the tip of the shunk, push their way in between the silk strands and start feeding. After the silk has dried out the larvae feed upon the developing kernels till they are soft.

2. Maize borer, *Chilo zonellus* (Swin.) (*vide* stem borers).

Frequently found in the cobs. At the early stage of the development of borers they enter the ear directly at the tip, base or side. Ordinarily the ear is entered at its tip by small borers which feed first upon the tender portion of the husk, and then work their way down into the cob and grain.

Pink borer, *Sesamia inferens* (Wlk.) (*vide* stem borers).

Not serious on cobs. The caterpillars usually enter the ears indirectly through the short stem, or shank, by which the developing cob is attached to the stalk. In such a case the stem is frequently so weakened by the injury that it breaks off before the ear has completed its development. The damage inside the cobs is similar to that produced by the maize borer.

The author is indebted to Dr. A. Rathore, Principal, for providing necessary facilities and encouragement for this work.

RAJASTHAN COLLEGE OF AGRICULTURE,
UDAIPUR,
July 27, 1959.

B. K. SRIVASTAVA

REFERENCES

1. Sen-Gupta, G. K. & Behura, B. K. (1957) : Annotated list of crop pests in the State of Orissa. *Mem. Ent. Soc. India*, No. 5 : 44 pp., New Delhi.
2. Srivastava, A. S. (1956) : Plant Protection Service in Uttar Pradesh, Bureau of Agricultural Information, U.P., Lucknow, pp. 22.
3. Trehan K. N. and Pingle, S. V. (1946) : Annotated list of crop pests in the Bombay Province. *JBNHS* **46** (1) : 139-153.

25. THE MELTING POINT OF THE WAX OF INDIAN BEES

In a recent report of the Apicultural Laboratory (Bombay Village Industries Board), Poona, there was a reference to the melting point of wax of the combs of *Apis dorsata*, the large Rock Bee, being lower than that of the other two honey-producing Indian species *A. indica* and *A. florea*.

The combs of *A. dorsata* are built on cliffs etc. thus liable to greater exposure to the sun and consequent heating up, and a *lower* melting point seemed an inconsistency which would be of distinct disadvantage to the species. We therefore wrote to the Hony. Research Director of the institution, Dr. G. B. Deodikar, for confirmation. He replies as follows:

'As regards melting point of *dorsata* wax, we also anticipated *a priori* that the melting point should be higher than in other bees building combs in shaded enclosures. Contrary to our expectation it has been repeatedly confirmed from samples collected in various parts of India that the melting point of *dorsata* wax is about 4° F. lower than *indica* wax. As the comb becomes older and impregnated with fat, soluble ingredients from nectars and pollens, or with propalis as also deposition of insoluble sediments and debris, the melting point does rise by a few degrees, but this is so in all the three species of

bees. This is rather difficult to understand. Though *dorsata* builds in shade, the nest is exposed to much higher temperature than that of *indica*. A partial explanation may be the fact that the bees cover the wax comb completely and they have a method of airconditioning by means of remarkably synchronised fanning of wings. Anyway lower melting point of *dorsata* wax is quite contrary to what might be normally expected.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
October 29, 1959.

EDITORS

26. IDENTITY OF A TIBETO-HIMALAYAN *RANUNCULUS*

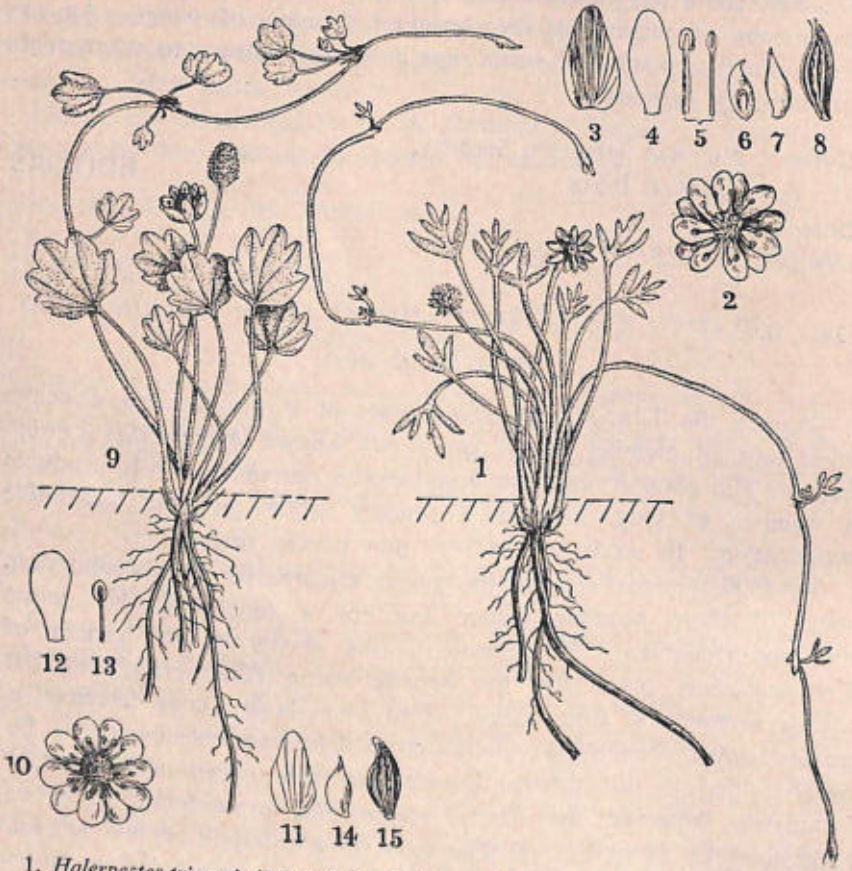
(With text-figures)

Among the Tibeto-Himalayan species of Ranunculaceae, a somewhat unusual member is the commonly known *Ranunculus cymbalariae*. The plant is dwarfish and lacks a proper stem. It produces a number of long, articulated runners which help in vegetative propagation. Its seeds have a very thin papery surface.

In 1900, Greene created the genus *Halerpestes* to accommodate some of these peculiar plants, but for a long time his genus was not recognised. Hutchinson in his review of the genera of Ranunculaceae, considered the generic name *Halerpestes*, but left it as a synonym of *Ranunculus*. Two years later, Dunn described a species called *Ranunculus palifolius* which was considered to be closely allied to the hitherto known *Ranunculus cymbalariae*. Unfortunately, however, the species *Ranunculus cymbalariae* itself, as understood by Hooker f. & Thomson, is a mixture of two species neither of which belongs to true *Ranunculus cymbalariae* Pursh [=*Halerpestes cymbalaria* (Pursh) Greene] as originally described by Pursh.

The first author who recognised *Halerpestes* as distinct from *Ranunculus* appears to be Komarov and he was followed a few years later by Handel-Mazzetti. The genus is characterised, among other things, by the absence of any proper stem and the achenes having thin texture and striated surface. A few years ago, the present author, while working in the Kew Herbarium, came across an unnamed specimen of *Ranunculus* collected from Kashmir (Koelz no. 2318). This specimen agreed with the specimen described earlier by Dunn as *Ranunculus palifolius*. On further scrutiny, it was found that Dunn's species agreed so well with *Ranunculus cymbalariae*, that it is

impossible to maintain Dunn's plant as a distinct species. Thus, while the identity of the Koelz specimen (no. 2318) became clear, both its nomenclature and the nomenclature of the plant hitherto known as



1. *Halerpestes tricuspis* (Maxim) Hand.-Mazz. General view ; 2 Flower; 3 Sepal ; 4. Petal ; 5 Stamens; 6 Carpel with ovule ; 7 Carpel, side view ; 8. Achene. 9. *Halerpestes sarmentosa* (Adams) Komarov. General view; 10 Flower; 11 Sepal; 12. Petal ; 13. Stamen ; 14 Carpel ; 15. Achene.

Ranunculus cymbalariae got more and more involved. It is, therefore, proposed to clarify the position. The Tibeto-Himalayan plant as understood by Hooker f. & Thomson, dissolves into two species and their nomenclature and distribution are as follows:

1. **Halerpestes tricuspis** (Maxim) Hand.-Mazz. in Acta Hort. Goteburg. **13**: 135 (1940).

