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FOOD HABITS OF SLOTH BEAR IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU, SOUTHERN INDIA[1]

BASKARAN, N[2], N. SIVAGANESAN[3], AND J. KRISHNAMOORTHY[4]

(*With two text-figures*)

Key words: India, sloth bear (*Melursus ursinus*), diet, fruiting seasonality

The food habits of sloth bear (*Melursus ursinus*) were studied in Mudumalai Wildlife Sanctuary, Tamil Nadu by analysing 567 fresh scats from five different habitat types between March, 1990 and February, 1991. Fruit was the major food, irrespective of vegetation types. Ants and termites appeared consistently in the diet. The percent occurrence of various diet items varied seasonally. Animal material dominated the second wet season. The fruits of *Syzygium cumini*, *Cassia fistula* and *Ziziphus mauritiana* formed the dominant diet component in most of the habitats. Utilization of plant and animal materials differed significantly between seasons. Though density of fruit trees varied across vegetation types, use of fruits did not, except in the thorn forest. There was no variation in the use of animal materials between vegetation types. Availability of ripe fruits varied significantly between seasons and therefore utilization.

INTRODUCTION

Among the four species of bears in India the sloth bear (*Melursus ursinus*) is the most widely distributed, ranging from the foot hills of the Himalayas to the southern end of the Western Ghats. However, its range is shrinking and population declining in many parts of its range due to the loss and deterioration of habitat (Johnsingh 1986). Poaching for its gall bladder, used in traditional medicines in south Asian countries, is also a serious problem (WWF, Conservation Year Book 1985-86). Sporadic attacks on humans by the bear has also created fear and animosity among the public in many areas of its range.

The Sloth bear is included in Schedule I of the Indian Wildlife Act 1972 (Amended 1991) and Appendix II of CITES (Servheen 1991). Very little is known about the ecology of the species, the only study being by Laurie and Seidensticker (1977) in the Royal Chitwan National Park, Nepal. Other information is anecdotal, or based on surveys and natural history observations (Prater 1965, Schaller 1967, Spillet 1967, Krishnan 1972, Davidar 1983). The study was carried out to determine food habits of the sloth bear in the tourism zone of Mudumalai Wildlife Sanctuary, South India from March, 1990 to February, 1991.

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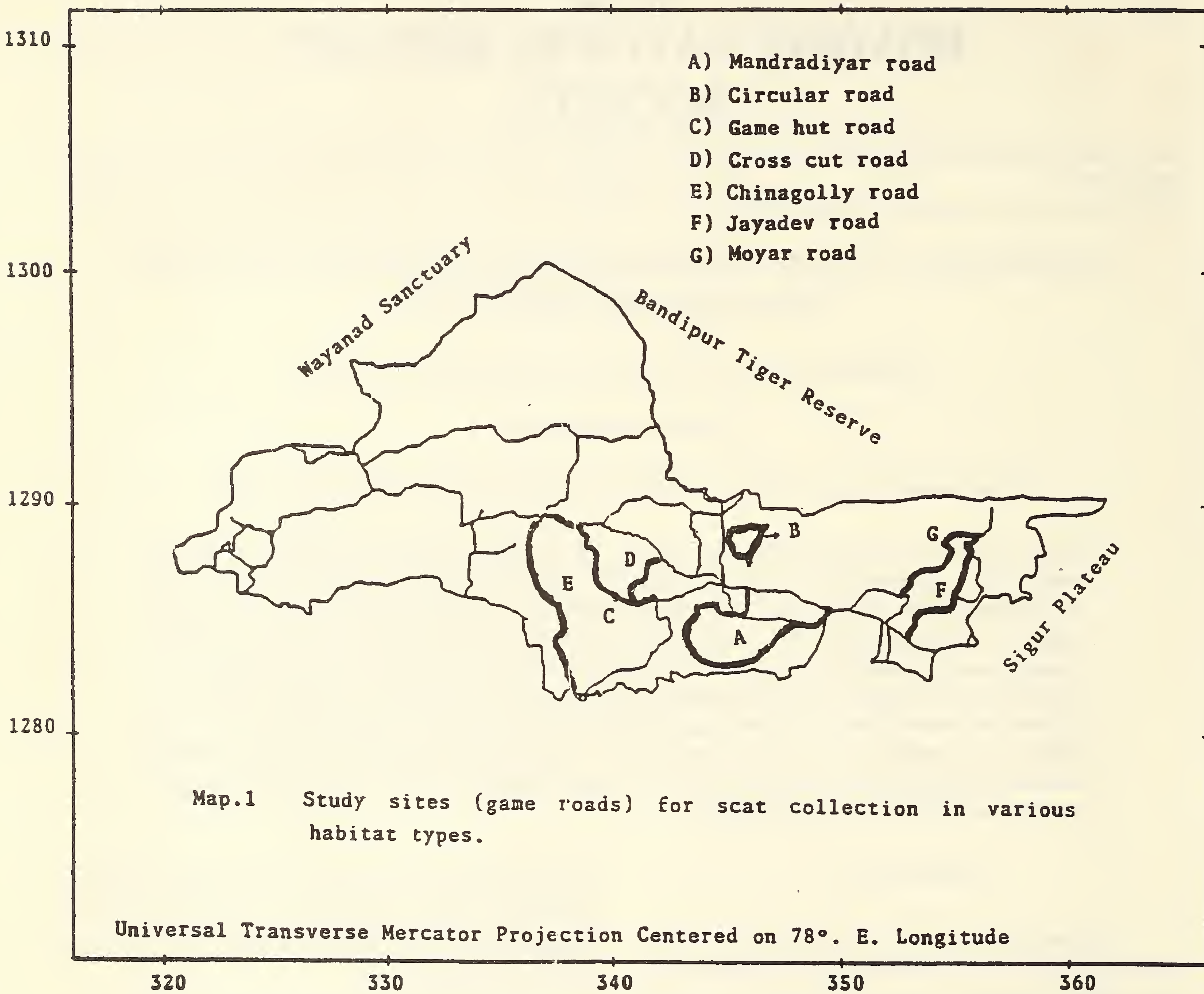
[2]Bombay Natural History Society, Asian Elephant Project, Kargudi, Nilgiris, 643 211.

[3]Sálim Ali Centre for Ornithology and Natural History, Coimbatore, 641 010.

[4]Division of Wildlife Biology, A.V.C. College, Mannampandal, Mayiladuthurai, 609 002.



Map.1 Study sites (game roads) for scat collection in various habitat types.

Fig. 1. Map of Mudumalai wildlife Sanctuary showing game roads used for scat collection.

Study Area

The Mudumalai Wildlife Sanctuary is situated (11° 30' N to 11° 39' N and 76° 27' E and 76° 43' E) in the Nilgiri District of Tamil Nadu and forms a part of the Nilgiri Biosphere Reserve (Fig. 1).

Most of the area has a gentle undulating terrain with elevation ranging from 920 to 1020 m. The temperature varies from 14°-17°C in December and January to 24°-33°C in March, April and May. Average annual rainfall varies from 900 mm to 1800 mm with most of the rainfall from the southwest monsoon (June to August) followed by the northeast monsoon (October to November). Based on the rainfall, three seasons can be identified: first wet season (May to August), second wet season (September to December) and dry season (January to April). Moyar, a perennial river which flows along the eastern boundary, drains the area.

The study area harbours a spectacular mammalian community consisting of Elephants (*Elephas maximus*), Gaur (*Bos gaurus*), Sambar

(*Cervus unicolor*), Chital (*Axis axis*), Barking deer (*Muntiacus muntjak*), Mouse deer (*Tragulus meminna*), Fourhorned Antelope (*Tetracerus quadricornis*), Common Langur (*Presbytis entellus*), Bonnet Macaque (*Macaca radiata*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Striped Hyena (*Hyaena hyaena*) and Dhole (*Cuon alpinus*).

We conducted field work from March, 1990 to February, 1991 in the tourism zone of the sanctuary, which is approximately 100 sq. km in extent. The study area comprises five broad vegetation types; dry deciduous short grass forest (DSG), dry deciduous forest (DDF), dry deciduous tall grass forest (DTG), moist mixed deciduous forest (MMF) and thorn forest (TFT). The thorn forest is degraded due to cattle grazing. These vegetation types are located close to each other, except the thorn forest which is located on the eastern boundary of the sanctuary. Therefore, scat collection from each of the vegetation types does not really reflect the diet of the bear with regard to habitat, except for the thorn forest. Detailed descriptions of these habitats have been given by Sivaganesan (1991).

Methods

Food habits

The food habits of sloth bear were studied by examining scats (Landers *et al.* 1979, Maehr & Brady 1984). Scats were collected from the game roads every fortnight. Game roads such as Mandradiyar Avenue in DSG areas, Circular road in DDF, Game hut and Cross cut roads in DTG, Chinagolly road in MMD and Jayadev and Moyar road in TFT were chosen for scat collection and vegetation studies (Fig. 1). In addition five unused watch towers frequented by bears for resting, especially during the wet seasons, were also visited periodically for scat collection.

Fresh scats were collected and preserved in 10% formalin for further examination. Each scat mass was immersed in a plastic tray containing water and food materials were segregated visually. Remains of ants and beetles were also segregated. Wax and bee remains in the scats were considered as evidence of a honey diet by the bear. Seeds of various fruit trees were also segregated from the scats up to species level. All the segregated food items were kept in a hot air oven at 60°C and later weighed separately.

Diet composition was estimated in terms of percent occurrence (number of times each food item appeared in the diet/total number of scats) and percent dry weight (dry weight of individual food item/total dry weight of all food items). Variation with regard to diet composition was estimated for three seasons; first wet (May to August), second wet (September to December) and dry seasons (January to April).

To assess fruiting seasonality and availability a total of 10 individuals of each species of important fruit trees: *Cassia fistula, Cordia domestica, Grewia tiliaefolia, Syzygium cumini,* and *Ziziphus mauritiana* were marked permanently and monitored fortnightly. Phenological phases such as vegetative phase; sprouting, young and mature leaves and reproductive phase; flowers, unripe and ripe fruits were assessed independently by giving percentage rating for each of them (Guy *et al.* 1979, Riper 1980).

Variation in the availability of fruits among seasons and habitats was tested by Two way-ANOVA. The relationship between fruit availability and utilization by the bear was tested with Pearson correlation co-efficient (r).

Density and diversity of trees

Density of trees of > 20 cm GBH (girth at breast height) was estimated using varying lengths of belt transects with 10 m width on either side of the game roads. Species name and GBH for all trees were recorded from the transects. We quantified density of food trees to determine relative proportion of fruit trees available to sloth bear in each habitat.

Results

Overall dietary composition

Examination of all the 567 scats had revealed that fruit remains of various plant taxa dominated the overall diet of the sloth bear (Table 1), forming 87.9% of the dry weight. Both plant and animal remains were present in all scats.

At least 20 plant and grass species, nearly 3 groups of insects and bird remnants (single occurrence) were recorded. Fruits of pulpy *Cassia fistula, Syzygium cumini, Ziziphus mauritiana* and *Cordia domestica* were the most frequently used. The same four species also dominated the diet in terms of percent dry weight, although there were differences between percent occurrence and percent dry weight. The animal food used by the bear were black and red ants, termites and honey bees. Among animal material, ants and termites occurred often, indicating their importance to the bear as a source of protein rich diet. Ants and termites also formed a major part of percent dry weight.

Table 1

PERCENT FREQUENCY AND PERCENT DRY WEIGHT OF DIFFERENT FOOD ITEMS IN 567 SCATS

Food items	% Frequency	% Dry weight
Trees		
Anogeissus latifolia	0.52	0.01
Bridelia retusa	0.35	0.06
Cassia fistula	23.46	17.12
Cordia domestica	7.05	1.00
Cordia obliqua	0.18	0.05
Diospyros melanoxylon	0.35	0.02
Diospyros montana	0.88	1.00
Ficus spp.	0.88	0.43
Grewia tiliaefolia	3.70	0.80
Schleichera oleosa	0.71	0.001
Semecarpus anacardium	0.18	0.01
Syzygium cumini	22.22	44.68
Ziziphus mauritiana	9.35	18.54
Woody shrubs		
Grewia hirsuta	4.94	2.00
Lantana camara	10.05	1.68
Toddalia asiatica	0.18	0.001
Climbers		
Ziziphus oenoplia	0.35	0.21
Ziziphus rugosa	0.88	0.09
Grasses		
Setaria intermedia	4.41	0.11
Sporobolus sp.	0.18	0.002
Unidentified	7.05	0.09
Animal material		
Ants	69.49	6.88
Beetles / Grubs	1.41	0.04
Honeybees / Wax	7.94	1.47
Termites	44.44	3.68
Unidentified bird feather	0.18	0.02

Occurrence of plant and animal remains did not vary much across vegetation types, indicating similarity in use pattern of food items by sloth bear between vegetation types. But contribution to dry weight by animal matter varied from 9.5% to 21.2% between vegetation types. Ants formed a major part of the animal matter in all the vegetation types except in the thorn forest. With regard to the plant matter used by the sloth bear, 1 to 3 species alone have contributed more than 75% of dry weight irrespective of vegetation types. It is interesting to note that the same food species were found across vegetation types and the major difference was only in minor food species which contributed < 5% of the dry weight.

Forage ratio

Fruit utilization was significantly different across vegetation types in various months (Kruskal one way analysis: H=25.85; df=11; $P < 0.05$). Likewise, consumption of animal matter varied significantly in different vegetation types across months (Kruskal one way analysis: H=31.35; df=11; $P < 0.05$). Overall ratio indicated that fruits appeared to be the principal diet of the bear in all vegetation types. By contrast, animal matter formed a small component of the total diet.

Seasonal diet

Relative contribution of animal material was highest in the second wet season (76%.8%) and least in dry season (20.6%) (Table 2).

The same trend was indicated by percent occurrence of animal and plant materials across seasons. Among animal materials ants dominated from more than 65% of animal materials in all seasons (Table 2). Among plants, the total number of species used was highest in dry months.

TABLE 2
PERCENT FREQUENCY AND % DRY WEIGHT OF VARIOUS FOOD ITEMS OF SLOTH BEAR IN VARIOUS SEASONS

	Seasons					
Food items	I wet N=272		II wet N=131		dry N=164	
	% F	% D.Wt	% F	%D.Wt	% F	%D.Wt
<u>Trees</u>						
Anogeissus latifolia	00.83	00.01	-	-	0.51	00.02
Bridelia retusa	-	-	-	-	2.67	1.56
Cassia fistula	21.32	15.50	01.34	00.06	45.65	37.47
Cordia domestica	14.23	3.45	-	-	2.67	0.78
Cordia obliqua	-	-	-	-	0.29	0.03
Diospyros melanoxylon	-	-	-	-	1.25	0.18
Diospyros montana	-	-	-	-	2.83	3.73
Ficus spp.	2.01	1.75	1.25	0.44	1.12	0.59
Grewia tiliaefolia	7.13	2.49	0.62	0.58	-	-
Schleichera oleosa	1.17	0.03	-	-	-	-
Semecarpus anacardium	-	-	-	-	0.83	0.92
Syzygium cumini	35.70	38.68	6.44	6.42	-	-
Ziziphus mauritiana	-	-	0.71	0.92	15.36	12.50
<u>Shrubs</u>						
Grewia hirsuta	-	-	8.47	7.25	12.31	12.21
Lantana camara	8.03	0.32	17.11	4.28	9.39	4.18
Toddalia asiatica	0.18	0.002	-	-	-	-
<u>Climbers</u>						
Ziziphus oenoplia	-	-	-	-	1.61	4.41
Ziziphus rugosa	-	-	0.56	0.59	2.18	0.32
<u>Grasses</u>						
Setaria intermedia	4.75	0.58	14.77	1.04	0.62	0.01
Sporobolus sp.	-	-	-	-	0.62	0.01
<u>Unidentified matter</u>	4.75	0.58	15.39	1.57	10.71	0.37
<u>Animal material</u>						
Ants	67.76	24.46	91.15	52.04	60.37	15.22
Beetles / grubs	3.40	0.23	-	-	-	-
Honeybees / wax	15.48	4.23	-	-	-	-
Termites	29.86	7.64	65.78	24.78	45.58	5.41
Unidentified bird feather	0.18	0.03	-	-	-	-

(% F - percent frequency. % D.Wt. - Percent dry weight)

During the dry season, fruit remains of 17 plant species were recorded from 164 scats. For instance, *Cassia fistula* was used by the bear in the first wet and dry seasons. Remains of *Syzygium cumini* were noticed in the scats only from wet seasons while *Ziziphus oenoplia* was recorded only in the dry season.

More or less similar plant taxa were used by sloth bear between vegetation types. However, occurrence of these species in the scats differed between the seasons. The use of animal materials increased from the first wet season onwards with ants and termites dominating the diet.

Density of fruit trees

A total of 8 tree species was recorded from 6.2 ha in DSG. The pulpy fruit *Cordia* spp. was the most common food tree (3.6/ha) followed by *Grewia tiliaefolia* (1.8/ha) (Table 3).

TABLE 3
DENSITIES OF FRUIT TREE SPECIES IN VARIOUS HABITAT TYPES IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU

Tree Species	DSG	DDF	DTG	MMD	TFT
Bridelia retusa	-	-	2.39	1.00	-
Cordia domestica	0.16	0.56	1.09	17.00	1.25
Cordia spp.	3.58	-	-	-	-
Cassia fistula	0.48	1.27	12.17	7.00	0.97
Ficus spp.	0.64	0.14	-	-	-
Grewia tiliaefolia	1.77	6.62	5.00	19.75	0.28
Odina wodier	0.48	-	0.43	-	-
Schleichera oleosa	0.64	0.14	0.43	0.25	-
Syzygium cumini	0.64	-	7.83	0.75	-
Ziziphus mauritiana	-	-	-	-	2.78
Area sampled (ha)	6.2	14.2	4.6	4.0	7.2

The densities of the other food species did not vary much, revealing that only a few species were common in the DSG. In DDF only 5 fruit tree species were recorded. *Grewia tiliaefolia* was most common (6.6/ha.) followed by *Cassia fistula.* Of the 7 fruit tree species in DTG, *Cassia fistula, Syzygium cumini* and *G. tiliaefolia* were the most abundant, indicating rich fruit resources for the sloth bear in DTG. Of the 6 species of fruit trees in MMD, *Cordia domestica* and *Grewia tiliaefolia* were the most abundant. In TFT only 4 species were available and the most abundant was *Ziziphus mauritiana* with a density of 2.8/ha. It is important to note that *Syzygium cumini* is more distributed along wet areas and hence it was not recorded in vegetation study but later found in the diet.

Fruit availability versus utilization

Fruiting seasonality of tree species varied among the vegetation types and utilization of fruits by the bear also varied accordingly (Fig. 2).

Availability of fruits significantly varied across the seasons (Two way-ANOVA; F=2.82 $P < 0.05$) but not between vegetation types. There was positive correlation between fruit availability and utilization by the bear in DSF (r=0.58; $P < 0.05$) and in TFT (r=0.59; $P < 0.05$). Use of various fruits by the bear showed considerable variation at least in some habitats in relation to their availability.

DISCUSSION

Food habits

In the study area the sloth bear is an omnivore, eating plant and animal (insects) food, but plant materials constitute a major part of its diet throughout the year. Prater (1965), Schaller (1969), Prue and Napier (1977) and Davidar (1983) have also reported a similar diet. Plants contribute a part of the diet in several bear species (Himalayan black bear: Schaller 1969, Manjrekar 1989; American black bear: Landers *et al.* 1979, Maehr and Brady 1984; Grizzly bear: Mace and Jonkal 1986 and Brown bear: Cicnjak *et al.*, 1987 and Odhachi and Aoi 1987).

Syzygium cumini, Ziziphus mauritiana and *Cassia fistula* were major components of the diet, although these species were unevenly distributed across the study area. Schaller (1969) observed preference for some palatable fruits by Himalayan black bear. Landers *et al.* (1979) reported that the black bear fed on plenty of sweet gallberry.

Seasonal diet

The significant relationship between fruit availability and utilization shows that seasonal diet was influenced by fruiting phenology. The positive correlation between fruit availability and utilization by bears has been reported in some other studies also (Laurie and Seidensticker 1977, Amstrup and Beecham 1976, Cicnjak *et al.*, 1987). In this study, the higher utilization of fruit in the first wet season was related to peak fruiting season.

The higher occurrence of animal materials in the second (II) wet season scats could also be due to poor availability of fruits in that season.

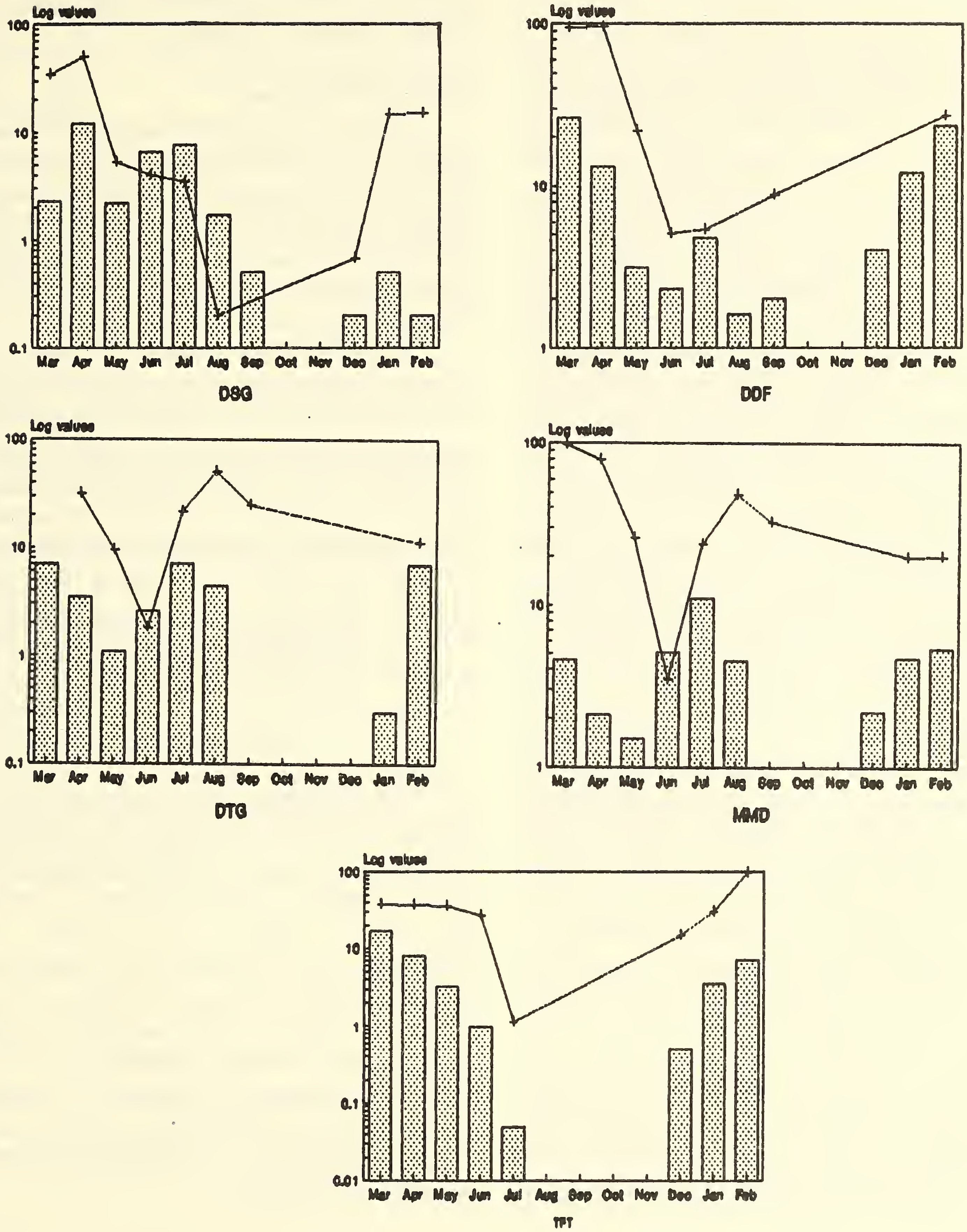


Fig. 2. Ripe fruit availability (%) and utilization (%) of them by sloth bear in various habitat types
A. DSG - Dry Deciduous Short Grass Forest; B. DDF - Dry Deciduous Forest;
C. DTG - Dry Deciduous Tall Grass Forest; D. MMD - Moist Mixed Deciduous Forest; E. TFT - Thorn Forest.

Ripe Fruit Availability — Utilization

Furthermore, fleshy fruits such as *S. cumini* were uncommon in II wet season and thus its share in the diet in terms of dry weight was reduced considerably. On the other hand, in the overall ratio fruit remains dominated due to the occurrence of more *S. cumini* which has more seed weight. This could be a reason for the variation of plant and insect ratio between wet and dry seasons. Murali and Sukumar (1993) found a correlation between insect abundance and rainfall during wet seasons in the same study area. Schaller (1967) and Davidar (1983) have reported the utilization of insects by sloth bear during the wet season. It has been reported that the exploitation of animal material could be to get more protein, since ants contain over 50% protein (Southwood 1973). Wackernagel (1961) stated that for the healthy growth of omnivorous animals, including bears, the diet must contain about 15% crude protein. The consistent occurrence of ants and termites in low quantity throughout the study period support the view of Cicnjak *et al.* (1987).

Fruit dominated the food during the dry season because of its availability. Landers *et al.* (1979) reported that summer fruits eaten by black bears contained more sugar, water and high nitrogen free extracts. Robbins (1983) also stated that fruits are rich in soluble carbohydrates and minerals. However, the importance of fruits in the dry season is not necessarily always the case in different regions. For example, in Mundanthurai Plateau at Kalakad - Mundanthurai Tiger Reserve, Tamil Nadu the scats of sloth bear contained more insect material during the dry season (Gokula 1991). The utilization of honey in DTG revealed their accessibility to sloth bear. In many places local people compete with the bear by removing honey combs which could have been available to the animal. The illegal collection of honey by local people may have a significant impact on the use of animal material by the bear.

Density of fruit trees

The study clearly indicates that DSG and TFT appear to be crucial foraging grounds for the sloth bear, because of greater availability of fruit species namely *Cordia* spp., *Grewia tiliaefolia, Ficus* spp., *Schleichera oleosa* and *Syzygium cumini.* The study also revealed the importance of *S. cumini* to the bear throughout the year.

The immediate threat to the bear in thorn forest is loss of ground cover through severe grazing by cattle. In these areas vegetation types intensively used by the bear are nullahs, dry stream beds, gallery forests and valleys. These microhabitats should be preserved and protected from biotic pressures. Forest authorities should enforce strict management policy for banning collection of honey at least from the tourism zone of the sanctuary, where the local people remove a considerable amount of honey from the forests during the wet season.

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PRELIMINARY OBSERVATIONS ON THE ROLE OF COFFEE PLANTATIONS AS AVIFAUNAL REFUGES IN THE PALNI HILLS OF THE WESTERN GHATS[1]

Ghazala Shahabuddin[2]

(*With two text figures*)

Key words: coffee, plantation, avifauna, forest, conservation

A preliminary study was undertaken to explore the role of coffee plantations as a refuge for the avifauna of fragmented forest patches in the middle Palnis of the Western Ghats. This was done by systematic observations using the line transect method in 6 one-hectare plantation plots and 3 forest plots in 2 valleys. Species composition, species richness and feeding guild abundances were compared between the two habitat types using non-parametric tests. Species composition of avifauna was found to be significantly different between forest and plantation plots. Several native forest-loving species were not observed foraging in plantations. The insectivorous guild was found to be more often sighted in forest habitat, while the omnivorous guild was found to be more abundant in the plantation habitat. However, the plantation habitat appeared to be a valuable secondary habitat for the foraging of a large subset of forest-dwelling species and may possibly be an effective buffer between fragmented forest habitat patches in this area. These are very preliminary trends for the season of study and need to be followed up with long-term detailed studies, both to confirm the trends observed in this study and to find out the modifications in agricultural practices, if any, needed to maximise the avifaunal conservation potential of coffee plantations in the middle Palnis.

Introduction

The Palni Hills are the southeastern offshoot of the Western Ghats in Tamil Nadu, ranging in altitude from 300 m to nearly 2500 m above msl. They cover an area of approximately 2400 sq. km and encompass a wide diversity of natural habitats ranging from evergreen montane forests (sholas) and grasslands in the higher reaches to scrub forest in the foothills (Sustainable Development Program, 1992).

The zone of the Palni Hills from 1000 to 1500 m is popularly known as the middle Palnis, and has the natural vegetation cover of moist deciduous and semi-evergreen forest which supports a rich diversity of avifauna, among other taxa. Expanding agricultural activity currently threatens to take over the natural habitat in this zone.

Coffee-planting and its effect on bird communities

Coffee-planting (*Coffea robusta*; *Coffea arabica*) was observed to be a dominant agricultural activity in the area. Coffee plantations had already taken over vast tracts of forest land, fragmenting it into 'islands' of original habitat. These 'islands' lay scattered in a mosaic of coffee plantations and other agricultural land use, some cultivated areas extending up to 400 acres.

The change from a multi-species, multilayered forest ecosystem to a monoculture of coffee bushes with a species-poor canopy is likely to have several negative effects on bird communities. This is due to a combination of microhabitat changes which take place during the process of conversion. Some of them are as follows:

1. Removal of the forest understorey and its replacement with a single shrub species, i.e. coffee.
2. Replacement of the existing forest trees with a few selected indigenous and exotic tree species,

[1]Accepted June, 1995.

[2]School of the Environment, Duke University, Durham, NC 27708 U.S.A.

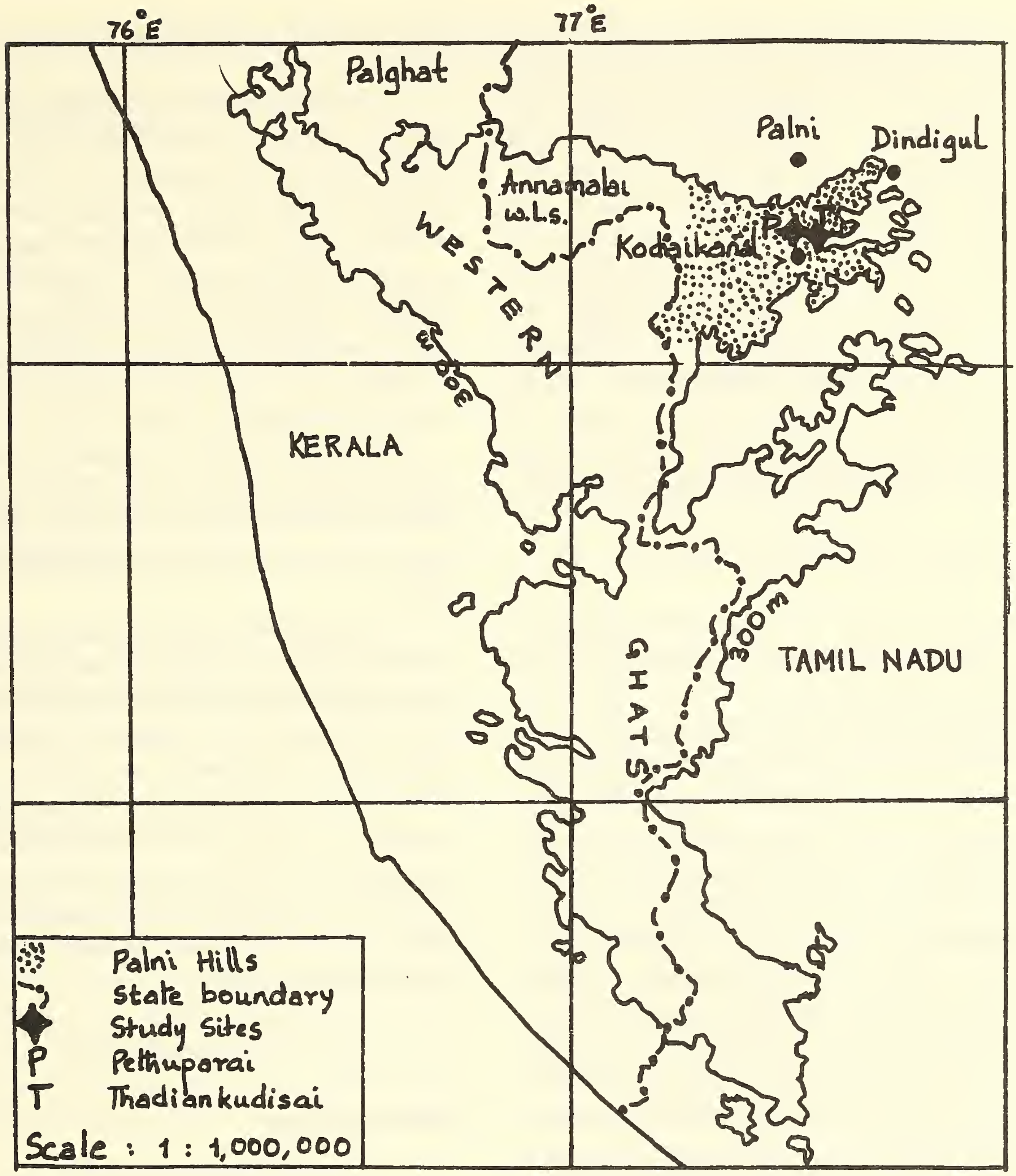

Fig. 1: The Palni Hills in relation to rest of the Western Ghats (Southern portion) and the location of study sites within them.

which are widely spaced and regularly pruned.

3. Use of pesticides for control of insect, virus and nematode pests.
4. Overall reduction in quantity of leaf litter.

Objectives

In this study I aimed to investigate the role of coffee plantations in the conservation of avifaunal species occurring in the natural forest habitat of the Middle Palni Hills. The study specifically aimed at exploring the impact of coffee-planting as an agricultural activity, on species richness, species composition and guild abundance of the avifaunal community of this area. I also intended to document the birdlife of this highly diverse, but neglected area of the Palni Hills.

I expected that the findings would help to indicate the avifaunal conservation potential of coffee plantations in the middle Palnis. I also designed it as a starting point for detailed studies aimed at designing/modifying agricultural practices so as to retain a high proportion of the original species pool of the natural habitat of the area, even while it is being used for economic activity. In the face of continual fragmentation of natural ecosystems, the challenge to conservation today is to reduce the structural contrast between habitat fragments and the matrix in which they exist, in order to preserve as much of the native species pool as possible (Wilcove, McLellan & Dobson, 1986; Meffe & Carroll, 1994).

Study sites and Methodology

The study was undertaken in two valleys of the Palni Hills - Pethuparai and Thadiankudisai during May and June, 1991.

Pethuparai valley is located in the northwestern section of the Palnis (Fig. 1). This area has recently come under coffee cultivation. The river Tayankariar runs through the centre of the valley on both sides of which lie a mosaic of coffee plantations, rice fields and other cultivation. There is almost no original forest habitat left in the area. The remnants consist of one or two small, degraded stands of *Syzygium cumini, Grewia tilifolia, Mangifera indica, Gmelina arborea* and *Terminalia bellerica,* among other species. A typical plantation in the area had shade trees of silver oak (*Grevillea robusta*), coral tree (*Erythrina lithosperma*) and jackfruit (*Artocarpus heterophyllus*); and an understorey of orange and pomegranate trees interspersed among coffee bushes.

Thadiankudisai valley, in the eastern section of the Palnis (Fig. 1), is drained by the Kodavanar river and is a prime coffee-growing area. Large patches of moist deciduous and semi-evergreen forest habitat still exist in this valley, having tree species such as *Trema orientalis, Messua ferrea, Acrocarpus fraxinifolius, Elaeocarpus serratus* and *Melia dubia.* Coffee plantations are very similar to those at Pethuparai except that here pepper (*Piper betel*) is grown commonly as a climber on the silver oak trees.

Three plantations in Pethuparai valley (P1, P2 and P3), three in Thadiankudisai (P4, P5 and P6) and three forest patches (F1, F2 and F3) in Thadiankudisai were chosen for the study. In each of these areas, a 1-hectare plot was marked out which was relatively homogenous in terms of vegetation. For six hours, the plot was intensively explored by a regular path that covered the whole plot. The hours of observation for each plot ranged from 6 am to 9 am and from 2 pm to 5 pm.

Whenever a bird was sighted, it was identified and notes were made on the approximate height above the ground where it was seen, the vegetation layer it was seen in and its foraging/breeding activity, if any.

The number of tree species in each plot were enumerated. The canopy cover and depth of leaf litter were ranked as low (L) or high (H), based on visual observations. In the case of plantation plots, information was gathered on pesticide use, coffee yield and major crop pests by talking to the owners/managers of the respective plantations. The surrounding land use for each plot was ascertained by extensive trekking in the respective area. The details that were obtained on these aspects for each plot are given in Table 1.

Results and Discussion

Species Richness

A total of 58 bird species was recorded from the six plots in Thadiankudisai area during the period of observation. In addition, 11 species were recorded outside the count hours and/or study plots. In terms of species richness, there was no difference between the forest and plantation habitats according to a two-tailed non-parametric Wilcoxon rank sum test ($U=0.3899$; $p>0.6966$). Table 2 gives the list of bird species found in Thadiankudisai and the habitats they were seen in.

In Pethuparai valley 45 species were seen during birdcounts while 19 were recorded outside

TABLE 1
DETAILS OF THE STUDY PLOTS IN PETHUPARAI AND THADIANKUDISAI VALLEYS

Plot No.	Name of Estate/Forest	Alt. (metres)	Tree sp. richness	Leaf Litter	Pesticide use	Surrounding Land use	Canopy cover	Bird sp. Richness
P1	Bhagyadan plantation	1100	14	H	Org.	Agri, River	L	24
P2	Brian Jenkins' Plantation	1100	33	H	Org.	Agri	H	27
P3	Avari Estate	1200	17	L	Non-org.	Agri	L	25
P4	Attakadu Estate	1000	13	L	Non-org.	Forest, River	L	32
P5	N.T.K. Estate	1000	18	L	Org.	Agri, River	H	27
P6	Coffee Demonstration Farm	1000	6	L	Non-org.	Agri, Forest	L	21
F1	Sengarakanal R.F.	1000	25	H	—	Agri, Forest	H	24
F2	Ponnaivetti R.F.	1100	28	H	—	River, Agri, Forest	H	28
F3	Ponnaivetti R.F.	1100	>30	H	—	River, Forest	H	27

Key: Alt.: Altitude; sp: species; L: Low; H: High; Org: Organic; Non-Org: Non-Organic; Agri; Agricultural; RF: Reserved Forest

the study plots/count hours. The bird species richness was comparable to that in Thadiankudisai plantations even though there was almost no colonising forest habitat left here besides some degraded forest patches.

Species Composition

In Thadiankudisai, 44 species were seen foraging in the forest plots while 47 were recorded in the coffee plantation plots. 33 species were recorded in both types of habitat and therefore there was nearly a 57% similarity of bird species composition between the two habitat types (according to Jaccard's Index).

$$\text{Jaccard's Index of Similarity} = \frac{\text{No. of species common to both habitats}}{\text{Cumulative no. of species in the two habitats}} = 56.9\%$$

(Refer to Table 2 for a listing of habitat-wise occurrence of all the bird species of the area).

Indices of similarity were also calculated between each pair of plots, whether forest or plantation. The results are shown in Table 4. Indices of similarity of species composition between similar habitat-plots, such as between F1 and F2 or between P1 and P3, for example, indicated the level of similarity between pairs of plots belonging to the same habitat type. Similarly, indices of similarity between pairs of plots belonging to contrasting habitat types, such as between P1 and F1 or between P1 and F3, for example, indicated the level of similarity between pairs of plots belonging to contrasting habitat types.

I hypothesised that the degree of similarity between pairs of plots belonging to similar habitat types should be greater, on an average, than that between pairs of plots belonging to contrasting habitat types, if the two habitat types differed significantly in terms of species composition. Using a one-tailed Wilcoxon rank sum test, I found a significant difference ($U=2.0145$, $p< 0.02$). Thus I concluded that species composition of forest plots differs significantly from that of plantation plots.

Out of the 44 species found in the forest plots, 33 were seen in one or more plantation plots also (Table 2). This indicates that coffee plantations are capable of supporting the foraging of a high percentage of forest avifauna, i.e. 75%. This included species such as the grey junglefowl, Indian lorikeet, grackle myna, greater racquet-tailed drongo and the little spiderhunter. However, these species could have been seen foraging inside plantations only because the latter were located close to thick forest patches which are the primary habitat for these birds

TABLE 2
CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in: Forest	Plantation
Family Accipitridae				
139	Shikra	BOP		**
144	Crested Goshawk	BOP	**	
172	Black Eagle	BOP		**
196	Crested Serpent-Eagle	BOP	**	**
Family Phasianidae				
301	Grey Junglefowl	GRA	**	**
Family Rallidae				
343	Whitebreasted Waterhen	AQU		**
Family Columbidae				
537	Spotted Dove	GRA		**
542	Emerald Dove	GRA	**	
Family Psittacidae				
550	Roseringed Parakeet	FSE	**	
558	Blossomheaded Parakeet	FSE	**	**
564	Bluewinged Parakeet	FSE	**	**
566	Indian Lorikeet	FNE	**	**
Family Cuculidae				
573	Common Hawk-Cuckoo	INS	**	**
595	Small Green-billed Malkoha	INS	**	
600	Crow-Pheasant	INS	**	**
Family Apodidae				
709	Crested Tree Swift	INS		**
Family Trogonidae				
712	Malabar Trogon	INS	**	
Family Alcedinidae				
735	Whitebreasted Kingfisher	INS		**
Family Meropidae				
744	Chestnutheaded Bee-Eater	INS	**	**
Family Upupidae				
763	Hoopoe	INS		**
Family Bucerotidae				
768	Malabar Grey Hornbill	FRU	**	
775	Malabar Pied Hornbill	FRU	**	
Family Capitonidae				
785	Small Green Barbet	FRU	**	**
792	Crimson-Breasted Barbet	FRU	**	**
Family Picidae				
798	Speckled piculet	INS		**
808	Little Scaly-bellied Green Woodpecker	INS	**	**
819	Lesser Goldenbacked Woodpecker	INS	**	**
825	Indian Goldenbacked Threetoed Woodpecker	INS	**	**
861	Larger Goldenbacked Woodpecker	INS	**	
Family Hirundinidae				
923	Redrumped Swallow	INS		**

Table 2 (*contd.*)
CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in: Forest	Plantation
Family Dicruridae				
965	Ashy Drongo	INS	**	
971	Bronzed Drongo	INS	**	**
977	Greater Racquet-tailed Drongo	INS	**	**
Family Artamidae				
982	Ashy Swallow-Shrike	INS		**
Family Sturnidae				
1015	Grackle Mynah	FRU	**	**
1009	Jungle Mynah	OMN	**	**
Family Corvidae				
1032	Indian Treepie	OMN	**	**
1054	Jungle Crow	OMN		**
Family Campephagidae				
1065	Pied Flycatcher-Shrike	INS	**	**
1068	Large Woodshrike	INS	**	
1078	Blackheaded Cuckoo-Shrike	INS		**
1081	Scarlet Minivet	INS	**	**
Family Irenidae				
1103	Goldenfronted Chloropsis	OMN		**
1109	Fairy Bluebird	OMN	**	
Family Pycnonotidae				
1120	Red whiskered Bulbul	OMN	**	**
1128	Red vented Bulbul	OMN		**
1144	Yellowbrowed Bulbul	FRU	**	**
Family Muscicapidae				
1224	Blackheaded Babbler	INS	**	
1259	Rufous Babbler	INS	**	**
1265	Jungle Babbler	INS		**
1173	Slatyheaded Scimitar Babbler	OMN		**
1442	Tickell's Blue Flycatcher	INS	**	**
1446	Nilgiri Flycatcher	INS		**
1449	Greyheaded Flycatcher	INS	**	
1465	Blacknaped Flycatcher	INS	**	**
1538	Tailorbird	INS	**	**
1661	Magpie-Robin	INS	**	**
1728	Malabar Whistling Thrush	INS	**	**
1734	Orangeheaded Ground Thrush	INS		**
Family Paridae				
1794	Grey Tit	OMN	**	**
1809	Yellow-cheeked Tit	OMN	**	
Family Sittidae				
1838	Velvet-fronted Nuthatch	INS	**	**
Family Dicaeidae				
1892	Thickbilled Flowerpecker	FRU		**
1902	Plaincoloured Flowerpecker	FRU	**	**

Table 2 (*contd.*)
CHECKLIST OF THE BIRD SPECIES OF THADIANKUDISAI AREA, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Name of species	Feeding Guild	Presence in: Forest	Plantation
Family Nectariniidae				
1908	Purplerumped Sunbird	NEC	**	**
1909	Small Sunbird	NEC		**
1931	Little Spiderhunter	NEC	**	**
Family Zosteropidae				
1933	White-eye	OMN	**	**
Family Ploceidae				
1968	Whitebacked Munia	GRA		**

Key to feeding guilds:
FRU: Predominantly frugivorous
NEC: Predominantly nectarivorous
GRA: Predominantly granivorous
INS: Predominantly insectivorous
BOP: Bird of Prey
AQU: Aquatic feeder
OMN: Omnivorous
FSE: Fruit and seed eating
FNE: Fruit and nectar eating

(Ali & Ripley, 1983). This inference is supported by the fact that several of these species were not seen in Pethuparai valley which lacks a good forest cover, i.e. 8 out of 33, including the little spiderhunter, pied flycatcher-shrike and the greater racquet-tailed drongo. Though the magpie-robin was seen in the forest habitat also, it was notably more abundant in plantation plots.

From the presence-absence data in Table 2, one finds that 8 species were found foraging only in forest plots. These included species habitually confined to thick moist deciduous, semi-evergreen or evergreen forest stands, such as the Malabar trogon, the Malabar grey hornbill, the ashy drongo, the yellow-cheeked tit, the large woodshrike and the fairy bluebird. The blackheaded babbler was conspicuous by its absence from plantations, maybe due to lack of leaf litter and dense herbage, which it needs for its foraging. Out of the 14 bird species seen only inside the forest in Thadiankudisai, 11 were not seen in the Pethuparai valley. Further observations are needed to find out if these species have completely disappeared from that area due to the almost complete loss of forest cover. These observations highlight the importance of the remaining patches of forest habitat as a refuge for these forest avifauna as a colonising source and a primary habitat.

Feeding Guilds

To investigate the impact of coffee-planting on guild abundances, I classified the bird species into feeding guilds based on their major food items (Ali & Ripley, 1983) and my observations on their feeding 'space'. The number of sightings of each species was assumed to be indicative of its relative abundance in the habitat. The relative abundances of each feeding guild are illustrated in Fig. 2. For the feeding guild assigned to each species and description of each guild, refer to Tables 2 and 3.

A series of two-tailed Wilcoxon rank sum tests was done between relative abundances of each feeding guild in the two habitats. It was found that the omnivorous guild of birds was more abundant in plantation habitat as compared to forest habitat ($U=6$, $p<0.0238$). This guild included birds such as the redvented bulbul, the Indian treepie, jungle crow and the goldenfronted chloropsis. This result indicates that the conversion of forest habitat into plantation may cause an increase in the competitive ability of these bird species which are opportunistic

Fig. 2: Relative abundances of feeding guilds in the study plots

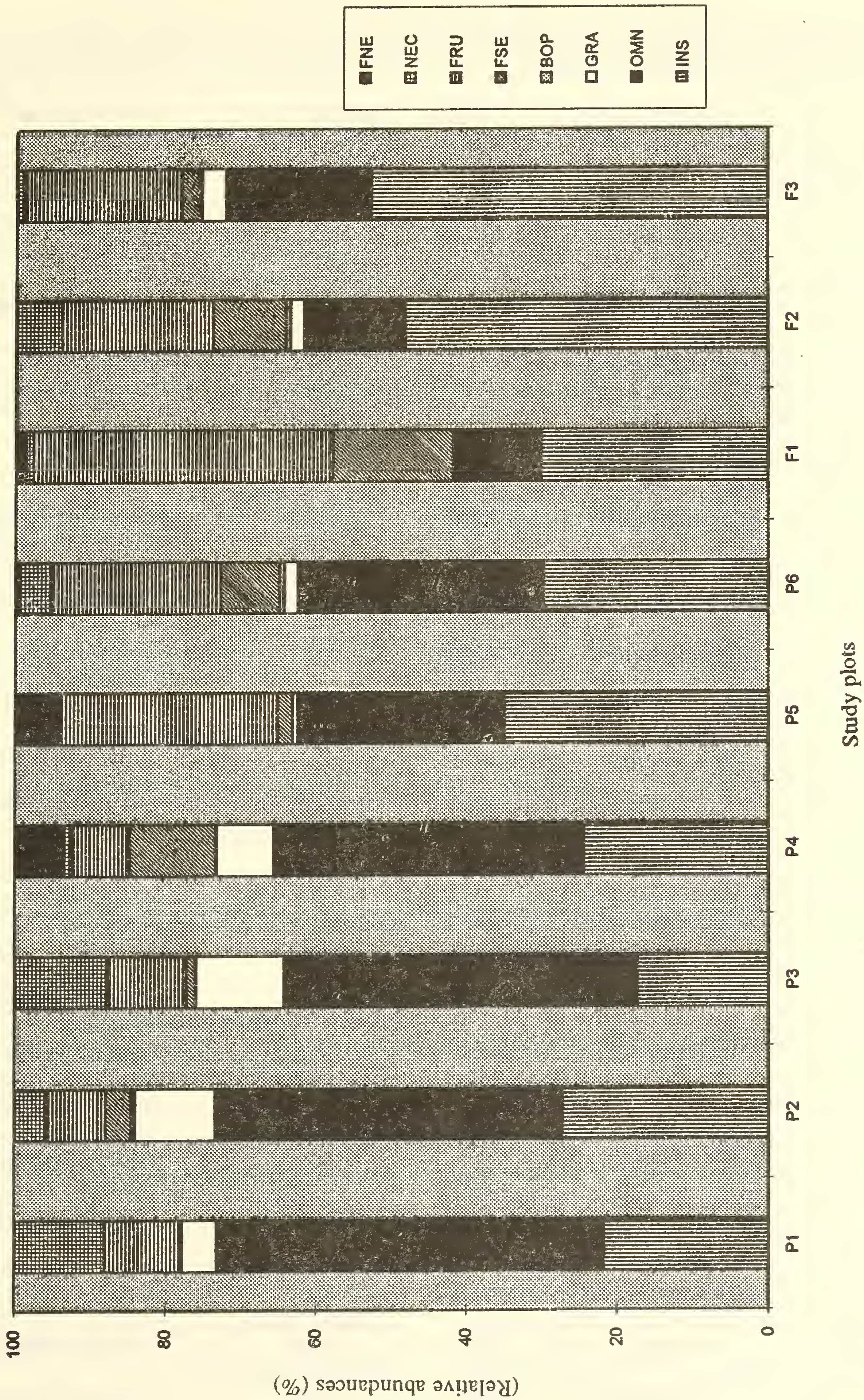

TABLE 3

CHECKLIST OF THE BIRD SPECIES OF PETHUPARAI VALLEY, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Common name of species	Feeding Guild
Family Accipitridae		
124	Blackwinged Kite	BOP
139	Shikra	BOP
Family Phasianidae		
301	Grey Junglefowl	GRA
Family Rallidae		
343	Whitebreasted Waterhen	AQU
Family Charadriidae		
366	Redwattled Lapwing	AQU
Family Columbidae		
537	Spotted Dove	GRA
542	Emerald Dove	GRA
Family Psittacidae		
558	Blossomheaded Parakeet	FSE
564	Bluewinged Parakeet	FSE
566	Indian Lorikeet	FNE
Family Cuculidae		
573	Common Hawk-Cuckoo	INS
590	Koel	INS
600	Crow Pheasant	INS
Family Alcedinidae		
722	Common Kingfisher	INS
735	White-Breasted Kingfisher	INS
Family Meropidae		
750	Green Bee-eater	INS
753	Bluebearded Bee-eater	INS
Family Upupidae		
763	Hoopoe	INS
Family Capitonidae		
785	Small Green Barbet	FRU
792	Crimson-Breasted Barbet	FRU
Family Picidae		
804	Rufous Woodpecker	INS
819	Lesser Goldenbacked Woodpecker	INS
847	Yellow-fronted Pied Woodpecker	INS
Family Pittidae		
867	Indian Pitta	INS
Family Laniidae		
946	Rufousbacked Shrike	INS
Family Oriolidae		
958	Blackheaded Oriole	FRU
Family Dicruridae		
967	Whitebellied Drongo	INS
971	Bronzed Drongo	INS
Family Artamidae		
982	Ashy Swallow-Shrike	INS
Family Sturnidae		
1009	Jungle Mynah	OMN
1015	Grackle Mynah	FRU
Family Corvidae		
1032	Indian Treepie	OMN
1054	Jungle Crow	OMN
Family Campephagidae		
1072	Large Cuckoo-Shrike	INS
1081	Scarlet Minivet	INS
1093	Small Minivet	INS
Family Irenidae		
1098	Common Iora	INS
1103	Goldenfronted Chloropsis	OMN
1109	Fairy Bluebird	OMN
Family Pycnonotidae		
1120	Red-Whiskered Bulbul	OMN
1128	Redvented Bulbul	OMN
1144	Yellowbrowed Bulbul	FRU
Family Muscicapidae		
1154	Spotted Babbler	INS
1259	Rufous Babbler	INS
1265	Jungle Babbler	INS
1442	Tickell's Blue Flycatcher	INS
1449	Greyheaded Flycatcher	INS
1451	Whitebrowed Fantail Flycatcher	INS
1465	Blacknaped Flycatcher	INS
1511	Plain Wren-Warbler	INS
1574	Brown Leaf Warbler	INS
1661	Magpie-Robin	INS
1728	Malabar Whistling Thrush	INS
1734	Orangeheaded Ground Thrush	INS
Family Paridae		
1794	Grey Tit	OMN
Family Sittidae		
1838	Velvet-fronted Nuthatch	INS
Family Dicaeidae		
1899	Tickell's Flowerpecker	FRU

TABLE 3 (*contd.*)

CHECKLIST OF THE BIRD SPECIES OF PETHUPARAI VALLEY, PALNI HILLS, WESTERN GHATS

Family & Synopsis No.	Common name of species	Feeding Guild
Family Nectariniidae		
1908	Purplerumped Sunbird	NEC
1917	Purple Sunbird	NEC
Family Zosteropidae		
1933	White-eye	OMN
Family Ploceidae		
1957	Indian Baya	GRA
1968	Whitebacked Munia	GRA
1974	Spotted Munia	GRA
1978	Blackheaded Munia	GRA

Key to feeding guilds:
INS: Predominantly insectivorous
FRU: Predominantly frugivorous
NEC: Predominantly nectarivorous
GRA: Predominantly granivorous
FSE: Fruit and seed eating
OMN: Omnivorous
BOP: Bird of prey
AQU: Aquatic or amphibious feeder
FNE: Fruit and nectar eating

Note: List contains some bird species not seen during my study which had been previously sighted in the area by Mr. Arthur Steele of Bhagyadan Plantation.

and adaptable compared to the forest-loving ones.

Another finding was that the insectivorous guild of birds was more abundant in the forest plots than the plantation plots (U=23, $p<0.047$). There could be three possible reasons for this difference: use of pesticides in coffee plantations, reduced depth of leaf litter in plantations and vegetational diversity of forest habitat. It would be interesting to find out if this trend is borne out by more detailed studies, including observations in other seasons.

None of the other feeding guilds showed significant differences in abundance between forest and plantation habitat. (Refer to Table 5 for the p-values of the Wilcoxon rank sum statistic)

TABLE 4

INDICES OF SIMILARITY BETWEEN PAIRS OF PLOTS IN THADIANKUDISAI AREA

Plots	P4	P5	P6	F1	F2	F3
P4		0.43	0.39	0.36	0.38	0.4
P5		1	0.39	0.36	0.32	0.4
P6			1	0.27	0.37	0.31
F1				1	0.37	0.65
F2					1	0.39
F3						1

TABLE 5

COMPARISON OF FEEDING GUILD ABUNDANCES BETWEEN FOREST AND PLANTATION HABITATS OF THADIANKUDISAI (WILCOXON RANK-SUM STATISTICS)

Feeding Guild	Statistic	P-value
INS	23	0.04676**
OMN	39	0.0238**
GFI	28	0.71
GRA	35	0.2619
FSE	25	0.2619
FRU	25	0.2619
NEC	12	0.5476
FNE	0.416	0.6774

Key:
INS: insectivores
OMN: omnivores
GFI: groundfeeding insectivores
GRA: granivores
FSE: fruit and seed-eaters
FRU: frugivores
NEC: nectarivores
FNE: fruit and nectar-eaters

Plantations as Foraging Areas

The pods of the silk-cotton (*Bombax ceiba*) shade trees in coffee plantations were observed to be an abundant source of food for the fruit and seed-eating bird species, including the Indian lorikeet, roseringed parakeet, bluewinged parakeet and blossomheaded parakeet. In one plantation a lesser goldenbacked woodpecker was seen feeding from a jackfruit still on the tree. Flowers of silver oak and orange trees were seen to provide food for several species of parakeets and sunbirds. Thus coffee plantations were found to be bountiful foraging grounds for a large variety of non-insectivorous birds.

However, the impact of the synchronous flowering pattern found in the plantations (due to monoculturing) as against the random and non-synchronous flowering of the moist deciduous forest ecosystem (which provides forage throughout the year) cannot be commented on unless avian foraging is studied intensively for a whole year.

Plantations as Breeding Areas

According to field observations, coffee plantations may not be as good breeding grounds/nurseries for forest species. Almost all the observations of breeding behaviour were made in forest plots. Fledglings of the bronzed drongo, grey junglefowl, little spiderhunter and the yellowcheeked tit were seen along with adult birds in plots F5 and F6. Courting Malabar grey hornbills were observed in plot F6, while an adult crested serpent-eagle was seen making a nest in plot F5. However, no definite conclusions can be drawn regarding this aspect until a much more detailed study is carried out.

Conclusions

This preliminary study indicates that in Thadiankudisai, species richness was not affected by conversion of forest habitat into coffee plantations. However, species composition differed significantly between forest and plantation habitats as indicated by the indices of similarity. This difference was due to the several bird species which were observed only in the forest plots. These included species which are reportedly confined to primary forest habitat in the Western Ghats (Ali & Ripley, 1983). Comparison between species composition of Pethuparai and Thadiankudisai indicate that some species may have been lost from the former area due to total loss of forest cover.

However, coffee plantations were found to be important foraging grounds for avifauna in the middle Palni, capable of supporting the foraging of a large subset (75%) of forest-dwelling species. Field observations indicated that the plantations had a diverse range of bird species utilising available fruit, seed and nectar resources. The relative abundance of the omnivorous guild of birds was significantly higher in plantation plots than in forest plots, while that of the insectivorous guild was higher in forest plots as compared to plantation plots, in the season of study. However, all these results should be treated with caution due to the very limited time-frame of the study. In particular, the assumption that the number of sightings of foraging birds of a species reflect its relative abundance in that particular habitat, may not be justified.

The study, however, does indicate that coffee plantations can be an important buffer between natural forest habitat patches in the mid-Palnis, with high potential for serving as a marginal habitat for some species, a dispersal corridor between patches and even a breeding/permanent habitat for some species. The more 'natural' these plantations can be kept, the richer they would be in terms of structure and the better these conservation functions could be served. Very much more detailed studies need to be carried out to determine exactly which agricultural practices need to be modified to maximise the conservation potential of coffee plantations in the middle Palnis of the Western Ghats.

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NOTES ON THE DISTRIBUTION AND ENDEMISM OF INDIAN *FIMBRISTYLIS*[1]

V.P. Prasad & N.P. Singh[2]

(*With one text-figure*)

Key words: *Fimbristylis*, distribution, endemism, India

The genus *Fimbristylis* is widely distributed in the tropics and subtropics. About 200 species have been reported from all over the world. Of the 92 species found in India, 37 are endemic. Peninsular India has the maximum number of endemics in the country with 30 species, followed by the northeast with 5 species. In the case of other angiosperms also, the high degree of endemism is distinct in peninsular India. Majority of the non-endemic *Fimbristylis* are also found in peninsular India. Availability of suitable habitat may be the cause for this kind of distribution. In fact, many non-endemic species are also restricted to India and the neighbouring countries of South Asia.

Introduction

The genus *Fimbristylis* of the family Cyperaceae was founded by Vahl in 1806 by segregating the species from the genus *Scirpus* which have spiral glumes and flat, ciliate, distigmatic, deciduous style with enlarged base. He created another genus *Abildgaardia* for the species having the same kind of floral structure, but having distichous glumes, while the tristigmatic species were left in the genus *Scirpus*. But there are species which have spikelets with partly distichous and partly spiral glumes. Similarly often distigmatic and tristigmatic flowers are found in one and the same species, rarely even in the same spikelet. Hence arrangement of the glumes and the number of stigmas are not very good characters for delimiting these genera. Moreover, Robert Brown (1810) found the deciduous style articulated with the nut as most characteristic of the genus *Fimbristylis*. Based on this he included many tristigmatic species in the genus *Fimbristylis* which were treated under *Scirpus* till then.

Another genus *Trichelostylis* founded by Lestiboudois (1819) is based on the tristigmatic nature. But subsequent workers treated this as a synonym of *Fimbristylis*, though Nees tried to revive that genus. The genus *Bulbostylis* has been merged with *Fimbristylis* by Asa Grey, Bentham and Koyama, but there is a concrete morphological difference between these two genera. Embryological studies done by van der Vekan (1965) on the species of both these genera have also proved this point, though cytologically both are the same, having the same basic chromosome number and similar chromosome size.

Iria (L.C. Rich.) Hedwig. f. (1806). *Echinolytrum* Desv. (1808), *Pogonostylis* Bert. (1833), *Microspora* Boeck. (1860) and *Actinoschoenus* Benth. (1883) are the other names assigned to this genus earlier.

Fimbristylis is characterised by the absence of perianth bristles in the flower and also by the absence of persistent style base on the nut. These characters also differentiate it from the closely related genera *Eleocharis* and *Bulbostylis* respectively.

Kern (1974) treated this genus under the tribe Cypereae of subfamily Cyperoideae. But Koyama (1985) placed it under the tribe Fimbristylideae.

A majority of the species like *F. dichotoma, F. bisumbellata, F. complanata, F. tenera*, and *F. tetragona* etc. prefer habitats like swampy areas, margins of rice fields, river beds, banks of rivers and streams, margins of lakes and open moist waste places etc. Some of these are found along seashores and along back waters. A few of them grow in forests and savannahs also. The majority are low land

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[2]Botanical Survey of India, Western Circle, Pune-411 001

species, but a few are found at high altitudes also. Species like *F. aestivalis* and *F. miliacea* are common weeds in wet rice fields.

Distribution

The genus *Fimbristylis* is widespread, especially in the tropics and subtropics. A few species are found in the warmer parts of the temperate region also. About 200 species have been reported from all over the world, of which the majority are concentrated in tropical Asia. So far, 92 species of *Fimbristylis* have been reported from India. A good number of varieties are also described due to the highly variable characters of many species like *F. dichotoma, F. falcata* and *F. aestivalis.*

Endemism

Of the 92 species reported so far 37 are endemic to India, while 5 varieties are reported to be endemic from the present political boundaries of India only. Within India, endemism in the species of *Fimbristylis* is more predominant in peninsular India. In the case of other angiosperms also the high degree of endemism is distinct in peninsular India and makes the flora of this part of the country unique. Turrill's (1964) contention that next to islands, the peninsular regions provide favourable conditions for endemism is true in the case of peninsular India also. Characteristic endemic species of the Western Ghats were enumerated by Subramanyam and Nayar (1974), who mentioned that Western Ghat summits are comparable with islands regarding endemic species. In general peninsular India has 32% of the endemics, while the rest of the country has only 27% (Nayar, 1980). According to Blasco (1971) there are 1,268 endemic dicotyledons in South India. Nayar (1980) has estimated a total of about 2,100 endemic species in peninsular India. Ahmedullah and Nayar (1987) have reported 29 species and one variety of *Fimbristylis* Hemadri is *nomen nudum* and hence should be rejected. *F. unispicularis* is endemic to peninsular India. Of this *F. junnarensis* Govind. and Hemadri is the correct name of this species. Similarly *F. ligulata* Govind. and *F. bisumbellata* var. *hirtistyla* Fisch. are synonyms of *F. merrillii* Kern and *F. squarrosa* var. *esquarrosa* Makino respectively, which are not endemic to India. Excluding these three taxa the actual number of endemics reported earlier from peninsular India is 27 species.

In the present study, of the 64 species reported so far, 30 species and 2 varieties were found to be endemic to this part of the country (see enumeration).

Next to peninsular India, the northeast has the maximum number of endemics, though the number is comparatively much less. There are only 5 species and one variety of *Fimbristylis* endemic to the northeast (see enumeration). Of this *F. hookeriana* Boeck. extends to Eastern India also. *F. multicephala* Govind. is the only species endemic to North India. *F. polytrichoides* var. *halophila* Kurz ex Clarke belong to southern as well as eastern India.

In the case of non-endemic species also, the majority of them can be found in peninsular India, followed by the northeast. As mentioned earlier, 64 species reported from peninsular India compromise more than 69% of the total number reported from the whole country. The high degree of species diversity in peninsular India and the northeast must be due to the availability of more wet and humid conditions in these parts of the country. It is evident that northeast and peninsular India, especially towards the coastal areas and Western Ghats experience more rain. Availability of wet habitats in the form of rivers, streams, ponds, lakes, lagoons, swamps, rice fields and other wetlands and also comparatively high atmospheric humidity must be the reason for the concentration of species in these parts. Moist or wet conditions are the most preferred by the majority of species. Even moist grasslands of high ranges, rocky slopes, mountain peaks and forest clearings in the Western Ghats are very good habitats for certain species like *F. consanguinea, F. falcata, F. narayanii, F. kingii,* and *F. semidisticha* etc. Species adapated to halophytic conditions like *F. polytrichoides* and *F. ferruginea* are found along the sea coast and near brackish waters.

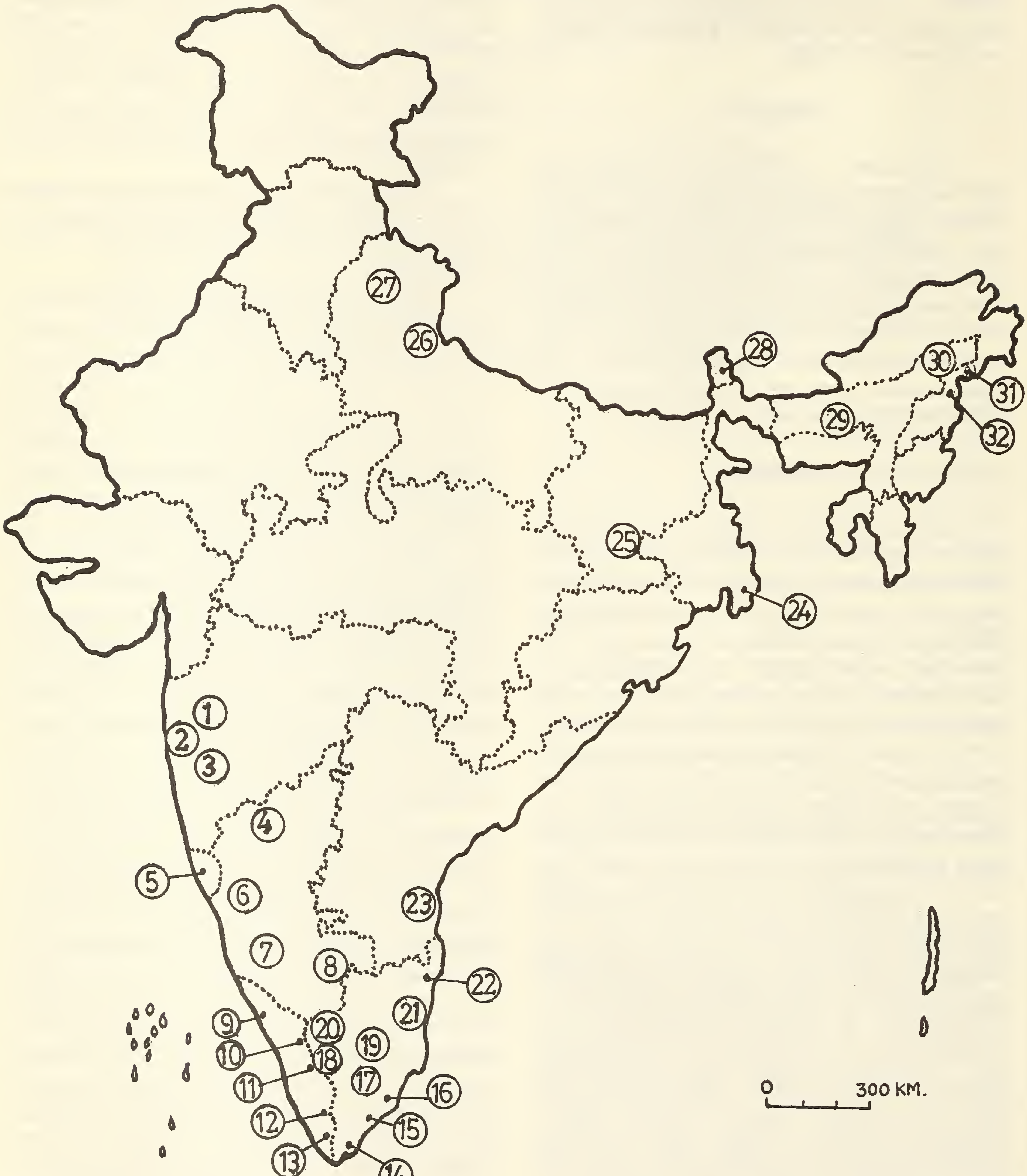

Fig. 1. Map showing the distribution of endemic *Fimbristylis*

INDIAN SPECIES EXTENDING TO SOUTH AND SOUTH-EAST ASIAN COUNTRIES

Many species found in India have world wide distribution. *F. dichotoma* (L). Vahl, *F. complanata* (Retz.) Link, *F. ferruginea* (L.) Vahl and *F. cymosa* R. Br. are a few examples. But several species and a few infra-specific taxa show an interesting range of distribution, being restricted to India and the neighbouring countries of South Asia and also extending to the southeast Asian region.

F. monticola Hochst. ex Steud., *F. pentaptera* (Nees) Kunth, *F. dichotoma* sp. *glauca* (Vahl) Koyama and *F. falcata* var. *abbreviata* (Boeck.) Karthik. are found in peninsular India and Sri Lanka only. *F. umbellaris* var. *vicaryi* (Clarke) Karthik, probably extends from North India to Pakistan, along the river Chenab. Similarly *F. intonsa* Blake, *F. merguensis* Clarke and *F. aestivalis* var. *trichopoda* Kern are found only in India and Malaysia. *F. multinervia* Govind. extends from the northeast to Myanmar. *F. disticha* Boeck. and *F. fimbristyloides* (F. V. Muell.) Druce, found in Andaman and Nicobar Islands and northeast India respectively, are also found in Myanmar, Thailand and China. *F. obtusata* (Clarke) Ridl., reported from eastern India, extends to Myanmar, Thailand and Malaysia. Similarly *F. sleumeri* Kern found in Thailand and Myanmar is also found in northeast India. *F. pierotii* Miq. occuring in east and northeast India is found in Malaysia, Korea, and Japan also. In India, *F. rigidula* Nees is distributed in the Himalayas, east and northeast India and also found in Nepal, southern China, Malaysia, Thailand and the Philippines. *F. fusca* (Nees) Clarke also extends from India to Nepal, Malaysia, Indochina and Thailand. In India *F. stolonifera* Clarke is restricted to central, east and northeast India, it is also reported from Nepal also. *F. umbellaris* (Lam.) Vahl found in north, east, northeast and Andaman and Nicobar Islands is also found in Nepal, Sri Lanka, Indo-China and Japan. *F. griffithii* Boeck. reported from northeast India and Andaman and Nicobar Islands is also found in Myanmar, Thailand, Malaysia and Indo-China. *F. eragrostis* (Nees & May. ex Nees) Hance extends from India to Sri Lanka, southern China, Malaysia and Indo-China. *F. merrillii* Kern reported recently from western peninsular India by Mistry and Almeida (1987) is found in China, Thailand, Queensland and Malaysia. There are some other varieties also showing this kind of distribution.

Species to be excluded

F. dura (Zoll. & Mor.) Merr. given by Clarke (1893) as *F. asperrima* Boeck. is not indicated from the present political boundaries of India but from Sri Lanka and Tavoy to Singapore. Hence, the presence of this species in India is doubtful, though it is included by Karthikeyan *et al* (1989) without actual locality.

ENUMERATION OF SPECIES AND INFRA-SPECIFIC TAXA ENDEMIC TO PENINSULAR INDIA

Taxa	Distribution shown in the map
Fimbristylis aggregata Fisch.	18
F. albicans Nees	Deccan (without exact locality)
F. amplocarpa Govind.	17
F. angamoozhiensis Ravi et Anil Kumar	12
F. arnottiana Boeck.	20
F. complanata var. *fenestrata* Clarke	Deccan (without exact locality)
F. contorta Fisch.	15
F. crystallina Govind.	18
F. dauciformis Govind.	11
F. dichotoma var. *nilgirica* (Clarke) Karthik.	20
F. eligulata Govind.	16, 22
F. kingii Clarke ex Boeck.	7, 8, 10, 20
F. latiglumifera Govind.	20
F. latinucifera Govind.	20
F. lawiana (Boeck.) Kern	2, 4, 6
F. longistigmata Govind.	14
F. monospicula Govind.	17, 19
F. narayanii Fisch. (also in NW Himalaya?)	15
F. paupercula Boeck.	15, 17, 20
F. pseudonarayanii Ravi et Anil Kumar	13
F. pustulosa Govind.	18

Taxa	Distribution shown in the map
F. rectifolia Govind.	20
F. rigidiuscula Govind.	17
F. rugosa Govind.	14, 17, 20
F. scabrisquama Govind.	17
F. semidisticha Govind.	17, 20
F. strigosa Govind.	16, 18
F. swamyii Govind.	9, 17
F. tortifolia Govind.	17
F. uliginosa Steud.	17, 18
F. unispicularis Govind.	1
F. woodrowii Clarke	3, 21

TAXA ENDEMIC TO NORTHEAST INDIA

Taxa	Distribution shown in the map
Fimbristylis carpopoda Govind,	31
F. circumciliata Govid.	30
F. filifolia Boeck	28
F. hookeriana Boeck.	25, 29 (Extending to E. India)
F. stolonifera var. *ludens* Clarke	29
F. yunnanensis Clarke	32

OTHER ENDEMIC TAXA WITH THEIR DISTRIBUTION

Taxa	Distribution	Ref. in the Map
F. fucinux Clarke	North, Northeast India	26, 28
F. multicephala Govind.	N. India	27
F. polytrichoides var. *halophila* Kurz ex Clarke	South & East India	23, 24

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CONSERVATION OF THE ENDANGERED RIVER TERRAPIN *BATAGUR BASKA* IN THE SUNDERBAN OF WEST BENGAL, INDIA[1]

S. Bhupathy[2]

(*With two text-figures*)

Key words: River terrapin, *Batagur baska*, endangered species, Sunderban, mangrove.

A status survey of the endangered River Terrapin, *Batagur baska* was conducted in the Sunderban of West Bengal, India from February to May 1994. Intensive searches were carried out to determine the present status of *Batagur* in the wild. Surveys were also conducted in Captive Breeding Centres, village ponds and markets to assess the captive stock and exploitation level. The only evidence obtained for *Batagur* nesting was in Mechua island (Bagmara block) of the Sunderban Tiger Reserve (STR). *Batagur* is rare in the wild and in captivity in India and currently not being exploited commercially. A captive breeding programme is suggested for *Batagur* using existing captive turtles involving villagers for restocking the species in the wild.

Introduction

India has one of the richest assemblages of chelonians in the world, with 31 species of turtles including five species of sea turtles, 22 species of freshwater turtles and four species of land tortoises (Das 1991). Among them, the River terrapin, *Batagur baska* and Asian giant soft-shell turtle, *Pelochelys bibroni* are restricted to brackish water with a wide distribution in southeast Asia. Uncontrolled exploitation of these species and their eggs has caused serious declines throughout their range (Moll 1990a). *Batagur* has been listed as endangered in the Red Data Book (Groombridge 1982) and in category 1X of the IUCN Action Plan Rating (APR), suggesting highest priority for its conservation (Stubbs 1991). Further, this species is also on Schedule I of the Indian Wildlife Protection Act 1972 (Anon 1991).

In India, *Batagur* was reported to occur in the Mahanadi and Brahmani-Baitarani Delta, Orissa and in Sunderban, West Bengal (Smith 1931). However, no authentic record of its presence on the Orissa coast is available for the last 25 years. The species was reported as common in the Hoogly river mouth of West Bengal in the mid 19th century (Blyth in Gunther 1864). Interest in the conservation of *Batagur* started in India after its rediscovery in village ponds in 1983 (Moll 1990 a) and observation of three nests on Mechua Island (of STR) in 1988 (Ghosh and Mandal 1990). A small scale captive rearing programme of *Batagur* has existed since then in Sunderban aimed at reintroduction into the wild (Ghosh and Mandal 1990). Four *Batagur* surveys have been conducted between 1983 and 1993 by various agencies (Das 1987; Moll 1990 a, b; Bhupathy *et al.* in press). The present paper deals with the status of *Batagur* in India in the wild as well as in captivity and gives suggestions for its conservation.

Materials and Methods

Sunderban

Sunderban (21° 32' - 22°20' N, 88° 03' - 89° 05'E), 24 Pargana district (South), West Bengal is one of the World Heritage Sites. It is located in the Ganges and Brahmaputra drainage and is bound by rivers Hoogly in the west and Raimangal and Kalindi in the east. Bay of Bengal forms the southern boundary, while the northern side has an indistinct boundary comprising of agricultural fields and

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[2]Sálim Ali Centre for Ornithology and Natural History, Kalampalayam P.O., Coimbatore-641 010, India

villages. Sunderban is one of the largest mangrove swamps in the world covering more than 12,000 sq.km. About one third of this mangrove area is within Indian territorial limits and the rest is in Bangladesh. Indian Sunderban has four protected areas, namely Sunderban Tiger Reserve (STR, 1330 sq.km), Saznakhali (362 sq. km), Saptamukhi (38 sq.km) and Halliday Island (4 sq.km) Wildlife Sanctuaries (Rodgers and Panwar 1988; Fig. 1). The remaining areas are made up of human habitations, agricultural fields and Reserve Forests.

The Tidal Swamp Forest in Sunderban (Champion and Seth 1968) is rich in flora with about 300 species (Hussain 1994). Dominant species among them are *Phoenix paludosa, Excoecaria agallocha, Sonneratia apetala, Bruguiera gymnorhiza, Xylocarpus granatum, Rhizophora* spp., *Avicennia* spp. and *Heritiera fomes. Heritiera fomes* (known as *Sundri* in *Bengali* from which the name Sunderban meaning 'beautiful forest' originated) and *Nypa fruticans* are some of the rare species found in the Indian Sunderban. In the sea facing islands, the grass *Saccharum cylindricum* is common. Sunderban is also rich in fauna with 42 species of mammals, 270 species of birds, 35 species of reptiles and 400 species of fishes reported (Hussain 1994). It is an abode for many rare and endangered species; Tiger *Panthera tigris,* Gangetic river dolphin *Platanista gangetica,* Giant heron *Ardea goliath,* Lesser adjutant stork *Leptoptilos javanicus,* King cobra *Ophiophagus hannah,* Indian python *Python molurus,* Water monitor lizard *Varanus salvator,* Common monitor lizard *V. benghalensis* and Saltwater crocodile *Crocodylus porosus.*

Survey and identification of nesting beaches

The study was conducted in the Indian Sunderban between February and May, 1994 covering both egg laying and hatching periods of *Batagur.* Moll (1990b) reported that *Batagur* nests only on the sandy beaches of rivers and the sea. Hence, surveys were conducted first to locate the sandy areas in the Sunderban. Field surveys were done in three phases using a mechanised boat.

Phase I: A rapid survey was conducted from 24th February to 12th March, 1994 along the coast from Mechua island in the east to the river Hoogly, in the southwest covering all major rivers, and primary, secondary and tertiary creeks. All sea-facing islands (Fig. 1) were surveyed on foot during high tide between High Tide Zone (HTZ) and mangrove forest. The following information was recorded to evaluate the suitability for nesting: (1) availability of dry sand (2) turtle nesting signs (3) turtle egg collection by inhabitants (4) fishing and (5) human settlement. Sandy areas comparable with known nesting area for eg. Mechua island, and with less human pressure were shortlisted for further intensive surveys. Field officers of the Sunderban Tiger Reserve (STR), local people and fishermen in the adjoining areas were also interviewed to obtain known records of *Batagur.*

Phase II: Only the Mechua island in Bagmara block of STR was found to be suitable for *Batagur* nesting, and hence the second phase of the survey was restricted to this island. Searches were carried out for three to four days in a week during the morning (0500-0800 hrs) and evening (1600-1900 hrs) between 15th March and 15th April, 1994. The area between HTZ and mangrove forest was included in the search. The habitat was open sandy area with sparse clumps of tall grass *Saccharum cylindricum* well above the HTZ. Tracks and signs were followed to locate nests. The nesting crawl of the *Batagur* may easily be identified from sympatric sea turtles by the following features: (1) lack of deep cuttings in the crawl of *Batagur* i.e. flipper marks and (2) presence of only four claw marks. Signs of nesting of sea turtles and egg predators, such as Wild Pig, were also recorded.

Phase III: Mechua Island was surveyed from 4th to 13th May, 1994 to record the hatching of *Batagur* in the wild. Searches were conducted in the early mornings (0500-0800 hrs) and evenings (1600-1900 hrs) covering the area between HTZ and mangrove forest. Signs of turtle hatchlings were recorded. Open water and potential basking habitats, such as fallen logs, mounds and banks, were also closely observed using a pair of binoculars while

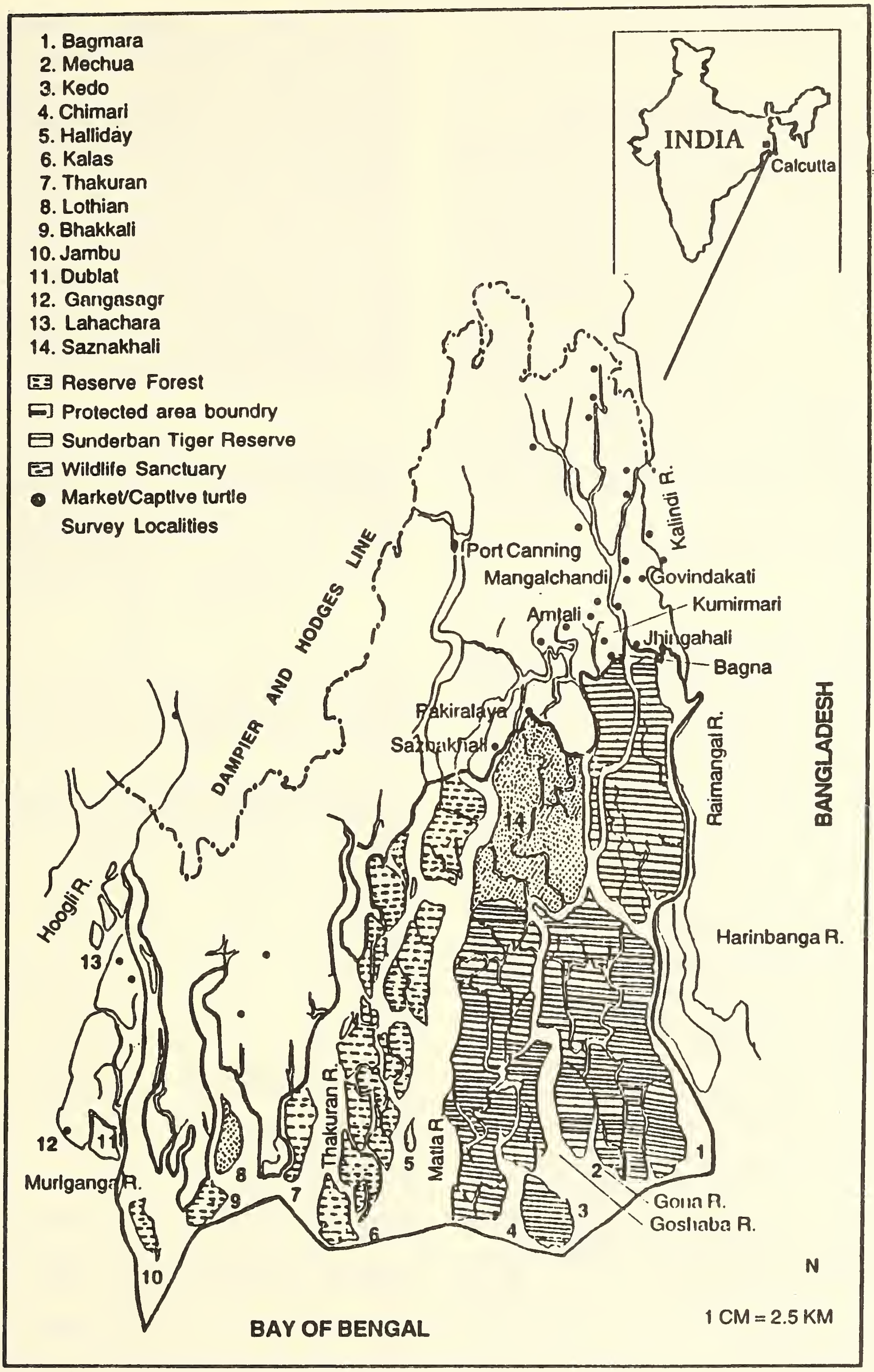

Fig. 1. Indian Sunderban showing major river systems and sea-facing islands.

travelling by mechanised boat during all phases of the survey.

Exploitation level and status in captivity

Fish markets adjacent to STR were surveyed for *Batagur* from 25th February to 20th May 1994 (mainly from 15-20th April and 15-25th May) to assess the level of exploitation by local people. Rapid searches were conducted in each fish market for turtles. Villagers were questioned to determine the number of *Batagur* in private collections. Forest Department Captive Breeding Centres in STR and Alipur Zoological Park, Calcutta were also visited. On locating a shell or live turtle in the wild or in captivity, morphometric measurements, colour pattern and origin of the specimen were noted.

Results and Discussion

Identity

Altogether three adult male, two female and 19 immature (1-4 years old) *Batagur* were examined during the survey. Morphometry of the largest specimens of both sexes: a) female - Straightline Carapace Length (SCL) 500 mm, Carapace Width (CW) 400 mm, Plastron Length (PL) 450 mm and Body Weight (WT) 17 kg and b) male - SCL 400 mm, CW 320 mm, PL 360 mm and WT 8 kg. Two captive males examined in early March had black heads, yellow-cream eyes and pale brown legs. Females had cream head, black eyes and brown shell and soft parts. *Batagur* of Indian and Burmese (Myanmar) origin are reported to be different from those of Malayan origin. Males of the Malayan forms develop a black head, and their eyes are yellow to cream in colour (Moll 1980) while in the males of Indian and Burmese forms the back of the head and forelimbs are bright red (Anderson cited in Das 1991). The occurrence of Malayan colour form of *Batagur* in the Sunderban is interesting and requires further investigation.

Status of nesting beaches

All major river systems and the thirteen islands facing the sea were surveyed between 24th February and 12th March, 1994 to assess the suitability of the habitat for nesting of *Batagur*. The river systems surveyed included Raimangal, Harinbanga, Gona, Goshaba and Matla in Sunderban Tiger Reserve (STR) and Thakuran, Saptamukhi, Muriganga and Hoogly outside STR (Fig. 1). None of these rivers had dry sand on their banks. Only some of the sea-facing islands had dry sandy areas. Inside STR only the island of Mechua in Bagmara block had sufficient dry sand during high tide and tracks of *Batagur* were noticed. Islands Kedo and Chaimari had less sandy area (Table 1).

Table 1
SUITABILITY OF SEA-FACING ISLANDS FOR *BATAGUR* TO NEST IN THE INDIAN SUNDERBAN.

Name of	Dry sand during high tide (1 x w in M)	Disturbance		
		Turtle egg collection	Fisherman seen	Habitation
Bagmara (TR)	1500 x 50	—	—	absent
Mechua (TR)	2000 x 50	—	—	absent
Kedo (TR)	—	—	5	absent
Chaimari (TR)	200 x 3	?	10	absent
Kalas (OT)	2000 x 25	—	10	absent
Chulkati (OT)	500 x 5	—	25	absent
Thakuran (OT)	—	—	50	50 houses
Lothian (OT)	—	—	60	absent
Bakkali (OT)	3000 x 25	+	200	100 houses
Jambu or New or Moor (OT)	3000 x 25	+	150	20 houses
Dublat (OT)	2500 x 25	+	150	50 houses
Gangasagar (OT)	3000 x 25	+	200	100 houses
Lahachara (OT)	—	—	25	absent

Note: TR — Tiger Reserve, OT — Outside Tiger Reserve

Outside STR nine islands were surveyed; none of them had evidence of *Batagur* nesting such as tracks and shells. Four islands, namely Bakkali, Jambu, Dublat and Gangasagar had vast stretches of sandy areas and other islands, such as Thakuran, Saptamukhi and Lahachara had no dry sand during high tide (Table 1). Among the islands located outside STR, island Kalas (Chulkati block, Fig. 1) appeared to be suitable for *Batagur* nesting with sufficient dry sand and comparatively less anthropogenic pressure. Twenty five records were obtained for sea turtle nesting in this island (Table 2). Bakkali, Jambu, Dubalt and Gangasagar had sufficient dry sand during high tide. Sea turtle nesting was sporadic (Table 3) and the disturbance was high due to human settlement (Table 2). Turtle egg collectors traverse the beach every morning and if at all *Batagur* were nesting there, it would have no chance of survival.

TABLE 2
TURTLE RECORDS IN VARIOUS SEA-FACING ISLANDS OF THE INDIAN SUNDERBAN DURING THE SURVEY. *Number in parenthesis is hatchlings* seen.

Name of the Island	Batagur signs	Number of sea turtle sign			
		Turtle shells	Predated nest	Intact nest	Tracks and young ones
Mechua (Bagmara block)	3 tracks	1	21	2	25 (20)
Kedo	—	—	—	—	—
Chaimari	—	1	—	—	—
Kalas	—	1	20	1	3
Chulkati	—	—	—	—	1
Thakuran	—	—	—	—	—
Lothian	—	1	—	—	—
Bakkali	—	—	—	—	—
Jambu	—	9	—	2	2
Dublat	—	2			
Gangasagar	—	1	—	—	—
Lahachara	—	—	—	—	—
Total	3	16	41	5	51

Note: Data on Mechua island is sum of 5 surveys.

The *Kedo* island in which *Batagur* was reported to have been nesting (Das 1987) lacked dry sand and hence nesting there appeared to be quite unlikely. Das (1987) reported nesting of *Batagur* in islands, such as Kanak and Nagbarchar; the former no longer exists, having sunk during the 1988 cyclone, and the latter was not traceable. None of the Forest Department officials, local inhabitants and fishermen were aware of the existence of such an island.

Status of *Batagur* nesting

First phase of the survey showed that only Mechua in the Bagmara block of STR provided suitable nesting habitat for *Batagur*, and hence further surveys were restricted to Mechua island only. The area is about 15 sq. km with 3 km shoreline. It has an area of about 2000 x 50 m (l x w) dry sand during high tide which is suitable for turtles to nest. Five surveys were conducted in Mechua island, the last one was during the hatching period for 10 days in the first fortnight of May (Table 3). Three *Batagur* tracks were recorded during the present survey which would account for a maximum of three nesting females. All of them were observed by 20th March. This indicates that the nesting (i.e. egg laying) of *Batagur* was probably over by the third week of March.

Seventy records were obtained for sea turtles in Mechua island: one carapace, two intact and 21 preyed upon nests and 46 tracks and young ones. Among the 23 nest records 21 (91%) had been preyed upon by predators, 20 of them by Wild Pig (Table 3). No *Batagur* hatchlings were observed in Mechua island during 4-13 May. However, the hatching of two nests of Olive Ridley Sea Turtle was recorded. Twenty hatchlings of the sea turtle were observed during the survey.

One *Batagur* nest was located in Mechua island during 1993 by Project Tiger officials. This was protected from predators by erecting an enclosure. Hatching success was about 90% and all hatchlings were reported to have been released in the wild (P. Sen Gupta, pers. comm.). Records of *Batagur* nesting in STR since 1988 show a maximum of 10 nests in February-March 1990 (Seth 1993). Three nests were recorded in *Bagmara* block of STR in 1989 and 1991 (Ghosh and Mandal, 1990 and Fig. 2). During the present five intensive surveys, three tracks of *Batagur* have been recorded.

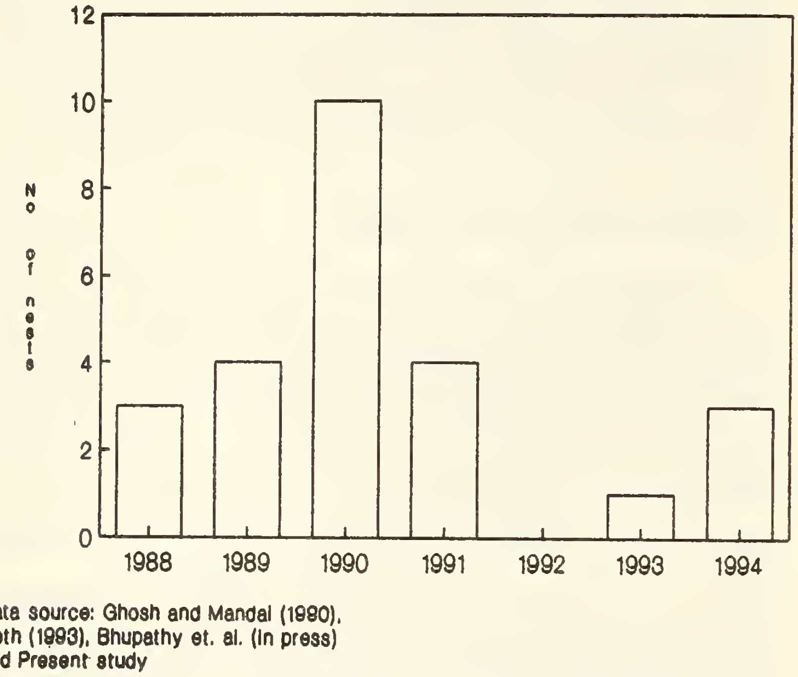

Fig.2 Batagur nest records in Sunderban Tiger Reserve between 1988 and 1994.

TABLE 3
NESTING RECORDS OF *BATAGUR* AND SEA TURTLES IN MECHUA ISLAND. *number in parenthesis is hatchlings seen*

Survey Date	Batagur signs	Sea y turtle sign			
		No. of shells	Predated nest	Intact nest	Fresh sign
5-6 March 1994	2 tracks	—	15	2	6
17-18 March 1994	1 track	—	5	—	9
27-28 March 1994	—	1	1	—	—
11-12 April 1994	—	—	—	—	—
4-15 May 1994	—	—	—	—	11 (20)
Total	3	1	21	2	46

Status of *Batagur* population in the wild

No *Batagur* was sighted in the wild during the 480 daylight hours of survey in the open estuarine system. Queries during the survey revealed that only people living in the northeastern parts of Sunderban were aware of *Batagur*. Based on the past seven years nesting data (Fig. 2), it is assumed that the number of nesting females in STR could be up to a maximum of only ten. Between 1990 and 1994 the Forest Department has released about 40 captive raised young *Batagur* (2-4 years old) in the river Harinbanga of STR (P. Sen Gupta, pers. comm.).

Gunther (1864) reported that *Batagur* was abundant in the Hoogly river mouth. However, during the present survey, no live turtle or nest was recorded in islands located in the Hoogly river mouth: Bakkali, Jambu, Dublat and Gangasagar. These islands have vast sandy areas, but all of them have human settlements. The major occupation of the people is fishing and many of them also poach turtle eggs. Hence, it appears that the population of *Batagur* described earlier by Gunther does not exist any longer and the present status of this species is 'extremely rare' in the Indian Sunderban.

Batagur in captivity

The West Bengal Forest Department initiated a captive breeding programme for *Batagur* in 1988 at Saznakhali in STR (Ghosh and Mandal 1990). In addition to this, rearing centres were established at Pakiralaya, Bagna Range Office and Jinghahali Beat Office in STR (Fig. 1). Twenty one nests were located in the wild between 1988 and 1991 and 645 eggs were collected to be transported to Saznakhali for artificial incubation and captive rearing. Less than 50% of hatching success was recorded (Ghosh and Mandal 1990, and Seth 1993). Captive rearing facilities of STR had only 11 *Batagur* during the present survey. In addition to this, Alipur Zoo, Calcutta had 10 individuals. At present about 25 *Batagur* are with the Captive Breeding Centres (CBC).

Inhabitants of the northeastern parts of STR believe that keeping *Batagur* in their ponds would bring good luck to them. Twenty five villages adjacent to STR were surveyed; only three of them, Govindakati, Mangalchandi, and Amtali had *Batagur.* Six more villages reportedly had *Batagur,* but the villagers did not co-operate in locating the turtles as they were scared of legal action by the Forest Department. All *Batagur* in the villages appear to be adult as they had cephalic coloration. According to local inhabitants *Batagur* lives in low saline areas. Incidentally, the waters of rivers Kalindi and Raimangal are less saline compared to other rivers in the Indian Sunderban. Queries revealed that till 10-15 years ago, *Batagur* used to be regularly collected by villagers from rivers Kalindi and Raimangal in the northeastern parts of STR bordering Bangladesh (Fig. 1). Low saline areas are mostly outside STR, where fishing activity is high. However, villagers informed that this species was not seen in recent years in the above mentioned rivers.

The survey revealed that approximately 20 adult *Batagur* are still in captivity with villagers. Further, it was learnt that three village ponds had *Batagur* with both sexes (2-4 individuals) together for many years. However, no record exists on successful breeding. The lack of breeding in captivity may be due to various factors such as lack of feeding and nesting habitats, quality food and an insufficient number of adult males and females.

Exploitation level

Seventeen daily and weekly fish markets were checked in Sunderban for *Batagur.* Local people were also interviewed regarding the availability of this species in markets. None of the markets had *Batagur* during the survey. However, one Olive Ridley sea turtle kept alive for sale was seen in Gangasagar market. Markets at Kumirmari and Mollahali had shells of Indian flapshell turtle. The absence of *Batagur* in the markets could be due to its extreme rarity in the wild and special protection offered by Project Tiger officials.

Conclusion

The present study shows that *Batagur* is extremely rare in the Indian Sunderban. The rarity cannot solely be related to its peripheral distribution ie. westernmost limit (Daniel 1983), as this species was reported to have been common in the 18th century (Gunther 1864) in the Hoogly river mouth of Sunderban. The present rarity of *Batagur* in the Indian Sunderban may be due to over-exploitation and reduction in the breeding and feeding habitat size.

Suggestions for *Batagur* Conservation in India

1. Monitoring of breeding population

Regular monitoring is suggested for *Batagur* in *Bagmara* block of STR during its nesting period (February-March) to determine the size of the breeding population. Monitoring is essential as the number of breeding females is estimated to be less than ten in the whole of Indian Sunderban. Surveys should be conducted in the early morning hours to avoid possible obliteration of tracks by strong wind.

2. Ecological study

Information on habitat use of an organism is vital for its conservation. Nothing is known about the habitat use of the breeding and non-breeding populations of *Batagur* in Sunderban and elsewhere. As weather conditions are very unstable and man-eating tigers are common in Sunderban, it is extremely difficult to study the habitat preference of *Batagur* in conventional ways, such as direct observation. Hence, satellite radio telemetry techniques may be adopted to study the habitat preference, home range and movement pattern of *Batagur.* This will further help in identifying corridors connecting feeding and breeding habitats of the species.

3. *In situ* conservation

As *Batagur* is extremely rare in the wild and its hatching success in artificial incubation is less than 50%, *in situ* conservation technique could be useful. The captive breeding programme was started in 1988 by the West Bengal Forest Department using eggs collected from the wild. On an average 50% hatching success was recorded by Ghosh and Mandal (1990). This low hatching success could be due to damage during transportation. In 1993, *in situ* conservation technique was adopted by the Forest Department by protecting nests in the wild, and about 90% hatching success was registered. As anthropogenic pressure is low in the Project Tiger area, *in situ* conservation methods will yield better results. As the nests are extremely difficult to locate in the wild an alternate method namely pig proof fencing may be experimented with, by covering a part of the sandy area (about 2 km) of Mechua island. Protection of larger areas is more advantageous than protecting an individual nest in many ways. (1) The latter case requires tremendous effort ie. daily monitoring of probable nesting areas to locate nests during egg laying, which is an extremely difficult task, whereas fencing protection requires efforts to fence an area only once in two years; (2) In the protection of larger area, hatchlings would find their own way to the sea, whereas in the latter case, a close watch on the nest is required and hatchlings should be removed from the enclosure soon after hatching and (3) Even though it is known that the eggs of *Batagur* hatch after about 60 days, monitoring would be a difficult task in the unpredictable weather and rough sea conditions that prevail in Sunderban. The pig proof fence would enhance the survival of *Batagur* nests and hatchlings and help build up the population.

4. *Ex situ* conservation (Captive breeding)

Ten villages in the northeastern part of STR have about 20 adult *Batagur* (of both sexes) in ponds and similar number in CBCs. A common *Batagur* captive breeding unit is suggested outside STR using captive turtles. The captive breeding unit should be designed considering ecological aspects involving the villagers. Inbreeding among a small population of turtles may be avoided by replacing males, if available, from the wild. Captive bred *Batagur* may be released in the wild after about 4 to 5 years. The restocked turtles should be monitored by marking them. Records relating to the released turtles should be properly maintained for future reference and monitoring.

5. Awareness programme

The inhabitants of Sunderban should be made aware of the rarity of *Batagur*. This may be done by publishing a poster with descriptions in the local language giving species identification, past and present status, and biology. The locals of Sunderban may be requested to inform Project Tiger officials on encountering a *Batagur*.

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CONSERVATION AND UTILISATION OF ECOGENETIC RESOURCES OF PANCHPATMALI HILL IN ORISSA[1]

B.C. Patra[2], S.D. Sharma[3], D.N. Roy[4] and R.K. Misra[5]

As many as 160 wild species belonging to 53 families occur in the Panchpatmali hill. The flora has both South Indian and Himalayan representatives due to the geographical position of the area. Efforts made by the National Aluminium Co. to conserve the regional flora and maintain the environmental status have been examined.

Introduction

The Panchpatmali hill on Damanjodi is located in the Koraput district of Orissa between 18° 45' and 19° 55' N latitude and 82° 58' and 83° 04' E longitude. The Panchpatmali hill has one of the largest deposits of bauxite ore in India, which is being mined for the extraction of alumina by the National Aluminium Company (NALCO). This hill range is considered as the northernmost part of the Eastern Ghats.

The floristic and ecogenetic resources survey of the hill was undertaken in the year 1992-93. The objective of the survey was to study the biodiversity of flora, and enumerate the endangered or vulnerable taxa, besides cataloguing the potentially medicinal and economically important plants.

Physiography: The Panchpatmali hill has a 17 km long and 20 m thick bauxite deposit. The highest elevation of the hill is 1336 m above msl and 450 m above the level of adjoining plains. Escarpments up to 10 to 30 m occur on all sides and thereafter gentle slopes extend towards the valley.

Climate: During summer, maximum temperature ranges from 28° to 31°C and the minimum from 16° to 20°C. During winter months the maximum temperature ranges between 7° to 14°C. April is the hottest and January the coldest month of the year.

Rainfall: The region receives rain from the southwest monsoon (June-September). In addition, occasional heavy showers are also received due to the northeast monsoon in the month of November and December, leading to many cloudy days. The annual average rainfall on the hill is 1520 mm with 20% variation.

Vegetational Analysis: The Panchpatmali hill at the bauxite ore deposit site has a very scanty vegetation except on the hill slopes or valleys where there is flow of water from streams. Broadly, the vegetation of the area can be designated as a mixed deciduous scrub jungle.

(a) **Flora on the hill top**: Since the plateau top is a table land with a calcareous hard surface there is no significant vegetation except a vast stretch of *Phoenix acaulis*. On rainy days, grasses and a few herbaceous elements occur, which make the vegetation appear as a grassland. The typical high altitude herbaceous plants found on the plateau region are *Pogostemon quadrifolius, Pimpinella heyneana, Exacum pedunculatum* and *Hypericum japonicum*. The other conspicuous plants are *Stachytarpheta indica, Commelina benghalensis, Crotalaria pallida, Kyllinga bulbosa, K. nemoralis, Cyperus* sp., and *Eriocaulon* sp. among others. At places where there is water accumulation and the soil is sandy/loamy, *Polygonum plebeium, P. barbatum, Borreria pusila, Mitracarpus verticillatus, Gnaphalium polycaulon* etc occur. The noteworthy insectivorous plants which often draw the attention of conservationists are *Drocera indica* and *D. burmannii*. The two alien species found in association with the above described plants are

[1]Accepted September, 1995.

[2]Scientist (Senior Scale), Genetic Resources Division, Central Rice Research Institute, Cuttack.

[3]Retd. Principal Scientist & Head, Central Rice Research Institute, Cuttack.

[4]Retd. Deputy Director, Department of Agriculture, Govt. of Orissa.

[5]Reader and Head, Basic Science College, Orissa University of Agriculture and Technology, Bhubaneswar.

Chromolaena odorata and *Lantana camara* var. *aculeata* which appear to have been naturalised on the hill top in the course of time with human interference. Among the wild species of crop plants, *Oryza nivara*, which is believed to be the progenitor of cultivated rice *Oryza sativa*, was found growing on seasonal swamps on the hill top.

With the onset of winter, some new species sprout. Among them are *Vicoa indica*, *Viola betonicifolia*, *Oxalis corniculata*, *Sphaeranthus indica*, *Solanum surattense*, *Setaria pumila*, *Aerva sanguinolenta* etc. Very few twiners/climbers are observed at the plateau, obviously because they do not get any supporting shrub or tree species on which they can grow. However, *Chromolaena odorata* and *Phoenix acaulis* sometimes provide support to a few twining species like *Cocculus hirsutus*, *Thunbergia fragrans* var. *laevis*, *Asparagus racemosus*, *Hemidesmus indicus*, *Clematis roylei* and species of *Ipomoea* and *Dioscorea*. Surprisingly, not a single tree species is found on the plateau top. Half-metre deep trenches dug by bears and wild boar in search of succulent tubers are often seen on the plateau.

(b) **Flora of the valleys and slopes**:

The vegetation at the slopes and the valleys is represented by mixed deciduous forest. The tree species of economic importance are *Terminalia bellerica*, *Phyllanthus emblica*, *Mangifera indica*, *Artocarpus heterophyllus*, *Murraya koenigii* etc. The other dominant wild tree species found in association are *Trema orientalis*, *Caryota urens*, *Semecarpus anacardium*, *Alstonia venenata*, *Memecylon umbellatum* and species of *Ficus*, *Gardenia*, and *Bauhinia*. The shrubs commonly found are *Cipadessa baccifera*, *Wendlandia tinctoria*, *Clerodendrum* sp., *Woodfordia fruticosa* and *Indigofera cassioides*. The dominant robust climbers or lianas are represented by *Bauhinia vahlii* and *Schefflera venulosa*. Among the scandent shrubs *Ziziphus rugosa* (a wild relative of *Z. mauritiana*, an arid zone fruit plant) and *Jasminum arborescens* (wild jasmine) are found. Most interestingly, *Atylosia cajanifolia*, a wild relative of *Cajanus cajan* (arhar) first described by Haines (1921) as an endemic species from Kuhuri forest of Puri district occurs on the slopes of Panchpatmali hill.

In the rocky crevices along the stream, *Thysanolaena maxima* and *Hypericum gaitii* are found in association with some fern species of *Pteris*, *Athyrium*, *Microlepis*, *Tectaria* etc. *Solanum torvum*, a potential indigenous medicinal plant is found occasionally on the hill slopes.

Along the roadside leading to the mining site, plants of the plains are noticed. They are *Celosia argentea*, *Pennisetum pedicellatum*, *Hydrophilla auriculata*, *Aerva lanata*, *Croton bonplandianum*, *Verbascum chinense*, *Parthenium hysterophorus* etc.

Statistical analysis of the Flora:

The flora of the region is represented by 160 wild and naturalised angiospermic species belonging to 53 families. The number and percentage of monocot and dicot families, genera and species are shown in Table 1.

TABLE 1

Groups	Families		Genera		Species	
	No.	%	No.	%	No.	%
Monocotyledons	9	21.42	29	27.35	34	26.98
Dicotyledons	42	78.58	106	72.65	126	73.02
Total	53		135		160	

The approximate ratio of monocot families to dicot families is 1:4.6, monocot genera to dicot genera is 1:3.6 and monocot species to dicot species is 1:3.7. Further, the approximate genus species ratio is 1:1.18, as against 1:2.4 for Bihar and Orissa (Haines, 1921-25 and Mooney, 1950) and 1:7 for British India (Hooker, 1907).

In order to get an insight into the relationship of the flora of Panchpatmali hill with that of Bihar and Orissa (Haines, 1921-25) and of India (Hooker, 1907) a comparative list of the dominant families of the region is provided in Table 2.

TABLE 2
FLORA OF PANCHPATMALI HILL, BIHAR AND ORISSA, AND INDIA, A COMPARISON

	Panchpatmali hill	Bihar and Orissa (Haines)	India (Hooker)
1.	Poaceae	Leguminosae	Orchidaceae
2.	Asteraceae	Graminae	Leguminosae
3.	Euphorbiaceae	Cyperaceae	Graminae
4.	Fabaceae	Compositae	Rubiaceae
5.	Rubiaceae	Euphorbiaceae	Euphorbiaceae
6.	Acanthaceae	Acanthaceae	Acanthaceae
7.	Cyperaceae	Orchidaceae	Compositae
8.	Lamiaceae	Rubiaceae	Cyperaceae
9.	Scrophulariaceae	Labiatae	Labiatae
10.	Solanaceae	Scrophulariaceae	Urticaceae

In the plantation programme, soil-conserving species, fast growing species (mostly exotics), indigenous forest species, ornamental flowering avenue trees and fruit bearing trees are selected. From the analysis of the comparative distributional pattern provided in Table 3, it is evident that as many as 7 species from among the scanty vegetation of the Panchpatmali hill occur both in Himalayas and Southern Peninsular region.

TABLE 3

Name of plant	Family	Other localities where it occurs
Clematis roylei Rehder	Ranunculaceae	Khasia hills
Pimpinella heyneana Kurz (DC.)	Apiaceae	Deccan hills
Schefflera venulosa (Wt. & Arn.) Harms	Araliaceae	Himalayas to South Deccan
Exacum pedunculatum L.	Gentianaceae	Khasia hills
Justicia simplex D. Don	Acanthaceae	Himalayas, Western Peninsula
Pogostemon quadrifolius (Benth.) Kuntze	Lamiaceae	Khasia, Deccan
Osbeckia chinensis L.	Melastomataceae	Deccan peninsula

CONCLUSION

The Panchpatmali hill possesses many elements of both Peninsular and Himalayan flora. Among them *Hypericum gaitii, H. japonicum, Clematis roylei, Pogostemon benghalensis, P. quadrifolius, Drosera indica, Exacum tetragonum,* and *Pimpinella heyneana* are noteworthy on the slopes. This confirms that higher elevations of Orissa have served as an intermediate step in the migration and stabilization of some species from the lower Himalayas to the hills of South India and viceversa (Patra and Choudhury, 1989). *Phoenix acaulis* which is present in such a vast range at the hill top, can be referred to as an indicator plant for bauxite ore.

NALCO has completed the plantation of about 100 hectares of land around Panchapatmali hill with more than 18 lakh saplings of 39 different species. A few exotic species have also been introduced in the area. Planting programmes are usually attempted to raise fast-growing tree species with almost complete exclusion of shrubs, climbers, rambling bushes and epiphytes that form the middle and lower canopy in a natural forest. Natural calamities like cyclones, frost or epidemic diseases and pests may damage man-made plantations to a greater extent. So, use of local broad-leaved deciduous species with exotic evergreens would give the necessary diversity to the vegetation cover, besides controlling atmospheric pollution and above all beautification of the area.

To obviate the lacuna due to the absence of the middle and lower canopy in man-made forests and also to ensure that all available plant species of the region are conserved, a Forest Park may be established which will serve as a "Gene Sanctuary" for the local flora. There is a vast diversity in the banana germplasm which should be collected, characterised and evaluated for its "built-inresistance" genes and utilised in the banana improvement programme. NALCO has already collected about 50 species of medicinal and economically important plants and has been maintaining them in its nurseries.

ACKNOWLEDGEMENTS

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HABITAT USE BY THE LESSER FLORICAN IN A MOSAIC OF GRASSLAND AND CROPLAND: THE INFLUENCE OF GRAZING AND RAINFALL[1]

R. SANKARAN[2]

(*With three text-figures*)

I studied effects of grazing and rainfall on habitat use by the Lesser Florican in a mosaic of grassland and cropland. I found that the most preferred habitat of the Lesser Florican is area under grass cover. However, as a result of disturbance due to grazing, the florican may temporarily prefer crop areas. In years of drought the Lesser Florican prefers irrigated cropland as these areas have sufficient vegetation cover. When grasses grow too tall, as in years of very well distributed rains, male floricans shift their territories to areas of shorter vegetation, like soyabean fields, and mud roads.

INTRODUCTION

To reproduce successfully, birds should do so when environmental conditions are most favourable (Earle 1981). Breeding seasons are, however, fixed for most species and the degree of variability in favourable environmental factors will play a major role in breeding success. The link between rainfall and the breeding environment of birds has been documented, and nomadism, cessation or delays in breeding are characteristic adaptations of species exploiting environments with variable rainfall; the more unpredictable the rainfall, the more extreme the response (Moreau 1950, Keat and Marshall 1954, Sinclair 1978, Davies 1979, Berry and Crowe 1985, Manry 1985, DeSante and Geupel 1987). In this paper, I examine the effects of a varying monsoon and livestock grazing on the habitat use of the Lesser Florican in a mosaic of grassland and cropland.

The Lesser Florican is an endangered endemic bustard of the Indian subcontinent. It breeds during the southwest monsoon, which normally begins by end June (Jerdon 1864, Baker 1921, Dharmakumarsinhji 1950, Ali and Ripley 1969). During this period, a distinct movement into Gujarat, eastern Rajasthan and western Madhya Pradesh, where it congregates in areas of good rainfall, has been documented (Jerdon 1864, Sankaran *et al.* 1992). The primary breeding habitat are grasslands where sufficient grass cover is available during the breeding season. In western India, these grasslands are fragmented and patchily distributed and the majority of habitat available to the Lesser Florican is a mosaic of grassland ana cropland.

STUDY AREA

I studied habitat use by the Lesser Florican in the Sailana Kharmor Sanctuary (354 hectares (ha); 23° 31' N and 75° 01' E; Fig. 1) near Sailana town, Ratlam district, western Madhya Pradesh. The Sanctuary is a mosaic of grassland, cultivated fields and grazing lands and is bounded by three villages, Sailana, Adwanya and Gordhanpura. The grassland area within the Sanctuary is about 200 ha, and is owned by agriculturists, and known as the Naulakha *bheed.* The grassland is maintained and protected for its hay produce. Livestock grazing is usually permitted upto five weeks after the onset of the monsoon, the cattle thus exploit the first flush of vegetation. After this the grassland is strictly protected from grazing until the hay harvest is completed in November. Once the hay harvest is done, grazing is again permitted, and the livestock thus exploit the remaining grass stubble.

The Naulakha grassland has six main ridges and their spurs, all sloping towards the eastern corner

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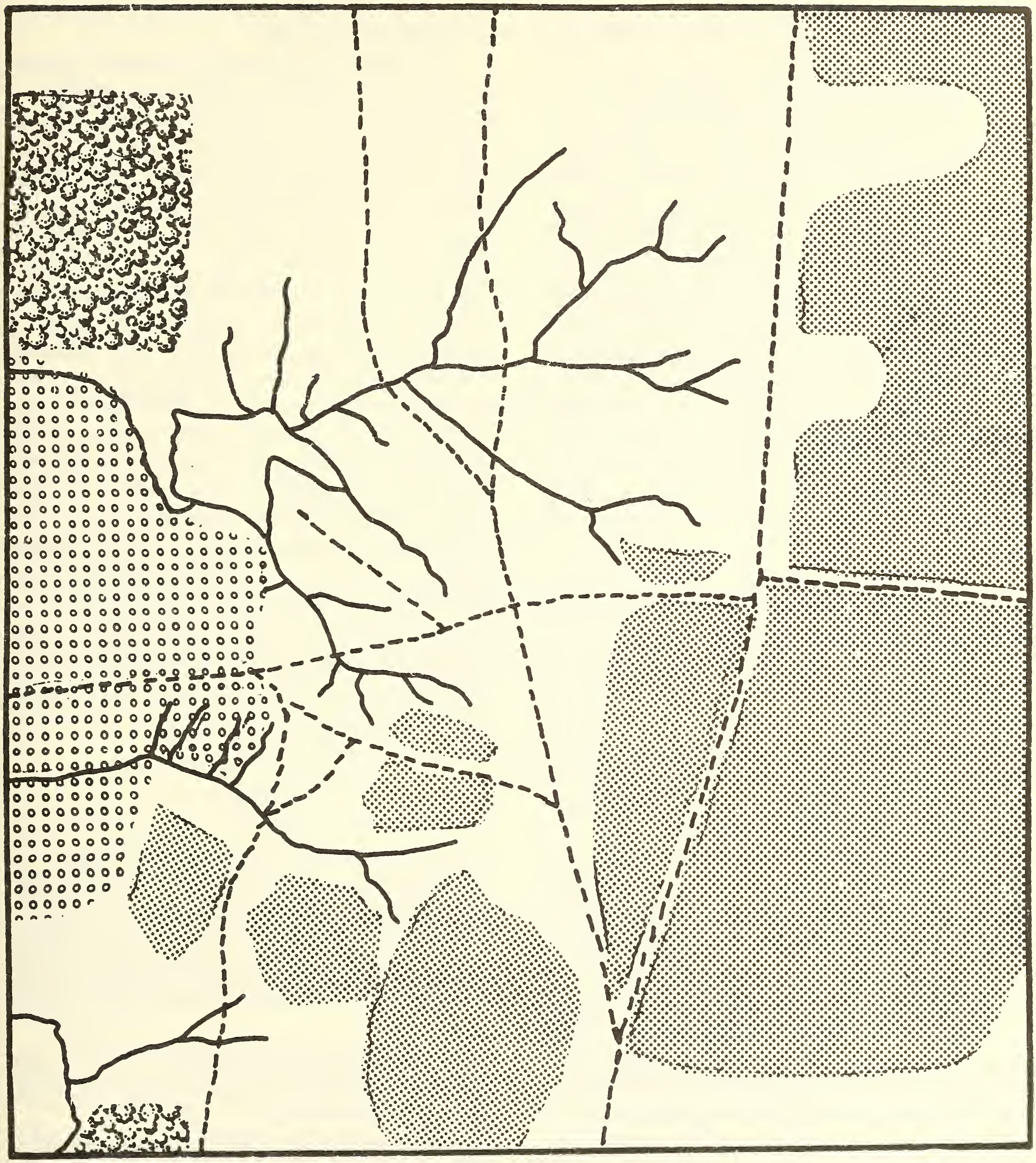
[1]Accepted May, 1995

[2]Bombay Natural History Society, Shaheed Bhagat Singh Road, Mumbai 400 023.
Present Address: Salim Ali Centre for Ornithology & Natural History, Kalampalayam P.O., Coimbatore 641 010



Crop Fields   Grazed area   Plantation   Grassland

Fig. 1. Map of the Sailana Kharmor Sanctuary (Not to scale)

of the Sanctuary, where lies a perennial reservoir, Gordhansagar. The shallow valleys between the ridges channelise rainwater rivulets towards this waterbody and two other smaller reservoirs.

At the Sailana Kharmor Sanctuary, the habitat available to the Lesser Florican was of three types:

a) Grassland: This was the Naulakha grassland which covered about 200 ha of pure contiguous grassland, almost devoid of trees. The grassland area conformed to the *Sehima nervosum - Chrysopogon fulvus* type, that is the dominant grassland type in the Lesser Florican's breeding range. Other grasses include *Heteropogon contortus, Apluda mutica, Cymbopogon martini, Aristida funiculata* and species of *Bracharia, Eragrostris, Dichanthium, Pseudoanthesterea, Digitaria, Setaria* and *Bothriocloa.* Wild rice *Oryza rufipogon* grows where water accumulates during the monsoon. *Butea monosperma* is a common bush, rarely growing into a tree.

b) Crop fields: On the periphery of the grassland are the agricultural fields, both irrigated and rain fed, of the nearby villages. The predominant monsoon crops were Cotton *Gossypium* sp., Sorghum *Hordeum vulgare,* Maize *Zea mays,* and Soyabean *Glycine max.* In winter Wheat *Triticum aestivum,* Bengal Gram *Cicer arietinum,* Garlic *Allium sativum,* Ajma (or Ajwain) *Trachyspermum ammi* and Poppy *Papaver somniferum* were cultivated.

c) Grass patches in crop areas: These were small isolated patches of grass amidst the cultivated fields which had not yet been brought under the plough. These patches were small, ranging from 0.1 to 1.5 ha and totally occupied only about 10 to 12 ha. While grass patches should be classified under grassland, this distinction is made purely on the basis of location and size. Moreover, such a distinction is meant to contrast the use between crop fields and areas under grass cover within crop areas.

Methods

The study extended over about 400 days between July 16 and October 6, 1985; June 22 and October 10, 1986; June 16 and October 1, 1987; June 24 and October 6, 1988.

All habitat types in the study site were scanned to locate Lesser Florican either by sighting or flushing them. Before territories were established, such scanning of the study area was done every day, and less frequently once territories were established and males became localised. Data on Lesser Floricans thus flushed, or located, was recorded primarily as to location in the study area and habitat i.e. whether in crop field, grass patches or in the main grassland. Habitat use data was based purely on the habitat a florican was using when it was first located. Subsequent movement was not taken into account.

As habitat classes occurred in different proportions over the study areas, the data for all habitats used have been normalised by dividing the data values with weights proportionate to the area under different habitats. Thus grasslands were quantitatively weighted as 15, crop as 5 and grass patches as 1. This was then standardised by converting values into percentage of total sightings for each habitat in a fortnight. Standardisation was necessary to make the data set comparable between years because the number of birds which were sighted varied between years and there was need to eliminate bias that arose out of this.

Results

Profiles of three monsoons 1986 - 1988.

1986: The monsoon began on time and the quantum was excessive (+49.03% of the normal).

1987: The monsoon was late and patchily distributed but quantum of rainfall was slightly above normal (+8.1%). Number of rainy days were 29, about -40%.

1988: The monsoon was on time and was uniformly distributed. The quantum of rainfall was above normal (+16.1%).

