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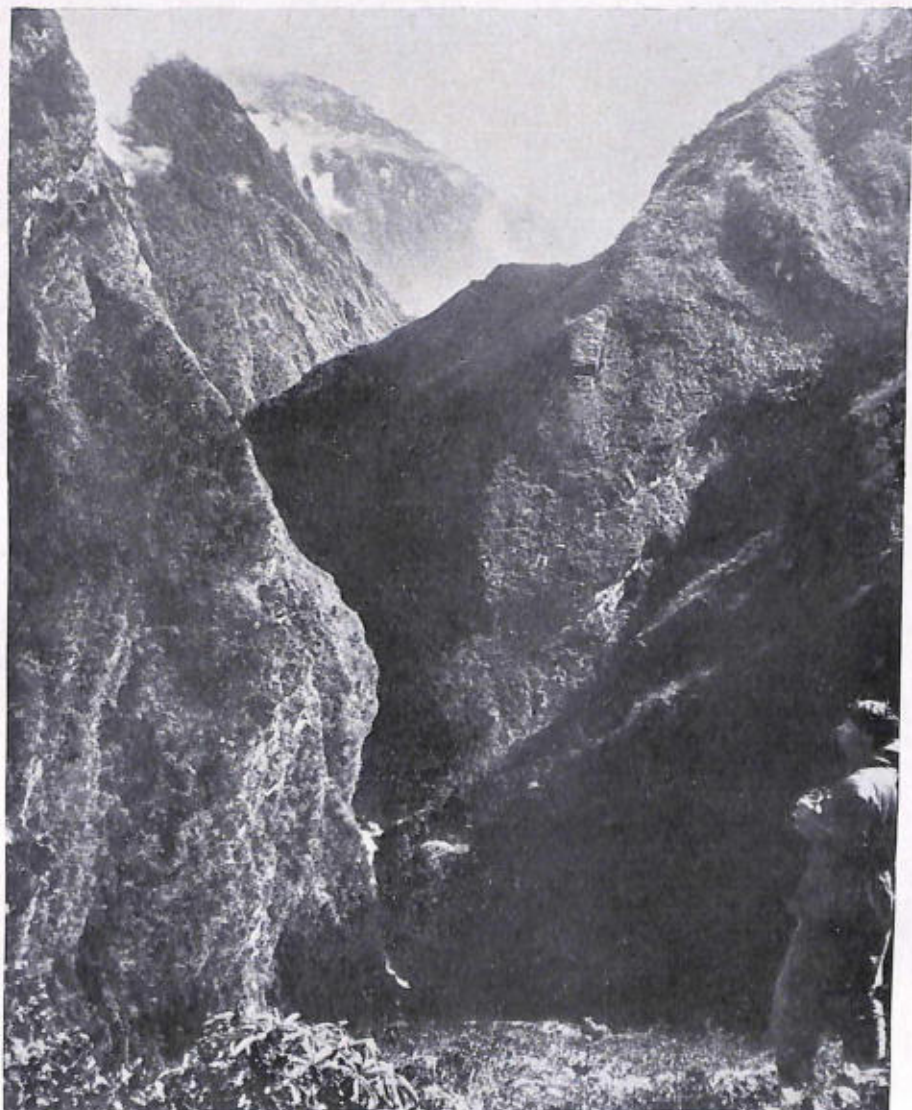
Between February 25 and April 5, 1972, I observed tahr on 20 days in and around the Kang Chu valley (also known as the Zom valley) of eastern Nepal. While my contact with the animals was limited to 80 hours of observation, the data contribute to the knowledge of the species and provide a basis for comparing the behaviour of Himalayan tahr with that of Nilgiri tahr (*Hemitragus hylocrius*).

The Kang Chu has its source in the Tibet province of China but soon crosses the border and flows southward through Nepalese territory for about 15 km before joining the Bhota Kosi river a stretch during which it descends from an altitude of 4000 m to 2500 m. A mountain range with peaks exceeding a height of 6000 m borders the valley on each side. At its confluence with the Kang Chu, the Bhota Kosi enters a canyon whose sheer cliffs rise 1000 m or more. After about 2 km the valley broadens, and soon after that, near the village of Lamobager, the river tumbles to lower altitudes. Tahr frequent most cliffs along the lower Kang Chu, the upper Bhota Kosi, and the adjoining Rongshar and Chyadu river valleys. I found tahr fairly abundant and observable only on the cliff that flanks the western bank of the Bhota Kosi between the mouths of the Kang Chu and Chyadu valleys (86° 14' E., 27° 57' N.). By climbing the cliff on the opposite side, I was able to observe tahr across the narrow canyon with a 20-power scope (Plate 1).

HABITAT

Himalayan tahr are found from the Jhelum river in the Pir Panjal Range of Kashmir eastward along the southern flanks of the Himalayas to about central Bhutan (Burrard 1925). Animals may occur from altitudes of as low as 1550 m in winter (Stockley 1928) to as high as 5300 m in summer (Caughley 1969). In the Kang Chu area, the species was observed between about 2500 and 4400 m, a range of altitudes which includes several vegetation types. The valleys and lower slopes up to an altitude of around 3000 m (the exact limit depending on degree of slope and exposure) are covered with a montane 'evergreen broadleaved forest' (Schweinfurth 1957). Although *Quercus* spp., *Buxus wallichiana*, and other trees may form almost monotypic stands, the forest usually consists of a variety of trees among which the genera *Rhododendron*, *Magnolia*, *Acer*, *Alnus* and *Tsuga* are prominent. Except for a few tall stands with a closed canopy beneath which there is little undergrowth, the trees are seldom more than 20 m high and the understory of saplings, shrubs, vines, and bamboo (*Arun dinaria*) may be dense. Boulders often litter the floor and occasional cliffs break the continuity of the forest. Above the broadleaved forest is a belt of conifers and rhododendrons, with particularly fine stands growing on gradual terrain with a northern or north-eastern exposure. Fir (*Abies*) is the dominant

Schaller : Himalayan Tahr



The main tahr study area along the upper Bhota Kosi River, Nepal.

(Photo : George B. Schaller)

Schaller : Himalayan Tahr



A young adult male (class II) tahr on a typical ledge covered with grass and some shrubs.

(Photo : George B. Schaller)

tree, and beneath it is a sparse understory of *Rhododendron* and *Betula*. At an altitude of about 3600 m the fir gives way to a stunted transitional zone of rhododendron, birch, willow and juniper, and it soon grades into the alpine vegetation of grasses, forbs, and mat-like shrubs. The line of permanent snow is at around 5600 m. Another habitat, one not recognized as distinct by Schweinfurth (1957), is found on cliffs, especially steep ones with a somewhat southern exposure. The faces of most cliffs are broken by many ledges and platforms which support much grass and occasional patches of shrub, bamboo, and broadleaved forest. With some cliffs rising for over 1000 m from the valley floor, this grassy habitat may grade into the alpine vegetation without an intervening forest belt.

The literature contains conflicting opinions about habitat preferences of tahr, although all authors agree that the animal 'revels in the steepest precipices' (Burrard 1925). Kinloch (1892). Burrard (1925) and others felt that tahr remain in forests and dense thickets, never ascending above timberline. Lydekker (1924), too, labeled them as 'essentially forest animals,' but he noted that they may wander into the open. Prater (1965) held a similar view, and added that animals are never found outside thickets 'after the sun has well-risen.' In contrast, Caughley (1969), who observed tahr in central Nepal rather than in India as did the previous authors, stated that 'the habitat of this species is the subalpine zone between 3900 m and 5300 m.' I found tahr to be considerably more adaptable than these statements would indicate. Tahr frequented all habitats in my study area, although the conifer-rhododendron belt appeared to be used mainly in transit, perhaps because there was little food near ground level, especially in winter when snow was deep. The animals certainly were not adverse to open terrain. Old sign in the form of droppings and rest sites indicated that tahr spent much time above timberline during summer and autumn, and groups often remained on open cliffs throughout the day. In fact, tahr in New Zealand have adapted to tree-less terrain (Caughley 1970). The favoured habitat of tahr in the Kang Chu area, at least from February to April, was the grassy cliffs broken by small stands of forest and bamboo below an altitude of 3500 m. I suspect that the animals spent the winter there too, for the oaks and other evergreen trees provide forage as well as protection from bad weather. Furthermore, grass on cliffs is often accessible, the snow removed by wind and sun, while forests and alpine meadows remain deeply covered.

DESCRIPTION OF ANIMALS

Tahr differ from goats of the genus *Capra* in that both sexes lack a beard and have short, laterally compressed horns which curve sharply

backward. They resemble typical goats in their strong body odour and in the absence of pre-orbital, inguinal, and pedal glands on the forefeet (Lydekker 1924). Male and female Himalayan tahr differ considerably in size and appearance, as do the sexes among most members of the tribe Caprini. I recognized several age and sex classes. The ages of subadults and of adult males were estimated on the basis of body size, pelage length, and other physical characteristics. It was sometimes possible to count growth rings on the horns of males. As Caughley (1965) has shown, one growth ring is laid down every winter of life after the first. The approximate ages are given as they were at the time of study.

Adult male (Class III), almost 5 or 6 years old and older. Males are handsome creatures with narrow, black faces and stocky bodies, the forequarters being particularly powerful. Their shoulder height ranges from 91 to 102 cm and their weight is around 90 kg (Lydekker 1924). Anderson and Henderson (1961) give similar figures for height of New Zealand tahr, but they estimate that some animals may weigh as much as 150 kg. The dark horns have a sharp keel in front. 'A well-developed set of bull tahr (*sic*) horns will measure 12-15 inches in length... and $8\frac{1}{2}$ -9 inches in circumference around the base' (Anderson and Henderson 1961). A male's most conspicuous feature is his ruff and mantle of flowing hair which drape from his neck, shoulders, and chest down to his knees and from his back and rump down to his flanks and thighs. The neck ruff is light brown in colour, as is the hair on each side of the dark mid-dorsal streak. There is also a light eyering and chin. The hair surrounding the anus is rusty in colour. The rest of the body is covered with a deep coppery brown to blackish pelage.

Young adult male (Class II), almost 4 years to perhaps 5 years old. Males of this age class resemble those in class III in size and in the presence of the shaggy ruff on neck and shoulders, but they are not as robust and the mantle of hair along the back is fairly short (Plate 2).

Subadult male (Class I), almost 3 years old. Class I males are only as large as or slightly larger than adult females. Their pelage is not as dark as that of adult males, and their horns are smooth and yellowish rather than corrugated and dark. Although a neck ruff is conspicuous, males of this class lack a mantle along the back.

Yearling male, almost 2 years old. Yearling males are smaller than adult females. In colour they resemble females, but they have a noticeable ruff.

Female, with a maximum weight of 36 kg (Anderson and Henderson 1961), adult females are considerably smaller than adult males. Their neck is yellowish brown in colour, except for a dark stripe along each side and along the mid-dorsal line. A light streak runs along each side of the back from the shoulders to the rump; the sides of the muzzle

also show a pale line. The abdomen is whitish. The rest of the pelage is dark brown. Some females have a small ruff but most have just a slight crest of hair on the back of the neck. The horns of females resemble those of subadult males in appearance, except that they are somewhat shorter and more slender. Yearling females are of the same size as yearling males, the most conspicuous difference between the two being that females lack a ruff.

Young, almost one year old. Young resemble yearlings, but they are considerably smaller, and, in the case of males, lack a ruff. Most young still followed and rested besides their mother even though they were weaned, judging by the fact that females discouraged occasional suckling attempts by stepping aside.

POPULATION DYNAMICS

Tahr were difficult to census because they were often out of sight in thickets. Although I often scanned the slopes of the Kang Chu Rongshar, and upper Bhota Kosi valleys, tahr were seldom seen, suggesting that they were scarce there. But there was one cliff along the Bhota Kosi, a huge pyramid-shaped one over 1 km long at the base and some 1000 m high, on whose face I readily found tahr. At least 45 tahr frequented this cliff, and, assuming a few were overlooked, the total was probably around 50.

TABLE I
TAHR POPULATION STRUCTURE

	A		B	
	Structure based on known number of different tahr on study cliff		Structure based on all animals tallied in study area	
	No.	%	No.	%
Male III	2	4.4	14	5.7
Male II	3	6.7	14	5.7
Male I	4	8.9	17	6.9
Yearl. male	4	8.9	28	11.4
Adult female	18	40.0	93	37.8
Yearl. female	4	8.9	18	7.3
Young	10	22.2	62	25.2
Total	45	100.0	246	100.0

Table 1A shows the population structure of the 45 tahr on the study cliff. Since females limit themselves to distinct home ranges whereas adult males tend to wander widely (Caughley 1966), the perc

are probably biased in favour of the former. Another way to analyze structure is to add up all tahr seen daily in the study area (Table 1B). This, however, skews data in favour of those animals which are met repeatedly. Nevertheless, the percentages derived by the two methods show close agreement. Adult females outnumbered classes I to III males by a ratio of about 2:1, in contrast to New Zealand tahr which seem to have a 1:1 ratio (Anderson and Henderson 1961). Fetuses examined by Caughley (1966) in New Zealand showed no disparate ratio. Male and female yearlings were represented equally in my study population. These facts suggest that males are perhaps not quite fully represented in the sample, solitary individuals being difficult to find, and that they may have a higher death rate than females, but I lack evidence on either point. Nilgiri tahr and Kashmir markhor (*Capra falconeri cashmiriensis*) also have a disparate sex ratio favouring females (Schaller 1970; Schaller and Mirza 1971).

Anderson and Henderson (1961) noted that some New Zealand tahr conceived as yearlings at the age of 18 months. The yearlings in my study population had slim abdomens, in contrast to the extended ones of adults, indicating that they were probably not pregnant. Himalayan tahr, in their natural habitat appear to have their first young at the age of 3 years. Males do not reach sexual maturity until at least 2 years of age, the testes of yearlings failing in most instances to increase in size and to produce sperm during the rut (Caughley 1971).

There was one pair of twins among 158 embryos examined by Caughley (1971) in New Zealand, and none in 66 examined by Rammell (1964). The 180 births in the New York Zoological Garden included one set of twins (Crandall 1964). Zuckerman (1953) reported on 115 births in the London Zoo and noted one pair of twins for every 12 births. Thus, single births seem to be the rule. Females in the Kang Chu had one young at heel, except for one female which had two. Three young were with a female on several occasions, but these were temporary associations, the extra young joining other females later. Some 22% of the study population consisted of young, or 56 young to 100 adult females. Taking into account that several adult females had not yet had their first young and that an occasional female was perhaps barren, the figures suggest that around a third of the young had died between birth and the age of 8 to 9 months. Yearlings comprised 18% of the population, or 44 yearlings to 100 adult females, a good increment. With the tahr seemingly healthy and reproduction good, the population should be increasing unless an excessive number of adults die. I have no observations on causes of death. Some animals probably have accidents, and a few are no doubt killed by leopard (*Panthera pardus*), and, in the event that they straggle to the headwaters of the Kang Chu, by snow leopard (*Panthera uncia*). Meat hunters visit the area every summer,

according to the local Tibetans, and it is perhaps not coincidental that I found the densest tahr population on a cliff that is almost inaccessible to man.

HERD DYNAMICS

The tahr population on the study cliff was divided into two herds separated by a strip of forest, one using the northern portion, the other the southern. The females and young associated only with members of their respective herd, judging by the fact that several animals which I recognized individually were always on their usual part of the cliff, but some males may have wandered from one herd to the other. The northern herd contained at least 10 females and 5 young, the southern herd 12 females and 5 young. Several males of varying ages were with or near each herd. A third herd, seen only once on a slope opposite the study cliff, contained 9 individuals of which 3 were males. Members of a herd were seldom all together, being instead scattered in small groups which often joined and separated in various combinations in the course of a day. One dawn, for example, I spotted a group of 11 tahr, but by mid-morning it had split into groups of 4 and 7 which moved in opposite directions. A total of 36 groups (excluding groups composed solely of males) were classified during the study, a group being defined as two or more individuals separated by at least 200 m of terrain from others. Groups ranged in size from 2 to 23 with an average of 6.5, as compared with at least 22 members in each of the two study herds.

The basic social unit consisted of a female and her young. Such pairs roamed at times far from other herd members. Another common association included two or three females, a young or two, and often a yearling of either sex. Table 2 shows the composition of 3 large groups.

TABLE 2

THE COMPOSITION OF THE LARGEST GROUP IN EACH OF 3 HERDS
SEEN DURING THE STUDY

Name of Herd	Male III	Male II	Male I	Yearl. Male	Adult Female	Yearl. Female	Young	Total
North	2	2	2	2	8	2	5	23
South	0	1	1	2	4	2	2	12
East	1	0	1	1	3	1	2	9

Nine out of 12 groups with 7 or more tahr contained at least one subadult or adult male. But, as is the case in many ungulate societies, contact between adult males and females outside the period of rut tends to be transitory. Males which were in a group in the morning had often left it by evening, going off singly and in twos or threes, perhaps to re-

join casually the following day. Even when such males were with a group, they often congregated at the periphery. For example, in the group of 23 (see Table 2), two class III males and one class II male fed and rested side by side near the others for several hours before leaving together. Eighteen per cent of the subadult and adult males I tallied were solitary or in twos. Stockley (1928) once observed a group of 6 male tahr and another time 24 of them together. Yearling males were usually with the females. However, on three occasions, a yearling was seen in the company of a subadult male far from any other group. Later in the season, contact between males and females may become even more tenuous. Caughley (1966), for instance, wrote that 'during the summer tahr range in three main kinds of groups: one consists of females, juveniles and kids, a second consists of young males and the third of mature males.' The males are said to join the females again in September prior to the rut (Burrard 1925).

The herd structure of Himalayan tahr resembled that of Nilgiri tahr (see Schaller 1970). In both species the herds tended to split into temporary groups and males had progressively less contact with the females after the rut. But there were two differences, at least in the populations I studied. The average group size of Himalayan tahr was 6.5 as compared to 23 in Nilgiri tahr. The latter species does most of its feeding on rolling grassland near cliffs. Such a habitat provides a concentrated and abundant food source, and this may well promote cohesiveness among herd members. In contrast, Himalayan tahr spend much of their time along narrow ledges where large groups would be at a disadvantage. Though average group size differs in the two species, average herd size possibly does not, but data on this point are lacking. Another difference between the species may be in the age at which males become solitary or join male herds. Some yearling Himalayan tahr, not quite 2 years old, had temporarily left the females, whereas Nilgiri tahr were not observed to join male herds until at least 3 years of age.

GENERAL BEHAVIOUR

Tahr spent most of the day feeding or resting, usually remaining several hours, or even a day or two, on a small section of the cliff. Only on a few occasions did a group move steadily for several hundred metres to another site. Sometimes animals travelled from a shady area until they reached one in the sun, and once they hurried away after boulders had crashed past them. At other times no reason for their movement was apparent. To obtain information about the activity pattern of tahr, I recorded the number of active animals every 5 minutes. The 6 points in each half-hour period were combined and expressed in per cent of animals active in the Figure which is based on 7146 activity observa-

tions between 0635 and 1730 hours. Tahr foraged and moved during all daylight hours, but there were peaks of activity before 0900 and after

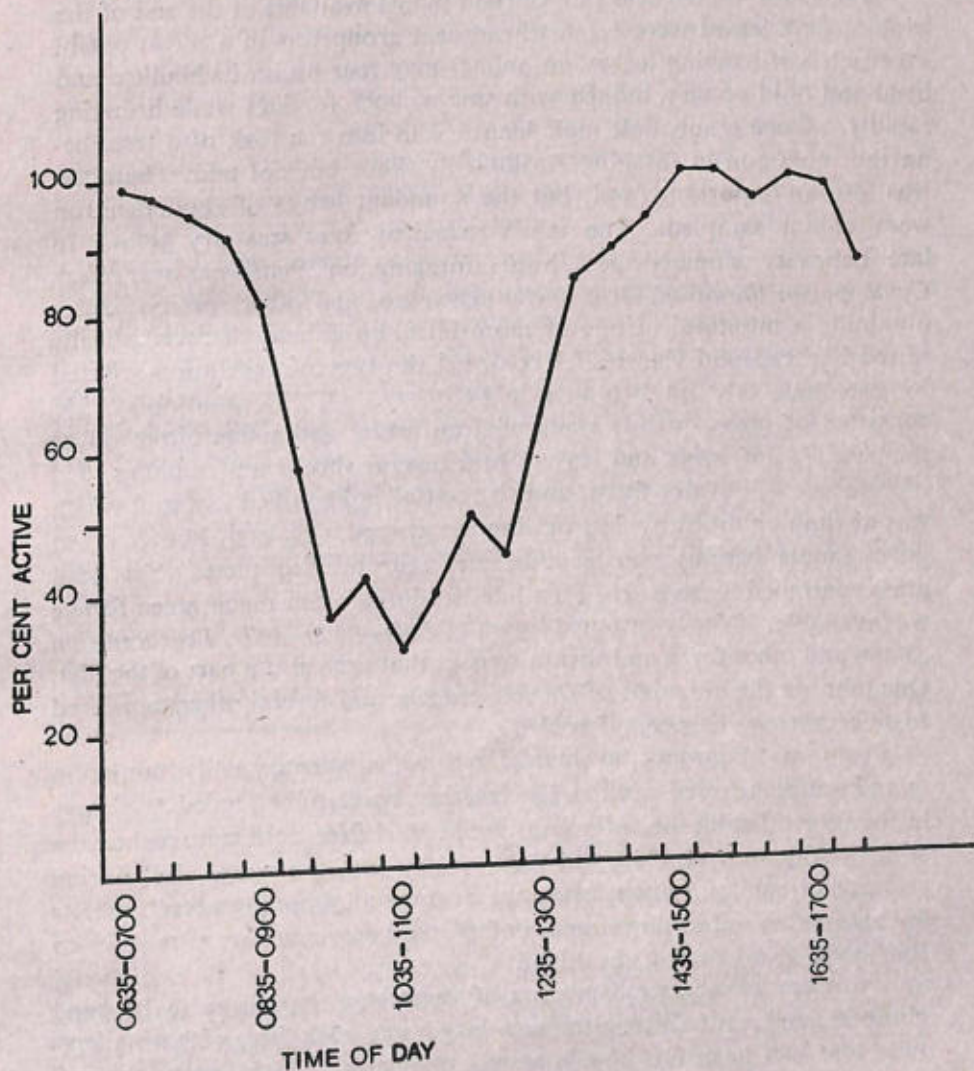


FIGURE. Per cent of tahr active at various times of day, 0635 to 1730 hours.

1330 hours. Although tahr were, in general, least active from mid-morning to early afternoon, the same groups sometimes varied considerably in their foraging pattern from day to day, often without obvious cause. Weather, however, may affect activity. On several occasions a group rested while the sky was clear, then began to forage as soon as it became cloudy. Groups seldom reclined for more than an hour or two

without at least one member feeding, and, in large groups, there was usually some activity from dawn to dusk.

Tahr had a limited selection of food plants available at the end of the winter. Oak leaves were eaten whenever a group was in a forest patch. To reach low-hanging leaves, an animal may rear up on its hindlegs and bend and hold down a branch with one or both forelegs while browsing rapidly. Once a subadult male leaped 2 m into the fork of a tree, behaviour common in foraging Kashmir markhor but not tahr. Bamboo was also an important food, but the abundant leaves of rhododendron were seldom sampled. The tahr's principal food was dry grass. In late February animals spent hours foraging on *Danthonia schneideri*, *Cymbopogon thwaitesii*, *Arundinella nepalensis*, and other species. After obtaining a mouthful in one or more bites, an animal characteristically raised its head and chewed. I recorded the type of vegetation selected by two male tahr on two days in February. Of 155 mouthfuls, 75% consisted of grass, mainly wads of dead leaves and stems bitten off at the base, 7% of twigs and leaves from several shrubs and saplings, 6% of bamboo, 4% of dry forbs, and the rest of unidentified material which was at time obtained by first pawing the ground. By early March, green grass shoots became conspicuous, and tahr nibbled these. Yet dead grass continued to be eaten, even late in March when much green forage was available. Newly sprouted leaves of *Polygonum molle*, *Leucocephalum canum* and other forbs and shrubs were at that time also a part of the diet. One tahr ate the blossoms of *Daphne gracilis*, and several others appeared to lick crustose lichens off rocks.

From mid-February to mid-March, when average daily minimum temperatures hovered around the freezing point, tahr tended to forage in the forest during the early morning hours. Not until sun reached the cliff, usually around 0830, did they venture into the open. But during the second half of March, when the average minimum temperature was 6°C, tahr were out at dawn, and, in fact, they may not have retreated into the forest at all during the night.

To reach the scattered patches of vegetation, tahr have to be good climbers, and, indeed, they traverse ledges and rock faces with an adeptness that can have few equals among ungulates. Their hooves are well designed for gripping rocks. 'The hoof pads are very soft, slightly convex posteriorly and surrounded by a hard horny rim which must serve a similar purpose to that of nails around the outside edge of mountaineers boots' (Anderson and Henderson 1961). Further traction is provided by the large dew claws. Tahr readily balance along ledges only a few centimetres wide and may leap with precision onto a small grass tussock growing on a sheer cliff 2 m below them. When confronted by a smooth, sloping rock face, an animal may rock back and forth and suddenly propel itself upward with a series of leaps, using the callus on each

knee rather than the hooves to grip the rock fleetingly. The tahr's breast is calloused too according to Blanford (1888-91). Callus-like areas are also present on the hocks and these are used to supplement the hooves as brakes when an animal slides in a squatting position down a steep incline.

During rest periods, tahr reclined on exposed ledges, on rocky spurs, in thickets, almost any place which offered some level terrain; animals also retreated beneath rock overhangs when such were available. On warm days, when shade temperatures reached 15 to 20°C, some tahr rested beneath trees yet others remained in the sun. Windy places were not avoided, and a male often rested on a promontory with his mane whipping in the breeze. 'It is common for a group of tahr to have one or two sentinels posted,' according to Anderson and Henderson (1961), but I saw no evidence of this. Tahr were never seen to paw the ground before lying down, behaviour which is, for example, conspicuous in markhor (Schaller and Mirza 1971). Animals either reclined with all legs tucked beneath the body or with one or both forelegs stretched forward. Cud-chewing was intermittent. Two subadult males were timed as they chewed a total of 25 boli. The average number of chews per bolus was 78 (65-87), and the time required to chew each bolus was 49 (40-65) seconds.

TABLE 3
AGE AND SEX OF TAHR INVOLVED IN LICKING INTERACTIONS

Animal licking	Animal being licked						
	Male			Female		Young	
	III	II	I	Yearl.	Adult	Yearl.	
Male III							
Male II							
Male I					1		
Yearl. male			3		11		
Adult female	1		1	11	7	3	12
Yearl. female					3		
Young					8		

Tahr sometimes interrupted their rest or search for forage to groom themselves, licking their pelage and scratching it with hindleg or horntip. Social grooming, with one tahr licking the head and neck of another, was observed on 61 occasions. An interaction may be cursory, limited to a few licks, but it may also last for as long as 10 minutes. Licking was often reciprocal, with, for instance, a female first licking her young and then being groomed in return. On a number of occasions an animal

invited licking by holding its head close to the muzzle of another. As Table 3 shows, most licking involved either two females or a female and a young; subadult and adult males seldom licked each other. Most interactions between adult females and yearling males, as recorded in Table 3, took place between the same pair of animals. Social grooming was a conspicuous activity among Himalayan tahr but not Nilgiri tahr, a difference for which I have no explanation.

REPRODUCTIVE BEHAVIOUR

The duration of the tahr's rut in the Himalayas is unknown, but since the gestation period is $6\frac{1}{2}$ months (Caughley 1971), and young are born either in May and June (Stockley 1928; Prater 1965) or June and July (Blanford 1888-91; Lydekker 1924), most mating must take place between mid-October and mid-January. The age difference between some young in my study population was at least two months, and, in New Zealand, Caughley (1971) noted that births were spread over a period of almost three months. I saw a few instances of courtship behaviour and one copulation long after the termination of the main rut, and my notes are summarized here.

Males showed several behaviour patterns only in response to the presence of females:

Lip-curl: On 5 occasions a male either sniffed the anal area of a female or the spot where she had recently rested and then lifted his muzzle high with the upper lip curled. Yearling, class I, and class II males behaved in this fashion.

Low-stretch: A male may approach a female with his neck lowered and almost parallel to the ground and with his muzzle directed ahead or slightly raised. Males typically come up behind females in this way and sniff their anal area. This display, which is common to many ungulates, has in tahr become further elaborated. By raising the muzzle until it points almost straight up and retracting the neck, the shoulders of the male are transformed into a hump. Instead of remaining behind the female, the male now faces her rigidly, a position which exposes the front of the neck ruff to best advantage. His tail may be raised vertically and his teeth bared. Standing there, he may lift his muzzle higher and higher until it reaches above the level of his hump. This posture resembles the head-up display, with head raised and neck erect, of some ungulates (Walter 1961; Geist 1971).

Twist: While approaching a female in the low-stretch, a male may twist his head so that his horns point away from her. This gesture was seen twice.

Tooth-baring: As he faces a female in the low-stretch, a male sometimes retracts his lips to expose his incisor teeth and gums whose whitish colour contrasts markedly with the black lips and nose. It is possible that this gesture is an exaggerated form of lip-curling. If so, its function has been extended from one mainly designed to test the estrous state of the female by olfactory means to one of display value.

Head-shake: A male may interrupt the low-stretch in front of a female and jerk his head down, as if nodding vigorously, all the while shaking it rapidly from side to side. Then he resumes his former posture, often to shake again a few minutes later. One male displayed behind a female in this fashion.

Tongue-flick: As a male shakes his head, the tongue usually flicks rapidly in and out of his mouth. This gesture may also be displayed when a male follows an estrous female and when he faces her in a low-stretch.

Kick: During the head-shake, a male sometimes lifted a foreleg some 15 cm off the ground and kicked it limply and slightly bent at the carpal joint. Such kicks did not touch the female.

Males possibly add further emphasis to their displays by vocalizing, as noted in several goat species by Walther (1961), but I was too far away to hear sounds.

To place the display patterns into their natural context, the only lengthy courtship I witnessed is here described in a condensed form. The same animals were presumably involved, but I am not certain of this.

March 24. A group of 16 tahr is scattered over a cliff. At 1050 hours, a class II male approaches a female and gives the low-stretch in front of her. He stands with muzzle raised and head turned to one side for 5 minutes before he shifts his gaze to face her directly. She has her neck lowered and muzzle pointed downward. Soon he assumes a similar posture. (Both the averted glance and lowered head seem to be gestures of submission, showing lack of aggressive intent). After a few minutes the female suddenly jabs him lightly in the neck, but he merely lowers his head still more. Both stand motionless. When the male raises his head, she jabs him again, and he promptly assumes his former position. One hour after meeting the female, the male gives an intense low-stretch, muzzle straining skyward, then turns aside, licks himself, and ambles off. A class III male has been lying in full view 30 m away. He now displays the low-stretch to the female, grazes by her side a few minutes, then drifts off too.

March 25. At 0815, a female is attended by a class III male and two class II males, all somewhat separated from the main group. When a class II male approaches the female, the class III male by her side ad-

vances toward him in a hunch display (see below). The smaller male turns aside, joins the other class II male, and both rest at least 10 m from the courting pair. The class III male assumes the low-stretch, but the female ignores it and he reclines. At 0910 hours the approach of a class II male brings him to his feet, and a hunch display causes the interloper to veer off. Once again he faces the female in a low-stretch. For 15 minutes they stand, he with muzzle raised, she with head averted. After that both feed and rest. At 1105 hours, the female approaches the male who lifts his muzzle so high that the underside of his jaw faces her. She licks herself, advances, licks again. Whenever she moves, he adjusts his position so that his muzzle points at her. Suddenly he steps behind her, his shoulder by her rump. He gives a low-stretch coupled with a twist, then shakes his head and kicks. Twice more he shakes and kicks before moving around to face the motionless female. There he alternately low-stretches with teeth bared and shakes a total of 9 times. Occasionally he nudges the female with his nose as if to get her attention, for when she looks at him he intensifies his low-stretch. The female begins to feed at 1200 hours. Slowly the male steps behind her and rears on his hindlegs, mounting her. He thrusts 10 times, barely leaning against her, without eliciting a response. The two then feed and rest near each other without further courting for several hours.

March 26. I spot the tahr at 0800 hours. A class II male is giving the low-stretch with teeth bared to a female. Above the pair on a ledge is a yearling male and a young. The yearling butts the young so hard that it falls 2 m and collides with the courting male. Although he is nearly knocked off his feet, he calmly resumes his displaying. He alternately low-stretches and shakes, also giving occasional kicks and flicks of the tongue. Once he and the female touch horns. Between 0800 and 0835 hours he has 74 bouts of head-shaking. The female just stands, her head turned aside, but twice she jerks her horns at him aggressively and once butts his shoulder. At 0835 hours she walks off out of sight, followed at a distance by the male.

Of particular note is the gentleness with which courtship was conducted. The males did not press their attention on the female, but limited themselves to displaying and lingering nearby. Although I saw only one prolonged courtship, other observations suggest that it was a representative one. A class I male once followed a female closely for two hours, obviously interested in her yet never approaching closer than 1.5 m. Low-stretch displays, sometimes accompanied by tongue-flicking, teeth-baring, and, on one occasion, by kicking, were observed a total of 17 times on 10 different occasions, in addition to the instances related above. Fourteen of these displays were given by yearling males and the rest by subadult and adult ones. Females usually ignored such displays, but on two occasions, when importuned by a yearling, they rebuffed

them. Once, when a yearling gave a low-stretch to a female, she jabbed him in the neck. He persisted and was rewarded with a poke in the rump. He in turn pressed his forehead against the base of her neck, a position which prevented her from horning him effectively. After a few futile jabs, she stepped aside and hooked his neck, and, as he turned to leave, his side too. Undaunted, the male displayed again, only to be butted in the shoulder. But all such attacks lacked vigour, they were limited to fairly gentle jabs. The males in turn did not retaliate, except twice to butt a female. On 9 occasions a pair also locked horns and tussled briefly and lightly. Alpine ibex (*Capra ibex*) and mountain sheep (*Ovis canadensis*) also court cautiously (see Geist 1971). Aside from other considerations, there would seem to be selective advantage in courting with restraint on cliffs.

Anderson and Henderson (1961) wrote that in New Zealand tahr 'the typical family group consists of a bull, a nanny, its kid, and either the offspring of the previous year or a 2-year-old, and together they move to a well-chosen piece of territory to remain for some 6 to 8 weeks.' Such 'monogamous grouping,' as these authors call it, was not evident in the one courtship I witnessed. Rather the largest male in the group claimed the estrous female, a pattern similar to that observed in markhor (Schaller and Mirza 1971) and ibex (Nievergelt 1967).

AGGRESSIVE BEHAVIOUR

Anderson and Henderson (1961) were impressed with the placid nature of tahr, noting that 'a more docile assembly would be hard to visualize.' While it is true that fighting is relatively uncommon, at least outside the rutting period, tahr do interact aggressively in a number of ways, using both direct and indirect forms of threat. Among the overt types were the following:

Jerk: A tahr may jerk down its head and point its horns at an opponent. The gesture signifies an intent to butt, and the threatened animal usually retreats a little. It was seen 15 times, directed mainly by females at courting males (6 times) and at young (4 times).

Lunge: On 3 occasions a female jerked down her head and at the same time lunged a metre or two at another animal, twice at a female, and once at a yearling male.

Jump: A young reared up on its hindlegs in front of another young on two occasions. A jump probably represents an intention movement to clash with a downward thrust of the horns.

Butt: Butting was the most common form of aggression in tahr. It consisted either of a push with the blunt edges of the horns or of a jab

with the tips. The attack was directed at the neck of the opponent 8 times, the shoulders and sides 8 times, the thighs 3 times, and rump 5 times. Females delivered most butts, usually to courting males; and young butted each other several times seemingly in play. However, butting also occurs in serious fights as described by Roberts (1971):

'While observing the movements of a group composed of a mature bull, ten females and young, my attention was drawn to a large, lone bull about 500 feet above this herd when he started to smash into the turpentine scrub with hooves and horns and moved downhill towards the bull with the females....The two bulls confronted each other, whistled sharply, and began to wrestle like domestic cattle. The tactics appeared to be to try to put the opponent off balance, for after a period of pushing, twisting, and sliding downhill one bull was heaved off balance and the victor immediately shot his horns under him and ripped him in the belly. This upset him, and he tumbled down into the steep gully.'

Clash: On 18 occasions two tahr clashed horns, or, in the case of young, primarily foreheads. Sometimes one animal took the initiative, the opponent merely catching the blow with the horns, but at other times both jerked down their heads in unison. With locked horns they then twisted their heads and pushed each other back and forth. Two to four clashes sometimes followed in quick succession. None were violent and all were brief. Yearling males and females clashed most often, usually after the former had displayed the low-stretch. Once a young approached a yearling male playfully with its head low and waving from side to side until their horns met. A yearling male and a yearling female sparred gently 3 times, and two young clashed twice. Probably Himalayan tahr also rear up on their hindlegs in unison and lunge downward to clash their horns forcefully in the manner of Nilgiri tahr, ibex, markhor and other goats, but I did not see such behaviour.

Head-to-tail: Two young once stood parallel and head-to-tail as they hooked at each other's sides. On two other occasions a female and yearling male assumed similar positions, but circled rapidly with their heads cocked as if to jab. This method of fighting is similar to the one I termed shoulder-push in Nilgiri tahr except that the animals did not shove with their bodies.

As Table 4 shows, the various age classes differed in the amount of overt aggression. In 106 animal-hours¹ of observation, class I, II and III males asserted themselves only 5 times. Females were also unaggressive except when being courted. Young had a fairly high aggressive

¹One animal observed for one hour equals one animal-hour.

TABLE 4
TYPE AND FREQUENCY OF OVERT AGGRESSION USED BY VARIOUS AGE AND SEX CLASSES OF TAHR

Age and sex class	Jerk	Lunge	Jump	Butt	Clash ¹	Head-to-tail	Total no. Aggressions	No. aggressions per animal-hour of observation
Male III	2				(1)		0	0
Male II	1			1			3	.06 (.03)
Male I	1			1 (2)	6 (9)	(3)	2	.05
Yearl. male	4 (6)	3		2 (12)	1 (10)	(3)	22	.11 (.19)
Yearl. female				1	3		41	.04 (.14)
Young	1		2	5	6	2	4	.08
							16	.10

¹ In the clash and head-to-tail interactions both participants are included in the tabulation because both behaved aggressively. Interactions during courtship are tabulated separately in parentheses. The data are based on 603 animal-hours of observation of tahr in groups.

rating, though some of their behaviour was playful, and yearling males had the highest. The goat-like blue sheep (*Pseudois nayaur*), which I observed during the same period as the tahr, showed a similar pattern of aggressive frequencies, except that young rated low (Schaller, in press). With respect to Nilgiri tahr, Schaller (1970) noted: 'A ranking of the classes based on relative frequency of fighting would place light brown males [class I] at the top, followed in decreasing order by yearlings, females, dark brown males and saddlebacks [classes II and III] and young.' The phase of a species' reproductive cycle has, of course, a considerable influence on aggressive frequencies. Schaller and Mirza (1971), for example, found that rutting adult male markhor were more aggressive than any other age and sex class.

Direct threats were mainly used by females toward individuals smaller than themselves, by one young toward another, and by courting pairs. Males, on the other hand, tended to employ various indirect forms of threat to intimidate each other as this example illustrates: After approaching to within 25 m, a subadult and yearling male halted and horned vegetation with vigorous sweeps of their heads, one using a grass tuft, the other bamboo. The subadult male then slowly came closer, once stopping to lick himself. Meanwhile the yearling grazed intensively. When the subadult had approached him to within 1.5 m, he licked and scratched himself, fed again, and groomed once more, a changing pattern he repeated 4 times. The subadult also groomed himself. But suddenly he hunched his back and stalked stiffly past the yearling. After that both foraged, drawing slowly parallel. They halted broadside to each other, standing motionless for 15 seconds with heads slightly lowered and averted before parting.

Horning vegetation: Nine instances of horning were observed, 5 of them by yearling males and the rest by subadult and adult ones. Some males horned during aggressive encounters, as the above example shows, but others thrashed vegetation in no particular context.

Hunch: On 5 occasions a subadult or adult male hunched his back, bunched his legs stiffly beneath him, lowered his neck either in an extended or retracted position, and pointed his muzzle obliquely downward. His tail was raised vertically, as in some low-stretch displays, exposing the small rump patch. The anus appeared puckered outward. With the hair on his nape and shoulders more erect than usual, he may walk or trot at another male in this posture, resembling a huge shaggy grass tussock with a black face peering from it. The threatened animal promptly avoided this apparition. At other times, the displaying animal walked broadside to his opponent, a position which did not cause immediate retreat.

Broadside: One tahr may stand close to another with its neck stretched somewhat forward, and with its muzzle held horizontally or tipped slightly up or down. Geist (1971) illustrates this posture in his book. The displaying animal either stands parallel to the other and facing in the same direction, a position which shows off the size of the ruff, or it halts in front or behind the other. A conspicuous feature of the display is that the muzzle is seldom pointed directly at the opponent but is averted to show a partial to complete profile. The threatened individual often responds by assuming the same posture with the result that the two display side by side or face to face, a metre or two apart, each with its muzzle turned away. I observed this display 7 times, once between 2 yearling males, 4 times between a subadult and a yearling male, once between an adult male and a yearling male, and once between an adult and yearling female. Most contacts were brief, lasting less than a minute, but on one occasion a subadult and a yearling male displayed to each other 3 times within a period of 50 minutes, each interaction lasting some 5 to 10 minutes. An animal sometimes terminated such an interaction by licking or scratching itself before turning away.

Tahr often groom themselves in conflict situations such as during courtship, when one male meets another, and when displaying broadside. For instance, during the brief meeting between the two males described earlier in this section, the subadult male groomed himself 7 times, but he did not lick or scratch during the 30 minutes preceding the interaction and only once in the hour succeeding it. A courting female groomed herself 19 times in 6 hours, usually when the male displayed to her. By indulging in an innocuous activity such as licking, tahr seemed to find relief from a tense situation or were able to terminate a confrontation without having to retreat abruptly.

DISCUSSION

In their physical characters, tahr appear to be evolutionary links between the rupicaprids or goat-antelopes, of which American mountain goat (*Oreamnos americanus*) and chamois (*Rupicapra rupicapra*) are well-studied representatives, and the true goats of the genus *Capra*. It would be of interest to find out if tahr are behavioural as well as morphological links, and this can best be done by comparing the courtship and aggressive displays of *Hemitragus* with those of various goats and rupicaprids. Schaller (1970) made a few such comparisons, and this account provides further information.

Treating first courtship among rupicaprids, Geist (1965) found that male mountain goats approach females from behind in a low-stretch, sometimes with tongue flicking. This may be followed by a vigorous kick that propels the female forward. 'If the female turns in horn-

threat on him, the male turns his head away from her, and thereby shows the broadside of his face and beard' (Geist 1965). The low-stretch of mountain goats is less elaborate than that of tahr, but with the kick the reverse is true. Male mountain goats may sit on their haunches and paw 'rutting pits', as Geist (1965) called them, behaviour not seen in tahr. Among chamois, the male approaches a female in a low-stretch, and then 'the courting billy stands behind the nanny with his head erected, thereby displaying his white throat' (Krämer 1969). Lip-curling is common among chamois, but kicking, twisting and other patterns found in tahr are not mentioned in Krämer's detailed account. Rutting male chamois may shake their body vigorously and at the same time urinate with the result that fluid is sprayed over their pelage. The courtship displays of ibex, tur (*Capra caucasica*) and markhor are similar to those of Himalayan tahr in many respects (Table 5). However, some variations exist even in those displays which are found in all these species. When kicking, for example, Kashmir markhor tend to raise the leg fairly stiffly for a few centimetres, Alpine ibex may make pawing movements with their flexed foreleg (Walther 1961), and Himalayan tahr merely raise a leg limply, bent at the carpal joint. Head-shaking, so typical of courting Himalayan tahr, has not been reported in *Capra*, but ibex shake their head in a somewhat different manner as a form of threat (Walther 1961). A rutting *Capra* male typically 'urinates on his forelegs and face, and he may insert his penis into his mouth. Although tahr were not seen to do this, it is possible that such behaviour occurs during the rut. As Table 5 shows, some displays, such as the low-stretch, are found in all species listed, and, in fact, tend to be widespread among ungulates, whereas others are unique to one species. In general, the two rupicaprids appear to have fewer courtship patterns than members of the genus *Capra*, and Himalayan tahr share more displays with the latter than with the former. Nothing is known about courtship in other species of tahr.

It is necessary to note similarities and differences in the aggressive behaviour of Himalayan and Nilgiri tahr before fruitful comparisons with other genera can be made. Jerking, lunging, jumping, butting, frontal clashing, and horning are similar in the two species, but several differences also exist. At times two Nilgiri tahr 'stood parallel and facing the same direction and in unison jerked their head sideways rapidly once or twice thereby clashing their horn against one of the opponent's' (Schaller 1970). Such behaviour was not observed in Himalayan tahr. Both species horn while standing head-to-tail, but, in addition, Nilgiri tahr push with their shoulders and may kneel while fighting. The hunch differs somewhat in the two tahr: in the Nilgiri species the neck and head may be arched so far down that the muzzle points back between the legs, whereas in the Himalayan species the neck and head are merely stretched

TABLE 5
THE OCCURRENCE OF SOME MALE COURTSHIP PATTERNS IN SEVERAL SPECIES OF THE SUBFAMILY *Caprinae*

Pattern	Himalayan tahr (this study)	Mountain goat (Geist 1965)	Chamois (Krämer 1969)	Markhor (Schaller & Mirza 1971)	Alpine ibex (Walther 1961)	Tur (Steinhauf 1958)
Lip-curl	+	+	+	+	+	+
Low-stretch	+	+	+	+	+	+
Tooth-baring	+	+	+	+	+	+
Twist	+	+	+	+	+	+
Head-shake	+	+	+	+	+	+
Tongue-flick	+	+	+	+	+	+
Kick	+	+	+	+	+	+
Head-up	+	+	+	+	+	+
Urinating on body	?	+	+	+	+	+
Inserting penis in mouth	?	+	+	+	+	+
Digging rutting pit	—	+	+	+	+	+
Body-shake	—	+	+	+	+	+
Tail folded over rump	—	+	+	+	+	+

obliquely downward. Possibly the accentuated body posture of Nilgiri tahr is an evolutionary alternative to having a prominent display structure, such as the ruff of Himalayan tahr. I saw no display resembling the broadside of Himalayan tahr in Nilgiri tahr, but more work will no doubt clarify whether differences between the two species are qualitative or merely quantitative.

Mountain goats and chamois both jerk, lunge, jump, and butt. The former do not clash (Geist 1965) and the latter clash seldom (Krämer 1969), probably because their thin, pointed horns are unsuited to such activity. Animals with massive horns commonly clash, a fact true also for takin (*Budorcas taxicolor*), which usually are considered to be rupicaprids. All *Capra*, as well as blue sheep (*Pseudois*) and tahr clash not only by facing an opponent on all fours and bashing horns, but also by rearing upright in unison and with a downward lunge crashing horns together. Interestingly, Krämer (1969) reported this type of combat in chamois, indicating that such behaviour is not confined to the tribe Caprini as was previously assumed. The head-to-tail method of fighting was observed in young chamois by Krämer (1960). And Geist (1965) noted an analogous pattern in mountain goats: 'They fight keeping side by side while moving about one another. Goats strike up and sideways with their head, driving the horns into the opponent's ventral body region.' This display, common to both tahr species, has not been described for *Capra*, although domestic goats may stand side by side and push each other with the shoulders (Geist, pers. comm.). Neck-pushing, a form of combat in which one animal places its neck over the neck or shoulders of another and pushes downward, has been observed in young chamois (Krämer 1969) and in adult *Ammotragus lervia* (Haas 1959), a species intermediate between sheep and goats. Such behaviour has not been reported for *Hemitragus* and *Capra*.

Turning to indirect forms of threat, the mountain goat has a hunch posture which resembles the one described earlier for Nilgiri tahr. The hunch of the chamois is similar to that of the Himalayan tahr. Chamois present their broadside with humped back and either lowered or raised head, showing off their dorsal ridge of hair. Males may lip-curl in this posture, having apparently incorporated a sexual pattern into a threat one (Krämer 1969). The takin also exhibits the hunch display. The three Burmese animals in the Bronx zoo commonly arch their neck far down with chin tucked in and ears retracted, and moving stiffly, present their broadside. The head is often slightly averted and snorts may be given. The hunch in all these species is a broadside display, serving to intimidate an opponent by presenting a conspicuous profile. However, Himalayan tahr have an additional broadside display distinct from the hunch. It was my impression that this tahr sometimes used the hunch as a direct threat, rather than only as an indirect one as is the case in

other species, whereas the broadside was solely an intimidation display. I observed hunch posture recently in wild goat *Capra hircus*. A broadside display has been described for markhor (Walther 1961).

There is almost no information about the Asian rupicaprids and many aspects of caprid behaviour remain unknown. Yet even this superficial review of some displays shows that the genus *Hemitragus* resembles both the caprids and rupicaprids in its behaviour. In the complexity of their courtship displays, Himalayan tahr seem to be closest to true goats, rather than to the mountain goat and chamois, but when individual patterns are considered the evidence remains somewhat equivocal. For example, tahr and rupicaprids probably do not fold their raised tail over the rump in the manner of true goats; but, in contrast to the two rupicaprid species, Himalayan tahr and *Capra* use the twist. The hunch and head-to-tail are prominent aggressive patterns in both tahr species and in rupicaprids. Tahr resemble true goats in their other forms of aggression. Thus tahr show a behavioural affinity to both rupicaprids and *Capra*, a conclusion which supports the morphological evidence.

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Orchids of Nepal—7

BY

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(With seven figures in two plates)

[Continued from Vol. 69 (2) : 289]

This instalment describes the genera under Subtribe Sarcanthea of Kerosphaereae and Pleuranthae of Monopodiales. The genera being *Acampe*, *Aerides*, *Chiloschista*, *Doritis*, *Esmeralda*, *Gastrochilus*, *Luisia*, *Ornithochilus*, *Rhynchostylis*, *Sarcanthus*, *Vanda* and *Vandopsis*.

ARTIFICIAL KEY TO THE GENERA

- A. Lip not spurred. Column without a foot, short and not winged—
- B. Sepals & petals not spreading widely; lip not jointed at base, lower part of lip (hypochile) concave, apical part (epichile) broad and decurved.....*Luisia*
- BB. Sepals and petals spreading widely—
- C. Lip not jointed at the base and shorter than the sepals; fls. of medium size
.....*Vandopsis*
- CC. Lip jointed at the base and differentiated into a hypochile and epichile
.....*Esmeralda*
- AA. Lateral sepals adnate to the foot of the column, forming a mentum; spur when present distant from the base of the lip—
- B'. Lip with a long claw, 3-lobed, not spurred; column winged. Lateral sepals adnate with the foot of the column to form a conical mentum.....*Doritis*
- B'B'. Lip saccate at its union with the foot of the column; column wingless; basal part of lip (hypochile) forming a hairy sac; lateral lobes of lip absent
.....*Rhynchostylis*
- B'B'B'. Lip adnate to the base of the column, gibbous or shortly spurred; sidelobes of lip large and erect; leafless when flowering, stem absent.....*Chiloschista*
- B'B'B'B'. Lip jointed to the foot of the column, spurred.....*Aerides*
- AAA. Lip saccate or spurred at the base; column wingless—
- D. Sepals and petals fleshy and widely spreading—

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² Horticultural Assistant, Indian Co-operation Mission, Kathmandu.

- E. Flowers large ; labellum large, sidelobes large, base saccate or spurred
.....*Vanda*
- EE. Flowers small ; labellum adnate to the base of the column, spurred
.....*Sarcanthus*
- EEE. Flowers small ; base of labellum with a long or short and wide spur,
sidelobes absent or very small.....*Gastrochilus*
- DD. Sepals and petals not spreading—
- F. Flowers small and fleshy, sepals and petals concave.....*Acampe*
- FF. Flowers large, sepals spreading, lateral sepals connate at the base of the
lip and together forming the mentum.....*Ornithochilus*

Acampe Lindl.

The name probably refers to the small and brittle flowers. Plants are epiphytic and the leaves are fleshy and slightly recurved. The floral structures are very much like those of *Sarcanthus*, and in fact the genus is treated as a section of *Saccolabium* by Hooker. According to Lindley this genus is characterised by the small, brittle and inflexible flowers.

ARTIFICIAL KEY TO THE SPECIES OF *Acampe*

- Leaves more than 15 cm long ; flowers pale yellow*longifolia*
- Leaves c. 10 cm long, obliquely notched ; flowers dark yellow.....*papillosa*

Acampe longifolia (Lindl.) Lindl. Fol. Orch. 1: 1853; Holttum, 621, 1953. *Vanda longifolia* Lindl. in Lindl. & Paxt. Flow. Gard. 2: 21, 1851-52. *Saccolabium longifolium* Hk. f. in Fl. Brit. Ind. 6: 662, 1890; King & Pantl. 220, t. 292, 1898.

Stem robust and densely leafy; leaves more than 15 cm long, upper part broader than the lower. Flowers fleshy c. 1.5 cm in diam., delicately fragrant; sepals and petals pale yellow with deep brown stripes, dorsal sepal 1.3 cm long, obtuse, lateral sepals slightly keeled, petals slightly smaller than the sepals. Lip 1 cm long, fleshy, white with a few purple spots, base saccate, sidelobes erect, midlobe reflexed and hairy at the base. Flowering during September and October. Distributed at 305 to 1075 m. Common.

A. papillosa (Lindl.) Lindl. Fol. Orch. 2, 1853. *Saccolabium papillosum* Lindl. Bot. Reg. t. 1552, et Gen. et Spec. Orch. 222, 1830; F.B.I. 6: 63, 1890.

Leaves about 10 cm long, obliquely notched. Scape 2.5-5 cm long; flowers 1.5 cm in diam.: sepals and petals dark yellow spotted with dull brown. Midlobe of lip ovate, rosy, spur conical, pubescent

within. Flowering during September to November. Distributed at about 610 m. Collected from Kuroanadi at Hittaura, Bindraban forest, Hittaura, Narayani.

Aerides Lour.

In vegetative appearance these orchids resemble the *Vandas*. The inflorescence is an elongated pendulous raceme bearing a number of flowers.

ARTIFICIAL KEY TO THE SPECIES OF *Aerides*

- Terminal lobe of lip large, hastate-rounded; spur short and straight... *multiflorum*
 Terminal lobe of lip small, oblong-lanceolate, incurved; spur long and incurved
 *odoratum*
 Terminal lobe of lip slightly dilated and bifid; spur long and straight... *longicornu*

Aerides longicornu Hk. f. Icon. Pl. 22, t. 2127, 1889 et F.B.I. 6: 44, 1890.

Flowers white, sepals and petals with crisp margin, lateral sepals much larger than the petals, petals orbicular or oblong. Lateral lobes of lip curved forwards, shorter than the long spur, mid-lobe narrow, clawed, tip slightly dilated, bifid. Flowering during September and October. Collected from Sundarijal area at c. 1525 m.

A. multiflorum Roxb. Pl. Corm. 3: 63, t. 271, 1820; F.B.I. 6: 44, 1890; King & Pantl. 212, t. 283, 1898; Duthie, 142, 1906; Holttum, 694, 1955; Hara, 425, 1966. (Fig. 1).

Inflorescence very densely flowered, longer than the leaves; flowers white or rose-purple, spotted with darker purple spots, c. 2 cm in diam., fragrant. Sepals and petals subequal, tips rounded. Lip twice as long as the sepals, purple but darker in the middle, lateral lobes small and recurved, midlobe hastate, c. 1.7 cm long, tip rounded, spur short and straight. Flowering during June and July. Distributed at 304 to 915 m. Collected from Dhupu to Wana, Hittaura, locality unknown (Herklotts).

A. odoratum (Poir.) Lour. Fl. Cochinch. 525, 1790; F.B.I. 6: 47, 1890. *Epidendrum odoratum* Poir. Encycl. Supp. 1: 385, 1811.

Inflorescence many-flowered equalling or longer than the leaves. Flowers purple or whitish purple, sweet smelling, 2.5 to 3.8 cm in diam., sepals and petals 1.2 cm long, lateral sepals much longer than the dorsal sepal and petals. Lip funnel-shaped, prolonged at the base to form a spur, lateral lobes erect, white midlobe linear, marginate, greenish at its apex and spotted all over, tip 3-lobed. Flowering

during July and August. Distributed at 304 to 915 m. Collected from Hittaura area.

Chiloschista Lindl.

Dwarf, epiphytic orchids, leafless when flowering. The name alludes to the cleft lip. Hooker (Fl. Brit. Ind.), and King & Pantl. placed it as a section under *Sarcochilus*. Pfitzer and J. J. Smith recognised the genus as an independent one. Later Schlechter (1927) again united it with *Sarcochilus*.

ARTIFICIAL KEY TO THE SPECIES OF *Chiloschista*

- Flowers white *usneoides*
 Flowers yellow, spotted with purple *lunifera*

Chiloschista lunifera (Reichb. f.) J. J. Sm. Fl. Buitenz. 6 : 553, 1905. *Thrixspermum luniferum* Reichb. f. in Gard. Chron. 1886, 786, 1886. *Sarcochilus luniferus* (Reichb. f.) Bth. ex Hk. f. in Bot. Mag. 115, t. 7044, 1889 et Fl. Brit. Ind. 6 : 37, 1890 ; King & Pantl. 207, t. 276, 1898.

Roots tufted and stem much reduced. Inflorescence elongate 7-15 cm long, many-flowered ; flowers c. 1.5 cm in diam., yellow spotted with purple. Sepals spreading, oblong, obtuse. Lip 3-lobed, sidelobes linear-oblong, obtuse, midlobe truncate, emarginate. Flowering during February and March. Distributed at 1300 to 1980 m. Collected from Bhadgaon to Dhulikhel, Hittaura.

Hooker remarks 'except in the colour of the flower, no difference from *usneoides*'.

C. usneoides (Don) Lindl. Gen. et Spec. Orch. 219, 1830 et Bot. Reg. sub. t. 1522, 1832. *Epidendrum usneoides* D. Don, Prodr. Fl. Nep. 37, 1825. *Sarcochilus usneoides* Reichb. f. in Walp. Ann. 6 : 497, 1861 ; F.B.I. 6 : 37, 1890.

Roots tufted and stem absent. Inflorescence 7 to 15 cm long, densely flowered. Flowers c. 1.3 cm in diam., white, sepals spreading, oblong, obtuse. Sidelobes of lip erect, linear-oblong, obtuse, disk between the lobes pubescent, midlobe truncate and emarginate. Flowering during February and March. Distributed at 1525 to 1830 m. Collected from Sundarikal, Sheopuri area, locality unknown (Herklotts).

Doritis Lindl.

According to Schultes and Pease the name refers to the hastate lip or perhaps to *Doritis*, one of the names of the goddess Aphrodite,

The column is winged, and its foot forms a spur-like mentum with the sidelobes of the lip. The plants have short stem and the few leaves are clustered.

Doritis taenialis (Lindl.) Benth. in Benth. & Hook. f. Gen. Pl. 3: 574, 1883; F.B.I. 6: 31, 1890; King & Pantl. 199, t. 266, 1898; Duthie, 138, 1906; Hara, 433, 1966. *Aerides taenialis* Lindl. Gen. et Spec. Orch. 239, 1833.

Inflorescence few-flowered (about 6), pendulous; flowers mauve-purple, c. 2 cm in diam., dorsal sepal oblong, lateral sepals broader, petals shorter than the sepals. Lip adnate to the foot of the column, sidelobes of lip very narrow, spatulate, reflexed on the disk, midlobe dark red. Flowering during May and June. Distributed at 915 to 1830 m. Collected from Chainpur to Mialay, Naudhara, Nagarjung.

Esmeralda Reichb. f.

Schultes and Pease giving the etymology of the name mention that it may possibly refer to the overwhelming beauty of the flower which makes this orchid a jewel in collections or perhaps to the very deep green hue of the foliage. Hawkes considered *Esmeralda* a synonym of *Arachnanthe*.

Esmeralda clarkei Reichb. f. Gard. Chron. 2: 552, 1886.

Arachnanthe clarkei Rolfe, Gard. Chron. 2: 567, 1888; F.B.I. 6: 28, 1890. *Arachnis clarkei* (Reichb. f.) J. J. Sm. in Nat. Tijdschr. Ned. Ind. 72: 76, 1912. (Fig. 2.)

Inflorescence c. 20 cm long, few-flowered (3-4), flowers c. 7.5 cm in diam., fleshy, very fragrant; sepals and petals falcate, bright chestnut brown with yellowish stripes, dorsal sepal erect. Lip almost the length of the petals, base narrowed, sidelobes short, broad, erect, midlobe ovate-cordate, obtuse, a small lobule at apex, surface with a number of ridges. Flowering during February and March and again in November. Collected from Sundarijal at 1830 m, locality unknown (Herklotts).

Gastrochilus D. Don

As the lip is belly-shaped, the name refers to that character. J. J. Smith who had previously treated *Gastrochilus* as a section of *Saccolabium*, raised it to generic level. *Gastrochilus* can be differentiated from *Sarcocochilus* R. Br. and *Saccolabium* Bl. by the fleshy flowers. Lip, immovable midlobe, flat, hairy, and fringed column very short, footless. The pollinia are shorter than the caudicles.

ARTIFICIAL KEY TO THE SPECIES OF *Gastrochilus*

Spur short—

Sidelobes of lip present, midlobe fringed, papillose-hairy.....*calceolaris*Sidelobes of lip absent, midlobe entire, surface more or less glabrous (not hairy)
.....*distichus*Spur long with a bilobed apex*affine*

Gastrochilus affine (King & Pantl.) Schltr. Fedd Rep. 12: 314, 1913; Hara, 434, 1966. *Saccolabium affine* King & Pantl. Ann. Roy. Bot. Gard. Calcut. 8: 228, t. 304, 1898.

Flowers smaller than those of *G. distichus*, lip not sub-orbicular but transversely elongated, tip of midlobe obtuse, lateral margins with irregular dentation, two lamellae in the centre of the midlobe; spur conical with a slightly bilobed apex. Authority Hara.

G. calceolaris D. Don, Prodr. Fl. Nep. 32, 1825; Holttum, 675, 1953; Hara, 453, 1966. *Aerides calceolare* Ham. ex Smith, Rees. Cyclop. 39 (11), 1818; *Saccolabium calceolare* Lindl. Gen. et Spec. Orch. 223, 1833; F.B.I. 6: 60, 1890; King & Pantl. 225, t. 300, 1898. (Fig. 3).

Scape spotted purple, stout and fleshy, shorter than the leaves, flowers yellow or greenish, speckled with red-brown, waxy, c. 1.5 cm in diam., mildly fragrant; sepals and petals 6 mm long. Lip yellow and speckled with brown spots, sidelobes 1 mm, white, midlobe 3 mm long, twice as wide at the base, margin white, fringed, central part yellow, hairy all over, spur short also yellow. Flowering during February and March. Distributed at 1525 to 1830 m. Collected from Rhingmo to Jubing, Sheopuri, Godavari.

G. distichus (Lindl.) O. Ktz. Rev. Gen. Pl. 2: 661, 1891; Hara, 435, 1966. *Saccolabium distichum* Lindl. in Journ. Linn. Soc. 3: 36, 1859; F.B.I. 6: 64, 1890; King & Pantl. 227, t. 303, 1898; Duthie, 148, 1906.

Inflorescence equalling the leaves, flowers greenish and spotted with brown. Sepals and petals obovate-oblong, green spotted with brown. Lip with a saccate spur, sidelobes absent, midlobe small, semicircular, fleshy with two calli at the base. Flowering during January and February. Collected from Borlong forest at c. 2285 m.

Luisia Gaud.

This orchid is named after a Spanish botanist Don Luis de Torres.

ARTIFICIAL KEY TO THE SPECIES OF *Luisia*

Flowers 10 mm long	<i>trichorrhiza</i>
Flowers 6 mm long	<i>teretifolia</i>
Flowers 4 mm long	<i>micrantha</i>

Luisia micrantha Hook. f. in Fl. Brit. Ind. 6: 23, 1890.

Flowers small, c. 8 mm in diam., and 4 mm long, greenish lateral sepals ovate, subacute, midrib very stout, dorsal sepal similar to the petals, petals oblong, obtuse, 1-nerved. Lip as long as the sepals, hypochile oblong, concave, two strong teeth, epichile fleshy, small. Flowering during August and September. Collected from Hittaura at c. 510 m.

L. teretifolia Gaud. Bot. Freyc. Voy. 427, t. 37, 1826; F.B.I. 6: 22, 1890; King & Pantl. 202, t. 271, 1898; Duthie, 140, 1906; Hara, 443, 1966.

Inflorescence few-flowered (2-3), flowers small, c. 1.8 cm in diam., and 6 mm long, foul smelling. Lateral sepals subacute, petals linear-oblong, obtuse, hardly longer than the sepals, yellowish-green. Lip equalling the sepals, usually dull purple and with 5 vertical lines. Flowering during March and April. Collected from Dhunibesi, Nagarjung at c. 1650 m.

L. trichorrhiza Bl. Rumphia 4: 50, 1848; F.B.I. 6: 23, 1890; Duthie, 140, 1906.

Inflorescence 4-5-flowered, flowers c. 2.5 cm in diam., and 1 cm long. Sepals unequal with faint purple lines, petals as long as the lateral sepals. Lip obovate-oblong, rather longer than the sepals, flat, dull purple, constricted at the base of the cordate epichile, marking the hypochile. Flowering during March and April. Distributed at c. 750 m. Collected from Dhulikhel to Kuwapani, Pokhra.

Ornithochilus Wall. ex Lindl.

The name is descriptive of the bilobed lip with the tips divaricate and verticle resembling a bird in flight.

Ornithochilus difformis (Wall. ex Lindl.) Schltr. Orch. Sino-Jap. 227, 1919; Hara, 446, 1966. *Aerides difforme* Wall. ex Lindl. Gen. et Spec. Orch. 242, 1833; *Ornithochilus fusca* Wall. ex Lindl. Gen. et Spec. Orch. 242, 1833 (pro. syn.); F.B.I. 6: 76, 1890; King & Pantl. 200, t. 268, 1898; Duthie, 139, 1906.

Inflorescence somewhat pendulous, twice or thrice longer than the leaves, many-flowered, flowers c. 1.25 cm in diam. Sepals and petals greenish-yellow with reddish stripes. Lip much larger than the sepals,

clawed, yellow, sidelobes quadrate, striped with brown, midlobe clawed and two lobulate, reddish or purple lower down, spur long, yellow. Flowering time June. Collected from Nagarjung at 1650 m.

Rhynchostylis Bl.

Usually stout and short-stemmed epiphytic orchid. Allied to *Saccolabium* Bl. and *Aerides* Lour. but can be distinguished by the scarcely lobed lip and the not sharply distinguished from the column-foot; the laterally compressed spur is directed backwards, and the rostellum is beaked. These orchids are popularly known as 'Fox-tail Orchids'.

Rhynchostylis retusa (Linn.) Bl. Bijdr. 286, 1825; F.B.I. 6: 32, 1890; King & Pantl. 213, t. 284, 1898; Duthie, 143, 1906; Holttum, 697, 1953; Hara 449, 1966. *Epidendrum retusum* Linn. Sp. Pl. 953, 1753. *Saccolabium guttatum* Lindl. (in Wall. Cat. 7308) Gen. et Spec. Orch. 220, 1833. (Fig. 4.)

Stem robust and completely hidden by the imbricating leaf-bases; leaves arching gracefully, very close together, leathery, apex obliquely bilobed. Inflorescence c. 25-30 cm long, densely flowered. Flowers white, spotted with pink or purple, c. 1.8 cm in diam., fragrant, waxy; lateral sepals c. 1 cm long, gibbously orbicular-ovate, obtuse or apex drawn out, dorsal sepal c. 1.2 cm long, oblong; petals 1.2 cm long, elliptic, obtuse. Epichile of lip usually cuneiform, emarginate, saccate, purple. Flowering during May and June. Distributed from 304 to 1830 m but commonly at about 915 m. Collected from Naikot, Dhupu to Wana, locality unknown (Herklotts).

Sarcanthus Lindl.

The name refers to the very fleshy flowers of most of the species. According to Holttum (1953) 'this is the largest genus of the small-flowered orchids of this group. The flowers are always rather fleshy and last several days. Their most distinctive feature is the large callus at the back of the spur. The back callus, also sometimes interlocks with the front callus....' The flowers are complex in structure and difficult to describe.

ARTIFICIAL KEY TO THE SPECIES OF *Sarcanthus*

- Leaves filiform; raceme 15-20 cm long, curved.....*filiformis*
 Leaves flat; racemes branched (panicle), 30-35 cm long.....*racemifer*

Sarcanthus filiformis Lindl. Bot. Reg. misc. 61, 1838; F.B.I. 6: 66, 1890.

Epiphytic with leaves filiform and narrowly cylindrical. Inflorescence rather dense, many-flowered, curved 15-25 cm long; flowers c. 8 mm in diam.; sepals oblong, obtuse, petals smaller and narrower, both dark purple with margin and midrib green. Lip broadly conical, fleshy, white with a broad yellow base, sidelobe acute, incurved, midlobe short, white, callus very large. Flowering time during August and September. Collected at 910 m at Hittaura and Narayani.

S. racemifer (Wall.) Reichb. f. in Walp. Ann. 6: 891, 1861. *Aerides racemiferum* Wall. ex Hook. f. in Fl. Brit. Ind. 16: 68, 1890. *Sarcanthus pallidus* Lindl. Bot. Reg. 78, 1840; F.B.I. 6: 69, 1890.

Epiphytic with leaves flat and broad, obtusely bilobed, very thick. Inflorescence erect, branched, loosely-flowered, flowers c. 8 mm in diam. Sepals and small petals oblong, obtuse, dark purple with edges yellow. Lip white, sidelobes triangular, acuminate, midlobe small and incurved, reniform, fleshy beak, spur cylindrical, obtuse, saccate, thick-walled, as long as the sepals but shorter than the ovary, callus bilobed. Flowering during June and July. Distributed at 1220 to 1525 m. Collected from Dhankutta, Pokhra.

Vanda Jones

The name refers to the Sanskrit word 'banda' which means an epiphyte but also used for parasitic plants. The *Vanda* orchids can be distinguished by the fleshy 3-lobed lip. The inflorescence is normally simple and erect; it usually arises from the leaf-axils or from opposite the leaf-bases and near the upper part of the plant but not at its apex.

ARTIFICIAL KEY TO THE SPECIES OF *Vanda*

- A. Lip spurred at the base—
 - B. Sepals & petals spreading—
 - C. Flowers small, disk of lip without ridges *parviflora*
 - CC. Flowers c. 3.5–5 cm in diam. disk of lip with fleshy ridges, sidelobes small and rounded..... *tessellata*
 - CCC. Flowers c. 7.5–10 cm in diam., disk of lip with sidelobes broad and incurved *teres*
 - BB. Sepals and petals incurved—
 - D. Sidelobes erect and triangular; flowers 5 cm in diam..... *cristata*
 - DD. Sidelobes rounded; flowers 2.5 cm in diam..... *pumila*
- AA. Lip gibbous, not spurred or saccate. Flowers c. 2.5 cm in diam..... *alpina*

Vanda alpina Lindl. Fol. Orch. 10, 1853; F.B.I. 6 : 53, 1890; King & Pantl. 217, t. 289, 1898; Duthie, 146, 1906; Hara, 452, 1966. *Luisia alpina* Lindl. Bot. Reg. 1858, misc. 56, 1858.

Racemes with usually 2 flowers; flowers nodding, faintly fragrant, c. 2.5 cm in diam., sepals and petals narrow, yellowish-green. Lip fleshy, sidelobes rounded, purplish inside, midlobe concave, ovate, retuse, pale yellow with purple shallow ridges, spur absent but gibbous. Flowering during May, one specimen collected from Sheopuri area at c. 1370 m.

V. cristata (Wall.) Lindl. Gen. et Spec. Orch. 216, 1833; F.B.I. 6 : 53, 1890; King & Pantl. 216, t. 287, 1898; Duthie, 146, 1906. *Aerides cristatum* Wall. ex Hook. f. in Fl. Brit. Ind. 6 : 53, 1890. (Fig 5.)