   Ranunculus tricuspis Maxim. Fl. Tang. **12** (1889); Enum. Pl. Mongol. 14, 16, tab. 4, fig. 17-27 (1889).

   Ranunculus palifolius Dunn in Kew Bull. 1925: 280.

Ranunculus cymbalariae Hook. f. & Thoms. var. alpinus Fl. Ind. **1**: 32 (1855).

Ranunculus cymbalariae Hook. f. & Thoms. *non* Pursh in Hook. f. Fl. Br. India **1**: 17 (1872) *pro parte*.

Distribution.—NW. Himalayas, *J. L. Stewart* s.n. (Herb. Cal.); Kashmir, Nulre (Mulra ?) valley 3300 m. *T. Thomson* s.n. (Kew); Baltistan, Dras valley, 3300 m. *J. F. Duthie* 11740 (Cal. et Kew); British Lahul, beyond Baralacha Pass 5000 m. *S. R. Kashyap* 44 (Kew); Ladak, *I. Thomson* s.n. (Kew); Ladakh 5000 m. *Thomson* 2010; Ladak, *J. L. Stewart* s.n. (Kew); Rupsu, Hanle river 4600 m. *W. Koelz* 2318 (Kew); Tibet, Khambajong, *Younghusband* 20, 51, 278 (Cal.); Tibet, without name of collector 246 (Cal.); Giri, *Younghusband* s.n. (Cal.); Tisum 5100 m. *Strachey & Winterbottom* 23 (Cal.); Chumbi & Phari, *Dungboo* s.n. (3 sheets in Cal.); Sikkim, Lhonak 5000 m. *Smith & Cave* 1910 (Cal.); Tongloo, *J. A. Soulie* 903; 936 (Kew).

2. **Halerpestes sarmentosa** (Adams) Komarov in Kom. et Klob-Alis, Key Pl. far East U.S.S.R. **1**: 550 (1931).

Ranunculus sarmentosus Adams in Mem. Soc. Nat. Mosc. **9**: 244 (1834).

Ranunculus cymbalariae Hook. f. & Thoms. var. *major* Fl. Ind. **1**: 32 (1855).

Ranunculus salsuginosus Pall. Resise **3**: 213, 265 (1776) non Georgi.

Halerpestes salsuginosa (Pall.) Greene in Pittonia **4**: 208 (1900).

Ranunculus subsimilis Printz in Contr. fl. As. int. **3**: 239 (1921).

Distribution.—Afghanistan (?), *Griffith* 1401 (Cal.); Afghanistan, *Aitchison* 354 (Cal.); Lahul near Kardong, *Jaeschke* s.n. (Cal.); Baltistan, Skardo, *C. B. Clarke* 30026 C (Cal.); Tibet frontier, Gyangtse, *H. J. Walton* 24 (Cal. et Kew); Topidhunga 5000 m., *Strachey & Winterbottom* 22 (Cal.); Western Nepal, Kali Valley 3500 m. *J. F. Duthie* 6321; Sikkim, Lajhep, 4000 m. *W. W. Smith* 3294 (Cal.); Nakuchu, Lhonak 5500 m. *Smith & Cave* 1900 (Cal.).

Besides the distribution shown above, both the species have been recorded from north Szechuan, Siberia, Persia, North America, Mexico, mountains of South America. *Halerpestes sarmentosa* (Adams) Komarov is distinguished by its more robust appearance, longer and more numerous achenes (80 to 130) collected in oblong capitulum, and more or less orbicular crenately incised leaves. *H. tricuspis* (Maxim.) Hand.-Mazz., on the other hand, is more slender, has broader achenes

numbering 40 to 50 in each roundish capitulum, and has elliptic and deeply cleft leaves.

In *Acta Hort. Goteburg* **13**: 136 (1940), Handel-Mazzetti has placed *Ranunculus palifolius* Dunn as a synonym of *Halerpestes linifolius* (Bert.) Hand.-Mazz. The present author is of the view that Dunn's plant should be more correctly placed under *Halerpestes tricuspis* (Maxim) Hand.-Mazz., and this has been done in this paper.

INDIAN BOTANIC GARDEN,
SIBPUR,
CALCUTTA,
September 26, 1959.

D. CHATTERJEE

REFERENCES

Greene, E. L. (1900) : *Pittonia* **4** : 207.
Hutchinson, J. (1923) *Kew Bull* : 88.
Dunn, S. T. (1925) : *Kew Bull* : 280.
Hooker. f. & Thomson. T. U. (1872) : *in* Hooker. f. Fl. Br. India **1** : 17.
Pursh, F, T. (1814) : Fl. 2 : 392.
Komarov, V. L. (1931) : Key Pl. far East Reg. U.S.S.R. **1** : 550.
Handel-Mazzetti, H. (1939): Acta Hort. Goteburg, **13** : 135.

27. *CEDRELA TOONA* ROXB. IN RAJASTHAN. A CORRECTION

N. C. Nair and G. R. Nathawat in the *Journal* (**54**: 288) mentioned *Cedrela toona* Roxb. as occurring at Harsh Nath in the Aravalli Hills. Shri K. S. Sankhala, the Div. Forest Officer, Jaipur, has called the Editors' attention to this point, and adds: 'The observation of the authors appears to be incorrect, as there is no *Cedrela toona* Roxb. on the hill. It appears that the authors have . . . identified *Lannea grandis* Engl. of the Anacardiaceae as *Cedrela toona* Roxb. *Lannea grandis* trees are often met with in the other hills of Sikar forests and occurrence of the tree in Harsh Nath is nothing new. Since the record of *Cedrela toona* Roxb. at Harsh Nath may create subsequent complications, particularly for the ecological studies, and may influence future forest management and plantation programmes, I consider it extremely necessary that a correction should be published.'

Cedrela toona Roxb. is found in moister forests than those of Rajasthan; for this reason the Editors will be hopefully awaiting confirmation of its existence in Harsh Nath; if this can be confirmed, it will form an interesting record.

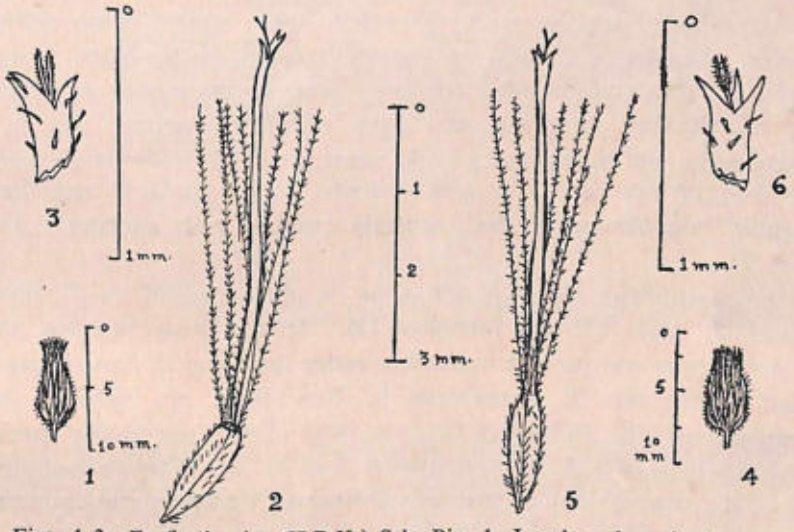
BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
June 16, 1959.

EDITORS

28. A NEW PLANT RECORD FOR INDIA—*ERIGERON FLORIBUNDUS* (H.B.K.) SCH. BIP.

(With text-figures and a plate)

During the course of a detailed systematic study of the Compositae of Dharwar, the authors came across a plant that was fairly similar to *Conyza ambigua* L. Later, it was referred to the Kew authorities who identified it as *Erigeron floribundus* (H.B.K.) Sch. Bip. This is,



Figs. 1-3. *E. floribundus* (H.B.K.) Sch. Bip. 1. Jug-shaped capitulum. 2. A single outer floret. 3. Apical portion of the above showing the bilabiate corolla and stigma.