Maximum grass growth rates and height were seen in those years when the monsoon was on time or early (third week of June), and when rainfall was distributed throughout the season (up to October). Though 1986 had the maximum quantum of rainfall,

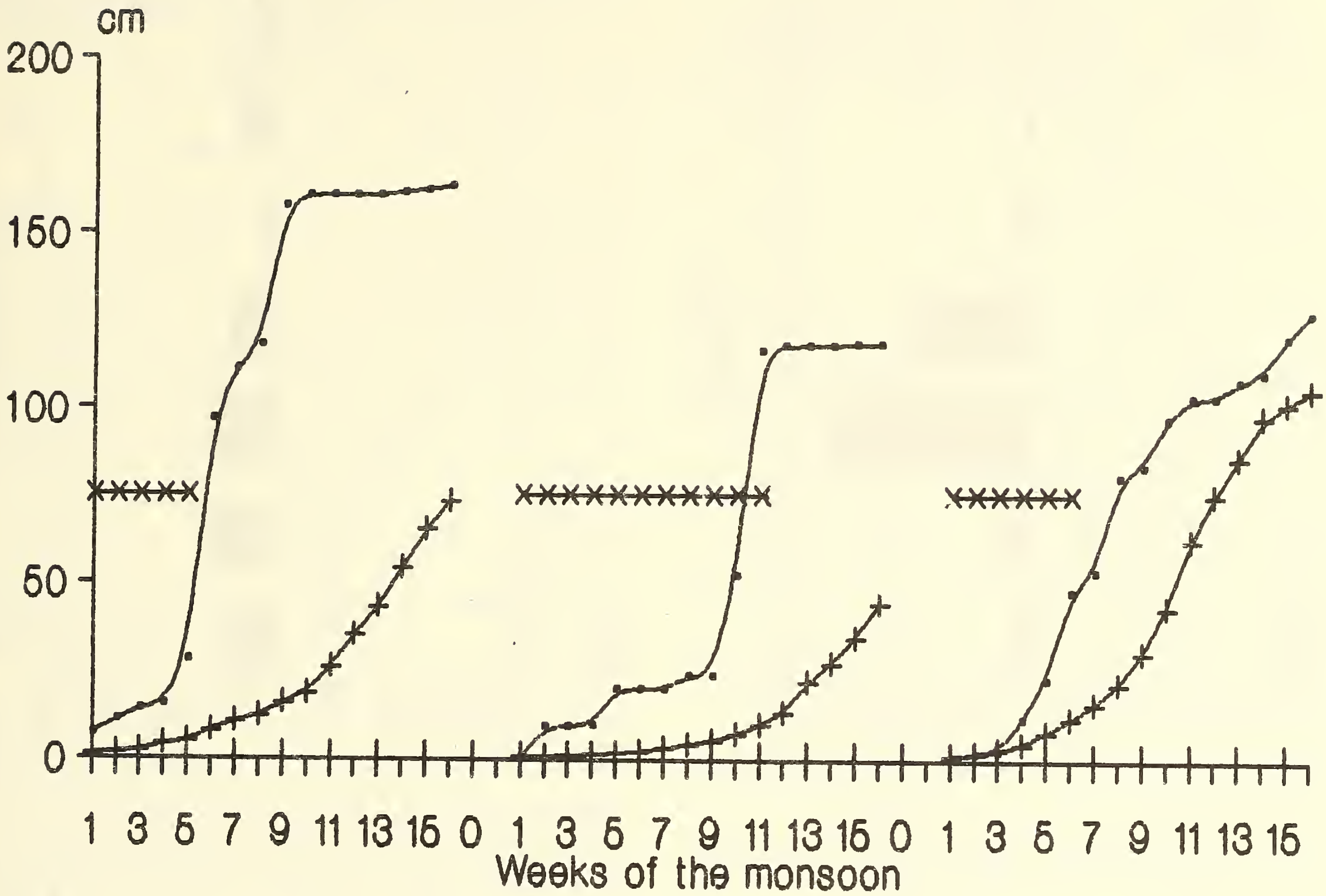


Fig. 2. Rainfall, grass growth and grazing - Naulakha grassland

Cumulative rainfall   Grass height   Grazing

the distribution was restricted more or less to the first half of the season, with the latter part being dry. This resulted in lower grass growth rates and height when compared with 1988 (Fig. 2). 1987 was a drought year with late commencement of rains and patchy distribution of rainfall. The late flush of growth in 1987 resulted from a few belated heavy showers (Fig. 2).

Livestock grazing was permitted at the Naulakha grassland for the first five weeks after the onset of the monsoon and was stopped subsequent to a week of heavy rainfall. The year 1987 was an exception, and grazing continued for 11 weeks after the commencement of the monsoon, due to poor rainfall. The influence of livestock grazing during the early monsoon was similar for all years except 1987, when grass growth rates were the lowest (Fig 2).

I found that there are significant differences in habitat use patterns in the Lesser Florican both between years, due to differences in rainfall and its effect on grass growth, and within a season, as a result of cattle grazing.

Within season changes in habitat use

In 1986, the Lesser Florican used grasslands, grass patches and crop fields in a descending order of preference (Table 1). In 1986, fornightly shifts in habitat preference showed maximum use of grasslands in the first fortnight. In the second fortnight, floricans used all three habitats equally. In the following five fortnights both grass patches

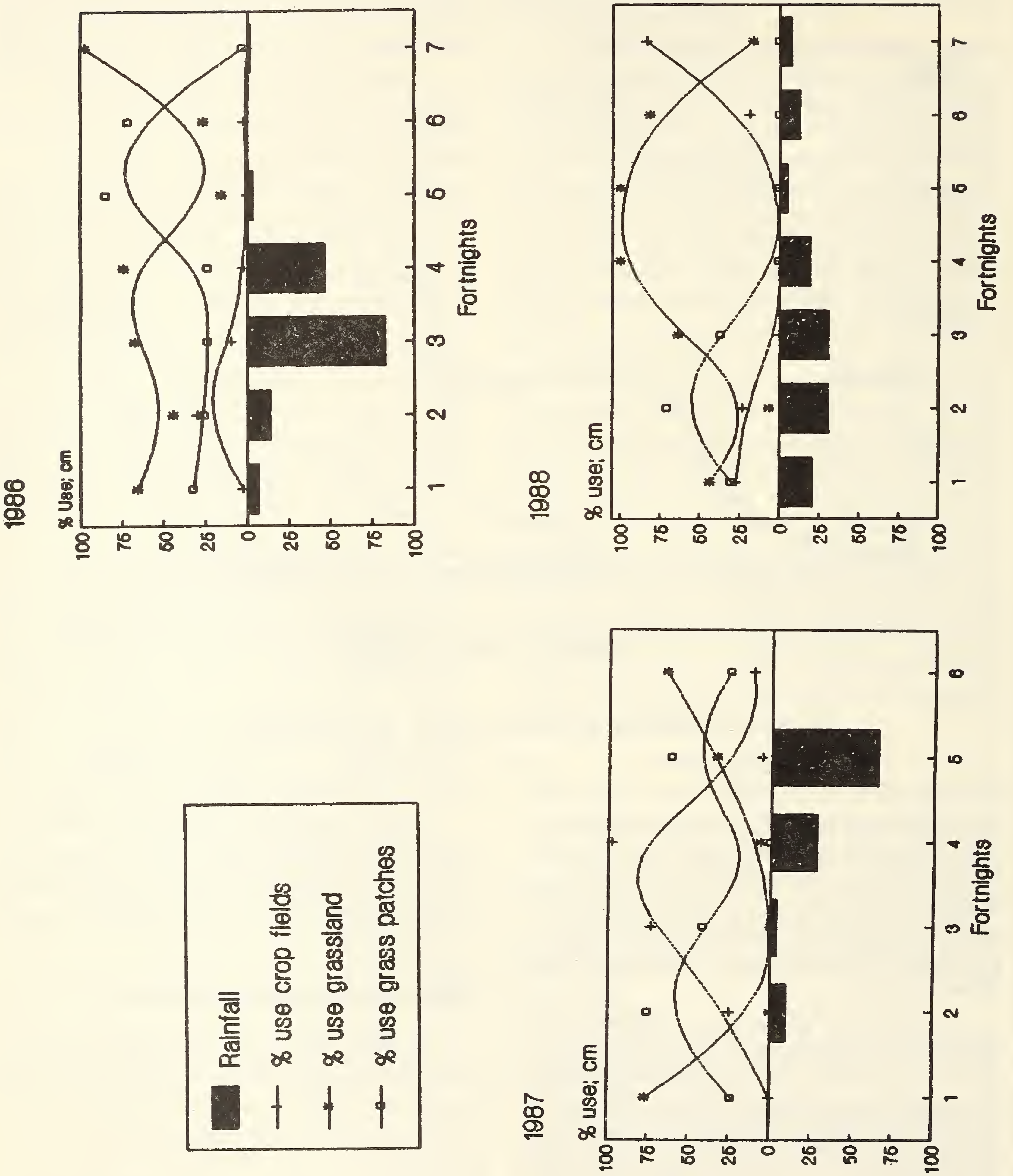


Fig. 3. Fortnightly pattern of habitat use by the Lesser florican under different monsoon conditions.

TABLE 1
VARIATION IN INTRA-YEAR HABITAT USE: 1986 TO 1988 KOLMOGROV-SMIRNOV TWO SAMPLE TEST RESULTS

		Grass MD	Grass p	GPC MD	GPC p
1986	Crop	0.791	<0.001	0.418	<0.001
	Grass			0.478	<0.001
1987	Crop	0.244	0.121	0.267	0.072
	Grass			0.111	0.921
1988	Crop	0.639	<0.001	0.194	0.448
	Grass			0.611	<0.001

and the main grassland were used the most and crop fields the least (Table 2 a; Fig. 3).

In 1987, all three habitats were used equally (Table 1). In the first fortnight the grassland was used more than grass patches while crop fields were not used at all. In the second fortnight all three habitats were used equally. In the third and fourth fortnights, crop fields were used almost exclusively. In the fifth fortnight all three habitats were used and in the sixth fortnight the grassland was used almost exclusively (Table 2b, Fig. 3).

In 1988, the grassland was used the most while grass patches and cropfields were used equally (Table 1). In the first two fortnights all the three habitats were used equally. In the third, fourth and fifth fortnights grasslands were used the most. In the sixth fortnight a shift was seen towards crop fields, and in the seventh fortnight crop fields were used the most (Table 2c; Fig. 3).

Between season differences in habitat use

Overall habitat use was similar in 1986 and 1988. The pattern in 1987 was different, with crop areas being used most frequently and grassland less frequently than in 1986 and 1988 (Table 3). In all three years grass patches did not show significant variation in intensity of use.

TABLE 2
COMPARISON IN HABITAT USE PATTERNS BETWEEN FORTNIGHTS OF THE BREEDING SEASON (KOLMOGROV-SMIRNOV TWO SAMPLE TEST RESULTS)

Table 2a. 1986

		Grass MD	Grass p	GPC MD	GPC p
Fortnight 1	Crop	0.875	<0.001	0.375	0.520
	Grass			0.625	0.049
Fortnight 2	Crop	0.300	0.664	0.200	0.962
	Grass			0.500	0.112
Fortnight 3	Crop	0.700	0.006	0.300	0.664
	Grass			0.700	0.006
Fortnight 4	Crop	0.857	0.006	0.286	0.919
	Grass			0.714	0.047
Fortnight 5	Crop	1.000	<0.001	1.000	<0.001
	Grass			1.000	<0.001
Fortnight 6	Crop	0.900	<0.001	0.900	<0.001
	Grass			0.800	<0.001
Fortnight 7	Crop	0.909	<0.000	0.091	1.000
	Grass			0.909	<0.001

Table 2b. 1987

		Grass MD	Grass p	GPC MD	GPC p
Fortnight 1	Crop	1.000	<0.001	0.250	1.000
	Grass			0.750	0.125
Fortnight 2	Crop	0.250	1.000	0.500	0.500
	Grass			0.750	0.125
Fortnight 3	Crop	0.900	<0.001	0.600	0.030
	Grass			0.300	0.664
Fortnight 4	Crop	1.000	<0.001	1.000	<0.001
	Grass			0.100	1.000
Fortnight 5	Crop	0.167	1.000	0.500	0.333
	Grass			0.333	0.778
Fortnight 6	Crop	0.545	0.063	0.182	0.986
	Grass			0.545	0.063

Table 2c. 1988

		Grass MD	Grass p	GPC MD	GPC p
Fortnight 1	Crop	0.333	0.778	0.167	1.000
	Grass			0.500	0.333
Fortnight 2	Crop	0.200	1.000	0.600	0.320
	Grass			0.800	0.080
Fortnight 3	Crop	1.000	<0.001	0.444	0.307
	Grass			0.556	0.111
Fortnight 4	Crop	1.000	<0.001	0.000	1.000
	Grass			1.000	<0.001
Fortnight 5	Crop	1.000	<0.001	0.000	1.000
	Grass			1.000	<0.001
Fortnight 6	Crop	0.750	0.125	0.250	1.000
	Grass			1.000	<0.001
Fortnight 7	Crop	1.000	<0.001	1.000	<0.001
	Grass			0.667	0.667

Table 3

VARIATION IN INTER-YEAR HABITAT USE IN THE LESSER FLORICAN: 1986 TO 1988. (KOLMOGROV-SMIRNOV TWO SAMPLE TEST RESULTS)

	Crop 87 MD	Crop 87 p	Crop 88 MD	Crop 88 p
Crop 86	0.442	<0.001	0.139	0.832
Crop 87			0.444	<0.001

	Grass 87 MD	Grass 87 p	Grass 88 MD	Grass 88 p
Grass 86	0.644	<0.001	0.167	0.640
Grass 87			0.667	<0.001

	GPC 87 MD	GPC 87 p	GPC 88 MD	GPC 88 p
GPC 86	0.178	0.440	0.111	0.961
GPC 87			0.167	0.640

Key For Tables 1 to 3
Crop = Cultivated fields
Grass = Grassland (Naulakha)
GPC = Grass patches amidst Cropfields

Discussion

A lack of disturbance and vegetation cover appear to be of greatest importance in habitat selection during the breeding season of the Lesser Florican.

During the monsoon the centre of disturbance shifts in the Sailana Kharmor Sanctuary. During the early monsoon, the main grassland was the most disturbed of the three types of habitat due to the presence of livestock and graziers. In this period, crop areas are relatively undisturbed because rains, wet slushy soil and freshly sprouting crops prevent farmers from working their fields. Once grazing is stopped the grassland is undisturbed. The fields soon become disturbed as farmers begin weeding, spreading fertilizers and spraying pesticides during dry spells. Grass patches are the least disturbed of all three types as these are neither grazed nor worked upon by farmers.

Subsequent to arrival, the floricans are mainly seen in the grassland. However, as the grassland is disturbed due to grazing during the early monsoon, the floricans begin using crop areas. A reversal is seen with the cessation of grazing, and due to the absence of disturbance, the grassland becomes the most used habitat type. That the Lesser Florican use crop areas primarily due to the disturbance by livestock in the grassland, was also seen by their movement away from the grassland into crop fields at about 0800 to 0900 hours, when the cattle start arriving in the grassland, and their movement back to grassland at about 1700 to 1800 hours when the cattle start leaving the grassland.

In 1986 and 1988, both high rainfall years, there was no significant variation in habitat use patterns. On the other hand, 1987 differed significantly because of the lack of adequate cover and greater disturbance (due to an extended grazing period) in the main grassland as a result of drought. The cropfields had more vegetation cover (due to crop growth as a result of irrigation) than the grassland, and was relatively less disturbed. The few birds that were present in 1987 were seen almost exclusively in the crop fields. However, once grazing was stopped, and late rains caused sufficient grass cover in the grassland, the floricans showed a shift towards increased use of the main grassland.

The optimal grass height range of the Lesser Florican is difficult to determine because the period of lowest grass heights coincides with grazing. However, very tall grass is not preferred by floricans, and males which had territories in the grassland shifted to crop fields or paths and mud roads within the grassland when grasses grew too tall, as was the case in 1988 when a distinct shift to crop areas was seen at the end of the breeding season.

Conclusion

The preferred breeding habitat of the Lesser Florican is grassland protected from livestock grazing during the monsoon. Choice of habitat, however, is determined by disturbance and, to a lesser extent, rainfall regimes. In normal years, depending on the location of greatest disturbance, birds used cultivated areas or grassland. When grazing took place in the grassland, the floricans used the crop areas more. But in cultivated areas the grass patches amidst crop fields were the preferred habitat. During drought conditions they were, however, more frequently seen in crop fields because of more vegetation cover as a result of irrigation. When grasses grow too tall, as in years of very well distributed rains or when the grassland is very well protected, male florican shift to areas of shorter vegetation, eg. soyabean fields.

In summation, under situations where adequate vegetation cover is available, the Lesser Florican utilises habitats or areas that are least disturbed. Under drought conditions, the Lesser Florican uses habitats that has greater vegetation cover. Very tall vegetation is not preferred by the Lesser Florican.

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NOMENCLATURAL AND SYSTEMATIC STATUS OF *BARBUS MUSSULLAH* SYKES, 1839[1]

K.C. Jayaram[2]

(*With one plate and one text-figure*)

Introduction

Sykes (1839) described *Barbus mussullah* collected from Ghod river near Sirur (18' 50° N 74' 23° E) Maharashtra. He illustrated his species in colour (Fig. 1B) and gave a description as below:

"Pectoral fins of 16 rays; ventral of 9 rays; dorsal fin of 12 rays, including the first double ray: tail forked, of 24 rays, including the short rays at each exterior side of the insertion of the tail: a remarkable projecting prominence between the upper lip and nostrils, giving the fish an appearance of being Roman-nosed: the eyes are situated far back, and between the eyes and the corners of the mouth there are a number of circular, rough, prominent *papillae*, but these are not constant: corners of the mouth furnished with a short feeler, and the base of the nasal prominence, near the tip, also with one on each side: dorsal fin in the centre of the back, on a prominence which slopes suddenly behind; ventral fins on the centre of the belly, on a perpendicular from the first dorsal ray: tail suddenly narrows below, after the anal fin; anal fin with the posterior angle bluntly rounded off. The lateral line is slightly arched at the shoulder, then falls, and runs straight to the anal fin; over this it rises a little, and then runs straight to the centre of the fork of the tail. The whole of the upper parts of the fish are covered with large, coarse silvery scales, having blue and red reflections, and on the under parts a yellow tinge prevails; it is very bony, and its length, to the end of the fork of the tail, is 30 cm, and height, 7.5 cm; but its greatest growth is 150 cm. When small this species resembles the *Kolus*, but in the latter the colour is more reddish-silvery: the fins are reddish, and the *Mussullah* is a much coarser, and larger fish. A male brought to me at Seroor, from the Goreh river, measured in length 102.5 cm, and in height 30 cm, and weighed nearly 15 kg. The flesh wanted flavour. The *mussullah* differs from the *mosal* of Dr. Hamilton, in having 1 ray less in the dorsal and pectoral fins, and in the first rays of these fins being double instead of quadruple; in the latter respect, and indeed in many others, resembling the *C. putitora*: it also differs in having the nose and upper lip tuberculated, and in colour. The prominence on the nose is also marked. Russell describes three Barbels, calling them *Cyprini*, but none of them are identical with the present fish."

It is clear at the outset that the description and figure do not tally in many respects. The fin ray and scale counts do not agree. Sykes cites that the upper part of the fish is covered with large, coarse silvery scales whereas the figure shows a larger number of medium sized scales. The shape of the anal fin is highly unnatural and is more of an artist's contrivation. The nomenclature and taxonomy of the species is in confusion and they are clarified in this paper.

Nomenclature

There is confusion in the generic position of *Barbus mussullah* Sykes. For many years the species has been included under *Tor* Gray following Hora (1943a). However, recently this species has been referred to under *Hypselobarbus* Bleeker by Menon (1992). The name *Hypselobarbus* was cited by Bleeker (1859) in a key without included species.

[1]Accepted August, 1996

[2]Pitambar Pant National Environment Fellow,
C/o. Madras Science Foundation,
22, III Main Street, Officers Colony, Adambakkam,
Chennai-600 088.

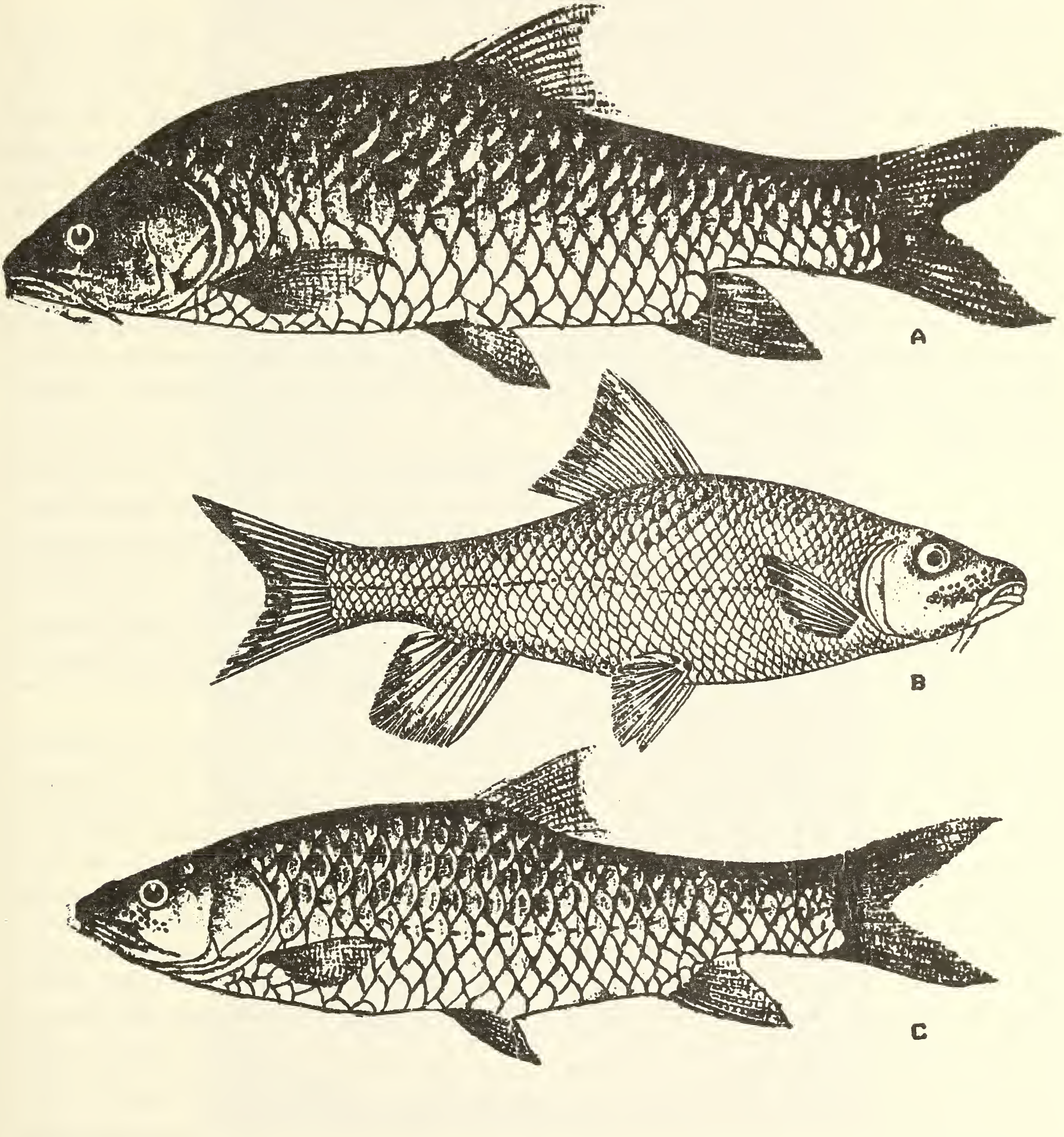

Fig. 1. A. *Barbus* (*Tor*) *mussullah* Sykes x Ca. ¼ drawing was made from colour sketch sent by Dr. M. Suter. B. Original sketch of *Barbus mussullah* as given by Sykes (1839). C. *Barbus* (*Tor*) *khudree* Sykes x Ca. ½ drawing was made from colour sketch sent by Dr. M. Suter.

In 1860 two species *mussullah* and *nancar* were apparently added. *Barbus mussullah* was designated as type subsequently in 1863a or 1863b. It looks like Bleeker had no specimen of *B. mussullah* which is known only from India. Day (1878) placed it in the synonymy of *Labeo* and *Barbus* and no species of *Hypselobarbus* has been placed in the synonymy of any Indian *Labeo* species.

Rainboth (1986) correctly observed that "Bleeker probably based his image of *Barbus mussullah* on the illustration by Sykes (1841)" which is now known to be not truly representative. Earlier Annandale (1919) rescued the species from the synonymy of *Barbus* and later Hora (1943a) ratified it. Thus, the only generic name applicable to *B. mussullah* is *Tor* Gray, 1834 which is also earlier to Bleeker (1859).

Taxonomy

For a number of years *Barbus mussullah* was not reported or recorded mainly because of the zoologically poor description of the species by Sykes, confusing illustration and also because of its isolated distribution and rarity.

Jerdon (1849) in his account on the freshwater fishes of southern India records *Barbus megalepis* from the Cauvery at Srirangapatnam. This species is a synonym of *Barbus mussullah.* He also lists *Barbus mussullah* though he did not collect any specimens.

Gunther (1868) regarded it as *species inquirendum* and Day (1878, 1889) synonymised it under his composite *Barbus tor.* After a gap of 30 years Annandale (1919) recorded the species, perhaps for the first time after Sykes, from "streams of Bombay presidency" and based his identity on the presence of tubercles on the cheek. He identified certain other characters such as the structure of the lip differentiating it from *B. tor.* Annandale found the species common in the upper Krishna where it is reported to occur along with *B. tor.* He also recorded a specimen appr. 9.5 kg in weight caught by Mr. McIver. Annandale clearly indicated that *mussullah* and *putitora* should not be referred to under *Barbus* and stated that they belonged to the Mahseer group (= *Tor*).

Hora and Law (1941), reporting on a collection of fishes made by Mr. S. Jones and Dr. C.C. John from the then Travancore state, recorded *Barbus (Tor) mussullah* on the basis of 13 young and half-grown specimens. They were collected from Pampadampara and Kallar stream. These specimens are now not traceable. It was stated that "this is the commonest species of these parts." Hora (1942) examined Annandale's specimens of *B. mussullah* (local name: *Masundi*) collected from Krishna river by McIver and concluded that they are *Barbus khudree* and not *mussullah.* He based his conclusion on the basis of presence or absence of tubercles which is now known as a variable, undependable character. I have now examined the same material seen by Hora and I am convinced that they are *mussullah* for reasons discussed later. Hora (1942) also discussed elaborately the status of *mussullah* and after comparing it with *Cyprinus curmuca* concluded hastily that *mussullah* is a synonym of *C. curmuca.* His contention was that *curmuca* also has four barbels and that Hamilton's figure of *curmuca* erroneously depicted only two barbels.

It is intriguing that Hora did not compare his specimens with the collection from Travancore (Hora & Law, 1941) which were identified by himself as *Barbus (Tor) mussullah.* However, in 1943 he changed his opinion, after Dr. M. Suter provided first-hand details of the provenance of *B. mussullah,* the local knowledge about the fish thus confirming the existence of the species. In the same paper, Hora synonymised Thomas' (1897) *Barbus tor* from Bhavani river under *mussullah* based on the figure only. Hora gave for the first time a good description of *mussullah* with data of five specimens. He also gave figures of *Tor mussullah* and *Tor khudree* (Fig. 1.A & C) drawn from specimens which were sent to him by Suter. This figure represents the true *T. mussullah.* In a later article (Hora 1943b) he synonymised *Barbus megalepis* Jerdon with *B. mussullah.*

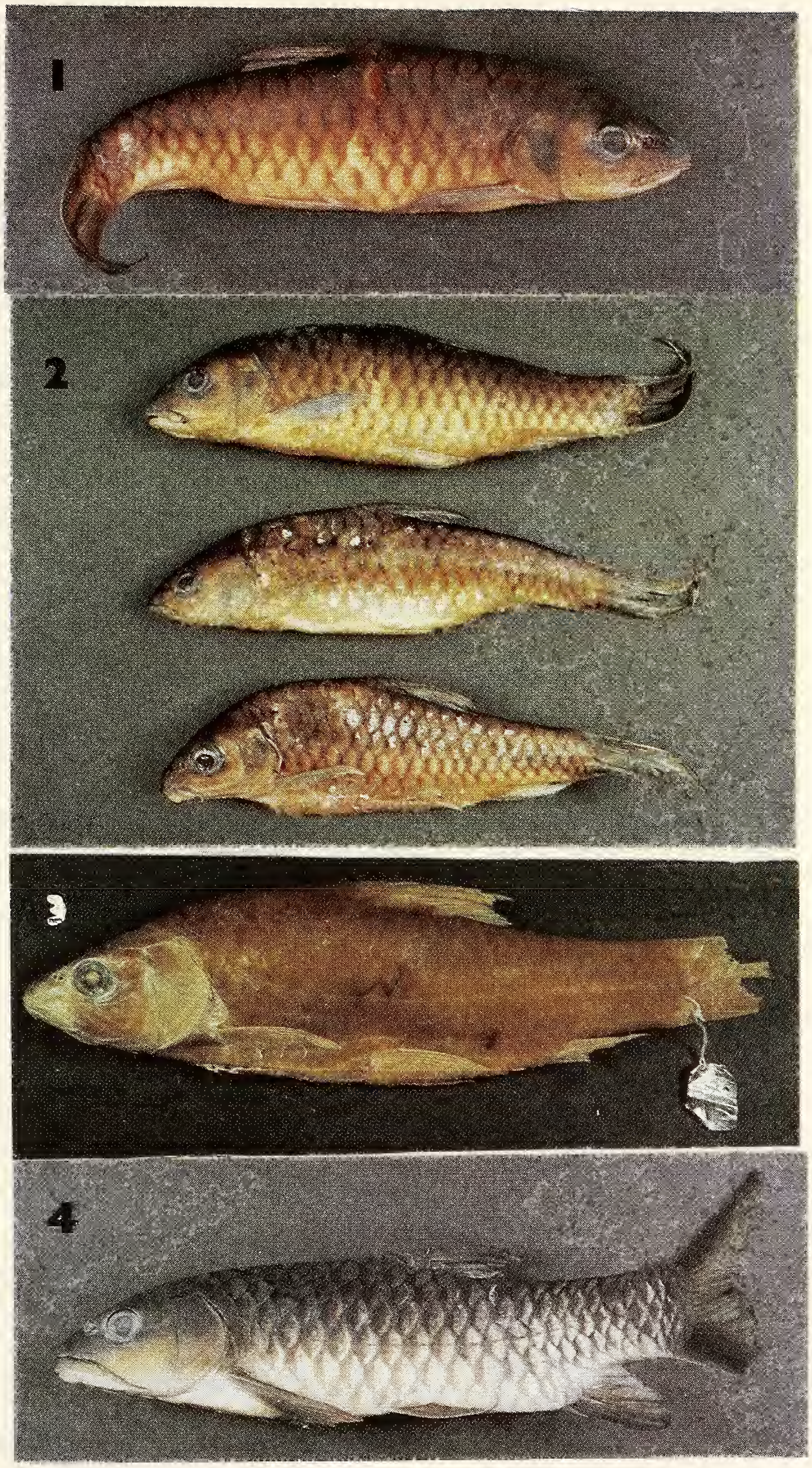

Fig. 1 & 2 *Tor mussullah*, four specimens from Meenmutty, Malappuram dist., Kerala. Coll. P.M. Suresh, 26.ii. 1992. ZSI WGRS 5946; Fig. 3. *Tor mussullah* specimen from "Deccan", Coll. F. Day, ZSI Calcutta, 1339; Fig. 4. *Tor khudree* specimen from Sheshela on river Kapila, Daskshina Kannada, Coll. KCJ, 10. iv. 1996.

Subsequent to Hora, Silas (1953) recorded five examples of *Tor mussullah* from Mahabaleshwar lake and Krishna river at Wai. These specimens are also not traceable either in the Bombay Natural History Society or in the Zoological Survey of India, Western Regional Station, Pune. Chacko (1952) recorded the species from Hogenakal and stated it as of rare occurrence. No material seems to have been preserved. David (1963) listed the species as occurring in Krishna and Godavary rivers. Though he stated that the species was recorded by him in his collections, the whereabouts of the material is unknown.

Menon (1992) on the basis of comparison of standard deviations and standard errors erroneously concluded that *Tor mussullah* is the same as *Tor khudree*. The differences between the two species are obvious and have been elaborated elsewhere.

From the above it appears that the number of ichthyologists who have seen and examined the true *mussullah* are very few and the species is also very rare. It is poorly represented in the National Zoological collection in ZSI Calcutta. The records of specimens are as below:

Tor mussullah (Sykes)

1. No locality	Coll. F. Day 1878	One specimen in ZSI No. 2176 (missing)
2. Deccan	Coll. F. Day 1878	Two specimens in ZSI No. 1338-39
3. Deolali, R. Darna Maharashtra	Coll. A.G.L. Fraser 1935	One specimen in ZSI each under No.F. 12528/1 and F. 12529/1 (both missing)
4. R. Krishna, Satara Dist. Maharashtra	Coll. C.D. McIver	Four specimens in ZSI under No. F.9578/1
5. Panchganga river system, Maharashtra	ZSI WRS 1334 4.8.1987	One specimen
6. Meenmutty, Malappuram, Kozhikode	Coll. P.M. Suresh, Feb. 1992	Four specimens ZSI WGRS 5946

1839. *Barbus mussullah* Sykes, *Trans. Zool. Soc. London.* 2, pp. 356-358 (type-locality, Ghod river, Sirur, Maharashtra).

1849. *Barbus megalepis* Jerdon, *Madras J. Lit. Sci.*, 15; 311 (Cauvery river, Srirangapatnam).

1849. *Barbus mussullah* Jerdon, *Madras J. Lit. Sci.*, 15; 313 (name only).

1864. *Barbus mussullah,* Gunther, *Cat. Fish. Brit. Mus.*, 7; 83 (as *species inquirande).*

1878. *Barbus mussullah.* Day, *Fish India,* p. 573 (as a synonym of *B. tor* Hamilton).

1919. *Barbus mussullah,* Annandale, *Rec. Indian Mus.*, 16, p. 135 (Krishna river, Satara dist.).

1932. *Barbus mussullah,* Spence & Prater, *J. Bombay nat. Hist. Soc.*, 36: 46 (brief account).

1941. *Barbus (Tor) mussullah,* Hora & Law, *Rec. Indian Mus.*, 43 (far 2): 237, 241 (13 exs. recorded from Kallar and Pampadampara, Kerala).

1942. *Barbus mussullah,* Hora, *J. Bombay nat. Hist. Soc.*, 43 (2): 164 (considered as a synonym of *Barbus curmuca* Sykes).

1943. *Barbus mussullah,* Hora, *J. Bombay nat. Hist. Soc.*, 44 (1): 5, pl. (considered as a valid species of *Tor*).

1943. *Barbus mussullah,* Hora, *J. Bombay nat. Hist. Soc.*, 44 (2): 166 (*B. megalepis* Jerdon *nec* McClelland synonymised).

1951. *Barbus (Tor) mussullah,* Hora, *J. Asiat. Soc.*, Letters, 27 (2): 157, 164 (reference in *Manasallosa* 1127 A.D.).

1951. *Tor mussullah,* Silas, *J. Bombay nat. Hist. Soc.*, 51 (3): 581 (Mahabaleshwar lake, Krishna river at Wai).

1953. *Tor mussullah,* Chacko, *Contrib. Madras Freshw. Fish. Biol. Sta.*, 4: 1-18 (Hogenekal).

1963. *Tor mussullah,* David, *Proc. Nat. Acad. Sci. India.* 33 (2): 280 (Krishna & Godavary rivers).

1992. *Hypselobarbus mussullah,* Menon, *J. Bombay nat. Hist. Soc.*, 89 (2): 210 (considered as synonym of *T. khudree*).

Specimens Studied:

ZSI 1339/2.12.519, 1 ex.*, 157.5 mm SL, Deccan, F.Day.

ZSI 9578/1, 2 exs.*, 134 & 153 mm SL, Krishna river, Satara district, Bombay Pres., C.D. McIver.

ZSI WRS P. 1334, 1 ex., 197 mm SL, Panchganga river system, Maharashtra, 4.8.1987. (Labelled as *Tor khudree mussullah*)

ZSI WGRS 5946, 4 ex., 153 to 215 mm SL, Meenmutti, Malappuram district, Kerala, P.M. Suresh, 26.2.1992. (Labelled as *Tor khudree malabaricus*)

Description

D. II, 8-9; P.i, 11-14; V.i-ii, 7-8; A.i-ii, 5-6; C.6-9 + 7-9

Dorsal profile steep with a hump at the occiput and running up to dorsal fin base, thereafter sloping gently. The hump is prominent and noticeable. Head small, length 3.6(3.4 - 3.9), body depth 3.7(3.3-4.2) in standard length. Width of head 2.0(1.6-2.3), height at occiput 1.3(1.2-1.4), snout 2.7(2.1-3.0), width of gape of mouth 4.4(3.9-5.3), eye diameter 4.8(4.4-5.5) in head length. Eye 4.8(4.4-5.5) in standard length, 1.7(1.5-1.9) in interorbital width, 1.7(1.6-1.9) in snout length. Snout obtuse, may be slightly conical in some. Mouth narrow, lips thick, with a continuous labial fold, lower lip forming a median lobe (mentum). Two pairs of short barbels, maxillary and rostral.

Dorsal fin inserted nearer tip of snout than caudal base or may be equidistant, concave in shape, anteriormost first branched ray and spine may be produced as a filament. Dorsal fin shorter than body depth. Dorsal spine strong, smooth, non-flexible. Pectoral fin concave in shape, its rays progressively shorter towards inner side. Outermost simple ray three or four times in the length of innermost first ray. Pectoral fins not reaching pelvic fin. Pelvic fin occasionally with an axillary scale, concave in shape, innermost ray nearly half the length of outermost ray. Pelvic fins not reaching anal fin. Anal fin cut straight, last simple ray may be produced as a conical tip, fin just reaching caudal fin base. Least depth of caudal peduncle 1.4(1.2-1.7) in its length. Lateral line complete, with 21 to 25 scales (24 or 25 common), not running in to the tail. Caudal fin deeply forked, its ray not produced.

Distribution.- South India: Cauvery, Godavary, Krishna river systems in the states of Karnataka, Kerala and Maharashtra along the Western Ghats. Distribution sporadic in isolated pockets.

Scales:

Lateral line	21 - 25
Predosal	4 - 6
Preanal	12 - 15
Dorsal fin /Lateral line	3 1/2 - 4 1/2
Pelvic fin /Lateral line	2 1/2 - 3 1/2
Anal fin /Lateral line	2 1/2
Circumpeduncular	9 - 11

Gill Rakers: 4 - 7 + 16 - 21.

Colour: Brown to dark brown in preserved specimens, abdomen pale, fin tips may be dark.

Relationship: It can be seen from the review that earlier workers considered *Tor mussullah* as allied to *Barbus curmuca* (Hora, 1942) and *Tor khudree* (Menon, 1992). In the course of my studies, I visited several localities in Karnataka and Kerala in search of *Tor mussullah*. This facilitated first hand observation of the populations of *Tor khudree* at many congregations in the different river sanctuaries in Karnataka. Eleven specimens of different sizes were selectively collected and their morphometric and meristic data have been recorded. In respect of *Tor mussullah* the holdings in the ZSI were borrowed and data obtained, I have seen specimens of *Barbus curmuca* also and the reference of this species under *Gonoproktopterus* Bleeker is justified. The species lacks a mentum or a continuous labial fold.

* one ex under 1338 (ZSI) and two under 9578/1 (ZSI) have not been examined so far

TABLE 1

FREQUENCY DISTRIBUTION OF SOME MERISTIC CHARACTERS IN *T. khudree* AND *T. mussullah*

1.1 Lateral line scales

Species	N	21	22	23	24	25	26	27
T. khudree	11	—	2	3	1	1	2	2
T. mussullah	8	1	1	1	2	3	—	—

1.2 Predorsal scales

Species	N	4	5	6
T. khudree	11	1	5	5
T. mussullah	8	1	4	3

1.3 Preanal scales

Species	N	12	13	14	15	16
T. khudree	11	3	2	3	2	1
T. mussullah	8	3	—	1	4	—

1.4 Prepelvic scales

Species	N	5	6	7	8	9
T. khudree	11	—	5	5	1	—
T. mussullah	8	1	3	3	—	1

1.5 Circumpeduncular scales

Species	N	9	10	11	12
T. khudree	11	—	3	6	2
T. mussullah	8	3	3	2	—

1.6 Gillrakers (upper limb)

Species	N	3	4	5	6	7
T. khudree	11	1	3	1	5	1
T. mussullah	8	—	2	2	2	2

1.7 Gillrakers (lower limb)

Species	N	15	16	17	18	19	20
T. khudree	11	2	2	2	1	1	3
T. mussullah	7	—	3	1	2	1	—

1.8 Mentum (length / width)

Species	N	<1.5	1.5-1.9	2.0-2.5
T. khudree	11	1	7	3
T. mussullah	8	1	1	6

Tor mussullah is easily distinguished from *T. khudree* by the characteristic hump at the occiput, though it may be very pronounced (Fig. 2, Pl. I). or slight as in Day's specimen (Fig. 3, Pl. I).

The scale counts also differ. It is seen that *T. mussullah* generally has 24 or 25 lateral line scales unlike *T. khudree* which has 22 or 23 (Table 1.1). The circumpeduncular scales also tend to be 9 or 10 in *T. mussullah* unlike 11 or 12 in *T. khudree* (Table 1.5).

The length/width ratio of the mentum in *T. mussullah* is generally more than 2.0 and in *T. khudree* it is less than 2.0 (Table 1.8).

The dorsal fin is inserted nearer the tip of the snout than caudal fin base in *T. mussullah* unlike in *T. khudree*. The two species differ markedly in body contour, shape of scales etc. as can be seen from photographs in Plate I, Figs. 1 to 3 and 4.

The frequency distribution of some of the meristic characters is presented in Table 1. The morphometric data in ratios and as percentages are given in Table 2.

It is thus clear that *T. mussullah* is a distinct species, different from *T. khudree*.

Ecostatus: From my field studies, it appears that *T. mussullah* is not as widely prevalent as *T. khudree* in the Western Ghats.

T. khudree is established mainly because of its introduction by the state fishery departments by releasing fingerlings obtained from the Tata Electric Company's Fish Farm at Lonavla. Even then, this species is also seen in disjointed locations and in protected habitats only. Whether it has spread further into the riverine habitats is still to be ascertained. In the Gangawali river at Oonchahalli, Uttara Kannada I collected a juvenile (55 mm SL, 31st May, 1996) which may be one such example of a natural stock.

In respect of *T. mussullah*, it is obvious that the species lives in very isolated pockets, uninhabitated jungle areas and is very rare, but vulnerable. Fishermen are aware of the species and at the same time are categorical about its rarity.

TABLE 2
MORPHOMETRIC DATA OF *T. mussullah*. N=8 SL. 134-215 mm

		Ratio	Mean	SD	Percent	Mean
1.	SL/Body depth	3.3 to 4.2	3.7	±0.29	23.8 to 30.3	27.0
2.	SL/LH	3.4 to 3.9	3.6	±0.16	25.6 to 29.4	27.8
3.	Snout/Eye	1.6 to 1.9	1.7	±0.11	52.6 to 62.5	58.8
4.	IOW/Eye	1.5 to 1.9	1.7	±0.14	52.6 to 66.7	58.8
5.	LH/Eye	4.4 to 5.5	4.8	±0.36	18.2 to 22.7	20.8
6.	LH/Snout	2.1 to 3.0	2.7	±0.26	30.3 to 47.6	37.0
7.	LH/Head Width	1.6 to 2.3	2.0	±0.19	43.5 to 62.5	50.0
8.	LH/Ht. at occiput	1.2 to 1.4	1.3	±0.08	71.4 to 83.3	76.9
9.	LH/Width of mouth	3.9 to 5.3	4.4	±0.40	18.9 to 25.6	22.7
10.	LH/LCPD	1.4 to 1.9	1.6	±0.18	52.6 to 71.4	62.5
11.	LH/HCPD	2.1 to 2.3	2.2	±0.07	43.5 to 47.6	45.5
12.	LCPD/HCPD	1.2 to 1.7	1.4	±0.16	58.8 to 83.3	71.4
13.	LH/Post-orbital length	1.9 to 2.7	2.2	±0.23	37.0 to 52.6	45.5
14.	Mentum L/W	1.4 to 2.2	1.9	±0.25	45.5 to 71.4	52.6

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AUTHOR'S NOTE:

After this paper was sent for publication I was able to survey parts of Karimpuzha, Maancherry river in Nilambur district, Kerala. Specimens collected by Kerala Forest Research Institute from Chaliyar drainage, Chinnar and Periyar Lake were also examined. *Tor khudree* is found naturally in these drainages. *Tor mussullah* remains elusive. However, a single specimens (259 mm sl) of this species collected from Thengumarda near Bhavanisagar, Moyar river, at present preserved in the Sálim Ali Centre for Ornithology & Natural History (SACON), Coimbatore, indicates its presence in the Moyar drainage.

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BREEDING BIOLOGY OF THE SOUTHERN CROW-PHEASANT *CENTROPUS SINENSIS PARROTI* STRESEMANN (AVES : CUCULIDAE) AT POINT CALIMERE, TAMIL NADU[1]

V. NATARAJAN[2]

(*With four text-figures*)

The breeding season extends from November to May. The size of the territory varied from 0.9 to 7.2 ha with a mean of 3.8 ha. Egg laying intensified after heavy rains. The nest is globular in shape with a lateral entrance and is made up of twigs, aerial roots and leaves. Altogether 56 nest materials were identified. Both sexes take part in the nesting activity. The preferred nesting height in the village habitat was 4-5 m, but in the forest, it is between 3-4 m. The eggs are chalky white in colour. Average size of 30 eggs measured were: length 34.8 ± 1.76 mm, breadth 28.2 ± 1.23 mm and weight 14.9 ± 1.87 g. The clutch size varied from 1 to 4 eggs with a mean clutch size of 2.6 ± 0.75. Incubation period is 15 to 16 days. It takes 18-22 days for the chicks to fledge. Both sexes take care of the young. The hatching, fledging and brood success were observed to be 77.1%, 97.3% and 66.7% respectively for the two seasons between 1987-1989.

INTRODUCTION

The southern crow-pheasant *Centropus sinensis parroti* is a resident bird at Point Calimere in Tamil Nadu. Its breeding biology has not been studied in detail. However, a note on the common crow-pheasant *Centropus sinensis sinensis* from a single nest is available (Dhindsa and Toor 1981). Some information on breeding records of the Southern crow-pheasant in different localities in India were given by Hume (1890), Gill (1924), Baker (1927, 1934), Whistler and Kinnear (1934), D'Abreu (1935), Ali and Whistler (1936), Ali and Abdulali (1938) and Ali (1954). The present study describes the breeding biology of the southern crow-pheasant in detail. This study formed part of an investigation into the ecology of this species carried out at Point Calimere (Natarajan 1990).

STUDY AREA AND METHODS

The studies were carried out at Point Calimere Wildlife Sanctuary (10° 18'N, 79°51'E) Nagapattinam Quaid-e-Milleth District, Tamil Nadu and the adjoining villages of Kodikkarai and Kodikkadu. The sanctuary has an area of 2401 ha. Intensive studies were carried out (in an area of 337 ha) in the two villages from 1986 to 1989. Observations were difficult in the very dense vegetation of the forest.

During 1988, six different breeding territories in Kodikkarai village were studied. Sightings of breeding pairs were marked on a map and their territorial areas were calculated following Odum and Kuenzler (1955).

From 1986 to 1989, nest survey was carried out in the village areas and in the forest during three breeding seasons. A total of 34 new nests were recorded. Among these, 21 nests in the village area were continuously watched to determine clutch-size, incubation, hatching success, fledging success and breeding success between the years 1987-1989. The incubation rhythm was observed daily in one of the nests continously from 0600 to 1800 hrs. The time of each bird arriving at the nest and leaving were noted, and percentage was calculated. Two nests were monitored during the nestling period. Observations were made from dawn to dusk, from egg laying up to the time the nestlings fledged. Four nests were regularly inspected to record growth rate of nestlings. The chicks were colour marked before

[1]Accepted September, 1996

[2]Present Address: P.G. Asst (Zoo), Govt. Hr. Sec. School, Vilundamavadi (P.O.), Nagai-Q.M. Dt 611112, Tamil Nadu.

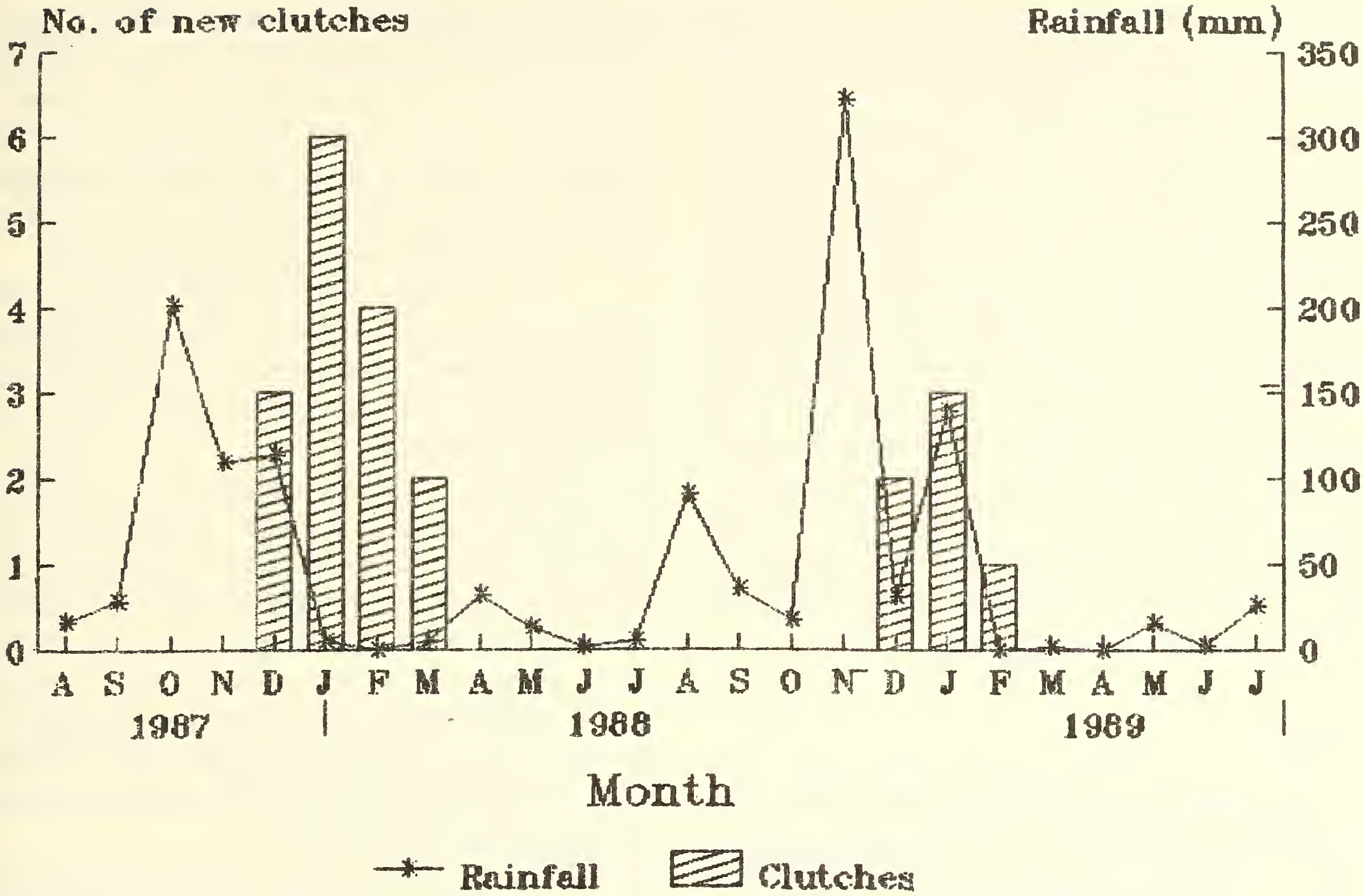

Fig. 1. Number of new clutches in relation to rainfall (1987-1989)

fledging. After breeding was completed, the nests were collected to identify their components.

Results and discussion

Breeding season

At Point Calimere the crow-pheasant raises only a single brood during the season extending from November to May. Egg laying was recorded from December to March and it intensified after heavy rains (Fig. 1).

Territory

The breeding pair occupy a well defined area defended by both the parents. The size of the territory varied from 0.9 to 7.2 ha (n=6) with a mean of 3.8 ha. In the crow-pheasant, nests were sometimes found in the subsequent season on the same nesting tree, or on a nearby tree. Other pairs entering this territory were threatened using the harsh *k'wisss* call. Birds such as house crow *Corvus splendens*, jungle crow *Corvus macrorhynchos*, shikra *Accipiter badius*, and brahminy kite *Haliastur indus* were tolerated in the territory, but not on the nesting tree. The *coop-coop-coop* call by which the ownership of the territory was advertised was also used to threaten intruders and keep them away. This type of call was heard frequently throughout the breeding season.

Courtship and pair formation

Display leading to mating was observed twice. In the first instance the male arrived with a frog in its bill and hopped along with the female on the branches of a neem tree *Azadirachta indica*. The female then glided from the tree to the ground and ran for a short distance with wings partly open and vibrating, uttering a harsh cry: *ske-e-e-a-aw* similar to the call of the common crow-pheasant (Briggs 1931). The male and female then flew up to the neem tree and continued to hop from branch to branch, and then mounted and copulated three times. After copulation the male ate the frog without sharing it with the female. In another instance a male was seen feeding the female during copulation.

During courtship display, the crow pheasant females sometime produced *tch-truu, tch-truu* call (a call usually produced by the juveniles while foraging with their parents) on seeing the male carrying food. Henry, as cited by Ali and Ripley (1983), noted during courtship a curious sound *djoonk* - like a stone dropped into deep water, or a tight cork drawn from an empty bottle. Such a call was not recorded during this study.

The nest

While searching for a new nest-site, the crow-pheasant hops from branch to branch, sits on a perch and calls, which is responded to by its partner. Sometimes, both sexes examine the site inside the thicket. In the beginning, the construction is slow but it accelerates before completion of the nest. Both sexes take part in nest building. Dhindsa and Toor (1981) recorded on the basis of observation at a single nest that the common crow-pheasant completed its nest within three days. During the present study, observations on two nests showed that one nest was constructed in seven days and eggs laid before completing the nest. In the second nest, a pair constructed a nest for about eight days, but abandoned it before completion due to human disturbance. At this nest, the male was observed, during a peak construction day, to visit the nest 35 times and to spend a total (of all trips) of 75 minutes in nest construction. The female came to the nest six times and spent only 10 minutes on the construction of the nest. Mostly the partners bring the nesting material from nearby trees or picked off from the ground or pulled from vegetation. The twigs or other material which could not be taken to the nest were left on the nesting tree. The crow-pheasant prefers thorny plants in which to build. Out of 45 nests studied, 28 (62.2%) were found on thorny plants, the rest on thornless plants, where the canopy was covered with climbers such as *Tinospora cordifolia, Rivea hypocrateriformis,* and *Mucuna pruriens*. These climbers protect the nest from direct sunlight and exposure to predators.

Out of 38 nests studied in the villages, nests were most frequently located in *Prosopis chilensis* (23.7%), followed by *Bamboo* sp. (18.4%). Seven nests were located in the forest, three of which were on *Zizyphus oenoplia*.

Among the 45 nests studied, 75.6% (34) were placed in the periphery of the nesting tree and 24.4% were located in the centre of the canopy. In the villages the maximum number of nests were located between 4-5 m (34.2%) height, but in the forest 71.4% of the nests were located at heights between 3-4 m. In the village two nests were noticed on *Borassus flabellifer* (covered with *Rivea hypocrateriformis*) at a height of 9.6 m and one nest on *Tamarindus indica* at 10.7 m.

In the forest the height of location of the nest was less than that of the nests found in the village area. In the village, the birds preferred to place the nests higher, which may have been due to the sparse vegetation.

The crow-pheasant uses twigs, stems, leaves, roots of various plants for nest construction. 56 nest materials were identified. Of the 36 nests analysed, the maximum used nest material was strips of fronds of *Cocos nucifera* (1319) with a mean of 36.6 number per nest followed by stem and aerial root of *Tinospora cordifolia* (839) with a mean of 23.3, and stem of *Tylophora indica* (706) with a mean of 19.6 number per nest. Among the nesting materials the longest was the aerial root of *Tinospora cordifolia* (mean length 110.4 cm) followed by the aerial root of *Cissus quadrangularis* (88.5 cm), stem of *Boerhaavia diffusa* (68.3 cm), strips of fronds of *Cocos nucifera* (61.2 cm) and *Borassus flabellifer* (43.3 cm).

The crow-pheasant builds a globular domed nest with a lateral entrance. However, some nests were deep and cup-like in shape. The nest dimension

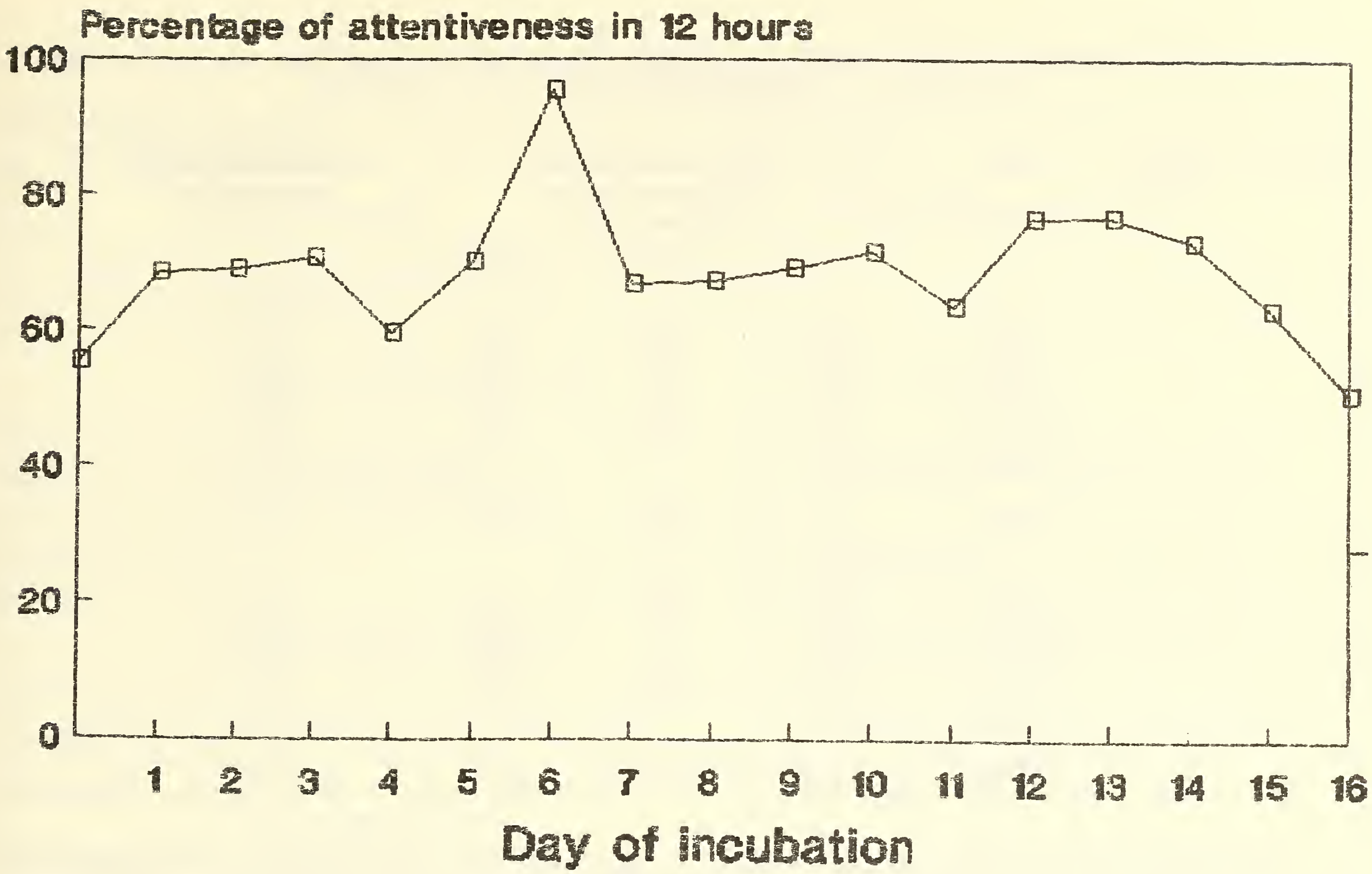

Fig.2 Incubation rhythm

is given in Table 1.

Egg laying, clutch size and incubation

Two nests were observed during egg laying, and in both the cases eggs were laid before completion of the nest. Afterwards the partners mostly engaged in building the dome-like structure of the chamber. Similarly Frith (1975) observed egg laying before completion of the nest in the Malagasy coucals *Centropus toulou insularis* in Aldabra Atoll. Once a nest with two eggs on the *Pandanus tectorius* bush was deserted due to clearing of the branches of the nesting tree by villagers for fencing. The same pair constructed another nest quite unlike the normal nest, having only a small deep cup-like structure in a nearby *Prosopis chilensis* tree and laid a single egg which successfully reached fledging.

TABLE 1
NEST DIMENSIONS (CM) OF THE CROW-PHEASANT

	Length	Breadth	Lengthwise circumference	Breadthwise circumference	Depth	Entrance opening Lengthwise diameter	Entrance opening Breadthwise diameter
No. of nests measured	13	13	14	14	14	12	12
Range	31-45	23-34	79-133	76-110	13-26	9-18	8-18
Mean	37.3	28.4	107.4	91.5	21.4	14.5	14.1
S.D.	5.3	3.4	14.5	9.3	3.4	2.6	2.7

TABLE 2
RATE OF NEST FEEDING DURING DIFFERENT HOURS AND DAYS OF NESTLING PERIOD OF THE CROW-PHEASANT

Nest No.	No. of nestlings	Days	Average per hour visits by the parents between different hours 6-10	10-14	14-18	Average per hour visits for whole day
		1 to 4	3.31	2.69	1.94	2.65
		4 to 8	3.88	3.88	3.31	3.69
1	4	8 to 12	6.06	3.81	2.19	4.02
		12 to 16	7.88	7.38	4.81	6.69
		16 to 19	7.63	4.75	4.44	5.60
		Average	5.75	4.50	3.34	4.53
		1 to 4	0.69	0.88	1.19	0.92
		4 to 8	2.38	2.38	1.94	2.23
2	2	8 to 12	3.81	2.50	2.63	3.00
		12 to 16	2.56	2.69	2.06	2.44
		16 to 21	2.44	1.94	2.00	2.13
		Average	2.38	2.08	1.96	2.14

The eggs are oval in shape and chalky white in colour, becoming yellow stained as incubation proceeds. The length of 30 eggs was 34.8 ± 1.8 and the breadth was 28.2 ± 1.2 mm. The mean weight of the fresh eggs was 14.8 ± 1.9 g. Acccording to Baker (1934), the average length of 30 eggs of *Centropus sinensis parroti* was 36.2 and breadth 26.3 mm. The clutch varies from one to four eggs, with a mean clutch size of 2.6 ± 0.75 eggs. The commonest clutch is of three eggs. The daily weight loss in eggs when incubation proceeds was recorded from two nests. The mean weight loss per day during incubation was 0.1036 ± 0.026 g. The incubation period was calculated from the laying of the last egg of a clutch to the hatching of the last nestling (Skutch 1945, Nice 1954) and was 15 to 16 days.

The percentage of nest attentiveness showed variation, except at the end of the incubation period and a drop was noticed before the day of hatching (Fig.2). The overall average attentiveness calculated was 68.7%. In this species both sexes take part in incubation during day time but at night only one of the partners was observed to incubate/brood. The sex of the partner which attends the nest during night could not be determined.

Regular feeding of the chicks starts after the last egg of the clutch is hatched. During first four days, the parents feed the nestlings by regurgitating the food, especially snails. Both parents feed the nestlings. The number of feeding visits per hour increased till the 16th day and then decreased. The parents visited the nest on an average 4.53 times per hour when there were four nestlings and 2.14 times when there was two nestlings (Table 2).

The removal of egg shell pieces was noticed after hatching, but in some cases unhatched eggs remained in the nest. Both the parents were seen carrying faecal sacs from the nest and dropping them away from the nest site.

Growth of the nestling

The newly hatched (0 day old) nestling was black in colour with eyes closed. Dorsally covered with long white hair-like down feathers named as

TABLE 3
PLUMAGE CHANGES IN CROW-PHEASANT NESTLINGS

Age in days	Plumage	Remarks
1	Body colour dark	Total body length 76mm
2 and 3	Remiges and rectrices feather pins emerge	—
4	Feather pins emerge in alula, upper wing and upper tail coverts	Eyes started opening
5	Spinal, humeral, capita tract pins beginning to emerge	Bill black. Eyes half to three quarters open
6	—	Eyes fully opened
7	Ventral tract had two longitudinal rows of feather pins emerging	Infection by the tick *Haemaphysalis intermedia* was noticed on the wings
8 to 12	Feather pins of primaries ready to open	Tick infection noticed on dorsal side of the body
13 and 14	Feather pins of few primaries and wing coverts emerge from sheath	Ticks were noticed under tail coverts
15 and 16	All remiges and rectrices feather pins emerge from sheath. Spinal, capital tract pins appear as black brush-like feathers	—
17 and 18	Plumage well developed. Nestlings fledged on 18th day	

'trichoptiles' by Friedmann (1930). These trichoptiles hang forward like a fringe over the eyes and bill, giving the chicks a comical appearance similar to that of black coucal chicks as described by Vernon (1971). The upper mandible was black with pink edges with a small egg-tooth. The centre of the belly was pinkish. The legs and claws were greyish in colour and the plumage changes at different ages (in days) are given in Table 3. The growth of wing, bill, tarsus, tail and the weight change in relation to age is given in Figs. 3 and 4.

Anti-predatory strategies of nestlings

The nestlings were noticed to exhibit a few antipredator mechanisms, namely (a) escaping through the rear end of the nest chamber (b) excretion of foul smelling, obnoxious sticky fluid and (c) a hissing sound. The hissing of the nestling has been likened to the hiss of a snake. Van Someren (1956) and Vernon (1971), believed it to be an imitation to frighten off predators. These three strategies have also been reported for other coucals (Vincent 1946, Van Someren 1956, Frauca 1967, Steyn 1972 and Frith 1975).

Fledging period

The mean fledging period was 19.7 ± 1.3 days. Fledging normally occurred in the morning. Even after fledging, the young were seen in the same nesting tree for a few more days and later they slowly moved to adjacent trees by hopping along the branches. The parents continued to feed them even

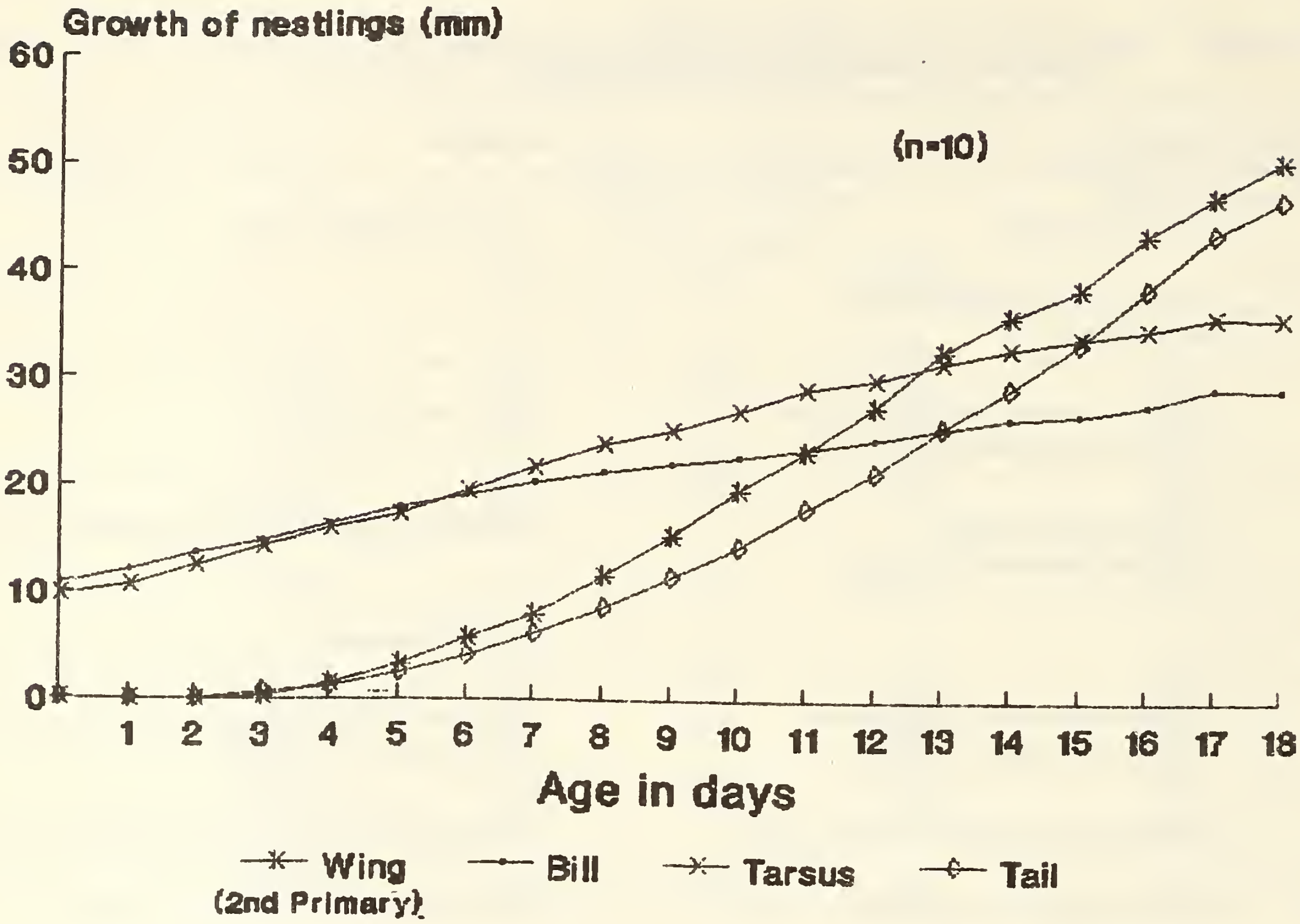

Fig. 3. Mean growth of nestlings

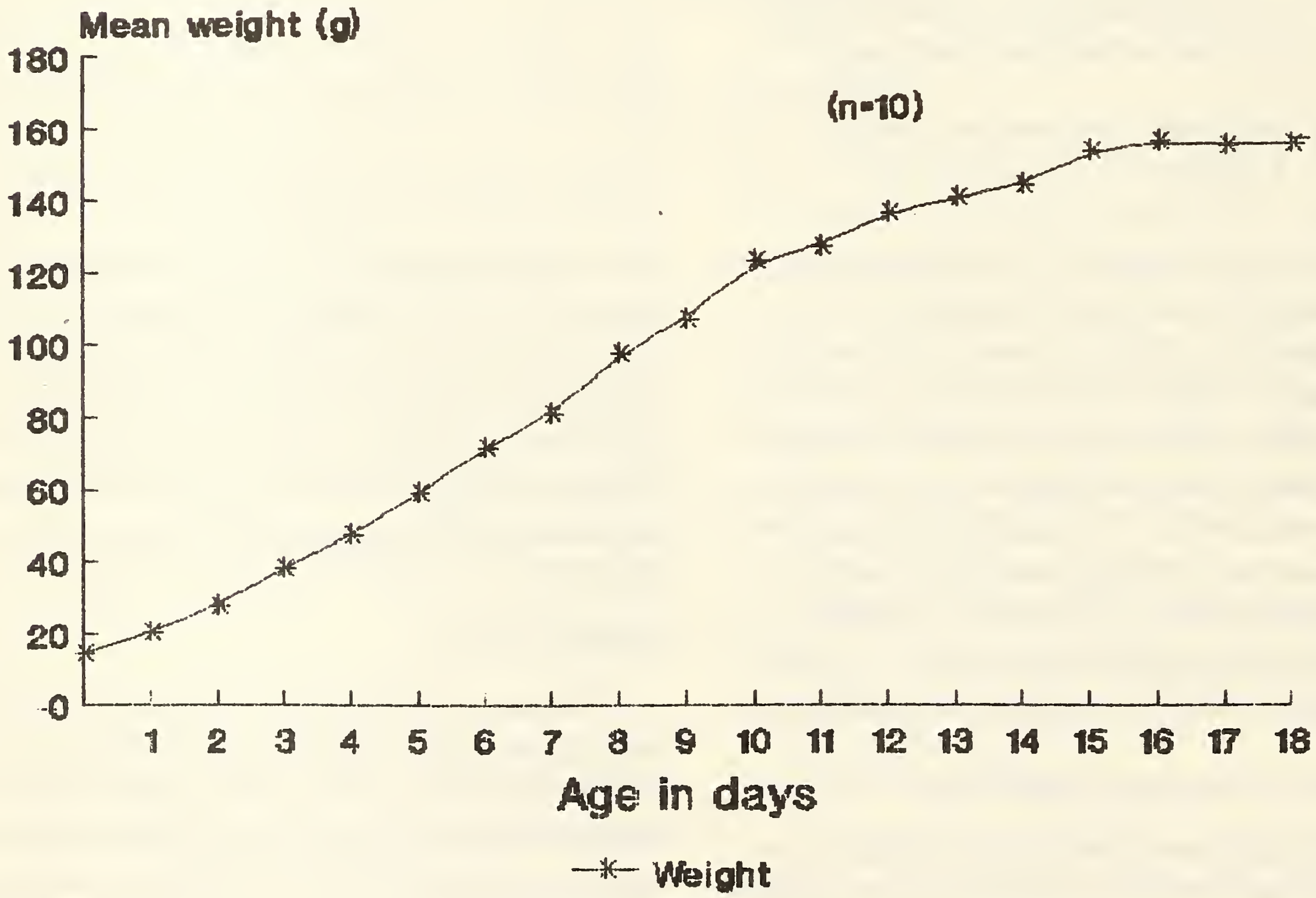

Fig. 4. Weight increase in nestlings

after fledging. Fledged young ones were seen with the parents and were noticed begging for food even two months after fledging.

Dispersal of young

During the study period 30 birds were ringed in the nestling and fledgling stages. Many birds were noticed feeding along with their parents about two months after fledging. After four months a search was made but only two colour banded young birds were noticed, one of which had moved 3 km from its parental territory. The other young one established its territory close to its parental territory. The other tagged birds were not seen in the parental territory. As the rate of predation on young ones was very low at Point Calimere (see below), most of them might have dispersed to other areas far away from their parental territories.

Hatching, fledging and brood success

Out of 21 nests examined from the village site, a total of 54 eggs was recorded out of which 48 eggs were left to hatch (two nests were deserted with a total of five eggs due to habitat destruction and human disturbance). The hatching success, fledging success and the brood success recorded was 77.1%, 97.3%, and 66.7% respectively.

Predation of eggs and nestlings of crow-pheasant was very low at Point Calimere. The crow-pheasant was observed to chase the jungle crow, house crow and brahminy kite and the common mongoose *Herpestes edwardsi* when they came near the nesting sites. However, in one instance an egg of the crow-pheasant was destroyed by a jungle crow as the nest was placed low in a *Prosopis chilensis* tree and the nest was visible from above. In the second instance, one nestling was attacked and killed by a jungle crow. In this case the nest was placed in a *Cocos nucifera* tree in between the fronds where crows could easily sit and prey upon the young. In the third case a jungle crow was seen to chase an adult crow-pheasant, and attack it while it was entangled in a thorn fence. Later the crow-pheasant managed to escape and flew to a nearby bush.

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POPULATION DYNAMICS, GROUP STRUCTURE AND NATURAL DISPERSAL OF THE ASIATIC LION *PANTHERA LEO PERSICA*[1]

H.S. SINGH[2]

(*With one text-figure*)

Key words: Asiatic Lion, Gir, population, dispersal

The Gir forest in the Saurashtra region of Gujarat is synonymous with the Asiatic lion. Recognising the serious danger to the lion and the pitiable condition of the tribal Gir Maldharis in 1972, the Gir Lion Sanctuary Project was implemented for five years which resulted in the improvement of habitat and wildlife. Lion numbers increased from 177 in 1968 to 304 in 1995. Availability of major ungulates increased from 53.5 ungulates per lion to 125.9 ungulates per lion. Studies indicate that the food preference has changed to wild animal from 25% in 1972 to 65% in 1990. Improvement of the Gir forests and increase in wildlife population have brought major changes in social behaviour and reduction in size of groups of lions. The Asiatic lion started migrating from Gir to the neighbouring forests in search of food and space. Dispersal paths of the Asiatic lion at present are almost similar to the extinction path adopted during the beginning of this century. There are four satellite populations of lions in Girnar, Mitiyala and coastal forests outside the Gir. It has become necessary to expand the present Gir forests to new areas by covering Girnar, Mitiyala, Barda, coastal forests and grasslands to manage the increasing lion population as well as to maintain the ecological security of the region.

Asiatic Lion and the Gir

Gir is the single largest tract of forest in the Saurashtra region of Gujarat State and is synonymous with the Asiatic lion, *Panthera leo persica.* The lion entered India from the west and was found in large numbers in the states of Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat and western Bihar. the last lion surviving in the wild outside Saurashtra was killed in 1884.

The Gir forest in Saurashtra has shrunk from 3070 sq. km in the 1880s to 1884 sq. km at present due to expansion of agriculture, and destruction of the habitat. In the early part of this century, the Gir was connected with Girnar, Mitiyala, Barda, Alech hills, Dhank and Chorwad by corridors of rough semi-wooded forests, grasslands and sparsely populated villages. This enabled the lions to move freely in the region.

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[2]Office of the Conservator of Forest & Wildlife, Junagadh, Gujarat.

Lions deserted the Barda and Alech hills towards the latter half of the 19th century, and disappeared from Girnar and Mitiyala by 1963 and 1955 respectively. At the time of notification of Gir forests as a Lion Sanctuary in 1965, lions were found only in the compact forest of the Gir. Gradually, the size of wildlife protected area increased to 1412 sq. km with the national park surrounded by the sanctuary. The rest of the 403 sq. km peripheral forests constitute the buffer zone of the wildlife reserve.

The most important aspect of the Gir is that it has become a very stable ecosystem with tremendous regenerating, self supporting, and sustaining capacity due to its rich and diverse flora and fauna. The Gir is an unique ecosystem which harbours over 400 plant, 32 mammal, 24 reptile, over 310 bird, and more than 2000 insect species, along with a number of micro-flora and fauna.

Conservation Measures to Save Lion

A study by Dr. Paul Joslin (1972) revealed that the Gir displayed an overwhelming evidence of accelerated degradation of the ecosystem, and warned that if nothing was done to arrest the rate of decline in the number of surviving Asiatic lions, the species would be extinct within two decades.

Recognising the serious danger to the lion and the pitiable condition of the Maldharis, the Gir Lion Sanctuary Project, a five year scheme was prepared in 1972, and the same was implemented at a total cost of Rs 58 lakhs. The work carried out under the project was: (i) fencing of the sanctuary by constructing a rubble wall 400 km along its periphery, (ii) constructing barricades along the water course traversing the periphery of the sanctuary, (iii) establishing check posts with barriers across all public roads passing through the sanctuary, and (iv) shifting of all Maldhari families from the national park, and majority of the families from the sanctuary, and resettling them outside the sanctuary by allotting cultivable lands, grazing land and house sites. Out of 845 Maldhari families, about two-thirds have been resettled at different sites.

Serious problems like grazing, poaching, lopping, illicit cutting etc. were tackled by the Forest Department and development programmes like soil and moisture conservation, habitat improvement, plantation etc. were implemented during the period. The degradation of the Gir ecosystem was reversed and habitats improved in the park and sanctuary. Many parts of the Gir have become dense since the launching of the project. Construction of water harvesting structures and artificial water holes has increased the availability of water to the wildlife.

Increase in Wildlife Population and Change in Food Pattern

The Gir habitat has improved since the declaration of the sanctuary. Implementation of the Gir Lion Sanctuary Project has resulted in increased availability of food and water. Six consecutive censuses have been conducted at an interval of five years since the declaration of the sanctuary. The lion population, along with other wild animals, has increased consistently. Figures of the last six censuses are given in Table 1.

TABLE 1
GROWTH OF WILDLIFE POPULATION IN THE GIR

Year	Lion	Leopard	Hyena	Herbivores (ungulates)	No. of ungulates per lion
1968	177	NA*	NA*	NA*	NA*
1974	180	142	63	9635	53.5
1979	205	161	84	14964	73.0
1985	239	201	192	16905	70.7
1990	284	212	97	31489	110.9
1995	304	268	137	38221	125.9

*NA: Not available

Herbivores in Table 1 include only six major species i.e. Chital, Sambar, Bluebull, Chinkara, Four horned Antelope and Wild boar. There has been a consistent increase in the carnivores and herbivores. Availability of ungulates number per lion has increased from 53.5 in 1974 to 125.7 in 1995 which makes wild kills easily available for carnivores.

Ungulate habitat relationship in the Gir has been studied by Berwick (1974). Joslin (1972) has investigated the Gir ecology and behaviour of the lions. Joslin (1972) reported that atleast 75% of the lion food came from livestock, mainly buffaloes and 25% from the wild herbivores. Gradual positive development took place during the last two decades and the ungulate population increased more than five fold. The study of Ravi Chellam (1993)has indicated that the food pattern of the lion has changed in favour of wild prey, as 65% of the lion diet was recorded as wild animals whereas 35% was made up of livestock kills.

Group Structure & Size

Lions are social animals with strong familial ties, they usually live and hunt in family groups. The size of groups recorded in the Gir was large in the past because live bait was provided for the lion show. This practice was stopped in 1987 and group size above a dozen is rarely seen at present.

304 lions were located at 94 sites on live bait during the last day of the lion census in May 1995, against 284 lions at 59 location in 1990. All

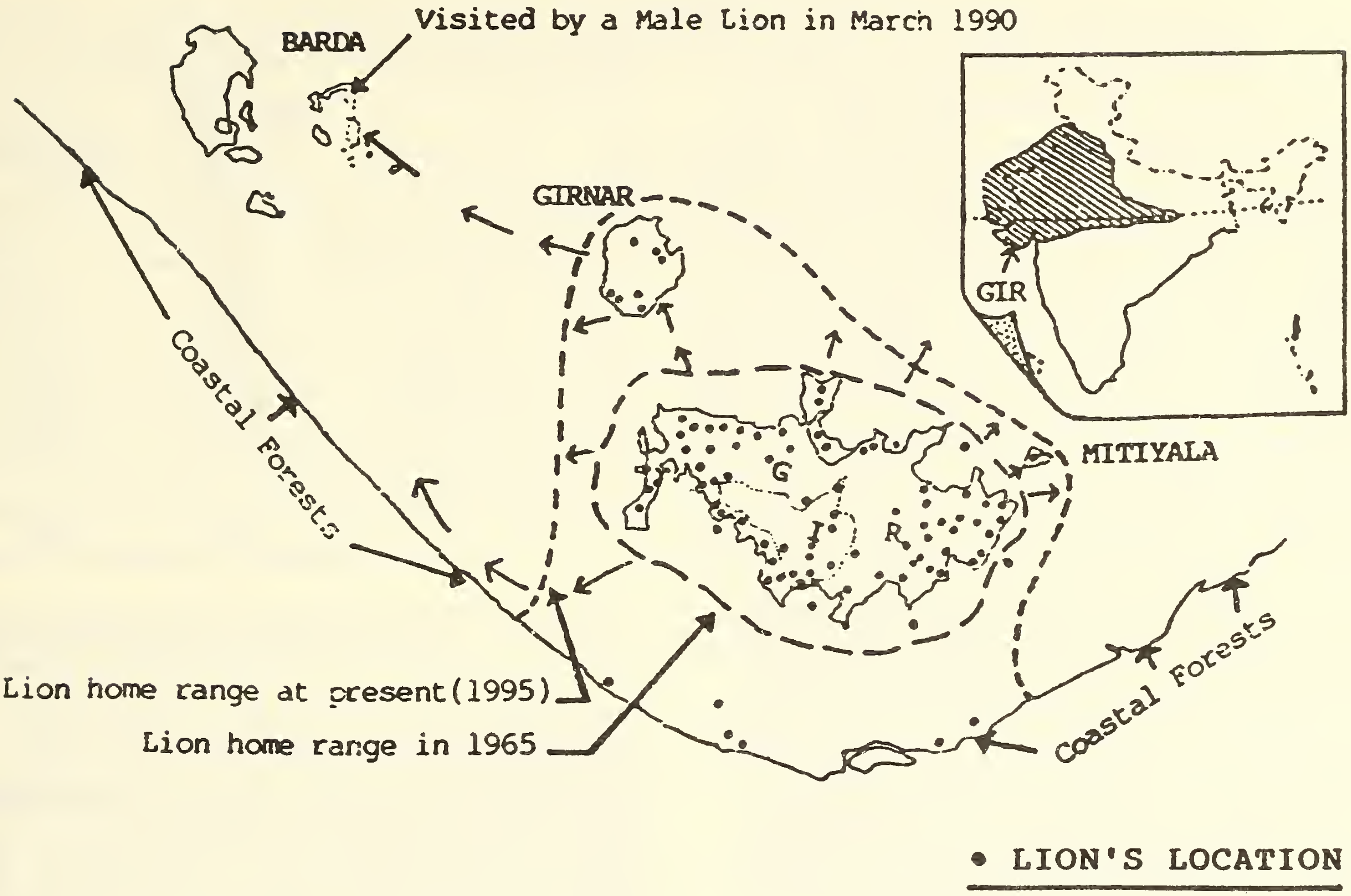

Fig. 1. Distribution of Asiatic lion in the Gir (India) in the 19th century and at present

groupings were natural except a group in Babara zone in which two or three groups of the same pride merged to form a big group of 15 at the bait site. Different types of composition of groups recorded during the census are given in Table 2.

The following findings have emerged after analysis of census data:

1. Single males were observed at 15 sites which was maximum among the five types of group structure. Pure male groups were found singly or in pairs except in one location where three males came to the bait site.
2. Location sites for a single male, two males, single female, and pairs were largest among different types of group structure
3. Single females were located at seven sites and some of them were very old.
4. Most of the male-female pairs were mating pairs or subadults
5. Large groups of animals were found in mixed groups with one male, and a few females and cubs.
6. Pure groups of males were not seen with any cubs.
7. Average group size in May, 1995 census was smaller than the size recorded during census in May, 1990.
8. Number of lion locations increased from 59 in 1990 to 94 in 1995.

Live bait may have caused artificial grouping at a few sites but such grouping was mostly limited to animals which normally share food at kills.

Natural Dispersal/Migration of Lions

Lions disappeared from the neighbouring forests outside the Gir, during the middle of this century. Habitat of the Gir improved, and the lion population gradually grew with increased level of protection and conservation. Before the census in

TABLE 2
GROUP STRUCTURE OF ASIATIC LION OBSERVED DURING LAST TWO CENSUSES

Group Composition	May, 1995 No. of animals	Average group size	Range of group size	May, 1990 No. of locations	Average group size	Range of group size
1	2	3	4	5	6	7
Pure male	33	1.42	1-3	24	1.40	1-3
Pure Female	17	1.55	1-3	11	1.38	1-2
Male & Female	87	3.37	2-8	26	4.62	2-11
Female & cub	73	4.05	2-9	18	6.75	4-10
Mixed group (Male, female & cubs)	94	6.27	3-15	15	11.3	3-28
Total/Average	304	3.23	1-15	94	4.81	1-28

1990, lions were occasional visitors to Girnar, Mitiyala and coastal forests but they started visiting neighbouring forests again. The situation has changed since then and this carnivore has started moving into former territories. Prides of lions have occupied Girnar, Mitiyala and the coastal forests permanently. At present, there are four satellite populations of lions. The second generation of migrated lion has made Girnar and the coastal forests its home range. Dispersal paths of the Asiatic lion at present are almost similar to the extinction path adopted during the beginning of this century and may follow similar trends till they reach other new areas.

It has been observed that the majority of the migrated lions were sub-adults, probably they were compelled by dominant males to leave the pride and territory. Wild lions in Girnar were often attracted by the roaring of captive lions kept in the Sakkarbaug zoo maintained by the Forest Department on the outskirts of Junagadh town in 1950. This was repeated after 40 years when two male lions regularly visited spacious lion enclosures constructed recently in the adjacent forest for breeding programmes, 4 lions were recorded in 1990 wnich have increased to 13 as per the census conducted in May, 1995.

A long strip of coastal plantation supports a small population of Bluebull and Wild boar. One pride of 16 lions in Kodinar Dhamrej Sutrapada and another of 10 lions in Rajula and Jafarabad depends on cattle and Bluebull. Lions were brought back to the Gir in the past but they repeatedly migrated to coastal forests in search of food and territory and settled permanently in these areas after 1990. The fourth satellite population of lion is in the Mitiyala forests of Bhavnagar Forest Division, and is in the process of settling there permanently. The distribution of the lion population in the Gir and extended Gir is given in Table 3.

TABLE 3
DISTRIBUTION OF LIONS IN DIFFERENT AREAS
LION CENSUS - MAY , 1995

Sr. No.	Site	Lion Population Male	Female	Cubs	Total
1	Gir	92	109	61	262
1.1	National Park	10	12	9	31
1.2	Sanctuary	72	92	50	214
1.3	Peripheral forests	10	5	2	17
2.	Girnar	10	3	-	13
3.	Mitiyala	2	1	-	3
4.	Kodinar-Sutrapada coastal forests	5	6	5	16
5.	Una-Rajula-Jafarabad coastal forests	3	2	5	10
		112	121	71	304

The number of lions outside the Gir is known as the floating population because some of them visit the above zones for short periods and come back to their original areas. Table 3 indicates that 42 lions including 10 cubs stay outside the Gir. It also indicates that the population of lions staying outside the protected area (PA) may keep on increasing under the existing protection level.

All four sites have a low herbivore count, therefore the migrant lions primarily depend on domestic livestock kills. The trend of dispersal still continues, as a lion made a kill in a grass vidi near Barda forests in 1990 and stayed there for 36 days. If this trend continues, the growing population from Girnar and the coastal forests may reach new areas in Saurashtra. In Barda forests, only improved prey-base and habitat might attract the lions to make this area another home for themselves.

Carrying Capacity of the Gir

The carrying capacity of an area depends on the availability of food, water, conduciveness to reproduction and space. Food is not a major limiting factor in the Gir as the population of important ungulates increased at the rate of 14.2% per year during the last three decades, but shortage of space may result in territorial fighting and migration. The population has remained almost at the same level (267 in 1990 and 262 in 1995) in the national park and sanctuary during last two censuses. Positive changes in the habitat may improve this figure marginally, but the growing population of the big cat can be managed through improving habitats in new areas naturally preferred by the lions.

The natural dispersal of the lion started after the last drought in 1987. 17 lions were recorded outside the Gir in 1990 which increased to 42 in 1995 but the number of the animal remained constant in the PA during the last two censuses. Thus, present levels of the lion population within the PA may be the carrying capacity of the park and sanctuary.

Need of Conservation Strategy

Panthera leo persica is a key indicator species which should decide the ecological boundary of the Gir. Against this background, the concept of management of the Greater Gir Ecosystem or extended Gir in new territories of lions has become the need of the hour in the interest of nature conservation and management of increasing lion population. Proper strategies should be designed for management of forests along with grasslands, wastelands to expand Gir forests from 1814 sq.km at present to 2370 sq.km in the near future by covering Girnar (179.5 sq. km), Mitiyala (19.4 sq. km), coastal forests (110.1 sq. km), Barda (187.4 sq. km) and vidis (approx. 60 sq. km). In addition to the forest lands, wastelands, and panchayat lands connecting Gir, the above forests, should be developed and managed as corridors for lions. Entire forests of Junagadh and Amreli districts should be managed as Greater Gir Forests under a unified administrative set up.

The following measures are required to be adopted as a part of the management strategy.

1. Habitat of the Gir should be improved and expanded by arresting the degradation of peripheral forests and wastelands.
2. For a better life outside the sanctuary, facilities should be created to attract the Maldharis who are residing inside the sanctuary without basic facilities.
3 Satellite population at four sites should be managed by increasing the prey base.
4. Girnar and coastal forests should be conserved and herbivore population should be increased to meet the requirement of the growing population of lions.
5. Barda forest, which was selected as an alternative home for the lion in 1979 should be rehabilitated and prey base should be increased by taking up breeding programmes of herbivores.
6. For herbivores, *in situ* breeding programme should be developed to increase the ungulate population in Girnar, Mitilaya and the coastal forests.
7. Necessary management practices should be followed to facilitate natural migration of lions in new area. Problem animals should be removed from the wild population and these should be utilised for breeding purposes in zoos.

8. Management of Girnar, Barda, Mitiyala, coastal forests and other neighbouring forests should be integrated with the management of the Gir. The concept of the Greater Gir Ecosystem Management should be evolved, not only for the conservation of the Asiatic lion but also to provide ecological security to the region. Management of wasteland, panchayat lands, grasslands and forests connecting Gir to new habitats should be covered under a management plan for a Greater Gir Ecosystem.

POPULATION OF WILDLIFE IN THE GIR
WILDLIFE CENSUS, MAY 1995

Species	Common name	Population
1. *Panthera leo persica*	Lion	304
2. *Panthera pardus*	Leopard	268
3. *Hyaena hyaena*	Striped Hyena	137
4. *Axis axis*	Chital	32061
5. *Cervus unicolor*	Sambar	2262
6. *Boselaphus tragocavmelus*	Bluebull	1856
7. *Gazella gazella*	Chinkara	441
8. *Tetracerus quadricornis*	Four horned antelope	387
9. *Sus scrofa*	Indian Wild boar	1214

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QUALITATIVE ANALYSIS OF MAJOR VERTEBRATE FAUNA FROM WARDHA RIVER BASIN (MAHARASHTRA STATE)[1]

M.S. Pradhan[2]

(With four text-figures)

In view of the proposed coal mining expansion programme in Wardha river basin in Maharashtra State, faunal studies of the river basin were undertaken. An inventory of 392 vertebrate species has been reported along with the status of their current occurrence in the basin. 14 species appear to have become locally extinct/rare/endangered, while 48 are facing the danger of extinction due to progressive degradation of natural habitat in the name of development.

Introduction

In response to the request received from the Chairman, Advanced Environmental Management Group set up by the Ministry of Coal, Govt. of India, studies on the occurrence of major vertebrate species from Wardha river basin in Maharashtra State was undertaken in 1988. Wardha river basin is vitally important due to its location in the mineral belt of the Deccan Plateau, especially in the coal belt. The basin accounts for almost the entire amount of coal produced in the state. The status of the important vertebrate species reported in the past from this region was the initial aim. However, considering the importance of the mineral and faunal wealth of the river valley, the scope of the studies was broadened. The present article is based on the report submitted to the Chairman of the AEM group.

Objective

The main objective was to prepare a document on the current status of the major vertebrate species reported in the past from Wardha river basin in the Vidarbha region (Maharashtra State). To achieve this aim, it was first essential to prepare a consolidated faunal inventory from the available past records. For this purpose, group-wise literature was consulted, the details of which have been given under "Vertebrate Fauna — Past and Present." Finally, it was also felt necessary to refer to the latest bibliography, undertake survey for sighting records and consult various experts and local authorities before reporting on the current status of the species mentioned in the faunal inventory.

Location and area

The Wardha river basin in the Vidarbha region of Maharashtra State lies between 78° & 79° E longitudes and 20° & 22° N latitudes at an average altitude of about 200 m. above msl. It cuts the state in north-south direction (Fig. 1) passing through atleast five districts, namely, Amravati, Nagpur, Wardha, Yavatmal and Chandrapur. Wardha river, a sub-tributary of Godavari river, covers a distance of about 300 km southwards after its origin on Betul plateau in Madhya Pradesh and meets Wainganga river to form Pranhita which, in turn, ultimately meets the Godavari river near Sironcha in Chandrapur district.

Surveys

Rapid surveys were undertaken at selected places of faunal importance along the entire course of the Wardha river. The major centres of the surveys are shown in Fig 2. Such surveys were conducted in a span of two years (1988, 1989) with the help of the authorities from Western Coalfield Ltd., Nagpur and officials from Forest Offices at Amravati,

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[2]Zoological Survey of India, W.R.S., Shivajinagar, Pune-411 005

Yavatmal, Chandrapur and Gadchiroli. Scientists from Punjabrao Krishi Vidyapeeth, Akola and District Fisheries Office at Chandrapur were also consulted for information on fishes.

Wardha River Basin

General: The most important tributary-basin that forms a part of the larger Godavari river system is of Wardha and Wainganga rivers in eastern Maharashtra. Wardha river emerges from the southern slopes of Satpura ranges, more specifically from Betul plateau, east of Multai (78° E longitude) in Madhya Pradesh. The river takes a long and tortuous course along the Satpura Hills. The Wardha river basin runs in south-easterly direction (Fig. 1) and has undulating plains of fertile soil in its

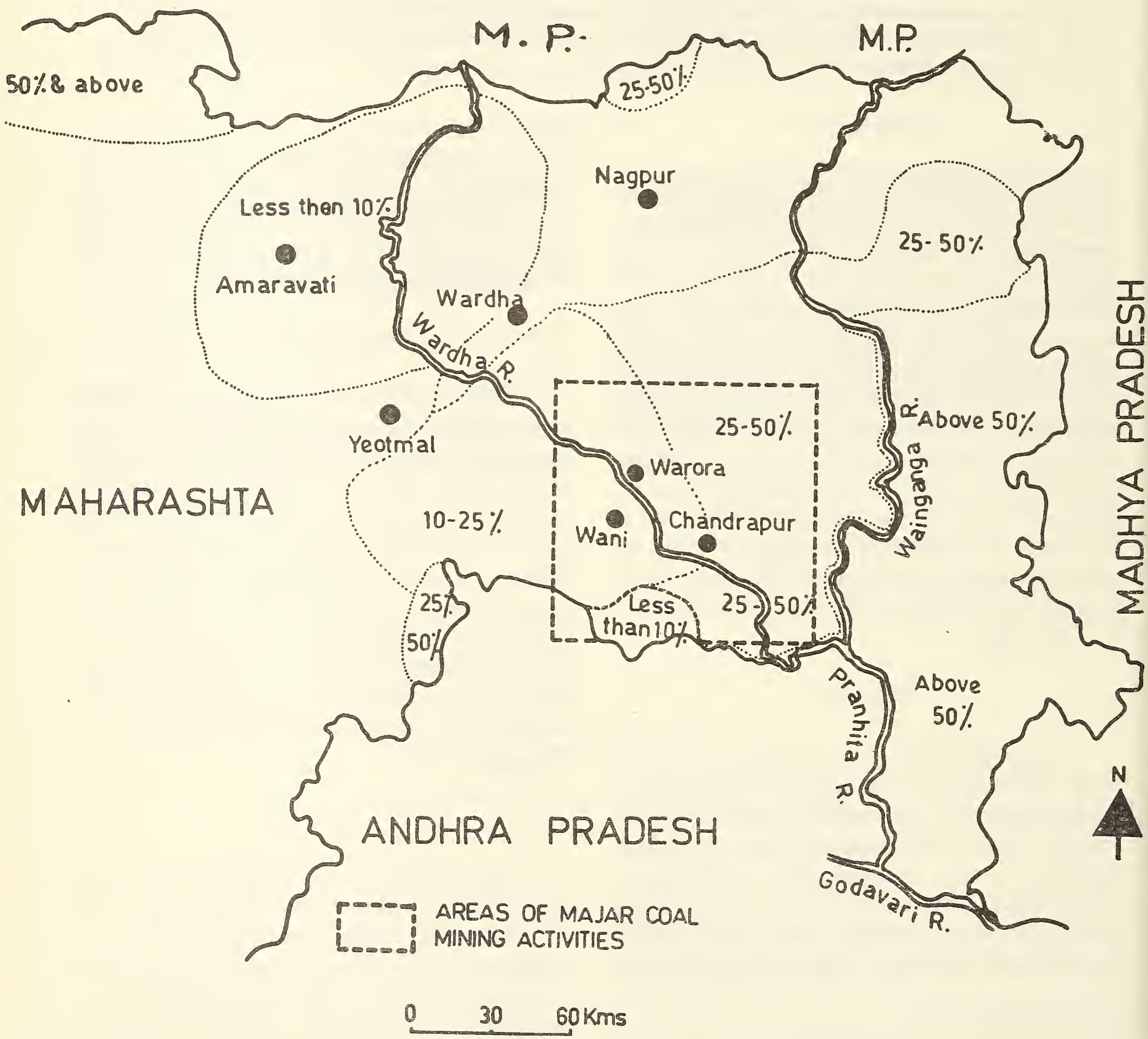


Fig. 1. Course of Wardha river and existing forest cover (in percentage) in Eastern part of Maharashtra state

neighbourhood. The course is quite zigzag after the origin and forms the border for atleast five districts of Maharashtra State. While the upper Wardha plain is an agricultural country, the lower part of the basin has the distinction of having the only coal-belt of the State and a considerable forest area with fairly rich wildlife.

The river, after descending from the Satpura ranges, passes along Ashti Forest Range in Wardha Dist. and flows on plains along Ajanta range in Yavatmal Dist. Later, the river course traverses rich coalfield areas near Rajur, Wani and Ghugus in Yavatmal Dist. and Warora, Ballarpur and Rajura in Chandrapur Dist. (Fig. 2). The confluence of the Wardha and Wainganga rivers in Gadchiroli Dist. is known as Pranhita river which ultimately meets the Godavari near Sironcha on the Maharashtra-Andhra Pradesh border.

Climate: The overall climate of the region is dry and extreme. It belongs to the tropical savannah type. The average minimum temperature is around 15°C in winter, while the highest temperature goes upto 45°C in summer in the areas around the thermal power station at Durgapur. However, summer evenings are cooler.

The eastern part of Maharashtra receives rains from the southwest as well as northeast monsoons. Obviously, the annual rainfall in Chandrapur Dist. (1000-2000 mm), is more than in Yavatmal Dist. (400-1000 mm). On an average, the two districts have 50-75 rainy days in a year.

Soil: The river valley has black and red soil. Upper Wardha valley has the agriculturally rich and fertile black cotton soil, whereas the lower basin is very rich in coal deposits, and also in minerals like manganese, iron, copper, etc. The coal deposits are mostly concentrated in Chandrapur and Yavatmal districts (Dikshit, 1985).

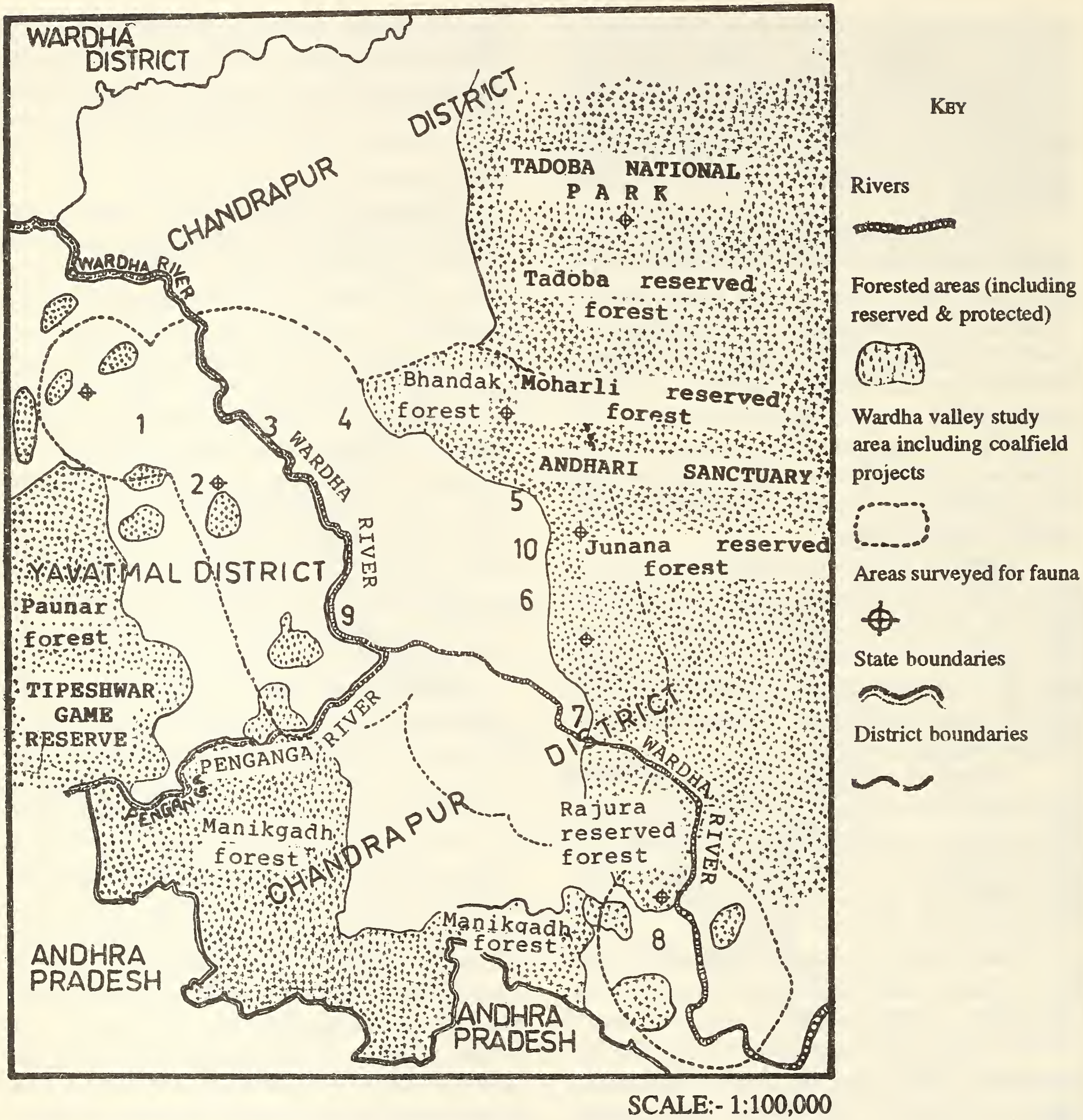
Mining activities: Large scale coal mining is already in progress in areas like Ghugus, Manjari, Durgapur and Ballarpur (Ballarshah). Fig. 2 shows encircled areas which include various existing and proposed coalfield projects (open cast mines) in Wardha river valley. The figure also shows that the mining activities extend over the dense forest cover in the two districts which form excellent habitat for rich and varied wildlife. The major drawback of the open cast coal mining system is that it destroys not only the habitat from where the coal is mined out but it also affects the adjacent habitats where the waste is dumped.

Sanctuary, National Park and Game Reserve: The lower Wardha river basin and its adjacent environs form such a wonderful habitat for wildlife that most of it has been reserved for the protection of vulnerable species like tiger, four-horned antelope, flying squirrel, ratel, gaur, sloth bear, lesser florican, python, etc. Tadoba National Park with an area of 117 sq. km is within 15 km of Chandrapur city and only a few km away from the Durgapur Thermal Power Station. All along the eastern side of the Chandrapur-Ballarpur belt, the newly formed Andhari Sanctuary with an area of about 520 sq. km is spread in the northsouth direction (Fig 2). The Tippeshwar Game Reserve with an area of about 225 sq. km is situated about 50-60 km away on the western side of Wani town.

Forest cover: Parts of eastern Maharashtra with existing forest cover (in percentage range) have been depicted in Fig 1. The forest in the Wardha river basin in Chandrapur and Yavatmal districts alone accounts for 30-35% of the entire state forest. The forest, mixed and dense, mostly belongs to Southern Tropical Dry Deciduous type (Champion and Seth, 1968) in the region where rainfall is less than 1000 mm, whereas it is Moist Deciduous type (Champion and Seth, 1968) in the rainfall zone of 1500-2000 mm. There is an abundant growth of wild bamboo species (*Dendrocalamus strictus*) at a number of places. Dominant plant species are teak (*Tectona grandis*), ain (*Terminalia tomentosa*), arjun (*Terminalia arjuna*), dhavada (*Anogeissus latifolia*), sal (*Shorea robusta*), shisham (*Dalbergia latifolia*), tendu (*Diospyros melanoxylon*), haldu (*Adina cordifolia*) etc. Cotton, rice and jowar are the predominant crops grown in this region.

VERTEBRATE FAUNA — PAST AND PRESENT

As stated earlier, the region exhibits a very



1. Rajur (Yavatmal Dist.)
2. Wani Town
3. New Majri open cast mines
4. Bhandak (Bhadravati)
5. Durgapur Coal mines & thermal power station
6. Chandrapur City
7. Ballarpur Coal mines
8. Wirur Town
9. Ghugus Coal mines
10. Chanda Rayatwari mines

Fig. 2 Parts of Yavatmal and Chandrapur district showing Wardha river valley coalfield and forest areas.

rich faunal diversity in vertebrate species (Fig 3). With only a few exceptions like wild buffalo and swamp deer, most of them are still found to be freely moving in the forested areas due to the continuity in forest cover from north to south in Chandrapur and Gadchiroli districts. About 55 out of 355 species reported in the past from Wardha river basin appear to have been threatened with local extinction.

Appendix II gives a complete account of the current status of major vertebrate species reported from Wardha river basin in the past. The comparative account of the specific status was prepared by referring to the available bibliography. Some of them are: Fauna Gazetteer for Maharashtra State Anon. (1974); Pocock (1939, 1941); Ellerman and Morrison-Scott (1951); Brander (1982); Prater (1980); Ali (1961); Khajuria and Ghosal (1981); Daniel (1983); Anon. (1986); Brosset (1962); Murthy (1985); Chitampalli (1980); Divekar *et al.* (1983); Ripley (1961); Inger and Dutta (1987); Kulkarni (1975); Pradhan (1978); Talwar and Jhingran (1991); Talwar (1991). Field trips for actual sightings and detailed discussions with experts in relevant subjects and also with the local authorities proved to be extremely useful at the time of compiling the data on faunal status. Faunal inventory prepared during the current studies was shown to the experts on various groups for updating the information. The following is the group-wise list of experts consulted:

1. Mammalia : M.S. Pradhan
2. Aves : M. Chitampalli, Ex-Dy. Director. Melghat Tiger Project, Paratwada and Shri Ramanand, A.C.F., Chandrapur.
3. Reptilia Amphibia : M.S. Pradhan, with the help of forest authorities and after consulting available bibliography.
4. Pisces : M.S. Pradhan, K.B. Dabhade, Asso. Prof., P.K.V. Akola and Experts from Dist. Fish Office, Chandrapur.

Species under Wildlife Act (Amend. 1991) Schedule: As per the Wildlife Act, 51 vertebrate species mentioned in the Appendix-II belong to Schedule I and Part II of Schedule II (Fig. 4). These species are endangered and locally threatened with extinction. Out of the 235 scheduled vertebrate species, 57 are mammalian, 160 are avian and 18 are reptilian and amphibian species. Besides these, 11 fish species have also been treated as threatened Talwar (1991).

Observations based on current studies

Appendix I gives group-wise record of vertebrate species from Wardha river basin, while Appendix II gives a detailed inventory of 392 species belonging to five vertebrate classes. Out of these, 14 species are locally extinct/rare/endangered (Appendix III) and 58 are facing the danger of local extinction from degradation of the natural habitat. The target groups are mammals and birds (Fig. 4). Wild buffalo and swamp deer have already disappeared from Chandrapur district due to increased industrial activities and disturbances on a large scale. Sensitive species like tiger, giant squirrel, flying squirrel, sloth bear, ratel, four horned antelope, python etc. are also known to inhabit the dense forested areas of the district and adjoining areas. Destruction of natural habitats on a large scale threatens the lesser known species also, like the Narmada rat, lesser florican, falcon, owlet, monitor lizard, rufescent burrowing frog, humped feather-back fish, chameleon fish and a few more which form part of the food chain. Any damage to such a fragile ecosystem will result in irreparable loss and affect the survival of sensitive species in the region.

Fig. 2 shows the areas where mining activities are already in progress. If these developments are extended further deep inside Moharli, Junana and Rajura reserved forests, they may damage the habitat and restrict the movement of wildlife in Chandrapur district. Rajura reserved forest forms a bottleneck between Junana and Manikgadh forests. If this region is protected it will help in establishing a corridor for free movement of the wildlife.

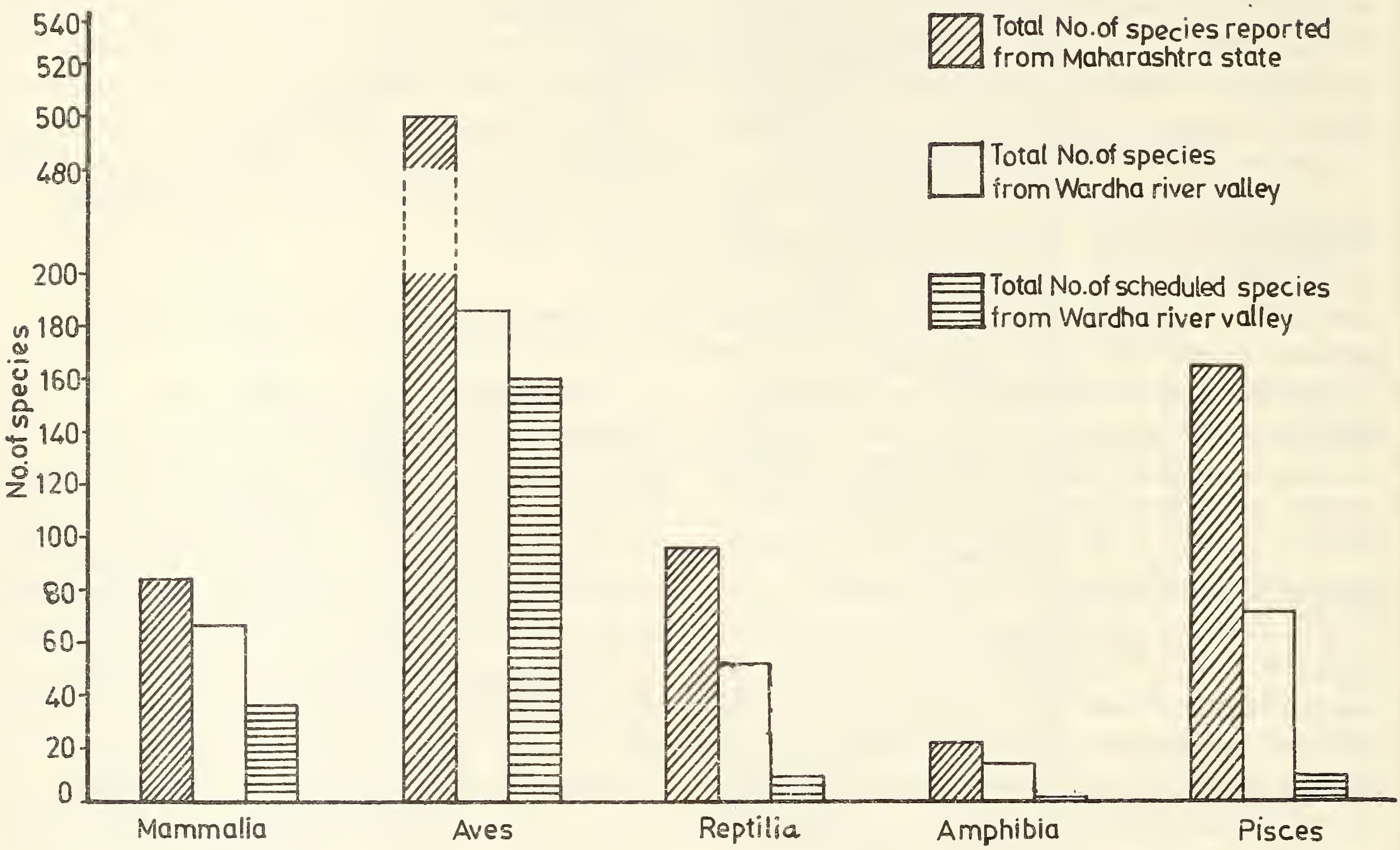


Fig. 3. Graph showing total no.of major vertebrate species.

Conclusion

1. Appendix I clearly shows that 14 out of 392 vertebrate species reported from Wardha river basin have either become locally extinct or rare due to degradation of natural habitats at a number of places. These are listed in Appendix III.

2. Wildlife in the region is represented by some of the most sensitive species like tiger, giant squirrel, flying squirrel, sloth bear, ratel, gaur, four horned antelope, lesser florican, sarus crane and flamingo. Four horned antelope was sighted in the forest, 2 km away from Durgapur Thermal Power Station.

3. About 32 vertebrate species belonging to Schedule I of the amended Wildlife Act (1986 & 1991) are still known to occur in Wardha river basin.

4. In all, 58 species (those species which are listed under Schedule I & II (II) of Wildlife Act and threatened and endangered categories of IUCN in Appendix II) are facing the danger of local extinction and need protection for their immediate conservation.

5. Wardha river, being a part of the Godavari river basin, possesses very good ichthyofauna. However, seven species of fish have also been considered as threatened species.

6. Survival of the nearly extinct, rare or endangered species is seriously threatened due to over-exploitation of the natural habitats from all sides of the entire river basin. If the present downward trend in the abundance of vertebrate species continues it will affect the local food chain and ultimately impair biodiversity and in turn the gene pool of the region.

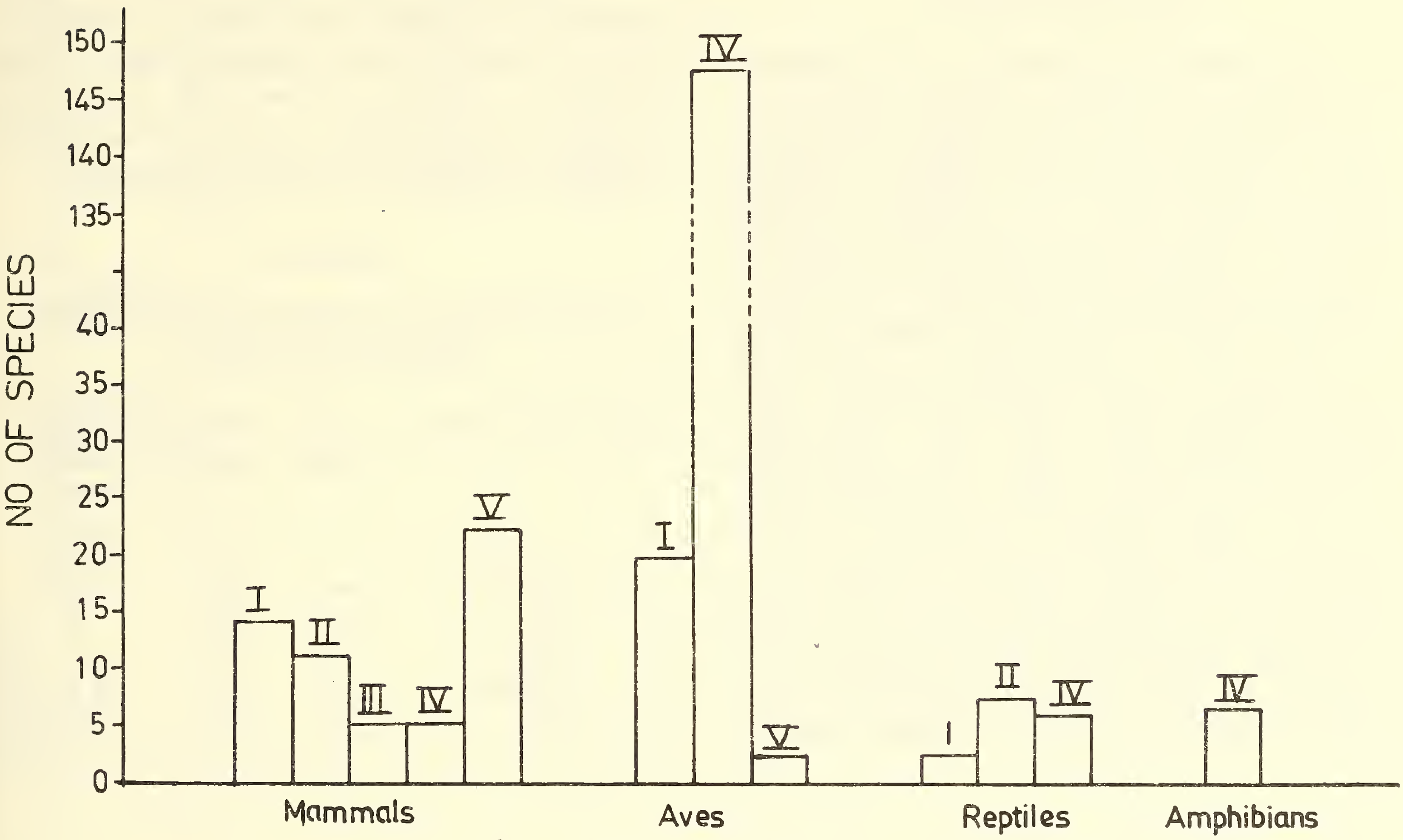


Fig. 4. Graph showing wildlife schedule-wise distribution of major vertebrate species.

7. The practice of open cast mining should not be encouraged further, as it will definitely cause long lasting damage to the natural habitats and will also be detrimental to the arboreal, terrestrial and subterrestrial fauna. Besides, regeneration is a very slow process and does not guarantee restoration of the original biodiversity. Hence, it is time to work out an alternative to open cast mining if one really wants to stop the onslaught on the environment.

8. Considering the richness of the natural resources in physical, mineral and biological components of Wardha river basin, one expects that it is possible to plan its sustainable development for the human race without impairing the total gene pool.

9. Further studies can be concentrated on the relative abundance and population status of selected species, particularly threatened ones reported in the present inventory. This may help in the restoration of some of the species in the undisturbed habitats of this region.

10. One national park (Tadoba National Park), one wildlife sanctuary (Andhari Sanctuary) and one game reserve (Tippeshwar) are situated in the close vicinity of the coal belt (Fig. 2). Converting Tippeshwar Game Reserve into a sanctuary under the amended Wildlife Act (1991), so that more undisturbed area is available to the wildlife for its propagation, is strongly suggested.

11. If Rajura reserved forest and its adjoining areas are afforded proper protection, a corridor between Junana and Manikgadh forests will be established for the free movement of wildlife.

12. Finally, it is imperative on our part to adopt stringent conservation measures in the Wardha-

Wainganga tributary basin to check over-exploitation of the available natural resources in the name of development.

Acknowledgements

My sincere thanks are due to the Director, Zoological Survey of India, Calcutta, for permission to undertake the studies and also to the Officer-in-Charge, Zoological Survey of India, Western Regional Station, Pune, for providing necessary facilities. I gratefully acknowledge the help and cooperation extended by Shri Dange, Joint Director, and other officials from Wardha Valley Coalfield Ltd., Nagpur and Chandrapur, Shri M.B. Chitampalli, Ex-Deputy Director, Melghat Tiger Project, Paratwada, Shri P.D. Ambaskar, Conservator of Forests, South Chandrapur Circle, Shri A.K. Nigam, Deputy Conservator of Forests, Tadoba National Park, Shri M.N. Athawale, Dy. Conservator of Forests, Shri Banot, A.C.F., Tadoba National Park, Chandrapur, Shri Ramanand, A.C.F., Chandrapur, Shri Manohar Sapre, Environmentalist, Chandrapur, Dr. K.B. Dabhade, Associate Prof., P.K.V., Akola, Experts from Dist. Fisheries Office, Chandrapur and a number of local people and tribals towards completion of the studies.

Finally, I also wish to thank Dr. G.M. Yazdani, Scientist-SE & Officer-in-Charge, Zoological Survey of India, Western Regional Station, Pune and Dr. V.C. Agrawal, Scientist-SF, Zoological Survey of India, Calcutta, for going through the manuscript and offering valuable suggestions.