Inflorescence erect, 3-5-flowered, flowers c. 5 cm in diam., waxy, fragrant. Sepals and petals narrow, incurved yellowish-green. Lip green on the underside, upper surface marked with purple stripes and spots, sidelobes of lip erect, triangular, truncate; midlobe oblong, golden yellow and striped with purple, tip with two divaricate oblong lobes and a fleshy beak pointed downwards, spur short and conical. Flowering time during March and April, even on to June. Collected from West Nepal (Parker), locality unknown (Herklotts). (The description and the flowering time have been based on the study of plants growing in Botanic Garden, Godavari).

V. parviflora Lindl. in Bot. Reg. 30, Misc. 45, 1844; F.B.I. 6 ; 50, 1890; King & Pantl. 215, t. 286, 1898; Duthie, 145, 1906. *Aerides testaceum* Lindl. Gen. et Spec. Orch. 238, 1833; *Vanda testacea* (Lindl.) Reichb. f. in Gard. Chron. 2 : 166, 1877.

Inflorescence arising below the leaves, rather loosely 5-7-flowered, flowers c. 1.5-2 cm in diam. Sepals and petals usually flesh-coloured, subequal, obovate-spathulate, obtuse, spreading. Lip 3-lobed, sidelobes small, incurved midlobe large, broadly oblong, fleshy, crenate at the apex, white, surface blue and purple-spotted, spur long and curved. Flowering during May and June. Distributed at 305-915 m. Collected from Simalbasa, Hittaura.

V. pumila Hk. f. in Fl. Brit. Ind. 6 : 53, 1890, et in Ann. Roy. Bot. Gard. Calc. 5 : 45, 1895.

Inflorescence about 15 cm long, loosely 2-4-flowered, flowers c. 2.5 cm in diam., fragrant; sepals and petals narrow, pale yellow or greenish-white. Lip 3-lobed, sidelobes erect and rounded, midlobe broadly ovate, concave, obtuse, pale and streaked purple, spur conical and as long as the midlobe. Flowering during April and May. Distributed at 1220 to 1525 m. Collected from Dhunibesi, Hokse.

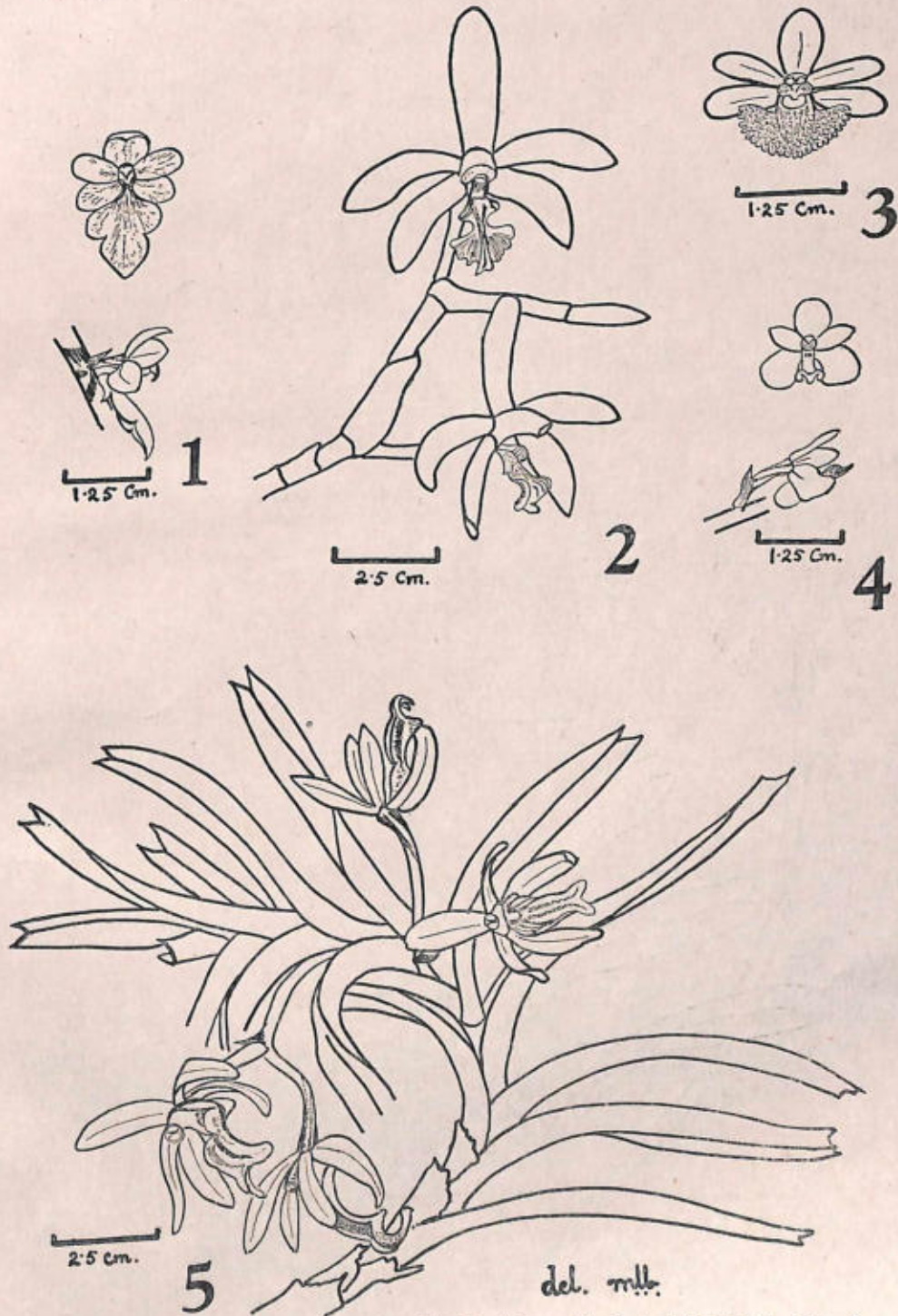


Fig. 1. *Aerides multiflorum* Roxb. Fig. 2. *Esmeralda clarkei* Reichb. f. Fig. 3. *Gastrochilus calceolaris* D. Don. Fig. 4. *Rhynchostylis retusa* (Linn.) Bl. Fig. 5. *Vanda cristata* (Wall.) Lindl.

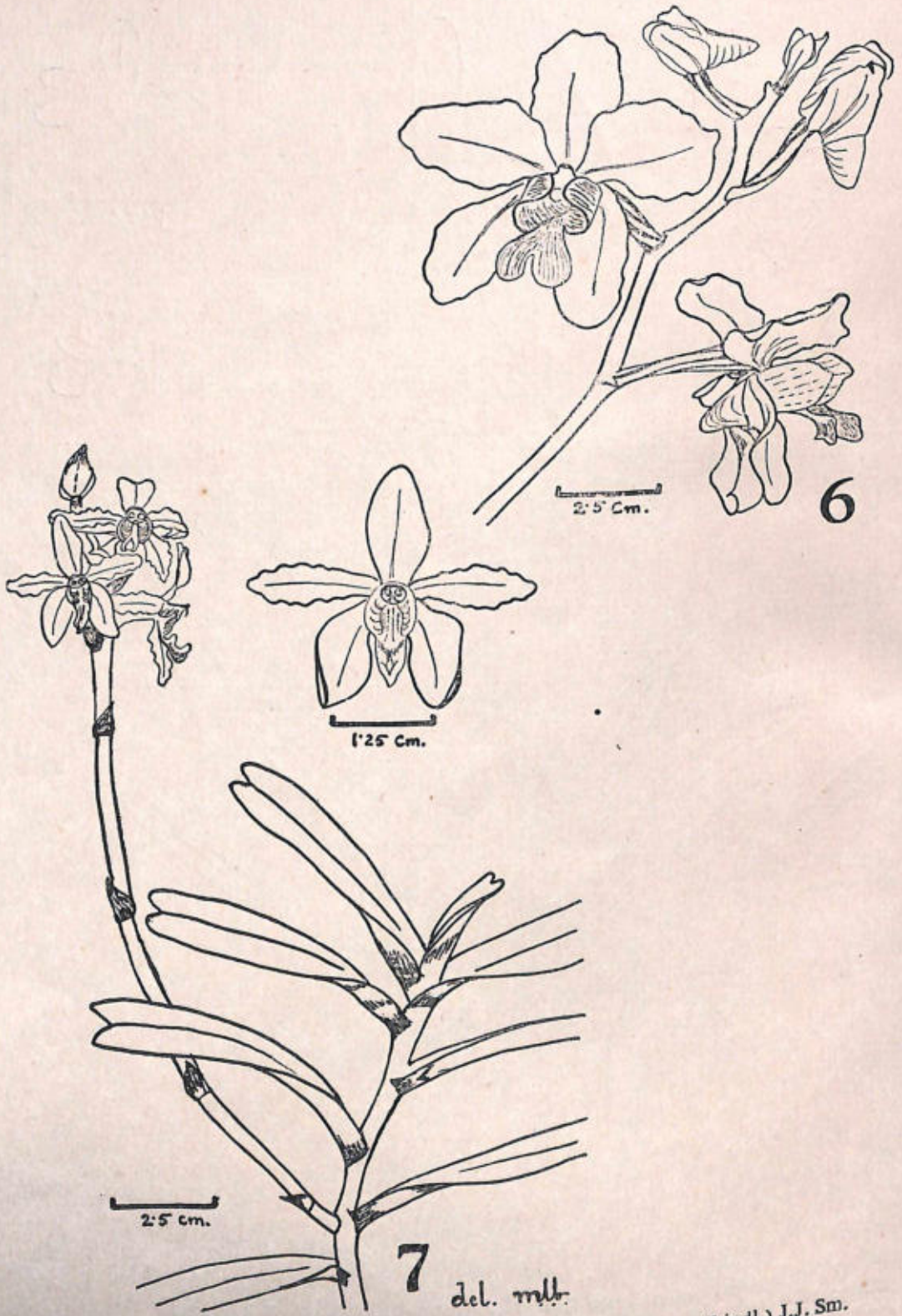


Fig. 6. *Vanda teres* (Roxb.) Lindl. Fig. 7. *Vandopsis undulata* (Lindl.) J.J. Sm.

V. tessellata (Roxb.) Hook. ex G. Don, Loud. Hort. Brit. 372, 1830. *Epidendrum tessellatum* Roxb. Pl. Corom. 1: 34, t. 42, 1795. *Vanda roxburghii* R. Br. in Bot. Reg. 6, t. 506, 1820; F.B.I. 6: 52, 1890; Duthie, 116, 1906. *V. tesselloides* Reichb. in Walp. Ann. 6: 864, 1861.

Inflorescence 5-10-flowered, longer than the leaves. Flowers *c.* 5 cm in diam., tessellated with brown, sepals *c.* 2.5 cm long, petals 2.3 cm long, clawed, obovate, waxy, tessellations yellowish-green or slightly bluish, margins white. Lip nearly as long as the sepals, side-lobes small, purple-spotted, midlobe panduriform, dull violet and paler at the base, tip dilated, truncate, 2-lobed, disk with fleshy ridges, spur conical. Flowering during July and August. Distributed in the sub-Himalayan region. Collected from Bhairwa, Hittaura, Narayanghat.

V. teres (Roxb.) Lindl. Gen. et Spec. Orch. 217, 1830; F.B.I. 6: 49, 1890. *Dendrobium teres* Roxb. Fl. Ind. 3: 485, 1832. (Fig. 6).

Inflorescence 15-30 cm long and with 3-6 flowers. Flowers *c.* 7.5-10 cm in diam., white or mauve, fragrant. Sepals and petals undulate, lip hairy towards the base, side lobes broad, incurved, deep yellow or lighter and spotted crimson, midlobe much larger, deeply cleft, purple, spur conical. Flowering during May and June. Distributed at 305 to 610 m. Collected from Hittaura, locality unknown (Herklotts).

Vandopsis Pfitz.

These are robust and spectacular orchids. The name implies that these orchids resemble *Vanda*. According to Hawkes they are allied to *Renanthera* Lour. and *Arachnis* Bl.

Vandopsis undulata (Lindl.) J. J. Sm. in Nat. Tijdschr. Ned. Ind. 72: 77, 1912. *Vanda undulata* Lindl. Journ. Linn. Soc. 3: 42, 1859. *Stauropsis undulata* (Lindl.) Benth. ex Hk. f. Fl. Brit. Ind. 6: 27, 1890; King & Pantl. 205, t. 257, 1898. (Fig. 7).

Inflorescence long, rachis thickened, 8-12-flowered, flowers *c.* 3.25 cm in diam., white, flushed with pink, waxy, fragrant; sepals oblanceolate, acuminate, margins undulate, lateral sepals deflexed, petals similar but smaller. Lip greenish-yellow or light yellow, base saccate, adnate to the sides of the column, sides pink, midlobe laterally compressed, 3-ridged, tip truncate, purplish. Flowering during March and April. Distributed at about 2135 m. Collected from Kaituka, Chandragiri, Godavari, locality unknown (Herklotts).

(to be continued)

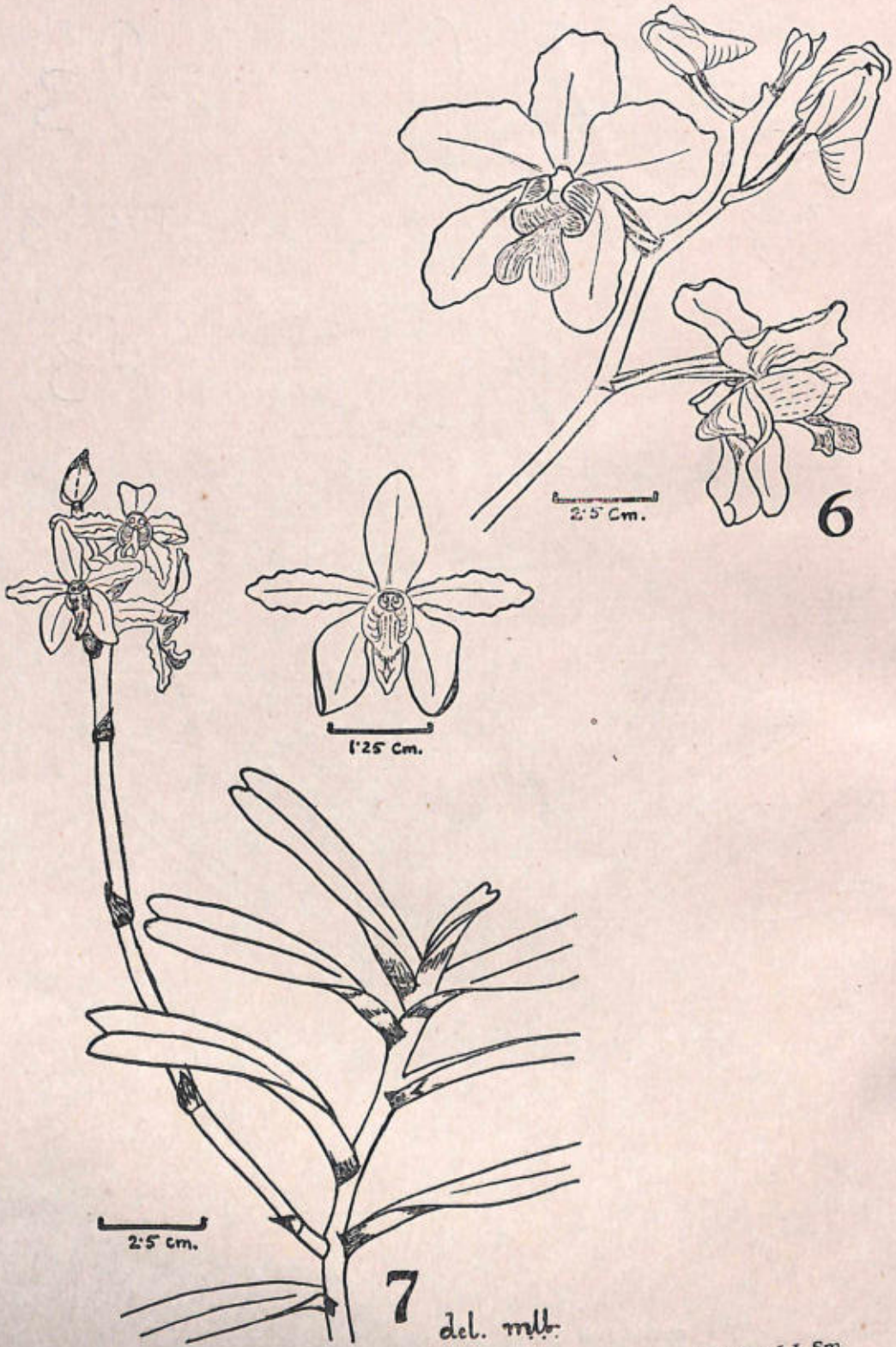


Fig. 6. *Vanda teres* (Roxb.) Lindl. Fig. 7. *Vandopsis undulata* (Lindl.) J.J. Sm.

V. tessellata (Roxb.) Hook. ex G. Don, Loud. Hort. Brit. 372, 1830. *Epidendrum tessellatum* Roxb. Pl. Corom. 1: 34, t. 42, 1795. *Vanda roxburghii* R. Br. in Bot. Reg. 6, t. 506, 1820; F.B.I. 6: 52, 1890; Duthie, 116, 1906. *V. tesselloides* Reichb. in Walp. Ann. 6: 864, 1861.

Inflorescence 5-10-flowered, longer than the leaves. Flowers c. 5 cm in diam., tessellated with brown, sepals c. 2.5 cm long, petals 2.3 cm long, clawed, obovate, waxy, tessellations yellowish-green or slightly bluish, margins white. Lip nearly as long as the sepals, side-lobes small, purple-spotted, midlobe panduriform, dull violet and paler at the base, tip dilated, truncate, 2-lobed, disk with fleshy ridges, spur conical. Flowering during July and August. Distributed in the sub-Himalayan region. Collected from Bhairwa, Hittaura, Narayanghat.

V. teres (Roxb.) Lindl. Gen. et Spec. Orch. 217, 1830; F.B.I. 6: 49, 1890. *Dendrobium teres* Roxb. Fl. Ind. 3: 485, 1832. (Fig. 6).

Inflorescence 15-30 cm long and with 3-6 flowers. Flowers c. 7.5-10 cm in diam., white or mauve, fragrant. Sepals and petals undulate, lip hairy towards the base, side lobes broad, incurved, deep yellow or lighter and spotted crimson, midlobe much larger, deeply cleft, purple, spur conical. Flowering during May and June. Distributed at 305 to 610 m. Collected from Hittaura, locality unknown (Herklotts).

Vandopsis Pfitz.

These are robust and spectacular orchids. The name implies that these orchids resemble *Vanda*. According to Hawkes they are allied to *Renanthera* Lour. and *Arachnis* Bl.

Vandopsis undulata (Lindl.) J. J. Sm. in Nat. Tijdschr. Ned. Ind. 72: 77, 1912. *Vanda undulata* Lindl. Journ. Linn. Soc. 3: 42, 1859. *Stauropsis undulata* (Lindl.) Benth. ex Hk. f. Fl. Brit. Ind. 6: 27, 1890; King & Pantl. 205, t. 257, 1898. (Fig. 7).

Inflorescence long, rachis thickened, 8-12-flowered, flowers c. 3.25 cm in diam., white, flushed with pink, waxy, fragrant; sepals oblanceolate, acuminate, margins undulate, lateral sepals deflexed, petals similar but smaller. Lip greenish-yellow or light yellow, base saccate, adnate to the sides of the column, sides pink, midlobe laterally compressed, 3-ridged, tip truncate, purplish. Flowering during March and April. Distributed at about 2135 m. Collected from Kaituka, Chandragiri, Godavari, locality unknown (Herklotts).

(to be continued)

Bionomics and Distribution of the land leeches of Kumaon Hills, U.P.

BY

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AND

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(with 5 text-figures)

INTRODUCTION

Land leeches are reported from almost all the hill areas in India where they swarm in an incredible profusion, and prove a very harmful pest to animals and mankind by sucking their blood. Very little accurate information concerning their activities is recorded. It is a well-known fact that they are very active during rainy weather but no one appears to know what actually becomes of them during the dry season, and their appearance immediately with the coming of rains, raises the question, 'Whence do they appear?'. Some believe that they lay eggs and die with the advent of dry season, and that those which reappear on its conclusion are a new generation. There is little literature on the subject.

Extensive field and laboratory observations were made for three continuous years, and it has been possible to gather first-hand information about several hitherto unknown and doubtful aspects of land leeches, which are recorded here.

Although several species of land leeches, commonly found in Kumaon Hills, were collected, the observations recorded here are based primarily on the behaviour of two very common species, *Haemadipsa zeylanica agilis*, and *Haemadipsa montana*, which should hold good for other varieties of land leeches elsewhere in India.

The Junior author owns an agricultural farm and also an apple orchard, in Kumaon and thus had the advantage of first hand knowledge, extending over several years, of the activities of land leeches throughout a calendar year. His valuable field observations of these creatures form subject matter of this paper.

HABIT

At the advent of rains, leeches emerge from hibernation and begin to swarm to the upper limits of the hills. During rains they are found on almost all patches of land in oak forests and are especially abundant along the foot-paths frequented by cattle, wild animals, and man. They are also present in large numbers in grass pastures adjacent to oak forests, which are frequently visited by man and domestic animals.

Moore (1927) reports that *Haemadipsa sylvestria* from Assam, enters water voluntarily during dry season and swims actively. Contrary to this, the common leeches of Kumaon region *Haemadipsa zeylanica agilis*, and *Haemadipsa montana*, do not enter streams during short dry spells during the monsoon and even in the prolonged drought period of hibernation. Their avoidance of wet and flooded areas of the forests suggests that they dislike such habitats.

In the early part of monsoon, after the first few showers, leeches are very active but when incessant rains set in, they crawl under dead oak leaves on the ground. During bright sun-shine also they hide under leaves and stones and resume their activities when it is cloudy and humid. They remain active during night, but become much more alert when rays of the early morning sun fall on them. Leeches are seen either standing erect on their posterior suckers, swaying all around, or moving on the ground. When erect they appear like small twigs among the layers of dry oak leaves. Leeches living in forests and swamps, may climb on leaves and branches, and wait until a suitable mammalian prey present itself.

After a full blood-meal, they crawl beneath the leaves or under some suitable cover and remain in a sluggish condition for a number of days, but those that do not get an opportunity of procuring a meal come out at the slightest disturbance.

Wounds caused by their bites generally heal up within a few days, though land leeches have the peculiar habit of biting repeatedly at the same spot which sometime causes pathological complications. Sometimes the bite becomes an open sore, probably due to secondary infection. Landleeches attack all the warm-blooded animals but find difficulty in getting blood from animals with thick fur covering. Some bare portion of the body of animals is selected for this purpose.

HABITAT

Haemadipsa zeylanica agilis and *Haemadipsa montana*, along with other land leeches are found abundantly between heights 5000 and 6000 ft. and range from ravines as low as 3000 ft. to hill-tops ranging up to 11,000 ft. above sea level. Oak forests which cover the major

part of the hill-tops of Kumaon, provide the most suitable habitat. But in late rainy season it is not uncommon to find them even in the

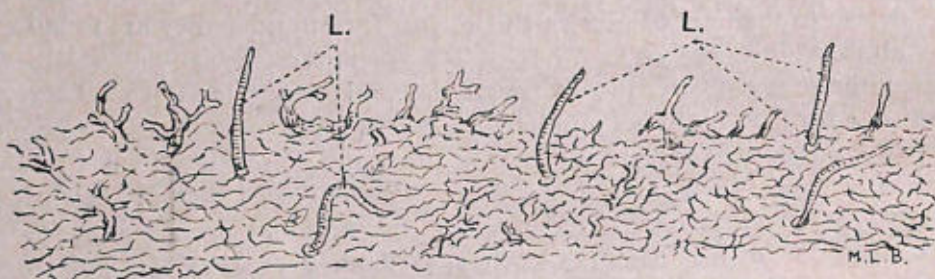


Fig. 1. A few leeches camouflaged in their natural habitat. L. leeches.

pine forest, orchards, grassy meadows, and even in cultivated paddy fields, adjacent to the oak forests. It has been noticed that they are totally absent from some parts of the forests, particularly forests on the southern aspects of the hills and heavily colonise some and are scanty in other parts of the northern aspect of the hill.

Leeches are primarily aquatic and have secondarily acquired life on land. Humidity remains their prime requirement for survival. The role of temperature is also significant as they are limited to a temperature between 10° and 25°C .

The extensive forests in the second and third climatic belt of Kumaon region, provide suitable conditions to these creatures. At elevations between 5000 and 11,000 ft. the rains during the monsoon are fairly heavy. In the second belt the average rainfall is 70" to 120", while in the third belt it is 40" to 80", of which eighty per cent falls during the rainy season. The forests are dense and evergreen on the northern face of the hill and thin on the southern side. The oak forests have luxuriant under-growth and the trees are draped in a rich epiphytic flora of ferns, mosses, and lichens. Other common trees in the oak forests are 'Brunch' (*Rhododendron*), 'Ringal' (*Arundinaria*), 'Kaphal' (*Myrica*), and a few species of *Berberis*, all with broad evergreen leaves.

The oak forests with this kind of luxuriant vegetation and with a rainfall of over 70", has high humidity during the rainy season and even otherwise. The average maximum temperature does not rise above 26°C . These two major factors coupled with a few other attributes of the oak forests, such as the shade under the broad-leaved, evergreen trees help in maintaining moisture. The greater water retaining capacity keeps the valleys humid during the hibernation period. The carpet of dead oak leaves on the ground provides shelter during temporary dry spells and checks surface evaporation and the luxuriant under-growth that keeps the forest

humid and provides a substratum for their movements. All these provide ideal ecological conditions for leeches. An additional advantage is the fire resisting qualities of oak forests that have saved leeches from total eradication.

The density of leech population varies much in different parts of the forest, due to several factors that influence the habitat. Dense forests on the north facing slopes provide a much more suitable habitat than the forests on the southern side, which are very sunny and almost bare, comparatively warm, and less moist and sometimes quite dry. It is interesting to note that human agency has influenced to some extent the colonisation by leeches, and densely infested leech localities are always found near the grazing grounds and human habitation.

Leeches found in other places, like orchards, meadows, paddy fields and open patches of land during the rains, are actually migrants from the main oak forests. There is evidence to support the fact that they do not really emerge in these parts; that they migrate to all these localities after their emergence in the oak forests. They are seen in these parts quite late in the season and they also disappear early. Leeches do not permanently colonise these areas due to unfavourable conditions, particularly during the hibernation period.

During the rains, they are also found in the neighbouring xerophytic pine forests which have the same altitudinal range, but are really migrants from adjacent oak forests. Certain mixed type of forests, along with ravines which have a large number of oak trees, are very heavily colonised. Leeches have not successfully colonised pine forest because of xerophytic conditions, lack of undergrowth, the disagreeable and repelling smell of resin, and the absence of suitable shelter among the needle-shaped pine leaves. To all these may be added prevalence of fire.

Although between 7000 and 9000 ft. altitude there are different types of forests in the same altitudinal range and with almost similar conditions of shade and temperature as those in oak forests, it is surprising to note that leeches do not inhabit these forests. Viewing the general conditions of these forests of Blue pine (*Pinus excelsa*, 6000 ft. to 8000 ft.); Spruce (*Picea norinda*, 7000 ft. to 9000 ft.); Cypress (*Cupressus torulosa*, 6500 ft. to 9500 ft.); and Deodar (*Cedrus deodara*, 8000 ft. to 10,000 ft.); it seems that the meagre rainfall (10" to 40"), needle-shaped leaves, scarce under-growth and lack of hibernating grounds have completely checked the infestation of these forests.

FOOD

Land leeches are blood-sucking ectoparasites and they are remarkably adept at taking from the host very considerable quantity of blood

without being noticed. In natural conditions it has been observed that they feed infrequently but take large quantities of blood at one time, over ten times its own weight. Digestion and absorption are very slow processes, and it takes nearly 8 to 10 months to assimilate a full blood-meal.

Smythies (1953) raised the question, whether land leeches feed only on blood or could also subsist on other food materials, such as humus and plant-juices etc. Harrison (1953) believes that they feed exclusively on blood, and we fully endorse this view. Hungry leeches kept in cages, containing humus, oak leaves, succulent herbs, and a few common invertebrate forms (earthworms, some arthropods, and slugs etc.) that are commonly found in leech localities, remained untouched by leeches and they starved and did not survive. On the other hand leeches fed on blood grow well and survive up to the hibernation period. It has been possible to keep leeches for more than three years by providing them a single blood-meal every year, with suitable conditions of temperature and moisture.

It is a well established fact that leeches feed on blood and blood only, but the information regarding the favourite victim is very meagre and it is also not known whether all the leeches are able to procure at least a single blood-meal. They rely for their nourishment on their ability to make contact with vertebrate hosts capable of rapid movement. The common vertebrates inhabiting the forests of Kumaon, like Barking Deer (*Muntiacus muntjak*); Goral (*Nemorhaedus goral*); Sambar (*Cervus unicolor*); Rhesus Monkey (*Macaca mulatta*); Langur (*Presbytis entellus*); and Serow (*Capricornis sumatraensis*), are all attacked by leeches. Birds are not usually attacked. Some birds (Kaleej and Koklas pheasants) were shot in the leech-infested areas during the rainy season and a few leeches were found on their tarsus, but there were no signs of previous bites by leeches on any of the birds to indicate that they had frequent leech attacks.

A number of species of rats, and moles exist in the oak forests, which become their victim. But leeches kept with the common rat (*Rattus rattus*) in a cage in the laboratory, did not touch the rats.

Moore (1927) refers to a freshwater crab (*Potamon atkinsonianum*) as a specific host of the leech *Haemadipsa sylvestris*. The only large invertebrate slug (*Limax*), common in leech localities in Kumaon, is not attacked by these leeches.

Kinloch (1922) reported a leech attacking *Dryophis*, an arboreal species of snake, in a coffee plantation at Nelliampathy hills in south India.

Moore (1927) reports to have received specimens of land-leeches collected from the local frogs of Ceylon. A large number of toads

(*Bufo melanostictus*) very commonly seen in the same locality during the rainy season, were found free from leeches.

The present study of leech habitats and the wide range of victims they come across gives the impression that leeches do not get frequent opportunity of securing a meal. Large wild animals capable of rapid movement usually abandon heavily infested areas, while rodents with their dense fur-coat and birds on account of feathers do not offer much chance of a meal to leeches. We feel that domestic animals are the main source of their subsistence. It has been noticed that some wild animals and cattle are their primary victims. The colonisation of grazing lands, cattle tracks and the areas near human habitat, support the above view. On cattle that daily visit or only pass through these areas for grazing, it is a common sight to find at least eight to ten leeches sticking in between their hooves and bare parts of the body, particularly the nasal and genital regions.

It has long been queried whether the entire leech population is able to secure a meal. In this connection it is worth noting that the reported abundance of leeches by previous workers appears to be an exaggeration. In fact the fear and annoyance caused by these agile creatures have probably led workers in the past to over-estimate their population. The same view has been expressed by Moore (1932) who made observations on land leeches in this country. Harrison (1953) made an attempt to give an approximate estimate of leech population. His figures seem quite reasonable but we feel that wild-stock alone, at least in the Kumaon, is not sufficient to provide meal to most of the leeches. During the present study an attempt was made to calculate the approximate density and leech population in different localities in Kumaon hills, and worked out as 4 leeches per square metre. According to this, a total land area of 10,000 square metres would have an approximate leech population of about 40,000 individuals. Considering the average number of leeches attacking per cattle (4 leeches to an animal) and number of cattle grazing in leech infested areas (100 animals a day); it could be estimated that most of the leech population is able to get at least one meal in an active season of approximately 100 days.

COPULATION

Land leeches, like other members of the group, are hermaphrodites. Reciprocal cross-fertilization takes place by the union of two individuals. The process of copulation in land leeches was observed in nature by Leslie (1951) and Harrison (1953). Leeches usually copulate in the month of April and it has been possible to watch the process in field and also in the laboratory.

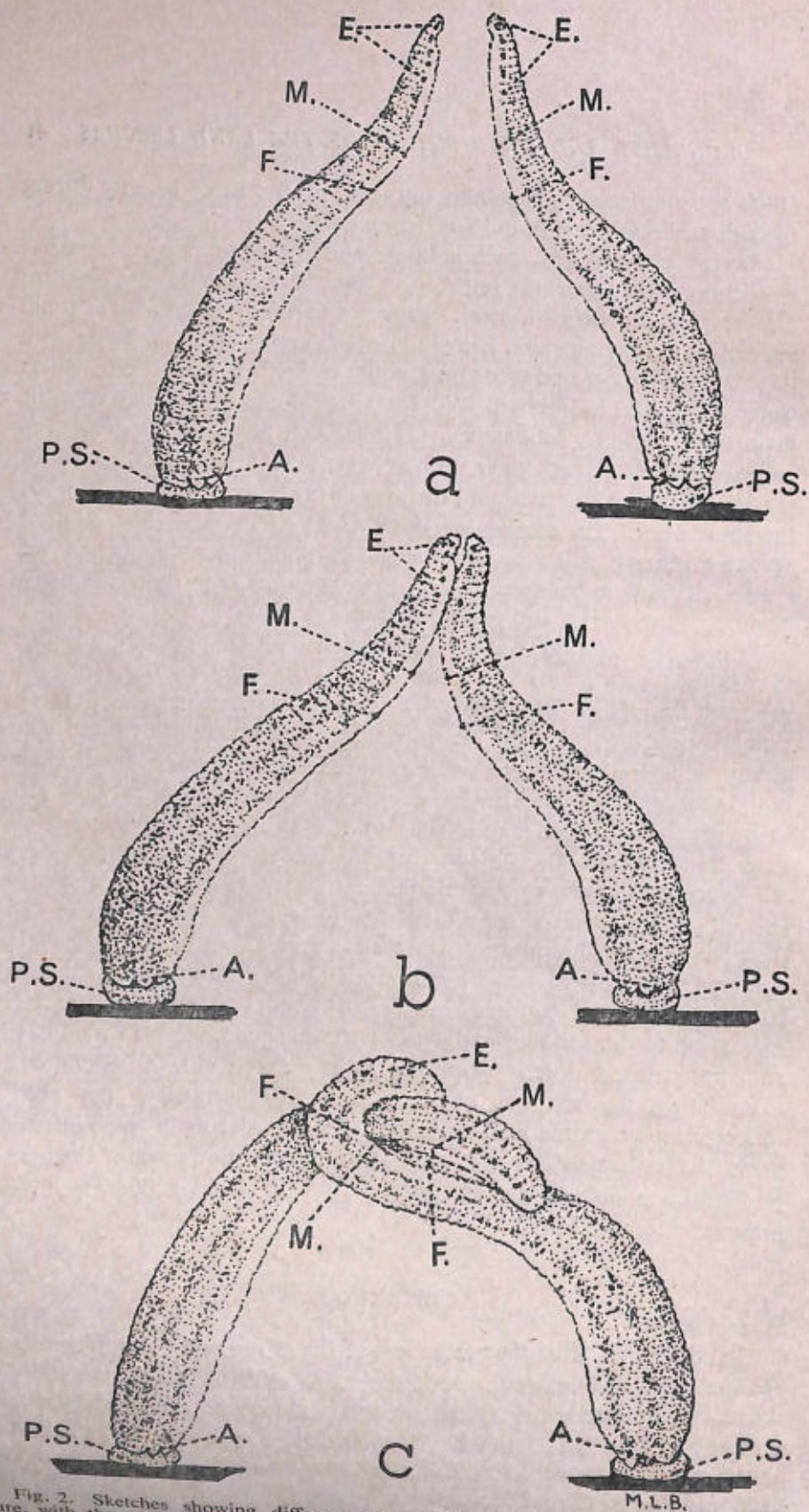


Fig. 2. Sketches showing different postures, leading to copulation. a. Pre-copulation posture, with the posterior suckers of both the leeches attached to the substratum, and body standing erect. b. Close contact of the pre-clitellar portions of the two worms. c. Copulating posture: anterior portion of one curves round the anterior portion of the other, entwined in a head to tail position. Both slightly raised from the ground in the form of an arc. The male genital pore of the one is opposed to the female aperture of the other and vice-versa. A. auricle; E. eyes; F. female genital aperture; M. male genital aperture; P.S. posterior sucker. M.L.B.

Leeches move about in different directions, and when two full-grown leeches meet head to head for a short while, they fix their posterior suckers on to the substratum and sway their bodies till they touch each other. The act of swaying and a sort of embracing action of the two, taking place before the actual process of copulation was termed by Leslie as 'Dance' which lasts for a few minutes. Such casual contacts between the two leeches are not of much significance in the beginning as leeches often come close together, touch each other and separate. In cases where such meeting leads to actual copulation the animals after some preliminary muzzling establish close contact. With the posterior suckers firmly fixed to the substratum, the anterior portion, up to the clitellar region of one curves round the anterior portion of the other, in a head to tail position. The part of both that are in close contact get slightly raised from the ground and assume the shape of an arc. The ventral side particularly the clitellar region gets slightly flattened. In this posture the male genital pore of one is opposed to the female aperture of the other and vice-versa. Both remain in this position almost motionless for some time, except for a continuous slight swaying backwards and forwards. This is followed by alternate pressing movements of both leeches, by which the clitellar regions of both get further flattened and develop still closer contact. At this stage the male organs of both project, as was observed and recorded by Leslie, and transference of seminal fluid takes place in a reciprocal manner.

During the process of copulation a whitish jelly-like lubricant material, probably secretion of the prostate or more likely of the clitellar glands, is seen in between the surfaces of the two worms that are in close contact, which becomes more evident when they separate after the copulation. Soon after the process the posterior suckers get detached and the leeches start moving the usual way.

In several copulating individuals it has been possible to watch the entire process and to record the total period involved in the act. Beginning from their coming in close contact, to actual copulation and separation, the time involved ranges from 40 to 65 minutes. Leslie records 'Dance' for about 2 minutes and actual process lasting for one and a half minutes. Harrison's note on sexual behaviour of leeches, leading to copulation, and the figure given by him show the posture prior to actual copulation, which he observed lasting for an hour and a half. Actual copulation takes place only after the male orifices get opposed to the female apertures, a position not achieved in the figure given by Harrison, which depicts only close contact of the two worms. He therefore missed this important point in his observation.

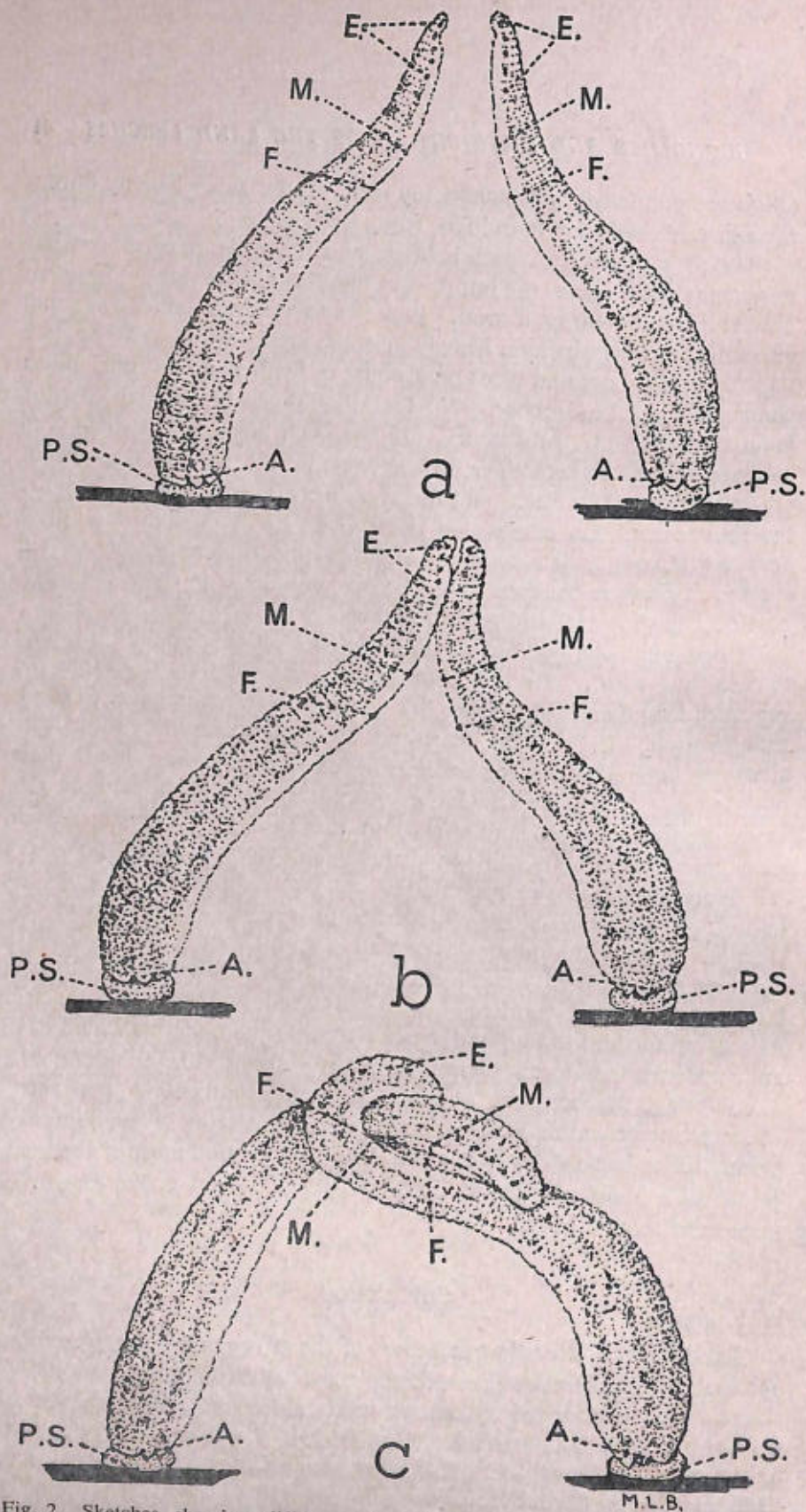


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COCOON FORMATION

Leeches that have successfully mated lay cocoons, generally in the months of May and June and sometimes even in July. During these months the clitellar region (segments IX, X, and XI) becomes slightly depigmented owing to the presence of large number of epidermal clitellar glands, and it becomes slightly yellow in colour. The cocoon laying process is almost similar to that in other members of the group described by Khan (1912), Matthai (1921) and Bhatia in *HIRUDINARIA* (1941). Just before the actual process of cocoon laying, the leech becomes sluggish and settles down at some shady place, free from any kind of disturbance. A copious secretion of several layers of snow-white froth, secreted by the glands of clitellum, appears all round the clitellar region in the form of a girdle. During the formation of the frothy material the front portion of the leech, up to the clitellum, shows a slow rolling, as well as dorsoventral movement, while the post-clitellar portion of the body exhibits no movement. Formation of the frothy girdle takes about an hour. After that, large quantity of albumen, and fertilized ova extruded through the female generative aperture pass into the frothy girdle. By rhythmic movements, the leech withdraws the entire front portion. The plugs at the two poles of the cocoon are secreted by the prostomial glands, as stated by Bhatia (1939). Cocoons are generally laid in well protected shady places. The cocoon formation is a comparatively slow process lasting for about 5 to 6 hours. The froth on exposure to air hardens and forms an outer spongy layer with spacious air cavities in it. Like other leeches, land leech lays successive cocoons after an interval of about 4 days.

COCOON

The cocoon is barrel-shaped and measures 8 to 12 mm in length and 6 to 9 mm in breadth. The cocoon-wall consists of two layers: an outer formed by the hardening of frothy secretion, and an inner chitinous layer. The froth, when fresh in the process of cocoon laying, is in several layers of large bubbles and during hardening process the bubbles unite and form hard partitions, and by pressure acquire a characteristic pentagonal shape. This layer protects the contents from minor shocks and from pressure of oak leaves and other objects under which the cocoons are generally laid. During rains and flooding of the area the air cavities provide buoyancy to the cocoon. The inner layer is quite hard, smooth and tough, and enclosed in it are a mass of albumen and fertilized ova. Both the layers are transparent.

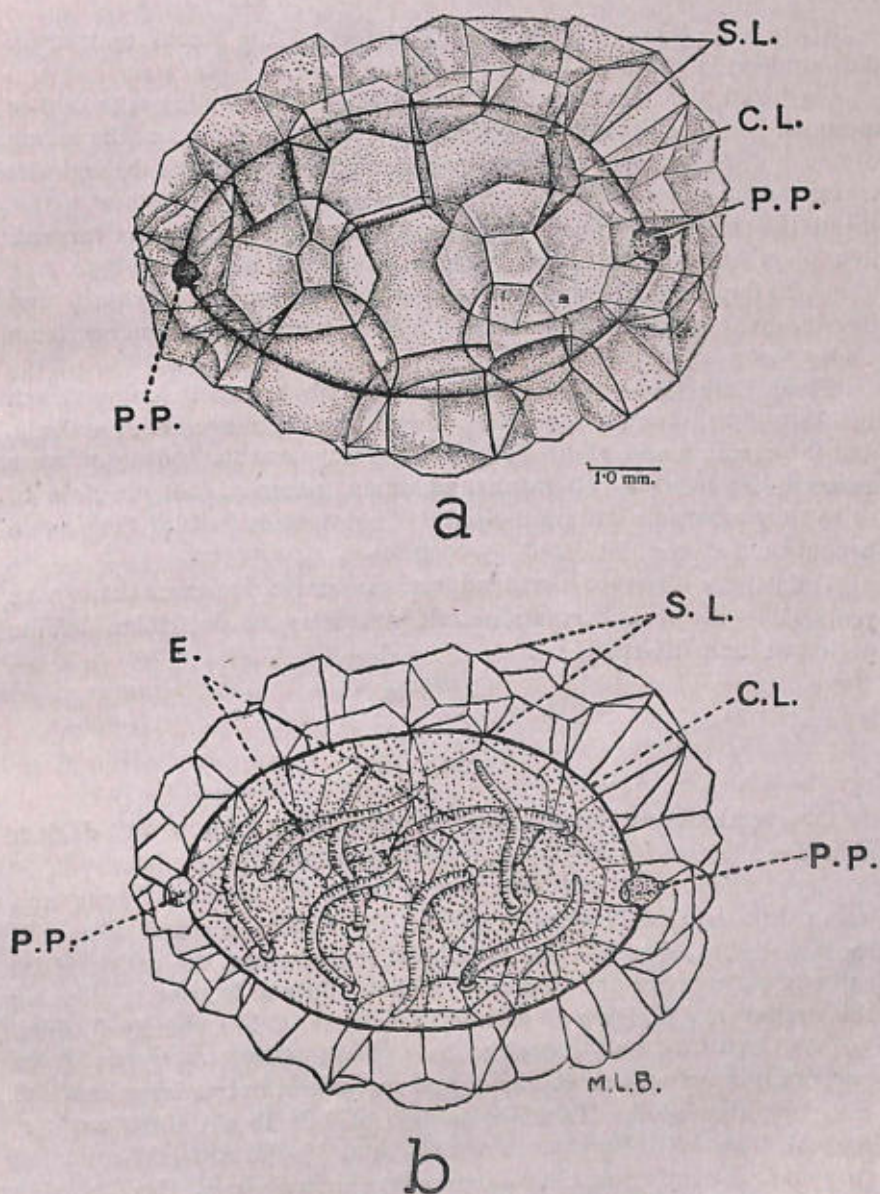


Fig. 3. Cocoon

a. Two days' old leech cocoon.

b. Longitudinal section of 18 days old, almost mature cocoon, showing 8 embryos inside it.

C.L. cuticular layer ; E. embryos inside the cocoon ; P.P. polar plugs at the two ends of the cocoon ; S.L. spongy layer.

DEVELOPMENT

There is no larval stage in the life-history of the leech, and entire development is completed inside the cocoon.

Fertilized ova develop into embryos, which swallow the entire albumen contained inside the cocoon. After about 5 days of the laying of cocoon, the embryos are seen making slight movements, through the transparent cocoon wall. 8 or 9 days later the embryos become active inside the cocoon and in about 15 days most of the organs are formed, five pairs of pigmented eyes become prominent in each embryo. In about 20 days typical coloration and pigmentation are developed and development is almost complete and 6 to 9 young leeches emerge from each cocoon.

Freshly emerged young leeches are reddish brown in colour, each measures 5 to 10 mm. Soon after emergence they move about actively, and they remain active throughout the rainy season. Most of these succeed in getting a full meal, and attain maturity. At the close of rains they hibernate and on the onset of next rainy season they again become active, copulate, and lay cocoons.

It has been observed that land leeches survive for more than three years, but further observations are necessary to determine definite period of their life-span.

LIFE-CYCLE

Observations on the life-cycle of land leeches show two distinct phases in their activities, an active phase and a dormant phase.

Active Phase: It generally starts from the month of June and lasts till the end of November. Since the appearance and disappearance of leeches depends on rainfall and temperature, the active phase extends mainly over the monsoon months (July to October). During this period they perform all essential functions of life namely feeding, growth, maturity and reproduction. Soon after emergence from cocoons they actively move about, and spread out over a large area and also migrate uphill. From the middle of July to the third week of August, their activities reach a climax, and by the end of September they start retreating to the valleys. By the middle of October they start hibernating and thus completely disappear.

Dormant Phase: The remaining six months (December to May) constitute the dormant phase or the hibernation period; but generally leeches disappear completely by November and reappear only by the end of June, thus extending the hibernation period to about eight months.

MIGRATION

Migration or mass movement of land leeches has been a subject of much inquiry for a proper understanding of their ecology and biology.

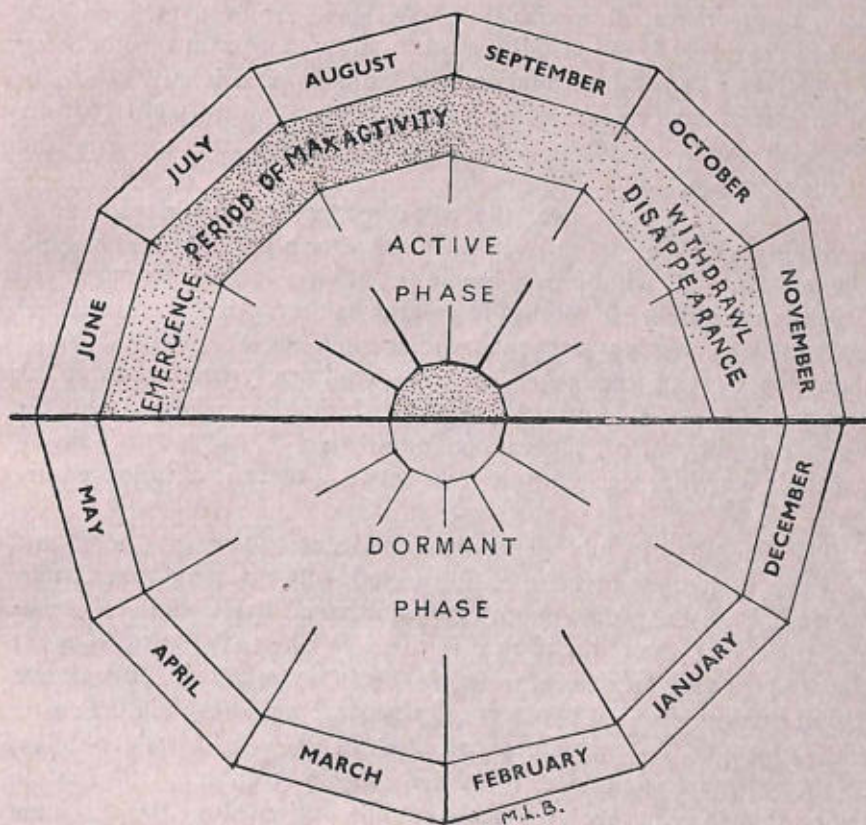


Fig. 4. Diagrammatic representation of the life-cycle of land leeches.

Among annelids the swarming of marine Polychaete worms is a phenomenon correlated with reproduction. In Oligochaeta and Hirudinea such examples are rare.

Moore (1932) has hinted on the seasonal migration in *Haemadipsa sylvestris* and *Haemadipsa zeylanica montivindicis*. In the latter species he describes an altitudinal migration also. Richardson (1942) has reported migratory behaviour in various species of freshwater leeches. In case of *Haemopsis marmoratis*, a scavenger freshwater leech, he observed uni-directional advance of half a mile or even more and in *Glossiphonia complanata* he observed a habit akin to swarming.

Land leeches hibernate in valleys during the months November to May. On the advent of the rainy season they emerge and lead an active life, as mentioned earlier, in the humid oak forests of the hills.

The first emergence of leeches as already stated, is in the first week of June, by the sides of dry water courses or nullahs, soon after heavy shower of rain.

The bulk of the population of leeches that emerge at this time consists of leeches of appreciable size, small or even medium size leeches are rarely found at this period. After more rain they become very active and spread throughout the valley, which is still dry. By the middle of June rains become quite a regular feature with frequent heavy showers. Leeches, then, start spreading up towards the northern slopes.

Continuous rain all over the oak forest creates humid and moist conditions sufficient to provide moisture after a prolonged dry spell. The presence of widespread humidity initiates leech migration. By this time the number of leeches is as large as four to six per metre, and medium-sized ones are more in number than the large adults. After about ten days of emergence leeches spread nearly 100 metres up the northern slope. The upward movement during June depends on the weather conditions. If there is continuous rain, the advance is quicker, and their activities slacken to a great extent if there is a prolonged dry spell.

The month of July generally experiences incessant rains and activities of leeches increase in this period. By the second week they are found all over the summit, the cultivated fields and grasslands near the top of the hill, and this is the time when they prove a great menace. A study of the leech population in the middle of July reveals that at the top of the hill leeches of large size, and in the middle region both large and medium-sized are present in considerable number. Freshly emerged young ones form the primary leech population in the valley, though some are seen in the middle region also. By this time large number of cocoons hatch resulting in tremendous increase in the population stock of young leeches in the valley.

By the end of July the number of young ones, in the middle region of the hill, exceeds that in the valley. This is probably due to the emergence of large number of leeches from the cocoons, laid by the migrating leeches in the middle zone and migration of fresh stock of young ones from the valley upwards in search of a meal.

Freshly emerged stock of young leeches reaches the top of the hill by the second week of August and they are most active in their attack on animals and also human population. Observations indicate that from the 2nd week of July to 3rd week of August, the activities of leeches remain at their peak, and as such this period could be regarded as the 'Peak period of activity'. During this period even the xerophytic pine forests are quite moist and leeches are seen advancing to all these places. In such cases the migration is altitudinal, horizontal and even

downward. In fact during this period leeches migrate indiscriminately and spread to all possible directions in search of food. In oak forests they start moving upwards from the very beginning and show definite upward trend of migration, much more on the northern slope of the hill. The southern slope which is mostly covered by pine forests, the intervening areas between the xerophytic pines and the evergreen oak forests, are comparatively exposed to sun and are warm and dry. Hence the movement of leeches through such areas is practically impossible till heavy and continuous rains set in.

By the third week of August a downward migration commences, as indicated by the decline of their population at the summit; to such an extent that in the fourth week of August they withdraw altogether from the top of hills and appear to concentrate in the middle region of the hills. It is interesting to note their complete absence from the valley at this time of the season.

Till the middle of September leeches are in great abundance in the middle region but towards the end of September the entire stock, consisting of the adults, medium-sized and the young individuals, get confined to an area of about 80 to 100 metres above the valley.

By the first week of October further descent occurs and they are found very near the valley. At this time they are very sluggish, hide under oak leaves and come out only when induced by disturbances or some sort of vibrations in the surrounding objects. By the second week they disappear from the entire hill and only a few stray specimens are seen up to about 40 ft. above the nullah in the valley. After a few days they disappear altogether.

Thus it is observed that with the advent of rains, leeches emerge in the valley and migrate upwards to half a mile distance. At the close of rainy season they return to similar areas and hibernate till the next rainy season.

CAUSES OF MIGRATION

The region of the valley provides enough moisture to leeches during dry months of winter and summer and the onset of rainy season not only provides favourable conditions for them to emerge, but also moistens the herbage at heights. Leeches emerge just after hibernation and the newly hatched young stock at the valley needs a meal. The herbage and oak leaves on the ground, shady and moist conditions on the northern slope of the hill, provide favourable conditions to them to move about and spread all over the area in search of food. At the close of rainy season the herbage on the heights dries up, therefore they begin to withdraw and migrate back toward the valley which is more moist and constitutes an ideal hibernating ground. Guiding factors for

migration are the moisture, temperature and food. The to-and-fro migratory habit of leeches seems to be induced by the combined effects of the following causes :

Upward Migration

- (i) Overcrowding, and scanty food supply in the valley.
- (ii) With an upward movement of the livestock there are better chances of procuring food uphill.
- (iii) Favourable conditions of humidity, temperature, and suitable moving space uphill on the northern slope.

Downward Migration

- (i) Decrease in humidity on the top of the hill.
- (ii) Availability of favourable hibernating spots at the base of the hill.

HIBERNATION

It has been observed that land leeches suddenly appear with the first shower of rain, gradually increase in number in certain areas, where they prove a great menace and suddenly disappear when cold weather sets in. Much attention was drawn by the old age mystery of their sudden emergence and disappearance. Suggestions on their probable hibernation were made as surmises rather than on any kind of actual field study of the problem. Tennant (1861) expressed surprise on the complete disappearance of leeches during the dry season and their appearance immediately with the coming of rains. Whitman (1886) suggested that 'they merely seek shelter under stones, sticks etc. as they do all times when not actively moving about, and thus protected against complete drying, await favourable conditions of moisture'. But he denied completely the possibility of hibernation except for those which live above the level of the occasional frost and snow.

Landon (1905) believed that land leeches died with the advent of dry season and those which reappeared on its conclusion are a new generation. *Macrobdella decora*, an aquatic American leech, has been reported by Moore (1927) to live in dry ponds during summer. Bhatia (1941) observed the same in the leech *Hirudinaria*. Similarly a little advanced type of 'draught torpidity' has been described in *Ozobranchus* by Oka (1922). On the contrary laboratory observations during the present course of study show that land leeches, once they become dry, are unable to regain activity, as is common with all living forms.

Moore (1927) summing up the previous views comments that leeches probably pass through a condition resembling hibernation. Later

(Moore 1932) suggested that leeches may concentrate in the vicinity of water sources. Recently Smythies (1953) writes, 'in the tropics they are active all the year round, but in a monsoon climate they disappear entirely for about six months, during the dry cold winter. Do they get through this period in the form of eggs or by burrowing into the soil ?

Our present observations are in conformity with the view of Moore (1932) and it has been noticed during the course of our field study that:

(i) The first emergence of land leeches, on the onset of rains, is always at the base of the hill, by the sides of dry water channels or nullahs.

(ii) After their emergence they spread all over, generally more towards the upper limits of the hill, and remain active throughout the rains. At the close of rainy season they gradually migrate to the valley and commence vanishing in the similar regions from where they first emerged.

These observations hint at their possible hibernating grounds. A search of the valley in winter months (December and January) reveals that leeches do not hibernate under the layers of decaying oak leaves, sticks etc., as was suggested by Whitman, a possible abode of their hibernation. Instead, it has been found that they hibernate fairly deep down in soft soil. On digging a foot or more deep, below the earth surface and on turning the underground buried stones and pebbles in the vicinity of water channels, a large number of hibernating leeches were everytime obtained, attached to undersurface of the stones.

Observations made during the active phase of leeches suggest that like all other living beings, food, congenial temperature, and moisture, are the primary guiding factors in the life of land leeches. It has been noticed in the laboratory that they can withstand fairly low temperature. Moreover, the subsoil temperature in the valley does not fluctuate beyond a critical limit. Thus, only moisture appears to be the chief influencing factor during the hibernation period.

Several other hibernating places have been suggested by previous workers, i.e., areas by the sides of water streams which are very damp and flooded, but leeches have not been found from any such localities. They do not resort to aquatic habit of any kind during hibernation. It has been confirmed in laboratory that leeches kept partially submerged in water or very near water, do not feel comfortable and immediately try to escape. They do not survive long in water.

The areas in the valley are slightly different from the other parts of the hill slopes. There is always loose layer of coarse sand and pebbles on the surface, under which, there is a mixed layer of humus, clay and sand. Sand and pebbles are brought down from the slopes of hill during heavy rains. Leeches make their way in to the underground sand

and humus through crevices in the upper layer of pebbles. The overlying layer of sand and stones protect leeches from dessication.

The sub-soil in the valley retains moisture and remains damp all the year round and this kind of constant wet conditions are maintained by various factors. In addition to the occasional rains, there is constant occurrence of what may be called the 'sub-soil moisture'. The soil in the oak forests retains comparatively greater amount of rain water. After heavy showers in the rainy season, at the lower levels of the hill there arise underground streams in the form of springs, which become a constant source of water supply to the nullah or water stream flowing at the base of the valley. When these seasonal springs and nullahs dry up in winter and summer, water retained by the roots of the oak trees in the upper limits, percolates through the underground streamlets. The presence of such streamlets is easily revealed by the marshy conditions even in dry season, when digging to a depth of about 1½ ft. in the region of the nullah. Such sub-soil moisture keeps the hibernating places moist throughout the dry season. The surface evaporation of the sub-soil moisture is further cut down by the presence of a large number of evergreen trees and thus chances of drying up of such places are meagre. The selection of such places for hibernating is obvious.

HIBERNATING LEECHES

Hibernating leeches lie in a dormant, contracted, and emaciated condition, attached by both the suckers to the undersurface of stones and other objects. *Haemadipsa montana* remains slightly more dormant than *Haemadipsa zeylanica agilis*, and its brownish or yellowish colour harmonises well with the surroundings to such an extent that sometimes it becomes difficult to spot these out in their hibernating habitat.

The hibernating leeches observed have been generally of large size, some of median size, but none of small size.

Behaviour of Hibernating Leeches :

Hibernating leeches are very sluggish, and they shun light. They do not respond to human breath or even touch. On pressing hard they show slight activity and immediately try to wriggle away and again hide under some nearby object. When submitted to slightly higher temperature than what they have in their natural habitat, they become slightly active, but not as agile as during the rainy season. Such activity lasts only couple of minutes even when the higher temperature is maintained for some time. When both higher temperature and moisture are provided, they become more active than when only

temperature is raised. Leeches that become temporarily alert try to escape. They do not respond to light of low intensity, and they respond negatively to strong light. They do not show any tendency to stick to the skin, bite and suck blood.

DISTRIBUTION IN KUMAON

The abundance and ferocity of land leeches have been reported from different parts of India by several naturalists. Haeckel (1883), Hooker (1854), Semper (1863) and others: Moore (1927) casually reported the occurrence of land leeches in Nainital district. As has been mentioned earlier, land leeches are confined only to oak forests, in Kumaon region. A general survey of the climate and vegetation of different regional belts of Kumaon, assists in explaining the distribution of oak forests, which provide suitable habitat to leeches.

The entire Kumaon area may be divided into several climatic belts, running approximately north-west to south-east, parallel to the Himalayas. The division is mainly based on the total rainfall and its relative percentage in winter and monsoon seasons.

I. A regional belt, the 'Sub-Himalayan tract', includes the area running along the foot-hills and consists of Bhabar and Tarai. Rains during monsoon are heavy, 50" to 70", and there are extensive forests of Sissu (*Dalbergia sissoo*), Khair (*Acacia catechu*) and Jaman (*Eugenia jambolana*). The maximum average temperature does not fall below 26°C which acts as a major influencing factor for the total absence of leeches from this region.

II. The 'outer hill range' stretches from the base of foot-hills in the region of Kotdwara, Kalagarh, Kathgodam, and Tanakpur, to the crest of the outermost range of the hills of Nainital. The hills rise, 1000 to 2000 ft. at the base and extend up to 4000 to 8000 ft. The general aspect of the hills is southern. Total rainfall ranges from 70" to 120" out of which 20% is during winter and 80% during the monsoon months. The dominant forests of Pine (*Pinus longifolia*) between 3000 to 7000 ft. are on the southern side. In pine forests due to xerophytic conditions and prevalence of frequent fire, the undergrowth is very scarce. On higher elevations and by the sides of ravines, the common oak (*Quercus incana*) replaces the pine. These forests are more common on the northern slopes, where the average maximum temperature does not rise beyond 26°C. The oak forests of Nainital district, Kilbery, China forest, Ratighat, Ramgarh, Gagar, Mukteshwar, Paharpani, Okhalkanda, Bhim-tal and Sat-tal etc. continue the upper boundary of this belt, are heavily infested with leeches.

III. Another regional belt, 'the central hill range' includes the vast area of mountainous country stretching to the outermost range of the

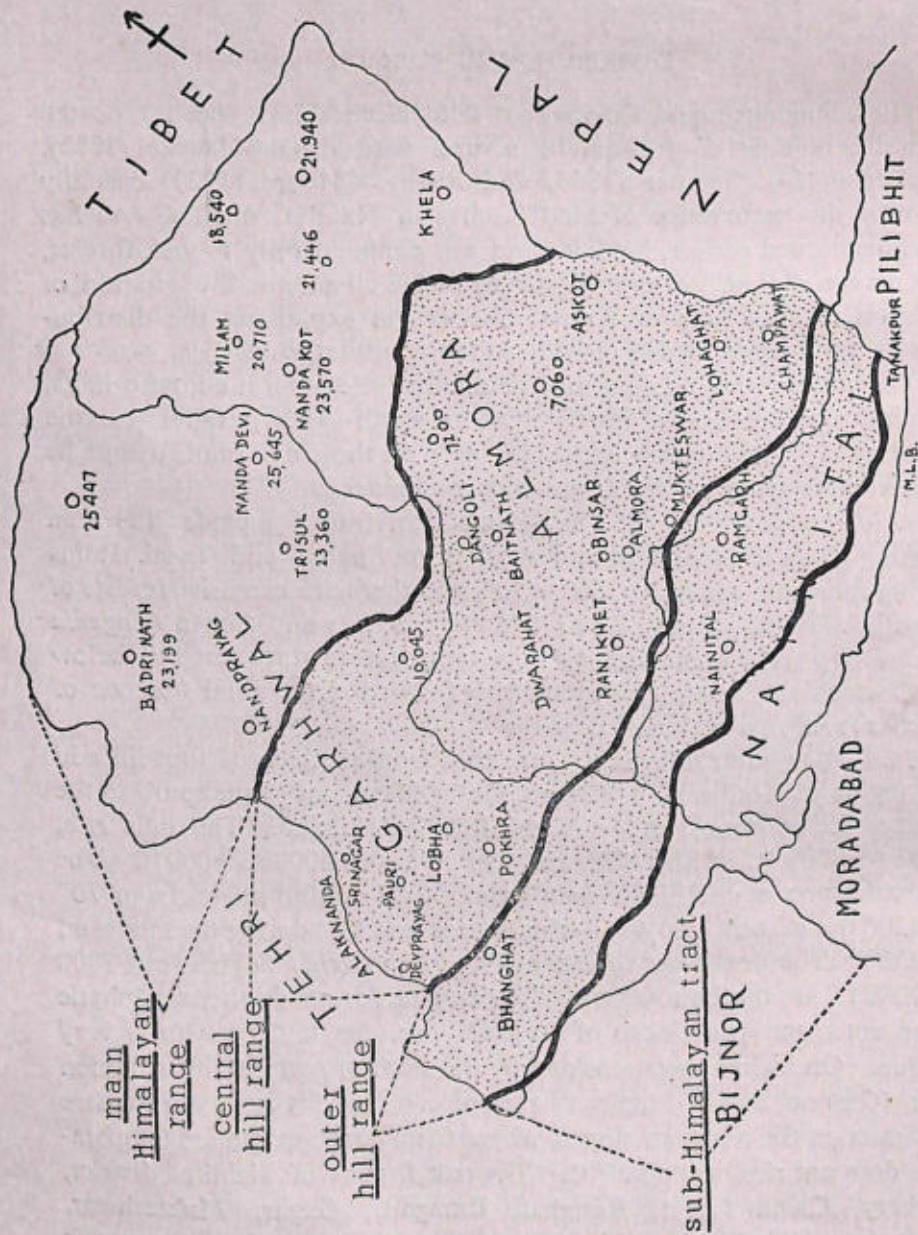


Fig. 5. Map of Kumaon, showing the topographical divisions and the distribution of land leeches in shaded regions.

main Himalayan peaks. The valleys of the river Sharda, Kosi, Ganga etc. lie at low level between the hills and the temperature is surprisingly high. Main intervening ridges range between 5000 and 10,000 ft. Annual rainfall varies from 40" to 80", 70% of which is during the monsoon season. Heaviest rain occurs in the prominent central ranges covered by oak forests (Dudotoli, Bhadkot, Binsar, Gageshwar etc.). Most of the area between 3000 and 6000 ft. is covered by extensive pine forests, which is replaced by oak above 6000 ft.

IV. In the main Himalayan range, rainfall is 10" to 40" in monsoon, and snow during winter. Banj oak (*Quercus incana*) is commonly found between 6000 and 8000 ft. height but in damp ravines it is represented down to 3000 ft. in the Chir zone. Moru oak (*Quercus dilatata*) is found between 6500 and 9000 ft. and the Kharsu oak (*Quercus semicarpifolia*), between 7500 and 11,500 ft. All these forests are thinly or heavily infested by land leeches. In the upper limits of the Kharsu zone, leeches are very rare. It is possible that on the highest regions of the Kharsu zone which extends up to 11,500 ft. they are absent because of extreme cold.

Some of the heavily infested places in this belt are the oak forests of Shyahi Devi, Sittakhet, Jalna, Mornauli, Debidhura, Panwanaula, Binsar, Jageshwar, Dholchina, Dhakuri, Loharkhet, Kapkot, Attigaon, Munsayari, Kalamuni, Tejam, Karmi, Kanda, Gwaldom, Kaushain, Ranikhet, Dunagiri, etc. in Almora District, and Dharchula, Chandak, Lohaghat, Champawat, Agar, Chhera, Kalsinkatia in Pithoragarh district.

In Garhwal district, Tehsil Deoprayag and Patti Barmabanger are heavily infested and Patti-Sora, Hindab, Silgarh and Mandar are thinly infested.

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Mud and Dung plastering in Baya Nests

BY

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(With two plates and two text-figures)

INTRODUCTION

This paper is mainly a discussion on the various explanations that have been offered by earlier investigators on the mud-blobs or dung plastering seen in the egg-chamber of several baya weaverbird nests. Some fresh data on the quantity of the plastering material used in individual nests, stage in the development of the nest when the mud/dung is brought to the nest and the time of the day when the plaster is fixed are furnished. Among the various theories on the mud-blobs, the following in particular have been discussed: for fixing fireflies for illuminating the nest, balancing the nest, protecting the inmates from rain, a relic of an ancient habit, and for cementing the fibre for greater reinforcement of the egg-chamber. The chief function of the plastering materials seems to be the strengthening of the fibre-nest particularly at regions that are subjected to great stress.

One of the best known attributes of the baya weaverbird (*Ploceus philippinus*) that has fascinated villagers for centuries is that based on the mud-blobs found in many of its nests. Nevertheless, observations made on these nests as well as those of the baya's other Asian and African cousins for nearly a century have not highlighted the full significance of the pasty material fixed at specific spots in the nest. A half-built nest of the baya, at what is known as the helmet stage, is divided by a vertical ring into two more or less equal halves. One of these, which is always built a bit ahead of the other, is the future egg-chamber. The other half, known as antechamber, extends downwards into an entrance tube. When the inner walls of the future egg-chamber in such an incomplete nest are examined, one may see on two opposite sides small or large quantities of mud-blobs, or a plastering of clay, cattle dung or in rare cases, human faeces. There is considerable variation in the quantity and quality of the plaster between nests, some not having any of these extraneous materials at all. A few explanations have been offered by ornithologists on the significance of the plaster. Apart from them, the most classical and romantic one based on poetic imagination is that it holds fireflies in order to illuminate the nest at night. Every

second villager who is familiar with the baya is likely to vouch emphatically for this explanation although none of them has actually seen a firefly fixed inside the nest. Some naturalists contend that the mud is used to stabilise the nest during gales, while others regard the mud as a relic of some ancient custom at one time beneficial to the species. Other explanations offered are: the mud protects the inmates from getting soaked in rain; prevents the nest robbers from pulling apart the initial ring, and when dry helps to sharpen the beak of the builder.