Figs. 4-6. *E. bonariensis* L. 4. Cup shaped capitulum. 5. A single outer floret. 6. Apical portion of the same showing the corolla with subequal lobes and stigma.

as far as we are aware, the first record of the occurrence of the plant in India. A detailed description as from actual examination of fresh specimens collected from Dharwar is given below:

Stout annual herb up to 1.4 m. high, generally branched from the base. Stem angular, longitudinally furrowed, often with purplish blotches, hairy to puberulous, becoming woody when old. Leaves pale green, alternate, sessile, simple, oblanceolate, pubescent on both surfaces, more so on the upper. Margin entire or distantly serrate or pinnatifid. Lower leaves up to 17 cm. by 3.5 cm., and gradually becoming smaller towards the apex. Heads many, about 0.7 cm. by 0.3-0.4 cm., in terminal and axillary panicles, the whole forming a pyramidal compound inflorescence. The lateral branches of the inflorescence do not overtop the apex of the main axis. Peduncles of

heads 0.6-1.2 cm. long, filiform, pubescent. Involucre cylindrical; bracts in 2-3 series, 20-30 in number, green, pubescent, sometimes purple at the apices, linear, acute, the innermost the largest, chestnut brown on the inside when reflexed (on the old dry heads). Disc naked, pitted, about 0.2 cm. in diameter. Outer florets about 0.5-0.6 cm. long, pistillate, in many series, filiform. Corolla rayed or bilabiate, upper lip generally bifid, the lower entire or obsolete. Style exserted or included, bifurcated; style-arms filiform. Inner florets disciform, 0.5-0.6 cm. long, numerous, bisexual. Corolla tubular; tube slightly dilated at the apex, 5-toothed, lobes acute, hairy outside, yellow. Stamens 5; anthers appendiculate; anther-bases entire. Style exserted, bifurcated; style-arms almost compressed or plano-convex, the tips lanceolate and hairy outside. Pappus hairs in a single series, spreading, many, pale straw coloured or brownish white. Achenes of ray- and disc-florets similar, about 0.1-0.13 cm. long, angular, laterally compressed, sparsely covered with appressed short hairs.

E. floribundus (H.B.K.) Sch. Bip. is closely allied to *E. bonariensis* L. (Syn. *Conyza ambigua* L.). It has been reported that *E. floribundus* was passing frequently under the name *E. bonariensis* L. Burtt (1948), (On *E. bonariensis* L. Kew Bull., pp. 369-373), has clearly shown the differences between these closely resembling species. *E. floribundus* and *E. bonariensis* are said to be of South American origin, the latter chiefly occurring in temperate Mediterranean countries, though it has spread out to the tropical countries, while the former is reported to have a preference for the tropical climate. Both occur as weeds. In India, *E. bonariensis* is well known as *Conyza ambigua* L.

The chief differences between these two species as given by Burtt (1948) are as follows:

E. bonariensis L.	*E. floribundus* (H. B. K.) Sch. Bip.
Herb up to 4 ft., branched, the lateral branches often overtopping or at least equalling the main axis (cf. *E. acris* L.); inv. bracts whitish inside; capitula when pressed commonly 1 cm. or more in diameter; pappus white or pinkish.	Herb up to 6 ft., branched, the lateral branches NOT overtopping the main axis and the whole forming a pyramidal compound infl. (cf. *E. canadensis* L.); inv. bracts showing chestnut brown on the inside when reflexed on the old capitula; capitula when pressed commonly less than 1 cm. in diameter; pappus straw coloured.
Further differences:	Further differences:
Corolla of outer flowers 3-4 toothed; teeth equal or subequal.	Corolla of outer flowers rayed bilabiate or rarely the lobes subequal.

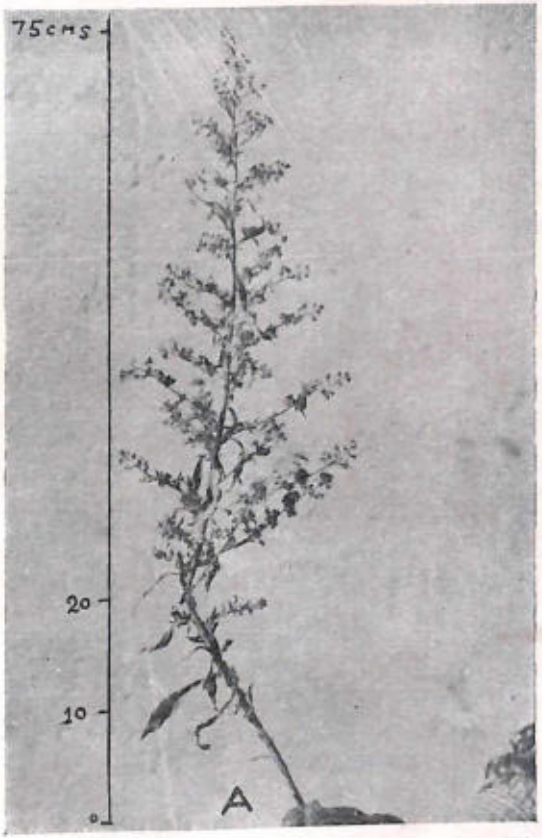


Photo A. *Erigeron floribundus* (H.B.K.) Sch. Bip.
The compound pyramidal inflorescence in which the lateral branches are *not* overtopping the apex.

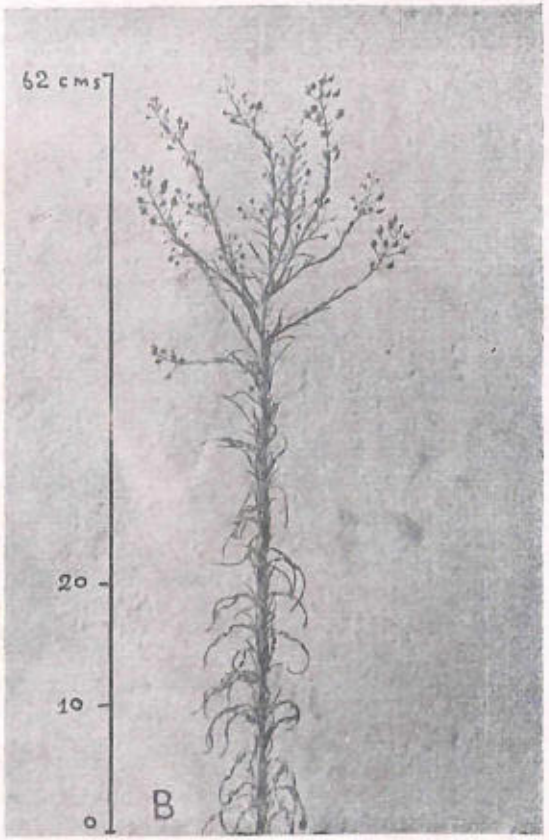


Photo B. *Erigeron bonariensis* L.
Part of the plant with compound inflorescence in which the lateral branches overtop the apex.

The authors are thankful to Prof. L. K. Gunjikar, Head of the Botany Department, Karnatak Science College, Dharwar, for laboratory facilities and to Rev. Fr. H. Santapau, St. Xavier's College, Bombay, for help in preparing this manuscript.

DEPARTMENT OF BOTANY,
KARNATAK SCIENCE COLLEGE,
DHARWAR,
NEW MYSORE STATE,
July 15, 1959.

H. R. LADWA
R. M. PATIL

29. RECORD OF *CRYPTOSTEGIA MADAGASCARIENSIS* BOJ. FROM BARODA

Cryptostegia madagascariensis Boj. is a woody, shrubby climber, grown in tropical gardens for its showy flowers, which are either purple-pink or white tinged with purple or pink. Although it is an ornamental garden plant, it is sometimes found established in a wild state as an escape.

This plant was first reported from some places near Bombay and Poona by Santapau and Irani (*JBNHS* **55**: 594-595, 1958) with a remark that 'it is a new record for Bombay and possibly for the whole of India'. In the same note they have given a detailed description of the plant along with a key to identify the two species of the genus *Cryptostegia*. The plants were collected in cultivated and wild state.