Appendix I

STATUS OF MAJOR VERTEBRATE SPECIES FROM WARDHA RIVER BASIN

Sl. No.	Name of Group	Past Record	Present Record	No of spp. locally extinct or rare
1.	Mammalia	64	62	2
2.	Aves	193	188	5
3.	Reptilia	52	49	3
4.	Amphibia	11	10	1
5.	Pisces	72	70	2

Appendix II

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
Class: *MAMMALIA*							
Order: INSECTIVORA							
	Family: ERINACEIDAE						
	Subfamily: Erinaceinae						
1.	Indian hedgehog	*Paraechinus microphus* (*nudiventris*)	?	+	-	-	Sighting by Forest officials.
	Family: SORICIDAE						
2.	House shrew	*Suncus murinus* (Linn.)	+	+	-	-	Sighting
3.	Savi's Pigmy shrew	*Suncus etruscus* Savi	+	+	-	-	
Order: SCANDENTIA							
	Family: TUPAIIDAE						
4.	Tree shrew	*Anathana ellioti* Waterhouse	+	+	-	-	Sighting
Order: CHIROPTERA							
	Family: PTEROPODIDAE						
5.	Leschenault's fruit bat	*Rousettus leschenaulti* (Desmarest)	+	+	V	-	
6.	Indian flying fox	*Pteropus giganteus* (Brunnich)	+	+	V	-	Sighting
7.	Short-nosed fruit bat	*Cynopterus sphinx* (Vahl.)	+	+	V	-	
	Family: RHINOPOMATIDAE						
8.	Hardwicke's rat-tailed bat	*Rhinopoma hardwickei* Grey	+	+	V	-	-
	Family: EMBALLONURIDAE						
9.	Long-armed tomb bat	*Taphozous longimanus* Hard.	+	+	V	-	-
10.	Bearded-tomb bat	*Taphozous melanopogon* Temminck	+	+	V	-	-
	Family: MEGADERMATIDAE						
11.	Malay false vampire bat	*Megaderma spasma* (Linn.)	+	+	V	-	-
12.	Indian false vampire bat	*Megaderma lyra* Geof.	+	+	V	-	-

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: RHINOLOPHIDAE						
13.	Roux's horse-shoe bat	*Rhinolophus rouxi* Temm.	+	+	V	-	-
14.	Leaf-nosed bat	*Hipposideros speoris* (Schn.)	+	+	V	-	-
15.	Bicoloured leaf-nosed bat	*Hipposideros bicolor* (Temm.)	+	+	V	-	-
	Family: VESPERTILIONIDAE						
16.	Dormer's bat	*Pipistrellus dormeri* (Dobson)	+	+	V	-	-
17.	Kelaart's pipistrelle	*Pipistrellus ceylonicus* Wroughton	+	+	V	-	-
18.	Pygmy pipistrelle	*Pipistrellus mimus* Wroughton	+	+	V	-	-
19.	-	*Miniopterus schreibersi* (Kuhl)	+	+	V	-	-
20	Indian painted bat	*Kerivoula picta* (Pallas)	+	+	V	-	-
Order: PRIMATES							
	Family: CERCOPITHECIDAE						
21.	Rhesus macaque	*Macaca mulatta* (Zimmer.)	+	+	II(I)	-	Sighting
22.	Hanuman langur	*Presbytis entellus* (Duf.)	+	+	(II(I)	-	Sighting
Order: CARNIVORA							
	Family: CANIDAE						
23.	Jackal	*Canis aureus* (Linn.)	+	+	II(I)	V	-
24.	Wolf	*Canis lupus* (Linn.)	+	+	I	V	-
25.	Indian Fox	*Vulpus bengalensis* (Shaw)	+	+	II(II)	V	Sighting
26.	Dhole or Wild dog	*Cuon alpinus* (Pallas)	+ (In Chandrapur Dist. only)	+	II(I)	V	Sighting
	Family: URSIDAE						
27.	Sloth Bear	*Melursus ursinus* (Shaw)	+	+	I	V	Sighting
	Family: MUSTELIDAE						
28.	Indian Ratel	*Mellivora capensis* (Schreben)	+ (In Chandrapur Dist. only)	+	I	V	Sighting by Forest officials.
29.	Smooth-coated otter	*Lutra perspicillata* (Geof)	+	+	III	V	Sighting by Forest officials

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: Viverridae						
30.	Small Indian civet	*Viverricula indica* (Desmart)	+	+	V	-	-
31.	Palm civet (Toddy cat)	*Paradoxurus hermaphroditus* (Pallas)	+	+	II(II)	V	-
	Family: Herpestidae						
32.	Indian common mongoose	*Herpestes edwardsi* (Geof.)	+	+	IV	-	Sighting
	Family: Hyaenidae						
33.	Striped hyena	*Hyaena hyaena* (Linn.)	+	+	III	V	Sighting
	Family: Felidae						
34.	Leopard cat	*Felis bengalensis* Kerr	+	+	I	V	-
35.	Jungle cat	*Felis chaus* Guldenst.	+	+	II(II)	V	Sighting
36.	Desert cat	*Felis silvestris* Gray	+	+	I	V	Sighting
37.	Leopard/Panther	*Panthera pardus* (Linn.)	+	+	I	V	Sighting
38.	Tiger	*Panthera tigris* (Linn.)	+	+	I	V	Sighting
Order:	ARTIODACTYLA						
	Family: Suidae						
39.	Wild boar	*Sus scrofa* Linn.	+	+	-	_	Sighting
	Family: Tragulidae						
40.	Mouse Deer or Indian Chevrotain	*Tragulus meminna* (Erxleb.)	+	+	I	V	-
	Family: Cervidae						
41.	Barking deer or Indian muntjack	*Muntiacus muntjak* (Zimmer.)	+	+	III	-	-
42.	Spotted deer	*Axis axis* (Erxleb.)	+	+	III	-	Sighting
43.	Swamp Deer or Barasingha	*Cervus duvauceli branderi* (Pocock)	+ (In Chandrapur	A	I	E	-

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
			Dist. only)				
44.	Sambar	*Cervus unicolor* Kerr	+	+	III	-	Sighting
	Family: Bovidae						
45.	Nilgai/Blue Bull	*Boselaphus tragocamelus* (Pallas)	+	+	III	-	Sighting
46.	Four-horned antelope	*Tetraceros quadricornis* (Blain)	+	+	I	V	Sighting
47.	Indian Black buck	*Antilope cervicapra* (Linn.)	+	+	I	E	Sighting by Forest officials
48.	Indian Gazelle	*Gazella bennettii* = *Gazella dorcas* (Linn.)	+	+	I	-	-
49.	Wild Buffalo	*Bubalus arnee* = *Bubalus bubalis* (Linn.)	+ (In Chandrapur Dist. only)	A	I	E	-
50.	Indian Gaur	*Bos gaurus* H. Smith	+ (In Chandrapur Dist. only)	+	I	V	Sighting
Order: PHOLIDOTA							
	Family: Manidae						
51.	Indian Pangolin	*Manis crassicaudata* Gray	+	+	I	I	-
Order: RODENTIA							
	Family: Sciuridae						
52.	Five striped squirrel	*Funambulus pennanti* Wroughton	+	+	IV	-	Sighting
53.	Three striped squirrel	*Funambulus palmarum robertsoni* Wroughton	+	+	-	-	Sighting
54.	Indian Giant squirrel	*Ratufa indica centralis* (Erxleb.)	+	+	II(I)	-	Sighting
55.	Indian Flying squirrel	*Petaurista petaurista philippensis*	+ (In Chandrapur Dist. only)	+	II(II)	-	-
	Family: Muridae						

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
56.	Indian gerbil rat	*Tatera indica* (Hardwicke)	+	+	V	-	-
57.	House rat	*Rattus rattus rufescens* (Gray)	+	+	V	-	Sighting
58.	House rat	*Rattus rattus narbadae* Hinton	+	?	V	-	-
59.	House mouse	*Mus musculus castaneus* Waterhouse	+	+	V	-	-
60.	Little Indian field mouse	*Mus booduga* Gray	+	+	V	-	-
61.	Lesser bandicoot rat	*Bandicota bengalensis* (Gray)	+	+	V	-	Sighting
62.	Larger bandicoot rat	*Bandicota indica* (Bech.)	+	+	V	-	Sighting
	Family: Hystricidae						
63.	Indian Porcupine	*Hystrix indica* Kerr	+	+	IV	-	Sighting
Order: LAGOMORPHA							
	Family: Leporidae						
64.	Indian hare	*Lepus nigricollis* F. Cur.	+	+	IV	-	Sighting
Class: *AVES*							
Order: PODICIPEDIFORMES							
	Family: Podicipedidae						
1.	Great crested grebe (WB, M)	*Podiceps cristatus* (Linn.)	+	+	IV	-	Present record is based on checklist published by DFO, Tadoba National Park, Chandrapur (1986).
2.	Little grebe (WB, M)	*Tachybaptus ruficollis* (Pallas)	+	+	IV	-	— do —
Order: PELECANIFORMES							
	Family: Phalacrocoracidae						
3.	Little cormorant (WB, M)	*Phalacrocorax niger* (Vieillot)	+	+	IV	-	— do —
4.	Darter or Snake bird (WB, M)	*Anhinga rufa* (Daudin)	+	+	IV	-	— do —
Order: CICONIIFORMES							
	Family: Ardeidae						

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
5.	Purple Heron (WB, M)	*Ardea purpurea* Var.	+	+	IV	-	— do —
6.	Grey Heron (WB, M)	*Ardea cinerea* Linn.	+	+	IV	-	— do —
7.	Pond Heron	*Ardeola grayii* (Sykes)	+	+	-	-	
8.	Cattle egret	*Bubulcus ibis* (Linn.)	+	+	IV	-	
9.	Median egret (WB, M)	*Egretta intermedia* (Wagler)	+	+	IV	-	— do —
10.	Large egret (WB, M)	*Egretta alba* (Linn.)	+	+	IV	-	— do —
11.	Little egret (WB, M)	*Egretta garzetta* (Linn.)	+	+	IV	-	— do —
	Family: Ciconiidae						
12.	Openbilled stork (WB, M)	*Anastomus oscitans* (Bod.)	+	+	IV	-	— do —
13.	Whitenecked stork (WB, M)	*Ciconia episcopus* (Bod.)	+	+	IV	-	— do —
	Family: Threskiornithidae						
14.	White Ibis (WB, M)	*Threskiornis aethiopica* (Latham)	+	+	IV	-	— do —
15.	Black Ibis (WB, M)	*Pseudibis papillosa* (Temm.)	+	+	IV	-	— do —
16.	Spoonbill (WB, M)	*Platalea leucorodia* Linn.	+	+	IV	-	— do —
	Family: Phoenicopteridae						
17.	Flamingo (WB, M)	*Phoenicopterus roseus* (Pallas)	?	+	IV	-	— do —
Order:	ANSERIFORMES						
	Family: Anatidae						
18.	Brahminy Duck (WB, M)	*Tadorna ferruginea* (Pallas)	+	+	IV	-	— do —
19.	Common Teal (WB, M)	*Anas crecca* Linn.	+	+	IV	-	— do —
20.	Redcrested Pochard (WB, M)	*Netta rufina* (Pallas)	+	+	IV	-	— do —
21.	White-eyed Pochard (WB, M)	*Aythya nyroca* (Gulden)	+	+	IV	-	— do —
22.	Tufted Pochard (WB, M)	*Aythya fuligula* (Linn.)	+	+	IV	-	— do —
23.	Cotton Teal (WB, M)	*Nettapus coromandelianus* (Gmelin)	+	+	IV	-	— do —
24.	Lesser Whistling Teal (WB, M)	*Dendrocygna javanica*	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
25.	Comb Duck (WB. M)	*Sarkidiornis melanotus*	+	+	IV	-	— do —
Order: FALCONIFORMES							
	Family: ACCIPITRIDAE						
26.	Blackwinged kite (BOP, R)	*Elanus caeruleus* (Desfontaines)	+	+	I	-	— do —
27.	Pariah kite (BOP, R)	*Milvus migrans* (Bodd.)	+	+	I	-	— do —
28.	Brahminy kite (BOP, R)	*Haliastur indus* (Bodd.)	+	+	I	-	— do —
29.	Indian Shikra (BOP, R)	*Accipiter badius* (Gmelin)	+	+	I	-	— do —
30.	Sparrow Hawk (BOP, M)	*Accipiter nisus*	?	+	I	-	— do —
31.	White-eyed Buzzard-Eagle (BOP, R)	*Butastur teesa* (Franklin)	?	+	I	-	— do —
32.	Crested Hawk-Eagle (BOP, R)	*Spizaetus cirrhatus* (Gmelin)	+	+	I	-	— do —
33.	Hodgson's Hawk-Eagle (BOP, M)	*Spizaetus nipalensis*	?	+	I	-	— do —
34.	Tawny Eagle (BOP, R)	*Aquila rapax* (Temminck)	+	+	I	-	— do —
35.	Grey headed Fish Eagle (BOP, R)	*Ichthyophaga ichthyaetus* (Horsefield)	+	+	I	-	— do —
36.	White-backed vulture (BOP, LM)	*Gyps bengalensis* (Gmelin)	+	+	I	-	— do —
37.	Scavenger vulture (BOP, LM)	*Neophron percnopterus* (Linn.)	+	+	I	-	— do —
38.	Pallid or Pale Harrier (BOP, M)	*Circus macrourus* (Gmelin)	+	+	I	-	— do —
39.	Marsh Harrier (BOP, M)	*Circus aeruginosus* (Linn.)	+	+	I	-	— do —
40.	Short-toed Eagle (BOP, R)	*Circaetus gallicus* (Gmelin)	+	+	I	-	— do —
41.	Crested serpent Eagle (BOP, R)	*Spilornis cheela* (Latham)	+	+	I	-	— do —
42.	Lagger falcon (BOP, R)	*Falco biarmicus jugger* (Gray)	+	?	-	-	— do —
43.	Peregrine falcon (BOP, M)	*Falco peregrinus* (Trunstall)	+	+	I	E	— do —
44.	Kestrel (BOP, M)	*Falco tinnunculus* (Linn.)	?	+	IV	-	— do —
Order: GALLIFORMES							
	Family: PHASIANIDAE						
45.	Painted partridge (GB, R)	*Francolinus pictus* (Jard. & Selby)	+	+	IV	-	— do —
46.	Grey partridge (GB, R)	*Francolinus pondicerianus* (Gmelin)	+	+	IV	-	— do —
47.	Grey quail (GB, R)	*Coturnix coturnix* (Linn.)	+	+	IV	-	— do —
48.	Black-breasted quail or	*Coturnix coromandelica*	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	rain quail (GB, R)						
49.	Jungle Bush quail (GB, R)	*Perdicula asiatica* (Latham)	+	+	IV	-	— do —
50.	Grey jungle-fowl (GB, R)	*Gallus sonneratii* (Temm.)	+	+	IV	-	— do —
51.	Red Jungle fowl (GB, R)	*Gallus gallus* Linn.	+	+	IV	-	— do —
52.	Peafowl (GB, R)	*Pavo cristatus* Linn.	+	+	I	-	— do —
53.	Red spurfowl (GB, R)	*Galloperdix spadicea* (Gmelin)	+	+	IV	E	— do —
Order: GRUIFORMES							
	Family: TURNICIDAE						
54.	Common Bustard-quail (GB, R)	*Turnix suscitator* (Gmelin)	+	+	IV	-	— do —
55.	Sarus Crane (WB, M)	*Grus antigone* (Linn.)	+	+	IV	E	— do —
	Family: RALLIDAE						
56.	Whitebreasted waterhen (WB, M)	*Amaurornis phoenicurus* (Pinn.)	+	+	IV	-	— do —
57.	Watercock (WB, M)	*Gallicrex cinerea* (Gmelin)	+	+	IV	-	— do —
58.	Indian Moorhen (WB, M)	*Gallinula chloropus* (Linn.)	+	+	IV	-	— do —
59.	Purple Moorhen (WB, M)	*Porphyria porphyra* (Linn.)	+	+	IV	-	— do —
60.	Coot (WB, M)	*Fulica atra* Linn.	+	+	IV	-	— do —
	Family: OTIDIDAE						
61.	Lesser florican (GB, R)	*Sypheotides indica* (Miller)	+	?	I	R	
Order: CHARADRIIFORMES							
	Family: JACANIDAE						
62.	Pheasant-tailed jacana (WB, R)	*Hydrophasianus chirurgus* (Scopoli)	+	+	IV	-	— do —
63.	Bronze-winged jacana (WB, R)	*Metopidius indicus* (Latham)	+	+	IV	-	— do —
	Family: CHARADRIIDAE						
64.	Redwattled lapwing (WB, R)	*Vanellus indicus* (Boddaert)	+	+	IV	-	— do —
65.	Little ringed plover (WB, R)	*Charadrius dubius* Scopoli	+	+	IV	-	— do —
66.	Curlew (WB, M)	*Numenius arquata* (Linn.)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
67.	Redshank (WB, M)	*Tringa totanus* (Linn.)	+	+	IV	-	— do —
68.	Greenshank (WB, M)	*Tringa nebularia* (Gunnerus)	+	+	IV	-	— do —
69.	Common sandpiper (WB, M)	*Tringa glareola* Linn.	+	+	IV	-	— do —
70.	Spotted sandpiper (WB, M)	*Tringa hypoleucos* Linn	+	+	IV	-	— do —
71.	Green sandpiper (WB, M)	*Tringa ochropus* Linn.	+	+	IV	-	— do —
72.	Fantail snipe (WB, M)	*Capella gallinago* (Linn.)	+	+	IV	-	— do —
	Family: Rostratulidae						
73.	Painted snipe (WB, M)	*Rostratula benghalensis* Linn.	+	+	IV	-	— do —
74.	Blackwinged stilt (WB, M)	*Himantopus himantopus* (Linn.)	+	+	IV	-	— do —
	Family: Burhinidae						
75.	Stone curlew (GB, R)	*Burhinus oedicnemus* (Linn.)	+	+	IV	-	— do —
	Family: Laridae						
76.	Indian river tern (WB, M)	*Sterna aurantia* Gray	+	+	IV	-	— do —
Order: COLUMBIFORMES							
	Family: Pteroclididae						
77.	Painted sandgrouse (GB, R)	*Pterocles indicus* (Gmelin)	+	+	IV	-	— do —
	Family: Columbidae						
78.	Greyfronted green pigeon (AB, R)	*Treron pompadora* (Gmelin)	+	+	IV	-	— do —
79.	Southern green pigeon (AB, R)	*Treron phoenicoptera* (Latham)	+	+	IV	-	— do —
80.	Blue rock pigeon (AB, R)	*Columba livia* (Gmelin)	+	+	IV	-	— do —
81.	Ring dove (AB, R)	*Streptopelia decaocto* (Frivaldszky)	+	+	IV	-	— do —
82.	Spotted dove (AB, R)	*Streptopelia chinensis* (Scopoli)	+	+	IV	-	— do —
83.	Turtle dove (AB, R)	*Streptopelia tranquebarica*	+	?	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
Order:	PSITTACIFORMES	(Hermann)					
	Family: PSITTACIDAE						
84.	Alexandrine parakeet (AB, R)	*Psittacula eupatria* (Linn.)	+	+	IV	-	— do —
85.	Roseringed parakeet (AB, R)	*Psittacula krameri* (Scopoli)	+	+	IV	-	— do —
86.	Blossom headed parakeet (AB, R)	*Psittacula cyanocephala* (Linn.)	+	+	IV	-	— do —
Order:	CUCULIFORMES						
	Family: CUCULIDAE						
87.	Pied crested cuckoo (AB, M)	*Clamator jacobinus* (Bodd.)	+	+	IV	-	— do —
88.	Brainfever bird or Hawk cuckoo (AB, R)	*Cuculus varius* (Vahl.)	+	+	IV	-	— do —
89.	Indian cuckoo (AB, R)	*Cuculus micropterus* (Gould)	+	+	IV	-	— do —
90.	Plaintive cuckoo (AB, M)	*Cacomantis merulinus* (Scopoli)	+	+	IV	-	— do —
91.	Koel (AB, R)	*Eudynamys scolopacea* (Linn.)	+	+	IV	-	— do —
92.	Sirkeer cuckoo (AB, R)	*Taccocua leschenaulti* (Lesson)	+	+	IV	-	— do —
93.	Crow-pheasant (AB, R)	*Centropus sinensis* (Stephens)	+	+	IV	-	— do —
Order:	STRIGIFORMES						
	Family: STRIGIDAE						
94.	Indian Barn owl (GB, R)	*Tyto alba* (Scopoli)	+	+	-	-	
95.	Great Horned owl (GB, R)	*Bubo bubo* (Linn.)	+	+	IV	E	
96.	Spotted owlet (AB, R)	*Athene brama* (Temminck)	+	?	IV	-	
Order:	CAPRIMULGIFORMES						
	Family: CAPRIMULGIDAE						
97.	Indian jungle nightjar (GB, R)	*Caprimulgus indicus* (Latham)	+	+	IV	-	— do —
98.	Common Indian nightjar	*Caprimulgus asiaticus* (Latham)	+	+	IV	-	— do —
Order:	APODIFORMES						
	Family: APODIDAE						
99.	Indian house swift (AB, R)	*Apus affinis* (Grey)	+	+	-	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
100.	Palm swift (AB, R)	*Cypsiurus parvus* (Lichtenstein)	+	+	-	-	— do —
101.	Crested tree swift (AB, R)	*Hemiprocne longipennis* (Tickell)	+	+	-	-	— do —
Order:	CORACIFORMES						
	Family: ALCEDINIDAE						
102.	Lesser pied kingfisher (WB, R)	*Ceryle rudis* (Linn.)	+	+	IV	-	— do —
103.	Small blue kingfisher (WB, R)	*Alcedo atthis* (Linn.)	+	+	IV	-	— do —
104.	Threetoed kingfisher (WB, R)	*Ceyx erithacus* (Linn.)	+	+	IV	-	— do —
105.	Storkbilled kingfisher (WB, R)	*Pelargopsis capensis* (Linn.)	+	+	IV	-	— do —
106.	White-breasted kingfisher (WB, R)	*Halcyon smyrnensis* (Linn.)	+	+	IV	-	— do —
	Family: MEROPIDAE						
107.	Small green bee-eater (AB, R)	*Merops orientalis* (Latham)	+	+	-	-	— do —
108.	Bluecheeked bee-eater (AB, R)	*Merops superciliosus* (Linn.)	+	+	-	-	— do —
	Family: CORACIIDAE						
109.	Blue jay or Indian roller (AB, R)	*Coracias benghalensis* (Linn.)	+	+	IV	-	— do —
	Family: UPUPIDAE						
110.	Hoopoe (AB, R)	*Upupa epops* (Linn.)	+	+	-	-	— do —
	Family: BUCEROTIDAE						
111.	Common grey hornbill (AB, R)	*Tockus birostris* (Scopoli)	+	+	-	-	— do —
Order:	PICIFORMES						
	Family: CAPITONIDAE						
112.	Coppersmith or crimson breasted barbet (AB, R)	*Megalaima haemacephala* (Muller)	+	+	IV	-	— do —
113.	Large green barbet (AB, R)	*Megalaima zeylanica* (Gmelin)	+	+	IV	-	— do —
	Family: PICIDAE						
114.	Wryneck (AB, M)	*Jynx torquilla*	+	+	-	-	— do —
115.	Rufous woodpecker (AB, R)	*Micropternus brachyurus* (Vieilot)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
		(Vieillot)					
116.	Goldenbacked woodpecker (AB, R)	*Dinopium benghalense* (Linnaeus)	+	+	IV	-	— do —
117.	Little green woodpecker (AB, R)	*Picus myrmecophoneus* (Stresemann)	+	+	IV	-	— do —
118.	Mahratta woodpecker (AB, R)	*Picoides mahrattensis* (Latham)	+	+	IV	-	— do —
119.	Pigmy woodpecker (AB, R)	*Picoides nanus* (Vigors)	+	+	IV	-	— do —
Order:	PASSERIFORMES						
	Family: Pittidae						
120.	Indian pitta (GB, R)	*Pitta brachyura* (Linn.)	+	+	IV	-	— do —
	Family: Alaudidade						
121.	Ashycrowned finch-lark (GB, R)	*Eremopterix grisea* (Scopoli)	+	+	IV	-	— do —
122.	Rufous-tailed finch-lark (GB, R)	*Ammomanes phoenicurus* (Franklin)	+	+	IV	-	— do —
123.	Crested lark (GB, R)	*Galerida cristata* (Linn.)	+	+	IV	-	— do —
124.	Indian small skylark (GB, R)	*Alauda gulgula* Franklin	+	+	IV	-	— do —
	Family: Hirundinidae						
125.	Common swallow (AB, M)	*Hirundo rustica* (Linn.)	+	+	-	-	— do —
126.	Wiretailed swallow (AB, M)	*Hirundo smithii* (Leach.)	+	+	-	-	— do —
127.	Redrumped swallow (AB, R)	*Hirundo daurica* (Linn.)	+	+	-	-	— do —
	Family: Laniidae						
128.	Brown shrike (AB, M)	*Lanius cristatus* (Linn.)	+	+	-	-	— do —
129.	Baybacked shrike (AB, R)	*Lanius vittatus* (Valenciennes)	+	+	-	-	— do —
130.	Rufousbacked shrike (AB, R)	*Lanius schach* (Linn.)	+	+	-	-	— do —
131.	Grey shrike (AB, R)	*Lanius excubitor* (Lnin.)	+	+	-	-	— do —
	Family: Oriolidae						
132.	Golden oriole (AB, M)	*Oriolus oriolus* (Linn.)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: DICRURIDAE						
133.	Black drongo (AB, R)	*Dicrurus adsimilis* (Bech.)	+	+	IV	-	— do —
134.	White bellied drongo (AB, R)	*Dicrurus caerulescens* (Linn.)	+	+	IV	-	— do —
135.	Racket-tailed drongo (AB, R)	*Dicrurus paradiseus* (Linn.)	+	+	IV	-	— do —
	Family: STURNIDAE						
136.	Common myna (AB, R)	*Acridotheres tristis* (Linn.)	+	+	IV	-	— do —
137.	Pied myna (AB, R)	*Sturnus contra* (Linn.)	+	+	IV	-	— do —
138.	Brahminy myna (AB, R)	*Sturnus pagodarum* (Gmelin)	+	+	IV	-	— do —
	Family: CORVIDAE						
139.	House crow (AB, R)	*Corvus splendens* (Vieillot)	+	+	V	-	— do —
140.	Jungle crow (AB, R)	*Corvus macrorhynchos* (Wagler)	+	+	V	-	— do —
141.	Indian tree pie (AB, R)	*Dendrocitta vagabunda* (Latham)	+	+	IV	-	— do —
	Family: CAMPEPHAGIDAE						
142.	Indian large wood shrike (AB, R)	*Tephrodornis pondicerianus* (Gmelin)	+	+	-	-	— do —
143.	Large cuckoo-shrike (AB, R)	*Coracina novaehollandiae* (Gmelin)	+	+	-	-	— do —
144.	Scarlet minivet (AB, R)	*Pericrocotus flammeus* (Forster)	+	+	IV	-	— do —
145.	Small minivet (AB, R)	*Pericrocotus cinnamoneus* (Linn.)	+	+	IV	-	— do —
	Family: IRENIDAE						
146.	Iora (AB, R)	*Aegithina tiphia* (Linn.)	+	+	IV	-	— do —
147.	Jerdon's chloropis (AB, R)	*Chloropsis cochinchinensis* (Gmelin)	+	+	IV	-	— do —
148.	Green bulbul or Golden-fronted chloropsis (AB, R)	*Chloropsis aurifrons* (Temminck)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: PYCNONOTIDAE						
149.	Redvented bulbul (AB, R)	*Pycnonotus cafer* (Linn.)	+	+	IV	-	— do —
	Family: MUSCICAPIDAE						
150.	Common babbler (GB, R)	*Turdoides caudatus* (Dumm.)	+	+	IV	-	— do —
151.	Jungle babbler (GB, R)	*Turdoides striatus* (Dumont)	+	+	IV	-	— do —
152.	Western redbreasted flycatcher (AB, M)	*Muscicapa parva* Bech.	+	+	IV	-	— do —
153.	Greyheaded flycatcher (AB, M)	*Culicicapa ceylonensis* (Swain)	+	+	IV	-	— do —
154.	Tickell's blue flycatcher (AB, R)	*Muscicapa tickelliae* (Blyth)	+	+	IV	-	— do —
155.	Whitethroated fantail flycatcher (AB, R)	*Rhipidura albicollis* (Vieillot)	+	+	IV	-	— do —
156.	Verditer flycatcher (AB, R)	*Muscicapa thalassina* (Swain)	+	+	IV	-	— do —
157.	Whitebrowed blue flycatcher (AB, R)	*Muscicapa superciliaris* (Jerdon)	+	+	IV	-	— do —
158.	Brown flycatcher (AB, R)	*Muscicapa latirostris* (Raffles)	+	+	IV	-	— do —
159.	Indian blacknaped monarch flycatcher (AB, R)	*Monarcha azurea* (Bodd.)	+	+	IV	-	— do —
160.	Paradise flycatcher (AB, R)	*Terpsiphone paradisi* (Linn.)	+	+	IV	-	— do —
161.	Streaked fantail warbler (AB, R)	*Cisticola juncidis* (Rafinesque)	+	+	IV	-	— do —
162.	Reed warbler (AB, R)	*Acrocephalus scirpaceus* (Herr.)	+	+	IV	-	— do —
163.	Jungle Wren-warbler (AB, R)	*Prinia sylvatica* Jerdon	+	+	IV	-	— do —
164.	Franklin's Ashy-grey wren-warbler (AB, R)	*Prinia hodgsonii* Blyth	+	+	IV	-	— do —
165.	Indian plain wren-warbler (AB, R)	*Prinia subflava* (Gmelin)	+	+	IV	-	— do —
166.	Ashy wren-warbler (AB, R)	*Prinia socialis* Sykes	+	+	IV	-	— do —
167.	Tailor Bird (AB, R)	*Orthotomus sutorius* (Pennant)	+	+	IV	-	— do —
168.	Magpie robin (AB, R)	*Cospychus saularis* (Linn.)	+	+	IV	-	— do —
169.	Black redstart (AB, R)	*Phoenicurus ochruros* (Gmelin)	+	+	IV	-	— do —
170.	Indian robin (AB, R)	*Saxicoloides fulicata* (Linn.)	+	+	IV	-	— do —
171.	Pied bush chat (AB, R)	*Saxicola caprata* (Linn.)	+	+	IV	-	— do —
172.	Brown rock chat (AB, R)	*Cercomela fusca* (Blyth)	+	+	-	-	— do —
173.	Orange headed ground thrush (AB, R)	*Zoothera citrina* (Latham)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: PARIDAE						
174.	Grey tit (AB, R)	*Parus major* (Linn.)	+	+	IV	-	— do —
	Family: SITTIDAE						
175.	Chestnutbellied nuthatch (AB, R)	*Sitta castanea* Lesson	+	+	IV	-	— do —
	Family: MOTACILLIDAE						
176.	Paddyfield pipit (GB, R)	*Anthus novaeseelandiae* (Gmelin)	+	+	IV	-	— do —
177.	Yellow wagtail (WB, M)	*Motacilla flava* (Linn.)	+	+	IV	-	— do —
178.	Grey wagtail (WB, M)	*Motacilla caspica* (Gmelin)	+	+	IV	-	— do —
179.	Pied wagtail (WB, M)	*Motacilla maderaspatensis* (Gmelin)	+	+	IV	-	— do —
180.	Yellowheaded wagtail (WB, M)	*Motacilla citreola* Pallas	+	+	IV	-	— do —
	Family: DICAEIDAE						
181.	Thickbellied flowerpecker (AB, R)	*Dicaeum agile* (Tickell)	+	+	IV	-	— do —
182.	Tickell's Flowerpecker (AB, R)	*Dicaeum erythrorhynchos* (Latham)	+	+	IV	-	— do —
	Family: NECTARINIIDAE						
183.	Purplerumped sunbird (AB, R)	*Nectarinia zeylonica* (Linn.)	+	+	IV	-	— do —
184.	Small sunbird (AB, R)	*Nectarinia minima* (Sykes)	+	+	IV	-	— do —
185.	Purple sunbird (AB, R)	*Nectarinia asiatica* (Latham)	+	+	IV	-	— do —
	Family: ZOSTEROPIDAE						
186.	White eye (AB, R)	*Zosterops palpebrosa* (Temminck)	+	+	IV	-	— do —
	Family: PLOCEIDAE						
187.	House sparrow (AB, R)	*Passer domesticus* (Linn.)	+	+	IV	-	— do —
188.	Baya weaver bird (AB, R)	*Ploceus phillippinus* (Linn.)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
189.	Red munia (AB, R)	*Estrilda amandava* (Linn.)	+	+	IV	-	— do —
190.	Green munia (AB, R)	*Estrilda formosa* (Latham)	+	+	IV	-	— do —
191.	Whitebacked munia (AB, R)	*Lonchura striata* (Linn.)	+	+	IV	-	— do —
192.	Spotted munia (AB, R)	*Lonchura punctulata* (Linn.)	+	+	IV	-	— do —
	Family: FRINGILLIDAE						
193.	Common Rosefinch (AB, M)	*Carpodacus erythrinus* (Pallas)	+	+	-	-	— do —
Class:	*REPTILIA*						
Order:	CROCODYLIA						
	Family: CROCODYLIDAE						
1.	Mugger or crocodile	*Crocodylus palustris* (Lesson)	+	+	I	E	Present record is based on Murthy (1982, 85).
Order:	TESTUDINES						
	Family: EMYDIDAE						
2.	Sail terrapin	*Kachuga kachuga* (Gray)	+	+	I	-	— do —
3.	Deccan sawback terrapin	*Kachuga tentoria* (Gray)	+	+	-	-	— do —
4.	Indian pond terrapin	*Melanochelys trijuga* (Schweigger)	+	+	-	-	— do —
5.	Three keeled turtle	*Melanochelys tricarinata* (Blyth)	+	+	I	-	— do —
	Family: TESTUDINIDAE						
6.	Indian starred tortoise	*Geochelone elegans* (Schoepff)	+	+	IV	-	— do —
Order:	SQUAMATA						
Suborder:	LACERTILIA (SAURIA)						
	Family: GEKKONIDAE						
7.	Banded rock gecko	*Cyrtodactylus deccanensis* (Gunther)	+	+	-	-	— do —
8.	Forest gecko	*Cnemaspis mysoriensis* (Jerdon)	+	+	-	-	— do —
9.	Rock gecko	*Hemidactylus maculatus* (Dum. and Bibr.)	+	+	-	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
10.	Brooke's gecko	*Hemidactylus brooki* (Gray)	+	+	-	-	— do —
11.	House gecko	*Hemidactylus gracilis* (Blanford)	+	+	-	-	— do —
12.	Bark gecko	*Hemidactylus leschenaulti* Dum. and Bibr.	+	+	-	-	— do —
	Family: AGAMIDAE						
13.	Fan-throated lizard	*Sitana ponticeriana* (Cuv.)	+	+	-	-	— do —
14.	Indian garden lizard	*Calotes versicolor* (Daudin)	+	+	-	-	— do —
15.	Forest calotes	*Calotes rouxi* (Dum. & Bibr.)	+	+	-	-	— do —
	Family: CHAMAELEONIDAE						
16.	Indian chamaeleon	*Chamaeleo zeylanicus* Laurenti	+	+	II	-	— do —
	Family: VARANIDAE						
17.	Indian monitor	*Varanus behgalensis* (Daudin)	+	+	I	E	— do —
	Family: SCINCIDAE						
18.	Snake skink	*Riopa punctata* (Gmelin)	+	+	-	-	— do —
19.	Common skink	*Mabuya carinata* (Schneider)	+	+	-	-	— do —
20.	Little Skink	*Mabuya macularia* (Blyth)	+	+	-	-	— do —
21.		*Mabuya trivittata* (Hard. & Gray)	+	+	-	-	— do —
Suborder: SERPENTES (OPHIDIA)							
	Family: TYPHLOPIDAE						
22.	Common blind snake	*Typhlina bramina* (Daudin)	+	+	IV	-	Daniel (1983)
23.	Beaked blind snake	*Typhlina acutus* (Dum. & Bibr.)	+	+	IV	-	— do —
24.	Slender blind snake	*Typhlops porrectus* Stoliczk	+	+	IV	-	Murthy (1982, 85)
	Family: BOIDAE						
25.	Indian python	*Python molurus* (Linn.)	+	+	I	R	— do —
26.	Common or Russel's sand boa	*Eryx conicus* (Schneider)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
27.	John's sand boa	*Eryx johni* (Russell)	+	+	IV	-	— do —
	Family: DIPSADIDAE						
28.	Shaw's wolf snake	*Lycodon striatus* (Shaw)	+	+	-	-	— do —
29.	Common wolf snake	*Lycodon aulicus* (Linn.)	+	+	-	-	— do —
30.	Russell's or variegated Kukri snake	*Oligodon taeniolatus* (Jerdon)	+	+	-	-	— do —
31.	Common kukri snake	*Oligodon arnensis* (Shaw)	+	+	-	-	— do —
	Family: NATRICIDAE						
32.	Striped keelback snake	*Amphiesma stolata* (Linn.)	+	+	-	-	— do —
33.	Green keelback snake	*Macropisthodon plumbicolor* (Cantor)	+	+	-	-	— do —
34.	Checkered keelback snake	*Xenochrophis piscator* (Schneider)	+	+	II(II)	-	— do —
35.	Olivaceous keelback snake	*Atretium schistosum* (Daudin)	?	+	-	-	— do —
	Family: COLUBRIDAE						
36.	Common trinket snake	*Elaphe helena* (Daudin)	+	+	IV	-	— do —
37.	Rat Snake	*Ptyas mucosus* (Linn.)	+	+	II(II)	-	— do —
38.	Banded racer	*Argyrogena fasciolatus* (Shaw)	+	+	IV	-	— do —
39.	Gunther's racer	*Argyrogena gracilis* (Gunther)	+	+	IV	-	— do —
40.	Smooth snake	*Coronella brachyura* (Gunther)	?	+	IV	-	— do —
41.	Painted bronzeback	*Dendrelaphis pictus* (Gmelin)	?	+	IV	-	— do —
42.	Common Indian bronzeback	*Dendrelaphis tristis* (Daudin)	+	+	IV	-	— do —
43.	Stout sand snake	*Psammophis longifrons* (Boulenger)	?	+	IV	-	— do —
44.	Common green whip snake	*Ahaetula nasutus* (Lacep.)	+	+	IV	-	— do —
	Family: HOMALOPSIDAE						
45.	Common cat snake	*Boiga trigonata* (Schneider)	+	+	IV	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
46.	Siebold's smooth water snake	*Enhydris sieboldi* (Schlegel)	+	+	IV	-	— do —
	Family: ELAPIDAE						
47.	Common krait	*Bungarus caeruleus* (Schneider)	+	+	IV	-	— do —
48.	Slender coral snake	*Callophis melanurus* (Shaw)	+	+	IV	-	— do —
49.	Common cobra	*Naja naja* (Linn.)	+	+	II(II)	-	— do —
	Family: VIPERIDAE						
50.	Russell's viper	*Vipera russelli* (Shaw)	+	+	II(II)	-	— do —
51.	Saw-scaled viper	*Echis carinatus* (Schneider)	+	+	IV	-	— do —
52.	Bamboo pit viper	*Trimeresurus gramineus* (Shaw)	+	+	IV	-	— do —
Class: *AMPHIBIA*							
Order: ANURA							
	Family: BUFONIDAE						
1.	Toad	*Bufo melanostictus* (Schneider)	+	+	-	-	Present record is based on Inger & Dutta (1987)
2.	Toad	*Bufo stomaticus* (Lutken)	+	+	-	-	— do —
	Family: MICROHYLIDAE						
3.	Ornate microhylid	*Microhyla ornata* (Dum. & Bibr.)	+	+	-	-	— do —
	Family: RANIDAE						
4.	Skipper frog	*Rana cyanophlyctis* (Schneider)	+	+	V	-	— do —
5.	Frog	*Rana hexadactyla* (Lesson)	?	+	IV	-	— do —
6.	Frog	*Rana leithii* (Boulenger)	+	+	IV	-	— do —
7.	Frog	*Rana limnocharis* (Boie)	+	+	IV	-	— do —
8.	Bull frog	*Rana tigerina* (Daudin)	+	+	IV	-	— do —
9.	Rufescent burrowing frog	*Rana rufescens* (Jerdon)	+	?	IV	-	— do —
	Family: RHACOPHORIDAE						
10.	—	*Polypedates maculatus* (Gray)	?	+	-	-	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
Order: GYMNOPHIONA							
	Family: ICHTHYOPHIIDAE						
11.	Caeclian	*Ichthyophis subterrestris* (Taylor)	+	+	-	-	— do —
Class: *PISCES*							
Subclass: *TELEOSTEI*							
Order: OSTEOGLOSSIFORMES							
	Family: NOTOPTERIDAE						
1.	Grey feather back	*Notopterus notopterus* (Pallas)	+	+	-	c	Present record is based on Talwar & Jhingran (1991).
2.	Humped featherback	*Notopterus chitala* (Ham.)	+	+	-	c	— do —
Order: ANGUILLIFORMES							
	Family: ANGUILLIDAE						
3.	Indian long-finned eel	*Anguilla bengalensis* (Gray & Hard.)	+	+	-	c	— do —
Order: CLUPEIFORMES							
	Family: CLUPEIDAE						
4.	Grizzled shad	*Gonialosa manmina* (Ham.)	+	+	-	-	— do —
Order: CYPRINIFORMES							
	Family: CYPRINIDAE						
5.	Catla	*Catla catla* (Ham. - Buch.)	+	+	-	c	— do —
6.	Cauvery white carp	*Cirrhinus cirrhosus* (Bloch)	+	+	-	Threatened	Talwar (1991)
7.	Reba carp	*Cirrhinus reba* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
8.	Kolas	*Gonoproktopterus kolus* (Sykes)	+	+	-	c	— do —
9.	Scarlet banded barb	*Puntius amphibius* (Val.)	+	+	-	-	— do —
10.	Fire fin barb	*Puntius ticto* (Ham.)	+	+	-	c	— do —
11.	Stigma barb	*Puntius sophore* (Ham.)	+	+	-	c	— do —
12.	Olive barb	*Puntius sarana* (Ham.)	+	+	-	c	— do —
13.	Fringed-lipped peninsular carp	*Labeo fimbriatus* (Bloch)	+	+	-	Threatened	Talwar (1991)

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
14.	Black rohu	*Labeo calbasu* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
15.	Deccan labeo	*Labeo potail* (Sykes)	+	+	-	Threatened	Talwar (1991)
16.	Bata labeo	*Labeo bata* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
17.	Boggut labeo	*Labeo boggut* (Sykes)	+	+	-	c	— do —
18.	Rohu	*Labeo rohita* (Ham.)	+	+	-	c	— do —
19.	Cotio	*Osteobrama cotio* (Ham.)	+	+	-	c	— do —
20.	-	*Osteobrama vigorsi* (Sykes)	+	+	-	c	— do —
21.	Sandkhol carp	*Thynnichthys sandkhol* (Sykes)	+	+	-	c	— do —
22.	Mahaseer	*Tor tor* (Ham.)	+	+	-	Threatened	Talwar (1991)
23.	Indian glass barb	*Chela laubuca* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
24.	Dadio	*Chela (Neochela) dadidurjori* (Menon)	+	+	-	-	— do —
25.	Bloch razorbelly minnow	*Salmostoma clupeoides* (Bloch)	+	+	-	-	— do —
26.	Large razorbelly minnow	*Salmostoma bacaila* (Ham.-Buch)	+	+	-	c	— do —
27.	Mola carplet	*Amblypharyngodon mola* (Ham.)	+	+	-	-	— do —
28.	Aspidoparia	*Aspidoparia morar* (Ham.-Buch.)	+	?	-	Locally threatened	Talwar (1991)
29.	Hamilton's barila	*Barilius bendelisis* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
30.	Barna baril	*Barilius bana* (Ham.)	+	+	-	-	— do —
31.	Danio	*Danio devario* (Ham.)	+	+	-	c	— do —
32.	Giant danio	*Danio aequipinnatus* (Meclell.)	+	+	-	c	— do —
33.	Flying barb	*Esomus danricus* (Ham.)	+	+	-	-	— do —
34.	Blackline rasbora	*Parluciosoma daniconius* (Ham.)	+	+	-	c	— do —
35.	Gangetic latia	*Crossocheilus latius* (Ham.)	+	+	-	c	— do —
36.	Mullya garra	*Garra mullya* (Sykes)	+	+	-	c	— do —
37.	Gotyla	*Garra gotyla* (Gray)	+	+	-	-	— do —
	Family: BALITORIDAE						
38.	Striped loach	*Nemacheilus (Acanthocobitis) botia* (Ham.)	+	+	-	c	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: Cobitidae						
39.	Guntea loach	*Lepidocephalus (Lepidocephalichthys) guntea* (Ham.)	+	+	-	c	— do —
40.	Malabar loach	*Lepidocephalus thermalis* (Val.)	–	–	-	c	— do —
Order: SILURIFORMES							
	Family: Bagridae						
41.	Long-whiskered catfish	*Aorichthys aor* (Ham.)	+	+	-	c	— do —
42.	Seenghala	*Aorichthys seenghala* (Sykes)	+	+	-	c	— do —
43.	Striped dwarf catfish	*Mystus vittatus* (Bloch.)	+	+	-	c	— do —
44.	Gangetic mystus	*Mystus cavasius* (Ham.)	+	+	-	c	— do —
45.	Gogra rita	*Rita pavimentatus* (Val.)	+	+	-	c	— do —
	Family: Siluridae						
46.	Indian butter catfish	*Ompok bimaculatus* (Block)	+	+	-	c	— do —
47.	Boal	*Wallago attu* (Schn.)	+	+	-	c	— do —
	Family: Schilbeidae						
48.	Ailia	*Ailia coila* (Ham.)	+	+	-	c	— do —
49.	Garua bachcha	*Clupisoma garua* (Ham.-Buch)	+	+	-	c	— do —
50.	Indian patasi	*Pseudeutrapius atherinoides* (Bloch)	+	+	-	-	— do —
51.	Indian toakree	*Proetropiichthys toakree* (Sykes)	+	+	-	-	— do —
52.	Batchwa vacha	*Eutropiichthys vacha* (Ham.)	+	+	-	c	— do —
53.	Silonia vacha	*Silonia silondia* (Ham.)	+	+	-	c	— do —
	Family: Pangasiidae						
54.	Pangas	*Pangasius pangasius* (Ham.)	+	+	-	Threatened	Talwar (1991)

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
	Family: Sisoridae						
55.	Gangetic goonch	*Bagarius bagarius* (Ham.)	+	=	-	— do —	— do —
	Family: Clariidae						
56.	Magur	*Clarius batrachus* (Linn.)	+	+	-	c	Talwar & Jhingran (1991)
Order: HETEROPNEUSTIDAE							
57.	Stinging catfish	*Heteropneustes fossilis* (Bloch.)	+	+	-	c	— do —
Order: CYPRINODONTIFORMES							
	Family: Belonidae						
58.	Freshwater garfish	*Xenentodon cancila* (Ham.)	+	+	-	c	— do —
Order: PERCIFORMES							
	Family: Ambassidae						
59.	Elongated glass perchlet	*Chanda nama* (Ham.)	+	+	-	c	— do —
60.	Indian glassy fish	*Pseudambassis ranga* (Ham.-Buch)	+	+	-	c	— do —
61.	Himalayan glassy perchlet	*Pseudambassis baculis* (Ham.-Buch)	+	?	-	Locally threatened	Talwar (1991)
	Family: Nandidae						
62.	Mottled mandus	*Nandus nandus* (Ham.)	+	+	-	c	Talwar & Jhungran (1991)
63.	Chameleon fish	*Badis badis* (Ham.)	+	?	-	Locally threatened	Talwar (1991)
	Family: Mugilidae						
64.	Corsula mullet	*Rhinomugil corsula* (Ham.)	+	+	-	c	Talwar & Jhingran (1991)
	Family: Gobiidae						
65.	Tank goby	*Glossogobius giuris* (Ham.)	+	+		c	— do —
	Family: Channidae						
66.	Giant snakehead	*Channa marulius* (Ham.)	+	+	-	c	— do —
67.	Banded snakehead	*Channa striatus* (Bloch.)	+	+	-	c	— do —

Appendix II (continued)

Sl. No.	Common Name	Scientific Name	Past Record	Present Record	Wildlife Act ('91) Schedule (part)	Current Status (IUCN)	Remarks
1	2	3	4	5	6	7	8
68.	Spotted snakehead	*Channa punctatus* (Bloch)	+	+	-	c	— do —
69.	Asiatic snakehead	*Channa orientalis* (Schneider)	+	+	-	c	— do —
	Family: MASTACEMBELIDAE						
70.	One stripe spiny eel	*Macrognathus aral* (Bloch & Schneider)	+	+	-	c	— do —
71.	Striped spiny eel	*Mastacembelus pancalus* (Ham.)	+	+	-	c	— do —
72.	Tire track spiny eel	*Mastacembelus armatus* (Lacep.)	+	+	-	c	— do —

Abbreviations and symbols used: Symbols: Present +; Absent A; Endangered E; Rare R; Vulnerable V; Indeterminate I; Common c; Not known (-). Water bird migratory WB, M; Water bird resident WB, R; Bird of prey migratory BOP, M; Bird of prey resident BOP, R; Bird of prey local migratory BOP, LM; Ground bird resident GB, R; Arboreal bird migratory AB, M; Arboreal bird resident AB, R.

Appendix III

LIST OF LOCALLY EXTINCT/RARE/ENDANGERED VERTEBRATE SPECIES

A) **MAMMALIA**
1) Wild buffalo *Bubalus bubalis* (Linn.)
2) Swamp Deer or Barasingha *Cervus duvauceli* Cuv.
3) Nermada rat *Rattus rattus nerbadae* Hinton

B) **AVES**
4) Lesser florican *Sypheotides indica* (Muller)
5) Falcon *Falco biarmicus jugger* Gray
6) Peregrine falcon *Falco peregrinus* Tustall
7) Spotted owlet *Athene brama* (Temminck)
8) Great Horned Owl *Bubo bubo* (Linn.)

C) **REPTILIA**
9) Crocodile *Crocodylus palustris* Lesson
10) Indian monitor lizard *Varanus bengalensis* (Daudin)
11) Python *Python molurus* (Linn.)

D) **AMPHIBIA**
12) Rufescent burrowing frog *Rana rufescens*

E) **PISCES**
13) Aspidoparia *Aspidoparia morar* Heckel
14) Chameleon fish *Badis badis* (Ham.)

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DISTRIBUTION OF *NEOSCORPIOPS* SCORPIONS IN THE WESTERN GHATS OF MAHARASHTRA AND GUJARAT AND POSSIBLE TRICHOBOTHRIDIAL VARIATIONS AMONG ISOLATED POPULATIONS[1]

D.B. Bastawade[2]

(*With forty seven text-figures*)

Introduction

Though the placement of the subfamily Scorpiopsinae under family Vaejovidae is doubtful (Stahanke 1974, Francke 1976) so far all Southeast Asian *Scorpiops* are placed under the same family Vaejovidae. The subfamily Scorpiopsinae comprises three genera, namely 1. *Scorpiops* Peters (1861), 2. *Parascorpiops* Banks (1928) and 3. *Dasyscorpiops* Vachon (1973). Francke (1976) doubted the taxonomic validity of the latter two and suggested that they be lowered to subgeneric rank under *Scorpiops*. He also suggested the revision of the taxonomic status of the sub-family Scorpiopsinae itself. Recently Kovarik (1995) raised the sub-family Scorpiopsinae to the rank of family Scorpiosinidae and included all the species known from SE Asia under this family. The genus *Scorpiops* represents a vast distribution right from Afghanistan to Burma through the Great Himalaya and at some places in Satpura and western ghats in south India (Bastawade 1992). This genus comprises 15 species and 7 subspecies nominated so far from India. Whereas the remaining two genera are monotypic and so far known to occur only at one place each as *Parascorpiops* from Borneo, Indonesia and *Dasyscorpiops* from Malacca, Malaysia (Francke 1976).

The major genus *Scorpiops* Peters has been revised and divided into four sub-genera, namely i. *Scorpiops* Vachon (Nominal), ii. *Neoscorpiops* Vachon, iii. *Euscorpiops* Vachon and iv. *Allos corpiops* Vachon (Vachon 1980). Among these, except *Neoscorpiops*, the remaining three have been commonly reported from the Indian Himalayan ranges, right from Kashmir to Arunachal Pradesh. However, the sub-genus *Euscorpiops* is observed to restrict itself to the North Eastern portion of India, Bangladesh, Bhutan and Burma (Bastawade 1992) and the sub-genus *Alloscorpiops* to Burma only (Francke 1976). The sub-genus *Scorpiops* (Nominal) is widely distributed throughout the Himalayas and also at certain places in Satpura such as Pachmarhi, Madhya Pradesh (Bastawade 1992), (See Fig. 1 & 2). The subgenus *Neoscorpiops* shows restricted distribution through the Western Ghats in Maharashtra and Gujarat (some data unpublished). This subgenus is so far known to comprise only three nominate species *viz.* 1. *Scorpiops* (*Neoscorpiops*) *satarensis* Pocock (1900) (Mahabaleshwar, Satara), 2. *S.* (*N*) *deccanensis* Tikader and Bastawade (1976) (Sinhagad, Pune) and 3. *S.* (*N.*) *tenuiacauda* Pocock (1900) (Matheran, Raigad). These species occur in three adjacent districts in the state of Maharashtra (Fig. 2).

After Fauna of India: Scorpions (Tikader and Bastawade 1983), I undertook an extensive survey of the Western Ghats for the collection of Scorpions during 1984-87. The intense effort of these surveys made it possible to collect Scorpiosinid Scorpions from as many as 20 new localities in Western Ghats in different districts (Bastawade 1986, 1987). The collection areas spread over 6 districts between Tapi and Koyana valleys of Maharashtra. The only district in Gujarat state from which these Scorpions are reported is Dangs, which also falls to the south of Tapi Valley. The records of this family from Dhulia, Nasik, Thane districts in Maharashtra and Dangs in Gujarat are new.

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[2]Zoological Survey of India, Western Regional Station, 1182/2, Fergusson College Road, Pune 411 005.

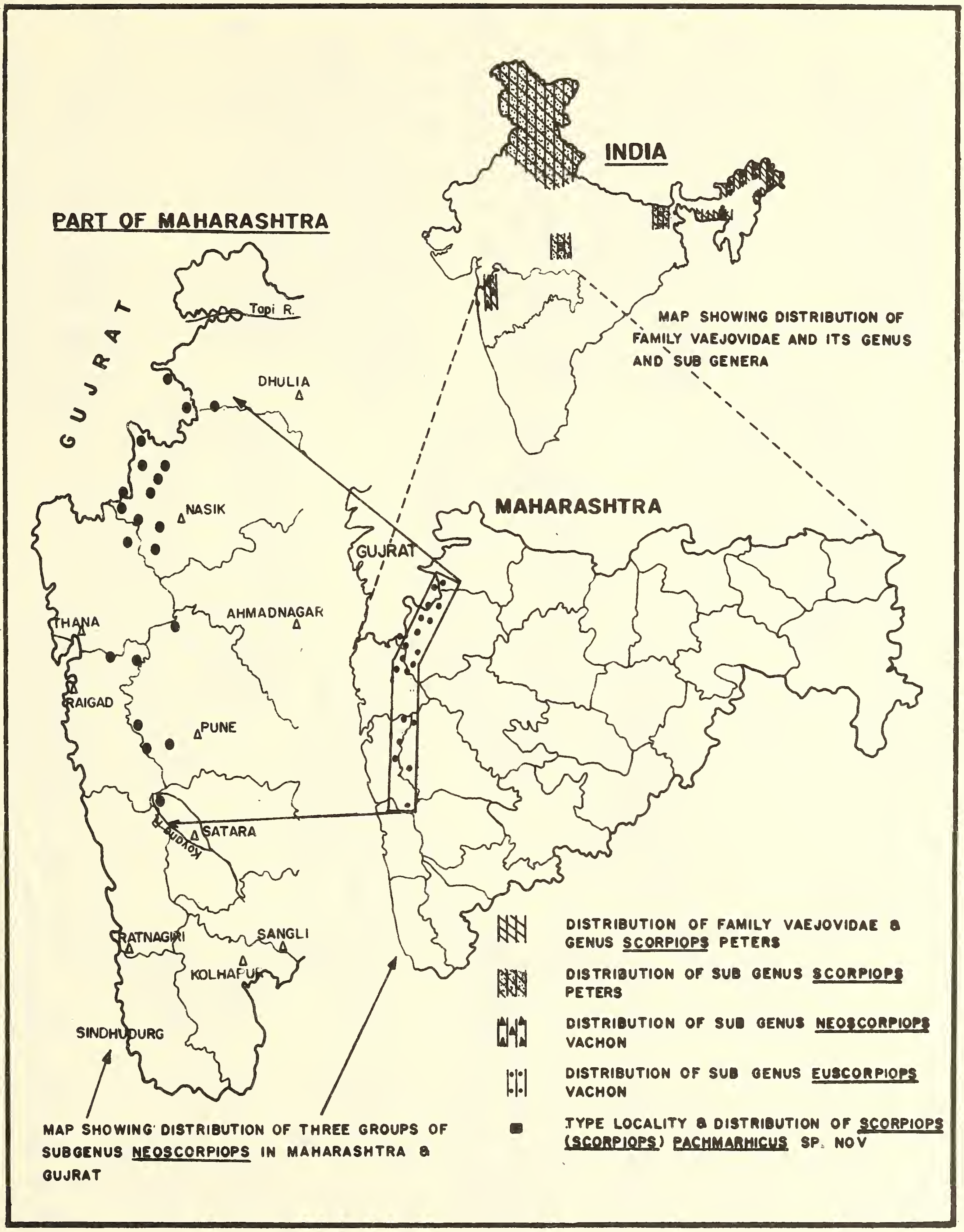
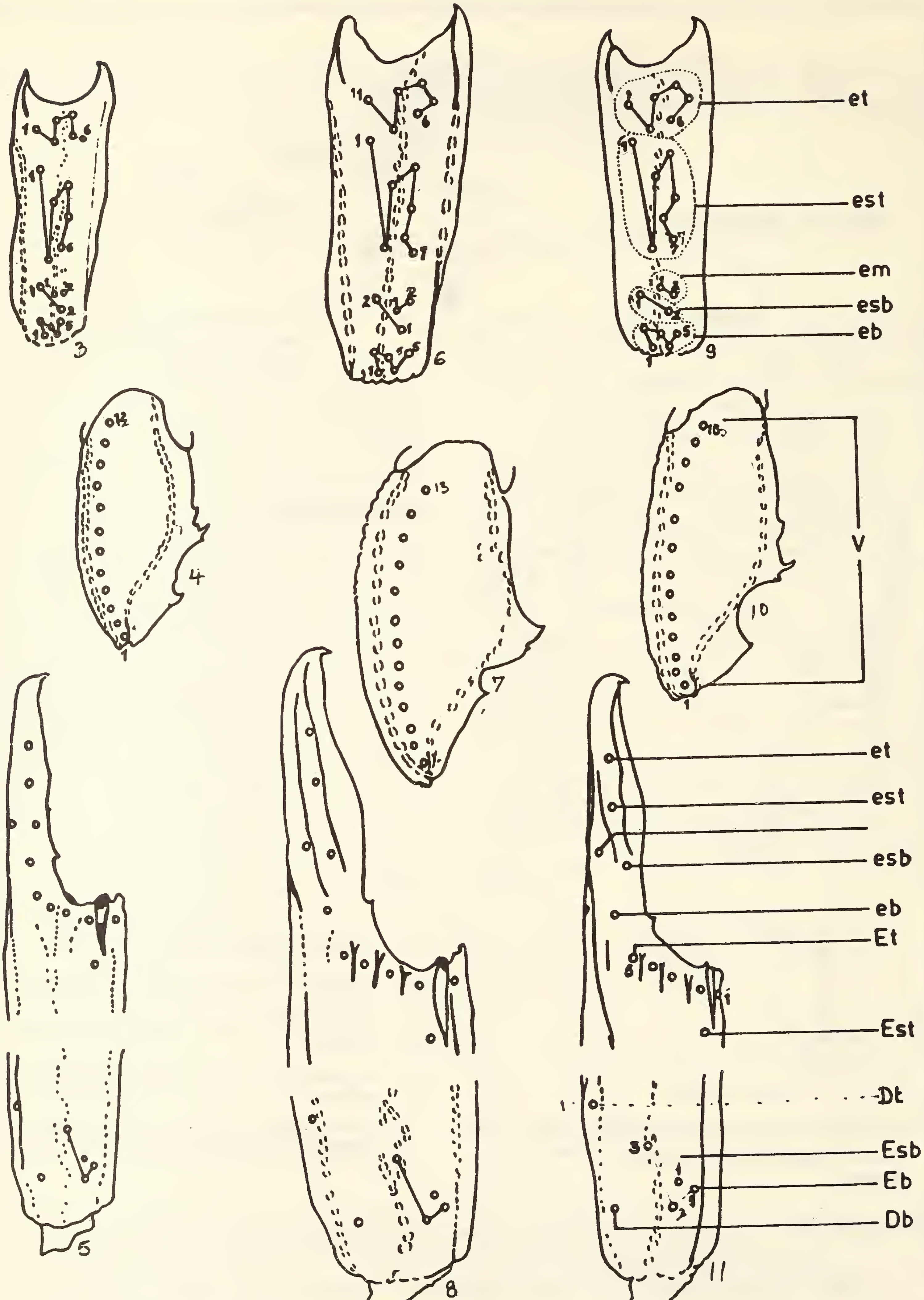


Fig. 1. Showing distribution of family Scorpiopsinidae and its genera and subgenera;
2. Showing distribution of three groups of subgenus *Neoscorpiops* in Maharashtra and Gujarat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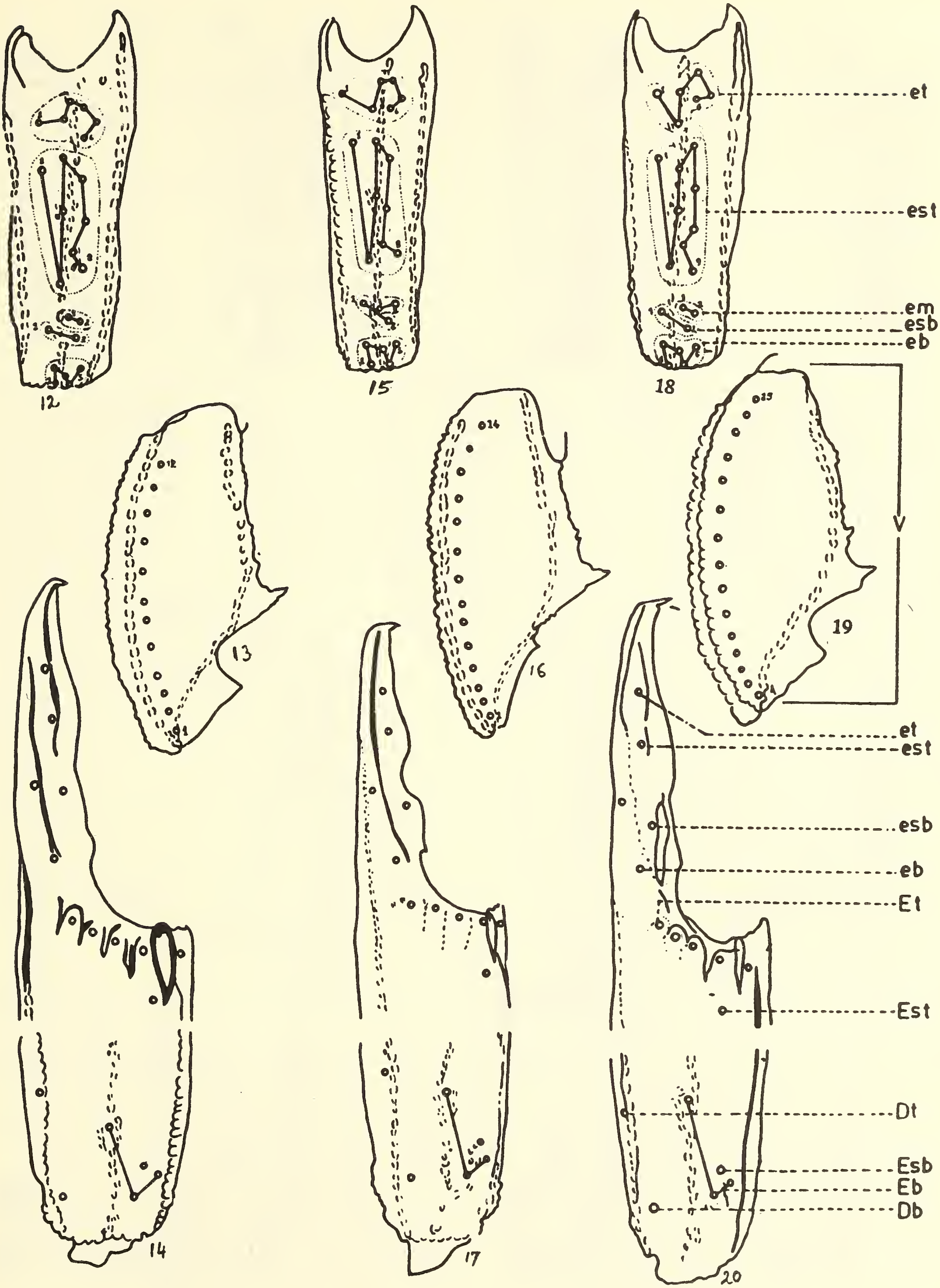
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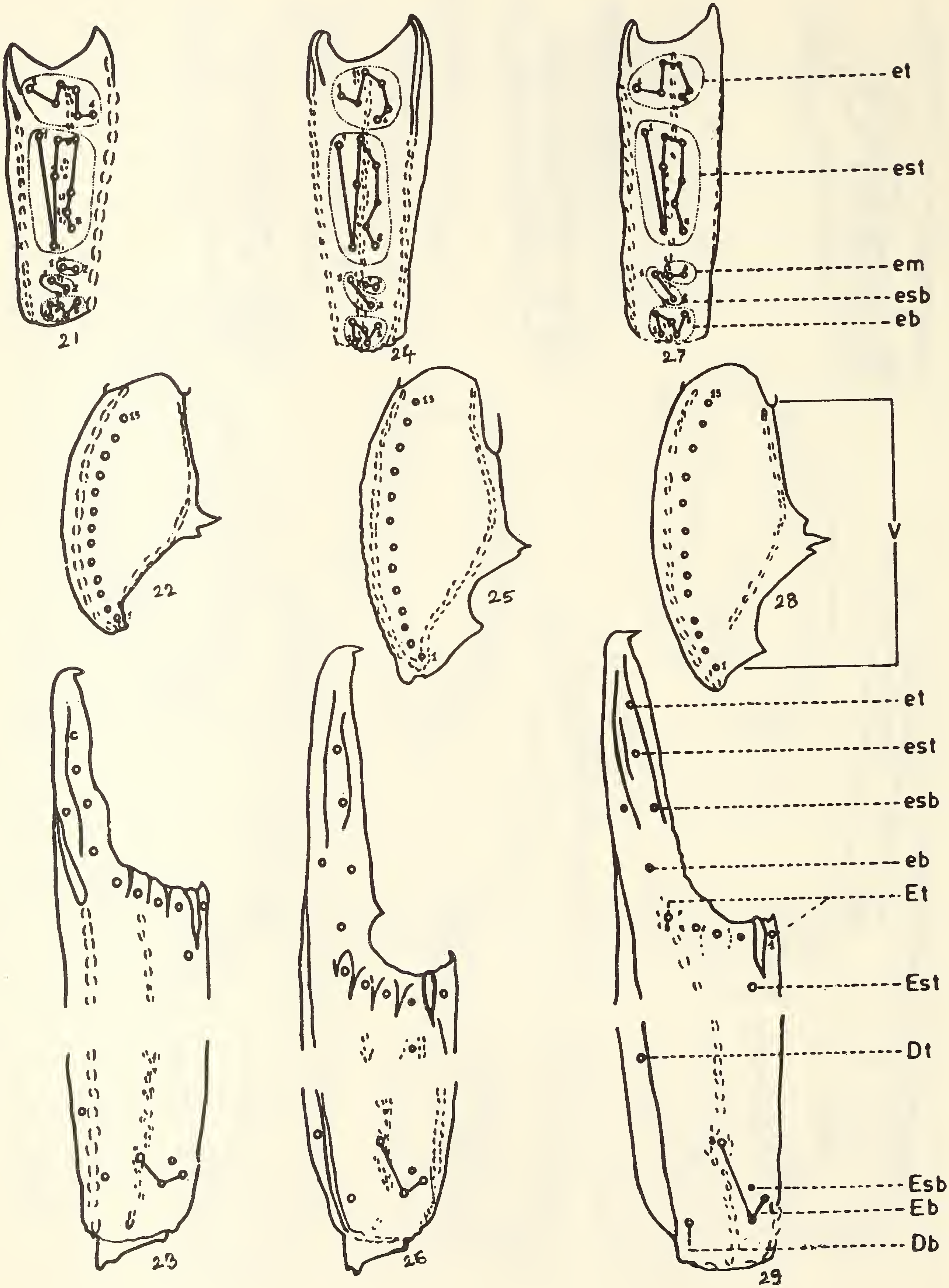
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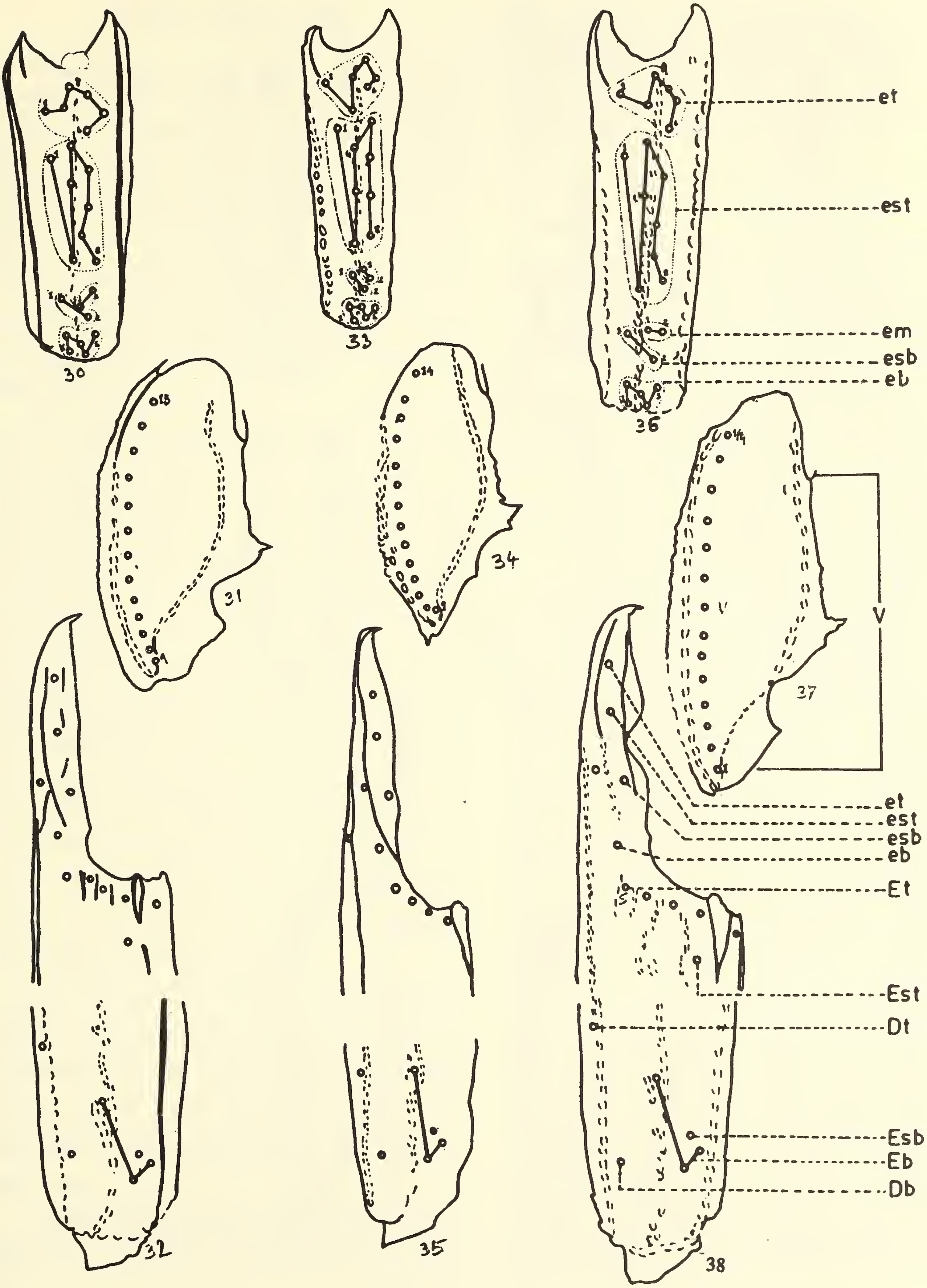
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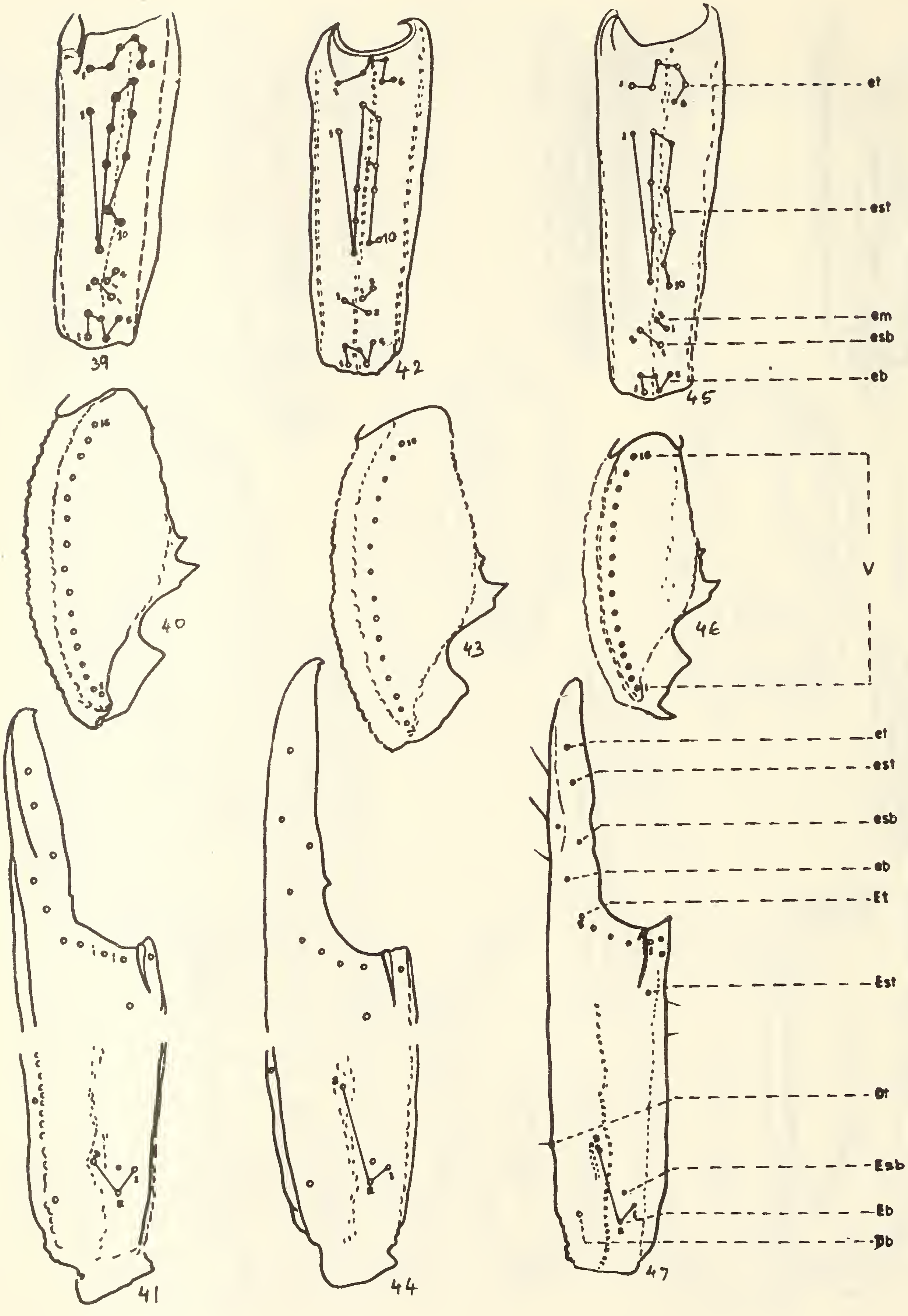
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Materials and Methods

The hilly terrain of Western Ghats was visited and particular spots were selected to prise out the Scorpions of the sub-genus *Neoscorpiops*. As these Scorpions are known to be lithophilous and rupicolous in nature, they occur more often in the cracks and crevices of the outcrops of natural hard rocks as well as in artificially cut road sides. Such rocks were located and broken carefully with the help of a flat trowel, hard and sharp crowbars. This method proved useful in getting a good yield of these Scorpions from the road side rocks, more than from natural rocks.

The specimens thus collected were directly preserved in 70% rectified spirit, precisely labelled indicating all the essential collection data, registered with Zoological Survey of India, Western Regional Station, Pune for unidentified Zoological Specimens in invertebrate section. Such specimens were studied wet under a CZ binocular for morphological as well as trichobothridial details. The studies of trichobothridial patterns on the pedipalps were compared between different forms. The diagrammatic representations were made with help of tubular camera lucida on the same binocular. The trichobothridial patterns on the external and ventral surface of the tibial segment of pedipalp and also on the manus and immovable finger of pedipalp for each specimen were studied for more details and analysed to segregate the different groups. Emphasis was given to the sets on external surface of tibia, manus and immovable finger, ventral surface of tibia and dorsal surface of manus of pedipalp.

The present communication deals with the distribution, status and variation in trichobothridial patterns among the different units of *Neoscorpiops* population in Western Ghats of Maharashtra and Gujarat and also investigates the possibility of isolation within this population due to the degradation of floral components once keeping it together.

During recent surveys (1948-87) *Neoscorpiops* have been collected from Mulsi (donated) and Bhimashankar, district Pune; Pandav leni, Waghera, Dagadpada, Birdipada, Saptashringi, Hathgad, Dholapgad, Kathiwadapada and Hadakaichond, district Nasik; Jowar Mokhada, district Thane; Kondaibari Ghat, district Dhulia in Maharashtra and Ahwa in Dang district, Gujarat State.

Results and Discussion

The hilly terrain of Western Ghats in Maharashtra and Gujarat shows a peculiar example of limited distribution for Scorpions of the subfamily Scorpiopsinae Scorpiopsindae. The distribution of this sub-family is almost restricted to some pockets in Western Ghats between Tapi Valley in the North and Koyana Valley in South (Figs. 1 & 2). It is also observed that these scorpions are distributed through hilly, comparatively humid areas and due to the heavy destruction of forests they are now inclined to be restricted to certain pockets in Western Ghats.

The detailed studies of trichobothridial patterns in the different sets on external surface of tibial digit of pedipalp *viz. eb* (1-5), *esb* (1-2), *em* (1-2), *est* (1-9) and *et* (1-7) and the ventrals (16) (Vachon 1980) show the nature of constant similarities in the composition of sets of trichobothries. Similarly, the trichobothries show some differences in the relative positions within the sets as in Figs. 3-47. The trichobothries present in the sets *eb, esb* and *em* (i.e. *eb* 1-5, *est* 1-2 and *em* 1-2) in the specimens studied also show the same constant numbers as those present in the species of the two other known subgenera from north and north-east India (Vachon 1980). The trichobothries present in the sets *est* and *et* show differences in respective numbers and in their placements. The ventrals (*V*) show differences in numbers only. The *Eb* and *Dt* on the manus also exhibit differences in their inter-relationary placements as in text Figs. 5, 8, 11...47.

The trichobothridial patterns on tibia, manus and immovable fingers of pedipalps are considered as one of the strong and stable morphological characters to distinguish the families, genera and subgenera in Scorpions (Vachon 1973, 1975, 1980). The sub-family Scorpiopsinae possesses the trichobothridal pattern of 'TYPE C' (Vachon 1973,

TABLE 1
SHOWING AFFINITIES AND DIFFERENCES IN THREE SUBGENERA OF THE GENUS *SCORPIOPS* PETERS
(F: SCORPIOPSINIDAE)

Characters	Manus wider than long	Manus longer than wide	Veside wider than long	Veside longer than wide	An annular ring at the base of veside	Total No. of Tricho-bothria	No. of tricho-bothries in *et* set on tibia	No. of tricho-bothries in *est* set on tibia	No. of tricho-bothries on exter-nal medium line in *est* set	No. of *V* tricho-bothria on tibia
Names of Subgenera	1	2	3	4	5	6	7	8	9	10
Scorpiops	60%	40%	60%	40%	Absent	54-62	Always 4	4	Always 2	6-13
Neoscorpiops	00%	100%	00%	100%	Absent	67-73	Always 6	6-11	vary bet. 2-4	12-17
Euscorpiops	00%	100%	00%	100%	Always	55-60	Always 5	4-5	Always 2	7-9

Tikader and Bastawade 1983). The type genus *Scorpiops* Peters has been divided into four subgenera as mentioned earlier, mainly on the basis of total number of trichobothries in the sets *est, et,* and *v* on tibia and some other important morphological characters such as telson (Vachon 1980). Present observations further reveal that the subgenus *Neoscorpiops* (Tikader & Bastawade 1983, Figs. 1069-1128) shows more affinities to the sub-genus *Euscorpiops* (Tikader & Bastawade 1983, Figs. 1247-1305) than to the stalk sub-genus *Scorpiops* (nominal) (Tikader & Bastawade 1983, Figs. 1129-1246) See Table I.

The present observations (Figs. 3-47) allow us to suggest appropriate modifications for the trichobothriotaxy proposed by Vachon (1980) as *eb* 1-5, *esb* 1-2, *em* 1-2, *est* 1-7 to 1-10 and *et* 1-5 to 1-7 on external surface of tibia (patella) of pedipalp. His observations were based on the types of *Scorpiops* (*Neoscorpiops*) *satarensis* Pocock and *S.* (*N.*) *tenuiacauda* Pocock, probably on a few specimens. These observations are now re-examined for a larger number of *Neoscorpiops* specimens, recently collected from many new localities from Western Ghats in Maharashtra and Gujarat as mentioned earlier.

It was necessary to modify the pattern of the trichobothriotaxy presented by Vachon (1980) to *eb* 1-5, *est* 1-2, *em* 1-2, *est* 1-6 to 1-11 and *et* 1-6 (Figs. 3, 6, 9...45) (See Table II). Vachon (1980) has not mentioned *V.* (ventrals) on tibia (patella) which vary from 12 to 16 in present observations (Figs. 4-7-10...46). Trichobothria *eb* 3 placed always distal to *esb* on external surface of manus (Figs. 5-8-11... 47). There seems be no relevant significance in its placement of *eb* 3 placed too close or too far away from either *esb* on external surface or to *Dt* on dorsal surface on manus (Figs. 5-8-11...47). There are always 4 *V* (ventral) trichobothries on manus (not illustrated), *db* on immovable finger always placed at the base (not shown in all the present illustrations).

Vachon (1980) discussed the nature of asymmetry and variation in trichobothridial patterns in the genus *Scorpiops* Peters. He also emphasised and synthesised the definite nature of these patterns and utilised them as one of the stronger characters in Scorpion taxonomy along with the other morphological characters as the basis. The modified trichobothridial pattern for the subgenus *Neoscorpiops* Vachon minimises the variations in the set *et* and gives scope to consider set *est* as one of the characters to be utilised for taxonomic importance

TABLE 2

SHOWING AFFINITIES AND DIFFERENCES IN THREE POPULATION UNITS OF THE SUB-GENUS *NEOSCORPIOPS* VACHON (*SCORPIOPS*: SCORPIOSINIDAE) FROM WESTERN GHATS

Characters	Trichobothriotaxies on tibial digit of Pedipalp								
Population Units	*eb*	*esb*	*em*	*est*	mediuan *est* along exterior carina	*et*	*V*	Occurrence in Western Ghats	Preferential humidity
I	5	2	2	1 to 6-7	always 2	6	12-13	Lower altitude	Less humid and hot
II	5	2	2	1 to 8-9	always 3	6	12-15	Medium altitude	Medium humid and warm
III	5	2	2	1 to 10-11	always 4	6	15-16	Higher altitude	Much humid and cool

along with total number of ventral (V) trichobothries on ventral surface of tibia (patella).

COMMENTS

The Western Ghats was once a continuous strip of semi-evergreen to deciduous forests (Mani 1968). Due to the enormous human activity and interference, under the name of development, much of the forest cover has now been depleted. Most of the places once under forest cover and connected through floral agencies, have now been cut off from each other, though not yet completely.

Such destructive activities have affected faunal life and created obstructions which limit the movements of fauna, specially the ground dwelling invertebrates such as Scorpions, which mostly have nocturnal life conditions and are true ground dwelling creatures. Their spatial movements within population units are basically very limited. Due to these conditions the high altitude places (peaks) of Western Ghats exhibit a typical case of formation of smaller units of suitable habitat for *Neoscorpiops* population now partly and partially isolated from each other, particularly at places such as Mahabaleshwar, Sinhagad, Matheran, Bhimashankar, Brahmagiri and Saptashringi, etc.

Subba Rao & Mitra (1979) state that "type localities for 16 species (Mollusca) recorded fall within the Pune district and the majority of them are recorded from hill streams near Khandala. All these species have a restricted range of distribution in the Western Ghats, and are not known beyond it." Interestingly, the Scorpion subgenus *Neoscorpiops* is limited to the south of Tapi Valley in the north and North of Koyana Valley in the south in Western Ghats (Map 2). As the species of to Mollusca, this Scorpion subgenus is so far unknown beyond these limits.

The genus *Scorpiops* Peters in course of evolution has diverged into three separate subgenera among Indian species. The subgenus *Scorpiops* Vachon retains the basic trichobothridial pattern and the numbers as in the stalk genus *Scorpiops* Peters. The two other sub-genera namely *Euscorpiops* Vachon and *Neoscorpiops* Vachon show change in this character. The pattern, number and placements of the trichobothries, at least in two sets namely *et* and *est* have changed. The original number of trichobothries 4 *et*, 4 *est* sets in *Scorpiops* Vachon have changed to 5 *et*, 4-5 *est* sets in Euscorpiops *and* 6 *et*, 6-11 *est* sets in *Neoscorpiops* respectively (See Table I). Such change is more prominent in the *est* set for subgenus *Neoscorpiops* Vachon, which further shows some isolation trend in each unit among the existing population in Western Ghats of Maharashtra and Gujarat. The trichobothries present on the external surface of tibia (patella) in *est* set along the median external carina observed to be considerably stable in topographically isolated forms of the subgenus *Neoscorpiops*. These exhibit three units having only 2 *est* trichobothries on external median carina (Fig. 3, 6 & 9), 3 *est* (Figs. 12, 15, 18, 21, 24, 27, 30, 33 & 36) and 4 *est* (Figs. 39, 42 & 45). The unit 3 *est* trichobothries seems to be more common and widely distributed than the remaining two. These three units show morphometric differences and the distributional stratigraphy of these units might also be requiring the preferential differences, for which further studies are needed. These are in progress.

Acknowledgements

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STUDIES ON THE STATUS AND CONSERVATION OF *FREREA INDICA* DALZ[1]

P. Tetali[2], Sujata Tetali[3], D.K. Kulkarni[4], M.S. Kumbhojkar[5]

(*With four plates and two text-figures*)

Key words: *Frerea indica*, conservation, endangered, propagation, pollinators, pests, ecology

Frerea indica Dalz. has been identified as one of the twelve most endangered plant species by International Union for Conservation of Nature and Natural Resources (IUCN). A low herbaceous perennial, *F. indica* is reported from only six localities in Maharashtra state. All these known habitats hold a few individuals. This paper gives details of research studies carried out in order to understand and save the plant in the wild and under nursery conditions.

The species has been propagated through vegetative cuttings and seeds. About 500 individuals have been reared under nursery conditions in order to save the plant from extinction. Variation in the striation patterns of the corolla indicate cross pollination. During the study pollinators were identified. Various forms of threats including pests have also been discussed.

Introduction

A new monotypic genus *Frerea indica* Dalz. (Family: Asclepiadaceae) was reported from the hills near Heware in Junnar taluka by Dalzell (1865). The generic name *Frerea* was derived by Dalzell in memory of Sir Henry Bartle Frere, the then Ex-Governor of Bombay Presidency, as a mark of respect and for promoting scientific research in India. The genus is closely related to *Caralluma fimbriata* Wall. and often wrongly identified as the latter (Bent, 1975). Extended distribution was reported later by Woodrow (1898) from the nearby hill fort Shivneri. Eightysix years later the same species was reported by Santapau (1951a, 1951b) from the neighbouring district of Satara. The locality was again a steep hill slope of Vazirgarh, a small supporting fort adjoining Purandhar hill fort (Santapau and Irani, 1960). An intensive search in the neighbouring areas further revealed only two localities, again on the cliffs of Sajjangad in the same district (Kumbhojkar *et al.*, 1993) and Shivtharghal in the Raigad district (Kothari & Murthy, 1994). The natural distribution of *F. indica* is known to lie between these six localities in three districts of Maharashtra State (Table 1). Each of these habitats shelter fewer individuals.

Material and methods

Habit, habitat, association and geographical studies were carried out in the natural habitat. Seeds collected from the Sajjangad hill slopes of Maharashtra were sown in Naoroji Godrej Centre for Plant Research (NGCPR) nursery at Shindewadi. Well grown and mature plants were studied for morphological characters with a view to formulate a precise conservation strategy. Extensive studies were carried out on the following aspects: i) Ecological and pollination studies, ii) propagation methods - sexual and vegetative, iii) pests and diseases and their management.

Habit

In the wild, *F. indica* grows on rock crevices of hill cliffs (Plate 1a). The species grows between 750 to 1347 m altitude and the hill slopes facing

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[2,3]Naoroji Godrej Centre for Plant Research, (NGCPR) Gate No. 431 Shindewadi, Post Shirwal, Taluka Khandala, Dist. Satara. Maharashtra - 412 801, India.

[4,5]Division of Plant Sciences, Agharkar Research Institute, Pune-5, Maharashtra, India.

TABLE 1
DISTRIBUTION AND REPORT REFERENCE OF
F. INDICA

Locality	District	Nearby town	Distance from Pune (km)	Year	Reference
Avre	Pune	Junnar	85	1865	Dalzell, N.A*
Shivneri	Pune	Junnar	92	1939	McCann, C
Vazirgarh	Pune	Purandhar	55	1951	Santapau, H
Kates point	Satara	Mahabaleshwar	120	1939	Bombay, R. D*
Sajjangad	Satara	Satara	120	1993	Kumbhojkar,M.S.*et al*
Shivtharghal	Raigad	Mahad	85	1993	Kothari,M.J & S. Murthy

* The species is not recollected from the locality

south-east of north-west directions (Table 2). Rainfall greatly varies in all the six localities.

Population

In the wild, the species is represented by few individuals, either concentrated in one spot as in the case of Purandhar and Sajjangad or a few spots in the case of Shivneri. The number of spots, number of individuals/population, size of the habitat and area occupied by *F. indica* is presented in Table 3.

About rarity

McCann (1939) considered *F. indica* as an elusive rare plant which in appearance resembled a miniature *Euphorbia neriifolia*. Opinions differ about the rarity of the species. Santapau (1951a) who reported this plant from Vazirgarh, believed that it is "not so rare as it appears". Due to small population size, the nature of habitat and palaeo-endemism, the species has been listed as endangered (Nayar and Sastry, 1987) and threatened (Jain and Sastry, 1980). Ahmedullah and Nayar (1986) believed that poor follicle formation in the wild is due to the extinction of pollinators. Moreover, IUCN declared *F. indica* as one of the twelve most endangered plants on earth. Such a situation prompted us to take up these studies, to understand its requirements and find out various strategies for saving the species. This paper gives details of the work done at NGCPR farm, Shindewadi.

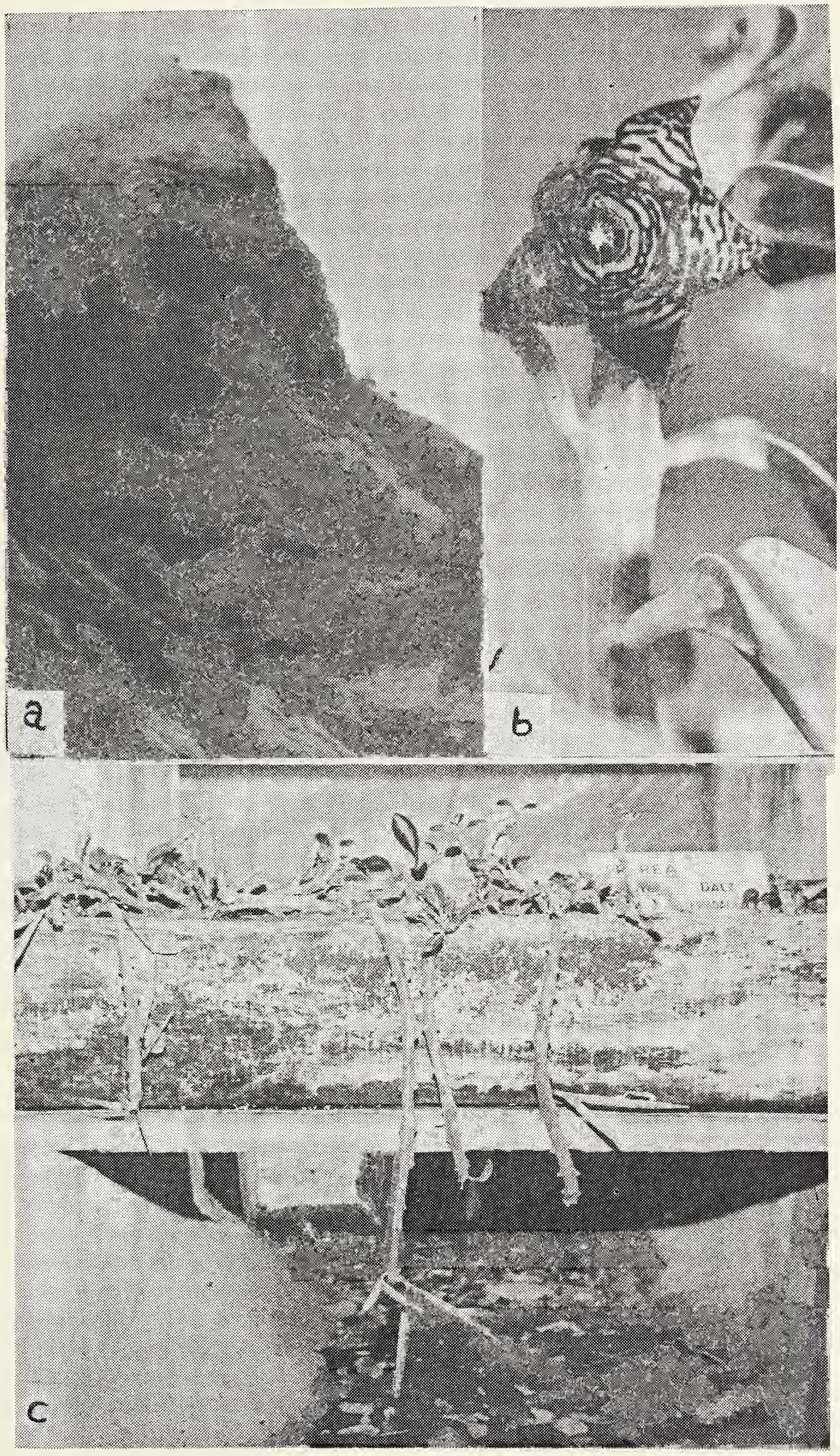
OBSERVATION AND DISCUSSION

F. indica is a fleshy, glabrous perennial. Branches spread on barren rocks and form patches of more than one metre across, or they may droop

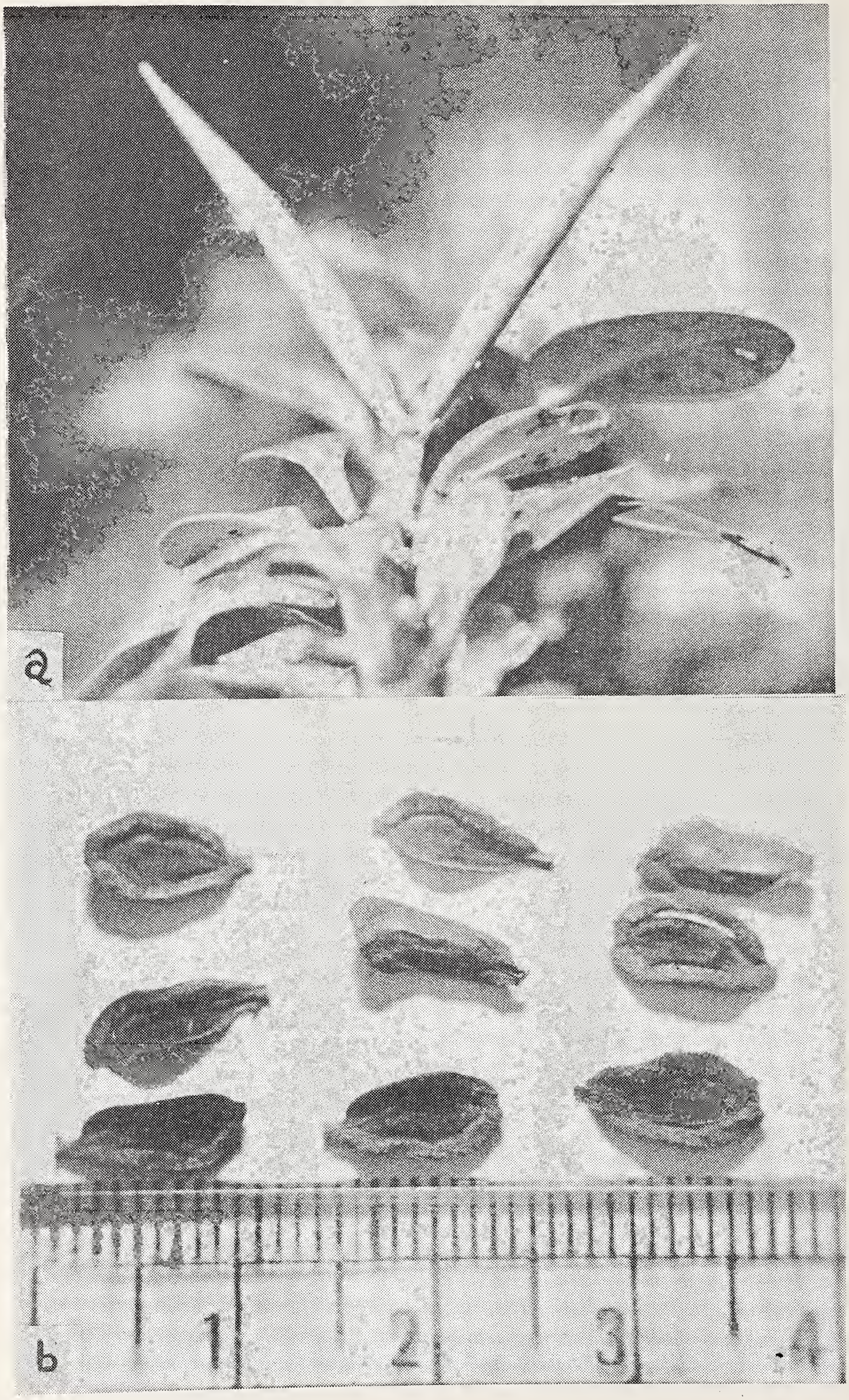
TABLE 2
PHYTOGEOGRAPHY OF *F. INDICA*

Locality	Latitude N	E	Altitude (m)	Rainfall (cm)	Direction *
Awre	19° 12'	73° 52'	914m	72.025	
Shivneri	19° 12'	73° 52'	1018m	72.025	South-East facing
Kates point	17° 55'	73° 35'	1438m	675.640	— —
Vazirgarh	18° 17'	74° 20'	1347m	256.250	North-West facing
Sajjangad	17° 35'	74° 35	670	-	South-East facing
Shivtharghal	17° 40'	74° 15	-	319.020	— —

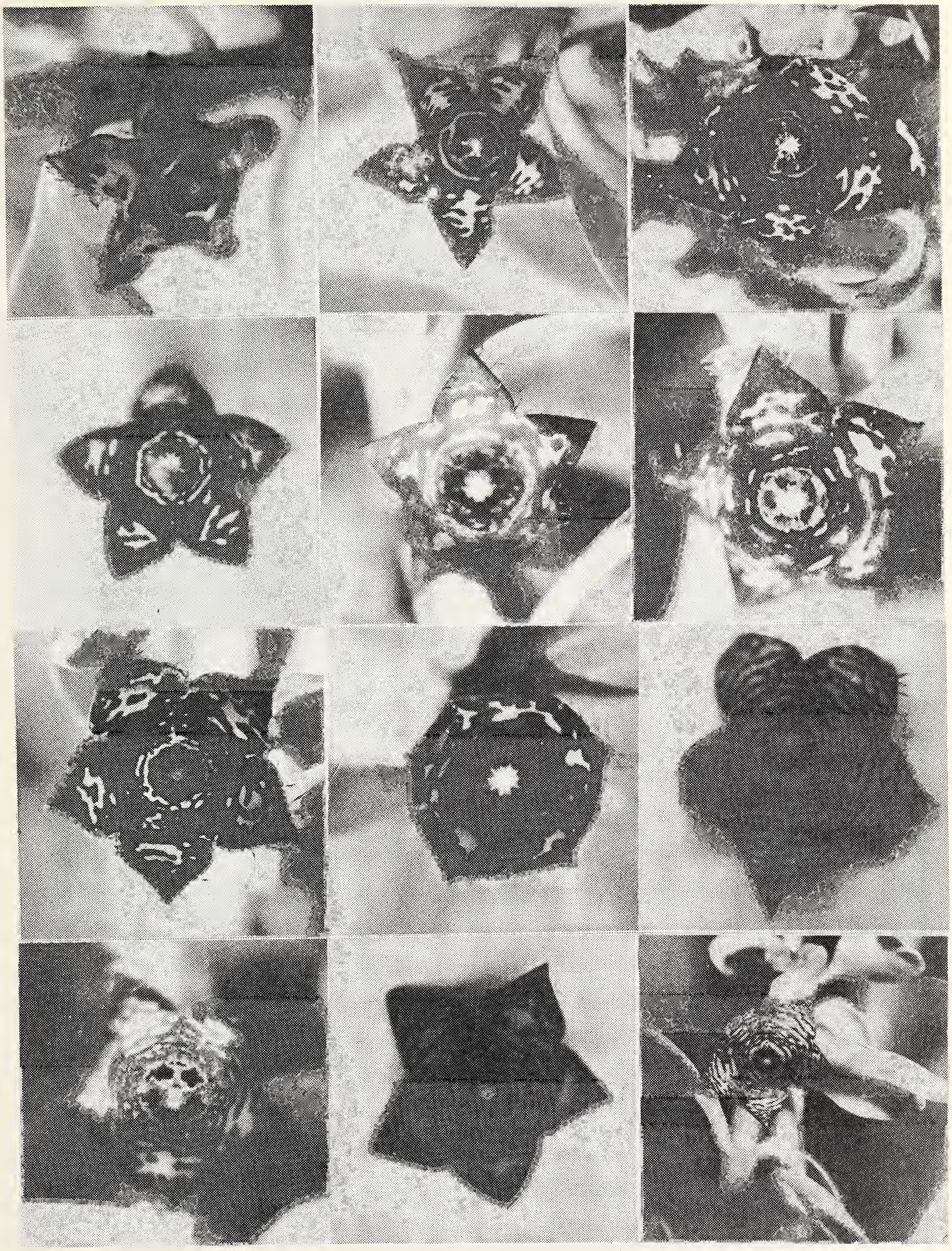
* Direction of hill slopes on which *F. indica* grew.



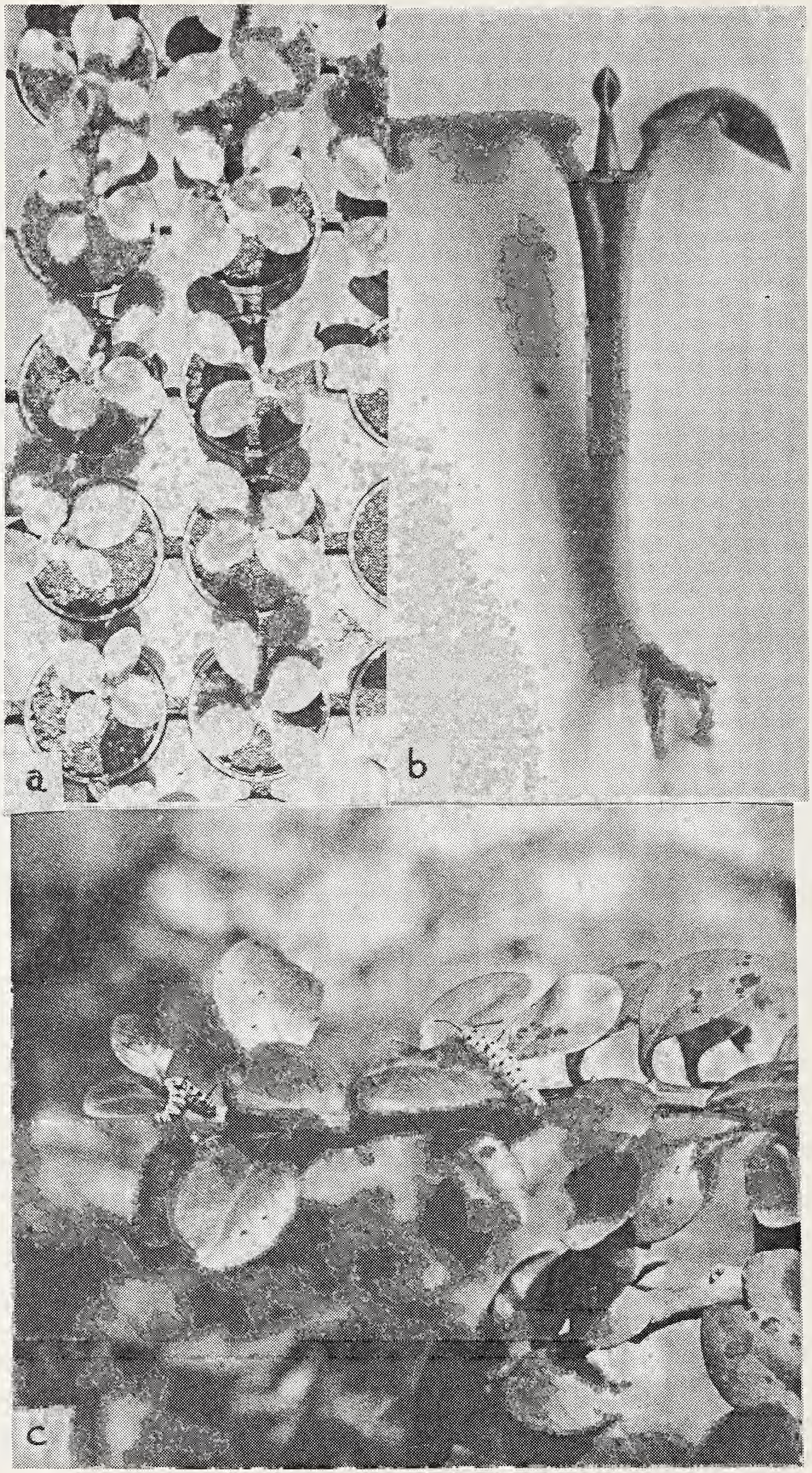
(a) *F. indica* in natural habitat; (b) Plant with solitary flower; (c) Follicle formation.



F. indica (a) Follicles; (b) Seeds.



F. indica variation in corolla striation.



F. indica (a) One month old seedling; (b) Single seedling; (c) Predator - Plain tiger caterpillar.

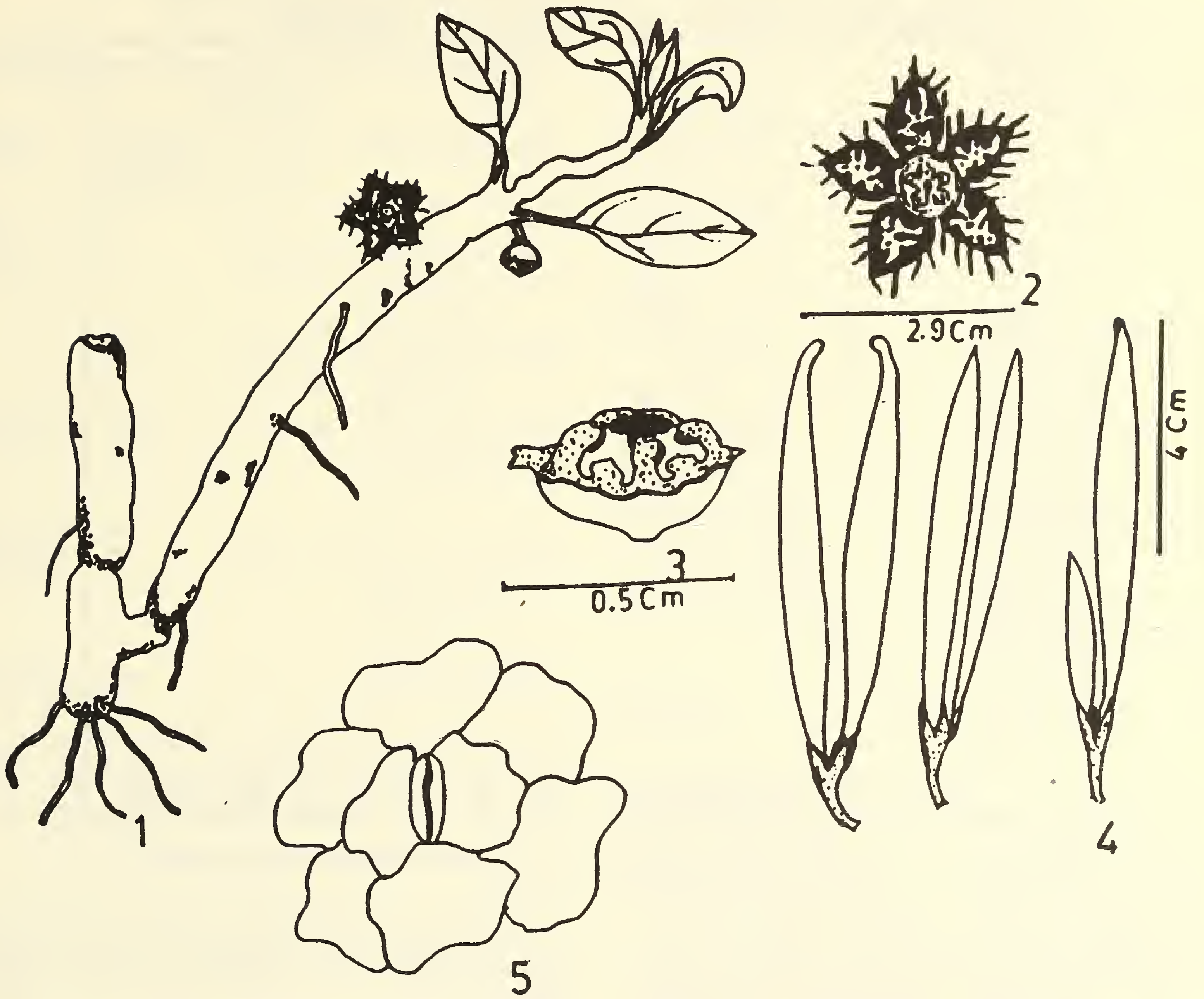


Fig. 1: *F. indica*: (1) Plant. (2) Flower. (3) Pollinia. (4) Follicle variation. (5) Stomata

while clinging to rocks. (Fig. 1 (1)). Fleshy branches under ideal conditions are more than 50 cm in length.

Branches are leafless during winter and summer. During the same period a thin silvery white non-living layer is formed around the stem and branches. Notches slowly appear all over the plant particularly on the connecting places of stems and branches and between new and old branches. With increasing summer intensity, the young branches slowly shrink, fold and turn dirty green in colour. Details of the plant description can be obtained from Hooker (1897) and Cooke (1905). However, the details of morphological characters need further description as additional information was collected during our studies.

McCann (1939) in a special note described the flower colour. The description is quoted below.

"Dalzell describes the flowers as purple, etc. It has been my experience that newly opened flowers are reticulated with bands of greenish-yellow and dull red-purple; with age both tints intensify, the former becomes yellow and the latter a richer red purple. The yellow then fades out and the entire flower assumes a deep red (almost black) purple. However, no two flowers are alike in colour."

As per our studies, unlike McCann's observations, the flowers do not change striation formation or turn to deep purple before fading.

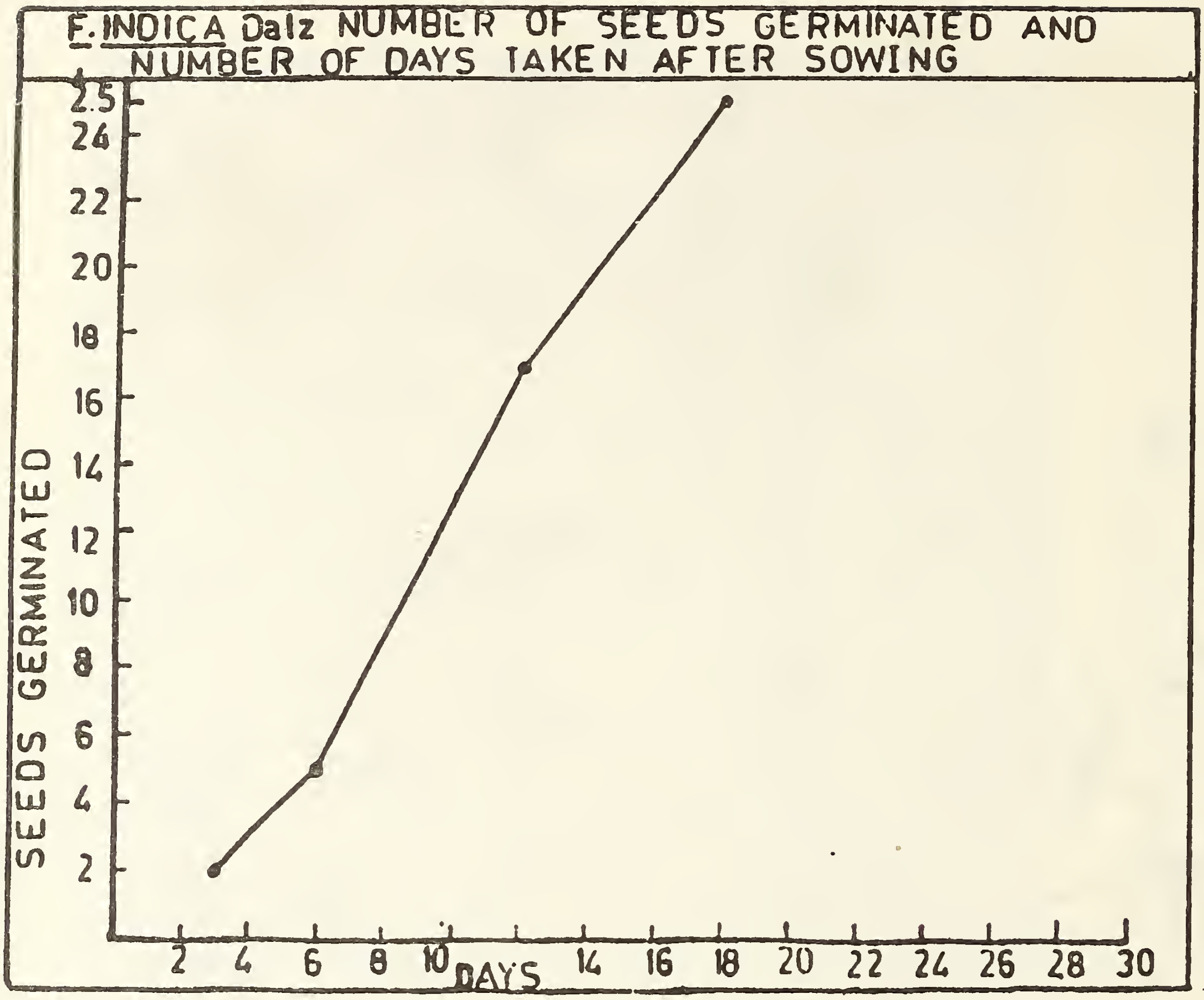


Fig. 2: *F. indica* Number of seeds germinated and number of days taken after sowing

Flowers of the same plant exhibit the same pattern of designs. The pattern does not change with the maturity of the flower. The additions to the earlier morphological descriptions are presented in Table 4.

Leaves and flowers appear with the onset of the monsoon. Leaves opposite (Fig.1 (1)), oblong 7.2 cm long, glabrous, stomata with anomocytic guard cells (Fig. 1 (5)).

Flowers solitary, occasionally in pairs (Plate 1b, Fig. 1 (2)). Flowers arise from pedicels (0.5 - 0.7 cm.). pedicels arise from dorsal side of leaf, between petiole and stem. It takes 25 - 50 days for a young bud to mature and flower. Corolla 2-3 cm across, star shaped, lobes valvate and sparsely fringed with purplish hairs (0.3 cm). Corolla crimson red to cherry red and decorated. Apparently there exist two types of designs - white or crimson coloured striations, designed like a spider web or irregularly designed spots. The former type flowers are generally big. During the study a variety of designs have been recorded (Fig. 6). Such designs tentatively indicate that cross pollination takes place in these plants. (Plate 3).

The flower remains open for two to three days. Pollinators start visiting it since, the time of opening. Under nursery conditions the flowers open during day time, before 12 noon. On the fourth day the petals deflex and then die. In many cases follicle formation takes place after a long time, say one month or even more. Follicle formation is rare (McCann, 1939). The poor follicle formation is believed to be due to the complicated pollinia translator mechanism. And absence of pollinators is attributed to the palaeotropic endemic nature.

Experiments were carried out to attract pollinators. During the study, two closely related species *Ceropegia fimbriata* and *C. bulbosa* Roxb. were grown separately with *F. indica*. These two plants morphologically look like *F. indica* and grow in the same localities. The trays in which *F. indica*

TABLE 3
F. INDICA - NUMBER OF POPULATIONS, SIZE OF HABITAT AND ASSOCIATED SPECIES IN NATURAL HABITAT.

Locality	Number of populations	Size of habitat	Plant association
Avre	—	—	—
Shivneri	9	30 x 20m	*Euphorbia neriifolia,*
	5	2 x 5m	*Tecoma stans, Sarcostemma*
	40	50 x 25	*brevistigma, Fluggea*
	2	2 x 3m	*leucopyrus, Tripogon* sp.
Vazirgarh	>100	75 x 25m	*Euphorbia neriifolia, Chlorophytum glaucum.*
Kates point	—	—	—
Sajjangad	> 50	25 x 15m	*Euphorbia neriifolia, Chlorophytum glaucum, Ensete superbum*
Shivtharghal	> 40	—	*Euphorbia neriifolia*

and *C. bulbosa* grew together set follicle formation (Plate 1c). Later the trays with *F. indica* and *C. fimbriata* also set follicle formation.

Pods appear from December onwards and reach maturity from March onwards. The follicles grow 5-9 cm in length. Follicles straight, cylindrical, tapering to a small rounded apex or finely pointed (Plate 2b) and glabrous (Fig. 1 (4)). From dark green colour they turn to brown before maturity. Suppression of one of the follicles is also noticed in adverse conditions.

Seeds are brownish black, comose, compressed on one side, ovate-oblong, about 1 cm in length (Plate 2c). Number of seeds per follicle varies, ranging between 6-52. Number of seeds per follicle depends upon the length of the pod. The longer the pods, the larger are the number of seeds. Follicles also bear some non-viable seeds occasionally. Fresh seeds readily germinate. Germination begins from the third day onwards. Seed germination and the number of days required for germination is shown in Fig.2. Sundara Raghavan (1976) reported the chromosome number as (2n=44).

Insect Visitors and Pollinators

The number of insect pollinators visiting the flowers was monitored. Most of the insect visitors are flies. Seven types of insects belonging to Order Diptera were observed visiting the flowers regularly. Only four species of insects are so far identified. They are *Danaus chrysippus* (plain tiger), *Danaus genuita* (striped tiger), *Musca domestica* (house fly) and *Monomorium* spp. (black ant).

TABLE 4
ADDITIONS TO THE DESCRIPTIONS OF F. INDICA

Descriptions of Dalzell (1865), Cooke (1904) McCann (1939)	Additional description
Altitude range	
1000m	750 - 1,347m
Herbs	
10-15cm high	Pendulous branches reach upto 50 cm
Stems	
Upto 2cm across	Upto 2.5 cm across
Leaves	
Oblong or ovoid Acute, acuminate	Oblong, ovoid or broadly ovate Acute, acuminate, deltoid
Upto 6.4 x 2.8cm	Upto 7.2 x 4.5cm Dark green above, pale beneath
Flowers	
2cm across	2-3cm across
Flowers purple (Dalzell) newly open flowers are reticulated with bands of greenish-yellow and dull red purple; with age both tints intensify, the former becomes yellow and the latter a richer red purple. The yellow then fades out and the entire flower assumes deep red purple almost black (McCann).	Newly open flowers crimson red to cherry red. Striations designed either like spider web or irregularly designed spots on white or yellow background
Follicles	
Tapering to a small rounded apex	Tapering to a small rounded apex or finely pointed.
Seeds	
Upto 0.9 x 0.5cm	Upto 1 x 0.5cm
Coma	
1.5 cm long	Upto 2cm long.

Propagation

F. indica can be propagated through seeds and stem cuttings. Seeds readily germinate without any treatment. Germination percentage of seeds under nursery conditions is excellent. Fresh seed germination lies between 90 - 100%, (Plate 4 (a,b)). Seeds are not viable for longer periods. About six month old seeds, when tested for germination, are found to be non-viable.

Vegetative propagation

The drooping branches, when they touch a suitable surface, form roots. The rooted branches can be grown into separate plants. During the dry season, old branches shrink and form notches. These branches can be separated at notches which can root in ideal conditions.

Cultural practices

In natural conditions *F. indica* grows on steep hill slopes covered with a thin layer of soil. The plant prefers slightly acidic soil (pH 5.5 - 7.0). *F. indica* grows well in red lateritic soil. Poor growth was observed in pots with black-cotton soil. For better growth, the following substratum is found to be ideal. In outdoor landscaping gravel and brick pieces need to be added to the soil mixture.

Red lateritic soil	2 parts
Soilrite or cocopeat	1 part
Vermiculite	1 part

Spacing: 45 x 45 cm

Water: The plant cannot withstand waterlogging or over watered conditions. Depending upon the location, the following tentative schedule can be followed for watering:

Rainy season	- no watering is required
Winter season	- once in two to three days
Summer season	- once in a day

Light: *F. indica* grows well under partially shaded conditions. Good growth is obtained under 60% shaded nets when compared with open places. Light requirement study is underway in order to find out its suitability as an indoor plant.

Threats

F. indica is most commonly infested by two types of insects. They are caterpillars of the plain and striped tiger (Plate 4 c) and *Aphis* sp. (Aphids). The former is a serious pest. Ignorance of it is almost catastrophic (Tetali, 1994). Aphids feed on slender shoots since they have sucking feeding habit, caterpillars feed on leaves, pods and defoliate the leaves. The following treatments are suggested for controlling the pest populations.

Aphids

Carbaryl 0.1%; Malathion 0.1%

Acorus calamus rhizome infusion is prepared by soaking the rhizome powder (7.5 - 15 gms) in 5 l water with equal quantity of soap. This is sprayed on the plants.

Caterpillars

Dusting 10% BHC; Methyl parathion 0.05%. The caterpillars can be hand-picked and killed.

Other types of threats

Biotic factors like fire, grazing and natural calamities like landslides are the main threats. Natural habitats are prone to bush or ground fires during summer. A devastating fire was recorded in Sajjangad habitat in May 1995. The impact of fire needs further study. Although the Vazirgarh habitat is protected by the Indian Army, part of the habitat is disturbed by cattle grazing. All the known habitats need protection from landslides. A single extensive landslide can make the species extinct from its habitat.

Conservation strategy

In its natural habitat *F. indica* resembles miniature *E. neriifolia* plant and often confuses its predators, especially caterpillars of *Danaus* spp. In all the known habitats the plant is commonly associated with *Euphorbia neriifolia*. Hence this unusual mimicry can be advantageously utilized to introduce *F. indica* where *E. neriifolia* is growing abundantly.

Keeping the serious threat to this species in mind, we have multiplied about 500 plants to maintain the minimum viable population through seeds and vegetative parts.

This pretty succulent, with star shaped flowers, when domesticated, can make a good indoor plant. When leafless, the plant is eaten. The species therefore warrants immediate attention for conservation. The pharmaceutical value of the plant is under careful investigation.

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NEW DESCRIPTIONS

CYRTODACTYLUS ARAVALLENSIS, A NEW GEKKONIDAE FROM THE DELHI RIDGE[1]

E.V.S. Gill[2]

(*With one plate*)

A new species of gecko *Cyrtodactylus aravallensis* is described from the Northern Aravalli Hills. The highlight of this discovery is that its closest relatives are found east of the Indus Basin.

While studying the lizards of the campus of Jawaharlal Nehru University, I caught a gecko of a species which could not be identified after Smith (1935). This new species belongs to a group of small, palaeartic *Cyrtodactylus* species referred to by some authors as *Cyrtopodion* (Leviton *et al.* 1992).

The description of the type, an adult male, is given below.

Cyrtodactylus aravallensis sp. nov.

Description: Snout slightly longer than the distance between the eye and the ear opening, the greatest diameter of which is half, or less than a half that of the eye; pupil vertical; 9 or 10 upper and 6 to 8 lower labials. Head covered above with irregular rounded scales, mixed with larger ones posteriorly.

Back covered with large subtrihedal tubercles forming 9 or 10 straight series, and separated from one another by one or two small scales. An indistinct lateral fold when dead. 26 or 27 rounded scales across the middle of the belly.

Limbs with keeled, imbricate scales above, the hind limbs being covered posteriorly with large spiny-looking subtrihedal tubercles; toes elongate; subdigital lamellae well developed, those on the basal phalanges as broad as the digits.

Tail longer than the head and body, slightly depressed, with small scales and rows of large, spiny-looking subtrihedal tubercles above; with a median series of enlarged plates below.

The specimen described has the lower half of the tail regenerated, this part being covered with uniform smooth small scales.

Male with a continuous series of 38 preano-femoral pores.

Colour (*in vivo*): Sandy coloured above with darker spots, forming 7 irregular cross-bands on the back, and more on the tail; white spots along the sides of the head, the body and the tail; skin above the eyes slightly transparent; bronze eyes; whitish below.

This gecko has a limited capacity to change colour according to the light and the background, although it is not as developed as in *Hemidactylus flaviridis*.

Length: From snout to vent 51 mm; tail 68 mm.

Etymology: The name *Cyrtodactylus aravallensis* is given to this species after its place of discovery, which is a part of the northern extension of the Aravalli Hills.