My interest in the common weaverbird was aroused in my early childhood (some 45 years ago) by a large colony that used to nest year after year in our small coconut garden surrounded by paddy fields in the southernmost district of India (Kanyakumari). As pulling down active baya nests having eggs or fledgelings was forbidden, I used to be contented to play with the nests that were periodically cut down by some male birds during the breeding season, and the innumerable ones gathered during non-breeding season. It was at this period that I saw for the first time mud-blobs fixed inside the nest and learned of the universally believed myth of the bird's alleged faculty of illuminating its nest. During the past eight years, the lost thread was taken up again and I could visit many tracts in almost all Indian States and make detailed observations on the variation in the baya nests between different pockets in various regions. With my observations together with what has already been recorded, I venture to make the following comments on the significance of the mud-blobs. Before doing so, some of my observations are presented.

PRESENTATION OF DATA

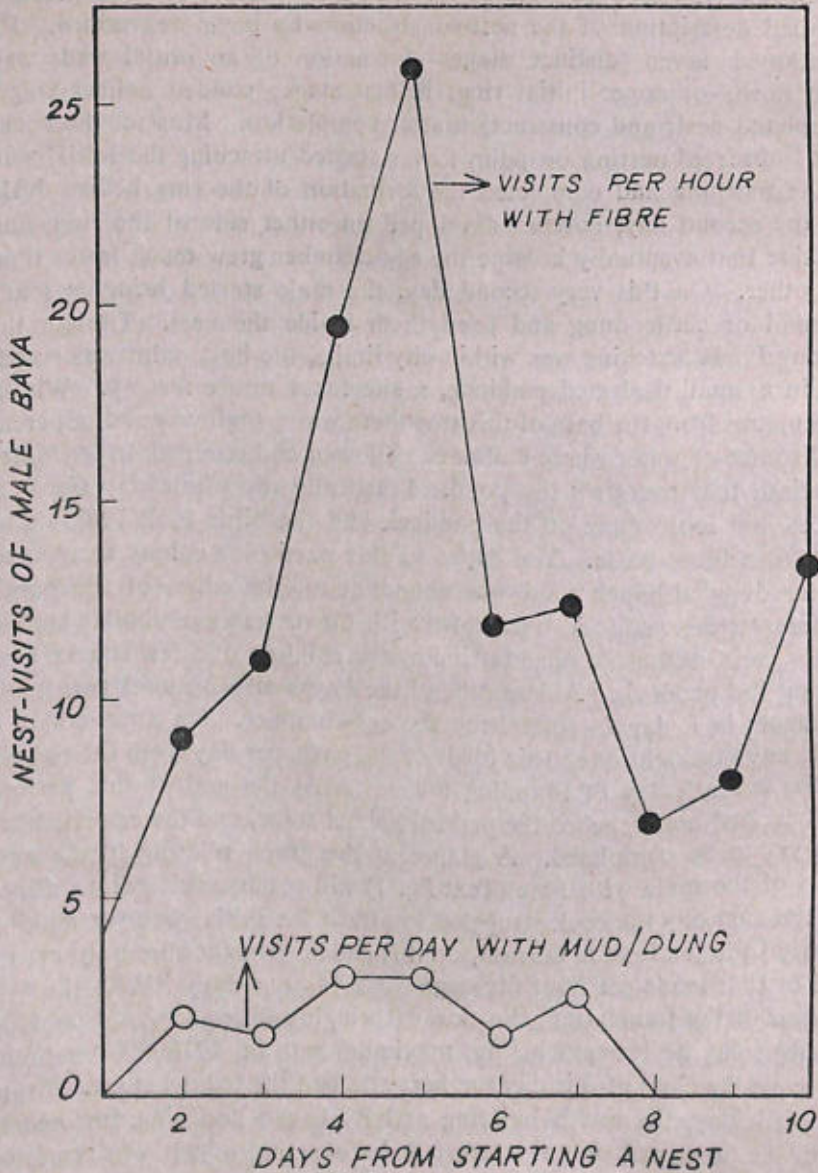
Loads of mud/dung per nest

Detailed observations on the weaving of a few baya nests were made in 1963 on a colony founded on a palmyra palm (*Borassus flabellifer*) at the northern border of Calcutta. The observations on the activities of the selected birds were recorded from the commencement of their day's work starting from about 5-00 a.m. upto their retirement at about 6-30 p.m. The starting and closing up of the activities in a day depended largely on the intensity of daylight. Records on the number and duration of nest-visits of the cock with or without fibre/mud; number of visits the hen made while selecting a nest, during brooding a clutch of eggs, and nursing the nestlings; kind of fibre brought and the region of the nest into which they were woven; pilfering of fibre; fights between cocks; and the behaviour of the cock and hen during courtship etc. were maintained. Hence I can say with some confidence when exactly the bird brought the plastering material while constructing the

nest. In Text-fig. 1, the number of loads of mud and dung fixed during a day (average for four nests watched throughout their construction) are shown.

Crook (1964), a prodigious worker on weaverbirds, has given a detailed description of the nest-construction by baya weaverbird. He mentioned seven distinct stages—formation of an initial wad; wad with horns or cone; initial ring; helmet stage; padded helmet stage; completed nest; and construction after completion. Most of the cocks that I observed nesting on palm leaves started attaching the initial wad in the morning and completed the formation of the ring before dusk. On the second day, porches developed on either side of the ring, and the side that eventually became the egg-chamber grew much faster than the other. On this very second day, the male started bringing loads of mud or cattle dung and fixed them inside the nest. Though the colony I was watching was within city limits, the host palm was standing in a small neglected paddock, a site for a future factory. Within two metres from the base of this tree there was a shallow pond, a perennial source of water where buffaloes wallowed and cropped up the water hyacinth that overgrew the pond. Practically the whole day the buffaloes laid loose dung on the paddock and the birds took beakfuls of this fresh loose paste. The bayas of this particular colony seemed to prefer dung although mud was abundant on the edges of the pond. Moreover, this paddock, overgrown with *Cassia tora* and similar annual weeds, was used as an open latrine by the children of a few shacks bordering the paddock. At least one of the bayas also brought two loads of faeces in a day for plastering the egg-chamber. On an average, a male baya brought one to six loads of the paste per day from the second to the seventh day of founding the nest. At the end of this period, the nest had only reached the padded helmet stage, and the egg-chamber was yet to be completed. A glance at the graph relating to the nest visits of the male with fibre (Text-fig. 1) will confirm this point. Since on the first day the cock struggled to attach the initial wad for making the vital foundation for the nest, on this day he brought fibre only at the rate of four loads per hour (average for a 14-hour day). With the formation of the foundation, the rate of bringing fibre increased, and on the fifth day he brought at the maximum rate of 27 loads per hour. Towards the close of this day the nest attained the helmet stage. From the sixth day, the cock's building activity began declining, for, henceforth he appeared more interested in courting a hen and enticing her to select his nest and thus have him as her future mate. This period of courtship continued up to the eighth day; then, obviously, with the acceptance of the nest by a hen, he resumed active nest-building to complete the egg-chamber which is indicated by the upward trend of the graph. It is quite obvious from the graph that no load of mud (or

dung) was brought once a female had approved and accepted the nest. The hen was never found bringing mud or dung.



TEXT-FIG. 1. Nest-visits of baya cock with fibre (per hour) and mud/dung (per day).

On an average, each of the four males observed brought 12.5 loads of mud during a six-day period. However, in general, the number of

loads per nest varied very greatly between nests of the same locality and between localities. Examination of 3 to 25 nests from different regions (or States) indicated that not all nests have mud plastering, but practically in every locality there are a few to a large number of nests, each containing one to about twenty loads of the plastering material. The quantity of mud (or dung) in a nest varied according to the quality of the weaving material used, and also depended on whether the nest was woven explicitly or shabbily.

Time of bringing mud/dung

The male baya starts collecting fibre and weaving them just after 5 a.m., and within an hour he goes for the mud or dung. The earliest I noticed a bird bringing mud was at 5.33 a.m., and the visits extended during the day at irregular intervals up to 4.50 in the evening. However, all visits excepting a single one were finished before 2 p.m. As most of the time I was observing the colony in Calcutta, I was comfortably perched on a 6-metre high machan, I was able to make note of the males during each of their almost vertically downward flights in search of mud or dung. When they flew to bring fibre or left for foraging or to the roost, the males always took a horizontal flight that was strikingly different from that when they went in search of mud/dung. Even without field glasses, I could clearly observe the male collecting the paste. During most of their trips a majority of the birds preferred to collect wet dung although mud of a similar consistency was available in close vicinity on the sides of the pond. While collecting the mud/dung, the bird inserts its bill slantingly and scoops out beakfuls. I have never seen the bird stirring or mixing the mud/dung either with its feet or beak. However, once or twice I noticed the bird making a second or even a third scoop at a stretch to collect the required quantity. Only fresh dung was used in all cases since after four or five hours a dung heap dries up and consequently it becomes harder for the bird to scoop out a small quantity from it.

Another point that struck me was the way groups of males went to collect mud/dung almost simultaneously. Table 1 gives information on the time of bringing mud/dung by two males building nests of almost similar stage close to each other on a palm. The group collection of mud was so striking that my attention was drawn to that even when the birds I was watching did not participate at it.

Either at the collection centre or on their way, the males seldom fight or spend time in fruitless conflicts. Usually, within 30 seconds of leaving the nest, the bird brings a load of mud/dung to the nest. So far I have never noticed pilfering of clay/dung from other nests although pilfering of fibre is part of the nesting activity in the case of most males. Some are more proficient than the others in the clandestine act.

TABLE I

Ploceus philippinus : DATA ON NUMBER OF MUD/DUNG LOADS BROUGHT IN TWO NESTS

Hour	Minute	NEST I		NEST II		Remarks
		Mud	Dung	Dung	Mud	
<i>April 29, 1963</i>						
						Activity commenced at 5:03 hrs.
5	48.5	..	1	..	..
5	49.5	..	1	..	..
5	51	..	1	..	..	Dung was collected from the paddock near the pond.
8	30	..	1	..	..
12	53	..	..	1	..	
12	54	..	..	..	..	7 others gathered mud.
12	55	1	..	..	..
12	57	1	..	..	..	7 others gathered dung.
13	26	..	..	..	..	4 others gathered dung.
13	53	..	..	..	..	3 others gathered dung.
<i>April 30, 1963</i>						
5	43.5	..	..	1	..	
5	45	..	..	1	..	
6	34	1	..	..	..
6	34.5	1	..	..	..
8	23	1	..	..	..
8	38.5	..	..	1	..	
8	39.5	..	..	..	1	
8	58	1	..	..	..
11	36	..	..	..	..	Many others gathered dung.
12	07	..	..	1	..	
12	40	..	..	1	..	
13	49	..	..	1	..	
16	50	1	..	..	..
<i>May 1, 1963</i>						
5	33	..	1	..	..	Mud was always collected from the side of the pond.
7	25.5	..	1	..	..
7	28	..	1	..	..
11	00	..	..	..	1	
11	02	1	..	..	..
11	04	1	..	..	..
13	51	1	..	..	..	Activity terminated at 18:15 hours.

N.B.—Foundations for nests I and II were made on April 28, and no mud/dung was brought to the nests on that day.

Weight of mud/dung loads

I could not weigh the fresh mud/dung used by a bird. Weighing the dry material collected from nests, in some cases several months after their fixing, may not reveal the exact situation. Nevertheless, the data suitably adjusted for the moisture content may give some idea of the

total weight of the materials used in a nest. Approximate percentages of moisture content in mud and dung have been calculated by weighing known quantities of fresh mud and dung collected from the same localities and getting their weights after drying them. The figures (in gm) are as follows :

Material	Wet weight	Dry weight	Moisture percentage
Mud	113.3	66.2	41.57 on wet weight
Dung	144.0	20.2	85.97 on wet weight

Thus, fresh mud weighs a little less than twice the dry mud, but wet dung weighs a little over seven times the weight of dry dung.

Figures 1-3 (Plate I & II) show views of mud or dung patches in four nests. Where abundant quantities of the mud/dung are used, they are generally dumped into a thick lump or coating. Hence by examining a patch it is often difficult to estimate the number of loads of the material used in such a patch, especially if it is dung plastering (Plate I, Fig. 2, and Plate II, Fig. 3). However, where the nests have smaller quantities of mud, it is possible to estimate the number of loads more or less accurately (Plate I, Fig. 1). It is still more easy if the mud-blobs are sparsely fixed. Another factor that helps in the identification of individual loads is the variation in the shades of colour of the different loads. In some other cases mud blobs alternate with dung (Plate II, Fig. 3). Faeces plastering is distinctly different from

TABLE 2

Ploceus philippinus: NUMBER OF LOADS AND WEIGHT OF MUD IN NESTS

Kind of fibre used in nest	Mud or dung	Wt. in gm. of plaster on side			Calculated wet wt.	Approx. No. of loads
		Left	Right	Total		
1. Sugarcane leaf	mud	3.09	7.36	10.45	17.87	7+17
2. Sugarcane ..	mud	7.05	5.56	12.61	21.56	16+12
3. Wild cane ..	mud	9.66	16.98	26.64	45.55	17+22
4. Sugarcane ..	mud	1.34	7.53	8.87	15.17	4+21
5. Wild cane ..	mud	2.48	7.58	10.06	17.20	6+16
6. Ordinary grass	mud	9.84	11.92	21.76	37.21	20+26
7. Rice leaf	dung	2.72	nil	2.72	19.39	9+nil
8. Rice leaf	dung	6.30	0.44	6.74	48.06	30+6
9. Ordinary grass	mud	13.86	7.64	21.50	36.77	22+15
10. Ordinary grass	mud	8.68	8.99	17.67	78.10	22+26
11. Rice leaf	& dung mud	35.30	..	35.30*	60.36*	72+ 0*

N.B.—*The figures relate to mud blobs present on only one side. That present on the other side was ignored as portion of it was lost while collecting.

Nest 10 had about equal quantities by dry weight of mud and dung.

the rest. It is on the basis of the above facts that the weight of a single load of mud/dung has been calculated. Table 2 gives data on the weight and number of loads of mud/dung used in individual nests.

It appears as though the weight of a single load of mud/dung varies from region to region, although the mean weight works out to be about one gramme. Where smaller numbers of loads are used, as in nests from southern and western India, the loads seem to be heavier than those seen in North-eastern India. The bird usually carries a load that is maximum for its capacity and since he has to make a steep ascent with the load to reach the nest, he often showed visible signs of strain. On windy days, I noticed some males carrying mud to the nest were tossed away to adjoining leaves. During two such occasions, the birds abandoned the mud/dung and flew for safety.

The mud/dung is fixed very firmly on the inner wall of the nest so that it is impossible to pull away the dry plaster without breaking the fibre. Since the bird effectively spreads the sticky material with his beak, beak marks are seen on the surface of the paste which are more clear on mud-blobs (Plate I, Fig. 1). Often fresh fibre is woven so as to cover part of the plaster (Plate I, Fig. 2).

Plastering in 'Bachelor nest'

The helmet-stage nest is also spoken of as 'bachelor nest' since up to this stage it has been owned and used during the day time only by the male (builder) who is yet to acquire a mate. If no female selects a nest for a long time, such a nest is either cut down by the builder himself, or more frequently, it is lengthened unusually with a droll look, still maintaining the two openings. It is more appropriate to consider only such nests as 'bachelor nests'. The body of some such nests measures three or even four times longer than that of a nest built by an efficient male and accepted fairly soon by a hen. The initial ring in such abnormal nest gets shifted downwards since the inner dome is also proportionally filled up as the nest grows (Davis 1971). It is rather difficult to explain the presence of mud in some 'bachelor nests' since most others do not have mud. An important reason for a nest to get rejected by females in the normal breeding colony seems to be that it is probably not strong enough to withstand the force of wind. Not only such clumsy and weak nests, but also the wrongly aligned ones are discarded by the hens. Most of these droll looking elongated nests do not have any mud/dung plastering at all. However, in a limited number of them, a maximum possible quantity of mud was seen. While dissecting out one of the nests, mud coating was noticed over a length of 25 cm. on two opposite sides of the portion meant for the egg-chamber. Obviously, most of the mud coating was covered with fibre because the ceiling of the dome was gradually lowered as the bridge

extended downward. Even in such a nest, not even a single blob of mud was seen on the wall of the antechamber.

DISCUSSION

Mud/dung present only on one side of ring

Even when the nest of baya weaverbird is incomplete, the birds enter the nest through the opening of the antechamber and perch on the bridge (lower part of the initial ring), facing the future egg-chamber. According to Collias & Collias (1962), this situation is remarkably applicable to the African village weaverbird (*Textor cucullatus*) which almost always enters the nest from one side and faces the same way, keeping one foot on each side of the bottom of the ring. Perching on the ring, the baya fixes some mud/dung on the wall of only the egg-chamber, usually in two patches, one to the left and the other to the right which happens to be the most convenient places as the bird does not reverse the direction of its perch. So far as the initial ring is concerned these two patches fall only on one side (egg-chamber side). But usually it is stated that mud-blobs are fixed on the two sides of the initial ring.

The firefly story

The purpose of the mud/dung seen inside the nest is certainly not to hold fireflies to illuminate the nest at night. According to Dewar (1909) and Ali (1931), this story is nothing more than a poetic exaggeration. This is a form of exaggerated eulogy by those who have been fascinated by the sagacity of the tiny bird who weaves an exquisite pendant nest. My observations throw further light on two additional points which would disprove this myth. From graph (Text-fig. 1), it is clear that the mud/dung is brought between the second and seventh day of building the nest, at a period when the nest has not reached beyond the helmet stage. It is an established fact that the builders do not spend the nights inside their nests, but they get back to the usual roosts. Moreover, at this stage the nest has not yet been chosen and occupied by a female. Therefore, the 'wet fittings' and the 'bedroom lamps' become meaningless in a vacant house. If at all illuminating the brood-chamber is justified, it should be after the hen starts to brood, and more so, when the mother is with fledglings. The other point is based on the information given in Table 1. The timings of bringing the cementing material clearly prove that the mud/dung is not meant for burying the heads of fireflies. Most of the plastering material is carried to the nest between 5-30 a.m. and 2-00 p.m. and by dusk, it becomes too dry and brittle to accommodate an insect. In none of the over one hundred nests I have examined, there was any firefly fixed to the mud—not even a head. None of my students and associates who once believed in the

myth, could convince me by bringing a nest bearing a firefly. Although beak marks are clearly seen on the dried up mud (Plate I, Fig. 1), they did not resemble the impressions caused by the burying of an insect.

Balancing the nest

Jerdon (1863), who was one of the earliest to describe the baya, mentioned the significance of mud-blobs thus: 'From an observation of several nests, the time at which the clay was placed in the nests, and the position occupied, I am inclined to think that it is used to balance the nest correctly, and to prevent it being blown about by the wind. In one nest lately examined, there was about three ounces of clay in six different patches.' Jerdon also believed that the pieces of clay are more commonly found in the unfinished nests (built by the males for his own special behoof) than in the complete nests. Ali (1931) reacted sharply to Jerdon's explanation of the mud being used for steadying the nest during violent winds. Ali did not come across in any of the over fifty nests examined by him, mud weighing more than 1.4 oz. and so he concluded that this insignificant extra weight could not keep the nest steady during violent winds. Usually in the same colony there are many nests which do not possess any mud at all, but having equal survival value like those with mud-blobs. The oropendolas (*Zarhynchus wagleri*) with long woven pendent nests do not provide any 'balancing material' against violent trade winds. Crook (1963) mentioned that the use of mud-blobs on either side of the initial ring may stabilise the swinging nest in high winds. But an additional or alternative function is also possible. About the quantity of mud or dung used in a nest, Ali's figures are somewhat less compared to some of those wet weights given in Table 2. Most of his earlier observations relate to nests from Maharashtra State where birds fix smaller quantities of mud whenever they use it. The quantity of mud used in one of the nests taken from a mahua tree (*Madhuca longifolia*) standing in a flooded rice field near Varanasi (U.P.) should have been more than what Jerdon had mentioned. While admitting that any extra weight in the nest will contribute towards its stability, and reduce the tilt during wind, it is rather unconvincing that small quantities of mud, and in many cases cattle dung that becomes so light when dry (one seventh), can prevent the nest from such violent swaying the nest is subjected to during gales. Moreover, mud is usually smeared only on two fixed positions. If balancing disproportionate nests, arising out of faulty construction, is the main purpose of the mud, why is it that it is always placed at specific regions? Small changes in the alignment of the nest can be brought about by making minor modifications in the construction of the nest. Another reason why the balancing theory seems untenable is the fact that the ball nests of *Ploceus megarhynchus* which are placed on branches and not liable to be tossed about

by wind also have mud-plastering on the inner wall (Ali & Crook 1959). Moreover, even in some nests hung on outgrowths on the walls of wells which are adequately protected from wind have mud-blobs.

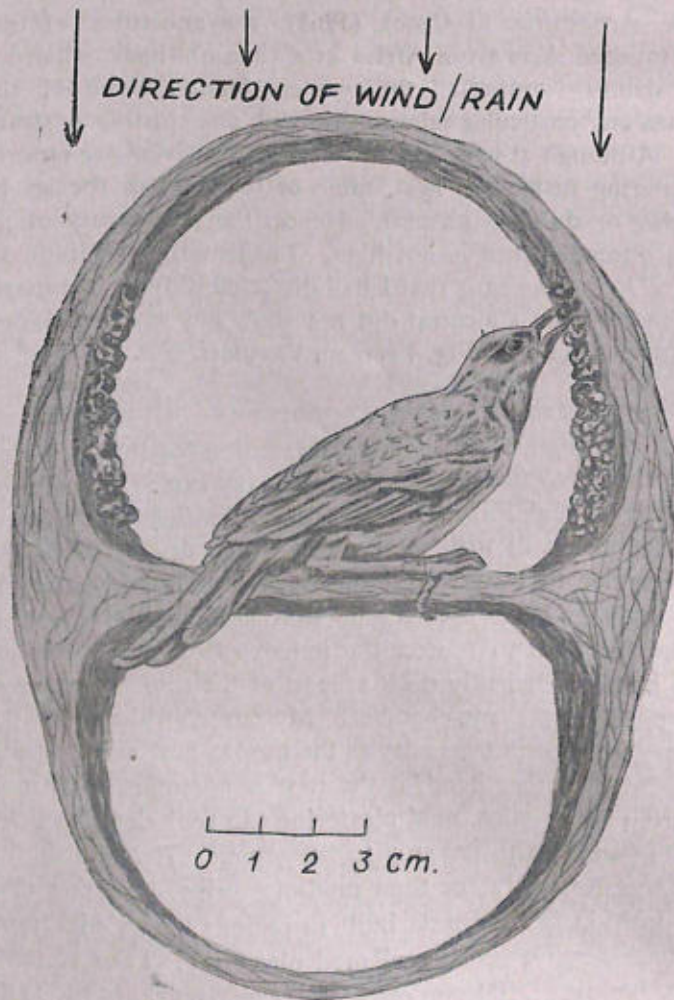
An ancient custom

Ali (1931) suggested that the habit of sticking mud in the nests is a form of atavism—the relic of some ancient custom at one time beneficial to the species. He also hoped that a study of allied forms, their evolution and development might throw some light on this point. Wood (1926) was also of similar opinion. Most of the 95 species of weavers (Ploceinae) occur in Africa and only five are known in Asia (*Ploceus philippinus*, *P. manyar*, *P. benghalensis*, *P. megarhynchus* and *P. hypoxanthus*). According to Crook (1963), the ancestors of the Asian weavers invaded Asia from Africa at a time or times, when a suitable tract of country connected the two continents. None of the Asian species has any particular relationship with any existing African *Ploceus* species. Although at least four of the Asian weavers are reported using mud-plastering inside the nest, none of the African species is known to use clay or dung in its nest. Hence, the probability of this habit being an ancestral trait is not high. Incidentally, the limited number of nests of *P. benghalensis* that I had dissected (2 from Varanasi, 2 from Karnal and 3 from Calcutta) did not show any mud or dung, one of them shown in Plate II, Fig. 4 is from Varanasi.

Protection against rain

Crook (1963) gave yet another explanation for the mud-blobs: that they give shelter to the inmates from pouring rain. He mentioned that *Ploceus manyar* and *P. benghalensis*, like *P. philippinus*, plaster part of the egg-chamber wall with mud which, when dry, is probably a most effective barrier to water. But the baya nest is adequately built not only to withstand the severe gale that accompanies the South-West Monsoon, but also to protect the inmates from being drenched. As the fibre nest is sufficiently thick at least at the roof, no water can enter and stagnate in the egg-chamber. Moreover, within minutes of the rain stopping, the nest gets dry as the porous nest allows quick evaporation. On the other hand, if the nest is not otherwise proof against rain, during heavy rains, mud plastering can soak down and cause more discomfort and health hazards to the young. Here, cattle dung coating can be effective rather than mud-plastering. Another objection to this proposition is that nests built in regions having high precipitation do not have large quantities of mud plastering. Parts of west coast of India receive over 2500 mm of rainfall every year. In the Tamil Nadu, Kerala and Mysore regions of West Coast, coconut is the most preferred tree siting for baya nests. This palm also provides very strong leaf

fibre for nest-building. In these nests, either no mud is fixed at all or very negligible quantities are seen. In the north-eastern region of India comprising West Bengal, Bihar and Orissa where the rainfall is only about 1000 mm per annum, baya nests show the maximum amount of the plaster. Moreover, the use of dung, a relatively better rainproof material is prevalent here. The rain-proofing theory may further run into difficulties atleast with baya nest, since the portion of the nest that faces the source of rain or wind is the egg-chamber. The central strip of the egg-chamber that faces rain most is devoid of any plaster since the mud patch or patches are seen on either side away from the middle line (Text-fig. 2).



TEXT-FIG. 2. Male baya perching on the lower portion of ring and fixing a mud blob at a point not far from the ring.

The hemispherical shape of the egg-chamber results from the fact that the male baya invariably builds while perching on the bottom of the ring. Hence, weaving is extended up to where his beak can reach. The bird obviously struggles to weave along the middle strip of the egg-chamber, the farthest region from the ring. This is also the region which is least accessible to the female at the time of her critical nest-examination. As explained earlier, the male carrying a heavy load finds it difficult to reach the middle strip of the egg-chamber. Therefore, he fixes the mud on the side wall nearer to the ring (Text-fig. 2). Thus, two regions are equally close to him, and accordingly, he fixes the mud or dung in two patches. The bird shows no preference for any particular direction for smearing the mud since there are some nests where only one patch is seen either on the left or right side. Some nests have an excess quantity of the plaster on one side either on the left or right. The numerous nests not having any mud/dung do not support the rainproofing theory.

Plastering reinforces nest

The above discussion shows that the various explanations offered by different ornithologists on the presence of mud/dung in the baya nest are not fully convincing. My views agree with those of Burgess (quoted by Jerdon) who mentioned that the plastering serves to strengthen the nest. Crook also conceded to this view indirectly. The following information may support this point :

1. Dismantling a nest, fibre by fibre, is impossible without removing the mud/dung coating wherever it is present. In order to find out the total number of fibres involved in the weaving of different types of baya nests from different regions of India, a few nests were disassembled. Separating the fibre from the free end of the entrance tube backwards, obviously, is the easiest possible way to dismantle a nest. The first nest chosen was a medium-sized coconut fibre nest removed from a coconut palm from Kerala. There were only 4 or 5 loads of mud fixed in two small patches. Dismantling the nest beyond three-fourths the tube was almost impossible since most of the long fibres were caught by the mud directly, or firmly entangled with those fixed by the mud. Removing the dry mud meant breaking of some fibre. Hence the nest was soaked in warm water and the mud washed away. This explains the powerful cementing capacity of even limited number of mud-blobs. Incidentally, the process of separating the fibres of this particular nest took a little over 14 hours, spread over 4 days. This nest had a total of 4,002 fibres (allowing a 2-3% increase due to the breakage of fibre) which measured a total length of about 800 metres. Since coconut leaflets yield very long (one fibre measured even 85 cm) and strong

fibre, the number used in this nest is much less compared to that of a nest made of grass blades.

2. Crook (1964) who conducted several tests on the baya, made the following remarks on the use of mud-blobs. 'In tests on nests under construction in which the ring was removed, mud-blobs were found scattered at random on the exterior of the structure and even near the point of attachment to the support.' Although this illustrates the importance of building position in determining the organisation of the normal structure, this also clearly demonstrates the importance of mud as a binding material. The ring being the vital framework of the nest, restoration of damage requires the maximum effort. Since the ring is formed directly from the initial wad at the attachment of the nest with an organ of the host tree, the bird's attempts to fortify even the point of attachment only suggest baya's response to reorient the ring from the initial point of the foundation.

3. The plaster keeps the nest intact in spite of the female's rather violent examination. When a female in search of a nest and a mate enters a half-built nest, she invariably perches on the ring and starts examining it by poking her beak into the walls of the egg-chamber and also by pulling out fibre. The two regions that are easily accessible to her are smeared with mud/dung which reduce her critical examination and save some more fibre from getting pulled out. On the other hand, the plaster appears to reassure her of the strength of the nest, and owners of such nests are likely to get mates quickly. During some of her visits, the nest examiner spends even up to ten minutes at a time in a nest. During this period, she is occasionally seen picking up small pieces of the plastering material and working them between the beaks. The exact significance of this is not clear. Whether there is any need to sharpen the beak, and how far the mud/dung helps this, remains to be investigated.

4. Nests built of long and strong fibre as those from leaves of coconut, sugarcane and some wild sugarcane have relatively small quantities of mud or none at all, while those built with weak fibre like those of rice, maize and banana leaves have heavy plastering. Nests in high rainfall areas generally have smaller quantities of mud in them.

5. The quantity of the plaster varies with the quality of nest-weave. For example, in many regions, the baya uses rice leaves. Those in north-eastern India use the whole unsplit blade or as very broad strips, and eventually such nests are not firm and compact and so they require more cementing material. But the birds in parts of Andhra, Maharashtra and Karnataka States, strip a rice blade into several narrow strands and weave the nest more carefully. Such nests generally do not possess any mud/dung.



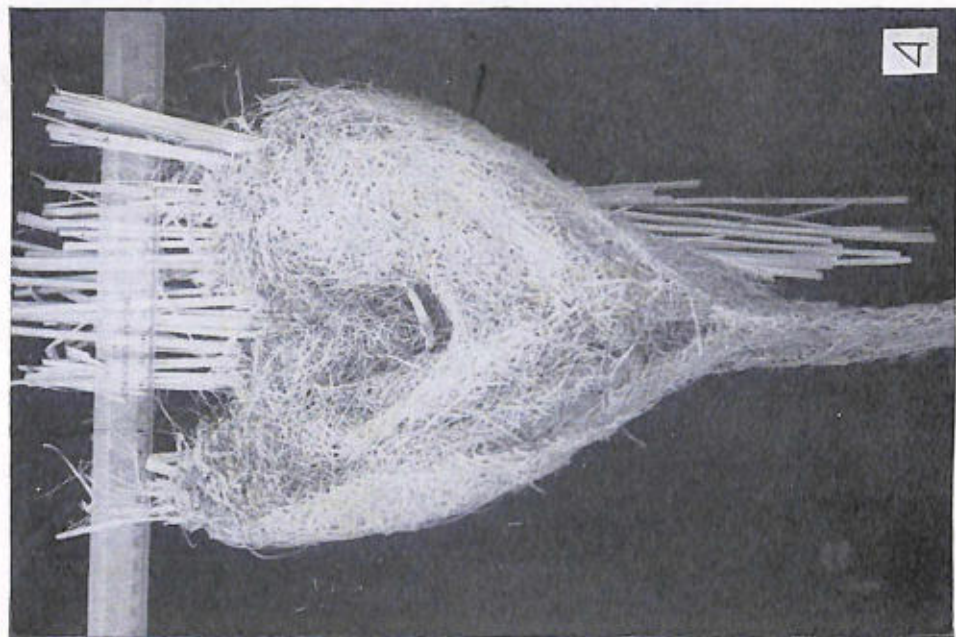
1. A patch of mud-bribs showing persisting beakmarks.



2. A portion of a heavy dung plastering covered by fibre.



3. Mud-blobs and dung plaster used in the same patch.



4. Inner view of *Ploceus benghalensis* nest.

6. A majority of the rejected nests as well as those woven by young males do not have any mud/dung coating at all.

7. The female is not known to weave a nest although she seems capable of selecting a durable one. The success of a brood depends on the strength of the nest since if the nest gives way when it holds either eggs or young, it can only end in disaster, since the female is apparently incapable of nest-repair. Such a selection of an efficient nest becomes all the more meaningful since the male generally deserts his mate and nest when the hen starts brooding her eggs. Ambedkar (1964) reported that some males not only look after the nest subsequently, but also feed the young though not as frequently as the females. The binding effect of the mud/dung need not be over-emphasized. The region of the nest likely to be strained most is the egg-chamber on account of the weight of the young and that of the mother, as well as the strain caused by the hen's frequent flights in and out of the nest. Therefore, additional reinforcement of the vulnerable part of the nest has been effected by the cementing material that is usually seen in large quantities inside nests which are otherwise weak.

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Contribution to the Flora of Tirap Frontier Division

BY

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[Continued from Vol. 69 (3) : 573]

ANACARDIACEAE

***Rhus semialata* Murr.**

Small tree with dull white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19934. Namsang-Shoha, Oct. 1959, *Rao* 20345.

***R. succedanea* Linn. var. *acuminata* (DC.) Hook. f.**

Medium-sized tree in fruit. One of the most common trees of this forest. Banfera-Kanubari, July 1961, *Deb* 26746.

***Pegia nitida* Colebr.**

Tapiria hirsuta Hook. f.

A scandent shrub. Chenglang, March 1958, *Murthy* 12913.

ACERACEAE

***Acer laevigatum* Wall.**

Large tree in fruit ; scarce. Chennhang, June 1961, *Deb* 26279.

STAPHYLEACEAE

***Turpinia nepalensis* Wall. ex Wt. et Arn.**

Small tree in fruit ; fruits 3-seeded, globose ; common. Chennhang, June 1961, *Deb* 26245, 26246, & 26249 ; Lailongsong, 510 m, June 1961, *Deb* 25804.

POTALIACEAE

***Fagraea obovata* Wall. ex Roxb.**

Medium-sized tree with yellow flowers ; common. Chennhang, June 1961, *Deb* 26237.

BUDDLEIACEAE

Buddleia asiatica Lour.

Shrub with small, pinkish showy flowers; scarce. Chennhang, March 1958, *Murthy* 12926.

B. macrostachya Benth.

Shrub in fruit. Fruits dark brown on drying; common. Lailong-song, June 1961, *Deb* 26131; Noglo, June 1961, *Deb* 26352.

STRYCHNACEAE

Gardneria ovata Wall.

Shrub in flower, rare. Pungchow, July 1961, *Deb* 26619.

Strychnos wallichiana Benth.

Climber with large fruits; rare. Kanubari, July 1961, *Deb* 26757.

OLEACEAE

Jasminum amplexicaule G. Don

Climber with white flowers. Margharita-Jairampur, Oct. 1959, *Rao* 19965.

J. attenuatum Roxb.

A climber in flower; scarce. Wakka, July 1961, *Deb* 26523.

J. coarctatum Roxb.

Shrub with white mild scented flower, scarce. Pungchow, July 1961, *Deb* 26595; Chenglang-Khela, March 1958, *Murthy* 12940.

J. glandulosum Wall. ex DC.

A scandent climber with white flowers; rare. Pungchow, July 1961, *Deb* 26618; Wakka-Nagminu, July 1961, *Deb* 26536.

J. sambac Ait.

A wild Jasmine with white flowers, fairly common. Namchick, 152 m, Oct. 1959, *Rao* 20176.

J. subtriplinerve Bl.

Shrub; scarce. Pungchow, July 1961, *Deb* 26631.

Ligustrum robustum Bl.

A tall shrub in fruit; scarce. Chennhang, June 1961, *Deb* 26209; Langsang forest, June 1961, *Deb* 26127.

L. roxburghii Clarke

Small tree with white flowers ; scarce. Laju-Raho, Aug. 1958, *Panigrahi* 14713 ; Jadua-Banfera, July 1961, *Deb* 26687.

Myxopyrum smilacifolium Bl.

A twiner on shrubs ; in fruit ; scarce. Deomali, Oct. 1959, *Rao* 20323.

APOCYNACEAE

Chonemorpha fragrans (Moon) Alston

A large climber with scented white flowers ; rare. Chenglang-Khela, 600 m, March 1958, *Murthy* 12941 ; Tipang, June 1961, *Deb* 25716 ; Banfera, June 1961, *Deb* 26708.

C. griffithii Hook. f.

A stout climber with scented white flowers. Langsang forest, June 1961, *Deb* 26144.

Ichnocarpus ovatifolius A. DC.

Climber with white flowers ; scarce. Banfera-Kanubari, July 1961, *Deb* 26731.

Melodinus khasiana Hook. f.

A tall climber with milky juice. Flowers white ; scarce. Langsang forest, June 1961, *Deb* 26120 ; Pungchow, July 1961, *Deb* 26629.

M. monogynus Roxb.

Climber with white flowers. This is larger than *M. khasiana* Hook f.; rare. Noglo, June 1961, *Deb* 26363.

Pottisia laxiflora (Bl.) O. Kuntze

A scandent shrub with purple flowers ; scarce. Tipang, June 1961, *Deb* 25706.

Strophanthus wallichii A. DC.

Shrub with scented white flowers. Jangkeng village, June 1961, *Deb* 25865.

Tabernaemontana divaricata (Linn.) R. Br. ex Roem. et Schult.

A small shrub with white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19919 ; Namchick, 152 m, Oct. 1959, *Rao* 20185 ; Chenglang, Oct. 1959, *Rao* 20246.

Trachelospermum axillare Hook. f.

A climber with milky juice. Scented red or pink flowers; rare. Chegum-Wakka, July 1961, *Deb* 26470; Chennhang, June 1961, *Deb* 26208; Pungchow, July 1961, *Deb* 26607.

T. lucidum (D. Don) K. Sch.

Shrub with white flowers. Noglo, June 1961, *Deb* 26353.

PEREPOLOACEAE

Cryptolepis buchanani Roem. & Schult. f.

Climber with fruits; scarce. Pungchow, July 1961, *Deb* 26588.

C. sinensis (Lour.) Merr.

C. elegans Wall. ex G. Don

Climber with pale yellow flowers; scarce. Lunwa, July 1961, *Deb* 26640; Lailongsong, 510 m, June 1961, *Deb* 25801.

Pentanura khasiana Kurz

Climber with milky juice in pinkish white flowers; scarce. Jadua-Banfera, July 1961, *Deb* 26694; Pungchow, July 1961, *Deb* 26603.

Periploca calophylla Falc.

A much-branched climber in fruits. Chennhang, June 1961, *Deb* 26219; Wakka, July 1961, *Deb* 26510.

ASCLEPIADACEAE

Asclepias curassavica Linn.

An undershrub. Flowers bright red with yellow projecting corona; scarce. Chenglang, Oct. 1959, *Rao* 20247.

Ceropegia angustifolia Wight

Climber with yellowish brown flowers with brown stripes; rare. Laju-Raho, Aug. 1958, *Panigrahi* 14748.

Cynanchum wallichii Wt.

A climber. Pungchow, July 1961, *Deb* 26573.

Dischidia bengalensis Colebr.

An epiphyte with milky juice on *Schima wallichii* Choisy; common. Jadua, July 1961, *Deb* 26662.

D. nummularia R. Br.

A small epiphyte with linear fruits ; rare. Khela, March 1958, Murthy 12970.

Dregea volubilis (Linn. f.) Benth. ex Hook. f.

A scarce twiner. Soha village, 1067 m, Oct. 1959, Rao 20363.

Haterostemma alatum Wt.

Twiner with brownish-yellow flowers ; scarce. Chegum-Wakka, July 1961, Deb 26491.

Hoya lanceolata Wall. ex D. Don.

An epiphyte with creamy-white flowers with pinkish stamens ; common. Wakka, Aug. 1958, Panigrahi 14935 ; Raho, July 1961, Deb 26457 ; Deomali, June 1961, Deb 25909.

H. linearis Wall. ex D. Don.

An epiphyte with milky latex ; scarce. Chennhang, June 1961, Deb 26183.

H. longifolia Wall. ex Wt.

An epiphyte with white flowers ; scarce. Kothong, June 1961, Deb 26044 ; Chegum-Wakka, July 1961, Deb 26475 ; Khonsa-Laju, June 1961, Deb 25990.

H. parasitica Wall.

A climber on *Shorea robusta* Linn. f. with white flowers ; common. Deomali, June 1961, Deb 25881.

Tylophora belostemma Benth.

A climber. Chegum-Wakka, July 1961, Deb 26480.

T. hirsuta (Wall.) Wt.

Climber with small violet flowers ; rare. Pungchow, July 1961, Deb 26579.

RUBIACEAE

Acranthera tomentosa Br.

A scarce shrub. Banfera, July 1961, Deb 26709.

Coffea arabica Linn.

A bushy shrub with white flowers. Cultivated. Khela, June 1961, Deb 25933.

Galium asperifolium Wall. ex Roxb.

A diffused herb with very small flowers; common. Khonsa, June 1961, *Deb* 25971; Chennhang, June 1961, *Deb* 26218; Kothong, June 1961, *Deb* 26073.

Hedyotis verticillata (L.) Lamk.

Herb with small white flowers; common. Margharita-Jairampur, Oct. 1959, *Rao* 19925; Niausa, July 1961, *Deb* 26564.

H. lindleyana Hook. f. ex Wt. & Arn.

A prostrate herb with white flowers, scarce. Raho, July 1961, *Deb* 26427.

H. scandens Roxb. ex D. Don

An undershrub with ripe bluish fruits, common. Margharita-Jairampur, Oct. 1959, *Rao* 19943; Nampong-Pangsupass, Oct. 1959, *Rao* 20055; Niausa. Sept. 1958, *Panigrahi* 15011, Langsang forest, June 1961, *Deb* 26140.

H. vestita R. Br. ex G. Don

Herb with greenish violet flowers; rare. Pungchow, July 1961, *Deb* 26587.

H. diffusa Willd.

A common herb. Soha village, Oct. 1959, *Rao* 20372.

Knoxia sumatrensis (Retz.) DC.

A rare herb. Jadua-Banfera, July 1961, *Deb* 26686.

Lasianthus biermanni King ex Hook. f.

Shrub with globose, winged fruits; common. Chennhang, June 1961, *Deb* 26248; Chegum-Wakka, July 1961, *Deb* 26481.

L. sikkimensis Hook. f.

Shrub in fruit; scarce. Pungchow, July 1961, *Deb* 26593.

L. tubiferus Hook. f.

A common shrub. Chegum-Wakka, July 1961, *Deb* 26478.

Morinda angustifolia Roxb.

Shrub with white flowers; scarce. Jadua-Banfera, July 1961, *Deb* 26673 & 26674; Deomali, June 1961, *Deb* 25883; Banfera, July 1961, *Deb* 26701.

M. villosa Hook. f.

A shrub about 3 m in height with orange red fruits; rare. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16913.

Mussaenda glabra Vahl

Shrub with hirsute flowers and dark green fruits; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20030; Jangkeng village, June 1961, *Deb* 25866; Raho, July 1961, *Deb* 26416; Chennhang, June 1961, *Deb* 26212; Chenglang, March 1958, *Murthy* 12914.

M. glabrata (Hook. f.) Hutch.

Shrub with green globular fruits; scarce. Jairampur, Oct. 1959, *Rao* 19973; Nampong-Pangsupass, Oct. 1959, *Rao* 20018.

M. macrophylla Wall.

Shrub with globose, hairy fruits; scarce. Kothong, June 1961, *Deb* 26021 & 26077; Lailongsong, 510 m, June 1961, *Deb* 25811.

M. roxburghii Hook. f.

Shrub with modified sepals white, leaf-like; in fruit; common. Tipang, 540 m, June 1961, *Deb* 25702; Longsek hillock, 1500 m, June 1961, *Deb* 25732.

M. wallichii G. Don

An undershrub with yellow flowers; common. Tipang, 540 m. June 1961, *Deb* 25700.

Mycetia longifolia (Wall.) O. Kuntze

Shrub with small, creamy white or yellow flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20069; Wakka, July 1961, *Deb* 26508; Jangkeng village, June 1961, *Deb* 25859; Banfera, July 1961, *Deb* 26707.

Myrioneuron nutans Wall. ex Kurz

An undershrub with small yellow fruits; scarce. Niauxa, Sept 1958, *Panigrahi* 16714; Banfera, July 1961, *Deb* 26704; Pungchow, July 1961, *Deb* 26576.

Neanotis ingrata (Wall. ex Hook. f.) W. H. Lewis

A soft herb with white flowers; common. Rusa, Sept. 1958, *Panigrahi* 16946; Chenglang-Khela, Oct. 1959, *Rao* 20265.

N. wightiana (Wall. ex Wt. et Arn.) W. H. Lewis

Small herb with white or violet flowers, scarce. Chennhang, June 1961, *Deb* 26184 & 26203; Langsang forest, June 1961, *Deb* 26136.

Ophiorrhiza calcarata Hook. f.

Herb with pink flowers; rare. Jangkeng village, June 1961, *Deb* 25864.

O. harrisiana Heyne

A common herb with white flowers. Grows gregariously and forms the undergrowth in moist situations. Pungchow, July 1961, *Deb* 26612; Noglo, June 1961, *Deb* 26333.

O. pauciflora Hook. f.

Small herb with white flowers; fairly common. Pungchow, July 1961, *Deb* 26601.

O. succirubra King ex Hook. f.

Herb with pink flowers; common. Chennhang, June 1961, *Deb* 26262; Langsang forest, June 1961, *Deb* 26121 & 26122.

O. treutleri Hook. f.

A succulent herb with pink flowers and green fruits; scarce. Kothong, June 1961, *Deb* 26065.

Paederia scandens (Lour.) Merr.

A twiner with hairy, violet flowers with pungent odour; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20014.

Pavetta subcapitata Hook. f.

Shrub with globose berries; scarce. Banfera, July 1961, *Deb* 26700.

Polyura geminata Hook. f.

A small herb with very minute red or pink flowers; common. Deomali, Oct. 1959, *Rao* 20392; Jadia, July 1961, *Deb* 26670; Deomali, June 1961, *Deb* 25888; Longsek hillock, 1500 m, June 1961, *Deb* 25737.

Psychotria fulva Buch.-Ham.

Herb with small flowers and fruits; scarce. Banfera, July 1961, *Deb* 26699; Lailongsong, 510 m, June 1961, *Deb* 25826; Longsek hillock, 1500 m, June 1961, *Deb* 25731.

P. montana Bl.

A common shrub. Fruiting; Langsang forest, June 1961, *Deb* 26128.

P. thomsonii Hook. f.

A common shrub of the undergrowth. Chegum-Wakka, July 1961, *Deb* 26469.

Randia griffithii Hook. f.

A tree in fruit. Khonsa-Laju, June 1961, *Deb* 25960.

R. wallichii Hook. f.

A medium-sized tree in flower, scarce. Chennhang, June 1961, *Deb* 26250.

Rubia sikkimensis Kurz

A rare climber. Langsang forest, June 1961, *Deb* 26154.

Saprosma ternatum Hook. f.

A shrub about 3 m in height. Fruiting; rare. Nginu-Niausa, Aug. 1958, *Panigrahi* 14802.

Spermacoce ocymoides Burm. f.

A common herb with woody base, white flowers and fruits. Lailongsong, 510 m, June 1961, *Deb* 25824.

Spiradiclis bifida Wall. ex Kurz

A common succulent herb with very small, pale white flowers; common. Tipang, June 1961, *Deb* 25705, Lailongsong, 510 m, June 1961, *Deb* 25822.

S. cylindrica Wall. ex Hook. f.

Small herb with small yellow or creamy-white flower; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20279; Lailongsong, 510 m., June 1961, *Deb* 25823; Chennhang, June 1961, *Deb* 26185.

Tarena odorata (Roxb.) Robinson

Tree with white flowers and fruits; rare. Deomali, June 1961, *Deb* 25879.

Uncaria macrophylla Wall.

A large shrub, scandent, in fruit. Margharita-Jairampur, Oct. 1959, *Rao* 19952.

U. homomalla Miq.

A scandent shrub with fruits; scarce. Chenglang, March 1958, *Murthy* 12915.

U. sessilifructus Roxb.

A large scandent shrub in fruit; scarce. Namchick-Chenglang, Oct. 1959, *Rao* 20211 (A); Raho-Wakka, July 1961, *Deb* 26393.

Meyna laxiflora Robyns

Vangueria spinosa Roxb.

A bushy shrub with flowers and fruits growing in clearings in the forest. Lunwa, July 1961, *Deb* 26641.

Wendlandia wallichii Wt. & Arn.

A small tree with small, sessile flowers and greyish green fruits in large bunches; common. Chennhang, June 1961, *Deb* 26244; Wakka, July 1961, *Deb* 26505.

BIGNONIACEAE

Radermachera bipinnata (Coll. et Hemsl.) Van Steenis

A climber. Flower showy, yellow outside and violet inside. This is worthy of introduction as an ornamental plant. Langsang forest, June 1961, *Deb* 26124; Khonsa-Laju, June 1961, *Deb* 25943.

R. gigantea Miq.

A rare tree. Fruiting. Pungchow-Niausa, June 1961, *Deb* 26645.

Stereospermum personatum (Hassk.) Chatter.

A medium-sized tree with violet and yellowish tinged flower; common, Longsek hillock, June 1961, *Deb* 25720; Wakka, July 1961, *Deb* 26537. Banfera-Kanubari, July 1961, *Deb* 26743.

PEDALIACEAE

Sesamum indicum Linn.

Cultivated near cottages. Margharita-Jairampur, Oct. 1959, *Rao* 19946.

VERBENACEAE

Callicarpa arborea Roxb. ex C. B. Clarke

A small tree with violet or pinkish flowers; scarce. Banfera, July 1961, *Deb* 26697; Lailongsong, 510 m., June 1961, *Deb* 25788.

C. longifolia Lamk. var. **lanceolaria** Clarke

A shrub in the exposed region of the forest; scarce. Deomali, Oct. 1959, *Rao* 20320; Deomali, July 1961, *Deb* 25892.

C. rubella Lindl.

A shrub with purple flowers and fruits; common. Khonsa, June 1961, *Deb* 25916; Kothong, June 1961, *Deb* 26074.

Clerodendron bracteatum Wall. ex Walp.

A shrub with ripe bluish fruits; Banfera-Kanubari, July 1961, *Deb* 26740.

C. colebrookianum Walp.

A shrub with white flower and dark green fruits with calyx; common. Margharita-Jairampur, Oct. 1959, *Rao* 19956; Nampong-Pangsupass, Oct. 1959, *Rao* 20041; Deomali, Oct. 1959, *Rao* 20388.

C. divaricatum Jack

A tall shrub with whitish blue flowers and oily green fruits ; common. Lailongsong (Chenglang), 510 m, June 1961, *Deb* 25816 ; Deomali, Oct. 1959, *Rao* 20393 ; Pungchow, July 1961, *Deb* 26585.

C. hastatum Lindl.

A small tree ; scarce. Banfera-Kanubari, July 1961, *Deb* 26737.

C. lasiocephalum C. B. Clarke

Shrub with dull to deep red flowers and small green fruits ; scarce. Chenlang-Khela, Oct. 1959, *Rao* 20268 ; Kothong, June 1961, *Deb* 26085 ; Chenglang-Khela, March 1958, *Murthy* 12954.

Premna racemosa Wall. ex Schaner.

Shrub or small tree with white, small flowers ; scarce. Raho-Wakka, July 1961, *Deb* 26442 ; Pungchow, July 1961, *Deb* 26608 & 26630 ; Pungchow-Niausa, July 1961, *Deb* 26651 ; Noglo, June 1961, *Deb* 26328 & 26364.

Verbena officinalis Linn.

An undershrub ; very common. Khonsa-Laju, June 1961, *Deb* 25998 ; Kothong, June 1961, *Deb* 26072.

Vitex canescens Kurz

A big tree in zygomorphic, dull white flowers with externally tomentose corolla ; scarce. Chennhang, June 1961, *Deb* 26207.

V. heterophylla Roxb.

A medium-sized tree with small white flowers and fruits ; common. Chenglang-Khela, Oct. 1959, *Rao* 20258 ; Longsek hillock, 1500 m, June 1961, *Deb* 25728.

V. negundo Linn.

A shrub with blue-violet flowers ; common. Niausa, July 1961, *Deb* 26556.

HELLEBORACEAE

Isopyrum adiantifolium Hook. f. & Th.

A succulent herb. This is recorded to occur in Sikkim and upper Burma only (*vide* S. K. Mukerjee in *Bull. Bot. Surv. India* 2 : 106, 1960). This record from NEFA indicates that it is distributed all over the Eastern Himalayas from Sikkim to Burma. Raho-Wakka, July 1961, *Deb* 26435.

RANUNCULACEAE

Anemone howellii W. W. Smith & Jeff.

A herb with dull white flowers ; scarce. Wakka, July 1961, *Deb* 26407.

Ranunculus diffusus DC.

A herb with yellow flowers ; scarce. Raho-Wakka, July 1961, *Deb* 26314.

R. laetus Wall. ex Royle

Herb with yellow flowers ; common. Khonsa-Laju, June 1961, *Deb* 25975.

R. cantoniensis DC.

Herb in yellow flowers ; scarce. Kothong, June 1961, *Deb* 26050 ; Pungchow, July 1961, *Deb* 26596.

Thalictrum foliolosum DC.

A herb with small flowers ; scarce. Wakka, July 1961, *Deb* 26514.

MENISPERMACEAE

Aspidocarya uvifera Hook. f. & Thoms.

A climber with red flowers ; rare. Pungchow, July 1961, *Deb* 26616 & 26628.

Haematocarpus thomsonii Miers

A woody climber ; rare. Langsang forest, June 1961, *Deb* 26147.

Pericamphylus glaucus (Lamk.) Merr.

A climber with small flowers ; scarce, Chennhang, June 1961, *Deb* 26189 ; Langsang forest, June 1961, *Deb* 26148 ; March 1958, *Murthy* 12907.

Stephania japonica (Thunb.) Miers var. **discolor** (Miq.) Forman

A climber with red fruits ; scarce. Jairampur, Oct. 1959, *Rao* 19979 ; Lailongsong, 510 m., June 1961, *Deb* 25786 ; Kothong, June 1961, *Deb* 26114.

ARISTOLOCHIACEAE

Aristolochia platanifolia Duchart.

A climber with 6-ridged fruits ; scarce. Wakka, July 1961, *Deb* 26501.

A. saccata Wall.

Climber with tan coloured flowers; common. Chennhang, June 1961, *Deb* 26239; Raho-Wakka, July 1961, *Deb* 26405; Noglo, June 1961, *Deb* 26319.

Asarum himalaicum Hook. f. & Th. var. **bhutanicum** W. W. Smith

A succulent herb. Grows in moist, shaded area; rare. Raho-Wakka, July 1961, *Deb* 26421.

PIPERACEAE

Peperomia heyneana Miq.

A succulent herb, sometimes grows as an epiphyte; common. Raho-Vokanoska, Aug. 1958, *Panigrahi* 16845; Kothong, June 1961, *Deb* 26090, Khonsa-Laju, June 1961, *Deb* 25970; Noglo, June 1961, *Deb* 26354.

P. pellucida (Linn.) H.B.K.

An annual succulent herb; common. Banfera-Longhoi, Aug 1958, *Panigrahi* 16755.

P. tetraphylla (Forst. f.) Hook. et Arn.

An epiphyte; scarce. Chennhang, June 1961, *Deb* 26196; Khonsa-Laju, June 1961, *Deb* 25970.

Piper attenuatum Buch.-Ham.

A climber; scarce. Jadua-Banfera, July 1961, *Deb* 26667; Lailongsong, 510 m, June 1961, *Deb* 25813.

P. betle Linn.

A cultivated twiner. Soha village, Oct. 1959, *Rao* 20361.

P. boehmeriaefolium Wall. ex C. DC. forma **glabrifolium** DC.

A scarce climber; fruiting. Kheti-Tinchha, Aug. 1958, *Panigrahi* 14542.

P. manni DC.

An epiphyte with spikes; scarce. Raho, Aug. 1958, *Panigrahi* 16823; Noglo, June 1961, *Deb* 26336.

P. mullesua D. Don

Succulent epiphyte; scarce. Langsang forest, June 1961, *Deb* 26116; Longsek hillock, 1500 m, June 1961, *Deb* 25748.

P. nepalense Miq.

An epiphyte with about 25 cm long spike ; scarce. Pungchow, July 1961, *Deb* 26597 ; Longsek hillock, 1500 m, June 1961, *Deb* 25755.

P. nigrum Linn. var. **macrostachyum** C. DC.

A succulent shrub with solitary whitish green spike ; rare. Wakka, Aug. 1958, *Panigrahi* 14925 ; Kothong, June 1961, *Deb* 26045 ; Khela, June 1961, *Deb* 25935.

P. peepuloides Roxb.

A root climber with spike ; common. Deomali, Oct. 1959, *Rao* 20316 ; Longsek hillock, 1500 m, June 1961, *Deb* 25749.

P. sylvaticum Roxb.

A climber with long, pale green spike having small conical fruits ; scarce. Soha village, Oct. 1959, *Rao* 20359.

P. thomsonii Hook. f.

A root climber with erect fruiting spike ; scarce. Jairampur, Oct. 1959, *Rao* 19995 ; Deomali, June 1961, *Deb* 25889 ; Jadua-Banfera, July 1961, *Deb* 26676.

SAURURACEAE

Houttuynia cordata Thunb.

A herb ; bracts white ; scarce. Jangkeng village, June 1961, *Deb* 25852.

CHLORANTHACEAE

Chloranthus officinalis Bl.

An undershrub with very small sessile white flowers ; common. Chenglang-Khela, Aug. 1958, *Panigrahi* 14440 ; Jairampur, Oct. 1959, *Rao* 19997 ; Lailongsong, 510 m, June 1961, *Deb* 25791 ; Jadua-Banfera, July 1961, *Deb* 26677.

PAPAVERACEAE

Papaver somniferum Linn.

A herb with solitary white flowers and fruits ; flowers and fruits vary much in size. Probably an escape from cultivation. Kothong, June 1961, *Deb* 26037.

CRUCIFERAE

Brassica juncea Czern. & Coss.

Herb under cultivation; yellow flower. Chennhang, June 1961, *Deb* 26272.

B. rugosa Prain

Herb. Probably an escape from cultivation. Chennhang, June 1961, *Deb* 26176.

Cardamine circaeoides Hook. f. & Th.

Herb. Noglo, June 1961, *Deb* 26318.

C. hirsuta Linn. var. *sylvatica* Link

An annual herb with small, white flowers; scarce. Raho, July 1961, *Deb* 26382; Noglo-Laju, June 1961, *Deb* 26368.

C. seoriarum W. W. Smith

A herb of moist shady situations at altitudes of 1800-2100 m; flowers and fruits in May-July. A native of China recorded for India by Deb in *Ind. For.* 91(3): 193, 1965. Wakka, July 1961, *Deb* 26411.

MOLLUGINACEAE

Mollugo pentaphylla Linn.

A diffused herb with greenish flowers; scarce. Niauxa, July 1961, *Deb* 26561.

CARYOPHYLLACEAE

Drymaria diandra Bl.

A diffused or prostrate herb with light green or whitish flowers; common. Nampong-Pangsupass, 791-1128 m, Oct. 1959, *Rao* 20087.

POLYGONACEAE

Fagopyrum cymosum Meissn.

Herb with flowers in white heads. Forms pure stands on the forest floor; very common. Kothong, June 1961, *Deb* 26050; Khonsa-Laju, June 1961, *Deb* 26000.

Polygonum alatum Buch.-Ham.

A herb with white, yellow or pink heads; common. Khonsa, June 1961, *Deb* 25917; Kothong, June 1961, *Deb* 26025 & 26068; Chennhang,

June 1961, *Deb* 26178 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20149 ; Pungchow, July 1961, *Deb* 26602.

P. barbatum Linn.

A perennial herb with greenish white flowers. Common in marshy places. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16960.

P. caespitosum Bl.

Herb with white or small pinkish flowers. Common in marshy places. Lailongsong, 510 m, June 1961, *Deb* 25830 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20054.

P. chinense Linn.

A tall herb with white flowers in marshy regions. Lailongsong, 510 m, June 1961, *Deb* 25818 ; Noglo, June 1961, *Deb* 26323 ; Chennhang, June 1961, *Deb* 26257.

P. chinense Linn. var. **malaicum** (Danser) Steward

A perennial herb with brownish red flowers ; rare. Laju hills, Aug. 1958, *Panigrahi* 14662.

P. chinense Linn. var. **ovalifolia** Meissn.

A herb with black fruits. Tipang, 540 m, June 1961, *Deb* 25719.

P. hydropiper Linn. var. **hispidum** (Hook. f.) Steward

A perennial herb with red flowers ; scarce. Khonsa-Kheti, Aug. 1958, *Panigrahi* 14520.

P. hydropiper Linn. var. **flaccidum** (Meissn.) Steward

A perennial herb in greenish white flowers ; scarce. Jairampur, Oct. 1959, *Rao* 20003 ; Chenglang-Khela, Aug. 1958, *Panigrahi* 14435 ; Khonsa-Laju, June 1961, *Deb* 25980.

P. runcinatum Buch.-Ham.

A herb in white flowers ; scarce. Kothong, June 1961, *Deb* 26057.

P. virginianum Linn.

A perennial herb in red flower buds ; scarce. Wakka, Aug. 1958, *Panigrahi* 14911.

Rumex maritimus Linn.

A scarce herb that occurs in small communities. Khonsa-Laju, June 1961, *Deb* 25997.

AMARANTHACEAE

Achyranthes aspera Linn.

A small herb. Longsek hillock, 1500 m, June 1961, *Deb* 25746.

A. bidentata Bl.

A herb with green spike with pinkish tips ; scarce. Pungchow, July 1961, *Deb* 26613 ; Raho-Wakka, July 1961, *Deb* 26418.

Alternanthera paronychioides St. Hill.

An introduced herb with whitish chaffy inflorescence. Wakka, Aug. 1958, *Panigrahi* 14908.

A. sessilis (Linn.) DC.

A soft herb with condensed spike with creamy white flowers ; scarce. Jairampur, Oct. 1959, *Rao* 19985.

A. lividus Linn.

Prostrate herb. Langsang forest (Kothong), June 1961, *Deb* 26141.

Celosia argentea Linn.

A small herb with deep mauve or pinkish spike. Probably an escape from cultivation ; scarce. Chenglang-Khela, 600m, March 1958, *Murthy* 12938.

Cyathula prostrata (Linn.) Bl.

An annual herb with greenish white flowers ; common. Jairampur, Oct. 1959, *Rao* 19993 ; Longsek hillock, June 1961, *Deb* 25746.

LYTHRACEAE

Cuphea balsamona Ch. & Schl.

A prostrate herb with blue flowers ; scarce. Namchick-Chenglang, Oct. 1959, *Rao* 20211.

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven sub sp. *sessiliflora* (Mich.) Raven

A scarce herb with yellowish flowers. Margharita-Jairampur, Oct. 1959, *Rao* 19931 ; Deomali, Oct. 1959, *Rao* 20303 & 20304 ; Niausa, July 1961, *Deb* 26562.

Ludwigia prostrata Roxb.

A herb of marshy places ; scarce. Namchick, 152 m, Oct. 1959, *Rao* 20183.

GENTIANACEAE

Canscora andrographioides Griff. ex C. B. Clarke

A common herb, in flower and fruits. Namchick-Chenglang, Oct. 1959, *Rao* 20210.

Exacum tetragonum Roxb.

Herb with beautiful blue flowers; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20161.

Tripterospermum speciosum (Wall.) Raizada

A twiner, in flower; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20033.

PRIMULACEAE

Lysimachia congestiflora Hemsl.

Herb with yellow flowers; scarce. Chennhang, June 1961, *Deb* 26192. This was originally described from China. Its occurrence is an extension of its distribution.

L. evalvis Wall.

Herb with solitary, pendent flowers; scarce. Langsang forest, June 1961, *Deb* 26123; Chennhang, June 1961, *Deb* 26258.

L. japonica Thunb.

A diffused much branched herb with yellow flowers; common. Noglo-Laju, June 1961, *Deb* 26371; Khonsa-Laju, June 1961, *Deb* 25962, Kothong, June 1961, *Deb* 26059.

L. lobelioides Wall.

Herb with campanulate flowers; scarce. Kothong, June 1961, *Deb* 26061.

L. laxa Bauda

Herb with yellow flowers; common. Raho-Wakka, July 1961, *Deb* 26397; Noglo, June 1961, *Deb* 26317.

L. rubiginosa Hemsl.

Herb with yellow flowers; scarce. Chegum-Wakka, July 1961, *Deb* 26483. Originally described from China, this record extends the distribution.

PLANTAGINACEAE

Plantago crosa Wall.

A very common herb in flower. Kothong, June 1961, *Deb* 26095; Lailongsong, June 1961, *Deb* 25815.

UMBELLIFERAE

Eryngium foetidum Linn.

A common perennial herb of open places. Flowering and fruiting. Sometimes cultivated for the leaves and fruits used in curries. Jadua-Banfera, July 1961, *Deb* 26679.

Heracleum wallichii DC.

A rare herb with white flowers, petiole winged with brown streaks. Laju-Raho, Aug. 1958, *Panigrahi* 14787; Chennhang, June 1961, *Deb* 26252.

H. wallichii DC. var. **elator** Clarke

A herb of moist soil; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20267.

Hydrocotyle nepalensis Hook.

A prostrate herb with small flowers. The juice of the leaves mixed with charcoal is used for wounds. The fruit is reputed to be a snake bite cure. Nampong-Pangsupass, Oct. 1959, *Rao* 20026; Tipang, June 1961, *Deb* 25710; Kothong, June 1961, *Deb* 26058; Raho-Wakka, July 1961, *Deb* 26396.

H. podantha Molkenb. var. **podantha** (Molkenboer) C.B. Clarke

A diffused runner; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20271; Langsang forest, June 1961, *Deb* 26142.

Oenanthe thomsonii Clarke

An annual herb with white flowers. Grows gregariously in the ground cover; very common. Khonsa, June 1961, *Deb* 25918; Jangkeng village, June 1961, *Deb* 25860; Kothong, June 1961, *Deb* 26070.

Pternopetalum senii Deb et Dutta

A perennial herb with purple flowers. Raho-Wakka, July 1961, *Deb* 26394.

Sanicula elata Buch.-Ham. ex D. Don

Perennial herb with white flowers and small fruits; rare. Wakka, Aug. 1958, *Panigrahi* 16900; Kothong, June 1961, *Deb* 26056.

LOBELIACEAE

Lobelia affinis Wall. var. **lobbiana** Hook. f. & Thoms.

A herb of moist soil with small, pale bluish violet flowers ; common. Chenglang-Khela, March 1958, *Murthy* 12946.

L. pyramidalis Wall.

Herb with solitary, axillary, bluish flowers ; rare. Chenglang-Khela, Oct. 1959, *Rao* 20261.

L. rosea Wall.

Shrub with violet flowers ; scarce. Khonsa-Laju, June 1961, *Deb* 25993.

L. succulenta Bl.

Small herb with minute violet flowers ; common. Chenglang, March 1958, *Murthy* 12912.

Pratia montana (Reinw.) Hassk.

A soft herb with white flowers ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20025 ; Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16990 ; Raho-Wakka, July 1961, *Deb* 26409.

P. nummularia (Lamk.) A.Br. et Ascherson

A prostrate herb with pinkish flowers and shining chocolate brown fruits. Common in moist places. Chenglang-Khela, Oct. 1959, *Rao* 20257 ; Chenglang-Khela, March 1958, *Murthy* 12945 ; Lailongsong, 510 m, June 1961, *Deb* 25827.

COMPOSITAE

Adenostemma lavenia (Linn.) O. Ktze.

Herb with whitish head ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20256 ; Wakka-Nagminu, July 1961, *Deb* 26540 ; Raho-Vokanoska, Aug. 1958, *Panigrahi* 16857 ; Pungchow, July 1961, *Deb* 26570.

Ageratum conyzoides Linn.

Herb in violet flowers. Very common in forest clearings. Namchick, Oct. 1959, *Rao* 20174 ; Chennhang, June 1961, *Deb* 26186.

Ainsliaea latifolia (D. Don) Schulz-Bip

A suffrutiscent herb with radical leaves ; scarce. Chennhang, June 1961, *Deb* 26259.

Artemisia nilagirica (C.B. Clarke) Pamp.

A gregarious herb ; very common. Wakka, July 1961, *Deb* 26530.

Bidens biternata (Lour.) Merr. & Sherff.

Herb with pinkish head ; grows gregariously in shade ; scarce. Chenglang, March 1958, *Murthy* 12928 ; Chennhang, June 1961, *Deb* 26188.

B. pilosa Linn.

An annual with white ligulate flowers ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20053.

Blumea henryi Dunn

Shrub. Khonsa, June 1961, *Deb* 25919.

B. pubigera (L.) Merr.

Shrub. Heads with yellowish stamens ; scarce. Khela-Chenglang, March 1958, *Murthy* 12988.

B. laciniata DC.

Herb with pinkish head ; scarce. Chenglang, March 1958, *Murthy* 12925.

Cnicus griffithii Hook f.

A tall plant. Leaves deeply cleft and thorny. Heads with greenish brown involucre of bracts ; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20150.

Cosmos caudatus Hook. f.

Herb with yellow flower ; scarce. Khonsa, June 1961, *Deb* 25922.

Crassocephalum crepidioides (Benth.) S. Moore

A herb with purplish flowers ; common. Chenglang, March 1958, *Murthy* 12921 ; Chennhang, June 1961, *Deb* 26187.

Eclipta prostrata (Linn.) Linn.

Prostrate herb with white flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20024.

Erigeron linifolium Willd.

Herb with whitish disked head ; scarce. Lailongsong 510 m, June 1961, *Deb* 25829 ; Laju-Raho, Aug. 1958, *Panigrahi* 14733.

Eupatorium capillifolium (Lamk.) Small.

A perennial herb. Cultivated as a garden plant. Margharita-Jairampur, Oct. 1959, *Rao* 19904.

Gynura cusimbua (D. Don) Moore

Herb with violet, orange yellow or pink red flowers. Grows gregariously in shade; fairly common. Lailongsong, 510 m., June 1961, *Deb* 25819; Kothong, June 1961, *Deb* 26048; Khonsa-Laju, June 1961, *Deb* 25983; Kothong, June 1961, *Deb* 26046.

Gnaphalium luteoalbum Linn.

A herb with yellow flowers in moist slopes or cultivated land. Chenglang, *Murthy* 12922; Chennhang, June 1961, *Deb* 26191.

Lactuca rostrata (Bl.) O. Kuntze

A herb with heads; rare. Kothong, June 1961, *Deb* 26049, Khonsa-Laju, June 1961, *Deb* 25995.

L. gracilis DC.

Herb with yellow flowers; scarce. Wakka, July 1961, *Deb* 26524.

Laggera pterodonta Benth.

A herb of moist soil with mauve coloured flowers; rare. Chenglang-Khela, March 1958, *Murthy* 12942.

Mikania cordata (Burm. f.) Robin.

A twining weed of *Jhum* land; very common. Namchick, Oct. 1959, *Rao* 20188.

Myriactis nepalensis Less.

Herb with dull white flowers; scarce. Noglo, June 1961, *Deb* 26355.

M. wallichii DC.

An annual herb with yellowish white head; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20151.

Sonchus arvensis Linn.

A herb with axillary and terminal inflorescence; rare. Raho-Wakka, June 1961, *Deb* 26480.

Spilanthus acmella (Linn.) Murr.

A herb with yellowish ligulate florates head; scarce. Namchick, Oct. 1959, *Rao* 20175.

Vernonia volkameriaefolia DC.

A tall shrub with brown head; common. Pungchow, July 1961, *Deb* 26586.

Wedelia wallichii Less.

An annual herb with yellow flowers ; common. Noglo, June 1961, *Deb* 26369.

Xanthium strumarium Linn.

An undershrub in fruit ; scarce. Jairampur, Oct. 1959, *Rao* 19986.

Youngia japonicum (L.) DC.

Herb with pink flowers ; rare. Chennhang, June 1961, *Deb* 26198.

(to be continued)

Spider Fauna of India : Catalogue and Bibliography

BY

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Family THOMISIDAE

Genus *REGILLUS* Cambridge 1884

341. *Regillus elephantus* Tikader 1966. *Proc. Indian Acad. Sci.* **64** :
54.