During the course of our local excursions, we came across several plants of *Cryptostegia*, which looked slightly different from *C. grandiflora*. These plants, on detailed examination of the flowers, turned out to be *C. madagascariensis* Boj. This is not only the first record for Baroda but for the whole of Gujarat.

At present the plants have been collected from a few localities in and around gardens, but we propose to study the range of distribution of these plants in the various areas of Baroda and environs.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
July 24, 1959.

A. R. CHAVAN
S. D. SABNIS

30. NOTES ON THE FLOWERING OF *CARVIA CALLOSA* BREMEK. (=*STROBILANTHES CALLOSUS* NEES)

Rev. Father H. Santapau (1955) in his paper on Excursion of the Indian Botanical Society to Pavagadh Hill near Baroda, on January 7th, noted this plant as 'only occasional in the lower half of the slopes; abundant in almost pure stands on the upper half in leaf only'. In the subsequent year a few plants flowered. Mr. B. B. Joshi (1956) collected this plant in flower (*Joshi*, 23-9-1956, 326 P.). In the succeeding year (1957) we observed the general flowering on the slopes of the hill (up to about 523 metres) in the months of September-November (*Oza*, 1-9-57, 103 and 6-11-57, 262). This shrub with bright purple flowers having the bracts green with a pink tinge, and pleasing scent, reached the height of about 60-120 cm., presence of minute hairs on the margins of leaves, stems squarish with continuous furrows; the plant species being fairly abundant on the upper half of the slopes of the hill. By the month of May in 1958, dried plants were noted on the same slopes of the hill. Observations during the months of September-November in the same year helped us to note only a few small plants in flower. The flowering was then random.

The year 1956 witnessed the partial flowering only and hence it could not be called general. As the general flowering occurred in 1957, the authors expect the next general flowering to take place some time about 1963. Further observations on the next general flowering of this plant will be reported to the *Journal* immediately it occurs either before or after 1963.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
February 28, 1959.

V. G. PHATAK, D.SC.
G. M. OZA, M.SC.

[The general flowering of *Carvia callosa* Bremek. reported in this note as having taken place in 1957 on Pavagadh Hill is of interest in one respect. When in the past there has been a general flowering of *Carvia* on any of the hills near Bombay, it has coincided with a similar general flowering practically all over Bombay and southwards to the limit of the distribution of the plant. Further it seems to have coincided also with a general flowering of *Phlebophyllum kunthianum* Nees (=*Strobilanthes kunthianus* T. Anders.) in the south of India. In 1957 there was no general flowering of *Carvia callosa* in Bombay, except for Pavagadh Hill near Baroda; a few plants were noted in flower in Mahableshwar, Khandala, etc. On the

Carvia callosa Brem.
A. Last year's spikes, B. This year's new leaves

other hand, to judge from the remains noted on the Kodaikanal Hills in May of this year, there seems to have been a general flowering of *Phlebophyllum* on the Palnis and Nilgiris.—EDS.]

31. THE FLOWERING OF *STROBILANTHES*

(With a plate)

Most of the plants listed in our floras under the name of *Strobilanthes* seem to belong to what Bremekamp has termed 'plietesials', that is to say they flower once after several years of vegetative growth and then die off. My experience of many years confirms that this is the normal behaviour of such plants.

Recently in Khandala (*c.* 2000 ft.) on the Western Ghats, I was surprised to see that some *Strobilanthes* plants appeared not to conform to the general habit of 'plietesials'. The top of the hill known as Echo Point, near Bhoma Hill, the higest point of Khandala, is practically covered with dense thickets of the *Karvi* plant, *Carvia callosa* Brem. (=*Strobilanthes callosus* Nees); the rains had been on for several days, and most of the *Karvi* shrubs were in leaf. Whilst walking to the top of the hill along paths through the *Karvi* thickets, I noticed exactly nine plants which showed remains of the flowering or fruiting spikes of last year together with fresh leaves of this year, both on one and the same branch. Some of these abnormal plants were collected and pressed and are now kept in Blatter Herbarium under the reference number *Santapau* 23140-23143. Together with these I noticed also four or five plants that had flowered last year and were obviously dead. This is the first time that I have noticed the survival of *Karvi* plants after their flowering. The number of survivors may have been much higher, but I did not stray from the paths to investigate further. (See plate.)

It is clear, then, that the *Karvi* plant may flower and survive to a second flowering, though this seems to be most unusual. The general rule is for the plant to flower once in several years, 7-12, and then die off before the next monsoon; at the beginning of June of the year following the flowering of the plant, the seeds that have remained on the dead parent plant are scattered by an elastic mechanism in the capsule or fruit and germinate at once on the arrival of the first steady showers.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
June 10, 1959.

H. SANTAPAU, S.J.

32. THE LEAVES OF *ALSEODAPHNE SEMECARPIFOLIA* NEES.—A CORRECTION

In a note published in the *Journal* (**56**: 160, 1959) mention is made of the properties of some leaves and tubers, which by mistake were said to be those of *Alseodaphne semecarpifolia* Nees. The leaves are indeed those of this plant; but the tubers are of *Dioscorea*, probably *D. bulbifera* Linn. This latter plant produces a large underground tuber and in addition brings out a number of small 'bulbils' or tubers in the axils of most of the leaves; it is these bulbils or tubers of *Dioscorea* that are used in the treatment of eczema. *Alseodaphne* does not produce any tubers, at least normally.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
August 3, 1959.

H. SANTAPAU, S.J.

Gleanings

Crop damage by Blackfaced Weaver Bird (Quelea quelea) in Tanganyika

'It has been calculated that one bird eats the equivalent of two ounces of mature wheat a day, so that a roost of 492,000 was eating 300×200 lb. bags of wheat a day, or 27 tons.'

[Extract from *Bull. Brit. Orn. Cl.* (1959) **79**, p. 38.]

Perennial Wheat

'After 35 years experimentation U.S. Department of Agriculture plant breeders appear to be on the verge of developing a commercially valuable perennial wheat. A hybrid of wheat and certain tall grasses, the perennial yields grain for several years, resists insects and disease and provides year-round cover for the soil.

The quest for perennial wheat was started by W. J. Sando, now retired, who in 1923 crossed wheat with wheat grass and other species of the genus *Agropyron*. Among those who followed up his work was C. A. Suneson, a Department of Agriculture agronomist working in the California Agricultural Experimental Station at Davis, Calif. He has evolved an especially promising perennial by backcrossing Sando's hybrids to spring wheat and intercrossing the progeny.

Suneson's plants live about four years and bear grain that is especially rich in protein. They withstand drought and are highly resistant to smut, rust, mildew, and other wheat diseases. Furthermore, they are not attacked by the Hessian fly and other insects that ravage wheat. There is, however, one drawback. While the yield of grain in the first year matches that of local wheats, it drops off by 40 per cent or more in the second year. But Suneson now believes that he can keep the yield high throughout the lives of the plants if he can work out ways to fertilize them every year and to control weeds.'

[From *Scientific American*, Vol. 200, No. 1, pp. 62-63, January 1959.]

Fishing with Air Curtain

'An ingenious method for herding herring into the fisherman's net has been developed by the Bureau of Commercial Fisheries, Fish and Wild Life Service.

In the method, the fish are blocked off from escape into other waters by use of a "bubble barrier" or underwater air curtain. The bubble barrier is created by pumping compressed air through long lines of plastic pipe laid down on the ocean floor. Air escaping from the tiny holes in the piping forms a wall of bubbles which serves as an effective barrier to a school of fishes.

Government experts say that tests have shown the air curtain to be successful in guiding the movement of herring. The plastic pipe can be swept across the bottom of the open ocean or a deep channel, driving the fish into water shallow enough for seine fishing.'

[From *Science Digest*, Vol. 45, No. 5, p. 12, May 1959.]