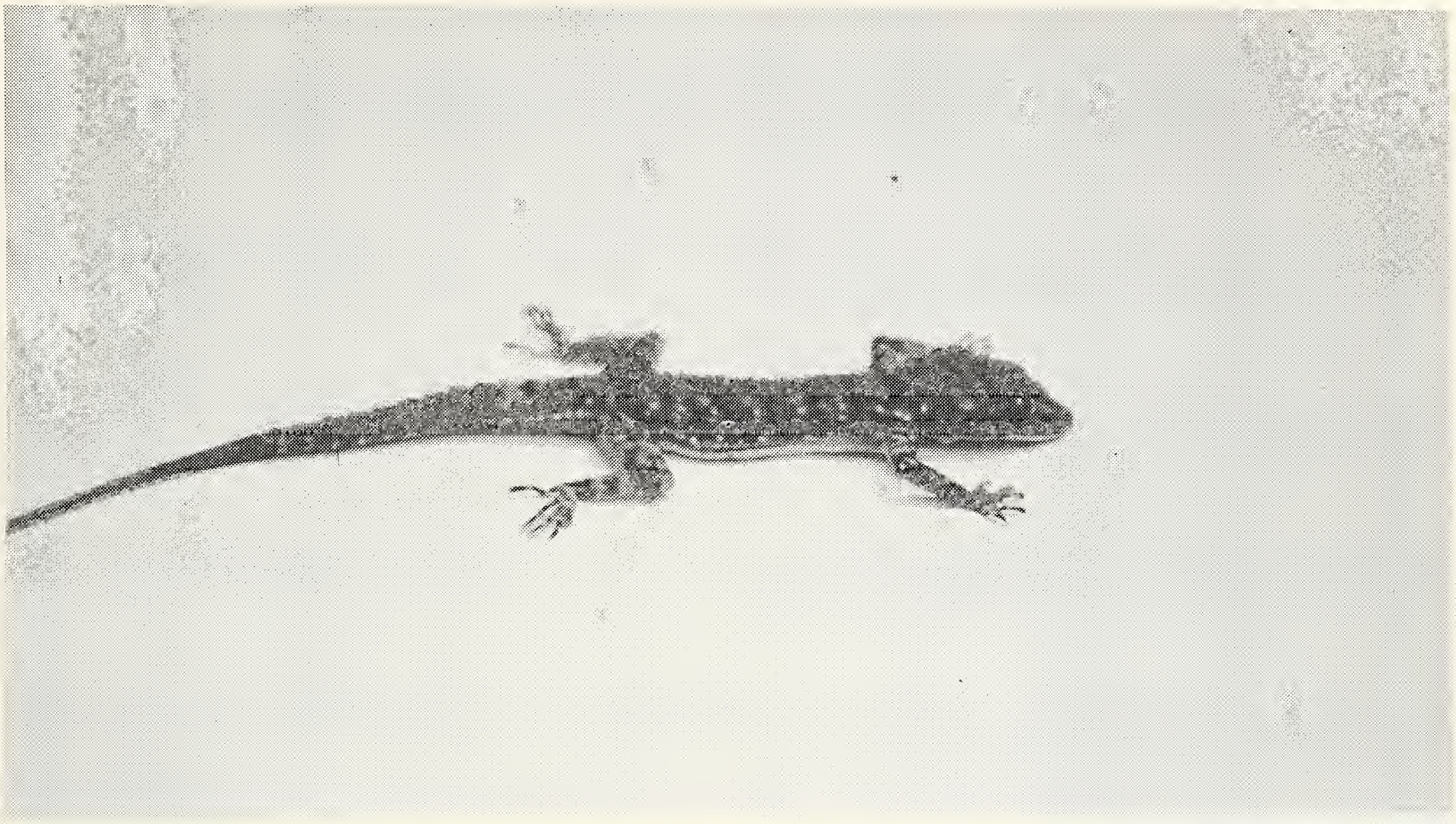
Holotype and paratype: The type specimen was caught on the campus of Jawaharlal Nehru University, on 1st September, 1995. It has been deposited with the BNHS (Regn. No. 1433, Lizard Collection).

Another adult male from the same location was similar, except for having only 21 ventral scales, 35 preano-femoral pores and two more series of large subtrihedal tubercles on the back.

Relationship and diagnosis: Referring to Smith (1935), we can say that this species, belonging to the *Cyrtodactylus scaber* group which is superficially distinguished from other *Cyrtodactylus* species by the straight series of large subtrihedal tubercles on the back, is closely allied to *Cyrtodactylus fedtschenkoi* and *Cyrtodactylus montium-salsorum* with which it shares the presence

[1]Accepted January 1996

[2]1313 Poorvanchal, Jawaharlal Nehru University, New Delhi-110 067.



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1. Lateral view of the type specimen (dead).
2. Free wild specimen in natural habitat, showing cryptic coloration.

of a continuous series of preano-femoral pores in the males.

It can, however, be distinguished from them by the presence of only 6 to 8 lower and 9 or 10 upper labials, versus 11 or 12 lower and 12 or 13 upper labials in these two species. Combined with the number of ventral scales: 21 to 27, versus 28 to 36 in *Cyrtodactylus fedtschenkoi* and 18 to 20 in *Cyrtodactylus montium-salsorum,* this character is diagnostic of the species.

While *Cyrtodactylus montium-salsorum* and *Cyrtodactylus fedtschenkoi* are known from the Punjab Salt Range, Baluchistan and further West respectively, the discovery of this species in the far away Aravalli Hills, east of the Indus basin is interesting.

Ecology: *Cyrtodactylus aravallensis* was discovered on a 265 m high, 600 m long rocky ridge surrounded by open, partly degraded tropical thorn forest. There, it shares the rocks with *Hemidactylus flaviridis, Hemidactylus brooki, Mabuya carinata* and *Calotes versicolor.*

It is a rather common lizard, coming out between sunset and dusk and moving with great speed. It behaves aggressively when caught, biting at any object within reach and depositing a white secretion, but temperament may vary with the individual. Both specimens had regenerated tails.

Further investigation and collection is needed to prove the validity of the species and to delimit its range.

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A NEW SPECIES OF THE GENUS *APANTELES* FOERSTER (HYMENOPTERA: BRACONIDAE) FROM INDIA[1]

S.M. Kurhade[2] and P.K. Nikam[3]

(*With three text-figures*)

Introduction

The taxonomy of the genus *Apanteles* Foerster is difficult and quite confusing.

The genus (of Indo-Australian region) was revised by Wilkinson (1928). Nixon (1965) revised the entire subfamily Microgasterinae and also attempted taxonomy of the genus *Apanteles*. Recently Mason (1981) contributed on the reclassification of *Apanteles* Foerster but the same was not accepted by Berg *et al.* (1988).

The earlier works on *Apanteles* in India are by Lal (1942), Bhatnagar (1948), Rao (1961), Rao and Chalikwar (1970a, b) and Sumodan and Narendran (1990).

In the present work, key to the Oriental species of *Apanteles* Foerster by Rao (1961) and work by Rao and Chalikwar (1970a, b) have been followed for the determination of the new taxa in the material collected in India, Maharashtra, Ahmednagar.

Types are deposited in the Entomological collection, Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

Apanteles ahmednagarensis, sp. nov. (Figs. 1-3)

Female: Length 2.3 mm (Fig. 1). Black. Trochanter, femur, tibia, tarsus, ovipositor reddish-brown; stigma, veins brownish-black; wings with fine black setae. Head (Fig. 2) 0.5 times as long as wide; vertex coarsely punctate, with pubescence; OOL as POL; frons moderately concave, shallowly punctate, with fine pubescence; face finely, shallowly punctate, with pubescence; clypeus transverse, smooth, shiny; malar space equals 2 x basal width of mandible, weakly punctate; eye height 3.3 x width, pubescent; mandible bidentate; temple closely punctate, pubescent; occiput smooth, shiny; occipital carina absent; antenna 2 + 16 segmented, filiform; scape length 1.75 x width; pedicel as long as wide, longer than penultimate; penultimate segment as long as wide; first 11 flagellar segments with dark transverse band dividing the segments into two halves.

Thorax: Pronotum smooth, shiny, weakly punctate, finely pubescent; mesonotum shiny, weakly, shallowly punctate; mesoscutum closely punctate, pubescent; mesoscutellar depression transversely carinated; scutellum convex, shiny, smooth, very weakly punctate, pubescent; mesopleurum anterior corner moderately punctate, rest smooth, shiny; subpleural area closely punctate, pubescent; mesopleural suture distinct; prepectal carina absent; anterior 0.5 of metapleurum smooth, shiny and posterior 0.5 rugulose, moderately punctate, pubescent; propodeum (Fig. 3) rugose, without areola, closely punctate, without longitudinal carina, pubescent, spiracle small. Fore wing length 3 x width; stigma length 3.5 x width; metacarpus 1.2 x length of stigma; costa 2.4 x length of stigma; 1st abscissa of radius as long as width of stigma; basal 0.45 x length of medius; nervulus inclivous 0.6 times as long as width of submedius, length 1.2 times as long as medius; hind wing length 3.4 x breadth. Hind coxa length 1.7 x width, smooth, weakly punctate, with fine pubescence; trochanter length 3 x width, smooth, weakly punctate, pubescent; femur length 3.3 x maximum width, closely punctate, pubescent; tibia length 5.8 x width apically; tibial spur 0.4 times the length of basitarsus;

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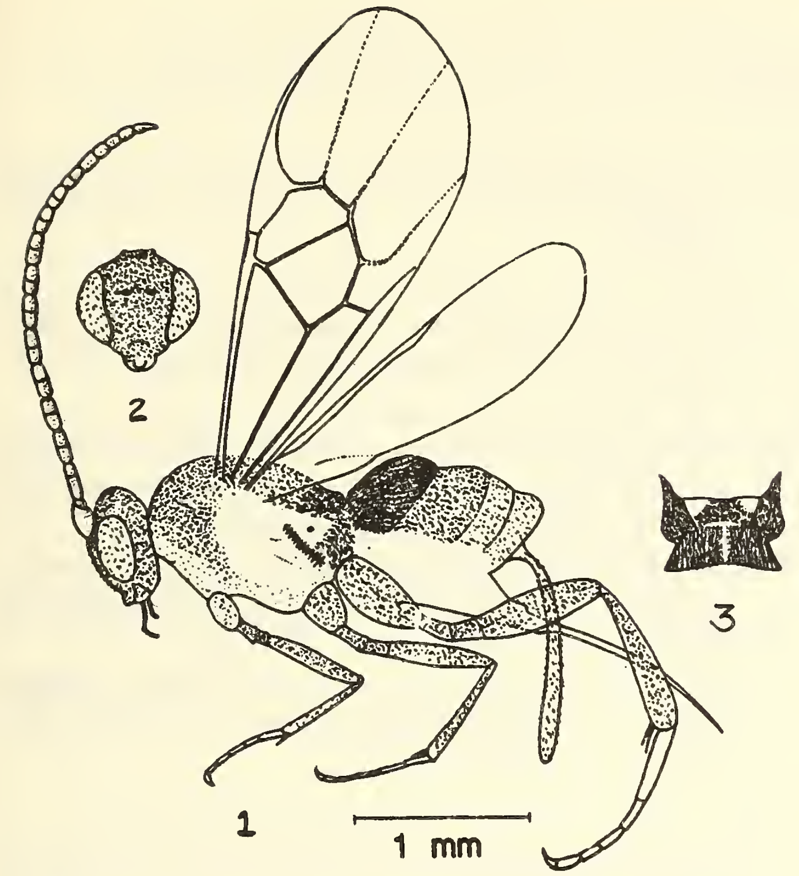
[1]Accepted October, 1996

[2]"Riddhi Siddhi" Vidya Colony, Opposite HUDCO, Pipeline Road, Ahmednagar-414 001. (Maharashtra)

[3]Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad-431 004 (Maharashtra), India.



Figs. 1-3. *Apanteles ahmednagarensis* sp. nov. (Female) 1. Adult lateral view; 2. Head, frontal view; 3. Propodeum with first abdominal tergite.

basitarsus length 0.2 times the width; claw simple, bifid.

Abdomen: 1.6 times as long as wide, spindle shaped; T 1 (Fig. 3) 0.7 times as long as wide apically, strigose mid-dorsally, with a shallow median suture, laterally subpolished, weakly punctate, pubescent; T 2 length 0.3 x width apically, smooth, subpolished, weakly, shallowly punctate, pubescent; T 3 length 0.3 x apical width, smooth, shiny, very weakly, shallowly punctate, pubescent; ovipositor pointed, as long as ovipositor sheath; ovipositor sheath with fine bristles throughout the length.

MALE: Unknown.

Holotype: FEMALE, INDIA: Maharashtra, Ahmednagar. 12. ix. 1989, on wing, Coll. S.M. Kurhade; Antenna, wings and legs mounted on slides and labelled as above.

Paratypes: 2 Females, data same as holotype except one female, 15. x. 1989, on wing.

DISCUSSION

The new species, *Apanteles ahmednagarensis* could not be placed near any species in the key to the Oriental species of *Apanteles* Foerster by Rao (1961) but it closely resembles *Apanteles mehdialii* Rao and Chalikwar (1970) in having the characters: (i) OOL as POL, (ii) face shallowly punctate, (iii) antenna 2 + 16 segmented, (iv) terminal flagellar segment longer than penultimate and (v) mesonotum shiny, shallowly punctate. However, the new taxon differs from *mehdialii* in the characters: (i) vertex coarsely punctate, with pubescence, (ii) frons moderately concave, shallowly punctate, with fine pubescence, (iii) first 11 flagellar segments with dark transverse band, (iv) scape length 1.75 x width, (v) penultimate segment as long as wide, (vi) disc of scutellum shiny, smooth, very weakly punctate and (vii) propodeum rugose, without median longitudinal carina.

The new taxon also resembles *Apanteles aurangabadensis* Rao and Chalikwar (1970) but it differs in having (i) vertex coarsely punctate, (ii) mesonotum shiny, weakly, shallowly punctate, (iii) scutellum shiny, smooth, very weakly punctate, (iv) propodeum rugose, without areola and (v) mesopleurum shiny, smooth.

ACKNOWLEDGEMENTS

We thank the Head, Department of Zoology, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for providing laboratory facilities. The senior author wishes to thank the Principal, New Arts, Commerce and Science College, Ahmednagar for permission to work at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

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NEW SPECIES OF GRASS FEEDING HECALINE LEAFHOPPER GENERA *GLOSSOCRATUS* AND *HECALUS* (HEMIPTERA: CICADELLIDAE) FROM INDIA[1]

Pratap Chandra Dash[2] and C.A. Viraktamath[3]

(*With forty-one text-figures*)

Two new species of *Glossocratus* Fieber namely, *G. indicus* sp. nov. (from Karnataka: Bangalore, Meghalaya: Shillong) and *G. ramakrishnai* (from Karnataka: Bangalore) and five new species of *Hecalus* Stål namely, *H. bifidus* sp. nov. (from Karnataka: Dharwar, Gadag), *H. caudatus* sp. nov. (from Karnataka: Bangalore), *H. compressus* sp. nov. (from Karnataka: Bangalore, Halebid-Belur), *H. dentatus* sp. nov. (from Karnataka: Jog falls, Kogar, Koppa) and *H. tuberculatus* sp. nov. (from Karnataka: Bangalore) are described and illustrated. Their relationship with other species of the genera are discussed. *Hecalus gressitti* Morrison is recorded from India. New locality records for other species of *Hecalus* are given. A revised key to Indian species of *Glossocratus* and *Hecalus* is also included.

Introduction

The tribe Hecalini, a small tribe of the subfamily Deltocephalinae, includes depressed grass feeding leafhoppers distributed in all the zoogeographical areas of the world. The Oriental Hecalini were revised by Morrison (1973) in which he dealt with five species of *Glossocratus* Fieber and ten species of *Hecalus* Stål from India. Linnavuori (1975) revised the Hecalini of the Afrotropical region. Rao and Ramakrishnan (1990) reviewed the Indian species of *Hecalus* and described three new species in addition to recording *H. prasinus* (Matsumura) from Delhi, bringing the total number of Indian species of *Hecalus* to 14.

During our studies on the Indian Deltocephalinae, we discovered *Hecalus gressitti* Morrison and new species of *Glossocratus* and *Hecalus* which are described here.

The following abbreviations are used for the repositories of the types of new taxa and other material dealt with in this study:

NHM - The Natural History Museum, London, U.K.

NPC - The National Pusa Collection, Indian Agricultural Research Institute, New Delhi, India.

UAS - The University of Agricultural Sciences, Bangalore, India.

ZSI - The Zoological Survey of India, Calcutta, India.

Key to distinguish the genera *Glossocratus* and *Hecalus*.

1. Gena very broad, lateral margin with a deep rectangular notch below eye (Fig. 1); pronotum densely granulose; hind femoral spinulation 2+2+1+1+1; female ovipositor not exceeding pygofer; male pygofer with 2-3 rows of short, stout setae on posterior margin (Fig. 2). . . . .*Glossocratus* Fieber

- Gena narrower, lateral margin moderately notched below eye; pronotum transversely rugose atleast in posterior half; hind femoral spinulation 2+2+1; female ovipositor exceeding pygofer (Fig. 18); male pygofer without short, stout setae on posterior margin (Fig. 20). . . . .*Hecalus* Stål

Genus **Glossocratus** Fieber

Key to Indian species of *Glossocratus* (for males only)

1. Aedeagus with one pair of terminal processes (Fig. 7) .... *G.indicus* sp. nov.
— Aedeagus with two pairs of terminal processes ... 2
2. Dorsal pair of aedeagal processes twice as long as ventral pair; shaft in ventral view uniform in thickness throughout . ... *G.breviceps* Morrison
— Both pairs of aedeagal terminal processes of equal length (Figs. 12, 13); shaft in ventral view broadened subapically (Fig. 12)........ *G. ramakrishnai* sp. nov.

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[1]Accepted November, 1996

[2]Present address: Department of Entomology, Orissa University of Agriculture and Technology, Bhubaneshwar 751 003, Orissa, India.
[3]Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore 560 065, India.

1. **Glossocratus indicus** sp. nov. (Fig. 1-7)
Glossocratus sp. Rao, 1990: 53-55

Ochraceous vertex, pronotum and scutellum with scattered dark brown spots. Vertex with callosities on either side of median line near posterior margin dark brown; a median triangular spot on posterior margin black. Scutellum with callosities anterior to transverse sulcus, a spot at mid point on lateral margin black. Forewing with a black spot at base and another at base of appendix, veins with a series of dark brown spots on either side. Frontoclypeus with brown spots arranged in oblique rows; transclypeal sulcus laterally brownish, anterior margin of clypellus black but interrupted in middle. Black fascia on pro and mesopleura and a black spot on metapleura. A subapical and apical spot on fore tibia, apical spot on mid tibia, large apical spot on hind tibia blackish brown; hind tibiae streaked with dark brown on dorsal surface, bases of setae dark brown.

Head anteriorly foliaceous. Vertex rather triangular, proportions of interocular distance to length 61:39. Ocelli close to eyes. Face (Fig. 1, anatomically includes part of frons, clypeus, clypellus, lora and genae which together form ventral part of head in leafhoppers) wider than long. Pronotum as long as vertex, 2.45 times as wide as long, hind margin slightly emarginate in middle. Scutellum longer than pronotum.

Male genitalia: Pygofer heavily setose in apical half. Valve broadly triangular. Subgenital plate broad at base, triangular, few marginal setae. Style with finger-like apophysis, preapical lobe well developed. Connective Y-shaped, arms slightly longer than stem. Aedeagus with a short dorsal apodeme, base bulbous, shaft with two dorsal rather triangular lamellate subapical processes; a pair of apical processes, laterally curved, each with a prominence at basal 0.33, gonopore apical.

Measurements: Male 7.5 and 8.0 mm long, 2.22 and 2.25 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Bangalore, 916 m, at light, 23.iv.1981, Coll. C.A. Viraktamath, (UAS). Paratype: 1 male, INDIA: Karnataka: Bangalore, 916 m, ex. cowpea, 27.iii.1977, Coll. Ramakrishna, (NHM). Other material: 1 male, INDIA: Meghalaya: Shillong, 3. xi. 1976, Coll. K.R. Rao, (ZSI).

Remarks: *G. indicus* can be identified easily by the single pair of terminal aedeagal processes. It is related to *G. orientalis* (Ishihara) and *G. platalea* (Noualhier) in that all the three share the triangular subapical lamellate process to aedeagal shaft. There is considerable variation in the shape of the vertex in the three specimens.

2. **Glossocratus ramakrishnai** sp. nov. (Figs. 8-13)

Ochraceous head, pronotum, scutellum with fine dark brown spots, those on vertex and pronotum running into longitudinal stripes. Vertex in one of the specimens with prominent blackish apical spots, one on either side of median line which is faint but discernible in the other, callosities brownish in the paler specimen, black in the darker specimen, basal lateral spots on scutellum and apex of scutellum black or fuscous, a submarginal stripe below lateral carina of pronotum piceous, pro and mesothoracic pleura with black stripe. Femora spotted with dark brown, bases of setae on legs dark brown

Head anteriorly foliaceous. Vertex triangular, proportion of interocular distance to length 55:41. Ocelli placed a distance equal to their own diameter from adjacent eye. Face longer than wide. Pronotum 2.34 times as wide as long, about as long as or slightly shorter than vertex, hind margin slightly emarginate. Scutellum as long as or slightly longer than pronotum.

Male genitalia: Similar to *G. indicus*. Aedeagus with well developed dorsal apodeme, shaft tubular, broadest subapically, with two pairs of short processes of equal length, apex of shaft with a V-shaped notch, gonopore apical.

Measurements: Male 6.7 and 7.5 mm long, 2.10 and 2.18 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Bangalore, 916 m, GKVK, 3.vi.1982, Coll. H.V.A. Murthy, (UAS). Paratypes: 1 male, data as for holotype 23.ix.1992, Coll. P.C. Dash, (NHM).

Remarks: *G. ramakrishnai* can be separated from other species of the genus by the position of ocelli in male which are placed slightly away from the adjacent eyes as in females. The aedeagal processes are unusually short and the apex of shaft is notched. These characters show its distant phylogenetic relationship to other species of the genus.

Genus **Hecalus** Stal

The new species described here have male pygofer heavily setose in apical half, valve triangular and subgenital plates flat, caudally tapering, with a few (3-5) submarginal setae. The style has well developed anteapical lobe, apophysis is laterally curved, its surface finely sculptured. Connective is somewhat Y-shaped, with a broad stem. Aedeagus invariably has dorsal marginal foliaceous lateral extension varying in width.

Key to Indian species of *Hecalus* (only males)

1. Thorax and face brown to piceous 2
— Thorax and face green to yellowish green. 3
2. Male 4.5 mm long, aedeagal shaft without prominent mid-dorsal lateral flares (Fig. 41) .... *H.dentatus* sp. nov.
— Male 5.8 mm long, aedeagal shaft with prominent mid-dorsal lateral flares .... *H.lutescens* (Distant)
3. Concentric parabolic orange fasciae on head and pronotum .... *H.arcuatus* (Motschulsky)
— Colouration not as above 4
4. One pair of aedeagal processes, not branched or forked 5
— Two pairs of aedeagal processes or one pair of branched or forked processes 14
5. Longitudinal orange lines on head, pronotum and scutellum, forewings brown in apical 0.33 with white spots in apical and anteapical cells .... *H. porrectus* (Walker)
— Without longitudinal orange lines (may have brown lines as in *H. umballaensis*); head, pronotum, scutellum and forewings entirely green to yellowish green 6
6. Apical process of aedeagus rather leaf-like, with serrated dorsal margin 7
— Apical process of aedeagus narrower, not leaf-like, with smooth dorsal margin 10
7. Vertex, pronotum and scutellum with longitudinal brown lines; aedeagal shaft of uniform width throughout length in lateral view .... *H.umballaensis* (Distant)
— Vertex, pronotum and scutellum uniformly green or yellowish green, without longitudinal brown lines; aedeagal shaft varying in width in lateral aspect .. 8
8. Apical aedeagal processes directed caudally (Figs. 23, 24) .... *H.caudatus* sp. nov.
— Apical aedeagal processes directed antero-laterally (Figs. 34-36) 9
9. Aedeagal shaft constricted medially .... *H. morrisoni* Rao and Ramakrishnan
— Aedeagal shaft broadened in apical 0.2 then slightly narrowed and rounded (Figs. 34, 35) .... *H.compressus* sp. nov.
10. Aedeagal shaft expanding distally into a diamond-shaped flare below apical processes 11
— Aedeagus without such a flare 12
11. Aedeagal shaft ventrally keeled, laterally compressed, constricted medially without lateral lamellate processes. .... *H.wallengreni* (Stål)
— Aedeagal shaft dorsally grooved, with lateral lamellate processes, uniformly distally narrowed .... *H.pusae* Rao and Ramakrishnan
12. Aedeagal shaft strongly narrowed caudally .... *H.ghaurii* Rao and Ramakrishnan
— Aedeagal shaft not narrowed caudally 13
13. Aedeagal shaft dorsally grooved with a subapical tooth on each edge subapically (Figs. 29, 30) .... *H.tuberculatus* sp. nov.
— Aedeagal shaft without subapical tooth on lateral margin dorsally, without dorsal groove .... *H.prasinus* (Matsumura)
14. Aedeagal shaft strongly grooved laterally in distal 0.33, with one pair of forked processes (Figs. 15-17); without orange lines on head .... *H.bifidus* sp. nov.
— Aedeagal shaft without grooves; with two pairs of processes; head with orange lines 15
15. Apical pair of aedeagal processes 0.2 as long as other pair .... *H.gressitti* (Linnavuori)
— Apical pair of aedeagal processes as long as the other pair. .... *H.apicalis* (Matsumura)

3. **Hecalus arcuatus** (Motschulsky)

Platymetopius arcuatus (Motschulsky, 1859: 115

Tetigonia (Diedrocephala) kalidasa Kirkaldy, 1900: 294

Parabolocratus concentralis Matsumura, 1912: 288

Parabolocratus citrinus Evans, 1941: 36

Varta moshiensis Rao, 1973: 96, synonymized by Rao, 1989: 66. *Hecalus arcuatus*: Morrison, 1973: 426; Rao, 1989: 66

Material examined: Several specimens from Karnataka: Bangalore, Bidar, Chincholi, Dharwar, Gadag, Gulbarga, Hagari, Halebid-Belur, Kemmannagundi (1100 m), Nandi Hills (1467 m), Raichur, Yalburga; Maharashtra: Dhond; Mizoram: Aizawl, Lunglei; Tamil Nadu: Barliar (860 m).

Remarks: A widely distributed species with very characteristic colouration.

4. **Hecalus bifidus** sp. nov.
(Figs. 14-17)

Yellowish green. Forewing yellowish green with a black spot at apex of clavus. Anterior rim of head margined both above and below with brown.

Vertex subtriangularly produced, proportion of interocular width to length 36:24. Pronotum longer than vertex, 2.07 times as wide as long.

Male genitalia: Aedeagus with well developed dorsal apodeme, shaft laterally grooved in apical 0.33 with a terminal pair of forked processes.

Measurements: Male 4.8 and 5.2 mm long, 1.43 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Dharwar, xi. 1969, Light trap, Viraktamath, (UAS). Paratype: 1 male, INDIA: Karnataka: Gadag, 21.ii.1978, C.A. Viraktamath, (NHM).

Remarks: This species is closely related to *H. furcatus* Morrison from China in having grooved aedeagal shaft and forked apical process of the aedeagus. It can, however, be distinguished from *H. furcatus* in the aedeagal shaft being of uniform width and aedeagal process larger and unequal in length.

5. ***Hecalus apicalis*** (Matsumura)

Parabolocratus apicalis Matsumura, 1912: 287

Hecalus apicalis: Morrison, 1973: 424

Material examined: Several specimens from Karnataka: Bangalore, Chincholi, Dharwar, Gadag, Jog Falls, Kemmannagundi (1100 m), Mudigere, Raichur; Tamil Nadu: Nilgiri Hills; Mizoram: Aizawl, Lunglei.

Remarks: It is a widely distributed species in the Oriental region to be recognised by the longitudinal orange lines on head and pronotum, and in males apical 0.33 of forewings dark brown to black with white spots. *H. gressitti* and *H. porrectus* also have similar colouration but can be distinguished by the aedeagal characters given in the key.

6. **Hecalus gressitti** (Linnavuori)

Parabolocratus gressitti Linnavuori, 1960: 272

Hecalus gressitti: Morrison, 1973: 423

Material examined: INDIA: 2 males, 4 females, West Bengal: Calcutta, 17.iv.1975, Coll. C.A. Viraktamath, 3 males, 1 female, Mizoram: Aizawl, 18.x.1981, Coll. C.S. Wesley, (UAS).

Remarks: Coloration similar to that of *H. apicalis* but differs in possessing shorter apical processes of aedeagal shaft which are 0.2 times as long as the subapical pair. This is the first record of the species from India. It was earlier known from W. Caroline Islands, the Philippines, Amboina, Singapore, Penang and Laos (Morrison, 1973).

7. **Hecalus porrectus** (Walker)

Acocephalus porrectus Walker, 1858: 232

Platymetopius lineolatus Motschulsky, 1859: 114

Hecalus kirschbaumi Stål, 1870: 737

Thomsoniella viridis Distant, 1908: 280

Parabolocratus rusticus Distant, 1918: 31, nom nov. pro *Thomsoniella viridis* not Uhler, 1877

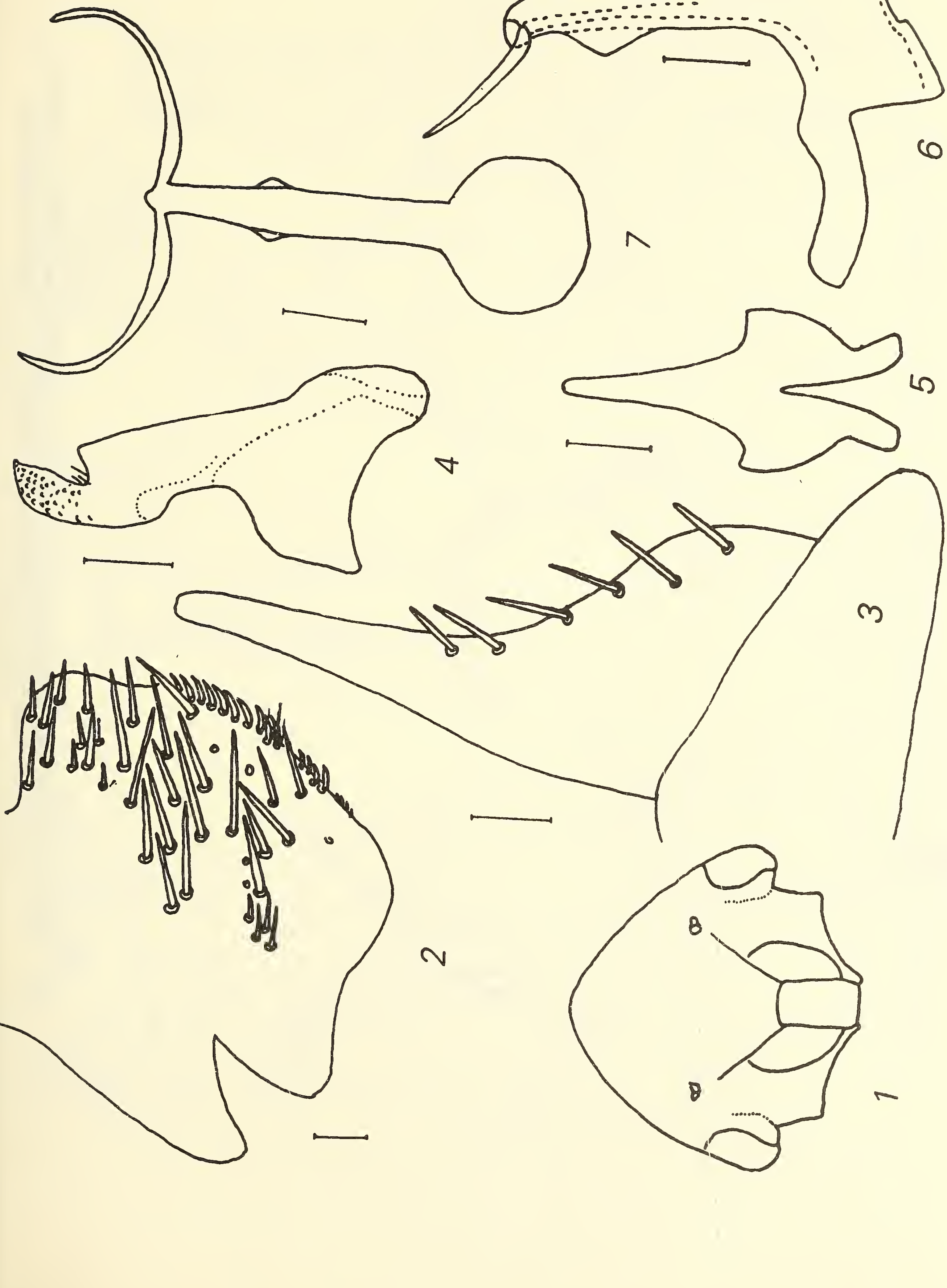
Thomsoniella albomaculata Distant, 1908: 280

Parabolocratus merinoi Capco, 1959: 333

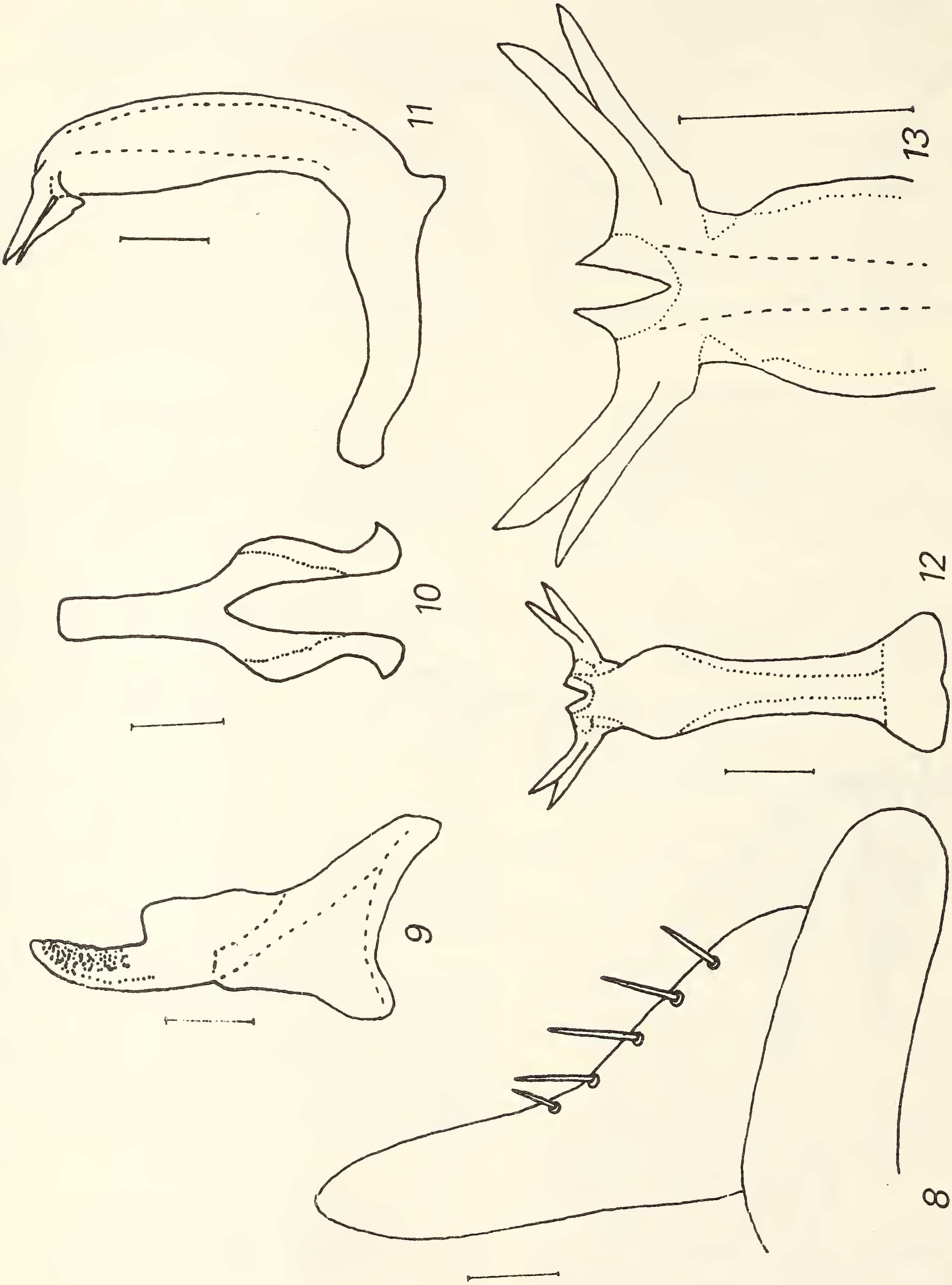
Hecalus porrectus: Morrison, 1973: 421

Material examined: Several specimens from Karnataka: Bangalore, Chincholi, Dharwar, Ilkalgad, Jog Falls, Mudigere; Meghalaya: Shillong; Mizoram: Aizawl; West Bengal: Calcutta.

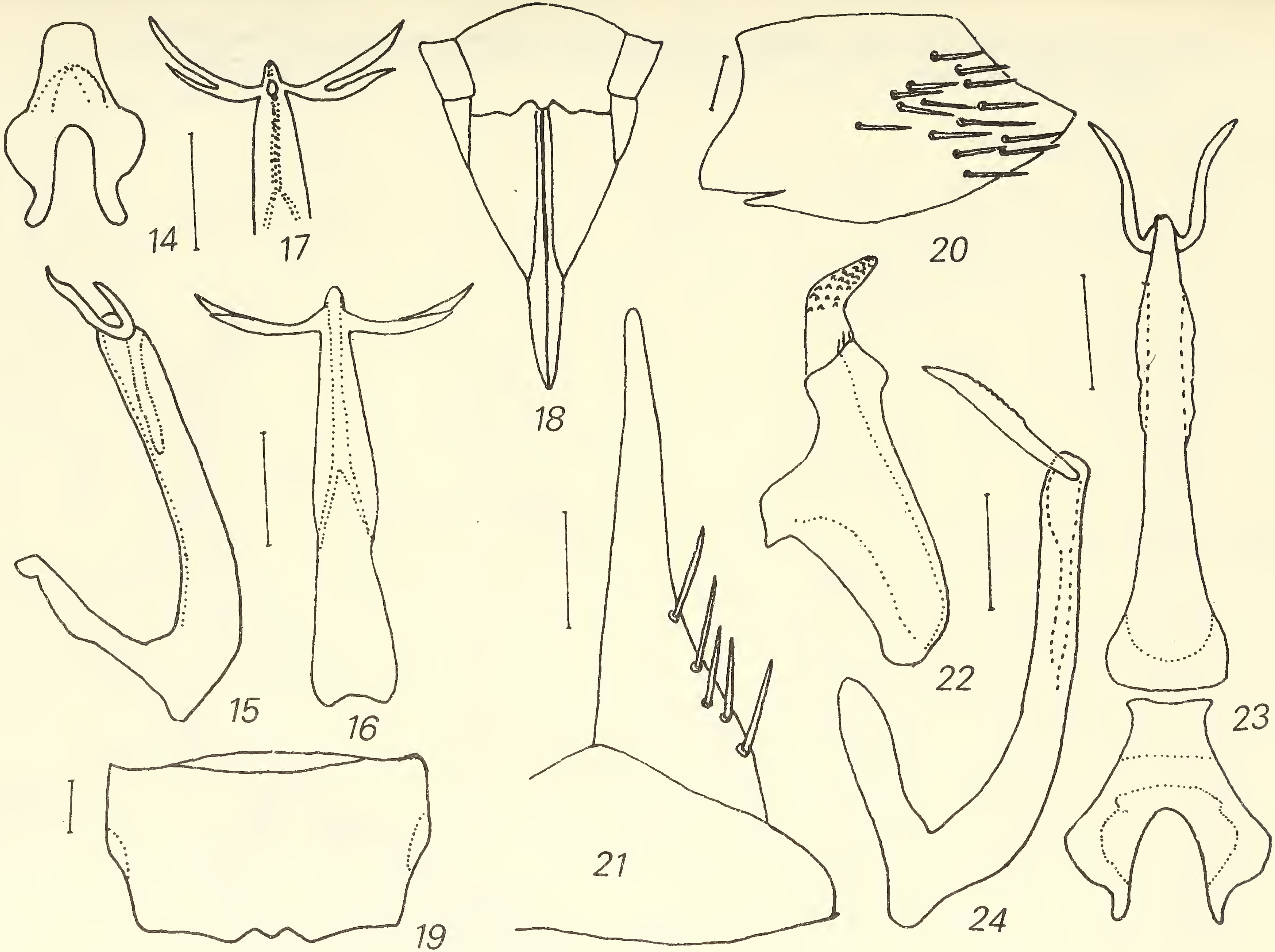
Remarks: It is similar to *H. apicalis* and *H. gressitti* in coloration but can be differentiated by the single pair of apical processes of aedeagus.



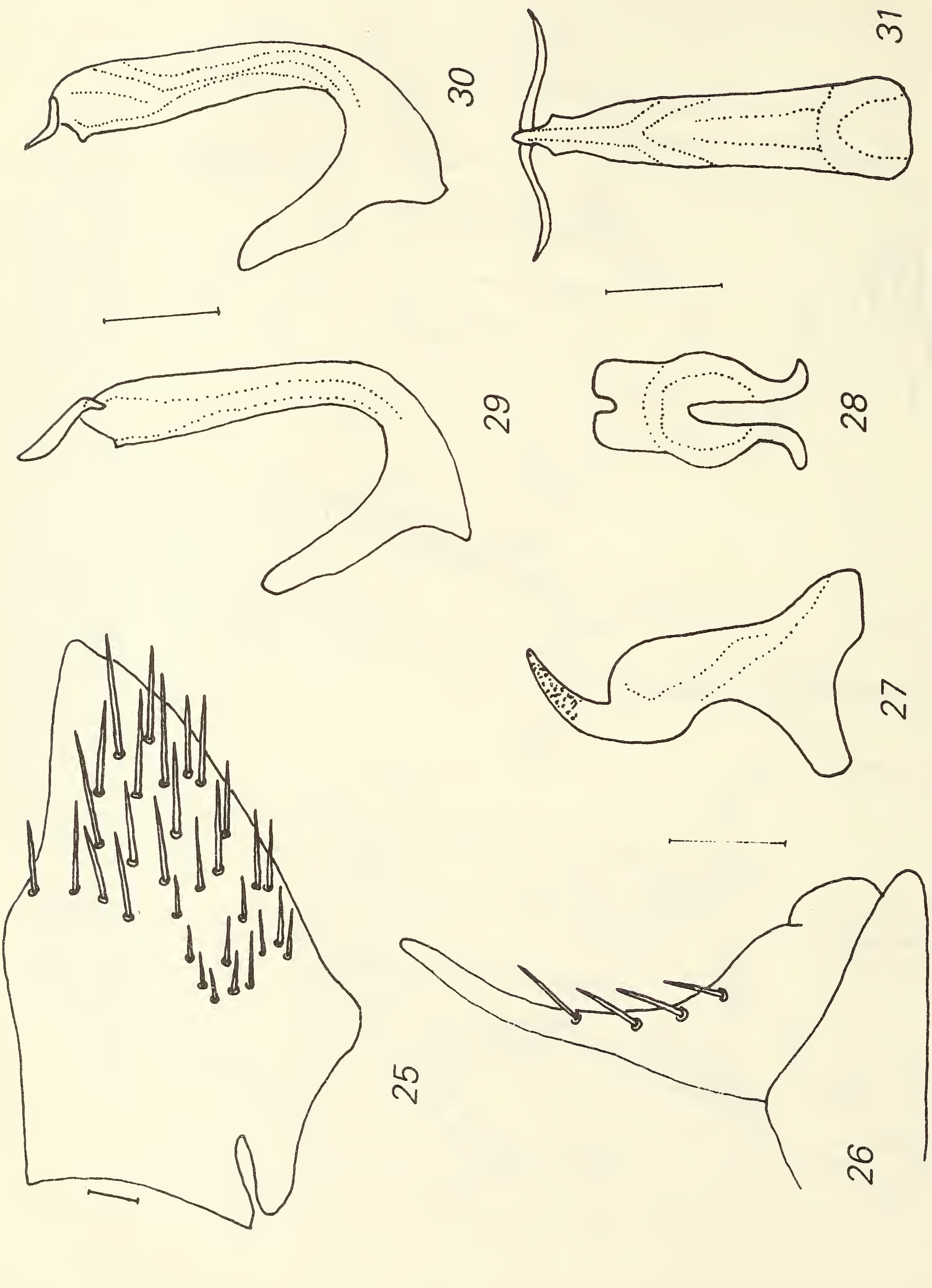
Figs. 1-7. *Glossocratus indicus* sp. nov. 1. Face; 2. Male pygofer; 3. Valve and subgenital plate; 4. Style; 5. Connective; 6. Aedeagus, lateral view; 7. Aedeagus, antero-dorsal view. Scale line = 0.1 mm.



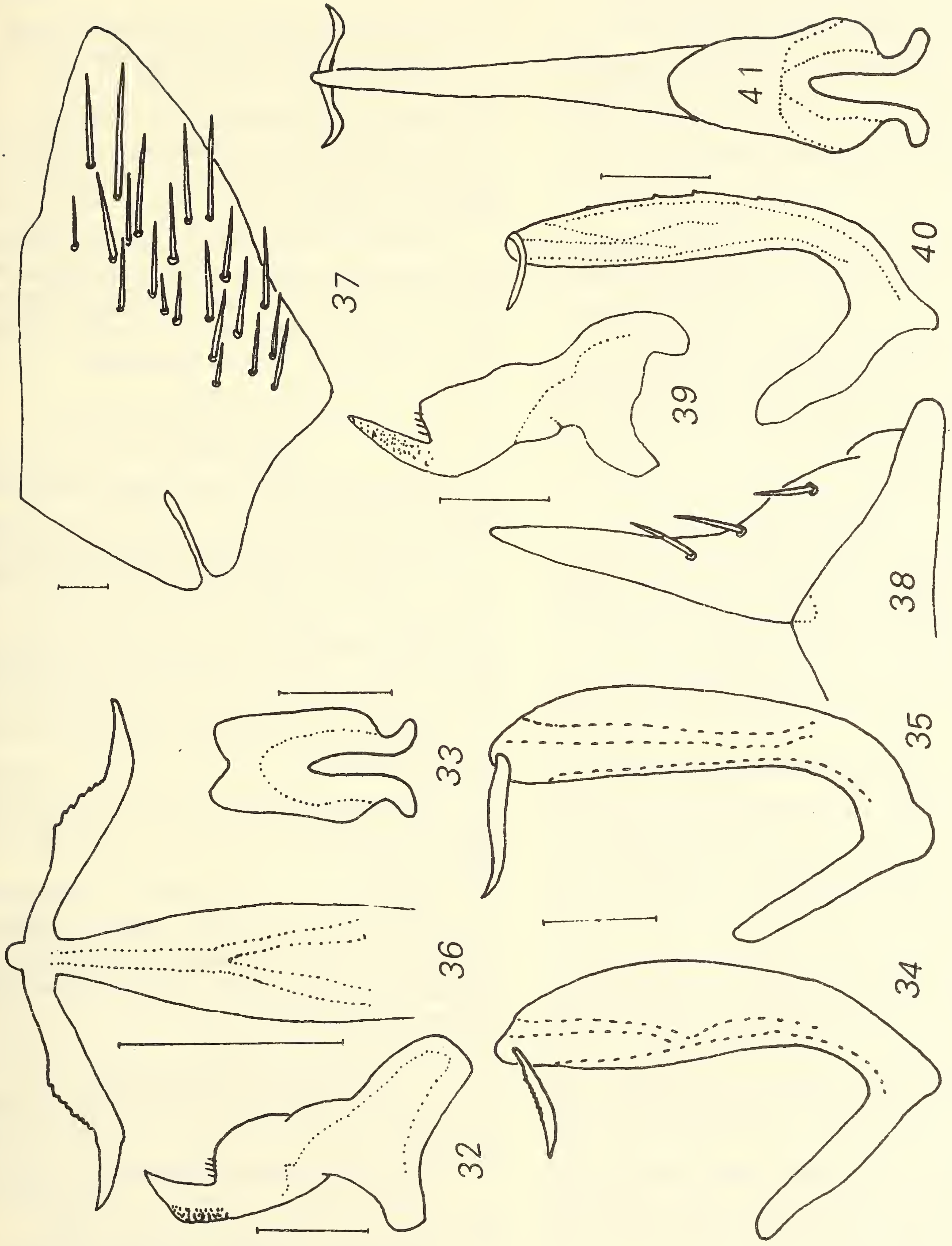
Figs. 8-13. *Glossocratus ramakrishnai* sp. nov. 8. Valve and subgenital plate; 9. Style; 10. Connective; 11. Aedeagus, lateral view; 12. Aedeagus, antero-dorsal view; 13. Apex of aedeagal shaft.



Figs. 14-24. Species of *Hecalus*. 14-17. *Hecalus bifidus* sp. nov. 14. Connective; 15. Aedeagus, lateral view; 16. Aedeagus, antero-dorsal view; 17. Apex of aedeagal shaft. 18-19. *Hecalus lutescens* (Distant) female. 18. Ovipositor; 19. Seventh sternum. 20-24. *Hecalus caudatus* sp. nov. 20. Male pygofer; 21. Valve and subgenital plate; 22. Style; 23. Connective and aedeagus, antero-dorsal view; 24. Aedeagus, lateral view. Scale line = 0.1 mm



Figs. 25-31. *Hecalus tuberculatus* sp. nov. 25. Male pygofer; 26. Valve and subgenital plate; 27. Style; 28. Connective; 29-30. variation in aedeagus, lateral views; 31. Aedeagus, antero-dorsal view. Scale line = 0.1 mm.



Figs. 32-41. Species of *Hecalus*. 32-36. *Hecalus compressus* sp. nov. 32. Style; 33. Connective; 34-35. Variations in aedeagus, lateral aspect; 36. Apex of aedeagal shaft. 37-41. *Hecalus dentatus* sp. nov. 37. Male pygofer; 38. Valve and subgenital plate; 39. Style; 40. Aedeagus, lateral view; 41. Connective and aedeagus, antero-dorsal view. Scale line = 0.1 mm.

8. **Hecalus lutescens** (Distant)
(Figs. 18-19)

Parabolocratus lutescens Distant, 1918: 31

Hecalus lutescens: Morrison, 1973: 419

Female genitalia: Ovipositor extending beyond pygofer by three times its width. Hind margin of seventh sternum with a short median projection.

Measurements: Male 5.5 mm long, 1.45 mm wide across eyes. Female 5.8 mm long, 1.55 mm wide across eyes.

Material examined: INDIA: Tamil Nadu: 1 male, 2 females, Oothu, 28.x.1975, Coll. C.A. Viraktamath, 2 males, 2 females, Valparai, 13.iv.1981, Coll. A.R.V. Kumar, (UAS).

Remarks: So far this species is known only from the hills of Tamil Nadu. The female is described for the first time here.

9. **Hecalus caudatus** sp. nov.
(Figs. 20-23)

Yellowish green. A black spot at apex of clavus.

Vertex broadly subtriangular, anterior margin slightly upturned, proportion of interocular width to length 48:43 in male, 59:56 in female. Face strongly tumid. Pronotum shorter than vertex, 2.1 and 2.23 times as wide as long in male and female, respectively.

Male genitalia: Aedeagus with well developed dorsal apodeme, shaft with lateral membranous narrow keel visible in antero-dorsal aspect, with a pair of caudodorsally directed processes, each process minutely serrate dorsally.

Female genitalia: Ovipositor extends by a distance equal to 2.5 times its width beyond pygofer. Hind margin of seventh sternum with a median triangular projection.

Measurements: Male 6.5 mm long, 1.7 mm wide across eyes. Female 7.3 mm long, 2.0 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Bangalore, 916 m, 9.ix.1980, Coll. Maragal, (UAS). Paratypes: 2 females, data as for holotype (NHM, UAS).

Remarks: *H. caudatus* is closely related to *H. umballaensis* from which it differs in having strongly caudodorsally directed aedeagal processes.

10. **Hecalus morrisoni** Rao and Ramakrishnan

Hecalus morrisoni Rao and Ramakrishnan, 1990: 389

Material examined: INDIA: holotype male, Pusa, Bengal, H.L.D. 26.vii.09, At Light (NPC) Coll. not named; Karnataka: several specimens from Bangalore and Bellary.

Remarks: *H. morrisoni* is closely related to and resembling *H. umballaensis* Distant. Specimens collected at Bangalore have aedeagal shaft of uniform width and serrations of the apical process not so prominent as in those from Delhi.

11. **Hecalus tuberculatus** sp. nov.
(Figs. 24-30)

Yellowish green. Lower edge of anterior margin of head brown.

Vertex subtriangular, proportions of interocular width to length 38:23. Pronotum longer than vertex, 2.1 times as wide as long.

Male genitalia: Aedeagus short, widened apically, with a subapical denticle on dorsal margin, apical process short, caudo-laterally directed.

Measurements: Male 5.3 mm long, 1.5 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Bangalore, 916 m, 22.x.1991, Coll. P.C. Dash, (UAS).

Remarks: *H. tuberculatus* is related to *H. wallengreni* Stal, but differs in the presence of a prominent tubercle on the dorsal margin of shaft near apex and in the shape of the subgenital plates which strongly taper caudally.

12. **Hecalus wallengreni** Stål

Hecalus wallengreni Stål, 1870: 736; Morrison, 1973: 413

Parabolocratus minutus Bierman, 1910: 63

Parabolocratus taiwanus Matsumura, 1912: 286

Parabolocratus mandlensis Pruthi, 1930: 20

Hecalus gramineus Merino, 1936: 353

Material examined: INDIA: West Bengal: 1 male, Calcutta, 17.iv.1975, Coll. C.A. Viraktamath, (UAS).

13. **Hecalus prasinus** (Matsumura)

Parabolocratus prasinus Matsumura, 1905: 48

Parabolocratus dubiatus Bierman, 1910: 64

Hecalus prasinus: Morrison, 1973: 417

Material examined: Several specimens from Karnataka: Bangalore, Bellary, Dharwar, Jog Falls, Raichur, Nandi Hills; West Bengal: Teesta.

Remarks: Very widely distributed in the Oriental region.

14. **Hecalus compressus** sp. nov.
(Figs. 31-35)

Yellowish green. Both upper and lower edges of anterior rim of vertex brown.

Vertex subtriangular, proportion of interocular width to length 41:31 in male, 52:46 in female. Pronotum shorter than vertex in male but longer in female, 2.16 as wide as long.

Male genitalia: Aedeagal shaft strongly compressed, widest at midlength in lateral aspect, with a pair of leaf-like apical processes with serrated dorsal margin.

Female genitalia: Ovipositor extending by a distance equal to twice its width. Hind margin of seventh sternum with a median triangular projection.

Measurements: Male 5.5 mm long, 1.5 mm wide across eyes. Female 6.5 mm long and 1.9 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Bangalore, 916 m, 10.ii.1992, Coll. P.C. Dash, ex. grasses (UAS). Paratypes: 1 male, 3 females, data as for holotype; 3 males, data as for holotype but collected at GKVK 2.xi.1992, 1 male, INDIA: Karnataka: Nandi Hills (1467 m), 22.xi.1978, Coll. S. Viraktamath, 1 male, INDIA: Karnataka: Sulikere (near Bangalore), 20.xii.1976, Coll. C.A. Viraktamath.

Other material examined: INDIA: Karnataka: 5 males, 15 km NW Ilkalgad, 19.xii.1974, Coll. Ghorpade, 2 males, 2 females, Halebid-Belur, 11.xi.1978, Coll. C.A. Viraktamath, Delhi: New Delhi, 1968, Coll. H.M. Harris, (UAS).

Remarks: This species is related to *H. ghaurii* Rao and Ramakrishnan but differs in the apex of the aedeagal shaft being much broader than in *ghaurii*.

15. **Hecalus dentatus** sp. nov.
(Figs. 36-41)

Dark fuscous green. Lower edge of anterior rim of head dark brown, lateral areas of face darker. Scutellum with four longitudinal dark brown stripes in a few males.

Vertex subtriangular, anterior margin slightly upturned, proportion of interocular width to length 36:24 in male, 48:35 in female. Pronotum longer than vertex in male but shorter in female, 2.24 and 2.16 times as wide as long in male and female, respectively.

Male genitalia: Aedeagus as in *H. lutescens* but considerably shorter, shaft widened apically in lateral aspect with denticles on ventral margin, apical process directed caudo-laterally.

Female genitalia: Ovipositor exceeding pygofer by a distance equal to its width. Hind margin of seventh sternum with a median triangular projection.

Measurements: Male 4.5 mm long, 1.38 mm wide across eyes. Female 5.5 mm long, and 1.63 mm wide across eyes.

Material examined: Holotype male, INDIA: Karnataka: Koppa, 27.xi.1982, Coll. H.V.A. Murthy, (UAS). Paratypes: 9 males, data as for holotype; 1 female INDIA: Karnataka: Jog Falls, 534 m, 18.xi.1976, Coll. B. Mallik, 1 female, Kogar (36 km W of Jog Falls), 23.ix.1991, Coll. P.C. Dash, ex. grasses (NHM, NPC, UAS).

Remarks: *H. dentatus* is similar to *H. lutescens* and *H. fuscovittatus* Morrison in being dark fuscous green. It shares the minute spines on the aedeagus with *H. lutescens* but has more uniformly curved aedeagal shaft, less prominent lateral laminate process, shorter and differently curved aedeagal processes. It is also smaller than *H. lutescens*.

16. **Hecalus ghaurii** Rao and Ramakrishnan

Hecalus ghaurii Rao and Ramakrishnan, 1990: 388.

Material examined: INDIA: Delhi: holotype male, "Swept on grass, Delhi, IARI, Oct. 65, R. Menon" "Host: Grasses, Loc. New Delhi, Date. Oct. 1965, Coll. M.G.R. Menon" (NPC). Karnataka: several specimens from Bangalore, Nandi Hills, Raichur (UAS). [collection data quoted from specimen labels]

Remarks: This species, as in the case of *H. compressus*, has a highly compressed aedeagal shaft, with dorsolateral margin laterally produced into a very narrow laminate process. This species can be recognised by its aedeagal shaft which strongly tapers caudally as seen in in lateral aspect.

ACKNOWLEDGEMENT

We are grateful to the Head, Division of Entomology, Indian Agricultural Research Institute, New Delhi for permitting us to study the types of Hecalinae under his care.

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REVIEWS

1. APPLIED ETHNOBOTANY - A CASE STUDY AMONG THE KHARIAS OF CENTRAL INDIA, by E. Varghese, S.V. D. Deep Publication. New Delhi-110063. pp i-xix + 1-307 (21 x 13.5 cm). Price Rs. 400.00 or $ 70.00

Ethnobotany is the study of human interaction with plants in a given environment. Ethnology is defined as the comprehensive study and analysis of non-literate people or aboriginal tribes of a particular region. Ethnobotanic studies concentrate on the areas inhabited by aboriginals or tribals of rural areas and their dependence on the plant wealth of their surroundings.

Effort is being made here to evaluate the work carried out by Rev. Fr. E. Varghese on the ethnobotany among the Kharias of Central India. Ethnobotany is closely related to Economic Botany, but the difference is that Ethnobotany is the applied botany known to restricted tribes and has limited utility among them.

Although Ethnobotany is as old as human history, growing ecological and environmental awareness has given a boost to this neglected branch of Science. According to Rev. Fr. Varghese, it is in the past one century or so that Ethnobotany has begun to emerge as an independent discipline. In India it is more than 4000 years old. It is believed that 'Atharvaveda' which also deals with 'Ayurveda' or the science of vegetable products useful in health care was well known from 2000 B.C. Information about these plant remedies was known to people and practitioners of Ayurveda and passed on from 'gurus' to 'sishyas' by word of mouth. It is only in the recent past that the knowledge of our ancient Vedas has been written down in the form of manuscripts and books. The major difference in vedic information and ethnobotanic information is that the former has remained alive and stood the test of time.

Data gathered by Fr. Varghese will be tested by the scientific community in future and the utility or otherwise of the information gathered will be ascertained. At present, the attempts of the author have been restricted to collecting reliable information and confirming it from as many people as possible in the same tribal community.

Fr. Varghese has rightly pointed out that ethnobotanical endeavours are known in India right from the time of the Vedas and Samhitas. Rigveda, the oldest available record dating back to 4000-5000 B.C. recounts some medicinal plants. Atharvaveda which contains 'Ayurveda', gives us information about 2000 plants and their medicinal properties. The Ayurvedic medicinal plants are described in the three following ancient texts:

1. Charaka samhita.
2. Sushruta samhita.
3. Ashtanga hridaya.

These three texts contain information on 700 species of plants, their properties, and methods of formulating drugs from them for treatment. Presently about 35,000 species of crude medicinal plants are used in practice.

According to Rev. Fr. Varghese, the term Ethnobotany, which was introduced by J.W. Harshberger in 1895, has been in use for 100 years.

Traditional medicine is known in Indian literature from the middle of the 16th century. Garcia D'orta - a Portuguese physician in Goa wrote the first book on medicinal plants in India COLOQUIAS DAS SIMPLES E DROGAS DA INDIA, or the Dialogue on Indian Medicinal Plants. It describes well known medicinal plants in India, especially in Goa and other areas.

Another reputed early work in India is Drakestein van Rheede's HORTUS MALABARICUS (1678-1703). This 12 volume work was prepared by a Dutch Administrator of Malabar region. It describes about 800 species of flowering plants. Over 600 species in this work have been provided binomials by Carl Linnaeus, in his famous work SPECIES PLANTARUM (1753).

The names of plants used in these 12 volumes are generally coined from their utilities and habitats etc. A few names are given to illustrate the origin of their local names, which is one of the points made by Fr. Varghese in his book:

1. Adalodekam - Adal = Internal.
   - Odecam = curing medicine.

   = *Adhatoda zeylanica* Medicus
   - *Justicia adhatoda* Linn.

2. Karakanjivam - Kara - Terrestrial (-herbaceous).
   Kanjivam = Bitter leaved.

   = *Andrographis paniculata* (Burm.f.) Wall ex Nees
   = *Justicia paniculata* Burm.f.

3. Vayalschulli - Vayal = Paddy fields.
   Schulli = spiny herb.

   = *Hygrophila schulli* (Ham.) Almeida & Almeida.
   = *H. auriculata* (K. Schum.) Heine

If we take for granted that Ethnobotany is the knowledge of a particular tribal group which is carried out for centuries within the tribe, then it is strange to find the inclusion of species like *Chromolaena odorata* (L.) King. & Robin (Syn. *Eupatorium odoratum* L.) (West Indian species, introduced in India - (Clarke, Comp. Ind. 30, 1878) and *Evolvulus nummularius* (L.) L. - a recently introduced weed found in Indian gardens.

However, this type of information is not found only in the present book. We encounter names like Sitaphal (*Annona squamosa* L.) and Ramphal (*Annona reticulata* L.) of plants which have come to India only after the discovery of the new world (America), which are believed to have been introduced by the Portuguese.

The history of Ethnobotanical works in India will not be complete if we do not give appropriate credit to the following works:

1. John Fleming (1810) - A CATALOGUE OF INDIAN MEDICINAL PLANTS AND DRUGS.
2. Ainshie (1812) - MATERIA MEDICA OF HINDUSTAN.
3. Chopra, R.N. (1933). - INDIGENOUS DRUGS OF INDIA.
4. George Watt (1896) - Dictionary of Economic Products of India.

This volume on Applied Ethnobotany of Kharias of Central India speaks for Rev. Fr. Varghese's capability and we, his friends and colleagues are proud of his achievements.

Indeed, Fr. Varghese has done pioneering work among the Kharias of Central India.

M.R. ALMEIDA

2. DIRECTORY OF NATIONAL PARKS AND SANCTUARIES IN INDIA MANAGEMENT STATUS AND PROFILES. Edited by Ranjit Lal, Ashish Kothari, Pratibha Pande, Shekhar Shah pp. 231 (19 x 24.5 cm) with maps and many illustrations in black and white. New Delhi 1994. Sponsored by Wildlife Institute of India, Dehradun and Centre for Public Policy, Planning and Environmental Studies, Indian Institute of Public Administration, New Delhi. Hardback Rs. 350, $ 30; paperback Rs. 200, $ 20.

The Directory, third in a series of volumes covering national parks and sanctuaries in India, elaborates on the management status and profiles of five national parks and nineteen sanctuaries in Karnataka. These directories are the result of the ongoing study on the management of national parks and protected areas in India. It is a good and timely attempt at building up a reliable and exhaustive database with maps on the National Parks and Sanctuaries of Karnataka. The attempt will definitely help in understanding and cataloguing the state's diverse ecosystems within the boundaries of its protected areas and the developmental pressures facing them.

The directory is a well coordinated exercise at collecting, collating and disseminating information on all the Protected Areas of the State of Karnataka under one cover. The information on various aspects of the management of National parks and Sanctuaries of Karnataka will prove beneficial to researchers, wildlife managers, policy makers and laymen alike.

The directory also contains an inventory of the floral and faunal components of the protected areas, though it is not as exhaustive as expected, especially the list of birds recorded in the areas covered. The list of endangered floral and faunal species is informative.

The format containing the information on the land use pattern in and around the protected areas, is well laid out and covers all aspects which might interest policy makers and laymen alike. Though many gaps remain in the current information, it is hoped that its widespread use will encourage both managers of the protected areas and the researchers to pool their knowledge to enhance the effectiveness of the directory.

Though the directory contains proposals for improving the wildlife protected area network in Karnataka, it does not mention the urgent need for increasing the manpower and material resources of the enforcement agencies, viz. the Forest department and its Wildlife wing. The understaffed and underequipped department appears to be fighting a losing battle in most areas.

The book is a must for all conservation oriented institutions and individuals. It must also form a part of the District administration's libraries across the state.

As rightly hoped by the authors, the directory will prove to be a catalyst in our efforts towards saving the state's and the country's wilderness areas from destruction. The only hope lies in planning sustainable use of the fast depleting natural resources on hand, of which the directory is a good benchmark.

S. ASAD AKHTAR

3. ANATOMY AND HISTOLOGY OF THE COMMON HOUSE SHREW By R. V. Ranade, University of Poona, Price Rs. 100/-

The book is a monograph based on the thesis, "Anatomical and histological studies on the house shrew, *Suncus murinus blanfordi* (Anderson)" that was submitted by the author to the University of Poona for the degree of Doctor of Philosophy.

The monograph has a good representation of anatomical and histological plates with relevant descriptions. The line drawings are neat and proportionate. Histological preparations are printed in black and white. As a result the clarity of the staining effects has been lost in certain cases.

A bibliographical list of references would be useful for researchers taking up further study on *Suncus*.

As such the book will have limited circulation and will be more useful to the departments and libraries where work on smaller mammals is undertaken.

A.M. BHAGWAT

MISCELLANEOUS NOTES

1. MOVEMENT OF NILGIRI LANGUR BETWEEN FOREST FRAGMENTS IN THE ANNAMALAI HILLS

On 22nd December, 1994, as part of an ongoing research programme, GU was observing the activities of the Lion-tailed macaque at Puthuthottem Cardamom Estate, at Valparai, Coimbatore district. At around 1600 hours while searching for an adult male Lion-tailed macaque (which always spent most of the time away from the group), GU heard the threatening call of an adult male Lion-tailed macaque. GU moved in the direction of the call and saw the Lion-tailed macaque threatening and chasing away a Nilgiri langur on a *Cullinea exelsa* tree. We were surprised to spot a Nilgiri langur in that area because the estate workers had informed us that the last time they had sighted a group of Nilgiri langurs was ten years ago. It had then comprised of 6 to 10 individuals and subsequently been reduced to two in 1989; later they also had disappeared.

In the early 1920's the Puthuthottem forest was a part of a continuous rain forest in the Annamalai Hills. This forest was under private ownership and the surrounding areas were clear-felled for tea cultivation. During clear-felling this patch of forest (60ha in area) was left with a good forest cover, which was under planted with cardamom. Later this forest fragment had been selectively felled many times, last in 1992. In 1980s intensive logging caused heavy damage to the forest and affected the habitat of the Nilgiri langur and Lion-tailed macaque there. Even though the trees logged had a high timber value they were of low fruit value and had affected the Nilgiri langur more than the Lion-tailed macaque. Moreover, the Nilgiri langurs were more intensively hunted than Lion-tailed macaque, during 1970's and early 1980's bringing down its population, and eventually leading to its extinction. Lion-tailed macaques, on the other hand, managed to survive since many fruit trees were left behind. Being more adapted to human presence it also utilized the surrounding coffee plantations, feeding on coffee beans and *Mesopsis* spp., Cardamom cultivation was abandoned after logging in 1982, after which wood cutting by local villagers have further degraded the forest. The Lion-tailed macaques have also been on the decline from 54 in 1991 to 34 at present, due to low birth rate from low food availability, high mortality during logging and predation by feral dogs.

After 22nd December, we started monitoring the presence of the Nilgiri langur every day and made some observation on its activities. It was very shy, restless and made loud alarm calls on seeing us. Since 26th December evening, we have not been able to locate the Nilgiri langur in the forest fragment.

The sighting of a male Nilgiri langur in the forest fragment is interesting for three reasons: Firstly it shows the ability of Nilgiri langur to move between forest fragments across a human dominated landscape; Puthuthottem Estate is a totally isolated forest fragment the nearest forest with Nilgiri langur being about 3 km away; the intervening area is covered with tea plantation and has human settlements. Secondly, this movement by males could to a very large extent curtail the effects of inbreeding in small fragmented forests. Thirdly, female Nilgiri langur, also perhaps emigrate like the male, the ability to move across man made landscapes enables the species to recolonise forest fragments from which the species had disappeared.

January 19, 1996

G. UMAPATHY
A. PRABHAKAR
Conservation Biology Divn.,
Sálim Ali Centre for Ornithology & Natural History,
Kalampalayam P.O.
Coimbatore-641 010.

2. AN OBSERVATION ON A MOTHER CARRYING DEAD INFANT IN THE BONNET MACAQUE, *MACACA RADIATA*

We saw a group of bonnet macaques (*Macaca radiata*) on 5th July, 1996 at Muthanga area in Wynaad Wildlife Sanctuary, in Northern Kerala. An adult female was on the ground carrying an infant, repeatedly trying to make it cling to her body by placing it to her chest. Whenever the mother attempted to get up, the infant kept falling down. We soon found that the infant was dead. The mother repeated her attempts, by jolting the body of the infant gently. On seeing us, the mother scooped up the infant with her left arm, raced into the nearest bamboo clump and sat inside safely. The mother started inspecting the body by smelling the anal region and the face. A juvenile female which had been watching the whole sequence for a long time tried to touch the baby, and was allowed by the mother only after several attempts. The juvenile also inspected the dead infant by smelling the anal region and face.

We saw the mother with the dead infant for four days. By the third day, the body had started smelling and was maggot ridden. The mother inspected the anal region less frequently. The female macaque had restricted its feeding and movement to the bamboo clumps. Other members of the group were in the nearby area on all these days. On the morning of the fourth day, the mother placed the dead infant on the ground and fed within a visible distance. The juvenile was with her, throughout watching the dead infant. On the fifth day, the dead infant was missing and we assumed that the mother had joined the group abandoning the dead infant.

Mothers carrying dead infants for several days have been recorded in Crab eating monkey (*Macaca irus*) and Hybrid Rhesus (Yerkes, 1915), in Gorillas and Langurs (Eimerl and DeVore, 1976) and in Baboons (Zuckerman, 1981). According to Zuckerman (1981) the behaviour of the mother with the dead infant could be a manifestation of maternal sentiment or maternal instinct.

ACKNOWLEDGEMENT

We thank Dr. P.S. Easa, Scientist, KFRI for comments on this note.

October 23, 1996

M. BALASUBRAMANIAN
S.A. SABU JAHAS
Division of Wildlife Biology, Kerala Forest Research Institute, Peechi, Thrissur, Kerala.

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3. DISCOVERY OF GOLDEN LANGUR (*PRESBYTIS GEEI*) AT KAKOIJANA RESERVE FOREST, ASSAM.

On 5th November, 1995 we, a group of nine members of NATURE'S FOSTER, an environmental activist group, conducting a field trip at Kakoijana Reserve Forest along with two Forest Officials, came across some langurs. After careful observations we confirmed that they were the golden langur (*Presbytis geei*). This was a great surprise because the occurrence of golden langur in Kakoijana

Reserve Forest was quite unexpected. At our first sighting, we were on the slope of a hill and the langurs were on the slope of the opposite hill, roosting on a tree. We were observing them from a stone hide at a distance of about 15 m. We spotted one new born infant and six adult langurs in that group. After that we made several trips to Kakoijana Reserve Forest covering about 10% area and saw 20 - 25 golden langurs, including some new born infants, in five different groups.

Kakoijana is a deciduous secondary forest 17.2 sq.km in area, on the hilly banks of the River Aie, and is about 12 km from Bongaigaon town. This forest is about 30 km south of Manas, and is isolated from other forests. The golden langur population is therefore an isolated one. Earlier records on the distribution of this highly endangered species are from Manas and Chakrashila.

Scientists of the Indo-U.S. Primate Project (Prof. Irwin S. Bernstein, Dr. Arun Srivastava and Mr. Prabal Sarkar) visited Kakoijana Reserve Forest with us in February, 1996 and confirmed our sighting.

I express my sincere thanks to Dr. P.C. Bhattacharjee (Head, Dept. of Zoology, Gauhati University), Dr. Arun Srivastava (Indo-U.S. Primate Project), Mr. G.C. Basumatary (D.F.O. Aie Valley Div. Bongaigaon), Mr. Mahendra Barman and Mr. Paresh Khatuniar for their co-operation.

October 31, 1996

ARNAB BOSE
Nature's Foster,
C/o Mitali Cycle Store,
(Near Prakash Cinema),
P.O. & Dist. Bongaigaon-783380.

4. INDUCED EMESIS BY JUNGLE CAT (*FELIS CHAUS*)

On 13th August, 1995 I was watching some larks near a nullah about 30 km from Udaipur, Rajasthan. The place is called Dholi Ghati and it is about 3 km from a township called Gogunda.

I was sitting behind a bush on the raised bank of a nullah and scanning the barren fields beyond the opposite bank, with field glasses. Both the banks of the nullah were overgrown with dense bushes and beyond that there was scanty vegetation. There was a small trickle of water in the nullah.

I suddenly caught sight of a Jungle Cat about 50 m from me on the opposite bank. It emerged from the dense undergrowth, scanned the surroundings and slowly walked towards the bank where I was sitting. From its appearance it looked quite sick, its limbs were not steady and were trembling. Slowly it crossed the nullah and stopped near a shrub. It sniffed at the shrub, and plucked a leaf and gulped it down. One by one it plucked and gulped five leaves. Then it remained motionless for a minute or so and then ate two more leaves. Then it took three steps away from the plant,arched its body and vomited. In this fashion thrice it ejected some food and secretion from its stomach. Then it raised its head, took a careful look all around and trotted off into the undergrowth as if it had no ailment and disappeared from my sight.

I took a specimen of the shrub and it was identified as *Eclipta alba* (Family Compositae). The Hindi name of the shrub is Bhringraj. From experts of Ayurved I came to know that the shrub is used in Ayurvedic medicines for liver ailments, to regulate bile secretions, for Jaundice and for improving the digestion.

Acknowledgement

I am thankful to Dr. Satish Sharma for his help in identifying the shrub.

April 10, 1996

RAZA H. TEHSIN
38/106, Panchwati,
Udaipur-313001.

5. WHITE-TAILED MOLE *TALPA MICRURA LEUCURA* BLYTH IN ASSAM - SOME NEW RECORDS

The White-tailed Mole *Talpa micrura leucura* Blyth, 1850, was recorded as a hill-dwelling species from Khasi Hills of Meghalaya and Naga Hills (now Nagaland) (Ellerman & Morrison-Scott, 1951; Prater, 1980).

On 2nd January, 1993, while on a field trip to Phillobari RF (27° 31' N, 95° 42' E) in Tinsukia district, I came across a live mole on the middle of the forest road, at *c* 1400 hrs. It was trying to hide itself under a large leaf.

On closer examination, I saw a small white-tail which enabled me to identify it specifically as well as sub-specifically. It measured *c*. 10 cm of head and body length. After photographing it I set it free.

The sighting was significant as it is the first record of the species from Assam (earlier reference of Assam implied Meghalaya and Nagaland), a new locality record, and also the first one from the flat plains. Phillobari is in the upper Brahmaputra Plains having an elevation of only 139 m above msl. The known altitude where the species as a whole is found is from 1525 m to 2440 m.

The local people often kill the species for medicinal purpose. Locally it is called *Uk-muk*.

April 10, 1996

ANWARUDDIN CHOUDHURY

The Rhino Foundation for Nature in North East India,
C/o. The Assam Company Limited,
Girish Chandra Bordoloi Path Bamunimaidam,
Guwahati, Assam -781 021.

6. RED PANDA *AILURUS FULGENS* F. CUVIER IN THE NORTH-EAST WITH AN IMPORTANT RECORD FROM GARO HILLS

(*With one map*)

The Red or Lesser Panda *Ailurus fulgens* F. Cuvier is distributed from Nepal to northern Myanmar and southern China (Ellerman & Morrison-Scott 1951, Prater 1980). However, there is no specific mention of Bhutan, North Bengal and Arunachal Pradesh in these important works. Gee (1964), however, stated that it occurs in Bhutan and north-western corner of Arunachal Pradesh.

The red panda is an animal of higher elevation, usually above 1500 m (Prater 1980), in temperate forests with bamboo. Roberts and Gittleman (1984) mentioned that it occurs above 2200 m.

Between 1990 and 1995, I was able to carry out field surveys in some potential habitats of the red panda in north-eastern India as part of a broader survey of wildlife in general. As well as travelling widely in Assam, I visited Arunachal Pradesh, North Bengal and Meghalaya.

In India, the red panda is confined to the north-east, i.e., along the middle and lesser Himalaya and Mishmi Hills covering parts of Sikkim, Darjeeling district of West Bengal, Tawang, West Kameng, East Kameng, Upper Subansiri, Upper Siang, West Siang, East Siang, Dibang Valley, Lohit and Changland districts, all in Arunachal Pradesh. The protected areas having the panda are listed in table 1 and the distribution in Figure 1.

However, the most startling find was its record from Garo Hills area of Meghalaya. Occurrence of red panda in the area was considered a rumour although the Forest department brochure on Balpakram contains its name. The main reason for disbelief was that Garo Hills are located far away from the red panda's known range, and a significant barrier in the form of the Brahmaputra valley exists

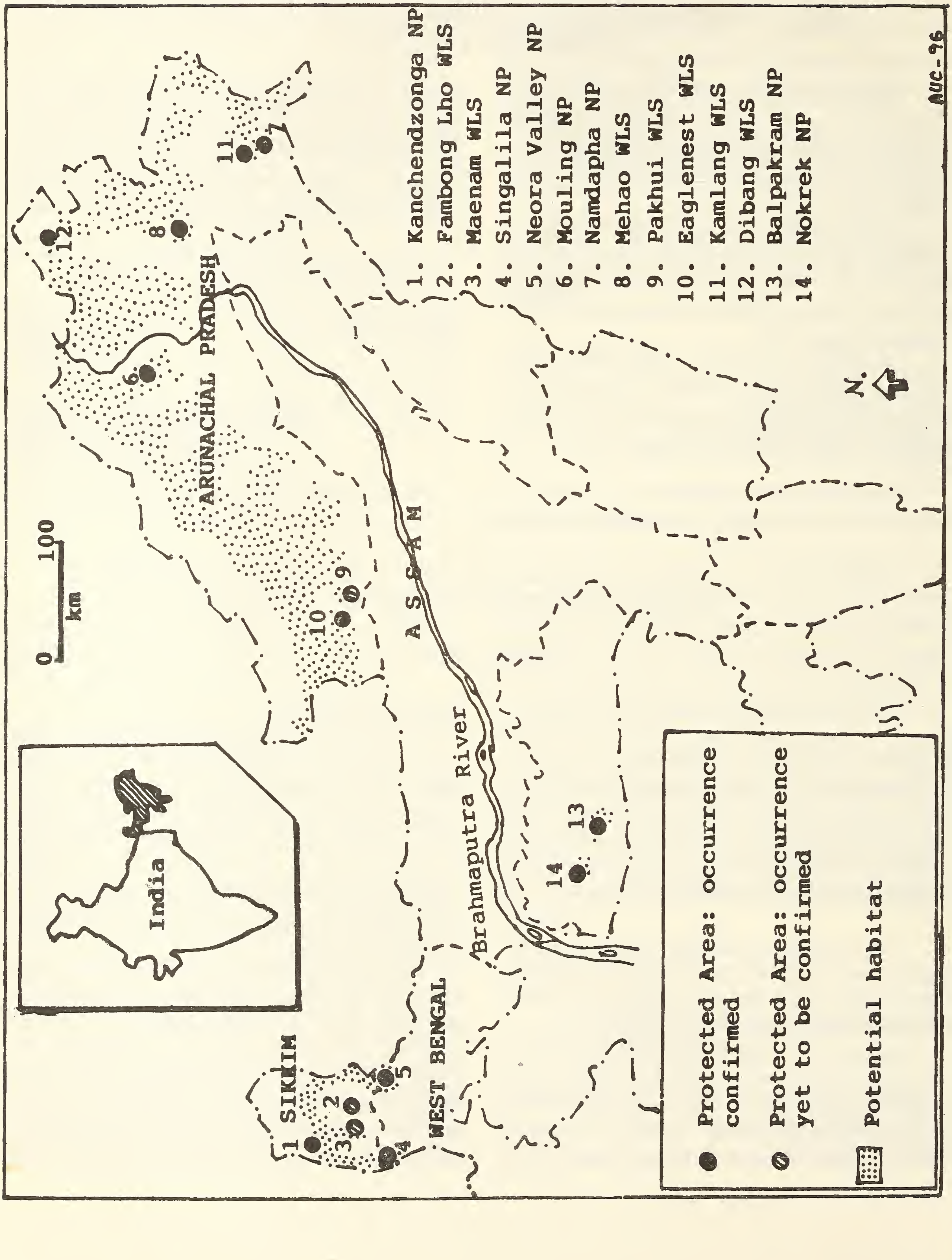

Fig. 1. Distribution of the Red panda in Northeastern India

TABLE 1
PROTECTED AREAS IN INDIA WITH KNOWN AND POSSIBLE RED PANDA POPULATIONS. THOSE MARKED WITH * ARE POSSIBLE AREAS

Protected Area	State	Area in sq km
Kanchendzonga NP	Sikkim	849.5
*Fambong Lho WLS	"	51.6
* Maenam WLS	"	35.3
Singalila NP	West Bengal	78.6
Neora Valley NP	"	86.9
Mouling NP	Arunachal Pradesh	483.0
Namdapha NP	"	1985.0
Mehao WLS	"	281.5
*Pakhui WLS	"	862.0
Eaglenest WLS	"	217.0
Kamlang WLS	"	783.0
Dibang WLS	"	4149.0
Balpakram NP	Meghalaya	312.0
Nokrek NP	"	47.5

NP= National Park; WLS= Wildlife Sanctuary.

between Garo Hills and the Himalaya. Moreover, no high elevation area with sub-tropical vegetation occurs in the area (which is basically a low rugged plateau with hot tropical climate).

On 10th October, 1995, on getting a report from an experienced Forest official (J. Datta, DFO, pers. comm.), I visited a locality in Tura town, and to my surprise found a skin in excellent condition. I examined and photographed it. It was reportedly shot by one Dr Lau sometime in the early sixties from Nokrek area of Garo Hills. It was high up in a tree when the hunter shot it mistaking it for a Giant squirrel *Ratufa bicolor.* One more skin, now damaged, was also reported, which was from Chutmang area of Balpakram, and was collected in 1982. Two more skins were reported from different parts of Garo Hills during the past few years (P. Marak, DFO, pers. comm).

From the skins and discussion with officials, it appears that the red panda is confined to the higher areas of Balpakram and Nokrek National Parks. The highest point of Balpakram is Chutmang, only 1023 m above msl while Nokrek, the highest peak of Garo Hills is 1412 m high. District wise, Balpakram is in South Garo Hills, while Nokrek is in East and West Garo Hills.

The occurrence of the red panda in Garo Hills has established many new records: (i) this is the lowest elevation in the entire range of the species; (ii) also the first record of the species from tropical forest; and (iii) the specimen measured: Head and body length= 73 cm, Tail length= 43 cm; this is the largest known specimen (skin) in the world. The previous maximum recorded length was 62.5 cm for head and body and 50 cm for tail (Prater 1980, MacDonald, ed, 1984).

Localiy, the red panda is called *Aaye-michinji* by the Idu Mishmis of Dibang Valley of Arunachal Pradesh and *Matchibel* by the Garos of Meghalaya.

I offer my thanks for their help during field trips to: Garo Hills, S.B. Singh (CCF-Wildlife), P. Marak, J. Datta (both DFOs), Sangma (ACF), Dr Lau and Dr (Mrs) Lau, Achinta Baruah and Hakim; Arunachal Pradesh, Yogesh (Field Director), A. Sen (DFO), Leto Mili, Kamal Kalita (JE), Maniraj Rai, Nur Hussain, Dilip Handique and Babul Debnath; North Bengal, Soumyadip Datta.

August 7, 1996 ANWARUDDIN CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road,
Guwahati 781 007,
Assam.

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7. NOTES ON FOETUSES OF MOUSE DEER *TRAGULUS MEMINNA* IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU, SOUTH INDIA

A female adult Mouse deer *Tragulus meminna* was found dead on a road in a dry deciduous forest in Mudumalai Wildlife Sanctuary on 14th March, 1996. The head and forelimbs were severely damaged probably by a vehicle. When I cut open the body to examine the stomach contents, I found two foetuses inside. The developmental stage of the two were not the same, one being about triple the size of the other. Almost in the same location but inside the forest, another pregnant mouse deer (24.5 cm shoulder height) was found dead on 28th of the same month. The vegetation around it and the entire body were badly burnt, hence the cause of death was probably forest fire. Only one well grown foetus was found in the womb. The foetus measured 17 cm in shoulder height and 26 cm body length. The weight was about 520 gm. The colour pattern of the foetus was similar to the adult.

The modern artiodactyls have a litter size of one, but there are some exceptions like Nilgai *Boselaphus tragocamelus,* Four-horned antelope *Tetracerus quadricornis* and the Mouse deer *Tragulus miminna* which often have a litter size of two. Prater says that the mouse deer usually has a litter size of two and gives birth at the end of the rains or the commencement of the cold season but there is no information on mouse deer's gestation period. Since all the foetuses were collected from dead females, litter size can not be determined correctly, because some deer during gestation period carry even more foetuses than their normal litter size. Since no further information is available, both the litter size (one with one foetus and another with two) can be considered. In the Encyclopedia Britannica Vol 23, the mouse deer's gestation period is stated generally as four months. Hence, the deer's birth season should probably be at the beginning of rains not at the end as reported by Prater (THE BOOK OF INDIAN ANIMALS, BNHS, Bombay). Thus, it may be concluded that the gestation of the mouse deer in this sanctuary would probably be during the dry season.

August 7, 1996

V. GOKULA
Sálim Ali Centre for Ornithology and Natural History, Kalampalayam, Coimbatore-641 010.

8. INTERESTING FEEDING HABITS OF THE FLYING FOX *PTEROPUS GIGANTEUS* ON THE PHYLLODES OF AUSTRALIAN ACACIA *ACACIA AURICULAEFORMIS*

The giant fruit bat or flying fox as it is popularly known *Pteropus giganteus* is essentially a fruit eating bat which feeds on the juice of fruits by chewing them dry and spitting the pulp out. But, I have been observing these bats for the last four years in our resort situated in the buffer zone of Kanha National Park, Madhya Pradesh, (22° 17'N, 80° 38' E) feeding extensively on the leaf like phyllodes of Australian acacia, *Acacia auriculaeformis* especially during the summer months which I think has never been reported in the diet of this bat earlier.

Acacia auriculaeformis is a medium sized tree, native of North Australia and Queensland. The tree was introduced for plantation in the semi-arid regions of Bihar, Orissa and West Bengal and is now widely used for social forestry plantations everywhere. It is a quick growing tree and does quite well on degraded land. The tree also shows xerophytic adaptation and what actually look like thick shiny dark green leaves are the rachises modified into phyllodes. I procured a few saplings of this tree in 1987 and planted them in our resort land in Mocha Village which is in the buffer zone of Kanha National Park. The plant responded quite well and by 1991 we had trees of 2.5-3 m in height. In May 1991, on a full moon evening, I noticed a few flying foxes *Pteropus giganteus* for the first time on the top most branch of an *Acacia auriculaeformis* squabbling and flapping. I wondered what these bats were up to. Coming back next morning to inspect the tree, I noticed some green chunks of residual matter that had been spat out by the bats on the ground. The supple fleshy phyllodes on the top most branch were absent and it was obvious that the bats had fed on them. I decided to observe them again that evening and I noticed more bats had settled on more Acacia trees. There was more squabbling and shrieking as they fed on the phyllodes in a frenzy. Most of them had settled on the upper branches and apparently they liked the juice of the tender phyllodes. Since then they have been coming every summer in hundreds from March onwards and are surprisingly absent during the winter months. Although now they have almost become pests of these Acacias, destroying most of the tender phyllodes, it is interesting to note a change in the feeding preference of fruit eating bats now relishing the phyllodes of an exotic tree.

September 18, 1996

E.P. ERIC D'CUNHA
Wild Chalet Resort,
Kanha National Park,
P.O. Kisli, Dist. Mandla
Madhya Pradesh 481 768.

9. MALE, FEMALE BURROW OCCUPANCY PATTERN OF THE SOUTH INDIAN GERBIL *TATERA INDICA CUVIERI*

(*With one text figure*)

Rodents have evolved several physiological and behavioural mechanisms ensuring maximum reproduction (Davies 1991). They may be colonial, solitary, or sometimes both (Barnett and Prakash 1982); and their burrow habits are usually complicated assuring them better protection (Hanney 1975, Prakash and Mathur 1987). Though tropical rodent species are diverse, and economically important, information regarding their field habits are scarce. Hence the present study on the habitat ethology of South Indian gerbil *Tatera indica cuvieri* was undertaken with regard to their burrow occupancy and social grouping.

Studies were conducted in selected coastal areas of Trivandrum district, where the burrows of *Tatera indica cuvieri* are common. Once a burrow was located, the grass and surface soil around 3 m of the burrow were cleared; and all exits used by the animals to escape were closed. The tunnels were then carefully excavated from the entry point into the interior. A soil plug within the tunnel a few feet from the entrance, and the presence of rat fleas in the fresh soil collected from the floor of the tunnel indicate a currently inhabited burrow. As all the emergency exits were closed prior to breaking into the burrow, the gerbils tend to move to the distal end of the tunnel, where they group together, enabling a complete capture of all animals of the burrow. Altogether 41 burrows, from which complete collections could be made, were considered for detailed study. Animals collected from each burrow were sexed and counted separately, and were categorized into adults, sub adults and juveniles based on the specific morphological features.

Two types of burrow patterns were observed among *Tatera indica cuvieri*; those inhabited by adult females along with young ones (subadults /juveniles), and those inhabited by adult males. The latter were comparatively smaller, with lesser number of branches and fewer emergency exits. From 41 burrows investigated, a clear diversity of male, female burrow occupancy is discernible, the details of which are shown in Fig. 1.

The male living independently, and the females living with young ones (subadults/juveniles) in separate burrows can be a kind of evolutionary

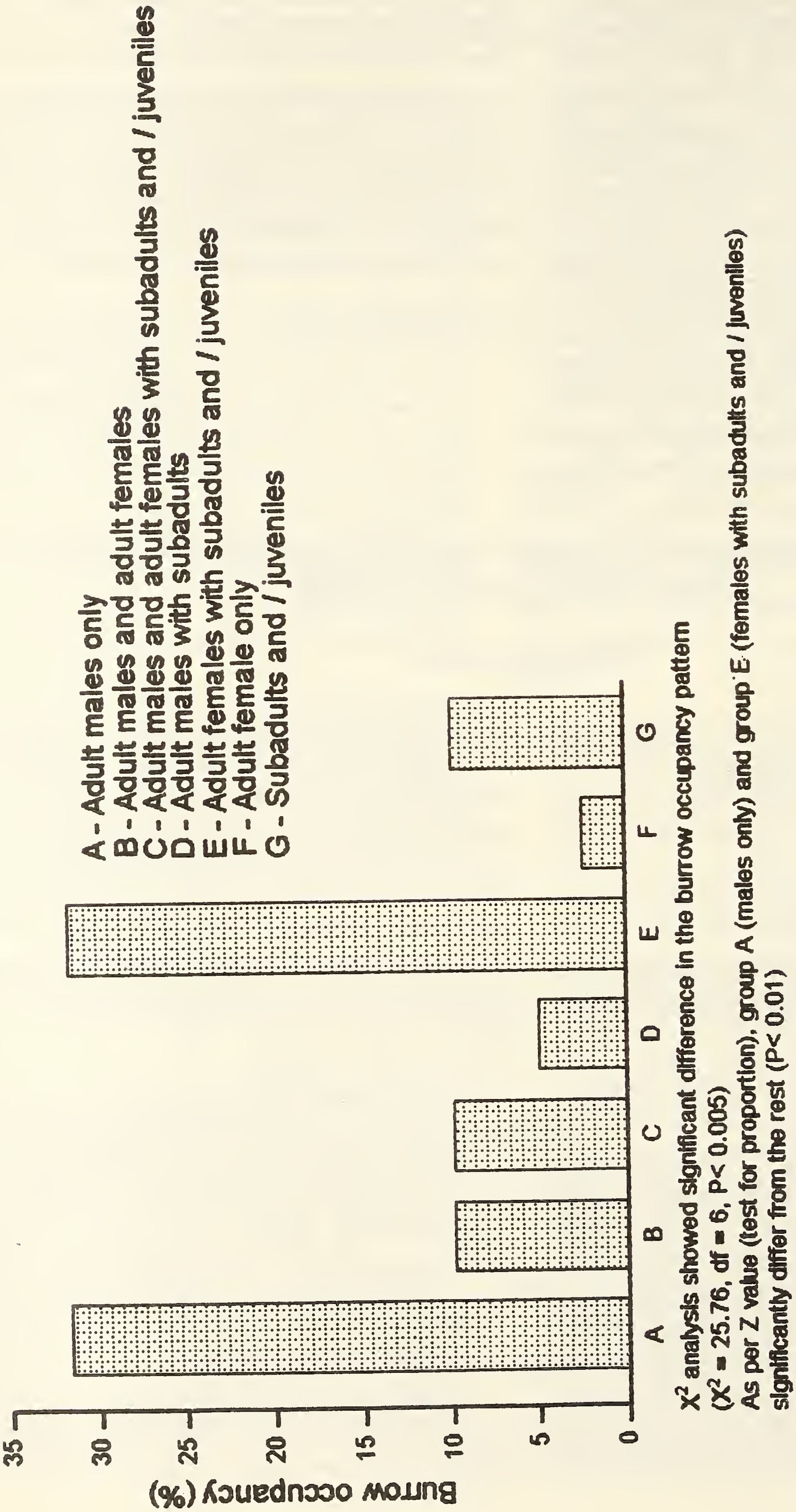

Fig. 1. Burrow occupancy pattern of *Tatera indica cuvieri*

adaptation, providing better security and maternal care to growing subadults and juveniles. Such a dichotomy in male-female burrow dwelling pattern is quite interesting. Inspite of several reports of colonial existence of subterranean rodents, this type of burrow dimorphism with regard to occupancy has not been projected. Since Indian rodents like the short tailed mole rat *Nesokia indica* and gerbil *Tatera indica* Hardwicke also exhibit a kind of colonial existence (Barnett and Prakash 1982), a dimorphism in male and female burrow occupancy among South Indian gerbils is characteristic. It was also noticed that in the majority of the burrows containing young ones, the only adult present was the female (may be their mother). Probably, males avoided such burrows, or were chased away by the females after mating. In several microtine rodents, adult females move away from the colony and seek separate existence prior to parturition, providing ecological space for their offspring (Lidicker 1975). In any case, the male *T. indica cuvieri* staying away from young ones subscribes to their negligible role in parental care. Such sex-wise separate existence can also indicate the absence of a long term monogamous relationship. In such a set up, the females of *T. indica cuvieri* face the possibility of mating with different males (multiple male matings), as in the case of Mongolian gerbils, *Meriones unguiculatus* (Agren *et al.* 1989), probably to avoid inbreeding.

November 26, 1996

BIJU B. THOMAS
MATHEW M. OOMMEN
Dept. of Zoology,
University of Kerala,
Kariavattom, Trivandrum,
Kerala 695581.

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10. NEW RECORDS OF THE MALABAR SPINY DORMOUSE (*PLATACANTHOMYS LASIURUS* BLYTH) IN THE INDIRA GANDHI WILDLIFE SANCTUARY, TAMIL NADU

In March 1994, we were conducting night transects in the wet evergreen forests in the Indira Gandhi Wildlife Sanctuary for surveying nocturnal arboreal mammals. On 4th March we were on a night transect along a foot path in the Varagaliar shola, 25 km south of Top Slip at an altitude of 650 m. After spotting and observing a couple of flying squirrels we were on our way back to the camp, when we spotted a Malabar Spiny Dormouse (*Platacanthomys lasiurus*) that had just fallen from a tree right in front of us.

During the last one year of live trapping of terrestrial rodents in rainforests in the Indira Gandhi Wildlife Sanctuary and in some private forests in the area, I trapped a few more individuals of the Malabar Spiny Dormouse. Some were in the Akkamalai hills at an elevation of 1280 m, far above the range of 600-900 m suggested by Ellerman (1961). Shankar (1996) recorded the Spiny Dormouse at an even higher altitude (2000 m) in the Upper Bhavani hills of the Nilgiris. Some other recent reports of the species have been within or close to the altitudinal range. Jayson and Christopher (1995) reported the species from Peppara Wildlife Sanctuary at an altitude of 600 m, Rajagopalan (1968) reported the species at lower altitudes, and Divya Mudappa (pers. comm.) from Kalakkad and Mundanthurai Tiger Reserve at an altitude of 1100 m.

These reports show that the species occurs over a wider altitudinal range than was previously thought. Rajagopalan (1968) reported the species to be a pest in arecanut plantations. However, we have been able to trap the species only from relatively undisturbed rainforests, suggesting that this endemic species might be sensitive to habitat disturbance.

September 18, 1996

A. PRABHAKAR
Sálim Ali Centre for Ornithology & Natural History, Kalampalayam P.O. Coimbatore 641 010.

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11. INDIAN ONE-HORNED RHINOCEROS *RHINOCEROS UNICORNIS* LINNAEUS 1758, IN ARUNACHAL PRADESH

(*With one map*)

Arunachal Pradesh is by and large not an ideal rhino habitat but stray animals have often been sighted in different areas, especially at the edge of the hills, near Assam border. Stray rhinos used to occur in the upper Dihing Valley (part of present Namdapha National Park) in Changlang district and in southern Tirap (Gee, 1964: WILDLIFE OF INDIA). However, specific identification of those stray animals could not be ascertained and there is a possibility of those animals being Sumatran rhino *Dicerorhinus sumatrensis*.

I report here the occurrence of the Indian one-horned rhinoceros *Rhinoceros unicornis* Linn. in Arunachal Pradesh in recent years, observed during field surveys in different parts of the state, which are listed below chronologically:

1978. A female rhino with a calf was sighted in Sonai-Rupai Sanctuary of Assam (not a notified protected area) by the Forest staff (T. Nath, pers. comm.). The location was not far from the border of West Kameng district of Arunachal Pradesh.

1986. A female with a grown-up calf sighted in Dulung Reserve Forest (RF) of Lakhimpur district of Assam. The location was near Assam-Arunachal Pradesh interstate border.

1987. A rhino suddenly appeared in Panir RF of Lower Subansiri district (now Papum Pare district). It first came to Kakoi RF of Assam then followed the Joihing river up to Arunachal Pradesh.

April-May, 1990. A lone rhino stayed for more than a month in Pakhui Wildlife Sanctuary of East Kameng district. It came via Nameri Wildlife Sanctuary of Assam.

September, 1990. Two rhinos strayed out of Kaziranga National Park and travelled through Sonitpur district to Papum RF of East Kameng district. On their way they crossed the Brahmaputra river, some tea estates, villages and forests. Later on they were chased back to Khatonibari Soil Conservation Area in Sonitpur district, on the opposite bank of Kaziranga National Park by the staff of the Assam Forest Department.

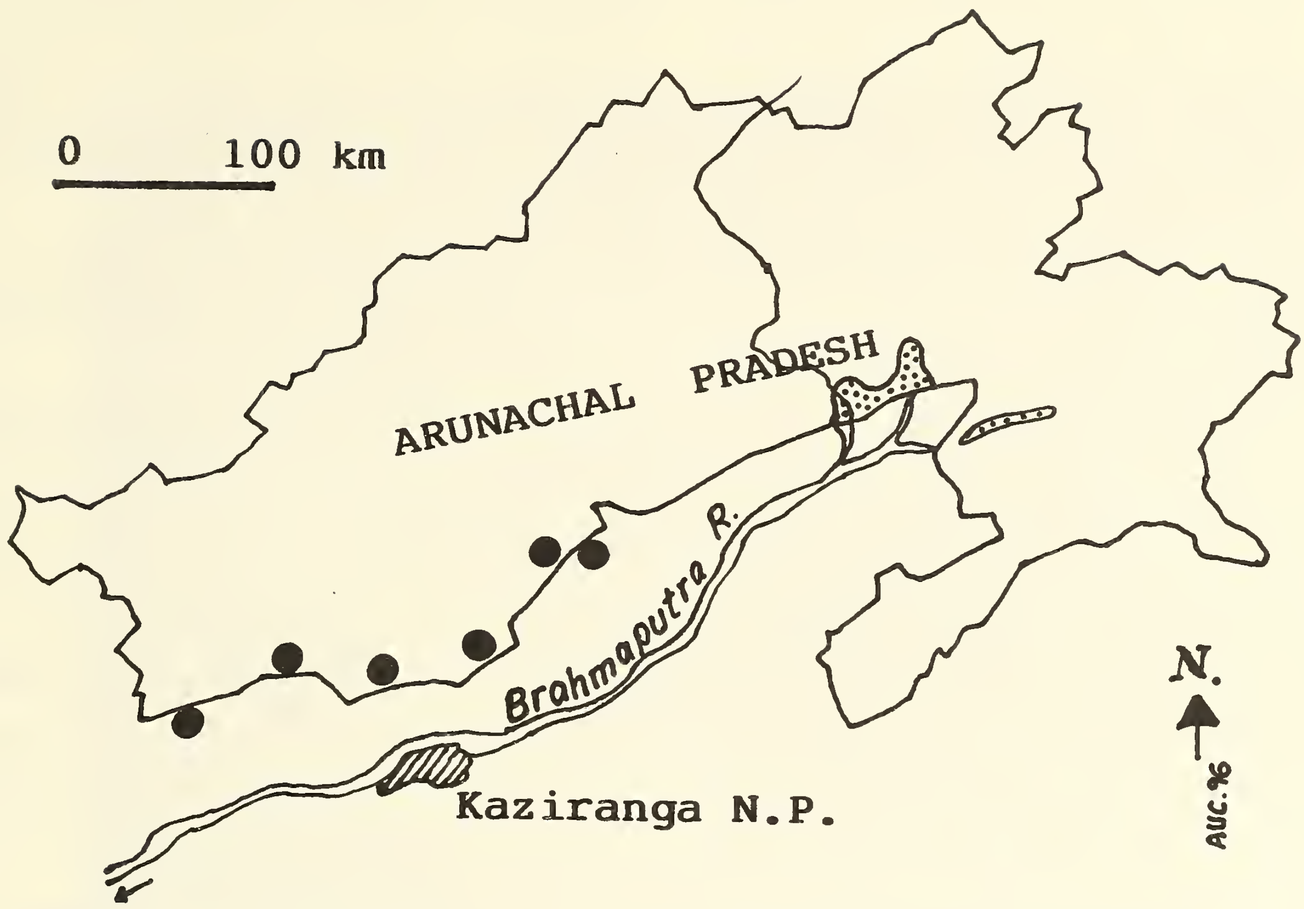


Fig. 1. Map showing the recorded localities of *Rhinoceros unicornis* (●) and the distribution of grassland (▩).

January, 1995. A lone rhino travelled through Narayanpur area of Lakhimpur district of Assam to Drupong RF of Papum Pare district, Arunachal Pradesh. In all probability it was from Kaziranga National Park, as every year a few from this national park wander up to Narayanpur area. It stayed in Drupong RF and adjacent areas of Torajuli (near Assam-Arunachal Pradesh border) for a week (mostly in the valley of the Pichola river). However, it fell to poachers near Narayanpur while coming back.

The above records suggest that the *Rhinoceros unicornis* sporadically wanders into Arunachal Pradesh although none of the recorded areas are suitable habitat for the species. The only large patch of grassland in Arunachal Pradesh is found near the confluence of the Siang, Lohit and the Dihing rivers covering parts of D'Ering Wildlife Sanctuary, Dibang RF and adjacent riverine areas (about 220 sq km) but there is no evidence of any recent occurrence of the rhino from these areas.

October 22, 1996

ANWARUDDIN CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road,
Guwahati 781 007, Assam.

12. A BAT EATING COMMUNITY OF CHHATARPUR DISTRICT OF MADHYA PRADESH

(*With one plate*)

During the Parliamentary election 1993 I was posted to village Patha of Damoh district as presiding officer. One of my polling officers K.C. Ahirwal, Asst. Veterinary Field officer, told me about the killing (he termed it suicide) of "birds" in the forests, near Bakswaha in District Chhatarpur during winter on some particular days from Dussehra to full moon of Kartick by the local people who eat them and extract oil for use against rheumatic and other pains. I decided to investigate this strange behaviour which could be similar to the bird deaths at Jatinga of Assam. I could not survey the area during the year but I kept in touch with Ahirwal who promised to join me the next year.

The next winter, a few days prior to Deepawali in November I met Ahirwal in his village Imalai for the exact location of the area. He introduced me to Mr. Mohammad Salim, Deputy Ranger of Forest of Kumharai (Hatta) who was also aware of the phenomenon. He informed me that the people of Durgwan village in district Chhatarpur trapped these "birds" in the forest in thousands from caves by covering the cave entrance at night with blankets. They sometimes ate them raw and also extracted oil which is useful against rheumatic and other joint pains.

On 10th November, 1994 we both started at 0730 hrs from our place and reached Durgwan (approx. 24° 20 N and 79° 40' E and 83 km away from Damoh) at 1115 hrs. The forest Chowki was on the road and we met and discussed our quest with the forest officials. According to them this phenomenon was an ancient practice and the local people, mainly Saur tribe, trap the Chempla (a local name for bat) like birds during the night on these days by covering the openings of various caves with blankets. Sometimes they trapped more than a thousand "birds". Some of them eat the "birds" without cooking. However, others extract oil from them in frying pans. I showed them the BOOK OF INDIAN BIRDS (Ali, 1979). Most of them pointed to the Palm Swift and gave slight differences, but nobody said that it was a bat.

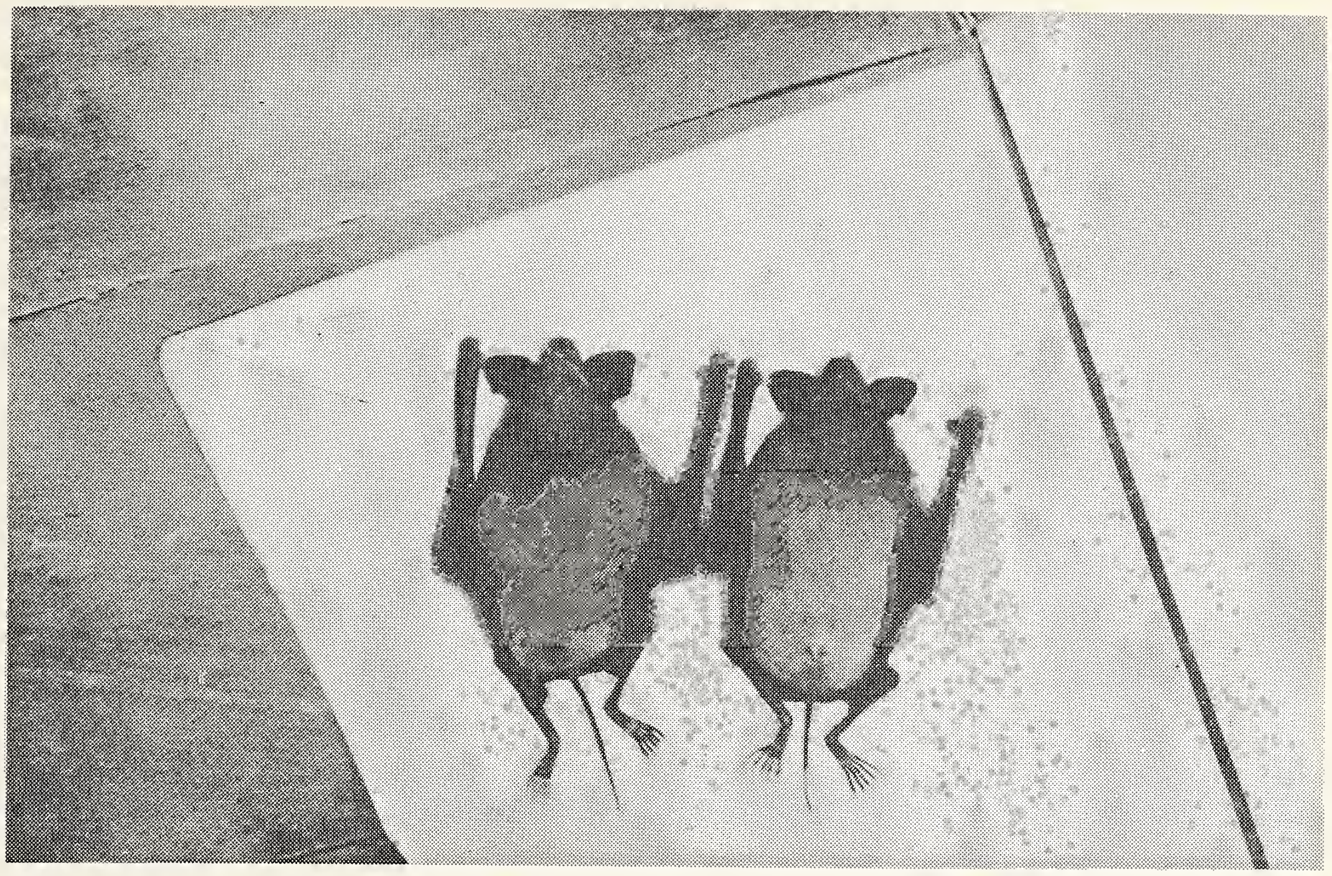
Before leaving the place we were able to collect some of the oil from a local. I went through the few available books and journals but could not trace the presence of Swiftlets in this region.

Next year on 30th October, 1995 we again reached Durgwan and the forest guard sent a local man to one of the trappers' houses. Soon that man brought a pair of the so-called "birds". We were surprised to see a pair of bats with a mouse-like free tail which we had never seen before. I took some measurements and interviewed some local people including the Saur tribals and took several photographs of the bats and of the whole team including some Saurs. Further enquiries revealed that:

1. The trapping of bats is a continuing practice from very early times during Dussehra to the Kartick fullmoon.
2. There are 30 to 40 and 8 to 10 houses of Saur tribals in Durgwan and Surajpura Roads resepctively. Prior to trapping, the oldest man of the tribe used to worship their God (Badai-Baba). Strangely, among the puja material Ganja (*Cannabis sativa*) is a must.
3. The tribe traps the bats in the night using blankets at the entrance of various caves, probably they know about the vision system of bats and kill them one by one in large numbers during one operation.
4. The event of trapping/use of oil attracts, local and nearby people everyday who also participate in large numbers.
5. For the extraction of oil, they stretch out the skin and wings of the bats and put them into hot frying pans. After filtering the crude oil, the remaining parts are eaten.
6. These bats are probably resident to this region as they are also seen by local people in pre- and post-trapping periods.

After getting back to Damoh, I identified the bats with the help of the Journal of Bombay Natural History Society (1993, 1994) and Encyclopedia of the Animal World (1972). The bats are commonly known as Lesser Mouse tailed bats *Rhinopoma* which due to (i) Smaller free rat-like tail (3.7-4.2 cm) in comparison to head and body length (9.4-10 cm) (ii) naked face, ear and connective membrane (iii) Small, triangular dermal ridge (iv) tragus in the ear, should be *Rhinopoma microphyllum*

In my view this old traditional phenomenon is not harmful for the bat species and the ecosystem if it is continued, limited to Saur tribe only, but its increasing popularity and the involvement of other



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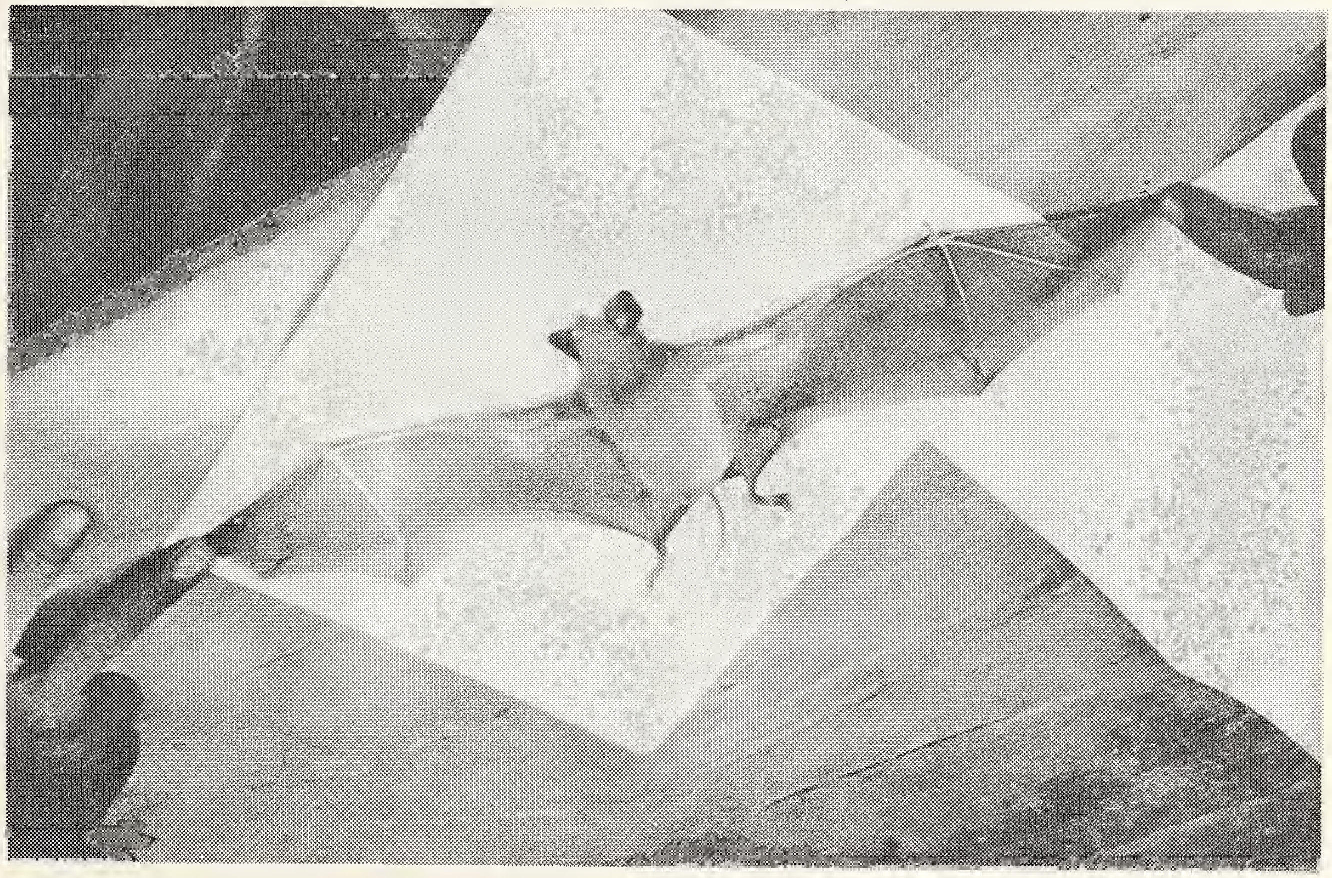

b

a. Ventral view of a pair of Lesser Mouse tailed bats.
b. Fully stretched ventral view of Lesser Mouse tailed bat.

people in large numbers may endanger this species in this area. More study is required to establish these facts and other details.

ACKNOWLEDGEMENT

I am thankful to Prof. A.K. Naik, Head Civil Engg. Department, Polytechnic College, Damoh for his valuable help.

October 11, 1996

A. KHER
Asstt. Prof. of Botany,
Govt. Girls College,
Damoh (M.P.). 470 661.

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13. SIGHTINGS OF THE SPANISH SPARROW *PASSER HISPANIOLENSIS* (TEMMINCK) AT KOTA IN SOUTH EAST RAJASTHAN

I have been observing mixed flocks of House sparrow *Passer domesticus* and Spanish sparrow *P. hispaniolensis* around Kota for the last 3 years (1992, 93, 94). These flocks are particularly abundant in the fields and grasslands, feeding on grass seeds. 3-4 flocks of about 500 birds each were seen moving around Abheda on 7th November, 21st December, 1994 and 4th January, 1995. The males are distinguishable by their chestnut head and grey markings on the flanks. The males with black markings on throat and flanks with white supercilium have been observed in late January and early February. The females are rather difficult to distinguish, but some show up with faint markings on the flanks.

Ali and Ripley (1987) have described the range of Spanish sparrow in India, whereby Bharatpur (27° 10' N, 77° 32' E) and Sambhar lake near Jaipur form the southernmost points of its distribution. Mohapatra and Rao (1990) have sighted and ringed Spanish sparrow at Karera (25° 30' N, 78° 12' E), Madhya Pradesh. Rahmani (1991) has also included this bird in the checklist of Karera. Kota (25° 10' N, 75° 52' E) is situated roughly 270 mm. south west of Karera. Thus these repeated sightings can be treated as a southward range extension of the Spanish sparrow.

March 6, 1995

RAKESH VYAS
2-P-22, Vigyan Nagar,
Kota-324 005.

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14. A SIGHT RECORD OF THE BESRA SPARROW-HAWK (*ACCIPITER VIRGATUS*) IN RISHI VALLEY, ANDHRA PRADESH

On 28th July, 1991 I located a shikra-sized raptor among the trees on the wooded hillside in the Asthachal area of the Rishi Valley School, Chittoor District, Andhra Pradesh. The bird was seen close to the grain thrashing area, which usually attracts several small passerine birds. It was quite aggressive and bold and was seen chasing crows that tried to mob it.

The bird afforded fairly good views and I was able to see all the field marks — the greyish brown upperparts, the whitish patch on the nape, atleast three dark tail bands, the dark throat-stripe flanked by two fainter moustachial streaks and the pale underparts with bold vertical streaks. I could identify the bird as an immature Besra sparrow-hawk.

This sighting may be of interest as, according to the HANDBOOK (Vol. 1), this species has been sparingly recorded in the Eastern Ghats and its status there is uncertain. Further, the habitat in which the bird was seen was dry deciduous (altered a little by artificial tree planting) and not the "evergreen or moist deciduous type", the known habitat in which the bird occurs.

ACKNOWLEDGEMENTS

I am grateful to the Staff and management of the Rishi Valley School for hosting me in their campus and to Mr. S. Rangaswami, Hon. Wildlife Warden of the Rishi Valley Bird Preserve for encouragement.

June 12, 1995

V. SANTHARAM,
68, I Floor, Santhome High Road,
Madras-600028.
Present address: SACON,
Kalampalayam,
Coimbatore 641 010).

15. SIGHTING OF WATER RAIL *RALLUS AQUATICUS* NEAR MUMBAI

A Water Rail *Rallus aquaticus* was spotted among the mangroves during low tide on 25th December, 1994 at Thane Creek. The bird was actively feeding in the marsh. The Water Rail has not been reported earlier from Mumbai and Maharashtra (Ali and Ripley 1983). The bird is reported to be resident and breeding in Kashmir and Ladakh: straggling south in winter as far at least as Madhya Pradesh (Ali and Ripley 1983). I have not come across any reference to the occurrence of this bird in Mumbai and Maharashtra. Probably this is the southern most record of this bird in the country.

The bird was photographed and the identification was confirmed by comparing it with the specimen at BNHS.

July 4, 1995

HIRA PUNJABI
6 Gautam Center, Thane East-400 603.

REFERENCE

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16. ORANGEBILLED JUNGLE MYNAH AND HODGSON'S BUSH CHAT IN KAZIRANGA NATIONAL PARK

The Orangebilled Jungle Mynah (*Acridotheres grandis*) was seen on two separate occasions in April 1995 in Benguri Range of Kaziranga National Park (26° 30' and 26° 45' N and 93° 5' and 93° 40' E) in Assam. In all 11 individuals of the species were seen on the two occasions in groups of five and six respectively. The species has been noted on other occasions also by the first author. This is a new species for the Kaziranga bird checklist and has gone unnoticed probably because of its similarity with the Jungle Mynah (*Acridotheres fuscus*). It is easily distinguishable by its completely orange bill as compared to the yellow-orange bill of the latter. In case of the Jungle Mynah, the base of the lower mandible tends to be bluish-black (Ali and Ripley, 1983). The Orangebilled Jungle Mynah also has a distinctively larger bunch of unruly hairs on its forehead than the Jungle Mynah. Earlier, this species was recorded from Nagaland, Manipur, Tripura, Mizo hills and the Chittagong Hill Tracts (Ali and Ripley, 1983). After this, birdwatchers have considerably enlarged its range by observations in Panidihing (Sibsagar district), (Barooah, 1994), Sibsagar town, Dambruchara (North Cachar district), Laokhawa and Burrha-Sapori (Naogaon district) and Guwahati town (Choudhury 1991). The species has also been reported from Karbi Anglong hill district (Choudhury, 1993) and from Naharlagun in Arunachal Pradesh (Singh, 1995). This gives the species a wide-ranging distribution throughout the North-East as compared to the earlier impressions of it being confined to the lower states alone. Its resident status in Kaziranga National Park must, however, be confirmed by trying to locate nesting sites which could be in tree-holes or earthern banks. Its relationship with other resident Sturnidae species such as the Jungle Mynah (*Acridotheres fuscus*), the Bank Mynah (*Acridotheres ginginnianus*) and the Pied Mynah (*Sturnus contra*) is also worth observing. If the species is a local migrant, which is a distinct possibility, more needs to be known of its movements within its range.

The second new species for Kaziranga observed was the Hodgson's Bush Chat (*Saxicola insignis*). Although Ali and Ripley, (1983) identified it from the Indian Bush Chat (*Saxicola torquata*) by its larger size and bigger white wing patch, it was observed in the field to be easily distinguished by its white throat band versus a black one. The wing patch is also noticeable although comparative sizes seemed a difficult proposition in the field. On 13th April, 1995, four to five bush chats which were seemingly different to *S. torquata* were noticed in Baguri range of Kaziranga National Park by the second author. Later, on 29th April, the third author saw a single individual of the same species in Baguri Range. The species is described by Ali and Ripley (1983) as having a range as far east as Jalpaiguri duars of North Bengal and Sikkim. Later it has been reported in Manas National Park of Assam (Narayan pers. comm.). Kaziranga is therefore a clear range extension for the species. The bird is also supposed to leave for its summer grounds in early April - the last recorded date being 10th April, (Ali and Ripley, 1983). Our observation is, therefore, also an extension of the recorded winter migration of the species. The range extensions of the two species into Kaziranga is an interesting species record as well as a reminder to ornithologists that even one of India's best known National Parks is yet to be fully surveyed for its avifauna.

August 28, 1995

PANKAJ SARMA
Range Officer, Baguri Range, Kaziranga National Park, 785109
MAAN BARUA
Wild Grass, Kaziranga, 785109
VIVEK MENON
Programme Officer, TRAFFIC-India, WWF-India, 172-B, Lodi Estate, New Delhi 3.