Distribution : India : Shillong, Assam.

Type : ZSI.

Genus *RUNCINIA* Simon 1875

342. *Runcinia escheri* Reimoser 1934. *Revue Suisse. Zool.* **14** : 487.

Distribution : India : Andhra Pradesh.

Type : ?

343. *Runcinia roonwali* Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 278.

Distribution : India : Poona, Maharashtra ; Shillong, Assam.

Type : ZSI.

Genus *SYNAEMA* Simon 1864

344. *Synaema brunettii* Tikader 1962. *J. Linn. Soc. London* **44** : 578
fig. 10.

Distribution : India : Darjeeling, West Bengal.

Type : ZSI.

345. *Synaema decorata* Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** :
174, fig. 2a-c.

Distribution : India : West Bengal ; Mysore ; Maharashtra.

Type : ZSI.

Genus *STRIGOPLUS* Simon 1885

346. *Strigoplus netravati* Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 252 ; fig. 3a, b.

Distribution : India : Chikmagalur district, and South Kanara district, Mysore.

Type : ZSI.

Genus *THOMISUS* Walckenaer 1805

347. *Thomisus beautifularis* Basu 1963. *J. Asia. Soc. Bengal* **5** : 23.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

348. *Thomisus bulani* Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 178.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

349. *Thomisus cherapunjeus* Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 55.

Distribution : India : Shillong, Cherapunjee, Assam.

Type : ZSI.

350. *Thomisus dhakuriensis* Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 180.

Distribution : India : West Bengal.

Type : ZSI.

351. *Thomisus elongatus* Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 227.

Distribution : India : West Bengal.

Type : ZSI.

352. *Thomisus katrajghatus* Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 259.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

353. *Thomisus lobosus* Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 285.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

354. **Thomisus memae** Sen and Basu 1963. *Sci. and Cult.* **29** : 515.
Distribution : India : West Bengal.
Type : ZSI.
355. **Thomisus peelianus** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** :
226.
Distribution : India : Sibsagar, Assam.
Type : ZSI.
356. **Thomisus pooneus** Tikader 1965. *Proc. Indian Acad. Sci.* **61** :
283.
Distribution : India : Poona, Maharashtra.
Type : ZSI.
357. **Thomisus projectus** Tikader 1960. *J. Bombay nat. Hist. Soc.*
57 : 182.
Distribution : India : West Bengal.
Type : ZSI.
358. **Thomisus pugilis** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 225.
Distribution : India : West Bengal ; Madras ; Punjab.
Type : ZSI.
359. **Thomisus shivajiensis** Tikader 1965. *Proc. Indian Acad. Sci.*
61 : 284.
Distribution : India : Poona, Maharashtra.
Type : ZSI.
360. **Thomisus shillongensis** Sen 1963. *Sci. and Cult.* **29** : 610.
Distribution : India : Shillong, Assam.
Type : ZSI.
361. **Thomisus sikkimensis** Tikader 1962. *J. Linn. Soc. London* **44** :
570, fig. 5a-c.
Distribution : West Sikkim.
Type : ZSI.
362. **Thomisus sorajaii** Basu 1963. *Sci. and Cult.* **29** : 606.
Distribution : India : West Bengal.
Type : ZSI.

Genus *THANATUS* Koch 1837

363. *Thanatus dhakuricus* Tikader 1960. *J. Bombay nat. Hist. Soc.* 57: 177, fig. 4.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

364. *Thanatus lanceoletus* Tikader 1966. *Rec. Indian Mus.* 59 (4) : 443.

Distribution : India : Bikaner, Rajasthan.

Type : ZSI.

365. *Thanatus mandali* Tikader 1965. *Sci. and Cult.* 31 : 39, fig. 1a, b.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

Genus *TIBELLUS* Simon 1895

366. *Tibellus chaturshingi* Tikader 1962. *J. Poona Univ. Sci. and Tech.* 22 : 133, fig. 1.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

367. *Tibellus elongatus* Tikader 1960. *J. Bombay nat. Hist. Soc.* 57 : 176, fig. 3a, b.

Distribution : India : West Bengal ; Poona, Maharashtra.

Type : ZSI.

368. *Tibellus katrajghatus* Tikader 1962. *J. Poona Univ. Sci. and Tech.* 22 : 136, fig. 3.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

369. *Tibellus poonaensis* Tikader 1962. *J. Poona Univ. Sci. and Tech.* 22 : 134, fig. 2.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

Genus *TMARUS* Simon 1875

370. *Tmarus kotigeharus* Tikader 1963. *Proc. Indian Acad. Sci.* 58 : 250, fig. 2a-c.

Distribution : India : Mysore ; Maharashtra ; Shillong, Assam.

Type : ZSI.

Genus *XYSTICUS* Koch 1835

371. *Xysticus hindustanicus* Basu 1963. *J. Asia. Soc. Bengal* **5** : 23.
Distribution : India : Dum Dum, Calcutta, West Bengal.
Type : ZSI.
372. *Xysticus joyantius* Tikader 1966. *J. Asia. Soc. Bengal* **8** (4) : 3.
Distribution : India : Khasi and Jaintia Hills, Assam.
Type : ZSI.
373. *Xysticus kamakhyai* Tikader 1962. *J. Linn. Soc. London* **44** : 575, fig 7.
Distribution : India : Shillong, Assam.
Type : ZSI.
374. *Xysticus kashidi* Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 261, fig. 11.
Distribution : India : Mysore.
Type : ZSI.
375. *Xysticus mandali* Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 58.
Distribution : India : Shillong, Assam.
Type : ZSI.
376. *Xysticus minutus* Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 173.
Distribution : India : West Bengal; Poona, Maharashtra; Shillong, Assam.
Type : ZSI.
377. *Xysticus pynurus* Tikader 1966. *J. Asia. Soc. Bengal* **8** (4) : 1.
Distribution : India : Khasi and Jaintia Hills, Assam.
Type : ZSI.
378. *Xysticus roonwali* Tikader 1964. *Rec. Indian Mus.* **59** (3) : 264.
Distribution : Nepal and Sikkim.
Type : ZSI.
379. *Xysticus shillongensis* Tikader 1962. *J. Linn. Soc. London* **44** : 578.
Distribution : India : Shillong, Assam.
Type : ZSI.

380. *Xysticus shyamrupus* Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 57.

Distribution : India : Shillong, Assam.

Type : ZSI.

381. *Xysticus sujatai* Tikader 1962. *J. Linn. Soc. London* **44** : 577.

Distribution : India : Shillong, NEFA.

Type : ZSI.

Family UROCTEIDAE

Genus *UROCTEA* Dufour 1820

382. *Uroctea indica* Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 243, fig. 83.

Distribution : India : Western India, Poona, Maharashtra.

Type : BMNH.

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Vegetation of Pachpadra Salt Basin in Western Rajasthan

BY

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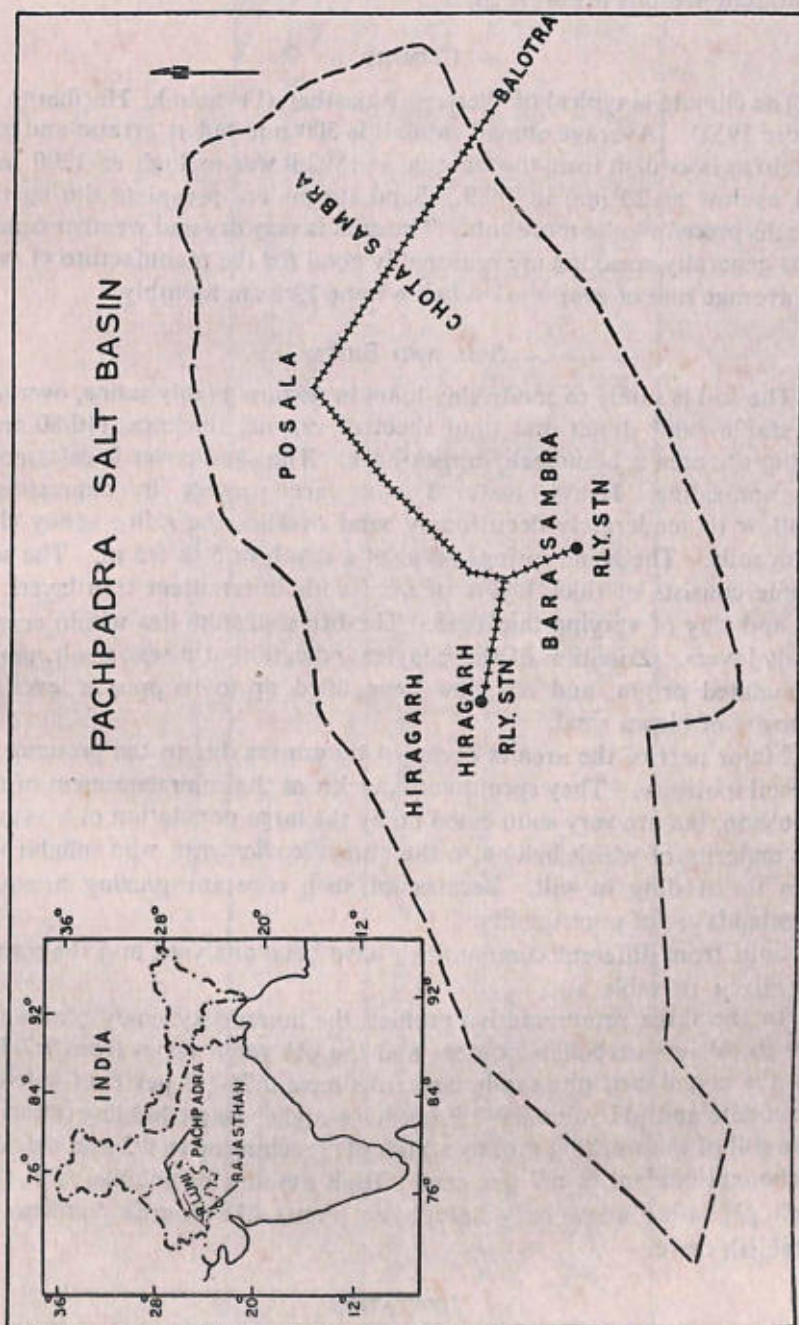
(With a map)

INTRODUCTION

Saline and sodic soils are widespread and extensive in the arid regions of India and form a conspicuous part of the landscape. Pachpadra Salt Basin is one such area where common salt is produced on a commercial scale. Divergent views regarding the origin of Salt have been expressed by Godebole 1951, Auden 1952, Holland & Christie 1909, and Ghose (1964). The area possesses sparse and specialised vegetation due to high salinity and where grasses grow, these are heavily grazed. Development of such areas for the production of palatable grasses is necessary in view of the acute shortage in cattle forage. No detailed information is available about the vegetation and flora of this basin except in the pioneer work of Blatter & Hallberg (1918-1921), Puri *et al.* (1964), Bhandari (1967), Satyanarayan & Shankarnarayan (1963), for central Luni Basin. The list of plants species along with a short description of vegetation of Pachpadra Salt Basin is presented in this paper.

LOCATION AND TOPOGRAPHY

The study area situated about 16 km to the west of River Luni and about 3 km in the same direction from the town of Pachpadra is an oval basin about 11-13 km long and 2-3 km wide in a sandy valley. It has a south-westerly course parallel to Luni River for several kilometres and then turns eastwards and joins the river. The eastern edge of the valley is capped by occasional hills and sand dunes sloping towards the Luni River, while to the west the sand dunes form an unbroken line. The total area of the basin is 32.3 sq km. The rain water leaches the salt from a catchment area of 560-640 sq km and carries it in to the subsoil of the shallow basin. About 1120 salt extraction pits are scattered all over this area, but the largest number lies in the western portion called



Hiragarh. Pits of the eastern part are generally silted up and abandoned. At present 428 pits are worked.

CLIMATE

The climate is typical of Western Rajasthan (Parmanik, Hariharan & Ghose 1952). Average annual rainfall is 300 mm but is erratic and uncertain as is evident from the fact that in 1892 it was as high as 1200 mm and as low as 20 mm in 1889. Sand storms are prevalent during the months preceding the monsoon. The area is very dry and weather conditions generally speaking are reasonably good for the manufacture of salt, the average rate of evaporation being some 12.5 cm monthly.

SOIL AND BIOTA

The soil is sandy to sandy-clay-loam in texture, highly saline, overlaid by stable sand dunes and sand sheet of varying thickness (10-80 cm), giving the area a hummocky appearance. The sand cover is calcareous but non-saline. Heavy textured soils are present in depressions. Shallow to moderately deep loamy sand overlies the saline sandy clay loam soils. The brine springs occur at a depth of 5 to 6.5 m. The soil profile consists of thick layers of sand with intermittent thin layers of silt and clay of varying thickness. The brine stratum lies within coarse sandy layers. Zonation of these layers indicate that it was a salt marsh of undated origin, and has now been filled up to its present level by deposits of blown sand.

Major part of the area is occupied by grasses due to the presence of subsoil moisture. They sprout very quickly at the commencement of the monsoon, but are very soon eaten up by the large population of livestock the majority of which belong to the nomadic, *Banjaras*, who inhabit the area for trading in salt. Because of such constant grazing pressure grasslands are of poor quality.

Soils from different communities have been analysed and the results are given in table 1.

In the three representative profiles, the hummocky sandy plains are low in calcium carbonate content and the pH value varies from 7.7-7.9. On the abandoned pits sandy clay soils have 0.75-1.8 per cent calcium carbonate and pH value 8.0-8.9 but have higher water holding capacity. The soil of the working pit has a high pH reaching up to 9.3 and calcium carbonate content is 5.7 per cent. High amount of soluble salts, and high pH value allow only halophytic plants like *Suaeda fruticosa* to establish there.

VEGETATION

Blatter & Hallberg (1918-1921) mentioned a few halophytic species, Biswas & Rao (1953) listed halophytic species of Rajputana desert.

TABLE I
SOIL ANALYSIS OF PACHPADRA SALT BASIN

S. No.	Location, Habitat and grass community	Soil depth cm.	pH	Ec. micromhos cm	Mechanical composition			CaCO ₃ %	Organic matter %
					Sand	Silt	Clay		
1	Sandy hummocky plain (Posali) with <i>Dactyloctenium aegyptium</i> , <i>Eleusine compressa</i>	0-30	7.7	6800	89.4	3.8	5.0	0.8	0.3
		30-60	7.9	6400	87.3	4.5	6.3	0.6	0.5
		60-100	7.8	5400	90.7	4.3	4.8	0.9	0.2
2	Abandoned pit (Hiragarh) <i>Sporobolus marginatus</i> — <i>Cyperus rotundus</i> — <i>Dichanthium annulatum</i>	0-30	8.9	4500	82.1	3.5	8.3	1.4	0.4
		30-60	8.0	3700	78.2	4.5	10.8	1.8	0.0
		60-100	8.0	5000	82.1	7.0	6.8	0.8	0.1
3	Working pit (Posali) No vegetation	Top	7.9	4400	85.1	1.8	5.3	3.4	0.1
		Middle	9.3	3900	87.1	3.3	4.3	5.7	0.1
		Bottom	8.3	9500	84.8	1.8	5.3	3.8	0.2

Shantisarup (1958) studied the halophytes of Luni river-bed in relation to soil structure and composition. Recently Bhandari (1968) studied the flora of Western Rajasthan but no complete account has ever been made from this region.

The following habitats have been recognised based on the floristic survey of the region. 1. Sandy plain, (a) Flat older alluvial plain and (b) Undulating hummocky plain, 2. Saline depression, 3. Salt pit, (a) Working salt pit and (b) Abandoned pit either completely filled or partially filled up and, 4. Sand dunes. The floristic composition of each type is as follows :—

1. Sandy plain

(a) *Flat older alluvial plain* : A part of the basin occupies this habitat with deep sand cover and loose top. Soils are calcareous and carbonate content increases with depth. It is dominated by a plant community of *Prosopis juliflora* DC. with 90 per cent relative dominance. Main associate is *Salvadora persica* L. The ground is occupied by a grass community of *Sporobolus-Eleusine-Cenchrus* sp. with 5-7 per cent basal cover.

(b) *Hummocky older alluvial plain* : A major portion of the basin is covered by undulating topography with loose soil on the top. The vegetation cover is very sparse and distributed in patches. *Acacia jacquemontii-P. juliflora* community dominates with 65 and 30 per cent relative dominance. *Dactyloctenium scindicum-Eleusine compressa* is the grass community supported by this habitat with 5.4 per cent basal cover. The percentage composition of these two grasses is 57.7 and 18.6 per cent respectively. About 13 species have been recorded with *Zygochloa simplex* as main associate. In this habitat one can rarely see *Lycium barbarum* due to the large scale extermination for the crystallization of salt. At present it is transported from the adjoining areas and hence large scale plantation of this species should be encouraged in the tract.

2. Saline depression

These are low lying patches which either occur in the interdunal areas or between two or more pits. Here the soils are heavier, deep, sandy-clay-loam, and highly saline. Fringes of these areas are occupied by a community of *Salvadora persica-Tamarix dioica* with 55 and 35 per cent relative dominance respectively. *Sporobolus marginatus-Cenchrus setigerus* is the grass community with 6.6 per cent basal cover.

3. Salt pit

(a) *Abandoned pits* : These are the old pits which are either fully or partially covered by gradual silting. These are surrounded by a community of *Prosopis juliflora-Salvadora oleoides* with 85 and 15 per cent

relative dominance. Some of the partially filled salt pits act as temporary ponds and support a pure community of *Fimbristylis ferruginea* (L.) Vahl. *Acacia nilotica* ssp. *indica* and *Suaeda fruticosa* (L.) Forsk. are the two chief associates.

(b) *Working pits*: Pits where salt is extracted. Practically devoid of any shrub vegetation. *Tragus biflorus*-*Aristida funiculata*-*Eleusine compressa* is the grass community with 3 per cent cover.

4. Sand dune

Medium to high, stabilised, transverse and longitudinal dunes demarcate the boundary of the basin. Few dunes are located in the basin itself. In the residential colony, office building and other small huts on the dunes are dominated by a community of *Calotropis procera*. Boundary dunes are generally cultivated for kharif crops. *Salvadora oleoides*-*Acacia jacquemontii*-*C. procera* form a sparse community while the ground community of grass is that of *Cenchrus biflorus*-*C. prieurerii* with two per cent cover. Stray plants of *Calligonum polygonoides* need mention.

ANNOTATED LIST OF PLANTS COLLECTED

The list of plants collected from the basin follows Bentham and Hooker's system of classification. Popular vernacular names, short description, time of flowering and fruiting and exact locality are given for each species. Based on available literature the nomenclature has been made up to date. The number after the description of each species refer to Herbarium sheets stored at the Herbarium of Central Arid Zone Research Institute, Jodhpur, India. A visual estimation of the plant species and their distribution on different habitat of the Basin has been given in Table 2.

TABLE 2
DISTRIBUTION OF PLANT SPECIES ON DIFFERENT HABITATS AT PACHPADRA SALT BASIN

Species	Habitat				
	Loose sandy soils	Saline depression	Working pits	Old pits	Dunes
TREES					
<i>Salvadora oleoides</i> Decne.	—	—	—	R	R
<i>S. persica</i> L.	—	—	R	A	—
<i>Prosopis cineraria</i> (L.) MC. bride	—	—	—	—	R
<i>P. juliflora</i> DC.	—	R	R	A	—
<i>Maytenus emarginata</i> (Willd.) Dinght-Hou.	—	—	—	—	C
<i>Acacia nilotica</i> (L.) Del. ssp. <i>indica</i> (Benth) Branen.	—	—	—	R	—

TABLE 2 (Contd.).

Species	Habitat				
	Loose sandy soils	Saline depression	Working pits	Old pits	Dunes
SHRUBS					
<i>Acacia jacquemontii</i> Benth.	A	—	—	—	R
<i>Calotropis procera</i> R.Br.	F	—	—	R	A
<i>Capparis decidua</i> (Forsk.) Edgew.	R	—	—	R	A
<i>Zizyphus nummularia</i> (Burm. f.) Wt. & Arn.	F	—	—	—	—
<i>Leptadenia pyrotechnica</i> Decne.	R	—	—	—	—
<i>Tamarix dioica</i> Roxb.	R	—	C	R	—
<i>Calligonum polygonoides</i> L.	—	—	—	—	C
<i>Lycium barbarum</i> L.	R	—	—	—	R
<i>Suaeda fruticosa</i> Forsk.	C	C	A	F	—
<i>Haloxylon salicornicum</i> Bunge ex Boiss.	C	—	R	R	—
<i>Salsola baryosma</i> (Schult.) Dandy	F	R	C	C	—
UNDER-SHRUBS					
<i>Aerva persica</i> (Burm. f.) Merrill.	F	—	—	R	A
<i>A. pseudotomentosa</i> Blatt. & Hallb.	A	—	—	R	C
<i>Crotalaria burhia</i> Buch.-Ham.	C	—	R	R	F
<i>Sericostoma pauciflorum</i> Stocks	—	—	—	—	R
HERBS					
<i>Tephrosia purpurea</i> (L.) Pers.	C	R	R	C	C
<i>Convolvulus microphyllus</i> Sieb. ex Spreng.	C	—	—	—	R
<i>Tribulus alatus</i> Delile	R	—	—	—	—
<i>T. terrestris</i> L.	A	—	—	—	R
<i>Cressa cretica</i> L.	R	A	F	C	—
<i>Zygophyllum simplex</i> L.	C	F	A	C	—
<i>Citrullus vulgaris</i> Schrad.	R	—	—	—	C
<i>C. colocynthis</i> (L.) Schrad.	—	—	—	—	—
<i>Amaranthus spinosus</i> L.	C	—	—	—	—
<i>Portulaca oleracea</i> L.	R	A	F	R	—
<i>Trianthema decandra</i> L.	A	F	—	F	—
<i>Cleome gynandra</i> (L.) Briquet.	A	—	—	—	—
GRASSES					
<i>Sporobolus marginatus</i> Hochst. ex A. Rich.	A	C	C	C	—
<i>S. helvolus</i> (Trin.) Dur et Schinz.	A	C	C	C	—
<i>Dichanthium annulatum</i> (Forsk.) Stapf	R	F	—	A	—
<i>Dactyloctenium sindicum</i> Boiss.	A	—	F	R	F
<i>Cenchrus ciliaris</i> L.	C	R	C	C	R
<i>C. setigerus</i> Vahl	C	—	C	A	C
<i>Eleusine compressa</i> (Forsk.) Asch. ex Schw.	A	—	R	C	F
<i>Aeluropes lagopoides</i> (L.) Trin. ex Thw.	—	A	—	C	—
<i>Aristida funiculata</i> Trin. et Rupr.	A	—	C	A	C
<i>Cenchrus biflorus</i> Roxb.	C	—	—	R	A
SEDGES					
<i>Cyperus rotundus</i> L.	C	A	C	A	C
<i>C. laevigatus</i> C. B. Clarke	C	—	—	—	A
<i>Fimbristylis ferruginea</i> (L.) Vahl	—	—	—	A	—

A=Abundant, C=Common, F=Frequent, R=Rare.

MENISPERMACEAE

Cocculus pendulus (Forsk.) Diels (Vern. Pilwan)

A large woody climber, common on *Salvadora persica* L. and *Tamarix dioica* Roxb. Flower greenish yellow; Oct.-Feb. Common around abandoned pits. Hiragarh. (Saxena 2542).

BRASSICACEAE

Farsetia hamiltoni Royle (Vern. Pilang)

40-45 cm high, slender, annual herb. Flower white; July-Oct. Fruit papery. Common on deep sandy soils. Hiragarh siding-2. (Saxena 2574).

CAPPARIDACEAE

Capparis decidua (Forsk.) Edgew. (Vern. Kair)

1-2 m tall spiny, leafless shrub. Flower deep orange red; July-Sept. and March-May. On loose sandy soil and hummocky plain. Hiragarh. (Saxena 2583).

Cleome gynandra (L.) Briquet (Vern. Bagra)

40-45 cm. high, annual herb. Flower white to creamy; July-Sept. Common on loose sandy soils near habitation. Posala siding-3. (Saxena 2649).

POLYGALACEAE

Polygala erioptera DC. (Vern. Chota Bekharia)

15-25 cm high, procumbent annual herb. Flower whitish pink to violet; July-Dec. Circuit House. (Saxena 2529).

PORTULACACEAE

Portulaca oleracea L. (Vern. Noonkhuri, Lunki, Noonia)

A prostrate, succulent herb. Flower yellow; Aug.-Nov. Common on saline depressions and abandoned pits. Hiragarh pit 296. (Saxena 2587).

TAMARICACEAE

Tamarix dioica Roxb. (Vern. Faras, Jhau)

1-2 m tall shrub. Flower pink; Aug.-Dec. Common on water logged saline areas and abandoned pits. Hiragarh siding-2. (Saxena 2535).

MALVACEAE

Abutilon indicum D. Don (Vern. Tarakanchi, Dabi, Jhili)

60-80 cm tall undershrub. Flower yellow; Aug.-Dec. Growing under shade of *S. persica* L. on abandoned pit. Bara Samra pit 288. (*Saxena* 2671).

Hibiscus punctatus Dalz.

90-100 cm tall suffruticose undershrub. Flower pale rose; Aug.-Dec. Hiragarh siding-3. (*Saxena* 2585).

Sida ovata Forsk. (Vern. Bila)

30-40 cm high, woody perennial. Flower yellow; Aug.-Dec. Circuit House. (*Saxena* 2528).

TILIACEAE

Corchorus depressus (L.) Stocks (Vern. Kagla-ki-tamaku, Hadu-ka-Khet)

Small, woody, perennial herb. Flower yellow; July-Dec. Hiragarh siding-2. (*Saxena* 2568).

C. tridens L. (Vern. Kagla-ki-tamaku, Hadu-ka-khet)

20-30 cm high, annual herb. Flower yellow; Aug.-Nov. Hiragarh and Posala. (*Saxena* 2649, 2538).

ZYGOPHYLLACEAE

Tribulus alatus Delile (Vern. Bokhra)

Procumbent to spreading herb. Flower light yellow, fruit winged; Aug.-Dec. Common on sandy soil. Posala siding-3. (*Saxena* 2644).

T. terrestris L. (Vern. Kanti)

A prostrate annual herb. Flower bright yellow, fruit spiny; July-Nov. Common on sandy plains. Posala siding-3. (*Saxena* 2643).

Zygophyllum simplex L. (Vern. Lunwa, Lunio)

20-30 cm high or procumbent, annual herb. Stem yellow to violet red. Flower yellow; July-Nov. Abundant on pit wall and inter pit areas. Hiragarh siding-2. (*Saxena* 2547).

There are two strains in the locality, one with pure yellow and the other with violet-red stem. Both were recorded growing side by side.

MELIACEAE

Azadirachta indica Juss. (Vern. Neem)

A cultivated tree around Barabbangla and office. Bara Bangla. (Saxena 2678).

CELASTRACEAE

Maytenus emarginata (Willd.) Ding Hou (Vern. Kangkeran)

3-4 m tall, spiny tree. Flower pinkish white, ripe fruit light purple ; Oct.-Jan. On sandy gravelly soil and sand dunes. Hiragarh boundary dune. (Saxena 2624).

RHAMNACEAE

Zizyphus nummularia (Burm. f.) Wt. & Arn. (Vern. Bordi)

1-2 m tall, spiny shrub. Flower pale whitish, ripe drupe red ; Aug.-Dec. Hiragarh siding-2. (Saxena 2536).

PAPILIONACEAE

Alhagi pseud-alhagi (M. Bieb.) Desv. (Vern. Jawaşa)

30-40 cm high, spiny undershrub. Flower red ; Oct.-Feb. On abandoned pits and saline areas. Hiragarh. (Saxena 2597).

Crotalaria burhia Buch.-Ham. ex Benth (Vern. Sannia)

60-80 cm high, spreading perennial undershrub. Flower yellow ; Aug.-March. Common on sandy soils. Hiragarh. (Saxena 2556).

Indigofera cordifolia Heyne ex Roth (Vern. Bekar, Bekario)

20-30 cm long, prostrate to procumbent, annual herb. Flower pinkish red. Pod 2-seeded ; July-Nov. Common on sandy soils. Circuit House. (Saxena 2526).

I. linifolia (L.) Retz. (Vern. Bekri, Bekar)

Small, wiry, annual herb. Flower pink. Pod globose, one-seeded ; Aug.-Nov. Hiragarh boundary dune. (Saxena 2614).

I. hochstetteri Baker (Vern. Bekrio)

30-40 cm long, prostrate to procumbent annual herb. Flower pinkish. Pod flat ; Aug.-Nov. Common on sandy soil. Hiragarh siding-2. (Saxena 2537).

I. linnaei Ali (Vern. Bekar)

20-30 cm high, prostrate to procumbent, woody herb with pink flowers. Pod 2-3 seeded Aug.-Dec. Common on loose sandy soils. Hiragarh. (Saxena 2527).

I. oblongifolia Forsk. (Vern. Goila)

80-100 cm tall, pubescent shrub. Flower pink to orange pink. Sept.-Feb. Common on abandoned pits. Hiragarh. (Saxena 2635).

Phaseolus trilobus Ait. (Vern. Panri, Jangli moth)

20-30 cm long, trailing, annual herb. Flower bright light yellow. Pod 6-8 seeded; Aug.-Oct. Rare on sandy soils. Hiragarh Boundary dune. (Saxena 2618).

Tephrosia purpurea (L.) Pers. (Vern. Dhamasia, Sarphunka)

30-60 cm tall biennial or perennial undershrub with violet pink to red flowers. Pod flat; July-Nov. Abundant on sandy plain. Hiragarh siding-2. (Saxena 2567).

Sesbania bispinosa (Jacq.) Fawe & Rend. (Vern. Ekar)

80-120 cm tall, soft-wooded shrub. Flower yellow with reddish spot; July-Nov. Frequent on old pit walls. Hiragarh siding-2. (Saxena 2575).

Heylandia latebrosa DC. (Vern. Gorakh-batti, Sonda)

20-25 cm long, prostrate to procumbent, annual herb. Flower yellow; Aug.-Nov. On dry pit walls. Bara Samra Pit 288. (Saxena 2667).

Psoralea odorata Blatt. & Hallb. (Vern. Goir, Guir)

30-50 cm high, perennial undershrub. Flower pinkish violet; Aug.-March. On abandoned pits only. Hiragarh siding-2. (Saxena 2661).

CAESALPINACEAE

Cassia obtusa Roxb. ex W. & A. (Vern. Beephini)

60-75 cm tall, woody undershrub. Flower pale yellow. Pod flat & wrinkled; Aug.-Dec. On abandoned pit. Hiragarh. (Saxena 2633).

Cassia siamea Lamk.

A cultivated tree with reddish glaucous branches. Flower yellow; July-Dec. Circuit House. (Saxena 2681).

MIMOSACEAE

Acacia nilotica (L.) Del. ssp. *indica* (Benth.) Bernan (Vern. Babul)

Thorny tree. Flower heads yellow. Pods tomentose; Aug.-Nov. and March-May. Frequent on fringes of abandoned pit. Chota Samra. (Saxena 2576)

Acacia jacquemontii Benth. ex Hook. (Vern. Bawli)

1-2 m tall, armed shrub. Flower heads yellow; Aug.-Dec. Common on sandy hummocky soils. Hiragarh siding-2. (Saxena 2645).

Albizzia lebbek (L.) Benth. (Vern. Siris)

A large tree. Flower greenish white to white. Pod long flat. Good top-feed species. Cultivated around office and quarters.

Prosopis cineraria (L.) Mac. bride (Vern. Khejri)

6-8 m tall, spiny tree. Flower yellow; Aug.-Dec. and March-July. Common on sandy soils. A good top-feed plant. Hiragarh. (Saxena 2595).

P. juliflora (Swartii) DC. (Vern. Vilayti babul, vilayti bawli)

3-5 m tall, spiny tree. Catkin yellow. Pods eaten by goats; Aug.-May. Hiragarh. (Saxena 2544).

CUCURBITACEAE

Blastinia imbristipula (Fenzl) Kotschy et Peyr. (Vern. Ankh-phutni-bel)

A large climber on *Capparis decidua* (Forsk.) Edgew. and *Salvadora* bushes. Flower white, fruit globose; Aug.-Nov. Hiragarh siding-2. (Saxena 2689).

Citrullus colocynthis (L.) Schrad. (Vern. Tastumba, Tumba)

1-2 m long trailing perennial herb. Flower light yellow; Aug.-Dec. Common on sandy soil and sand dunes. Seeds utilized for oil extraction. Bara Samra. (Saxena 2613).

C. vulgaris (L.) Schrad. (Vern. Matera)

1-2 m long trailing, annual herb. Flower yellow, fruit juicy with white or pinkish pulp; Aug.-Dec. Natural as well cultivated. Oil is extracted from seed. Hiragarh boundary dune. (Saxena 2612).

Coccinia grandis (L.) Voigt. (Vern. Ankh-phutni bel)

Large perennial climber on *Capparis*, *Zizyphus* and *Salvadora* bushes. Flower white, fruit bright scarlet; Aug.-Dec. Hiragarh siding-2. (Saxena 2631, 2537).

Cucumis callosus (Rottp.) Cogn. (Vern. Kachri)

1-2 m trailing, scabrid herb. Flower yellow; Aug.-Nov. Posala. (Saxena 2684).

AIZOACEAE

Gisekia pharnaceoides L. (Vern. Sardi, Morang)

10-20 cm long, prostrate to sub-erect annual herb. Stem pinkish-red; July-Oct.

Glinus lotoides L. (Vern. Badka)

10-15 cm high, spreading herb. Flower greenish white; Aug.-Dec. Common on silted pits. Pachpadra. (Shankarnarayan 1845).

Sesuvium sesuvioides (Fenzl.) Verde (Vern. Lonia)

10-15 cm long, procumbent annual herb. Flower axillary, red to pink; Aug.-Dec. Common on saline heavy soils. Pachpadra. (Shankarnarayan 1126, 1221).

Trianthema portulacastrum L. (Vern. Safedsanter, Sarta)

20-30 cm long prostrate, succulent, annual herb. Flower axillary solitary; Aug.-Dec. Pachpadra. (Shankarnarayan 1222).

T. decandra L. (Vern. Sarta, Sato, Santar)

20-30 cm long, prostrate, annual herb. Flower red, fruit violet-pink; Aug.-Dec. On loose sandy soils with some organic content. Rly. Station. (Saxena 2633).

T. triquetra Willd. ex Rottl. (Vern. Lunia, Lunaki)

10-20 cm long prostrate, annual herb. Flower greenish white; Aug.-Dec. Common on low lying areas. Hiragarh boundary dune. (Saxena 2608).

ASTERACEAE

Eclipta prostrata L. (Vern. Jalbhangra)

20-40 cm long, prostrate, annual herb. Floral heads white; Aug.-Feb. Common on old silted pits. Bara Samra. (Saxena 2661).

Glossocardia bosvallia (L.f.) DC.

8-15 cm long, prostrate, annual herb. Flower head yellow; Oct.-Jan. Pachpadra. (Shankarnarayan 1856).

Dichotoma tomentosa Cass. (Vern. Vajradanti)

20-30 cm high, spiny, annual herb. Floral head spiny; Sept.-Dec. Frequent on sandy hummocky terrain. Hiragarh. (Saxena 2623 A).

Gnaphalium pulvinatum Delile (Vern. Kallali)

30-40 cm tall, woody perennial undershrub. Leaves whitish with wax coating. Flower heads yellow; Sept.-Jan. Common on silted pits. Hiragarh siding-3. (*Saxena* 2636).

Launaea chondrilloides Hook. f. (Vern. Dudhia)

10-30 cm tall, perennial herb with yellow juice. Heads terminal and yellow; Oct.-Feb. Frequent on silted pits. Bara Samra. (*Saxena* 2666).

L. nudicaulis Hook. f. (Vern. Janglio-gobhi)

15-30 cm tall, perennial herb. Floral heads yellow. Achenes thickly ribbed; Oct.-Feb. Frequent on silted pit. Bara Samra. (*Saxena* 2665).

Pulicaria angustifolia DC. (Vern. Soneli)

20-30 cm high, annual herb. Floral heads deep yellow; Aug.-Feb. Common on sandy soil. Hiragarh siding-3. (*Saxena* 2636, 2525).

P. wightiana (DC.) Benth. ex Clarke (Vern. Sonela, Soneli)

30-45 cm tall, annual herb. Flower heads bright yellow; Sept.-Feb. Frequent on sandy soil. Pachpadra. (*Shankarnarayan* 247).

Vernonia cineraria (L.) Less. (Vern. Phulni, Shadair)

20-30 cm tall, annual, hairy herb. Flower heads pinkish violet, white at maturity; Aug.-Dec. Common on silted pit walls. Bara Samra. (*Saxena* 2670).

V. cinerascens Sch.-Bip. (Vern. Bari phulni, Lalia)

50-70 cm tall, woody, spreading undershrub. Flower heads purple violet; Aug.-Nov. Common on silted pit surface. Hiragarh pit 85. (*Saxena* 2637).

Voluterella ramosa (Roxb.) Sant. (Vern. Lin-katmanda, Telkant)

20-30 cm high, spiny, much branched herb. Flower heads pink; Aug.-Dec. Common on sand dunes. Hiragarh boundary dune. (*Saxena* 2626).

SALVADORACEAE

Salvadora oleoides Decne. (Vern. Mitha-jal)

3-5 m tall tree. Flower white. Drupe orange yellow; Jan.-June. Bara Bangla dune. (*Saxena* 2659).

S. persica L. (Vern. Khara-jal)

4-7 m tall tree. Flower white, fruit violet red; Dec.-June. Plenty around old and silted pits. Hiragarh siding-2. (*Saxena* 2541).

ASCLEPIADACEAE

Calotropis procera (Ait.) R.Br. (Vern. Ak, Akda, Akra)

1-2 m tall, perennial undershrub. Flower whitish-violet; Aug.-Jan. Common around old pit and hummocky areas. Hiragarh siding-3. (*Saxena* 2594).

Leptadenia pyrotechnica (Forsk.) Decne. (Vern. Khimp, Khinmpra)

1-1.5 m tall, leafless undershrub. Flower yellowish green; Aug.-Dec. Frequent on hummocky areas. Bara Samra. (*Saxena* 2679).

GENTINACEAE

Enicostomma verticillatum (L.) Engl. (Vern. Jalbhangra)

Small, procumbent herb. Flower yellow; Sept.-Jan. Hiragarh boundary dune. (*Saxena* 2620).

BORAGINACEAE

Arnebia hispidissima (Lehm) DC. (Vern. Rambas)

20-25 cm high, suberect herb. Root violet red. Flower yellow; Sept.-March. Rare on sandy soils. Hiragarh boundary dune. (*Saxena* 2615).

Heliotropium bacciferum Forsk. var. *subrosa* (Vern. Kalibui)

15-20 cm high, annual herb. Flower sessile, numerous in rigid spike; Aug.-Nov. On silted pits. Pachpadra. (*Shankarnarayan* 1215).

H. paniculatum R. Br. (Vern. Kalibui)

25-30 cm high, annual herb. Flower white in cylindric raceme, fruit four lobed; Aug.-Dec. On sandy soil. Hiragarh siding-3. (*Saxena* 2554).

H. strigosum Willd. (Vern. Choti-santri)

A scabrid, prostrate to procumbent herb. Flower white in elongated spike; Aug.-Dec. Bara Bangla. (*Saxena* 2655).

H. subulatum Hochst. ex DC (Vern. Kalibui)

30-40 cm high, perennial, woody herb. Flower pale white; Aug.-Dec. Common on moist sandy soil. Hiragarh boundary dune. (Saxena 2617).

Sericostoma pauciflorum Stocks (Vern. Kharsan, Kharsni)

30-40 cm tall, perennial undershrub, clothed with appressed hairs. Flower white; Aug.-March. On sand dunes only. Bara Bangla dune. (Saxena 2654).

Trichodesma indicum R. Br. (Vern. Sal-kanta, Phuldar)

20-30 cm high, hispid herb. Flower light blue; Aug.-March. Pachpadra salt basin. (Shankarnarayan 1138).

CONVOLVULACEAE

Convolvulus microphyllus Sieb. ex Spreng. (Vern. Phulwati, Santri, Kerjan).

30-35 cm long, prostrate to procumbent, perennial herb. Flower white or light pink; Aug.-Jan. Common on sandy soil. Hiragarh siding-3. (Saxena 2695, 2586).

Cressa cretica L. (Vern. Lana, Ovindo, Kharia)

10-15 cm high, procumbent, annual herb. Flower white in small axillary clusters; Aug.-Jan. Abundant on saline soils. Hiragarh siding-2. (Saxena 2555).

Ipomoea pes-tigridis L. (Vern. Panwa, Pherwana)

60-70 cm long, twining, annual herb, clothed with spreading hairs. Flower whitish pink on sessile heads; Aug.-Dec. On moist sandy places. Bara Samra. (Saxena 2669).

I. verticillata Forsk. (Vern. Chirawri)

40-60 cm long, prostrate, annual herb. Flower white; Aug.-Nov. Common on shady places. Chota Samra. (Saxena 2676, 2684).

SOLANACEAE

Lycium barbarum L. (Vern. Murali, Morali)

1-2 m tall, spinous, shrub. Flower white solitary or in fascicle; Aug.-Jan. On hummocks and dunes. Hiragarh. (Saxena 2639).

Physalis minima L. (Vern. Janglo-bheri)

40-60 cm long, prostrate, perennial herb. Flower creamy; Sept.-Dec. On moist shady places below *S. ersica* tree. Hiragarh pit 85. (Saxena 2634).

SCROPHULARIACEAE

Anticharis senegalensis (Walp.) Bhand.

30-45 cm high, branched, annual herb. Flower reddish-violet; Aug.-Dec. On sandy saline soils. Hiragarh siding-2. (Saxena 2558).

Striga angustifolia (D. Don) Saldhana (Vern. Misso)

20-30 cm high, annual herb. Flower in the axil of floral bract; July-Oct. Bara Samra. (Saxena 2665).

ACANTHACEAE

Justicia vahlii Roth (Vern. Kagnero, Mokrogas)

20-30 cm high, slender, annual herb. Flower violet-pink; Aug.-Dec. On moist shady places. Hiragarh. (Saxena 2680).

Blepharis sindica T. Anders. (Vern. Bhangri)

Small, spiny undershrub. Flower bluish; Aug.-Nov. On sandy gravelly soils. Hiragarh siding-2. (Saxena 2548).

Peristrophe bicalyculata (Retz.) Nees (Vern. Kagner)

80-100 cm tall, perennial herb. Flower deep violet-pink; July-Oct. Frequent under the shade of trees. Hiragarh siding-3. (Saxena 2539).

LABIATAE

Leucas urticaefolia (Vahl) R. Br. [Vern. Goma (Hindi)]

25-30 cm high, hairy, annual herb. Flowers white, in globose terminal heads; Aug.-Dec. Common on sandy soils. Bara Samra. (Saxena 2638).

NYCTAGINACEAE

Boerhaavia diffusa L. (Vern. Chelavri, Pawa, Sata)

50-70 cm long, trailing perennial herb. Flower light to dark pink; July-March. Common on sandy soils. Posala. (Saxena 2641).

B. repanda Willd. (Vern. Bara-sata)

1-1.5 m long, climbing, perennial herb. Flower pink; July-Feb. Common on moist shady places. Posala. (*Saxena* 2646).

B. elegans Choisy (Vern. Chirio-panio)

25-35 cm high, annual herb. Stem dichotomously and panicle trichotomously branched; July-Sept. On old working pits. Hiragarh siding-2. (*Saxena* 2672).

AMARANTHACEAE

Achyranthus aspera L. (Vern. Unda-kanta, Andhajaro, Narkanta)

40-60 cm tall herb. Flower whitish pink, deflexed against large rachis, fruit prickly; Aug.-Dec. Among bushes in shady places. Hiragarh siding-2. (*Saxena* 2540).

Aerva persica (Burm. f.) Merrill (Vern. Bui, Buida)

40-80 cm tall, woody, perennial undershrub with thick tomentum. Greenish white spike; Oct.-Feb. Common. Hiragarh siding-2. (*Saxena* 2566).

A. pseudotomentosa Blatt. & Hallb. (Vern. Choti-Bui)

60-100 cm tall, woody perennial. Panicle leafy; Sept.-March. Hiragarh pit 85. (*Saxena* 2632).

Amaranthus spinosus L. (Vern. Kateli-cholai)

40-60 cm high, spiny herb. July-Oct. On waste places near habitation. Bara Bangla. (*Saxena* 2606).

Digera muricata (L.) Mart. (Vern. Laler, Latoor, Lulero)

20-30 cm high, annual herb. Flower deep pink in lax spike; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2580).

CHENOPODIACEAE

Salsola baryosma (Roem. et Schult.) Dandy (Vern. Jerio-lana, Iani)

0.8-1.2 m high, much branched undershrub. Flower in short cylindrical spike; Oct.-Jan. Common in the area. Hiragarh. (*Saxena* 2627, 2543).

Suaeda fruticosa Forsk. (Vern. Kala-lana, Lunki)

0.8-1.5 m high, diffusely branched undershrub. Leaves thick & fleshy, turn black on drying; July-Dec. Abundant on saline soils, salt pit and silted up pits. Hiragarh siding-2. (*Saxena* 2577, *Shankar-narayan* 1130, 1180, 1217, 1849).

Haloxylon salicornicum Bunge ex Boiss. (Vern. Sajjio-lano, Lana)

1-1.5 m tall, much branched, leafless shrub. Flower yellow; Oct.-March. On loose sandy soils. Chota-Samra. (Saxena 1673).

POLYGONACEAE

Calligonum polygonoides L. (Vern. Phoog, Phogra)

1-1.5 m tall, leafless shrub. Stem reddish woody. Flower pinkish white; Feb.-June. On boundary dunes. Hiragarh boundary dune. (Saxena 2672).

EUPHORBIACEAE

Euphorbia granulata Forsk. (Vern. Dudhi)

10-20 cm long, prostrate, annual herb. Leaves coriaceous; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (Saxena 2569).

E. jodhpurensis Blatt. & Hallb. (Vern. Duheli)

10-15 cm high, slender, procumbent, annual herb. Capsule trilobular; Aug.-Oct. Common on sandy soils. Posala. (Saxena 2652).

Phyllanthus fraternus Webster

20-30 cm high annual herb. Stipule peltate; Aug.-Dec. Common on moist sandy soils. Circuit house. (Saxena 2530).

P. maderaspatensis L. (Vern. Hazardana)

40-60 cm tall, annual herb. Flower axillary, greenish; Aug.-Jan. Hiragarh. (Saxena 2596).

LILIACEAE

Aloe barbadensis Mill (Vern. Guar-patta)

A cultivated succulent under-shrub with dense, aggregate of narrow leaves.

CYPERACEAE

Cyperus laevigatus L. = *C. arenarius* Retz. (Vern. Motha)

15-30 cm high, sedge with creeping rhizome; Aug.-Dec. Common on loose sandy soils. Hiragarh boundary dune. (Saxena 2611).

C. bulbosus Vahl (Vern. Motto Mothrio)

15-25 cm high, perennial, rhizomatous sedge, bulbous root. Spike violet-red; Aug.-Dec. Common on sandy soil. Hiragarh pit 204. (Saxena 2604).

C. rotundus L. (Vern. Motha)

20-45 cm high, perennial, rhizomatous sedge. Flower spike brownish-red; Aug.-Jan. Abundant on silted pits. Hiragarh siding-2. (Saxena 2562, 2592).

C. tuberosus Rottb.

0.9-1.2 m tall, rhizomatous, perennial, amphibious sedge. Spike red when mature; Aug.-Dec. Common on water logged area. Posala siding-3. (Saxena 2642).

Fimbristylis ferruginea (L.) Vahl

40-45 cm tall, perennial, amphibious sedge. Spike umbellate, spikelets, pale brown; Sept.-March. Common on semi-silted pits. Chota-Samra. (Saxena 2675).

POACEAE

Aeluropus lagopoides (L.) Trin. ex Thw. (Vern. Kharia-ghas)

30-80 cm long, trailing grass with convolute leaves. Spike terminal; Aug.-Dec. Common on clayey saline soils or rann. Hiragarh siding 2. (Saxena 2628, Shankarnarayan 1851).

Aristida adscensionis L. var. **adscensionis** (Vern. Lump, Lompra)

40-60 cm tall, diffused annual grass. Awn dark blackish on maturity; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (Saxena 2673).

A. funiculata Trin. et Rupr. (Vern. Lomp, Lompra)

25-40 cm high, slender, annual grass. Awn very troublesome; July-Oct. Abundant on sandy soils. Hiragarh siding-2. (Saxena 2565).

A. funiculata Trin. et Rupr. var. **mallica** (Edgew.) Henr. (Vern. Lompra)

40-50 cm high, annual grass. Awn bigger than in *funiculata* and troublesome; July-Nov. Posala. (Saxena 2642).

A. mutabilis Trin. & Rupr. (Vern. Lompra)

45 cm tall, annual grass. Spikelets brown; July-Sept. Common on sandy soils. Posala (Saxena 2581).

Brachiaria ramosa (L.) Stapf (Vern. Kuri)

20 cm high, procumbent to spreading, annual grass. Spikelets turgid; Aug.-Oct. Frequent on moist soils. Hiragarh siding-2. (Saxena 2552, Shankarnarayan 1214).

Cenchrus biflorus Roxb. (Vern. Bhurut)

30-40 cm high, annual grass. Involucres echinate spiny; July-Oct. Common on sandy soils. Hiragarh siding. (*Saxena* 2563).

Cenchrus ciliaris L. (Vern. Safed-Dhaman, Anjan)

A tussocky perennial grass. Involucre not spiny; Aug.-Dec. Common on old pit walls on sandy soil. Three different strains have been recorded:

1. 60-70 cm tall; spike 8-10 cm long, violet on ripening (*Saxena* 2598).
2. 25-30 cm tall; with small clump. Spike 4-5 cm long, light violet on ripening. (*Saxena* 2599).
3. Same as No. 2. Spike colourless on ripening. (*Saxena* 2571, 2579).

C. prieurii (Kunth) Maire. (Vern. Dhaman)

40-50 cm high, annual grass. Long spike; Aug.-Nov. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2549).

C. pennisetiformis Hochst. et Steud. ex Steud. (Vern. Dhaman)

50-90 cm tall, perennial grass; Aug.-Dec. Rare on moist sandy soils. Hiragarh. (*Saxena* 2599)

C. setigerus Vahl (Vern. Kala Dhaman)

30-50 cm high, perennial tussocky grass. Spike of various colours, some lax while others compact; Aug.-Dec. Common on sandy soils of the old pits. Three distinct strains have been recognized:

1. 30 cm tall, small, tussocky grass. Common on alluvial plain. (*Saxena* 2601).
2. 30-45 cm tall, small tussocky grass. On old pit walls. (*Saxena* 2589).
3. 70-110 cm tall, large tussocky grass. Rare on moist shady places. (*Saxena* 2650). Hiragarh pit 296, Hiragarh siding-3 and Posala. (*Saxena* 2601, 2589, 2650).

Chloris virgata Sw. (Vern: Gharnia-ghas)

24-30 cm tall, annual grass. Digits 4-5 rayed. Blackens when ripe; Aug.-Dec. Common on saline soils. Hiragarh pit 296. (*Saxena* 2602).

Dactyloctenium aegyptium (L.) P. Beauv. (Vern. Kuri, Makro, Mansa)

15-20 cm tall suberect spreading annual. Digits 3-4 rayed; Aug.-Oct. Common on sandy, clay, loam, soils. Rly. Station. (*Saxena* 2534).

Dactyloctenium indicum Boiss. (Vern. Makra, Ganthia ghas)

25-40 cm tall small tussocky perennial. Stolons rooting at nodes; Aug.-Dec. On hummocky terrain. Circuit House. (Saxena 2525).

Desmostachya bipinnata (L.) Stapf (Vern. Dab)

40-60 cm tall, perennial, tussocky grass. Spike in long raceme; Aug.-Feb. Common on moist sandy soils. Hiragarh siding-2. (Saxena 2549).

Dichanthium annulatum (Forsk.) Stapf (Vern. Karad)

50-90 cm tall, perennial, tussocky grass. Spike reddish to brown purple; Aug.-Dec. Common on silted pits. A very good fodder grass. Hiragarh pit 85. (Saxena 2630).

Digitaria adscendens (H.B.K.) Henr. (Vern. Tara, Kuri)

25-35 cm high, slender annual grass with terminal spike, highly palatable; Aug.-Oct. Hiragarh siding-2. (Saxena 2550).

Echinochloa colonum (L.) Link (Vern. Soma, Homa)

A decumbent annual grass. Stem violet-red; July-Nov. On moist clayey soils or on semi-silted pits. Bara Samra pit 288. (Saxena 2664).

Eleusine compressa (Forsk.) Asch. ex Schw. (Vern. Tantia, Gandil)

Stoloniferous, trailing perennial grass. Spike 4-5 digitate; July-Dec. Common on hummocky terrain. A very good sheep grass. Hiragarh siding-2. (Saxena 2557).

Enneapogon brachystachys (Jaub. et Spach.) Stapf

8-10 cm tall, small tufted, perennial grass. Spike 2-3 cm long; July-Oct. On gravelly soils. Circuit House. (Saxena 2653).

Eragrostis ciliaris (L.) R. Br. (Vern. Chirio-ghas)

15-20 cm tall, annual grass. Spike solitary; July-Dec. Common on sandy soil. Hiragarh boundary dune. (Saxena 2570).

E. poaeoides P. Beauv. (Vern. Chirioro-ghas)

20-35 cm tall, annual grass. Culm shining, bluish white; Aug.-Nov. Common on sandy soils. Hiragarh boundary dune. (Saxena 2626).

E. tremula Hochst. ex Steud. (Vern. Kiria, Phunkia)

30-35 cm tall, annual grass. Spike in lax panicle; July-Nov. On sandy soils. Hiragarh pit 85. (Saxena 2621).

Lasiurus indicus Henr. (Vern. Sewan)

40-60 cm tall, stoloniferous, woody perennial grass. Spike terminal; Aug.-Feb. On dune bases. Hiragarh boundary dune. (Saxena 2619).

Latipes senegalensis Kunth (Vern. Kuri)

20-30 cm tall, annual grass. Stem light pink on maturity ; Aug.-Dec. Hiragarh siding-2. (Saxena 2560).

Melanocenchris jacquemontii Jaub. et Spach. (Vern. Phoolia, khargose-chutti)

10-15 cm tall, annual grass. Spike lax and woolly ; Aug.-Nov. Common on sandy soils of old pits. Hiragarh siding-2. (Saxena 2578).

Panicum antidotale (L.) Retz. (Vern. Gramna, Girona)

100-150 cm tall, tussocky, perennial grass. Spike long in lax panicle ; Aug.-Feb. Recorded in bushes of *Capparis decidua*. Hiragarh siding-3. (Saxena 2582).

Panicum turgidum Forsk. (Vern. Murut)

70-100 cm tall, tussocky perennial grass. Old culm woody ; Aug.-Dec. On dunes and hummocks. Hiragarh pit 265. (Saxena 2593).

Sporobolus coromandelianus (Retz.) Kunth

20-25 cm tall, densely tufted annual grass ; Aug.-Dec. On gravelly soils. Hiragarh siding-2. (Saxena 2553).

S. helvolus (Trin.) Dur. et Schniz. (Vern. Deva, Lunagas, Kharia)

40-70 cm high, tufted perennial grass ; Aug.-Dec. Common on sandy saline and clayey soils. Hiragarh siding-2. (Saxena 2564).

S. marginatus Hochst. ex A. Rich. (Vern. Deva, Kharia-ghas)

40-60 cm tall, tussocky perennial grass. Panicle pyramidal ; Aug.-Feb. Common in the area. Hiragarh siding-2. (Saxena 2564).

Schoenofeldia gracilis Kunth (Vern. Tarwaria)

30-45 cm high, slender, annual grass. Spike terminal ; Aug.-Oct. On low lying saline soils. Hiragarh siding-2. (Saxena 2576).

Tetrapogon tenellus (Roxb.) Chiov.

30-40 cm high, annual grass ; Aug.-Nov. Common on gravelly soils under prote. tion. Hiragarh siding-3. (Saxena 2588).

Tragus biflorus (Roxb.) Schult. (Vern. Sitagas, Charchada)

6-10 cm high, annual grass ; July-Oct. On gravelly soils. Hiragarh siding-2. (Saxena 2572).

EPHEDRACEAE

Ephedra foliata Boiss. (Vern. Lanra)

A straggling climber recorded on *Capparis* and *Lycium* bushes. Bhandari (1954) described in detail its distribution in Western Rajasthan.

SYNOPSIS OF SALT BASIN FLORA

Out of 58 families, 226 genera and 440 species recorded indigenous in Western Rajasthan. 36 families covering 97 genera and 137 species are collected from Pachpadra Salt Basin. Thirteen families have only single species viz. Menispermaceae, Brassicaceae, Polygalaceae, Portulacaceae, Tamaricaceae, Meliaceae, Celastraceae, Rhamnaceae, Gentinaceae, Labiatae, Polygonaceae, Liliaceae and Ephedraceae, Poaceae (Graminae) has the maximum genera (34) while Papilionaceae (12) and Asteraceae (Compositae) (11) stand second and third respectively.

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Effects of temperature and salinity on the oxygen consumption in clams

BY

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(With eight text-figures)

The importance of oxygen as an oxidizing agent in energy releasing mechanism is well known. Utilization of oxygen is, therefore, a direct measure of degree of activity, food conversion and heat production (Bishop 1950). In lamellibranchs, which are filter-feeders, the current of water drawn through the inhalent siphon is used for feeding and respiration. The fluctuations in the estuarine environment where clams are found, are, therefore, bound to influence the oxygen-consumption in clams. Dam (1935, 1954) has studied oxygen utilization in *Mya arenaria* and scallops. Berkeley (1921, 1923) has studied anaerobic respiration in pelycypod mollusks. Mitchell (1912) and Hazelhoff (1938) have given oxygen requirements of shellfish and other invertebrates. Galtsoff & Whipple (1930) have investigated the oxygen-consumption in normal and green oysters under different conditions. The oxygen-consumption of tissues in *Venus merceraria* has been studied by Hopkins (1948).

Amongst various other factors that affect oxygen-consumption, the influence of body size and temperature on respiration of some animals has been studied by Kleiber (1947), Zeuthen (1947, 1953), Scholander *et al.* (1953), Rao & Bullock (1954) and Dawson *et al.* (1956). But most of these studies are made on the arctic and temperate forms. Wolvekamp & Waterman (1960) have reviewed respiration in crustacea. Studies on oxygen-consumption in tropical poikilotherms have recently attracted attention (Job 1955, Saroja 1959, and Parvatheswararao 1959, 1960).

The influence of salinity on oxygen-consumption has been studied by Bloch and Schlieper (1953) in *Asterias rubens*, Eliassen (1952) in *Artemia salina*, Potts (1954) in brackish and fresh water animals, Schlieper (1955) in *Mytilus edulis*, Lofts (1956) in *Palaemonetes varians* and Gross (1957) in some decapod crustacea. The only work of this type in tropical species is that of Gopalkrishna (1953) on penaeid prawns and Rao

(1958) on *Metapenaeus monoceros*. No work has been done on the oxygen-consumption in clams from tropical waters. The present investigation was, therefore, undertaken with a view to studying the effects of temperature and salinity on the oxygen-consumption in the common clams *Meretrix meretrix* and *Katelysia opima*.

MATERIALS AND METHODS

Clams collected from Kalbadevi estuary were stored in the same manner as described in the earlier paper (Ranade & Kulkarni 1972). For determining oxygen-consumption in clams, the method adopted by Saroja (1959) was followed, except that instead of a cork to close the respiratory chamber, a three centimetre layer of liquid paraffin was put on the surface of the water to stop gaseous exchange between the sea water in the respiratory chamber and the atmosphere as suggested by Galtsoff & Whipple (1930).

Temperature being an important factor in controlling the rate of oxygen-consumption, care was taken to keep the required temperature constant, with a variation of only $\pm 1^{\circ}\text{C}$, by providing a thermostat. Observations on the rate of oxygen-consumption were made at three different temperatures namely 20, 30 and 40°C at a constant salinity (34‰). The temperature of the water available in the laboratory varied between 28° and 30°C . For measuring oxygen-consumption at 40°C , the respiratory-chamber was kept in an aquarium tank filled with water, heated to 40°C by means of a heater and maintained at this level by a 'Sunvic' thermostat. For obtaining a temperature of 20°C , ice was used in the aquarium tank in which the respiratory-chamber was kept and the tank in turn was kept in a thermocole insulated box.

The differential values of oxygen in the samples of water from the respiratory-chamber before and after the experimental period i.e. one hour, gave the amount of oxygen consumed. The clams were taken out immediately after the experiment and shelled. The wet weight of the flesh was taken after removing the extra water by using a blotting paper.

In order to study the effect of salinity on the oxygen-consumption, observations were made at three different salinities namely 34‰, 25.5‰ and 17‰, which was equal to 100%, 75% and 50% sea water respectively. In these experiments the temperature was kept constant at 30°C . The lower grades of salinities were prepared as usual, by diluting sea water with distilled water.

As the clams remain buried in the sand in the natural habitat, the respiratory-chamber was painted black, to avoid activity of clams on account of light. The oxygen contents of water were determined by Winkler's method as described by Barnes (1959).

ANALYSIS OF DATA

The rate of oxygen-consumption was plotted as a function of body weight (weight-specific) on a double logarithmic grid. Such a plot over an adequate weight range gives a straight line with a negative slope (Dehnel 1960).

The regression of oxygen-consumption on body weight assumes a form :

$$O_2 = aW^b \dots\dots$$

$$\text{or } \text{Log } O_2 = \text{Log } a + b \text{ Log } W,$$

where O_2 is the volume of oxygen consumed in ml, W is the weight of the body in grams and a and b are constants being respectively the intercept and the slope of the line or the exponent. The regression of oxygen-consumption on body weight at three different temperatures and salinities were calculated separately.

RESULTS

Results of the oxygen-consumption at various temperatures in both the species are summarised in Tables I and II and are plotted as size metabolism curves in Figs. 1 and 2.

TABLE I

TOTAL OXYGEN CONSUMPTION IN *M. meretrix* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		20°C	30°C	40°C
1	0.40	0.16	0.30	0.42
2	0.60	0.17	0.28	0.43
3	1.00	0.30	0.42	0.54
4	1.25	0.36	0.51	0.60
5	1.58	0.45	0.60	0.68
6	1.99	0.57	0.66	0.80
7	2.51	0.75	0.78	0.83
8	3.16	0.93	0.96	0.95
9	4.00	1.14	1.17	1.15

TABLE II

TOTAL OXYGEN CONSUMPTION IN *K. opima* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		20°C	30°C	40°C
10	0.54	0.35	0.40	0.55
11	0.85	0.38	0.46	0.58
12	1.03	0.49	0.65	0.69
13	1.52	0.65	0.80	0.85
14	2.00	0.80	1.05	1.15
15	2.25	0.95	1.08	1.19
16	3.02	1.05	1.38	1.24

Oxygen-consumption as a function of body size in relation to temperature :

From the study of the data given in Tables I and II it could be seen that the oxygen-consumption in clams increases with increase in body weight at all the temperatures studied. However, this increase in oxygen-consumption with increase in body weight is not the same at the three temperatures, which is apparent from the regression coefficients of the size metabolism curves. The regression coefficient of oxygen-consumption in relation to body size is maximal in both the species at 20°C and decreases as the temperature increases. The straight lines of the size metabolism curves also suggest that throughout the weight range studied the oxygen-consumption increases with the same power of body weight. From Tables I and II, it could be also seen that at any given temperature, the oxygen-consumption per unit of time is lesser in smaller clams than in larger ones.

From the curves given in Figs. 1 and 2 the values of weight specific QO_2 or the unit oxygen-consumption, (O_2 ml/gm/hr), were calculated for the representative weight of clams. These are given in Tables III and IV.

TABLE III

OXYGEN-CONSUMPTION PER GRAM OF BODY WEIGHT PER HOUR IN *M. meretrix* OF DIFFERENT WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		20°C	30°C	40°C
1	0.50	0.32	0.54	0.76
2	0.75	0.30	0.48	0.62
3	1.00	0.29	0.42	0.53
4	2.00	0.29	0.35	0.39
5	3.00	0.28	0.30	0.31
6	4.00	0.28	0.29	0.29

The values are calculated from the size metabolism curves presented in Fig. 1.

TABLE IV

OXYGEN-CONSUMPTION PER GRAM OF BODY WEIGHT PER HOUR IN *K. opima* OF DIFFERENT WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		20°C	30°C	40°C
7	0.50	0.54	0.72	0.94
8	0.75	0.48	0.60	0.74
9	1.00	0.45	0.55	0.66
10	2.00	0.39	0.43	0.45
11	3.00	0.38	0.42	0.42
12	4.00	0.32	0.32	0.32

The values are calculated from the size metabolism curves presented in Fig. 2.

From Tables III and IV, it would be seen that the unit oxygen-consumption (O_2 ml/gm/hr) decreases with increasing body weights of clams at all temperatures studied. However, this decrease in unit oxygen-consumption is more conspicuous at 40°C and 30°C than at 20°C.

Oxygen-consumption as a function of temperature :

The values of regression coefficient 'b' are given in Table V.

TABLE V

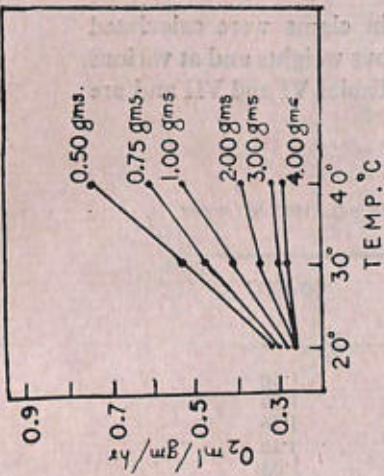
Species	Temperature		
	20°C	30°C	40°C
<i>M. meretrix</i>	0.94	0.66	0.57
<i>K. opima</i>	0.75	0.66	0.50

The size metabolism curves given in Figs. 1 and 2 show that the 'b' (Table V) value decreases with increase in temperature and in *M. meretrix* is 0.94 at 20°C, 0.66 at 30°C and 0.57 at 40°C; whereas in *K. opima* it is 0.75 at 20°C, 0.66 at 30°C and 0.50 at 40°C. This decrease in 'b' value with increase in temperature indicates that the increase in oxygen-consumption in larger clams with increase in temperature is lesser than in smaller clams, and therefore, smaller clams can be regarded as more sensitive to temperature changes than the larger ones.

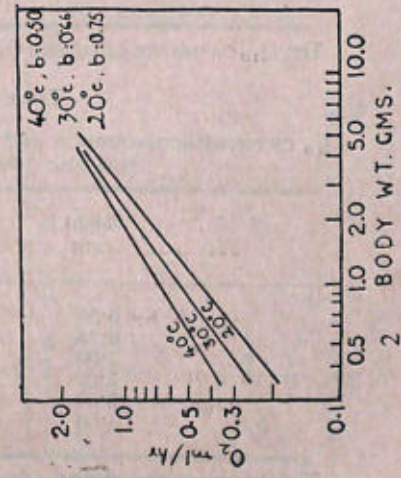
The unit oxygen-consumption values of clams of different weights are given in Tables III and IV and are plotted as rate-temperature curves in Figs. 3 and 4. The examination of these curves also indicates that the weight or body size of the clam is an important parameter in influencing the pattern of metabolic response at various temperatures. It will also be seen from these curves that the smaller clams are more sensitive to temperature changes than the larger ones in both the species studied. Thus in 1.00 gm clam of *Meretrix meretrix* the weight specific QO_2 rises from 0.42 to 0.53 when the temperature rises from 30°C to 40°C and drops from 0.42 to 0.29 when the temperature drops from 30°C to 20°C. The corresponding rise and fall in 3.00 gm clam is very much less. In case of *K. opima* also a similar trend is seen, the weight specific QO_2 rises from 0.55 to 0.66 with the rise in temperature from 30°C to 40°C and falls from 0.55 to 0.45 with the fall in temperature from 30°C to 20°C. The corresponding increase or decrease in case of 3.00 gm clam is much smaller.

Q₁₀ as a function of temperature :

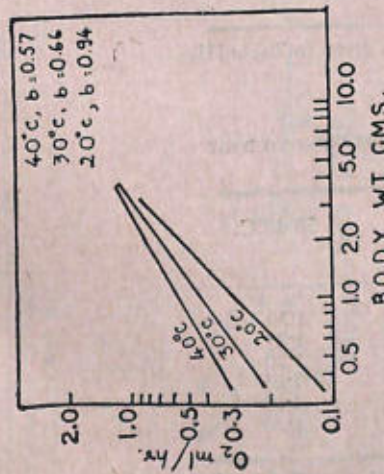
To describe the magnitude of temperature effect on respiratory processes, the frequently used expression Q_{10} is a convenient



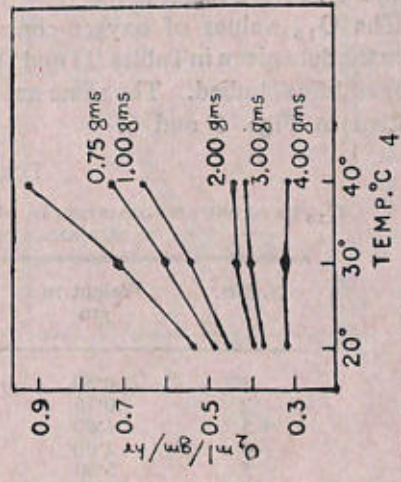
1



2



3



4

FIG. 1. Total oxygen-consumption in *M. meretrix* as a function of body size at different temperatures. (20°C, 30°C and 40°C).
 FIG. 2. Total oxygen-consumption in *K. opima* as a function of body size at different temperatures. (20°C, 30°C and 40°C).
 FIG. 3. Rate of oxygen-consumption (O_2 ml/gm/hr) as a function of temperature in *M. meretrix*.
 FIG. 4. Rate of oxygen-consumption (O_2 ml/gm/hr) as a function of temperature in *K. opima*.

measure over the biological temperature range. It is a factor by which a reaction velocity is increased for a rise of temperature of 10 degrees.

$$Q_{10} = (K_2/K_1)^{\frac{10}{t_1-t_2}}$$

where K_1 and K_2 are velocity constants corresponding to temperatures t_1 and t_2 .

The Q_{10} values of oxygen-consumption in clams were calculated from the data given in Tables III and IV for various weights and at various temperatures studied. The same are given in Tables VI and VII and are plotted in Figs. 5 and 6.

TABLE VI

Q_{10} OF OXYGEN-CONSUMPTION IN *M. meretrix* IN RELATION TO BODY SIZE AND TEMPERATURE

S. No.	Weight in gm	20-30°C	30-40°C
1	0.50	1.70	1.40
2	0.75	1.60	1.29
3	1.00	1.40	1.26
4	2.00	1.26	1.15
5	3.00	1.07	1.03
6	4.00	1.03	1.00

The Q_{10} values are calculated from the data given in Table III.

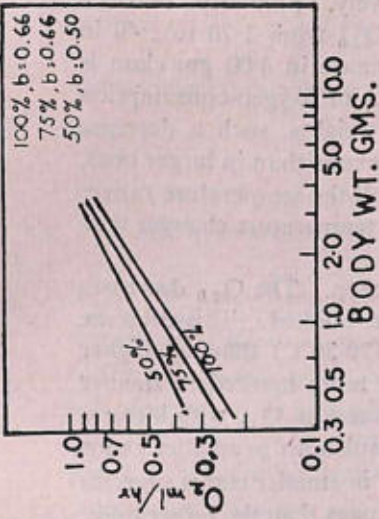
TABLE VII

Q_{10} OF OXYGEN-CONSUMPTION IN *K. opima* IN RELATION TO BODY SIZE AND TEMPERATURE

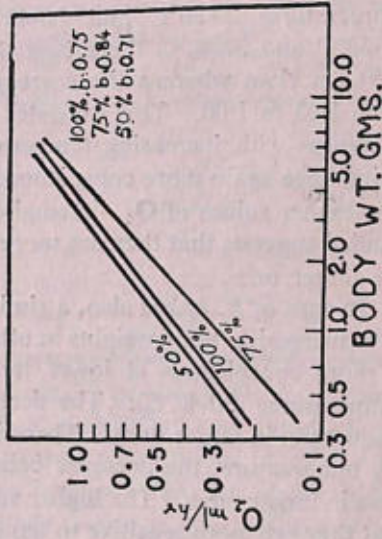
S. No.	Weight in gm	20-30°C.	30-40°C.
7	0.50	1.33	1.30
8	0.75	1.25	1.23
9	1.00	1.22	1.20
10	2.00	1.10	1.05
11	3.00	1.10	1.00
12	4.00	1.00	1.00

The Q_{10} values are calculated from the data given in Table IV.