Termites

'The termite is a fascinating creature to study but is also a very frightening menace. In America where only fifty-five species are known, the active damage caused by termites was reckoned in 1934 as forty million dollars a year. Over four hundred species have been identified in the continent of Africa, some of which live and work underground, tunnelling into the centre of their prey, be it beams or door frames or stalks of plants, and eating away the inside unnoticed, until the outer walls collapse. The termites are invading the earth. From Australia to India, Malaya and Ceylon, from California to San Francisco, from North to South America, one or another species of the four hundred main families of termites has made its home. Climate is no deterrent to them, for they adapt themselves to withstand cold as well as heat and have been found high in the Himalayas. In a right proportion they are beneficial to agriculture and to life. It is the terrific pace of their increase that has caused them to become enemies instead of friends.'

[Richard St. Barbe Barbe Baker (1954): SAHARA CHALLENGE. (London. Lutterworth Press.)]

Mixed Forests

'For successful forestry it is well to study the natural forest. . . . The virgin forest often contains a preponderance of so-called secondary timbers, for which there is little economic use. On the face of it the obvious solution is to concentrate on promoting the regenerating growth of a few of the most valuable timbers, and to transform the mixed, uneven-aged virgin forest—this apparently struggling mass—into uniform plantations of a single valuable species. This was done in the mahogany forests. . . . That experiment failed. . . .

'In the Kingdom of Wood there is a complicated society of living things in which each is a dependent member. No single species can thrive by itself, nor may it be used in plantations where it is isolated from its natural nurses and helpful neighbours. Observation shows that the trees that man regards as useless to cultivate can each make their own especial contribution to the good of the community. The slogan "Back to Nature", as applied to silviculture, holds a deep significance, for once the rhythm of the forest is broken, growth will lag and degeneration will set in. The harmonious functioning of all parts of the forest is the best guarantee of its health and well-being. It should be remembered, however, that in the virgin forest growth only keeps pace with decay, and until man harvests the matured trees, they are unproductive of timber.'

[Richard St. Barbe Baker 1942): AFRICA DRUMS.]

Notes and News

Bird Migration Study

In the April (1959) issue reference was made to the Society's plans for Bird Migration study in Kutch. A pilot project was put through between 15 and 30 September mainly to test the potentialities and train personnel for the field work proper in spring 1960, in which financial participation by W.H.O. is expected. The phenomenally heavy and long-drawn monsoon this year, with the resulting inundations and road breaches, rendered it impossible to reach the venue originally selected, namely Kuar Bet in the Great Rann. Therefore a more accessible area in the neighbourhood of Bhuj had to be chosen which would provide reasonably adequate opportunities. The project was financed out of the grant received by the Society from the Rockefeller Foundation earlier. Thanks to a special donation from W.H.O., we were enabled to invite to India Dr. Alfred Schifferli, Director of the Swiss Migration Research Centre, Sempach, for a few weeks to impart the necessary training to our personnel in the use of Japanese mist nets and other relevant migration study techniques. The trainees included three members of the Society's staff and several amateur ornithologists who, it is expected, will participate in the field work next March.

During the fortnight's operation 2060 birds of 56 forms were netted, including some 300 recaptures. 27 species of these 56 were migrant. Owing to the abnormal weather conditions migration appeared to be greatly retarded. Many species though overdue had not arrived, while those present were also in small numbers. The birds were banded with aluminium rings of 3 sizes—A, B, C—bearing, in addition to a serial number, the legend INFORM BOMBAY NAT. HIST. SOCIETY. Readers are requested to publicize this information as widely as possible by every means at their command. The success of the scheme depends upon ensuring that no recovery of a ring goes unreported to the Society.

The birds were identified, registered, measured, and weighed. Prior to release, all except 33 were also examined for ectoparasites by technicians of the Virus Research Centre, Poona, who accompanied the field party. Ticks were found on only 6 birds, two of which belonged to migratory species. The netting operations produced 3 new birds for Kutch—species not recorded before. (See Misc. Note 11, p. 635.)

The spring migration field work is provisionally scheduled for 8-31 March 1960. Persons willing to participate (and prepared to put up with a certain amount of physical discomfort) should contact Dr. Sálim Ali.

* * * *

The Marine Biological Association of India

The Marine Biological Association of India was founded at Mandapam Camp, to promote interest in marine biological and cognate sciences. The Association was formally inaugurated by the Hon'ble Mrs. Lourdammal Simon, Minister for Fisheries and Local Administration, Madras State, on January 3rd, 1959. The following office bearers were elected: Dr. S. Jones (President), Prof. R. V. Seshaiya (Vice-President), Dr. R. Raghu Prasad and Dr. C. P. Gnanamuthu (Secretaries), Dr. R. P. Varma (Asst. Secretary), Shri. K. V. Rao (Treasurer), Dr. P. N. Ganapati (Editor), Dr. R. Subramanyan (Joint Editor), and Dr. S. V. Job (Managing Editor). The official organ of the Association, the 'Journal of the Marine Biological Association of India', is expected to be issued half-yearly. Membership is open to all interested. All correspondence may be addressed to the Secretary, Marine Biological Association of India, Marine Fisheries P.O., Mandapam Camp, South India.

* * * *

The All-India Congress of Zoology

The First All-India Congress of Zoology, sponsored and organized by the Zoological Society of India, was held at Jabalpur, October 24-27th, under the presidentship of Dr. M. L. Roonwal.

Nearly 120 papers were received on many branches of zoology, in addition to contributions to the three Symposia on 'Reorientation of teaching of Zoology in India', 'Marine Zoology and fisheries in the Indian Ocean', and 'Recent evolutionary studies in India.'

Proceedings of the Congress, including these papers in full, are being printed. Abstracts, which were issued in advance, and other information may be obtained from the General Secretary, Dr. B. S. Chauhan, c/o. Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta 12.

It is proposed to hold similar Congresses every three years.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR ENDING 31ST DECEMBER 1958

President

SHRI SRI PRAKASA, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

Executive Committee

Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I.
Dr. D. V. Bal, M.Sc., Ph.D.
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.Sc., Ph.D.
Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Mr. J. A. Singh, I.F.S.
Mr. Humayun Abdulali (*Hon. Secretary*)
Mr. M. J. Dickins (*Hon. Treasurer*)

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. G. V. Bedekar, I.C.S.	*Aurangabad*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S.	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Assam*
Col. R. C. Morris, F.R.G.S., F.Z.S.	*Attikan*
Lt.-Col. E. G. Phythian-Adams, O.B.E., F.Z.S., I.A. (Retd.)	*Nilgiris*
Dr. Baini Prasad, D.Sc., F.N.I.	*Dehra Dun*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*
Dr. M. L. Roonwal, M.Sc., Ph.D., F.N.I., F.Z.S.I. ...	*Calcutta*

List of members of the Executive and Advisory Committee elected for the year 1959:

President

SHRI SRI PRAKASA, *Governor of Bombay*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S.
Rev. Fr. H. Santapau, S.J.
Dr. Sálim Ali

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Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Mrs. Barbara J. Tufty
Mr. Humayun Abdulali (*Hon. Secretary*)
Mr. Surendr Lall (*Hon. Secretary*)

Advisory Committee

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*Calcutta*
Mr. G. V. Bedekar, I.C.S.	*Aurangabad*
Sir Chintaman Deshmukh, Kt., C.I.E., I.C.S. (Retd.)	*New Delhi*
Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D.	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Dr. Baini Prasad, D.SC., F.N.I.	*Dehra Dun*
Dr. M. L. Roonwal, M.SC., Ph.D., F.N.I., F.Z.S.I. ...	*Calcutta*
Mr. P. D. Stracey, I.F.S.	*Dehra Dun*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1958

THE SOCIETY'S JOURNAL

Parts 1, 2, and 3 of Volume 55 were published during the year. It was decided to complete this and future volumes with the third number so that each volume will now coincide with the calendar year. The last volume contained 39 articles and 85 miscellaneous notes.

The routine work of the Society included the identification of specimens and the answering of many enquiries, several of which have led to miscellaneous notes.

GENERAL

With the formal sanction of the Government grant, referred to in the last report, the Society's offices have been moved to 91, Walkeshwar Road, where it is hoped that members will be able to take better advantage of the library and, in due course, of the reference collections also.