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17. RECENT SIGHTINGS OF LARGE HAWK-CUCKOO (*CUCULUS SPARVERIOIDES*) IN THE NILGIRI BIOSPHERE RESERVE, SOUTHERN INDIA

During the course of a study on the distribution of small carnivores in the Nilgiri Biosphere Reserve between October 1994 and July 1995, I had two sightings of the large hawk-cuckoo. The first sighting was on 24th December, 1994 around 1730 hrs in a moist deciduous forest patch near TWAD Board Quarters in the foothills (altitude 450 - 500 m) of the Siruvani hills (Tamil Nadu side), which is the southernmost part of the Reserve. A single bird flew from one of the low lying branches, to another branch some 50 m ahead. The flight was typical of an *Accipiter.* Any one could have mistaken the bird for a Shikra (*Accipiter badius*) but for its larger size, which puzzled me about its identity. I followed the bird to get a better look. I went close to it and there was ample time for me to confirm the identity of the bird as large-hawk cuckoo. It was an overall ashy-brown bird with more brown on the upper parts, unlike the ashy-grey of the Common Hawk-cuckoo (*Cuculus varius*). It had a proportionately long tail, with blackish bands, tipped with white. A few days after my sighting, a bird was sighted in the Siruvani dam area (Kerala side) by Justus Joshua and V. Santharam (pers. comm.). This species was again sighted by Justus Joshua in March 1995 in the foothills of Siruvani (Tamil Nadu), close to the area where I had seen the bird.

The second sighting was in New Amarambalam Reserve Forest (Kerala) on 25th January, 1995. I was walking towards Panapuzha from Maancheri, sampling the low-lying (altitude 350 - 400 m) moist deciduous forests of the western slopes of the Western Ghats. It was about 1100 hrs and I was nearing Panapuzha when I saw a large Hawk-cuckoo. It was not difficult for me to recognise this species as it was my second sighting of this species in a short span. It flew across the path swiftly at a low level and abruptly swept up near one of the trees and landed on a lower branch. The place it was sighted was a transition area between moist deciduous and semi-evergreen vegetation types.

I have an unconfirmed third record of this bird from Wynaad Wildlife Sanctuary, Kerala. It was in the moist deciduous forests near Nellur Vayal watch tower in the Muthanga forest range. I did not sight the bird on this occasion but I heard its call, which went like "*Pi Peēē.. Pi Peēē..*" The call was different enough to be mistaken for the call of the Common Hawk-cuckoo, which I am very familiar with. The third syllable of this call was extended, in contrast to the Common Hawk-cuckoo's call which ends abruptly. There was also a shrill note like "*Pee whi, Pi whi.*" heard frequently, which was unlike that of the Plaintive Cuckoo (*Cacomantis passerinus*) which I have heard many times before. The bird was too far from me to approach and look at, and I had to move away from that place to continue with my sampling. I hoped to hear the call some other time, so that I could follow it. This was almost towards the end of 25th April, 1995 when this species was expected to have gone back to its breeding ground. It left me to wonder about the bird calling in its wintering quarters.

Ali and Ripley (1987) report that this species migrates in winter from Hiamalayas, southwards into the peninsula, and had been recorded from Tamil Nadu, Karnataka and Kerala. But Ali (1969) and Neelakantan *et al.* (1993) do not mention this bird in their compiled information on the birds of Kerala. Zacharias andGaston (1993) record this bird in the moist deciduous habitat in Wynaad and they claim this as the first record for Kerala. However, a bird survey of the Wynaad Wildlife Sanctuary, held in January 1992, came across three individuals of this species in the Tholpatty range, which is again a moist deciduous forest area (Uthaman, 1993). It may be noted that the habitat at all the three places from where I recorded this bird was moist deciduous forests. This species has probably been under-recorded in its wintering range and this is likely to be due to its elusiveness.

November 9, 1995

T.R.K. YOGANAND
Sálim Ali Centre for Ornithology and Natural History,
Kalampalayam P.O. Coimbatore 641 010.

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18. RANGE EXTENSION OF THE NEPAL BABBLER (*ALCIPPE NIPALENSIS*)

On 25th March, 1991 we were coming down the steep slopes of the Shivaliks which were covered with bamboo (*Dendrocalamus strictus*), *Anogeissus latifolia, Lannea coramandelica* and *Shorea robusta* in the *Guwalgad sot* (sot = stream or river) area of the Rajaji-Corbett corridor in the western part of Uttar Pradesh. We were trying to locate a radio collared cow elephant. A small brownish bird was disturbed from a bamboo clump. We went near the bamboo clump to which the bird had gone and located it. It had a prominent white ring around the eye with a black supercilium and buff with white in the breast region. The head was greyish brown with greyish cheeks. The upper parts of the body was light brown with a long tail. It was solitary and moved from one bamboo clump to another, probably foraging for insects.

On going through the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Ali and Ripley (1983) OUP, Delhi, we found that it was the Nepal Quaker or Nepal Babbler, which has been reported to be found only in the north eastern Himalayas The Nepal babbler has not been reported from this part of Uttar Pradesh and thus this is a positive "range extension" for this species. This species was sighted and photographed by one of us (SFWS) in 1989 near River Rawason, the western boundary of the corridor.

August 17, 1995

S.F. WESLEY SUNDERRAJ
JUSTUS JOSHUA[1]
Wildlife Institute of India,
Post Box 18,
Dehradun-248 001.
[1]Present address:
Sálim Ali Centre for Ornithology and Natural History,
Kalampalayam PO,
Coimbatore-640 010.

19. WAS RICHARD MEINERTZHAGEN'S RECORD OF A "GREAT BLACK-BACKED GULL *LARUS MARINUS*" IN RAJASTHAN REALLY HEUGLIN'S GULL *L. HEUGLINI*?

The Great Black-backed Gull *Larus marinus* of the northern shores of the Atlantic Ocean is reported by Ali and Ripley (1981) and Roberts (1991) to have occurred in the Indian subcontinent on the strength of a single report of a bird killed on Deoli jheel 88 km south of Nasirabad in Rajasthan on 16th November, 1899 by Richard Meinertzhagen (1900). On working through the records of large, white-headed gulls occurring around southern Asia I was unable to find any other satisfactory published description of this species, so that in view of the doubts about this observer's credibility (Crocker 1989, Knox 1993) it seems time the record received further scrutiny.

At the time Meinertzhagen was a subaltern in the Royal Fusiliers, aged 21 with no scientific training, and according to Crocker (1984) it was another dozen years before he published any other important ornithological contribution. He reported that the gull came to a goose he had shot, whereupon he killed it as well, recognised it immediately from experience in Britain as a Great Black-backed Gull, and threw it away without bothering to preserve it. The only details that he provides are that it was "fully adult and with a fine dark mantle', and had a body-length within one or two inches (2.5-5 cm) of that of the goose, which should have been approximately 30-35 inches (55-89 cm). He thought that the most remarkable feature of the record was not that the bird had occurred in India, but that it was so far inland.

Since Colonel Meinertzhagen (1935) later became an authority on this group of gulls nobody appears to have questioned his identification. By current standards it is quite inadequate for a member of a rather difficult group of birds. There is, moreover, a more likely alternative identification of which it is unlikely that anyone would have been aware at that time, Heuglin's Gull *Larus (fuscus)* *heuglini*, which seemed to me as large and dark on the back as a Great Blackback, and has a wing-length of 405-469 mm compared to 447-523 mm (and an overall length of 64-78 cm, just as large as a goose) in the latter (Cramp and Simmons 1983). While *heuglini* normally winters further west, there is a subadult from the Whistler Collection in the British Museum (Natural History) taken on the Ganges at Patna, Bihar, on 11th March 1939, so that Meinertzhagen's bird could well have belonged to this form instead.

Heuglin's Gull is usually treated as a race of either the Herring Gull *L. argentatus*, or much more appropriately the more marine Lesser Black-backed Gull *L. fuscus*, but the breeding distribution of all these birds may overlap around the White Sea, with some intergradation along the River Volga, and *L. heuglini* is now regarded by some Russian ornithologists as a distinct species (Stepanyan 1990, Filchagov 1994). Most nominate *heuglini* appear to winter on the west side of the Indian Ocean, and the Patna bird may be the most easterly record, whereas most similar gulls wintering around the coasts of the Indian subcontinent appear to belong to its paler-backed eastern ally or race *L. (h?) taimyrensis*, which winters eastwards to China (Bourne 1994).

The curious feature of this record is surely not that Meinertzhagen misidentified a difficult gull in his youth, but that he failed to correct the identification when he became older and supposedly wiser. Possibly he forgot about it, or thought that other people had done so, but he had a curiously dismissive attitude to mistakes. Thus, when I wrote to him in the early 1950s asking what else he saw when he made field notes on the feeding behaviour of the rare Raza Lark *Calendrella razae* (Meintertzhagen 1952), he replied "he had nothing to add to what he had already written", when it later became notorious that he had never set foot on the only island where this lark occurs (Crocker 1989). But while in this case he may also have been unwilling to admit an error, it seems unnecessary to dismiss the record as a fraud while there is a natural explanation for misidentification available.

August 26, 1995

W.R.P. BOURNE
Department of Zoology,
Aberdeen University,
Tillydrone Avenue,
Aberdeen AB9 2TN, Scotland.

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ALI, S. & S.D. RIPLEY (1981): Handbook of the Birds of India and Pakistan. 2nd edition, Vol. 3, Oxford University Press, New Delhi.

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20. NOTES ON GROWTH AND MATURITY IN THE INDIAN ROOFED TURTLE (*KACHUGA TECTA*)

Sayaji Baug Zoo, Vadodara, Gujarat, India has been successfully breeding the Indian roofed turtle (*Kachuga tecta*) since 1991. The first batch of seven hatchlings were maintained in an enclosure

TABLE 1

LIST OF PLANT SPECIES CONSUMED BY *KACHUGA TECTA* IN CAPTIVITY*

1. *Coriandrum sativum.*
2. *Hydrilla verticillata.*
3. *Lemna gibba.*
4. *L. perpusilla.*
5. *Vallisneria sp.*
6. *V. spiralis.*
7. *Sagittaria sagittifolia*
8. *S. guayanensis.*

* Listed as per preference of terrapin.

measuring 2.0 x 2.5 m.

The enclosure has a half-metre high periphery wall and the centre with 80 x 80 x 60 cu cm water with necessary slopes. The top of the enclosure is covered with wire-mesh for protection against predators.

The turtle hatchlings were daily fed with various species of plants (Table 1) in adlibitum quantity. Cockroaches, crickets and earthworms were also offered once a week, up to the age of one year. Turtles were less interested in insects and worms.

The following measurements were taken once a year: Straight carapace length (CL), carapace width (CW), plastron length (PL), shell height (H), and body weight (W) (Table 2). Four hatchlings died during the first year, possibly due to some fungal and parasite (*Ascaris* sp.) infections.

Sexual-dimorphic features became apparent in the third year. Males had comparatively longer and thicker tails than the females. Body shape of male became oblong and female became oval during the same period.

At the end of fifth year the terrapin CL reached three times and the weight was twenty times more than the size at birth.

About the aspect of reproductive maturity in turtles, there are two divergent views among turtle workers. One is that it is related to the age of the turtle (Risley, 1938) and the other view regards the attainment of maturity to be primarily size related and not age related (Hidebrand, 1932; Cagle, 1948). The present study shows that male turtles attain maturity earlier than females, at the age of three, when average of CL was 6.5 cm. According to Verma

TABLE 2

MEASUREMENTS OF CAPTIVE HATCHLINGS OF INDIAN ROOFED TURTLE AT SAYAJI BAUG ZOO, VADODARA, GUJARAT. MEASUREMENT IN CM, WEIGHT IN GM.

Sample size	Date of measurement	carapace length	carapace width	Plastron length	Shell length	Body Weight	Remarks
7	Birth May 91	3.52 (3.37-3.67)	3.08 (2.95-3.17)	3.06 (2.96-3.14)	2.33 (1.96-2.20)	9.14 —	All hatchlings brightly coloured
3	May 92	5.73 (5.59-5.90)	4.86 (4.78-4.97)	5.06 (4.85-5.20)	3.25 (3.20-3.30)	36.6 (35-40)	Four hatchlings died
3	Jun 93	6.50 (6.20-6.80)	5.43 (5.20-5.70)	5.93 (5.55-6.30)	3.53 (3.50-3.55)	51.60 (45-60)	
2	May 94	7.44 (7.20-7.93)	6.03 (5.80-6.45)	6.80 (6.40-7.40)	3.90 (3.83-4.05)	71.6 (65-85)	Sexual-dimorphic features
2	May 95	8.43 (8.42-8.45)	6.70 (6.70-6.70)	7.87 (7.85-7.90)	4.32 (4.20-4.45)	103.0 (100-105)	
2	May 96	10.45 (10.0-10.9)	7.86 (720-8.52)	10.06 (9.70-10.42)	5.19 (5.00-5.38)	182.5 (60-205)	

Numbers in parenthesis are range

and Sahi (1996) the male attains maturity at the size of CL > 6.0 cm, which supports the present study.

The maturity in turtles is related either to age or size, and requires more study.

I thank V.A. Jadeja, Curator of the Sayaji Baug Zoo, Vadodara for the support and facilities extended.

October 3, 1996

RAJU VYAS
Sayaji Baug Zoo,
Vadodara-390 018,
Gujarat, India.

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21. RECORDS OF THE GHARIAL *GAVIALIS GANGETICUS* (GMELIN) FROM THE BARAK RIVER SYSTEM OF NORTH-EASTERN INDIA

(*With one text-figure*)

The Barak river and its tributaries drain the southern areas of north-eastern India, notably parts of Nagaland, Manipur, Mizoram, Tripura and the entire southern Assam (Fig. 1). The main tributaries of the Barak are the Irang, Makru, Tipai (Tuivai), Jiri, Chiri, Madhura, Jatinga, Sonai, Dhaleswari (Tlawng) with its distributary, the Katakhal, Shingla and the Longai. Near Badarpur, the river bifurcates into two - the Surma and the Kushiyara and then flows through Bangladesh.

Occurrence of the gharial in the Barak river system was not reported in any of the recent publications on the species (Whitaker and Basu 1982; Singh, Kar and Choudhury 1984; Singh 1991). Smith (1931) also did not mention specifically. However, Choudhury (1989, 1992) mentioned its recent reports from a tributary of the Barak river.

An excellent account of the past abundance of the gharial in the Barak river system is found in Cooper (1951a, b). His Tepi', Macrup and Irung are now known as Tipai (Tuivai), Makru and Irang respectively, all tributaries of the Barak river. He and his companions shot a few of these reptiles in the upper reaches of the Barak and in the Tipai rivers. The first one was shot in 1906 up the Tipai river. In the twenties, he found the gharial to be "fairly plentiful" in the upper reaches of the Barak, especially near its confluence with the Tipai. The site of confluence is known as Tipaimukh. The river Tipai marks the boundary of the present day Manipur and Mizoram states.

Although Singh (1991) mentioned the reference of Cooper (1951a, b), he mistook the Barak river system to be that of the Brahmaputra and also did not mark it on the map.

During field survey in different parts of the river basin over the past decade, I came across a few authentic reports on the species, and also visited all the recorded localities. These reports are presented chronologically.

1934-35: One gharial seen in broad daylight in Katakhal river, a tributary of the Barak river, near Matijuri in Hailakandi district, Assam. It was a large specimen, 4-5 m long (A. Mazid Choudhury, pers. comm.).

1948: One recorded in the Kushiyara river, Karimganj district, Assam. The Kushiyara river also marks the Indo-Bangladesh international border.

1950: One killed in the Dhaleswari river near Hartaki, about 32 km downstream of Sairang in Mizoram. The river is locally called by the Mizos as Tlawng.

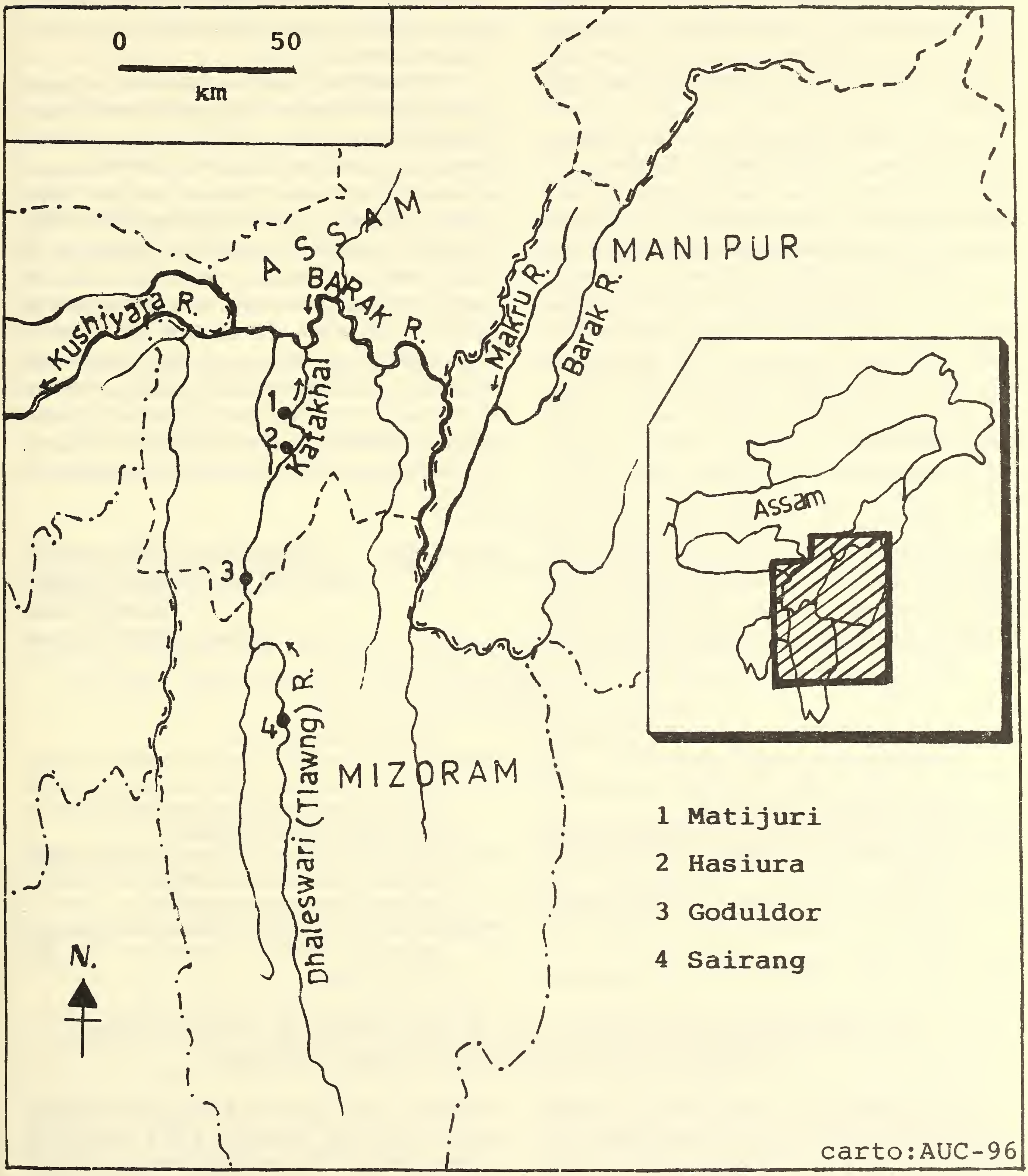

Fig. 1. Map showing the Barak River system and the rivers and places mentioned in the text.

1954-55: One seen floating in the Katakhal river near Hasiura, Hailakandi district. It was shot with a gun but could not be killed. It was a large specimen, 4-5 m long (A. Mazid Choudhury, pers. comm.).

Early 1960s: One shot by a 'white' hunter in the Dhaleswari river, south of Gharmura in Hailakandi district. After that killing, the place is called Goduldor (Godul= Gharial in local Bengali dialect) and is inside the Innerline Reserve Forest.

1988: During a short field survey in Manipur, I came across reports of stray, or rather, remnant individuals of gharial from the upper reaches of the Barak river and its tributary, the Makru river (Choudhury 1989, 1992). I cross checked with the Forest Department who were also aware of these facts. Unfortunately, no survey could be carried out due to insurgent activities in the area. Cooper (1951a, b) did not cover these stretches of the rivers either.

1996: In January, I visited some sites in the upper reaches of the Barak and its tributaries, the Makru and the Irang in Tamenglong district of Manipur. Although no gharial could be seen, the long deep pools with sand banks showed potential habitat for the reptile. This time again some of the stretches, farther interior, could not be surveyed due to insurgent activities.

Although the gharial was present in the Barak river system, it was never common in the recent past. The main reasons for its decline in the area are (1) Heavy year-round use of the rivers for fishing and as waterway to transport bamboo and other forest produce; (2) Encroachment of basking and breeding beaches (occupied by humans for setting up of fishing camps, logging camp and bamboo-collection camp); (3) Chasing and attempt to kill any gharial sighted; (4) Siltation of river-beds due to heavy deforestation in the hills; and (5) Use of poison and dynamite for fishing by tribals in the upper reaches of the rivers. While there are possibilities of a few gharials still living in the upper reaches of the Barak and the Dhaleswari rivers, they are unlikely to survive for long.

June 4, 1996

ANWARUDDIN CHOUDHURY
Near Gate No. 1 of Nehru Stadium,
Islampur Road,
Guwahati 781 007, Assam.

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22. AN OBSERVATION ON ECDYSIS IN THE COMMON HOUSE LIZARD *HEMIDACTYLUS FLAVIVIRIDIS* RUPELL OF INDIA

During the last part of March 1996, I collected a copulating pair of the common house lizard, from the outside wall of a verandah at Kolasib of Mizoram, India at 0755 hrs. The outside atmospheric temperature was measured and was found to be 16°C, there was a heavy shower during the preceding night. Kolasib is a hilly terrain at an altitude 1067 m. The lizard pair was caught and kept in a 250 ml borosil glass beaker with a paper lid having some pores for ventilation. The pair was kept under constant watch to observe the moulting. On 4th April, 1996 at 1000 hrs when I left for college both the lizards were normal and one of them was sitting on the bottom. Around 1230 hrs when I returned from college I saw some loose skin on the head of one lizard, which was sitting on the floor of the jar. From this it is presumed that the loosening of skin may have started an hour before i.e. around 1100 or 1130 hrs. The process of shedding of skin was complete by 1800 hrs. i.e. complete shedding took 6.5 to 7.00 hours. During this period slight movement of the moulting lizard was observed but the lizard did not seem to show any sign of restlessness or uneasiness. After the shedding of its skin, 2/3rd of its moult (except the lower portion of the snout) was eaten by one of the two lizards.

This observation is in contradiction to the earlier observation of Prasad (1916) taken at Panipat which states that the process of moulting was completed in 52 hours. He also mentioned that the animal was very restless and rubbed against the sides of the glass jar in which it was kept. Such peculiar behaviour could be due to the ectoparasitic infection of reddish 'ticks' or mites which, he mentioned, were on the body of the lizard and did not come off with the cast, but bored through it and remained attached to the animal. Restlessness was not observed in the present investigation as the animal was free from ticks or mites. However it confirms Prasad's (1916), observation that skin is shed in pieces.

June 4, 1996

DAYA NAND HARIT
Head, Department of Zoology,
Government Kolasib College,
Kolasib-796 081,
Mizoram. India.

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23. OCCURRENCE OF THE FAT TAILED GECKO, *EUBLEPHARIS HARDWICKII* GREY (SAURIA: GEKKONIDAE) WITH REMARKS ON THE VARIATION IN CERTAIN TAXONOMIC CHARACTERISTICS

(*With one plate*)

A fat tailed lizard was captured in Aushgram village of Burdwan District, West Bengal on 6th April, 1995, and kept in the Ecological Park for a few days and then brought to the Zoology Department of Burdwan University, West Bengal, India.

The colour of the head and the body is deep tobacco brown above with one 10 mm broad cream coloured transverse band at the middle of the body and another similar 7.5 mm broad band at the junction of the body and tail. There is a cream coloured "V" shaped narrow band round the neck extending to some extent towards the body proper on one side, and upto the tip of the snout through upper labials on the otherside. The belly is creamy white. One brown spot is noted on each hind limb. The tail is bluish with deep brown spots; the tip is brown. The head and body measures 100 mm and the tail 45 mm.

Behaviour

After capture, the animal starved for the first two months. Then gradually it started feeding on soft-bodied insects like dragonfly, moth, butterfly, grasshopper, mosquitoes etc., but never took hard, chitinised insects indicating a selective feeding habit. It ate a few hatchlings of the common house lizard. It is nocturnal but moves in artificial darkness during day time. The lizard moves or walks solely on its feet and digits, keeping its whole body off the ground. It cannot move or walk on a vertical wall but sometimes raises the whole body vertically with the support of the forelimbs on the wall and the tip of the tail on the ground. Information regarding the natural habitat of this lizard is not well known.

Identification and remarks:

Four species of the Fat-tailed Gecko belonging to genus *Eublepharis* Grey are so far known from the Indian region, of which *E. hardwickii* Grey is known to occur in the Eastern Indian states with particularly in Orissa, Bihar, Madhya Pradesh and West Bengal (Smith, 1935). The present specimen has been identified as *Eublepharis hardwickii* Grey (Family Gekkonidae) by the Herpetology Department of Zoological Survey of India. The Accession Registrar of the National Zoological collection (Z.S.I. Calcutta) reveals that a single specimen was collected and reported for the first time from the southern part of West Bengal by a British scientist in 1858. The collection of the present specimen is therefore significant as thge second report of the species after a lapse of 137 years. The present record of the specimen signifies interesting zoogeographical implications in terms of its occurrence and rarity. In addition, the present specimen exhibits a noteworthy variation in its measurement (145 mm. *vs* 195 mm as referred by Smith, 1935) and colouration or banding pattern (a single creamy band at the base of the tail *vs* 4-5 creamy bands as referred by Smith, 1935). The tail of the present specimen is dotted with deep brown spots instead of bands as described by Smith (1935). In spite of these variations, it is not possible to describe this specimen as a new variety, since the present find is based on a single specimen.

Acknowledgement

We are indebted to Dr. S.K. Talukdar, Scientist, Division of Herpetology, Zoological Survey of India for identifying the specimen and valuable suggestions.

June 4, 1996

G. CHANDRA
S.N. CHATTERJEE
C. DATTA
M. MAJUMDAR,
Zoology Department, Burdwan University West Bengal, India.
A. NATH
Ecological Park, Krishnasayar, Burdwan, University, West Bengal, India.

Reference

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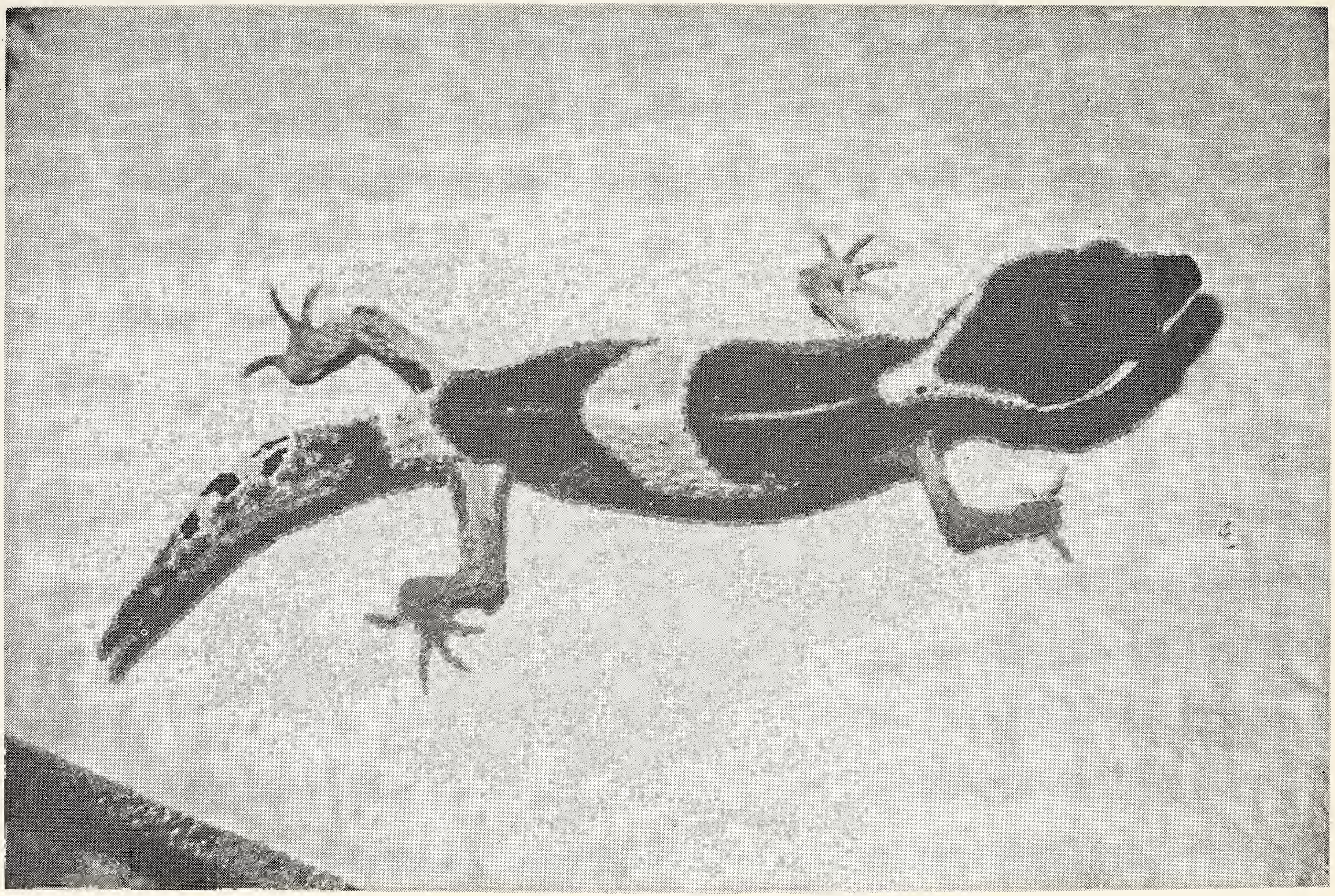
24. *CALLOPHIS NIGRESCENS* (GUNTHER), (SERPENTES: ELAPIDAE) A COLOUR VARIATION FROM SILENT VALLEY NATIONAL PARK, KERALA

Gunther (1864) described the colour characteristics of *Callophis nigrescens* as having dark blackish ash or black upper side and uniformly red ventral side. Upper part of the head is symmetrically marbled with black, a black spot below the eye, another descending from the occipital to the angle of the mouth, a black horse-shoe like marking is present on the collar with the convexity directed forwards. A narrow black vertebral line slightly edged with yellow runs from the collar to the tip of the tail. A series of small ovate black spots, indistinctly ridged with a whitish tint, is present along each side of the trunk, which disappears posteriorly. The tail is coloured like the body without black rings. Later, Smith (1943) described three colour forms of *Callophis nigrescens.* (1) Pale reddish or brownish above with 5 black stripes on the body, a vertebral and two lateral pairs, and three stripes on the tail, the outermost stripes being on scale rows one and two. The top of the head is black with light regular



Fat tailed lizard in West Bengal

markings and a broad black bar on the nape, reddish below. Upper lip has black vertical markings. (2) Light or dark purplish brown above, with 5 black stripes edged with white, the white lines being continuous or regularly broken, the brown of the dorsum extends on to the lateral edges of the ventrals. (3) Blackish or greenish blue above, with 3 or 5 black stripes, not edged with white. When only 3 striped, the outer pair are absent. Head markings are usually less distinct than the fist one.

Recently while conducting a herpetological survey in the Silent Valley National Park in Kerala, a *Callophis nigrescens* was collected with the following colour pattern. The specimen has a uniform glossy black dorsum without any stripes on the body and tail. The head is blackish with white symmetrical markings. The upper jaw is blackish with two separate white markings. The lower jaw is white in colour. The basal row of costals have a narrow, indistinct white line, which ends near the vent region. The ventral side is deeply reddish, lighter in the anterior region, with white cross markings, produced by the free end of the ventrals.

Callophis nigrescens has not yet been reported from Silent Valley or adjacent areas (Murthy, 1986). Hence, this is an addition to the herpetofauna of Silent Valley.

June 4, 1996

JOSEPH THOMAS
P.S. EASA
Division of Wildlife Biology, Kerala Forest Research Institute, Peechi-680 653, Kerala.

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25. NOTES ON A NEW DISTRIBUTIONAL RECORD AND THE ECOLOGY OF *RHABDOPS OLIVACEUS* (BEDDOME) (REPTILIA: SERPENTES: COLUBRIDAE)

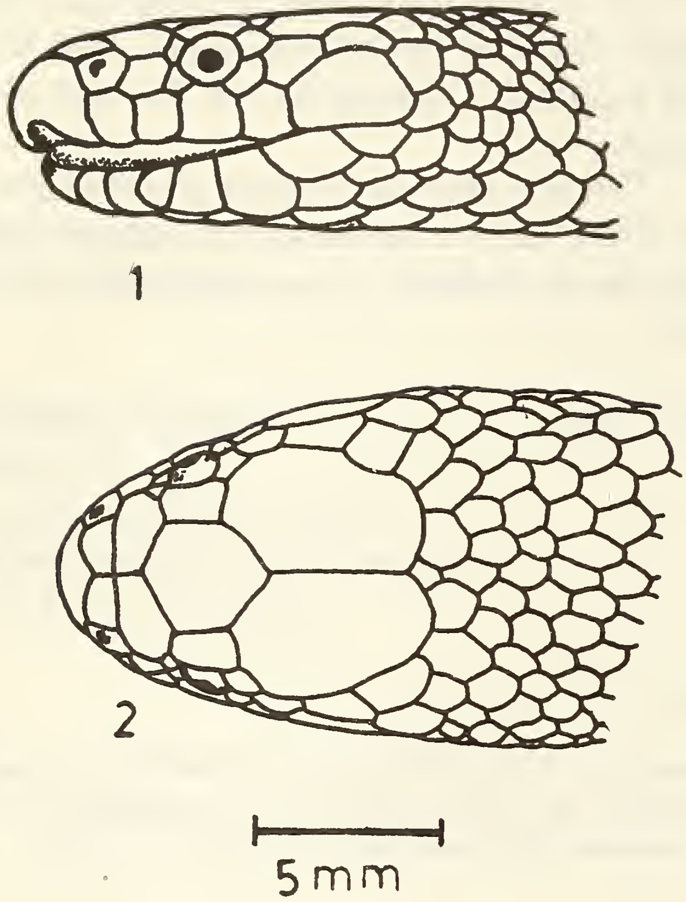
(*With one text-figure*)

The Olive forest snake, *Rhabdops olivaceus* (Beddome), as the common name denotes, is olivaceous or yellowish brown above and below in colour, with 4 longitudinal series of small black spots (2 dorso-lateral and 2 lateral) on the body. The snake can be distinguished by its short maxilla bearing 10-12 small, subequal teeth; head not distinct from neck; nostril in the nasal, valvular, crescentic; body cylindrical, elongate; scales in 17 rows throughout, without apical pits; ventrals rounded, indistinctly edged with dark brown; 2 internasals and 2 prefrontals.

The species originally discovered from Mananthavadi, Wynaad district, Kerala is so far recorded to be confined to Wynaad (Smith, 1943; Murthy, 1986).

A recent faunistic survey conducted in Trichur district, Kerala resulted in the collection of a specimen of *R. olivaceus* (Figs. 1, 2) from an evergreen forest patch at an altitude of approximately 610 m above msl on the Vellanimala Hill top. The specimen was collected below a boulder from a spring fed shallow stream. Along with the snake, caecilians (Amphibia) and earthworms (Annelida) were also collected.

The genus *Rhabdops*, besides *olivaceus* (Beddome) includes the species *bicolor* (Blyth) known from the Khasi and Mishmi Hills (north-eastern India), Kachin Hills (Myanmar) and western Yunnan (China). *R. bicolor* is found in hills along its range and feeds on worms and slugs. *R. olivaceus* also appears to be a hill species as it is known from



Figs. 1-2. Head of *Rhabdops olivaceus* (Beddome). 1. Lateral view. 2. Dorsal view.

the hill district of Wynaad and currently from the Vellanimala Hill of Trichur district. Besides, the food habits of *R. olivaceus* are likely to be similar to that of *R. bicolor*, as the snake was found to be associated with other vermiform animals mentioned above.

The collection data and morphometric measurements of the specimen examined are as follows:

Material examined: 1 ex. Locality: Vellanimala, Pattikkad Forest Range, Trichur district, Kerala, India. Date of Collection: 9-x-1995.

Collector's name: K.C. Gopi *et al.* Z.S.I, Calicut. Total length including tail: 542 mm. (Tail, 88 mm.) Ventral: 218. Anal: 2. Caudal: 64.

The specimen collected is deposited in the faunal holdings of the Western Ghats Field Research Station, Zoological Survey of India, Calicut. Drawings of the head pattern of *R. olivaceus* are provided for easy identification as the same is not given by Smith (1943) in his Fauna volume.

The present record of collection of *R. olivaceus* from Trichur district establishes its occurrence in the hill areas of Western Ghats south of Wynaad. Ecological observations suggest similarity in habits and habitat with that of *R. bicolor.*

ACKNOWLEDGEMENT

I am grateful to the Director, Zoological Survey of India, Calcutta for facilities.

September 17, 1996 C. RADHAKRISHNAN
Zoological Survey of India, Western Ghats Field Research Station, Calicut-673002.

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26. RANGE EXTENSION AND SOME ASPECTS OF MORPHOLOGY AND HABITAT OF AN ANURAN SPECIES *LIMNONECTES BREVIPALMATA* (PETERS, 1871) (RANIDAE)

The frog species *Limnonectes brevipalmata* (Peters, 1891) (=*Rana brevipalmata*), though it resembles *Limnonectes limnocharis* closely, is a distinct species (Pillai, 1980). The distribution of this uncommon frog was given as Kerala and Tamil Nadu by Inger and Dutta (1986). Sekar (1991) extended its range of occurrence upto Karnataka based on a specimen in the BNHS collection collected from Someshwar, south Kanara in Karnataka.

During a study on the amphibian fauna of the Sanjay Gandhi National Park (SGNP), Borivali, Bombay in 1993, I collected one calling male of *Limnonectes brevipalmata* among the vegetation during the monsoon at an altitude of 75 m. Thereafter, seven more specimens were collected from a nursery situated at the eastern side of the park. Another survey at Mahabaleshwar (Satara district, Maharashtra state), at a height of 1260 m, also provided eight specimens of *L. brevipalmata.* All the specimens have been deposited with the BNHS amphibian collection. The morphological characters are as follows:

Materials from Borivali: 8 ex. (BNHS Reg. No: 2940-2947). The snout-vent length of the specimens ranged from 36.7-46.2 mm; Tibia length 20.0-26.6 mm; Head length 12.05-17.0 mm. All were blackish brown above and dirty white below. Warts and broken, elliptical glands were black in colour. A pair of prominent glands in the form of inverted 'V' present on the back at the centre of the body just behind the eyes. All except one lacked vertebral streak. The inner metatarsal tubercle was very weak, and not shovel shaped.

Material from Mahableshwar: 8 ex. (BNHS Reg. No: 2955-2962). The snout-vent length of the specimens ranged from 34.8-60.75 mm; Tibia 18.6-30.0 mm; Head length 13.2-19.0 mm; the largest specimen was a female. Specimens were greyish brown and olive brown. As in the frogs from Borivali, the back had small, elliptical glands. A pair of prominent glands in the shape of inverted 'V' were also present on the back. The glands were bordered with black. All the specimens except one had a narrow to broad vertebral streak. The inner metatarsal tubercle was elliptical, strong, and shovel shaped.

The other morphological characters of the specimens of both the localities match the description by Boulenger (1920), Daniel (1975) and Pillai (1980).

In Borivali the individuals of this species were collected from microhabitats like wet ground among monsoon plants on the damp floor of the nursery, whereas in Mahabaleshwar the frogs were collected from the edge of a pool, open areas of rocky ground with short grass and on wet leaf litter at the edge of the forest. All the individuals in both the places were collected at night between 1900 to 2200 hrs in the monsoon.

The ecology of this frog is poorly known. Pillai (1980) has reported little about the microhabitat preference of this frog. According to him this species prefers to be on the sloping banks of streams with some undergrowth. He opined that the brief webbing indicated lesser dependence on water and the compressed metatarsal tubercles were for excavation of soil for making 'nests'. Though the individuals from Mahabaleshwar with strong, shovel shaped inner metatarsal tubercles support his view, the specimens from Borivali, with weak and thin inner metatarsal tubercles, do not lend support to his view of use for making nest in the soil. Moreover, the present collections were made far from water.

As the occurrence of this species in Maharashtra has not been reported so far, the record of this species from Borivali (Bombay) and Mahabaleshwar is the first record from Maharashtra and this extends the range of occurrence of this species northwards along the Western ghats upto 19° 21' N.

I thank Mr. Vithoba Hegde, Field Assistant of BNHS for his company in the field work. I also thank BNHS for supporting the field trips.

February 5, 1996

ALOYSIUS G. SEKAR
Bombay Natural History Society,
Hornbill House, Shaheed Bhagat Singh Road,
Bombay-400 023.

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27. REDISCOVERY OF THE BLACK MICROHYLID FROG, *MELANOBATRACHUS INDICUS* (BEDDOME 1878)

(*With one plate*)

The monotypic genus *Melanobatrachus* is endemic to the Western Ghats of South India. *Melanobatrachus indicus*, commonly called the rare black microhylid, was first described by Beddome in 1878. This description was based on a few specimens collected from "the Annamalais and the ghat range to the south of those mountains" (Beddome 1878). Subsequent descriptions of the species were based on the initial collection made by Beddome.

I have been conducting systematic surveys of amphibians in Kalakad-Mundunthurai Tiger Reserve (KMTR) from May 1996. KMTR falls within the South-Western Ghats in Tamil Nadu State. This survey was part of the studies on the impact of fragmentation of rain forests on herpetofauna and small mammals in the Western Ghats. One individual of *M. indicus* was seen in Kakachi in (KMTR) at 1200 m altitude, on 26th June, 1996. This individual was sighted at 1920 hours on a rock at the edge of wet-evergreen forest. Previous collections were made at altitudes ranging from 1000 to 1500 m (Parker 1934). They were reported from moist evergreen forest in a torpid state, curled up in a ball (Beddome 1878). The localities of the specimens collected earlier were Annamalai hills, North Travancore, South West India and Cochin (Parker 1934). The present sighting would fall within the old Travancore province reported earlier. However, distribution of the species in the Western Ghats remains confounding, due to lack of information on the exact locality of earlier collections.

The external morphology and colour of the microhylid sighted corresponds well with the description provided by Boulenger (1890). The scarlet blotches on the underside of the forelimb and thigh region were prominent. The skin was pustular, with pustules arranged in five longitudinal rows on the dorsum. It had small pale blue spots on the flanks and on the sides of limbs. It is interesting to note that this species has not been recorded in any of the surveys or collection-based studies in the region since its description in 1878. There is clear indication that this species is rare and intensive surveys are required to gather more information on this enigmatic species.

October 10, 1996

KARTHIKEYAN VASUDEVAN
Wildlife Institute of India,
P.O. Box 18, Dehradun 248 001.

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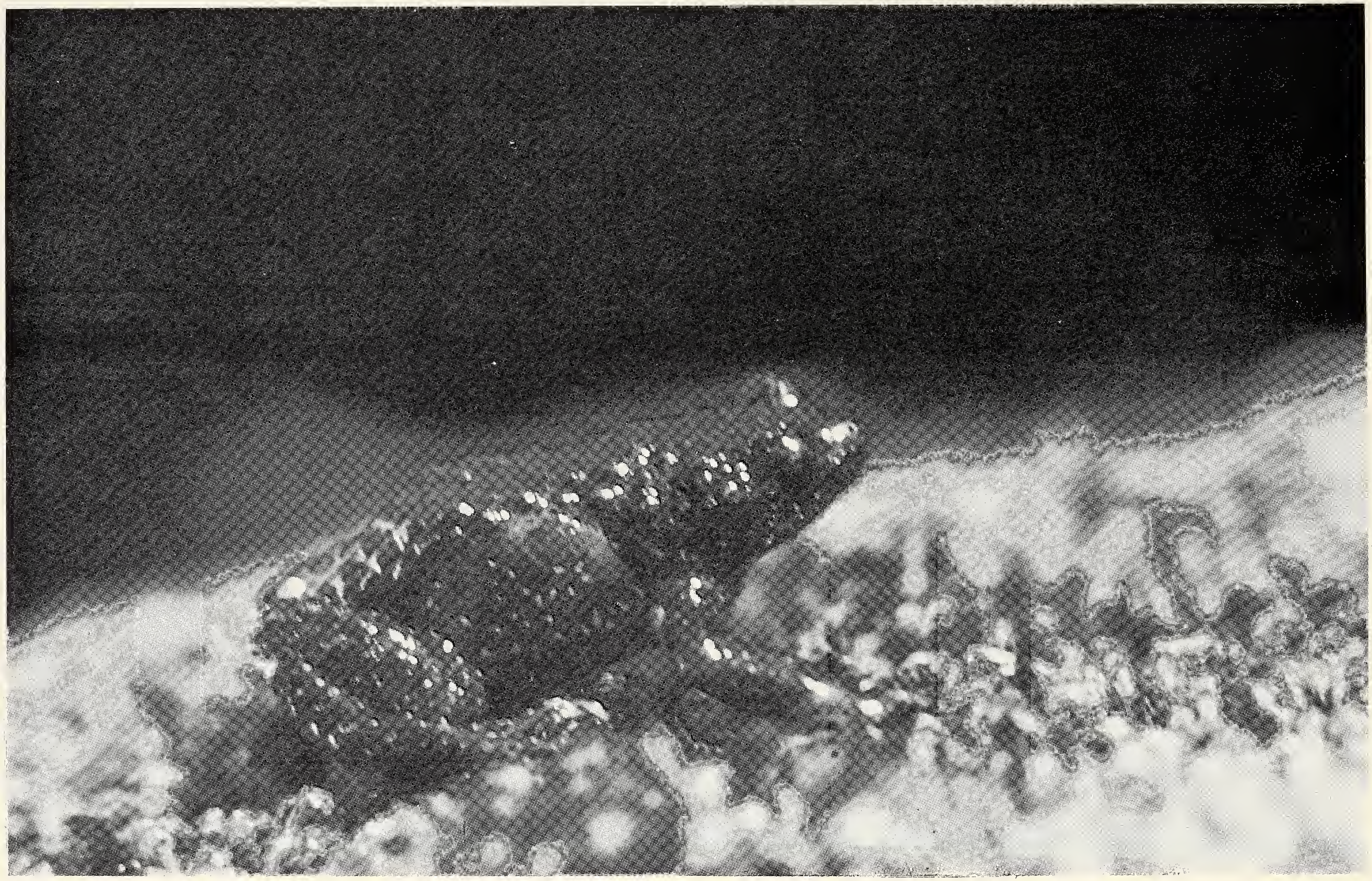
28. NEW RECORD OF *SCHISMATORHYNCHUS (NUKTA) NUKTA* (SYKES) (PISCES: CYPRINIDAE) FROM MOYAR RIVER, TAMIL NADU

During the course of our studies on the status and conservation perspectives of rare and endemic fishes of the Nilgiri Biosphere Reserve (NBR), a specimen of *Schismatorhynchus (Nukta) nukta* (Sykes), a cyprinid fish was collected from the river Moyar, near Thengumarada in Tamil Nadu. This species, commonly called "Nukta", has not been previously recorded from Tamil Nadu. The southernmost limit of its distribution is, till now, up to Karnataka (Talwar and Jhingran, 1991) and this

PLATE 1



S.U. SARAVANAKUMAR

The black microhylid frog *Melanobatrachus indicus*: intensive studies are required to gather more information on this enigmatic species.

species is not commonly found in its range.

Moyar river originates in the Nilgiri hills at an altitude of about 1800 m and drains into the Lower Bhavani dam at 280 m. It cuts the Sigur plateau from the Mysore plateau to the north and forms a natural boundary between Tamil Nadu and Karnataka. It flows through the well-forested areas of Mudumalai Wildlife Sanctuary, Sigur reserve forest and Moyar Reserve Forest, for almost its full length. Hitherto, four individuals of *Nukta* species of fish have been recorded from this river. Occurrence of *Tor khudree*, a rare and threatened fish and *Puntius mudumalaiensis*, an endemic species of Moyar river of Mudumalai Wildlife Sanctuary here is remarkable. Downstream, poaching pressure is high and this river needs to be protected for its fish diversity.

Earlier records:

Sykes (1841), Day (1877, 1889), Hora (1942), Suter (1944), Kalawar and Kelkar (1956), Yazdani and Singh (1990), Singh (1990), Talwar and Jhingran (1991) recorded this species from the rivers of Deccan, viz. River Inderanee, River Indrayani (type locality), River Krishna, Ujni wetland etc., but mostly from Maharashtra, and it has not been reported from Tamil Nadu earlier. Therefore, the present record of this fish in the Moyar river extends its range of distribution in southern India.

ACKNOWLEDGEMENT

Our sincere thanks to the Forest Department of Tamil Nadu for permission to work in the forests along Moyar river. Our thanks are also due to Mr. Kaliyappan, our efficient field assistant.

February 23, 1996

A. MANIMEKALAN
D.F. SINGH
Sálim Ali Centre for Ornithology & Natural History, Kalampalayam P.O., Coimbatore-641 010.

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29. DUNG BEETLE (COLEOPTERA: SCARABAEIDAE: SCARABAEINAE) FAUNA OF BANGALORE, KARNATAKA

India, like other tropical countries, has a rich scarabaeid fauna, but in spite of overwhelming numbers they rarely make their presence felt. Not much work has been done on the fauna of this group of beetles after Arrow (1931)in his comprehensive account on Indian scarabs, reported four tribes, 26 genera and 354 species. A survey was conducted in and around Bangalore to study the dung beetle fauna during 1981-1985. This survey revealed the presence of 61 species (Table 1) of Scarabaeinae belonging to three tribes. Of these, 33 are being reported for the first time from Bangalore. Members of the tribe Panelini were not encountered. The great majority of the species belong to the genus *Onthophagus*. Seven species viz., *Heliocopris gigas. Onthophagus ramosellus, O. negligens, O. vividus, O. faveri, O.*

Table 1
DUNG BEETLE FAUNA AND THEIR ASSOCIATED MAMMALIAN EXCREMENT FROM BANGALORE, KARNATAKA, SOUTH INDIA.

No.	Species	Associated Mammal dung	No.	Species	Associated Mammal dung
Tribe Scarabaeini					
1.	*Scarabaeus (Kheper) sanctus* (Fabricius)	Sheep, Cow	31.	*C. volcanus* (Fabricius)	Cow, Sheep, Dog
2.	*S. gangeticus* (Castelnau)	Cow	* 32.	*C. unicornis* (Fabricius)	Cow
* 3.	*S. brahminus* Castelnau	Cow	* 33.	*C. inermis* Arrow	Cow. Dog
4.	*S. erichsoni* (Harold)	Cow. Sheep	34.	*C. indicus* Harold	Cow, Dog
* 5.	*Gymnopleurus cyaneus* (Fabricius)	Cow. Sheep	* 35.	*Onthophagus gazella* (Fabricius)	Cow, Elephant
6.	*G.spilotus* (Macleay)	Man,Cow, Sheep	36.	*O. rectecornutus* Lansberge	Cow
7.	*G. koenigi* (Fabricius)	Sheep, Cow	* 37.	*O. duporti* Boucomont	Cow, Dog
* 8.	*G. dejeani* Castelnau	Cow	* 38.	*O. amplexus* Sharp	Cow
9.	*G. gemmatus* Harold	Man,Cow. Sheep	39.	*O. ramosus* (Wiedemann)	Cow
10.	*G. miliaris* (Fabricius)	Man,Sheep, Cow	40.	*O. dama* (Fabricius)	Cow, Elephant, Horse
			41.	*O. pactolus* (Fabricius)	Cow, Sheep
Tribe Sisyphini			* 42.	*O. unifasciatus* Schaller	Cow, Sheep, Dog,
* 11.	*Sisyphus crispatus hirtus* (Wiedemann)	Sheep, Cow			and carcass of Crow,
* 12.	*S. longipes* (Oliver)	Sheep, Cow			Frog, Tenebrionid
* 13.	*S. neglectus* Gory	Sheep,Cow, Monkey			Beetle
14.	*S. hirtus* Wiedemann	Sheep, Cow	* 43.	*O. turbatus* Walker	Cow, Horse
			* 44.	*O. spinifex* (Fabricius)	Cow
Tribe Coprini			45.	*O. quadridentatus* (Fabricius)	Cow, Elephant
* 15.	*Helicopris bucephalus* (Fabricius)	Elephant, Cow	46.	*O. igneus* Vigors	Elephant
16.	*H. gigas* (Linnaeus)	Elephant, Cow	47.	*O.pygmaeus* (Schaller)	Dog,Cow, Sheep
17.	*Copris signatus* Walker	Sheep	* 48.	*O. tarandus* (Fabricius)	Cow
18.	*C. repertus* Walker	Cow, Elephant	* 49.	*O. centricornis* (Fabricius)	Horse, Cow
* 19.	*C. fricator* Fabricius	Cow, Sheep	* 50.	*O. laevigatus* (Fabricius)	Cow
20.	*C. andrewesi* Waterhouse	Sheep	* 51.	*O. ludio* Boucomont	Cow, Sheep
21.	*C. indicus* Gillet	Cow	* 52.	*O. pusillus* (Fabricius)	Cow, Sheep
22.	*Catharsius molossus* (L.)	Cow, Elephant, Pig	* 53.	*O. tritinctus* Boucomont	Sheep,Cow, Dog
23.	*C. pithecius* (Fabricius)	Cow	54.	*O. ephippioderus* Arrow	Cow
24.	*Onitis philemon* F.	Cow, Elephant	55.	*O. kchatriya* Boucomont	Cow,carcass of
25.	*O. subopacus* Arrow	Cow			Crow Sheep
* 26.	*O. siva* Gill	Elephant	* 56.	*O. gratus* Arrow	Cow, Sheep
* 27.	*Drepanocerus setosus* (Wiedemann)	Cow, Elephant	* 57.	*O. abreui* Arrow	Cow
* 28.	*Oniticellus pallipes* (Fabricius)	Cow	58.	*Onthaphagus* sp.	Cow
* 29.	*O. cinctus* (Fabricius)	Cow	* 59.	*Phalops divisus* (Wiedemann)	Cow
30.	*Caccobius meridionalis* Boucomont	Cow, Sheep, Dog,	* 60.	*Liatongus rhadamistus* (Fabricius)	Cow
		Pig	* 61.	*Tiniocellus modestus* Arrow	Cow, Elephant

Note: * indicates species being reported from Bangalore for the first time.

brevicollis and *O. brahma* reported by Arrow (1931) from Bangalore were not found during this study.

ACKNOWLEDGEMENT

We thank Dr. R. Madge of the Natural History Museum (London) for helping us to identify the dung beetles.

February 23, 1996

K. VEENAKUMARI
Central Agricultural Research Institute, P.B. No. 181, Port Blair, Andamans.
G. K. VEERESH
Vice Chancellor, University of Agricultural Sciences, G.K.V.K., Bangalore, 560065.

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30. FIRST RECORD OF *DIRHINUS ALTICORNIS* (MASI) AND *ANNECKEIDA ANGUSTIFRONS* BOUCEK (HYMENOPTERA: CHALCIDOIDEA) FROM INDIA

(*With three text-figures*)

During the faunal exploration of tropical rainforests of Western Ghats by Zoological Survey of India, Western Ghats Field Research Station, Calicut, two interesting chalcids were collected from semievergreen forest patches in Coorg district (Karnataka) and Kannur district (Kerala).

Dirhinus Dalman, one of the most distinctive genera of the family Chalcididae is distributed in all warmer countries of the world, Africa, Europe, Asia, Australia and Pacific islands. Members of this genus are parasitic on puparia of various Diptera, especially Calliphoridae, Sarcophagidae, Muscidae and also of certain Tephritidae.

Dirhinus alticornis (Masi), a remarkable species of the genus was originally described from Philippines by Masi (1927) under the name *Pareniaca alticornis*. Narendran (1989) examined a male specimen of *alticornis* from Philippines. One female specimen of the species was collected by me from a semievergreen forest patch at Aniyad, falling under the Kannavam RF of Kannur district, Kerala. The present record of *D. alticornis* (Masi) from the Western Ghats proves the further extension of its distribution to peninsular India and the third record from the Oriental Region.

D. alticornis is a characteristic species having the anterior inner edge of its frontal horn crenulate with an additional tooth on the outer edge. It has a strong facial tooth, and the posterior median area of pronotum depressed with an impunctate shagreened area. In males the antenna is peculiar with a spatulate club.

Specimen examined: 1 FEMALE. INDIA: Kerala, Aniyad (Kannavam RF), 1. ii. 1995, Coll. P.M. Sureshan *et al.*

Anneckeida Boucek, an African genus of Torymidae is represented by four Oriental species from West Malaysia, Thailand, Laos, and East Malaysia, apart from the type species from Rhodesia (Africa). *A. angustifrons* was originally described by Boucek (1978) based on a female specimen collected from Thailand. One female specimen of this species was collected by me from a forest patch at Chitekanum, falling under the Sampage reserve forests of Coorg district, Karnataka. This record constitutes its rediscovery from the Oriental Region subsequent to the original description and proves the extension of its distribution to Peninsular India.

Like all other Oriental species *A. angustifrons* also has hind femur with a ventral comb of teeth which begins with a conspicuous larger tooth. The species is also characterised by a face with inner orbits, distinctly converging upwards frons only 0.25 x the breadth of head and the ocelli in acute angular triangle, with lateral ones virtually touching the eyes.

Specimen examined: 1 FEMALE. INDIA: Karnataka, Chitekanum (Samapge R.F.), 4.iii. 1994, Coll, P.M. Sureshan *et al.*

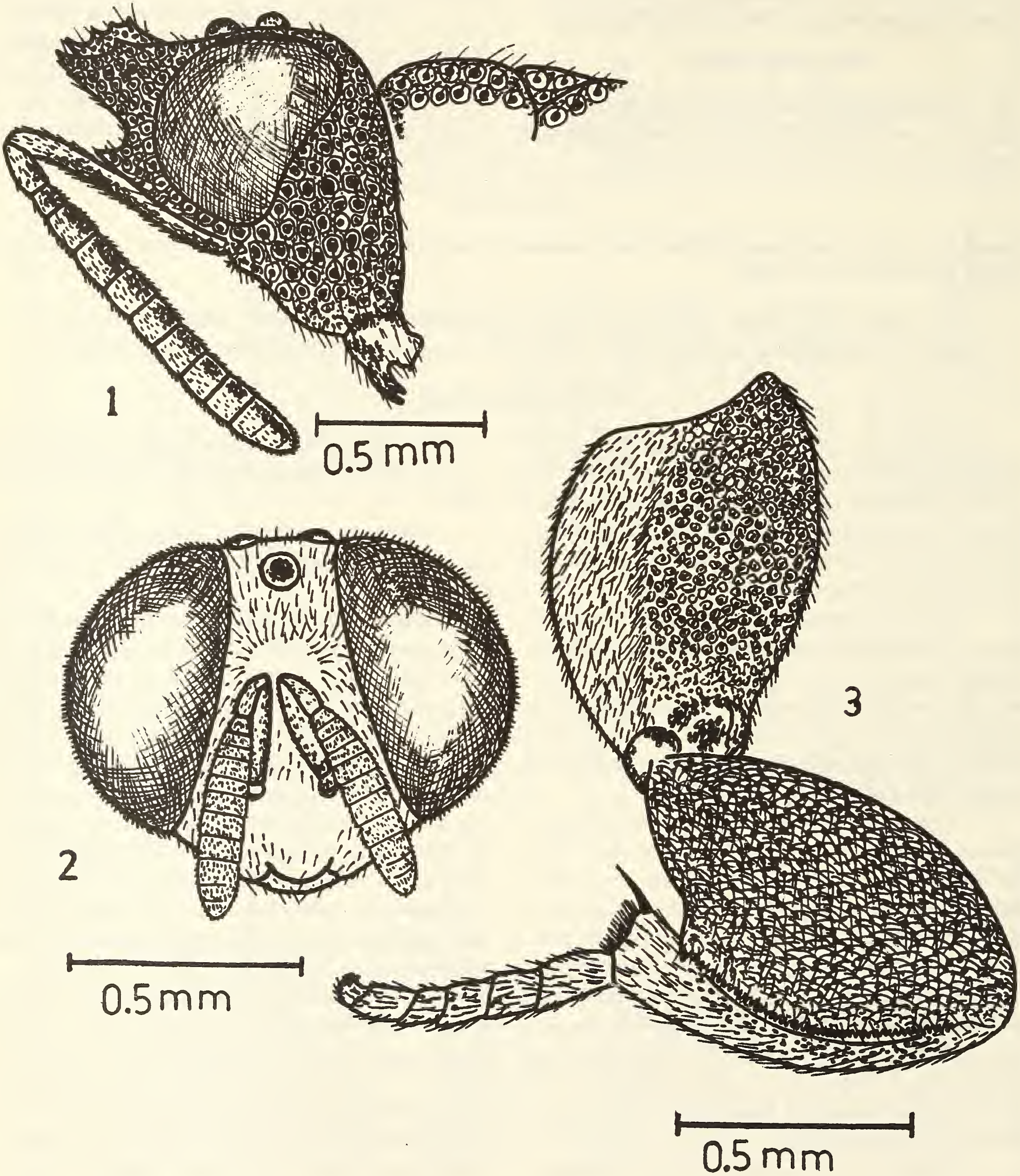

Fig. 1. *Dirhinus alticornus* (Masi) - Female. Head with antenna in lateral view.
Fig. 2-3. *Anneckeida angustifrons* Boucek - Female. 2. Head in anterior view. 3. Hind leg.

The specimens are presently kept in the collections of Zoological Survey of India, Western Ghats Field Research Station, Calicut, eventually to be deposited in the National Zoological collections of Zoological Survey of India, Calcutta.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India, Calcutta and the Officer-in-charge, Zoological Survey of India, Western Ghats Field Research Station, Calicut for providing facilities and encouragement. I am also grateful to Dr. T.C. Narendran, Professor, Dept. of Zoology, University of Calicut, Kerala for confirming the species identification and for critically going through the manuscript and offering valuable suggestions.

April 4, 1996

P.M. SURESHAN
Zoological Survey of India,
Western Ghats Field Research Station,
Calicut. Kerala 673 002.

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31. *GROOCA*, A NEW NAME FOR *NEOEPISTENIA* SURESHAN & NARENDRAN (HYMENOPTERA: CHALCIDOIDEA: PTEROMALIDAE)

The name *Neoepistenia* was applied (Sureshan and Narendran, 1995) to a genus erected for the new species *N. coorgensis* collected from the forests of Coorg (Karnataka). Unfortunately the authors overlooked the valid and prior use of *Neoepistenia* by Hedqvist (1958). *Neoepistenia* Hedqvist was erected with *N. flavoscapus* Hedqvist as the type species (Hymenoptera: Pteromalidae). Hence *Neoepistenia* Sureshan and Narendran is a junior homonym which has to be replaced according to the rules of the International Zoological Nomenclature. The new name *Grooca* is an arbitary combination of letters of feminine gender.

FAMILY: Pteromalidae
Genus **Grooca**, nom. nov.

Neoepistenia Sureshan and Narendran (1995) *J.Bombay nat. Hist. Soc. 92(1)*: 96-99. Not Hedqvist, 1958.

Grooca coorgensis (Sureshan and Narendran), comb. nov.

Neoepistenia coorgensis Sureshan and Narendran, 1995, *J. Bombay nat. Hist. Soc. 92(1)*: 96-99.

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April 4, 1996

P.M. SURESHAN
Zoological Survey of India,
Western Ghat Field Research Station,
Calicut,
Kerala 673 002.
T.C. NARENDRAN
Department of Zoology,
University of Calicut,
Kerala 673 635.

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32. NOTES ON SOME NON-INDIGENOUS PLANTS FROM ANDAMANS

While working on the Flora of Andaman and Nicobar Islands, we have come across three weed species from South Andaman. A perusal of literature and herbarium specimens at Port Blair revealed that these taxa grow sporadically in South Andaman and their occurrence on the Islands has not been reported. The present note on the occurrence of these non-indigenous plants would call the attention of Botanists and Horticulturists, before they spread rapidly and get naturalised in the Islands. Since these weeds were not mentioned by the earlier workers (Prain, 1891; Dagar et al 1991; Vasudeva Rao, M.K., 1986) the same are described here. The specimens have been deposited in the herbarium of the Botanical Survey of India, Andaman and Nicobar Circle, Port Blair.

Corchorus aestuans L. Syst. Nat. ed. 10. 1079. 1759. *C. acutangulus* Lam. Encycl. 2:104. 1786; Wight, Ic. t. 739. 1844; Mast. in Hook. f., Fl. Brit. India 1: 398. 1874. 'Hade-ka-khat' (Hindi) (TILIACEAE)

Glabrous annual herbs, 40-75 cm high. Leaves 2-6 x 1.5-5.0 cm, ovate or ovate-lanceolate, serrate.

Fl. & Fr.: August - October.

Specimens Examined: SOUTH ANDAMAN: Long Island, 22.x.1994 P.V. Sreekumar 16461.

Cuscuta chinensis Lam. Encycl. Meth. Bot. 2: 229. 1786; Wight, Ic. 4(2): 14. t. 1373. 1848; Clarke in Hook. f. Fl. Brit. India 4: 226. 1883 'Amarbel, Akashbel' (Hindi) - (CUSCUTACEAE).

Leafless stem-parasites, with yellow, filiform, twining, much-branched stems forming tangled mass.

Fl. & Fr.: August - November.

Specimen examined: SOUTH ANDAMAN: Port Blair, Horticulture road, near the Mushroom Centre. 5.v.1995 Marcel Tigga & P.V. Sreekumar 18144.

Hosts: We have noted this plant on the following host: *Mikania cordata* (Burm. f.)Robins; *Barleria prionitis* L., *Paederia scandens* (Lour.) Merr., *Chromolaena odorata* (L.) King and Robins., *Ipomoea sepiaria* Koen. ex Roxb.

Polygala arvensis Willd. Sp. Pl. 3: 876. 1802; Banerjee in Fl. India 2: 460. t. 87. 1993; Burtt in Notes Roy. Bot. Gard. Edinburgh 32: 404. 1973. *P. chinensis* auct. non L. 1753; Bennett in Hook. f. Fl. Brit. India 1: 204. 1872 p.p. (POLYGALACEAE).

Hindi: Maradu, Kon: Negli, Mar: Phutan, San: Gaighura.

Herbs, 5-30 (-40) cm high, branches arising from base. Leaves subsessile, orbicular, obovate, oblanceolate to oblong, narrowed towards base, subacute, obtuse or emarginate and mucronate at apex, 10-40 (-50) x 5-20 mm, glabrous to densely pubescent or hirsute; petioles upto 3 mm long. Flowers *c* 4 mm long, purplish-white and pink-streaked, solitary or in 3-15 flowered, racemes.

Specimen examined: SOUTH ANDAMAN: Port Blair, Gandhi Park, 18.vi.1995 P.V. Sreekumar 18148.

ACKNOWLEDGEMENT

We are grateful to Dr. P.S.N. Rao and Dr. P.K. Hajra of the Botanical Survey of India for encouragement.

June 15, 1996

MARCEL TIGGA,
B.K. SINHA
P.V. SREEKUMAR
Botanical Survey of India, Andaman and Nicobar Circle, Port Blair.

33. FLOWERING BEHAVIOUR OF MANGO (*MANGIFERA INDICA*) IN ANDAMANS

The typical humid tropical climate of Andaman and Nicobar Islands (native of two rare species of mango: *Mangifera andamanica* and *Mangifera nicobarica*. Parkinson 1972: Kostermans

1993) is suitable for mango cultivation. In addition to these two species *Mangifera sylvatica* is also recorded in these islands. The mango has been introduced in these islands when settlers were brought from different corners of India and also during the period when the Japanese ruled these islands and making these islands a rich source of mango genetic material.

In the tropics the flower induction takes place during dry period. If this lasts long enough, about four months then flowers will appear in the same dry season. Otherwise bloom will be during the rains which could prevent pollination and fruit setting. Generally mango tree flowers in December-January and fruiting takes place in April-July but there are some varieties which produce flowers twice a year e.g. Neelum and some are irregular bearers e.g. Malgoa. But while surveying in 1992-93 to select some promising clones which produces physiologically mature fruits before the onset of the monsoons, it was noticed and recorded that some mango trees in South Andaman-flower and fruit throughout year and there are some quite old trees which have not flowered yet. This flowering and fruiting throughout year varies from low to moderate. The physiological and biochemical details are required to be studied for this nature of flowering. This typical flowering behaviour of mango in Andamans can be due to uneven distribution of floreigen and other assimillates. Due to typical tropical climate of these islands the minimum and maximum temperature range is very narrow which can also be a cause of erratic flowering but whatever the cause may be, this typical flowering in mango can be utilized for an improvement programme.

January 19, 1996

D.B. SINGH
T.V.R.S. SHARMA
Central Agricultural Research Institute, Port Blair, Andaman & Nicobar Islands.

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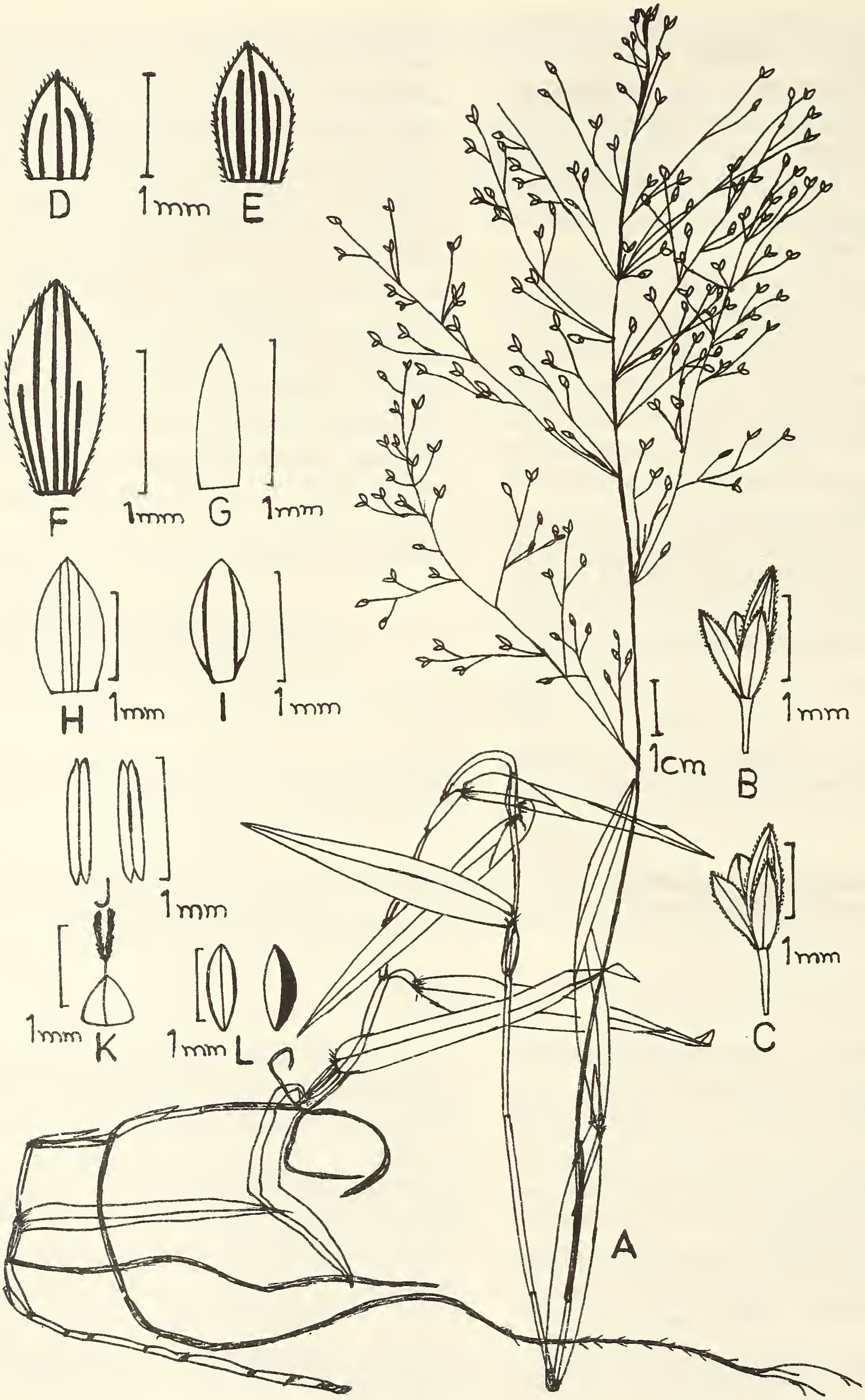
34. REDISCOVERY AT A NEW LOCATION OF A RARE GRASS, *CYRTOCOCCUM SPARSICOMUM* (NEES EX STEUD.) A. CAMUS, IN TAMIL NADU

(*With one text-figure*)

The specimens of a grass species, collected under shade in the dry mixed deciduous forest of the Alagarkovil MCPA of Dindigul Anna District in Tamil Nadu, were sent for identification to the Director, Royal Botanic Gardens, Kew, England, and identified by the grass expert, T.A. Cope, as *Panicum sparsicomum* Nees ex Steud. The present record is a rediscovery at a different location after its discovery from Kodaikanal Ghats in Tamil Nadu. There is no specimen in MH.

Hook.f. (1896), Alston (1931), Bor (1960), Nair (1989) and Davidse (1994) followed the treatment of *Panicum sparsicomum* Nees ex Steud. Bor (*l.c.*) opines that the species seems to occupy an intermediary position between *Panicum* and *Cyrtococcum* and they retained it in *Panicum*. Davidse (*l.c.*) corroborates the same and further says that the spikelets lack the typical crest characteristic for *Cyrtococcum*. On the other hand, Fischer (1934, 1957) and Senaratna (1956) followed A. Camus treatment, i.e. *Cyrtococcum sparsicomum* (Nees ex Steud.) A. Camus, who effected combination based on slightly compressed and somewhat gibbous nature of the spikelets. T.A. Cope (in *litt.*) states that "J.F. Veldkamp, author of GRASSES FOR FLORA MALESIANA considers it as a true *Cyrtococcum*." Even though



Figs. A-L. *Cyrtococcum sparsicomum* (Nees ex Steud.) A. Camus - A. Habit; B. Spikelet flowering; C. Spikelet fruiting; D. Lower glume; E. Upper glume; F. First lemma; G. Palea; H. Second lemma; I. Palea; J. Anthers: dorsal and ventral views; K. Ovary; and L. Caryopsis the species occupies an intermediary position between these two genera, the author accepts J.F. Veldkamp's opinion because similarities are more to *Cyrtococcum* rather than *Panicum.*

Cyrtococcum sparsicomum (Nees ex Steud.) A Camus in *Bull. Mus. Hist. Nat.* (Paris) 27:118.1921; Fisher in Gamble, *Fl. Pres. Madras* 1786. 1934&3: 1237. 1957 (repr. ed.); Senaratna, Grass. Ceylon 121:1956. *Panicum sparsicomum* Nees ex Steud., Syn. Pl. Glumac. 1:83.1854; Hook.f., *Fl. Brit. India* 7:58.1896; Alston in Trimen, Handb. Fl. Ceylon 6 (Suppl.): 321.1931; Bor, Grass. Burma Ceylon India Pakistan 330. 1960; Nair in Henry, Chithra and Balakrishnan, Fl. Tamil Nadu Series 1: Analysis 3:131.1989; Davidse in Dassanayake, *Rev. Handb. Fl. Ceylon* 7:344.1994.

Specimens examined: Tamil Nadu: Dindigul Anna District, Alagarkovil MPCA, Alagarmalai R.F.: ± 475 m, 7.iii.1994, M.B. Viswanathan 3075; ± 215, 3.ii.1995. M.B. Viswanathan 17016; ± 450 m, 4.ii.1995, M.B. Viswanathan 17027.

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June 17, 1996 M.B. VISWANATHAN
Sri Paramakalyani Centre for Environmental Sciences, Manonmaniam Sundaranar University, Alwarkurichi-627 412.

35. *SCURRULA PARASITICA* LINN. PARASITIC ON *CALLIANDRA* SPP. AND ITS MANAGEMENT

Scurrula parasitica is an epiparasite on a variety of economically important trees including ornamental trees of high aesthetic value. It spreads on branches affecting bio-mass production of its host (William 1980).

The genus *Calliandra* (Leguminosae: Mimosae) also called Trinidad Flame Tree is represented by a group of ornamental flowering trees with handsome, bipinnate feathery leaves and powder-puff like flowers. *Calliandra guildingi* (*tweedii*) is a free flowering hardy tree blooming round the year. The flowers (anthers) are reddish-purple. White flowered *Calliandra speciosa* is also in cultivation.

In 1994, it was observed that *C. guildingi* planted on either side of the front of the old Agricultural College, Hebbal, Bangalore which had grown beyond their usual size, the tertiary branches stretching laterally,were invaded by the flowering parasite *S. parasitica.* Another species *C. speciosa* grown near the entrance of the floriculture section at GKVK Campus of the University of Agricultural Sciences, Bangalore, was also found parasitized by the same species.

As characteristic of any true parasite. *S. parasitica* also does not kill the host immediately. Only the branches of *C. guildingi* heavily infested by *S. parasitica* succumbed ultimately, which effectively is in partial agreement with the observation made by Bidie in Fischer 1926, who wrote that the exotic plants invaded by the parasites of Loranthii are killed. In the case only two of the four branches infested by the parasite were killed, which may be due to allelopathic effect, at a later stage. The parasitized branches beyond the point of cortical root development were thin with sparse flowers and presented a very sickly and dried appearance at the tip, thus affecting both growth as well as its aesthetic value, while the parasite putting forth a luxuriant growth looked like a leafy cascade. The parasite spread on all the branches and established itself very well, at the cost of the host.

Interestingly, of the several (105) trees in the first location belonging to 15 species of 11 genera, only two plants of *C. guildingi* and *C. speciosa* plants not pruned and maintained properly were infested by the parasite, indicating the parasites' preference to these neglected plants, while the other plants of *Calliandra* spp. which were pruned regularly were free from *S. parasitica*. Periodical pruning a little below the point of infestation would result in the selective elimination of the parasite along with its haustoria.

ACKNOWLEDGEMENTS

We thank Rev. Dr. C.J. Saldhana for identification of the parasite.

January 19, 1996

D. NUTHAN
Associate Professor, Department of Forestry,
M. VASUNDHARA
Assistant Professor, Division of Horticulture,
University of Agricultural Sciences, GKVK,
Bangalore-560 065.

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36. TWO NEW RECORDS OF *ASTERACEAE* FOR ANDHRA PRADESH

During the course of floristic studies on Asteraceae in Andhra Pradesh, India, some interesting specimens were collected from the Eastern Ghats. After critical studies on the specimens, thorough perusal of literature and authenticated specimens in various herbaria, viz. MH and CAL, these were identified as *Adenostemma lavenia* (L.) O. Ktze, var. *angustifolium* (Clarke) Koster and *A. lavenia* (L.) O. Ktze. var. *madurense* (DC.) Panigrahi which are new distributional records for Andhra Pradesh. An artificial key, description along with nomenclatural citations, distribution, ecological and phenological data are given for both the taxa.

Adenostemma J.R. Forster et J.G.A. Forster

1. Leaves broadly ovate, chartaceous, distinctly dentate to serrate-dentate, achenes more than 4 mm long, minutely glandular to glabrous .... var *madurense*

1. Leaves lanceolate, coriaceous, serrate or crenate, achenes less than 3 mm long, muricate .... var. *angustifolium*

1. Leaves maximum 10 cm broad, crenate to serrate, achenes densely warty .... var. *lavenia*

Adenostemma lavenia (L.) O. Ktze., Rev. Gen. Pl. 1: 304. 1891. var. *angustifolium* (C.B. Clarke) Koster in Blumea 1: 475. 1935; Panigrahi, Kew Bull. 30 (4): 652. 1975.

A. angustifolium Arnott in Nov. Act. Nat. Cur. 18. 347. 1836; DC., Prodr. 7:266. 1838; Grierson in Dass. & Fosb. Rev. Handb. Fl. Ceylon. 1:138. 1980. *A. viscosum* J.R. & G. Forst. var. *angustifolium* C.B. Clarke, Fl. Brit. Ind. 3:242. 1882. Pro parte.

Erect herb, 30- 50 cm, stem glabrous. Leaves opposite, 3.5 - 13 x 0.8 - 2 cm, base attenuate in lower ones, obtuse in uppermost ones, entire in the lower half, crenately serrate to serrate in upper half, obtuse. Heads solitary or a few in terminal corymbs, 6 mm, white, homogamous, not rayed; peduncle 0.6 - 2 cm, puberulous and glandular. Involucral bracts 18, 2-seriate, 4-4.5 mm, oblong or narrowly oblong-elliptic, 3-veined, pubescent on dorsal side, obtuse or obtusely apiculate. Receptacle alveolate, 2 mm across. Florets 30 - 34, corolla 3 mm long, 5-lobed; lobes ovate, obtuse, glabrous, sparsely hairy at base on dorsal side. Stamens 5; anthers oblong, 1 mm long obtuse at base, hood ovate, obtuse. Style 5.5 mm, exerted; exertion 2 - 2.5 mm; branches 3-3.5 mm, spathulate, obtuse. Pappus of 3-5 clavate scales, 0.4 mm long, basally united to form a ring. Achene oblanceolate, 1.6 - 2 mm, muricate.

Ecology: Along the streams in forests, rare.

Flowering: October - January.

Distribution: India: Andhra Pradesh, Assam, Konkan, U.P., Bengal.

World: Sri Lanka, (Myanmar) Burma, Thailand.

Specimens examined: Talakona (Chittoor district), C.P. Raju 13245.

Adenostemma lavenia (L.) O. Ktze. var. *madurense* (DC.) Panigrahi in Kew Bull. 30 (4): 654. 1975; R.R. Rao *et al.*., Fl. Ind. Enum. - Ast. 12. 1988 *A. madurense* DC. in Wt., Contrib. Bot. Ind. 9. 1834. *A. viscosum* J.r. Forst. & J.G. Forst. var. *reticulatum* Hk. f., Fl. Brit. Ind., 3:242. 1881. pro parte.

Erect herb, 30-100 cm; stem glandular pubescent. Leaves opposite, sparsely puberulous, 2-17 x 1-11 cm, obtuse-attenuate at base, serrate-dentate, apex acute. Heads few, terminal on divaricating branches, white, 7 mm long, homogamous, not rayed; peduncle up to 2 cm, densely glandular and pubescent. Involucral bracts 13, sub-biseriate, elliptic, obovate or elliptic-oblanceolate, 4.5 - 5.5 mm, very sparsely glandular and hairy on dorsal side towards base, margin usually ciliate with glands, obtuse or minutely dentate. Receptacle alveolate, 1-2 mm across. Florets 18 - 20, corolla 3 mm long, 5-lobed; lobes ovate, 0.5 mm long, densely hairy on dorsal side, acute. Stamens 5; anthers linear-oblong, 1 mm, hood retuse at apex, base truncated to obtuse. Style 5 mm, exerted to 2.5 mm, branches 3.5 mm, broad, spathulate, obtuse. Pappus of 3 clavate scales, on a short ring, 1 mm. Achene compressed, oblanceolate, 5 mm, slightly curved, young ones yellow, matured black, minutely glandular.

Ecology: Along streams at higher elevations, rare.

Flowering: August - January.

Distribution: India: South India, Assam.

World: Malaya, Myanmar (Burma), Sri Lanka.

Specimens examined: Anantagiri (Visakhapatnam district), C.P. Raju 9959.

ACKNOWLEDGEMENTS

We thank the authorities of the CAL and MH herbaria for permission to consult herbaria and libraries and Council of Scientific and Industrial Research, New Delhi for financial assistance.

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R.R. VENKATA RAJU
C. PRABHAKAR RAJU
Department of Botany,
Sri Krishnadevaraya University,
Anantapur - 515 003, India.

37. SUN-TRACKING IN *RANUNCULUS HIRTELLUS* ROYLE EX D.DON.

(*With one text-figure*)

The facility with which heliotropic leaves and flowers turn to face the sun has for so long been part of nature lore that it may well be surprising to the casual observer that so little is known of the mechanism of perception and response of foliar orientation (Smith, 1984). Heliotropic movement by flowers have been described for over a century (Hooker, 1881). Kevan (1972) defined these heliotropic movements or heliotropism as the "diel bending response or turning of plants directly to and with the sun". It is now known that heliotropic movements are mediated by changes in cell turgor pressure (Vogelmann, 1984). Heliotropic movements have been studied in detail in the arctic flowers like *Dryas integrifolia, Papaver radicatum* Kevan, 1975), tropical alpine flowers like *Oritrophium limnophilum* (Smith, 1975), alpine flowers like *Ranunculus adoneus* (Stanton and Galen, 1989), in leaves of *Lavatera cretica, Malva parviflora* (Koller, 1980) etc.

Heliotropism in the flowers of alpine plants growing in the Himalayan arc have still not been noticed. The Himalayan alpine zones, similar to other alpine zones of the earth, are very cold and any biotic mechanism such as heliotropism for maximizing use of small heat budget in the form of solar radiation is

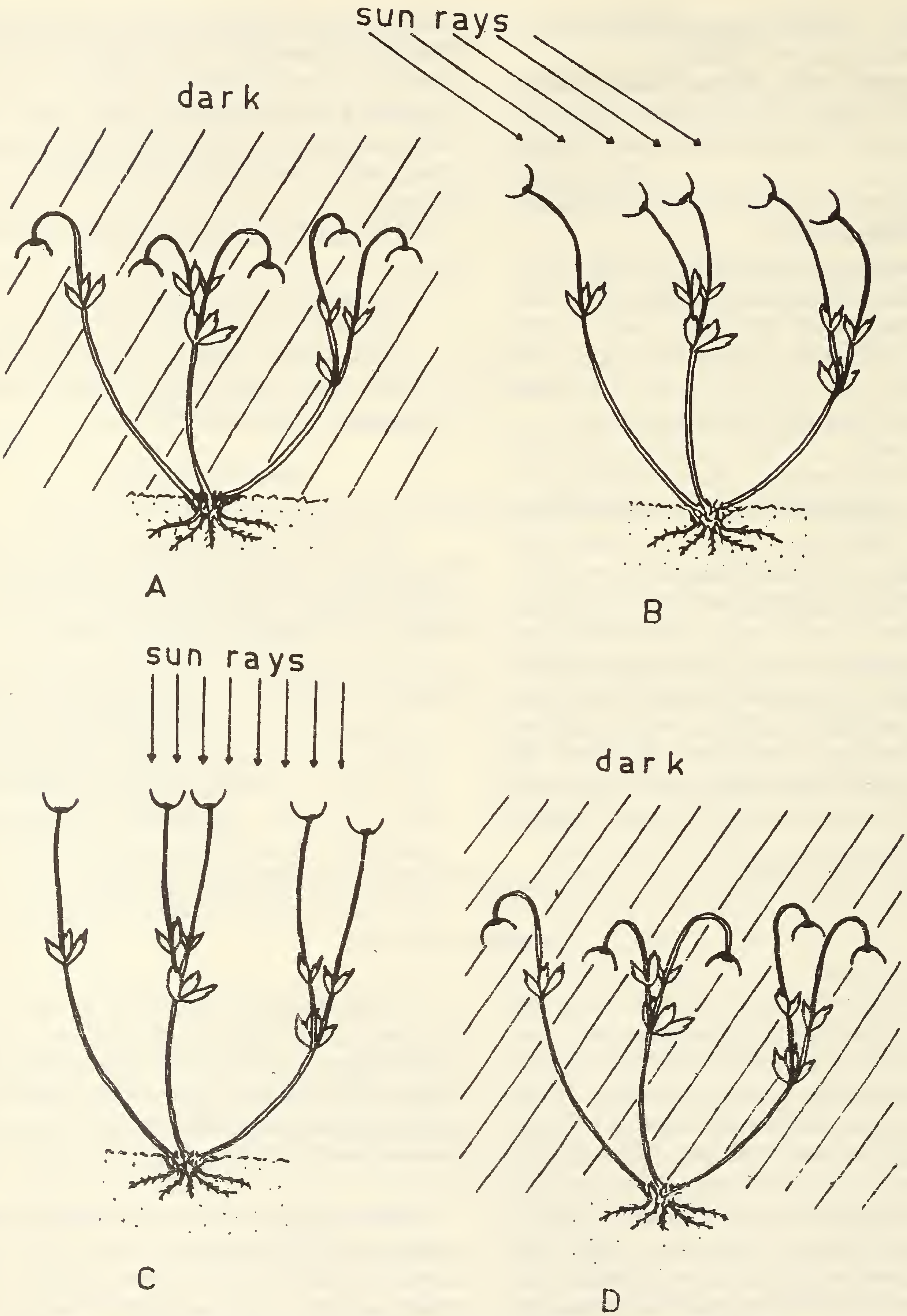

Fig. 1 General trend of heliotropism in *Ranunculus hirtellus* Royle ex D.Don
A - at 00 hrs the flowers are pendent; B - at 0008 hrs the flowers are oriented towards the suns heat; C - at 1200 hrs the flowers face the sky; D - at 2000 hrs the flowers are pendent again.

advantageous. During the third week of June, 1994 we noticed partial heliotropism in *Ranunculus hirtellus* Royle ex D.Don,. This is the first report of heliotropism in any alpine plant of the Himalaya, although the possibilities had already been indicated (Ohba, 1988).

Observations on *Ranunculus hirtellus* Royle ex D.Don revealed that this species shows sun-tracking from early morning hours to mid-afternoon. The observation site is located in the glacial valley of Kedarnath (3560 m above msl), Garhwal Himalaya, India. The valley lying in north south direction has high ridges (*c.* 5000 m) on either side with typical alpine vegetation on slopes and in the centre.

Ranunculus hirtellus is an ascending perennial herb growing early in the marshy areas near snow edges. During the days of observations, the sun rose at 0745 hrs and the sky remained clear till 1300-1400 hrs in the evening it rained or remained overcast. These environmental conditions are common in the Himalayan alpine zones during June and prevailed throughout the observation week. The flowers were shining yellow, bowl-shaped with a diameter of 1.0-1.5 cm. In our simplified observations 150 flowers of this species were randomly selected and their positions - sunfacing (S) or randomly oriented (R) were recorded at 0008 hrs 1200 hrs, 2000 hrs and 00 hrs continuously for a week. The reading at 1600 hrs were avoided as the sky remained overcast and the sun-tracking movement get discounted in cloudy sky. The results are provided in the table below:-

All 150 flowers were closely observed and it was found that the majority of the flowers moved with the sun, i.e. *c.* 15° per hour, starting their movement just before sunrise and became vertically oriented between 1200 hrs to 1300 hrs. It was also noticed that majority of the flowers remained pendent in the night. Young flowers with shining bowl-shaped petals and long slender pedicels (2-3 cm or more) are more efficient in sun-tracking than mature flowers with sepals perpendicular to floral axis and short thick pedicels. The most efficient sun-tracking flowers show about 15° turn per hour for about 4-5 hours i.e. from 0008 hrs - 1300 hrs. Unfortunately after 1300 hrs the sky usually becomes cloudy, hiding the sun and if raining (in the rain flowers become pendent) the sun-tracking is discontinued. In overcast sky orientation of the flowers was random in most of the flowers.

In a separate experiment 25 unopened flowers of *Ranunculus hirtellus* were emasculated and rest of the flowers in the surrounding (about 10 m area on all sides) were clipped to prevent anemophily. It was observed that all the flowers developed normal achenes indicating successful entomophily. Small flies are seen as the most frequent flower visitors, resting on the bowl-shaped flowers for long durations.

Similar observations have also been recorded for *Ranunculus adoneus* in Colorado Rockies of USA and the significance of sun-tracking for more efficient pollination and seed setting has been proved (Stanton and Galen, 1989). Hocking and Sharplin (1965) discovered flower basking by insects in arctic *Dryas integrifolia* and *Papaver radicatum* and have suggested that in an environment where the season is short and every calorie counts, it must have survival value in

Time	I	Day	II	Day	III	Day	IV	Day	V	Day	VI	Day	VII	Day
	S	R	S	R	S	R	S	R	S	R	S	R	S	R
0008 hrs	78	72	60	90	66	84	69	81	73	77	80	70	71	79
1200 hrs	133	17	125	25	137	14	128	22	138	12	124	26	129	21
2000hrs	16	134	13	137	20	130	12	142	23	127	18	132	22	128
00 hrs	8	142	9	141	12	128	13	137	15	135	18	132	20	130

S = sun facing (when sun is available i.e. 0008 hrs to 1300hrs) or sky facing (when sun is not available).
R = randomly oriented (not facing sun when sun is available, i.e. 0008 hrs to 1300 hrs) or pendent (when sun is not available).

accelerating the ripening of the insect germ cells. Kevan has also indicated that the extra warmth obtained by the basking insect due to heliotropic movement of flowers must be valuable in increasing the insects' metabolism, giving them greater mobility by preheating them for flight, thus increasing their abilities of pollination (Kevan, 1975). Similar significance could not be ruled out in case of *Ranunculus hirtellus*. Heliotropism has been considered as an adaptive feature of arctic and alpine plants and its could also be an adaptive feature in alpine plants of the Himalaya having bowl shaped flowers.

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D.S. RAWAT
R.D. GAUR
Herbarium and Plant Systematic Lab.
Department of Botany, P.B. 86
HNB Garhwal University
Srinagar (Garhwal), 246 174, U.P.

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BOMBAY NATURAL HISTORY SOCIETY

Hornbill House, Dr.Salim Ali Chowk, S.B. Singh Road, Bombay 400 023.

111th ANNUAL REPORT AND ACCOUNTS
FOR THE YEAR 1ST APRIL 1994 TO 31ST MARCH 1995
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REPORT OF THE SUB-COMMITTEES OF THE EXECUTIVE COMMITTEE

The following office bearers were Ex-officio members of all the Sub-Committees.

Hon. Secretary	Dr. Ashok M. Bhagwat
Hon. Treasurer	Mr. Sunil Zaveri
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PUBLICATIONS SUB-COMMITTEE

Chairman	Dr. Jay Samant (Director)
Members	Dr. Pratap Saraiya (Vice President)
	Mr. B.F. Chhapgar
	Mr. J.C. Daniel
Convenor	Dr. Gayatri Ugra (Publication Officer)

The Publications Section has adhered to its policy of self-sufficiency with the sale of its popular titles such as the **Book of Indian Birds**, **Book of Indian Animals** and the **Book of Indian Reptiles**. Also popular were **Pictorial Guide to the Birds of the Indian Sub-Continent** and **Some Beautiful Indian Trees**. The books are marketed through the Oxford University Press. The royalty from sale of books for the year 1994-95 was Rs. 9,10,995. The revised edition of the **Pictorial Guide to the Birds of the Indian Sub-Continent** and the **Book of Indian Birds** are nearing completion. Several new titles are being worked on, including books on Indian trees, wetland flora and a field guide to Indian sea shells.

The **Hornbill Series** booklets published by the NCSTC in collaboration with the Society are intended to popularize various aspects of natural history. Six titles are now ready for the press.

The Section has succeeded in tightening up the schedule of publication of **Hornbill** and **Journal**. In this financial year, **Hornbill** 1993 (3) and (4) and 1994 (1) and (2) were published. Of the **Journal**, Vol. 90:3(1993), Vol. 91:1,2 and 3 (1994) have been published. **Hornbill** and **Journal** continue to be a resource drain, though some advertising support has been obtained for the **Hornbill**, as well as grants from the Mehta Scientific Education and Research Trust and Seth Purushotamdas Thakurdas and Divaliba Charitable Trust. The Department of Science and Technology, Govt. of India released a grant of Rs. 50,000 for this financial year. The shortfall for **Hornbill** and **Journal** is met by the Society as these publications are crucial in dissemination of scientific information, which is one of the main activities of the Society.

One Sr. Computer Operator and a Publication Assistant were recruited in March 1995. A new computer (486DX2 - assembled) installed with **Pagemaker 5.0** was purchased for the Publication Section.

The Publication Officer conducted a one day workshop on Print Media for the CEP staff.

PRODUCTS SUB-COMMITTEE

Chairperson	Mrs. D.S. Variava (Vice President)
Members	Mr. Atul Mathur
	Mrs. Meenu Kamat
	Mrs. Juliet Mendonca
	Mr. Francis D'Costa
Convenor	Mr. Joslin Rodrigues (Product Executive)

The Product Section continued to fulfill its objective of producing cards and calendars that reflected the Society's commitment to excellence in quality and reasonable prices.

Due to problems in production of the catalogue, the season started late, but in all, approximately 1,35,000 cards and 15,000 calendars were sold along with other products, leading to a net surplus of approximately Rs. 4.47 lakhs.

A new concept was introduced in the table calendar by using lithographs of Himalayan flowers for a new series entitled "Gems from Nature". The idea of this series is to make available to members and others, pictures which may not otherwise be easily available because the pictures are from rare, out of print books. Eventually, the Society may be able to use these prints for publication in book form.

The Product Committee appreciates the co-operation of all concerned members of the staff and volunteers to produce high quality products.

NATURE EDUCATION, PROGRAMME & MEMBERSHIP SUB-COMMITTEE

Chairman	Mr. Ulhas Rane
Members	Dr. Ashok Kothari
	Dr. Arun Joshi
	Dr. Shashi Menon
	Mr. T.V. Sowrirajan
	Mr. V.K. Paralkar
	Mr. Vilas Shingre
	Mr. Naresh Chaturvedi (Curator)
	Mr. Deepak Apte (Nature Education Officer)
Convenor	Ms. Caroline Vincent (Membership Officer)

MEMBERSHIP

This year ordinary membership showed a slight increase. Similarly, Life Members increased to 1421 from 1345. It was observed that several Ordinary members converted their membership to Life membership. An attempt to increase membership during the celebration of Dr. Salim Ali's Birth Centenary will be undertaken with the help of members, along with other BNHS departments like Nature Education, SANCF, Public Relations & Products.

The Environment Workshops organised for the Armed Forces have yielded good results in the form of new membership. More such workshops should be organised. We also conducted special membership drives for the Bombay Chartered Accountants' Society and IAS & IPS Wives' Association, which was very successful in enrolling new members and enabled the BNHS to publicise its activities.

Membership for the year 1994 - 95

Type of membership	Year		
	1992	1993	1994/95
Ordinary (Indian)	1527	1663	1677
Student	403	480	409
Life (Indian)	1305	1345	1421
Corporate	32	54	7
Compound Corporate	111	111	111
Family	57	8	0
Ordinary (Foreign)	15	24	25
Life (Foreign)	211	211	192
Institutional	0	0	77

PROGRAMMES

Annual Nature Camps

Several annual nature camps were arranged, out of which camps at Har-Ki Doon in Garhwal Himalayas, Corbett National Park in Uttar Pradesh, Kanha National Park near Jabalpur, Dajipur Wildlife Sanctuary near Kolhapur, Nanaj Wildlife Sanctuary near Solapur and a combined visit to National Parks and Sanctuaries of Vidarbha were some of the more successful camps.

Overnight Nature Camps

These camps were arranged with a duration from 2 to 4 days at Mahabaleshwar, Ransai Lake, Nandur-Madhmeshwar and Kelwe Dam.

Nature Walks

These walks were held during weekends. The outings were arranged at Sanjay Gandhi National Park, Yewoor Trail, Tungareshwar, BNHS land and Jijamata Udyan (Bombay Zoo) for study of flora and fauna. In all, 30 such nature walks were organised.

Film/Slide Shows

Video as well as 16 mm films on various natural history subjects were screened during the year. Talks illustrated with slide shows were given by invited guest speakers, BNHS members and staff. Altogether, 72 shows were held.

Wildlife Week

Wildlife Week was celebrated from 3rd to 8th October during which an exhibition of nature on postal stamps was organised. Postal stamps on birds, mammals, marine life, butterflies and other insects from the collection of the Curator, Mr Naresh Chaturvedi, were exhibited.

An exhibition of wildlife photographs was organised by the BNHS members at Panvel.

World Forestry Day

World Forestry Day was celebrated on 21st March. On this occasion the beautified footpath of Hornbill House was inaugurated by the Municipal Commissioner, Shri Sharad Kale. The inauguration was followed by tree planting by the Commissioner.

NATURE EDUCATION

Summer Camp

The annual programme began with a summer vacation camp for students at Tansa Wildlife Sanctuary. The camp was held from 21st to 23rd May. Tansa, a dry deciduous forest is ideal for watching birds in summer. A total of 60 species of birds were seen during the three days stay. A leopard was sighted by a few students. Tracks of various animals were observed. Demonstration of how to take pug mark casts was also given. Since it was summer, all afternoon programmes were held indoors, which included sketching, quiz competition and a session on nature education and students' participation. In all, 17 students participated in the camp.

Monsoon Camp

Nature orientation camps conducted regularly at the IIT had been discontinued for a couple of years. This year the camp was held at the IIT from 26th to 30th June, in which 30 participants attended. New topics like rain forests, remote sensing techniques and snake show were covered along with other activities.

Post Monsoon Camp

To study the breeding habits of Great Indian Bustard and the grassland habitat, a four day camp was organised at Nanaj Sanctuary at Solapur from 20th to 24th August 1994. 22 participants attended the camp.

Rural Camps

The Nature Education Scheme has always had a special interest in rural camps. This year a rural camp at Pirangut in Mulsi Taluka, District Pune, was sponsored and held from 14th to 18th November. 120 students and 15 teachers attended the camp. A rural camp was also arranged for Kamalabai Nimbkar Balbhavan at Phaltan, in Satara district at Mahabaleshwar for two days. 22 students participated in this camp.

Nature Rambles

In all, 40 field trips to various places like Sanjay Gandhi National Park, Tungareshwar, Karnala and Prabalgad and Juhu beach were conducted. Out of these 40 trips, 5 were arranged for college students while the rest were for school students of stds. 8-10. Altogether 1734 students participated in nature rambles throughout the year.

Talks illustrated with slides/films

Various schools were visited for slide shows on different aspects of natural history and nature education. In all, 22 slide shows were held.

Five film shows were held at schools and one at an organisation (SOCLEEN). Besides these activities, seven snake shows, two visits to the natural history section of the Prince of Wales Museum and two visits to the BNHS collections were also conducted. Of these, snake shows were the most popular and were attended by maximum number of students. 3714 students attended various slide shows, film shows and snake shows, visits to zoo and museum.

Programme for Forest Guards

An awareness programme was conducted for the forest guards of Tansa Wildlife Sanctuary. Importance of proper documentation of field data and data entry methods were explained. 30 forest guards participated in the programme.

Workshop

A Nature Orientation Workshop for teachers was organised at the BNHS from 9th to 11th January 1995. A grant was received from Ministry of Environment and Forests, through the BAIF for this programme. Though 18 teachers had registered for the workshop, only 10 of them were able to attend. Lecture-cum-slide shows were presented by various resources persons from the BNHS. A one day nature walk was arranged at the BNHS land at Goregaon.

Seminar

A seminar organised by Paryavaran Vahini, Thane unit was attended by the Education Officer at Thane as resource person. A one day trail was conducted at Tansa, Suryamal and Shahapur.

Another Seminar conducted by the CEP was attended by the Education Officer as participant. Later, a half day nature trail was led during the seminar at the BNHS land.

Special Programmes

A *Shramadan* was arranged for six consecutive Sundays at the BNHS land to build an earthern bund for soil and water conservation. On an average 10 members participated every Sunday.

A special programme was arranged at the IIT, as a part of the Wildlife Week celebration. Four film shows and one slide show were held for the IIT students and general public. Around 100 visitors attended the shows. The BNHS stalls were arranged at the IIT campus. The BNHS stall was also arranged at St. Xavier's College during the Malhar festival. Besides being educational, these activities were conducted as membership drive also.

As resource person, the Education Officer attended a camp at Junnar in Pune for the YMCA secretaries from all over India. Three sessions on nature education and people's participation were held and a morning nature trail was arranged.

Tree plantation was undertaken to celebrate World Environment Day at the BNHS land.

Competitions

A painting competition for school students was arranged on the eve of Late Dr. Salim Ali's birthday. 220 students participated in the competition. Paintings were judged by a panel of judges. The prizes were distributed on 23rd November 1994 by the President, BNHS.

An all-India essay competition was held in which 140 essays were received. The final selection of the prize winning essays was done by a panel of judges. The prizes will be distributed on a special occasion.

In all, a total of 6224 students and others participated in various activities like camps, nature rambles, slide/film shows, snake shows, workshops, painting competition, essay competition training programmes and other activities.

CONSERVATION EDUCATION PROJECT SUB-COMMITTEE

Chairman Dr. Shashi Menon
Members Mr. Ramesh Dandekar
Mr. P.V. Bole (Sp. Invitee)

Convenors Mr. Arvind Karandikar (Proj. Mgr.)
Mr. T.K. Bharatan (Proj. Adm. Mgr.)

Activity Report

The three field teams conducted educational programmes in selected villages on identified issues, initially using available material from other sources. Later, based on their experience in the field, they initiated development of project's own educational material. This is being field tested. Results obtained till now are very encouraging.

Joint activities alongwith NGOs and individuals working in the project area were initiated in all the three field areas. In Gudalur about 20 NGOs have been brought together for formalising 'Network' specifically to handle environmental issues.

Trainings and Workshops

Trainings were conducted in development activities, communication techniques and production of educational aids like puppets, flannel talk.

Six staffs from the project team visited United Kingdom for two weeks in September 1994. The visit was organised by the RSPB. The team could study and analyse different interpretation techniques at centres in the UK.

The Project Co-ordinator and Project Field Manager spent about two weeks in the UK on invitation of the Overseas Development Administration (ODA) and Royal Society for the Protection of Birds (RSPB), visiting various interpretation centres and holding discussions with other organisations for possible new activities by the BNHS. They got good insight in centre management and good response from important organisations like Royal Botanic Gardens.

Technical coordinator and a resource person from the RSPB came during the year. Draft of promotional plan for Conservation Education Centre has been prepared and circulated among experts for comments.

The local population including women in all the three project areas responded well to the educational programmes, meetings and discussions. Similarly, there has been good cooperation from the local forest officials, who participated in the project activities along with local NGOs.

From the experience of implementing the project, BNHS identified many areas where the RSPB experts can provide inputs through workshops and seminars. The BNHS senior scientists and members now take part in meetings and discussions for designing the education centre and other programme related aspects.

Conservation Education Centre

The frame structure was completed along with slabs and plastering in parts. Civil work will be completed by September 1995. Simultaneously, work on interiors and products of the Centre will be initiated in May 1995. It is hoped to have the Centre to be operational by the end of 1995 after which production, multiplication and dissemination of materials useful for educational activities will be taken up. These include brochures, educational kits, games, slide sets and booklets. All such materials have been designed to suit the specific needs of the Indian audience.

UNIVERSITY STUDIES SUB-COMMITTEE

Chairman Dr. Jay Samant (Director)
Members Mr. M.R. Almeida
Prof. P V. Bole
Dr. B.F. Chhapgar
Mr. J.C. Daniel
Mr. N. Chaturvedi (Curator)

Convenor Mr. Deepak Apte (Education Officer)

At present following students have registered for M.Sc. (by research) and Ph.D. in Zoology and Botany:

Name	Guide	Course
Ms. Hema Somnathan	Dr. Jay Samant	Ph.D. Zoology
Mr. Subash Mali	— " —	— " —
Mr. A.G. Sekar	— " —	— " —
Mr. A.S. Brar	— " —	— " —
	***********	
Ms. Nikita Prakash	Mr. J.C. Daniel	M.Sc Zoology
Mr. Prakash Rao	— " —	Ph.D. — " —
Mr. N. C. Chaturvedi	— " —	— " —
Mr. Asad Akhtar	— " —	— " —
	***********	
Ms. Deepika Bhardwaj	Dr. B. F. Chhapgar	M.Sc. — " —
Ms. Vidya Ullal	— " —	Ph.D. — " —
	***********	
Mr. P .D. Vivek	Dr. R. B. Grubh	M.Sc. — " —
Mr. Alagar Rajan	— " —	Ph.D. — " —
	***********	
Ms. V. Subhalakshmi	Mr. N. C. Chaturvedi	M.Sc. — " —
	************	
Ms. T. Sinh	Dr. Mrs.Almeida	Ph.D. Botany

Ph.D. in Zoology

Mr. Bharat Bhushan successfully completed Ph.D. in Zoology and the degree was awarded.

A circular on the M.Sc. (by research) and Ph.D. courses was sent to all the colleges in Bombay and major research institutes all over India. A press release was also given. In response to this, 30 applications were received for both the courses, out of which following candidates were selected.

No.	Name	Guide	Course
1.	Yogesh Gokhale	M.R. Almeida	M.Sc. Botany
2.	Utkarsha Ghate	M.R. Almeida	M.Sc. Botany
3.	Ajay Gramopadhyay	Dr. R. Borges	M.Sc. Zoology
4.	Navneet Manj	Dr. R. Borges	M.Sc. Zoology
5.	B.S. Swamy	Dr. B.F. Chhapgar	Ph.D. Zoology
6.	Vivek Kulkarni	Dr. B.F. Chhapgar	Ph.D. Zoology

Diploma Course in Conservation Biology

This vocational course was successfully conducted at the BNHS. The course was coordinated by Nature Education Officer and Principal Scientist with help from faculty members and visiting experts. This intensive course, with 72 lectures and a seven day field visit to Melghat Tiger Reserve covered various aspects of ecology, political issues involved in biological diversity conservation, protected area network, wildlife trade and sustainable development. The course was found to be ideal foundation to wildlife enthusiasts and students wishing to pursue post-graduate studies in ecology and environmental sciences.

LIBRARY SUB-COMMITTEE

Chairman	Dr. Ashok Kothari
Members	Dr. B.F. Chhapgar
	Ms. Mehru Dubash
	Ms. Doreen D'sa
	Mr. V.K. Paralkar
	Mr. Vilas Shingre
	Mr. N. Chaturvedi (Curator)
	Mr. Isaac Kehimkar (PRO)
Convenor	Ms. Shubhangi Puradkar (Asst. Librarian)

This year altogether 2050 new titles were added to the library, including 505 books from late Dr. Salim Ali's collection, and 70 books purchased, 15 received for review and 1460 received as donation and complimentary. Eight new journals were subscribed bringing the total to 170 national and international journals that are received in the library. A majority of the journals are received in exchange for the Society's **Journal**. A revolving display rack was purchased to display the latest periodicals received in the library.

The objective of the library is to provide correct information from right the source to a person at the right time. However, with ever increasing collection of information, the retrieval of information has become more and more complex. Therefore, for efficient handling of information, a library management software package, SLIM was purchased. Till date about 1000 titles have been computerized. To clear the backlog, a library assistant was appointed.

Every month, members and staff are informed of the new books received for approval and those added to the library. The list is displayed on the library notice board. Clippings of current news appearing in leading newspapers on natural history and conservation are displayed on the notice board.

As an insurance against loss and damage of library books, a deposit of Rupees 250.00 was introduced.

The Assistant Librarian attended a six-week training course on **Paper Conservation and Preventive Maintenance in Libraries**, organised by INTACH and Indian Conservation Institute at Lucknow.

RESEARCH AND COLLECTION SUB-COMMITTEE

Chairman	Mr. M.R. Almeida
Members	Dr. Pratap Saraiya
	Mr. K.P. Karamchandani
	Dr. B.F. Chhapgar
	Mr. J.C. Daniel
	Dr. Shashi Menon
	Dr. Rajendra Shinde
	Mr. H. Abdulali (Invitee)
	Dr. Renee Borges (Pricipal Scientist) till 8.4.1995
	Mr. N. Chaturvedi (Curator)
Convenor	Mr. S.R. Nayak (Project Secretary)

COLLECTIONS

Post graduate students from various colleges in and around Bombay, from the J.N. University, Jodhpur, College of Agriculture, Dapoli and participants of the Refresher Course for zoology teachers visited the collections. They were told about the collection and preservation methods and use of collection for various purposes .

Minister of State for Environment and Forest, Govt. of India, Directors from the MOEF, Delhi, Director, Zoological Survey of India, visitors from organisations like Bombay Chartered Accountants' Society, ICICI, and IPS and IAS Wives' Association visited the collections. The collection was also referred to by members and scientists. Some of the prominent were Dr. Indra Neil Das, Mr. T.N. S. Murthy, Dr. K. K. Tiwari, Dr. K. Padhyan, University of Bradford, U.K., Dr.William Oliver, Conservation Officer, Jersey Wildlife Trust, Channel Islands and Dr. Dolttinger from Germany. Ms. Pamela Rasmussen of Smithsonian Institution, Washington visited the collections for reference. Assistance was given to Ms. Malvika Choudhary of Meerut University and Ms. Vidya Athreya in referring to the collections. Information on identification of dragonflies belonging to genus *Orthetrum*, and a key for identification of aquatic beetles were sent to students from Iran.

Identification

Photographs, specimenss of plants and animals (mammals, birds, reptiles ,amphibians and insects) brought by members and research students were identified and information was given . 108 plant specimens received from the Grassland Project were identified. *Avicennia marina*, new secondary host plant was recorded for Teak Defoliator Moth, *Hyblaea puera*.

Additions

A specimens of Rusty Spotted Cat, *Felis rubiginosa* received from Shri Digveerendra Sinh was added to the collection. 688 Bird specimens donated by St. Xavier's College, Bombay from Br. Navarro's the collection were brought to The BNHS were treated, registered and are kept separately. A specimen of Frigate Bird, *Fregata ariel iredalei* was added to the collection. 60 specimens of butterflies from the collection of Roger Ashton were also added to collections.

Computerisation

Computerisation of the specimens listing of mammals, plants, reptiles and amphibians was over. Bird specimens are being catalogued and has been completed up to pipits and wagtails.

Survey

Scientists of the section undertook a status survey of flora and fauna of Rajbhavan. Phase one of the survey commenced in January 1995 and was completed in March 1995. During the Survey, 117 species of plants, 36 species of birds, 32 species of butterflies and 12 species of molluscs were recorded.

Maintenance

The collections were checked periodically and specimens were treated where necessary. The collection rooms were painted with antifungal paint. Cupboards having mammal and bird collections were painted and wooden cupboards were polished. Three ultraviolet light baits were installed to prevent insect pests in collections.

Seminars and Workshops

Scientist in-charge, mammal section participated in the International Environmental Education Course conducted in the U.S. during which he also visited Florida Museum and Smithsonian Institution .

Scientist in-charge, herpetology section presented a paper in the National Seminar on Endangered Species held at Kanyakumari.

The Curator at the instance of University of Bombay gave a series of lectures on Taxonomy of Insects for M.Sc. (Part II) for entomology students.

The collection staff also assisted in conducting a diploma course in Conservation Biology.

ENVIRONMENTAL IMPACT ASSESSMENT CELL

The EIA Cell had been set up with the intention of carrying out Environmental Impact Assessment projects and to undertake laboratory analysis of physico-chemical parameters of soil/ water regimes. In India, EIA studies are linked to statutory clearances and the EIA Cell has, through meetings, correspondence with Department of Environment, Maharashtra Pollution Control Board, Industrial Associations and other EIA Agencies has succeeded in communicating the word to these and other peripheral agencies that we have now entered into this specialized field.

This being the inception year of the EIA Cell, much of the activity was focused on setting up the environmental analytical laboratory and developing its facilities in addition to communicating to various interest groups. We are hopeful of applied research (EA) projects materialising in 1995-96, indications of which have already been received by the BNHS from early 1995.

An Action Plan along with laboratory layout plan and other details for setting up of the EIA Cell has been prepared and submitted. Interaction with British Council Division and United States Asia Environment Programme (US-AEP) have been initiated and is ongoing for access to new EIA Legislations/Guidelines in the UK and the USA. Laboratory Instruments, chemicals, books and consumables have been acquired and/or repaired for the laboratory towards the establishment of a soil and water analytical laboratory. Analytical equipments have been put under service contracts. Guidelines for acceptance of EIA projects by industrial project proponents have been prepared. General Terms of Reference for EIA projects have been prepared and list of parameters and analysis charges have been prepared for the laboratory. A.B. Inamdar, CRSE-IIT, has agreed to work with The BNHS in remote sensing applications for BNHS-EIA studies on a project-to- project basis.

Application for registration of the laboratory has been submitted to Bombay Municipal Corporation and Central Pollution Control Board.The EIA Cell has been registered by the British Council Division as part of the Working Group on EIA. There has been ongoing correspondence with bodies like UNEP, Asian Development Bank, World Bank, European Economic Community and University of Manchester,U.K. towards inclusion of the BNHS in different working/expert groups for EIA studies.Contacts have been established with other EIA agencies (towards collaborative work in EIA studies.

Following an invitation from the Maharashtra Pollution Control Board (MPCB), Bombay, the EIA Scientist attended a MPCB-NGO meeting at MPCB HQ in May, to discuss the formation of a MPCB-NGO Cell at Maharashtra Pollution Control Board to disseminate EIA reports. A meeting to discuss the Environmental Impact Assessment Study of Bombay-Vadodara Expressway, at Collector's office, Thane was attended. IIIrd Gurudas Committee meeting at Mantralaya on the Century Rayon accident was attended in July to analyse technical causes of the accident and to suggest mitigating measures to prevent recurrence of such disasters.

RESEARCH

During the year 1994-95 the BNHS had eight major and minor research programmes.

Bird Hazard Research Cell: Identification of bird strike remnants and consultancy service to aerodrome officials was continued.

A project proposal for developing electrophoretic techniques for bird and bat strike remnants was approved for funding by the ARDB. The concerned scientist was deputed by the Director to visit New Delhi for discussion with funding authorities for extension.

Members of the high level committee of

ARDB visited Bombay and held a meeting with President, BNHS to discuss plans for continuation of bird hazard research by the BNHS. A suggestion was made for National Centre for Bird Hazard Research and Prevention to be set up at the BNHS.

Grassland Ecology Project: Studies were carried out at the following field stations: Nanaj, Sholapur (Maharashtra), Rollapadu (A.P.), Fuley Chhari (Kutch), Dahod (Gujarat), Velavadar (Gujarat) and Dudwa National Park (U.P.).

Studies were conducted on Indian Fox at Rollapadu. Permission to collar 10 foxes was granted by the forest department.

Avifauna studies were undertaken at Banni grasslands to determine the effect of severe drought condition during the year. Dry grasslands of Jaisalmer were surveyed. A rapid survey of alpine grassland in Sikkim was undertaken. US advisor Prof. Mark Behan and USFWS Co-ordinator Mr David Ferguson visited Aligarh for discussions.

Major Findings and Recommendations

At Nanaj (Solapur) bustard population has increased. Owing to our representation, plan to build a large spinning mill, very close to bustard breeding ground, was cancelled. Studies on wolf indicated their preference for livestock during breeding season and during non breeding season they prey on black buck. Blackbuck population has increased in Nanaj.

In Rollapadu after ten years protection, grassland biomass has increased, but species richness has decreased. Blackbuck population has increased from 17 in 1985 to 275 in 1995. Crop damage has become a major problem.

It is desirable to reduce blackbuck population to 100. Studies conducted on Fox indicated population fluctuation. From half a dozen in 1984 to 40 in 1994 then a sharp decline due to an epidemic in 1995.

Banni and Velavadar in Gujarat are invaded by *Prosopis juliflora*. Livestock demography has changed due to invasion of this plant. Habitat of Chinkara and Wolf has been destroyed, and feeding ground of wintering common cranes is under increasing threat. We estimate that 40,000 common cranes winter in Banni.

Velavadar grassland is one of the best breeding ground of Lesser Florican. We estimate a population of 50 to 60 floricans.

In Thar desert there is nearly 50% drop in bustard population in last 10 years. This could be due to extensive poaching. Desert National Park is under increased threat due to a plan to build a canal. The bird diversity has shown an increase due to the Indira Gandhi Canal but local desert dwelling birds have declined. Chinkara population has recovered since mid 1980s. The Sultana grassland is badly damaged by mismanagement.

In the terai grassland of Dudhwa National park we found that invasion of weedy unpalatable lemon grass in the sort grass patches at higher elevation. This is due to the current management practice of annual burning. This has destroyed the grazing ground of Swamp deer. We suggest a combination of rotational burning and harvesting to control lemon grass.

Birds of Prey Project: Comments from USFWS were received on the draft final technical report.

The main objective of the Project was to obtain information on the distribution and numbers of resident raptors and assess conservation status of their population in the country.

Major Findings and Recommendations

A new species of raptor, Greyfaced Buzzard was added to the checklist of the raptors of the Indian subcontinent. Two species, namely Lesser Spotted and Lesser Fishing Eagles were found to be very rare. The Nicobar Serpent Eagle and Nicobar Sparrow Hawk which were never common were also found to be very rare. The range extensions of Crested Honey Buzzard and Amur Falcon in Andamans, Changeable Hawk Eagle and Besra Sparrowhawk in Nicobar, Rufousbellied Eagle and Eastern Marsh Harrier in Upper Gangetic Plains were recorded. The Amur Falcon was observed nesting in India for the first time after the year 1928 near Namdapha National Park, Arunachal

Pradesh . The nesting failure was recorded in Lesser Fishing eagle for three consecutive years in Corbett National Park due to suspected pesticide contamination.

General Recommendations were given for group of raptors in a particular habitat types as well as species specific recommendations were given for the rare raptors.

Giant Squirrel Project: Malabar Giant Squirrel is being studied in the Bhimashankar Wildlife Sanctuary. To develop a management plan for the conservation of the species, an attempt will be made to address the specific objectives, *viz.* food selection, ranging patterns and relationship between food availability and reproductive success.

USFWS Coordinator Mr David Ferguson visited the BNHS to discuss the progress of the project with the Principal Investigator.

Ecology of Elephants : The term of the project was over in March 1994. Salim Ali Nature Conservation Fund sanctioned a grant to help the scientist to collect data for a further period of 9 months. Radio collars on the elephants are still active.

Major Findings and Recommendations

The study established that Home ranges of elephant clans had been grossly underestimated previously when telemetry was not available and emphasised that Sanctuary boundaries should follow ecological rather than administrative boundaries. The fact that elephants in sanctuaries receive from various degrees of protection as their ranges extend beyond protected areas has been clearly defined. The importance of corridors linking metapopulations has been clearly brought out. Conflict between man and elephants caused by encroachment into elephant territories and the fact that elephants whose ranges have been encroached raid crops as they continue to use their territory and that management should consider these points when considering removing such trouble some elephants has been brought out. The food and habitat usage and the effect of selective removal of favoured food species on the forest structure was one of the main findings of the study.

The study on peripheral populations established that overuse by man and elephants degraded habitats rapid by making it impossible for such habitats to hold sustainable elephant population.

The study of isolated population at Dalma showed how a continuously degraded habitats is unable to sustain its elephant population leading to migration and enormous damage to both man and elephants. The study is a classic example of what could happen to small populations in habiting non-viable habitats.

Birds of Sriharikota: Research programme on this project concluded in June 1994. Field station was closed. Draft final technical report is under preparation.

Jerdon's Courser Project: The project started with the objective of surveying the avifauna of eastern ghats to establish status of the Jerdon's Courser. The scientist working on the survey has reported having seen five individuals of this rare species. The survey will continue for a further period of six months.

Study of Harriers: Velavadar National Park has an unusual concentration of roosting harriers, during the winter. Monitoring of this roost has been going on for the past 3 years during the winter season. The study is sponsored by Hawk & Owl Trust (U.K.).

SALIM ALI NATURE CONSERVATION FUND SUB-COMMITTEE

Conservation Issues were highlighted and the problems being faced by certain sanctuaries and protected areas which are threatened with unplanned development activities were discussed during a public meeting held in September 1994. The areas covered were **Narayan Sarovar Wildlife Sanctuary, Bhitar Kanika Wildlife Sanctuary, Balukhand-Konark Wildlife Sanctuary, Mangroves and the protected areas in the Andaman & Nicobar Islands**. As a result of public discussions of critical environmental issues, certain areas like the Gulf of Kutch, Bhitar Kanika Wildlife Sanctuary, Narayan Sarovar, Chinkara Sanctuary and the Melghat Tiger Reserve were specifically surveyed. These surveys helped the BNHS to acquaint itself with the current ground realities in these localities.Certain issues like the controversy about the allotment of land in the Gir National Park which needed immediate attention were also addressed and a clarification obtained from the concerned authorities.

Environment and nature conservation workshops were also organised for the Armed Forces. This interaction with members of the armed forces is helping to bring about an attitudinal change vis-a-vis environmental awareness amongst the defence services.

A public meeting to highlight the implications of the draft Forest Bill was also organised at Hornbill House. It generated a highly enlightened response from the members of the public, the forest department and experts in the field. A talk to highlight the ecological implications of the Sharavathy Valley Hydro Electric Project was also organised. At the local level ecological reconnaissance of the Powai lake area was initiated with a view to highlight its deteriorating condition in an appropriate forum. Networking with like-minded conservation oriented organisations has been initiated. It has generated a good response.

The Salim Ali Bird Count - 1994 was organised on 14th November. It received a fair response. Analysis of the count data is in progress, the analysis of the inaugural Salim Ali Bird Count - 1993 was completed and a final report submitted.