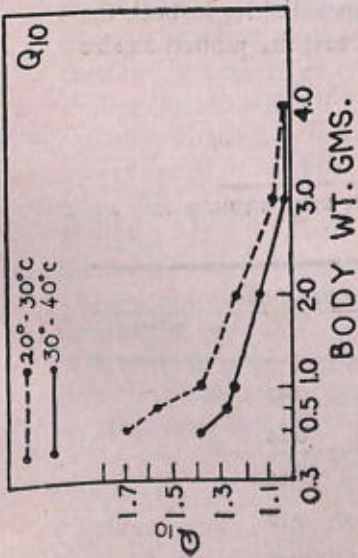
In case of *M. meretrix* Q_{10} values are size dependent at all temperatures studied. It systematically decreases with increase in body weight at all the temperatures studied. However, this trend is more conspicuous at temperature range of 20-30°C than at 30-40°C. It will also be seen that the decrease in Q_{10} at both the temperature ranges is more marked



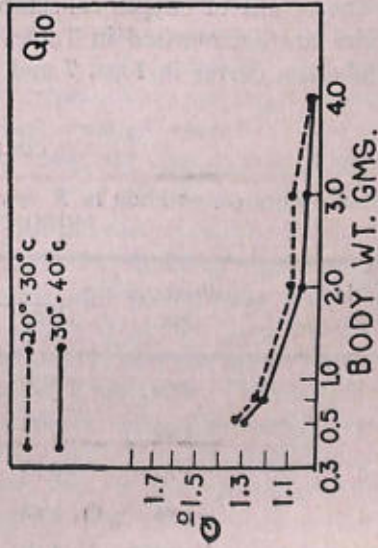
7



8



5



6

FIG. 5. Q_{10} of oxygen-consumption in *M. meretrix* as a function of body size at different temperature ranges.
 FIG. 6. Q_{10} of oxygen-consumption in *K. opima* as a function of body size at different temperature ranges.
 FIG. 7. Total oxygen-consumption in *K. opima* as a function of body size at different salinities (100%, 75% and 50% sea water).
 FIG. 8. Total oxygen-consumption in *M. meretrix* as a function of body size at different salinities (100%, 75% and 50% sea water).

in smaller clams than in the larger ones. Thus the Q_{10} between 0.50 gm and 2.00 gm clams, drops from 1.70 to 1.26 between 20-30°C and from 1.40 to 1.15 between 30-40°C whereas the corresponding drop between 2.00 and 4.00 gm clams is from 1.26 to 1.03 and 1.15 to 1.00 between temperatures 20-30°C and 30-40°C respectively. Similarly between 20-30°C and 30-40°C there is a decrease in Q_{10} from 1.70 to 1.40 in 0.50 gm clam whereas the corresponding decrease in 4.00 gm clam is from 1.03 to 1.00. This indicates that the Q_{10} of oxygen-consumption decreases with increasing temperature at all weights, such a decrease being once again more conspicuous in smaller clams than in larger ones. The higher values of Q_1 in smaller clams at all the temperature ranges studied suggests that they are more sensitive to temperature changes than the larger ones.

In case of *K. opima* also, a similar trend is seen. The Q_{10} decreases with increasing body weights at all temperatures studied. This decrease is more conspicuous at lower temperatures (20-30°C) than at higher temperatures (30-40°C). The decrease is also more marked in smaller clams than in larger ones. There is also a decrease in Q_{10} with increasing temperature, the decrease being more conspicuous in smaller clams than in larger ones. The higher values of Q_{10} in smaller clams suggests that they are more sensitive to temperature changes than the larger ones.

Oxygen-consumption as a function of body size in relation to salinity :

The results of oxygen-consumption at various salinities in both the species are summarised in Tables VIII and IX and are plotted as size metabolism curves in Figs. 7 and 8.

TABLE VIII

TOTAL OXYGEN-CONSUMPTION IN *K. opima* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		100%	75%	50% sea water
1	0.60	0.29	0.36	0.45
2	1.03	0.45	0.51	0.58
3	1.52	0.52	0.59	0.66
4	1.98	0.63	0.70	0.79
5	2.20	0.70	0.81	0.87
6	3.02	0.85	0.95	1.26

TABLE IX

TOTAL OXYGEN-CONSUMPTION IN *M. meretrix* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen consumed ml/hr			
		100%	75%	50%	sea water
7	1.00	0.40	0.32	0.52	
8	1.25	0.50	0.38	0.58	
9	1.58	0.62	0.46	0.70	
10	2.00	0.73	0.58	0.80	
11	2.51	0.86	0.75	0.96	
12	3.16	0.95	0.96	1.10	

From the data given in Table VIII it could be seen that the oxygen-consumption in *K. opima* increases with increasing body weight at all the salinities studied. However, the regression coefficients of the size metabolism curves presented in Fig. 7 show that the increase in oxygen-consumption with increase in body weight is not the same at all salinities studied. The regression coefficient of oxygen-consumption in relation to body size is maximal in 100% sea water ($b=0.66$) and decreases as the salinity decreases. The straight lines of the size metabolism curves also suggest that throughout the weight range studied, the oxygen-consumption increases with the same power of body weight. It is also evident from Table VIII that at any given salinity the oxygen-consumption per unit time is less in smaller clams than in larger ones.

In case of *M. meretrix* (Table IX), however, the trend is slightly different. The oxygen-consumption increases with increase in body weight at all the salinities studied. However, this increase in oxygen-consumption with increase in body weight is not the same at all the salinities studied. The regression coefficient of oxygen-consumption on body weight is maximal in 75% sea water ($b=0.84$) instead of in 100% sea water as in case of *K. opima*. The regression coefficient decreases as the salinity either increases above or decreases below 75% sea water. This is rather an interesting behaviour and will be discussed later. The straight lines of the size metabolism curves suggest that throughout the weight range studied, the oxygen-consumption increases with the same power of body weight. From Table IX it is also evident that at any given salinity the oxygen-consumption per unit time is less in smaller clams than in larger ones.

From the curves given in Figs. 7 and 8 the values of weight specific QO_2 or the unit oxygen-consumption (O_2 ml/gm/hr) were calculated

for the representative weights of clams. These are given in Tables X and XI.

TABLE X

OXYGEN-CONSUMPTION PER GRAM BODY WEIGHT PER HOUR IN *K. opima* OF DIFFERENT WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		100%	75%	50% sea water
1	0.50	0.56	0.64	0.81
2	0.75	0.46	0.53	0.65
3	1.00	0.37	0.44	0.50
4	2.00	0.32	0.35	0.39
5	3.00	0.30	0.31	0.32
6	4.00	0.30	0.31	0.32

The values are calculated from the size metabolism curves presented in Fig. 7.

TABLE XI

OXYGEN-CONSUMPTION PER GRAM BODY WEIGHT PER HOUR IN *M. meretrix* OF DIFFERENT WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		100%	75%	50% sea water
7	0.50	0.52	0.36	0.62
8	0.75	0.48	0.34	0.56
9	1.00	0.40	0.32	0.50
10	2.00	0.34	0.27	0.40
11	3.00	0.33	0.25	0.37
12	4.00	0.31	0.25	0.33

The values are calculated from the size metabolism curves presented in Fig. 8.

From Table X it could be seen that in *K. opima* the unit oxygen-consumption decreases with increasing body weight at all the salinities studied, such a decrease being more conspicuous in 50% and 75% sea water than in 100% sea water. However, in *M. meretrix* (Table XI) though the unit oxygen-consumption decreases with increasing body weight at all salinities, the decrease is more conspicuous in 50% and 100% than in 75% sea water.

Oxygen-consumption as a function of salinity :

The values of regression coefficient 'b' are given in Table XII.

TABLE XII

Species	Percentage of sea water		
	100%	75%	50%
<i>K. opima</i>	0.66	0.60	0.50
<i>M. meretrix</i>	0.75	0.84	0.71

The size metabolism curves given in Figs. 7 and 8 show that the 'b' value of the curve varies with the salinity. In *K. opima* the 'b' value decreases with decrease in salinity which is 0.66 in 100%, 0.60 in 75% and 0.50 in 50% sea water. This decrease in 'b' value with decrease in salinity indicates that the increase in oxygen-consumption in larger clams with decrease in salinity is less than in smaller clams and can, therefore, be regarded as being more sensitive to salinity changes than the larger ones.

As stated above in case of *M. meretrix* the 'b' value is maximal in 75% sea water ($b=0.84$) and decreases above ($b=0.75$) and below ($b=0.71$) this concentration. This decrease in 'b' value on either side of 75% sea water also appears to be on account of the less increase in oxygen-consumption in larger clams than in smaller ones with the change in the salinity. The smaller clams can, therefore, be regarded as more sensitive to changes in salinity either decrease below or increase above 75% sea water.

The unit oxygen-consumption values given in Table X for *K. opima* indicate that the weight or body size is an important parameter in influencing the pattern of metabolic response at various salinities. The smaller clams are more sensitive to salinity changes than the larger ones. Thus in case of 0.50 gm clam the weight specific QO_2 rises from 0.56 to 0.64 and to 0.81 as the salinity decreases from 100% to 75% and to 50% sea water. However, the corresponding rise in 4.00 gm clam is very much less.

In case of *M. meretrix* (Table XI) the weight specific QO_2 drops from 0.52 to 0.36 in a 0.50 gm clam as the salinity drops from 100% to 75% sea water and then rises from 0.36 to 0.62 as the salinity further drops to 50% sea water. But the corresponding drop and rise in a 4.00 gm clam is much less. This also indicates that the smaller clams are more sensitive to changes in the salinity than the larger ones.

DISCUSSION

It has been well established that the metabolism of animals is considerably influenced by body size and temperature, of the environment. Similarly the tendency for the rate of metabolism in animals to vary with some power of body weight has been recognised and discussed by Zeuthen (1947, 1953). There is a general concept that the weight specific QO_2 is higher for smaller animals than the larger ones when measured at a given temperature for a given species and, therefore, if the logarithm of rate of oxygen-consumption is plotted as a function of logarithm of weight a linear relationship is obtained.

On the basis of the magnitude of metabolic rate in relation to body size, Bertalanffy (1951) has classified animals into three major groups of metabolic types by using the slope of the regression line of the logarithm of metabolic rate against the logarithm of body weight. According to him the three types are :—

- (1) respiration surface-proportional, the allometric line showing a slope of $2/3$ ($b=0.67$);
- (2) respiration weight proportional ($b=1.00$) and
- (3) intermediate group which is neither surface nor weight proportional ($b > 0.67$ and $b < 1.00$).

However, the relationship of body size to metabolism has been a subject of controversy. In a majority of cases amongst fishes, Bishop (1950) and Fry (1957) have shown that the increase in oxygen-consumption with size is surface area dependent rather than weight dependent. On the other hand intermediate condition has been shown by Job (1955) in *Salvelinus fontinalis* ($b=0.8$ to 0.9) and Parvatheswararao (1959) in *Eutoplus maculatus* ($b=0.77$). Job (1955) has discussed the metabolic response to body size in fishes and states, 'it seems rather likely that the Pisces fall into at least two of the Bertalanffy's metabolic types, some being of the first group i.e. surface proportional and others of an intermediate type neither surface nor weight proportional'. However, Parvatheswararao (1960) found that in *Puntius sophoro* the increase in oxygen-consumption is nearly weight dependent ($b=0.96$ and 0.91) nearabout the habitat temperature (25°C and 30°C). He has further shown the influence of temperature on this relation, the increase in oxygen-consumption following surface area dependence at 35°C ($b=0.59$) and intermediate condition at 15°C ($b=0.86$).

Studies on the different invertebrate groups have also revealed that the value of 'b' changes within a group of animals and is not constant for the same species under different environmental conditions and at different developmental stages. This has been shown by Rao & Bullock (1954) and Zeuthen (1953). Thus for crustacea (Wolvekamp & Waterman

1960) the 'b' is generally between 0.67 and 1.00 i.e. between surface proportional to weight proportional. Kruger (1952) and Saroja (1959) have shown that the oxygen uptake is proportional to surface area in case of *Eisenia foetida* and *Megascolex mauritii* respectively. Recently Conover (1960) has shown that in case of *Artemia salina* the regression coefficient varies from 0.67 at 5°C to 0.93 at 13°C indicating two very different metabolic types. Zeuthen (1953, Fig. 4) has plotted metabolism and body size in different animals from eggs or larvae into mature stages. In the figure he has shown that in case of *Mytilus* sp. the 'b' value increases from 0.80 to 0.95 and then decreases to 0.65 as the animal grows.

In the present investigation it will be seen that in both the species studied the regression values ($b=0.66$) nearabout the habitat temperature (30°C) indicate that the increase in oxygen-consumption is surface area dependent, however, an intermediate condition is seen in *K. opima* at 20 and 40°C. and in *M. meretrix* at 40°C., whereas the latter species shows that the oxygen-consumption may follow weight dependence at 20°C.

From the size metabolism curves presented in Figs. 1 and 2 it will be seen that the oxygen-consumption in clams increases with the same power of body weight at any given temperature throughout the weight range studied. Conversely, the unit oxygen-consumption decreases with increasing body weight this decrease being marked at 40°C. Thus the unit oxygen-consumption in *M. meretrix* decreases from 0.76 to 0.29 at 40°C, whereas the corresponding decrease at 30°C and 20°C is only from 0.54 to 0.29 and 0.32 to 0.28 respectively, between 0.5 and 4.0 gm clam. Similarly the decrease in *K. opima* is from 0.94 to 0.32 at 40°C the corresponding decrease at 30° and 20°C being from 0.72 to 0.32 and 0.54 to 0.32, respectively in 0.5 and 4.0 gm clam. If we consider 30°C as the habitat temperature then it will be seen that the size metabolism curves for 40°C and 20°C (Figs. 1 and 2) considerably deviate from the curve for 30°C. There is widest displacement of curves between 30°C and 20°C in *M. meretrix*, and less so in *K. opima* than between 30°C and 40°C. The curve for 20°C has the maximum slope. The displacement of curves is also more conspicuous in younger clams than in larger ones indicating that the former ones are more sensitive to changes in temperature than the latter.

In both the species of clams, the regression coefficients of size metabolism curves are shown to be temperature dependent. The 'b' values decrease with increasing temperature and appear to be correlated with the greater responsiveness of smaller clams than the larger ones. When the temperature is lowered (20°C) the curve towards lower weight ranges is pulled down, similarly when there is rise in temperature (40°C) the curve rises mainly due to the more sensitive nature of smaller clams

than the larger ones to changes in temperature. Therefore, the smaller clams have higher Q_{10} values at these two temperature ranges.

In case of both the species studied, the Q_{10} of oxygen-consumption is size dependent at all the temperatures, decreasing with increasing body weight, the dependence being more marked in lower temperature ranges than the higher ones. The Q_{10} also decreases with increasing temperature, the decrease being more marked in smaller clams indicating that they are more sensitive to changes in temperature than the larger ones. Rao & Bullock (1954) have shown that in many poikilotherms the Q_{10} decreases with increasing body weight within the physiologically normal range of temperature. In the present case also the Q_{10} decreases with increasing body weight at all the temperature ranges studied and it also decreases with increasing temperature.

As in respect of metabolism in relation to temperature in clams, salinity also has considerable influence on their metabolic activity. In *K. opima* in 100% sea water, the increase in oxygen-consumption is surface area dependent ($b=0.66$). The oxygen-consumption increases with decrease in salinity and in 75% sea water ($b=0.60$) and in 50% sea water ($b=0.50$) an intermediate condition is observed. In *M. meretrix* the oxygen-consumption shows an intermediate condition in all the salinities studied. However, in 100% and 50% sea water there is a slight tendency towards surface area dependence ($b=0.72$ in 100% and $b=0.71$ in 50% sea water). The slight high value of 'b' (0.72) in 100% sea water as compared with that at 30°C given earlier ($b=0.66$) may perhaps be on account of the difference in the experimental temperature which in the present case was around 29°C.

From the size metabolism curves presented in Figs. 7 and 8 it will be seen that the oxygen-consumption in clams increases with the same power of body weight at any given salinity throughout the weight range studied. Conversely the unit oxygen-consumption decreases with increasing body weight, this decrease being more marked in 50% sea water. Thus the unit oxygen-consumption in *K. opima* decreases from 0.81 to 0.32 in 50% sea water whereas the corresponding decrease in 75% and 100% sea water is from 0.64 to 0.31 and from 0.56 to 0.30 respectively between 0.5 and 4.0 gm clam. Considering 100% sea water as the habitat salinity, in which the clams show minimum activity, it will be seen that the curve for 75% and 50% sea water considerably deviates from the curve for the 100% sea water, which has the maximum slope. It is also evident from the curves that the displacement is more conspicuous in smaller clams than in larger ones, indicating that the former are more sensitive to salinity changes.

In *M. meretrix* also the unit oxygen-consumption decreases from 0.63 to 0.33 in 50% sea water whereas the corresponding decrease in 75% and 100% sea water is from 0.36 to 0.25 and 0.52 to 0.31 respectively

between 0.5 and 4.0 gm clam. However, in this species the maximum slope ($b=0.84$) is obtained in 75% sea water instead of 100% sea water ($b=0.72$). This is rather a peculiar behaviour. Thus this species shows minimum activity in 75% sea water and not in 100% sea water as in *K. opima*. Therefore, unlike *K. opima* in which the oxygen-consumption increases with decrease in salinity in *M. meretrix* the oxygen-consumption decreases with decrease in the salinity from 100% to 75% sea water, in which the minimum activity is noticed. With further reduction in the salinity from 75% to 50% sea water, however, the oxygen-consumption increases. Considering the importance of 'b' value it is likely that *M. meretrix* is more at home in 75% sea water than in 100% sea water and, therefore, could be considered as more adapted to low salinity conditions than *K. opima*. From the experiments conducted on the salinity tolerance in the two species, it has been found that *M. meretrix* is more tolerant to low salinity conditions than *K. opima*, and has, therefore, succeeded better in invading estuaries and backwaters and is often found quite far up the river. The metabolic response in this species, in relation to salinity, showing minimum activity in 75% sea water (salinity=25.5‰), also lends support to this idea. Presuming that 75% sea water as the natural requirement for *M. meretrix* (ideal habitat salinity) it will be seen that the oxygen-consumption increases with either increase or decrease in this salinity, perhaps on account of the osmotic stress either ways, to be discussed later. Considering 75% sea water as ideal habitat salinity, it will be observed that the curves for other two salinities considerably deviate from the one for 75% sea water, the displacement being more conspicuous in smaller clams than the larger ones, indicating their more sensitive nature to changes in the salinity, either above or below the ideal salinity.

Considerable amount of work has been done on the effects of osmotic conditions of the metabolic activities. It is well-known that the animals show an increase in metabolism when placed in stress media. *Carcinus maenas* shows an increase in oxygen-consumption with decrease in salinity (Schlieper 1929). Flemister & Flemister (1951) found lowest oxygen-consumption in sea water (378 mM Cl/L) isotonic with the crab blood in case of *Oecypoda albicans*, but more hypotonic than the field conditions (480 mM Cl/L). They found that the oxygen-consumption increased as the sea water varied from isotonicity, highest being in hypotonic media. More or less similar results were obtained by Schwabe (1933) in case of cray fish *Potamobius fluviatilis*. The observations made by the abovementioned authors suggest that the increase in oxygen-consumption has resulted from increased osmotic work. But Gross (1957) has shown that in *Uca* oxygen-consumption did not always increase with osmotic stress. Marshall *et al.* (1935) also found that there was 30% reduction in oxygen-consumption when measured in 50% sea water

than in normal sea water (salinity=34‰). Potts (1954) also has shown that in *Eriocheir* only a very small fraction of increased oxygen-consumption represents osmotic work done. The results of Gross (1957), Marshall *et al.* (1935) and Potts (1954) are not in agreement with those of the earlier quoted authors.

The tendency for CO₂ to accumulate in lower salinities, resulting in increased respiratory rate has been suggested by Schlieper (1929). Another interpretation of increased oxygen-consumption with lowering of salinity was proposed by Schlieper (1935) on the idea that due to absorption of water in low salinity, the volume of tissue and surface is increased facilitating absorption and hence oxygen-consumption. Wikgren (1953) is of opinion that increase in oxygen-consumption is not due to osmotic regulation but either on account of swelling of tissues as suggested by Schlieper (1935) or by its influence on the endocrine balance. Violent attempts to escape from unfavourably low salinity, leading to extra muscular activity, resulting in increased oxygen-consumption has been suggested by Gross (1957) in the crab *Pachygrapsus*. Dehnel (1960) who studied metabolic response in *Hemigrapsus oregonensis* and *Hemigrapsus nudus* in relation to temperature and salinity, found results in the former species which could be considered as in accordance with Gross (1957) or Schlieper (1935); whereas in the other species the results were contradictory. Lofts (1956) compared respiratory rate of *Palaeomonetes varians* from two different populations, one from low saline environment (salinity=1.3‰) and the other from high saline environment (salinity=23.5‰), and found minimal respiratory rate in water of salinity 26.00‰ for high salinity population, a condition which was isotonic with the animal, whereas the minimal rate in low salinity population was found in salinity 6.00‰, a condition somewhat hypertonic to the environment in which these animals were found. Rao (1958) who compared oxygen-consumption in marine and brackish water populations of *Metapenaeus monoceros*, found that prawns from marine environment showed minimum activity in 100% sea water (salinity=35.5‰) whereas the minimum metabolic activity in prawns from brackish water environment was exhibited in 50% sea water (salinity=16.75‰), their oxygen-consumption increasing in 100% sea water. In both the groups of prawns the oxygen-consumption increased with decrease in salinity below the habitat salinity, and in the brackish water population the increase was also effected as the salinity increased to 100% sea water. He suggested that these differences may be due to osmotic adaptation and operation of a metabolic homeostatic mechanism in relation to osmotic regulation.

The results obtained in the present investigation on the metabolic response in clams, though it involves two different species from the same environment, could be favourably compared on the strength of meta-

bolic response as those belonging to two groups of populations physiologically, one, *M. meretrix* as more adapted to low saline environment (25.5‰) and the other *K. opima* as adapted to marine environment (34.0‰). Therefore, the minimum activity in *M. meretrix* is found in salinity 25.5‰ and in *K. opima* in salinity 34.0‰. Hiscock (1953) states, 'In euryhaline marine species oxygen-consumption is at its lowest when the external medium is isotonic and rises as the later becomes hypo or hypertonic to the blood'. No data is available on the osmoregulation in these clams and, therefore, it is not possible to say whether isotonic condition is found in *M. meretrix* when exposed to 75% sea water and in *K. opima* in 100% sea water. It would be very interesting to study this aspect which might throw some light on the metabolic response in clams in relation to salinity. It is only suggested here that the differential metabolic response in clams to different saline media might be due to osmotic stress, though possibilities of increase in oxygen-consumption on account of absorption of water and subsequent swelling of the tissues, as suggested by Schlieper (1935) cannot be completely overruled in absence of any data on this aspect. In the experiments described earlier (Ranade & Kulkarni 1972) on the opening of the shell valves in relation to salinity, it has been shown that the opening of the valves in clams is progressively delayed as the salinity of the environment decreases. So in media hypotonic to blood, the closing of the shell valves relieves the animal from osmotic embarrassment. When the clams open after some time, depending on the strength of the solution, chloride ions are lost. These are perhaps replaced by active absorption from the environment as suggested by Krogh (1939). This process must require energy and hence the increase in the rate of oxygen-consumption with decrease in the salinity of the external medium.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—14

Meropidæ and Coraciidæ

BY

HUMAYUN ABDULALI

[Continued from Vol. 69 (3) : 546]

This part deals with 302 specimens of 20 species and subspecies upto No. 762 in IND. HANDBOOK (4: 123) and No. 23692 of the Society's register. Mr. S. A. Hussain, Research Assistant, assisted with measurements.

744 *Merops leschenaulti leschenaulti* Vieillot (Java, *errore* Ceylon)
Chestnutheaded Bee-eater 4 : 240

21 : 10 ♂♂ (3 juv.) 8 ♀♀ 3 o ?

1 Sawantwadi; 1 Kadra, Kanara; 2 Coonoor Ghats, Nilgiris; 2 Manalur, Palni Hills; 1 Rajaputtee, Saran, Bihar; 1 Kurseong Division; 2 Goalpara, 1 Shillong, 2 Rema T.E., Sylhet, 1 N. Cachar, Assam; 2 *Singhaling*, *Hkanati*, 1 *Manswa*, *W. Bank*, *Chindwin*; 1 *Mogok*, *Ruby Mines*; *1 *Thayetmyo*; 1 *Sandoway Dt.*; 1 *Ngewpharo*, *Prome Dt.* *missing.

The males and females, and northern and southern birds show no differences in size.

	Wing	Bill	Tail
16 ♂♂	104-110 av. 106.5 (IH 104-111)	26-33 av. 31.5 from skull 35-40	76-85 av. 81.3 76-84)

The tail is slightly forked with the central pair of feathers projecting into the gap, but not as long as the outermost. Of the three juvenile males, with incomplete breastbands, one with a short bill has green on the forehead while another older bird has green at the rear end of the chestnut cape.

As this bird does not appear to have been recorded from Bihar, I may mention that Mr. D. E. Reuben saw a Chestnutheaded Bee-eater in his compound at Patna, Bihar, on 7 March 1953 (pers. comm.).

745 *Merops leschenaulti andamanensis* (Marien) (Port Blair, South Andaman Island) Andaman Chestnutheaded Bee-eater

7 : 5 ♂♂ 2 ♀♀

3 Wrightmyo, 2 Bambooflats, 1 Port Blair, 1 South Andaman.

746 *Merops apiaster* Linnaeus ('Europa australi; oriente') European
Bee-eater 4 : 233

27 : 8 ♂♂ 11 ♀♀ (2 juv.) 8 o? (3 juv.)

1 Amara, 1 Shushan Mounds, 1 Zinjan, Karim Tabriz, (?) Mesopotamia; 1 Fad,
1 Mishim, 1 Persian Gulf; 5 Shiraz, 1 Kain, Persia; 1 Randha Tanhat, Yemen,
1 Muscat, Arabia; 4 Mastung, Baluchistan; 1 Quetta, 1 Peshawar, 4 Chitral;
2 Srinagar, 1 Kashmir.

	Wing	Bill	Tarsus	Tail
♂♂	145-157 av. 151.5 (IH 144-156)	34-37 av. 36 from skull 37-44	12-14 12-14	108-118 108-120
♀♀	144-146, one 157 (?) (IH 138-148)	32-36 av. 35 —	11-12 —	100-112 —

14 in summer plumage between 14 February and 13 June.

8 in winter plumage between 30 May and 30 September.

5 juveniles 4 May to 14 October.

747 *Merops superciliosus persicus* Pallas (Shores of the Caspian Sea)
Bluecheeked Bee-eater 4 : 239

40 : 14 ♂♂ (4 juv.) 8 ♀♀ (2 juv.) 18 o? (7 juv.)

3 Muscat, 2 Siyahad (? Philby), Arabia; 1 Amara, 2 Shaiba, 2 Nahr Umar, Basrah;
1 Mesopotamia; 1 Fao, 3 Bahm-i-Shur, 1 Boghan on Nihing, Persian Baluchis-
tan; 2 Harbud, about 55 m east of Panjgur, 2 Teghab, 107 m south of Kalat,
1 Shinzai, Patti, Baluchistan; 2 Hyderabad, Sind; 1 Bharatpur; 1 Hamavas
Lake, Pali Dist., Jodhpur; 1 Bhuj, Kutch; 2 Bhavnagar, 1 Ajwa, Baroda;
1 Ghoti, 1 Dindori, Nasik; 7 Thana Dist.; 2 Kihim, Kolaba Dist.

This race is currently accepted as breeding from Palestine eastwards through Iraq to Baluchistan and north-western India, having been found nesting as far south as Bhavnagar in Gujarat arriving there in May. The young of the year (juveniles) are duller in colour and show more blue and less green on the underparts and on the rump. The central tail-feathers though projecting a few millimetres beyond the others are not attenuated as in the adults. Nine of the 18 birds obtained in India are in this plumage.

Among the adults there are differences in the intensity of colour but extra-limital specimens appear more green than those from India. Accepting one complete moult between November and January (Marien, *JBNHS* 49 : 158) the 12 birds in fresh (green) plumage are 4 in March, 5 April, 2 May, and 1 June *contra* 11 in worn (bluish) plumage 1 in April, 1 July, 4 August, 2 September, 1 each October, November, and December. Except for shorter tails, 90-140 av. 108 *contra* 130-150 av. 129, there is no difference in measurements. The small proportion of sexed birds does not suggest any difference in size between males and females, and all are measured together.

	Wing	Bill	Tarsus	Tail
Ad. ♂♀	130 (next 141)-157 av. 149 (146-160)	36-44 av. 38 35-44	11-12 11-12	90-150 135-148)
Imm. ♂♀	135-145 av. 140	35-41 av. 38	11-12	86-101 av. 94

[243]

Sp. No. 11160 ♂ Kalat, Baluchistan has the second outermost tail-feather blunt and not attenuated but projecting 15 mm beyond the others.

748 *Merops philippinus philippinus* Linnaeus (Philippine Islands)
Bluetailed Bee-eater 4: 237

30: 16 ♂♂ 11 ♀♀ 3 o?

1 Simla Hills, 2 Jagadhri, Ambala; 1 Mandi, Dhar State, C.I.; 1 Thana Creek; Bombay, 1 Ratnagiri; 2 Karwar; 1 Karupadana, Travancore State, 1 Cumbum Valley, 2 Krishna Dt., 1 Vizagapatnam, A.P.; 1 Cuttack, Orissa; 3 Baghowni, Tirhut; 1 Kahanpur, Cawnpore, 2 Kumaon, Naini Tal; 1 Dibrugarh, 2 Assam; 1 Maymyo, 1 Bambooflats, 1 South Andamans; 1 Camorta, 2 Trinkut, Central Nicobars; 1 *Henzada, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	121-136 av. 131 (IH 133-139)	38-41 av. 38.5 from skull 45-48	10-12 11-13	120-146 av. 134 130-141
♀♀	127-133 av. 130 (IH 126-131)	35-40 av. 37 from skull 43-46	10-12 —	115-141 av. 127 115-136

The juveniles, with no pinfeathers in the tail but otherwise almost fully grown, have paler rufous throats and the underparts more bluish than green. No. 11145 ♀ Baghowni, Tirhut is younger (bill 28 mm, wings and tail in moult) but approaches the adults in colour.

749 *Merops orientalis beludschicus* Neumann (Sarbaz, Persian Baluchistan) Sind Small Green Bee-eater 4: 236

6: 4 ♂♂ 1 ♀ 1 o? (juv.)

1 Mand, Iraq; 2 Mishun, 2 Charbar, 1 Baba Kallu, Persian Gulf.

The four adult males with pins in the tail have pale blue underparts which, together with the general paleness all over, immediately separate them from all specimens from India and Pakistan, which show a fair amount of variation among themselves.

The single female (wing 95, bill 25), which lacks the tail pins and the black pectoral band, is varying shades of pale blue and white (reminiscent of a Verditer Flycatcher) with no green and very different from females of the nominate form. The juvenile is, to use Ticehurst's words, a washed-out edition of the adult.

The type locality Sarbac=Sarbaz (Vaurie) is only a hundred miles from Chah Bahar (Charbar) in Persian Baluchistan along the coast of Gulf of Oman, west of Indian (Pakistan) limits. Two birds from Gajar 2200' and Korak 1900', which are noted as 165 and 185 m respectively S.S.W. of Kalat, Baluchistan, are quite different, and though slightly paler can be included among the variations in the Indian birds. They are marked *beludschicus* by Ticehurst (?).

Ticehurst (1923, Birds of Sind, *Ibis* p. 29) refers to comparison of Sind birds, which he calls *beludschicus*, with topotypes (the type locality is not mentioned) and states 'they are paler blue on the throat, paler

below and less bronzy on the nape than Southern Indian birds. This race extends to the lower Punjab and Jodhpur at all events.'

This was before publication of Vol. 4 of Stuart Baker's FAUNA (1927) and it is not known what specimens or literature were available to Ticehurst.

Specimens from Rawalpindi, Jullundur, Ambala, Bahawalpur, and Jodhpur can be unhesitatingly left with nominate *orientalis* as has been done below.

Having regard to the reports of later authors, e.g. Marien (*JBNHS* 49: 162) and the material available, I cannot help feeling that a mistake has been made in accepting all birds from Baluchistan as *beludschicus* and then having difficulty in establishing that they are different from those from India. Though *beludschicus* may (?) extend towards Karachi along the coast, it does not occur all over Baluchistan and Sind and our westernmost birds, though perhaps slightly paler than those from peninsular India, are really much closer to the nominate race.

750 *Merops orientalis orientalis* Latham (India = Pondicherry) Indian Small Green Bee-eater 4: 234

50: 26 ♂♂ 18 ♀♀ 6 o?

1 Gajar, 165 m. SSW. of Kalat, 1 Korak 180 m. S. of Kalat, Baluchistan; 1 Rawalpindi, 1 Nawashahr, Jullundur, 3 Ambala, Punjab; 1 Bahawalpur; 3 Delhi; 1 Bhinmal, Jodhpur; 3 Kutch, 1 Dalkhania, Amreli Dt., 1 Cambay City, 1 Gir Forest, 1 Bodeli, Baroda, Gujarat; 1 Kolkaz, Melghat, Berar; 1 Kolshet, Thana, 1 Kandivli, Salsette, 1 Bombay; 2 Walwan, Poona; 2 Satara; 2 Ratnagiri; 1 Nilambur, S. Malabar, 1 Gudalur, Nilgiris; 1 Kuttani, 1 Jamestown, Kanyakumari; 1 Kalai, Trichnopoly, 1 Chitteri Range, 1 Seshachalam Hills, 1 Cudappah, 1 Cumbum Valley, Kurnool Dt., A.P.; 2 Antagarh, Bastar; 1 Dholpur, Band, Orissa; 1 Baghowni, 1 Tirhut, Bihar; 1 Sarun, 1 Calcutta Market, Bengal; 1 Meerut, 1 Bulandshahr, U.P.; 2 Bankulwa Morang, Nepal, 1 Goalpara, Assam.

There is some variation in the amount of blue on the chin, the intensity of green both above and below, and the extent of the golden sheen on the head. These differences however cannot be segregated and must be accepted as variations within the same race. One ♀ No. 21448 [(wing 91; bill 25; tail 116) Ratnagiri, coastal Maharashtra] collected on 7 January shows an inordinate amount of blue both above and below, but does not resemble *beludschicus*.

	Wing	Bill	Tarsus	Tail
♂♂	89-97 av. 91.5	23-28 av. 25.8	8-10	105-140 av. 121
♀♀	89-98 av. 92.5	22-27 av. 25	8-10	92-127 av. 109

751 *Merops orientalis birmanus* Neumann (Myingyan, Irawaddy River, Burma) Burmese Small Bee-eater 4: 236

3: 1 ♂ 2 ♀♀

1 Maymyo, 1 Sinda, Prome, 1 Kyagyun, Henzada, Burma.

[245]

Wing	Bill	Tarsus	Tail
89, 95, 98	25, 25, 27	9-10	103, —, 120

The golden cap on the head is larger, extending on to the nape. The two females show very little of the black gorget across the front.

752 *Merops orientalis ceylonicus* Whistler (Kalawewa, Ceylon)
Ceylon Small Green Bee-eater

1 ♂ Hambentota, Ceylon
Wing 89 (IH 92-95); bill 26; tarsus 9 (IH 9-10); tail 80 without pins.

This is a poor specimen, but the chin and underparts show blue, the bill is heavy, and the golden sheen on the head extends on to the nape.

EL *Merops orientalis cyanophrys* Cabanis & Heine (Al Qunfidha, Asir, Arabia)

1 ♂ Muscat, Muttrah
Wing 92; bill 25; tarsus 9; tail 91.

This bird received from the Peabody Museum is marked *M.o. muskatensis* which is synonymized with *cyanophrys* by Vaurie, 1959, *Am. Mus. Novit.*, 1971, p. 8.)

753 *Nyctornis athertoni athertoni* (Jardine & Selby) (Bangalore)
Bluebearded Bee-eater 4 : 242

21 : 12 ♂♂ 6 ♀♀ 3 o?

2 Bhopalpatnam, Bastâr; 1 Pithabhata, 1 Gurguria, Simlipal Hills, Mayurbhanj, 1 Mahendragiri, Orissa; 3 Dehra Dun, 3 Kumaon, 1 Terai, U.P.; 1 Longview T.E., Darjeeling; 2 Kurseong Div.; 2 Goalpara, 2 Margherita, Assam; 1 North Shan States, 1 Prome Dt., Burma.

The original description refers to the forehead and crown being verditer-blue, and the beard 'a fine caerulean or verditer-blue varying in intensity and lustre as exposed in different positions to the light.' The accompanying plate shows a greater amount of blue on the forehead than is visible in any specimen, and the 'beard' lacks the dark blue feathers invariably present. The 'beard' is also followed by a patch of chestnut absent in the specimens.

In the absence of any material from the type locality or southern India, a ♂ collected by Sâlim Ali at Hunsur, Mysore State, on 9 December 1939, was borrowed from American Museum of Natural History. Together with the five from Bastar and Orissa, they can in series be easily separated from the others from the north and east, by the clear grass green ('sap green' in original description) upperparts which are darker in the others. Some of the eastern birds are lighter above but all have their cheeks a slightly darker green than in peninsular birds. Eastern birds are also 'more richly coloured and more heavily striped on the underparts' (*a la* Koelz for *bartletti*).

5 (2 ♂♂ 1♀ 2 o?) from Terai (1), Kumaon (2), and Dehra Dun (1) and Goalpara (1) have their green upperparts washed with blue, a character missing in southern birds, though Jardine & Selby refer to the type of unspecified origin having a few of the feathers (of the upperparts) being tipped with verditer-blue. The evidence available suggests that northern and eastern birds differ from those from the south, but an examination of a larger series is necessary to permit a decision. Hodgson (1836, *J. A. S. B.* v, p. 361) has already described *Bucia nipalensis* from Nepal (obviously without knowledge of *athertoni*) while Koelz's *bartletti* (1954, *Contrib. Inst. Regional Exploration*, No. 1 : 25) from Keitum, Lushai Hills, may be available for the eastern birds.

Two specimens (♂ and ♀) Tama, Central Bhutan, collected by Sálím Ali in March 1967, but which have not yet been registered, are an outstandingly deeper green above and the blue on the forehead is more prominent than in the others.

	Wing	Bill	Tail
	From south of Brahmaputra		
5 ♂♂	133-141 av. 138.5	38-45 av. 43.6	130-139 av. 134.5
	Others from northern India		
♂♂	134, 135(3)	37, 40, 41, 42	131, 132(2), 133
♀♀	132(2), 135, 136	39(3), 41	125, 127, 130, 134
o?	132, 136, 137	39, 40, 42	130(2), 131
	From Orissa & Bastar		
♂♂	136(2), 137	44(2), 45	128, 130, 132
♀♀	132, 138	40(2)	127, 130
♂ Mysore	144	43	134

IND. HANDBOOK (4 : 112) refers to this species occurring in the Western Ghats complex from Khandesh southwards through Surat Dangs (?), Maharashtra, and southwards. Osmaston (*JBNHS* 38 : 805) saw it at Pachmari, Hoshangabad, C.P., while Sálím Ali heard it near Songadh, Navsari Dist., Gujarat (*JBNHS* 52 : 446). I have been unable to trace any records from anywhere else in Maharashtra, north of Karwar. Sp. No. 18819 collected by A.E. Jones at Dehra Dun on 8th February 1940 bears the following: 'Pair seen at Rajpur (Dehra Dun). Displaying before another like a roller (*Coracias*). Notes also reminiscent of roller.'

754 *Coracias garrulus semenowi* Loudon & Tschudi (Transcaspia)
Kashmir Roller 4 : 222

19 : 7 ♂♂ (3 juv.) 7 ♀♀ (1 juv.) 5 o?

1 Red Sea ; 1 Baghdad, 1 Hindiyeh Barrage, 1 Shustar Mounds, 1 Mesopotamia ;
2 Mishum, Persian Gulf ; 1 Mastung, Baluchistan ; 1 Razmak, N. Waziristan,
1 Quetta, 2 Chitral ; 1 nr. Kapurwara, 54 m. from Srinagar, 1 Lolab Valley,
1 Kashmir ; 1 Chadva, Bhuj ; 1 Ajwa, Baroda ; 2 Malad, Bombay.

♂ No. 11016, Red Sea, an old skin dated May 1893, wing 193, tail 127, with underparts showing a tinge of greenish, may be of the nominate race. Among the others, unsexed No. 11013 Mesopotamia 23rd

April, 1917, is the specimen identified by Ticehurst in 'The Birds of Mesopotamia' (*JBNHS* 28 : 303) as *Coracias g. garrulus*. It differs from most of the others in having the throat and upper breast a deeper blue, a character shared with three others, a ♂ from Razmak, N. Waziristan, and two females from Kashmir.

It is curious that the 4 specimens from peninsular India are all young birds, 3 juveniles recognized by their paler upperparts and short outer tail-feathers and the fourth with a fully-grown tail but a brown wash on the breast. The sexes show no differences in size and the 15 adults are measured together :

	Wing	Bill	Tarsus	Tail
♂♀	189-213 av. 197 (180-210)	30-36 av. 33 30-35	20-26 av. 22 25-26	116-127 av. 124 122-135)

755 *Coracias benghalensis benghalensis* (Linnaeus) (Tulin, Purulia, West Bengal) Northern Roller 4 : 224

31 : 17 ♂♂ (1 juv.) 11 ♀♀ 3 o ?

Northern birds are slightly larger than those from the south, but in the specimens available the extra-limital and western birds have their upperparts paler than those from the east and also the south. Though part of the paleness may be due to wear, no dark specimen comes from west of the Punjab and Kutch. The few paler birds from further south (Satara and Santa Cruz, Bombay) may well be winter visitors.

A better series is necessary to take any definite decision, but I am for the moment listing the paler birds separately though under nominate *benghalensis*.

(a) *benghalensis* (darker)

14 : 10 ♂♂ 1 ♀ 3 o ?

1 Bhagat State; 2 Ambala, Punjab; 1 Sanchi, Bhopal State; 1 Bhanupratappur, Kanker, C.P.; 2 Barkot, Bamra, Orissa; 1 Baghownie, 1 Tirhut, 2 Hazaria, Patherghata, Bihar; 1 Nawalpur, 1 Bankulwa Morang, Nepal; 1 Rema T.E., S. Sylhet.

No 18995 from Bhanupratappur, Kanker, C.P., has deep blue behind the eye, which extends backwards forming a very distinctive and different border to the blue of the head.

(b) *subsp.?* extra-limital and western (paler)

17 : 7 ♂♂ (1* juv.) 10 ♀♀

1 Nahr Umar, R. Tigris, Mesopotamia; 1 Chahrbar, Persian Gulf; 2 Gajar (Mastkai) 165 m. SSW. of Kalat, Baluchistan; 1 Jajjah, Abbasian, Bahawalpur, Punjab; 6* Kutch, 1 Gir Forest, 1 Patan, Mehsana Dt., 1 Bodeli, Baroda, 1 Golana, Cambay, Gujarat; 1 Santa Cruz, Bombay, 1 Mehda, Satara, Maharashtra.

The juvenile from Kutch lacks all traces of blue on the upper breast

and, though paler both above and below, resembles in this respect, two juveniles of *indica* (Cumbum Valley).

	Wing	Bill	Tarsus	Tail
(a) 14 ♂♀	175-196 av. 187	30-34 av. 32.2	21-25 av. 23.5	122-132 av. 127
(b) 17 ♂♀	176-192 av. 183	29-34 av. 31.5	21-25 av. 23.5	120-134 av. 125.7
	(th 178-201)	from skull 39-49	25-29	117-140)

756 *Coracias benghalensis indica* (Linnaeus) (Ceylon) Southern Roller 4: 226

11: 6 ♂♂ 3 ♀♀ (2 juv.*) 2 o?

1 Bombay, 2 Walwan, 1 Poona, Maharashtra; 1 Karwar, 1 Cassimode, 1 James-town, Kanyakumari; 1 Chitteri Range, Salem; 2* Cumbum Valley, Kurnool; 1 Induni (?)

	Wing	Bill	Tarsus	Tail
♂♀	175-184 av. 180.7	30-32 av. 31	20-24 av. 22	119-130 av. 125.5
	(th 170-190)	from skull 41-49	24-26	109-132)

The 42 specimens available from over a wide area covering the accepted range of the two subspecies nominate *benghalensis* and *indica* cannot be separated on the basis of the colour characters generally accepted, namely: (1) intensity of colour of nuchal collar, and (2) darker, more greenish upperparts of *indica*. Southern birds are slightly smaller, but those from Nepal and Bihar do not differ in colour from the southernmost specimens.

757 *Coracias benghalensis affinis* Horsfield (Assam) Burmese Roller 4: 226

12: 4 ♂♂ 5 ♀♀ 3 o?

1 Bankulwa, Morang, Nepal; 1 Kurseong Div., Bengal; 2 Dibrugarh, 1 Roop chena, 2 N. Cachar, 1 Golaghat, Assam; 1 Kamaing, 1 Maymyo, 2 Prome, Burma

	Wing	Bill	Tarsus	Tail
♂♀	180-197 av. 189	32-37 av. 35	24-27 av. 25.5	117-135 av. 126.5
	(184-204)	30-36	26-28	118-137)

These birds are darker than *benghalensis*, both above and below, the underwing coverts being deep blue, matching the colour of the wing quills. All except No. 11062, a female from Golaghat, Assam, show a few pale blue feathers on the underwing. ♂ No. 11034, Bankulwa, Morang, Nepal, collected by N. A. Baptista on 16th March 1921, agrees with *affinis* except for a few additional pale blue feathers under the wing and the fact that the feathers on the throat show pale shaft streaks as in *benghalensis*. Another ♂ No. 11033 collected at the same place on 5th March 1921 agrees entirely with *benghalensis* with which it is listed suggesting that the area of intergradation is much further east than 85°E. suggested in IND. HANDBOOK (4: 119).

One unregistered female from Mangdechu, C. Bhutan, has the streaks on the chin brighter than in the others.

758 *Eurystomus orientalis cyanicollis* Vieillot (Chandernagor, Bengal)
Himalayan Broadbilled Roller 4 : 228

10 : 5 ♂♂ (1 juv.) 2 ♀♀ 3 o ?

1 Almora, 2 Kumaon, Naini Tal, U.P. ; 1 Balasun, Darjeeling ; 1 Golaghat, 2 Margherita, 1 Bagho Bahar, Cachar, 2 Rema T.E., Sylhet, Assam

5 specimens, including the juvenile, do not have the clear pale blue patch on the primaries which appears to be an adult character.

	Wing	Bill	Tarsus	Tail
♂♀	178-206 av. 194	25-32 av. 27.5	17-19 av. 18	95-109 av. 101.5
	(H 178-198	from skull 27-35	20(1)	90-102)

The juvenile is duskier all over, and has a black upper mandible.

759 *Eurystomus orientalis laetior* Sharpe (Forests of Malabar, the Nilgiris and Ceylon, restricted to Eridge, Travancore) Kerala Broad-billed Roller 4 : 228

3 ♂♂

2 Thattakad, North Travancore, 1 Tenmalai, Central Travancore

	Wing	Bill	Tarsus	Tail
	191, 199, 200	27, 28(2)	15(2), 16	101, 105, 108
	(H 194-205	from skull 33-36	19-20	99-106)

760 *Eurystomus orientalis irisi* Deraniyagala (Maha-oya, Ceylon)
Ceylon Broadbilled Roller
nil.

762 *Eurystomus orientalis gigas* Stresemann (Rutland Island, Andaman Islands) Andaman Broadbilled Roller 4 : 231

8 : 6 ♂♂ 2 ♀♀

3 Chirria Tapoo, 2 Wrightmyo, 1 Port Blair, South Andamans ; 2 South/Middle Andamans

	Wing	Bill	Tarsus	Tail
♂♀	190-202 av. 195.8	29-33 av. 31	18-19	102-112 av. 107
	(184-205	27-30	c. 21	106-112)

762a *Eurystomus orientalis* subsp.

1 ♀ Narcondam Island

(See Ripley's comments *JBNHS* 68 : 406)

Wing 193 ; bill 30 ; tarsus 18 ; tail 91.

(to be continued)

The Food-plants of Indian Rhopalocera

BY

D. G. SEVASTOPULO

Some years ago I published a series of four papers in this *Journal* on the Food-plants of Indian Heterocera (1940, Vol. 41, Bombyces; 1941, Vol. 42, Agaristidae and Noctuidae; 1948, Vol. 47, Geometridae and Pyralidae; 1949, Vol. 48, Supplementary Lists). The present paper on the food-plants of the butterflies, follows the same pattern, except that I have added the botanical family after the name of the plants.

The various books consulted are as under :—

- Bingham — FAUNA OF BRITISH INDIA, Vols. 1 & 2.
Talbot — FAUNA OF BRITISH INDIA, 2nd edit., Vols. 1 & 2.
Moore — LEPIDOPTERA OF CEYLON, Vol. 1.
Seitz — INDO-AUSTRALIAN RHOPALOCERA, Vol. 9.
Peile — A GUIDE TO COLLECTING BUTTERFLIES OF INDIA.
Bell — Common Butterflies of the Plains of India (Part xxxii et seq., *J. Bombay. nat. Hist. Soc.* xxx et seq.).
Common — Australian Butterflies.

I regret that I have been unable to consult the earlier parts of Bell's paper, neither Davidson & Aitkens' 'Notes on the Larvae and Pupae of some of the Butterflies of the Bombay Presidency' (1890, *J. Bombay nat. Hist. Soc.* 5) nor Davidson, Bell & Aitkens'. 'The Butterflies of the *North Kanara District*' (1896/7, *J. Bombay nat. Hist. Soc.* 10 & 11) but these are quoted extensively in both editions of the FAUNA OF BRITISH INDIA.

It must be emphasised that the term 'India' is here used in the zoo-geographical sense, and not the political, and includes India, Pakistan, Bangladesh, Burma and Ceylon.

PAPILIONIDAE

TROIDES Hbn.—All recorded food-plants belong to the Aristolochiaceae.

T. helena L.—*Aristolochia indica*, *Bragantia wallichii* (Aristolochiaceae) (Peile, Talbot), *Aristolochia* (Bingham, Moore, Seitz).

POLYDORUS Swains.—Although usually referred to as *Aristolochia* Swallowtails, one species, *P. alcinous* Klug is reported to feed on *Cocculus thunbergi* (Menispermaceae) in Japan, and another, see below, on *Nepenthes* (Nepenthaceae).

- P. jophon** Gray—*Bragantia wallichii* (Aristolochiaceae) (Talbot).
P. hector L.—*Aristolochia indica* (Peile, Seitz, Talbot), *Bragantia wallichii*, *Aristolochia* sp. (Moore, mihi) (All Aristolochiaceae).
P. aristolochiae F.—*Aristolochia indica* (Peile, Bingham), *Bragantia wallichii* (Talbot), *Aristolochia* sp. (Moore, mihi), *Aristolochia indica*, *A. bracteata* (Seitz) (All Aristolochiaceae). Seitz adds 'Also on Piperaceae'.
P. philoxenus Gray—*Nepenthes* (Nepenthaceae) (Talbot, Seitz).
P. dasarada Moore—*Aristolochia* (Aristolochiaceae) (Talbot).

CHILASA Moore

- C. agestor** Gray—*Machilus odoratissima* (Lauraceae) (Peile, Bingham, Talbot, Seitz). Seitz adds 'possibly other Laurineae'.
C. clytia L.—*Tetranthera apetala*, *Alseodaphne semicarpifolia* (Bingham, mihi), *Tetranthera* (Moore), *Alseodaphne*, *Tetranthera*, *Cinnamomum*, etc. (Seitz), Lauraceae (Talbot). All Lauraceae.

PAPILIO L.

- P. polymnestor** Cr.—*Citrus grandis* (Peile), *Citrus*, *Atalantia* (Bingham), *Citrus decumana*, *Atalantia*, *Paramigyna monophylla* (Talbot), *Citrus decumana* (Moore), *Citrus* spp. (mihi), *Citrus*, *Atalantia*, *Paramigyna* etc. (Seitz). All Rutaceae. Also *Garcinia xanthochymus* (Bingham), *Garcinia* (Talbot) (Guttiferae).
P. memnon L.—*Citrus* (Rutaceae) (Talbot, Seitz).
P. rhetenor Westw.—*Citrus* spp. and other Rutaceae (mihi).
P. protenor Cr.—*Zanthoxylum alatum* (Bingham), *Zanthophyllum* (Talbot, Seitz). (Rutaceae).
P. bianor Cr.—Aurantiaceae (Seitz) (Now included in Rutaceae).
P. polyctor Bsd.—*Zanthoxylum alatum* (Talbot, Seitz), *Citrus* spp., other Rutaceae (mihi). All Rutaceae.
P. paris L.—*Citrus* spp. and other Rutaceae (mihi), *Evodia roxburghiana* (Rutaceae) (Seitz).

- P. arcturus** Westw.—Various Rutaceae (mihi).
- P. crino** F.—*Chloroxylon swietenia* (Meliaceae) (Talbot, Moore),
Chloroxylon (Seitz).
- P. buddha** Westw.—*Zanthoxylum rhetsa* (Rutaceae) (Talbot, Seitz).
- P. dravidarum** Wd-Msn.—*Glycosmis pentaphylla* (Rutaceae) (Bingham,
Talbot, Seitz).
- P. helenus** L.—*Zanthoxylum rhetsa* (Bingham), *Citrus* spp. and other
Rutaceae (mihi), *Citrus*, *Zanthoxylum* (Seitz). All Rutaceae.
- P. fuscus** Goeze—*Citrus* (Rutaceae) (Seitz). In Australia on *Citrus*,
Microcitrus australasica, *Fagara brachyacanthum*, *Halfordia scleroxyla*,
Morinda citrifolia (Rutaceae) (Common).
- P. polytes** L.—*Citrus sinensis*, *C. aurantifolia* (Peile), *Citrus* spp.
(Bingham), *Citrus*, *Murraya*, *Triphasia*, *Glycosmis*, *Zanthoxylum*
(Talbot), *Citrus* spp., *Aegle marmelos* (mihi), *Citrus*, *Murraya*, *Tri-*
phasia, *Zanthoxylum* (Seitz). All Rutaceae.
- P. liomedon** Moore—*Acronychia laurifolia* [Bingham (as *demoleon* Cr.),
Talbot], *Acronychia laurifolia*, *Evodia roxburghiana* (Seitz). All
Rutaceae.
- P. demoleon** Cr.—*Citrus* (Rutaceae) (Seitz).
- P. demoleus** L.—*Citrus sinensis*, *C. grandis*, *C. aurantifolia*, *Aegle marmelos*
(Peile), *Aegle*, *Citrus* spp. (Bingham, mihi), Rutaceae spp. (Talbot),
Glycosmis, *Murraya*, *Citrus*, *Ruta angustifolia*, etc. (Seitz). All
Rutaceae. Also *Zizyphus* (Bingham), *Zizyphus jujuba* (Peile) (Rham-
naceae). In Australia on *Citrus* (Rutaceae), *Psoralea tenax*, *P. patens*
(Papilionaceae) (Common).
- P. alexanor** Esp.—*Seseli dioicum*, *S. montanum*, *Ptychotis heterophylla*
and other Umbelliferae (Talbot).
- P. machaon** L.—*Ammi majus*, *A. visnaga*, *Ducrosia anethifolia*, *Foeni-*
culum vulgare, *Conium maculatum* (Peile), *Foeniculum vulgare*, *Conium*
maculatum (Bingham), *Daucus* (Talbot), *Daucus*, *Foeniculum* (Seitz).
All Umbelliferae. Also *Ruta tuberculata* (Rutaceae) (Peile).
- P. xuthus** L.—*Aegle sepiaria*, *Citrus nobilis* (Rutaceae) (Talbot). In
Japan.

GRAPHIUM Scop.

- G. eurous** Leech—*Machilus odoratissimus* (Lauraceae) (Talbot, Seitz).

- G. nomius** Esp.—*Polyalthia longifolia*, *Saccopetalum tomentosum* (Anonaceae) (Seitz).
- G. aristeus** Cr.—*Mitrephora froggattii* (Anonaceae) (Common). In Australia.
- G. antiphates** Cr.—*Unona lawii* (Anonaceae) (Bingham, Talbot, Seitz).
- G. cloanthus** Westw.—*Machilus odoratissimus* (Lauraceae) (Talbot, Seitz).
- G. sarpedon** L.—*Machilus odoratissimus*, *Cinnamomum*, *Alseodaphne*, *Litsaea*, *Camphora officinalis* and other Lauraceae (Talbot), *Machilus odoratissimus*, *Geijera salicifolia*, *Litsaea*, *Alseodaphne*, *Camphora officinalis* (Seitz). All Lauraceae. And in Australia on *Geijera salicifolia*, *Daphnandra aromatica*, *Tristania luarina*, *Cryptocarya*, *Planchonella laurifolia* (Laurineae), *Macaranga* (Euphorbiaceae), eggs on Avocado [*Persea americana* (Lauraceae) (Common)].
- G. doson** Feld.—*Cinnamomum* (Lauraceae), *Polyalthia* (Anonaceae) (Talbot, Seitz), *Polyalthia longifolia* (Anonaceae), *Michelia champaca* (Magnoliaceae) (mihi).
- G. eurypylus** L.—Anonaceae (Seitz). In Australia on *Anona*, *Diploglottis australis*, *Rauwenhoffia leichhardtii*, *Mitrephora froggattii* (Anonaceae) (Common).
- G. agamemnon** L.—*Anona squamosa* (Peile), *Anona*, *Saccopetalum*, *Gualteria*, *Polyalthia* (Talbot, Seitz), *Anona* (Moore). All Anonaceae, Also *Michelia* (Magnoliaceae) (Seitz), Magnoliaceae (Moore), *Cinnamomum* (Lauraceae) (Moore). In Australia on *Anona*, *Mitrephora froggattii* (Anonaceae) (Common).

LAMPROPTERA Gray

- L. meges** Zink.—*Illigera burmanica* (Combretaceae) (Bingham).

TEINOPALPUS Hope

- T. imperialis** Hope—*Daphne nipalensis* (Thymeleaceae) (Bingham, Talbot, Seitz).

HYPERMNESTRA Men.

- H. helios** Nick.—*Zygophyllum turcomanicum* (Zygophyllaceae) (Talbot).

PIERIDAE

LEPTOSIA Hbn.

- L. nina** F.—*Capparis heyneana*, *Crataeva religiosa* (Capparidaceae) (Peile, Talbot), *Capers* (Capparidaceae) (Bingham).

APORIA Hbn.—Larvae on Prunaceae, Rubiaceae and Berberidaceae (Talbot).

A. *leucodice* Evers.—*Berberis lycium* (Berberidaceae) (Talbot, Seitz).

A. *agathon* Gray—*Berberis nepalensis* (Berberidaceae) (Bingham, Talbot, Seitz).

DELIAS Hbn.—Larvae on *Loranthus* (Loranthaceae) (Talbot, Seitz).

D. *eucharis* Drury—*Loranthus* (Loranthaceae) (Peile, Bingham, Moore, mihi), *Loranthus longiflorus*, *L. elasticus*, *L. scurrula* (Talbot). Seitz says polyphagous, but also mentions *Hibiscus chinensis* (Malvaceae).

D. *aglaia* L.—*Nauclea rotundifolia* (Rubiaceae) (Bingham, Talbot, Seitz). Talbot adds 'It is much more likely that the larvae feed on a *Loranthus* growing on the tree mentioned'.

D. *belladonna* F.—*Loranthus* (Loranthaceae) (Seitz).

D. *hyparete* L.—*Averrhoa bilimbi* (Geraniaceae) (Seitz). I think that Talbot's remark under *aglaia* might well apply here also.

CEPORA Bilb.—Capparidaceae (Talbot, Seitz).

C. *nerissa* F.—*Capparis aphylla*, *C. sepiaria*, *C. heyneana*, *C. horrida* (Capparidaceae) (Talbot), *Capparis* (Bingham, Moore, mihi).

C. *nadina* Luc.—*Capparis heyneana*, *C. moonii*, *C. roxburghii* (Capparidaceae) (Talbot), *Capparis* (Bingham).

PRIONERIS Wall.—*Capparis* (Capparidaceae) (Talbot, Seitz).

P. *sita* Feld.—Capers (Talbot), *Capparis* (Bingham), *Capparis tenera* (Seitz). All Capparidaceae.

ANAPHEIS Hbn.—Capparidaceae (Seitz).

A. *aurota* F.—*Capparis pyrifolia*, *C. aphylla* (Peile), *Capparis pyrifolia* (Bingham), *Capparis aphylla*, *C. sepiaria*, *C. heyneana*, *Cadaba indica*, *Maerua arenaria* (Talbot), *Capparis horrida* (mihi), *Capparis* (Seitz). All Capparidaceae.

APPIAS Hbn.—

A. *libythea* F.—*Capparis horrida* (Bingham), *Crataeva religiosa*, *Capparis sepiaria* (Talbot), *Crataeva*, *Capparis* (Seitz). All Capparidaceae.

A. *lyncida* Cr.—*Crataeva religiosa* (Peile, Talbot, Moore, Seitz) (Capparidaceae). Seitz also mentions *Gymnosporia* (Celastraceae) and

- 'cotton tree', presumably *Bombax* sp. (Bombacaceae). Capers (Bingham).
- A. albina** Bsd.—*Hemicyclia venusta* (Euphorbiaceae) (Seitz).
- A. wardi** Moore—*Capparis heyneana* (Capparidaceae) (Talbot, Seitz).
- PIERIS Schrank
- P. callidice** Hbn.—No Indian records, in Europe on alpine Cruciferae.
- P. napi** L.—Cruciferae (Talbot), in Europe on Cruciferae and Resedaceae.
- P. brassicae** L.—Cruciferae (Talbot), in Europe on Cruciferae, particularly *Brassica*, and *Tropaeolum* (Tropaeolaceae).
- P. rapae** L.—No Indian record, in Europe on Cruciferae, particularly *Brassica*, and *Tropaeolum* (Tropaeolaceae). Similar Australian records (Common).
- PONTIA F.
- P. daplidice** L.—*Reseda* (Resedaceae), *Turritis*, *Sisymbrium*, *Sinapis*, *Alyssum* (Cruciferae) (Talbot).
- EUCHLOE Hbn.
- E. ausonia** Hbn.—Cruciferae (Talbot).
- IXIAS Hbn.—*Capparis* (Capparidaceae) (Seitz).
- I. marianne** Cr.—*Capparis sepiaria*, *C. divaricata*, *C. aphylla*, *C. grandis* (Capparidaceae) (Talbot).
- I. pyrene** L.—*Capparis sepiaria* (Capparidaceae) (Talbot).
- COLOTIS Hbn.
- C. calais** Cr.—*Salvadora persica*, *S. oleoides*, *Azima tetracantha* (Salvadoraceae) (Talbot), *Salvadora persica* (Peile).
- C. phisadia** Godt.—*Salvadora persica* (Salvadoraceae) (Peile, Bingham, Talbot).
- C. vestalis** Btlr.—*Salvadora persica* (Salvadoraceae) (Peile).
- C. fausta** Oliv.—*Capparis spinosa* (Peile), *Maerua arenaria* (Talbot). Both Capparidaceae.
- C. etrida** Bsd.—*Cadaba indica* (Capparidaceae) (Talbot).
- C. eucharis** F.—*Cadaba indica* (Capparidaceae) (Talbot, Seitz).

C. danae F.—*Cadaba indica*, *Capparis sepiaria*, *C. divaricata*, *Maerua arenaria* (Capparidaceae) (Talbot).

HEBOMOIA Hbn.—*Capparis* (Capparidaceae) (Seitz).

H. glaucippe L.—*Crataeva religiosa*, *Capparis moonii* (Peile, Talbot), *Capparis* (Moore), *Capparis* spp., *Crataeva* (Seitz). All Capparidaceae.

VALERIA Horse.—Capparidaceae (Talbot, Seitz).

V. ceylanica Feld.—*Capparis heyneana* (Bingham, Seitz) (Capparidaceae).

V. valeria Cr.—*Capparis heyneana* (Talbot, Seitz), *Capparis* (mihi) (Capparidaceae).

CATOPSILIA Hbn.—*Cassia* (Caesalpinaceae) (Seitz).

C. crocale Cr.—*Cassia siamea* (Peile), *Cassia* (Seitz, mihi), *Cassia fistula* (Moore), *Cassia*, *Bauhinia racemosa* (Talbot). All Caesalpinaceae. Also *Butea frondosa* (Papilionaceae) (Talbot).

C. pomona F.—*Cassia fistula* (Peile, Talbot), *C. fistula*, *C. siamea* (mihi). In Australia *Cassia fistula*, *C. australis* (Common). All Caesalpinaceae.

C. scylla L.—In Australia *Cassia glauca*, *C. s. etesia* (Caesalpinaceae), (Common).

C. pyranthe L.—*Cassia tora*, *C. auriculata* (Peile, Talbot), *Cassia occidentalis* (Bingham), *Cassia* (Seitz). In Australia *Cassia* (Common). (Caesalpinaceae).

C. florella F.—Leguminosae (Moore). In East Africa *Cassia* spp. (Caesalpinaceae).

GONEPTERYX Leach

G. rhamni L.—*Rhamnus* (Rhamnaceae), *Vaccinium* (Ericaceae) (Talbot). In Europe recorded from *Rhamnus* spp. only.

EUREMA Hbn.

E. brigitta Cr.—*Cassia kleinii* (Caesalpinaceae) (Talbot). In East Africa on *Cassia* (Caesalpinaceae), *Hypericum* (Hypericaceae), *Acacia*, *Albizzia* (Mimosaceae).

E. blanda Bsd.—*Wagatea spicata* (Caesalpinaceae) (Peile, Bingham, Seitz), *W. spicata*, *Cassia* spp., *Delonix regia* (Caesalpinaceae) (Talbot), *Cassia* spp. (mihi).

E. hecabe L.—*Sesbania aculeata* (Papilionaceae) (Peile, Bingham), *Cassia tora* (Caesalpinaceae) (Bingham), *Cassia, Wagatea, Caesalpinia* (Caesalpinaceae), *Acacia, Albizzia, Pithecolobium dulce* (Mimosaceae), *Sesbania* (Papilionaceae) (Talbot), Leguminosae, *Pithecolobium dulce* (Mimosaceae) (Moore), *Cassia* (Seitz, mihi). In Australia on *Breynia oblongifolia*, *B. nivosa*, *B. cernua*, *Phyllanthus tenellus* (Euphorbiaceae), *Albizzia lebbek*, *Leucaena glauca* (Mimosaceae), *Sesbania aculeata*, *Indigofera* (Papilionaceae), *Cassia surattensis* (Caesalpinaceae) (Common). In East Africa on *Cassia* (Caesalpinaceae), *Hypericum* (Hypericaceae), *Albizzia*, *Entada abyssinica*, *Parkia filicoides* (Mimosaceae), *Aeschynomene*, *Lespedeza*, *Sesbania* (Papilionaceae).

COLIAS F.

C. erate Esp.—*Parochetus communis* (Papilionaceae) (Peile), *Trifolium* (Bingham) (Papilionaceae).

DANAIDAE

IDEA F.

I. malabarica Moore—*Aganosoma cymosa* (Apocynaceae) (Talbot, Seitz).

I. jasonia Westw.—A climber allied to the Genus *Hoya* (Asclepiadaceae) (Seitz).

DANAUS Klug

D. chrysippus L.—*Calotropis procera*, *C. gigantea* (Peile), *Calotropis gigantea* and other Asclepiads (Bingham), *Asclepias curassavica*, *Calotropis* (Talbot), *Calotropis gigantea*, *Asclepias curassavica* (Moore), *Calotropis procera* (mihi). In Australia *Asclepias fruticosa*, *A. curassavica*, *Pentatropis atropurpurea*, *P. quinquepartita*, *Marsdenia leichhardtiana* (Common). In East Africa on *Asclepias*, *Calotropis*, *Caralluma*, *Ceropegia*, *Cynanchum*, *Gomphocarpus*, *Huernia*, *Kanaria*, *Pergularia*, *Periploca*, *Schizoglossum*, *Secamone*, *Stapelia*. All Asclepiadaceae.

D. genutia Cr.—*Ceropegia* (Peile, Talbot), *Raphis pulchellum*, *R. lemma*, *Passularia*, *Ceropegia intermedia* (Bingham). All Asclepiadaceae.

D. affinis F.—In Australia *Cynanchum carnosum* (Asclepiadaceae) (Common).

D. limniace Cr.—*Calotropis*, *Asclepias*, *Hoya* (Bingham, Seitz), *Dregea volubilis*, *Hoya*, *Calotropis* (Talbot), *Asclepias* (Moore). In East Africa on *Daemia*, *Hoya*, *Pergularia*. All Asclepiadaceae.

- D. hamata** MacLeay—*Vallis dichotoma* (Apocynaceae) (Bingham, Talbot). In Australia on *Marsdenia*, *Parsonia* (Asclepiadaceae) (Common).
- D. aglea** Stoll.—*Tylophora carnosia*, *T. tenuis* (Peile), *Tylophora carnosia* (Bingham), *Tylophora carnosia*, *T. tenuis*, *Cryptolepis buchanani* (Talbot), *Cryptolepis*, etc. (Moore), Asclepiadaceae (Seitz). All Asclepiadaceae.
- D. sita** Koll.—*Marsdenia roylei* (Asclepiadaceae) (Bingham, Talbot).

EUPLOEA F.

- E. core** Cr.—*Nerium oleander* (Apocynaceae) (Peile), *Nerium oleander* (Apocynaceae), *Cryptolepis paucifolia* (Asclepiadaceae), *Ficus indica*, *F. glomerata* (Moraceae) (Bingham), *Nerium odorum* (Apocynaceae), *Ficus religiosa* (Moraceae) (mihi), *Streblus asper*, *Ficus bengalensis*, *F. religiosa*, *F. glomerata* (Moraceae), *Nerium odorum*, *N. oleander*, *Ichnocarpus frutescens* (Apocynaceae), *Hemidesmus indicus* (Asclepiadaceae) (Talbot), three species of *Ficus* and three of Apocynaceae (Seitz). In Australia on *Oleander*, *Mandevillea*, *Trachelospermum* (Apocynaceae), *Stephanotis*, *Hoya australis*, *Marsdenia leichhardtiana* (Asclepiadaceae), *Ficus* (Moraceae) (Common).
- E. sylvester** F.—*Ichnocarpus frutescens* (Apocynaceae) (Talbot, Seitz). In Australia on *Ficus glomerata* (Moraceae) (Common).
- E. midamus** L.—*Strophanthus divergens* (Apocynaceae) (Talbot, Seitz). Seitz adds 'also occasionally found on imported oleander'.
- E. klugii** Hors.—*Ficus hispida* (Moraceae) (Talbot), *Streblus asper*, *Ficus* (Moraceae) (Seitz).

SATYRIDAE

On Monocotyledons such as Gramineae and Palmaceae (Talbot).

MYCALESIS Hbn.—Grasses (Gramineae) (Seitz).

- M. anapita** Moore—Certain rare grasses (Gramineae) (Talbot, Seitz).
- M. perseus** F.—Grasses (Gramineae) (Seitz, mihi).
- M. mineus** L.—Grasses (Gramineae) (Talbot, Seitz).
- M. visala** Moore—Grasses (Gramineae) (Talbot, Seitz, mihi).
- M. patnia** Moore—Grasses, *Oryza* (Talbot), *Oryza* (Seitz). All Gramineae.

LETHE Hbn.—On bamboo or grass (Gramineae) (Seitz, Talbot).