Mrs. Barbara Tufty, a member of the Society, has very kindly undertaken the cataloguing and arrangement of the large number of books and magazines in our library, but her efforts are being hampered by our inability to obtain all the steel bookcases which have been ordered.

The reference collections will also be brought over with the completion of the agreement with the Prince of Wales Museum and, after these are under the same roof as the library, members and others will have better opportunities to study them.

The negotiations with the Ministry of Scientific Research and Cultural Affairs regarding the building funds have not progressed any further.

With the funds made available by the Sir Dorabji Tata Trust grant, six students have been given varying awards for field work.

Owing to technical difficulties Dr. J. H. Crook of Cambridge University, who is working on the breeding biology of the baya around Poona, has not been accepted by the University of Bombay as a teacher for the M.Sc. course in Zoology (Field Ornithology), and at the moment this work is being supervised by Dr. Sálim Ali. The only student on our rolls is, however, working in conjunction with Dr. Crook and is one of the beneficiaries under the Sir Dorabji Tata Trust grant.

Through the courtesy of the Canadian High Commissioner in Delhi, we were able to show three excellent films entitled 'Hunting with a Camera', 'Your Forest Heritage', and 'Life on the Western Marshes' on 11th July at the B.E.S.T. Conference Hall.

A number of antlers, horns, and skeletons of many different mammals, which had been lying in the Society's godown for many years, were distributed to some 14 colleges and institutions in India for display in their Zoology Departments.

PUBLICATIONS

The second edition of THE BOOK OF INDIAN ANIMALS is now in the press but, as most of the coloured plates are being replaced, it will

be at least another year before it is ready. THE SYNOPSIS OF INDIAN BIRDS by Dr. S. Dillon Ripley is making progress and should be ready by the end of next year.

NATURE EDUCATION

The Nature Education Scheme financed by the Government of Bombay is now in its 11th year. Though limited by the funds available, the usual activities were continued. Some 3400 children were taken over the Natural History Section of the Prince of Wales Museum (44 visits), the Taraporevala Aquarium (9 visits), and the Municipal Gardens (4 visits). Nine field trips to different places, e.g. Kanheri Caves, Powai Lake, etc., were arranged for the Nature Study clubs.

In addition to the talks accompanying these excursions, 65 talks on different natural history subjects were delivered at the Museum and 40 conversational meetings held in the schools.

A series of eight lectures on 'Plant Life' with demonstrations was thrice arranged for teachers. They were also given the benefit of a course in geology by Dr. R. N. Sukheshwala of St. Xavier's College. This included two field trips into Salsette Island.

A meeting of children to celebrate Wild Life Week was called on 7th October when films were shown and Dr. Sálim Ali and Fr. H. Santapau addressed them.

REVENUE ACCOUNTS

In the latter part of 1957 the entrance fee of Rs. 25 for membership of the Society was reduced to Rs. 5 with the object of attracting more members. It is perhaps still a little too early to say, but this move does not appear to have been particularly successful and the increase in membership during 1958, although slightly larger than in the past, has not been significant. Efforts to attract more members, however, continue and it is becoming increasingly apparent that the reduction in entrance fees will have to be supplemented by other measures before a larger growth in membership can be achieved.

As at the end of 1958 the register showed a total membership of 1255 but this is misleading in that approximately 274 members have either not paid their subscription or cannot now be traced. Although efforts are continuing to ascertain their whereabouts, it seems likely that most of them will have to be struck off the membership rolls in the near future.

During the year under review the income of the Society was Rs. 47,374 as against Rs. 50,992 in the previous year. This drop of

Rs. 3618 was due almost entirely to the Society not having received the usual annual grant of Rs. 8000 from the Government of India and attempts are still being made to secure these funds from the Government both in respect of 1958 and for the future.

The operations of the Society during 1957 had, as you already know, shown a deficit of Rs. 9542 and, though attempts were made to prevent a recurrence, the delay in receipt of the Government of India grant to the Society has led to the showing of a further deficit of Rs. 11,448 as at the end of the year under review. A promised recovery of Rs. 3210 from the Prince of Wales Museum (half the salary of the Acting Curator who has now been taken over by the Museum) has not been taken into account as the amount had not been received before the close of the year. Had it been possible to effect this recovery in time, the deficit for the year would have been reduced to to Rs. 8238.

Expenses during the year amounted to Rs. 58,822, a drop of Rs. 1711 as compared to the previous year. This is very satisfactory if it is borne in mind that the increased responsibilities of the Society necessitated a small increase in the staff, resulting in an increase of Rs. 2559 in expenditure on staff, despite which an overall saving has been achieved.

As for the future, it is still hoped that there will be no curtailment of the Government of India grant, but the seriousness of recurring deficits cannot be ignored. This matter is already engaging the attention of the Executive Committee and ways and means are being explored of cutting expenses without impairing the work being done by the Society, or in any way reducing the facilities it affords to its members.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in United Kingdom.

APPENDIX TO THE HONORARY SECRETARY'S REPORT COVERING THE PERIOD JANUARY TO AUGUST 1959

This report for January to August 1959 is in several ways supplementary to that for 1958.

The agreement with the Prince of Wales Museum has been signed and the Reference Collection, consisting of some 21,000 mammal skins, 20,000 birds, 3,500 fish, 4,000 reptiles, 1,000 amphibians, 80,000 insects and a large number of miscellaneous items, has been brought over to the Society's premises where it is now available to members and other research students. The Society retains two representatives on the Board of Trustees of the Museum and it is hoped that the apparent separation will not lead to any dissociation from the management and maintenance of the Natural History Section of the Museum which is accepted as the best in India, if not in Asia.

It has not yet been possible to appoint the additional staff necessary for the proper maintenance, working, and development of the collections. The salary of a Senior Research Assistant is to be paid out of the annual grant from the Government of Bombay and the scale provided under the Government notification is insufficient to enable us to secure a suitable person. We are trying to persuade Government to increase the grade.

In the meantime, we have had the opportunity of sending members of the staff into the field with foreign and other expeditions. P. W. Soman, Junior Research Assistant, spent several months in Nepal with Mr. Klavs Becker-Larsen of Denmark while two members of the junior staff were attached to an American Museum expedition to Madhya Pradesh where they have had excellent instructions and practice in the preparation of bird and mammal skins. Later P. B. Shekar was attached to the Virus Research Centre's trip to Kashmir for the collection of some birds in the course of their investigations and he has brought in 73 birds for our collection.

The Virus Research Centre at Poona is investigating the Kayasanur Forest Disease which occurs in restricted areas in Mysore, some parts of Russia, and of which traces have been found in Kathiawar. From this distribution it is suspected that the disease, which is sporadic, is carried by migratory birds and large numbers of many species will have to be captured for the examination of their blood.

Dr. Sálim Ali attended a WHO Conference at Geneva and negotiations are in progress to secure their financial co-operation for a relatively large project for the capture and ringing of birds on migration in the Rann of Kutch. Some preliminary investigations

have been made and a trial project is going into operation next week. If this shows promise, a much larger effort will be made next spring.

From the funds made available by the Rockefeller Foundation, the Society has offered financial assistance for specific pieces of field work in natural history to be completed during the current year. Unfortunately, as has been our experience in the past, most of the applicants have a very poor idea of what they propose to do and very few have made any definite proposals. The majority of the applications are yet to be considered but some of those already sanctioned and completed may be of interest. Mr. E. P. Gee whose photographs are familiar to you was commissioned by the Survival Service of the International Union for Conservation of Nature and Natural Resources to inquire into the present status of the Great Indian Rhinoceros in Nepal. The Society contributed Rs. 250 towards his expenses and I hope that you will be able to read Mr. Gee's report in the December number of our *Journal*.

We helped Dr. Sálim Ali with his travelling expenses on a trip to Uttar Pradesh in search of Finn's Baya. This species was discovered and named by Hume in 1869 and then rediscovered by Finn in 1901 in the Calcutta Bazar. Though it occasionally turned up in the bird markets both at Calcutta and in Bombay, it had never been found again in a wild state and the Indian Board for Wild Life placed it among the rarer of our birds, completely prohibiting its export, dead or alive. Dr. Sálim Ali saw large numbers in the Kumaon terai and also obtained photographs and movie films some of which we hope to be able to show you in the near future.