Requests for funding were received from different parts of the country, out of which funding was given to the following:

Elephant Radio Telemetry Studies at Mudumalai Wildlife Sanctuary	Rs. 20,000.00
Grant to BHNS Scientist to attend Seminar on Endangered Fauna at Kanyakumari	Rs. 1,800.00
Grant to Narmada Bachao Andolan	Rs 5,000.00

VISITORS

Minister of State for Environment and Forests, Govt. of India, Directors from the MOEF; Delhi, Mr Sharad Kale, Commissioner, Bombay Municipal Corporation, Director, Zoological Survey of India, visitors from organisations like Bombay Chartered Accountants' Society, ICICI, and IPS and IAS Wives' Association visited the collections and library. The collections were also referred by some of the prominent scientists like Dr. Indra Neil Das, Dr. T.N.S. Murthy, Dr. K.K. Tiwari, Dr. K. Padhyan, University of Bradford, U.K., Dr.William Oliver, Conservation Officer, Jersey Wildlife Trust, Channel Islands, Dr. Dolttinger from Germany and Ms. Pamela Rasmuesan of Smithsonian Institution, Washington.

Mr. Malcolm Whitehead,International Centre for Conservation Education, UK, Ms. Chris Skinner, Pulborugh Brooks, RSPB, UK, Mr David Elcome, Head, Education Unit, RSPB, UK, Mr John Edmundson, First Secretary, Cultural Affairs, BCD-Bombay, Mr.A.K.Nigam,IFS, Conservator of Forests (Wildlife), Western Region, Mr Johari, IFS, Mr. A R Bharati, Deputy Conservator of Forests, SGNP, 15 School Teachers from the German Embassy School, Bombay visited the Conservation Education Centre

STAFF ACHIEVEMENTS

Dr. Jay Samant, Director visited United States to attend **Initiative in Environmental Protection in the US** under the US Information Agency's Visitors' Programme. This visit resulted in interaction with various American NGOs, National Park managers and heads of federal and state environmental agencies. He was also invited by the RSPB to visit their Conservation Interpretation Centres and Nature Reserves in the UK and Ireland. Additional visits were to the Royal Botanic Gardens, Edinburgh, Bradford University, Hawk and Owl Trust, Harrison Zoological Museum and Birdlife International.

Mr Naresh Chaturvedi, Curator gave lectures in entomology (insect taxonomy) to the M.Sc. (Part II) students at the Bombay University.

Publications:

1. Chaturvedi,N.(1994): New adult male attractants of Danaid butterflies.JBNHS 91:152-153.
2. Paralkar, V. K. & Chaturvedi, N.(1994): An unusual roosting site of the marsh harrier *Circus aeruginosus*. JBNHS 91:311 .

Mr. A. G. Sekar, Scientist, Herpetology conducted a survey of Mahabaleshwar during the monsoon to study amphibian fauna. Presented a paper on the habitat of the amphibian fauna of the Kanyakumari district at the Seminar on Endangered Fauna of Kanyakumari District A talk on the **Endangered species of herpetofauna** was given at the Conservation Biology Course conducted at Hornbill House.

Publications:

1. Sekar, A.G. and Almeida, M.R. (1994):Range extension of the Bombay Shield tail snake, *Uropeltis macrolepis*. JBNHS 90:520-21.
2. Sekar, A.G.(1994): Range extension of the Spotted Forest Gecko *Cyrtodactylus collegalensis collegalensis*. JBNHS 91:323-24.

Dr. (Mrs.) S. Unnithan, Scientist in-charge birds section gave talk to the members of Indo-Japanese Association and the Bombay Chapter of the Bonsai Study Group on attracting birds to gardens and how to keep off sparrows and pigeons.

Mr. Manoj Muni,Scientist,in-charge mammal section attended a specialised training course **International Environmental Education** at Front Royal,US . Visited Conservation Research Centre, Front Royal, Smithsonian Institute, Washington, Florida Museum of Natural History. At the University of Boston, a lecture on **Conservation of Bats in India** was given to the post-graduate students. Participated as speaker/instructor in the diploma course in Conservation Biology, where a seminar was given on **Present Status of Indian Mammals** and **Role of Museums in Conservation**. At the Teachers' Training Course lectures were delivered on the **Role of Teachers in Environmental Education** and **Use of Communication Strategies in the Field of Environmental Education**.

Publications:

1. Bates, P.J.J., Harrison, D.L. and Muni, Manoj (1994): The Bats of Western India revisited. Parts I,II and III. JBNHS 91:1-15; 224-40 and 360-80.
2. Bates,P.J.J., Harrison, D.L., Thomas, N.M. and Muni, Manoj (1994): The Indian Fruit Bat *Latidens salimalii* rediscovered in Southern India. Bonn zool. Beitr. 45:89-98.
3. Muni, Manoj, Kothari, A. and Bhiwgade, D.A.(1994): Occurrence of the Leaf-nosed Bat *Hipposideros lankadiva* in Ratnagiri District, Maharashtra. JBNHS 91:136.
4. Muni, Manoj (1994): Rarest of the rare - *Latidens salimalii*. Hornbill 1994:28-32.

Dr. C.R. Ajithkumar, Scientist A, Ecology of Grassland Project

Publication:

1. Ajithkumar, C.R. and Asthana, A. (1994): Circadian variation in the movement of fry in a feeder canal. JBNHS 91:194-202.

Mr. Satish Kumar, Sr. Research Fellow, Ecology of Grassland Project, was invited to participate in a conference **Wolves and Humans - 2000: Global Conflicts of Wolf Management** held in the University of Minnesota, USA. He presented a research paper **Strategies for Wolf Conservation in marginal areas of the Deccan, India** .

Mr. J. K. Tiwari, Junior Scientist, Ecology of Grassland Project.

Publications:

1. Tiwari, J.K.(1994): Unusual feeding behaviour of the grey musk shrew *Suncus murinus*. JBNHS 91:305
2. Tiwari, J.K. & Langha, A.O.(1994): A breeding record of the crested honey buzzard *Pernis ptilorhyncus ruficollis*. JBNHS 91: 310.

Mr Arvind Karandikar, Project Manager, Conservation Education Project, visited the United Kingdom along with the project team comprising of Ms Lima Rosalind, Research Officer, Dr Renu Kohli, Mr Manish Khodaskar, Mr Prashant Mahajan, Mr Shekar Shiveshwarkar and Mr Parag Mungle. During the training the team visited Pulborough Brooks, RSPB Reserve and Vistor Centre, Woodsmill, Sussex Wildlife Trust Centre and Arndel Wildfowl and Wetlands Trust Centre.

Dr Renu Kohli, Education Project Officer and Mr Manish Khodaskar, Education Project Officer presented two papers on **Communicating Conservation around Keoladeo National Park** at the Seminar on **Ecodevelopment, Habitat and Wildlife Conservation in Rajasthan** held at Kota, Rajasthan.

Mr Prashant Mahajan, Education Project Officer presented a paper on **Masinagudi group of villages - Biotic pressure, Conservation Education and Possible Alternatives** at the seminar on **Ecological Concerns and Policy Issues as relevant to Nilgiris**.

Publications:

1. Rosalind, Lima.(1994): BNHS Role in Conservation of India's Natural History. AVEHI(Avehi Educational Media Magazine).

Mr. Alex Abraham, EIA Scientist delivered a lecture on the concept of EIA & the BNHS-EIA Cell to CEP project team and as faculty member for the Course on "Conservation Biology" at the BNHS, delivered lectures on Environmental Impact Assessment and Environmental Audit.

Submitted a paper on "Role of EIA in the protection of Biodiversity for the National Seminar on Wildlife Resources-Networking organised by MoEF & BNHS.

Symposia and Seminars attended:

1. Workshop on EIA organised by British Council Division, Bombay, July 1994.
2. Workshop on Economic Valuation of Air Pollution in Chembur, MEIP project, organised by IGIDR, Bombay, July 1994.
3. National Seminar on Environment and Development, organised by WWF-India & Chemtech Foundation, October 1994.
4. Training Programme on EIA Practice, organised by British Council Division, Lonavala, April 1995.
5. Brainstorming Workshop on Action Plans on EIA, sponsored by UNEP, MoEF, organised by Centre for Environmental Studies and Education (CESE), IIT, Bombay, May 1995.

Ms Shubhangi Puradkar, Assistant Librarian attended a six-week training course on "Paper Conservation and Preventive maintenance in Libraries" organised by the INTACH and Indian Conservation Institute at Lucknow. She was awarded the **Best Participant's Award**.

DONATIONS AND GRANTS

We are grateful to the following donors and well-wishers for the grants and donations to the Society.

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GOVT. OF INDIA	50,000.00
(Dept. of Science & Technology)	
GOVT. OF MAHARASHTRA	2,50,000.00
(For maintenance of collections and building)	

WELL-WISHERS

DR. ABDUL KARIM NAIK
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ACKNOWLEDGEMENT

We are grateful to the following persons for their assistance in various activities of the Society:

Mr Sudheer Agashe
Mr Shahid Ali
Mr M R Almeida
Dr Mark Behan
Mr Navroz Behramfram
Dr Renee Borges
Mr J C Daniel
Dr B Dasgupta
Mrs V B Desmukh
Mr Mihir Deware
Mr Robert D'Souza
Mr Arvind Karandikar
Mr. Manoj Karkhanis
Mr Isaac Kehimkar
Mr Kini K.V.
Dr Ashok Kothari
Dr Arun Joshi
Mr Rahul Marathe
Maj. M. Maskar
Mr Athul Mathur
Mr Parag Mungale
Mr N D Mulla
Mr A K Nigam
Dr Parvish Pandya
Mr V K Paralkar
Mr Shirish Pitale
Mr Ulhas Rane
Ms Lima Rosalind
Mr Gulab Sakpal
Dr. Jay Samant
Mr Vivek Samant
Mrs Ranjana Shah
Mr Vilas Shingre
Mr S Shiveshwarkar
Mr T V Sowrirajan
Ms Varsha Waghmare

The Executive Committee acknowledges with thanks the assistance given to the BNHS by the Ministry of Environment, Forests and Wildlife and the Ministry of Defence of the Government of India, the United States Fish & Wildlife Service, Overseas Development Administration,UK, British Council Division, Bombay, the Government of Maharashtra, and the Charity Commissioner, Bombay. It also thanks the members and staff of the BNHS for their unstinted support in the various activities of the Society.

Dr Ashok Bhagwat
Honorary Secretary

HONORARY TREASURER'S REPORT ON THE ACCOUNTS FOR THE YEAR 1ST APRIL 1994 TO 31ST MARCH 1995

I have the pleasure to report on the 111th Annual General Meeting of the Society and the following points may be highlighted while considering the Accounts and the Auditor's Report for the year 1994-95.

1. During the year the Society has received the following major donations/grants :

   (A) The Tata Iron and Steel Co. Ltd (TISCO) has made a generous grant of Rs 20,00,000. The same has been utilised to create the TISCO Conservation Education, Awareness and Research Fund.

   (B) The Industrial Credit and Investment Corporation of India (ICICI) has donated a munificent grant of Rs. 15,00,000. The same has been utilised to create the ICICI Environmental Research, Education and Awareness Fund.

   (C) Government of Maharashtra and the Royal Western India Turf Club have generously donated Rs 17,78,263 and Rs 1,68,327 respectively, for repairs and maintenance of Hornbill House and Collections.

2. I am happy to state that in response to Prof. P V Bole's, (Ex-President, BNHS), request at the AGM of 28th January 1993, Mr. Vasant Panse has included the Society as one of the largest beneficiary in his Will. He has already given a sum of Rs 1,00,002 out of his estate. I therefore request all of you to follow such noble examples and include our esteemed Society as some part of the beneficiary in your Will. The Society has undertaken to preserve all such copies of the Will.

3. The long promised and sanctioned grant from the Government of India for Air-conditioning grant is till date not forthcoming. The expenditure till date is Rs 16,56,103 approximately. A serious view of the same has to be taken and stern appropriate action needs to be taken. Similar is the case of recovery of Rs 1,00,000 for the Army Cell. Both the amounts are due from Ministry of Environment and Forests, Government of India.

4. The Management Information System of the Society is now in force. Recently the Society undertook a major exercise in comparing budgeted expenditure and income for the year 1995-96 with the actual of half year. I am proud to state that no major deviations have been noted. Further as for last year, the strict budgetary controls with internal control and internal checks, are still enforced and strengthened.

5. The surplus of the Society would have been higher by Rs 2,30,800 had the said amount due from Government of Maharashtra and Rs 1,74,912 due for Nature Education Scheme from Government of Maharashtra not been written off. The same had to be written off as per the advice of the auditors as the same is over 3 years old. However, the Society is actively pursuing the grants from the Government of Maharashtra for the full value of the Reference Collections and for the upkeep and repairs of Hornbill House.

6. I regret to state that despite the best of efforts, the shortfall in terms of inadequate funding as reported last year still continues.

   However, I am happy to state that our capital has increased by 23.45% which in actual forms amounts to Rs 33,90,113.

7. The Fund Raising Committee along with the Salim Ali Centenary Celebrations Committee have been merged together and all the members of the Executive Committee are members of the Fund Raising Committee. This is done specifically to effectively collect donations and to avoid overlaps of donors being approached for separate causes, within the members of the Committee. The Committee has till date received the funds or sanction orders of nearly 25 lakhs. The target amount during the Centenary Celebrations is, however, 50 lakhs which the Society is hopeful of receiving.

Sunil Zaveri
Honorary Treasurer

AUDITORS' REPORT

R: BOMBAY NATURAL HISTORY SOCIETY

Registration No. F-244 (Bom)

We have audited the attached Balance Sheet of the Society as at March 31st, 1995 and also the annexed Income & Expenditure Account for the financial year ended on that date and report that in our opinion and to the best of our information and according to the explanations given to us:

(a) the accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950, subject to the observation that as per the past practice separate Receipts and Payments Account has been drawn for the Nature Education Scheme and the same has not been incorporated in accounts of the Society. While referring to the observations made in para (a) of our last report dated 12th September, 1994, we observe that the grant from the government not forthcoming, a contribution of Rs.1,74,912.12 has been made by the Society to the said Scheme interalia covering the accumulated deficit in the said Scheme. The said contribution, we understand, has been approved by the Executive Committee in its meeting held on 28th September 1995,

(b) the receipts and disbursements have been properly and correctly shown in the accounts, subject to the observation that as per the accounting practice adopted, grants from State Government and other sponsoring organisations are being accounted in anticipation of receipt of sanction letters based on the claims preferred/to be preferred. While referring to the observations made in para (b) of our last report dated 12th Sept. 1994 accompanying the statement of accounts for the year ended March 31, 1994, we observe that the following items so accounted in the earlier years still remain unrealised:

(i) Central Government (Ministry of Environment & Forests) Grant for Air-conditioning of Reference Collections Room and Library — Rs. 8,63,707.46

(ii) Government of India (Ministry of Environment & Forests) Grant for Nature Conservation Courses for Indian Army — Rs.1,00,000.00

We observe that in the case of Central Government grant for Air-conditioning of reference collections room and library, expenditure of Rs.3,30,263.91 out of the expenditure incurred during the year towards electric charges and maintenance of air conditioning system has been treated as recoverable by way of grant. Thus the aggregate amount of grant accounted as recoverable amounts to Rs.11,93,971.37 as at the date of Balance Sheet. In the case of the Nature Conservation Course for Army, we observe that by the date of Balance Sheet, the Society has already spent a sum of Rs. 69,204/- in that behalf out of its own funds. Incidentally, we may point out that a sum of Rs.2,30,804/- which had been accounted as income in the year 1991-92, as grant recoverable from Maharashtra State Government had to be written back during the year, as the anticipated receipt did not materialise. We are not in a position to offer any comments about the realisability of the aforesaid outstanding dues. We reiterate our views that the income of such nature be recognised as income, when there is no uncertainty about its realisation,

(c) the cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of accounts,

(d) the books, deed, accounts, vouchers and/or other documents or records required by us were produced to us,

(e) the register of movable and immovable properties has been maintained. However, the changes therein have remained to be communicated to the Regional Office. In the context of equipments and other such items of capital nature acquired out of various grants and other project funds, we observe that initially the cost of such equipments, etc. is charged to the relevant project accounts and on completion of the projects, the Society generally seeks the permission of the concerned sponsoring authorities to retain such assets, as are found to be useful for other projects and/or other purposes and on obtaining such approvals the necessary entries are passed in the books of accounts to record the residual value of such items. In this context we also wish to refer to the observations made in para (i) hereinbelow in respect of the expenditure towards erection of the Conservation Education Centre. While referring to the observations made in our aforesaid last report we observe that the value of a Jeep, so retained, still remains to be brought into account. In the absence of adequate information, it has not been possible for us to verify if the value of all the items allowed to be retained has been brought into accounts.

We further observe that a vehicle, which had been retrieved from certain projects completed in some earlier year has been disposed off during the year and the proceeds of Rs.69,000/- (net)has been credited to Fixed Assets Account. An expenditure of Rs.48,939/- incurred during the year on major overhauling of a vehicle (which had been so retrieved from certain project), in order to put it in proper working condition for the purpose of the Society has been capitalised.

We also understand that the Society is holding a number of "medals" of different precious and semiprecious metallic contents, which were awarded to late Dr. Salim Ali and which under his Will have been obtained by the Society. The same, we are informed, are being held as commemorative souvenirs. The value thereof, has not been brought into accounts as it is contended that the said Souvenirs being of aesthetic and sentimental value and commemorative nature,can not be reduced to monetary value,

(f) the Hon. Treasurer and the Accountant appeared before us and furnished the necessary information required by us.

(g) We are not aware of any property or funds of the Society having been applied for any objects or purpose other than the objects of the Society,

(h) the following amounts were outstanding for more than one year :

— Dues towards supplies & services		55,162.95
— Loans to staff		14,125.00
— Advances for Expenses (for projects & other expenses):		
Employees (including ex.employees)		
Others	31,259.45	
	12,397.00	43,656.45
— Other dues		10,143.50
— Grants receivable: From Government of India		8,63,707.46
From Government of India		1,00,000.00
— Suspense Account	1,570.25	
— Income tax refundable	11,279.00	

In the context of the aforesaid outstanding of Rs.31,259.45 representing advance to the employees we understand that it includes Rs.26,264.45 due from three persons, who are no longer in the employment of the Society. Of the said amount Rs.24,453.45 has since been recovered, leaving a balance of Rs.1,811/- which is proposed to be adjusted against other dues payable to the concerned ex.employee. The advances to others include Rs.7,397/- paid to certain persons for certain projects, of which Rs.2,397/- has since been adjusted. It will be appreciated, if proper account is obtained for the balance advance and the account is appropriately adjusted. The advances to others also include Rs.5,000/- paid to a printing press, which has remained to be adjusted pending settlement of their bill. The other dues represent the expenditure incurred in connection with certain projects which is sought to be recovered from the concerned organisations. We are not in a position to express any opinion about the realisability of the said dues. In regard to balance in Suspense Account we suggest that effective steps be taken to recover the amount and clear the balance in Suspense account.

During the year the following amounts have been written off:

— Dues from Bihar State Government	Rs. 6,534.00
— Dues towards supplies & services	Rs.23,627.75

It may however, be pointed out that the amount of Rs.23,627.75 has been debited to Income from other sources from Greeting Cards and Calendars of the current year instead of being charged to bad debts written off. The amounts so written off may also be confirmed in the next meeting of the Executive Committee. In this context, we also wish to refer to the observations made in para (b) hereinabove in regard to the write back of the grant from State Government. We have been informed that the other outstanding balances are considered good and recoverable,

(i) during the year under report a sum of Rs. 9,02,427.55 was spent on repairs to the Hornbill Building. We have been informed that limited enquiries were floated and based on the estimates received work was awarded to one of the contractors. Besides, we observe that during the year under report a sum of Rs.29,75,855/- has been spent on construction of Conservation Education Centre at Goregaon Centre at Goregaon (E), bringing the total cost of construction to Rs.32,35,982/- till the date of Balance Sheet. We understand that tenders were invited for the said construction work and the work was entrusted to one of the contractors on the recommendations of the architect. The said amount stands charged to the Conservation Education Project as shown in Schedule "C" attached to the Balance Sheet. We are informed that the grant had been received for the purpose of erection of the Conservation Education Centre. In so far as the said outlay is on a property which would form part of the properties & assets of a permanent nature of the Society,it would be more appropriate to reflect the said outlay as construction work in progress and the amount spent be transferred from the relevant fund a/c. to 'Fixed Asset Fund Account' or 'Grant Utilisation Account'. The procedure being followed merits reconsideration.

(j) we are not aware of any money of the Society having been invested in contravention of Sec. 35 of the Bombay Public Trust Act, 1950,

(k) we are not aware of any immovable property of the Society, therefore, the question of alienation of any property contrary to the provisions of Sec. 36 of the Bombay Public Trust Act, 1950 does not arise,

(l) i) in regard to the expenses charged to various grants and funds we have relied on the information given to us and the authentication of the Hon. Secretary and Hon. Treasurer that the expenses so charged relate to these grants and have been spent on the specific objects for which the grants were received. While checking the statement of accounts in regard to the expenditure incurred at various camps, we have relied on the authorisation by the Hon. Secretary and Hon. Treasurer, as to the reasonableness of the expenditure. In this context we observe that during the year a sum of Rs.8,86,236/- had been received from the Maharashtra State Government (as special Charity Race meeting) grant. The said amount together with the unutilised grant of Rs.8,92,000/- brought forward from the earlier year has been credited to Income & Expenditure account of the year under report. It has been explained to us that the said amount has been utilised for the following purposes:

— Repairs to Hornbill House	Rs. 9,02,427.55
— Repairs to Electric fittings	Rs. 2,30,000.00
— Salaries of Reference collection and maintenance Staff (other than met out of other grant)	Rs. 3,82,521.25
— Reference collection Expenses (including electricity charges for air conditioning system of reference room other than that met out of other grants)	Rs. 3,12,559.81
	Rs.18,27,508.61

On perusal of the sanction letters for the said grant, we observe that the said grants were sanctioned to the Society to enable it to maintain and up-keep the collection of natural history material. It is contended that the above expenses were necessary for the said purpose.

ii) while on the above subject, we observe some of the local field workers, whose services were engaged for one of the projects at Bharatpur, are claiming reinstatement and other service benefits, which is being disputed by the Society. The contingent liability in this regard remains undeterminate. The matter, we are informed, is pending before the Labour Court at Bharatpur and Provident Fund authorities. A provision of Rs.1,94,060.70 has been retained in the accounts in this behalf. The liability has not been determined on actuarial basis,

iii) the income towards membership subscription is being accounted on realisation basis,

iv) we are given to understand that on physical verification of the fixed assets certain items were found to be lying with some members for research/study purpose. We suggest that proper records in this regard may be maintained and year end confirmation be obtained from such borrowing members,

v) we suggest the following items of disbursements effected, appropriations made and administrative charges levied be confirmed and ratified at the next meeting of the Executive Committee:

A. DISBURSEMENT FROM:

		Rs.
(i)	Salim Ali Nature Conservation Fund Investment Revenue Account	2,12,283.64
(ii)	Salim Ali Memorial Fund	12,839.50
(iii)	Staff Gratuity Fund	1,12,669.00
(iv)	Ministry of Defence, ARDB for Bird Hazard Research Cell	74,663.75
(v)	Department of Space, Ecological Investigation of Avian Community of Shriharikota	23,541.90
(vi)	Elephant Telemetry Projects	34,194.30
(vii)	Ministry of Environment & Forests - Nature Conservation Course for Indian Army	12,761.60
(viii)	Grants from United States, Department of Interior, Fish & Wild Life Service for:	Rs.
	(a) Ecology of Dry Grassland	12,72,740.25
	(b) Study of Conservation of Birds of Prey with particular emphasis upon restoration of Endangered Species	34,042.50
(ix)	Hawk & Owl Trust - Grassland & Roosting Harriers	50,343.85
(x)	Endangered Turtles of Pondicherry	110.60
(xi)	Wetland, Mangrove & Coral Reefs in India (UNDP)	13,299.75
(xii)	Smithsonian Institution, Washington for revision of **Handbook of the Birds of India & Pakistan**	892.85
(xiii)	Grant for Chilka Lake Project	2,931.70
(xiv)	Conservation Education Project	54,67,677.87
(xv)	Govt. of India for Seminar on N.G.O.	69,282.00
(xvi)	Department of Science & Technology NCSTC - for Publication of Hornbill Series	22,544.00

B. APPROPRIATIONS

1.	Proposed Institution	1,00,000.00
2.	Staff Welfare Fund	25,000.00
3.	Charles McCann Vertebrate Zoology Fieldwork Fund	600.00
4.	Fixed Assets Fund towards depreciation on Fixed Assets	4,49,664.11

C.	Administrative Fees charges to various Grants/Funds for handling the projects,etc.	5,69,988.56
D.	Addition to Fixed Assets	3,93,619.01
E.	Amount drawn out of funds:	
	- For Nature Conservation	2,12,283.64
	- For Gratuity Payment	1,12,669.00
	- For Depreciation	4,49,664.11
	- For Beautification of Dr.Salim Ali Chowk	12,839.50
		Rs.
	- Publication Fund (John Gould Paintings)	1,00,000.00
	- For Staff Medical Expenses (Staff Welfare Fund)	17,155.95
	- From General Reserve Fund (for various expenses)	65,000.00
	- ICICI Environment Research & Education Fund	1,12,291.68
	- TISCO Conservation Education, Research & Awareness Fund	77,479.44

While on the subject, we observe that unlike the past practice, administrative fees for handling the projects have not been charged in respect of the projects relating to certain specific funds. No explanation has been furnished for the said change in practice. We therefore, suggest that the said change in the procedure may be confirmed in the next meeting of the Executive Committee. We also observe, that by the end of the year under report the following projects were completed and the accounts thereof reflect the over run position as under:

Ministry of Defence (ARDB) for Bird Hazard Research Cell	37,278.54
Elephant Telemetry Project	21,074.15
Smithsonian Institution, Washington for revision of **Handbook of the Birds of India & Pakistan".**	284.08

The above balances may be appropriately adjusted, if the same be not likely to be recouped from grant/donation. We are in a position to comment on its realisability.

vi) We observe that the contribution to Employees' Provident Fund (both the employees and management contribution) continues to be deposited with the Trustees of a recognised Provident Fund established by the Society and governed by the rules framed for the purpose. There seems to have been certain amendments to the Employees Provident Fund and Miscellaneous Provisions Act, 1952, where under the Society may be considered to be liable not only to transfer the accumulated balance in the Employees' Provident Fund Account, to the Provident Fund Commissioner, Government Scheme, but also for the difference in the amount of contribution. The liability in this regard remains undeterminate. We suggest that proper legal opinion may be sought in this regard and needful may be done in the matter.

vii) In the context of the foreign contributions by way of grant/donations, etc. being received by the Society, we wish to invite attention to the requirements of the Foreign Contribution (Regulation) Act, 1976, and the rules framed thereunder and suggest that the compliance thereof may be ensured, particularly in regard to the submission of the prescribed returns to the department concerned,

(m) so far as it is ascertainable from the books of accounts and according to the information and explanation furnished to us by the Hon. Treasurer and the Hon. Secretary, there were no cases of irregular, illegal or improper expenditure or failure to recover the moneys or other properties belonging to the Society or loss or waste of money or other property of the Society, subject to the observations made in para (h) hereinabove,

(n) provisions of Section 31-A of the Bombay Public Trust Act, 1950 and Rule 16-A of the Rules framed under the said Act have been complied with,

(o) the maximum and minimum number of Executive Committee Members is maintained having regard to the provisions in the Rules and Regulations of the Society,

(p) there is no specific provisions in the Rules and Regulations of the Society regarding the holding of the meetings of the Executive Committee,

(q) the minute book recording the proceedings of the meetings is maintained,

(r) no member of the Executive Committee has any interest in the investment of the Society,

(s) no member of the Executive Committee is a debtor or creditor of the Society, subject to the observation that a sum of Rs.2,397/- given as an advance for expenses to a member had been outstanding as at the date of the Balance Sheet, but has since then been adjusted,

(t) there were no irregularities pointed out in our last report dated 12/09/94 accompanying the statement of accounts for the year ended March 31, 1994 except the observations made in paras (e), (h) and (l)(v), the observations whereof have been reiterated hereinabove to the extent the issues remain still outstanding.

PLACE: BOMBAY
DATED: 30TH SEP, 1995

HABIB AND COMPANY
CHARTERED ACCOUNTANTS

BOMBAY NATURAL HISTORY SOCIETY
BOMBAY PUBLIC TRUST ACT, 1950 : REGISTRATION NO. F-244 (BOM)
SCHEDULE VIII VIDE RULE 17(1)
BALANCE SHEET FOR THE YEAR ENDED 31ST MARCH 1995

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.
	LIFE MEMBERSHIP FUND (INDIVIDUALS)		
18,30,325.16	Balance as per Last Balance Sheet	19,90,515.12	
1,60.189.96	Add: Received during the year	2,00,700.00	
19,90,515.12			21.91,215.12
	CORPORATE LIFE MEMBERSHIP FUND		
2,25,742.31	Balance as per last Balance Sheet		2,25,742.31
	VICE PATRON FUND		
42,769.00	Balance as per last Balance Sheet		42,769.00
	CORPUS FUNDS		
25,36,287.97	As Per Schedule 'A'		25,36,687.97
	OTHER FUNDS		
96,60,244.63	As Per Schedule 'B'		1,28,49,257.61
	CURRENT LIABILITIES		
38,31,762.12	For Unspent Grants as per Schedule 'C'	60.90,115.92	
6,74,210.44	For Expenses	3,61,851.32	
8,200.00	For Library Deposits	31,200.00	
50,573.31	For Sundry Credit Balances	33,299.10	
30,426.11	For Advances for Publications and Products	30,256.11	
45,95,171.98			65,46,722.45
1,90,50,731.01	Carried over		2,43,92,394.46

Previous year 1993-94 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1994-95 Rs.
	INVESTMENTS (AT COST)		
2,000.00	5.5% Govt of India Loan 2000 of the Face Value Rs. 2000/- Market Value Rs. 1,380/-)		2,000.00
8.53,000.00	8530 Units of Unit Trust of India Under CRTS 1981 of the Face Value Rs.100/- Each (Repurchase Value Rs. 9,98,010.00)	8,53,000.00	
4,94,000.00	4940 Units of Unit Trust of India Under CRTS 1981 of the Face Value Rs.100/- Each (Repurchase Value Rs. 5,77,980.00)	4.94.000.00	
4,77,000.00	4770 Units of Unit Trust of India Under CRTS 1981 of the Face Value Rs.100/- Each (Repurchase Value Rs. 5,58,090.00)	4,77,000.00	
4,85,000.00	4850 Units of Unit Trust of India Under CRTS 1981 of the Face Value Rs.100/- Each (Repurchase Value Rs. 5,67,450.00)	4,85,000.00	
9,99,637.50	70150 Units of Unit Trust of India Under Unit Scheme 1964 of the Face Value Rs.10/- Each (Repurchase Value Rs. 10,90,832.50)	9,99,637.50	
7,00,000.00	50,000 Units of Unit Trust of India Under US 1964 Plan of the Face Value of Rs. 10 Each (Repurchase Value Rs. 7,77,500)	7,00,000.00	
40,08,637.50	Carried forward	40.08,637.50	
2000.00	Carried over...		2000.00

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.
1,90,50,731.01	Brought Over		2,43,92,394.46
	OTHER LIABILITIES		
Nil	Professional Tax	815.00	
Nil	Employees Provident Fund	2,150.00	
Nil	T.D.S.	6,014.00	
Nil	L.I.C. Gratuity	35,801.00	
Nil			44,780.00
	INCOME & EXPENDITURE ACCOUNT		
84,410.86	Balance as per last Balance Sheet	1,10,911.99	
Nil	Less:Appropriation towards proposed institute fund	1,00,000.00	
84,410.86		10,911.99	
26,501.13	Add: Excess of income over expenditure during the year	1,568.78	
1,10,911.99			12,480.77
1,91,61,643.00	Carried over ...		2,44,49,655.23

Previous year 1993-94 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1994-95 Rs.
2000.00	Brought over		2000.00
40,08,637.50	Brought forward	40,08,637.50	
13,440.00	1200 Units of Unit Trust of India Under US 1964 Plan of Face Value Rs. 10/- each	Nil	
Nil	10000 Units of Unit Trust of India under US 1964 Plan (Repurchase Value Rs. 1,55,500.00)	1,48,000.00	
Nil	14030 Units of Unit Trust of India Under US64 Plan (Repurchase Value Rs. 2,18,166.50)	2,07,644.00	
6,22,080.00	48600 Units of Unit Trust of India under US 1964 of Face value Rs. 10/- each. (Repurchase value Rs. 7,53,730.00)	Nil	
Nil	100000 Units of MIP 94 (III) of Unit Trust of India (Earmarked specifically against ICICI Environmental Research & Education Fund).	10,00,000.00	
Nil	50000 Units of Unit Trust of India under MIP 94 (II). (Earmarked specifically against ICICI Environmental Research & Education Fund).	5,00,000.00	
46,44,157.50			58,64,281.50
	Fixed Deposits with		
15,00,000.00	Housing Development Finance Corporation Ltd.	15,00,000.00	
5,00,000.00	ICICI	5,00,000.00	
5,00,000.00	IDBI	5,00,000.00	
Nil	Indian Oil Corporation (Earmarked specifically against TISCO Conservation Edn. & Awareness Fund)	20,00,000.00	
Nil	Steel Authority of India	10,00,000.00	
25,00,000.00			55,00,000.00
71,46,157.50	Carried over...		1,13,66,281.50

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.	Previous year 1993-94 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1994-95 Rs.
1,91,61,643.00	Brought over...		2,44,49,655.23	71,46,157.50	Brought over...		1,13,66,281.50
					VEHICLES		
				25,962.74	Balance As Per Last Balance Sheet	3,92,755.62	
				4,65,000.00	Add: Major Repairs of Vehicles	48,939.00	
				4,90,962.74		4,41,694.62	
				18.22	Less: W.D.V. of vehicle sold	Nil	
				4,90,944.52		4,41,694.62	
				98,188.90	Less: Depreciation during the year	88,367.53	
				3,92,755.62			3,53,327.09
					FURNITURE, FIXTURES & EQUIPMENTS		
				18,89,007.79	Balance As Per Last Balance Sheet	25,45,691.57	
				10,20,354.00	Add: Additions during the year	3,44,680.01	
				29,09,361.79		28,90,371.58	
				3,63,670.22	Less: Depreciation during the year	3,61,296.58	
				25,45,691.57			25,29,075.00
					LOANS		
				1,03,479.00	(Unsecured Considered Good)		1,43,625.00
					ADVANCES		
				4,65,539.05	To Employees		
					(For project & other expenses)	60,636.90	
				1,81,206.76	To Others		
					(For Project & Other Expenses)	2,00,064.89	
				15,000.00	Against Journal Papers	80,160.00	
				4,956.00	Adv. against salaries to employees	800.00	
				36,500.00	Adv. against equipment	Nil	
				1,51,353.37	Dues from Nature Education Scheme	Nil	
				4,500.00	Advance for rent	4,500.00	
				1,25,000.00	Computer Maintenance	93,623.00	
				Nil	Other dues for travel & other expenses	76,853.45	
				9,84,055.18			5,16,638.24
1,91,61,643.00	Carried over....		2,44,49,655.23	1,11,72,138.87	Carried over...		1,49,08,946.83

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.	Previous year 1993-94 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1994-95 Rs.
1,91,61,643.00	Brought over...		2,44,49,655.23	1,11,72,138.87	Brought over...		1,49,08,946.83
					DEPOSITS		
				77,270.00	BEST Undertaking	77,831.00	
				15,000.00	Mahanagar Telephone Nigam Ltd.	59,982.00	
				11,000.00	P & T Dept. for Project Telephone	Nil	
				1,000.00	NCST for Eletronic Mailing	1,000.00	
				9,850.00	Gas Cylinder for Projects	6,850.00	
				561.00	Elec. Deposit for Projects	Nil	
				2,500.00	For Vehicle Fuel Supply	2,500.00	
				420.15	For Franking Machine	401.80	
				2,28,396.00	For Accommodation	2,28,396.00	
				50.00	For Burner	50.00	
				40,000.00	Security Deposit (CEP)	90,000.00	
				Nil	Tata Sumo Vehicle	20,000.00	
				3,86,047.15			4,87,010.80
					STOCKS As Per Inventories Valued and Certified by the Hon. Secretary		
				14,03,907.82	BNHS Publications	7,29,831.55	
				1,42,857.00	Govt Publications	34,405.93	
				98,946.00	Greeting Cards	2,05,577.00	
				1,760.00	BNHS T Shirts	11,300.00	
				2,632.00	BNHS Mugs	2,303.00	
				7,258.00	BNHS Caps	5,539.00	
				4,439.00	BNHS bags	3,860.00	
				5,788.75	BNHS stickers	5,663.75	
				16,67,588,57			9,98,480.23
					Books under Publication (Expenses Incurred Till Date)		
				1,70,625.00	Book of Indian Birds revised Edition	1,82,725.00	
				Nil	Flora of Keoladeo National Park	63,444.60	
				1,70,625.00			2,46,169.60
1,91,61,643.00	Carried over....		2,44,49,655.23	1,33,96,399.59	Carried over...		1,66,40,607.46

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.	Previous year 1993-94 Rs.	PROPERTIES AND ASSETS		Rs.	Current Year 1994-95 Rs.
1,91,61,643.00	Brought over...		2,44,49,655.23	1,33,96,399.59	Brought over...			1,66,40,607.46
					INCOME OUTSTANDING			
				2,00,385.12	Interest Accrued		2,50,149.67	
				6,378.20	For Publications		6,38,651.75	
				44,543.40	For Greeting Cards		42,317.95	
				70,763.92	For Calendars		1,46,422.50	
				5,000.00	For Souvenir Adv.		Nil	
				11,980.00	For Xerox charges		447.00	
				3,39,050.64				10,77,988.87
					GRANTS RECEIVABLE			
				8,63,707.46	From Govt. of India, Ministry of Env. & Forests (Reference Collection Airconditioning expenses / expenditure for the year Rs. 5,37,604.77		11,93,971.37	
				4,80,804.00	From Govt. of Maharashtra (1993-94 and 1994-95)		Nil	
				2,96,000.00	Elephant Telemetry Project		Nil	
				1,00,000.00	From Govt. of India, Ministry of Environment Nature Conservation Course for Indian Army		1,00,000.00	
				Nil	Royal Western India Turf Club Ltd.		40,106.45	
				8,92,000.00	From Govt. of Maharashtra for upkeeping, repairs to Hornbill House and Collection		Nil	
					Grants Receivable (Project)			
				Nil	Sriharikota	50,655		
				Nil	Jerdon's Coursers Project	44,000	94,655.00	
				26,32,511.46				14,28,732.82
				11,279.00	**INCOME TAX (TDS)**			79,181.00
					CASH AND BANK BALANCES			
				27,82,402.31	(As per Schedule D)			51,64,508.31
1,91,61,643.00	Carried over....		2,44,49,655.23	1,91,61,643.00	Carried over...			2,43,91,018.46

Previous year 1993-94 Rs.	FUNDS AND LIABILITIES	Rs.	Current Year 1994-95 Rs.	Previous year 1993-94 Rs.	PROPERTIES AND ASSETS	Rs.	Current Year 1994-95 Rs.
1,91,61,643.00	Brought over...		2,44,49,655.23	1,91,61,643.00	Brought over...		2,43,91,018.46
					UNADJUSTED DEFICIT ON PROJECTS		
				Nil	(a) Ministry of Defence (ARDB) for BHRC	37,278.54	
				Nil	(b) Elephant Telemetry Project	21,074.15	
				Nil	(c) Smithsonian Inst., Washington for revision of the Handbook of Birds of India and Pakistan.	284.08	58,636.77
1,91,61,643.00	Total Rs.		2,44,49,655.23	1,91,61,643.00			2,44,49,655.23

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

Sd/-
HABIB & COMPANY
CHARTERED ACCOUNTANTS

Bombay

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH 1995

SCHEDULE A : CORPUS FUNDS

Name of the Corpus Fund	Balance As per last Balance Sheet	Amounts Received/ Appropriated during the year	Total of Columns 1 & 2	Balance as on 31-3-1995
	1	2	3	4
	Rs.	Rs.	Rs.	Rs.
Sálim Ali Nature Conservation Fund	20,81,668.45	400.00	20,82,068.45	20,82,068.45
Sálim Ali / Loke Wan Tho Ornithological Research Fund	4,03,136.52	Nil	4,03,136.52	4,03,136.52
Pirojsha Godrej Foundation Fieldwork Fund	40,000.00	Nil	40,000.00	40,000.00
Col. Burtons Nature Conservation Fund	11,483.00	Nil	11,483.00	11,483.00
Total Rs.	25,36,287.97	400.00	25,36,687.97	25,36,687.97

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH 1995
SCHEDULE B : OTHER FUNDS

Name of the other fund	Balance As Per Last Balance Sheet	Amount Recd/ during the year	Interest Credited during the year	Total of Columns 1, 2 & 3	Transferred to Income & Expenditure Account during the year	Expenditure on objects of Trust/ other exps. as shown in Income & Exp. account	Balance as on 31-3-1995
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Sálim Ali Nature Conservation Fund Investment Revenue Account	2,79,813.45	Nil	2,08,166.84	4,87,980.29	2,12,283.64	2,12,283.64	2,75,696.65
Sálim Ali Loke Wan Tho Ornithological Fund Investment Revenue Account	1,47,293.40	Nil	40,313.65	1,87,607.05	Nil	Nil	1,87,607.05
Pirojsha Godrej Foundation Fieldwork Fund Investment Revenue Account	11,350.49	Nil	4,000.00	15,350.49	Nil	Nil	15,350.49
Col.Burton Nature Conservation Fund Investment Revenue Account	5,487.17	Nil	1,148.30	6,635.47	Nil	Nil	6,635.47
Charles MaCann Vertebrate Zoology Fieldwork Fund	93,226.61	600.00	9,322.66	1,03,149.27	Nil	Nil	1,03,149.27
Plant Study Fund	43,774.80	Nil	Nil	43,774.80	Nil	Nil	43,774.80
Education & Research Fund Created Out of Income	51,762.76	Nil	Nil	51,762.76	Nil	Nil	51,762.76
Chacko Fund For Education And Conservation	37.559.70	Nil	Nil	37,559.70	Nil	Nil	37,559.70
Sálim Ali Memorial Fund	24,87,181.99	1,00,000.00	Nil	25,87,181.99	12,839.50	12,839.50	25,74,342.49
Publication Fund - BNHS	17,13,787.72	41,899.73	Nil	17,55,687.45	1,00,000.00	1,00,000.00	16,55,687.45
Publication Fund From Govt of India Dept of Science & Technology	6,29.132.58	Nil	Nil	6,29,132.58	Nil	Nil	6,29,132.58
Fixed Assets Fund	13,91,349.15	69,000.00	Nil	14,60,349.15	4,49,664.11	4,49,664.11	10,10,685.04
Building Fund	5,03,227.68	Nil	Nil	5,03,227.68	Nil	Nil	5,03,227.68
Carried over...	73,94,947.50	2,11,499.73	2,62,951.45	78,69,398.68	7,74,787.25	7,74,787.25	70,94,611.43

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH 1995
SCHEDULE B : OTHER FUNDS

	Balance As Per Last Balance Sheet	Amount Recd/ during the year	Interest Credited during the year	Total of Columns 1, 2 & 3	Transferred to Income & Expenditure Account during the year	Expenditure on objects of Trust/ other exps. as shown in Income & Exp. account	Balance as on 31-3-1995
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over....							
ICICI Environmental Research and Education Fund.	Nil	15,00,000.00	1,12,291.68	16,12,291.68	1,12,291.68	1,12,291.68	15,00,000.00
TISCO Conservation Education Research and Awareness Fund	Nil	20,00,000.00	77,479.44	20,77,479.44	77,479.44	77,479.44	20,00,000.00
General Reserve Fund	9,33,638.22	Nil	Nil	9,33,638.22	65,000.00	65,000.00	8,68,638.22
Staff Gratuity Fund	1,72,067.81	35,801.00	Nil	2,07,868.81	1,12,669.00	1,12,669.00	95,199.81
Staff Welfare Fund	3,05,717.34	3,373.00	25,000.00	3,34,090.34	17,155.95	17,155.95	3,16,934.39
Donation From Seth Purshotamdas Thakurdas & Divaliba Charitable Trust For Publication of Tree Book	75,000.00	Nil	Nil	75,000.00	Nil	Nil	75,000.00
Proposed Institute Fund	7,78,873.76	1,00,000.00	20,000.00	8,98,873.76	Nil	Nil	8,98,873.76
Total	96,60,244.63	38,50,673.73	4,97,722.57	1,40,08,640.93	11,59,383.32	11,59,383.32	1,28,49,257.61

Summary of Expenditure From Funds/Donations

Expenditure Head Amount		Amount Rs.
Expenses on Objects:		
Nature Conservation	2,12,283.64	
Environmental Education and Research	1,12,291.68	
Conservation Education, Research and Awareness	77,479.44	
Publication Fund BNHS	1,00,000.00	
		5,02,054.76
Others:		
Miscellaneous		
Beautification of Dr. Sálim Ali chowk	12,839.50	
Gratuity to staff	1,12,669.00	
Depreciation	4,49,664.11	
For various expenses	65,000.00	
for staff welfare	17,155.95	
		6,57,328.56
		11,59,383.32

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST MARCH, 1995

SCHEDULE C : GRANTS

Name of the Grant	Balance as per last Balance Sheet	Amount Recd./ Receivable during the year	Total of columns 1 & 2	Transferred To Income & Expenditure Account during the year	Expenditure On Objects of Trust / Other Exps. as shown in Income & Exp. Account	Balance as per 31-3-1995
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
GRANTS FROM GOVT. OF INDIA						
Ministry of Defence, ARDB For Bird Hazard Research Cell	37,385.21	Nil	37,385.21	74,663.75	74,663.75	(37,278.54)
Elephant Telemetry Project	13,120.15	Nil	13,120.15	34,194.30	34,194.30	(21,074.15)
Ecology of Jerdon's Courser	49,000.00	44,000.00	93,000.00	59,403.65	59,403.65	33,596.35
Dept. of Science & Technology For Publication of Tree Book.	51,873.10	Nil	51,873.10			51,873.10
Dept. of Space: Ecological Investigation of Avian Community of Sriharikota	6,681.40	50,655.00	57,336.40	23,541.90	23,541.90	33,794.50
Dept. of Science & Technology NCSTC - For publications of Hornbill Series	2,40,000.00	Nil	2,40,000.00	22,544.00	22,544.00	2,17,456.00
Ministry of Environment & Forests Nature Conservation Course Indian Army Ministry of Defence	43,557.60	Nil	43,557.60	12,761.60	12,761.60	30,796.00
ARDB for Project in Development of Electrophorensis Tech. for identifying birds and bats aircrafts strike remains.	Nil	1,87,454.00	1,87,454.00	Nil	Nil	1,87,454.00
Aeronautics Research and Development Board Grants Bird Hazard Research Cell	Nil	99,475.00	99,475.00	Nil	Nil	99,475.00
Govt. of India for seminar on NGO	Nil	1,25,000.00	1,25,000.00	69,282.00	69,282.00	55,718.00
GRANTS FROM UNITED STATES DEPT. OF INTERIOR, FISH & WILDLIFE SERVICE FOR RESEARCH PROJECTS						
Ecology of Dry Grasslands	7,48,336.77	14,02,932.00	21,51,268.77	12,72,740.25	12,72,740.25	8,78,528.52
Carried over	11,89,954.23	19,09,516.00	30,99,470.23	15,69,131.45	15,69,131.45	15,30,338.78

Schedule C (Contd.)

Name of the Grant	Balance as per last Balance Sheet	Amount Recd./ Receivable during the year	Total of columns 1 & 2	Transferred To Income & Expenditure Account during the year	Expenditure On Objects of Trust / Other Exps. as shown in Income & Exp. Account	Balance as per 31-3-1995
	1	2	3	4	5	6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	11,89,954.23	19,09,516.00	30,99;470.23	15,69,131.45	15,69,131.45	15,30,338.78
Study of Conservation of Birds of Prey with particular emphasis upon Restoration of Endangered Species1	1,47,868.20	Nil	1,47,868.20	34,042.50	34,042.50	1,13,825.70
OTHER GRANTS						
The Smithsonian Institution, Washington For Revision of 'the Handbook of Birds of India & Pakistan'	608.77	Nil	608.77	892.85	892.85	(284.08)
Hawk & Owl Trust - Grassland Roosting Harriers	11,905.60	50,510.00	62,415.60	50,343.85	50,343.85	12,071.75
Endangered Turtles of Pondicherry	4,074.25	Nil	4,074.25	110.60	110.60	3,963.65
Wetland, Mangroves and Coral Reefs in India (UNDP)	1,04,568.60	Nil	1,04,568.60	13,299.75	13,299.75	91,268.85
Grant for Chilka Lake Project	1,000.00	15,000.00	16,000.00	2,931.70	2,931.70	13,068.30
Govt. of Maharashtra, for upkeeping, repairs and maintenance of Hornbill House and Collection.	8,92,000.00	8,86,263.00	17,78,263.00	17,78,263.00	Nil	Nil
Conservation Education Project	14,79,782.47	82,55,121.60	97,34,904.07	54,67,677.87	54,67,677.87	42,67,226.20
TOTAL	38,31,762.12	1,11,16,410.60	1,49,48,172.72	89,16,693.57	71,38,430.57	60,31,479.15

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31-3-1995

SCHEDULE D : CASH AND BANK BALANCES

	Rs.
A. In Current Account With	
ANZ Grindlays Bank p.l.c. M.G.Road Branch	9,874.38
B. In Savings Account With	
ANZ Grindlays Bank p.l.c. M.G.Road Branch	3,891.10
Bank of India Museum Savings Branch	62,580.13
State Bank of India Gateway of India Branch	1,15,811.16
State Bank of India (CEP)	41,77,226.20
Canara Bank Sir P.M. Road Branch	2,790.95
Corporation Bank Dalal Street Branch S.B. A/c 20024 LIC GGS	36,711.00
Corporation Bank Dalal Street Branch (FCRA Account)	34,261.21
Deutsche Bank, Bombay Branch	7,21,362.18
Total Rs.	51,64,508.31

BOMBAY NATURAL HISTORY SOCIETY
BOMBAY PUBLIC TRUST ACT, 1950 : REGISTRATION NO. F-244 (BOM)
SCHEDULE IX VIDE RULE 17(1)
INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 1995

Previous year 1993-94 Rs.	EXPENDITURE	Rs.	Current Year 1994-95 Rs.
	EXPENDITURE IN RESPECT OF PROPERTIES		
9,489.00	Municipal Taxes	11,156.00	
278.00	Building Insurance	285.00	
6,850.00	Repairs and Maintenance includes Rs. 9,02,427.55 met out of Grant	9,49,886.55	
16,617.00	from Govt. of Maharashtra		9,61,327.55
	ESTABLISHMENT EXPENSES		
5,35,437.75	Salaries of Reference Collection and Maintenance staff	5,91,333.00	
13,12,326.95	Salaries to other staff	17,16,473.60	
36,083.40	Leave Travel Allowances	27,345.00	
22,000.00	Reimbursement of Medical Expenses met out of staff welfare fund	17,155.95	
68,400.00	Compensation for staff accommodation	54,000.00	
Nil	Uniform and umbrellas to staff	9,264.00	
4,110.00	Washing Allowances	2,130.00	
84,588.00	Management's contribution to Provident Fund	88,388.00	
1,72,232.00	Gratuity paid to staff	75,600.00	
9,35,664.00	Premium paid to BNHS Employees' Group Gratuity Scheme	37,069.00	
9,190.10	Casual Labour	17,083.25	
53,525.50	Meeting expenses	27,852.60	
37,414.90	Postage Expenses	70,842.95	
40,482.90	Printing & Stationery	47,421.75	
30,058.00	Advertisements	9,350.50	
70,795.90	Telephone Expenses	82,403.40	
78,773.52	Electricity Expenses	74,771.80	
5,785.50	Travelling Expenses	33,137.20	
22,733.00	Conveyance Expenses	24,294.85	
35,19,601.42	Carried forward	30,05,916.85	
16,617.00	Carried over....		9,61,327.55

Previous year 1993-94 Rs.	INCOME	Rs.	Current Year 1994-95 Rs.
	INTEREST (RECEIVED & ACCRUED)		
110.00	On Government Securities	110.00	
3,40,925.93	On Fixed Deposits	4,25,095.01	
23,499.35	On Saving Accounts	10,355.17	
52,562.00	On ICICI Bonds	80,000.00	
60,358.50	On IDBI Bonds	48,000.00	
4,77,455.78			5,63,560.18
7,30,432.00	**Distn. of Income from UTI**		10,93,845.01
	DONATIONS (In cash or kind)		
	i) **For Specific Purposes:-**		
5,000.00	a) SANCF Corpus Fund	400.00	
Nil	b) Salim Ali Memorial Fund	1,00,000.00	
2,00,000.00	c) Publication Fund	Nil	
600.00	d) Charles MaCann Vertebrate Zoology Fund	600.00	
25,000.00	e) Hornbill printing	40,000.00	
1,87,549.00	f) General purposes	1,23,005.65	
2,00,000.00	g) For various projects	Nil	
Nil	h) ICICI Environmental Research & Edn. Fund	15,00,000.00	
Nil	i) TISCO - Conservation Education Research & Awareness Fund	20,00,000.00	
6,18,149.00			37,64,005.65
	GRANTS		
	i) From Govt. of Maharashtra for 1994-95		
1,80,042.75	a) For Collections	2,08,811.75	
61,957.25	b) For Nature Education	33,188.25	
8,000.00	c) For Building Maintenance	8,000.00	
2,50,000.00	Carried forward	2,50,000.00	
18,26,036.78	Carried over...		54,21,410.84

Previous year 1993-94 Rs.	EXPENDITURE	Rs.	Current Year 1994-95 Rs.
16,617.00	Brought over...		9,61,327.55
35,19,601.42	Brought forward	30,05,916.85	
77,951.49	Vehicle Maintenance	1,07,831.40	
2,985.80	Bank Charges (Net)	3,699.55	
2,000.00	Audit Fee	5,000.00	
24,036.25	Xerox Servicing Charges (Net)	1,865.00	
54,399.00	Repairs and maintenance to furniture and equipment	74,845.30	
4,084.90	Repairs and maintenance to electrical fittings includes Rs. 2,30,000 met out of grants from Govt. of Maharashtra	2,31,050.80	
6,685.00	Insurance other than building	11,258.00	
12,250.00	Professional and Legal Fees	12,500.00	
15,351.00	Computer maintenance and stationery	76,387.00	
37,19,344.86			35,30,353.90
	AMOUNT WRITTEN OFF		
Nil	Receivable from Bihar Government		6,534.00
Nil	Prior period adjustment for unrealised grant from Govt. of Maharashtra 1991-92		2,30,804.00
	MISCELLANEOUS EXPENSES		
3,925.00	Garden Maintenance Expenses	2,700.00	
387.00	Beautification of Dr. Salim Ali Chowk	12,839.50	
25,217.79	General Expenses	42,987.29	
1,076.00	Aquarium maintenance	645.00	
30,605.79			59,171.79
	DEPRECIATION (Met out of fixed assets fund as per schedule "B")		
3,63,670.22	i) On Furniture and Equipment	3,61,296.58	
98,188.90	ii) On Motor Vehicles	88,367.53	
4,61,859.12			4,49,664.11
42,28,426.77	Carried over..		52,37,855.35

Previous year 1993-94 Rs.	INCOME	Rs.	Current Year 1994-95 Rs.
18,26,036.78	Brought over...		54,21,410.84
2,50,000.00	Brought forward	2,50,000.00	
1,01,200.00	ii) Journal Printing from Dept. of Science & Technology, Govt. of India	50,000.00	
61,85,839.89	iii) Other Grants as per Schedule "C" (To the extent utilised during the year)	89,16,693.57	
Nil	iv) Royal Western India Turf Club Limited	1,68,827.11	
1,45,820.36	v) Unspent surplus allowed to be retained (Net)	Nil	
66,82,860.25			93,85,520.68
	SUBSCRIPTIONS		
	Ordinary Members		
2,99,584.61	Individual	2,08,390.90	
510.00	Family	Nil	
23,085.00	Students	22,925.00	
47,038.00	Corporate Membership	1,18,299.50	
1,60,189.96	Life Membership (Individual)	2,00,700.00	
66,071.43	Journal Members	89,978.95	
65,034.00	Journal - Non-Members	1,02,177.00	
35,749.01	Entrance Fee	42,593.30	
6,97,262.01			7,85,064.65
	INCOME		
4,20,886.69	From BNHS Publications (Net)	2,88,804.87	
1,05,443.56	From Govt. Publications	9,460.36	
4,53,748.04	From Greeting Cards	4,01,382.71	
1,82,619.46	From Calendars	44,501.73	
126.75	From Stickers	4.00	
2,495.00	From BNHS Caps	671.00	
49.50	From BNHS Mugs	131.00	
21,800.00	From old Paintings, Photographs	Nil	
235.00	From T-Shirts	555.00	
294.00	From Bags	64.00	
11,87,698.00			7,45,574.67
1,03,93,857.04	Carried over...		1,63,37,570.84

Previous year 1993-94 Rs.	EXPENDITURE	Rs.	Current Year 1994-95 Rs.
42,28,426.77	Brought over...		52,37,855.35
	AMOUNTS TRANSFERRED TO FUNDS AGAINST INCOME		
	Specific Purpose Donations		
2,30,600.00	as per Contra	1,000.00	
1;60,189.96	Life Membership Fees Fund	2,00,700.00	
16,095.45	50% Royalty on Dr. Salim Ali's Publications	41,899.73	
Nil	ICICI Environment Research & Education Fund	15,00,000.00	
Nil	TISCO Conservation Education Research and Awareness Fund	20,00,000.00	
1.312.14	Govt. Publication Fund	Nil	
4,212.00	Interest on loan to staff	3,373.00	
2,30,532.78	Fixed Asset Funds (Net)	69,000.00	
2,83,953.95	Interest allocation to funds	2,82,951.45	
Nil	Salim Ali Memorial Fund	1,00,000.00	
Nil	Staff Gratuity Fund	35,801.00	
61,957.25	Nature Education Scheme 1994-95	33,188.25	
9,88,853.53			42,67,913.43
	APPROPRIATIONS TO FUNDS OUT OF SURPLUS		
1,00,000.00	Staff Welfare Fund	25,000.00	
2,00,000.00	Staff Gratuity Fund	Nil	
2,00,000.00	General Reserve Fund	Nil	
50,000.00	Publication Fund	Nil	
5,00,000.00	Proposed Institution Fund	Nil	
2,00,000.00	Salim Ali Memorial Fund	Nil	
12,50,000.00			25,000.00
	EXPENDITURE ON THE OBJECTS OF THE TRUST		
1,94,371.87	Expenses met out of funds as per Schedule "B"	5,02,054.76	
61,85,839.89	Expenses met out of grants as per Schedule "C"	71,38,430.57	
4,29,013.20	Journal printing and Postage	1,34,709.50	
68,09,224.96	Carried forward	77,75,194.83	
64.67.280.30	Carried over...		95,30,768.78

Previous year 1993-94 Rs.	INCOME	Rs.	Current Year 1994-95 Rs.
1,03,93,857.04	Brought over...		1,63,37,570.84
	OTHER RECEIPTS		
2,908.04	Foreign exchange fluctuations	Nil	
7,555.65	Miscellaneous receipts	19,240.78	
32,190.91	Royalty on Dr. Salim Ali's Publications	83,799.46	
4,212.00	Interest on Loan to Staff	3,373.00	
1,150.00	Post-Graduate Dept. of Bombay Univ.	39,452.00	
1,67,061.46	Surplus on Seminar (Net)	Nil	
Nil	Transparency Fee	58,000.00	
Nil	Staff Gratuity	35,801.00	
Nil	Surplus on surrender of units of UTI	1,08,990.00	
2,30,532.78	Sale proceeds of Vehicles (Net of repairs)	69,000.00	
4,000.00	Advertisement for Hornbill	Nil	
4,49,610.84			4,17,656.24
	ADMINISTRATIVE FEES		
5,80,093.35	For Project Funds	5,68,971.24	
1,312.14	For Govt. Publication Funds	1,017.32	
4,71,520.70	For other funds	Nil	
10,52,926.19			5,69,988.56
	AMOUNTS DRAWN FROM FUNDS		
39,248.12	For Natural History Studies	Nil	
1,52,100.25	Nature Conservation	2,12,283.64	
3,023.50	For other Educational Expenses	Nil	
11,07,896.00	For Gratuity Payment	1,12,669.00	
4,61,859.12	For Depreciation	4,49,664.11	
387.00	For Beautification of Dr. Salim Ali Chowk	12,839.50	
Nil	For Publication Fund (John Gold Painting)	1,00,000.00	
Nil	For Staff Medical Expenses (Staff Welfare Fund)	17,155.95	
17,64,513.99	Carried forward	9,04,612.20	
1,18,96,394.07	Carried over...		1,73,25,215.64

Previous year 1993-94 Rs.	EXPENDITURE	Rs.	Current Year 1994-95 Rs.	Previous year 1993-94 Rs.	INCOME	Rs.	Current Year 1994-95 Rs.
64.67,280.30	Brought over...		95,30.768.78	1,18.96.394.07	Brought over....		1,73.25,215.64
68.09,224.96	Brought forward	77.75,194.83		17.64.513.99	Brought forward	9,04,612.20	
1,29,531.74	Hornbill Printing and Postage	2,63,335.44		Nil	From General Reserve Fund (For various expenses)	65,000.00	
10.740.20	Nature Eduation	1.85.932.51		Nil	ICICI Environment Research and Education Fund	1,12,291.68	
62,769.55	Members Activities	1.09.573.50		Nil	TISCO Conservation Education Research and Awareness Fund	77,479.44	
20,855.10	Library, Books Binding, Subscriptions & Contingencies	1,10,553.21					
1,33,433.43	Reference Collection Maintenance Exp.	3,12,559.81					
274.75	Postgraduate studies	37,828.00		17,64,513.99			11,59.383.32
296.90	Laboratory Expenses and Contignecies	1,57,284.10					
71,67,126.63			89,52,261.40				
26,501.13	Balance of Surplus Carried Forward		1,568.78				
1,36,60,908.06			1,84,84,598.96	1,36,60,908.06			1,84,84,598.96

BOMBAY NATURAL HISTORY SOCIETY

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

AS PER OUR REPORT OF EVEN DATE

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS

Bombay
Dated: 30th September, 1995

BOMBAY NATURAL HISTORY SOCIETY
NATURE EDUCATION SCHEME
RECEIPT AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31-3-1995

Previous year 1993-94	RECEIPTS	Current Year 1994-95	Previous Year 1993-94	PAYMENTS	Current Year 1994-95
Rs.		Rs.	Rs.		Rs.
	To Opening balance In Current Account With		1,62,386.62	By Opening Balance	1,51,353.37
1,200.99	ANZ Grindlays Bank p.l.c.	700.99		By Salaries To Nature Education	
			47,924.00	Organiser	53,747.00
61,957.25	To Grant Govt. of Maharashtra	33,188.25			
			3,000.00	By Contingency Expenses	3,000.00
Nil	To Contribution from BNHS (Sp. Charity Race)	1,74,912.12	500.00	By Bank Charges	700.88
1,51,353.37	To Closing Balance	Nil	700.99	By Closing Balance in Current Account with ANZ Grindlays Bank p.l.c.	0.11
2,14,511.61		2,08,801.36	2,14,511.61		2,08,801.36

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

Sd/-
HONORARY SECRETARY

Sd/-
HONORARY TREASURER

Sd/-
HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay
Dated: 30th September 1995

BOMBAY NATURAL HISTORY SOCIETY

Annual General Meeting held on 12th December 1995

The Annual General meeting (AGM) of the Society for the year 1994-95 was held on 12.12.1995 at Hornbill House at 6.30 PM, when the following members were present :

Mr. A D Samant, Maj. Madhav Mhaskar, Dr Arun Joshi, Mr. Mihir Devare, Mr. Shashank Ranjit, Mr. Nitin Jamdar, Dr Anita Borges, Dr E. Borges, Dr P G Natrajan, Dr H Buch, Mr. Pramod Paranjpye, Dr Nagraj H, Ms. Asha D Sawant, Mr. D. M. Sawant, Dr M. B. Goyal, Dr Sanjay Sharma, Dr Santosh Rai, Ms. Sonali Saha, Mr. Subodh Tari, Dr Anuradha Samant, Mr. Atul Mathur, Ms. Juliet Mendonca, Mr. Dilip Patil, Mr. J. N. Pande, Mr. V. K. Paralkar, Mr. S. M. Kalim, Dr. S. Unnithan, Ms. Namita Sankhe, Dr. S. M. Satheesan, Mr. Naveen Khanna, Mr. N. V. Adhikari, Mr. S. G. Deshpande, Mr. Shakunt Tari, Mr. R. S. Vartak, Mr. T. R. Munsiff, Mr. A. T. Palande, Mr. Sameer Nangare, Dr. B. F. Chhpagar, Mr. Vijay Pore, Dr. Sanjay Bhagwat, Mr. Vijay Thite, Dr. A. S. Kothari, Mr. F. S. Kazi, Ms. Geeta Pardiwalla, Ms. Visha Gangadharan, Ms. Lakshmi Sundaram, Maj. Gen. E. D'Souza, Ms. Vijaya Deshmukh, Mr. K. P. Karamchandani, Dr. Pratap Saraiya, Prof. P. V. Bole, Mr. M M Sant, Mr. Bansi Mehta, Mrs. Norma Perry, Mr. P. H. Butani, Mr. D. P. Bannerjee, Mr. Meghnad Kulkarni, Mr. Shekhar Shiveshwarkar, Mr. Manish Khodaskar, Dr. L. N. Deshpande, Mr. Suresh Sawant, Mr. Manoj Karkhanis, Ms. Philipa Mukherjee, Mr. Avinash Supe, Mr. Hira Punjabi, Dr. Vibhu Prakash, Mr. S. Futehally, Ms. Lima Rosalind, Mr. Prashant Muley, Mr. Shyam Ghate, Mr. Anil Kunte, Mr. Parvez Cama, Mr. Vilas Shingre, Mr. K. R. Shah, Mr. Sunil R. Zaveri, Dr. Renee M. Borges, Mr. Shahid Ali, Mr. Krishna Kumar, Mr. A. K., Ms. Rita Ganguli, Mr. Rokad Zubair, Mr. R. Singh, Ms. Mehera Dubash, Mr. D. Yesodharan, Mr. K Rameshan, Mr. Chitrasen Chaubey, Mr. S. S. Bandiwadekar, Mr. Subhash Bijlani, Dr. S. M. Almeida, G. V. K. Unnithan, Mr. Pradeep V Rane, Mr. Prasad P Rane, Mr. K P Rane, Mr. V. I. Naik, Mr. V. Arun, Mr. A. S. Mahajan, Mr. H. B. Gupte, Dr S R Gawde, Mr. Chandra Shekhar, Mr. Surendra J, Mr. Ulhas Rane, Mr. K. N. Shroff, Mr. Naresh Chaturvedi, Dr. Shashi Menon, Mr. M. R. Almeida, Mr. Asad Akhtar, Mr. Reis Manfred, Dr. Sanjay Deshmukh, Ms. D. S. Variava, Mr. J. C. Daniel, Mr. D. A. Patil, Mr. N. N. Muley, Mr. Parag Mungale, Dr. R. D. Bapat, Dr. Parvish Pandya, Mr. Ravi Mahimkar, Dr. A. M. Bhagwat, Ms. M. Kirloskar, Mr. Sachin Kulkarni, Mr. D. V. Gotalkar, Ms. J Sethna, Mr. Manoj Kulkarni, Mr. V. Gopi Naidu, Ms. Bakul Khatau, Mr. S S Sapre, Mr. S. R. Nayak Mr. R. H. Kumavat, Mr. Rishad Naoroji, Ms. Doreen D'Sa Mr. N. D. Mulla, Mr. V. Madhav, Mr. B. Samant. Mr. V. M. Meher Homji, Mr. Pradeep Limaye, Ms. Soonoo Taraporewala, Ms. Neelima Gohil, Mr. Parimal V Shah, Mr. Sanjeev Joshi, Mr. S. P. Godrej, Mr. Piyush Shah, Mr. Shishir Parikh, Mr. Vijay Sanghavi, Mr. Jatin Mehta, Mr. M B Parag, Mr. S. S. Bhujbal, Mr. S. D. Bhaumik, Mr. Dhiren P, Mr. Joslin Rodrigues, Mr. Mayank Mehta, Mr. A. M. Shah, Mr. Ranjit Parikh, Mr. Pradip Doshi, Mr. Sam Bhacka, Mr. Gautam Jain, Mr. M. H. Choksi, Mr. Hemant C. Patel, Mr. L. S. Patel, Mr. Sudhir R. Paradkar, Mr. M. Panicker, Mr. Hitesh R. Shah, Mr. Ravidas Madavkar, Mr. Prakash S. Rane, Mr. S. A. Futehally, Mr. Debi Goenka, Ms. B. Pimento, Ms. Caroline Vincent, Mr. M Surveyor, Ms. Nita Mehta, Mr. Rafiq Sayed, Mr. K K Vajifdar, Mrs. S K Vajifdar, Mr. Paresh Vakil, Ms. Torcato Ronita, Mr. Manual Fernandes, Mr. Deepak Apte, Mr. Ashok Ghangurde, Mr. Jitendra Jhaveri, MR. S. S. Mehta, Mr. Arun Samant, Mr. H. C. Mistry, Mr. Mohan Amladi, Dr. Ashok Joshi, Mr.. Suresh Bhatkal and Mr. Rajan John.

FELICITATION TO DONORS

Before the commencement of the AGM, all those who had donated more than Rs. 1 lakh to the Society during the year 1994-95 were felicitated by the Vice President, Mrs. D. S. Variava. Mementos were presented to representatives of: Royal Western India Turf Club and Purshotamdas Thakurdas and Divaliba Charitable Trust. The following donors were not represented, their mementos were sent to them : Shri Vasant Panse, Siporex, ICICI Ltd., TISCO Ltd.

Mrs Variava stated that it is necessary to recognise both the donor and the person who encourages the donation to be given, and she extended thanks to Mr. B. G. Deshmukh, Dr. P. R. Saraiya and Mr. Sunil Zaveri for the donations that had been received. This programme was followed by High Tea. The AGM then started at 6.30 PM.

NO CONFIDENCE MOTION

Mrs. D. S. Variava, Vice President, who was in the Chair announced that the first business of the meeting would be the consideration of a No Confidence Motion and the Executive Committee (EC)'s views on the same. The No Confidence Motion received read as under :

"Resolved that the members express NO-CONFIDENCE in the present Office Bearers (i.e. President, Vice-Presidents, Honorary Secretary, Honorary Treasurer and Director) of the BNHS". (Proposed by Ms Mehera Dubash and Mr. Anil Kunte and seconded by Mr Dilip Patil and Mr. Shakunt Tari).

Before addressing this issue Mrs. Variava stated that she wished to explain why she was taking the Chair and not the Society's President, Mr. B. G. Deshmukh. She then read out the letter of resignation from Mr. Deshmukh. She informed the members that the Executive Committee had considered the letter of resignation and had passed the following resolution :

"The EC received with deep regret and sadness the letter of resignation dtd. 12 December 1995 from Mr. B. G. Deshmukh from the Presidentship of the Society due to his name "being dragged by some members unnecessarily into the electoral politics of the Society".

The EC hereby records its full confidence in its President, Mr. B. G. Deshmukh and deep appreciation of all that he has done to strengthen the Society through selfless service and through sterling qualities of leadership of the Society.

The EC urges Mr. B. G. Deshmukh to kindly reconsider his resignation in the interest of the Society".

Mrs. Variava stated that this resolution was passed by all members of the EC present at its meeting today with one exception, Mr. Ulhas Rane, who dissented.

Mrs. Variava further stated that the proposed motion of No Confidence was against the President, Vice Presidents, Honorary Secretary, Honorary Treasurer and the Director. The President had resigned and the Vice President felt that it was not appropriate to take the Chair and therefore requested the EC to elect a member to take the Chair. Mr. Karamchandani was unanimously elected to take the Chair for the EC meeting and also for the AGM.

Mrs. Variava pointed out that Mr. Karamchandani was a nominated member, and was not standing for election. She said the EC receives the proposed resolutions and has to decide whether to place the matter before the AGM or put it up for a Referendum. Mr. Karamchandani would apprise members of the EC's decisions.

Mrs. Variava then requested Mr. Karamchandani to take the Chair. At this point name of Maj. Gen. (Retd) E. D'Souza was proposed to Chair the AGM. However, it was pointed out that under Rule 55 only if none of the members of the EC is present at the AGM, members can nominate and appoint a member from amongst themselves as a Chairman. Mr Karamchandani, Chairman, read out the EC's resolution as given below :

"Resolved that the Resolution of No-Confidence in the present office bearers of the Society (i.e. President, Vice Presidents, Honorary Secretary, Honorary Treasurer and Director) of the BNHS be placed before all the members of the Society by a Referendum as the No-Confidence motion will affect the working of the Society and therefore all the members of the Society. (Rule 70)".

Mr. Rane insisted that the motion of No-Confidence should be put before the AGM and not sent for Referendum to all members.

Mr. Rane's attention was drawn to the fact that the No Confidence Motion concerns all members of the Society and therefore it was necessary to obtain their opinion thereon and this was the reason why the EC decided to send it for Referendum. Mr. Rane again suggested that under Rule 71 there was no necessity for a Referendum. Mrs. Variava then read out the Rule 71 which relates to only interpretation of the rules and bye-laws and specifically refers to any questions not provided in the rules.

The Chairman then asked the members to discuss the No Confidence Motion. Several members aired their grievances and there was a certain amount of agitation and in some cases a loss of decorum. After considerable discussions Mr. Nitin Jamdar drew attention to the fact that the EC was due for re-election and at this point of time a No Confidence Motion would serve no purpose other than incurring of considerable expenditure by the Society. Other members also requested the sponsors of the Resolution to withdraw the same and Ms. Mehera Dubash agreed to do so provided a meeting was arranged within 10 days between members and the ECto discuss problems faced by the members. On a verbal assurance from the Chairman that such a meeting would be convened soon Ms Mehera Dubash and others withdrew the resolution and members expressed their appreciation of their action.

The Chairman then took up the regular agenda items for consideration.

Item 1

Confirmation of the Minutes of the AGM held on 15 September 1994.

Some members protested that minutes had not been received by them. It was pointed out that as per the notes sent with the agenda, the minutes and the accounts were to be supplied to members on written request. Mr. Rane stated that members who had joined after 14th July had not received the minutes. Mr. Debi Goenka pointed out that there was an earlier decision that minutes will be circulated only to members who had attended the AGM and that others will be supplied the minutes on a written request.

Mr. Daniel proposed and Mr. Sunil Zaveri seconded that the minutes be adopted and they were so adopted.

Item 2

Consideration and adoption of the Annual Report of the Executive Committee for the year ended 31st March 1995.

(A) CONSERVATION

Concern was expressed that the BNHS was not pulling its weight on conservation issues. The Chairman of the Salim Ali Nature Conservation Fund Sub-Committee explained the various fields in which the Society and its Conservation Officer has been active. A detailed note on the action taken on conservation problems was available for members.

Mrs. Philipa Mukherjee, Secretary of the Palni Hills Conservation felt that the Society should be much more active and publicly oriented if it was to be effective. She felt that the membership was rather low for a Society of its eminence and age and research in conservation activities should be increased.

Mrs. Variava felt that the Society had an important role to perform in providing a scientific background for conservation issues.

An apprehension was expressed that acceptance of funds may dilute the conservation efforts of the Society. It was assured that the EC had the Society's commitment to conservation in mind and would not permit any dilution of its conservation role.

(B) CONSERVATION EDUCATION PROJECT

Dr. Shashi Menon, Chairman of the Conservation Education Project (CEP) Sub-Committee replied to the queries concerning the progress of the CEP.

The main reason for the delay in implementation was the fact that the land had not been transferred to the Society by Government. But through the good offices of the President, the Municipal Commissioner was willing to overlook the non-availability of transfer deed for the work to continue. The initial calculation of the area of the Centre as 500 Sq Mts was arbitrary, and so also the estimated cost of Rs 23 lakhs. As the area had to be increased to 700 Sq Mts an amount of 43 lakhswas provided by Overseas Development Administration (ODA), UK. There were unfortunately several lacunae in the information inputs from the Architect, namely several peripheral works such as security deposits with the municipality totaling 68 lakhs, subsequently reduced to 10% of the amount, through the good offices of the President, internal access road, water tank, street lights, electric substation, water supply, electrical fixtures. The cost of these worked out to 28 lakhs which had to be paid from the Society's funds. The Centre which should have been completed within 43 lakhs would end up costing over 60 lakhs.

A member, who is a Civil Engineer expressed surprise that the Architect should have omitted to advise his client of these crucial points and wanted to know how the costs are to be met. The Honorary Treasurer explained that through the good offices of the President several organisations had extended financial support for the purpose.

Mr. Rane, the Architect, admitted that the layout proposal, etc. were not included in the estimate which was limited to the building of the Centre. Tender costs have not increased. He stated that he was satisfied with the quality of work. Only 5% of work remained to be done. The Architect emphasised that he was working in an honorary capacity (out of the 7% architect fee he would be returning to the Society 2%, the rest being utilised for structural consultants 2% and architect's out of pocket expenses 3%) but he has had problems with the EC. The location being beyond availability of infrastructure facilities has put up the cost.

Dr. P. R. Saraiya emphasised that it was expected that the entire cost of commissioning the Centre would be met by the ODA, else the Society would not have taken up the project if its own funds had to be utilised.

(C) SCIENTIFIC STAFF

In reply to a query on the scientists leaving the Society, the Honorary Secretary gave a statement on the present status of the scientists who had left our service. He also advised that a corpus fund for core scientists was being established and presently the President had acquired funds for employing two core scientists. The idea was to collect more funds of this nature so that our scientific staff could be sustained on a more permanent basis.

(D) NANDADEVI CAMP

A member queried the cancellation of the Nandadevi Camp which had caused considerable inconvenience. The Honorary Secretary explained that the basic reason for the cancellation was that in spite of personal meetings with the Forest Department by the Programme Officer, we were not able to obtain permission to visit the Nandadevi sanctuary which had now been completely closed for a period of 5 years. This ban is likely to be extended. The Society was, therefore, reluctantly compelled to cancel the programme. There was no possibility of our members being allowed into the sanctuary or its buffer zone.

(E) ADVERTISEMENT ON TRAINS

Mr Subhash Bijlani inquired whether any action had been taken on his suggestion that advertisements carrying conservation messages be put on the railway rakes. Mrs. Variava stated that she had also wished to advertise some of the BNHS products similarly. However, financial constraints prevented action and this matter is kept pending till resources are available.

(F) BIGGER BUS FOR BNHS FIELD ACTIVITIES

There was a suggestion to try and obtain a bus with a larger seating capacity. The Honorary Secretary stated the Committee would look into the matter provided funds were available.

Mr. Sunil Zaveri proposed and Dr. Saraiya seconded the adoption of the Annual Report. It was so adopted.

Item 3

Consideration and adoption of the balance sheet and statement of accounts for the year ended 31st

March 1995

(A) The Honorary Treasurer advised that due to the good offices of the President, Shri B. G. Deshmukh the Society has received donations totaling Rs 55 lakhs and has been able to wipe out the deficit of the previous year and is in a comfortable financial position. It was noted with regret that Mr. Panse had withdrawn his offer of Rs 1 lakh donation owing to internal dissensions within the Society. Mr. P Cama expressed his appreciation of the President's efforts to put the Society in a financially stable position and wondered why other members were not able to assist the Society similarly.

(B) Mr. Rane said that he had given a proposal for fund raising through various activities which was never considered by the EC. Mrs. Variava said that whenever an EC member put a proposal he should be able to convince other EC members of its viability.

(C) Capt. Deshpande inquired about the decreasing receipts from the membership as compared to that of last year, while we have shown an increasing membership number. He also inquired about the receipt from Publications as compared to last year. The Honorary Treasurer clarified that the last year'sbalance sheet was for 15 months because of the change in the financial year and the figuresare therefore on the higher side as compared to this year.

(D) Maj. Madhav Mhaskar inquired about charging of administrative fees on various projects. The Honorary Treasurer replied that such fees were charged only on the projects funded by outside agencies to meet the administrative costs. However, there is no administrative fees charged on projects internally sponsored and funded by SANCF, Natural History Funds, etc.

Dr. Sanjay Bhagwat proposed and Mr. J. C. Daniel seconded that the balance sheet and accounts be adopted.

Item 4

Appointment of auditors for the year 1st April 1995 to 31st March 1996 and fixing of their remuneration

It was resolved that M/s. Habib & Co., Chartered Accountants, Mumbai 400 023, be reappointed as the Auditors for the Society for the year 1.4.1995 to 31.3.1996 on a total remuneration of Rs 5000/- (Rupees five thousand only).

Item 5

Election to the Executive Committee for the Calendar Years 1996 and 1997

The Honorary Secretary announced that a total of 39 names have been received. Of these 2 are rejected due to lack of proposer and seconder's names, two members have withdrawn their names and one has sent the form in duplicate. There are therefore 34 valid nominees for election to the EC of 1996-97. To an inquiry raised by a member regarding election procedures, it was stated that it is conducted as per the rule nos. 34 and 35. There was a suggestion that it should be supervised by an independent Committee. However the rules do not permit appointment of such an external authority for the conduct of the election.

Item 6

Any other business with the permission of the chair

Resolutions received :

(A) Members' address list. Rule No. 19 :-

"The list of up to date members with addresses and phone numbers shall be furnished to any member at reasonable cost (xerox charges/printout cost/ floppy) to be fixed by the EC from time to time, within seven days of his written request to the Honorary Secretary".

(Proposed by Dr. Renee Borges and seconded by Mr. Shakunt Tari).

It was noted that many members objected to their names and addresses being given to any party whether a member of the Society or otherwise. It was therefore agreed to accept the proposal with the modifications that members who do not wish to have their names and addresses included for circulation should inform the Society. With this modification the amendment was accepted.

(B) Denotification of Protected Areas :-

"It is resolved that BNHS condemn the denotification of protected areas from wildlife sanctuaries and tiger reserves by State Governments.

BNHS calls for renotification of areas which have been denotified and for a halt on any further denotification".

(Proposed by Dr. A. M. Bhagwat and seconded by Mr. J. C. Daniel).

The proposal was accepted unanimously.

(C) Corpus Funds :- "Resolved that the funds of ICICI Environmental Research and Education Fund of Rs 15 lakhs (Rupees fifteen lakhs only) and TISCO Conservation Education, Research and Awareness Fund of Rs 20 lakhs (Rupees twenty lakhs), presently shown under Schedule - B, i.e. other funds of the Bombay Natural History Society, shall not be withdrawn without the prior approval of 90% of the members of the Society by way of Referendum as provided in the Rules and Regulations of the Society.

These funds which are presently invested in 1,50,000 units monthly income plan of the Unit Trust of India of Rs 15 lakhs for ICICI Environmental Research and Education Funds, and in fixed deposits with Indian Oil Corporation of Rs 20 lakhs for TISCO Conservation Educaton Research and Awareness Funds, shall not be encashed, before maturity, without the prior approval of 90% of the members of the Society by way of Referendum as provided in the rules and regulations of the Society. Further, when the above deposits mature, the same shall be immediately reinvested in a similar manner.

The Society shall utilise only the interest from the above earmarked funds in accordance with the Terms of Reference as given by the Donors and approved by the Executive Committee of the Society".

(Proposed by Mr. Sunil Zaveri and seconded by Dr. A. M. Bhagwat)

The proposal was approved unanimously.

(D) President's Resignation :-

Prof. P. V. Bole proposed and Mr. M. R. Almeida seconded a resolution requesting the President, Mr. B. G. Deshmukh to withdraw his resignation from the Presidency of the Society. The resolution was approved unanimously by the General Body.

The meeting terminated with the vote of thanks to the Chair, which was proposed by Mr. N. D. Mulla and seconded by Mr. Nitin Jamdar.

THE SOCIETY'S PUBLICATIONS

The Book of Indian Animals, by S.H. Prater, 4th edition (Reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations *(Price to members Rs.* 170)

The Book of Indian Birds, by Sálim Ali, 12th edition (revised enlarged) 64 coloured and many monochrome plates. *(Price to members Rs.* 296)

A Pictorial Guide to the Birds of the Indian Subcontinent, by Sálim Ali & S. Dillon Ripley. (Reprint with corrections) *(Price to members Rs.* 278)

Checklist of the Birds of Maharashtra, by Humayun Abdulali, 2nd edition. *Rs.* 2

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ERRATA

Vol. 94, No. 1, p. 23, for line 36 to 41 read:
Ahmedullah and Nayar (1987) have reported 29 species and one variety of *Fimbristylis* to be endemic to peninsular India. Of this *F. junnarensis* Hemadri is *nomen nudum* and hence should be rejected. *F. unispicularis* Govind. and Hemadri is the correct name of this species.

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THE EFFECT OF INDIRA GANDHI NAHAR PROJECT ON THE AVIFAUNA OF THE THAR DESERT[1]

Asad R. Rahmani[2]

(*With two text-figures*)

Key words: Thar desert, canal, avifauna, checklist, environmental impact

The 208,000 sq.km Thar desert is one of the smallest deserts in the world. Being at the crossroads of the Palaearctic and Oriental biogeographical regions, the Thar has high avian diversity of nearly 250 species. The Thar has a very high human density, which is exerting tremendous pressure on the fragile ecosystem. The development of the Indira Gandhi Nahar Project (IGNP) during the last two decades has resulted in large scale ecological changes. Traditional crops have been replaced by cash crops, which need more water. Owing to the misuse of irrigation facilities, water logging and salinity is increasing all along the IGNP. Canal-side plantations and seepage wetlands, now attract many new forest and wetland birds. Shikra, honey buzzard, yellow-legged green pigeon, roseringed parakeet, jungle babbler, striated babbler, crow pheasant, whitebrowed fantail flycatcher and paradise flycatcher are spreading through linear plantations on both sides of the canal, and ducks, waders, egrets, herons etc. are becoming common. The common crane is also spreading along the IGNP. During four surveys in 1993 and 1994, 213 species of birds were identified, nearly half being non-desert taxa. Purely desert and dry grassland birds such as the great Indian bustard, houbara, cream-coloured courser, desert lark, hoopoe lark and whitebrowed bushchat are decreasing, some at an alarming rate. Despite the IGNP being perhaps the longest desert irrigation canal in the world, no environmental impact assessment has been done.

Introduction

The Thar desert occupies nearly 9% of India's geographical area and covers more than 208,000 sq.km. It extends into Pakistan but nearly 62% is present in eleven districts of western Rajasthan and parts of Kutch. A major portion of the Thar desert is occupied either by dry open grassland or by grassland interspersed with trees and thorny bushes (Gupta, 1975a). Sand dunes are present in nearly 58% of the area (Shankarnarayan, 1988).

One of the smallest deserts in the world, the Thar has a high avian diversity, from its location on the crossroads of the Palaearctic and Oriental biogeogrphic regions. It is connected to the Sahara desert via Persian and Arabian deserts, and shows avian affinity with these deserts, and to some extent with the Etho pian region (e.g. bustards, coursers, francolins).

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[1]Accepted September, 1995.

[2]Centre of Wildlife & Ornithology, Aligarh Muslim University, Aligarh 202 002, India
Present address: Bombay Natural History Society, S.B. Singh Road, Hornbill House, Mumbai 400 023

As the Thar desert is not isolated, avian endemicity is very low. To the west it is connected through the Sind plains with the Persian and then Arabian deserts, on the north lie the fertile plains of the Punjab, to the northeast the Gangetic plain, and to the east, it joins the semi-arid plains of the Deccan. In the south, it merges with the Rann of Kutch. Most species of birds of the Thar have a wide distribution. Stoliczka's whinchat or whitebrowed bushchat *Saxicola macrorhyncha* is one of the endemic birds. The low degree of endemicity is also due to the fact that most birds are highly mobile, and to evolve into localized endemic species, need very effective barriers, either physical or ecological, which in the case of the Thar are generally absent.

Although no detailed work on the avifauna of the Indian Thar has been done, nearly 250 species of birds have been recorded by various workers such as Adam (1873, 1874), Barnes (1886), Ticehurst (1922), Whistler (1938), and Rahmani (1994).

Brief history of ornithology in the Thar

The Thar, including the Sind region in Pakistan, has a long history of human occupation. Perhaps the first scientific bird study which included the Thar was by R. M. Adam in 1873 and 1874, in the first ornithological journal of India, *Stray Feathers* (vol. 1 and 2). Although the major emphasis of these two papers was on the birds of Sambhar Lake, nearby areas were also covered. Later, E. A. Butler's 'Notes on the avifauna of Mount Aboo and northern Gujarat', in *Stray Feathers* (vol. 3, 4, and Addendum in vol. 5) in 1875 and 1876 also partly dealt with the birds of the Thar desert.

The first exclusive study on the birds of the Thar (Sind province) was by Scrope Doig, who while constructing the east Nara canal in the 1870s kept extensive notes and later published them in the form of two papers: 'Birds Nesting on the Eastern Nara Sind', *Stray Feathers*, (*8*, pp 369-379), and 'Birds Nesting on the Eastern Nara, (Sind) Additions and Alterations', *Stray Feathers 9*, pp 277-282. At about the same time H. E. Barnes in 1886, published a paper 'Birds nesting in Rajpootana', in the first issue of the *JBNHS*. Later he published another article 'Nesting in western India', in seven parts in the same journal (1888-1890). This paper also covered birds of the Thar desert. Hume (1873, 1877a, b, 1878) also wrote extensively on the birds of Sind, including the Thar desert .

In the first few decades of this century, three eminent ornithologists studied the avifauna of the Thar and Sind. Claude B. Ticehurst between 1922 and 1924, published 'Birds of Sind' in eight parts, in the British journal *Ibis*. He also collected nearly 1500 specimens which are lodged in the British Museum (Natural History). The doyen of Indian ornithology, Hugh Whistler published an exhaustive paper 'The Ornithological Survey of Jodhpur State', in 1938 in *JBNHS*, based on the birds collected and seen by La Personne in 1933-34. He also incorporated the works of R. M. Adam, A. O. Hume (Birds of a Drought, *Stray Feathers,6*). and King, who collected birds at Mount Abu (=Aboo) and Jodhpur for nearly two years but never published his findings.

K. R. Eates, a police officer posted in Sind for almost 20 years, between 1926 and 1943 published many interesting notes in *JBNHS*, on the breeding birds of Sind (Eates 1937, 1939). Dr. Sálim Ali unfortunately never got the opportunity to work in the Thar desert of Rajasthan but his, and Dr. Dillon Ripley's monumental 10 volumes 'The Handbook of the Birds of India and Pakistan' extensively cover the birds of the Thar desert.

With the establishment of Central Arid Zone Research Institute (CAZRI) at Jodhpur, extensive work on desert ecology was started but not much work was done on the avifauna, except for brief notes on sighting and rarity of the great Indian bustard by Ishwar Prakash and P. K. Ghosh (1963, 1964). Rana *et al.* (1994) of CAZRI have made some unreliable checklists of the birds of the Thar, which incidentally even include extinct species such as the pink-headed duck *Rhodonessa caryophyllacea* !

Recently, T. J. Roberts (1991, 1992) has written a seminal book, 'The Birds of Pakistan' which will always be indispensible for oriental ornithologists. This excellent book is in two parts and describes almost all the birds found in the Indian Thar desert.

Between 1990-94, raptors of the Thar desert were studied by Vibhu Prakash of the BNHS, under a large project on raptors of India, funded by the U.S. Fish & Wildlife Service. The results of this study were published recently in the form of a report. In 1993-94, the Oriental Bird Club, U.K., funded a small project by Harkirat Sangha to study the birds of the Desert National Park.

Methodology

This paper is based on three major surveys between February 1993 and February 1994, and one brief survey during May 1994.

First Survey

It was conducted from 2nd February to 13th March, 1993, and the following areas in the Thar were visited (only important names are given):

Name of the area	District
Taal Chhaper	Churu
Diyatra, Bajju, Gajner, Ecological Task Force (ETF), Choranwala, Modiath	Bikaner
Bap, Phalodi, Khara, Keechan, Dhawa-Doli, Guda-Vishnoian	Jodhpur
Nokh, Nachna, Mohangarh, Ramdeora, Pokhran, Desert National Park (DNP), Phalsund	Jaisalmer
Undu, Shiv, Dhorimanna	Barmer

In the Desert National Park (DNP) the following areas were visited: Sam, Sudasari, Khuri, Phulia, Miyajlar, Bandra, Barsiala and Sotto. Most of these areas have fenced core areas of the Park. While some of these core areas were visited only once or twice, Sam and Sudasari were visited during all four trips.

Second survey

The second survey was conducted between 15th July and 23rd August, 1993 in Rajasthan and Gujarat, and the following areas (in the Thar) were visited:

Name of the area	District
Taal Chhaper, Dungargarh	Churu
Diyatra, Bajju, Gajner, Lunkaransar, Sathasar ETF, Pugal	Bikaner
Bap, Phalodi, Lohawat, Kanasar	Jodhpur
Nachna, Mohangarh, DNP, Bhikampur, Nokh	Jaisalmer
Shiv, Dhorimanna, Gandhav, Bhagardha	Barmer

Third survey

In one month between 12th January to 12th February, 1994, the following areas were visited:

Name of the area	District
Sambhar Lake, Didwana, Sethranwali, Shri Balaji	Nagaur
Diyatra, Bajju, Gajner, Kolayat, Lunkaransar, ETF, Bap, Arjunsar, Agneu, Dantur	Bikaner
Suratgarh, Badopal	Ganganagar
Bap, Phalodi, Khara, Lohawat, Pilu, Savreej, Osiyan, Keechan, Guda-Vishnoian, Phitkasani, Dangiawas, Kaparda, Jaitaran, Bilara	Jodhpur

Name of the area	District
Bhikampur, Nokh, Digha, Madha, Mohangarh, Khinya, DNP, Dhanana, Phalsund, Rasla, Sankara, Banniyana, Ramdeora, Noda Minor	Jaisalmer

The Sonkhaliya bustard area in Ajmer district, was also visited for two days.

Fourth survey

A brief survey of one week was conducted in Jodhpur, Jaisalmer and Barmer districts from 17th to 23rd May, 1994, and the following areas were visited:

Name of the area	District
Phalodi, Khara	Jodhpur
Ramdeora, DNP, Rasla	Jaisalmer
Shiv, Dhorimanna	Barmer

The Indian Thar desert has 11 districts and is divided from the semi-arid scrubland of eastern Rajasthan, through the Aravalli mountains (Fig. 1). Except Jhunjhunu, all the 11 districts of the Thar were visited during the surveys, though more thorough surveys were conducted in Bikaner, Jodhpur, Jaisalmer and Barmer districts. Nearly 10,000 km were covered in four surveys, and 125 censuses were conducted. Roadside census of all wildlife was done in a slow moving vehicle. Beside 125 roadside censuses, 38 line transects of 1.5 to 2 km were randomly conducted on foot. These censuses were mainly conducted during the third and fourth surveys. Moreover, a general account of birds was kept even while we were not doing the census or line transect. The whole length of the IGNP from Chhattergarh to Mohangarh was surveyed. Additionally, areas near tributaries and channels were also visited to study the changes in animal life. Frequent stops were made near crop fields and seepage wetlands to study bird life. All the three protected areas (see below) and many Vishnoi areas were visited.

This paper deals with the avifauna of the Thar desert of Rajasthan but wherever necessary, comparison is made with the birds found in the adjoining deserts of Pakistan (Fig. 1). Common and scientific names of birds are based on Ali and Ripley (1983, 1987). Wherever necessary, the name of the site and date of sighting are given. The whole IGNP is marked by numbered pillars every 300 metres (RD means reduced distance, and is 300 m in length). Wetlands and plantations can be identified by these marked pillars.

Indira Gandhi Nahar Project (IGNP)

Since the early 1960s, the Thar desert has seen tremendous human activity which has greatly affected the wildlife. The greatest change, with far-reaching consequences, was brought about by the development of the Indira Gandhi Nahar Project (IGNP), earlier known as the Rajasthan Canal. Details of the IGNP are given elsewhere (Rahmani, 1989, 1994). However, to understand the conservation problems, I will briefly describe the IGNP.

The Thar desert extended to different princely states (Jaisalmer, Jodhpur, Bikaner) and it was the desire of every ruler to bring water to the thirsty landscape of his state. One of the first attempts to 'green the desert' was made in 1927 by Ganga Singh, ruler of Bikaner, when the 130 km Ganga Canal was constructed, which brought water from River Sutlej and irrigated about 1.4 lakh ha in Ganganagar district.

When India became independent in 1947, plans were developed to bring marginal areas under cultivation to feed the growing population. The Thar with its vast, thinly populated areas was considered a land bank, which could be brought to some use. An ambitious plan was prepared to bring water through canals. Work on the Indira Gandhi Nahar (Canal) Project (IGNP), earlier known as Rajasthan Canal, was started in 1958 but the actual excavation commenced only in 1960. The canal is still not complete. The total length of the main canal is 649 km from Harikke

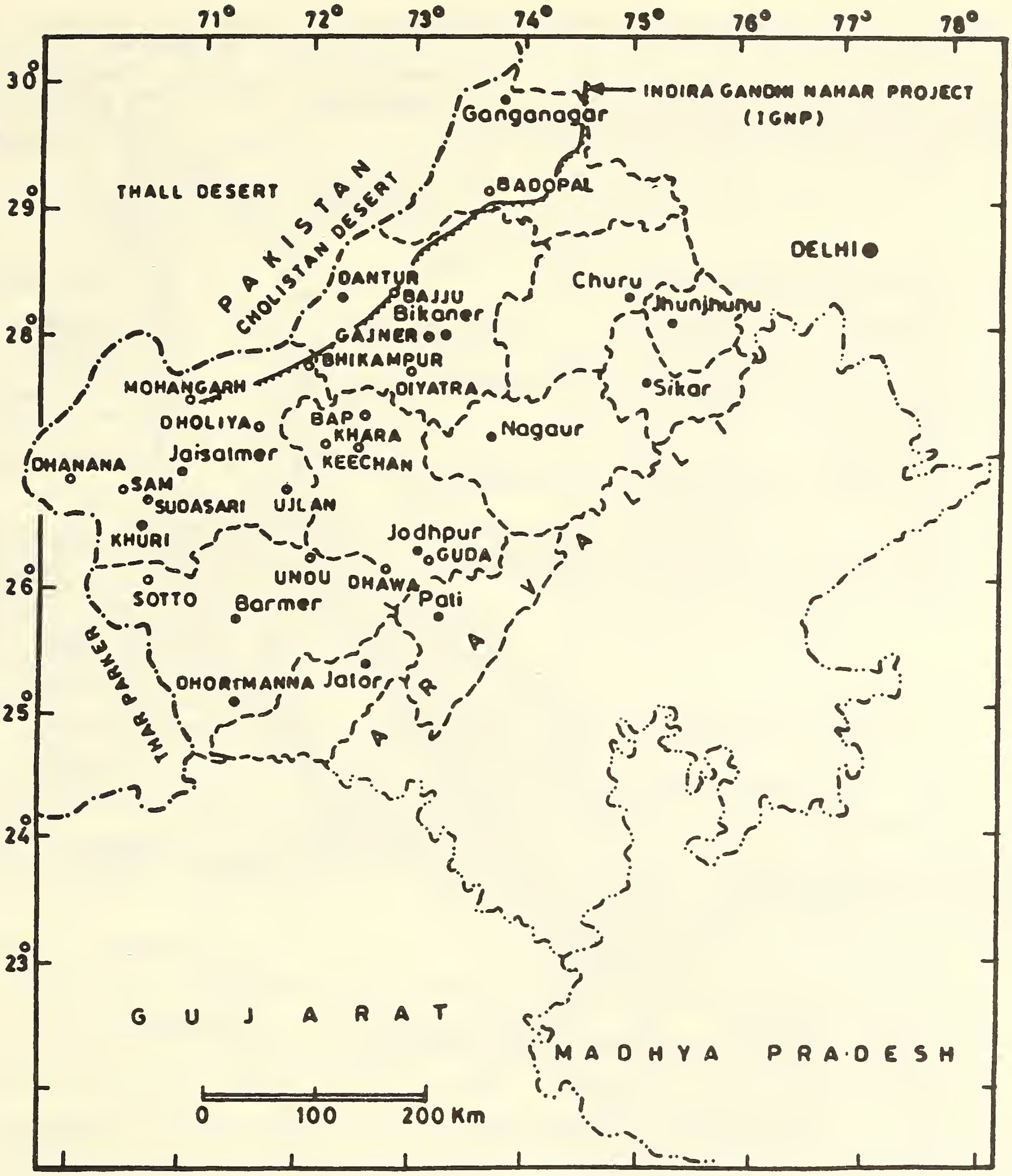

Fig. 1. Map of the study area in western Rajasthan. Only the sites mentioned frequently in the text are indicated by open circles. District headquarters indicated by closed circles.

barrage in Punjab to Mohangarh in Jaisalmer (Fig. 2). In addition to the main canal, feeder channels total nearly 8,000 km in length.

The project was conducted in two stages: Stage I was completed in 1973 and Stage II in 1985 (only the main work). In Stage II, out of the total irrigation potential of 8.10 lakh ha, only 0.6 lakh ha have been created under the lined canal system. The IGNP is one of the largest and the most expensive irrigation systems in the world. When completed the command area of the IGNP will cover 5,25,000 ha in Stage I and 8,10,000 ha in Stage II, or nearly 11% of western Rajasthan (Chatterji and Saxena, 1988). Arrival of water in the Thar will open up land for colonization, as in Ganganagar district and certain other parts of Rajasthan. The Thar is already the most densely populated desert in the world with the last few

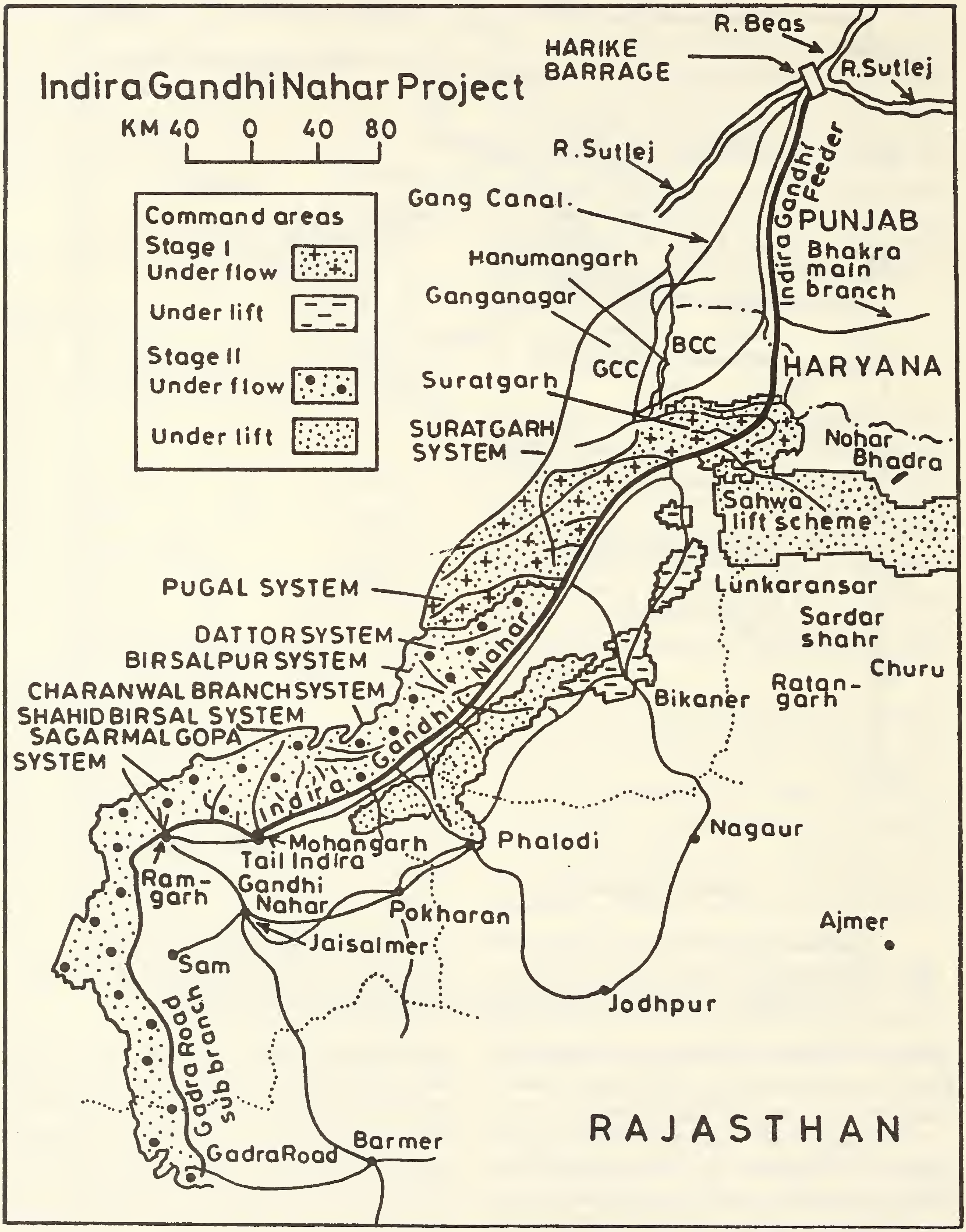

Fig. 2. Details of the Indira Gandhi Nahar Project (thick line). Channels and subdivisions shown by thin lines.

decades having seen an unprecedented rise in human population, from 17.2 sq. km in 1921, 30 in 1961 to 68.4 in 1981 (Dhir, 1988). The increase is both, by immigration (especially in Ganganagar and Bikaner districts) to new canal irrigated areas, and by natural population growth of the local people.

Changes in cultivation pattern

The IGNP has also brought tremendous change in the crop pattern from subsistence farming to commercial farming (Gupta, 1975b). Moong *Vigna radiata*, moth *Vigna aconitifolia*, guar *Cyamopsis tetragonoloba*, til *Sesamum indicum*, bajra *Pennisetum typhoides* have been replaced by, groundnut *Arachis hypogea*, cotton *Gossypium* spp., paddy *Oryza sativa*, sugarcane *Saccharum officianarum*, wheat *Triticum sativum* and barley *Hordeum vulgare* (Chatterji and Saxena, 1988).

Apart from land that was cultivated with the development of IGNP, the human population in the whole of Thar brought 44.6% of the marginal land under cultivation in 1951 - 61 and an additional 9.47% during 1961-71 (Mann, 1988).

Changes in vegetation

In the canal irrigated areas, the groundwater table is rising due to seepage from the canals, field channels and irrigated fields (Chatterji and Saxena, 1988). Moreover, owing to leakage in the channels and bad maintenance of the canals, in many places, interdunal reservoirs have been formed where the vegetation cover has changed from xerophytic and psammophytic to hydrophytic and mesophytic plants. Many wetlands are covered by aquatic vegetation such as *Typha angustata, Arundo donax, Eichhornia crassipes, Imperata cylindrica, Phragmites* and *Saccharum spontaneum.*

Displacement of grazers

An indirect effect of the expansion of agriculture in western Rajasthan is through the displacement of grazers to non-command areas, thus exerting even more pressure on the already overgrazed countryside. Due to increase in the population, and the consequent reclamation of land for cultivation, the area available to nomads for grazing their livestock has been shrinking.

Waterbodies and Plantations beside IGNP

Bird life of the Thar desert is changing rapidly due to the development of plantations on both sides of IGNP, and development of large waterbodies due to seepage, which now attract many species which were not seen earlier in the Thar desert (Rahmani, 1994). Many species of waterfowl are seen in the canal and/or in the waterbodies beside the canal (Table 1). Avian diversity has increased, but at the cost of local desert species (see below).

Birds of the protected areas of the Thar desert

There are only three protected areas in the Thar desert:

Table 1
FOREST AND WATERBIRDS SEEN IN IGNP

Little Grebe	Little Cormorant
Indian Shag	Cormorant
Darter	Purple Heron
Grey Heron	Large Egret
Chestnut Bittern	Painted Stork
Blacknecked Stork	Barheaded Goose
Common Shelduck	Ruddy Shelduck
Marsh Harrier	White Ibis
Spoonbill	Indian Shikra
Honey Buzzard	Demoiselle Crane
Common Crane	Purple Moorhen
Indian Moorhen	Coot
White-tailed Lapwing	Yellow-legged Green Pigeon
Red Turtle Dove	Rose-ringed Parakeet
Crow-pheasant	Collared Scops Owl
Small Minivet	Jungle Babbler
Striated Babbler	Great Reed Warbler
Paradise Flycatcher	White-browed Fantail Flycatcher
Baya	

a) The Desert National Park (DNP) is spread over 3,162 sq. km in Jaisalmer and Barmer districts. Presently, the area is technically not a national park, because under the Wildlife (Protection) Act 1972, a park should not have any private human habitation, but in the DNP there are 37 villages (Rahmani, 1989, 1994).

b) Gajner Sanctuary (30 sq.km) was established in 1905, by the erstwhile Maharaja of Bikaner, for wildlife viewing and hunting. After India's Independence and merger of the princely States, the Gajner sanctuary went under litigation, as a result of which the wildlife came under the control of the Forest Department, but the land remained with the princely family. This dual control has devastated the sanctuary. Gajner has a large water tank which attracts a large number of waterfowl and sandgrouse. It was world famous for imperial sandgrouse *Pterocles orientalis* shoots organized by the Maharaja. Owing to the development of the IGNP and resultant seepage wetlands, the importance of Gajner tank as a water-fowl refuge has diminished, but it still harbours a few hundred ducks, coots, egrets, herons and waders (Rahmani, 1994).

c) The 7.22 sq. km Taal Chhaper in Churu district, notified as a sanctuary in 1962, is a vast expanse of treeless depression which used to get inundated during good rainfall years. However, as the district falls under the arid zone, rainfall is generally insufficient to inundate the sanctuary. Therefore, for most of the year, the depression or *taal* remains dry. This tiny sanctuary is famous for blackbuck *Antilope cervicapra*, demoiselle crane *Anthropoides virgo* and barheaded goose *Anser indicus* (Rahmani,1994).

The birds of these three protected areas have been described in detail elsewhere (Rahmani, 1994).

Annotated checklist of birds seen in the Thar desert

1. **Little Grebe** *Tachybaptus ruficollis*

Common in village tanks and seepage wetlands of IGNP. During 1993-94, a total of 180 seen in Taal Chhaper, Gajner, Kolayat, Diyatra, Bap, Guda-Vishnoian, Keechan and Khinya, in Sambhar Lake, and seepage wetlands near Lunkaransar, RD 764 and Noda Minor. Parents and chicks found in a seepage wetland at RD 954 near Bajju, in Bikaner dist. on 17 July, 1993.

2. **Great Cormorant** *Phalacrocorax carbo*

Earlier uncommon but now spreading with seepage wetlands of the IGNP. 26 individuals seen during winter and monsoon surveys, none during May 1994. Four birds in Gajner tank, all others on seepage wetlands, e.g. 16 roosting near RD 954 on 8 February, 1993.

3. **Indian Shag** *Phalacrocorax fuscicollis*

Uncommon. Ten roosting on a dry tree in RD 954 near Bajju on 17 July, 1993. On 23 January, 1994, possibly this species in flight over IGNP near RD 860.

4. **Little Cormorant** *Phalacrocorax niger*

Common and spreading with seepage wetlands of IGNP. Noticed in Gajner, Bajju, Bangasar Lift Canal, Guda-Vishnoian, Nachna, Kolayat, Noda Minor and Suratgarh. Nearly 200 found roosting near Badopal near Suratgarh in Ganganagar dist..

5. **Darter** *Anhinga melanogaster*

Rare in the Thar. One seen on 21 January, 1994, in a large waterspread near RD 507, where fishermen were active.

6. **Chestnut Bittern** *Ixobrychus cinnamomeus*

One seen flying over the reed covered canal near Mohangarh in Jaisalmer dist., on 21 July, 1993. Roberts (1991), found it widespread in suitable habitat, common in east Nara and Thatta dist. (Thar, Pakistan).

7. **Little Green Heron** *Butorides striatus*

Uncommon. Only one seen on 17 July, 1993, near Bajju on a seepage wetland.

8. **Pond Heron** *Ardeola grayii*

Not uncommon in village tanks, and seepage ponds perhaps spreading with IGNP. Fourteen individuals seen on six sites during winter and monsoon.

9. **Cattle Egret** *Bubulcus ibis*

Uncommon, only three sightings. Two sightings near IGNP (RD 954 and Mohangarh) and once a flock with sheep between Nokh and Bap on 18 July, 1993. A few days earlier, very heavy rains had occurred in the area. Likely to increase with the spread of agriculture along the IGNP.

10. **Little Egret** *Egretta garzetta*

Not uncommon in suitable habitats. Twenty in Kolayat tank (7 February, 1993) and 6 near RD 954 near Bajju (8 February, 1993). One individual was without yellow legs. It could have been a Reef heron *Egretta gularis*. Little Egret spreads out more widely during the monsoon. For instance, 10 seen flying over the grasslands of Sudasari on 24 July, 1993.

11. **Intermediate Egret** *Egretta intermedia*

Uncommon. Only three records, one each from Gajner (16 January), Diyatra tank (17 January) and seepage of Noda Minor (21 January, 1994).

12. **Large Egret** *Egretta alba*

Rare, but could become more common with the development of large seepage waterbodies. One seen on Samra water tank near Nokh on 28 January, 1994 and two in a seepage near RD 507 on 20 January, 1994

13. **Grey Heron** *Ardea cinerea*

Uncommon, only 16 records from eight sites. In future it will become more common in the Thar desert with the development of seepage wetlands.

14. **Purple Heron** *Ardea purpurea*

Uncommon, only five records from four seepage wetlands of the IGNP.

15. **Painted Stork** *Mycteria leucocephala*

Rare. Three seen inside Suratgarh town on 20 January, 1994. Likely to spread with the IGNP.

16. **Openbill Stork** *Anastomus oscitans*

Rare, only two seen on 29 January, 1994 in a seepage wetland at RD 507. Roberts (1991) found it a rare winter visitor in Pakistan; he does not have any recent record from the Thar or Cholistan deserts.

17. **Black Stork** *Ciconia nigra*

Rare winter migrant to the Thar. Only three, including an immature, seen on 28 January, 1994, about 250 m from a waterbody near Samra village, at the edge of Rann of Nokh, in Jaisalmer dist.

18. **Whitenecked Stork** *Ciconia episcopus*

Whistler (1938), has not listed this species in the birds of Jodhpur State. I saw one individual on a wetland near Guda-Vishnoian Rest House on 7 March, 1993. Perhaps the first record from the Thar. Roberts (1991), say that it is not found in the Pakistan desert regions.

19. **Blacknecked Stork**
Ephippiorhynchus asiaticus

Whistler (1938), records it as rare in the erstwhile Jodhpur State. I found two on 20 January, 1994 in a large wetland near RD 507, where fish and waterlily roots were being harvested. Beside a large number of waterfowl, it also had a greater spotted eagle.

20. **Black Ibis** *Pseudibis papillosa*

Common. Generally found foraging on sand-dunes, grasslands and drying wetlands. Nearly 350 seen on 37 sites during winter and monsoon surveys but none in summer . Atleast 200 seen with cormorants and egrets on 19 January, 1994, in a large roost on eucalyptus trees near Manaktheda between Suratgarh and Badopal.

21. **White Ibis** *Threskiornis melanocephalus*

Not common. Only two seen on a large roost near Manaktheda near Badopal on 19 January, 1994.

22. **Spoonbill** *Platelea leucorodia*

Many records. Generally seen on village tanks, but could be spreading with seepage wetlands of the IGNP. On 7 March 1993, 49 birds seen foraging in a wetland near the rest house in Guda-Vishnoian.

23. **Greater Flamingo** *Phoenicopterus roseus*

Many records. 1500-2000 in Sambhar Lake on 14 January, 1994. On the same day about 400, including 30 immatures, seen in Didwana. On 19 January, 1994, 380 foraging in Badopal near Suratgarh and 14 (5 immature) on a waterspread near RD 507 on 20 January, 1994.

24. **Greylag Goose** *Anser anser*

Rare. Two in Badopal near Suratgarh on 19 January, 1994. Rare in the Thar, Pakistan (Roberts, 1992).

25. **Barheaded Goose** *Anser indicus*

Uncommon. Not recorded by Whistler (1938). Roberts (1992), says it is now rare in Pakistani Thar. However, on the Indian side it is still common in some localities such as Taal Chhaper. According to Forest Department figures, 52 were seen in 1990-91, and 125 in 1992-93. Many seen by me on 4 February, 1993. It is reported to occur in Sambhar Lake in large numbers. I could not survey the whole lake. I saw only two geese on 14 January, 1994, in a small portion of this wetland. However, near Koliya villlage in Didwana subdivision of Nagaur dist., on 14 January, 1994, 37 were grazing close to human habitation.

26. **Brahminy Duck** *Tadorna ferruginea*

Rare in the Thar. Only two in Gajner on 6 February, 1993.

27. **Common Shelduck** *Tadorna tadorna*.

Perhaps the first record from the Thar. I found 22 in Badopal near Suratgarh on 19 January, 1994.

28. **Wigeon** *Anas penelope*

Uncommon, but will spread with the development of seepage wetlands beside the IGNP. Already seen regularly near Bajju, on 19 February, 1993, 25 in a wetland at RD 540. Four on Sambhar Lake on 14 January, 1994 and 18 in a village tank near Kolayat on 17 January, 1994.

29. **Gadwall** *Anas strepera*

Common in suitable wetlands and village tanks all over the Thar. 142 birds seen on 8 waterbodies, including 50 birds in Gajner tank. There were many more, but all could not be counted due to intervening vegetation.

30. **Common Teal** *Anas crecca*

Common in suitable wetlands. A total of 272 teals seen on 11 waterbodies. A total of 96 birds seen on a tank near the resthouse of Guda Vishnoian, and 70 found on a seepage wetland near RD 507 on 20 January, 1994.

31. **Mallard** *Anas platyrhynchos*

Uncommon. Four found at RD 954 on 8 February, 1993, and 23 on the same seepage on 21 January, 1994.

32. **Spotbill Duck** *Anas poecilorhyncha*

Two in Guda-Vishnoian wetland (7 March, 1993). They have started breeding in the dense seepage wetlands, overgrown by *Typha, Saccharum, Phragmites* and *Arundo*. Two adults with chicks in a wetland near RD 954, on 17 July. On 20 January, 1994, 17 were seen on a seepage at RD 507 and two in Cut No. 5 on the same day.

33. **Pintail** *Anas acuta*

Common in all types of wetlands, with other ducks. Sometimes constituting the major proportion of Anatidae. e.g. 156 seen in Gajner on 6 February, 1993; 340 on a seepage wetland at RD 507 on 20 January, 1994, and 97 in Noda Minor on 21 January, 1994.

34. **Garganey** *Anas querquedula*

Uncommon. Fifteen seen in Guda-Vishnoian on 7 March, 1993. Hume (1878), has also reported it from Jodhpur State.

35. **Shoveller** *Anas clypeata*

Like the pintail, shoveller is very common, and spreading due to IGNP. A total of 359 birds seen on 10 wetlands, including 116 on a part of Sambhar Lake, and 110 on Didwana lake.

36. **Red-Crested Pochard** *Netta rufina*

Uncommon but could be spreading with IGNP, e.g. 25 seen on a seepage near RD 507 on 20 January, 1994 and 13 on the main IGNP on 25 January, 1994. There were many more birds all over the main canal but we could not count them.

37. **Common Pochard** *Aythya ferina*

Much more common than the previous species. At least 483 seen on 14 sites. Abundant on the main IGNP and Gajner tank.

38. **White-eyed Pochard** *Aythya nyroca*

Uncommon, but regularly seen every year. Reported by Hume (1878), from Jodhpur, and Roberts (1992), frequently found in Pakistan. I saw only 8 birds in three wetlands i.e. Gajner, Guda-Vishnoian and Kolayat.

39. **Tufted Duck** *Aythya fuligula*

Common in certain deep wetlands such as the Gajner tank where 100 were seen on 6 February, 1993. A few seepage wetlands with deep waters also attract these diving ducks. Nearly 150 were seen near RD 954 on 8 February, 1993, and 70 on 21 January, 1994. A total of 371 seen on 5 sites.

40. **Demoiselle Crane** *Anthropoides virgo*

Thousands on passage during autumn and spring but many stay during winter in suitable localities in the Thar. Two famous areas are Taal Chhaper sanctuary in Churu dist., and Keechan in Jodhpur dist. On 2 February, 1993, we counted nearly 300 in Taal Chhaper. According to records of the Forest Department, in December of 1991, there were 500, in 1992, 1000 and in 1993, 2000. The birds are attracted to feed on tubers of *Cyperus*.

Upto 4,000 are found around Keechan village, near Phalodi, where the villagers have a programme to feed them cereals. Most of the time the cranes wander around near three wetlands or on the sand-dunes, but every morning and evening, during feeding time, they converge on a small area inside the village where cereals are spread.

Seen in other parts of the Thar but not in good numbers, e.g. 22 flew over the Rest House at Shiv, on 5 March 1993, and the same day, on Shiv-Besu road, we saw more than 85 feeding on tubers of *Cyperus* in a fallow field which was earlier inundated during the monsoon. Smaller flocks of 10, 2, 3, 26 were found in nearby fields.

Unlike the common crane, not many demoiselle cranes are found beside the IGNP. I found only 14 in a seepage at RD 954, on 21 January, 1994. The canal and resultant agriculture may have beneficial effect on these cranes, and they are likely to increase in future.

41. **Common Crane** *Grus grus*

This species is spreading in the commmand area of the IGNP. I saw hundreds near Bajju in

Febraury, 1993. In January, 1994, they were seen at the following sites: 21 between RD 507 and ETF (RD 710); 4 after RD 860; 31 between RD 910 and Dantur; 8 between RD 930 and Bhikampur, and 29 between Bhikampur and Nachna. Ten birds, including two juveniles were seen in Taal Chhaper (4 February, 1993).

42. **Black-shouldered Kite** *Elanus caeruleus*

Common all over the Thar. Seen in all seasons. Seventy-two individuals counted in 35 roadside census by vehicle. Many more noticed on line transects.

43. **Crested Honey Buzzard**
Pernis ptilorhynchus

It was not reported from the Thar desert earlier, but now it is colonizing the forest plantations coming up beside the IGNP. A dark phase morph seen in Bajju Plantation on 8 February, 1993 and three seen separately near Bhopalpura plantation on 20 January, 1994. In Sind and Baluchistan (Pakistan), according to Roberts (1991), it has increased with the plantations.

44. **Black Kite** *Milvus migrans govinda*

Commonly seen in winter, but very few records during summer, which indicates that the birds move out of the Thar during adverse conditions.

45. **Blackeared Kite** *Milvus migrans lineatus*

According to Vibhu Prakash (pers. comm. 1994) it occurs in the Thar, but I did not see any.

46. **King Vulture** or **Red-headed Vulture**
Sarcogyps calvus

Still frequent all over the Thar. Seen on most carcases, with other vultures. 27 birds seen in 18 transects during roadside counts, and many more during line transects and bird walks. One nest each found near Sudasari (2 February) and Ujlan (7 February, 1994).

47. **Cinereous Vultur**
Aegypius monachus

Uncommon winter visitor. Twenty-six individuals seen at 13 different sites, generally solitary or in twos; only once four birds seen sitting in shade after feeding on a goat carcase. Most of the carcases found in winter had 1 - 2 cinereous vultures, along with 1 - 2 king and numerous oriental whitebacked vultures.

48. **Griffon Vulture** or **Eurasian Vulture**
Gyps fulvus

Not uncommon during winter. A total of 52 individuals seen on 12 different sites. In Lakhasar enclosure in Jaisalmer dist., on 7 February, 1994, in the early morning, 18 were seen sitting on *Prosopis cinerarea* (khejri) trees. One tree had 7 birds.

49. **Indian Longbilled Vulture** *Gyps indicus*

Much more common in winter than in summer. Generally seen mixed with whitebacked and Egyptian vultures on carcases. Probably nesting near Dhorimanna on bare hills as white faecal patches could be seen from the road. Virtually absent, in the Pakistani part of the Thar, except for a few pairs nesting on cliffs on the rocky outcrops in Nagar Parker area (Roberts, 1991), not very far from Dhorimanna.

50. **Indian Whitebacked Vulture**
Gyps bengalensis

Appears to be much more common than the previous species. Found on all carcases which we located. Nests found on old *Prosopis cinerarea* trees during the monsoon in Sikar, Churu and parts of Bikaner dist. A total of 184 birds seen in 30 roadside censuses, and many more during line transects.