L. sidonis Hew.—Grasses (Gramineae) (mihi), *Arundinaria falcata* (Gramineae) (Talbot, Seitz).

L. europa F.—Bamboo (Gramineae) (Talbot).

L. rohria F.—Grasses (Gramineae) (Bingham, mihi).

L. drypetis Hew.—*Bambusa arundinaceae* (Peile, Talbot), *Bambusa* (Bingham) (Gramineae).

L. insana Koll.—*Arundinaria falcata* (Gramineae) (Seitz).

L. verma Koll.—Grasses (Gramineae) (mihi).

L. yama Moore—Bamboo (Gramineae) (Talbot, Seitz).

PARARGE Hbn.

P. schakra Koll.—Grasses (Gramineae) (Talbot).

AULOCERA Btlr.

A. swaha Koll.—Grasses (Gramineae) (Bingham, Talbot), Wild Blue Iris (Iridaceae) (Bingham). The latter appears doubtful.

EREBIA Dalm.—Grasses (Gramineae) (Talbot).

E. nirmala Moore—Grasses (Gramineae) (Talbot).

YPHIMA Hbn.

Y. ceylonica Hew.—Grasses (Gramineae) (Talbot, mihi).

Y. asterope Klug—In East Africa on grasses (Gramineae).

Y. sakra Moore—Grasses (Gramineae) (mihi).

ORSOTRIOENA Willgrn.

O. medus F.—*Oryza sativa* (Bingham), Grasses (Talbot, Seitz). In Australia on Grasses (Common). All Gramineae.

MELANITIS F.

M. ieda L.—*Oryza*, Grasses (Peile, Talbot), Grasses (mihi), Gramineae (Moore). In Australia on *Imperata*, grasses and *Saccharum* (Common). In East Africa on *Bambusa*, *Digitaria*, *Panicum repens*, *Pennisetum purpureum*, *Zea mays*, Grasses generally. All Gramineae.

M. phedima Stoll.—Grasses (Gramineae) (Talbot).

M. zitenius Herbst.—Bamboo (Gramineae) (Talbot),

ELYMNIAS Hbn.—Palms (Palmaceae) (Seitz, Talbot).

E. hypermnestra L.—Various Palms, *Phoenix*, *Cocos nucifera*, *Areca*, *Calamus* (Peile), Palms (Talbot, mihi), Palmaceae (Moore). All Palmaceae.

E. panthera F.—Palms (Palmaceae) (Seitz).

AMATHUSIIDAE

FAUNIS Hbn.

F. eumeus Drury—Probably on grass and dwarf bamboo (Gramineae) (Seitz).

AMATHUSIA F.

A. phidippus L.—*Cocos nucifera* (Bingham), *C. nucifera*, *Borassus flabellifer*, *Elaeis guineensis* (Seitz). All Palmaceae, the latter two species introduced from Africa.

DISCOPHORA Bsd.—Palmaceae, *Saccharum*, Bamboo (Gramineae) (Seitz).

D. sondaica Bsd.—Bamboo (Talbot, Seitz). (Gramineae).

D. lepida Moore—Bamboo (Talbot), Bamboo, *Dendrocalamus* and other Gramineae (Seitz).

ACRAEIDAE

ACRAEA Hbn.

A. issoria Hbn.—*Debregeasia bicolor* (Peile), *D. bicolor*, *Boehmeria salicifolia* (Talbot), *Boehmeria salicifolia* (Seitz). Both Urticaceae. Seitz adds 'and all sorts of other weeds'.

A. violae F.—*Modecca palmata* (Passifloraceae) and cultivated kinds (Peile), *Modecca palmata* (Bingham, Talbot, Seitz), Cucurbitaceae (Moore).

N.B.—The preceding families have been arranged in the order adopted by Talbot in the FAUNA OF BRITISH INDIA, 2nd edition. The succeeding families are arranged according to Seitz' INDO-AUSTRALIAN RHOPALOCERA.

NYMPHALIDAE

Biblinidi

ERGOLIS Bsd.—On *Ricinus communis* and *Tragia* (Euphorbiaceae).

E. ariadne L.—*Tragia involucrata* (Peile), *T. involucrata*, *T. cannabina* (Bingham, Seitz). All Euphorbiaceae.

E. merione Cr.—*Ricinus communis* (Euphorbiaceae) (mihi).

BYBLIA Hbn.—*Tragia cannabina* (Euphorbiaceae) (Seitz).

B. ilithyia Drury—*Tragia cannabina* (Euphorbiaceae) (Seitz, by inference).
In East Africa on *Tragia*, *Daleschampia* (Euphorbiaceae).

Pseudergolidi

PSEUDERGOLIS Feld.—*Debregeasia bicolor* (Urticaceae) (Seitz).

P. wedah Koll.—*Debregeasia bicolor* (Urticaceae) (Bingham).

Issorodidi

CUPHA Hbn.—*Flacourtia* (Flacourtiaceae) (Seitz).

C. erymanthis Drury—*Flacourtia* (Flacourtiaceae) (Bingham), *Glochidion eriocarpum* (Euphorbiaceae) (Seitz).

AELLA Dbl.—*Ixora* (Rubiaceae) (Seitz).

A. phalanta Drury—*Flacourtia* (Flacourtiaceae) (Bingham, Moore), *Salix* (Salicaceae) (Moore). In East Africa on *Gymnosporia*, *Maytenus ovatus* (Celastraceae), *Aberia*, *Dovyalis*, *Flacourtia* (Flacourtiaceae), *Populus*, *Salix* (Salicaceae).

A. alcippe Cr.—*Alsodeia zeylanica* (Violaceae) (Seitz).

Issoria Hbn.

I. sinha Koll.—In Australia on *Xylosma ovatum*, *Homalium circumpinatum* (Samydaceae) (Common).

CYNTHIA F.—*Modecca palmata* (Passifloraceae) (Seitz).

C. erota F.—*Modecca palmata* (Passifloraceae) (Bingham).

CIRROCHROA Dbl.—*Hydnocarpus wightiana* (Flacourtiaceae) (Seitz).

C. thais F.—*Hydnocarpus wightiana* (Flacourtiaceae) (Seitz).

Cethosiinae

CETHOSIA F.—Passiflorae (Seitz).

C. **nietneri** Feld.—*Modecca* (Peile, Moore), *Modecca palmata* (Bingham) (Passifloraceae).

C. **biblis** Drury—*Modecca* (Passifloraceae) but refused cultivated *Passiflora* (mihi), *Passiflora foetida* (Passifloraceae), *Balbas baquero* (? family ?) (Seitz).

C. **cyane** Drury—*Passiflora* (Passifloraceae) (Bingham, Seitz).

Argynnidi

MELITAEA F.

M. **didyma** O.—In Europe on *Plantago* (Plantagineae).

BOLORIA Moore

B. **pales** Schiff.—In Europe on *Viola* spp. (Violaceae).

ARGYNNIS F.

A. **lathonia** L. }
A. **adippe** L. } In Europe on *Viola* spp. (Violaceae).
A. **aglaia** L. }

A. **hyperbius** L.—*Viola* (Violaceae) (mihi). In Australia on *Viola* (Common).

Vanessidi

PRECIS Hbn.

P. **iphita** Cr.—*Strobilanthes* (Acanthaceae) (Bingham).

P. **atlites** L.—*Hygrophila spinosa* (Acanthaceae) (Seitz).

P. **almana** L.—*Acanthus*, (Acanthaceae), *Lippia nodiflora* (Verbenaceae), *Osbeckia* (Melastomaceae), *Gloxinia* (Gesneriaceae) (Seitz).

P. **orithya** L.—*Hygrophila* (Acanthaceae), *Antirrhinum orontium* (Scrophulariaceae) (Seitz), *Acanthus* (Acanthaceae) (Moore). In Australia on *Thunbergia alata* (Acanthaceae), *Antirrhinum* (Common). In East Africa on *Hygrophila* (Acanthaceae), *Englas scandens* (Labiatae), *Antirrhinum*, *Striga lutea* (Scrophulariaceae).

P. **hierta** F.—In East Africa on *Asystasia*, *Barleria*, *Justicia*, *Paulowilhelmia*, *Ruellia* (Acanthaceae).

PYRAMEIS Hbn.

P. cardui L.—*Artemisia*, *Blumea* (Compositae) (Bingham), *Artemisia* (Compositae) (Moore), *Carduus* (Compositae) (mihi). In Australia on *Helichrysum*, *Artemisia* (Compositae), *Cryptostemma* (? family ?) (Common). In East Africa on *Anchusa*, *Cyanoglossum*, *Echium* (Boraginaceae), *Arctium*, *Arctotis*, *Artemisia*, *Carduus*, *Chrysanthemum*, *Cirsium*, *Cynara scolymus*, *Filago*, *Gnaphalium*, *Heliochrysum*, *Laggera alata*, *Madia*, *Pentzia*, *Senecio*, *Sonchus*, *Stobaea* (Compositae), *Althaea*, *Malva* (Malvaceae), *Argyrolobium*, *Dolichos*, *Glycine*, *Lablab niger*, *Lupinus*, *Phaseolus* (Papilionaceae), *Boehmeria*, *Girardinia*, *Laporta*, *Urtica* (Urticaceae).

P. indica Herbst.—*Urtica* (Urticaceae) (Peile).

VANESSA F.

V. urticae L.—In Europe on *Urtica* (Urticaceae).

V. cashmirensis Koll.—*Urtica* (Urticaceae) (Peile, mihi).

V. xanthomelas Esp.—*Celtis australis* (Ulmaceae), *Pistacia integerrima* (Anacardiaceae), occasionally *Salix* (Salicaceae) (Seitz). In European *Salix* (Salicaceae).

V. polychloros L.—In Europe on *Ulmus* (Ulmaceae), *Salix* (Salicaceae), *Prunus* (Rosaceae).

V. antiopa L.—In Europe on *Salix* (Salicaceae), *Urtica* (Urticaceae), *Betula* (Amentaceae).

V. canace L.—*Smilax* (Liliaceae) (Bingham, Moore, Seitz, mihi).

POLYGONIA Hbn.

P. c-album L.—In Europe on *Ulmus* (Ulmaceae), *Humulus*, *Urtica* (Urticaceae), *Prunus* (Rosaceae), *Ribes* (Ribesiaceae).

P. l-album Esp.—In Europe on *Salix*, *Populus* (Salicaceae).

P. egea Cr.—In Europe on *Parietaria officinalis* (Urticaceae).

ARASCHNIA Hbn.

A. proroides Blch.—*Urtica* (Urticaceae) (Seitz).

SYMBRENTHIA Hbn.

S. hippoclus Cr.—*Debregeasia bicolor*, *Girardinia heterophylla* (Urticaceae) (Seitz).

RHINOPALPA Feld.

R. polynice Cr.—*Conocephalus suaveolens* (Urticaceae) (Seitz).

HYPOLIMNAS Hbn.

H. misippus L.—*Portulaca oleracea* (Portulacaceae) (Bingham), *Abutilon* (Malvaceae), *Abelmoschus* (Malvaceae) (Moore), *Batatas* (Convolvulaceae), *Portulaca* (Portulacaceae), *Abutilon* (Malvaceae) (Seitz). In East Africa on *Asystasia*, *Justicia* (Acanthaceae), *Portulaca*, *Talium* (Portulacaceae). In Australia on *Pseuderanthemum* (Acanthaceae), *Portulaca* (Common).

H. bolina L.—Portulacaceae, Urticaceae (Seitz). In Australia on *Sida rhombifolia* (Malvaceae), *Asystasia scandens*, *Pseuderanthemum variable*, *Ruellia* (Acanthaceae), *Alternanthera denticulata* (Amaranthaceae), *Richardia* (Aroideae), *Synedrella* (Compositae) (Common).

DOLESCHALLIA Feld.—*Eranthemum malabaricum*, *Gratophyllum hortense* (Acanthaceae) (Seitz).

D. bisaltide Cr.—Acanthaceae (Moore), *Gratophyllum hortense* (Acanthaceae), *Urtica* (Urticaceae) (Seitz). In Australia on *Pseuderanthemum variable* (Acanthaceae) (Common).

KALLIMA Dbl.—*Strobilanthes callosus*, *Eranthemum malabaricum* (Acanthaceae) (Seitz).

K. inachus Bsd.—*Strobilanthes capitatus* (Acanthaceae), *Girardinia heterophylla* (Urticaceae), *Polygonum orientale* (Polygonaceae) (Seitz).

K. philarchus Westw.—*Strobilanthes* (Acanthaceae) (Bingham), *Strobilanthes callosus*, *Eranthemum malabaricum* (Acanthaceae) (Seitz).

Marpesiidae

CYRESTIS Bsd.—*Ficus*, *Urostigma*, *Covellia* (Moraceae) (Seitz).

C. thyodamas Bsd.—*Ficus glomerata*, *F. nemoralis* (Peile), *Ficus indica* (Bingham).

CHERSONESIA Dist.—Possibly *Uvaria* sp. (Anonaceae), *Ficus* (Moraceae) (Seitz).

Neptididi

NEPTIS F.

N. jumbah Moore—Byttneriaceae, etc. (Moore), on 13 different plants belonging to the Malvaceae, Sterculiaceae, Tiliaceae, Rhamnaceae, Leguminosae and Urticaceae (Seitz).

- N. hylas** L.—Leguminosae (Moore), *Lathyrus* (Papilionaceae) (Seitz),
N. soma Moore—Malvaceae, Leguminosae, Urticaceae (Seitz).
N. viraja Moore—*Dalbergia latifolia*, *D. racemosa* (Papilionaceae)
 (Moore, Seitz).

RAHINDA Moore

- R. hordonia** Stoll.—*Acacia*, *Albizia* (Mimosaceae) (Bingham).

PANTOPORIA Hbn.

- P. perius** L.—*Glochidion velutinum*, *G. lanceolatum* (Bingham), *Glochidion*, *Phyllanthus* (Seitz). (All Euphorbiaceae).
P. ranga Moore—*Olea dioica*, *Linociera malabarica* (Oleaceae) (Bingham, Seitz). N.B.—Seitz writes *Lonicera* for *Linociera*.
P. opalina Koll.—*Berberis aristata* (Berberidaceae) (Peile).
P. selemophora Koll.—*Adina cordifolia* (Rubiaceae) (Bingham).

- P. nefte** Cr.—*Glochidion velutinum*, *G. zelanica* (Euphorbiaceae) (Bingham), *Glochidion* spp. (Euphorbiaceae), *Mussaenda frondosa* (Rubiaceae) (Seitz).

LIMENITIS F.

- L. procris** Cr.—*Mussaenda*, *Cinchona* (Rubiaceae) (Bingham, Moore), *Mussaenda frondosa*, *Wendenlandia*, *Nauclea cadamba* (Rubiaceae) (Seitz).
L. calidasa Moore—*Mussaenda*, *Cinchona* (Rubiaceae) (Moore, Seitz).

PARTHENOS Hbn.—*Zehneria umbellata* (Cucurbitaceae) (Seitz).

- P. cyaneus** Moore—*Modecca* (Passifloraceae) (Bingham, Moore, Seitz).
 Euthaliidi

EUTHALIA Hbn.

- E. lepidea** Btlr.—*Melastoma malabaricum* (Melastomaceae) (Bingham, Seitz), *Careya arborescens* (Myrtaceae) (Seitz).
E. garuda Moore—*Mangifera indica* (Anacardiaceae) (mihi), *Mangifera indica*, *Anacardium occidentale* (Anacardiaceae), *Loranthus scurrula* (Loranthaceae), *Bryonia* (Cucurbitaceae), *Morus* (Moraceae), *Rosa* (Rosaceae), *Trophis aspera* (? family ?) (Seitz).

- E. vasanta** Moore—*Mangifera indica* (Anacardiaceae) (Moore, Seitz).
E. anosia Moore—*Mangifera indica* (Anacardiaceae) (Seitz).

- E. phemius** Dbl.—*Nephelium litchi* (Sapindaceae) (Seitz).
E. lubentina Cr.—*Loranthus* (Loranthaceae) (Moore, Seitz).
E. nais Forst.—*Diospyros* (Ebenaceae) (Peile), *Diospyros melanoxyton* (Ebenaceae) (Seitz).
E. evelina Stoll.—*Diospyros candolleana* (Bingham), *Diospyros candolleana*, *D. melanoxyton* (Ebenaceae) (Seitz).

Apaturidi

APATURA F.

- A. parisatis** Westw.—*Celtis lycodoxylon* (Ulmaceae) (Moore, Seitz).
A. ambica Koll.—*Ulmus wallichiana* (Ulmaceae) (Seitz).

EURIPUS Westw.—Urticaceae (Seitz).

- E. consimilis** Westw.—*Trema orientalis* (Urticaceae) (Seitz).

Charaxidi

ERIBOEA Hbn.

- E. athamas** Drury—*Delonix regia* (Caesalpinaceae), *Acacia pennata*, *A. coesia*, *Albizia lebbek* (Mimosaceae) (Peile). *Caesalpinia* (Caesalpinaceae) (Moore), *Grewia* (Tiliaceae), *Caesalpinia*, *Poinciana* (Caesalpinaceae), *Albizia milletti*, *Acacia* (Mimosaceae), *Alsicia* (? family ?) (Seitz).

- E. schreiberi** Godt.—*Nephelium lappaceum* (Sapindaceae), *Rourea santaloides* (Connaraceae), *Cynometra cauliflora*, *Wagatea spicata* (Caesalpinaceae) (Seitz).

CHARAXES O.

- C. fabius** F.—*Tamarindus indicus*, *Wagatea spicata* (Caesalpinaceae), 'occasionally noticed on Cardenia' (? family ?), possibly a misprint for *Gardenia* (Rubiaceae) (Seitz).

- C. polyxena** Cr.—*Saccopetalum* (printed *Saroptalum*) *tomentosum* (Anonaceae) (Peile), *Saccopetalum tomentosum* (Anonaceae), *Aglaia roxburghiana* (Meliaceae) (Seitz).

ERYCINIDAE

Libytheini

LIBYTHEA F.

- L. celtis** Fuessl.—In Europe on *Celtis australis* (Ulmaceae).

- L. lepita** Moore—*Celtis* (Ulmaceae) (Seitz).
- L. myrrha** Cr.—*Celtis tetrandra* (Ulmaceae) [Bingham, Seitz (printed *tetranta*)].
- Riodinini
- ZEMEROS Bsd.
- Z. flegyas** Cr.—*Maesa montana* (Bingham), *Maesa chisia* (mihi) (Myrsinaceae).
- DODONA Hew.—On *Maesa* (printed *Moesa*) (Myrsinaceae), Gramineae and alpine bamboo (Gramineae) (Seitz).
- D. eugenes** Bates—Grasses, Hill Bamboo (Bingham), Gramineae, Alpine Bamboo (Gramineae) (Seitz). I am doubtful of the correctness of this record.
- D. adonira** Hew.—*Maesa chisia* (Myrsinaceae) (mihi), *Moesa* (sic) *chisia* (Seitz).
- D. ouida** Moore—*Maesa chisia* (Myrsinaceae) (mihi).
- ABISARA Feld.—Myrsinaceae (Seitz).
- A. fylla** Hew.—*Maesa chisia* (Myrsinaceae) (mihi).
- A. echerius** Stoll.—*Ardisia* (Myrsinaceae) (Moore), Myrsinaceae (Seitz).

LYCAENIDAE

Liphyrinae

LIPHYRA Westw.

- L. brassolis** Westw.—Carnivorous on Ant larvae (Bingham). Also in Australia (Common). Seitz writes 'Holland's presumption that the larvae are carnivora, is due to a rather ingenious and for the present uncontrollable combination'.

Gerydinae—Carnivorous on aphides (Seitz).

GERYDUS Bsd.

- G. biosduvali** Moore—Carnivorous on aphides (Seitz).

Lycaeninae

MEGISBA Moore

- M. malaya** Hors.—Sapindaceae (Moore).

LYCAENOPSIS Feld.

L. puspa Horsf.—*Cylista scariosa* (Papilionaceae), *Xylia dolabriformis* (Mimosaceae), *Hiptage madablota* (Combretaceae), *Schleichera trijuga* (Sapindaceae) (Seitz).

L. argiolus L.—In Europe on *Rhamnus* (Rhamnaceae), *Hedera* (Araliaceae), *Ilex* (Ilicineae).

PITHECOPS Horsf.—Leguminosae (Seitz).

P. hylax F.—Leguminosae (Seitz).

P. zalmora Btlr.—*Glycosmis pentaphylla* (Rutaceae) (Seitz). Also in Australia (Common).

SPALGIS Moore—Carnivorous feeding on the Aphid *Dactylopius adonideum* (Seitz).

S. epius Moore—Euphorbiaceae (Moore). Almost certainly incorrect, the real food being Aphids feeding on the Euphorbiaceae.

CASTALIUS Hbn.

C. ananda de N.—*Zizyphus xylopyrus* (Rhamnaceae), *Loranthus* (Loranthaceae) (Bingham).

C. rosimon F.—*Zizyphus jujuba* (Rhamnaceae) (Peile, Bingham, Seitz).

C. ethion Dbl.—*Zizyphus jujuba*, *Z. xylopyrus* (Rhamnaceae) (Seitz).

C. caleta Hew.—*Zizyphus rugosa* (Rhamnaceae) (Bingham).

TARUCUS Moore—*Zizyphus jujuba* (Rhamnaceae) (Seitz).

T. plinius F.—*Plumbago* (Plumbaginaceae) (Bingham). Also in Australia (Common). In East Africa on *Burkea*, *Crotalaria*, *Indigofera*, *Medicago*, *Melilotis*, *Mundulea*, *Phaseolus*, *Pisum*, *Sesbania* (Papilionaceae), *Plumbago* (Plumbaginaceae).

T. theophrastus F.—*Zizyphus* (Peile), *Zizyphus jujuba* (Bingham) (Rhamnaceae). Also in East Africa.

T. nara Koll.—*Zizyphus* (Peile), *Zizyphus jujuba* (mihl) (Rhamnaceae).

AZANUS Moore

A. ubaldus Cr.—*Acacia* sp. (Peile), *Acacia arabica* (Seitz) (Mimosaceae).

A. uranus Btlr.—*Acacia* sp. (Peile), *Acacia arabica*, *A. senegal* (Seitz) (Mimosaceae).

- A. *jesous* Guer.—In East Africa on *Acacia* (Mimosaceae), *Medicago* (Papilionaceae).

COSMOLYCE Tox.

- C. *boeticus* L.—*Cajanus indicus*, *Butea frondosa* (Peile), *Crotalaria striata* (Bingham), *Lupinus*, *Pisum* (mihi), *Vigna sinensis*, *Melilotus*, *Crotalaria striata* (Seitz). In Australia on *Crotalaria*, *Dolichos*, *Sesbania*, *Lupinus*. In East Africa on *Cajanus cajan*, *Canavallia*, *Colutea*, *Crotalaria*, *Indigofera*, *Lathyrus*, *Lupinus*, *Medicago*, *Phaseolus*, *Pisum*, *Podalyria*, *Sutherlandia*, *Virgilia*. All Papilionaceae.

LYCAENESTHES Moore

- L. *emolus* Godt.—*Nephelium litchi* (Sapindaceae), *Heynea trijuga* (Meliaceae), *Cassia fistula* (Caesalpinaceae) (Bingham, Seitz). In Australia on *Caesalpinia nuga*, *Cassia* (Caesalpinaceae), *Pongamia pinnata* (Papilionaceae), *Clerodendron* (Verbenaceae), *Cupaniopsis anacardioides* (? family ?), *Faradaya splendida* (? family ?) (Common).

JAMIDES Hbn.

- J. *bochus* Cr.—*Xylia dolabriformis* (Mimosaceae), *Butea frondosa* (Papilionaceae) (Bingham, Seitz).

LAMPIDES Hbn.

- L. *celeno* Cr.—*Heynea trijuga* (Meliaceae) (Bingham), *Heynea trijuga* (Meliaceae), *Butea frondosa* (Papilionaceae), 'but presumably also on other plants, such as *Cardamomae*' (Seitz).
- L. *elpis* Godt.—*Kaempferia pandurata*, *Elettaria cardamomum* (Zinziberaceae) (Bingham, Seitz).

NACADUBA Moore

- N. *berenice* H. Sch.—In Australia on *Cupaniopsis* (? family ?), *Alectryon* (? family ?) (Common).
- N. *atrata* Horsf.—*Embelia robusta* (Sapotaceae) (Bingham).
- N. *perusia* Feld.—*Vateria indica* (Dipterocarpaceae) (Moore).

CATOCHRYSOPS Bsd.

- C. *cnejus* F.—*Phaseolus trilobus*, *Dolichos catjang* (Papilionaceae) (Bingham, Seitz). In Australia legume flowers (Common).
- C. *pandava* Horsf.—*Cycas revoluta* (Cycadaceae) (Bingham, Seitz), *Cycadaceae* (Moore).

EVERES Hbn.

E. argiades Pall.—*Trifolium*, etc. (Papilionaceae) (Bingham).

TALICADA Moore

T. nyseus Geur.—*Bryophillum calycinum* (Crassulaceae) (Bingham, Seitz),
Bryophillum (Moore).

ZIZERA Moore

Z. lysimon Hbn. (= *Zizeeria knysna* Trim.)—*Zornia diphylla* (Papilionaceae) (Bingham). In Australia on *Tribulus terrestris* (Zygophyllaceae) (Common). In East Africa on *Amaranthus* (Amaranthaceae), *Euphorbia* (Euphorbiaceae), *Oxalis* (Oxalidaceae), *Medicago*, *Zornia* (Papilionaceae), *Tribulus* (Zygophyllaceae).

Z. gaika Trim. (= *Zizula hylax* F.)—In East Africa on *Oxalis* (Oxalidaceae).

Z. otis F.—In Australia on Legumes including *Medicago* (Papilionaceae) (Common).

Z. maha Koll.—*Oxalis corniculata* (Oxalidaceae) (mihi).

CHILADES Moore

C. trochilus Fr.—*Heliotropium strigosum* (Boraginaceae) (Bingham),
Rhynchosia minima (Papilionaceae) (mihi). In Australia on *Indigofera* (Papilionaceae) (Common). In East Africa on *Indigofera*.

C. laius Cr.—*Citrus* spp. (Rutaceae) (Bingham, mihi).

LYCAENA F. (= *Polyommatus* Latr.)

L. astrarche Bgster.—In Europe on *Erodium cicutarium* (Geraniaceae).

L. cyllarus Rott.—In Europe on Leguminosae.

L. icarus Rott.—In Europe on Leguminosae, especially on *Ononis spinosa* (Papilionaceae).

CHYSOPHANUS Hbn. (= *Lycaena* F.)

C. phlaeas L.—*Rumex nepalensis* (Polygonaceae) (Peile). In Europe on *Rumex* spp.

ILERDA Dbl. (= *Heliophorus* Geyer)

I. brahma Moore—*Rumex* (Polygonaceae) (mihi).

I. sena Koll.—*Rumex hastatus* (Polygonaceae) (Peile).

CURETIS Hbn.

C. **bulis** Dbl.—*Pongamia glabra* (Papilionaceae) (Bingham).

APHNÆUS Hbn.

A. **lohita** Horsf.—Convolvulaceae (Moore).

APHARITIS Riley

A. **acamas** Klug—*Cassia* (Caesalpinaceae) (Seitz).

IRAOTA Moore

I. **timoleon** Stoll.—*Ficus glomerata* (Peile), *F. religiosa* (Moore) (Moraceae).

AMBLYPEDIA Horsf.—On *Schleichera* (Sapindaceae), *Lagerstroemia* (Lythraceae), *Xylia* (Mimosaceae), *Hopea* (Styraceae), etc. (Seitz).

A. **apidanus** Cr.—*Eugenia* (Myrtaceae), *Lagerstroemia* (Lythraceae) (Seitz).

A. **centaurus** F.—*Schleichera trijuga* (Sapindaceae) (Moore).

A. **dodonaea** Moore

A. **rama** Koll.

A. **ganesa** Moore

} *Quercus incana* (Fagaceae) (Peile).

ZEPHYRUS Dalm.

Z. **birupa** Moore—*Rhododendron arboreum* (Ericaceae) (Peile).

CHAETOPROCTA de Nic.

C. **odata** Hew.—*Juglans* (Juglandaceae) (Peile).

CAMENA Hew. (=Pratapa Moore)

C. **deva** Moore—*Loranthus tomentosa* (Loranthaceae) (Peile, Seitz).

TAJURIA Moore

T. **cippus** F.—*Loranthus* (Loranthaceae) (Moore, Seitz).

T. **melastigma** de Nic.—*Loranthus* (Loranthaceae) (Seitz).

T. **jalindra** Horsf.—*Loranthus elastica* (Loranthaceae) (Seitz).

T. **cleobis** Godt.—*Loranthus elastica* (Loranthaceae) (Seitz).

T. **diaeus** Hew.—*Loranthus bicolor* (Loranthaceae), *Lantana* (Verbenaceae) (Seitz).

HORAGA Moore

- H. onyx** Moore—*Coriaria nepalensis* (Coriariaceae) (Seitz).

HYPOLYCAENA Feld.

- H. erylus** Godt.—*Vangueria spinosa* (Rubiaceae) (Seitz).

RATHINDA Moore

- R. amor** F.—*Eugenia ceylonica* (Myrtaceae), *Hopea* (Styraceae) and presumably on some other plants (Seitz), *Ixora coccinea* (Rubiaceae), *Nephelium litchi* (Sapindaceae) (mihi).

CHERITRA Moore

- C. freja** F.—*Xylia dolabriformis* (Mimosaceae) (Seitz).

LOXURA Horsf.

- L. atymnus** Cr.—*Smilax* (Smilacaceae) (Moore), *Dioscorea* (Dioscoraceae) (Seitz).

ZEZIUS Hbn.

- Z. chrysomallus** Hbn.—*Terminalia* (Combretaceae) (Moore), *Terminalia tomentosa*, *T. paniculata* (Combretaceae), *Xylia dolabriformis* (Mimosaceae) (Seitz).

DEUDORYX Hew.—In fruits (Seitz).

- D. epijarbas** Moore—*Punica granatum* (Lythraceae), *Aesculus* (Hippocastaneae) (Peile), *Connarus ritchiei* (Connaraceae), *Punica* (Lythraceae), *Aesculus indicus* (Hippocastaneae) (Seitz). In Australia in fruits of *Harpullia pendula* (Sapindaceae) (Common).

- D. perse** Hew.—*Randia dumetorum* (Rubiaceae) (Seitz).

- D. isocrates** F.—*Punica* (Lythraceae) (Peile), *Punica granatum* (Lythraceae), *Psidium guajava* (Myrtaceae), *Eriobotrya japonica* (Rosaceae), *Randia dumetorum*, *R. uliginosa* (Rubiaceae) (Seitz).

RAPALA Moore

- R. melampus** Cr.—*Nephelium lappaceum* (Sapindaceae), *Melastoma polyanthus* (Melastomaceae), *Zizyphus rugosus* (Rhamnaceae), *Ougei-nea dalbergeoides* (Papilionaceae) (Seitz).

- R. selira** Moore—*Indigofera purpurea* (Papilionaceae) (Peile).

- R. varuna** Horsf.—*Lantana camara* (Verbenaceae), *Zizyphus xylopyrus* (Rhamnaceae) (Seitz).

- R. sphinx** F.—*Melastoma polyanthus* (Melastomaceae), *Elaeagnus ferruginea* (Elaeagnaceae) (Seitz).
- R. schistacea** Moore—*Quisqualis indica* (Combretaceae) (mihi), *Quisqualis* (Combretaceae), *Acacia caesia* (Mimosaceae), *Spiraea sorbifolia* (Rosaceae) (Seitz).

HESPERIIDAE

Hesperinae

COLADENIA Moore

- C. dan** F.—*Achyranthes aspera* (Amarantaceae) (Seitz).

CELAENORRHINUS Hbn.

- C. asmara** Btlr.—*Clerodendron fragrans* (Verbenaceae) (Seitz).
- C. plagifera** de N.—*Impatiens* (Balsamineae) (mihi).

TAGIADES Hbn.—Roxburghiaceae, Dioscoraceae, Convolvulaceae (Seitz).

- T. japetus** Cr.—*Dioscorea oppositifolia* (Dioscoraceae) (Seitz).

ODONTOPTILUM de N.

- O. angulata** Feld.—*Hibiscus tiliaceus*, *Urena lobata*, *Eriodendron* (Malvaceae), and other plants (Seitz).

HESPERIA Latr.

- H. galba** F.—*Sida rhombifolia* (Malvaceae) (mihi).

CARCHARODUS Hbn.

- C. alcae** Esp.—In Europe on Malvaceae.

Ismeninae

HASORA Moore

- H. badra** Moore—*Derris uliginosa* (Bell), *Pongamia volubilis* (Seitz) (both Papilionaceae).
- H. alexis** F.—*Pongamia glabra* (Papilionaceae) (Bell). Also in Australia (Common).
- H. butleri** Auriv.—*Derris scandens* (Papilionaceae) (Bell).
- H. vitta** Btlr.—*Millettia racemosa*, *M. auriculata* (Papilionaceae) (Bell).

BIBASIS Moore

- B. sena** Moore—*Combretum extensum* (Combretaceae) (Bell), *Combretum latifolium* (Seitz).

BADAMIA Moore

- B. exclamationis** F.—*Terminalia bellerica* (Combretaceae) (Bell). In Australia on *Terminalia* (Common).

ISMENE Swains.

- I. harisa** Moore—*Zinziber zerumbet* (Zinziberaceae) (Seitz).

- I. gomata** Moore—*Heptapluron venulosum* (Araliaceae) (Bell), *Heptapluron lucidum* (Araliaceae), *Embelia garciniaefolia* (Myrsinaceae), *Trevesia sondaica* (Araliaceae), *Horsfieldia* (Myristicaceae), etc. (Seitz).

- I. oedipodea** Swains.—*Combretum latifolium* (Combretaceae) (Seitz).

- I. jaina** Moore—*Combretum extensum* (Combretaceae) (Bell).

RHOPALOCAMPTA Wallgrn.

- R. benjamini** Guer.—*Sabia campanulata*, *Meliosma pungens* (Sabiaceae) (Bell).

Pamphilinae

SUASTUS Moore

- S. gremius** F.—Palms (mihi), *Caryota urens* and other Palms (Palmaceae) (Bell).

IAMBRIX Wats.

- I. salsala** Moore—Grasses (Bell), Bamboo (Seitz) (both Gramineae).

- I. stillifer** Btlr.—Bamboo (Gramineae) (Seitz).

AEROMACHUS de Nic.

- A. stigmata** Moore—Grasses (Gramineae) (mihi).

- A. discreta** Plotz—Grasses (Gramineae) (Bell).

HYAROTIS Moore

- H. adrastus** Cr.—*Phoenix* (Bell), Rotang and Phoenix Palms (Seitz) (Palmaceae).

MATAPA Moore

- M. aria** Moore—Bamboo (mihi, Bell, Seitz) (Gramineae).

ERIONOTA Mab.

- E. thrax** L.—*Musa* spp. (Musaceae) (Bell), *Musa* and other Monocotyledons such as *Saccharum* (Gramineae), *Cocos nucifera*, *Rhaphis* (Palmaeae), *Metroxylon* (Palmaceae) (Seitz).

GANGARA Moore

- G. thyrasis** F.—Palmaceae (Moore), *Calamus*, *Cocos nucifera*, *Caryota urens* and other Palms (Bell), Palms, particularly on cocconut (sic) trees and dwarf palms, but it is said to occur also on ratan, *Calamus rotang*, and other Monocotyledons (Seitz).

SANCUS de Nic.

- S. pulligo** Mab.—*Phrynium spicatum* (Marantaceae) (Bell), a common Arum (Araceae) (Seitz).

BARACUS Moore

- B. hampsoni** Elw.—Grasses (Gramineae) (Bell).

AMPITTIA Moore

- A. dioscorides** F.—*Oryza* (Gramineae) (Bell, Seitz).

TARACTROCERA Btlr.

- T. maevius** F.—Grasses (Gramineae) (Bell).

- T. nicevillei** Wats.—Grasses, *Oryza* (Gramineae) (Bell).

PADRAONA Moore

- P. gola** Moore—Grasses (Gramineae) (Bell), *Imperata arundinacea*, *Paspalum conjugatum* (Gramineae) (Seitz).

- P. dara** Koll.—*Paspalum conjugatum* (Gramineae) (Seitz).

TELICOTA Moore

- T. bambusae** Moore—Bamboo (Bell, mihi), bamboo, *Saccharum* (Seitz) (all Gramineae).

- T. augias** L.—*Saccharum*, *Oryza*, Bamboo (Gramineae) (Bell). In Australia on *Flagellaria indica* (Gramineae) (Common).

- T. palmarum** Moore—*Cocos nucifera*, *Phoenix* (Bell), *Cocos nucifera*, *Calamus rotang* (Seitz) (all Palmaceae).

- T. maesoides** Koll.—*Bambusa*, *Oxytenanthera*, *Dendrocalamus*, *Teinostachyum* (Gramineae) (Bell).

GEGENES Hbn.

G. nostradamus F.—Grasses (Gramineae) (Bell), *Oryza* (Gramineae) (Seitz).

PARNARA Moore

P. philippina H. Sch.—Bamboo (Bell), presumably on *Oryza*, *Saccharum*, Bamboo (Gramineae), perhaps also on Palms (Palmaceae) (Seitz).

P. guttatus Brem.—Grasses, *Oryza*, *Saccharum*, Bamboo (Bell), *Oryza*, *Zea mays*, *Saccharum*, Bamboo (Seitz). All Gramineae.

P. colaca Moore—Grasses, *Oryza* (Bell), *Oryza* (Seitz) (Gramineae), Gramineae (Moore).

P. bevani Moore—*Saccharum*, *Paspalum conjugatum*, *Imperata arundinaceae* (Gramineae) (Seitz).

P. kumara Moore—*Imperata arundinaceae* (Gramineae) (Seitz), Bamboo (Gramineae) (Bell).

P. oceia Hew.—*Bambusa arundinaceae*, *Ochlandra talboti* (Gramineae) (Bell), *Saccharum* (Gramineae) (Moore).

P. canaraica Moore—Bamboo (Gramineae) (Bell).

P. mathias F.—Grasses (Bell), *Oryza*, *Saccharum* and other Gramineae (Seitz).

P. subochracea Moore—Grasses (Gramineae) (Bell).

P. zelleri Led.—Grasses (Gramineae) (Bell).

HALPE Moore

H. astigmata Swinh.

H. moorei Wats.

H. hyrtacus de Nic.

H. honorei de Nic.

} Bamboo (Gramineae) (Bell).

PLASTINGIA Btlr.

P. submaculata Stg.—*Calamus subtenuis* (Palmaceae) (Bell).

CUPITHA Moore

C. purreea Moore—*Combretum ovalifolium*, *Terminalia bellerica*, *T. paniculata* (Combretaceae), *Ehretia laevis* (Boraginaceae) (Bell).

PIRDANA Dist.

P. hyela Hew.—*Dracaena*, *Cordyline rumphii* (Liliaceae) (Seitz).

NOTOCRYPTA de Nic.

- N. curvifascia** Feld.—*Curcuma* (Zinziberaceae) (Seitz).
N. restricta Moore—*Zinziber casumunar*, *Curcuma decipiens* (Zinziberaceae) (Bell).
N. feisthameli Bsd.—*Zinziber casumunar*, *Curcuma decipiens* (Bell).
Zinziber (mihi). All Zinziberaceae.
N. alysos Moore—Zinziberaceae (Moore).

UDASPES Moore

- U. folus** Cr.—*Curcuma decipiens* and other Zinziberaceae (Bell), *Curcuma* (Zinziberaceae), *Fagraea racemosa* (Loganiaceae) (Seitz).

KERANA Dist.

- K. diocles** Moore—*Zinziber*, *Curcuma* (Zinziberaceae) (Seitz).

PADUCA Dist.

- P. lebadea** Hew.—Palmaceae (Moore), *Calamus* (Palmaceae) (Seitz).

UNKANA Dist.

- U. attina** Hew.—*Pandanus fascicularis* (Pandaneae), *Psychotria* sp. (Rubiaceae) (Seitz).

HIDARI Dist.

- H. ivava** Moore—Various palms, particularly *Cocos nucifera* and *Caryota urens* (Palmaceae) (Seitz).

N.B.—In most of the works consulted, the spelling of the botanical names leaves much to be desired, Seitz is particularly bad, the same name often appearing twice on the same page with different spellings.

Reviews

1. BEHAVIOUR OF WOLVES, DOGS AND RELATED CANIDS. By M. W. Fox. pp. 214 (16×24 cm) with numerous black-and-white photographs and line drawings. London, 1971. Jonathan Cape. Price £3.60 net.

In the sub-family Canidae only the wolf forms permanent packs. Family groups of coyotes and jackals may hunt together for a time, but foxes drive their young away early, and the breeding pair often separate also. The author of this interesting book shows that though these species have the same basic behaviour patterns, these have become more complex in the more social species. New facial expressions have evolved, often combining more than one primitive expression. Interestingly these complex expressions appear later in the development of cubs than do the primitive ones common to all species. The domestic dog is believed to have evolved from a wolf-like ancestor, but it has been suggested, and not yet conclusively disproved, that in some parts of the world primitive man domesticated the jackal. As a result of selective breeding some behaviour patterns have atrophied, others hypertrophied, and yet others have acquired a new significance, so no clue as to origin can be obtained from behaviour. Dog owners will be intrigued to know that when two dogs circle one another this is the same behaviour as that of young pups, which circle each other until they fall asleep in a tight warm heap. This is only one of a number of infantile behaviour patterns which persist, and are incorporated in a changed form into adult behaviour.

Dr. Fox's observations have been on hand-raised canids, which he compares with field data whenever possible. The wolves are by far the most attractive subjects, and there are some fascinating chapters on the development of dominance in wolves and on wolves as parents. Observations both on captive and on wild wolves indicate that normally only one pair in a pack breeds and that the dominant wolf is not one of them. All the members of the pack co-operate in looking after the cubs. This is a population-regulating mechanism. In addition, in the wild numbers are controlled by the availability of prey species, and when there is little food there is high mortality among pups. On page 128 the author cites a number of authorities who believe that there is no reduction in the number of pups born in lean year, and yet on pages 113-114 he hypothesises, apparently without data, that poor nutrition could lead to infertility and resorption of foetuses. There seems to be no good reason for the subject to be discussed in two different places. Another subject

that is discussed at some length is submission, and its function in social organisation. Some dominance-submission rituals would in a human context be interpreted as affection, and the term 'love' is used here. This seems unnecessarily anthropomorphic, and also inappropriate as the word has a wider meaning than that to which it is restricted here.

The photographs in this book are excellent throughout, but the writing is often awkward. Lay readers will find the jargon in some of the earlier chapters particularly trying. It is difficult to imagine anyone being helped by descriptions like 'dorsal vertical postero-horizontal retraction of lips', meaning a simultaneous grin and a snarl. Often there does not seem to be any connection between sub-titles and subject matter. This is due to poor organisation. For example, a discussion of the development in hand-reared wolf cubs of allegiances to pack members and nervousness of strangers occurs at the end of a section on mate preferences, when it belongs at the beginning of the same chapter, which deals with social organisation, or perhaps in another chapter entitled 'Development of Social Relationships: Wolf Socialisation'. It is to be hoped that these irritations will be corrected in future editions.

One would now like to have a comparison between wolf socialisation and that of the dhole, the South American bush dog, and the Cape hunting dog, all pack-hunters which belong to the sub-family Simocyoninae. These lack the range of complex facial expressions which characterise the wolf, and apparently do not all show dominance. Dr. Fox is the obvious person to make these comparisons and I hope that he will do so before too long.

R. R.

2. INSECT POLLINATION. By J. B. Free. pp. xi + 544 (15×23 cm) with 170 figures. London & New York, 1970. Academic Press. Price £7.25.

This reviewer is indeed struck by the wealth of information this book possesses. It reviews all the important information on the subject into a most comprehensive volume and makes it a very valuable reference work on pollination of the most important crops of temperate regions. 'Although there are many facets of pollination of different crops that are similar, it is very striking how many crops have their own unique pollination problems.'

The author who is connected with the Rothamsted Experimental Station, Hampden, Herts, England, is without doubt fully conversant with this subject. In the first part of the book, he has discussed the pollinating insects—particularly the honey bee and points out how it

tain ranges in the world. The flora and fauna of a mountain have partly evolved from the lowland species of the area at the time when the mountain range was uplifted, and have been remoulded at every phase of the slow process of rising. Other species have colonised the mountain from the lowland or from distant mountain ranges. Then there are relict species which have survived glaciations on widely separated high mountains though extinct elsewhere. Specialisation has everywhere tended to produce local subspecies and races, some restricted to a single peak.

This comprehensive book is likely to be an essential reference book on this subject for a long time to come. There are 1141 papers cited.

R. R.

6. CEDRUS. BOTANICAL MONOGRAPH NO. 5. By P. Maheshwari and Chhaya Biswas. pp. 115 (16.5×24.5 cm) with 55 figures. New Delhi, 1970. Council of Scientific and Industrial Research. Price Rs. 24, sh. 48, \$8.

This botanical monograph has been the last one in which the celebrated Indian botanist, late Professor P. Maheshwari actively participated. In fact, the other author points out in the footnote of the preface, Prof. Maheshwari passed away when the manuscript was almost completed for the press. This monograph gives an excellent account of the phytomorphology of the genus *Cedrus*. The major part of the text deals with *Cedrus deodara*, one of the most valuable timbers found in India.

Of the 108 pages of the text, 90 are taken up by phytomorphology—53 dealing with embryology. Eighteen pages are utilised to give a résumé of cytological studies, phytopathology, ecology, silviculture and economic importance of the genus. The illustrations are excellent and take about 50 pages.

Figure no. 55 giving time relation of *Cedrus deodara* is interesting. It appears that one of the figures of years (June 1956 or January 1957) needs correction in view of the explanation in the relevant table and text—18 months from June 1956 should make 1958 January.

The Introduction gives 4 interesting biblical and Chinese legends on Cedar wood. It would have been in the fitness of this monograph to mention a few from ancient Indian literature wherein 'Devdaru' is well-known. This monograph forms a valuable review of the phytomorphological studies of the genus *Cedrus* and will certainly prove useful in that field of study with its comprehensive bibliography. In view of

Miscellaneous Notes

1. ECOLOGICAL AND BEHAVIOURAL NOTES ON THE LIONTAILED MACAQUE (*MACACA SILENUS*) IN SOUTH INDIA

The Liontailed Macaque (*Macaca silenus*) has the most restricted range of all primates of the Indian subcontinent, where it is restricted to the evergreen forest of the Western Ghats (Krishnan 1971). Blanford (1888) indicated that the species occurs from 14°N. to the southern limits of the Western Ghats while Sugiyama (1968) found the species between 9°30' and 11° 30'N. Krishnan (1971) indicates that it is no longer present in the forests of Thirunelveli District at Courtallam. I was very fortunate to observe the Liontailed Macaque on two consecutive days (2-3 March 1972) at the Manjulai Tea Estate of Bombay Burma Trading Company above Kalladaikurichi. This area is located in Thirunelveli District of Tamil Nadu State at about 8° 38'N., 77° 25'E. and about 1000 metres elevation. The region can be characterized as extensive tea and cardamom plantations interspersed with stands of relatively undisturbed forest.

I first observed a group of Nilgiri Langur (*Presbytis johni*) near the edge of a tea field. After several minutes an individual with the distinct, short, drooping tail of *Macaca silenus* was observed walking slowly along a branch. Later, when tea pickers moved into the area three *Macaca* were observed fleeing along with the group of langurs. A noteworthy difference in the behaviour of the two species was observed; the langur moved through the canopy with long jumps accompanied by swishing of branches while the macaque walked slowly and deliberately in single file along the interior branches of the large forest trees. Only subdued vocalizations were heard from the macaque (see below), while the langur has loud call reminiscent of the whooping of the Black Howler Monkey (*Alouatta*) of Central America.

The following morning one, and perhaps two, females with young infants were observed in the same area. Judging from the size of a known age infant in the Zoo Negara, Kuala Lumpur, Malaysia, the infant at Manjulai was about two months old in early March. Sugiyama's observations (1968) indicate January is the season of birth while Prater (1971) suggests that young are seen regularly in September.

As many as six adult individuals were counted simultaneously but no doubt more were present on March 3. Throughout the observations individuals appeared and disappeared in the forest canopy over an area of several hectares, indicating that bands spread out rather widely during feeding.

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2. NOTES ON THE BIRTH AND GROWTH OF A SLOW LORIS (*NYCTICEBUS COUCANG*) IN CAPTIVITY

A pregnant Slow Loris (*Nycticebus coucang*) received at the Nandankanan Biological Park (Orissa) on 1.ii.1971 from the forests of Assam, gave birth to a female young on 21.ii.1971. After delivery the mother weighed 1.4 kg.

The new born young weighed 50 gm and measured 14 cm in total length. The eyes were open at birth. The young had a coat of dense fur and numerous long glistening grey hairs were scattered throughout the body and projected far beyond the fur. These long hairs gradually disappeared when the young was about 11 weeks old. The body coat was grey throughout except the hands and limbs which were silvery white. The brown stripe on mid back was very prominent.

A single young is usually born (Prater 1971; Walker *et al.* 1964; Asdell 1964). Crandall (1965) reported that all births were of single young except the two twin births which were found dead within a day or two. The eyes of a Slow Loris young are open at birth (Crandall, loc. cit.). There is no mention of birth weight and size in the available literature.

Up to the age of seven weeks the young was seen clinging to the mother's abdomen and sucking her teat throughout the day. From the eighth week onwards and up to the age of 10 months, the young was clinging to the mother's abdomen throughout the day, partly keeping her hind quarters on the ground either in between the two limbs of the mother or over the mother's lap. Whenever attempts were made to handle or see the young during the day time, the mother with her baby curled up like a ball and twittered in annoyance. The mother cleaned the baby by licking. After sunset the young was always seen separated from the mother and was either clinging to the chainlink mesh wall or moving about in the house from the very first day. From the third day it was able to produce a feeble noise when handled and this noise immediately attracted the attention of the mother. Up to 8 weeks of age the young one was at times seen clinging to the abdomen of another

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3. ON SOME MELANISTIC SPECIMENS OF HOUSE RAT,
RATTUS RATTUS (LINNAEUS) [MAMMALIA :
 RODENTIA : MURIDAE]

It is a well-known fact that the coat colour of rodents, specially the rats, is subject to great variations. But extreme colour variations, commonly known as albinism and melanism, are rare. The latter has been reported in several species of mammals, including rodents, but I find no record of it in *Rattus rattus* (Linnaeus). It is therefore recorded here. The note is based on a collection of five adult rats, *Rattus rattus* (Linnaeus), present in the collection of the Zoological Survey of India. Two are males (Z.S.I. Reg. No. 8366, 8374) and three females (Z.S.I. Reg. No. 8365, 8369, 8370), all collected from Calcutta in the year 1906.

The colour of the body and the tail is completely black, with no line of demarcation between the dorsal and ventral aspects. In three out of five specimens, the pinna is of lighter colour than in the other two.

All measurements are in millimetres and are taken after Ellerman (1963).

MEASUREMENTS :

External : 2 ♂♂—Head and body 181, 182 ; tail 190, 231 ; hind-foot 33, 34 ; ear 23, 24.

3 ♀♀—Head and body 145, 147, 178 ; tail 193, 195, 224 ; hind-foot 33·5, 34·5, 34·5 ; ear 19, 21, 24.

Cranial : 1 ♂—Occipitonasal 42·3 ; nasal 16·0 ; palate 22·3 ; palatal-foramina 7·6 ; diastema 12·0 ; upper tooth-row 6·3 ; bulla 7·2.

3 ♀♀—Occipitonasal 36·8, 39·0, 44·2 ; nasal 13·5, 14·0, 16·3 ; palate 19·3, 20·2, 24·0 ; palatal-foramina 6·5, 6·6, 8·9 ; diastema 10·0, 10·8, 13·0 ; upper tooth-row 6·0, 6·1, 6·8 ; bulla 6·8, 7·0, 7·7.

Different views have been put forward as to the causes of melanism. Keeler & King (1941) are of the opinion that melanism acts as a simple Mendelian recessive character. Rohe (1961) found a melanistic population of the Norway Rat (*Rattus norvegicus*), confined to underground sewers. The fact that the population was completely isolated and that the litters were all melanistic led him to believe that it was a true breeding melanistic colony. Svihla's (1956) finding that heat conservation at

For many weeks we did not see him at all. Then on Wednesday, November 29, I entered the room and to my surprise the rat was there ! It was about 1 p.m. He looked fatter than before, his fur in very good condition. The platform on which he lay was in a sorry state after weeks of disuse, but on Wednesday he brought no twigs and did not repair it in any way.

When my husband returned about 6 p.m., I showed him the rat and it was still there after 10 p.m. when we went to bed, but the following morning it was not there and has not been seen since. This is its briefest visit so far.

C.M.C. HOSPITAL,
VELLORE 632004,
TAMIL NADU,
December 1, 1972.

M. P. WALKEY

5. ALBINISM IN THE LESSER RAT-TAILED BAT,
RHINOPOMA H. HARDWICKEI GRAY
(CHIROPTERA : RHINOPOMATIDAE)

Allen (BATS 1939, p. 154) has mentioned a few cases of albinism in a few species of bats with the remarks that both albinism and melanism are rare in bats. No case of albinism came to my notice in the Indian species during examination of over four thousand specimens belonging to several species particularly from Central India. On 26th April, 1972, however, a beautiful albino adult female of the Lesser Rat-tailed Bat was collected alive along with others from a colony of about 100 individuals in caves under granite boulders near Jabalpur city. The general pelage, the wing membranes, the metacarpals, the phalanges and the ears are white or dirty white. The legs, the feet, the arms, the tail, the face, the chin and the throat are pinkish. The colour of eyes was not noted in the living specimen but in the dead specimen it is blackish. The specimen has been exhibited in the departmental museum. The specimen was kept in captivity along with other specimens for a few hours but died during night possibly because of an injury on the chest. Some parts of it were found eaten by ants during night. It kept aloof from other specimens in captivity.

Recently a friend reported that he collected an albino of *Hipposideros* sp. from a large colony in a cave in another district of Madhya Pradesh.

183/581, SOUTH CIVIL LINES,
JABALPUR,
June 26, 1972.

H. KHAJURIA

ACKNOWLEDGEMENTS

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BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1,
January 25, 1973.

ROBERT B. GRUBH

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7. CALCIUM INTAKE IN VULTURES OF THE GENUS *GYPUS*

Vultures grouped under the genus *Gyps* were known to feed only on meat and other soft tissues of carcasses and not on bones, and therefore their mode of calcium intake, required to build up bones, had always been a mystery.

During one of my observations on vultures at Gir Forest I came across the following incident. In the western Gir, close to Sasan village, about ninety-five Whitebacked (*Gyps bengalensis*), seven Longbilled (*Gyps indicus*), four Griffon (*Gyps fulvus*), and three King (*Torgos calvus*) vultures were feeding off the skinned carcass of an ox on 23rd January 1972 at 1245 hrs. Soon a few vultures with bulging crops emerged from the squabbling flock, walked about twenty feet aside, and started picking up and swallowing pieces of old, dry bones including ribs of small animals and chopped up pieces of skull. It is a village carcass dumping site, adjacent to the forest.

To further check this up on captive birds I introduced old bone pieces into my vulture aviary. The vultures were not kept hungry. Soon after introducing bones, Longbilled, Whitebacked, and also the only Griffon I had came one by one and swallowed some bones, one of the birds dipping a piece into water before swallowing it. This observation on captive birds was also witnessed by Dr. Salim Ali during his visit to the Gir two weeks later.

ask observers not only in the field but also those with access to other collections, to see if they can obtain corroborative evidence.

75, ABDUL REHMAN STREET,
BOMBAY-3.

HUMAYUN ABDULALI

BOMBAY NATURAL HISTORY SOCIETY,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1,

S. A. HUSSAIN

September 21, 1972.

9. DAMAGE TO MAIZE CROP BY ROSERINGED
PARAKEET, *PSITTACULA KRAMERI* (SCOPOLI)
IN THE PUNJAB

(With a photograph)

INTRODUCTION

Damage by birds to crops and fruits is not a new problem and references to their damage have been listed periodically in the last five centuries. The Roseringed Parakeet has been reported to be very destructive to crops and ripening fruits thus reducing subsequent yields. It eats by gnawing, thus wasting far more than what it actually eats (Whistler 1949; Lamba 1952; Ali 1964 and Ali & Futchally 1967). Taking into consideration its destructiveness to crops and fruits the present studies were undertaken to evaluate the extent of damage to maize crop.

MATERIAL AND METHODS

To evaluate the extent of damage to maize crop by parakeets, a plot having a total area of 1.5 acres was selected at the Punjab Agricultural University Farm, Ludhiana. The data were recorded on ten rows selected at random when the grains were set in the cobs. The damaged cobs were graded on the basis of the amount of damage done as fully damaged, $\frac{3}{4}$ damaged, $\frac{1}{2}$ damaged, $\frac{1}{4}$ damaged and $\frac{1}{8}$ damaged. Total number of fully damaged cobs were calculated by summing up the damage done to all cobs put together. The percentage of loss to the grains on cob basis was then worked out.

RESULT AND DISCUSSION

On an average, there were 60.7 cobs per line, each having 39.2 un-attacked cobs. Maximum damage was observed in the form of

Per cent loss to maize crop on cob basis was also worked out and is given in Table 2.

TABLE 2
PER CENT LOSS TO MAIZE BY PARAKEET

Row No.	Total No. of cobs	Loss as damaged cobs*	Per cent loss
1	61	9.2	15.1
2	63	10.4	16.5
3	67	6.7	10.1
4	55	6.4	11.5
5	53	7.1	13.4
6	58	6.1	10.5
7	62	7.4	11.8
8	61	8.2	13.2
9	66	6.9	10.4
10	61	7.2	11.9
Average			12.4

* Obtained by adding figures $\frac{2}{3}$ of column 2, $\frac{1}{2}$ of column 3, $\frac{1}{3}$ of column 4 and $\frac{1}{4}$ of column 5 of Table 1.

The data presented in Table 2 reveal that the percentage of loss to maize crop varied from 10.1 to 16.5, average being 12.4 per cent. However, Sekhon (1966) recorded on an average 20.6% loss to maize crop due to Roseringed Parakeet. His observations were based on just three rows of plants in a field. Whistler (1949) reported that it feeds bit by bit and causes damage in the gardens and fields. Ali (1964) and Ali & Futehally (1967) mentioned it to be a serious pest to the farmers and fruit growers, causing enormous losses to their standing crops and ripening fruits by gnawing at and wasting far more than it actually eats.

On the basis of the present study it may be concluded that the Rose-ringed Parakeet causes considerable loss to maize crop and warrants control.

ACKNOWLEDGEMENTS

We are thankful to Dr. O. S. Bindra, Professor & Head, Zoology-Entomology Department, for providing the necessary facilities to carry out these investigations.

DEPT. OF ZOOLOGY & ENTOMOLOGY,
P. A. UNIVERSITY,
LUDHIANA,
November 11, 1971.

M. RAMZAN
H. S. TOOR

Railway Station. This railway station is situated on the outskirts of the town where the human population is very scanty. The other roosting site at Chuchura is a banyan tree standing on the bank of the Hooghly river on the eastern boundary of the town.

Sinthi is a densely populated suburb of Calcutta (population : 50,000) with large trees (coconut, banyan, mango and peepul, etc.) scattered all over the area. Here the Common Myna can be seen in abundance from dawn to dusk feeding solitarily most of the feeding time on the household refuse. But at dusk the birds leave the area to roost on trees on the outskirts of Sinthi.

Santiniketan is a university town in the district of Birbhum, West Bengal. Here I have found only one roosting site of the Common Myna; a clump of bamboo (*Bambusa* sp.) growing inside a walled graveyard at the southern boundary of the university campus (area : c. 6 square km).

It is therefore, clear that the preferred roosting on babul trees above all others at Berhampore, on a banyan tree on the outskirts of Chuchura, and on bamboo in a secluded graveyard at Santiniketan is because these sites are relatively undisturbed.

At Berhampore construction of a bridge over the Bhagirathi river near the rows of the babul trees was started in the early part of June 1963. Soon tents and huts were installed to house a large number of people who were connected with the construction of the bridge on the river bank close to the rows of babul trees. Work continued all through the day and night. At first I observed a sudden awakening of the Common Myna accompanied with puffing of body feathers and loud calls at intervals during the night. This behaviour was noticed till the last week of June 1963 when one evening I found three or four mynas had taken to roosting on a banyan tree about 300 metres away from the bank of the river towards the town. Within a week that banyan tree was heavily crowded with roosting mynas. Around the middle of July 1963 there were no mynas roosting either among the babul trees or on the banyan tree. I searched for their new roosting site within the town but without success. I left Berhampore in September 1967 when the bridge was still under construction. Later I learnt that the bridge was completed in the early part of 1969 and the river bank reverted to the previous undisturbed condition around July 1970. On February 10, 1971, I happened to pay a visit to Berhampore and made a trip to the Bhagirathi river. To my surprise I found a large congregation of the mynas on the rows of babul trees as before. I presume that this was due to the return of undisturbed and safe conditions on the river bank, though I was not sure if these were the same birds that had roosted on the babul trees earlier.

It appears, therefore, that selection of the roosting site in the Common Myna is dependent on protection against predators and distur-

11. A CREST IN THE PLUMAGE OF THE SPOTTED BABBLER *PELLORNEUM RUFICEPS* SWAINSON

On 2nd May, 1971, I was on a hillside at Khandala when I came across a party of Spotted Babblers (*Pellorneum ruficeps*) some of which were singing on horizontal branches of trees. I had a close view of these birds for about ten minutes and noticed that the birds in song had crests.

During the course of rather casual conversation with Mr. Humayun Abdulali a few days later I mentioned this fact. He informed me that the standard reference works on Indian ornithology do not mention that the Spotted Babbler has a crest and he, therefore, arranged to show me specimens of *Pellorneum ruficeps* in the Society's collection.

We found that this bird does have slightly elongated feathers on the crown which can apparently be raised in life into a fairly noticeable tuft. In the prepared skin the elongated feathers have to be looked for.

C/O MERCANTILE BANK LTD.,
P.O. BOX No. 128,
BOMBAY-1,
June 22, 1971.

D. A. STAIRMAND¹

[The occipital feathers, when they are slightly elongated, as in this species, give an impression of having a crest when the bird is excited and fluffs out the feathers on the crown. Some species of the family Pycnonotidae, e.g. Redvented Bulbul (*Pycnonotus cafer*) show this character, as also some other babblers, e.g. Browncapped Babbler, Tickell's Babbler. It is interesting to note that in such cases the birds show a definite 'cap' on the crown—the feathers on this area being different in structure and colour from the feathers on the back—Eds.]

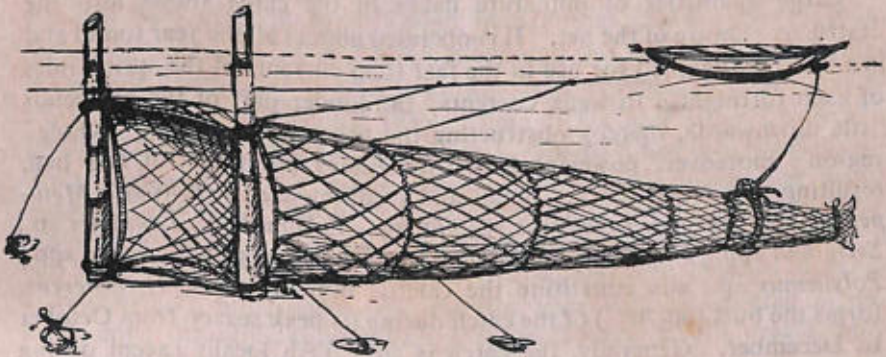
12. PIT VIPER [*TRIMERESURUS MACROLEPIS* (BEDDOME)] BITES AT A SOUTH INDIAN TEA ESTATE

(With two plates)

The Singampatti Group of tea estates lies on the eastern side of the southernmost reach of the Western Ghats. The estate and nearby forests are very interesting for many herpetological reasons. One is the abundance of certain species of snakes which are limited to a certain biotope corresponding to specific elevations and flora. *Trimeresurus*

¹ Present address: Oddicombe House Hotel, Chillington, Near Kingsbridge, South Devon, England.

strong tidal current is necessary for its successful operation. Principally it is a 'filter gear', which depends on the fact that many of the small fishes and crustacea carried by the tidal currents are swept into the stationary bag, from which they cannot normally escape while the water filters out.



A typical 'Golva' measures 22 metres in length, with 1300 meshes at the mouth and tapering to 150 meshes at the cod end. Lengthwise, it consists of five parts, locally called 'Galu', 'Tija', 'Bara chauthi', 'Chota chauthi' and 'Khola' with mesh sizes of 10, 7.5, 5, 2 and 1 centimetres respectively. A bunch of 4 ropes each of 5 mm diameter is tied to the mouth or the head rope all along the circumference to provide additional strength at the mouth. The bunch is tied to the head rope at an interval of 3 meshes both at upper and lower portions of the mouth while the interval is 2 meshes laterally to make them stronger for resisting the pressure of fast currents. It is set during the low tide by fixing two strong long poles on which the mouth of the net is tied at four points facing the incoming high tide making a rectangle, as shown in the figure. The rectangular mouth, at this stage, measures 9.5×6.25 m. The open cod end is knotted and is left adrift in the water. A 10 m long rope is loosely tied around the anterior portion of 'Khola' (Cod region) through loops by one end and the other end is attached to a floating indicator buoy. The small fishes and prawns which drift with the high tide current pass through the long net and accumulate at the cod end. The catch is periodically hauled by pulling the rope thereby lifting the 'Khola' into the canoe and untying the knot. The net is easily removed during low tides for drying by simply pulling the few strings that are fastened by special knots. Refixing of the net by the skilled fishermen before the onset of the high tide also takes about 15 to 20 minutes. A

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- *Not referred in original.

15. ON THE OCCURRENCE OF JUVENILE MACKEREL *RASTRELLIGER CANAGURTA* (CUVIER) OFF GOA COAST

Goa along with the west coast of India has a flourishing mackerel fishery solely, supported by *Rastrelliger canagurta*. Though the small-sized mackerel have been observed elsewhere yet from the Konkan Coast except for isolated records of small-sized mackerel off Karwar (Pradhan 1956) and off Ratnagiri (George & Annigiri 1960) young mackerel below 10 cm length have not, so far, been reported. I collected juvenile mackerels several times during 1964-69. The details are given in the Table. Peter (1969) has reported the occurrence of larvae from Persian Gulf, Red Sea and Bay of Bengal in Indian Ocean (22° 22' N., 60° 50' E., 16° 37' N., 41° 09' E, 18° 15' N., 87° 48' E.) from deeper waters.

The occurrence of 48-70 mm juveniles at Goa in May 1965, indicates that the spawning must have commenced much earlier than June-September as reported by Devanesan & John (1940), whereas Balakrishnan (1957) observed that breeding of mackerel commenced during March-April. George & Annigiri (1960) considered the occurrence of small sized mackerel in September as a result of spawning a few months earlier. Similar inferences can be drawn from five instances in Goa also, as recorded above. Peter (1969) has recorded occurrence of small larvae of mackerel in the Indian Ocean in October-November. This difference in the time of occurrence of larvae and juvenile in earlier

small numbers during the course of this study, it indicates that these are stragglers from the main shoals which probably are not very far from the actual spawning ground. This could be a useful clue towards exploration of the spawning grounds of mackerel. The occurrence of small-sized mackerel from May-September adds strength to the contention that the Indian mackerel may have a prolonged spawning season. No doubt, the occurrence of juveniles and even adult with spent gonads in an area does not always reveal correct picture about spawning grounds and spawning season yet the probability of these grounds being close to the area of occurrence cannot be completely ruled out. Prolonged breeding season with periodic spawning during the season (more than once) indicates the possibility of different races coming into commercial fishery with gonad in different stages of maturity.

Food of juvenile mackerel :

The food of the small-sized mackerels up to 95 mm size as revealed in the gut contents consisted of diatoms, dinophyids, and a few copepods and protozoa. The gut contents of mackerel, between 95-105 mm was mainly post-larvae of fishes, and crustacean larvae, with negligible phytoplanktonic organisms. The feeding intensity was appreciably high. The food of size groups constituting the commercial fishery between 170-230 mm was mainly diatoms like *Coninodiscus*, *Rhizosolenia*, *Biddulphia*, *Planktonella*, *Pluerosigma* and *Chaetoceros* sp. The zooplankton constituents of mackerel food, along this coast are forms like calanids, copepods, cladocera and advanced stages of crustacean, and molluscan larvae, tintinnids and dinoflagellates. The feeding intensity of mackerel is generally high from September to March but moderate from April to June. During April-June period fish scales were often found in the stomachs of mackerel caught by purse seines.

ACKNOWLEDGEMENTS

I wish to express my thanks to Dr. M. S. Prabhu, formerly Director of Fisheries, Panjim, for his guidance during the course of this work. I am also grateful to Dr. P. V. Dehadrai, Scientist, National Institute of Oceanography, Panjim, for going through the manuscript.

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PANAJI, GOA,
March 23, 1972.

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17. A NOTE ON *IDIOSCOPUS CLYPEALIS* (LETH.)
(HEMIPTERA : CICADELLIDAE)

During local faunistic surveys of Poona and its surrounding areas I collected some Jassids on mango leaves from Nasrapur, about 40 km east of Poona. They were studied at the laboratory to find the nature and distribution of clypeal spots in both the sexes. Distant (1907) while examining the species observed 'face immaculate or with the small black median spots'. Capriles (1964) also made a similar observation, but while classifying the species, described the presence of the spots in the female. I, therefore made three collections in June, July and August 1968, in order to study the exact nature of the distribution of the spots in both of the sexes and the results are tabulated below :

Idioscopus clypealis (Leth.)

Date	♀♀		♂♂	
	No. of specimens with clypeal spots	No. of specimens without spots	No. of specimens with clypeal spots	No. of specimens without spots
21-vi-68	114	1	4	82
20-vii-68	109	—	6	85
22-viii-68	99	—	8	93

It is clear from the above data that the males also possess these spots although their number and ratio is very small when compared with those of the females. Almost all the females possess the spots.

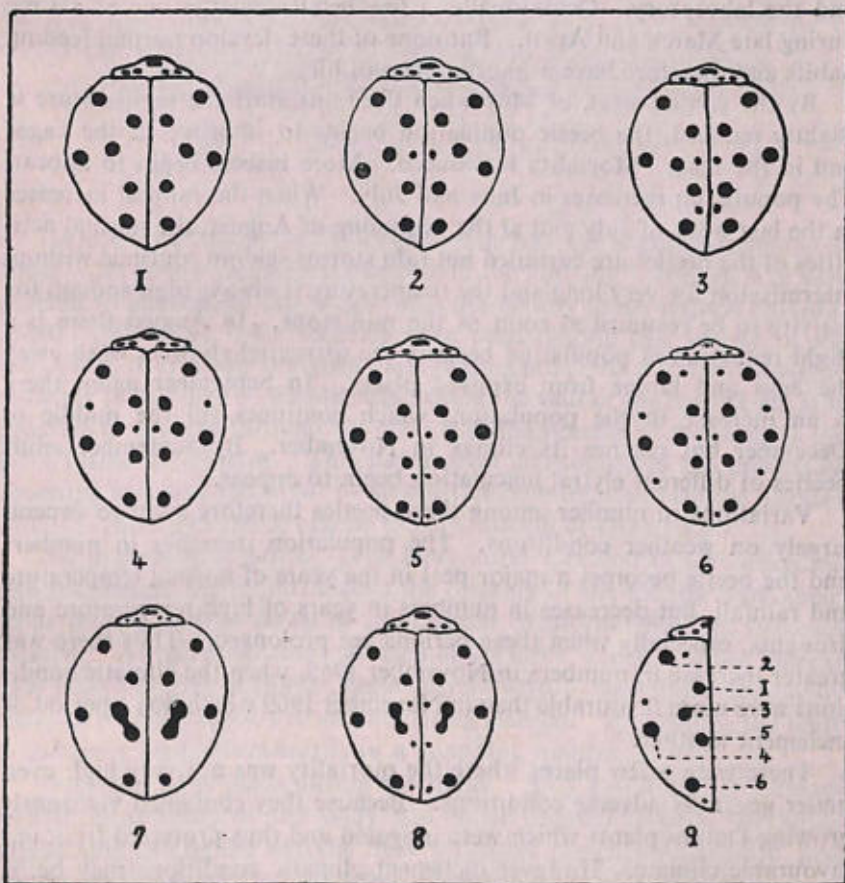
ACKNOWLEDGEMENT

I thank Shri B. S. Lamba, Officer-in-Charge, Western Regional Station, Zoological Survey of India, for laboratory facilities and encouragement.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
POONA,
March 21, 1970.