The pioneer bird banding project in Kutch to which I referred earlier is also being assisted to the extent of Rs. 5000.

Dr. Gardiner Bump of the U.S. Fish and Wildlife Service is in India on a two-year visit to study the ecology and habits of some Indian game birds which it is proposed to introduce into the United States. Attempts are being made to collaborate with him and have the food of these species studied. The results would be of considerable importance and interest in India itself. Dr. Bump showed to our members a most remarkable film on 'The Bobwhite Quail' at the U.S.I.S. Auditorium, on 19th March. This was followed by a talk on Game Preservation.

I am sorry to have to announce the death of Lt.-Col. E. G. Phythian-Adams who was a member since 27-10-1909 and has been actively associated with our Advisory Committee since January 1930.

Mr. M. J. Dickins, our Honorary Treasurer since 1950, has

retired from India and the office taken over by Mr. Surendr Lall. We would like to record our deep gratitude to Mr. Dickins for the help which he has rendered to the Society not only as Honorary Treasurer, but also as a constant adviser and consultant while the Society's offices were at Messrs Phipson & Co. Ltd. Mr. Dickins has presented to the Society a large meeting table as also photographs of the earlier Directors of Phipson & Co. who were also closely associated with the administration of the Society since its inception.

The negotiations with the Ministry of Scientific Research and Cultural Affairs for a building grant are progressing very slowly, but it is hoped that in due course it will be possible to put up a new building in the Museum premises and increase the extent of the educational and research work which we can sponsor or handle.

The wall charts for the identification of poisonous snakes in English, Marathi and Gujarati are ready and prospectuses will go out to members shortly.

Since the last Annual General Meeting 102 members have joined, 47 in 1958 and 55 during the current year.

NEW MEMBERS

The following 102 members have joined since the last Annual General Meeting:

FROM 19 JUNE TO 31 DECEMBER 1958

Mr. H. B. Fossey, London; Mr. Gerald Malcolm Durrell, Hampshire; The Peermade Game Association, Peermade; Mr. C. S. Machia, Mudis; Mr. R. C. Patil, Mugar; Mr. Pratapsinh R. Morarji, Bombay; Mr. B. R. Dave, Bombay; Mar Ivanios College, Trivandrum; Mr. Abdul Rahman M. Yusuf, Bombay; Mr. S. S. Podar, New Delhi; Mr. Oden Meeker, New Delhi; Messrs Sarabhai Chemicals, Baroda; Mr. K. Sivaloganathan, Kandy; Central Botanical Laboratory, Allahabad; Mr. Kamal Singh, Dumraon; Officers' Mess, Bengal Engineer Centre, Roorkee; Mr. Edwin T. Goodridge, New Jersey; Gorakhpur University, Gorakhpur; Mr. J. S. Lall, New Delhi; Central National Herbarium, Howrah; Mrs. Harold Tufty, Bombay; Director of Indian Aid Mission in Nepal, Kathmandu; Union Club, Raipur; Mr. Syed Shamsuzzoha, Comilla; Government College, Sirohi; Mr. A. C. Thimiah, Virajpet; Shan & Kayah States, Taunggyi; Dayanand College, Sholapur; Institute of Pre-University Course, Gadag; Fr. Joe Rodrigues, Poona; Conservator of Forests, Junagadh; Lady Shri Ram College for Women, New Delhi; Dr. Gardiner Bump, New Delhi; Mr. Sanit Tongsanga, Calcutta; Mr. Yakubali Mohamedali, Bombay; Mr. K. Becker-Larsen, New Delhi; Mr. Yashwant H. Talcherkar, Sironj; Miss Ellen Drake, New Delhi.

FROM 1 JANUARY TO 31 AUGUST 1959

Mr. T. N. Mehrisi, Sendhwa; Mr. David Livingstone, Palayamkottai; Col. S. S. Bhatnagar, Bombay; Mr. A. F. Burdett, Dehra Dun; Mr. H. F. Bartsch, Jamshedpur; Mr. H. A. R. Eadie, Digboi; PMC. Officers Mess, C/o 56 APO; Mr. S. I. Hassan, Mombasa; Mr. Bijay Narain Sinha, Latehar; Mr. J. E. Matthews, Marangi; Mr. Sergei Postupalsky, Michigan; Dr. G. K. D. Roy, Arunachal; Messrs. Davidoss & Co., Bangalore; Miss E. L. Campbell, Balaghat; Mr. P. S. M. Molyneux, Coonoor; Mr. D. M. Holmes, Bombay; Mr. Georges Gogel, Bombay; St. Thomas Inter College, Shahganj; Mr. Urendra T. Mehta, Bombay; Mr. Walter Mink, Bombay; Government Degree College, Mandsaur; Bombay Veterinary College, Bombay; Mr. Dix Campbell, Mass.; Maharaj Kumar Fatehsinh of Kutch, Bhuj; Mr. N. K. C. Parish, Town Khalispur; St. Xavier's College, Ahmedabad; Indian Botanical Gardens, Howrah; Chief Wild Life Warden, Lucknow; Mr. K. S. Sadananda, Barsikatte; Mr. Kalyan Kumar Gupta, Shillong; Major Kumar S. N. Rai Deb, Calcutta; Mr. Mohamed Aminuddin Khan, Munnar; Mr. Jan Roger van Oosten, Washington; Mr. R. G. Brown, North Lakhimpur; Karachi University Library, Karachi; Mrs. William H. Mathers, Long Island; Fisheries Research Officer, Udaipur; Mahatma Gandhi Memorial College, Udipi; Mr. Wayne H. Bohl, New Delhi; University College of Ghana, Accra, Ghana; University of Jammu & Kashmir, Srinagar; Mr. Jagdish Narain, Moradabad; Yuvraj Digvijaysinh, Wankaner; Divisional Forest Officer, Tirap; Mr. Nar Singh Sidhu, Tamkote; Divisional Forest Officer, Tezu; Jamal Mohamed College, Tiruchirapalli; Mr. A. N. C. Lothian, New Delhi; Mr. P. K. Basu, Dalsingpara; Mrs. Martha Howe Gogel, Bombay; Dr. Chas E. Klontz, Vellore; Duke University, Carolina; College of Science & C. B. Patel's Arts Institute, Nadiad; Dr. Bankay S. Lall, Sabour; Wild Life Preservation Society of Northern India, Dehra Dun; Mr. R. A. S. Melluish, Madras; Mr. L. A. Woodfall, Bombay; Holkar College, Indore; Dr. Edward W. Taylor, Kansas; Rajasthan College of Agriculture, Udaipur; Mr. J. MacLellan, Calcutta; Mr. S. M. Zubair, Bombay; Delaware Museum of Natural History, Delaware; Mr. A. A. Salunkey Patil, Damoh.

THE BOMBAY NATURAL HISTORY SOCIETY

BALANCE SHEET AS AT 31 DECEMBER 1958

FUNDS AND LIABILITIES	Rs nP	Rs nP
Trust Fund or Corpus:		
Life Membership Fund		
Balance as per last Balance Sheet ...	97,190.28	
Add: Amount received during the year ...	150.000	97,340.28
Other Earmarked Funds:		
Expedition Fund	1,800.00	
Field Work Fund		
Balance as per last Balance Sheet 523.72		
Add: Transferred from Income and Expenditure Account 2,380.25	2,0 09.97	
Wild Life Fund	715.25	
Mammal Survey Fund	3,265.73	
Building Fund	30,000.00	
Reserve for Snake Wall Charts ...	3,000.00	
Unspent Grant of Government of Bombay		
Transferred from Income and Expenditure Account	33,515.43	75,206.38
Liabilities:		
For Expenses	18,970.12	
,, Advances (Subscriptions and Entrance Fees)	936.14	
,, Sundry Credit Balances ...	4,674.54	4,580.80
Income and Expenditure Account		
Balance as per last Balance Sheet	38,098.49	
Less: Deficit as per Income and Expenditure Account	11,447.80	26,650.69
Carried forward ...		2,23,778.15