51. **Egyptian** or **Scavenger Vulture**
Neophron percnopterus

Very common all over the Thar. A total of 176 individuals seen during 51 roadside censuses. Present on almost all carcases.

52. **Hen Harrier** *Circus cyaneus*

Rare. A male seen near Kalran Sharif on Bap-Khara road on 11 February, 1993, and another on 5 February, 1994, between Sudasari and Jaisalmer.

53. **Pale Harrier** *Circus macrourus*

Fairly common winter visitor. A total of 12 seen during line transects and 22 during roadside census. Roberts (1991), also found it to be common in Thar and Cholistan deserts of Pakistan, which borders India. According to him, it is found in more arid areas than those favoured by other harriers.

54. **Montagu's Harrier** *Circus pygargus*

Uncommon winter migrant to the Thar. Only seven sightings during winter surveys. Roberts (1991), found it to be the least common harrier in the Thar and Cholistan deserts.

55. **Marsh Harrier** *Circus aeruginosus*

Generally in the vicinity of water, so likely to spread with the development of seepage wetlands of the IGNP. All my 14 sightings were close to the canal.

56. **Short-toed Eagle** *Circaetus gallicus*

Common. A total of 15 birds seen at 14 sites in all seasons. Except one, all sightings of solitary birds but Shantanu Kumar (*in litt.* 1994), reported seeing 16 in Taal Chhaper on 8-9 September, 1988. On 20 May, 1994, between Dabla and Akal in Jaisalmer dist., on a hot sunny day, two immatures sitting with legs immersed in a small leakage from a water pipe.

57. **Longlegged Buzzard** *Buteo rufinus*

One of the commonest buzzards of the Thar. During roadside census by vehicle, two seen at two sites during February-March, 1993, and 29 seen in 17 places during January-February 1994. None noticed in the Thar between 18 and 20 May, 1994. Roberts (1991), also found it to be the commonest buzzard during winter in the arid plains of Pakistan.

58. **Desert Buzzard** *Buteo buteo vulpinus*

One drinking water from canal near Mohangarh on 6 February, 1993, and two seen near Radrao near Mohangarh in Jaisalmer dist. exactly a year later.

59. **Tawny Eagle** *Aquila rapax vindhiana*

Very common Aquila of the Thar desert. Hume (1878), also found it a very common breeding bird. Atleast five nests, some with immatures, seen by me. Roberts (1991), reported it breeding all over the Thar and Cholistan deserts. A nest on a *Prosopis cinerarea*, with three individuals, 16.8 km before Bap on Kanasar road. Except the nesting branch, the whole tree was lopped. Between Phalodi and Ramdeora on 18 May, 1994, from 1140 to 1300 hrs, four individuals seen. One picking bones from a road kill, along with two Egyptian vultures, two on a waterhole, and one on a pole. On 19 May, 1994, atleast 25 tawny eagles visited the waterhole in Sudasari. Sometimes six eagles seen together. During four surveys, 25 birds sighted in 16 areas during roadside censuses.

60. **Eastern Steppe Eagle**
Aquila rapax nipalensis

A winter visitor in the Thar. One seen inside Sudasari and another near Kolayat in February, 1993. Thirteen birds sighted in 8 areas during roadside census.

61. **Lesser Spotted Eagle** *Aquila pomarina*

Probably this species was seen between Ratangarh and Taal Chhaper on 4 February, 1993. It occurs regularly in Bharatpur (Vibhu Prakash, pers. comm. 1994), and unconfirmed records are from Pakistan (Roberts 1991), so it is likely to occur in the Thar. A rare resident in Saurashtra and western Peninsula (Ali and Ripley 1987). Its occurrence in the Thar is not unlikely, though it must be very rare.

62. **Greater Spotted Eagle** *Aquila clanga*

This large *Aquila* is invariably found near waterbodies so it is generally absent in the Thar desert. But with the development of seepage wetlands and congregation of its prey (water birds), it is likely to increase in the Thar. We saw one adult flying on a large waterspread near RD 507 on 20 January, 1994. This waterbody had plenty of fish and ducks. Even a pair of blacknecked stork was present. Whistler (1938), had collected a specimen from Pichiak Lake in Bilara dist. of the erstwhile Jodhpur State. Hume (1878), has also included it in his Jodhpur list. Roberts (1991), has reported it in the Pakistani Thar. He says that they breed occasionally in the better forested areas of the Nara canal and the Indus river.

63. **Shikra** *Accipiter badius*

Mainly a species of thin forest and groves, so the Thar desert is not its favoured habitat. However, with the spread of plantations, the shikra will become more common in the desert. I had 10 sightings, generally near the canal. However, two were seen hunting within 5 km of each other in sandy area, in the early morning among tall, dense, widely scattered *Prosopis cinerarea* trees, near Mankasar in Jaisalmer dist. Roberts (1991), found it to be resident and largely sedentary throughout the Indus plains, being partial to irrigated forest plantations and better wooded tracts.

64. **White-eyed Buzzard-eagle** *Butastur teesa*

Another common raptor, generally seen in winter and monsoon in the Thar. Thirteen birds were seen at 11 sites. None seen during four days survey in May 1994, indicating emigration of birds during the hot summer months. Roberts (1991), also found it abundant during winter in the Thar and Cholistan deserts, and commented "resident with some local summer migration".

65. **Saker** *Falco cherrug*

One falcon in flight, perhaps this species, with something thin and long hanging from its talons, probably a leather 'jesses' from an escaped bird trained for falconry.

66. **Laggar Falcon** *Falco biarmicus jugger*

The most common resident falcon of the Thar desert, seen in all seasons. Thirty-one individuals, a few in pairs, spotted at 21 different sites. One bird was seen inside Bikaner town on 24 January, 1994. According to T. J. Roberts (*in litt.*, 1994), the Laggar is nearly extinct in Pakistan because trappers use it as decoy to trap peregrine and saker for illegal falcon markets.

67. **Redheaded Merlin** *Falco chicquera*

Uncommon, only four sightings during four surveys. Three sightings were in July 1993, during the locust plague: one seen in Taal Chhaper on 13 July, 1993; another near Undu on 25 July, in an area where finchlarks had concentrated in large numbers to feed on hoppers; and third between Undu and Kanasar on 26 July, in locust infested area. Only one bird was seen during the third survey (in Taal Chhaper) on 4 February, 1994. None seen during May 1994, indicating that the birds probably move away from the Thar during summer.

68. **Kestrel** *Falco tinnunculus*

Very common winter visitor. Forty-one individuals seen during line transects and 143 birds seen during roadside censuses.

69. **Grey Francolin** *Francolinus pondicerianus*

Very common, and probably increasing due to expansion of agriculture. If not molested, seen just outside villages and towns. Present even inside Dholomaru Rest House in Bikaner city !

70. **Black Francolin** *Francolinus francolinus*

Earlier not found in the Thar desert, but likely to spread with development of irrigated crop fields and dense hedges among fields. On 15 July, 1993, heard from a crop field between Rosa and Kankarwala near Lunkaransar in Bikaner dist.. Probably the first record of this species from this area. According to Roberts (1991), they are entirely absent from the main desert tracts such as the Thar or Cholistan, but occur in *Saccharum* thickets in the east Nara.

71. **Grey Quail** *Coturnix coturnix*

Common winter migrant. It may breed in the Thar in crop fields during favourable conditions. All my four sightings were of pairs flushed from tall grasses in winter.

72. **Blackbreasted** or **Rain Quail** *Coturnix coromandelica*

Abundant during monsoon, depending upon the rainfall and growth of grass. In Taal Chhaper, during the monsoon of 1993, characteristic calls were heard everywhere. Calls were heard in Sudasari enclosure also, but they appeared slightly different in tone. Not seen or heard during winter and summer months.

73. **Indian Peafowl** *Pavo cristatus*

Abundant and spreading with IGNP. Near Gunga village, 7 km before Shiv, 150 peafowls were seen in about 1 sq. km area, during winter of 1994, in totally bare area with no ground cover, but strangely not even one peafowl was seen in the same area on 20 May, at 1600 hrs.

74. **Coot** *Fulica atra*

Perhaps the most numerous water bird of the Thar desert. More than 590 seen in Gajner on 16 January, 1994, and 230 in Kolayat temple tank on 17 January, 1994. Abundant on the IGNP. Near Mohangarh, very common on the main IGNP, wherever submerged vegetation is present. Seen in open waters also. On 31 January, 1994, 325 counted in about 10 km of the canal.

75. **Purple Moorhen** *Porphyrio porphyrio*

Earlier uncommon in the Thar desert but now spreading with the canal and seepage wetlands. Seen during monsoon and winter (I did not visit the IGNP during summer), so there are chances that it has started breeding in *Typha*-infested parts of the canal. Always seen associated with emergent vegetation.

76. **Indian Moorhen** *Gallinula chloropus*

Another beneficiary of canal irrigation and development of waterbodies. Now common, and spreading in the Thar. Present in village tanks with aquatic and emergent vegetation. Avoids open waters. Very common in Gajner and certain parts of the main IGNP with emergent vegetation. Twenty-six individuals seen on the IGNP near Mohangarh in a distance of 10 km (31 January, 1994). Always found close to aquatic vegetation, unlike coot which prefers open water. In July 1993, all adult birds were in breeding plumage, with brick red bill. Sometimes seen in extremely small water tanks, in the middle of the barren desert. For instance, on 24 January, 1994, three birds were seen in a circular cement water-collecting tank, overgrown with *Typha*, in Mankasar village in Bikaner dist.

77. **Great Indian Bustard** *Ardeotis nigriceps*

Still found in many areas of the Thar, but declining everywhere due to poaching, habitat deterioration, and human disturbances (Rahmani, 1994).

78. **Houbara** *Chlamydotis undulata*

Winter migrant, widespread in very low density in undisturbed areas of the Thar, especially near the border. Still extensively hunted by poachers, both local and outsiders. Only 21 birds seen during January-February 1994, after much effort.

79. **Redwattled Lapwing** *Vanellus indicus*

Numerous records from the Thar. Adaptable and quick to colonize newly created suitable habitats. It will become more common with expansion of agriculture and canals. Common on sewage streams of towns and cities. For instance, atleast 50 seen on sewage in Barmer town on 20 May, 1994. Many in brackish wetland near Lunkaransar on 15 July, 1993.

80. **Yellow-wattled Lapwing**
Vanellus malabaricus

Uncommon. Roberts (1991), found it only in Lower Sind in Pakistani Thar. I saw one bird on 16 January, 1994, near Gajner.

81. **White-tailed Lapwing** *Vanellus leucurus*

Another uncommon lapwing of the Thar desert but likely to spread with seepage wetlands. I saw it on three sites in 1994: 2 in Gajner on 16 January; 3 in Badopal on 19 January; and 2 in a seepage at RD 507 on 20 January. Roberts (1991), also found it common on the seepage zones of all the major irrigation head works in the Punjab, and the east Nara (Thar), but not from the Cholistan desert.

82. **Cream-coloured Courser**
Cursorius cursor

Common all over the Thar. In 26 roadside censuses, 180 individuals were seen during winter. There seems to be an influx in winter, as they are seen everywhere in flocks of 8-15 in all sorts of habitats, specially in gravel flat areas with 30-40% ground cover. During monsoon, both Indian and Cream-coloured coursers are seen together. On 8 August, 1993, outside the pasture plot in Bap area, many groups of these two species were noticed. Also found on barren ground around *dhanis* (hamlets), littered with goat/sheep pellets on which many insects occur, on which these coursers feed. It is so well recognised that it has a local name *Patpadri*. None seen between 19-20 May, in DNP and other places. It breeds in the Thar in small numbers (Rahmani and Manakadan, 1989).

83. **Indian Courser** *Cursorius coromandelicus*

It is found in more mesic habitat than the cream-coloured courser but during monsoon it spreads out in the Thar. Some individuals can be seen during winter also, but none during summer. Out of five records, four were during monsoon. I have only one winter record, when a group of 10 birds was seen foraging in a flat, fallow field, before Gajner in Bikaner dist. (16 January, 1994). Roberts (1991), has reported it as resident in the Thar desert of Pakistan., but not in Cholistan.

84. **Collared Pratincole** *Glareola pratincola*

On 22 July, 1993, I saw five birds in a temporary pool, 7 km before Kanoi in Jaisalmer dist., along with 7 little stints, 3 little ringed plovers and 2 sand plovers.

85. **Stone Curlew** *Burhinus oedicnemus*

Call heard in Taal Chhaper on 4 February and 13 July, 1993. As it is secretive and crepuscular, it may be widespread in the Thar. It prefers dry scrub and dunal areas, so it is likely to decrease with the development of agriculture.

86. **Little Stint** *Calidris minuta*

Occasional in drying up pools and margins of large village tanks. Seven seen on 22 July, 1993, on a temporary pool near Konoi.

Roberts (1991), has also noted the first arrival in Lower Sind as early as 21 July.

87. **Temminck's Stint** *Calidris temminckii*

Common winter migrant to tanks, drying up pools and recently inundated shallow areas. Commonly seen with Little Stint. Nearly 60-70 seen mixed with Little Stint in Sambhar Lake on 14 January, 1994.

88. **Redshank** *Tringa totanus*

Uncommon, but may become widespread in winter with the development of waterbodies along the IGNP. This winter migrant sometimes arrives as early as July. One seen on 20 July, 1993, in Kanasar, which was a very early arrival.

89. **Spotted or Dusky Redshank**
Tringa erythropus

A winter migrant. Three found in the Diyatra tank on 17 January, 1994. Likely to become more common with the development of seepage wetlands along the canal.

90. **Greenshank** *Tringa nebularia*

A winter migrant, but one was found on 20 May, 1994, in Barmer town on a sewage stream, with atleast 50 redwattled lapwings.

91. **Green Sandpiper** *Tringa ochropus*

Occasional on village tanks and seepage wetlands in winter. Sometimes the birds can be seen as early as July. One bird was seen on a temporary pool on 20 July, 1993, and another the same day on another temporary pool. Heavy rains had occurred between 17 and 19 July, in the Thar desert.

92. **Wood Sandpiper** *Tringa glareola*

Only once in a tank near Taal Chhaper on 13 July 1993, which is a very early record of this winter migrant. According to Ali and Ripley (1987), wood sandpiper begins to arrive in northern districts in early August. Apparently, oversummering of this species in India is unusual and unrecorded. Therefore, the record of 13 July, is noteworthy.

93. **Common Sandpiper** *Tringa hypoleucos*

Fairly common winter migrant to all sorts of wetlands from roadside ditches to margins of large lakes. Likely to increase with the development of suitable habitats along the canal.

94. **Ruff & Reeve** *Philomachus pugnax*

Fairly common winter migrant, sometime arriving as early as end-July. Six seen on a temporary pool between Bap and Phalodi on 20 July, 1993, after three days of rain. 20 seen in a small part of Sambhar Lake (14 January, 1994), and more than 100 in brackish waters of Badopal (19 January, 1994), only one in a freshwater lake near Keechan (26 January, 1994).

95. **Blackwinged Stilt** *Himantopus himantopus*

Common bird near waterbodies, ditches, temporary pools, and sewage streams of towns and cities. All my records are during monsoon, none in winter. Many individuals were located on a brackish wetland near Lunkaransar (15 July, 1993), and 7 individuals, including two immatures, near RD 954 near Bajju (17 July, 1993), 6 between Bap and Phalodi, and one on a roadside ditch between Bap and Kanasar.

96. **Black-tailed Godwit** *Limosa limosa*

Nearly 250 seen on a waterspread near Badopal on 19 January, 1994. Roberts (1991), has recorded it from the Thar in Pakistan, but not in Punjab or Cholistan. However, I have seen it in Badopal, which is in Suratgarh, close to Punjab.

97. **Little Ringed Plover** *Charadrius dubius*

Many records both from fresh and brackish waters. It is a resident bird so its presence on 15 July, 1993 on a saltpan near Lunkaransar was not surprising. One seen on a seasonal pool between Bap and Kanasar (20 July). Later three were seen on a temporary pool near Kanoi in Jaisalmer dist. on 22 July. Also recorded on Diyatra, Keechan and Kowadisar tanks.

98. **Kentish Plover** *Charadrius alexandrinus*

Found both in fresh and brackish waters — one seen on a salt pan near Lunkaransar (19 January), two in Sambhar Lake which is brackish and two in a freshwater tank near Gajner.

99. **Lesser Sand Plover** *Charadrius mongolus*

Only one record of two birds in a temporary pool, on 22 July, 1993, 7 km before Kanoi in Jaisalmer dist. It is mostly found on the sea-coast, with very few records from inland waters (Ali and Ripley, 1987, Roberts, 1991). It arrives on the sea-coast by early August, so the birds which I saw must be on the passage.

100. **Snipe** *Gallinago gallinago*

Only one record of two birds in Guda Vishnoian on 7 February.

101. **Avocet** *Recurvirostra avosetta*

It is generally found in brackish water. I saw it on three different sites in the Thar desert.

102. **Indian River Tern** *Sterna aurantia*

Two recorded in Guda Vishnoian wetland on 7 March, 1994. One was found dead in the same wetland.

103. **Blackheaded Gull** *Larus ridibundus*

One near Sambhar Lake on 14 January, 1994, and three on a seepage at RD 507 on 20 January, 1994. Roberts (1991), has found it wintering in the Thar desert in Pakistan but not in Cholistan.

104. **Great Blackheaded Gull** *Larus ichthyaetus*

One confirmed sighting on a seepage wetlands near RD 507 on 20 January, 1994. Probably first record from the Thar. It has not been recorded from the desert regions of Pakistan (Roberts 1991, pp 369, map 178). Ali and Ripley (1987), however, reported it from Bharatpur, Delhi, Nepal, Bihar, Corbett (Uttar Pradesh) so its presence in the Thar, though unusual, is not unexpected.

105. **Common Indian Sandgrouse** or **Chestnut-bellied Sandgrouse** *Pterocles exustus*

Abundant all over the Thar.

106. **Spotted Sandgrouse** *Pterocles senegallus*

Uncommon. Sixty seen inside Sam enclosure on 1 February, 1994, and many hundreds outside Sam along with Indian Sandgrouse. Seven were seen on 1 February, between Mohangarh and Jaisalmer. According to Roberts (1991), it is an abundant, but erratically occurring winter visitor to the main deserts of Cholistan in Punjab and Thar in Sind. It appears to be declining.

107. **Imperial Sandgrouse** *Pterocles orientalis*

Common winter migrant. A few thousands still come to Gajner every morning to drink water. e.g. on 16 January, 1994, 3-4 thousand were seen in Gajner. Always found in large numbers from 2-3 hundreds to a few thousands. Extensively hunted, hence declining all over its range.

108. **Blue Rock Pigeon** *Columba livia*

Abundant in villages and settlements. Apparently absent in uninhabited parts of the Thar, but now spreading due to development of plantations. According to Major Harjit Singh, Environment Task Force (ETF) (pers. comm. 1993), pigeons were not seen earlier in this area. They came after ETF was established, and human settlements came up in 1983. Roberts (1991), has not shown its distribution in the Thar and Cholistan deserts bordering the Indian Thar desert. I found them roosting/nesting in abandoned wells and water storage tanks. Huge numbers live around temples where grains are provided daily for birds.

109. **Indian Ring Dove** *Streptopelia decaocto*

Abundant all over the Thar, especially around Vishnoi settlements where grains are fed daily to birds.

110. **Red Turtle-dove** *Streptopelia tranquebarica*

Normally not present in very dry, treeless regions but with the development of canals and plantations, this dove is colonizing new areas. During monsoon they appear to be more widespread than during winter and summer. For instance, about 30-40 were found roosting with ring doves on *Acacia tortilis* trees near RD 954 near Bajju on 17 July, 1993. In Mohangarh on 21 July, pure flocks of 12-20 were seen roosting on *A. tortilis* at the edge of a grove, all sitting on 2-3 branches only, not spread out. Red turtle-dove was not seen during winter months in these areas, except for a male which was unable to fly on 29 January, near Tepu village in Jaisalmer dist. In Pakistan it is a summer migrant from India. Roberts (1991), has not recorded it in the Thar or Cholistan deserts, so its occurrence in Mohangarh in Jaisalmer is of significance.

111. **Little Brown Dove**
Streptopelia senegalensis

Much more common than *S. tranquebarica*, but not as abundant as the ring dove. Prefers groves and thickets of *Prosopis* and *Acacia*, and will become more common with plantations coming up with the IGNP.

112. **Yellowlegged Green Pigeon**
Treron phoenicoptera

Hume (1878), reported it from Jodhpur State. It is generally found in groves and forest, so the Thar is not a suitable habitat. However, with the development of plantations, it is being seen in new areas. I saw 8 birds on a tall, dense *Zizyphus* tree, 60 m from an *Eucalyptus* plantation of IGNP near Bajju on 9 February, 1993. At another site, more than 39 were eating the fruit of pipal *Ficus religiosa* near Manakthedi village between Suratgarh and Badopal on 19 January, 1994. On 30 January, 1994 one bird was seen on *Eucalyptus* near Mohangarh. Roberts (1922), also found that this species has extended its range in Pakistan due to plantation.

113. **Roseringed Parakeet** *Psittacula krameri*

Earlier uncommon in the Thar desert but now spreading very fast, thanks to cultivation and dense plantations along the canal. On 21 January, 1994, more than 1000 were roosting noisily on tall trees in Bajju. Also noticed in ETF, Mohangarh, Nachna, Bhikampur, and other areas beside the canal. Roberts (1992), found it widespread in the Indus river basin, but not in the Cholistan desert.

114. **Pied Crested Cuckoo** *Clamator jacobinus*

A migrant arriving with the start of the monsoon, so all my sightings were during July and August. It prefers scrub, forest and plantations. With the increase in numbers of its chief host i.e. babbler (thanks to thick plantations), it is likely to be found breeding more often in the Thar. I saw 15 individuals on 8 sites in July 1993.

115. **Crow-pheasant** or **Coucal**
Centropus sinensis

This is another bird of light forests, scrubland and groves so naturally it is not found in very arid areas where such habitats are absent, but with canal side plantations, the crow-pheasant is spreading in the Thar desert. I heard its call near Bajju and saw one bird near RD 954 on 9 February, 1993. During the roadside census, five birds were seen in as many sites.

116. **Short-eared Owl** *Asio flammeus*

A winter migrant of the grasslands and thin shrubland. I saw them in three different areas. On 16 January, 1994 in Diyatra region, ten owls were flushed out from an area of about 5 ha and in the same area, 9 individuals were flushed out from about 100 sq. m on 18 January. On 19 January, one was found crushed on the road between Bamanwala and Lunkaransar. In a grove of *Zizyphus* near Sangori village in Jaisalmer dist., on 29 January, 15 short-eared owls were seen, all sitting in the shade of small bushes. Roberts (1991), found it widespread in the desert of Pakistan.

117. **Spotted Owlet** *Athene brama*

Common in villages, *dhanis* and old disused wells.

118. **Collared Scops Owl** *Otus bakkamoena*

One individual seen at 1945 hrs in a thick *Dalbergia sissoo* grove near Mohangarh 27 July, 1993. According to Roberts (1991), "it is a species which requires good tree cover and is therefore uneven in distribution in the Indus plains, being found mainly in irrigated forest plantations or patches of riverine forest or in the shady gardens of old bungalows. It is entirely absent from desert or open treeless country but odd pairs will turn up in every district of Punjab and Sind". Its presence in a dense grove in the middle of almost treeless desert, (before the construction of IGNP, Mohangarh area was almost treeless) is noteworthy. Like other forest-loving species, the collared scops owl is certainly going to increase all along the IGNP.

119. **European Nightjar**
Caprimulgus europaeus

A crushed nightjar was found on the road near Mohangarh (22 July, 1993), from which wing/tail feathers were collected which were later identified in BNHS as those of the European nightjar. Dense groves of *A. tortilis* were present on both sides of the road from where the feathers were collected. R. G. Soni (pers. comm. 1994), has seen this species in the IGNP areas in Bikaner dist. Whistler (1938), had collected specimens from Hamvas in the erstwhile Jodhpur State.

120. **House Swift** *Apus affinis*

Mostly seen during the monsoon. May not be uncommon, but easily overlooked. Nearly 115 individuals seen on nine sites in July 1993. Roberts (1991), has not reported it from the desert regions of Pakistan but Ali and Ripley (1987), have shown its distribution covering the whole of peninsular India, including Rajasthan.

121. **Green Bee Eater** *Merops orientalis*

Common and now spreading with cultivation. Seen in all seasons. Nearly 460 individuals in 51 roadside censuses, out of which 290 were seen during the monsoon. In the Thar, the paler subspecies *beludschieus* is generally seen.

122. **Blue-cheeked Bee-eater**
Merops superciliosus

Breeds in the Thar during the monsoon so by May and June, the birds start moving in. During July, 210 individuals were seen on 16 roadside censuses. During May 1994, many birds were seen near Osiyan, Phalodi and Sudasari.

123. **European Roller** *Coracias garrulus*

An autumn passage migrant, seen during July and August. Five individuals seen during July 1993.

124. **Indian Roller** *Coracias benghalensis*

Prefers more mesic habitats than available in the Thar desert but now spreading due to cultivation and plantation. Seen in all seasons. 64 individuals seen during 25 roadside censuses, and many others during line transects. Roberts (1991), says that the Indian Roller is absent from extensive desert tracts, but we found it in many areas in the Thar.

125. **Whitebreasted Kingfisher**
Halcyon smyrnensis

Although comparatively more independent of water than other kingfisher species, it is still not found very far from water, hence it is not a true desert species. However, it can be seen near permanent village tanks, and now it is spreading all along the IGNP. We have seen it in the following areas: near Bajju, Bangasar Lift Canal at RD 860, Bhikampur, Nidai on Jaisalmer-Mohangarh road, near Mohangarh, ETF, and near Lunkaransar. Additionally, 21 individuals were seen during roadside censuses.

126. **Blackcapped Kingfisher**
Halcyon pileata

This is not a desert species, but we saw one bird at a village tank near Keechan on 26 January, 1994. This is probably the first record from the Thar desert. Not reported by Hume (1878), Whistler (1938), and Roberts (1991). According to Ali and Ripley (1987), it is primarily a maritime species, but sporadically reported from inlands (e.g. Bharatpur, Gonda, Monghyr) so its presence in a wetland in the Thar is not unexpected, though unusual.

127. **Common Kingfisher** *Alcedo atthis*

One bird was seen at a village tank near Kolayat on 17 January, 1994. Associated with wetlands, so the dry Thar is not its main habitat. Roberts (1991), has not reported it in Cholistan desert but only in a small part of the Thar Desert (see Roberts, 1991, pp 514, map 260).

128. **Pied Kingfisher** *Ceryle rudis*

One individual seen inside Suratgarh town on 19 January, 1994. At present rare in the Thar but likely to spread with the IGNP.

129. **Hoopoe** *Upupa epops*

Common in the Thar, but none seen during four days survey during the summer. It generally avoids extensive deserts (Roberts 1991), but during favourable conditions in the rains, it spreads out widely. I saw 26 birds during monsoon and winter on 17 roadside censuses and 11 during line transects.

130. **Wryneck** *Jynx torquilla*

Found in open scrubland and thin forests during winter. I saw one individual feeding on the ground in a plantation, about 2 km before Dedawa, on Gandhav-Dedawa road in Nagaur dist.

131. **Yellowfronted Pied Woodpecker**
Picoides mahrattensis

This species is also found in scrub forests, and it is likely to increase with the spread of *Acacia* plantations. I saw two on *Prosopis cinerarea* near Rolsabsar, Fatehpur tehsil in Sikar dist., on 4 February, 1993, and later the same day a female on *Prosopis cinerarea* in Taal Chhaper in Churu dist. On 14 January, 1994, one woodpecker was seen, 6 km before Nawan in Nagaur dist. in a *Prosopis cinerarea* grove on a hillock. In Phulia enclosure of DNP in Jaisalmer, a circular hole was found on a *Salvadora* trunk, about 3 m high, which appeared to be of a woodpecker, but we did not see any woodpecker in this area. Roberts (1991), found it resident in the sparse *Prosopis spicigera* thorn scrub of the Thar desert in Pakistan.

132. **Lesser Golden-backed Woodpecker**
Dinopium benghalense

This species of woodpecker is found from scrub forest to thick deciduous forest of the Himalayas. Whistler (1938), collected specimens from Jawa and Jaswantpura in the erstwhile Jodhpur State. We saw one individual foraging on *Prosopis cinerarea* near Rolsabsar, Fatehpur Tehsil, Sikar on 4 February, 1993. R. G. Soni (per. comm. 1994), has reported it from Bikaner dist.

133. **Redwinged Bush Lark**
Mirafra erythroptera

It is found in the broader valleys and eroded hills of the Thar desert (Roberts 1992). Whistler (1938), collected specimens near Hamavas lake. Hume (1878), considered it common in Jodhpur. Ali and Ripley (1987), recorded its presence in western Rajasthan (Thar), and northern Gujarat, including Kutch dist. I saw it only once near Fakeran ki dhani in Jaisalmer dist. on 31 January, 1994.

134. **Ashycrowned Finch Lark**
Eremopterix grisea

It is generally not present in the drier parts of the Thar, but during monsoon it tends to spread out all over the Thar. According to Roberts (1992), it is "locally nomadic, dispersing into remoter desert areas in the monsoon season". Whistler (1938), collected it in Pali, Bhinmal and Jalor but Hume (1878), did not collect any in Jodhpur. We found it to be common inside Sudasari enclosure during July (monsoon) but absent during May (summer). However, during winter some were seen in a dry area near Khetoosar, near Kanasar in Jodhpur dist. (28 January, 1994). Out of 191 seen during roadside census, 170 were sighted during July, and the rest during winter.

Near Undu, in Barmer dist. on 25 July, during a locust plague, more than 100 were seen feeding on hoppers in about 200 m area on the metalled road. They did not gulp the hoppers, but battered them to small pieces and then ate the pieces.

135. **Blackcrowned Finch Lark**
Eremopterix nigriceps

Very common in the Thar. Breeds during the monsoon. Many males displaying during July and August. Regularly seen during May in all the places studied.

136. **Rufoustailed Finch Lark**
Ammomanes phoenicurus

Very common in Taal Chhaper during monsoon. According to Roberts (1992), it is largely absent from the more arid northwest (in Pakistan), but I found it fairly common in the Thar during the monsoon. Out of the 168 birds seen during 17 roadside censuses, 159 were seen during monsoon. On 25 July, 1993, some birds were seen feeding on locusts. On a hot noon on 26 July, between Kashmira and Makhab in Barmer dist., the telegraph wires were full of finch larks, including the rufous-tailed.

137. **Hoopoe** or **Bifasciated** or
Large Desert Lark *Alaemon alaudipes*

A bird of extremely hot and barren areas. The Thar is the easternmost limit of this widely distributed species in the Middle East and northern Africa. I have seen it on four sites, all flat and very arid: between Jaisalmer and Sam; near Digha; near Dholiya; and in Sanghana ki Basti near Dhanana. It breeds during the monsoon in July, as a male was found displaying between Jaisalmer and Sam. Before aerial display it sings softly and then jumps about 3 m, and falls with closed wings. White flashes are seen on the wings when ascending. Near Dholiya village, on 28 January, 1994, many were seen feeding on roots of *Dactyloctenium sindicum*.

138. **Greater Short-toed Lark**
Calandrella brachydactyla (Leisler)
or **Short-toed Lark**
Calandrella cinerea longipennis (Ali & Ripley).

Abundant during winter, in flocks of upto one thousand. Sometimes moves with the eastern calandra lark. It appears to be partial to grasslands and feeds on grass seeds, e.g., about 300 were found feeding on seeds of *Aristida funiculata* in very short grass.

139. **Eastern Calandra Lark**
Melanocorypha bimaculata

An erratic winter visitor, enormous flocks in some years, while largely absent in others. During February 1993, huge flocks seen all over the Thar, but especially in Diyatra, Phalodi, Bap, Khara, and Sam areas. Sometimes moves with equally huge flocks of short-toed larks.

140. **Crested Lark** *Galerida cristata*

In some areas very common, as between Bikaner and Kolayat on 17 January, 1994, 30 seen in a distance of 20 km, foraging on the road on fallen grains. Specially common in fine, sometimes extremely dry, gravel areas. During winter and monsoon surveys, 203 birds were counted in 29 roadside censuses. Not seen during May, so probably moves to more mesic areas during summer.

141. **Eastern Skylark** *Alauda gulgula*

Hume (1878), found it in Jodhpur. I have a few sightings of this species. On 19 February, 1993, I saw two birds near Bhikampur which appeared to be this species. They had very faint breast streaks, almost invisible, and two black markings on either side of neck, conspicuous crest, erect posture, and long flesh coloured tarsus. They were foraging at 1230 hrs on the roadside, on bare stony ground. In July a few individuals, perhaps of this species, were seen in Taal Chhaper and Sudasari.

Confirmed sighting of three birds near Tanwarwala in Jaisalmer on 24 January, 1994. They were in a sandy area, moving restlessly on the ground, picking up seeds. Sometimes sitting on top of *Aerva* and eating seeds from standing shrubs.

142. **Plain Sand Martin** *Riparia paludicola*

A nesting colony was found on a sand bank near Mohangarh on 4 March. 1993. Another active colony was found 200 m from IGNP, in a sand bank on 25 January, 1994. White on the belly extends upto breast unlike in PICTORIAL GUIDE

(Ali and Ripley, 1983) where white is shown only on the belly.

143. **Swallow** *Hirundo rustica*

Fairly common winter visitor to the suitable biotopes in the Thar desert. It may spread widely due to cultivation and canal irrigation. We saw one near Bajju on 8 February, 1993, another near a brackish wetland near Lunkaransar on 15 July, 1993, which is very early for this species. Roberts (1992), say that they can be found in the plains from August onwards, so my record is much earlier .

144. **Wiretailed Swallow** *Hirundo smithii*

Found in the vicinity of water. Earlier it may not have been common in the Thar, but now it is spreading along the canal. Roberts (1992), has not recorded it in the Cholistan and Thar deserts of Pakistan (map 309, pp 40, vol. 2) but I saw it at four different sites near the IGNP: two birds were seen near Bajju on 17 July; a loose group of 20 between RD 931 and RD 961; a solitary bird between Bajju and Bhikampur (both on 18 July); and the fourth sighting of three birds was near Mohangarh on 21 July.

145. **Indian Cliff Swallow** *Hirundo fluvicola*

At Bhikhampur in Jaisalmer dist. we saw many birds collecting nesting material and probably nesting under a bridge over the main canal (10 February, 1993). According to Roberts (1992), the Indian cliff swallow is largely confined to the Indus plains, but in recent years it has colonized many new areas. Similar colonization is being seen on the IGNP.

146. **Common Wood Shrike**
Tephrodornis pondicerianus

Unlike true shrikes, it is entirely arboreal in foraging, thus found only in scrubland and open forests with trees. According to Roberts (1992), in Pakistan it frequents old plantations around canals. Whistler (1938), found it common in the tamarisk forest in Tilwara in Jodhpur estate. One seen in a plantation near Bajju.

147. **Small Minivet** *Pericrocotus cinnamomeus*

This species was not recorded by Hume (1878), or Whistler (1938), from the Thar, but I sighted four birds on 4 February, 1993, on a roadside plantation near Rolsabsar, Fatehpur tehsil in Sikar dist. Second sighting was on 14 January 1994, near Nawan (Nagaur dist.) in a scrubland. According to Roberts (1922), it is well adapted to irrigated cultivation, plantations. (map 330, pp 77, vol. 2, shows this species on the Pakistani Thar side of Gadra Road, (Gadra Road is in Barmer).

148. **Whitebellied Minivet**
Pericrocotus erythropygius

Hume (1878), collected it near Jodhpur, and Adam near Marot and Koochamun. I saw a pair foraging on *Acacia* at a roadside plantation near Robsar (Fatehpur Tehsil, Sikar) on 4 February, 1993.

149. **Whitecheeked Bulbul**
Pycnonotus leucogenys leucotis

Abundant, prefers drier habitat than *cafer* (Roberts 1992). In addition to birds seen during line transects and general studies, nearly 320 birds were sighted during 68 roadside censuses.

150. **Redvented Bulbul** *Pycnonotus cafer*

One of the most common birds of the Thar. Earlier it was absent from the more extensive desert tract (Roberts 1992), where its place was taken by whitecheeked bulbul but now it is spreading with canal irrigation. It was noticed on 55 roadside census paths, and a total of 204 individuals were seen.

151. **Black Drongo** or **King Crow**
Dicrurus adsimilis

Widespread during winter and monsoon, invariably found following sheep and goats. More than 200 individuals seen during 43 roadside censuses during winter and monsoon, but none during summer months.

152. **Indian Tree Pie** *Dendrocitta vagabunda*

One seen on a *Prosopis cinerarea* tree in a crop field between Sambhar and Nawan in Nagaur on 14 January, 1994. Likely to spread with thick plantations which are coming up beside the IGNP.

153. **House Crow** *Corvus splendens*

Commensal with human beings, so present around *dhanis* and villages. Generally uncommon in remote uninhabited areas. Breeds during monsoon months. Numerous pairs with young ones seen in July and August.

154. **Raven** *Corvus corax*

In the plains of India, the raven is found only in the Thar, where it replaces the jungle crow. I saw 104 birds during 33 roadside censuses. Many more were seen during line transects and general studies. During summer months, there appears to be emigration from the more arid parts of the Thar to less arid, because during May no raven was seen between Jodhpur, Phalodi, Jaisalmer and Shiv. The first raven was seen 5 km before Dhorimanna, which is not a true desert country, being more hilly and vegetated. After Dhorimanna, many ravens were noticed. They were sometimes seen in flocks on garbage near filthy roadside hotels or on animal carcases with vultures.

155. **Common Babbler** *Turdoides caudatus*

Very common. Wherever a few *Capparis* bushes are present, this species is seen. Scattered bushes appear to be a critical habitat factor in the Thar. More than 650 individuals were counted in 83 roadside censuses. It was present practically all over the Thar.

156. **Large Grey Babbler** *Turdoides malcolmi*

Not found in very dry parts of the Thar. Common in Jodhpur, the Luni basin and western foothills of the Aravalli mountains. Its distributional line runs from Gajner (Bikaner) to Fetehpur-Ratangarh (Churu-Sikar) to Taal Chhaper (Churu) up to Lohawat (Jodhpur) and Jaitaran-Bilada (Jodhpur) to Dhorimanna (Barmer). From Lohawat to Jodhpur this species is seen in increasing numbers. The Gajner population appears to be isolated. According to Roberts (1992), it is not so well adapted to semi-desert regions as *T. caudatus*, nor does it like such well-wooded regions as *T. striatus*. The large grey babbler is likely to increase its range with the development of plantations along the canal.

157. **Jungle Babbler** *Turdoides caudatus*

This is also a forest-loving babbler, so naturally it was absent from the Thar. Whistler (1938), had collected it from Sunda Hills in Aravallis in the erstwhile Jodhpur State but he did not observed it elsewhere. However, with the development of excellent plantations and undershrubs along the canal, this species is spreading. I have seen it feeding on roadside plantations near Mokulsar between Arjunsar and Rajaisar (19 January, 1994). On both sides were good *Eucalyptus* and *A. tortilis* plantations, and sugarcane crop. One flock was seen between Gopalsar and Bakhtavarpura on 20 January, 1994, near IGNP. One found crushed on the road, about 1 km from Bajju. Its companions sitting around the dead body. Good *Eucalyptus/tortilis* plantation present nearby. Later 6 seen in the same area on 25 January, 1994. One more flock was seen in a dense eucalypt of IGNP near Chhatergarh (15 July, 1993). All these sites were near IGNP in Bikaner dist.

158. **Striated Babbler** *Turdoides earlei*

This is a typical riverine species, present along the larger rivers of north India and the Indus river system. Therefore, its presence along the IGNP is quite interesting. First evidence was a flock among *Arundo* reeds in a jheel of RD 954 on 17 July, 1993. They showed typical skulking behaviour. Presence of fledglings begging for food proved that the birds had bred in the areas. On 20 January, 1994, another flock was seen among *Arundo* growing in a seepage wetland of IGNP between Bakhtavarpura and Bhopalpura.

Arundo, which was flowering, extended many metres on both sides of the canal. The rest of the canal was covered with water hyacinth. The third group of 8-10 was seen on 29 January, 1994, on a seepage with *Typha, Arundo and Saccharum*, 14 km before Chinnu and 16 km after Bhikampur. They were 200 m from the main IGNP. Roberts (1992), says that it is found all along the Indus river and its tributaries, but has adapted and spread along major irrigation canal systems in Pakistan.

159. **Bluethroat** *Erithacus svecicus*

A common winter migrant to the foothills and plains of north India, extending in decreasing numbers to south India. Prefers shaded, damp areas, so the dry Thar is not the main habitat of this bird. However, with the development of crop fields and plantations in the Thar, the bluethroat is now increasingly being seen. I saw a male in Taal Chhaper in Churu dist., a male and female in Mohangarh in Jaisalmer dist. (6 February, 1993), and again one on the lawns of Mohangarh Rest House on 6 February, 1994.

160. **Rufous Chat** *Erythropygia galactotes*

A passage migrant through Pakistan and northwest India to East Africa, passing through the Thar during monsoon and autumn. Whistler (1938), says they appear in September in Jodhpur but I saw many individuals on 24 and 25 July, 1993 in Sudasari enclosure in Jaisalmer. They were going from bush to bush, fighting among themselves, regularly cocking and fanning the tail.

161. **Black Redstart** *Phoenicurus ochruros*

Common in winter, generally found in shaded areas. According to Roberts (1992), it shuns open bare regions and likes tree plantation avenues. I have seen it in extremely arid areas also, e.g. near Nokh on 10 February, 1993, a female redstart was seen in an arid area, under two *Capparis* bushes, with a lesser whitethroat. The area can be considered super arid, with very scattered bushes and flat barren *rann* nearby. I saw 76 individuals during 24 roadside censuses. Both subspecies *phoenicuroides* (grey crown) and *rufiventris* (black crown) were seen in Bajju in February 1993.

162. **Magpie Robin** *Copsychus saularis*

Another new entrant to the arid regions of the Thar along with canal irrigation, cultivation and plantations. We saw a female inside ETF on 20 January, 1994, and another female between Bajju and Bhikampur on 25 January, 1994. Ali and Ripley (1987), and Roberts (1992), have not reported it from the arid regions of the Thar.

163. **Brown Rock Chat** *Cercomela fusca*

An endemic Indian bird, irregularly distributed in the Thar. Whistler (1938), reported it to be common at Phalodi, Jalore and on the Sunda Hill. Robert (1922), does not report it from the Thar in Pakistan. I found it very common in Keechan village near Phalodi in Jodhpur dist.

164. **Indian Robin** *Saxicoloides fulicata*

The Indian Robin is generally absent from very dry areas of Jaisalmer, Jodhpur and Bikaner. It is more common near the Aravalli mountains. Its distribution in the Thar more or less follows the distribution of the large grey babbler, but sometimes isolated populations are found, such as I saw in Sankara village, in Jaisalmer (7 February, 1992). One bird in rocky, stony areas between Phulia and Jaisalmer (26 February, 1993), and another between Bikaner and Lunkaransar (19 January, 1994), were also seen. Not seen between Phalodi and Osiyan, but between Osiyan and Jodhpur, it was frequently seen as I proceeded towards Jodhpur.

165. **Stoliczka's Bushchat** *Saxicola macrorhyncha*

Rare, localized and endemic to the northwestern arid and semi-arid parts of India. Roberts (1992), considered it extinct in Pakistan. However, no survey has been done there. I found it fairly common in Diyatra, DNP, Nokh, and Khara areas. Altogether 86 individuals were seen at 18 sites (Rahmani, 1993).

166. **Collared Bushchat** *Saxicola torquata*

Fairly common winter visitor to the Thar. Roberts (1922), found it all over the Pakistani Thar. I also saw it in many areas. Whistler (1938), collected it at Hamavas, Jalore and Bhinmal.

167. **Pied Bushchat** *Saxicola caprata*

Common resident in suitable areas. Whistler (1938), found it very common in Jodhpur State. I found it frequently during monsoon and winter but not during the four days of a summer survey. In Sudasari on 24 July, a male in heavy moult; head and neck whitish with some black feathers. Middle tail feather missing, so tail appeared forked. Faint wing patch, belly whitish, and rump also white. Later, two immatures were seen in the same area. I collected specimen of a dead juvenile; only the skeleton was present, but both wings and tail feathers were undamaged. Immatures had conspicuous wing and black tail. Upper parts and head blotched. The bill was black and the rump chestnut.

168. **Isabelline Chat** *Oenanthe xanthoprymna*

Common winter visitor throughout the more barren and uncultivated tracts of the Indus plains (Roberts, 1992). Very generally distributed except in the hill tracts (Whistler, 1938). I saw 35 individuals during 14 roadside censuses, and many more during line transects. Most sightings generally in open, barren sandy or gravel areas, but one bird was found foraging near a hamlet (*dhani*), very tame, sometime perching on house walls.

169. **Desert Wheatear** *Oenanthe deserti*

Perhaps the commonest wheatear of the Thar desert, reported to be very common in Barmer and Phalodi (Whistler, 1938). I had hundreds of sightings during winter. Aerial display was seen on 27 February, 1993 inside Sam enclosure.

170. **Pied Chat** *Oenanthe picata*

Another common winter migrant to the Thar desert. It has three morphs: Blackbellied *opistholeuca*, Whitebellied *picata* and White-crowned *capistrata*. All three morphs seen, sometimes within 100 m of each other, but the *picata* morph most frequently. The earliest arrival, a *picata* morph male, was sighted on 23 July, in Sudasari enclosure in the DNP.

171. **Red-tailed Wheatear** *Oenanthe xanthoprymna*

The rarest *Oenanthe* of the Thar desert. Only ten individuals seen in two winter surveys of one month each. Generally found in dry, sandy or gravelly arid areas. Roberts (1992), found it to be locally common in Pakistan, but rather selective in the areas it chooses.

172. **Indian Great Reed Warbler** *Acrocephalus stentoreus*

Very common in the IGNP. It breeds mainly in central Asia, sporadically in Pakistan (Roberts, 1992), but I found it breeding during July all along the main IGNP canal. Very common on *Typha* near RD 954, and all along the IGNP wherever *Typha* clumps were present. On 17 July 1993, seen or heard every 200 m. Strangely seen only on the IGNP, not in the jheel of RD 954. Near Nachna (20 July), every patch of *Arundo/Typha* in the IGNP had a warbler. Whistler (1938), said "abundant in the extensive reed beds of Hamavas Lake... it is extremely probable that the birds breed where they were found". During five roadside censuses along the IGNP in July, 96 birds were noted.

173. **Rufous-fronted Wren Warbler** *Prinia buchanani*

Addicted to semi-desert tracts thickly studded with *Zizyphus* bushes. Specimens were collected from Phalodi, Tilwara, Jalor and Hamavas Lake (Whistler, 1938). Robert (1992), found it common in the Thar. It is a resident species and I found it in many places.

174. **Streaked Wren Warbler** *Prinia gracilis*

We saw one in Sudasari on 27 July, 1993, and four between Mohangarh and Jaisalmer on 1 February, 1994.

175. **Plain Wren Warbler** *Prinia subflava*

A largely sedentary species found throughout the Indus plains. It is adapted to cultivated tracts, particularly irrigated tall crops such as wheat, cotton, sorghum and millet (Roberts 1992). Not reported by Whistler (1938), but I found some in fallow fields, between Bap and Phalodi on 10 February, 1993. Another was seen calling agitatedly from the top of a *Capparis* bush inside Sudasari enclosure (1 March, 1993). Later, in Mohangarh on 4 March, one was seen in breeding plumage. During the monsoon, we noted it at Taal Chhaper (13 July), in a plantation, and in a crop field near Lunkaransar (15 July, 1993).

176. **Orphean Warbler** *Sylvia hortensis jerdoni*

A winter visitor, likely to occur in roadside thorny plantations and scrubland. I saw one on 1 February, in Sam, and a female (head not black) in a roadside plantation between Bikaner and Gajner (17 January, 1994). One more was seen in Diyatra region on 18 January. Hume had collected it at Jodhpur. Whistler (1938), called it *S. crassirostis jerdoni*

177. **Desert Lesser Whitethroat** *Sylvia curruca minula*

Widespread in the Thar, in low scrub and bushes. Whistler (1938), called it *S. c. minuta*. It occurs in the same habitat as *Sylvia nana*. Another subspecies *blythi* very common in *Acacia* plantations in Punjab and Sind (Roberts, 1992). This subspecies is likely to spread with canal irrigation and development of canal plantations. Whistler (1938), collected it from Hamavas Lake in Pali, Sunda Hill, Jalor. I saw lesser whitethroat in many roadside plantations and low scrub growing among sand dunes.

178. **Desert Warbler** *Sylvia nana*

Common in winter all over low scrub and uncultivated tracts in the desert. Invariably seen following a wheatear, lesser whitethroat or some other small bird. Display call heard/seen at 0820 hrs in Sudasari enclosure on 3 February, 1994.

179. **Streaked Fantail Warbler** *Cisticola juncidis*

Common in open bog or marshy grasslands. Erratic distribution due to habitat restrictions. Not found in the dry areas of the Thar. It will spread with cultivation. I saw it displaying over a salinized field overgrown with *Cyprus* near Bajju (18 July, 1993). Also seen in another similar field. Later, display seen in Sudasari enclosure on 24 July, 1993.

180. **Booted Warbler** *Hippolais caligata*

Roberts (1992), has reported two subspecies from the Thar desert: *caligata* is largely a passage migrant, while *rama* breeds in Baluchistan and erratically in the riverine tracts of Sind, and winters throughout the Indus plains. Whistler (1938), collected *rama* (Syke's tree warbler), in Hamavas Lake, and said that they are probably passage migrants. Both subspecies are likely to occur in the Thar. R. G. Soni (pers. comm. 1994), has reported it from Bikaner.

I saw four warblers, possibly this species, foraging in *Acacia tortilis* grove near Mohangarh on 27 July, 1993, constantly calling *chirr chirr.* All in the same tree at the edge of a dense grove, they were bigger than lesser whitethroat, closer to house sparrow in size, with longish bill, white supercilium joining forehead, underparts pale whitish, while upper part earthy brown (as in juvenile babbler). Legs whitish. Sometimes hovering to catch insects.

181. **Brown Leaf Warbler** or **Chiffchaff** *Phylloscopus collybita tristis*

Winter visitor in shrubs, bushes, light forests, groves and hedges. According to Roberts (1992), it prefers irrigated canal colonies and well wooded areas in Punjab and Sind and it is abundant in the Indus plains. Whistler (1938), collected it from Hamavas Lake and Tilwara. I saw it in Taal Chhaper (4 February, 1993). Probably this species was seen on 25 February, 1993, inside Miyajlar enclosure where three individuals were foraging separately among low

Tamarix bushes. Later, this species was seen inside Phulia enclosure (25 February), in plantation near Mohangarh (4 March, 1993), and in the ETF plantation (21 January, 1994). With the establishment of plantations and crop fields, it is likely to increase in IGNP areas.

182. **Tailor Bird** *Orthotomus sutorius*

It was largely absent in the Thar, but now due to cultivation and plantation it is spreading. I heard call in Bajju on 21 January, 1994. According to Whistler (1938), it was not observed west of Tilwara, and Roberts (1992), says that it usually shuns extensive areas of desert, but is frequently found on the edge of barren desert.

183. **Grey Shrike** *Lanius excubitor*

The most common shrike of the Thar desert, it was seen in most of our roadside censuses. 515 individuals were seen in 82 censuses. In July 1993, one shrike was found pecking at a snake of about 84 cm. Another was seen on a cow carcase near Mohangarh on 31 January, 1994. Four fledglings were found with parents in the DNP office in Jaisalmer on 18 May, 1994. The nest was located on the thatched roof of an abandoned hut. A pair was seen probably nesting on a pole between Jodhpur and Mathaniya (18 May, 1994), reluctant to fly from the nest site. There were lots of bushes in the vicinity, so why should it nest on the open pole?

184. **Baybacked Shrike** *Lanius vittatus*

This shrike avoids pure desert country, preferring scrubland and plantation, so it is not uniformly distributed in the Thar unlike *L. excubitor*. However, it is likely to increase with the ecological changes brought about by the IGNP. Even Whistler (1938), had reported it from Barmer and Pholodi, and in most rest house gardens. Roberts (1992), found that it particularly prefers canal-bank tree plantations. I have seen it in Ralsabsar (4 February 1993), Taal Chhaper (4 February), 2 km before Dedwa in a roadside plantation on Shiv-Dhorimanna road (12 February), and on Sudasari-Khuri (2 March, 1993). During the monsoon survey, it was seen in many plantations, e.g. between Khara and Jamsar, (15 July), near Lunkaransar (15 July), near Bajju (17 July), near RD 961 near Bajju (18 July), (all in Bikaner dist.); Sudasari enclosure (24 July), (Jaisalmer dist.); between Harsani-Balewa (25 July), Undu (26 July), and Dhorimanna (26 July), (all in Barmer dist.).

During the winter survey of 1994, I had only one sighting i.e. in *Acacia tortilis* plantation and crop fields near Lunkaransar (19 January). It was seen during the summer survey, also indicating that it may be resident. One baybacked shrike was found in a green crop area and plantation between Mathaniya-Osiyan (18 May), (Jodhpur), another between Barmer and Dhorimanna (20 May).

A shrike of bay-backed size, with very dark head like Burmese shrike, was seen on 17 July, 1993, near RD 954 near Bajju.

185. **Rufousbacked Shrike** *Lanius schach*

Like *L. vittatus*, the rufousbacked shrike also avoids very arid tracts and dunal areas. It prefers cultivation, gardens, scrubland and plantations. Whistler (1938), found it at Phalodi, Gadra Road and Barmer. It is another beneficiary of the IGNP. I found it in many canal plantations and scrubland. Evidence of its breeding, two juveniles were located with an adult near RD 954 on 17 July, 1993, in Bikaner.

186. **Pale Brown Shrike** *Lanius collurio* or **Isabelline Shrike** *Lanius isabellinus*

According to Whistler (1938), common in all the drier parts; the classification of these two species/subspecies is still arguable. I had many sightings during winter and monsoon but not during summer.

187. **Whitebrowed Fantail Flycatcher** *Rhipidura aureola*

A bird of thin forests, scrubland, orchards and gardens. According to Whistler (1938), it is not found west of Balotra, but this statement is no longer valid due to ecological changes brought about by canal irrigation in the Thar. According to Roberts (1992), it is common in the irrigated canal colonies of the Punjab. In lower Sind, it is mainly found in relict patches of riverine forest or in orchards.

I have seen solitary birds in many areas in Bikaner dist. e.g. in a plantation near Bajju (9 February, 1993 and 23 January, 1994); near RD 820 (21 January, 1994); Mohangarh (4 March, 1993); plantation/crop near Lunkaransar (15 July, 1993); and near Chhatergarh in IGNP plantation (15 July). I did not go to the IGNP areas during the summer survey of 1994, so I do not have any record nor do I know whether it is found in this area in summer.

188. **Paradise Flycatcher** *Terpsiphone paradisi*

Not noted by Whistler (1938), but Roberts (1992), found that it occurs over most of Sind and Punjab as a double passage migrant. I saw a female chasing a little green bee-eater in a *Tecomela undulata* grove, about 1 km from the Forest Department rest house near Mohangarh in Jaisalmer dist. On the other side of the road was a thick grove of *Dalbergia sissoo*.

189. **Tawny Pipit** *Anthus campestris*

Common winter migrant, but Whistler (1938), did not procure it in Jodhpur State. We have many sightings which could be due to recent spreading of this species: Taal Chhaper (4 February, 1993); Katar-Jasrasar in Churu (5 February, 1993); Sudasari Rest House (1 March, 1993); outside Sudasari enclosure (2 March, 1993); Undu (5 March, 1993); Diyatra (18 January, 1994); sandy area near Damodra pasture Plot (1 February, 1994); one very dark bird near Sam (2 February, 1994); inside Sudasari enclosure and 4 birds outside Sudasari (3 February) and one Digha Minor (6 February, 1994). We saw 24 more birds during 11 roadside censuses during January-February 1994, most solitary individuals.

190. **Brown Rock Pipit** *Anthus similis*

Not listed by Whistler (1938), but we found it in four different sites in 1994. A bird was seen on the way to Nokh from Bhikampur (25 January). In Jaisalmer dist. we saw this species at the following sites: two birds near Fakeran ki dhani (31 January), one near Khuri (2 February) and two birds inside Sudasari enclosure (3 February). Roberts (1992), has not reported it from the Pakistani Thar and Cholistan (Vol. II, pp 53, map 316) but Ali and Ripley (1987), have shown its occurence in the whole of Gujarat and Rajasthan.

191. **Yellow Wagtail** *Motacilla flava*

Common passage migrant. I saw one individual in a seepage of IGNP, 10 km after Lunkaransar in Bikaner on 19 January, 1994.

192. **Blackheaded Yellow Wagtail** *Motacilla melanogrisea*

Hume (1878), refers to it as *M. feldegg malanogriseus* while Roberts (1992), calls it *M. flava melanogrisea*. One individual, probably of the species was sighted near IGNP.

193. **Yellow-headed Wagtail** or **Citrine Wagtail** *Motacilla citreola*

One seen on the edge of Bangas Lift canal near Bajju, 9 February, 1993. It is generally found on larger marshes and wetlands, foraging on the floating vegetation. Roberts (1992), has recognised three subspecies. Hume (1878), received skins of *M. c. calcarata* from Jodhpur.

194. **Grey Wagtail** *Motacilla cinerea*

Frequently found in relict patches of riverine forest where there are drainage channels or oxbow lakes. Reported by R. G. Soni (pers. comm. 1994), from Bikaner. I saw one on a saltpan near Lunkaransar in Bikaner dist. on 19 January, 1994.

195. **White** or **Pied Wagtail** *Motacilla alba*

Invariably found near water, so it is absent from the greater part of the Thar. This winter migrant is likely to be seen more frequently with the spread of canal network. All the following sightings were near IGNP or on village tanks: Bajju (8 February, 1993); Bangasar Lift Canal (9 February); Bhikampur (10 February); Guda-Vishnoian (7 March, 1993); and in a village tank near Samra, 3 km from Nokh (28 January, 1994). Roberts (1992), has not reported it from Cholistan and Thar deserts.

196. **Large Pied Wagtail** *Motacilla maderaspatensis*

This species is found on streams, rivers, canals and at the margin of large lakes. Roberts (1992), found it sparingly in Punjab and the lower stream debouching into the Indus, but absent from most of Sind. He has not reported it from the Thar and Cholistan deserts. I have seen it on five sites: IGNP near Bajju (9 February, 1993); Nachna (20 July, 1993); seepage wetland near Bhadera village, 10 km after Lunkaransar (19 January, 1994); one foraging on a bridge of IGNP near ETF (20 January, 1994); and on an old camel carcase with common babbler, feeding on insects and maggots, near Noda Minor (21 January, 1994).

197. **Brahminy Myna** *Sturnus pagodarum*

Earlier reported only from the edge of the Thar desert. Hume (1878), considered it fairly common in Jodhpur and Whistler (1938), collected it from Pali, Hamavas Lake and Jalor. But now it appears that this species has spreaded to some towns in the interior desert region. For instance, I have seen many individuals foraging inside Phalodi town (19 July, 1993), and have many records from the edge of the Thar desert, e.g. a pair seen between Fatehpur-Ratangarh (4 February, 1993); one bird between Jasrasar-Kakra in Churu dist. (5 February); a pair near Dhawa-Doli (6 March); another pair between Jodhpur and Bilada (7 March); and 6 between Ringas and Sikar (12 July); a pair near Dhorimanna (26 July, 1993); a pair between Sambhar and Nawan in a crop field (14 January, 1994); 1 bird betwen Alai and Nokha (Nagaur) on 15 January; a pair between Osiyan and Jodhpur (10 February); a pair between Jodhpur and Mathaniya (18 May, 1994); and, one bird, 2 km before Dhorimanna (20 May, 1994). R.G. Soni (pers. comm. 1994), has occasionally seen Brahminy Myna in Bikaner dist.

198. **Rosy Pastor** *Sturnus roseus*

Common autumn and winter migrant, but erratically distributed in the Thar desert, perhaps due to lack of suitable foraging areas in winter. Between Bikaner and Gajner on 6 February, 1993, I found hundreds of rosy pastors sitting inside *Zizyphus* bushes feeding on fruit, while in January 1994, not many were seen at the same spot. On 8 February, 1994, hundreds of rosy pastors with bank myna, ring dove and pigeon were seen feeding on capsicum kept for drying near Mathaniya village in Jodhpur dist. The bird menace was so great that boys were employed to chase them away.

Rosy pastors arrive as early as July in huge numbers, but most of them move to other areas. Out of 1089 birds seen during 21 roadside censuses in winter and monsoon, 925 were counted during the monsoon.

199. **Starling** *Sturnus vulgaris*

Another common winter migrant, but erratically distributed in the Thar due to lack of foraging areas. It is likely to spread with the expansion of cultivation and irrigation facilities. Most of our sightings were near the IGNP, e.g. more than 2000 bank and common mynas and starlings were found roosting on *A. tortilis* in ETF on 20 January, 1994 in Bikaner dist.

200. **Pied Myna** *Sturnus contra*

According to Roberts (1992), it is largely absent from the "dry northwestern parts" i.e. Thar in Pakistan. Whistler (1938), had also not recorded it in Jodhpur State. It is generally found at the edge of the Thar. R. G. Soni (pers. comm. 1994), has seen it occasionally in Bikaner dist. I have a confirmed sighting of two pied mynas in a fishing settlement near 5 No. Cut near Suratgarh and again inside Suratgarh town on 20 January, 1994. Both these sites in Ganganagar dist. are at the edge of the main Thar desert.

201. **Bank Myna** *Acridotheres ginginianus*

Roberts (1992), thinks that the Bank Myna avoids deserts or dry rocky country and it is most common in rice cultivation. It has increased with extension of rice cultivation and also water-logging and seepage zones. In the Indian Thar desert also, it has increased, and is sometimes found in very dry areas. On 11 February, 1993, I found a large flock foraging on flowering and fruiting *Capparis* bushes, in the middle of very dry area, 17 km from Phalsund in Jaisalmer dist. However, most of my sight records are close to IGNP and in crop fields. A very large roost of bank and common mynas was present on *Arundo* and *Typha* clumps at RD 954 near Bajju (8 February, 1993). Another huge multi-species communal roost consisting of more than 2000 mynas was found on *A. tortilis* plantation near ETF on 20 January, 1994 in Bikaner dist..

The bank mynas breed during the monsoon. We found numerous pairs with juveniles in Bikaner dist. during our monsoon surveys. Scattered pairs were occasionally seen following livestock in Khara-Jaimsar in Bikaner (15 July); 4 between Ratangarh and Chhaper (4 February, 1993); a pair between Sendwa and Bidasar in Bikaner (5 February, 1993); a pair in Mankasar villager in Bikaner (24 January, 1994); cultivation/habitation before Dantur (24 January, 1994); a pair with cattle near Sam (6 February, 1994). I also found hundreds of bank mynas with ring doves, pigeons and rosy pastors, feeding on capsicum seeds kept for drying near Mathaniyan in Jodhpur dist. (8 February, 1994).

152 bank mynas were seen during 17 roadside censuses, out of which 129 were seen during monsoon on six transects.

202. **Common Myna** *Acridotheres tristis*

Abundant, commensal with man, so found even in remote settlements, but largely absent in uninhabited areas. Nearly 170 individuals, mostly in pairs, were seen in 47 roadside censuses.

203. **Purple Sunbird** *Nectarinia asiatica*

It is found mainly in *Calotropis* dominated areas. According to Roberts (1922), in the Pakistani desert, it shows erratic movement in all seasons, because of its partial dependence on flower nectar, and in winter there is a general drift southward. When the false caper *Capparis aphylla* is in bloom, it can be encountered far out in the desert (Roberts 1992). During the roadside census, we saw 160 sunbirds, out of which 112 were seen during monsoon over 14 censuses. Interestingly, no sunbird was seen during the summer visit, thus indicating emigration. The sunbirds probably move to the Thar desert at the onset of the monsoon and remain through winter, till spring. In summer they leave the area due to lack of sufficient food. However, territorial fights and calls were heard during late February and March.

204. **Whitethroated Munia**
Lonchura malabarica

The most common munia of the Thar desert, it is abundant near temples where cereals are spread for birds. On 27 July, 1993, in Sudasari, nest building was observed over an old cupshaped nest of some other species. On 7 February, 1994, in Ramdeora enclosure, four munias sitting just below an active nest of steppe eagle on a *Zizyphus* tree (4 m), must be roosting under the nest. A total of 236 birds were seen in 34 roadside censuses.

205. **Green Munia** *Amandava formosa*

Probably the first record of this species from the Thar desert, when I saw one on *Capparis* in Sudasari enclosure on 24 July, 1993. Despite its rarity, the green munia is caught for pet bird trade. It could have been an escaped bird. However, Suresh C. Sharma (*in litt.* 1993), has seen it on 29 and 31 March, 1991, in Taal Chhaper sanctuary in Churu dist., so there appears to be some movement of this bird in the Thar desert.

206. **House Sparrow** *Passer domesticus*

Abundant around settlements and remote *dhanis*. Large flocks during winter, whence population is augmented by winter migrants. Sometimes associated with yellow-throated and spanish sparrows.

An albino house sparrow was seen in a market in Nachna on 19 July, 1993.

207. **Spanish Sparrow** *Passer hispaniolensis*

The Spanish sparrow was not reported from the Thar desert by Ali and Ripley (1987), but Roberts (1992), has reported it in winter in the Pakistani Thar and Cholistan deserts just across the IndoPak border (closer to Bikaner and Jaisalmer dists of India). R. G. Soni (pers. comm. 1994), has seen it occasionally in Bikaner dist.

I have seen this species, with migrant (?) house sparrows, on three sites. Two males were noticed on 10 February, 1993, with 200-300 house sparrows at 0750 hrs feeding on seeds, 20 km from Phalodi. The next day, two males were seen with a flock of 100 house sparrows between Phalodi and Khara. The third sighting was of two males and two females, with a large group of house sparrows and short-toed larks drinking on leakage of water at 0945 hrs outside Sudasari enclosure (2 March, 1993).

208. **Yellowthroated Sparrow**
Petronia xanthocollis

Resident, widespread and specially abundant around villages in old community forests (*Uran*) of *Zizyphus* and *Acacia*, where they can get good nesting holes. Also common around temples where cereals are spread for birds.

209. **Baya** *Ploceus philippinus*

This species is invariably found near waterbodies, so it is not common in the Thar. However, it is most likely to spread to more areas with the IGNP. We saw a small nesting colony near the forest rest house in Taal Chhaper on 13 July, 1993, in Churu district, and four birds between RD 931 and RD 961 on 18 July, and nearly 20 birds between RD 507 and ETF, in Bikaner dist.

210. **Streaked Weaver Bird** *Ploceus manyar*

Like the baya, it is also found near water, so it not widespread in the Thar at present. R. G. Soni (pers. comm. 1994), has found it occasionally, in Bikaner dist. It is likely to increase with IGNP, for the reasons cited earlier. Whistler (1938), reported it from Jodhpur State. Roberts (1992), found it throughout the Indus flood plains and its tributaries and the increase in irrigated rice cultivation seems to have favoured its spread. Far much more addicted to seasonal inundation or permanent swamps because of its nesting habit. I found it nesting on *Typha* reeds growing in the main IGNP near Bajju (18 July, 1993).

211. **Redheaded Bunting** *Emberiza brunniceps*

Roberts (1992), found it mainly in northern Sind and southern Punjab on passage. The passage route taken by this species is different from the blackheaded. Whistler (1938), collected it in Jalor, and Hume (1878), at Pali and Soojat. I saw two birds between Bap and Phalodi on 10 February, 1993, and three on *Capparis* between Sudasari and Sam, on 1 March, 1993.

212. **Greynecked Bunting**
Emberiza buchanani

Whistler (1938), collected it near Phalodi and Pali but Roberts (1992, pp 577, map 564) does not show it in the Thar and Cholistan deserts. On 24 January, 1993, I saw 50-60 birds were seen between Dandkalan and Jarakri in Jaisalmer dist. in very sandy area.

213. **Striolated Bunting** *Emberiza striolata*

Hume (1878), found it in Jodhpur on the flanks of a rocky hill, and Whistler (1938), collected it from Jalor. According to Roberts (1992), it avoids sand dune and open gravel, and is found in rocky hills. On 8 February, 1994, I saw 8 birds on a heap of stones near Lohawat temple in Jodhpur dist.

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FIRST BREEDING RECORD OF THE COLLARED FALCONET *MICROHIERAX CAERULESCENS* FOR THE INDIAN SUBCONTINENT IN CORBETT NATIONAL PARK, UTTAR PRADESH[1]

Rishad Naoroji[2]

(*With one text-figure*)

Key Words: collared falconet *Microhierax caerulescens*, breeding record, courtship, incubation, Corbett, India.

Little is known about the collared falconet *Microhierax caerulescens* which is distributed in India throughout the lower Himalayan foothills from Garhwal eastwards to Assam, Northeastern hill states and Arunachal Pradesh usually upto 900 m, but has been recorded as high as 2000 m. Previously recorded from the Terai, where most of its former habitat has now shrunk or disappeared, it is a deciduous to moist-deciduous and evergreen forest dwelling species, most often observed hunting in man-made clearings, natural open spaces and forest margins. It commonly forages in degraded secondary deciduous and semi-evergreen biotope. Breeding within Indian limits has not been previously recorded for this comparatively common bird. The species appears to have been overlooked due to its small size (often mistaken for a passerine), its tendency for perching within forest (when not foraging), crepuscular habits and roosting and breeding within relatively high nest-holes of barbets, which to some degree may account for low detectability during the breeding season. However, the species is relatively conspicuous during courtship when frequent calls and associated self-evident demonstrative activity by a pair draws the observer's attention to the birds. Scant breeding data, however, is available on the extralimital Burmese race *M.c. burmanicus* (Baker, 1935; Ali and Ripley, 1978). This paper presents preliminary observations on courtship and incubation of this little studied raptor.

[1]Accepted May, 1997

[2]Godrej & Boyce Mfg. Co. Ltd., Godrej Bhavan,
4A, Home Street, Mumbai 400 001, India.

Study Area

The study was carried out in Corbett National Park which lies between the two sub-Himalayan districts of Pauri and Nainital in Uttar Pradesh (29° 31'- 29° 35' N. lat., 70° 41' E. long.). It is situated in the lower central Himalayan Sivalik foothills (Fig. 1) which form part of the Bhabar tract. The central portion of the Park is located partly along a valley, between the lesser Himalaya to the north and the Sivalik ranges to the south. The middle reaches of the Ramganga river flow through most of the Park along the Patli Dun. About 10% of the grassland area has been submerged by the damming of the Ramganga river at Kalagarh, forming a large reservoir in the western corner of the Park, covering an area of about 80 sq. km, of which 42 sq. km is within the Park. A number of *sots* (springs) emerge from the numerous ridges which comprise the secondary source of water in the Park, after the Ramganga river. The altitude varies from 300 to 1040 m. The Park is contiguous with extensive reserved forest to the west and the east which probably facilitates lateral avifaunal movement. Further, its location at the foot of the lower Himalaya acts as a meeting ground for avian species of high altitude and plains, which account for its species richness and diversity.

Three main vegetation zones exist. The forest, grassland (locally called *chaur*) and the Ramganga riverine valley. Though 110 species of trees have been recorded, the dominant tree species is sal *Shorea robusta* forming almost pure forest stands. There are six major flat grasslands holding

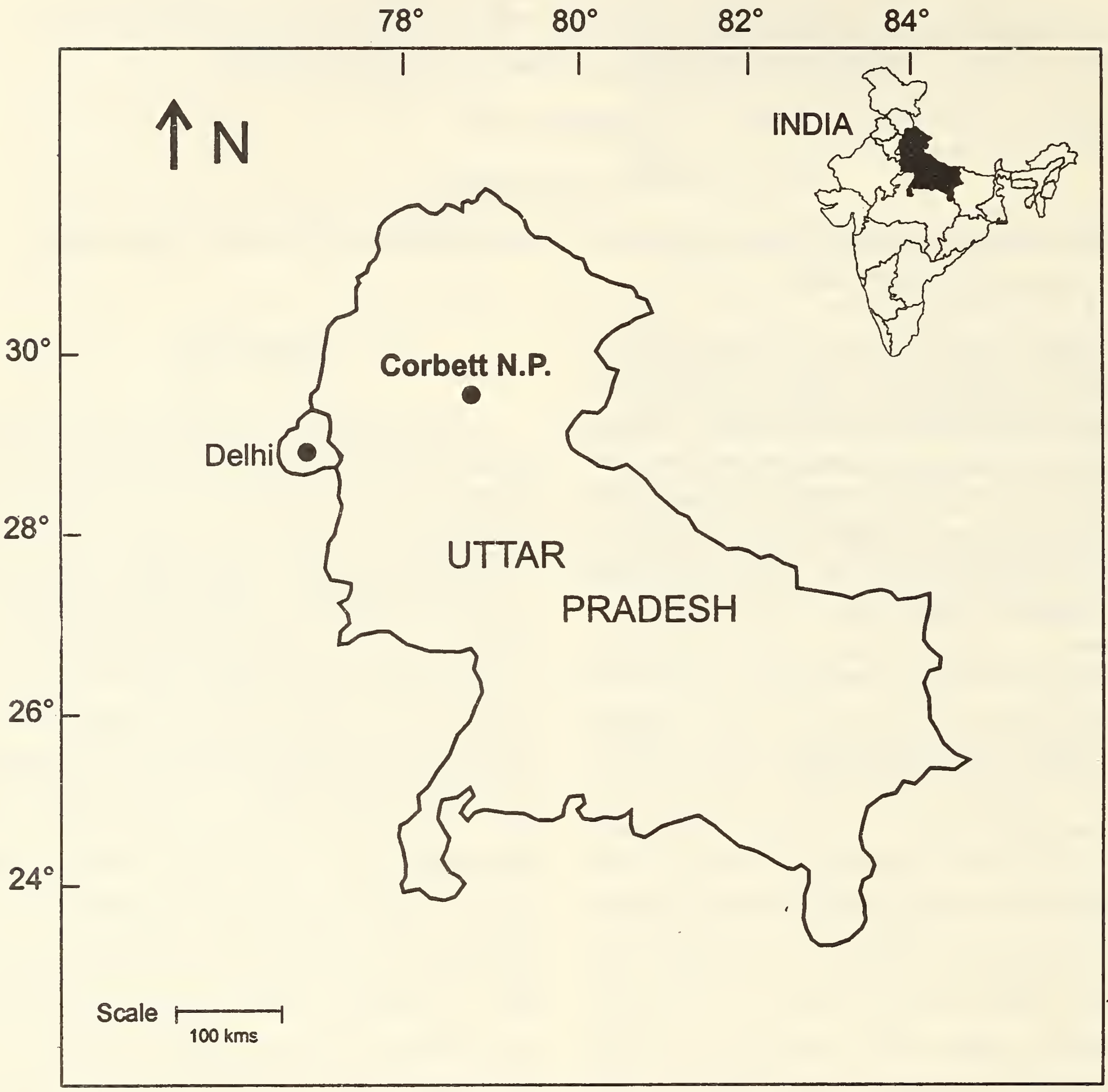

Fig. 1. Map of Uttar Pradesh and location of Corbett National Park

thirty-seven species of grasses. The largest grasslands are around Dhikala and Khinnanauli. The main forest types are a mixture of deciduous, tropical and subtropical. Sal dominates the moist deciduous biotope in the northern region of the Park. The biotope in the southern half of the Park, especially along the Sivalik hills, is dry deciduous. These three zones account for the genetic richness (both floral and faunal) and biogeographic diversity of the area. The river bed, the high banks and islands are colonised by sheeshum *Dalbergia sissoo*. *Lantana camara* is spreading unchecked, and is likely to adversely affect the native vegetation by suppressing the regeneration of sal and other herbaceous species. *Cannabis sativa* (bhang) grows profusely in parts of the grassland and in open areas. Bamboo clumps occur frequently in the Park on the higher hill slopes. Chir *Pinus roxburghii* are confined in small numbers on some of the highest ridges, eg., the Sultan watch tower. A nest was located in moderately dense sal forest, 300 m from the grassland. The leaf fall and shedding of dried sal flowers was in progress at the outset of the courtship period.

Methods

A nest was located while on elephant back. Shrill piercing calls drew my attention to a branch 4 m above me where a pair of falconets was mating. The male flew, plucked off a dried sal leaf and entered a disused barbets' nest-hole. Periodic observations through a spotting scope were made from a safe distance along the tracking line at the edge of which the nest-tree stood. Once incubation commenced, sustained close-up observations were made from an inverted cot, locally procured, secured between two trees, above the reach of wild elephants. The nest was under observation from 16th April to 15th May, 1993, for a total of 38 hrs.

Results

The female collared falconet was larger, with the diagnostic red throat patch and belly deeper than the male whose plumage was overall lighter. An unused barbet's nest-hole (either the large green *Megalaima zeylanica* or lineated *M. lineata*) was occupied for nesting. The larger, dominant female influenced the male's activities during incubation. The characteristic, constant vertical flicking of the tail facilitated location of the bird, given its small size. Vantage perches on bare branches around the nest were utilized during the day for food transfers, feeding, and by the male, for perching.

Nest and Nest-tree specifications

A disused barbet's nest 18 m high on a sal tree (three quarters up the nest-tree below the canopy) was used for nesting. The nest-hole faced northwest and was on the underside of a 45° vertically angled, outward sloping bare branch (perhaps as protection against adverse weather conditions). The rim formed an almost complete circle, the vertical and horizontal diameters being 6.5 cm and 6 cm respectively. The depth of the entrance was 29.5 cm. Two nests from Burma described by Baker (1935) were varyingly 7 m to 30 m high on different tree species, usually on the underside of a decayed or bare branch.

The nest-tree was well over 20 m high with the girth at breast height being 165 cm. The nest-tree's leaf fall was complete, the tree itself bare while other sal trees in the vicinity were all in new leaf. The nest-tree was situated in moderately dense sal forest (in forestry terms 0.5 to 0.6) at the edge of the tracking line, 300 m from Thandi Sadak road, the dividing line between the *chaur* and the forest. The undergrowth consisted mainly of *Lantana* sp., curry leaf *Murraya coenigii*, rohini *Mallotus phillipensis* and sal leaf litter.

Courtship and Mating

Courtship and mating were in progress when the pair were located on 16th April, 1993. Prior to mating, the male performed an extended courtship ritual, accompanied by frequent shrill and piercing whistles. The female mostly remained perched on a bare horizontal branch, while the male flew intermittent sorties of a short duration, returning frequently to perch excitedly alongside the female before flying off. On these sorties, the male would often pluck dried sal leaves with the feet in active flight and deposit them in the nest-hole (n=4). The larger leaves frequently got wedged at the nest-hole entrance and were dropped. Sometimes he would perch alongside the female with the leaf (an offering?) before depositing it in the nest. After each sortie, when the male alighted alongside the female, the pair greeted each other with calls, the male additionally attracting the female's attention by frequently spreading his wings. The pair would perch close, indulging in much bill touching and cheek preening initiated mainly by the male, occasionally by the female. Clumping and extended bouts of allopreening appears to be common among the sociable *Microhierax* falconets (Sparks 1965, Kemp and Crowe 1994). The depositing of leaves, bill touching and allo-preening appear significant in maintaining the pair bond. During the late courtship period the pair would occasionally deposit leaves in the nest-hole without any ritual.

Mating usually followed the courtship display and continued well into the incubation period. Mating was more frequent throughout courtship than during the early incubation period. Once mating was observed 20 m from the nest, but mostly it occurred within a few metres of the nest.

During incubation no extended courtship ritual preceded mating. Either one of the incubating adults, generally the female, would fly from the nest-hole to where its mate was perched. The pair would either briefly touch bills with much chattering or immediately commence copulation, which was accompanied by a rapid high-pitched chatter. Duration of copulation was 4 to 8 seconds (n=9), the male maintaining balance with much wing-flapping. Once the male mounted the female for almost a minute, though actual mating lasted only a few seconds. Copulation was mostly observed during the mornings of both the courtship and early incubation periods.

Incubation

A total of about 33 observation hours were spent monitoring incubation between 30th April to 15th May, 1993. The attentiveness of the female at the nest increased markedly after 28th/29th April. Prior to these dates, incubation was sporadic and its duration gradually increased till the complete clutch was laid. Tight incubation commenced on 30th April. Both adults incubated, the female for longer periods 82%, male 12%, while the eggs were unattended for 6% of the observation period. The longest incubation stint by the male was, an hour. Once during the early incubation period, after steady incubation had commenced, the nest was unattended for 36 mins from 0645 to 0721 hrs. During incubation dried sal leaves were occasionally deposited in the nest-hole by the pair (male n=3, female n=1). This activity was performed primarily by the male for both courtship and early incubation periods. When both adults were observed to be in the nest-hole (n=7, usually during the afternoon), the female invariably incubated, with the male settled just within the nest-hole entrance (for durations ranging from 2 mins to 2.38 hrs). All sounds (whether human, animal or bird) were immediately investigated by peering out of the nest-hole, or flying momentarily to a nearby perch to assess the potential danger, before returning to the nest.

By the fourth or fifth day of incubation, an increasing patch of droppings on the lower rim of the nest-hole, on the branch below, and favourite perches in the nest-vicinity were indicative of an active nest. During the afternoon hours, the male would often settle just within the nest-hole entrance, instead of the usual perches used during the mornings and evenings. Once the male remained mostly within the nest-hole entrance from 1500 to 1900 hrs except for two short bouts (outside the nest) totalling 72 mins. The female initiated changeovers by flying to the male, chattering constantly. She sidled up to him, and after brief bill touching, nudging and finally shrill vocal urging, the male would be induced to commence incubation. The pair suddenly abandoned the nest on 17th May, (after 19 days of incubation) and vanished thereafter. Mynas and parakeets repeatedly investigated the deserted nest-hole, but did not occupy it.

Calls

In greeting or prior to mating, the pair would chatter in unison. Frequent, shrill, piercing whistles accompanied the courtship ritual and mating. A typical, thin, rapid high-pitched chatter (in unison) *Che-che-che-che-che* was associated with mating, while similar calls were delivered singly in slower, shorter, staccato whistles. Many of the male's activities (eg. relieving the incubating female, hunting, prey visits, nest defence) were initiated through calls by the dominant female. She vocalised more frequently than the male (89% versus 11% by the male), and her calls were more high pitched.

High pitched, quickly repeated calls (suggesting urgency?) that subsequently lapsed into single note calls were mostly used to summon the male. Persistent calling by the female resulted in the male sometimes flying to the nest-hole perch with prey. She would greet him with a shrill *twe, twe, twe...* in rapid succession, the call rising to a crescendo, then varyingly repeated. The incubating female vocalised solely from the nest-hole entrance, never from within the incubation chamber.

Roosting

The pair roosted together in the nest-hole generally by 1920 hrs about 30 mins after sunset or occasionally earlier. The female always incubated at night, while the male roosted just within the nest-hole entrance.

Interspecific Conflicts

The competition for nest-holes by other species was severe during the incubation period, and even a momentary absence from the nest often invited investigation from other hole-nesters. The pair had to repeatedly repel attempts mostly by parakeets, mainly rose-ringed *Psittacula krameri*, red-breasted *Psittacula alexandri* and common mynas *Acridotheres tristis* from investigating their nest-hole. The male was once displaced from his perch by an Indian tree-pie *Dendrocitta vagabunda* and twice engaged in an extended dogfight with a black drongo *Dicrurus adsimilis*. The female occasionally broke off incubation to drive away parakeets and mynas.

Food and Hunting

Only three prey visits to the nest were observed during the study period. One fresh and two cached prey items were brought to the nest solely by the male, relieving the female (once for upto 23 mins) at incubation while she fed away from the nest. Prey was not taken into the nest-hole, but eaten mainly on the nest-hole branch or nearby perches.

Though the collared falconet takes a variety of prey, mainly insects and lizards (Ali and Ripley 1978, Baker 1935, Brown and Amadon 1968), only birds were observed being brought to the nest. Prey was cached on the nest-hole branch and on other frequently used bare horizontal branches in the nest vicinity. The male mostly hunted during the late courtship stage (though sometimes with the female), and solely during the incubation stage. The male foraged in the forest around the nest and in the nearby *chaur* upto at least 200 - 300 m from the nest.

Discussion

The sudden termination of incubation and disappearance of the pair remains a mystery. In all likelihood, the eggs may have been addled and the pair lost interest. Predation too cannot be ruled out.

Baker (1935) collected a full clutch of eggs from a nest on 14th April from Burma, which perhaps indicates a later nesting period in the Central Himalayan foothills relative to that in Burma, or late nesting by the pair under observation. Although the nest was not physically checked to avoid disturbance, it is likely that the clutch was completed at about the time the female's attentiveness at the nest increased. The full clutch was, therefore, incubated for about 19 days before being abandoned.

Clumping and allopreening is apparently not restricted to the breeding period of the species, as observed by Sparks (1965) in a non-breeding captive pair.

It has been suggested that clumping and allopreening indicate the social nature of the species and the genus as a whole, and may be linked with aggression and autopreening behaviour, acting probably to reduce aggressive behaviour and facilitate clumping, and that the species may even breed cooperatively (Sparks 1965, Kemp and Crowe 1994). In a subsequent study, Kemp and Van Zyl (in prep.) report co-operative breeding in the race *burmanicus*, having observed two almost fledged young attended to by five adults, and fed by at least three — two possible males and the breeding female. I observed no signs of aggression, the pair under observation nested in isolation from congenerics. One explanation could be that at Corbett the species has a naturally low breeding population density or it could be a straggling breeder. The species is evidently social, moving about in small parties in the non-breeding season, and frequently observed at Corbett between October and February.

The information presented here adds much to our basic knowledge of the biology of the species, though more information is required on the breeding biology and ecology of the species, the full extent of the breeding period, duration and commencement of courtship, incubation and nestling periods and detailed role of sexes during the breeding period. Prey and prey preferences throughout the breeding period, preferably from different areas should be studied as the limited hunting and prey data suggests that when breeding, the species supplements its normal prey (mainly insects but also lizards) with larger prey *viz.* small birds. Nestling success and average number of young reared, whether co-operative breeding does occur and to what extent, habitat requirements and territory; hunting success and dependency period of young are all areas for further investigation.

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PHYTOPLANKTON AS INDICATION OF ECOSYSTEM STATUS: A CASE STUDY OF AN URBAN WATERBODY[1]

Z.D. Kanhere[2] and V.R. Gunale[3]

Key words: phytoplankton, ecosystem status, physico-chemical parameters

The influence of urbanisation on an aquatic ecosystem was investigated using changes in the phytoplankton species composition over the years. In addition to phytoplankton, supportive parameters such as dissolved oxygen, carbon dioxide, chlorides, hardness and nutrients (nitrates and phosphates) from the water were analysed and compared with the data from studies carried out about 16 years ago.

There was a definite shift in the algal species, as also increase in the nutrient levels. The paper discusses the types of phytoplankton species, which were once common, that have not been recorded in the present study. The appearance of a few new species indicates the changing quality of water. These findings when compared with the earlier work signify the changes in the ecosystem.

Introduction

Rapid urbanisation over the past few years has created numerous environmental problems. It is estimated that at the end of this century nearly 40% of the population will be living in urban areas, as compared to the current 25-30%. Increase in urban population has created pressure on natural resources. Most of the urban areas in a developing country like ours are spreading without proper provision of sanitation and water supply, resulting in the deterioration of water quality.

The use of an algal community to indicate trophic status has been made by many workers following the pioneering work by Kolkwitz and Marsson (1908). These authors have classified water-bodies into poly(-), meso(-) and oligo-saprobic categories. Thereafter, a number of workers began using planktonic algae to indicate organic enrichment of water bodies. A more comprehensive account was proposed by Palmer (1969). He presented a list of algal genera and species, based on which a genus or species index can be calculated. Descy (1976), reported algae to be the most important group among aquatic plants for assessment of water quality. Groups of algal species, particularly diatoms, were used to indicate quality of water by Patrick (1973). Cairns and Schalie (1980), have also suggested the use of living organisms as the best biological indicators.

Venkateswaralu *et al.* (1994), showed that growth of algal species was influenced by environmental factors and used them as indicators of pollution gradient. Gunale (1991), also used algal communities as indicators of water pollution, in a study of Mula-Mutha rivers from Pune city.

In this study we examine the changes in the phytoplankton composition and water quality of an urban lake, known as Pashan Lake, from Pune metropolitan area, which supplies water to Pashan and surrounding areas. The lake is situated on Ram river and was away from urban influence in the past. The data are compared with the previous studies of the same lake (Pingle 1976).

Material and Methods

Physico-chemical and biological analysis were carried out at monthly intervals from 5 different sampling stations covering 4 different seasons. The physico-chemical parameters have been analysed as per APHA (1989).

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[1]Accepted March, 1997

[2]School of Environmental Sciences, University of Poona, Ganeshkhind, Pune 411 007, India.

[3]Department of Botany, University of Poona, Ganeshkhind, Pune 411 007, India.

TABLE 1

ALGAL SPECIES COMMON IN 1976 BUT ABSENT DURING THIS STUDY

1. *Dictyospherium pulchellum*
2. *Errerlla bornheniensis*
3. *Euastrum pulchellum*
4. *Golenkinia radiata*
5. *Nephrocyticum agardhianum*
6. *Sphaerocystis* sp.
7. *Staurodesmus* sp.
8. *Sphaerelopsis iyengarii*
9. *Phacotus lenticularis*
10. *Chlamydocapsa ampla*
11. *Tetrahedron gracile*
12. *Dinobryon sortularia*
13. *Synura uvella*
14. *Gymnodinium neglectum*
15. *Arthrospira* sp.
16. *Spirulina gigantea*
17. *Lepocinclis texta*
18. *Trachelomonas armata*

TABLE 2

ALGAE ABSENT IN 1976 BUT COMMON IN PRESENT STUDY

1. *Cladophora* sp.
2. *Ankistrodesmus* sp.
3. *Selenastrum* sp.
4. *Tetraspora* sp.
5. *Gleocapsa* sp.
6. *Gleocystis* sp.
7. *Amphora* sp.
8. *Volvox* sp.
9. *Stauroneis* sp.
10. *Mastogloia* sp.
11. *Diatoma* sp.

Biological analysis: Plankton net of 25 mesh size was used for qualitative analysis of phytoplankton species.

The quantitative plankton analysis was done by using Lackey's (1938) drop method to calculate the percentage of each class of algae.

RESULTS AND DISCUSSION

The pH of lake water was slightly alkaline, the maximum pH value was 8.8 in summer, indicating conditions suitable for high production of phytoplankton. The total alkalinity was in the range of 246-355 mg/l. The dissolved oxygen values fluctuated from a low of 1.6 mg/l to a maximum of 8.8 mg/l in summer and winter respectively. The low value was indicative of inflow of biodegradable waste into the lake. Nitrates and phosphates also showed some increase as compared to the previous study (Table 3), indicating conversion of the water body from oligotrophic to eutrophic condition. The encroachment of macrophytic growth and seasonal blooms of certain algae also indicate a succession from oligotrophic to eutrophic condition. Absence of species such as *Synura uvella, Dictyosphaerium puchellum, Dinobryon sortulavia,* etc., which are known to occur in clean (oligotrophic) water-bodies (Gunale, 1991), also indicate eutrophication.

TABLE 3

COMPARISON OF SOME PHYSICO-CHEMICAL PARAMETERS

	Pingle 1976		This study 1993	
	Min	Max	Min	Max
pH	7.5	7.6	6.7	8.6
D.O	0.5	15.8	0.9	7.3
Tot. Alk	67.0	155.0	205.0	435.0
Chloride	0.5	31.0	24.5	81.9
Nitrates	0.0	3.67	0.09	1.25
Phosphates	0.0	0.49	0.04	0.55

(All parameters are in mg/l except pH)
D.O = Dissolved oxygen
Tot. Alk = Total alkalinity

TABLE 4

DOMINANT CLASSES OF ALGAE IN PREVIOUS AND PRESENT STUDY

	Pingle 1976	This study 1993
1. Dominant class	Chlorophyceae (40-60%)	Bacillariophyceae (30-70%)
2. Second class	Euglenophyceae	Cyanophyceae

The species which were rather common 16 years ago were not recorded in the present study (Table 1), whereas a few new species from Bacillariophyceae and Cyanophyceae are now common (Table 2). Occurrence of these algae supports the process of eutrophication. Patrick (1973) has correlated dominance of diatoms and blue green algae with increasing levels of nitrates and phosphates.

There was a shift in dominance of algal groups (Table 4). There are nearly 18 genera, which were commonly found in 1976 and are absent in 1993. Similarly, there are 9 new genera recorded such as *Amphora* sp., *Tetraspora* sp., *Selenastrum* sp. which were not found in 1976 (Table 2).

From the above discussion, it is quite clear that there was a change, both in terms of qualitative and quantitative aspects of phytoplankton. Such changes in species diversity are due to increasing inflow of biodegradable and other wastes.

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MORPHOMETRIC RELATIONSHIPS IN TROPICAL ANURANS AND THEIR RELATIONSHIP TO SOME LIFE HISTORY PARAMETERS[1]

J.K. Mahanta, S.K. Swain & Madhab C. Dash[2]

(*With one text-figure*)

Key words: morphometry, life history, terrestrial, arboreal, semi-aquatic, aquatic.

Morphometric relationships between snout-vent length (SVL), femur length (FL), body weight (BW) and gonad weight (GW) of two terrestrial, three terrestrial burrowing, one arboreal, one aquatic swimming and two semi-aquatic jumping anuran species collected from five different habitats show that the ratio of body mass of female : male is highest (2.6) in aquatic species and lowest (1.053-1.287) in the terrestrial burrowing species. In semi-aquatic (1.553-1.616) and arboreal species (1.784) this ratio lies in between these two extreme values. The SVL was approximately 2.4, 2.0 and less than 2.0 times larger than the femur length in terrestrial and terrestrial burrowing species, in aquatic and semi-aquatic anurans and in arboreal species respectively. Significant sexual dimorphism, except in the burrowing species, with regard to body mass and other parameters were observed. The gonad development is a function of body size and is sex specific. The amplex adult weight is sex specific. Morphometric features appear to be correlated to habitat requirement of each species.

Introduction

Although India has a very rich fauna of amphibians (Inger and Dutta, 1987; Das, 1996), extensive quantitative ecological studies have not been made on the amphibian communities in the Indian ecosystems except for the recent work of Dash and Mahanta (1993). The different morphological parameters, like total body length (snout to vent), femur length, body weight, gonad weight are indices of growth and development in the amphibians. The growth and development processes are sequential and usually proportionate (Mahapatro and Dash 1991). Hence a proportionate relationship among the various growth parameters like snout-vent length (SVL), femur length (FL), body weight (BW) and gonad weight (GW) etc. is theoretically expected.

We wanted to examine if these relationships are species-specific, functions of some life history parameters and based on their habitat requirements. The present study involving 15 months of field work also covered the morphometry of nine anuran species i.e. *Bufo melanostictus, B. stomaticus, Microhyla ornata, Ramanella variegata, Polypedates maculatus, Euphlyctis cyanophlyctis, Limnonectes limnocharis, Hoplobatrachus tigerinus,* and *Tomopterna rolandae* collected from five different habitats. Dutta *et al.* (1991) made size analysis and reported the sex ratio of *Hoplobatrachus crassus*. Mohanty-Hejmadi (1974) provides information on the range of snout-vent length, and femur length of 11 anuran species (mature individuals of 10 species and juvenile individuals of 2 species) but does not answer the questions we have examined.

Material and Methods

Study sites

The study sites consisted of 500 acres of irrigated and unirrigated paddy fields, 20 acres of natural hill forest and two human habitation

[1]Accepted January 1996

[2] School of Life Sciences, Sambalpur University,
Jyoti Vihar - 768019, Orissa, India.

sites (one urban 300 acres and one rural 500 acres of Larambha village area) in the Sambalpur district of Orissa. The maximum, minimum and mean temperature of 15 months (October 1990 to December 1991) was 33.9°C, 17.9°C and 24.9°C respectively. The total rainfall during the study period was 1528.9 mm and maximum rainfall of 537.9 mm was recorded in July. The mean relative humidity was 65.7% (range: 48.3 to 84.6%).

The detailed descriptions of the study sites and sampling methods have been reported in Dash and Mahanta (1993). Adult and immature anurans were collected by stratified transect sampling and brought to the laboratory for morphometric measurements and identification of sex, and then the animals were released near the sampling plots (using the methods of Crump 1971, Heyer 1973, Daniel 1963, 1975). Sampling sizes varied as the relative density and availability of species during the sampling time was not constant. On some occasions, animals had to be sacrificed to note the development of gonads. The snout-vent length, femur length were measured by calipers and the weight was measured by chenomatric balance (± 1 mg).

Morphometric relationships were analysed by regression and correlation analysis (Snedecor and Cochran 1967).

Definition of some terms used:

(a) Snout-vent length (SVL): The length (mm) from snout to vent.
(b) Femur length (FL): The length from vent to end of femur.
(c) Gonad development: After dissection the development of gonad was observed under a magnifying glass and dissecting microscope.
(d) Minimum amplex size: The smallest male and female size observed in amplexus.
(e) Life history groups: The species were grouped according to their habits and ecological adaptations, as follows:

(i) Terrestrial: *Bufo melanostictus*, *B. stomaticus*.
(ii) Terrestrial burrowing: *Microhyla ornata*, *Ramanella variegata*, *Tomopterna rolandae*.
(iii) Arboreal: *Polypedates maculatus*.
(iv) Semi-aquatic jumping: *Limnonectes limnocharis*, *Hoplobatrachus tigerinus*.
(v) Aquatic Swimming: *Euphlyctis cyanophlyctis*.

Results and Discussion

Morphometric measurements:

Measurement of parameters like snout-vent length (SVL), femur length (FL), body weight (BW), gonad weight (GW) of nine tropical anuran species indicate that the mature female in all species has a larger body mass than the mature male, showing distinct sexual dimorphism. The highest ratios of SVL of female : male is 1.45 and body mass of female : male is 2.60 in *Euphlyctis cyanophlyctis*, an aquatic swimming species. The ratios are lowest in the terrestrial burrowing species irrespective of their body sizes (Table 1 & 2) (SVL ratio 1.067 ± 0.036 and BW ratio 1.145 ± 0.125). In semi-aquatic species which make big jumps, the SVL ratio is 1.181 ± 0.008 and body weight ratio is 1.584 ± 0.044). In *Bufo* species (complete terrestrial) the SVL ratio is 1.079 ± 0.048 and BW ratio is 1.401 ± 0.182). These data support the view that female anurans are typically larger than their male counterparts (Crump 1974, Shine 1979, Mahapatro and Dash 1991) but in some burrowing species (*Microhyla ornata* and *Ramanella variegata*) there is no statistically significant difference in adult male and female body size (Table 1).

The SVL is found to be 2.383 ± 0.18 and 2.548 ± 0.212 times larger than in terrestrial and terrestrial burrowing species respectively. The ratio of SVL to FL is lowest (1.82 ± 0.026) in the arboreal species. This ratio is 1.962 ± 0.033 in aquatic swimming species and 1.944 ± 0.12 in

TABLE 1

RELATIONSHIP IN THE BODY WEIGHT OF MALE AND FEMALE ANURANS

		Average Body Weight (g) ± SD		Body Weight Ratio	
Habits	Species	Male	Female	't' value	Female / Male
Terrestrial	*Bufo melanostictus*	41.374 ± 12.054 (50)	63.309 ± 23.024 (77)	6.194	1.530
	Bufo stomaticus	27.650 ± 2.694 (16)	35.20 ± 6.840 (17)	2.60	1.273
Terrestrial burrowing	*Microhyla ornata*	0.933 ± 0.259 (18)	0.983 ± 0.314 (09)	0.545*	1.053
	Ramanella variegata	1.570 ± 0.420 (13)	1.720 ± 0.380 (14)	1.22	1.095
	Tomopterna rolandae	3.635 ± 0.515 (20)	4.680 ± 0.730 (25)	5.408	1.285
Arboreal	*Polypedates maculatus*	5.960 ± 1.137 (05)	10.632 ± 2.872 (17)	3.508	1.784
Semi-aquatic jumping	*Limnonectes limnocharis*	1.731 ± 0.346 (236)	2.688 ± 0.532 (370)	24.495	1.553
	Hoplobatrachus tigerinus	225.000 ± 77.780 (02)	363.750 ± 38.670 (10)	4.057	1.616
Aquatic swimming	*Euphlyctis cyanophlyctis*	4.900 ± 1.312 (57)	12.740 ± 2.383 (36)	20.458	2.600

Number in parentheses indicates the sample size.
* Difference is not statistically significant.

semi-aquatic jumping species (Table 3). These values do not differ significantly between male and female and size groups (mature males, mature females and immatures) (Table 3, Fig. 1).

Considering the SVL/FL length in different ecological groups of amphibians, we interpret that since the arboreal species make long strides (jumps) from tree to tree and place to place, the body weight and SVL should be such that it does not put a lot of pressure on the femur for jumping purpose. Hence the ratio is minimum in *Polypedates maculatus* in comparison to other groups. The semi-aquatic and aquatic species not only swim very fast but also often jump from the banks to the water and hence a larger body weight/ SVL would be disadvantageous. Their SVL/FL ratio varies between 1.859 to 2.023 which is close to the arboreal species. The terrestrial surface dwelling and terrestrial burrowing species do not make long strides; they move slowly and hence a large body weight or a larger SVL is not disadvantageous to them. Besides, a large body size would be advantageous to repel smaller predators.

Irrespective of the habitats, significant positive correlation exists in the adult anurans between the values of SVL and FL, SVL and BW (log values) SVL and GW, FL and BW (log values), BW and GW. In *Bufo melanostictus,* gonad development starts when SVL is 40 mm and the corresponding average BW is 6.92 + 1.285 g. The amplex adult weight is sex specific. The amplecting males have a minimum SVL of 61 mm and corresponding average BW 26.83 +

TABLE 2
RELATIONSHIP IN THE SVL OF MALE AND FEMALE ANURANS

		Average SVL mm ± SD			SVL Ratio
Habits	Species	Male	Female	't' value	Female / Male
Terrestrial	*Bufo melanostictus*	70.74 ± 6.38 (50)	78.77 ± 7.88 (77)	16.987	1.135
	Bufo stomaticus	59.96 ± 3.50 (16)	62.70 ± 2.78 (17)	3.358	1.045
Terrestrial burrowing	*Microhyla ornata*	19.16 ± 1.42 (18)	20.66 ± 1.12 (09)	3.191	1.078
	Ramanella variegata	24.15 ± 2.20 (13)	24.80 ± 2.10 (14)	1.151*	1.027
	Tomopterna rolandae	29.20 ± 1.19 (20)	32.00 ± 1.00 (25)	8.964	1.096
Arboreal	*Polypedates maculatus*	42.60 ± 3.13 (05)	50.70 ± 4.18 (17)	7.990	1.190
Semi-aquatic jumping	*Limnonectes limnocharis*	24.18 ± 1.10 (236)	28.71 ± 1.73 (370)	36.618	1.022
	Hoplobatrachus tigerinus	114.50 ± 9.50 (02)	134.50 ± 7.14 (10)	9.507	1.175
Aquatic swimming	*Euphlyctis cyanophlyctis*	34.96 ± 2.61 (57)	50.75 ± 2.90 (36)	44.976	1.452

Number in parentheses indicates the sample size.
* Difference is not statistically significant.

1.44 g. Amplecting females have a minimum SVL 66 mm and corresponding average BW 28.83 + 6.525 g. In *Bufo stomaticus* the gonad development starts when the SVL is 35 mm and the average BW is 5.825 + 0.377 g. The amplecting males have a minimum SVL 58 mm with corresponding BW of 28.4 + 1.277 g. In *Euphlyctis cyanophlyctis* development of gonad starts when SVL is 25 mm and the corresponding average BW is 1.84 + 0.255 g. The amplecting males have a minimum SVL of 46 mm with average BW of 10.867 + 0.416 g. In *Limnonectes limnocharis* the SVL value is 20 mm and the corresponding average BW value is 1.064 + 0.134 at the time of gonad development. The amplecting males have a minimum SVL 23 mm with average BW 1.454 + 0.237 g. The amplecting females have a minimum SVL 27 mm with corresponding BW of 2.175 + 0.323 g (Table 4).

Data on the gonad development of other species are not available. The amplecting males have the minimum SVL of 16 mm, 40 mm, 20 mm, 105 mm, 28 mm and corresponding average BW 0.600 g, 5.65 + 1.343 g, 1.3 + 0.141 g, 170.0 g, 3.275 + 0.266 g in *Microhyla ornata, Polypedates maculatus, Ramanella variegata, Hoplobatrachus tigerinus,* and *Tomopterna rolandae.* The amplecting females have the minimum SVL of 19 mm, 45 mm, 22 mm, 125 mm, 31 mm and corresponding average BW of 0.7 g, 7.267 + 1.040 g, 1.3 g, 320.25 + 0.353 g, 4.025 + 0.594 g in *Microhyla ornata, Polypedates maculatus, Ramanella variegata, Hoplobatrachus tigerinus* and *Tomopterna rolandae* (Table 4).

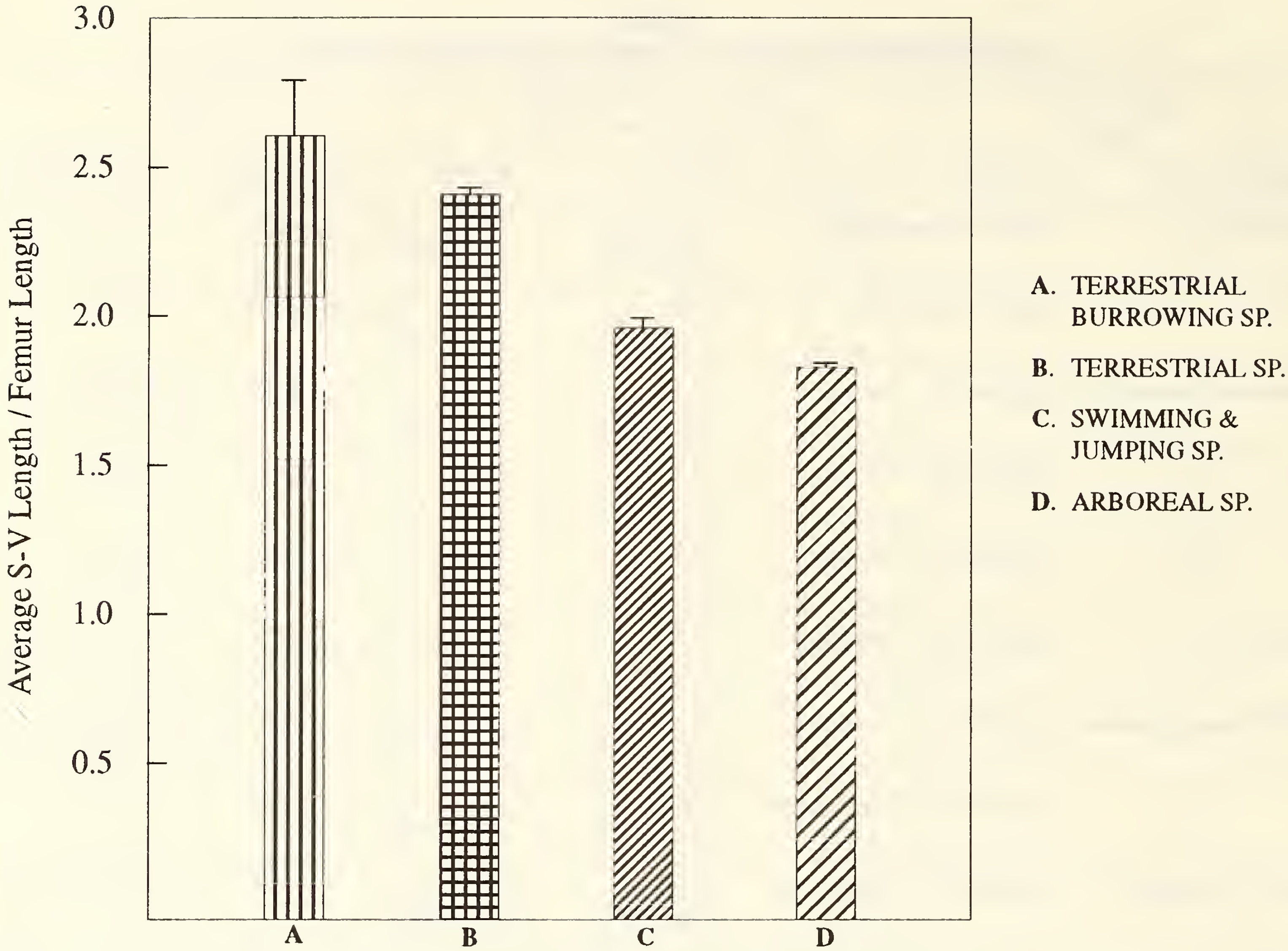

Fig. 1. Ratio of average S-V length/femur length in four groups of tropical anurans with different mode of living

Conclusion

A review of literature indicates that generalisation based on morphometric relationships, life history parameters and habits in anurans have not been made earlier. This generalisation indicates a distinct trend in the ratio of SVL and FL in different groups of anurans with different habitats (terrestrial, arboreal, terrestrial burrowing, aquatic swimming and semi-aquatic jumping etc.). The work also provides field data on the body size at gonad development and of amplecting adults of nine tropical anuran species. The data indicates that ecological groupings of amphibians like terrestrial, terrestrial burrowing, arboreal, aquatic swimming and semi-aquatic jumping, etc. are an added value to pure taxonomic classification.

Table 3

RELATIONSHIP OF THE SNOUT-VENT LENGTH (SVL) AND FEMUR LENGTH (FL) OF NINE ANURAN SPECIES

Habit	Species	SVL/FL		
		Male	Female	Immature
Terrestrial	*Bufo melanostictus*	2.359	2.389	2.44
	Bufo stomaticus	2.320	2.379	2.41
Terrestrial burrowing	*Microhyla ornata*	2.63	3.20	2.46
	Ramanella variegata	2.616	2.58	2.47
	Tomopterna rolandae	2.30	2.33	2.354
Arboreal	*Polypedates maculatus*	1.85	1.81	1.80
Semi-aquatic jumping	*Limnonectes limnocharis*	2.02	2.02	2.03
	Hoplobatrachus tigerinus	1.76	1.847	1.971
Aquatic swimming	*Euphlyctis cyanophlyctis*	1.946	2.00	1.94

* sample size is given in Table 4

TABLE 4
RELATIONSHIP OF SNOUT-VENT LENGTH AND BODY WEIGHT WITH GONAD DEVELOPMENT AND MINIMUM AMPLEX ADULT SNOUT-VENT LENGTH

Habit	Species	Start of gonad development				
		Minimum SVL (mm)	Average BW (g) ± SD	Sex	Minimum SVL (mm) (for amplex adult)	Average BW (g) ± SD (Range in parentheses)
1	2	3	4	5	6	7.
	Bufo melanostictus	40	6.925 ± 1.285 (8)	M	61	26.83 ± 1.44 (26.00-28.50) (3)
Terrestrial				F	66	28.83 ± 6.52 (22.00-35.00) (3)
	Bufo stomaticus	35	5.825 ± 0.377 (4)	M	55	23.00 (1)
				F	58	28.40 ± 1.27 (27.00-29.50) (3)
	Microhyla ornata	—	—	M	16	0.60 (1)
				F	19	0.70 (1)
Terrestrial Burrowing	*Ramanella variegata*	—	—	M	20	1.30 ± 0.14 (2) (1.20-1.40) (2)
				F	22	1.30 (2)
	Tomopterna rolandae	—	—	M	28	3.27 ± 0.26 (2.80-3.60) (8)
				F	31	4.02 ± 0.59 (3.00-4.60) (8)
Arboreal	*Polypedates maculatus*	—	—	M	40	5.65 ± 1.34 (4.70-6.60) (2)
				F	45	7.26 ± 1.04 (6.10-8.10) (3)
	Limnonectes limnocharis	20	1.06 ± 0.13 (22)	M	23	1.45 ± 0.23 (0.92-1.70) (18)
Semi-aquatic Jumping				F	27	2.17 ± 0.32 (1.50-2.70) (20)
	Hoplobatrachus tigerinus	—	—	M	105	170.00 (1)
				F	125	320.25 ± 0.35 (320.00-320.50) (2)
Aquatic Swimming	*Euphlyctis cyanophlyctis*	25	1.84 ± 0.255 (9)	M	33	3.87 ± 0.38 (3.20-4.50) (18)
				F	46	10.86±0.41 (10.40-11.20) (3)

M — Male
F — Female
SVL — Snout-Vent Length
BW — Body weight
Numbers in parentheses indicate the sample size.

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TINGIFAUNA OF SOUTHERN INDIA: DISTRIBUTION, HOST PLANTS, NATURAL ENEMIES AND GENERIC KEY[1]

David Livingstone, M.H.S. Yacoob, S. Jeyanthibai and A.R. Livingstone[2]

(*With one plate and two text-figures*)

Key words: Tingidae, southern India, distribution, host plants, egg parasitoids, generic key.

The pattern of distribution of 45 species belonging to 28 genera and 2 subfamilies of Tingidae of southern India, along with 56 species of their host plants and 5 species of their egg parasitoids, have been documented. Twenty species of tingids and four species of their egg parasitoids are new discoveries. Thirty two species of host plants are new records. Verbenaceous plants support a larger number of tingid species, whereas more species of Labiatae support the Ocimum tingid *Cochlochila bullita.* While *Tingis buddleiae* Drake is recorded only at 2500 m above msl, *C. bullita, Habrochila laeta* and *Teleonemia scrupulosa* occur at all elevations in this region throughout the year, *Teleonemia scrupulosa,* the Mexican Lantana lace bug, raises more than 12 generations in a year on *Lantana* weed and is well established in this region. *Paralleloptera polyphaga,* a mymarid egg parasitoid of more than twenty species of Tingidae, *Erythmelus empoascae,* also a mymarid egg parasitoid, *Lathromeromyia (lathromeromina) tingiphaga*, L (l.) *corythaumaii* and *Epoligosita* (*epoligositina*) *duliniae* of Trichogrammatidae have been reported as new. Generic key for 28 genera has been formulated.

Introduction

The Tingidae Laporte, commonly known as lace bugs and polyglottally known by different names in different countries, are relatively small (1.5 mm to 4.5 mm), phytosuccivorous cimicomorphs, with gorgeous lacy designs on their hemelytra. All the five instars and adults congregate underneath leaves, where they feed, moult, defecate and foul the area, causing chlorotic patches that betray their presence on the affected plant. Older instars move to more tender parts of the plant. The adults mate and insert their eggs into tender tissues such as mesophyll, tender stems, pistil and other floral parts, exposing only the operculum of the egg. With very few exceptions, all nymphal instars bear characteristic, species-specific body outgrowths (Plate 1) such as the tubercles that carry a tracheal branch (Livingstone, 1962 a & b, 1968, 1976 & 1978b). Only the cephalic tubercles are retained, as the loral, frontal, postgenal and antenniferous tubercles, in the adults. Species of *Copium* (*on Teucrium-Labiatae*) and *Paracopium* (*on Clerodendron*-Verbenaceae) are specialized cecidogenous anthophagous tingids, causing monolocular floral galls (Monad and Carayon, 1958; Drake and Mamet, 1961; Jaeger, 1976). Leaf curl galls are caused by *Corythauma ayyari* on *Jasminum* (Livingstone, 1962, 1977, 1978a). The mechanism of rotation of the eggs by 180° in the bursa, while ovipositing in the flower bud in gall - producing tingids, is still an unresolved question.

One of the earliest biocontrol agents tried in India at the Forest Research Institute, Dehradun, to control the mexican weed *Lantana,* is *Teleonemia scrupulosa* Stal, the Mexican Lantana lace bug, imported in 1941. The unfounded fear that this bug would become a

[1]Accepted May, 1995

[2]Division of Entomology, Department of Zoology, Madras Christian College, Tambaram, Chennai 600 059, India.

threat to teak plantations forced the FRI insectary management to destroy the entire culture stock in 1943 (Khan, 1945; Roonwal 1952, 1953); but a few escaped and established themselves in the adjacent hill range. Interestingly, this insect that raises hardly two to three generations in a year in north India is very successfully established on *Lantana* in southern India, raising more than 12 generations a year (Livingstone *et al.* 1980, 1981b). Livingstone (1961, 1978b), on the basis of the incidence of population and sweating phenomenon, categorized the Tingidae of northern India into summer and winter species.

While the Coconut lace bug *Stephanitis typica* (Mathen, 1960; Mathen and Kurian, 1972; Mathen *et al.*, 1972), the Ocimum lace bug *Cochlochila bullita* (Samuel, 1939; Sharga, 1953; Mohanasundaram and Rao, 1973); the Brinjal lace bug *Urentius hystricellus* (Patel and Kulkarny, 1955), the Jasminum lace bug *Corythauma ayyari* (Livingstone, 1977) and the Barleria lace bug *Habrochila laeta* (Mohanasundaram and Basheer, 1963; Asari, 1972) are known to be alarmingly serious pests of agriculture and horticulture, the rest of the species are not pests.

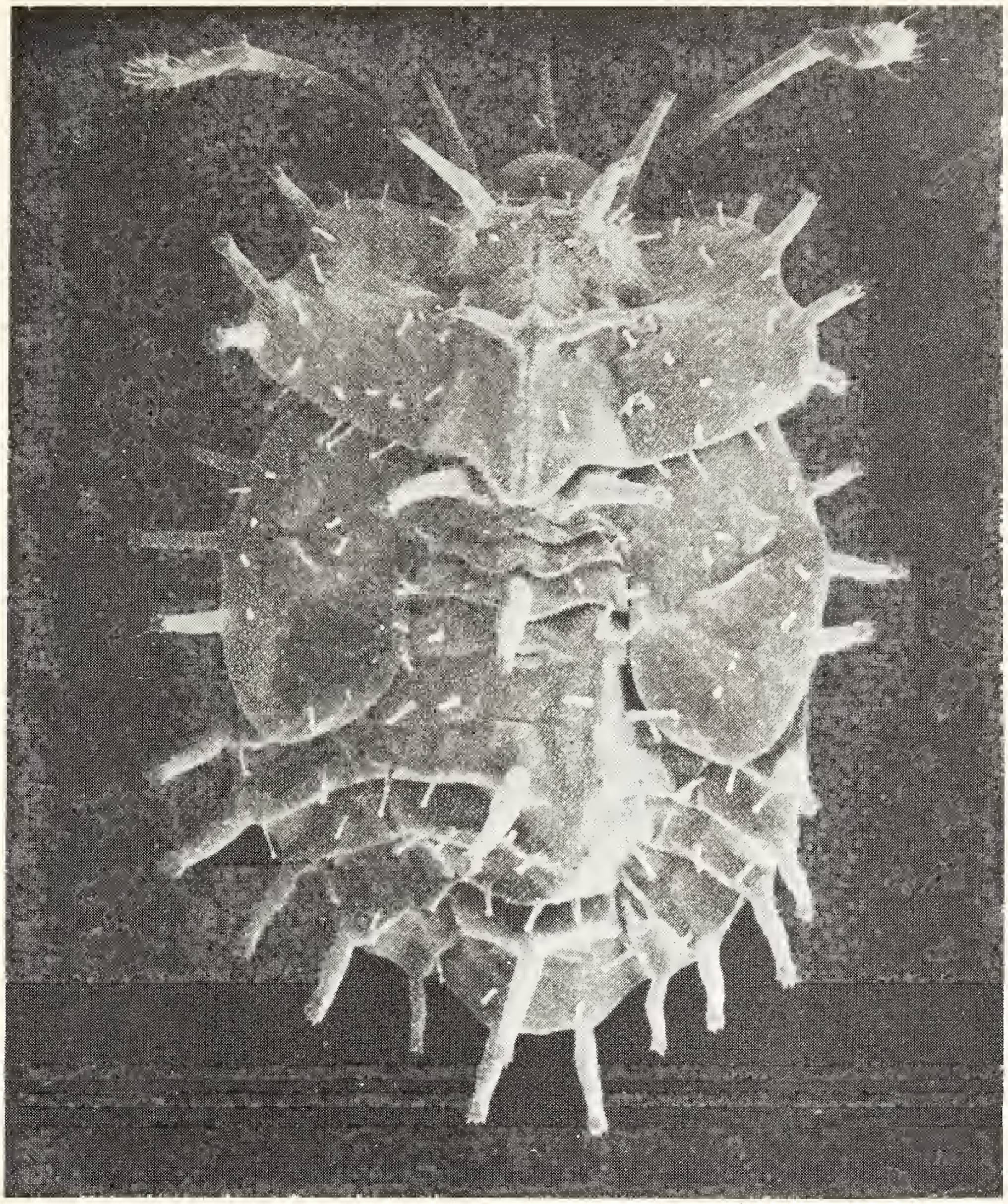
In their world catalogue of Tingidae, Drake and Ruhoff (1960, 1965) listed 1820 species belonging to 236 genera and 3 subfamilies. Of these, only 99 species of 49 genera and 2 subfamilies (Cantacaderinae and Tinginae) were known from India. The third subfamily Vianaidinae, whose members (4 species) are myrmecophilous, and whose nutritional and reproductive behaviours are not fully established, are not so far known from India. Since then, numerous species have been added from other parts of the world, mostly from the Ethiopian Region. After the publication of the taxonomic descriptions of 57 species of 30 genera and 2 subfamilies of Tingidae from India, Burma and Ceylon, by Distant (1904, 1910), the systematics of Oriental Tingidae has undergone substantial revision (Bergroth, 1911; Drake and Maa, 1953, 1954, 1955; Drake and Lutz, 1953). Menon and Hakk (1959a) reported a new subfamily called Phyllogastrotingis which was none other than the coreid *Craspidum*. Their (Menon and Hakk, 1959b) revision of the genus *Urentius*, with the addition of five more new species (*U. euphorbiae, U. indicus*; *U. pusaensis*; *U. sidae* and *U. ziziphifolius*), also was rejected as *nomen nudum* by Drake and Ruhoff (1965). Subsequently, Mohanasundaram (1962), Drake and Mohanasundaram (1961), Drake and Livingstone (1964), Livingstone (1972), Livingstone and Jayanthibai, 1993, 1994 a, b added more species to the checklist of Indian Tingifauna.

In most records, the host plants are "unrecorded". The first attempt in India to fill this lacuna was made by Livingstone (1961, 1962a) for north Indian species and subsequently by Mohanasundaram (1972) for a few South Indian species. The biology and population dynamics of not more than twenty Indian species are known (Iyengar, 1924; Samuel, 1939; Khan, 1945; Sharga, 1953; Patel and Kulkarny, 1955; Mathur, 1955, 1979; Mathen, 1960; Livingstone, 1959, 1968, 1976, 1978b; Livingstone *et al.*, 1980, 1981, 1982, 1983; Asari, 1972; Nair and Nair, 1974). The natural enemies of Tingidae in India have been identified by Livingstone (1962b, c, 1962, 1977); Mathen, Shantha and Kurien (1972), and the tingid egg parasitoids, representing Mymaridae and Trichogrammatidae (Hymenoptera) were reported by Livingstone and Yacoob (1982, 1987 a, b); Livingstone *et al.* (1982a, b).

In the present paper, we give primary importance to updating and documenting host plant records, and natural enemies of Tingidae and provide a key for the identification at least upto generic level.