K. RAMACHANDRA RAO

being usually bigger than the latter. Occasionally some spots may coalesce.



Henosepilachna sparsa Herbst.: Figs. 1-9

1. Basic elytral maculation of 6 black spots. 2-6. spot patterns of elytra showing presence of 1-5 non-persistent spots on each elytron. 7-8. coalescence of spots. 9. left elytron, persistent spots numbered 1-6.

From the middle of December throughout January a slight reduction in the population is noticed. This becomes more pronounced in February and in March. By this time only six-spotted beetles are seen and occasionally 7-spotted ones. By April the reduction in the population reaches its climax. Of the insects present only few lay eggs and there is considerable reduction in the number of eggs in each batch. Due to the heat and dry air most of the eggs, larvae, pupae and adults are killed. Mortality is highest in the first and the second instars. The eggs remain dead and dry on the plants; the larvae and adults are killed

19. THE PROCESS OF MOULTING AND THE NUMBER OF INSTARS IN THE TIGER BEETLE, *CICINDELA CANCELLATA* DEJ. (COLEOPTERA : CICINDELIDAE)

(With a text-figure)

Cicindela cancellata Dej. is a tiger beetle which is widely distributed in India. Its larvae live inside burrows in the soil and therefore it is very difficult to observe all the details of its life-history under natural environmental conditions. The authors have been rearing this species in the laboratory in specially designed glass rearing jars. As a few of the larvae excavate their burrows accidentally, along the wall of the rearing jar, it is possible to observe through the glass wall the process of moulting in the larva inside the burrow. This paper gives an account of the process of moulting and also the result of an indirect investigation into the number of larval instars in this beetle by the application of Dyar's Law.

The process of moulting. The larva, after a period of active feeding and just before the moult, blocks the opening of the burrow with sand, stops feeding, settles down at the bottom of the burrow and becomes inactive. At this stage, the abdomen of the larva, which at other times is light brown or grey in colour, becomes yellowish. The larva occasionally wriggles its body rapidly in an undulating fashion. Frequently, the body is suddenly bent ventralwards in a snapping manner.

Moulting takes place during the night. As a result of the characteristic movements of the body and other internal factors, the larval cuticle splits along the ecdysial lines which are present on the head and the thorax. On the head, splitting of cuticle takes place along the short coronal suture and the arms of the frontal suture which are relatively long and slightly wavy, diverging widely and terminating anteriorly at the dorsal edges of the antennal sockets. In the thorax, the cuticle splits along the mid-dorsal line of weakness or ecdysial line. The pattern of ecdysial splitting of the cuticle is clearly seen in the exuviae collected from the burrows.

The number of instars.—Dyar (1890)¹ stated that in lepidopteran larvae, the width of the head capsule increases in a regular geometric progression through successive instars, by a ratio of about 1.4. This principle which is known as Dyar's law, has been used successfully to determine the number of larval instars in some insects.

¹DYAR, H. G. (1890) : The number of moults of Lepidopterous larvae. *Psyche*, 5 : 420-422.

is seen that the growth ratio between successive instars is approximately constant.

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CALICUT-1, KERALA,
July 7, 1969.

A. B. SOANS
J. S. SOANS

20. NEW RECORDS OF HYMENOPTEROUS PARASITES
OF PEA LEAFMINER *PHYTOMYZA ATRICORNIS*
MEIGEN (DIPTERA : AGROMYZIDAE)

The pea leafminer *Phytomyza atricornis* Meigen is the most common and widespread leafminer throughout the world. The larva of this pest is polyphagous and attacks a large number of plants belonging to several natural orders. According to Trehan & Sehgal (1963), the larva feeds indiscriminately on palisade and spongy mesenchymatous tissues but never consumes the entire tissues between the upper and lower epidermis and the endodermal cells containing starch are largely avoided. Ahmad & Gupta (1941), while studying the biology of this pest on pea, reared an Eulophid, *Solenotus* sp. from its larval stages. Narayanan *et al.* (1956) reared an ectoparasite *Solenotus* sp., an endoparasite, *Rhopalotus* sp. and an unidentified braconid on the larval stages of this host fly. Only recently Odak *et al.* (1968) have recorded *Opius* sp. (Braconidae) and *Neochrysocharis* sp. (Eulophidae) as parasites of *P. atricornis* from Gwalior (India). The present study was, therefore, undertaken to investigate parasites of this leafminer in the Ranchi area and leaves of pea (*Pisum sativum* Linn.) were collected. The following six hymenopterous insects emerged from the leafmines.

1. *Chrysocharis* sp. (Eulophidae)

Thompson (1943, 1954) has recorded *Chrysocharis* sp., *C. elongatus* and *C. syma* from New Zealand, Yugoslavia and England respectively, as parasites of this leafminer.

2. *Tetrastichus* sp. (Eulophidae).

3. *Cirrospilus* sp. (Eulophidae).

4. *Opius* sp. ? *phaseoli* Fischer (Braconidae).

5. *Opius* sp. ? *lantanae* Bridw. (Braconidae).

6. *Sphегigaster* sp. (Pteromalidae).

(*Zizyphus jujuba*), 'Dudhi' (*Euphorbia hirta*) and banyan (*Ficus bengalensis*) as the alternate hosts. The larvae were also observed, in forests, to feed on 'Babool' (*Acacia arabica*) and *Albizia amara* by Bhasin & Roonwal (1954). The present report records the feeding of *A. janata* larvae on two additional hosts, namely the hedge plant *Dodonea viscosa* (Family Sapindaceae) and the ornamental Rangoon creeper, *Quisqualis indica* (Family Combretaceae). Both these plants are important garden ornamentals. So far, we have observed feeding of this pest in laboratory on more than a dozen hosts in varying degrees of intensity but observations made during the last two years at Jobner, Udaipur and Jaipur revealed that the two plants reported here suffer substantial damage by this insect from July onwards. Further, both *Quisqualis* and *Dodonea* were observed to be attacked in the field simultaneous to the occurrence of the insect on castor within a distance of 7 metres and 13 metres respectively. This showed that even in the presence of the primary host the gravid female moths oviposited on these garden plants indicating a potential preference of the insect to these plants. Detailed studies on the host preference of this insect are under-way.

DEPARTMENT OF ENTOMOLOGY,
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF UDAIPUR,
UDAIPUR,
September 12, 1970.

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local specimens revealed that they belonged to the last two species described by Reddiah (op. cit.) from *M. meretrix* (L.). This is thus the first record of the genus *Conchylurus* from the West Coast of India.

So far about nine species have been described under this genus. Considering the richness of the molluscan fauna of India, more species are likely to be discovered in future. It is therefore, considered, that the distribution (Table) of all known species of this genus, together with their type hosts and localities, would be useful for future workers on this group.

TABLE

Species	Host	Locality
<i>Conchylurus solensis</i> Bocquet & Stock (1957)	<i>Solen marginatus</i> Don*	Near Roscoff, France**
<i>C. cardii</i> Gooding (1957)	<i>Cardium echinatum</i> L.*	Near Plymouth, England
<i>C. cardii cardii</i> *** Gooding (1957)	<i>Solen marginatus</i> Don, <i>Cardium echinatum</i> L.,* <i>Meretrix chione</i> (L.)	France
<i>C. cardii tapetis</i> Bocquet & Stock (1958)	<i>Tapes decassatus</i> (L.),* <i>Tapes pullastra</i> (Montagu), <i>Tapes aurens</i> (Gmelin)	France**
<i>C. torosus</i> Humes & Cressey (1958)	<i>Mactra glabrata</i> L.,* <i>Mactra largillerti</i> Phillippi	Free Town, Sierra Leone,** West Africa
<i>C. lobatus</i> Humes & Cressey (1958)	<i>Cardita ajar</i> Bruguere*	Free Town, Sierra Leone,* West Africa
<i>C. maximus</i> Reddiah (1960)	<i>Sanguinolaria</i> (<i>Soletellina</i>) <i>diphos</i> (Gmelin),*	Near Portonovo,** east coast of India
<i>C. bombasticus</i> Reddiah (1961)	<i>Meretrix meretrix</i> (L.)* <i>Meretrix casta</i> Deshayes	Near Portonovo,** east coast of India Ratnagiri, west coast of India
<i>C. fragilis</i> Reddiah (1961)	<i>Meretrix meretrix</i> (L.)*, <i>Meretrix casta</i> Deshayes	Near Portonovo,** east coast of India, Ratnagiri, west coast of India.

* Type host, ** Type locality, *** Bocquet & Stock (1958) downgraded Gooding's species *C. cardii* into a subspecies and referred to it as *C. cardii cardii* Gooding.

that is discussed at some length is submission, and its function in social organisation. Some dominance-submission rituals would in a human context be interpreted as affection, and the term 'love' is used here. This seems unnecessarily anthropomorphic, and also inappropriate as the word has a wider meaning than that to which it is restricted here.

The photographs in this book are excellent throughout, but the writing is often awkward. Lay readers will find the jargon in some of the earlier chapters particularly trying. It is difficult to imagine anyone being helped by descriptions like 'dorsal vertical postero-horizontal retraction of lips', meaning a simultaneous grin and a snarl. Often there does not seem to be any connection between sub-titles and subject matter. This is due to poor organisation. For example, a discussion of the development in hand-reared wolf cubs of allegiances to pack members and nervousness of strangers occurs at the end of a section on mate preferences, when it belongs at the beginning of the same chapter, which deals with social organisation, or perhaps in another chapter entitled 'Development of Social Relationships: Wolf Socialisation'. It is to be hoped that these irritations will be corrected in future editions.

One would now like to have a comparison between wolf socialisation and that of the dhole, the South American bush dog, and the Cape hunting dog, all pack-hunters which belong to the sub-family Simocyoninae. These lack the range of complex facial expressions which characterise the wolf, and apparently do not all show dominance. Dr. Fox is the obvious person to make these comparisons and I hope that he will do so before too long.

R. R.

2. INSECT POLLINATION. By J. B. Free. pp. xi + 544 (15×23 cm) with 170 figures. London & New York, 1970. Academic Press. Price £7.25.

This reviewer is indeed struck by the wealth of information this book possesses. It reviews all the important information on the subject into a most comprehensive volume and makes it a very valuable reference work on pollination of the most important crops of temperate regions. 'Although there are many facets of pollination of different crops that are similar, it is very striking how many crops have their own unique pollination problems.'

The author who is connected with the Rothamsted Experimental Station, Hampden, Herts, England, is without doubt fully conversant with this subject. In the first part of the book, he has discussed the pollinating insects—particularly the honey bee and points out how it

can be used by man to supplement wild pollinators and the ways in which this can be done most effectively.

In the second part, each crop—over a hundred treated in the book—is discussed individually. In every case the flower structure as related to the pollination is effectively illustrated. The insect species which are reported to pollinate the flower together with the crop's pollination requirement are specifically mentioned. Admittedly the information from tropical crops is rather sparse and it is felt that lack of sufficient pollination may be one of the reasons for only a small proportion of fruit and seed set in the tropics.

The book is written very lucidly and the simple and logical way in which the process is explained in each case should inspire anyone who wishes to carry out useful work on this fascinating and highly important aspect of biological productivity in nature. In the context of the present whole-scale use of insecticides, the publication of the book is timely and worthy of serious attention by agriculturists, horticulturists and foresters in India. The book opens an immense scope of similar type of work to be carried out in India and the tropics. The book contains about 1500 reference titles, a separate index of plant names, also of animal names and a general index. All the above features make this book a very valuable and important reference work in the field of reproduction of crop plants.

P. V. B.

3. THE NATURAL HISTORY OF SHARKS. By Thomas H. Lineaweaver III & Richard H. Backus. pp. 256 (22×14 cm). London, 1970. André Deutsch Limited. Price £2.75 net U.K. only.

Until recent years, man had not succeeded in crossing the boundary that separated him from the world of marine life. He had never observed sharks in their natural habitat, except in a few brief and involuntary encounters, as in a shipwreck, and mostly ending in disaster for him. Brought face to face with these marine monsters, man's perplexity has been considerable, and his attitude variable. The first emotion was, understandably, terror. And, as always when fear plays a part, legends about sharks multiplied.

The increasing tempo of undersea exploration, aided mainly by scuba diving and submersibles, has led to increased exploration, so that much more is known about sharks. And, after all, there is nothing simple about any aspect of the relations between the monarch of the sea and the ruler of the lands of the earth. The result is that numerous books dealing specifically with sharks have appeared during

the last several years. These books have covered the subject reasonably well, and one or two could be classified as superb. The present one is rather a late-comer on the scene.

Starting, in the first chapter, by summarizing the differences between sharks and bony fishes, the authors go on to an inventory of things found in sharks' stomachs, and the few animals inside whose stomachs sharks have sometimes been found. The third chapter describes the habits, factual and fancied, of two constant companions of the shark, pilot fish and remoras. The fourth chapter is a listing and analysis of shark attacks on man. Chapters 5 to 10 relate to the different kinds of sharks found both in the seas and in fresh water. Chapter 11 is a review of the reproduction, or rather, whatever little is known about it. Chapter 12 deals with sense organs and anatomy. The final chapter tackles the problem most vital to man when he faces a shark in its own element—survival.

A key to the families of sharks, prepared by Dr. John Musick, is given towards the end, followed by a glossary which will be of little use to ichthyologists already familiar with biological nomenclature but will be of considerable use to non-scientists who might be newly involved in the study of sharks. The bibliography, at the very end, is only a brief listing, but is meant to be sufficient for the layman to follow up.

A good deal of researching into earlier literature, especially scientific papers, must have gone into the writing of the book, and the book is excellently edited, with no technical mistakes. The fact that the senior author is not a professional biologist, but a journalist, does not reduce the scientific value of the book.

But the greatest difficulty with collections of this type is the lack of focus, and the frequent mention of sources and dates in the text tends to slow down the narrative. A few of the chapters are quite interesting, but a large part of the space used in the book presents a rehash of information that has been previously published over and over again.

The photographs are uninspiring, and the drawings shoddy (although, here, I might add that my opinion might have been prejudiced because this book happened to be reviewed immediately after seeing the excellent quality of the colour photographs in Jacques-Yves and Philippe Cousteau's book *THE SHARK: SPLENDID SAVAGE OF THE SEA*).

A valuable source book.

B. F. C.

4. PATTERNS OF CHANGE IN TROPICAL PLANTS. By G. P. Chapman. pp. 112 (21.5×14 cm) with 9 plates and 12 figures. London, 1970. University of London Press Ltd. Price £1.00.

The quotation on the title page 'Botanical teaching based on the temperate flora must necessarily be ill-based and inadequate' C.G.G.J. van Steenis—defines the objective of this little but most valuable book. The author aims to indicate the value of cytogenetics in understanding the process of plant speciation and in the case of crop plants he wishes to point out how these processes can be turned to our advantage. With the help of examples of some well-known taxa viz. *Casuarina*, *Catharanthus*, *Euphorbia*, *Musa*, *Lycopersicon*, *Dichanthium*, Maize, etc. the author has discussed the processes of reproduction and plant breeding in the past.

The author succeeds in building up an optimistic picture of food production in the tropics while advocating intensive research on evolutionary patterns of other tropical plant species of agricultural interest.

In his concluding remarks, the author brings out clearly the need for more botanists to live and work in the tropics for several years, experiencing at first hand the march of environmental change and plant response. He is aware of the fact that every aspect of botany will not develop equally in the tropics but commends the important activity of continuing appraisal and reappraisal of traditional systematics followed by the work of an evolutionist and plant breeder who can recognise the tropics as the area of greatest potential interest.

This little book must be read by all botanists in the tropics—especially in India—where a new phase of agricultural development has been ushered in and many of our food plants like pulses, oil seeds, spices, etc. can be developed with better understanding of reproductive processes in tropics.

P. V. B.

5. ECOLOGY AND BIOGEOGRAPHY OF HIGH ALTITUDE INSECTS—SERIES ENTOMOLOGICA VOLUME 4. By M. S. Mani. pp. xiv + 527 (25×16 cm) with 79 figures. The Hague, 1968. W. Junk N.V. Publishers.

Professor Mani's studies on high altitude entomology in the Himalayas are well-known. In this book he discusses in general climatic conditions at high altitudes, and the adaptations which make it possible for insect life to survive. He then goes on to describe in detail the physiography, vegetation, and insect fauna of each of the major moun-

tain ranges in the world. The flora and fauna of a mountain have partly evolved from the lowland species of the area at the time when the mountain range was uplifted, and have been remoulded at every phase of the slow process of rising. Other species have colonised the mountain from the lowland or from distant mountain ranges. Then there are relict species which have survived glaciations on widely separated high mountains though extinct elsewhere. Specialisation has everywhere tended to produce local subspecies and races, some restricted to a single peak.

This comprehensive book is likely to be an essential reference book on this subject for a long time to come. There are 1141 papers cited.

R. R.

6. CEDRUS. BOTANICAL MONOGRAPH NO. 5. By P. Maheshwari and Chhaya Biswas. pp. 115 (16.5×24.5 cm) with 55 figures. New Delhi, 1970. Council of Scientific and Industrial Research. Price Rs. 24, sh. 48, \$8.

This botanical monograph has been the last one in which the celebrated Indian botanist, late Professor P. Maheshwari actively participated. In fact, the other author points out in the footnote of the preface, Prof. Maheshwari passed away when the manuscript was almost completed for the press. This monograph gives an excellent account of the phytomorphology of the genus *Cedrus*. The major part of the text deals with *Cedrus deodara*, one of the most valuable timbers found in India.

Of the 108 pages of the text, 90 are taken up by phytomorphology—53 dealing with embryology. Eighteen pages are utilised to give a résumé of cytological studies, phytopathology, ecology, silviculture and economic importance of the genus. The illustrations are excellent and take about 50 pages.

Figure no. 55 giving time relation of *Cedrus deodara* is interesting. It appears that one of the figures of years (June 1956 or January 1957) needs correction in view of the explanation in the relevant table and text—18 months from June 1956 should make 1958 January.

The Introduction gives 4 interesting biblical and Chinese legends on Cedar wood. It would have been in the fitness of this monograph to mention a few from ancient Indian literature wherein 'Devdaru' is well-known. This monograph forms a valuable review of the phytomorphological studies of the genus *Cedrus* and will certainly prove useful in that field of study with its comprehensive bibliography. In view of

its economic importance to lumber and perfumery industry, further ecological and sylvicultural studies of this most valuable of temperate conifer in India appear desirable.

The production values of the publication are kept very high and the printers must be congratulated along with the artists for good reproduction of figures and photographs.

P. V. B.

Miscellaneous Notes

1. ECOLOGICAL AND BEHAVIOURAL NOTES ON THE LIONTAILED MACAQUE (*MACACA SILENUS*) IN SOUTH INDIA

The Liontailed Macaque (*Macaca silenus*) has the most restricted range of all primates of the Indian subcontinent, where it is restricted to the evergreen forest of the Western Ghats (Krishnan 1971). Blanford (1888) indicated that the species occurs from 14°N. to the southern limits of the Western Ghats while Sugiyama (1968) found the species between 9°30' and 11° 30'N. Krishnan (1971) indicates that it is no longer present in the forests of Thirunelveli District at Courtallam. I was very fortunate to observe the Liontailed Macaque on two consecutive days (2-3 March 1972) at the Manjulai Tea Estate of Bombay Burma Trading Company above Kalladaikurichi. This area is located in Thirunelveli District of Tamil Nadu State at about 8° 38'N., 77° 25'E. and about 1000 metres elevation. The region can be characterized as extensive tea and cardamom plantations interspersed with stands of relatively undisturbed forest.

I first observed a group of Nilgiri Langur (*Presbytis johni*) near the edge of a tea field. After several minutes an individual with the distinct, short, drooping tail of *Macaca silenus* was observed walking slowly along a branch. Later, when tea pickers moved into the area three *Macaca* were observed fleeing along with the group of langurs. A noteworthy difference in the behaviour of the two species was observed; the langur moved through the canopy with long jumps accompanied by swishing of branches while the macaque walked slowly and deliberately in single file along the interior branches of the large forest trees. Only subdued vocalizations were heard from the macaque (see below), while the langur has loud call reminiscent of the whooping of the Black Howler Monkey (*Alouatta*) of Central America.

The following morning one, and perhaps two, females with young infants were observed in the same area. Judging from the size of a known age infant in the Zoo Negara, Kuala Lumpur, Malaysia, the infant at Manjulai was about two months old in early March. Sugiyama's observations (1968) indicate January is the season of birth while Prater (1971) suggests that young are seen regularly in September.

As many as six adult individuals were counted simultaneously but no doubt more were present on March 3. Throughout the observations individuals appeared and disappeared in the forest canopy over an area of several hectares, indicating that bands spread out rather widely during feeding.

Several types of feeding activities were observed. The female with infant ate fruits of unknown identity in addition to probing into the cup formed by a broken off branch. I could not determine if water or perhaps arthropods were taken from the cavity. Another adult climbed to the uppermost branches of a tall emergent tree where several dead branches projected above the surrounding canopy. Pieces up to a foot long were broken off and torn apart, presumably in search of arthropods in the rotting wood. The macaque moved lower in the tree before dismantling the branch and then moved to the upper branches again, peered into the broken stub and tore off another dead branch. A third adult was observed feeding on small red or dark brown fruits.

In addition to the perhaps fortuitous association between the langur and macaque on 2 March I did observe one aggressive response by a macaque female with infant to the close approach of an Indian Giant Squirrel (*Ratufa indica*).

Two vocalizations were heard during these observations. One, written as *ughh* or *uhhh*, carried only very short distances. This call reminded me of a warning cry of the white-faced monkey, *Cebus capucinus*, in Panama. The second call was a *cooo* or *oooo* very similar to the single *cooo* of many pigeons but of shorter duration. This call has been reported earlier but Krishnan (1971) had questioned the nature of this call as being monosyllabic or, alternatively, polysyllabic like the modulated calls of several species of *Treron*.

The most discouraging aspect of my observations is the apparent lack of subadult individuals in this group of macaques. Several factors could be responsible for this but the most likely seems to be capturing of infants for sale in the market of large cities. I am told that young Liontailed Macaques can frequently be found in the Calcutta market despite the fact that capturing them is illegal. It seems that two major factors threaten this species: (1) Habitat destruction in its restricted range, and (2) Illegal capture of infants for sale in markets.

These observations were made during the tenure of grants from the Smithsonian Tropical Research Institute, Balboa, Canal Zone and the Office of International Activities of the Smithsonian Institution, Washington, D. C. Special thanks go to Mr. J. C. Daniel and Mr. Z. Futehally of the Bombay Natural History Society for their advice, S. Poolappan for his assistance with field work and to the Bombay Burma Trading Co. and Mr. J. J. Bland for allowing me to use their facilities at Manjolai.

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January 2, 1973.

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2. NOTES ON THE BIRTH AND GROWTH OF A SLOW LORIS (*NYCTICEBUS COUCANG*) IN CAPTIVITY

A pregnant Slow Loris (*Nycticebus coucang*) received at the Nandankanan Biological Park (Orissa) on 1.ii.1971 from the forests of Assam, gave birth to a female young on 21.ii.1971. After delivery the mother weighed 1.4 kg.

The new born young weighed 50 gm and measured 14 cm in total length. The eyes were open at birth. The young had a coat of dense fur and numerous long glistening grey hairs were scattered throughout the body and projected far beyond the fur. These long hairs gradually disappeared when the young was about 11 weeks old. The body coat was grey throughout except the hands and limbs which were silvery white. The brown stripe on mid back was very prominent.

A single young is usually born (Prater 1971; Walker *et al.* 1964; Asdell 1964). Crandall (1965) reported that all births were of single young except the two twin births which were found dead within a day or two. The eyes of a Slow Loris young are open at birth (Crandall, loc. cit.). There is no mention of birth weight and size in the available literature.

Up to the age of seven weeks the young was seen clinging to the mother's abdomen and sucking her teat throughout the day. From the eighth week onwards and up to the age of 10 months, the young was clinging to the mother's abdomen throughout the day, partly keeping her hind quarters on the ground either in between the two limbs of the mother or over the mother's lap. Whenever attempts were made to handle or see the young during the day time, the mother with her baby curled up like a ball and twittered in annoyance. The mother cleaned the baby by licking. After sunset the young was always seen separated from the mother and was either clinging to the chainlink mesh wall or moving about in the house from the very first day. From the third day it was able to produce a feeble noise when handled and this noise immediately attracted the attention of the mother. Up to 8 weeks of age the young one was at times seen clinging to the abdomen of another

female kept in the same house. Later the second female did not allow the young to cling to her, probably because of its increased body weight. The young one took bananas for the first time at the age of about one month. The mother was able to crawl along with the baby clinging to her abdomen till the baby was seven months old.

Hill (1937 b) reported that the female Slow Loris may deliberately place her baby on the ground, later picking it up but this behaviour was neither observed by Crandall (loc. cit.) nor in this Park. Crandall (loc. cit.) reported that a young born in New York Zoological Park was found clinging either to the mother or to the father and he has never seen a mother touch an infant, beyond the usual cleaning treatment with the tongue. The young remains with the mother until it is as large as the mother (Prater, loc. cit.). The young appeared to be dependent upon the mother for at least 9 months or more and a youngster was seen nursing when it was as large as the parent (Crandall, loc. cit.).

The young one reached its maximum weight of 1605 gm at the age of 44 weeks (about 10 months) on 26.xii.1971. Weekly weight growth records were taken at the end of every week and an abstract of the growth records of this animal up to the age of one year is as follows :

Date	Age in weeks	Weight in kg.
21.ii.1971	Birth	0.050
21.iii.1971	4	0.140
18.iv.1971	8	0.295
16.v.1971	12	0.480
13.vi.1971	16	0.718
11.vii.1971	20	0.920
8.viii.1971	24	1.040
5.ix.1971	28	1.222
3.x.1971	32	1.315
31.x.1971	36	1.420
28.xi.1971	40	1.530
26.xii.1971	44	1.605
23.i.1972	48	1.590
20.ii.1972	52	1.588

VETERINARY ASSISTANT SURGEON,
NANDANKANAN ZOO,
P.O. BARANG,
DISTRICT CUTTACK.

L. N. ACHARJYO

WILD LIFE CONSERVATION OFFICER,
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OLD SECRETARIAT BUILDING,
CUTTACK-1,
March 3, 1972.

R. MISRA

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3. ON SOME MELANISTIC SPECIMENS OF HOUSE RAT,
RATTUS RATTUS (LINNAEUS) [MAMMALIA :
 RODENTIA : MURIDAE]

It is a well-known fact that the coat colour of rodents, specially the rats, is subject to great variations. But extreme colour variations, commonly known as albinism and melanism, are rare. The latter has been reported in several species of mammals, including rodents, but I find no record of it in *Rattus rattus* (Linnaeus). It is therefore recorded here. The note is based on a collection of five adult rats, *Rattus rattus* (Linnaeus), present in the collection of the Zoological Survey of India. Two are males (Z.S.I. Reg. No. 8366, 8374) and three females (Z.S.I. Reg. No. 8365, 8369, 8370), all collected from Calcutta in the year 1906.

The colour of the body and the tail is completely black, with no line of demarcation between the dorsal and ventral aspects. In three out of five specimens, the pinna is of lighter colour than in the other two.

All measurements are in millimetres and are taken after Ellerman (1963).

MEASUREMENTS :

External : 2 ♂♂—Head and body 181, 182 ; tail 190, 231 ; hind-foot 33, 34 ; ear 23, 24.

3 ♀♀—Head and body 145, 147, 178 ; tail 193, 195, 224 ; hind-foot 33·5, 34·5, 34·5 ; ear 19, 21, 24.

Cranial : 1 ♂—Occipitonasal 42·3 ; nasal 16·0 ; palate 22·3 ; palatal-foramina 7·6 ; diastema 12·0 ; upper tooth-row 6·3 ; bulla 7·2.

3 ♀♀—Occipitonasal 36·8, 39·0, 44·2 ; nasal 13·5, 14·0, 16·3 ; palate 19·3, 20·2, 24·0 ; palatal-foramina 6·5, 6·6, 8·9 ; diastema 10·0, 10·8, 13·0 ; upper tooth-row 6·0, 6·1, 6·8 ; bulla 6·8, 7·0, 7·7.

Different views have been put forward as to the causes of melanism. Keeler & King (1941) are of the opinion that melanism acts as a simple Mendelian recessive character. Rohe (1961) found a melanistic population of the Norway Rat (*Rattus norvegicus*), confined to underground sewers. The fact that the population was completely isolated and that the litters were all melanistic led him to believe that it was a true breeding melanistic colony. Svihla's (1956) finding that heat conservation at

low temperatures does not differ in white from dark coloured rats, shows that melanism does not have any beneficial effect over non-melanistic forms. However, no opinion can be given on this aspect as my observations are based on dead specimens.

ACKNOWLEDGEMENTS

I am thankful to the Director, Zoological Survey of India, for providing facilities. I am grateful to Dr. B. Biswas for going through the manuscript and to Dr. V. C. Agrawal for valuable suggestions.

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4. THE 'DAY NEST' OF A RAT

Our house has mosquito netting in the windows. Outside one first-floor bedroom window grows a creeper which we believe is the Rangoon Creeper (*Quisqualis indica*). It has sweet pink and red flowers, fragrant in the evenings. There are some dead branches of the creeper close to the window. On these a few months ago a platform of twigs roughly 5 inches long appeared. For some days we saw no creature near it, but one day we saw a large male rat with a long tail, stretched out upon it. As we were close to the window and looked, he got a bit nervous and slowly got off the platform and hid beneath it. This rat continued to be all day long on this platform for at least a week. Then he disappeared and we wondered if he had been sick and had died. But about a week later, we noticed some activity and saw that the rat had plucked off some leafy twigs from the creeper and arranged them all around the platform and was again lying there, partially hidden from us by the leaves. As the leaves withered, he plucked off more twigs and replaced them. He lay there for over a week in this way and appeared most of the time to be sleeping. Then he again disappeared.

For many weeks we did not see him at all. Then on Wednesday, November 29, I entered the room and to my surprise the rat was there ! It was about 1 p.m. He looked fatter than before, his fur in very good condition. The platform on which he lay was in a sorry state after weeks of disuse, but on Wednesday he brought no twigs and did not repair it in any way.

When my husband returned about 6 p.m., I showed him the rat and it was still there after 10 p.m. when we went to bed, but the following morning it was not there and has not been seen since. This is its briefest visit so far.

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TAMIL NADU,
December 1, 1972.

M. P. WALKEY

5. ALBINISM IN THE LESSER RAT-TAILED BAT,
RHINOPOMA H. HARDWICKEI GRAY
(CHIROPTERA : RHINOPOMATIDAE)

Allen (BATS 1939, p. 154) has mentioned a few cases of albinism in a few species of bats with the remarks that both albinism and melanism are rare in bats. No case of albinism came to my notice in the Indian species during examination of over four thousand specimens belonging to several species particularly from Central India. On 26th April, 1972, however, a beautiful albino adult female of the Lesser Rat-tailed Bat was collected alive along with others from a colony of about 100 individuals in caves under granite boulders near Jabalpur city. The general pelage, the wing membranes, the metacarpals, the phalanges and the ears are white or dirty white. The legs, the feet, the arms, the tail, the face, the chin and the throat are pinkish. The colour of eyes was not noted in the living specimen but in the dead specimen it is blackish. The specimen has been exhibited in the departmental museum. The specimen was kept in captivity along with other specimens for a few hours but died during night possibly because of an injury on the chest. Some parts of it were found eaten by ants during night. It kept aloof from other specimens in captivity.

Recently a friend reported that he collected an albino of *Hipposideros* sp. from a large colony in a cave in another district of Madhya Pradesh.

183/581, SOUTH CIVIL LINES,
JABALPUR,
June 26, 1972.

H. KHAJURIA

6. ON THE OCCURRENCE OF *GYPVS FULVUS* AND *AEGYPIUS MONACHUS* IN THE GIR FOREST

The known range of the Fulvous Griffon Vulture *Gyps fulvus* (Hablizl) within the limits of the Indian subcontinent is Pakistan and northern Gujarat, although stragglers have been recorded east to western Assam, and south to Bombay (once). It has been known to be a regular winter visitor only as far south as Kutch and northern Gujarat (Sálim Ali & S. D. Ripley 1968).

However, during my field study of vulture in the Gir forest (21°6' N., 70°46' E.) for two years from 1970 to 1972 I found this species a common bird in the whole of the Gir forest during winter. From November to March this vulture constituted approximately five per cent of the total individuals of *Gyps* vultures observed at carcasses. The other species were the Longbilled Vulture (*Gyps indicus*) and the Indian Whitebacked Vulture (*Gyps bengalensis*).

During their stay at Gir the fulvous griffon used the cliffs of Charakio Hill which is the highest in the Gir, for roosting and resting. Continuous usage has left droppings that gave a white-washed appearance to the broad face of these cliffs which could be seen from a long distance. The name *Charakio* has been derived from the Gujarati word *charak* which means bird droppings. Fulvous griffon were also found roosting on the cliffs of the Girnar Hills, about 40 km north of the Gir, along with *Gyps indicus* which also breed there. In addition to roosting on cliffs the fulvous griffon spent nights on trees with other vultures near carcasses, to enable feeding early next morning. One such bird was caught at night with the aid of a search light and was used for captive experiments. A specimen (Reg. No. 23524) has been deposited in the bird collection of the Bombay Natural History Society.

Another species of vulture which was recorded for the first time in the Gir forest, although within its known range, is the Cinereous Vulture (*Aegypius monachus*). On 3 March 1972 at 1340 hrs a single bird came to feed off the remnants of a dead buffalo beside Hiran river at Karam-nadadea ness in the western Gir. It approached a King Vulture (*Torgos calvus*) which was feeding on the hard tissues of a limb, chased it aside and started pulling at the limb. This bird was similar in general appearance to the king vulture but bigger, had pinkish white legs and head, and had no lappets. Dharmakumarsinhji (1955) has observed this bird as a rare winter visitor in other parts of the Kathiawar Peninsula, namely, Bhavnagar, Dhrangadhra, and the Girnar.

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BOMBAY NATURAL HISTORY SOCIETY,
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SHAHID BHAGAT SINGH ROAD,
BOMBAY-1,
January 25, 1973.

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7. CALCIUM INTAKE IN VULTURES OF THE GENUS *GYP*S

Vultures grouped under the genus *Gyps* were known to feed only on meat and other soft tissues of carcasses and not on bones, and therefore their mode of calcium intake, required to build up bones, had always been a mystery.

During one of my observations on vultures at Gir Forest I came across the following incident. In the western Gir, close to Sasan village, about ninety-five Whitebacked (*Gyps bengalensis*), seven Longbilled (*Gyps indicus*), four Griffon (*Gyps fulvus*), and three King (*Torgos calvus*) vultures were feeding off the skinned carcass of an ox on 23rd January 1972 at 1245 hrs. Soon a few vultures with bulging crops emerged from the squabbling flock, walked about twenty feet aside, and started picking up and swallowing pieces of old, dry bones including ribs of small animals and chopped up pieces of skull. It is a village carcass dumping site, adjacent to the forest.

To further check this up on captive birds I introduced old bone pieces into my vulture aviary. The vultures were not kept hungry. Soon after introducing bones, Longbilled, Whitebacked, and also the only Griffon I had came one by one and swallowed some bones, one of the birds dipping a piece into water before swallowing it. This observation on captive birds was also witnessed by Dr. Sálím[¶]Ali during his visit to the Gir two weeks later.

ACKNOWLEDGEMENTS

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BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY,
January 1, 1973.

ROBERT B. GRUBH

8. ON THE OCCURRENCE OF GOLDENBACKED
THREETOED WOODPECKER [*DINOPIUM SHORII*
(VIGORS)] SOUTH OF THE HIMALAYAN RANGE

In the course of cataloguing the Society's collection, we came across a ♂ specimen of *Dinopium shorii* (Vigors) [wing 158 ; bill 34 ; tail 98] No. 10298 (collected by Major F. T. Williams) marked 'Kolatur North, S.I.R., 31st October 1897'. Kolatur North is on the South Indian Railway not far from Madras. This is so far out of the currently accepted range of the species that we decided that though Major Williams obtained a partridge at the same place on 6th February 1898, there was some error in the labelling and that it may have been obtained in Burma where Williams had collected birds in May and June 1897.

That the labelling was not incorrect is suggested by references we have come across later. Blyth (1849) in 'The Catalogue of Birds in the Collection of Asiatic Society', p. 56, refers to a specimen from Gumsur (Coll. Capt. McPherson) while earlier in 1845 in *Jour. Asiat. Soc.* 14 : 193, he said that this species inhabits 'the sub-Himalayan region as well as the hilly ranges of peninsular India'. Also we have Jerdon's (1862) statement in *BIRDS OF INDIA* (1 : 299) that he saw it on the slopes of the Nilgiris up to about 5000 ft. It may be noted that Blanford (1895) (*FAUNA* 3 : 63) referring to Blyth's record said: 'The reported occurrences in the Indian peninsula need confirmation ; they may have been founded on large specimens of *T. javanensis*'. Later, Stuart Baker (*FAUNA* 4 : 74) ignored the continental records but included Orissa in the range of *Dinopium javanense rubropygialis*. Whistler & Kinnear (*J. Bombay nat. Hist. Soc.* 37 : 294) said the last name could not refer to a bird from the southwest and called it *D. j. malabaricus*. They objected to Baker's inclusion of Orissa in its range, but though they also referred to Blyth's record, made no attempt at its identification.

The discovery of Major William's specimen prompts us to draw attention to the probability of the earlier records being correct, and to

ask observers not only in the field but also those with access to other collections, to see if they can obtain corroborative evidence.

75, ABDUL REHMAN STREET,
BOMBAY-3.

HUMAYUN ABDULALI

BOMBAY NATURAL HISTORY SOCIETY,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1,

S. A. HUSSAIN

September 21, 1972.

9. DAMAGE TO MAIZE CROP BY ROSERINGED
PARAKEET, *PSITTACULA KRAMERI* (SCOPOLI)
IN THE PUNJAB

(With a photograph)

INTRODUCTION

Damage by birds to crops and fruits is not a new problem and references to their damage have been listed periodically in the last five centuries. The Roseringed Parakeet has been reported to be very destructive to crops and ripening fruits thus reducing subsequent yields. It eats by gnawing, thus wasting far more than what it actually eats (Whistler 1949; Lamba 1952; Ali 1964 and Ali & Futchally 1967). Taking into consideration its destructiveness to crops and fruits the present studies were undertaken to evaluate the extent of damage to maize crop.

MATERIAL AND METHODS

To evaluate the extent of damage to maize crop by parakeets, a plot having a total area of 1.5 acres was selected at the Punjab Agricultural University Farm, Ludhiana. The data were recorded on ten rows selected at random when the grains were set in the cobs. The damaged cobs were graded on the basis of the amount of damage done as fully damaged, $\frac{3}{4}$ damaged, $\frac{1}{2}$ damaged, $\frac{1}{4}$ damaged and $\frac{1}{8}$ damaged. Total number of fully damaged cobs were calculated by summing up the damage done to all cobs put together. The percentage of loss to the grains on cob basis was then worked out.

RESULT AND DISCUSSION

On an average, there were 60.7 cobs per line, each having 39.2 un-attacked cobs. Maximum damage was observed in the form of

$\frac{1}{2}$ damaged followed by $\frac{1}{4}$ and $\frac{1}{8}$ (see photograph). The damage in the form of $\frac{3}{4}$ was the least and no cob was found fully damaged (Table 1).

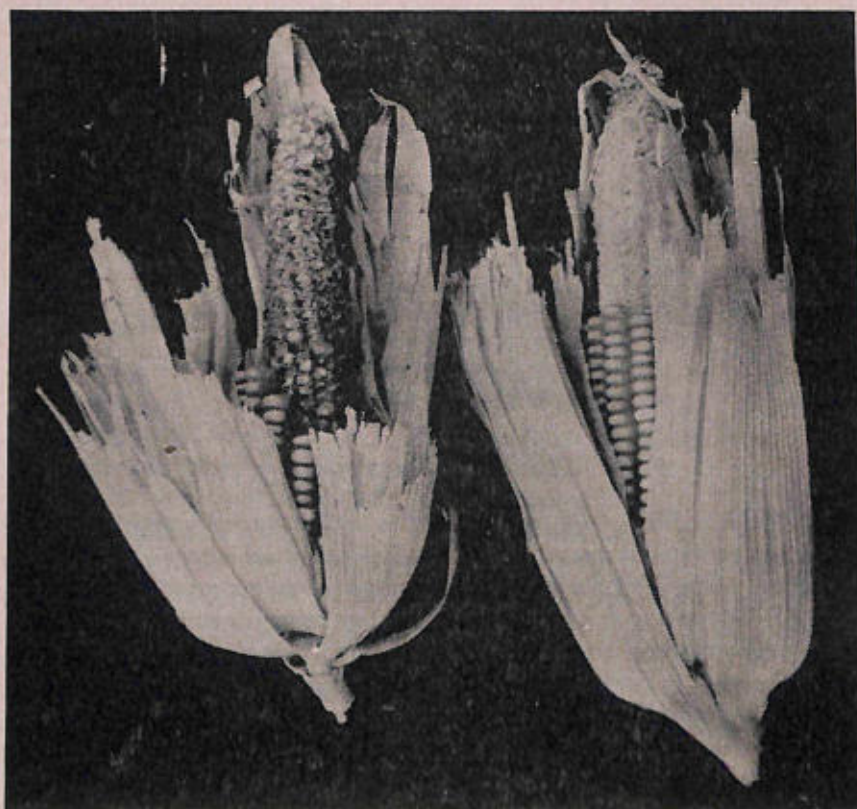


TABLE 1

INCIDENCE OF DAMAGE TO MAIZE COBS BY PARAKEET

Row No.	No. of cobs with different amount of damage					Total
	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	Nil	
1	2	10	10	2	37	61
2	4	11	5	5	38	63
3	3	4	6	8	46	67
4	3	5	2	9	36	55
5	2	7	5	7	32	53
6	2	5	6	5	40	58
7	1	9	5	7	40	62
8	3	5	12	4	37	61
9	2	7	5	5	47	66
10	1	8	7	6	39	61
Average	2.3	7.1	6.3	5.8	39.2	60.7

Per cent loss to maize crop on cob basis was also worked out and is given in Table 2.

TABLE 2
PER CENT LOSS TO MAIZE BY PARAKEET

Row No.	Total No. of cobs	Loss as damaged cobs*	Per cent loss
1	61	9.2	15.1
2	63	10.4	16.5
3	67	6.7	10.1
4	55	6.4	11.5
5	53	7.1	13.4
6	58	6.1	10.5
7	62	7.4	11.8
8	61	8.2	13.2
9	66	6.9	10.4
10	61	7.2	11.9
Average			12.4

* Obtained by adding figures $\frac{2}{3}$ of column 2, $\frac{1}{2}$ of column 3, $\frac{1}{3}$ of column 4 and $\frac{1}{4}$ of column 5 of Table 1.

The data presented in Table 2 reveal that the percentage of loss to maize crop varied from 10.1 to 16.5, average being 12.4 per cent. However, Sekhon (1966) recorded on an average 20.6% loss to maize crop due to Roseringed Parakeet. His observations were based on just three rows of plants in a field. Whistler (1949) reported that it feeds bit by bit and causes damage in the gardens and fields. Ali (1964) and Ali & Futehally (1967) mentioned it to be a serious pest to the farmers and fruit growers, causing enormous losses to their standing crops and ripening fruits by gnawing at and wasting far more than it actually eats.

On the basis of the present study it may be concluded that the Rose-ringed Parakeet causes considerable loss to maize crop and warrants control.

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10. SIGNIFICANCE OF COMMUNAL ROOSTING IN THE COMMON MYNA [*ACRIDOTHERES TRISTIS* (LINN.)]

Although some species roost alone, in pairs or small groups, there are numerous cases in which hundreds or thousands of birds gather at a communal roosting place both during and after the breeding season. Yet till recently very little attention has been paid to explaining the function of this phenomenon in bird life. This paper summarises the result of relevant observations on the Common Myna.

The Common Myna, a black-headed vinous-brown bird about 18 cm long, is one of the most familiar species in India. It occurs in close association with man and can be found wherever man normally lives, except in high mountains, sandy desert and dense forest. It is basically an insectivorous bird but due to its association with man it is omnivorous. It roosts communally on trees in enormous flocks throughout the year.

Berhampore, a district town, is situated on the eastern side of the Bhagirathi river in the midlands of West Bengal. The eastern bank of the river is lined for about half a mile with double rows of densely growing heavily spinous babul (*Acacia arabica*) trees. A large number of tall trees like sisu (*Dalbergia sissoo*), mango (*Mangifera indica*), banyan (*Ficus benghalensis*) and peepal (*Ficus religiosa*), etc. are scattered all over the town. During the course of my study on the life of the Common Myna (Sengupta, 1969, *Proc. Zool. Soc. Calcutta* 22 : 129-137) I found that the babul trees formed the only roosting place of the Common Myna in Berhampore (area : ten square miles) although many other suitable roosting trees were abundant. As the shadow lengthened, party after party arrived from all directions and settled for the night to the accompaniment of a great deal of cacophony.

Chuchura is also a district town at a distance of 40 km away from Calcutta and is situated on the western bank of the Hooghly river. The town encompasses 6 square km and contains a large number of tall trees like banyan, mango, peepul. At Chuchura I have found only two roosting sites. The largest roosting congregation of the Common Myna is, however, on a tall banyan tree standing very close to the Chuchura

Railway Station. This railway station is situated on the outskirts of the town where the human population is very scanty. The other roosting site at Chuchura is a banyan tree standing on the bank of the Hooghly river on the eastern boundary of the town.

Sinthi is a densely populated suburb of Calcutta (population : 50,000) with large trees (coconut, banyan, mango and peepul, etc.) scattered all over the area. Here the Common Myna can be seen in abundance from dawn to dusk feeding solitarily most of the feeding time on the household refuse. But at dusk the birds leave the area to roost on trees on the outskirts of Sinthi.

Santiniketan is a university town in the district of Birbhum, West Bengal. Here I have found only one roosting site of the Common Myna; a clump of bamboo (*Bambusa* sp.) growing inside a walled graveyard at the southern boundary of the university campus (area : c. 6 square km).

It is therefore, clear that the preferred roosting on babul trees above all others at Berhampore, on a banyan tree on the outskirts of Chuchura, and on bamboo in a secluded graveyard at Santiniketan is because these sites are relatively undisturbed.

At Berhampore construction of a bridge over the Bhagirathi river near the rows of the babul trees was started in the early part of June 1963. Soon tents and huts were installed to house a large number of people who were connected with the construction of the bridge on the river bank close to the rows of babul trees. Work continued all through the day and night. At first I observed a sudden awakening of the Common Myna accompanied with puffing of body feathers and loud calls at intervals during the night. This behaviour was noticed till the last week of June 1963 when one evening I found three or four mynas had taken to roosting on a banyan tree about 300 metres away from the bank of the river towards the town. Within a week that banyan tree was heavily crowded with roosting mynas. Around the middle of July 1963 there were no mynas roosting either among the babul trees or on the banyan tree. I searched for their new roosting site within the town but without success. I left Berhampore in September 1967 when the bridge was still under construction. Later I learnt that the bridge was completed in the early part of 1969 and the river bank reverted to the previous undisturbed condition around July 1970. On February 10, 1971, I happened to pay a visit to Berhampore and made a trip to the Bhagirathi river. To my surprise I found a large congregation of the mynas on the rows of babul trees as before. I presume that this was due to the return of undisturbed and safe conditions on the river bank, though I was not sure if these were the same birds that had roosted on the babul trees earlier.

It appears, therefore, that selection of the roosting site in the Common Myna is dependent on protection against predators and distur-

bance by man. It was found in all the abovementioned places that at dawn the mynas leave their roost and disperse for foraging far and near. Several ringed mynas were found feeding 3 km away from the roost site. Mynas feed individually in populated town areas and in small parties of four to eight in the countryside yet roost communally. This habit is also found in many other birds. However, where plentiful food is available considerable congregations of mynas are found. This also happens after a moderate shower, especially in the countryside when insects come out from their hideouts. Therefore, in the Common Myna the feeding pattern (i.e. gregarious, or individual) is determined by the amount of food available in a particular area. Since the Common Myna is omnivorous its food source is not localised in patches, as for instance in granivorous birds, but is generally distributed. Hence Ward's (1965, *Ibis*, 107 : 173-214) contention that communal roosting helps birds to find patchy food source seems untenable in the case of a semi-domesticated omnivorous bird species with an unlocalized food source. Siegfried (1970, *Proc. XV Int. Ornith. Cong.* : 197) and Zahavi (1971, *Ibis*, 113 : 107-109) while discussing the communal roosting in *Ardeola ibis* and in *Motacilla a. alba* respectively have also suggested its origin in relation to food supply. Zahavi's (loc. cit.) contention that a species feeding individually cannot have communal roosting also seems untenable in a species like the Common Myna which feeds both individually and gregariously yet roosts communally. Simmon (1965, *Brit. Birds* 85 : 161-168) has also found some solitary feeders to roost communally. Therefore, the relationship between feeding habit and communal roosting as postulated by Siegfried and Zahavi (loc. cit.) cannot be applicable to all bird species especially whose food source is not patchy like the mynas. The position and pattern of the roost sites of the Common Myna suggest that communal roosting behaviour may have evolved through natural selection primarily as an antipredator adaptation leading to the survival of the species thus supporting the view expressed by Lack, 1968, THE ECOLOGICAL ADAPTATION FOR BREEDING IN BIRDS.

DEPT. OF ZOOLOGY,
VISVA-BHARATI UNIVERSITY,
SANTINIKETAN, W.B.,
May 2, 1972.

S. SENGUPTA

11. A CREST IN THE PLUMAGE OF THE SPOTTED
BABBLER *PELLORNEUM RUFICEPS* SWAINSON

On 2nd May, 1971, I was on a hillside at Khandala when I came across a party of Spotted Babblers (*Pellorneum ruficeps*) some of which were singing on horizontal branches of trees. I had a close view of these birds for about ten minutes and noticed that the birds in song had crests.

During the course of rather casual conversation with Mr. Humayun Abdulali a few days later I mentioned this fact. He informed me that the standard reference works on Indian ornithology do not mention that the Spotted Babbler has a crest and he, therefore, arranged to show me specimens of *Pellorneum ruficeps* in the Society's collection.

We found that this bird does have slightly elongated feathers on the crown which can apparently be raised in life into a fairly noticeable tuft. In the prepared skin the elongated feathers have to be looked for.

C/O MERCANTILE BANK LTD.,
P.O. BOX NO. 128,
BOMBAY-1,
June 22, 1971.

D. A. STAIRMAND¹

[The occipital feathers, when they are slightly elongated, as in this species, give an impression of having a crest when the bird is excited and fluffs out the feathers on the crown. Some species of the family Pycnonotidae, e.g. Redvented Bulbul (*Pycnonotus cafer*) show this character, as also some other babblers, e.g. Browncapped Babbler, Tickell's Babbler. It is interesting to note that in such cases the birds show a definite 'cap' on the crown—the feathers on this area being different in structure and colour from the feathers on the back—EDS.]

12. PIT VIPER [*TRIMERESURUS MACROLEPIS* (BEDDOME)]
BITES AT A SOUTH INDIAN TEA ESTATE

(With two plates)

The Singampatti Group of tea estates lies on the eastern side of the southernmost reach of the Western Ghats. The estate and nearby forests are very interesting for many herpetological reasons. One is the abundance of certain species of snakes which are limited to a certain biotope corresponding to specific elevations and flora. *Trimeresurus*

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macrolepis is one of over a dozen Indian pit-vipers and is common in the estate and in certain forest types (wet bamboo, streamsides) over 3000 ft.

Dr. Krishnamurthy, the Medical Officer of the Singampatti Group gave me the following interesting notes concerning *T. macrolepis* (Beddome) and the incidence of bites to the workers. This snake often spends the day quietly in tea and coffee bushes, at the base of cardamom plants, ferns near streams and in passion fruit and other vines. The snake is nocturnal and will sometimes snap when poked or pulled at.

There were 18 cases of pit-viper bite in the Group estates from June 1970 to April 1971, from *Trimeresurus macrolepis* which often rest in places where pickers will put their hands, or step.

Workers invariably tie a rope tourniquet above the bite. Bites are about 60% on women (being in the majority in field work). Incidence for hand and foot bites is 50/50; all bites occur during the day, an average of 18 to 20 a year.

Condition on admission. Generally no tooth marks visible; slight swelling at the alleged site of bite (which a tourniquet can cause). The limb gradually swells (hard œdema) up to shoulder or knee. The victim experiences intense burning pain at site of bite for some hours and pain in the limb for 3-4 days after the bite, after which swelling subsides. No neurological or cardiac symptoms.

Treatment. Elevation of the limb. Magsulph fomentation to the swollen area and antibiotics given. Septic bite is rare, no mortality or serious symptoms caused by these bites. No known incidence of bites from other venomous snakes at the estate.

MADRAS SNAKE PARK,
MADRAS-22,
November 13, 1972.

R. WHITAKER

13. A NOTE ON 'GOLVA', A BAG NET, IN THE DAMANGANGA ESTUARY AT DAMAN

(With a text-figure)

Approximately 80 per cent of the inshore fish catches at Daman are by 'Golva' nets set in the Damanganga estuary. The Damanganga is a comparatively sluggish river, generally shallow except during peak monsoon months.

'Golva' is a fusiform wide-mouthed bag net made of cotton twine, of different dimensions depending upon available operational space. It is kept in position by attaching it to two poles by its mouth in the tidal zone of the estuary for catching miscellaneous fishes. Being a fixed net,

Whitaker : Pit Viper

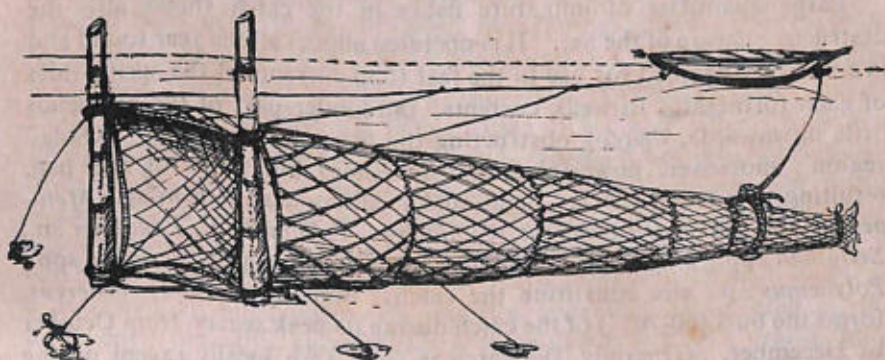


Cardamom plantation at 4,500 ft. above MSL, typical habitat of *Trimeresurus macrolepis*.



Trimeresurus macrolepis from Manjulai, Tirunelveli Dist., Tamil Nadu.

strong tidal current is necessary for its successful operation. Principally it is a 'filter gear', which depends on the fact that many of the small fishes and crustacea carried by the tidal currents are swept into the stationary bag, from which they cannot normally escape while the water filters out.



A typical 'Golva' measures 22 metres in length, with 1300 meshes at the mouth and tapering to 150 meshes at the cod end. Lengthwise, it consists of five parts, locally called 'Galu', 'Tija', 'Bara chauthi', 'Chota chauthi' and 'Khola' with mesh sizes of 10, 7.5, 5, 2 and 1 centimetres respectively. A bunch of 4 ropes each of 5 mm diameter is tied to the mouth or the head rope all along the circumference to provide additional strength at the mouth. The bunch is tied to the head rope at an interval of 3 meshes both at upper and lower portions of the mouth while the interval is 2 meshes laterally to make them stronger for resisting the pressure of fast currents. It is set during the low tide by fixing two strong long poles on which the mouth of the net is tied at four points facing the incoming high tide making a rectangle, as shown in the figure. The rectangular mouth, at this stage, measures 9.5×6.25 m. The open cod end is knotted and is left adrift in the water. A 10 m long rope is loosely tied around the anterior portion of 'Khola' (Cod region) through loops by one end and the other end is attached to a floating indicator buoy. The small fishes and prawns which drift with the high tide current pass through the long net and accumulate at the cod end. The catch is periodically hauled by pulling the rope thereby lifting the 'Khola' into the canoe and untying the knot. The net is easily removed during low tides for drying by simply pulling the few strings that are fastened by special knots. Refixing of the net by the skilled fishermen before the onset of the high tide also takes about 15 to 20 minutes. A

small dug-out canoe with two men can operate a number of such nets. One such net costs about Rs. 750 and remains serviceable for about five years if properly maintained by timely repairs and tanning. Generally, these nets are tanned once a month with the bark of a *Terminalia* species. The bark is boiled for about 5 to 6 hours and the nets, thoroughly washed in freshwater, are kept immersed in the decoction for 10 to 12 hours and thereafter these are dried in the sun.

Large quantities of immature fishes in the catch shows also the destructive nature of the net. It is operated almost all the year round and is admirably adapted for use in the fast tidal currents of the spring tides of each fortnight. In weak currents, the hinder part of the net bends little downwards, thereby obstructing the fishes from entering 'Khola' region; moreover, powerful fishes sometimes burst out of the bag, resulting in a lesser catch. Small and medium-sized *Peneus* sp., *Metapeneus* sp., *Harpodon nehereus*, *Cuilia* spp., *Pellona* spp., *Engraulis* sp., *Setipinna* spp., *Mugil* spp., *Lutianus* spp., *Therapon* spp., *Otolithus* spp., *Polynemus* sp., etc. constitute the catch. Bombay duck, *H. nehereus*, forms the bulk (60-70%) of the catch during its peak season from October to December. Generally, the catch is sold fresh locally except during the peak 'Bumla' (*H. nehereus*) season, when the heavy catch is sundried for export to Surat, Bulsar and Bombay markets. The space for operation of 'Golva' are leased out by the Department of Fisheries on auction for a specific period of time, and in Daman, 97 families almost exclusively earn their livelihood from the income of such nets.

ACKNOWLEDGEMENTS

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SUPERINTENDENT OF FISHERIES,
DAMAN, UNION TERRITORY,
January 1, 1971.

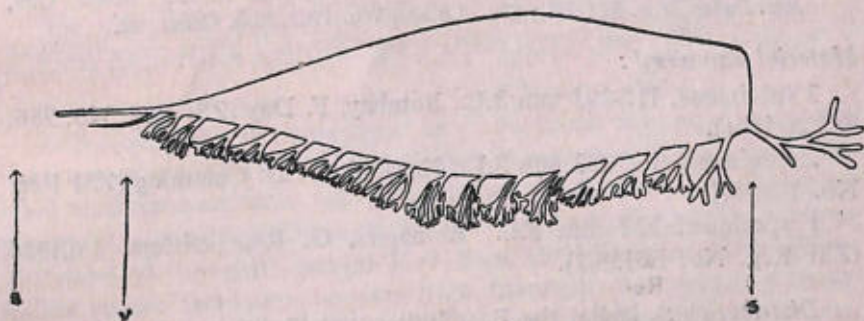
P. DAS¹

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14. A GENERIC ASSESSMENT OF *CORVINA SEMILUCTUOSA* CUVIER, 1830 (PISCES : SCIAENIDAE)

(With a text-figure)

Corvina semiluctuosa was originally described under the genus *Corvina* by Cuvier (1830) followed by Günther (1860). Kner (1865) included the species under *Johnius* Bloch and this nomenclatural combination was recognised by all subsequent workers (Bleeker 1874; Fowler 1933; Weber & de Beaufort 1936; Misra 1959; and Chu, Lo & Wu 1963). Day (1876), however, considered *Johnius* Bloch as a subgenus of *Sciaena* Linnaeus and hence treated *semiluctuosa* under the genus *Sciaena* in the group *Johnius*. The assignment of *semiluctuosa* Cuvier to any of these genera is considered inappropriate since the species has a carrot-shaped Otolithine gas-bladder (text-figure) with 15 pairs of arborescent tubular appendages, the anterior appendages branching in the head under the skull, surrounded by the soft tissue of the head-kidney and various ligaments, blood vessels and muscles.



TEXT-FIG.—1. Gas-bladder of *Nibea semiluctuosa* (Cuvier) in ventral view (diagrammatic); appendages shown on one side only.

- a. position of septum transversum.
- b. position of vent.
- c. position of second anal spine.

Recent workers (Trewavas 1962, 1964; Chu, Lo & Wu 1963; Sinha & Rao 1969) have emphasised the taxonomic value of the gas-bladder structure in the generic groupings and nomenclature of the Sciaenidae. This discovery of a basis for the generic classification of the Sciaenidae has completely reoriented the classification when the gas-bladder structure was ignored in favour of tropic adaptations which have proved to be only due to convergence. The species is, therefore, much more nearly related to *Nibea mitsukurii* (Jordan & Snyder), the type species of *Nibea*

Jordan & Thompson, 1911, than to the species associated with it under *Johnius*.

Corvina Cuvier has the same type-species as *Sciaena* Linnaeus, *Sciaena umbra* Linnaeus which has a gas-bladder without appendages; and *Johnius carutta* Bloch, the type of *Johnius*, has a hammer-shaped Otolithine gas-bladder. '*Corvina*' *semiluctuosa* Cuvier has no hammer-shaped expansion of the front of the gas-bladder and this, the mandibular pores and strong second anal spine place it in *Nibea*.

***Nibea semiluctuosa* (Cuvier, 1830) comb. nov.**

Corvina semiluctuosa Cuvier, 1830, *Hist. nat. Poiss.*, 5: 106 (Malabar, Goa & Pondicherry).

Corvina semiluctuosa Günther, 1860, *Cat. Fish. Brit. Mus.* 2: 304; Day, 1865, *Fish Malabar*: 53.

Johnius semiluctuosa Kner, 1865, *Reise Novara Fische*: 124; Bleeker, 1874, *Verh. Akad. Wet.*, 14: 54.

Sciaena semiluctuosa Day, 1876, *Fish. India*: 191; Day, 1889, *Fauna Brit. India. Fish.* 2: 121.

Johnius semiluctuosa Fowler, 1933, *Bull. U.S. Nat. Mus.* (100) 12: 404; Weber & de Beaufort, 1936, *Fishes Indo-Australian Archipelago* 7: 535; Misra, 1959, *Rec. Indian Mus.* 59: 271; Chu, Lo and Wu, 1963, *Fish. China*: 22.

Material Examined:

3 specimens, 115-295 mm S.L., Bombay, F. Day (ZSI Reg. No. 986, 987 & 1001).

2 specimens, 156-223 mm S.L., Karachi, W. D. Cumming (ZSI Reg. No. F2816/1).

1 specimen, 222 mm S.L., Ratnagiri, G. Ramakrishna, 1.6.1954 (ZSI Reg. No. F6159/2).

Distribution: India, the East Indies, the Philippines and China.

ACKNOWLEDGEMENTS

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ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-13,
October 24, 1970.

P. K. TALWAR

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- *Not referred in original.

15. ON THE OCCURRENCE OF JUVENILE MACKEREL *RASTRELLIGER CANAGURTA* (CUVIER) OFF GOA COAST

Goa along with the west coast of India has a flourishing mackerel fishery solely, supported by *Rastrelliger canagurta*. Though the small-sized mackerel have been observed elsewhere yet from the Konkan Coast except for isolated records of small-sized mackerel off Karwar (Pradhan 1956) and off Ratnagiri (George & Annigiri 1960) young mackerel below 10 cm length have not, so far, been reported. I collected juvenile mackerels several times during 1964-69. The details are given in the Table. Peter (1969) has reported the occurrence of larvae from Persian Gulf, Red Sea and Bay of Bengal in Indian Ocean (22° 22'N., 60° 50'E., 16° 37'N., 41° 09'E., 18° 15'N., 87° 48'E.) from deeper waters.

The occurrence of 48-70 mm juveniles at Goa in May 1965, indicates that the spawning must have commenced much earlier than June-September as reported by Devanesan & John (1940), whereas Balakrishnan (1957) observed that breeding of mackerel commenced during March-April. George & Annigiri (1960) considered the occurrence of small sized mackerel in September as a result of spawning a few months earlier. Similar inferences can be drawn from five instances in Goa also, as recorded above. Peter (1969) has recorded occurrence of small larvae of mackerel in the Indian Ocean in October-November. This difference in the time of occurrence of larvae and juvenile in earlier

reports may be due to the difference in breeding at far off places from where the larvae were obtained. Nevertheless, some observations at

TABLE
JUVENILE OF *Rastrelliger canagurta* OFF GOA COASTS

Date	Place of collection	Size Range in mm	Mode of collection	Total No. of Juvenile observed	Depth in fathoms
28/ix/64	Panjim	60-90	Purse seine	63	12
3/x/64	Panjim	80-110	-do-	87	8
6/v/65	Calangute	48-70	Trawling	12	10
20/ix/65	Baina	105-140	Purse seine	47	10
14/x/65	Calangute	90-120	-do-	18	10
23/ix/67	Baina	80-110	-do-	35	9
1/vi/68	Baina	58-75	Trawling	18	10
1/vi/69	Calangute	55-75	-do-	9	10

Goa support Balakrishnan (loc. cit.) that spawning probably takes place as early as March.

The mackerel fishery in this area generally commences in September with the appearance of younger size groups varying between 160-200 mm. However, from November onwards the fishery is supported by 220-240 mm groups with mode at 230 mm during January-March. These are mostly with gonads in III stage of maturity. The largest specimen measured during this period was 290 mm in April 1968. During April and May, in all the years of observations, occasionally spent specimens were observed indicating probably termination of spawning. However, in August 1971, some stray specimens of mackerel from Rampan Catches which were in advanced stages of maturity, being V or early VI were observed on this coast. This suggests that mackerel perhaps has a prolonged breeding season with periodic spawning (more than once) during this period. There is need for further detailed investigation to confirm this observation. Plankton collections made during this period in the area do not seem to have eggs showing resemblance to mackerel eggs.

The main season of spawning of the mackerel along Konkan Coast according to Pradhan (1956), is from May to September. A subsidiary spawning season was reported on Mangalore Coast during January and February by George *et al.* (1959). Since the spawners and young mackerel have been obtained from this area at several places though in

small numbers during the course of this study, it indicates that these are stragglers from the main shoals which probably are not very far from the actual spawning ground. This could be a useful clue towards exploration of the spawning grounds of mackerel. The occurrence of small-sized mackerel from May-September adds strength to the contention that the Indian mackerel may have a prolonged spawning season. No doubt, the occurrence of juveniles and even adult with spent gonads in an area does not always reveal correct picture about spawning grounds and spawning season yet the probability of these grounds being close to the area of occurrence cannot be completely ruled out. Prolonged breeding season with periodic spawning during the season (more than once) indicates the possibility of different races coming into commercial fishery with gonad in different stages of maturity.

Food of juvenile mackerel :

The food of the small-sized mackerels up to 95 mm size as revealed in the gut contents consisted of diatoms, dinophyids, and a few copepods and protozoa. The gut contents of mackerel, between 95-105 mm was mainly post-larvae of fishes, and crustacean larvae, with negligible phytoplanktonic organisms. The feeding intensity was appreciably high. The food of size groups constituting the commercial fishery between 170-230 mm was mainly diatoms like *Consinodiscus*, *Rhizosolenia*, *Biddulphia*, *Planktoneilla*, *Pluerosigma* and *Chaetoceros* sp. The zooplankton constituents of mackerel food, along this coast are forms like calanids, copepods, cladocera and advanced stages of crustacean, and molluscan larvae, tintinnids and dinoflagellates. The feeding intensity of mackerel is generally high from September to March but moderate from April to June. During April-June period fish scales were often found in the stomachs of mackerel caught by purse seines.

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I wish to express my thanks to Dr. M. S. Prabhu, formerly Director of Fisheries, Panjim, for his guidance during the course of this work. I am also grateful to Dr. P. V. Dehadrai, Scientist, National Institute of Oceanography, Panjim, for going through the manuscript.

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16. THE SOCIAL SPIDER, *STEGODYPHUS SARASINORUM*
KARSCH. FEEDING ON THE LEMON BUTTERFLY,
PAPILIO DEMOLEUS LINN.

The senior author during a visit to Hatta village in Parbhani District found the webs of the Social Spider holding the dead bodies of the adult lemon butterflies *Papilio demoleus* Linn. on orange trees in a citrus garden. Some of the webbed branches were collected and brought to the laboratory where the webs were kept under a bell jar with a piece of cotton swab dipped in chloroform and spiders that emerged out of the web and died were counted and preserved in 70% alcohol. The webs were then cut and the butterflies separated and counted. It was observed that the bigger webs on an average had 58 spiders and the smaller webs 26 spiders, living almost in the heart of the web. On an average 18 and 8 adult lemon butterflies were collected from the bigger and small webs respectively. The abdomen of the butterflies were completely eaten.

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ENTOMOLOGY SECTION,
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April 7, 1972.

A. K. RAODEO
D. T. TIKAR
ABDUL MUQUEEM

17. A NOTE ON *IDIOSCOPUS CLYPEALIS* (LETH.)
(HEMIPTERA : CICADELLIDAE)

During local faunistic surveys of Poona and its surrounding areas I collected some Jassids on mango leaves from Nasrapur, about 40 km east of Poona. They were studied at the laboratory to find the nature and distribution of clypeal spots in both the sexes. Distant (1907) while examining the species observed 'face immaculate or with the small black median spots'. Capriles (1964) also made a similar observation, but while classifying the species, described the presence of the spots in the female. I, therefore made three collections in June, July and August 1968, in order to study the exact nature of the distribution of the spots in both of the sexes and the results are tabulated below :

Idioscopus clypealis (Leth.)

Date	♀♀		♂♂	
	No. of specimens with clypeal spots	No. of specimens without spots	No. of specimens with clypeal spots	No. of specimens without spots
21-vi-68	114	1	4	82
20-vii-68	109	—	6	85
22-viii-68	99	—	8	93

It is clear from the above data that the males also possess these spots although their number and ratio is very small when compared with those of the females. Almost all the females possess the spots.

ACKNOWLEDGEMENT

I thank Shri B. S. Lamba, Officer-in-Charge, Western Regional Station, Zoological Survey of India, for laboratory facilities and encouragement.

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
POONA,
March 21, 1970.

K. RAMACHANDRA RAO

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18. SEASONAL CHANGES IN THE POPULATION OF
EPILACHNA BEETLE *HENOSEPILOACHNA SPARSA* HERBST.
(COLEOPTERA : COCCINELLIDAE)

(With nine text-figures)

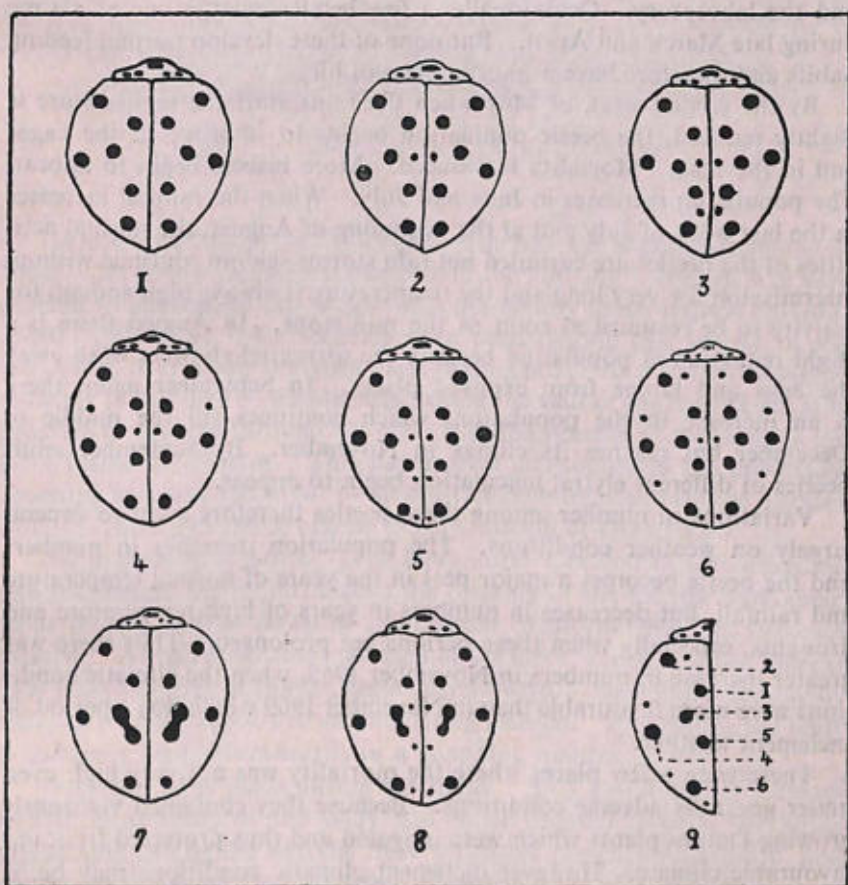
Observations have been made by the authors on the seasonal changes in the population of Epilachna beetles, *Henosepilachna sparsa* Herbst. in the field and laboratory. The beetles were reared in the laboratory in rearing cages specially designed by Edona and Soans. Outside the beetles thrive on *Datura fastuosa* in the Malabar Christian College compound. Seasonal changes affect the population both inside the laboratory and outside, but outside the seasonal changes are more pronounced.