ASSETS	Rs nP	Rs nP
Immovable Properties		nil
Investments:		
Rs. 14,000 4% Bombay Port Trust Bonds	10,780.00	
,, 15,000 4% Bombay Improvement Trust Bonds ...	11,400.00	
,, 36,000 3% Funding Loan 1966-68	35,812.62	
,, 25,000 3% Conversion Loan 1946	25,000.00	
,, 2,000 3% First Development Loan 1970-75 ...	1,948.75	
,, 92,000	84,941.37	
(Market value Rs. 82,098.50)		
£ 460 3½% Defence Bonds	6,133.34	
	91,074.71	
Less: Provision for Depreciation ...	3,750.00	87,324.71
Furniture and Fixtures:		
Balance as per last Balance Sheet ...	2,030.11	
Less: Sold during the year	338.40	
	1,691.71	
Less: Depreciation during the year ...	250.22	1 441.49
Loans: (Secured) *Good* *Doubtful*		
Loan Scholarships nil nil		
Other Loans (to staff) ... ,, ,,		
Advances:		
To Trustees	nil	nil
,, Employees	,,	
,, Contractors	1,956·84	
,, Lawyers	nil	
,, Nature Education Scheme	2,004. 11	
,, Others	246.2 9	4,207.24
Income Outstanding:		
Rent	nil	
Interest (Accrued)	1,741.89	1,741.89
Other Income:		
Supplies and Services	9,082.60	
Government of Bombay (Grant) ...	4,000.	13,082.60
Carried forward ...		1,07,797.93

BALANCE SHEET AS AT 31 DECEMBER 1958—(continued)

FUNDS AND LIABILITIES		Rs nP	ASSETS	Rs nP	Rs nP
Brought forward ...		2,23,778.15	Brought forward ...		1,07,797.93
			Stock of Books on hand: (At cost or under) As certified by the Honorary Secretary ...		53,411.16
			Cash and Bank Balances:		
			(a) *In Current Account with :*		
			National and Grindlays Bank Ltd., Bombay	12,677.88	
			National and Grindlays Bank Ltd., London (£ 715 11-9)	9,547.18	
			Call Deposit with the Comptoir National d'Escompte de Paris, Bombay	40,000.00	
			(The above accounts are in the name of the Society)		
			(b) With the Trustees	Nil	
			(c) With the Cashier (Shri A. L. Hegde).	350.00	62,569.06
Total ...		2,23,778.15	Total ...		2,23,778.15

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Properties and Assets of the Trust.

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

THE BOMBAY NATURAL HISTORY SOCIETY

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31 DECEMBER 1958* *Cr.*

EXPENDITURE	Rs nP	Rs nP
To Expenses in respect of Properties:		
Rates, Taxes, Cesses, Repairs, and Maintenance	nil	
Salaries	"	
Insurance	"	
Depreciation (by way of provision or adjustments)	"	
Other expenses	"	nil
Expenses from the Special Grant of Government of Bombay:		
Rent	7,000.00	
Purchase of Furniture	3,231.80	
Salaries	1,111.15	
Miscellaneous	141.62	11,484.57
Establishment Expenses:		
Salaries (including Dearness Allowance)	30,737.20	
Society's contribution to Staff Provident Fund	1,254.94	
Rent	1,600.00	
Postage	1,281.81	
Printing and Stationery	1,277.29	
Advertisement	56.80	
Editor's Travelling Expenses	900.00	37,103.04
Remuneration to Trustees:		nil
Remuneration (In the case of a Math).		nil
Legal Expenses		nil
Audit Fees		500.00
Contribution and Fees		nil
Amounts written off:		
Bad Debts	nil	
Loan Scholarships	"	
Irrecoverable Rents	"	
Other items	"	nil
Carried forward ...		49,087.61

INCOME	Rs nP	Rs nP
By *Rent:* Accrued	nil	
Realised	"	nil
Interest (Realised and Accrued)		
On Securities	4,441.67	
On Bank Account	1,003.79	5,445.46
Dividends		nil
Donations in cash or kind		"
Grants:		
Government of Bombay	4,000.00	
Government of Bombay Special Grant.	45,000.00	
Sir Dorabji Tata Trust Grant for Field work	3,000.00	52,000.00
Income from other sources:		
Subscriptions	21,637.75	
Entrance Fees	15.00	22,052.75
Publications:		
Journal Sales	7,025.28	
Books etc., Profits:		
Book of Indian Birds	3,169.22	
Book of Indian Animals	7.65	
Some Beautiful Indian Climbers and Shrubs	1,008.32	
Some Beautiful Indian Trees... ...	756.18	
Butterflies of the Indian Region ...	782.99	
Circumventing the Mahseer and other Sporting Fish	318.86	
Game Birds Vol. III...	42.32	
Indian Molluscs	161.66	
Calendars	2,030.91	
Other Publications	92.32	
Taxidermy, etc.	58.55	15,454.26
Carried forward ...		94,952.47

Dr. INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31 DECEMBER 1958—(continued) Cr.

EXPENDITURE	Rs nP	Rs nP	INCOME	Rs nP	Rs nP
Brought forward ...		49,087.61	Brought forward ...		94,932.47
To Miscellaneous Expenses:			By *Refund of Insurance Premium in respect of the year* 1957		421.87
Field Work Expenses	619.75		*Deficit carried to Balance Sheet* ...		11,447.80
General Charges	2,305.69				
Fire Insurance	138.63				
Sales Tax and Central Sales Tax ...	637.35	3,701.42			
Depreciation:					
On Investments	nil				
,, Furniture	250.22	250.22			
Amounts Transferred to Reserve or Specific Funds:					
Unspent Grant of Government of Bombay	35,515.43				
Unspent Grant for Field Work transferred to Field Work Fund	2,380.25	35,895.68			
Expenditure on Objects of the Trust:					
(*a*) Religious	nil				
(*b*) Educational—Journal Expenses ...	16,716.04				
Library	1,171.17				
(*c*) Medical relief	nil				
(*d*) Relief of Poverty	,,				
(*e*) Other Charitable Objects	,,	17,887.21			
Total ...		1,06,822.14	Total ...		1,06,822.14

BOMBAY, *30th March, 1958*

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

For Bombay Natural History Society
(Sd.) SÁLIM ALI,
Trustee.

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 December 1958

Receipts	Rs nP	Payments	Rs nP
To Bank balance as at 1 January 1958 brought forward	1,221.83	By Repayment of Advance from Bombay Natural History Society	1,000.00
Grant from Government of Bombay for 1957-58 ...	6,100.00	Salaries of Nature Education Organiser	5,915.00
Sales of Line drawings, etc.	50.12	Postage	221.03
Sales of Booklet No. I	655.05	Printing and General Charges	288.36
Sales of Booklet No. II	658.29	Cost of Booklet No. III	2,800.00
Sales of Booklet No. III	631.80	Cost of Booklet No. IV	9.25
Advance Receipt for Booklet No. IV	1.19	Balance carried forward :—	
Bombay Natural History Society Advance ...	2,004.11	Cash with the Cashier 50.00	
		Bank Balance on 31 December 1958 ... 1,038.75	1,088.75
Total ...	11,322.39	Total ...	11,322.39

Bombay, 30th March, 1958

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE B.E.S. & T. CONFERENCE HALL, BEST HOUSE, ORMISTON ROAD, BOMBAY 5 ON MONDAY 31ST AUGUST 1959 AT 5.45 P.M. WITH REV. FR. H. SANTAPAU, S.J., IN THE CHAIR

1. The Honorary Secretary's Report for the year ended 31st December 1959 which was circulated among members prior to the meeting was taken as read and adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The Honorary Secretary then read a Supplementary Report on the activities of the Society from January to August 1959.

4. After completion of the formal business the following films were exhibited and greatly appreciated:

(1) WHERE THE TIGER PROWLS.
(2) JOURNEY IN SPRING.

5. The meeting terminated with a vote of thanks to Mr. Saul Blickman of New York for the gift of the tiger film and to the British Information Services for the loan of the film JOURNEY IN SPRING.

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