The presence of Epilachna beetles can be best determined by examining the leaves of *Datura fastuosa*. The leaves are seen eaten up in irregular patches with the thin upper cuticle of the leaf entirely or partly covering those areas. When the underside of these injured leaves is examined, one is likely to find epilachna beetles in one stage of development or the other.

The beetle population reaches its highest numerical strength about the middle of October and continues till the end of November. The favourable climatic conditions which succeed the rainy season seem to be responsible for this increase. Beetles breed rapidly and feed voraciously in the field. Both the larvae and adults feed on the under surface of the leaves skeletonizing them and producing a new crop of adults. Dry yellow leaves with practically all the tissue eaten and with a fine net work alone remaining indicates heavy infestation.

In the laboratory also beetles multiply rapidly during these days. Specimens with different elytral maculation appear during this season. The basic elytral maculation consists of 6 black spots always present on each elytron arranged as in fig. 1; but these may be augmented by the presence of 1-5 black non-persistent spots variably present (figures 2-6). Both persistent and non-persistent spots are variable in size, the former

being usually bigger than the latter. Occasionally some spots may coalesce.



Henosepilachna sparsa Herbst. : Figs. 1-9

1. Basic elytral maculation of 6 black spots. 2-6. spot patterns of elytra showing presence of 1-5 non-persistent spots on each elytron. 7-8. coalescence of spots. 9. left elytron, persistent spots numbered 1-6.

From the middle of December throughout January a slight reduction in the population is noticed. This becomes more pronounced in February and in March. By this time only six-spotted beetles are seen and occasionally 7-spotted ones. By April the reduction in the population reaches its climax. Of the insects present only few lay eggs and there is considerable reduction in the number of eggs in each batch. Due to the heat and dry air most of the eggs, larvae, pupae and adults are killed. Mortality is highest in the first and the second instars. The eggs remain dead and dry on the plants; the larvae and adults are killed

and fall to the ground ; while the pupae are left dark brown and black to dry up on the plants. These conditions are common both in the field and the laboratory. Occasionally a few beetles emerge one at a time during late March and April. But none of these develop normal feeding habits and therefore have a shorter span of life.

By the second week of May when the rains start the temperature is slightly reduced, the beetle population begins to improve in the cages and in the field. Mortality is reduced. More insects begin to appear. The population increases in June and July. When the rainfall increases in the last week of July and at the beginning of August, the normal activities of the beetles are curtailed but rain storms seldom continue without intermission for very long and the temperature is always high enough for activity to be resumed as soon as the rain stops. In August there is a slight reduction in population because the torrential showers wash away the eggs and larvae from exposed places. In September again there is an increase in the population, which continues till the middle of December but reaches its climax in November. By September adult beetles of different elytral maculation begin to appear.

Variations in number among these beetles therefore seem to depend largely on weather conditions. The population increases in numbers and the beetle becomes a major pest in the years of normal temperature and rainfall, but decreases in numbers in years of high temperature and droughts, especially when these periods are prolonged. Thus there was greater increase in numbers in November 1968, when the climatic conditions were more favourable than in November 1969 which was a period of inclement weather.

There were a few places where the mortality was not very high even under generally adverse conditions. Because they contained vigorously growing *Datura* plants which were irrigated and thus protected from unfavourable climate. However inclement climatic conditions may be, it does not seem likely that total eradication of the beetle will occur. The insect either persists on *Datura* throughout the year or is only temporarily held in check by unfavourable weather conditions.

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1, KERALA,
December 27, 1969.

V. I. EDONA
A. B. SOANS

19. THE PROCESS OF MOULTING AND THE NUMBER
OF INSTARS IN THE TIGER BEETLE, *CICINDELA*
CANCELLATA DEJ. (COLEOPTERA : CICINDELIDAE)

(With a text-figure)

Cicindela cancellata Dej. is a tiger beetle which is widely distributed in India. Its larvae live inside burrows in the soil and therefore it is very difficult to observe all the details of its life-history under natural environmental conditions. The authors have been rearing this species in the laboratory in specially designed glass rearing jars. As a few of the larvae excavate their burrows accidentally, along the wall of the rearing jar, it is possible to observe through the glass wall the process of moulting in the larva inside the burrow. This paper gives an account of the process of moulting and also the result of an indirect investigation into the number of larval instars in this beetle by the application of Dyar's Law.

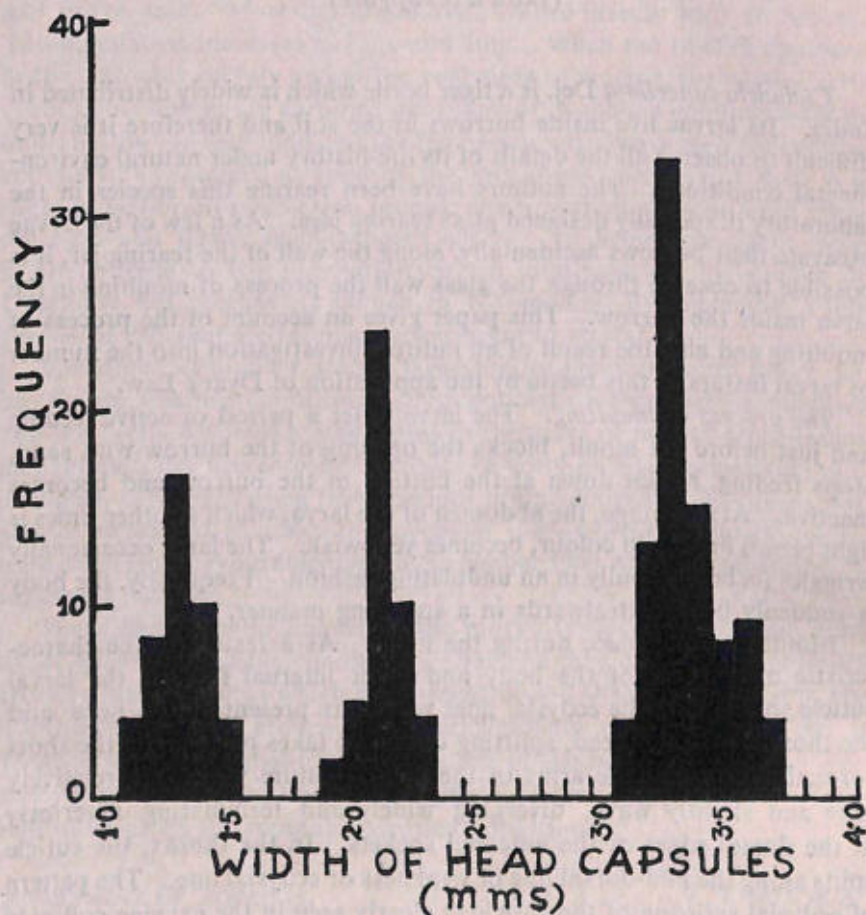
The process of moulting. The larva, after a period of active feeding and just before the moult, blocks the opening of the burrow with sand, stops feeding, settles down at the bottom of the burrow and becomes inactive. At this stage, the abdomen of the larva, which at other times is light brown or grey in colour, becomes yellowish. The larva occasionally wriggles its body rapidly in an undulating fashion. Frequently, the body is suddenly bent ventralwards in a snapping manner.

Moulting takes place during the night. As a result of the characteristic movements of the body and other internal factors, the larval cuticle splits along the ecdysial lines which are present on the head and the thorax. On the head, splitting of cuticle takes place along the short coronal suture and the arms of the frontal suture which are relatively long and slightly wavy, diverging widely and terminating anteriorly at the dorsal edges of the antennal sockets. In the thorax, the cuticle splits along the mid-dorsal line of weakness or ecdysial line. The pattern of ecdysial splitting of the cuticle is clearly seen in the exuviae collected from the burrows.

The number of instars.—Dyar (1890)¹ stated that in lepidopteran larvae, the width of the head capsule increases in a regular geometric progression through successive instars, by a ratio of about 1.4. This principle which is known as Dyar's law, has been used successfully to determine the number of larval instars in some insects.

¹DYAR, H. G. (1890): The number of moults of Lepidopterous larvae. *Psyche*, 5: 420-422.

A large number of larvae of *Cicindela cancellata* in the various stages of growth, were collected from the field and from the rearing jars in the laboratory. The measurements of the width of their head capsules were recorded and the frequency distribution of the various values was studied. The text-figure gives the results in the form of an histogram.



Histogram of the width of head capsules of the larvae of *Cicindela cancellata*.

The histogram clearly shows that the width of head capsules fall under three distinct and discontinuous classes, indicating that there are three larval instars in the life cycle of *Cicindela cancellata*. The mean width of head capsules of the three instars are, 1.31, 2.12, and 3.36 millimetres respectively. The growth ratio between the first and second instar is 1.63 and that between the second and the final instar is 1.59. It

is seen that the growth ratio between successive instars is approximately constant.

Grateful acknowledgement is made of a grant from the University Grants Commission to one of the authors (A.B.S.).

DEPARTMENT OF ZOOLOGY,
MALABAR CHRISTIAN COLLEGE,
CALICUT-1, KERALA,
July 7, 1969.

A. B. SOANS
J. S. SOANS

20. NEW RECORDS OF HYMENOPTEROUS PARASITES
OF PEA LEAFMINER *PHYTOMYZA ATRICORNIS*
MEIGEN (DIPTERA : AGROMYZIDAE)

The pea leafminer *Phytomyza atricornis* Meigen is the most common and widespread leafminer throughout the world. The larva of this pest is polyphagous and attacks a large number of plants belonging to several natural orders. According to Trehan & Sehgal (1963), the larva feeds indiscriminately on palisade and spongy mesenchymatous tissues but never consumes the entire tissues between the upper and lower epidermis and the endodermal cells containing starch are largely avoided. Ahmad & Gupta (1941), while studying the biology of this pest on pea, reared an Eulophid, *Solenotus* sp. from its larval stages. Narayanan *et al.* (1956) reared an ectoparasite *Solenotus* sp., an endoparasite, *Rhopalotus* sp. and an unidentified braconid on the larval stages of this host fly. Only recently Odak *et al.* (1968) have recorded *Opius* sp. (Braconidae) and *Neochrysocharis* sp. (Eulophidae) as parasites of *P. atricornis* from Gwalior (India). The present study was, therefore, undertaken to investigate parasites of this leafminer in the Ranchi area and leaves of pea (*Pisum sativum* Linn.) were collected. The following six hymenopterous insects emerged from the leafmines.

1. *Chrysocharis* sp. (Eulophidae)

Thompson (1943, 1954) has recorded *Chrysocharis* sp., *C. elongatus* and *C. syma* from New Zealand, Yugoslavia and England respectively, as parasites of this leafminer.

2. *Tetrastichus* sp. (Eulophidae).

3. *Cirrospilus* sp. (Eulophidae).

4. *Opius* sp. ? *phaseoli* Fischer (Braconidae).

5. *Opius* sp. ? *lantanae* Bridw. (Braconidae).

6. *Sphagigaster* sp. (Pteromalidae).

ACKNOWLEDGEMENTS

My thanks are due to Sri Y. Sankaranarayanan, Director and Dr. A. Bhattacharya, Entomologist of the Institute, for encouragement. Thanks are also due to Sri B. P. Mehra, Scientific Officer of the Institute for constant help and going through the manuscript and to Mr. R. D. Eady, Commonwealth Institute of Entomology, London, for the identification of the parasites.

INDIAN LAC RESEARCH INSTITUTE,
NAMKUM, RANCHI, BIHAR,
May 20, 1970.

R. S. GOKULPURE

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21. CONTRIBUTION TO THE STUDY OF AQUATIC BEETLES
—14. *COPELATUS NEELUMAE* SP. NOV. (DYTISCIDAE)
FROM INDIA

(With a text-figure)

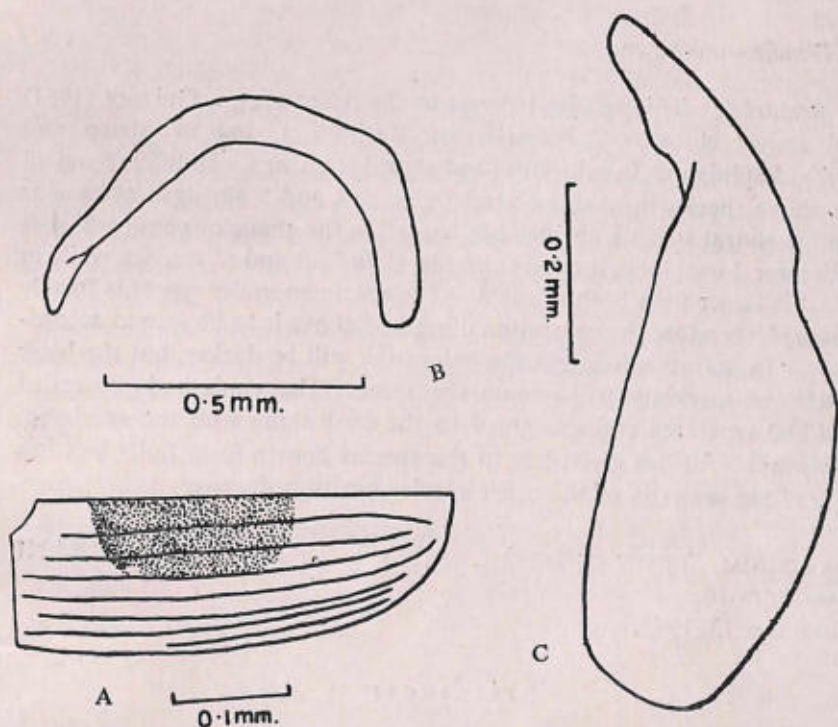
Copelatus neelumae sp. nov.

Holotype—♂, Tamilnadu: Ottokovil, Tiruchirapally District, from a tank near Uppada river, 13.iii.1971, K. V. Lakshminarayana coll. In the National Collections, Zoological Survey of India, Calcutta.
Z.S.I. Regd. No. ⁶⁰⁵²
H4A.

Length 5.4 mm. Breadth 2.8 mm.

Head rufo-ferruginous, slightly paler anteriorly; punctation on the disc quite dense, separated by its own diameter, irregular, more sparse anteriorly and towards the sides; surface distinctly microreticulate.

Pronotum rufo-ferruginous with sides slightly paler; anterior row of punctures quite regular; punctuation of surface finer and less dense than on the head, on the disc separated by 2-3 times its own diameter; surface micro-reticulate as on the head.



TEXT-FIGURE. *Copelatus neelumae* sp. nov., A—left elytron; B—lateral view of penis; C—protibiae in male. All from holotype specimen.

Elytra (Text-fig. A) pale testaceous with irregular rufo-ferruginous spots between the suture and third striae, but neither touching the base nor the apical one-third of the elytra. Elytral striae disposed as under.—Striae 1, 2 and 5 abridged at base (1 more than the other two), while striae 3, 4 and 6 commence from the base; striae 1 more abridged at base than striae 2 and striae 2 less abridged at base than striae 5; submarginal striae extending a little beyond the middle anteriorly and terminating almost near the apex of striae 6. Striae 6 shorter than 5 at apex, striae 5 shorter than 4 at apex, striae 4 and 1 terminate beyond apex of 3 and 2, nearly enclosing both of them. Punctuation and reticulation as on pronotum but less impressed.

Ventral side pale testaceous; metacoxae and 3 visible abdominal sternites with short, oblique, profound striae, those on the abdominal

sternites a little longer than on metacoxae. Male protibiae (Text-fig. C) enlarged towards apex, distinctly curved and notched at base; basal three segments of protarsi and mesotarsi moderately enlarged; penis (Text-fig. B) slender, curved, asymmetrical from dorsal surface (rather twisted).

Female—unknown.

Remarks: This species belongs to the *irinus* group, Guignot (1961) and comes close to *C. bangalorensis* Vazirani, *C. indicus* Sharp and *C. freudei* Guignot; in coloration and elytral markings. It differs from all the above species in having elytral striae 1, 2 and 5 abridged at base as against elytral striae 1 abridged at base. In the shape of penis, which is without a dorsal lobe, it comes close to *C. indicus* and *C. freudei*, while in size it is larger than both of them. The specimen under report is freshly emerged, therefore the coloration described above is to be viewed accordingly. In mature specimens the coloration will be darker, but the basic pattern of markings will remain the same. The penis had protruded and had separated and was glued to the card along with the specimen. Vazirani (1970) has given key to the species known from India and has figured the genitalia of the other species mentioned above.

T. G. VAZIRANI

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-16,
November 13, 1972.

REFERENCES

- GUIGNOT, F. (1961): Revision des Hydrocanthares d' Afrique (Coleoptera Dytiscoidea). *Ann. Mus. R. Congo Belge Sci. Zool.* 90: 659-995.
- VAZIRANI, T. G. (1970): Contributions to the study of Aquatic Beetles (Coleoptera). VII. A. revision of Indian Colymbetinae (Dytiscidae). *Oriental Ins.* 4: 303-362.

22. *QUISQUALIS INDICA* LINN. AND *DODONEA VISCOSA* LINN. AS NEW HOSTS OF CASTOR SEMILOOPER, *ACHOEJA JANATA* LINN.

Castor semilooper, *Achoeja janata* L. (Lepidoptera, Noctuidae) is a serious pest of Castor (*Ricinus communis*), guava fruits (*Psidium guajava*) in (Srivastava 1960) and citrus fruits (Ayyar 1940 and Rakshpal 1945) in orchards, Pruthi & Mani (1945) reported rose (*Rosa indica*), pomegranate (*Punica granatum*) and *Euphorbia pilulifera* as the alternate hosts while Khan (1946) further included 'Kachnar' (*Bauhinia variegata*), 'Ber'

(*Zizyphus jujuba*), 'Dudhi' (*Euphorbia hirta*) and banyan (*Ficus bengalensis*) as the alternate hosts. The larvae were also observed, in forests, to feed on 'Babool' (*Acacia arabica*) and *Albizia amara* by Bhasin & Roonwal (1954). The present report records the feeding of *A. janata* larvae on two additional hosts, namely the hedge plant *Dodonea viscosa* (Family Sapindaceae) and the ornamental Rangoon creeper, *Quisqualis indica* (Family Combretaceae). Both these plants are important garden ornamentals. So far, we have observed feeding of this pest in laboratory on more than a dozen hosts in varying degrees of intensity but observations made during the last two years at Jobner, Udaipur and Jaipur revealed that the two plants reported here suffer substantial damage by this insect from July onwards. Further, both *Quisqualis* and *Dodonea* were observed to be attacked in the field simultaneous to the occurrence of the insect on castor within a distance of 7 metres and 13 metres respectively. This showed that even in the presence of the primary host the gravid female moths oviposited on these garden plants indicating a potential preference of the insect to these plants. Detailed studies on the host preference of this insect are under-way.

DEPARTMENT OF ENTOMOLOGY,
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF UDAIPUR,
UDAIPUR,
September 12, 1970.

V. S. KAVADIA
S. K. VERMA

REFERENCES

- AYYAR, T. V. R. (1940): A Handbook of Economic Entomology for South India. Madras Govt. Press, Madras, xviii+528 pp.
- BHASIN, G. D. & ROONWAL, M. L. (1954): A list of insect pests of forest plants in India and the adjacent countries. *Indian Forest Bulletin* (New Series) Entomology, No. 171 (1): 1-93.
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Female—unknown.

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ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-16,
November 13, 1972.

T. G. VAZIRANI

REFERENCES

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(*Zizyphus jujuba*), 'Dudhi' (*Euphorbia hirta*) and banyan (*Ficus bengalensis*) as the alternate hosts. The larvae were also observed, in forests, to feed on 'Babool' (*Acacia arabica*) and *Albizzia amara* by Bhasin & Roonwal (1954). The present report records the feeding of *A. janata* larvae on two additional hosts, namely the hedge plant *Dodonea viscosa* (Family Sapindaceae) and the ornamental Rangoon creeper, *Quisqualis indica* (Family Combretaceae). Both these plants are important garden ornamentals. So far, we have observed feeding of this pest in laboratory on more than a dozen hosts in varying degrees of intensity but observations made during the last two years at Jobner, Udaipur and Jaipur revealed that the two plants reported here suffer substantial damage by this insect from July onwards. Further, both *Quisqualis* and *Dodonea* were observed to be attacked in the field simultaneous to the occurrence of the insect on castor within a distance of 7 metres and 13 metres respectively. This showed that even in the presence of the primary host the gravid female moths oviposited on these garden plants indicating a potential preference of the insect to these plants. Detailed studies on the host preference of this insect are under-way.

DEPARTMENT OF ENTOMOLOGY,
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF UDAIPUR,
UDAIPUR,
September 12, 1970.

V. S. KAVADIA
S. K. VERMA

REFERENCES

- AYYAR, T. V. R. (1940): A Handbook of Economic Entomology for South India. Madras Govt. Press, Madras, xviii+528 pp.
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- SRIVASTAVA, B. K. (1960): *Achoea janata* as a pest of ripening guavas. Proc. 47th Indian Sci. Congress 3: 558.

23. THE OCCURRENCE OF THE COMMON PALMFLY
(*ELYMNIAS HYPERMNESTRA CAUDATA* BUTLER)
NEAR BOMBAY

On 27th September 1972 I captured a female of the Common Palmfly (*Elymnia hypermnestra caudata* Butler) at Kihim, Kolaba District, a few miles south of Bombay. This appears to be an extension of its range as there are no definite records of this butterfly from anywhere near Bombay.

According to Wynter-Blyth (BUTTERFLIES OF THE INDIAN REGION) the species may be found 'at low elevations in suitable localities in the peninsula as far north as Madhya Pradesh', but till now *E. h. caudata* has not been apparently recorded north of Karwar (N. Kanara) which is the northernmost point from where a specimen in the Society's collection has been obtained.

The specimen, now in the Society's collection, was seen settled near the ground on a bush along the seashore. As the wings were rather tattered it may have been carried northwards by the monsoon winds.

I am grateful to the Society for the use of their equipment and in particular to Mr. N. T. Nadkerny who kindly confirmed the identification of the specimen and supplied some of the references.

SUNBEAM,
PERRY CROSS ROAD,
BANDRA, BOMBAY-50,
November 24, 1972.

SALMAN ABDULALI

24. OCCURRENCE OF THE GENUS *CONCHYLIURUS*
BOCQUET & STOCK (CYCLOPOIDA-CLAUSIDIIDAE)
IN RATNAGIRI

While studying the biology of *Meretrix meretrix* L., I came across a number of semi-parasitic copepods in the mantle cavity of the clam. These copepods belonged to two different species of the genus *Conchylurus*. This genus was created by Bocquet & Stock (1957) with *C. solensis* as the type species. From Indian waters, the genus *Conchylurus* was first recorded by Reddiah (1960), who described a new species *C. maximus* Reddiah from *Sanguinolaria (Soletellina) diphos* (Gmelin) from Portonovo. In the following year, Reddiah (1961) described two more new species, *C. bombasticus* Reddiah and *C. fragilis* Reddiah from *Meretrix meretrix* (L.) from Portonovo. A detailed examination of the

local specimens revealed that they belonged to the last two species described by Reddiah (op. cit.) from *M. meretrix* (L.). This is thus the first record of the genus *Conchylurus* from the West Coast of India.

So far about nine species have been described under this genus. Considering the richness of the molluscan fauna of India, more species are likely to be discovered in future. It is therefore, considered, that the distribution (Table) of all known species of this genus, together with their type hosts and localities, would be useful for future workers on this group.

TABLE

Species	Host	Locality
<i>Conchylurus solensis</i> Bocquet & Stock (1957)	<i>Solen marginatus</i> Don*	Near Roscoff, France**
<i>C. cardii</i> Gooding (1957)	<i>Cardium echinatum</i> L.*	Near Plymouth, England
<i>C. cardii cardii</i> *** Gooding (1957)	<i>Solen marginatus</i> Don, <i>Cardium echinatum</i> L.,* <i>Meretrix chione</i> (L.)	France
<i>C. cardii tapetis</i> Bocquet & Stock (1958)	<i>Tapes decassatus</i> (L.),* <i>Tapes pullastra</i> (Montagu), <i>Tapes aurens</i> (Gmelin)	France**
<i>C. torosus</i> Humes & Cressey (1958)	<i>Maetra glabrata</i> L.,* <i>Maetra largillerti</i> Phillippi	Free Town, Sierra Leone,** West Africa
<i>C. lobatus</i> Humes & Cressey (1958)	<i>Cardita ajar</i> Bruguere*	Free Town, Sierra Leone,* West Africa
<i>C. maximus</i> Reddiah (1960)	<i>Sanguinolaria</i> (<i>Soletellina</i>) <i>diphos</i> (Gmelin),*	Near Portonovo,** east coast of India
<i>C. bombasticus</i> Reddiah (1961)	<i>Meretrix meretrix</i> (L.)* <i>Meretrix casta</i> Deshayes	Near Portonovo,** east coast of India Ratnagiri, west coast of India
<i>C. fragilis</i> Reddiah (1961)	<i>Meretrix meretrix</i> (L.)*, <i>Meretrix casta</i> Deshayes	Near Portonovo,** east coast of India, Ratnagiri, west coast of India.

* Type host, ** Type locality, *** Bocquet & Stock (1958) downgraded Gooding's species *C. cardii* into a subspecies and referred to it as *C. cardii cardii* Gooding.

I wish to express my sincere thanks to Dr. K. Reddiah, Officer-in-Charge, Eastern Regional Station, Zoological Survey of India, Kench's Trace, Shillong (Assam) for his help in identification of the species and loan of some important references. I am also grateful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State and Dr. H. G. Kewalramani, Senior Scientific Officer, for their helpful criticism.

MARINE BIOLOGICAL RESEARCH
RATNAGIRI, STATION,
March 4, 1970.

M. R. RANADE

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- REDDIAH, K. (1960): Copepods associated with Indian Molluscs. (a) Description of *Conchyliliurus maximus*, *Sanguinolaria (Soletellina) diphos* (Gmelin) (Lamellibranchiata-Psammodiidae). *J. Zool. Soc. India* 12(2): 137-146.
- (1961): Copepods associated with Indian Molluscs. (B) Description of two new *Conchyliliurus* species from *Meretrix meretrix* (L.). *Crustaceana* 2 (4): 300-312.

25. ON THE OCCURRENCE OF *CUSCUTA SANTAPAU*
BANERJI & DAS IN WESTERN
HIMALAYAS

While working on the flora of Kinnaur district, Himachal Pradesh, the author came across a few plants of this species growing along the banks of Tangling khud nala at Shongtong and at Kilba. The species was first described by Banerji & Das (loc. cit.) based on materials collected from East Nepal and Assam. Vaid & Naithani (loc. cit.) recently reported its occurrence in Chandanwari (Kashmir) and in New Forest (Dehra Dun). The present report from Shongtong and Kilba, besides being additional information about its distribution in the country, helps to some extent also in bridging the vast discontinuity in its distribution from Assam and East Nepal in the east to Chandanwari at the northwestern limit of the Himalayas. A careful search in the field and in herbaria may provide more data of its distribution elsewhere in the

Himalayas. The data on the distribution available now indicate that the plant has a wide distribution, probably occurring over the entire range of the Himalayas.

This species is often confused with *C. reflexa* Roxb. which it resembles closely. The characters which enable one to distinguish the two species have been dealt with in detail by Banerji & Das (loc. cit.) and Vaid & Naithani (loc. cit.). The figures of the floral parts of the two species in the plate in Banerji & Das (loc. cit. 88) are also very helpful in distinguishing the present species from *C. reflexa* Roxb.

The nomenclature of the plant is as follows :

Cuscuta santapau Banerji & Das in *Journ. Arn. Arb.* 46(1) : 87, 1965 ;
Vaid & Naithani in *Ind. For.* 97(8) : 467-468, 1971.

The plant is usually seen in open situations on the margins of forests. The whole plant is creamy white or hay-coloured when young and turns pale reddish-brown later. The fruits are creamy white when mature ; they also turn pale reddish-brown on ageing. The stem and fruits are dotted with brownish-black spots which are clearly visible even in dried herbarium material.

Specimens examined : HIMACHAL PRADESH : Shongtong, on the banks of Tangling khud nala, alt. \pm 1970 m, 6th October 1971, K. P. Janardhanan 46486, in fls. & frts., parasitic on *Prunus persica* (Linn.) Stokes ; Kilba, hillslope above the Forest Rest House, alt. \pm 2100 m, 10th October 1971, K. P. Janardhanan 46577, in fls. & frts., parasitic on *Desmodium tiliaefolium* G. Don ; Sangla, alt. \pm 2700 m, 25th September 1964, N. C. Nair 34272, in fls. & frts., parasitic on *Desmodium tiliaefolium* G. Don (BSD).

ACKNOWLEDGEMENT

I am thankful to Dr. M. L. Banerji, Reader in Botany, University of Kalyani, Kalyani, for confirming the identity of the above specimens.

BOTANICAL SURVEY OF INDIA,
DEHRA DUN,
September 18, 1972.

K. P. JANARDHANAN

26. PLANT RECORDS FOR MAHARASHTRA STATE
FROM CHANDRAPUR DISTRICT

During botanical explorations of Chandrapur district of Maharashtra State, some interesting plants new to the state were recorded.

In this note the correct nomenclature, diagnostic characters, details of collection and critical notes are given. All the specimens cited here are deposited in the herbarium of the Western Circle, Botanical Survey of India, Poona (BSI).

RUBIACEAE

Hedyotis coerulea Wt. & Arn. Prodr. 412, 1834; Fl. Brit. India 3 : 60, 1880.

An erect herb. *Leaves* linear, sessile, bristle pointed. *Flowers* greenish blue. *Capsules* nearly globose. *Fls. & frts.* : August-December. Rare, on sandy soil. Pamburna, *Malhotra* 123790; Wamanpalli, *Malhotra* 123806.

Gamble (1921) records this plant from eastern coast (Rampa in Ganjam, Nellore to Tanjore) and also South Kanara on West coast. The present record of the species from Chandrapur district (Maharashtra) extends its distribution further north.

CONVOLVULACEAE

Ipomoea sindica Stapf in Kew Bull. 346, 1894; Rolla Rao & Kanodia in Ann. Arid Zone 2(1) : 38, 1963.

A trailing herb. *Leaves* oblong, hastate, acute. *Flowers* light pink. *Capsule* glabrous; seeds velvety. *Fls. & frts.* : August-October. Rare. On coarse soil. Taroba National Park, *Malhotra* 122594 & 122787.

This plant has been earlier recorded from drier parts of Kutch (Gujarat State) and also from Jodhpur division of Rajasthan. Therefore, the occurrence of this plant in such dry deciduous forests of Chandrapur district (Maharashtra) indicates the possibility of locating this taxon in the surrounding deciduous forests and hilly tracts of central India.

EUPHORBIACEAE

Acalypha lanceolata Willd. Sp. Pl. 4 : 524, 1805; *A. fallax* Muell-Arg. in Linnaea 34 : 43, 1865; Hook. f. Fl. Brit. India 5 : 416, 1887.

Annual slender herb. *Leaves* ovate-lanceolate cuncate at the base. *Flowers* pale greenish. *Capsules* longer than the bracts, hispid. *Fls. & frts.* : August-October. Not common, on coarse soil. Taroba National Park, Malhotra 122596.

The present record is interesting, as it links up the earlier known distribution in southern India, namely N. Circars, Deccan and Carnatic to S. Travancore (Gamble 1925) and Central Bengal in the east (Prain 1903). It is quite possible the species might occur in the deciduous forests of Bihar and Orissa.

POACEAE

Arthraxon echinatus (Nees) Hochst. in *Flora* 39 : 188, 1856 ; Bor, Grass. Burma, Ceylon, India and Pak. 99, 1960 ; *A. spathaceus* Hook f. in *Fl. Brit. India* 7 : 145, 1896.

Annual grass. *Spikelets* greenish yellow. Lower glume of sessile spikelet narrowly lanceolate, nerves on back echinulate. *Fls. & frts.* : August-November. Rare, growing along the rocky crevices. Taroba National Park, Malhotra 122823.

This species was recorded by Gamble (1934) from Madras State. The present record extends its distribution further north.

ACKNOWLEDGEMENTS

We are thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona for kindly going through the manuscript and giving constructive suggestions and to the Director, Botanical Survey of India, Calcutta, for providing the facilities.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, POONA-1,
November 30, 1971.

S. K. MALHOTRA
SIRASALA MOORTHY

27. *UTRICULARIA STRICTICAULIS* STAPF FROM BHUBANESWAR—A NEW RECORD FOR ORISSA

Utricularia stricticaulis Stapf (= *U. reticulata* Sm. var. *uliginosa* C.B. Cl.) a species known from south Deccan Peninsula, Bengal and Ceylon, is recorded here for the first time from Orissa. The species is characterised by short scape with basifix scales, linear bracteoles ; suberect pedicels in fruiting, acute, yellow, decurrent calyx, enlarged in fruit, bluish corolla about equalling the calyx ; obovoid, slightly dorsiventrally

compressed capsule; elongate obovoid striated seeds with elongate epidermal cells. The species is closely related to *Utricularia uliginosa* Vahl, *U. graminifolia* Vahl and the African *U. spiralis* Sm. which, however, differ in the seeds or the corolla. Seeds in *U. uliginosa* and *U. spiralis* are globose with isodiametric epidermal cells. *U. graminifolia* differs in twining scapes, larger corolla and the lower corolla-lip and spur exceeding the purplish calyx.

Bhubaneswar, in rice fields, fl. & fr. 22-xii-1971. Saxena 277.

REGIONAL RESEARCH LABORATORY,

H. O. SAXENA

BHUBANESWAR,

January 7, 1972.

28. SOME INTERESTING AND RARE PLANTS FROM MAHARASHTRA STATE

(With four plates)

During botanical explorations in the Phonda-Ambolighat area of Ratnagiri district (Maharashtra State) from the year 1965 onwards, some interesting and noteworthy plants have been collected and are being reported as additions to the Flora of Maharashtra.

The species reported here are not only new records for Maharashtra but also interesting from phytogeographic point of view as these were earlier recorded southwards from North Kanara and the present report shows their wider distribution.

While examining critically the collections from Ratnagiri district, another interesting plant *Polygonum strictum* All. collected from Mahableshwar (Satara district) was also worked out and has been reported in this paper. The collection includes two rare grasses namely, *Bhidea burnisiana* Bor and *Danthonidium gammiei* (Bhide) C. E. Hubbard, obtained in recent explorations in Ratnagiri.

In this paper, correct nomenclature, diagnostic characters of each species, collector's name, field no., habitat as well as critical notes are given.

All the specimens cited in this paper have been deposited in the herbarium of Western Circle, Botanical Survey of India, Poona (BSI).

BORAGINACEAE

Heliotropium cornutum Johnst. in Contr. Gray Herb. Henr. 92 : 90, 1930 ; Fischer in Fl. Mad. Pres. Part 11 : 1883, 1936 ; Arora & Banerjee in Bull. bot. Surv. India 8 : 341-342, 1966.

Prostrate to suberect herb. Flowers white in small helicoid cymes.

Rare, as a weed, in the rice fields in association with *Heliotropium scabrum* Retz. and *Coldenia procumbens* Linn.

Arora & Banerjee (loc. cit.) reported this plant as endemic to South Kanara (Mysore State). The present collection is an extension of distribution further north along the Western Ghats and is also a new record for Maharashtra.

Specimens examined. Ghotge, Kudal taluka, Kulkarni 107868.

SCROPHULARIACEAE

Bacopa floribunda (R. Br.) Wettst. in Engl. & Prantl Pflanzenfam. 4(3b) : 77, 1895. *Herpestis floribunda* R. Br. Prodr. 442, 1810 ; Hook. f. Fl. Brit. Ind. 4 : 273, 1884. *Moniera floribunda* Cooke, Fl. Bomb. Pres. 2 : 286, 1904.

A delicate erect herb, 8-10 cm tall. Flowers pedicellate. Capsules long, subglobose. Seeds oblong, truncate at both ends.

Rare, on wet sandy soil associated with *Cyanotis* sp.

Cooke (loc. cit.) states 'The occurrence of this plant in the Bombay Presidency is somewhat doubtful. Woodrow reports its occurrence from S. Kanara. Law has in his Herbarium Kew, specimens from Kanara and Mysore and of these the Kanara ones are most probably also from S. Kanara'. The present records show extension of distribution through Goa (Rolla Rao 1969, unpublished).

Specimens examined. Deobag, Malvan, Kulkarni 121336.

POLYGONACEAE

Polygonum strictum All., Auct. Syn. 42, 1773 et Misc. Taur. 5 : 94, 1774-76 ; Wt. Icon. t. 1800, 1852 ; Dandy in Taxon 19(4) : 623, 1970. *P. minus* Huds. Fl. Angl. 148, 1762 ; Meissn. in DC. Prodr. 14 : 111, 1857 ; Hook f. Fl. Brit. Ind. 5 : 36, 1886 ; Gamble Fl. Mad. Pres. Part 7 : 1189, 1925.

Annual herb, rooting at nodes. Stipules sparsely strigose, ciliate. Flowers, minute, pink. Bracts stiff, ciliate on the margins. Perianth eglandular.

Rare, in water logged soil.

This species has been earlier reported from Nilgiris and Palni hills in south India. This report is an extension of distribution and a new record for the State,

Specimens examined. Near lake, Mahableshwar, *Ansari* 67688.

POACEAE

Coelachne simpliciuscula (Wt. & Arn.) Munro & Benth. in Journ. Linn. Soc. Bot. 19 : 93, 1881 ; Bor, Grass. Burma, Ceylon, India, Pak. 576, 1960. *Coelachne pulchella* R. Br. var. *simpliciuscula* Hook. f. Fl. Brit. Ind. 7 : 270, 1896 (non R. Br. 1810).

Suberect or trailing annual grass. Spikelets in speciform panicles, with short usually ascending branches.

Rare, near the streams or nallahs in association with *Centella asiatica* (L.) Urban.

This species has been reported from South Kanara downwards from an altitude of 600-1825 m. Of late, it has also been collected from Londa in Belgaum district (Mysore State) by the Botanical Survey of India. The present record is a northward extension of its range.

Specimens examined. Solia jungle, Chaukul (10 km from Ambolighat), *Kulkarni* 108631 ; Londa, *Ansari* 78597.

Dimeria hohenackeri Hochst. ex Miq. in Verh. Nederl. Inst. 3 : 35, 1851 ; Bor, Grass. Burma, Ceylon, India, Pak. 142, 1960. (Plate I).

Annual grass, 20-30 cm high, golden yellow. Spikelets parallel to rachis, delicate.

Rare, on rocky plains in association with *Dimeria stapfiana* C. E. Hubb. and *Cyperus* sp.

This species is distinguished from other closely allied species, namely *D. stapfiana* on the basis of parallel arrangement of spikelets on the rachis.

Bor (loc. cit.) mentions this species as endemic to Mangalore (Mysore State). There is every possibility of its occurrence between Mangalore and Ambolighat but it has escaped the attention of botanists so far. Besides being a distributional record, the present report is also a new record for Maharashtra.

Specimens examined. Mangaon, *Kulkarni* 106428.

Dimeria woodrowii Stapf in Hook. Icon. Pl. sub tab. 2312, 1894 ; Bor, Grass. Burma, Ceylon, India, Pak. 144, 1960. (Plate II).

Annual grass. Spikelets awned. Rachis of each raceme coiled into a hoop.

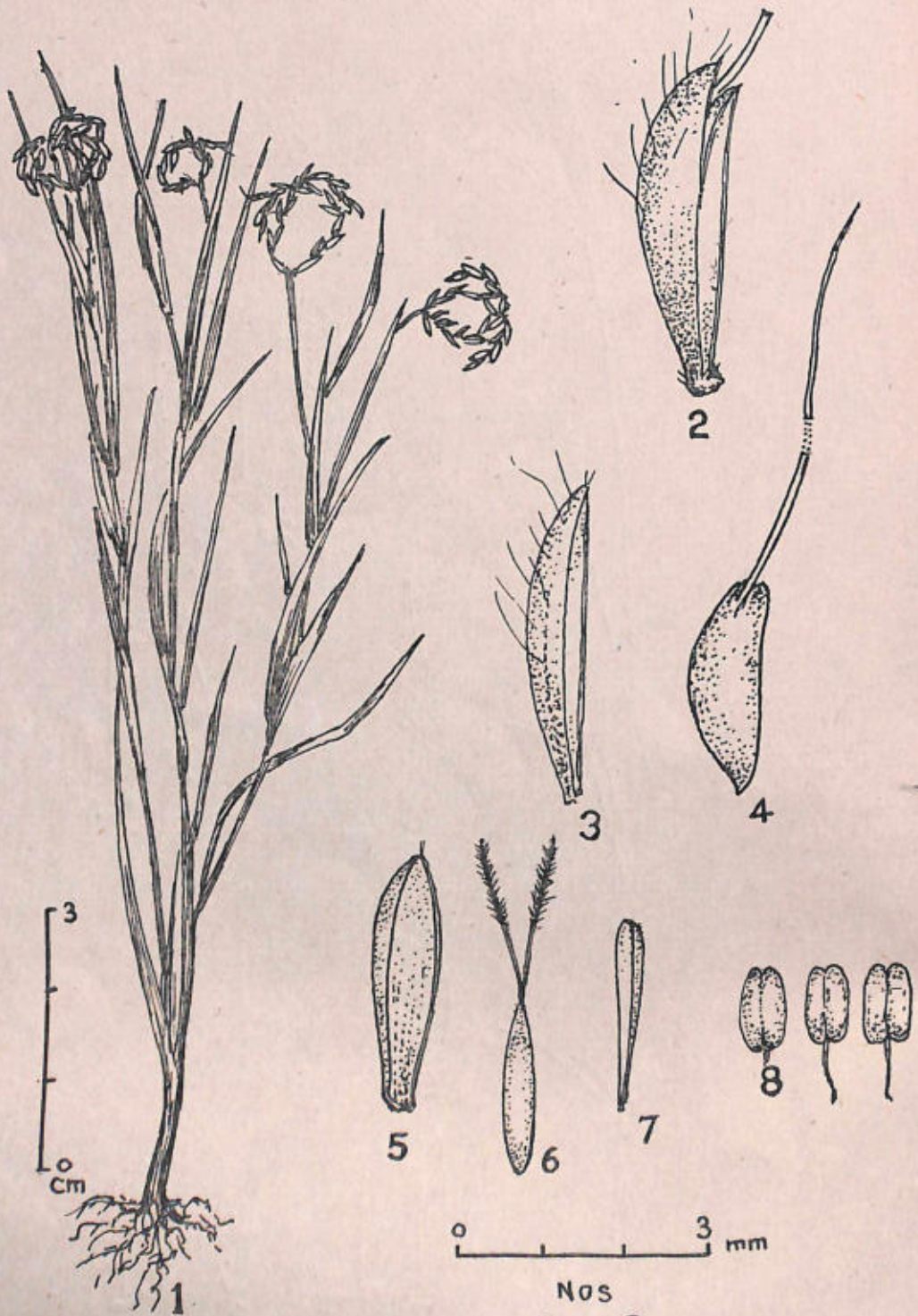
Kulkarni & Wadhwa : Plants from Maharashtra



Dimeria hohenackeri Hochst. ex Miq.

1. Whole plant ; 2. Spikelet ; 3. Upper glume ; 4. Upper lemma ;
5. Lower lemma ; 6. Lower glume ; 7. Stamens ; 8. Ovary with style
and stigma.

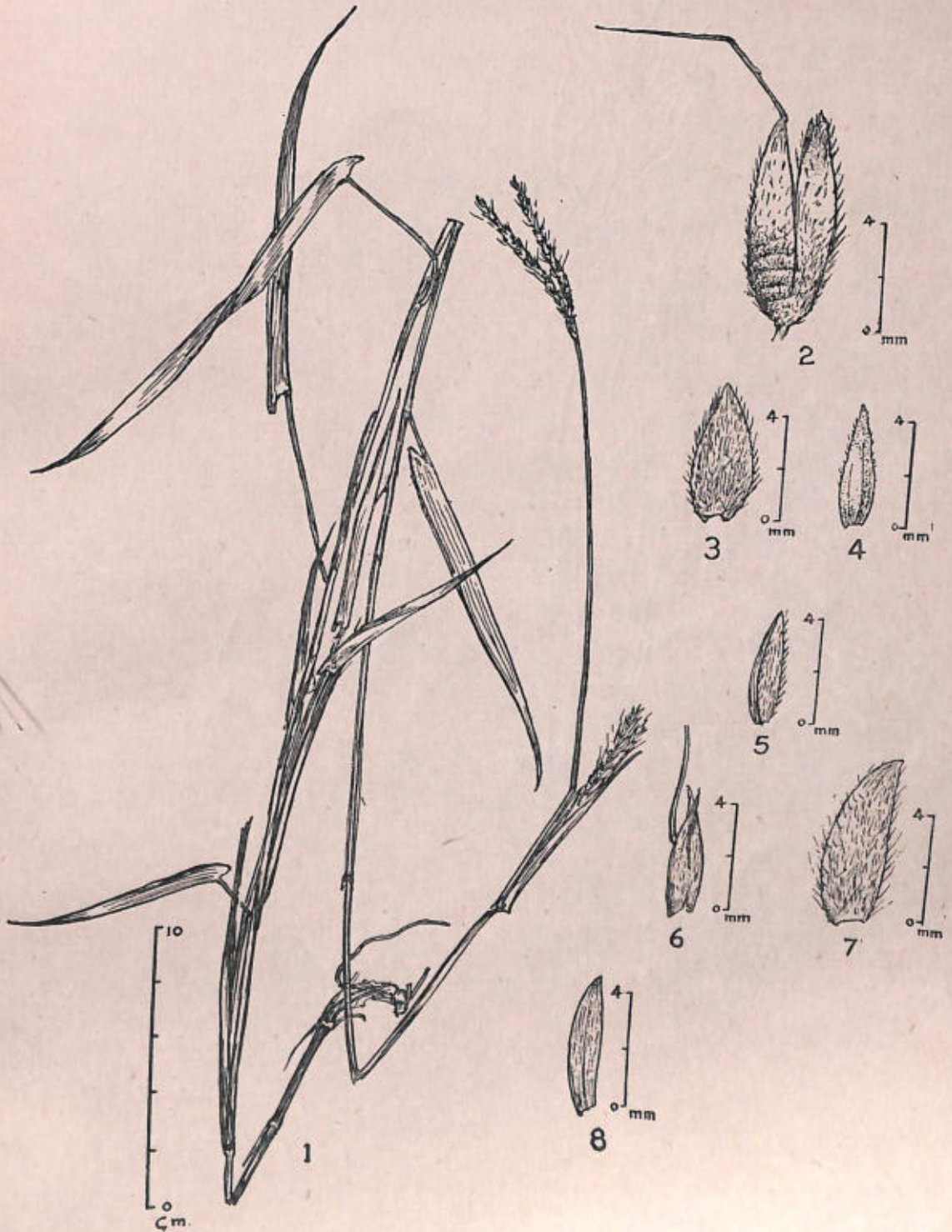
Kulkarni & Wadhwa : Plants from Maharashtra



Nos
2 - 8

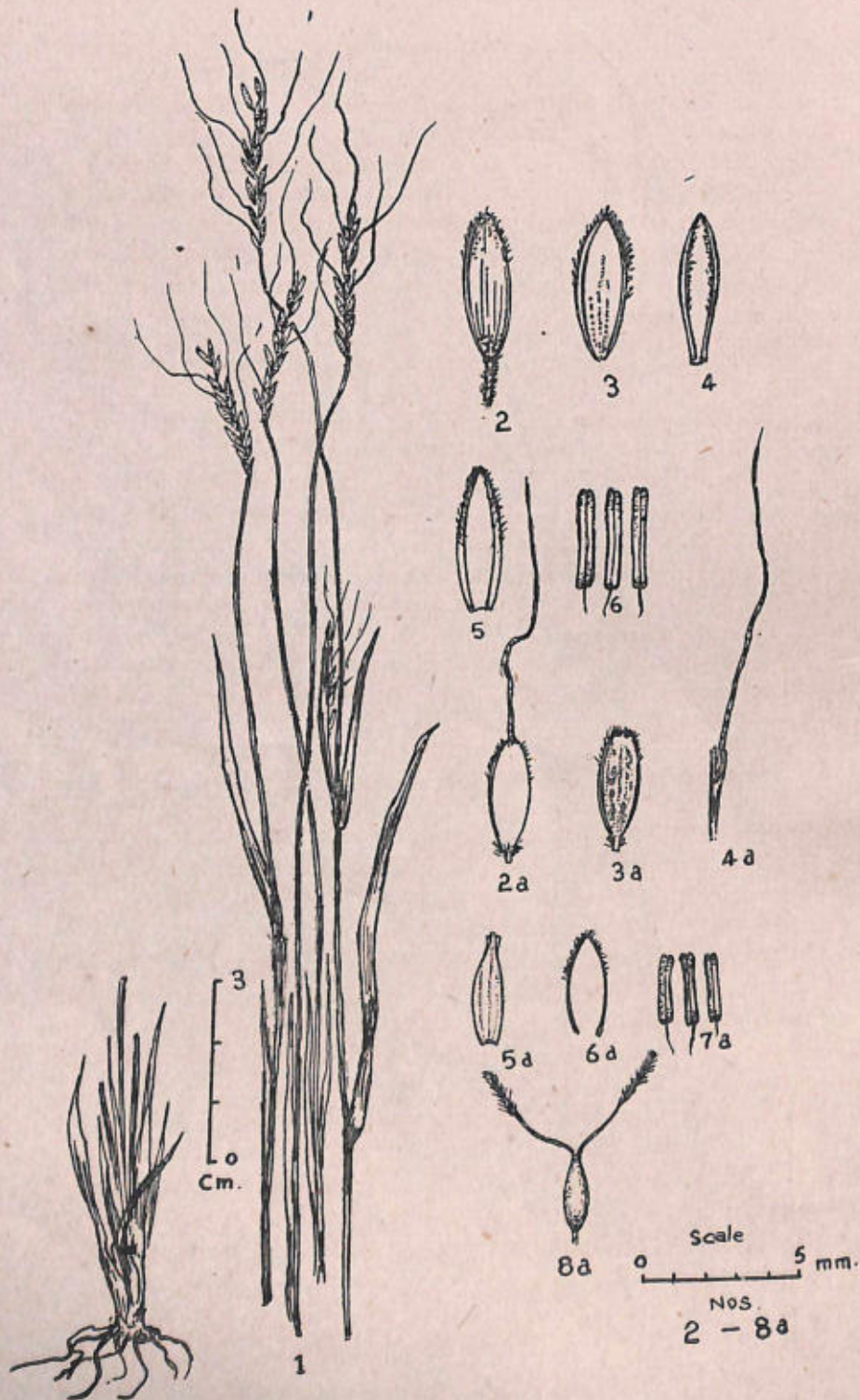
Dimeria woodrowii Stapf

1. Whole plant; 2. Spikelet; 3. Upper glume; 4. Upper lemma; 5. Lower glume; 6. Ovary with style and stigma; 7. Lower lemma; 8. Stamens.



Ischaemum dalzellii Stapf ex Bor

1. Whole plant; 2. A pair of spikelets. *Sessile Spikelet*; 3. Lower glume (dorsal view); 4. Upper involucre glume; 5. Lower lemma (ventral view); 6. Upper lemma. *Pedicelled spikelet*; 7. Lower glume; 8. Upper glume.



Schizachyrium paranjpeanum (Bhide) Raiz. et Jain

1. Whole plant; 2. Pedicelled spikelet; 3. Lower glume (ventral view);
 4. Upper glume; 5. Lower lemma; 6. Stamens.
 2a. Sessile spikelet; 3a. Lower glume; 4a. Upper lemma; 5a. Upper
 glume; 6a. Lower lemma; 7a. Stamens; 8a. Ovary with style and stigma.

Common, on rocky plateau in association with *Manisuris goaensis* Rolla et Hem. and *Ischaemum* spp.

Talbot No. 2557 (type sheet) cited by Bor (loc. cit.) from Bombay is actually not from Bombay, but from Goa (Marmagao, collected on October 15, 1891) as per locality given on the isotype available in herbarium of Western Circle, Botanical Survey of India, Poona. The new report is the second collection after a lapse of 79 years from an adjoining area of the type locality.

Specimens examined. Adari-Nandruk, Malwan, Kulkarni 121287.

Ischaemum dalzellii Stapf ex Bor in Kew Bull. 1951 : 448, 1952 ; Bor, Grass. Burma, Ceylon, India, Pak. 178, 1960. (Plate III).

A robust grass up to 1 m tall. Lower leaves petiolate, hastate at base of lamina. Joints of the racemes linear-clavate ; lower spikelets often hairy.

Rare, on rocky plateau along with *Ischaemum pilosum* (Klein ex Willd.) Wt., *I. timorense* Kunth. and *Schizachyrium paranjpeanum* (Bhide) Raiz. & Jain.

This species has so far been collected from North Kanara (type locality). The present report indicates its extension further north into Ratnagiri district.

Specimens examined. Ambolighat, Kulkarni 106369A.

Schizachyrium paranjpeanum (Bhide) Raiz. & Jain in Proc. Ind. Sci. Congr. Abst. Part 3 : 130, 1953 ; Bor, Grass. Burma, Ceylon, India, Pak. 216, 1960. *Andropogon paranjpeanum* Bhide in J. Proc. Asiat. Soc. Beng. (n.s.) 7 : 514, 1911. (Plate IV).

Annual tufted, delicate grass. Spikelets in long exerted racemes from the subtending sheaths.

Rare, on open rocky plateau of Ambolighat Reserve Forest in association with *Ischaemum pilosum* (Klein ex Willd.) Wt. and *Ischaemum dalzellii* Stapf ex Bor.

Bor (loc. cit.) states that this species is probably endemic to Castlerock (North Kanara district, Mysore State). The present report indicates its extension of distribution and is a new record for Maharashtra. Besides, this species is extremely rare from the fact that it is collected after a lapse of 56 years. The last collection (type material) was made in 1909, by R. K. Bhide from Castlerock.

Specimens examined. Ambolighat, Kulkarni 106365.

ACKNOWLEDGEMENTS

We are thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona, for kindly going through the manuscript and giving constructive suggestions and to the Director, Botanical Survey of India, Calcutta for providing the necessary facilities.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
7-KOREGAON ROAD, POONA-1,
January 1, 1972.

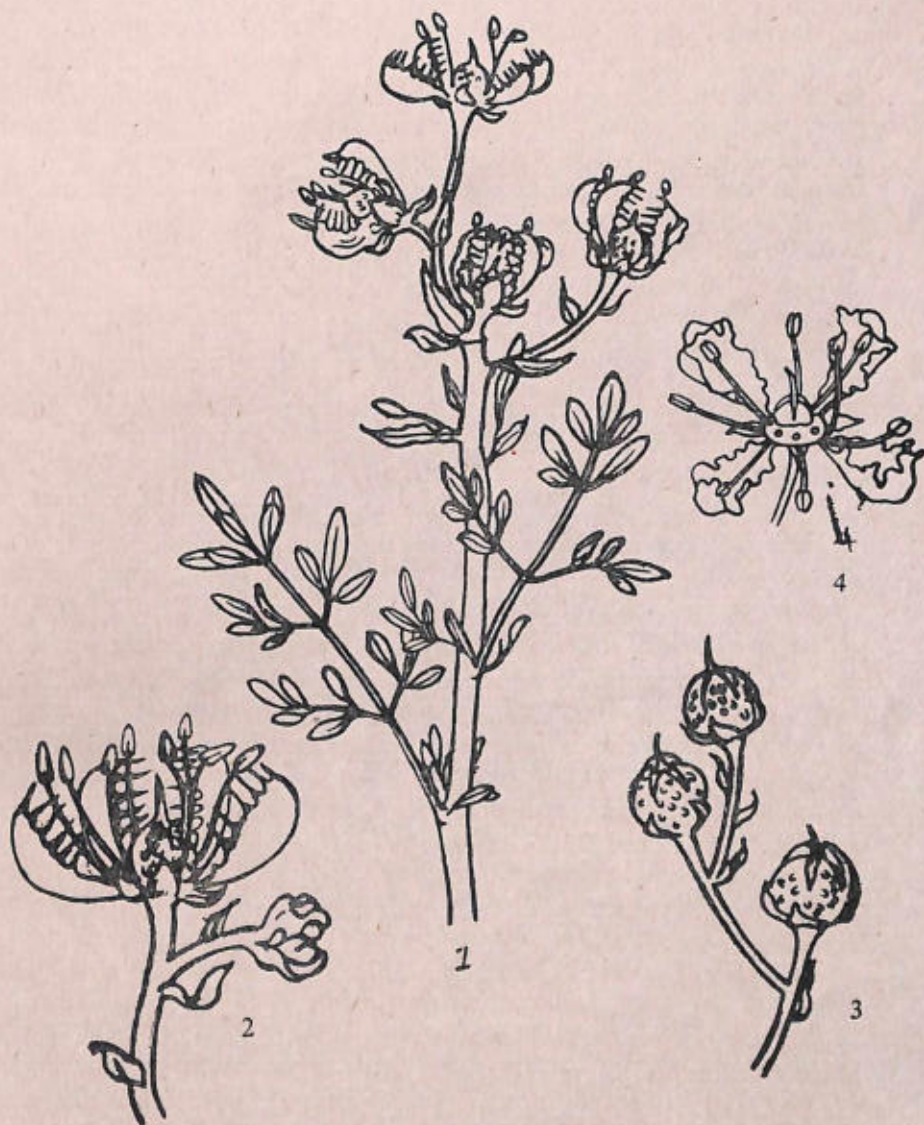
B. G. KULKARNI
B. M. WADHWA

29. ON THE OCCURRENCE OF *RUTA CHALEPENSIS* LINN.
IN INDIA

(With a plate)

While reviewing the literature on the species of *Ruta* Linn. for the WEALTH OF INDIA, a Dictionary of Indian Raw Materials, published by the Council of Scientific & Industrial Research, some doubts were cast on the identity and nomenclature of the plant reported from India. Hooker in FLORA OF BRITISH INDIA, recorded under the name *R. graveolens* Linn. var. *angustifolia* Hook. f. (syn. *R. angustifolia* Pers. and *R. chalepensis* Wall., Cat. 7113), a plant said to be introduced and cultivated in India and comprising one or more forms. He seems to have considered the Indian plant as a variety, on the basis of the floral petals having ciliated margins, a feature by which *R. angustifolia* Pers. and *R. chalepensis* Linn. have been distinguished from *R. graveolens*: in *R. graveolens* the petals have wavy or slightly dentate margins. All the subsequent Indian works mentioned the plant as *R. graveolens* var. *angustifolia*, or as *R. graveolens*, and attributed many of the economic properties known mostly for *R. graveolens* to the Indian plant. Some reproduced along with their account, also a figure of *R. graveolens* redrawn evidently from European sources. In the figures reproduced, the petals of the flower are clearly shown to have wavy or slightly toothed margins so characteristic of *R. graveolens* and not ciliated as recorded for the Indian plant in FLORA OF BRITISH INDIA (Vol. I, pt. 3, p. 485).

According to recent European works, such as FLORA EUROPEAN, vol. 2, p. 227; 1968, the three species mentioned above, namely *R. graveolens*, *R. chalepensis* and *R. angustifolia* are considered distinct from one another, differing in their floral characters. *R. graveolens* is distinguished from the latter two, in having the petals with more or less wavy or denticulate



1. *Ruta chalepensis* Linn. flowering branch ($\times 2$).
2. Flower showing the ciliated margins of petals ($\times 2$).
3. Fruiting branch showing the sharply pointed lobes ($\times 2$).
4. *Ruta graveolens* Linn. flower showing the denticulate margins of petals (Redrawn from Bentley and Trimen).

margins (Fig. 4), while *R. chalepensis* and *R. angustifolia* are similar to each other, in having petals with ciliated margins, i.e. with long, conspicuous, upstanding, tooth-like hairs (Fig. 1 and 2). Further in *R. graveolens* the capsules are reported to have somewhat rounded lobes, while in the other two, the capsules have sharply pointed lobes (Fig. 3). Between *R. angustifolia* and *R. chalepensis*, the former is said to differ from the latter, mainly in the marginal hairs being as long as the width of the petals and the bracts not broader than the subtending branch. However, according to some authorities, (Chittenden 1951, Uphof 1968) *R. angustifolia* is considered as a synonym of *R. chalepensis* or only as a variety, *R. chalepensis* Linn. var. *angustifolia* (Pers.) Wilke et Lange (Mansfeld 1959).

While dealing with *R. graveolens* in Malaya, Burkill (1935) stated, that *R. graveolens* seems to have spread into India overland at no very distant date and 'the Rue has been adopted so thoroughly in India that, in some parts such as Bombay, it is planted in almost every garden.' In order to confirm whether the plants are still grown in Bombay, fresh specimens were obtained from Poona and Bombay, through the courtesy of Prof. V. S. Rao, Ramnarain Ruia College, Matunga, Bombay. An examination of the floral parts showed that the plant commonly grown in Bombay and Poona agreed closely with the description of *R. chalepensis* Linn. rather than with *R. graveolens* or even var. *angustifolia*. Fresh plants obtained from other centres also, namely Bangalore, Coimbatore and Banaras, all appeared to be of *R. chalepensis* and not of *R. graveolens*. All of them had hairs on the margin of their petals, but not as long as reported for *R. angustifolia*; none of them had denticulate or wavy margins, characteristic of *R. graveolens*. As far as present enquiries indicate, all the plants examined from various centres in India appear to be of *R. chalepensis* Linn. Although it is not improbable that *R. graveolens* may be grown in some places, its record in India could not be confirmed at present.

Besides the differences in the floral characters mentioned already between *R. graveolens* on one hand and *R. chalepensis* and *R. angustifolia* on the other, there is also a difference in their chromosome number (Darlington & Wylie 1965). *R. chalepensis* is reported to have $X=36$ chromosomes, while *R. graveolens* has $X=72$ or 81. The characteristics of the essential oil obtained from the two species are also known to differ in detail (Guenther 1952). Oil distilled from *R. graveolens* is said to contain chiefly methyl nonyl ketone, while oil from *R. chalepensis* (syn. *R. bracteosa* DC.) contains chiefly methyl heptyl ketone.

The plants received recently from various places are all reported to be cultivated and used for the same purpose for which *R. graveolens* is reputed, although as shown above they truly belong to *R. chalepensis*. While it is not improbable the plants may possess all those attributes,

no actual investigation has been made either of the chemical constituents or the medicinal properties of the Indian material. This note has been written mainly to bring to the notice of Indian scientists the need for a detailed investigation of the Indian material.

ACKNOWLEDGEMENTS

Our thanks are due to Prof. V. S. Rao (Bombay), Dr. M. H. Marigouda (Bangalore), Dr. Daniel Sundararaj (Coimbatore) and Dr. R. S. Singh (Banaras), for their ready response in sending fresh specimens from their localities and to late Sri S. Jayaram Sharma for preparing the illustrations. Our thanks are also due to Sri A. Krishnamurthi, for his interest.

PUBLICATIONS & INFORMATION
DIRECTORATE, CSIR,
NEW DELHI-12,
December 12, 1970.

K. R. RAMANATHAN
KAMALA RAMACHANDRAN

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Notes and News

Symposium on Ecological Studies in the Gir Wildlife Sanctuary

Under the auspices of the Bombay Natural History Society, World Wildlife Fund—India, and the Indian Board for Wildlife, a symposium on ecological studies in the Gir Wildlife Sanctuary was held at the India International Centre, New Delhi, on 17th November 1972. Paul Joslin of the University of Edinburgh, K. T. B. Hodd of Aberdeen University, and S. H. Berwick of Yale University, all of whom had studied some aspect or other of the Gir Forest ecosystem were invited to participate in the symposium.

Zafar Futehally, introducing the speakers to the audience referred to the special responsibility of conservationists towards fostering good international relationships, 'for the simple reason that nature respects no man made boundaries and we cannot do better than follow her wise example'.

Paul Joslin summarised some of the important reasons for the present decline in the lion population in Gir forest. The lion's habitat in the Gir forest has been considerably reduced in the last few decades by human encroachment, and this has reflected on the number of lions since they are territorial animals.

The population of domestic livestock living permanently inside the Sanctuary as well as the migrant cattle which come during the rains has had a strong impact on the feeding habits of the lion. Domestic buffaloes and cattle now far outnumber the natural prey species of the lion. An analysis of 500 lion droppings showed remains of 75% domestic animals and 25% wild animals. While studying the lion kills in the Sanctuary Joslin found that 24% of the kills were not consumed by lions. This was largely due to human interference, as fifty per cent of the kills were appropriated by local harijans for hide and meat and this operation disturbed the lions. Incidentally I was concerned with the study of the ecology and behaviour of vultures in the Gir and I found that the remains of most of the lion kills visited by harijans were consumed by vultures. The reasons were: (1) by dragging out the kills from dense cover to the open the harijans helped vultures to spot the carcasses much more easily; (2) by chasing away the lions they enabled vultures to come down and feed fearlessly, and (3) by skinning the kills they made it possible for vultures to clean up the carcasses in minutes.

K. T. B. Hodd's research was aimed at finding out how the lion habitat was changing because of grazing by domestic livestock, and to investigate ways to prevent the habitat from further deterioration. He studied some aspects of the domestic animals' impact on the lion's habitat, namely the effects of domestic animals on the grass and forbes, the effects of domestic animals and their graziers on the capacity of the

forest trees to regenerate naturally and the effects of domestic animals on the structure of the soil.

His significant findings were :

1. There are about four times as many domestic animals as can be safely allowed to graze in the Gir. This has resulted in overgrazing and trampling of the soil, which in turn has inhibited the growth of grass.

2. Trampling has begun to destroy the porosity of the Gir soil, which is essential for productivity. Also exposure of the soil due to overgrazing has resulted in heavy soil erosion which is detrimental to the flora. By reducing the number of cattle to the optimum it is possible to recover the porosity and fertility of the soil. One of Hodd's recommendations was a rotational grazing system for the domestic livestock, involving splitting of the grazing lands around each ness into three equal parts and allowing the livestock to graze in one part for only four months a year.

S. H. Berwick studied the habitat relationships, numbers and distribution of wild ruminants of the Gir forest. He estimated about 6,800 wild ungulates in the Gir as against the 30,000 or more of the domestic buffaloes and Zebu cattle which graze within the sanctuary. The wild ungulates are the chital, sambar, nilgai, fourhorned antelope, chinkara and wild boar. Food preferences of domestic and wild ruminants for various plant species were studied by observing free-ranging animals. Additional data on this was collected from feeding choice experiments using captive animals, from feeding choices of captive leashed animals in the field, from analysis of rumen contents of animals recovered in the field, and from identification of microscopic plant fragments in fecal pellets of free-ranging wild ruminants. Other studies included energy flow and balance of nature in the Gir ecological system. He found that up to 90% of the annual production of grasses is removed primarily by domestic livestock and this constitutes a serious imbalance between vegetative production and grazing. Also much of the energy and nutrients cycled through domestic stock is lost to the Gir ecosystem because of the removal of dung and butter for use outside the Sanctuary.

Since the researchers had not yet fully analysed their data they did not submit written papers at the symposium but papers will be published when ready.

After the talks by the three researchers, Shri Dharmakumarsinhji led a floor discussion in which many members of the audience participated.

ROBERT B. GRUBH

Gleanings

India a Hundred Years ago

'The lion, which was long supposed to be unknown in India, is now ascertained to exist in considerable numbers in the districts of Saharanpur and Ludhiana. Lions have likewise been killed on this side of the Ganges, in the northern parts of Rohilkhand, in the neighbourhood of Moradabad and Rampur, as large, it is said, as the average of those in the neighbourhood of the Cape of Good Hope. Both lions, where they are found, and tigers, are very troublesome to the peoples of the villages near the forest, who, having no elephants, have no very effectual means of attacking them with safety. The peasantry here, however, are not a people to allow themselves to be devoured without resistance, like the Bengalees, and it often happens that, when a tiger has established himself near a village, the whole population turns out, with their matchlocks, swords, and shields, to attack him. Fighting on foot and compelled to drive him from his covert, by entering and beating the jungle, one or two generally lose their lives, but the tiger seldom escapes; and Mr Boulderson¹ has seen some skins of animals of this description, which bore the strongest marks of having been fought with, if the expression may be used, hand to hand; and were in fact slashed over with the cuts of the "talwar" or short scimitar. A reward of four rupees for every tiger's head brought in, is given by Government; and if the villagers of any district report that a tiger, or lion, is in the neighbourhood, there are seldom wanting sportsmen among the civil or military officers, who hear the news with pleasure, and make haste to rid them of the nuisance. A good shot, on an elephant, seldom fails, with perfect safety to himself, to destroy as many of these terrible animals as he falls in with.' (INDIA A HUNDRED YEARS AGO, by Bishop Heber, D.D. First published by Longmans in 1927).

¹ Collected in 1824-5 of what are now Shahjehanpur and Pilibhit districts.—Eds.

Announcement

Sálim Ali/Loke Ornithological Research Fund

The Fund has been established by the *Bombay Natural History Society* with the object of promoting scientific ornithology and bird preservation in India.

Monetary assistance will be given to biologists, whether graduates or not, preferably between the ages of 20 and 30 years and preferably resident within the Indian sub-Region, desirous of undertaking research projects approved by the Executive Committee of the Society.

Assistance may take the form of small grants, either a lump *ad hoc* sum or tenable over a specified period. Details of the problem intended to be followed should be submitted to the Honorary Secretary, along with particulars of the candidates qualifications to undertake the study and details of the financial assistance required.

Research Fellowships may be granted for more serious problems extending over a long period. The rules relating to the Fellowships may be obtained from the Honorary Secretary.

Charles McCann Vertebrate Zoology Field-Work Fund

This Fund originated in 1972 in a grant Rs. 14,398.55 made by Mr. Humayun Abdulali, being the unspent balance of a sum of Rs. 20,000 paid by him towards the expenses of three natural history expeditions to the Andaman and Nicobar Islands, reports of which have appeared in the pages of the *Journal*. In 1972 at the instance of Mr. Humayun Abdulali the Fund was given its present name in honour of Mr. Charles McCann (at present in New Zealand), Assistant Curator of the Society from 1922 to 1947, who during his stay in India made several notable contributions to our knowledge of the botany and zoology of the Indian Region. Recently the Society has received a generous contribution of Rs. 2,500 towards the Fund from Shri Fatehsingh Rao Gaikwad of Baroda. Further contributions will be welcome. Persons wishing to avail themselves of help from the Fund should apply to the Honorary Secretary, giving particulars of the proposed field-work and the extent of the help required.

THE SOCIETY'S PUBLICATIONS

Mammals

- The Book of Indian Animals, by S. H. Prater. 3rd (revised) edition. 2 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 30
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- The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett Rs. 10

Birds

- The Book of Indian Birds, by Salim Ali. 9th (revised) edition. 66 coloured and many monochrome plates. Rs. 25
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- Checklist of the Birds of Maharashtra, by Humayun Abdulali. Rs. 2.50
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- Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. Rs. 5

Miscellaneous

- Picture Postcards of 12 representative Indian Birds (In colour) per set Rs. 2.50
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- Back numbers of the Society's Journal. Rates on application.

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Lytton Lodge, Codicote, Near Hitchin,
Herts, England.

The Society will gratefully accept back numbers of the *Journal*, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 (25p.) and a life membership fee of Rs. 600 (Inland), £45.50 (Foreign).

Ordinary Members pay an entrance fee of Rs. 5 (25p.) and an annual subscription of Rs. 36 (Inland), £3 (Foreign).

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £3.00 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 23 Fenchurch Street, London E.C. 3.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.



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