1. Spatial Distribution

Ecosystem and altitude wise distribution of 45 species belonging to 28 genera and 2 subfamilies of Tingidae in the four southern states with more intensive survey of Tamil Nadu, are represented in Figs. 1 & 2 respectively. All are macropterous, performing short circled flights. *Cantacader*

1


2


1. Nymph of *Habrochila laeta*, Barleria tingid
2. *Stephanitis typica* nymph. Globules of tubercles

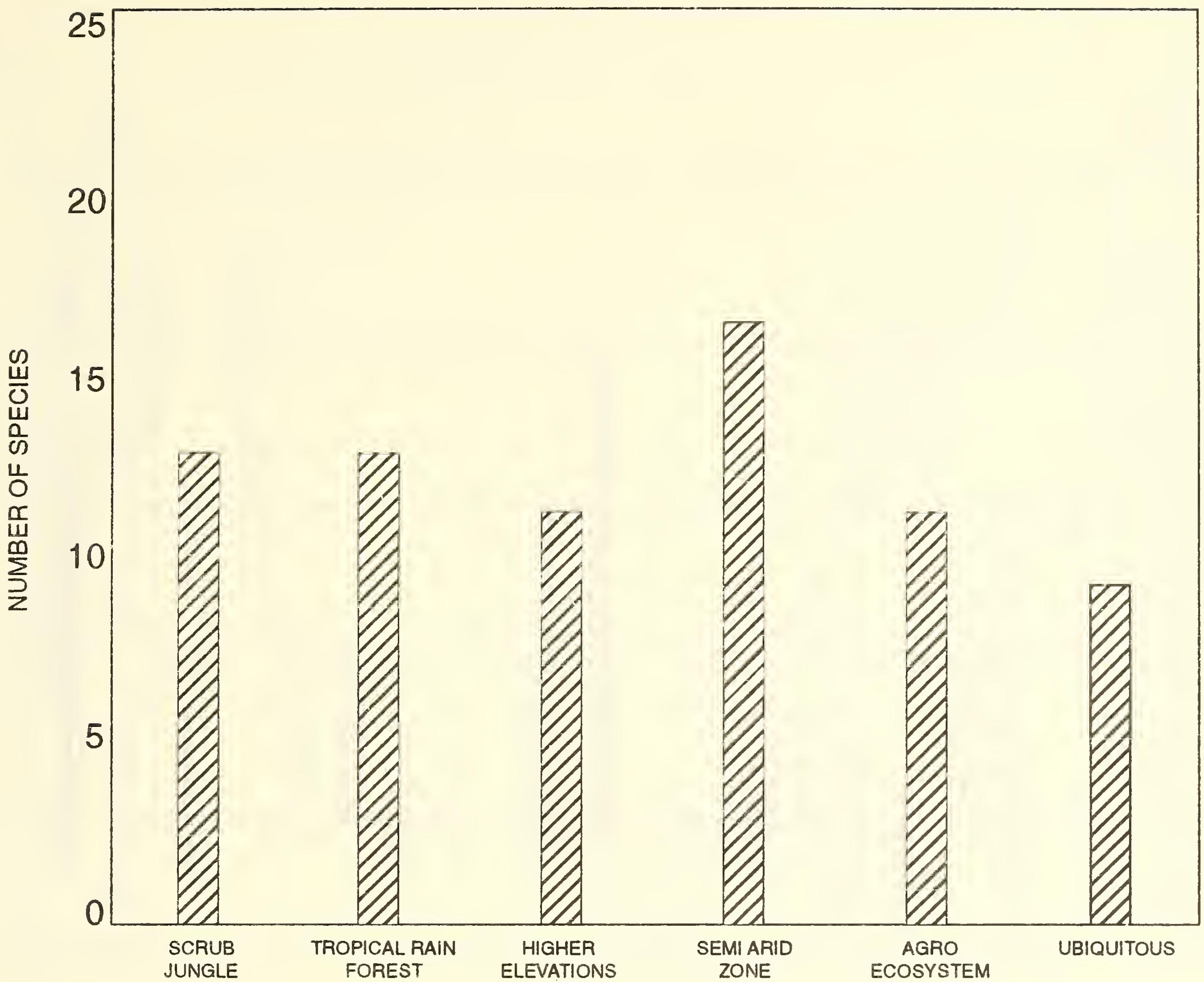


Fig. 1 Ecosystem-wise distribution of tingidae of southern India

quinquicostatus and *Balenus dentatus* are collected in light traps and their host plants are not known. In the former, no males are known and all specimens collected have been immature females. None of the known 30 spp. of *Cantacader* and 7 spp. of *Belenus* from the world have any host record and all were collected in light traps (Drake and Ruhoff, 1965; Livingstone 1972).

Every ecosystem has its representative tingifauna. The scrub jungle ecosystem that prevails in this region, extending from plains to moderate elevations, intervening agroecosystem and semiarid zones, records the maximum number of tingid species, the characteristic ones being *Afrotingis phanueli*, *Agramma therasii*, *Belenus dentatus*, *Cantacader quinquicostatus*, *Haedus grewii*, *Naochila nigra*, *Physatocheila asiatica* and *Tingis premnae*. The characteristic species of semiarid zone include *Agramma gramini*, *Ammiarus ravanus*, *Haedus manii*, and *Perissonemia ecmeles*. In the tropical rainforests more endemic species are recorded, namely *Corythauma gibbosa*, *Dictyla hessargattaensis*, *Eteoneous cinchonii*, *Haedus yacoobii*, *H. ruthii*, *Longiscutella menonii*, *Naochila minuta*, *Phatnoma costalis*, *Pontanus puerilis*, *Stephanitis charieis*, *S. cinnamomi* and *Tingis buddleiae*. The ubiquitous species include *Cochlochila bullita*, *Corythauma ayyari*, *Dulinius conchatus*, *Habrochila laeta*, *Phenotropis cleopatra*, *Stephanitis typica*, *Teleonemia scrupulosa*, *Urentius hystricellus* and *U. euonymus*.

Fig. 2 Vertical distribution of Tingidae and their parasitoids in southern India

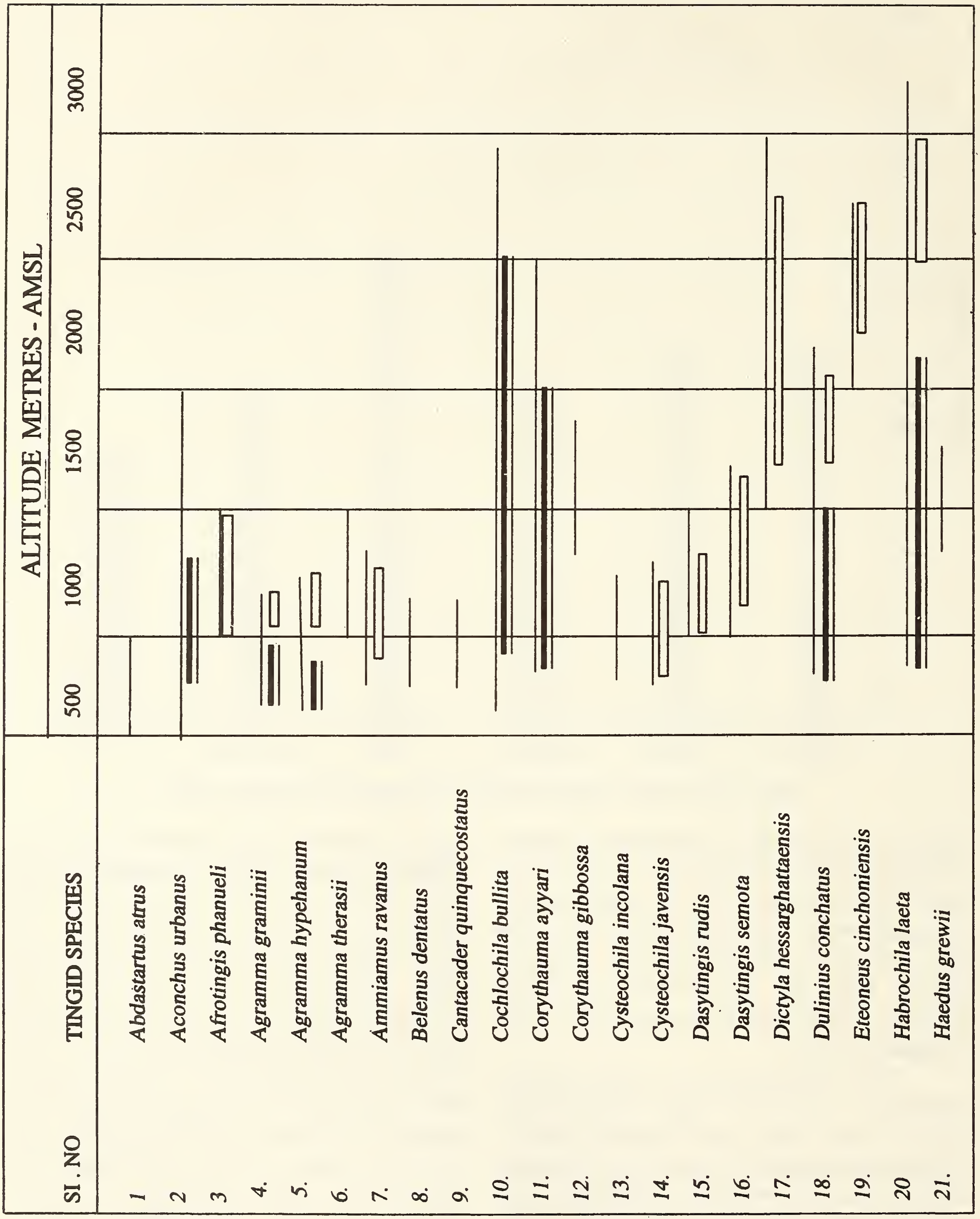


Fig. 2 *Contd.*

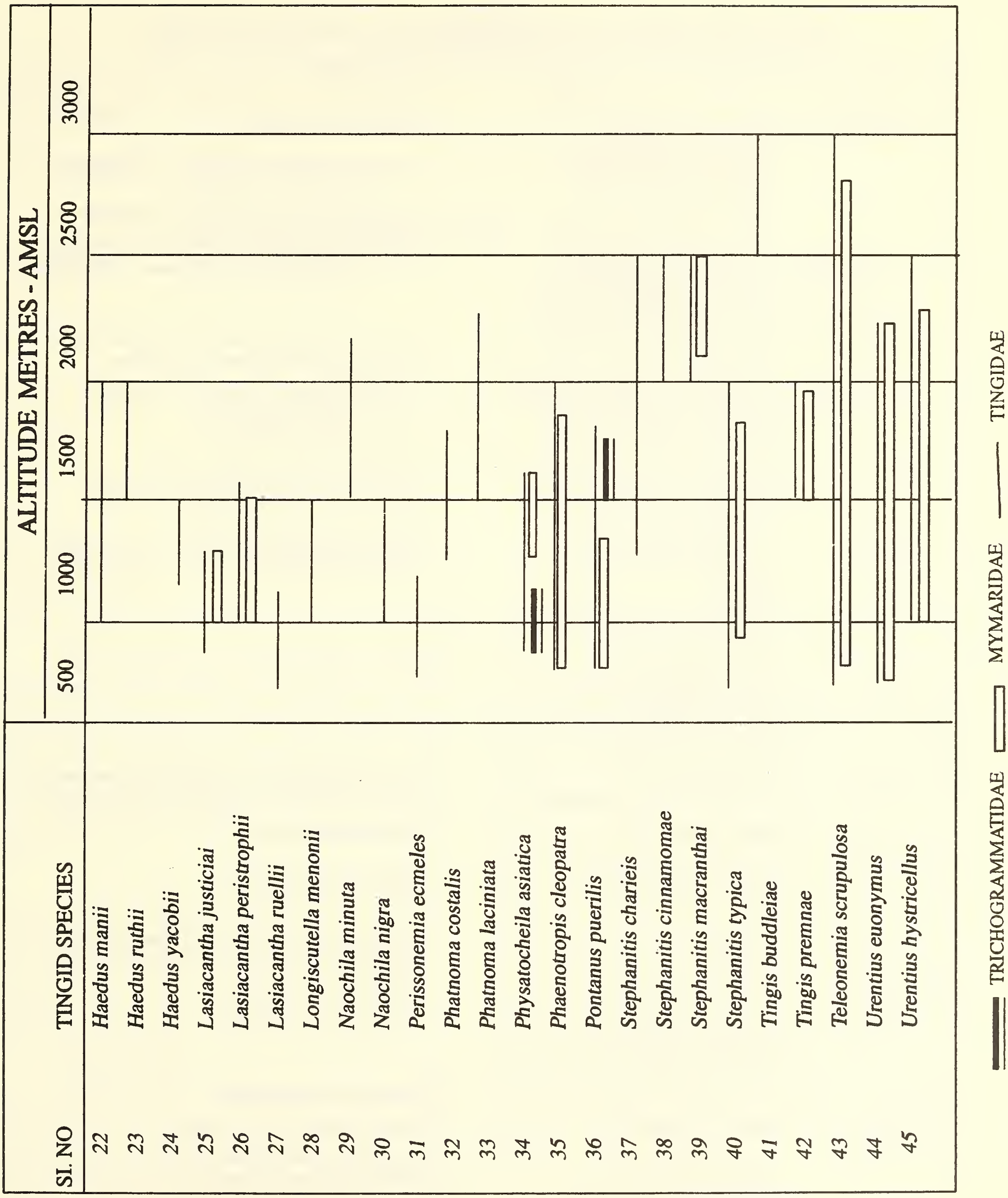

SI. NO
TINGID SPECIES
ALTITUDE METRES - AMSL
500
1000
1500
2000
2500
3000
22 Haedus manii
23 Haedus ruthii
24 Haedus yacobii
25 Lasiacantha justiciai
26 Lasiacantha peristrophii
27 Lasiacantha ruellii
28 Longiscutella menonii
29 Naochila minuta
30 Naochila nigra
31 Perissonemia ecmeles
32 Phatnoma costalis
33 Phatnoma laciniata
34 Physatocheila asiatica
35 Phaenotropis cleopatra
36 Pontanus puerilis
37 Stephanitis charieis
38 Stephanitis cinnamomae
39 Stephanitis macranthai
40 Stephanitis typica
41 Tingis buddleiae
42 Tingis premnae
43 Teleonemia scrupulosa
44 Urentius euonymus
45 Urentius hystricellus
TRICHOGRAMMATIDAE
MYMARIDAE
TINGIDAE

TABLE 1
HOST PLANT RECORDS OF SOUTH INDIAN TINGIDAE (* NEW HOST RECORDS)

S.No.	Host family	Host plant	Tingid species
1.	Acanthaceae	*Barleria cristata* Linn.	*Habrochila laeta* Drake
		**Barleria mysoriensis* Roth.	"
		**Justicia prostata* Gamble	*Lasiacantha justiciaii* Livingstone & Jeyanthibai
		**Justicia simplex* D. Don	"
		**Ruellia (Justicia) prostata* Poir	*Lasiacantha ruelli* Livingstone & Jeyanthibai
		**Peristrophe bicalyculata* Nees	*Lasiacantha peristrophi* Livingstone & Jeyanthibai
2.	Boraginaceae	**Cynoglossum denticulatum* A. DC var zeylanicum C.B.Clarke	*Dictyla hessarghattaensis* Livingstone & Jeyanthibai
		**Cynoglossum furocatum* Wall.	"
		**Carmona microphylla* (Lamk.) Don.	*Naochila minuta* Livingstone & Jeyanthibai
		**Ehretia* sp.	*Naochila nigra* Livingstone & Jeyanthibai
3.	Euphorbiaceae	**Acalypha alnifolia* Klein ex Willd.	*Afrotingis phanueli* Livingstone & Jeyanthibai
		**Chryzophora rottleri* A. Juss.	*Urentius euonymus* Distant
4.	Graminae	**Chrysopogon fulcrus* (Spreng) Chiov.	*Aconchus urbanus* (Horvath)
		"	*Agramma hupehanum* (Drake & Maa)
		**Chrysopogon verticillatus* (Roxb)	*Agramma gramini* Livingstone & Jeyanthibai
		Saccharum officinarum Linn.	*Abdastartus atrus* (Motschulsky)
5.	Labiatae	**Colebrookea* sp.	*Eteoneus cinchonaensis* Livingstone & Jeyanthibai
		**Hyptis suaveolens* Poit.	*Cochlochila bullita* (Stal)
		Mentha sp.	"
		**Moschosma polystachyum* Benth.	"
		Ocimum basilicum Linn.	"
		Ocimum canum Sims.	"
		Ocimum gratissimum Linn.	"
		Ocimum sanctum Linn.	"
		**Orthosiphon glatratus* (Benth.)	"
		**Salvia coccines* Linn.	"
6.	Lauraceae	**Cinnamomum* sp.	*Stephanitis cinnamomae* Livingstone & Jeyanthibai
		**Persea macrantha* (Nees) Kostreum	*Stephanitis macranthai* Livingstone & Jeyanthibai
7.	Loganiaceae	*Buddleia asiatica* Linn.	*Tingis buddleiae* Drake
8.	Malvaceae	**Hibiscus rosa sinensis* Linn.	*Phatnoma costalis* Distant
		**Pavania zeylanica* Cav.	*Urentius euonymus* Distant
		Sida sp.	"
9.	Moraceae	*Artocarpus integrifolia* Linn.	*Stephanitis charieis* Drake & Mohanasundaram
		Ficus sp.	*Pexissonemia ecmeles* Drake & Mohanasundaram
10.	Musaceae	*Musa paradisiaca* Linn.	*Stephanitis typica* (Distant)
11.	Oleaceae	**Jasminum cardifolium* Wall.	*Corythauma ayyari* (Drake)
		Jasminum rigidum Zenk.	"
		Jasminum sambac Ait.	"
12.	Palmae	*Cocos nucifera* Linn.	*Stephanitis typica* (Distant)
13.	Papilionaceae	*Tephrosia purpurea* Pers.	*Phaenotropis cleopatra* (Horvath)
14.	Rubiaceae	**Borreria hispida* K.Sch.	*Cysteochila javansis* Drake & Poor
		**Morinda citrifolia* Linn.	*Dulinius conchatus* (Distant)
		Morinda tincotoria Roxb.	"
15.	Sterculiaceae	**Pterospermum obtusifolium* Wight	*Haedus ruthii* Livingstone & Jeyanthibai

TABLE 1 (*contd.*)
HOST PLANT RECORDS OF SOUTH INDIAN TINGIDAE (* NEW HOST RECORDS)

S.No.	Host family	Host plant	Tingid species
16.	Solanaceae	*Solanum melongena* Linn.	*Urentius hystricellus* (Richter)
		Solanum torvum Swartz.	"
		Solanum trilobatum Linn.	"
		Solanum xanthocarpum Schrad & Wendal	"
17.	Tiliaceae	**Grewia villosa* Wild	*Haedus grewii* Livingstone & Jeyanthibai
		**Triumfetta pilosa* Roth	*Haedus yacoobi* Livingstone & Jeyanthibai
			Longiscutella menoni Livingstone & Jeyanthibai
18.	Verbenaceae	*Gmelina asiatica* Linn.	*Physatocheila asiatica* Livingstone & Jeyanthibai
		Lantana camara Linn.	*Teleonemia scrupulosa* Stal
		**Premna tomentosa* Wild.	*Tingis premnae* Livingstone & Jeyanthibai
		Tectona grandis Linn.	*Pontanus puerilis* (Drake & Poor)
		**Vitex negundo* Linn.	*Ammianus ravanus* (Kirkaldy)
			Dasytingis rudis Drake & Poor
			Dasytingis semota Drake & Lutz
		**Vitex trifolia* Linn.	*Dasytingis rudis* Drake & Poor
		"	*Dasytingis semota* Drake & Lutz
19.	Zingiberaceae	*Elettaria cardamomum* Maton	*Stephanitis typica* (Distant)

* New Host records

Most species occur in the plains and lower elevations below 2000 m above msl *Eteoneus cinchonii, Stephanitis cinnamomii, S. macranthii* and *Tingis buddleiae* occur at more than 2000 m above msl whereas, *Cochlochila bullita, Dictyla hessargattaensis, Habrochila laeta* and *Teleonomia scrupulosa* occur at all elevations.

No gall making tingids are known from this region, even though *Clerodendron* spp. are found at all elevations. The mymarid egg parasitoids are recorded at all elevations, whereas the trichogrammatid egg parasitoids occur in lower elevations (Fig. 2).

All species of Tingidae from southern India were found to be multivoltine, occurring throughout the year at varying population densities. Heavy rains wash away the life stages, even though they remain concealed underneath leaves and other parts of plants that become charred and crinkled during heavy infestation. Congregational feeding is a rule and positively geotactic behaviour among the grass tingids such as *Agramma* spp. and *Aconchus urbanus* is common. Almost all collections of these two genera were made from congregates in root mesh in loose, moist soil. Falling from twigs, feigning death and swift running towards the base of the stem when disturbed, are some of the evasive behaviour patterns of these bugs. Jerky movement characterise *Haedus* and *Lasiacantha* species. Body outgrowths of nymphal instars (Plate 1) secrete an adhesive substance for the arhenaceous materials, promoting camouflaging behaviour (Livingstone, 1976). The spreading rate of these bugs from one plant to another and from one region to another, apparently varies from about 4 km a year (Roonwal, 1952) in northern India to several kms, as in *Teleonemia scrupulosa* in southern India.

2. Host plants and host specificity

The largest number of species of tingids (130 spp.) so far recorded from all over the world, are on Leguminaceae (87 spp.), and the largest

TABLE 2
OCCURRENCE OF PARASITOIDS OF THE TINGID EGGS IN SOUTHERN INDIA

	Parasitoids	Host tingids	Host Plants
	MYMARIDAE		
a.	*Parallelaptera polyphaga* Livingstone & Yacoob	1. *Afrotingis phanueli*	*Acalypha* alnifolia Klein ex Willd
		2. *Agramma gramini*	*Chrysopogon verticillatus* Roxb.
		3. *Agramma hupahanum*	*Chrysopogonfulcrus* (Spreng) Chiov
		4. *Cochlochila bullita*	*Ocimum canum* Sims *Ocimum sanctum* Linn. *Ocimum basilicum* Linn.
		5. *Cysteochila javensis*	*Borreria hispida* & K.Sch.
		6. *Dasytingis rudis*	*Vitex negundo* Linn.
		7. *Dasytingis semota*	*Vitex trifolia* Linn.
		8. *Dictyla karnatica*	*Cynoglossum denticulatum* A.DC var. *zeylanicum* C.B. Clarke
		9. *Dulinius conchatus*	*Morinda tinctoria* Linn. *Morinda citrifolia* Linn.
		10. *Eteoneus cinchoniensis*	*Colebrookea* sp.
		11. *Habrochila laeta*	*Barleria cristata* Linn.
		12. *Lasiacantha justiciaii*	*Justicia prostata* Gamble
		13. *Lasiacantha peristrophii*	*Peristropha bicalyculata* Nees.
		14. *Lasiacantha ruellii*	*Ruellia (Justicia) prostata* Poir.
		15. *Phaenotropis cleopatra*	*Tephrosia purpurea* Pees.
		16. *Physatocheila asiatica*	*Gmelina asiatica* Linn.
		17. *Stephanitis macranthai*	*Persea macrantha*
		18. *Stephanitis typica*	*Cocos nucifera* Linn. *Musa paradisiaca* Linn.
		19. *Teleonemia* scrupulosa	*Lantana camara* Linn.
		20. *Tingis premnae*	*Premna tomentosa* Wild.
		21. *Urentius euonymus*	*Chrysophora rottleri* A. juss. *Pavania zeylanica* Cav. *Sida* sp.
		22. *Urentius hystricellus*	*Solanum melongena* Linn. *Solanum torvum* Swratz. *Solanum trilobatum* Linn. *Solanum xanthocarpum* Schrad & Wendl.
b.	*Erythmelus empoascae* Subba Rao	1. *Ammianus ravanus*	*Vitex negundo* Linn.
		2. *Pontanus puerilis*	*Tectona grandis* Linn.
		3. *Teleonemia scrupulosa*	*Lantana camara* Linn.

number of recorded species (98) of host plants belong to Compositae, that hosts 75 spp. of tingids. Only 33 species of tingids are known to be species specific, (Drake and Ruhoff, 1965).

In the present survey (Table 1) 45 species of tingids belonging to 28 genera and 2 subfamilies, are recorded on 58 species of host plants from 44 genera and 19 families; Verbenaceae is found to be the most favoured of all. As these bugs are poor fliers, host preference is detectable only when several plants of the same host species occur among several other species in the same locality at the same time. *Cochlochila bullita* is specific to the genus *Ocimum*, but it prefers *O. canum*, when all other species such as *O. sanctum*, *O. basilicum* and *O. gratissimum* are

TABLE 2 (*contd.*)
OCCURRENCE OF PARASITOIDS OF THE TINGID EGGS IN SOUTHERN INDIA

	Parasitoids	Host tingids	Host Plants
	TRICHOGRAMMATIDAE		
a.	*Lathromeromyia* (l) *tingiphaga* Livingstone & Yacoob	1. *Aconchus urbanus*	*Chrysopogon fulcrus* (Spreng) Chiov.
		2. *Agramma graminii*	*Chrysopogon verticillatus* Roxb.
		3. *Agramma hupehanum*	*Chrysopogon fulcrus* (Spreng) Chiov.
		4. *Cochlochila bullita*	*Ocimum canum* Sims. *Ocimum sanctum* Linn. *Ocimum basilicum* Linn. *Mentha* sp.
		5. *Habrochila laeta*	*Barleria cristata* Linn.
b.	*Lathromeromyia* (1) *corythaumaii* Livingstone & Yacoob	1. *Corythauma ayyari*	*Jasminum cordifolium* Walk. *Jasminum rigidum* Zenk. *Jasminum sambac* Ait.
c.	*Epoligositae* (*e.*) *duliniae* Livingstone & Yacoob	1. *Dulinius conchatus*	*Morinda tinctoria* Linn. *Morinda citrifolia* Linn.
		2. *Physatocheila asiatica*	*Gmelina asiatica* Linn.

also present in the same locality. Spreading occurs only in the event of *O. canum* being completely destroyed and when the other species of *Ocimum* are not in the vicinity, they spread on adjacent plants of Labiatae such as *Mentha, Salvia, Orthosiphon, Hyptis, Moschosma* etc., and raise one or two generations on them.

Similarly, *Corythauma ayyari* is specific to *Jasminum* sp. But it rarely attacks *J. primulium* and *J. grandiflorum*, when heavy infestation occurs on *J. sambac, J. multiflorum* and *J. pubescens* that grow in the same locality and elsewhere. While *Urentius hystricellus* is confined only to Solanaceae, with specific preference to *Solanum melongena, Urentius euonymus* that enjoys a permanent abode on the perennial, *Abutilon indicum,* attacks several other malvaceous annuals as well as *Chrysophora rottleri* of Euphorbiaceae. Most other species have been found to be host specific.

Plot effect characterises tingid attack in this region. By this, several bushes of the same locality and adjacent localities remain refractile to tingid attack when a bush in the middle remains susceptible and subjected to heavy attack. Plot effect in Tingidae is reported by Livingstone (1962c, 1968,1977), Asari (1972), Harley *et al.* (1979) and Livingstone *et al.* (1981b). It is difficult to ascribe the status of a primary host plant in the context of polyphagy because nothing deters this bug from raising one or two generations on any host plant that it invades during heavy infestation, and diapause phenomenon is not yet known in these bugs in this temperate region. Khan (1945) tried forced feeding of *Teleonemia scrupulosa* on teak leaves and reported that such nymphs never completed development.

Several species of a genus of different genera of host plants are simultaneously attacked by different species of the same genus of tingids, *Lesiacantha justiciaii, L. peristrophic* and *L. ruellii* are found on *Justicia prostata, Justicia simplex, Peristropha bicalyculata* and *Ruellia prostata*, all are members of the family Acanthaceae. Similarly, *Naochila nigra* and *N. minuta* attack *Ehretia* sp. and *Carmona microphylla* respectively, of the family Boraginaceae. Diverse species of diverse genera of tingids are also found on plants of the same genus. The grass tingids such as *Aconchus urbanus*, *Agramma gramini* and *Agramma hupehanum* are found on the grass *Chrysopogon fulerus*, *C. verticullatus* and *C. fulerus* respectively. More than one species of tingids concurrently attacking the same host plant is also common. *Dasytingis rudis*, *D. semota* and *Ammianus ravanus* are found affecting *Vitex negundo* at different localities at the same time. *Headus yacoobii* and *Longiscutella menonii* are found concurrently on the same host plant *Triumfetta pilosa*.

3. Natural enemies

The list of the natural enemies of Tingidae does not appreciate much in space and time, being variable regionwise and countrywise. Coleopteran, neuropteran, thysanopteran, dermapteran, heteropteran and acarinid predators as well as brachonid, mymarid and trichogrammatid parasitoids have been reported on stray cases of tingids by a few authors. Larvae and adults of *Coccinella* spp. (Coccinellidae); *Chrysopa* spp. (Neuroptera); *Stethoconus praefactus/Apollodotus praefactus* (Miridae) and *Xystieus cristatus* (Acarinidae) have been recorded as predators of economically important species of Tingidae in India by Mathen, Shantha and Kurien, (1972) and Livingstone, (1968). Among the five chalcidoid egg parasitoids so far recorded in this region (Table 2), the mymarid *Erythmelus empoascae* Subba Rao, originally reported as an egg parasitoid of Jassidae, is now known to be an egg parasitoid of the teak tingid, *Pontanus puerilis*, Lantana tingid *Teleonemia scrupulosa* and the Vitex "giant" tingid, *Ammianus ravanus*, all three of which have long operculate eggs. The second mymarid *Parallelaptera polyphaga* Livingstone & Yacoob is highly polyphagous, so far recorded on no less than 22 species of Tingidae, at all elevations. Polymorphism of the female genitalia, corresponding to the opercular height of the host egg, has been considered as convincing evidence of biodiversity in parasitoid-host relationship (Livingstone and Yacoob 1986). The three species of trichogrammatid egg parasitoids are:- *Lathromeromyia* (*lathromeromina*) *tingiphaga* Livingstone & Yacoob, which is predominantly found on grass tingids such as *Aconchus urbanus*, *Agramma hupehanum* and *A.graminii*, as well as on the Barleria tingid, *Habrochila laeta* and the Ocimum tingid *Cochlochila bullita; Lathromeromyia* (*lathromeromina*) *corythaumai* Livingstone & Yacoob which is specific to the Jasmine tingid, *Corythauma ayyari* and *Epoligosita* (*epoligositina*) *duliniae* Livingstone & Yacoob which is specific to the Morinda lace bug, *Dulinius conchatus*. Parasitised tingid eggs always exhibit the characteristic development of the compound eyes and the ocelli of the pupating parasitoid at the cephalic end and the accumulation of the meconium at the caudal end.

GENERIC KEY FOR THE IDENTIFICATION OF THE SOUTH INDIAN TINGIDAE

a. Subfamily: Cantacaderinae Stal
Stenocostal area present, cephalic tubercles 4 in number; bucculae far exceeding the limit of the head .... *Cantacader* Amyot & Serville
— Stenocostal area absent: 7 porrect cephalic .... *Phatnoma* Fiebr.

b. Subfamily: Tinginae Laporte
1. Cephalic tubercles either absent or reduced to not more than three nodules; paranotum present or absent; pronotum either with median carina or with very much reduced median and lateral carinae 2
— Cephalic tubercles always five in number; paranotum either reduced or highly expanded: pronotal hood either absent or highly expanded 3
2. Cephalic tubercles absent: pronotum with lateral spine; paranotum absent .... *Eteoneus* Distant
— Cephalic tubercles reduced to a single pair of nodules (loral pair): either small or large in size; paranotal expansion wanting: pronotum with only a median carina; hemelytra without tumid elevations 2a
— Cephalic tubercles 3: moderately tuberculate; small to median size; paranotal expansion well developed and reflexed back upon the pronotum

with varying degrees of complexity: cephalic hood present or absent: hemelytra with tumid elevation: median carina well formed, often concealed by the paranotal expansion, lateral carinae moderately developed 2b

2a. Minute to small, antennae short, the first flagellar segment not exceeding double the length of the terminal segment, often setaceous; body elongate; hemelytra without any markings .... *Agramma* Stephens

— Body oval, hemelytra with dark patch .... *Afrotingis* Drake & Hill

— Larger size: more elongated, antennae very long, the first flagellar segment more than three times longer than the terminal segment, almost bare; distinct cell present .... *Perissonemia* Drake & Poor

2b. The paranotal expansion completely reflexed back and completely covering the pronotum on either side of the median carina; pronotal hood moderately developed; bucculae not prominently projecting anteriorly beyond the level of the head; minute to medium size; discoidal area vesicular .... *Naochila* Drake

— Paranotal expansion reflexed but not completely covering the pronotum on either side of the median carina 2c

2c. Paranotal expansion reflexed and almost reaching the pronotum, leaving a narrow space on either side of the median carina; discoidal area with only tumid elevation; bucculae anteriorly protruding beyond the level of the head: moderately large .... *Dictyla* Stal

— Paranotal expansion developing as a vesicle but not touching the pronotum: the median carina hairy, not forming vescile anteriorly the lateral carina uniseriate but concealed by the paranotal vesicle; 2 tumid elevations along the radial vein .... *Cochlochila* Stal

3. Pronotal hood present; paranotal expansion well developed and elaborately expanded 4

— Pronotal hood absent: paranotal expansion either absent or when present broadly expanded 5

4. Pronotal hood laterally compressed and moderately gibbose, elongate, extending beyond the base of the head; paranotal expansion earlobe-like, uniseriate or multiseriate 6

— Pronotal hood moderately bulbous: paranotal expansion multiseriate, not extending beyond the base of the head. 7

— Pronotal hood enormously gibbose: paranotal expansion uniformly broad, vertically uniseriate or multiseriate and reflexed back on the pronotum and often extending beyond the base of the head 8

5. Paranotal expansion absent or narrow and uniseriate: cephalic tubercles either prominently stout or slender 5a

— Paranotal expansion broadly expanded or foveated: cephalic tubercles conspicuously spinous: hemelytra angulate 5b

5a. Paranotal expansion absent, only median carina present and the pronotum darkly punctate: cephalic tubercles very feeble .... *Phaenotropis* Horvath

— Paranotal expansion uniseriate: pronotum tricarinate, each carination uniseriate; hemelytra bare or with spines: cephalic tubercles prominently elongate 5c

5b. Paranotal expansion broadly expanded anteriorly with spines on the anterior margin, otherwise with long non-pedicellate hairs .... *Belenus* Distant

— Paranotal expansion deflected back opposed in the pronotum of either side of the median carination and transversely foveated: body dorsally clothed with sharp pedicellate spines .... *Urentius* Distant

5c. Antennal segment highly setose: flagellar segments stout: hemelytral constriction not well defined: body moderately elongate .... *Teleonemia* Costa

— Antennal segment very slender and elongate: body slim and much elongated with prominent subapical constriction of hemelytra: paranotum anteriorly pointed reaching the eye 5d

5d. Body very much elongated: bare, lacking spines: legs very long; with spatulate hairs on the distitarsus .... *Abdastartus* Distant

— Body moderately elongate, clothed with both decumbent and punctate hairs: ommatidia with setal combs: pterostigma on the radial vein may or may not present .... *Haedus* Distant

6. Paranotal expansion earlobe-like vertically uniseriated: pronotal median carina laterally compressed anteriorly and sharply pointing, extending beyond the head; the median carina and scutellum together forming vesicle: hemelytral areolations much limited in number with tumid elevations in the discoidal area: body non-spinous .... *Aconchus* Horvath

— Paranotal expansion broadly expanded, multiseriate; median carina deeply constricted in the middle, anteriorly developed into moderately expanded vesicle and posteriorly into vertical multiseriate plate; lateral carinae raised, uniseriate; hemelytra subapically constricted and body clothed with pedicellate spines .... *Lasiacantha* Stal

7. Middle region of the paranotal expansion developed into a transversely elongate multiseriate plate; hood more prominent; largest known among tingids; subcostal area multiseriate: hemelytra banded in the middle and the sutural area pigmented .... *Ammianus* Distant (largest species recorded in S. India)

— Paranotal expansion either gradually enlarged in the middle or uniformly broad 7a

— Paranotal expansion deflected back and fused along the margin of the pronotum; the head and pronotum beset with stramineous hairs .... *Physatocheila* Fieber

7a. Paranotal expansion moderately prominent only in the middle; the hemelytra banded in the middle and the sutural area pigmented: large in size .... *Dasytingis* Drake & Poor

— Paranotal expansion broad, marginally wavy and dentate: multiseriate or slightly reflexed on the pronotum and then deflexed vertically 7b

7b. Paranotal expansion broad; multiseriate and marginally wavy and dentate; body bare .... *Pontanus* Distant

— Paranotal expansion slightly reflexed on the pronotum and then deflexed vertically, body tomentouse; areolae with cartwheel arrangement of hairs .... *Tingis* Fabricius

8. Paranotum vertically uniseriate or 2-3 areolae thick, hemispherical or earlobe-like or broadly expanded extending beyond the eye; hemelytra with tumid elevation or vesiculate 8a

Paranotum either narrow and transversely uniseriate or broad and multiseriate: median carina constricted behind the anterior hood or not constricted or terminating midway 8b

8a. Paranotal expansion auricular or hemispherically expanded: discoidal area or discoidal and radial area together forming vesicle: lateral carinae expanded or not visible: median carina posteriorly expanded with the scutellum or not 8c

— Paranotal expansion broad and anteriorly extending upto the eye; median carina not forming any hood behind the anterior vesicle; lateral carinae short and reduced; radial area vertically disposed .... *Stephanitis* Stal

8b. Paranotal expansion broad and multiseriate: median carina constrictd in the middle and posteriorly extending along with the scutellum far beyond the middle of the discoidal area; body almost bare .... *Longiscutella* Livingstone & Yacoob.

— Paranotal expansion narrow and uniseriate or multiseriate and reflexed; median carina not constricted and scutellum not extending beyond the anterior half of the discoidal area 8d

8c. Paranotum hemispherically expanded: median carina posteriorly not expanded but the lateral carinae expanded and meeting above the median carina: forming a vesicle. concealing the entire scutellum, discoidal area alone vesicular .... *Dulinius* Distant

— Paranotum auricular, median carina anteriorly and posteriorly forming vesicles; the posterior one completely concealing the scutellum: the lateral carinae absent; discoidal and radial areas together forming the vesicle .... *Habrochila* Horvath

8d. Paranotal expansion narrow, uniseriate, the anterior hood of the median carina almost completely concealing the head; scutellum obtusely pointed ...... *Corythauma* Drake & Poor

— Paranotol expansion multiseriate and reflexed, covering the pronotum lateral to the lateral carination .... *Cysteochila* Stal

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SPECIES COMPOSITION, SEASONAL VARIATION, SEX RATIO AND BODY LENGTH OF SMALL CETACEANS CAUGHT OFF WEST, SOUTH-WEST AND SOUTH COAST OF SRI LANKA[1]

Anouk Ilangakoon[2]

(*With three text-figures*)

Key words: species composition, seasonal variation, sex ratio, cetaceans

The present study on small cetacean catches in Sri Lanka was undertaken in an attempt to fill atleast some of the many gaps in the knowledge regarding the interaction between small cetaceans and the fisheries industry in Sri Lanka. The study concentrated on data from four selected sites on the west, southwest, south coasts of Sri Lanka and species composition, seasonal trends, sex ratios and size categories occurring in the catch are discussed. The study recorded a total of 14 species in the catch and found *Stenella longirostris* to be the most abundantly caught species at all sites. Contrary to the results of previous short term studies, the post-monsoonal period from the end of August to November was the season when peak catches were recorded at all sites selected for data collection. Sex composition and length frequency distribution were comparatively analysed for the four major species in the catch, bringing out certain interesting trends which may be a cause for concern. The practice of deliberate harpooning was found to account for a sizable proportion of the small cetacean catch while the practice itself seems to be spreading to new areas.

Introduction

Very little information is available on the species composition of small cetaceans around Sri Lanka although they inhabit these waters. The first known record of a cetacean in Sri Lanka was by Emerson Tennent (1859). Dolphins had been hunted and eaten by local populations since early days. Nevill (1887), reports of a dolphin fishery that existed in Ceylon in the late 1880's. Recent studies on the accidental take of small cetaceans around Sri Lanka are limited to short term studies at a few fish landing sites along the west and east coasts. Prematunga *et al* (1985), concentrated on the landed catch at Trincomalee on the east coast and recorded 11 species, having examined 398 specimens. Joseph *et al.* (1983) undertook a four month study at the Negombo fish landing site on the west coast and recorded 5 species, having examined 33 specimens. Alling (1985b) examined the catch at three landing sites, namely Beruwala (west coast), Valaichenai and Trincomalee (east coast), recorded 11 species and estimated nearly 40,000 small cetaceans being landed in Sri Lanka's fishery annually. Joseph and Siddeek (1985) recorded 11 species from the catch at Beruwala and Negombo (west coast) and estimated an annual catch rate of only 9,129 small cetaceans in Sri Lanka. Leatherwood (1986) and Leatherwood and Reeves (1989) report on all aspects of small cetaceans in Sri Lanka, including historical data, sightings at sea, stranding and observations at fish landing sites and markets all around the island.

Though only preliminary figures are available, it is evident that the accidental by-catch of small cetaceans has been increasing since the mechanisation of the fishing fleet and the introduction of synthetic gillnets in the late 1960's.

[1] Accepted October, 1995

[2]Director Field Studies, Fauna International Trust,
218/1 Bauddhaloka Mawatha, Colombo 7, Sri Lanka

Material and Methods

From May 1985 to December 1988, four commercial fish landing sites, namely Negombo, Beruwala, Mirissa and Kottegoda were visited once a fortnight and the species composition of small cetaceans in fishing boats was sampled. Species were identified based on Watson (1981) and Leatherwood and Reeves (1983). Species composition, total body length and sex were recorded. Further, the number of small cetaceans killed by harpooning was also noted by observing harpoon marks on the animals. The area of gillnetting and harpooning was recorded by questioning the fishermen. The stretched mesh size of the gillnets, the number of pieces in each net, their height, number of hours spent fishing etc. were also recorded.

In Sri Lanka a variety of boats ranging from 510 cm fibreglass boats with outboard engines to fully mechanised 780 - 960 cm boats operate, to fish for pelagic species such as tuna, shark, marlin and skipjack, using gillnets (stretched mesh size 125 mm), pole and lines, long lines and trolling. Hand held harpoons are used in some areas for direct take, of small cetaceans from mechanised boats.

Results

Species Composition

Fourteen species were identified from the four landing sites (Table 1). *Stenella longirostris* was the dominant species in the catch at all sampling stations. The maximum number of species recorded at a station was 11, for both Negombo and Mirissa, and the minimum was 7 at Kottegoda.

Stenella longirostris constituted 51.4% of the total recorded catch at all stations together and *S. coeruleoalba* 13.9%, *Tursiops truncatus* 9.3%, *S. attenuata* 9.0%, *Grampus griseus* 5.5%, *Peponocephala electra* 4.1%, respectively. Each of the remaining 8 species constituted less than 2.0%.

Table 1
NUMBER OF SPECIMENS RECORDED FOR EACH SPECIES

Species	St.1	St.2	St.3	St.4	Total	%
Stenella longirostris (Spinner Dolphin)	39	75	55	19	188	51.4%
Stenella coeruleoalba (Striped Dolphin)	7	22	10	12	51	13.9%
Tursiops truncatus (Bottle-nose Dolphin)	8	9	17	—	34	9.3%
Stenella attenuata (Spotted Dolphin)	5	7	19	2	33	9.0%
Grampus griseus (Risso's Dolphin)	4	10	4	2	20	5.5%
Peponocephala electra (Melon-headed Whale)	7	5	2	1	15	4.1%
Kogia simus (Dwarf Sperm Whale)	2	2	—	1	5	1.4%
Steno bredanensis (Rough-toothed Dolphin)	2	1	2	—	5	1.4%
Lagenodelphis hosei (Fraser's Dolphin)	1	—	3	—	4	1.1%
Feresa attenuata (Pygmy Killer Whale)	—	1	2	1	4	1.1%
Pseudorca crassidens (False Killer Whale)	—	1	2	—	3	0.8%
Delphinus delphis (Common Dolphin)	—	—	2	—	2	0.5%
Kogia breviceps (Pygmy Sperm Whale)	1	—	—	—	1	0.3%
Orcinus orca (Killer Whale)	1	—	—	—	1	0.3%

* St.1=Negombo St.2=Beruwala St.3=Mirissa St.4=Kottegoda

Seasonal Variation

The seasonal distribution of catches, according to station, is shown in Fig. 1. Negombo showed year round catches with zero catch only in June and a catch peak in October. Two sub-

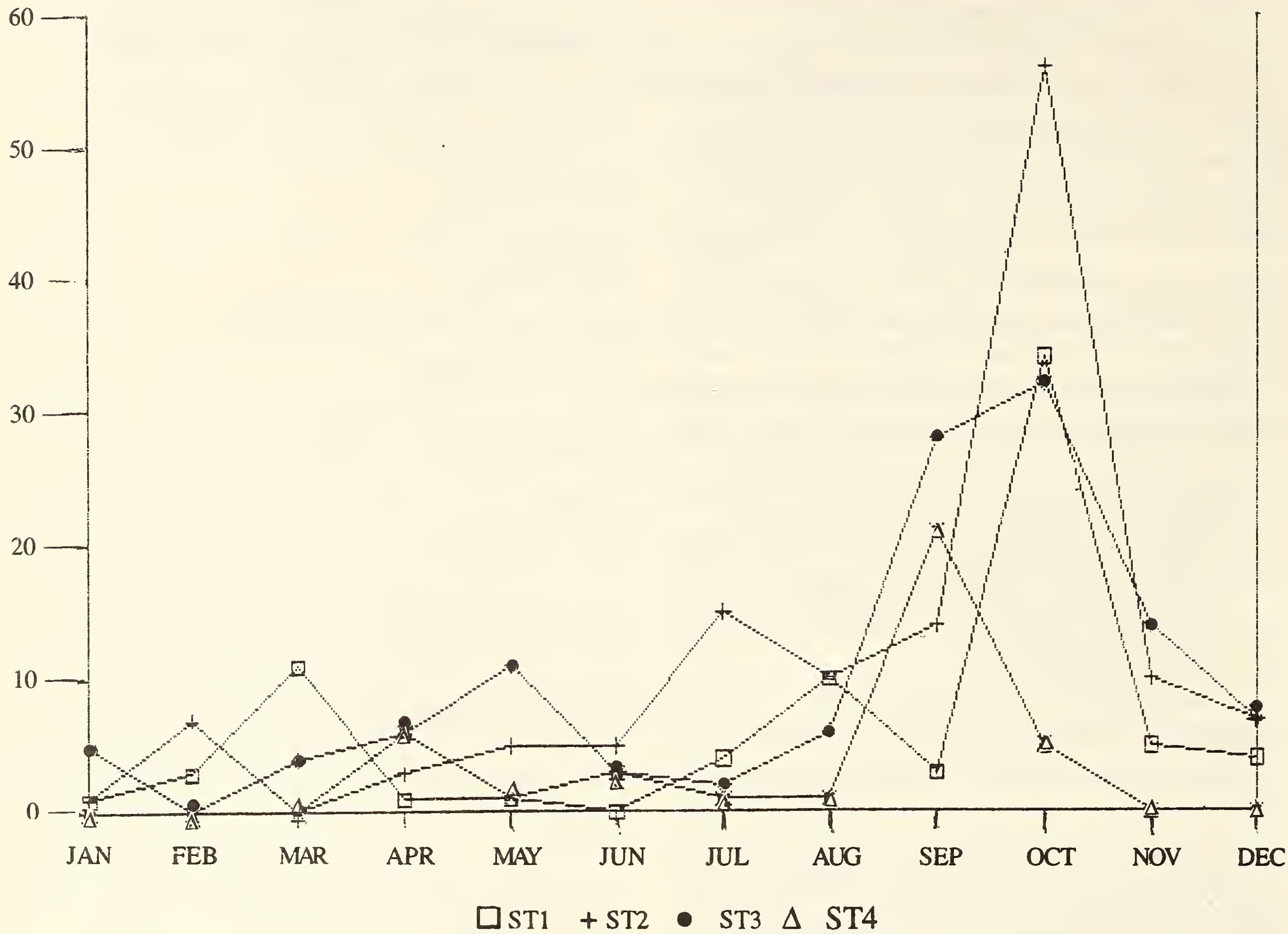


Fig. 1. Seasonal distribution by stations

peaks were seen in March and August. Beruwala also had year round catches, with a zero catch in March, a sub-peak in July and the maximum catch in October. Mirissa had zero catch in February and a sharp increase in numbers caught in September, reaching a peak in October. These three stations showed a definite peak in catches in October, dropping sharply in November. Kottegoda differed from this pattern as catches were recorded only in the period from April to October with zero catches in the other five months of each year. The maximum catch for this station was in September, with declining numbers in October.

The seasonal variation of the catch for the four major species, namely *Stenella longirostris, S. coeruleoalba, S. attenuata* and *Tursiops truncatus* is shown according to season for the total catch in Fig. 2. All four species had peak catches in the post-monsoon season from September to December and smaller numbers at other times of the year. *Stenella longirostris* and *Tursiops truncatus* were caught in larger numbers during the monsoon season from May to August than in the pre-monsoon season between January and April. However, there was no difference in the catch rates of *Stenella coeruleoalba* and *S. attenuata* between the pre-monsoon and monsoon seasons. There was a slight variation from the general pattern at Kottegoda for *Stenella coeruleoalba*, which had a peak catch in the pre-monsoon season with large numbers being landed in April and a smaller peak in the post-monsoon season in October, which was the peak at other stations.

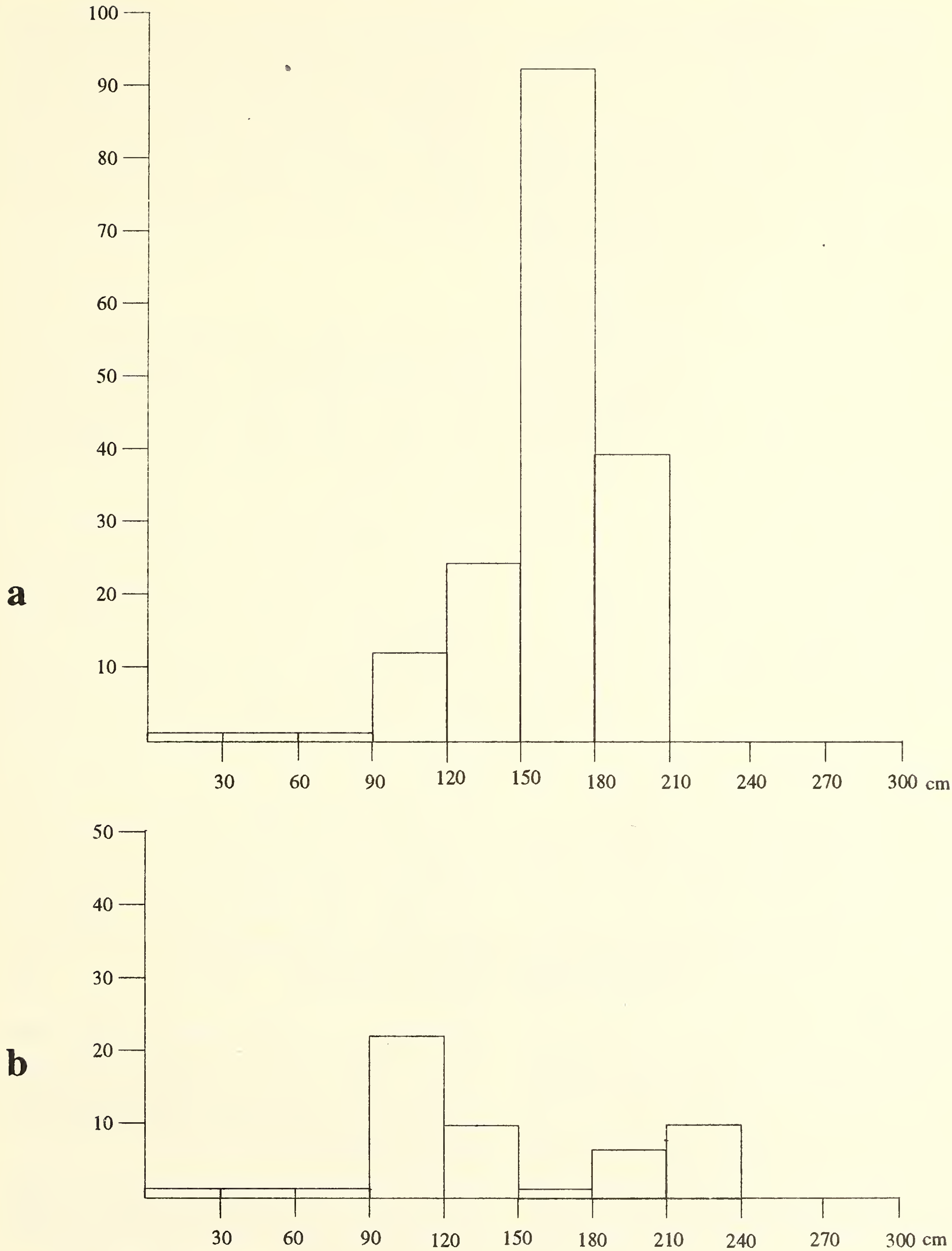
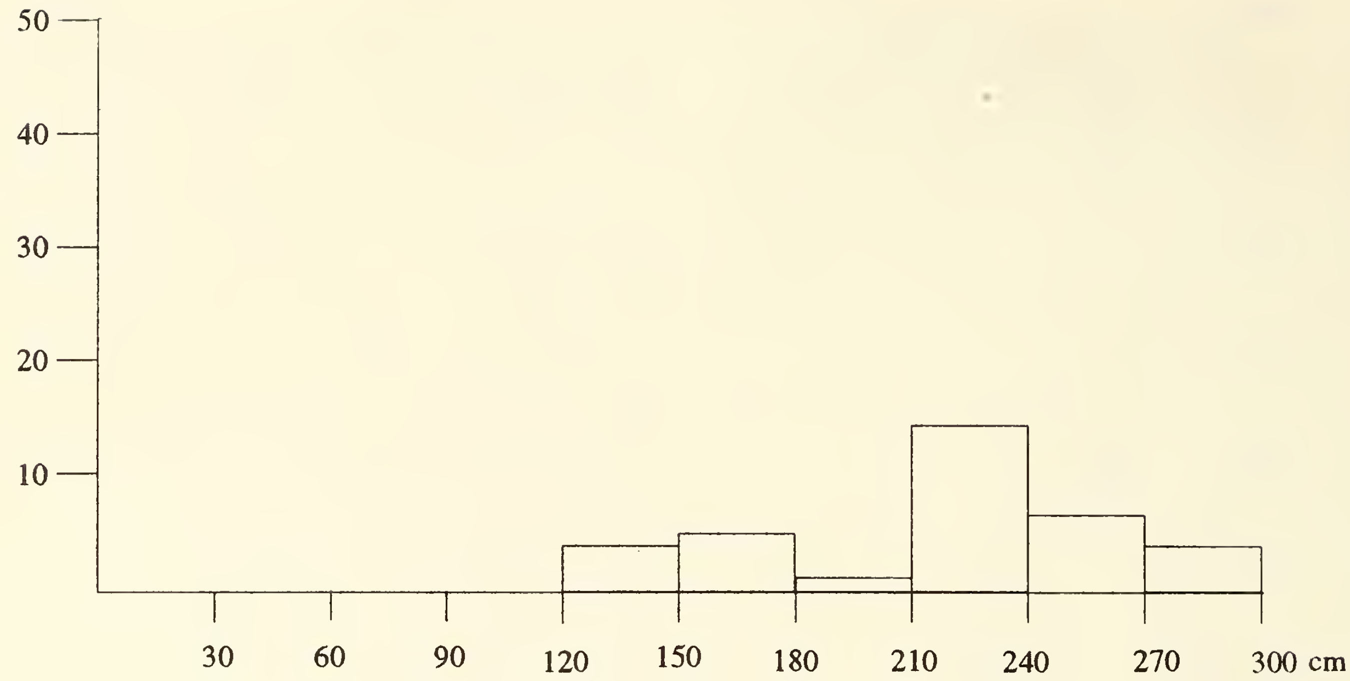


Fig. 2. Length frequency distribution range (of 4 major species)
a: *Stenella longirostris;* b: *S. coeruleoalba*

c



d

Fig. 2 contd. Length frequency distribution range (of 4 major species)
c: *Tursiops truncatus;* d: *Stenella attenuata*

Sex Ratio

The sex ratio of the catch for each species and each station is given in Table 2. For all species together, the catch at Negombo consisted of an equal number of males and females. At Beruwala and Kottegoda a larger number of males were caught while at Mirissa a larger number of females were caught. A significantly larger number of *Stenella longirostris* males were caught at Beruwala and Kottegoda, while at Negombo also more males were caught but the difference between the sexes was less significant. Of the total 366 specimens, 197 males and 159 females were recorded while 10 were unidentified, comprising a frequency of 53.8% males, 43.4% females and 2.7% unidentified.

For *Stenella longirostris* the largest percentage of both males and females caught came in the range of 150 - 179.9 cm and from 90 - 119.9 cm for *S. coeruleoalba*. In *Tursiops truncatus* most males caught measured 150.0 - 179.0 cm, and 210 - 239.9 cm, but most females caught measured 210 - 239.9 cm. Females of *Stenella attenuata* were caught in high numbers in the 150 - 179.9 cm range and the males in the 180 - 209.9 cm range, with fairly high numbers between 150 - 179.9 cm, and 210 - 239.9 cm. Only 3, females of the four dominant species measured less than 90 cm. The only catch larger than 240 cm was *Tursiops truncatus*, the majority of which were females.

Body Length

The body length of *Stenella longirostris* ranged from 86.25 to 197.50 cm (SD=22.08), *Stenella coeruleoalba* from 86.25 to 228.12 cm (SD=49.43), *Tursiops truncatus* from 120.00 to 278.75 cm (SD=44.22) and *Stenella attenuata* ranged from 86.25 to 225.00 cm. (SD=37.97).

The frequency distribution of *Stenella longirostris* was similar for Negombo, Beruwala and Mirissa, but all specimens recorded at Kottegoda were above 120 cm in length, ranging upto 210 cm. The frequency distribution for *Stenella coeruleoalba* was similar for all four stations. A high percentage of specimens at all stations come within the 90 - 119.9 cm range, indicating that a large number of juveniles are caught. *Tursiops truncatus* had a similar frequency distribution at Negombo and Beruwala. At Mirissa all specimens were above 180 cm indicating that only adult animals were caught at this station. This species was not recorded at Kottegoda during the study period. The sample size for *Stenella attenuata* was not adequate to comment on frequency distribution.

Capture Methods

The capture methods resulting in the mortality of small cetaceans in Sri Lanka are shown according to station in Table 3. Negombo and Mirissa practise direct harpooning in addition to accidental gillnet entrapment. All small cetaceans recorded at Beruwala and Kottegoda were accidental bycatch of the gillnet fishery. At Mirissa more small cetaceans were caught by direct harpooning than as bycatch, and *viceversa* at Negombo. Of the total of 366 specimens recorded from all four stations, 69.1% was bycatch in gillnet fishery while 30.9% was by harpooning.

Table 2

SEX RATIO BY SPECIES AND STATION

Species	St.1		St.2		St.3		St.4	
	M	F	M	F	M	F	M	F
Stenella longirostris	21	18	53	18	24	31	15	4
Stenella coeruleoalba	5	2	12	9	6	4	5	7
Tursiops truncatus	2	5	4	5	6	11	-	-
Stenella attenuata	2	1	5	2	9	10	2	-
Grampus griseus	2	2	6	4	2	2	2	-
Peponocephala electra	2	5	3	2	1	1	-	1
Kogia simus	-	-	1	1	-	-	-	1
Steno bredanensis	1	1	1	-	1	1	-	-
Lagenodelphis hosei	1	-	-	-	-	3	-	-
Feresea attenuata	-	-	-	1	1	1	-	1
Pseudorca crassidens	-	-	-	1	2	-	-	-
Delphinus delphis	-	-	-	-	-	2	-	-
Kogia breviceps	-	1	-	-	-	-	-	-
Orcinus orca	-	1	-	-	-	-	-	-
Total	36	36	85	43	52	66	24	14

*St.1=Negombo St.2=Beruwala St.3=Mirissa St.4=Kottegoda

Area of Operation

The area of operation of mechanised boats (780 - 960 cm) engaged in gillnet operations in all sampling stations was approximately 55 to 60 km offshore. Therefore, the area in which small cetaceans are killed as a result of accidental bycatch is an approximately 15 km wide belt off the west and southwest coast as shown in Fig. 3. Direct harpooning, on the other hand, could be done anywhere between the shorelines and 60 km offshore when small cetaceans are sighted and weather conditions are favourable.

Discussion

The present paper has identified 14 species in the total recorded catch, two of which (*Peponocephala electra* and *Orcinus orca*) have not been recorded before. De Silva (1987) reports of a *Peponocephala electra* skull in the Calicut

TABLE 3
CAPTURE METHOD BY STATION

Station	Bycatch		Harpooned	
	No.	%	No.	%
Negombo	43	55.8%	34	44.2%
Beruwala	133	100.0%	0	-
Mirissa	39	33.1%	79	66.9%
Kottegoda	38	100.0%	0	-
Total	253	69.1%	113	30.9%

museum and sight records of *Orcinus orca* off southern Sri Lanka in the 19th century. I found that *Peponocephala electra* was among the six most frequently caught species in the catch, comprising 4.0% of the total recorded catch. *Orcinus orca* was recorded only once during the present study when a 277.5 cm long female specimen was landed as bycatch at Negombo on 8th April, 1986. Joseph *et al.* (1983), Joseph and Siddeek (1985) recorded *Orcella brevirostris* as one of the dominant species in the landed catch at Negombo. However, this species was not recorded at all during the present study. Prematunga *et al.* (1985) and Alling (1985a, b) did not record this species from either Beruwala on the west coast or Trincomalee and Valaichenai on the east coast. *Pseudorca crassidens* and *Steno bredanensis* have both been recorded by Alling (1985a) at Beruwala and in the present study *Pseudorca crassidens* was recorded at Beruwala and Mirissa while *Steno bredanensis* was recorded at Negombo, Beruwala and Mirissa in small numbers. The species *Globicephalus macrorhynca* and *Ziphius cavirostris* recorded by Alling (1985b) at Trincomalee were not encountered in the present study. Joseph and Siddeek (1985) report that *Stenella longirostris* was the dominant species in the catch at Negombo and Beruwala, comprising 40.1% of the catch and Alling (1985a, b) records it as the dominant species in the catch both on the west and east coasts. The present study also confirms that *Stenella longirostris* was the dominant species at all four landing sites, comprising 51.3% of the total recorded catch. Alling (1985b) reported that

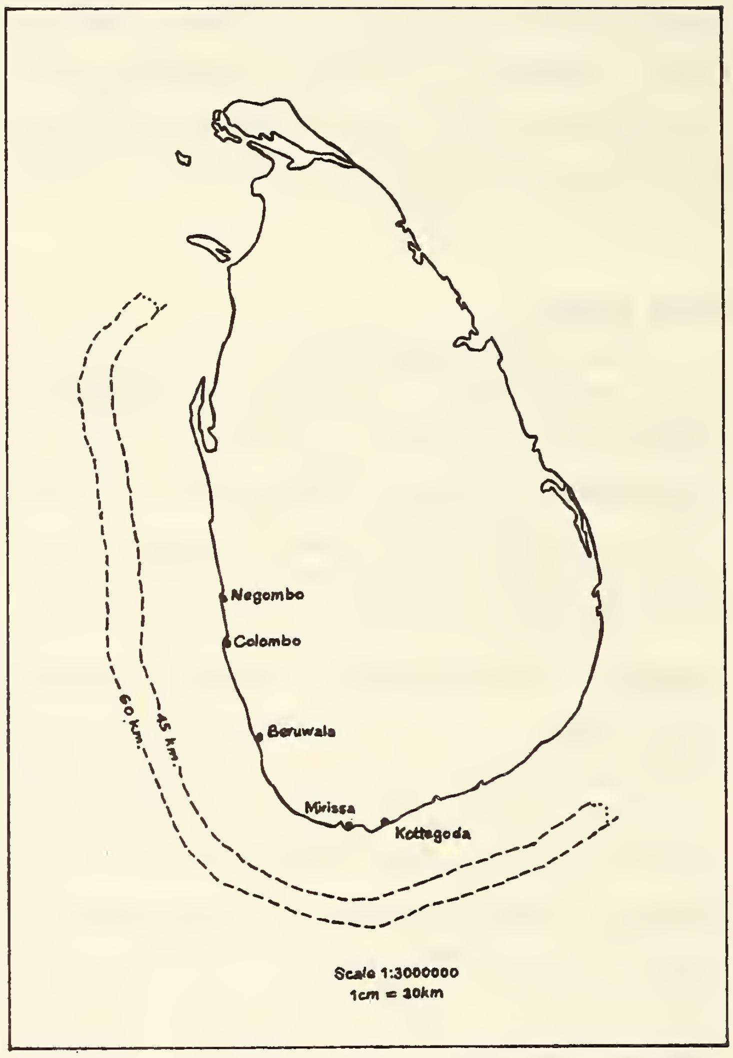


Fig. 3. Map of Sri Lanka showing the study area

Stenella longirostris comprised 34% of total sightings within 48 km off the coast. This could possibly account for the abundance of this species in the catch. However, not enough is known about the population dynamics of small cetaceans in Sri Lanka's waters to reach an accurate conclusion on this at present.

Seasonal variation of the catch in the present study differs from previous studies. Joseph and Siddeek (1985) record that April, May and August had large landings at Negombo and Beruwala. Alling (1985a) records large numbers for Beruwala in June, July and December 1982, November and December 1983, and January, April, and November 1984. In the present study, there was a consistent increase in numbers landed in September, reaching a peak in October at Negombo, Beruwala and Mirissa. At Kottegoda the peak was in September, declining in October. Fairly high catch rates were also recorded for August and November at all stations. There were slight variations between stations in the seasonal catch of individual species, but in general the peak was always between the end of August and November which was considered as the post-monsoon season in the present study. The only exception was at Kottegoda which had a peak catch of *Stenella coeruleoalba* in April. The only explanation that can be offered at present for the general peak between August and November is that fishing effort is generally highest during the calm season, between the southwest and northeast monsoons. Therefore, bycatch in gillnet operations shows an increase in these months on the southwest coast. In Negombo and Mirissa, where harpooning is practised, this would also be the ideal time of year as harpooning is only possible when the sea is calm. Therefore, the increased catch in September and October is possibly due to the calm sea conditions.

Joseph *et al.* (1983), Joseph and Siddeek (1985), and Alling (1985a, b) have not discussed frequency distribution of body length of different species in relation to the sex ratio. These two sets of data were compared in the present study for the four major species. In *Stenella longirostris* 54.3% of the measured specimens were in the 150 - 179.9 cm range, while 60.1% of these specimens were males and 37.7% were females. Therefore, it can be concluded that a high percentage of adult males are being caught. In *Stenella coeruleoalba* also, the percentage of males caught is 54.9%, and 42.0% of the catch were in the 90 - 119.9 cm range. This indicates a high percentage of juvenile males being caught. The reason for this is not known. High juvenile mortality is a cause for concern as it could have an adverse effect on the recruitment rate of the population. *Tursiops truncatus* differs from the general pattern by having a higher percentage of females (61.7%) in the total catch, while 46.8% of the total catch is within the 210 - 239.9 cm range. The adult body length for this species is 220 - 400 cm and females are known to reach sexual maturity at 220 - 240 cm (Leatherwood *et al.*, 1982). Therefore, a majority of this species being caught off the south and west coast are breeding females. The pattern for *Stenella attenuata* is very similar to that of *S. longirostris,* with a higher percentage of males (54.4%) being caught, while 32.2% of the total catch is in the 150 - 179.9 cm range.

Of the four fish landing sites chosen for this study, harpooning was practiced only at Negombo and Mirissa. Joseph *et al.* (1983) and Joseph and Siddeek (1985) state that no specimens examined by them either at Negombo or Beruwala were harpooned. In the present study, 44.1% of the catch at Negombo and 66.9% at Mirissa were harpooned. Of the total 366 specimens examined from all four landing sites 30.8% were harpooned. Thus, although harpoon-ing is only practised in a few areas it is a cause for concern. This practice might spread to other areas since the present study found it being done in Negombo where it had not been recorded earlier by Joseph and Siddeek (1985).

More offshore research is necessary to assess the impact of fishery on the population of small cetaceans in Sri Lanka's waters. More information on the population dynamics of the various species is also essential.

Acknowledgements

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POPULATION AND DISTRIBUTION OF BRONZEWINGED (*METOPIDIUS INDICUS*) AND PHEASANT-TAILED (*HYDROPHASIANUS CHIRURGUS*) JACANAS IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN[1]

RAMACHANDRAN N.K.[2] AND VIJAYAN V.S.[3]

(*With four text-figures*)

Key words: *Metopidius indicus, Hydrophasianus chirurgus,* macro-invertebrate, PCA, population, spatial distribution.

The temporal and spatial patterns of the population of two species of jacana (*Metopidius indicus* and *Hydrophasianus chirurgus*) were studied in a monsoonal wetland (Keoladeo National Park, Bharatpur, Rajasthan) of the Gangetic plains of India for three years. The population of both the species varied significantly over seasons and years, usually rising during monsoon-winter. The Pheasant-tailed had the highest number in 1988, and for the Bronzewinged in 1986. The spatial distribution of jacanas inside the Park was not determined by the size of the aquatic blocks. Both the species had particular patterns of distribution which correspond with the distribution pattern of certain macro-invertebrate taxa.

INTRODUCTION

Detailed information on the ecology of most Jacanidae, a circum-tropical family of shorebirds that inhabit freshwater swamps and marshes, is very scanty. This family comprises eight species and possesses a number of unique characteristics, the most outstanding of which are their exceedingly long toes and claws which allow them to walk with ease over floating vegetation (Austin 1983).

The species which occur on the Asian continent are pheasant-tailed jacana (*Hydrophasianus chirurgus*) and bronzewinged jacana (*Metopidius indicus*). The general distribution of both pheasant-tailed and bronzewinged jacanas in the Indian subcontinent was reported by Ali and Ripley (1983) and their population has been estimated as part of the Asian waterfowl census (Scott and Rose 1989). However, intensive studies on the population and distribution in a specific area have not been attempted so far. Therefore, a three year study was undertaken at Keoladeo National Park, Bharatpur to look into the spatio-temporal aspects of their population.

The spatial abundance of jacanas in the Park did not have a positive linear relation to the aquatic area, as smaller blocks had more birds than did the larger blocks. Many researchers have emphasized the role of macro-invertebrates in the habitat preference of different waterfowl species, especially during the breeding season (Murkin 1979, 1982, Murkin and Kadlec 1986, Murkin and Batt (1987). Therefore, a spatial correspondence between the distribution of jacanas and macro-invertebrate taxa inside the Park is expected during their breeding season. This correspondence is examined using principal component analysis.

STUDY AREA

The study was conducted in Keoladeo National Park, Bharatpur, a well known, man-

[1]Accepted February, 1995

[2]Bombay Natural History Society, Hornbill House,
S.B. Singh Road, Mumbai 400 023.
[3]Present Address:
Sálim Ali Centre for Ornithology and Naturlal History,
Kalampalayam P.O. Coimbatore- 642 010.

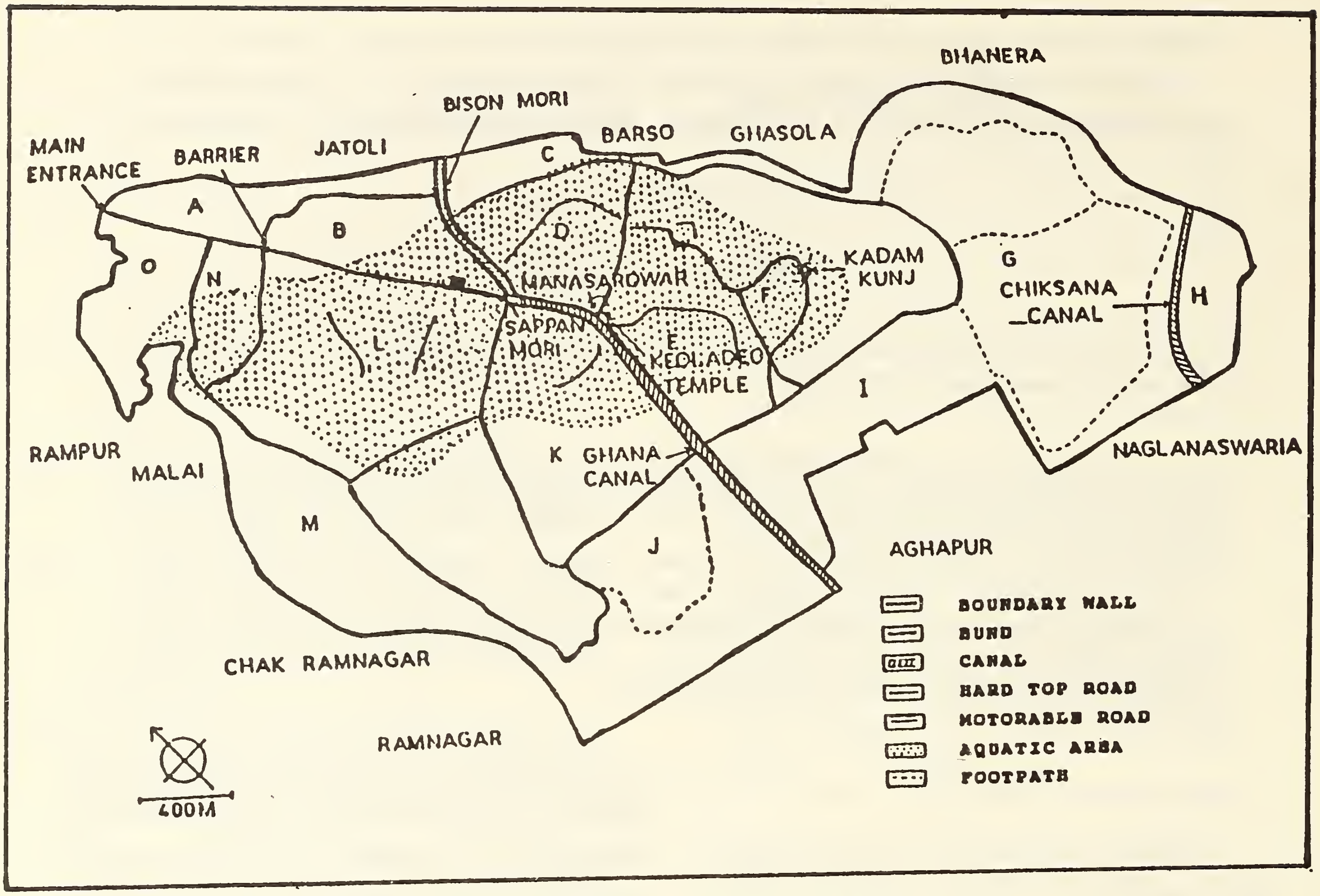

Fig. 1 Map of Keoladeo National Park

modified wetland situated in the Indogangetic plains. The Park is situated between 27° 7.6' & 27° 12.2' N, and 77° 29.5' & 77° 33.9' E in Rajasthan. The total area of the Park is 29 sq. km. It is almost flat with a gentle slope towards the centre forming a depression and, during the years of normal rainfall and water supply, the inundated area covers around 8.5 sq. km. The aquatic portion of the Park has been divided into various unequal compartments or blocks by means of dykes (Fig. 1). The Park receives water annually from a reservoir — the Ajan bund — situated about 500 m south of the Park.

Bharatpur receives the southwest monsoon which sets in towards end-June and continues upto September, sometimes to October. The total rainfall was 424.7, 423.4 and 614.2 mm during 1986, 1987 and 1988 respectively. The monthly rainfall varied from year to year (Fig. 2).

Material and Methods

Fortnightly census was conducted in the morning hours using the dykes as transects. All the birds seen on either side of the dykes were counted, using a pair of binoculars. Duplication of sighting was assumed to be nil, as the species concerned restrict themselves to the same area once they are settled. The entire aquatic area was surveyed in each census trip.

Macro-invertebrates were sampled weekly from fixed sampling stations (Fig. 1) using a modified version of the Wisconsin Trap (Clark and Murkin 1989). The radius of the sampler was 7.5 cm. It was immersed in water for some time, so as to nullify the disturbance caused by the movement of the sampler, as well as boat, and then taken out gently. The contents along with the vegetation and other material present inside the sampler were washed carefully into a sieve

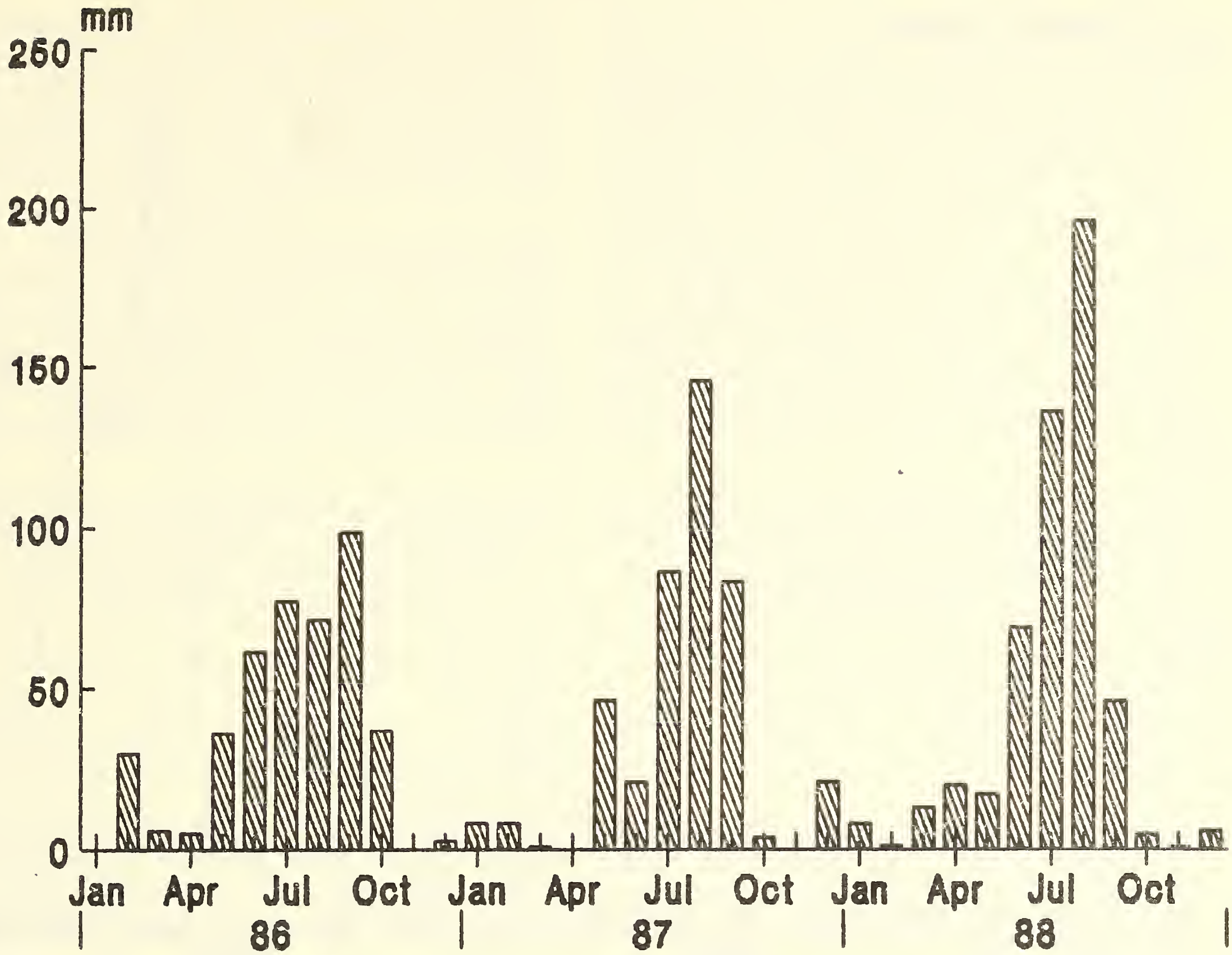

Fig. 2 Monthly variation of rainfall in the Park from 1986 to 1988

and the macro-invertebrates were hand-picked from it. Insects were identified up to order level and counted.

Statistical analysis

Analysis of variance (ANOVA) was used to compare the population mean of jacanas over the years. The differences of population between years were also tested using ANOVA. To compare the mean of population of both the species in a given a year, paired sample t-test was used.

Similarly, ANOVA was used to determine the overall differences in the population of jacanas among the blocks. Newman-Keuls test was used for the multiple comparison of blocks to identify the pairs of blocks which differ significantly. All statistical analyses were done using the software SYSTAT (Wilkinson 1988).

Multivariate analysis

Data on the population of jacanas were sorted out block-wise and correlated with different macro-invertebrate taxa in order to identify the taxa influencing the spatial pattern of the distribution of jacanas. Only the data for the monsoon and winter (August to March) were taken into consideration. This was deemed necessary for avoiding the effect of seasons in the analysis. Three such seasons, starting from August 1986, and ending with December 1988, were included in the principal component

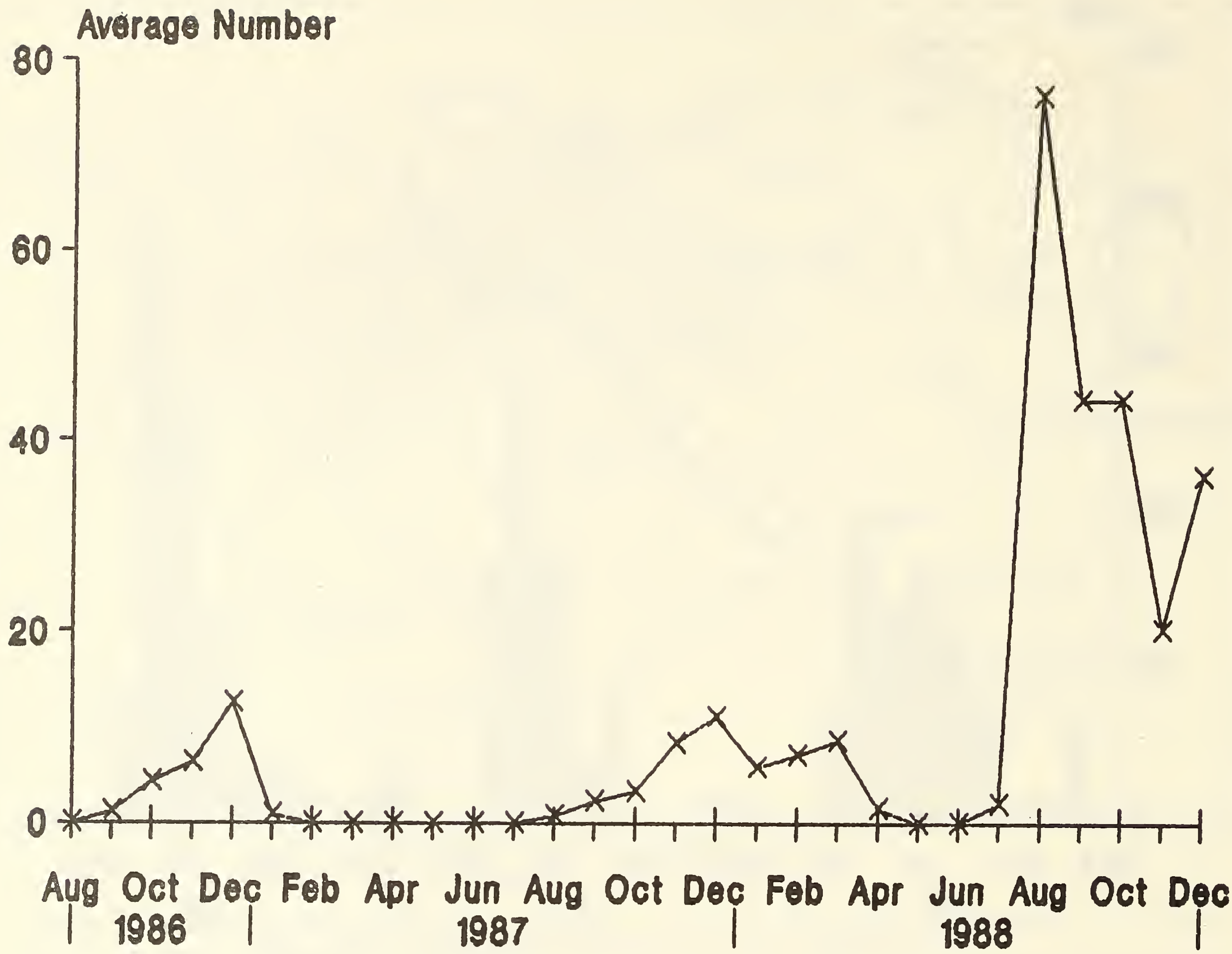

Fig. 3 Population of the Pheasant-tailed jacana from 1986 to 1988

analysis. To begin with, principal component analysis was done on each data set which included block wise data on both species of jacana and abundance of different macro-invertebrate taxa. The components derived from each data set represent the spatial variability of a particular data set. The analysis began with the extraction of the first principal component which is the linear function of the eight variables accounting the highest variation. The analysis then proceeds with computation of the next component and so on, till all the variabilities in the data set were accounted for. All the components were extracted from the original data set containing of 42 observations independent of one another. The first component of each data set was taken for further analysis. Thus, the first principal component of each jacana species was correlated with the first components of each macro-invertebrate taxa. The significance of the correlation coefficients was obtained with 40 degrees of freedom (Jeffers 1987).

Results and Discussion

Population of the Pheasant-tailed Jacana.

Population of the pheasant-tailed jacana had a distinct seasonal pattern: the number shot up in autumn and winter, decreased in the spring and was totally absent during summer (Fig. 3). Ali and Ripley (1983) observe that the pheasant-tailed jacana is a local migrant and can be seen in good numbers in the plains during autumn-winter. The pattern obtained during this study support their observation.

The population of the pheasant-tailed varied significantly in 1988, from that of 1986, and 1987, thereby making the total variation significant (ANOVA, F = 58.98; P = 0.0001). The contribution of variation from 1986 vs. 1987 was not significant to the over all variation (Table 1). Their population was high during monsoon and winter of 1988 compared to that of 1986 and 1987 {x = 12 (1986), 5.82 (1987), 44 (1988)}. During 1988 they bred inside the Park, unlike in 1986 and 1987. The failure of breeding in 1987 may be due to poor monsoon. But 1986, was partially good in terms of rain and water input to the Park. Thus, the absence of nesting in this year cannot be attributed to the monsoon. Instead, it might be the result of abundant growth of *Eichhornia crassipes*. Thus, yearly fluctuation in the population of the pheasant-tailed jacana must be a combined effect of monsoon and the availability of suitable habitat (Ramachandran 1993).

Table 1
COMPARISON TO DETERMINE THE CONTRIBUTION BY INDIVIDUAL YEARLY VARIATION TO THE TOTAL YEARLY VARIATION IN THE POPULATION OF PHEASANT-TAILED JACANA.

	1986 vs 1987	1986 vs 1988	1987 vs 1988
F value	0.592	100.888	90.015
Probability	0.446	0.0001	0.0001

Population of the Bronzewinged Jacana.

The population of the bronzewinged jacana also had a distinct, but different seasonal variation from that of the pheasant-tailed jacana (Fig. 4). Their population started building up in August and attained a peak in October, December and November during 1986, 1987 and 1988 respectively. During autumn and winter (September through December) the number did not show much change as in other seasons. From January the population started declining and reached the lowest point during summer, especially in May and June.

Significant variation in the population of the bronzewinged was noticed in different years (ANOVA, F = 8.00 P = 0.001). It was striking between 1986 and 1987, and 1986 and 1988 but not so between 1987 and 1988 (Table 2). In contrast to the population of the pheasant-tailed jacana, the population of bronzewinged was maximum during the monsoon and winter of 1986 (Table 2), which was mainly due to their breeding success. Their preferred habitat for nesting — *Eichhornia crassipes* patches — was abundant during this season in 1986. Barman and Bhattacharjee (1993) also reported the importance of *Eichhornia sp.* for bronzewinged as the preferred cover besides *Hymanachae* sp. During 1987, the population declined because of the failure of the monsoon, whereas during the monsoon and winter of 1988, they could not breed in good numbers (only one nest and two families with chicks were sighted) as the habitat was unsuitable. The near total absence of *Eichhornia crassipes* and *Ipomoea aquatica* might have been the reason for their decreased nesting activity. It may be noted that while the bronzewinged use mainly *Eichhornia crassipes* patches for nesting, they use *Ipomoea aquatica* as a cover for themselves and their young ones from predators.

Table 2
COMPARISON TO DETERMINE THE CONTRIBUTION BY INDIVIDUAL YEARLY VARIATION TO THE TOTAL YEARLY VARIATION IN THE POPULATION OF BRONZEWINGED JACANA

	1986 vs 1987	1986 vs 1988	1987 vs 1988
F value	12.723	10.298	0.017
Probability	0.001	0.003	0.898

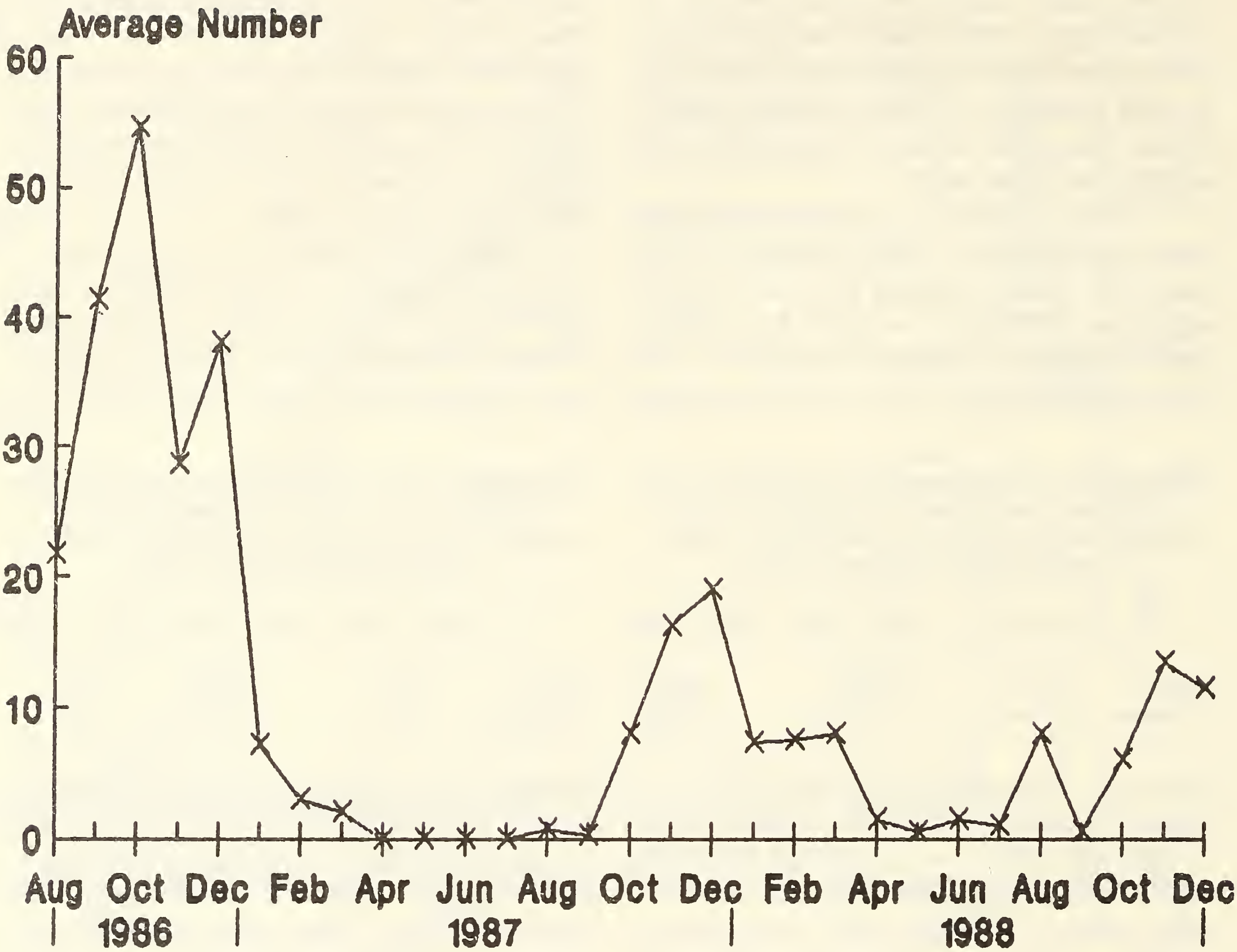

Fig. 4 Population of the Bronzewinged jacana from 1986 to 1988

Comparison of population of the Pheasant-tailed and the Bronzewinged Jacanas

The population of both the species varied significantly during the monsoon and winter of 1986 and 1988, whereas in 1987 it did not vary (Table 3). Thus, the year 1986 was productive for the bronzewinged and 1988 for the pheasant-tailed but 1987 was not particularly so for either of the species. Since both 1986 and 1988 had more or less similar rainfall, it cannot be considered as a factor for the difference in population between the two species. Therefore, it can be explained only by the different habitat requirement of both species and the availability of preferred habitat patches.

Table 3

PAIRED SAMPLES T-TEST SHOWING VARIATION BETWEEN THE PHEASANT-TAILED AND BRONZEWINGED JACANAS IN THE SAME YEAR

	Year		
Parameters	1986	1987	1988
Mean Difference	21.429	2.735	-36.100
Sd Difference	17.188	5.966	22.158
t-statistics	4.987	1.890	-5.152
Degree of freedom	15.000	16.000	9.000
Probability	0.0001	0.077	0.001

Distribution of the Pheasant-tailed Jacana

The highest mean number of the pheasant-tailed was sighted in block D and lowest in block

B. The blocks E and F held the same number of the pheasant-tailed jacana (Table 4). Similarly blocks N and Lw, and L and K had the same average population. However, the population varied significantly between many of the blocks (ANOVA: F = 7.47, P = 0.0001).

TABLE 4
MEAN FOR THE BLOCK-WISE POPULATION OF JACANAS (n = 42).

Blocks	Pheasant-tailed jacana	Bronzewinged jacana
N	0.3	0.5
Lw	0.3	0.6
L	0.6	4.0
B	0.1	0.4
K	0.8	1.5
D	5.2	3.5
E	3.5	3.2
F	3.2	0.9

The multiple comparison of absolute mean using Newman-Keuls test (Table 5) showed that blocks D, E and F differed significantly from all other blocks and at the same time did not vary among themselves.

Distribution of the Bronzewinged Jacana.

The highest mean population of the bronzewinged was in block L followed by D and E. The blocks N, Lw, and B held almost the same mean population (Table 4). In this species also, there was significant difference in its population between blocks (ANOVA: F = 5.98, P = 0.000).

As in the pheasant-tailed multiple comparison of blocks was attempted (Table 6). The analysis showed that block D differed from blocks N, Lw, L and B'; block E from blocks N, Lw, B and K; and block F from blocks L, D and E. The blocks B and K differed from L, and L from N and Lw.

The role of macro-invertebrate taxa in the distribution pattern of the bronzewinged and pheasant-tailed jacanas.

Eight taxa of macro-invertebrates were recorded from the Park comprising six insect orders, molluscs and oligochaetes (Table 7). The first principal component obtained for each taxa of macro-invertebrate and the jacanas with the total variation explained is given in Table 8 and 9 respectively.

When the first principal component obtained for pheasant-tailed jacana was subjected to correlational analysis (Table 10) with that of different macro-invertebrate taxa, it was found that the spatial pattern of this species positively corresponds with the spatial pattern of Odonata, Mollusca and Oligochaeta. But its relation with the Ephemeroptera was negative. Its relation with Mollusca is striking because in a year when the

TABLE 5
NEWMAN-KEULS MULTIPLE COMPARISON OF THE DISTRIBUTION OF PHEASANT-TAILED JACANA IN VARIOUS BLOCKS

BLOCKS	N	Lw	L	B	K	D	E	F
N	0.000							
Lw	0.048	0.000						
L	0.351	0.304	0.000					
B	0.155	0.202	0.506	0.000				
K	0.543	0.495	0.192	0.698	0.000			
D	4.913*	4.865*	4.561*	5.067*	4.370*	0.000		
E	3.202**	3.155**	2.851**	3.357**	2.659**	1.710	0.000	
F	2.988**	2.940**	2.637**	3.143**	2.445**	1.925	0.214	0.00

Note: the values are absolute mean differences
* P = 0.000; ** P <0.02

TABLE 6

NEWMAN-KEULS MULTIPLE COMPARISON OF THE DISTRIBUTION OF BRONZEWINGED JACANA IN VARIOUS BLOCKS

BLOCKS	N	Lw	L	B	K	D	E	F
N	0.000							
Lw	0.147	0.000						
L	3.577*	3.431*	0.000					
B	0.114	0.261	3.691*	0.000				
K	1.044	0.897	2.533***	1.158				
D	3.040*	2.893*	0.538*	3.154*	1.996	0.000		
E	2.737**	2.590**	0.841	2.850**	1.692+	0.303	0.000	
F	0.444	0.297	3.134*	0.558	0.600	2.596*	2.293***	0.000

* P = 0.00; ** P = 0.01; *** P = 002; + P = 0.05
Note: the values are absolute mean differences.

TABLE 7

AVERAGE NUMBER OF DIFFERENT MACRO-INVERTEBRATE TAXA IN DIFFERENT BLOCKS OF THE PARK (n = 42)

Taxa	Blocks							
	B	D	E	F	K	L	Lw	N
Coleoptera	0.18	0.89	0.46	0.19	0.25	0.77	0.14	0.11
Diptera	0.45	0.33	0.31	0.69	0.21	0.27	0.41	0.18
Ephemeroptera	0.04	0.19	0.20	0.13	0.15	0.21	0.16	0.08
Hemiptera	0.37	1.04	0.66	0.60	0.71	0.79	0.38	0.09
Lepidoptera	0.19	0.37	0.59	1.25	0.48	0.37	0.28	0.14
Odonata	0.95	0.71	1.95	1.80	2.14	0.68	0.67	0.35
Mollusca	0.38	3.52	1.48	0.19	0.75	1.75	1.16	0.06
Oligochaeta	0.26	0.23	0.60	0.86	0.35	0.15	0.29	0.20

TABLE 8

THE FIRST COMPONENT AND THE PROPORTION OF VARIATION ACCOUNTED FOR EACH MACRO-INVERTEBRATE TAXA

Blocks	COL	DIP	EPH	HEM	LEP	ODO	OLI	MOL
B	0.85	0.87	0.16	0.87	0.35	0.56	0.45	0.84
D	0.67	0.05	0.51	0.64	0.93	0.52	0.57	0.31
E	0.83	0.71	0.39	0.42	0.79	0.79	0.72	0.80
F	0.19	0.64	0.23	0.72	0.40	0.85	0.90	0.74
K	0.34	-0.12	0.08	0.80	0.49	0.69	0.75	0.56
L	0.56	0.56	0.84	0.34	0.89	0.54	0.67	0.36
Lw	0.72	-0.11	-0.06	0.63	0.60	0.35	0.85	0.56
N	0.07	0.32	0.76	-0.15	0.03	0.77	0.85	0.00
% of Vari. Exaplained	35.38	26.38	22.23	38.03	39.63	42.49	53.71	34.27

Note: COL = Coleoptera, DIP = Diptera, EPH = Ephemeroptera, HEM = Hemiptera, LEP = Lepidoptera, ODO, Odonata, OLI = Oligochaeta, MOL = Mollusca

TABLE 9
THE FIRST PRINCIPAL COMPONENT OBTAINED FOR THE BRONZEWINGED AND THE PHEASANT-TAILED JACANA.

BLOCK	Bronzewinged jacana	Pheasant-tailed jacana
B	0.119	0.453
D	0.422	0.509
E	0.807	0.832
F	-0.157	0.798
K	0.921	0.660
L	0.844	0.394
Lw	-0.021	0.604
N	-0.288	0.578
% Vari. Explained	31.416	38.548

TABLE 10
COEFFICIENTS OF CORRELATION BETWEEN THE FIRST PRINCIPAL COMPONENT OF THE BRONZEWINGED AND THE PHEASANT-TAILED JACANA AND THE FIRST PRINCIPAL COMPONENT OF VARIOUS MACRO-INVERTEBRATE TAXA

Taxa	Bronzewinged jacana	Pheasant-tailed jacana
Coleoptera	0.371*	-0.197
Diptera	-0.071	0.045
Ephemeroptera	0.101	-0.373*
Hemiptera	0.217	0.065
Lepidoptera	0.685*	-0.125
Odonata	-0.035	0.655*
Mollusca	0.199	0.406*
Oligochaeta	-0.336*	0.590*

* significant at P = 0.05

abundance of Mollusca inside the Park was very poor, the pheasant-tailed chose to breed in an artificial village pond in Banera. 50 m away from the boundary of the Park, where the molluscs were abundant. None of the taxa showed any significant correspondence with the pheasant-tailed. Since some other factors also contribute to the variability in the distribution of this species, the combined effect of all these may be the reason for the pattern observed, or all the correlated macro-invertebrate components may be inter-related in their distributional pattern.

In the case of the bronzewinged, the first principal component had significant positive relation to Coleoptera and Lepidoptera, but negative to Oligochaeta (Table 10). The negative relation of Oligochaeta may be due to the negative relation of this taxa with other positively related taxa. It need not be the result of direct interaction between the bronzewinged and Oligochaeta.

Invertebrate food resources are an important factor in determining the waterfowl and blackbird (*Xanthocephalus xanthocephalus* and *Agelaius phoeniceus*) use of prairie wetlands, particularly during the breeding season (Murkin, 1979; Murkin and Kadlec, 1986; Murkin and Batt, 1987). Habitat preferences of breeding black ducks (*Anas rubriceps*) appear to be influenced by the cover and invertebrate densities ((Ringelman *et al.*, 1982). They indicated that the ducks avoided wetland habitat types having low invertebrate densities. Similarly the distribution of jacanas inside the Park in a given season may be explained by three major factors, namely distribution of vegetation patches, macro-invertebrate fauna and water depth, or combined effect of all these factors. Among the above mentioned variables, variability of water depth among the different blocks in any particular season was negligible and the distribution of macro-invertebrates is defined by the characteristics of vegetation patches as recorded by Jeffries (1993). The importance of a macro-invertebrate diet in fulfilling the protein demand of ducks, especially from the pre-laying period to egg-laying period has been documented earlier (Swanson and Meyer 1973, Krapu 1974, Swanson *et al.* 1979, Noyes and Jarvis 1985). Moreover, Barman and Bhattacharjee (1993) found animal food as the most preferred item for the bronzewinged jacana. Hence, macro-invertebrate can be a good predictor variable for the spatial distribution patterns of waterbirds, especially during their breeding season.

The correlation obtained between the distribution of jacana species and the distribution of various macro-invertebrate taxa indicates that jacanas might be fulfilling their protein demand by feeding opportunistically on them. Baldessarre and Bolen (1994) had come to the same conclusion in the case of waterfowl.

Whilst correspondence has been documented in the spatial distribution of both the species of jacanas and various macro invertebrate taxa by this study, it is to be mentioned that the observed relation cannot be explained fully until quantitative data on their food habits are available. Nevertheless, correspondence of their occurrence with a particular taxon of macro-invertebrate suggests that they should be feeding on it.

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LABORATORY STUDIES ON THE LIFE CYCLE OF *SIMOCEPHALUS SERRULATUS* KOCH 1881 (CLADOCERA: CRUSTACEA)[1]

[2]Subash Babu and C.K.G. Nayar

(*With one plate*)

Key words: *Simocephalus serrulatus,* Cladocera, life cycle, instar, parthenogenetic, ephippium.

The life cycle of the cladoceran *Simocephalus serrulatus* has been described on the basis of laboratory culture. The neonates produced from the same brood pouch may be all female, all male or both male and female. The female neonates pass through 3 preadult instars and 18 adult instars, while the males have only 2 preadult instars and there is no moulting in the adult stage. Egg production starts at the 4th instar. The maximum number of eggs is produced during 10th to 12th instars.

Introduction

The successful culture of Cladocera depends on our knowledge of the biology and life cycle of individual species.Several investigators have attempted to study the life cycle of a few species of Indian Cladocera. These include the works of Navaneethakrishnan and Michael (1971) on *Daphnia carinata,* Murugan and Sivaramakrishnan (1973) on *Simocephalus acutirostratus,* Murugan (1975a) on *Moina micrura*, Murugan and Sivaramakrishnan (1976) on *Scapholeberis kingi,* Murugan (1975b) on *Ceriodaphnia cornuta,* Murugan and Venkataraman (1977) on *Daphnia carinata,* Murugan and Job (1982) on *Leydigia acanthoceroides,* Kanaujia (1982) on *Ceriodaphnia cornuta.* Kanaujia (1983) on *Daphnia lumholtzi* and Kanaujia (1987) on *Simocephalus vetulus.* Recent study of Thresiamma *et al.* (1991) on the production and population density of *Moina micrura* is the only report on similar studies from Kerala. The above papers give good accounts of the life history of parthenogenetic females,but they do not give sufficient information about the role of males and ephippial females in the life cycle. The present study is a detailed investigation of the life cycle of *Simocephalus serrulatus,* a common cladoceran species of Kerala.

Material and Methods

Simocephalus serrulatus is a large cladoceran found among the littoral weeds and sediments of ponds. The specimens for the present study were collected from a shallow pond situated near Christ College campus and brought live to the laboratory. Twenty-five healthy, egg-bearing females were sorted out under a stereoscopic microscope and were transferred into an earthern pot of 5 litre capacity containing the culture medium. This was maintained as the stock culture. The culture medium was prepared in pond water and filtered through a net made of No. 25 bolting silk. Powdered groundnut cake (500 mg/l) was used as manure for growing algal cells. The medium contained mainly unicellular alga *Chlorella* sp. at a density of about 10×10^3 cells/l.

One ovigerous female was isolated from the stock culture with the help of a pipette and inoculated into a beaker containing 250 ml of the

[1] Accepted August,1995.

[2] Research Laboratory, Christ College,Irinjalakuda 680 125, Kerala, India.

same culture medium. This female was kept under constant observation so as to isolate the newly hatched young neonates. They were individually reared in 20 different petri dishes containing the culture medium which was changed every 24 hours. The time of hatching and moulting, number of neonates hatched in each brood and the life span of all the individuals were regularly recorded until their death. The experiments were repeated thrice and mean values were taken. All observations were made at room temperature 27±2°C.

The ephippial females were also collected from the stock culture and isolated under the microscope. Free ephippia found in large numbers floating on the surface of the culture medium as well as sticking onto the sides of the container were easily collected with the help of a brush or a pipette. Another set of 5 individuals was simultaneously reared in the same medium for dissection, using microtungsten needle. Measurements were made with a calibrated ocular micrometer.

Observations

In the culture medium, the females were generally found clinging on to the side wall of the container with the help of their antennal hooks. They kept their body upside down while swimming. The males were found to be more active than the females, and always swimming in the medium. During mating, the male remained adhered to the hind end of the female. The mating behaviour is found to be similar to that of *Pleuroxus denticulatus*, as described by Shan (1969).

In the first set of experiments, out of the 20 neonates produced from a brood, 16 were found to be females and the rest males. The female neonates measured a mean length of 0.615 mm while males measured 0.55 mm. But in the second set all the neonates produced were males while in the third set all the neonates were parthenogenetic females. In addition to their smaller size, the males could also be distinguished by the presence of two sensory setae on the middle of the antennule and prehensile claws on the first thoracic leg. Unlike other daphnids, the antennule of the male is not elongated. The newly hatched young were found to be similar to the adults in morphology except for their miniature size. (Plate 1, Fig. 1).

The female neonates pass through 3 preadult instars and 18 adult instars in a life span of 35.8 days, with an average instar duration of 40.9 hours. The males, however, had only 2 preadult instars and there was no moulting in the adult stage. The average instar duration of a male was 56 hours with a life span of 6.5 days. The males matured after two moults. A pair of elongated testes extending over one-third of the length of the animal was distinctly visible at this stage. The mature males had a mean length of 0.675 mm (Plate 1, Fig. 2)

In mature females, the ovaries were seen as a pair of elongated sacs on each side of the alimentary canal. The contents of the ovaries were discharged through a small opening at the posterior end into the brood-pouch. This discharged mass later became spherical and formed the eggs. (Plate 1, Fig. 3). The relationship between mean size of each instar and the number of eggs produced from each brood, and instar duration are given in Table 1.

The morphological features of the embryonic stages of *S. serrulatus* are given below, following the terminology of Green (1966):

Early stage: At this stage, the newly formed eggs are spherical with a mean diameter of 0.27 mm. They are green in colour with a transparent marginal zone (Plate 1, Fig. 4).

Middle stage: At this stage the embryo is somewhat elongated. The head lobe and rudiments of thoracic legs and antennae are visible. Numerous fat globules are also present (Plate 1, Fig. 5).

Final stage: The head is distinct and the eyes are well developed. Antennae are elongated and segmented. A transparent carapace is formed

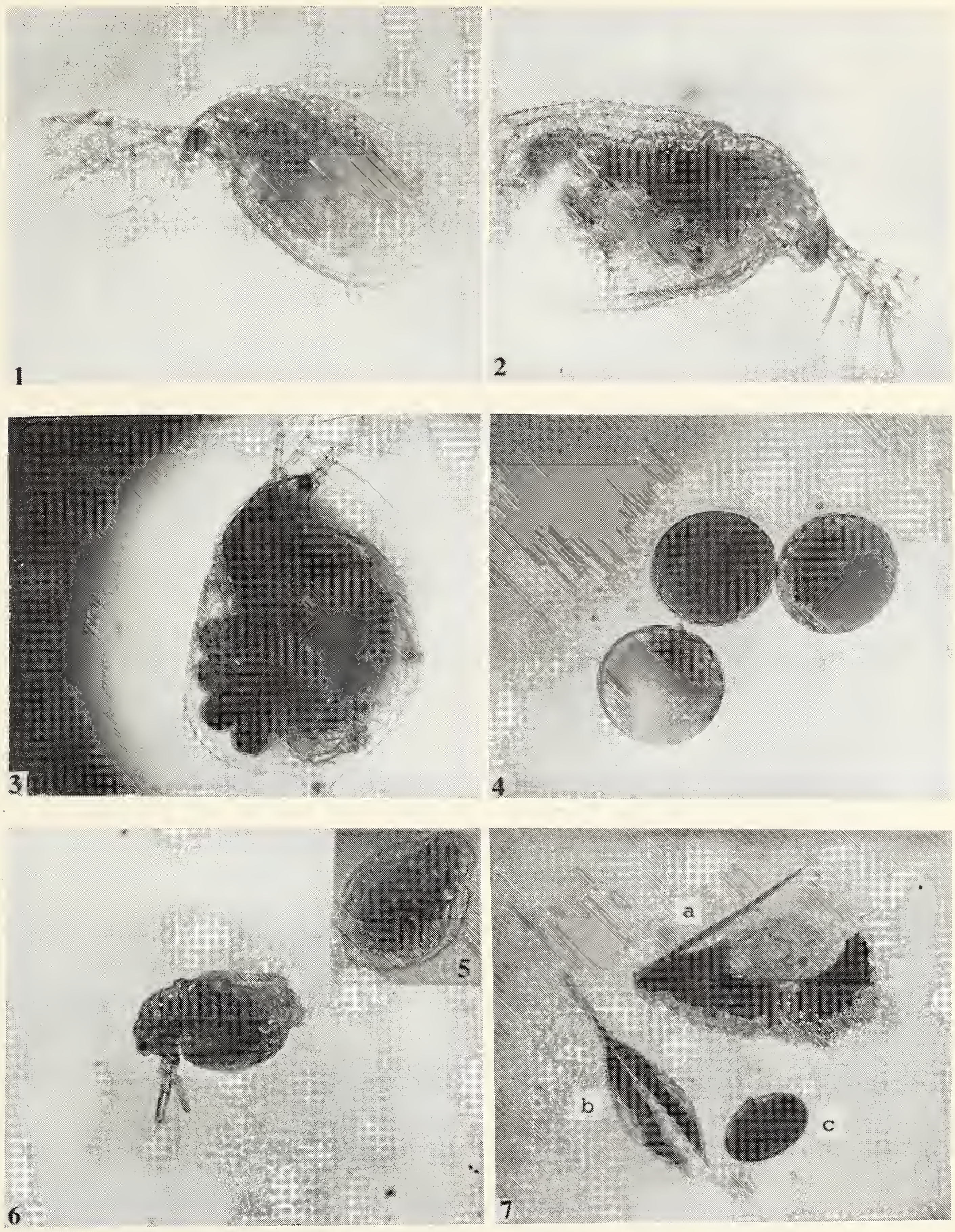

Fig. 1. Newly hatched young (0.6 mm); 2. Mature male (0.67 mm);
3. Parthenogenetic female (1.6 mm); 4. Parthenogenetic eggs (0.25 mm);
5. Developing embryo (0.304 mm) (inset); 6. Embryo with well developed antennae. (0.329 mm);
7a. Ephippium (0.63 mm); 7b. Leathery chorion (0.63 mm);
7c. Resting egg showing outer membrane. (0.27 mm).

TABLE 1
VARIATION IN SIZE AND DURATION OF INSTARS OF *SIMOCEPHALUS*

Instar No.	Mean leanth (mm)	Mean height (mm)	Eggs/brood	Cumulative no. of eggs	Instar duration in hours	Cumulative duration of instar in hrs.
1	0.615	0.42	—	—	32.15	32.15
2	0.87	0.52	—	—	32.30	67.45
3	1.05	0.67	—	—	35.30	99.75
4	1.27	0.90	4.6	4.6	38.00	137.75
5	1.46	1.05	7.2	11.8	38.67	176.42
6	1.65	1.20	14.3	26.1	41.82	218.24
7	1.73	1.33	14.6	40.7	41.58	259.82
8	1.82	1.46	25.6	66.3	36.30	296.12
9	1.90	1.50	32.6	98.9	40.30	336.42
10	2.00	1.60	35.8	134.7	39.45	375.87
11	2.05	1.65	35.2	169.9	41.82	417.69
12	2.15	1.68	37.4	207.3	43.32	461.01
13	2.20	1.72	29.6	236.9	40.28	501.29
14	2.25	1.75	32.4	264.3	42.17	543.46
15	2.28	1.76	27.5	296.8	40.30	583.76
16	2.35	1.85	22.8	319.6	46.30	630.06
17	2.45	1.87	19.5	339.1	44.35	674.41
18	2.47	1.88	17.6	356.7	46.22	720.63
19	2.47	1.88	12.6	369.3	44.42	765.05
20	2.47	1.88	7.6	376.9	46.18	811.23
21	2.48	1.88	7.6	384.5	48.65	859.88

enclosing the body appendages and postabdomen. Alimentary canal is fully extended (Plate. 1, Fig. 6). Towards the end of this stage the appendages are fully developed and the young starts exhibiting movements.

The total duration of embryonic development was observed to be 40-42 hours, after which the young were released from the brood-pouch by jerking movements of the postabdomen of the mother. This took place at any time before the mother passed through the next moult. Immediately after moulting, another clutch of eggs was discharged into the brood-pouch and the parthenogenetic cycle was repeated.

The ephippial females could be distinguished from the parthenogenetic females by their smaller size and by the absence of the blunt posterior spine on the carapace. The ephippium is a modified brood pouch formed on the dorsal half of the valves and is slightly yellowish in colour,its outer surface ornamented with a honeycomb pattern. It is somewhat triangular in shape, with a mean length of 0.63 mm and contains only the resting egg. (Plate 1. Fig. 7a). The resting egg was encased by two membranes, an inner vitelline transparent membrane and an outer thick leathery chorion. When the ephippial females collected from the stock culture were transferred to the beaker containing fresh culture medium, many of them cast off their ephippia along with the moult. The newly released ephippia floated on the surface of the medium for some time and then sank to the bottom or remained adhered to the side walls of the container.

DISCUSSION

Simocephalus acutirostratus and *S. vetulus* are the other two tropical species of the genus *Simocephalus* whose life cycles have been studied by Murugan (1977) and Kanaujia (1987)

TABLE 2
COMPARISON OF THE LIFE CYCLES OF THREE SPECIES OF *SIMOCEPHALUS* FROM INDIA

Species	No. of preadult instars		No. of adult instars		Total number of eggs	Average instar duration	Total lifespan
	Female	Male	Female	Male			
S. acutirostratus	4	—	18	—	248	47.61 hrs.	44 days
S. vetulus	3-4	—	20	—	496	45.10 hrs.	41 days
S. serrulatus	3	2	18	nil	384	40.80 hrs.	35.7 days

similarities, particularly in the number of preadult instars, adult instars and instar duration (Table 2). The effect of temperature and food on the number and duration of instars has been studied by a few workers. Anderson and Jenkin (1942), Murugan and Sivaramakrishnan (1976) have observed that differences in the culture medium might cause variation in the number of instars. Kanaujia (1988) pointed out in *S. vetulus* that temperature is one of the factors influencing the number of adult instars, and lack of food and temperature above 20°C might increase the number of preadult instars. In the present study, however, no such variation was observed. Murugan (1975a) and Venkataraman (1981) could not observe any variation in the number of instars in *Moina micrura* and *Daphnia carinata* respectively. Since the number of instars is likely to be hereditary and species-specific, the influence of extrinsic factors on the number of instars needs further study.

Increase in the size of the individual at each instar is found to be more rapid during the preadult phase and gradually slows down towards the later stages of the life cycle (Table I). Green (1956) also observed the maximum growth rate in the early preadult instars of many daphnids. Murugan and Job (1982) have observed uniform preadult instar durations in *Leydigia acanthoceroides*. In the present study, however, both preadult and adult instar duration varied widely. But the duration of preadult in star was always shorter than the adult instar duration. Primiparous instar had a longer duration than the longest preadult instar duration. Murugan and Job (1982) have also observed a long primiparous instar duration in *L. acanthoceroides*.

In *S. serrulatus* the egg production was initiated at the fourth instar and the maximum number of eggs per brood was found during the 10th to 12th instars, after which there was a decline. Similar observations were also made by Green (1956), and Kanaujia (1988). However, Navaneethakrishnan and Michael (1971) observed in *Daphnia carinata* that the egg numbers gradually increased from the first to the last instar. In *L.acanthoceroides*, Murugan and Job (1982) observed only two eggs in all adult instars, without any increase or decrease in egg-production rate.

Reduced number of preadult instars with long instar duration, absence of adult instars and short life-span of males observed in the present species are likely to apply to other species as well. The rare occurrence of males in the natural population of cladoceran species indicates that the appearance of males is not obligatory in their life cycle. The male, however, is important in the production of ephippial females, which enable the species to tide over drought and other unfavourable environmental conditions. In the present study, a large number of ephippial females appeared in the stock culture when the population attained its peak, with a density of 29,000 individuals per litre of culture medium. Pennak (1953), Michael (1962) and Hutchinson (1967) also observed the presence of a large number of ephippial females when the culture medium became overcrowded.

An important observation in this study is the development of both males and females from the same brood of parthenogenetic females. This has also been observed by Muthu (1983) in *Moina micrura.* Factors responsible for this phenomenon are not yet understood.

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CROP DAMAGE CAUSED BY BLACKBUCKS (*ANTILOPE CERVICAPRA*) AT KARERA GREAT INDIAN BUSTARD SANCTUARY, AND POSSIBLE REMEDIAL SOLUTIONS[1]

Jagdish Chandra[2]

(*With three text-figures*)

Key words: blackbuck, crop damage, great Indian bustard (GIB), sanctuary, management, culling, capture.

An alarming increase in the population of the blackbuck, (*Antilope cervicapra*), at Karera Great Indian Bustard Sanctuary, has been a cause of concern for its nuisance value as a pest of agricultural crops. This paper deals with two and half years of efforts to resolve the problem, along with possible remedial solutions. Efforts were made to catch the animals to translocate them to Madhav National Park, Shivpuri. On experimental basis, one animal was captured alive, but later it died of shock within the enclosure, therefore the process was discontinued. Crops like Mung (a pulse) and Ramas (a bean) were sown near the affected fields so as to reduce the pressure of grazing on the privately owned agricultural fields. Experts from the Wildlife Institute from India, Dehradun, were requested to survey and evaluate the crop damage, and to suggest alternatives to mitigate this problem. Their findings are still awaited.

Introduction

In 1981, the State Govt. of Madhya Pradesh declared Karera Great Indian Bustard Sanctuary, near Shivpuri district, to protect the Great Indian Bustard and other wildlife. Evidently, it was aimed to provide fullest protection to this bird. As a result, other fauna of the sanctuary also started increasing. I took over as the first superintendent of the Karera GIB sanctuary, in January 1983, and estimated the population of blackbucks to be around 150. With protection and management, their population increased alarmingly and in the year 1991, it was estimated at 2626 animals. Such an increase resulted in the problem of crop raiding in the cultivated fields (Prasad, 1982). This paper reports the observations and studies made from 1985 to 1988, for two and half years. Steps were also taken to mitigate the crop damage problem. Proposals and project reports were sent to the Chief Conservator of Forests (Wildlife), M.P., Bhopal, to cope with this problem.

Distribution of Blackbuck:

In India, blackbuck used to be distributed from northwest to south-central India, almost everywhere, except for the thickly forested areas of Kerala, and high forests of Madhya Pradesh. It is also not found on the high altitudes of Uttar Pradesh, Jammu & Kashmir and in the Eastern parts of the country, (Ranjitsinh, 1982, Prasad, 1982). (Map-1). As early as 1947, the popula-tion was estimated at 80,000 heads, but by the end of 1964 only 8,000 remained (Prasad, 1982). After the enactment of the Wildlife (Protection) Act, 1972, and owing to protection, the blackbuck population increased considerably. Presently, their population is variably estimated to be around 11,000 plus (Prasad, 1982), and more than 22,500 (Ranjitsinh, 1982). The statewise populations are given in Table 1.

[1] Accepted August, 1995

[2]Assistant Director, Pench National Park, Barapathar 480 661, Seoni (M.P.) & Ex.- Superintendent, GIB Sanctuary, Karera.

Fig. 1 Present distribution of blackbuck in India

Apart from this, more than 350 animals have been reported from various parts of Seoni, Rajnandgaon, Raisen, Hoshangabad, Gwalior, Mandsaur, Vidisha, Guna, Damoh, Narsingarh and Shahdol district (Ranjitsinh, 1982).

The Karera Sanctuary:

Located in the Karera and Narwar Tehsil of the Shivpuri district of Madhya Pradesh, the Karera Great Indian Bustard Sanctuary covers an area of 202.21 sq. km, and lies between 25° 30' to 45' lat. and 78° 5' to 15' long. The main sanctuary area is 20 km from Karera.(Map 1)

Geology and Topography:

Most of the terrain is plain, with gentle

TABLE 1
THE DISTRIBUTION OF BLACKBUCK IN INDIA

State	Ranjitsinh, 1982	Prasad, 1982
1. Andhra Pradesh	670+	690
2. Gujarat	2300+	2035
3. Bihar	35	Not reported
4. Haryana	50	Not reported
5. Karnataka	2800	1100+
6. Madhya Pradesh	1300	55+
7. Maharashtra	500	Present (Nos. not reported)
8. Rajasthan	7600+	4220+
9. Orissa	700	140+
10. Tamil Nadu	1850	1818
11. Uttar Pradesh	940	142+
12. West Bengal	37	37
Total	22648	11237

In Madhya Pradesh, blackbuck are reported in the following protected areas (Ranjitsinh, 1982):

	approx popln.
Noradeshi Sanctuary, Sagar	466
Bagdara Sanctuary, Sidhi	313
Kanha National Park, Mandla	30
Karera Sanctuary, Shivpuri	80
Madhav National Park, Shivpuri	26
Palpur Sanctuary, Morena	20
Chambal Ghariyal Sanctuary, Morena	113
Total	1048

slopes and undulations which can be seen more toward the east and northwest of the sanctuary. However, a few chains of hills which are exposed on the top and look saddle-shaped are also scattered over the area. The highest peak is 368 m above msl. The sanctuary area has sandy loam and laterite (Murram) soil, but low lying areas have shallow black cotton soil. Boulders and stone consisting of granite mixed with quartz are frequently seen near the foothills and on the elevated areas. Two roads, namely Karera-Behgawan and Karera-Sunari, trisect the sanctuary (Map 3). There are seven man-made wetlands interspersed within the sanctuary; these are Ronija tank, Barsori tank, Berkhera tank, Karai-Ramgarha tank, Gadhai tank, Baraua tank and the Dihalia jheel. Constructed mainly for irrigation and fishery, one of them is famous (Dihaila jheel), and is the largest water body inside the sanctuary. About 377 ha in area, this jheel is visited by tens of thousands of migratory birds in the winter season (Chandra, 1987). It has been proposed as a Ramsar site (Rahmani, 1987).

Vegetation:

Most of the sanctuary land is barren, with scattered vegetation, mostly comprising ber (*Ziziphus jujuba*), babool (*Acacia nilotica*), etc. Kardhai (*Anogeissus pendula*) trees, found on most of the hills, are now growing horizontally because of overgrazing. One can still see the old remnants of kardhai as sacred groves in some of the plain areas of the sanctuary. According to Champion and Seth (1968), the sanctuary area comes under the Northern Tropical Dry deciduous Forest (5B/D54) type.

Climate:

There are three distinct seasons, viz. summer (March-June), rain (July -October), and winter (November-February). Temperature varies from a minimum of 4°C in winter to 46°C in the summer. Sometimes the ground temperature goes up to 48°C in the peak summer. Annual rainfall varies from 65.00 cm to 75.00 cm mostly in the months of August-September.

Human Settlements:

The Karera Great Indian Bustard Sanctuary is peculiar in that out of 202.21 sq.km., only 56 ha belong to the forest department, the rest being private holdings (145.31 sq.km), revenue department (55.55 sq.km) or is covered under village constructions (1.35 sq.km). There are 33 villages spread over the sanctuary, out of which one is abandoned. Nearly 27,000 (census 1981) people reside in the sanctuary i.e. about 133.50 persons per sq.km.

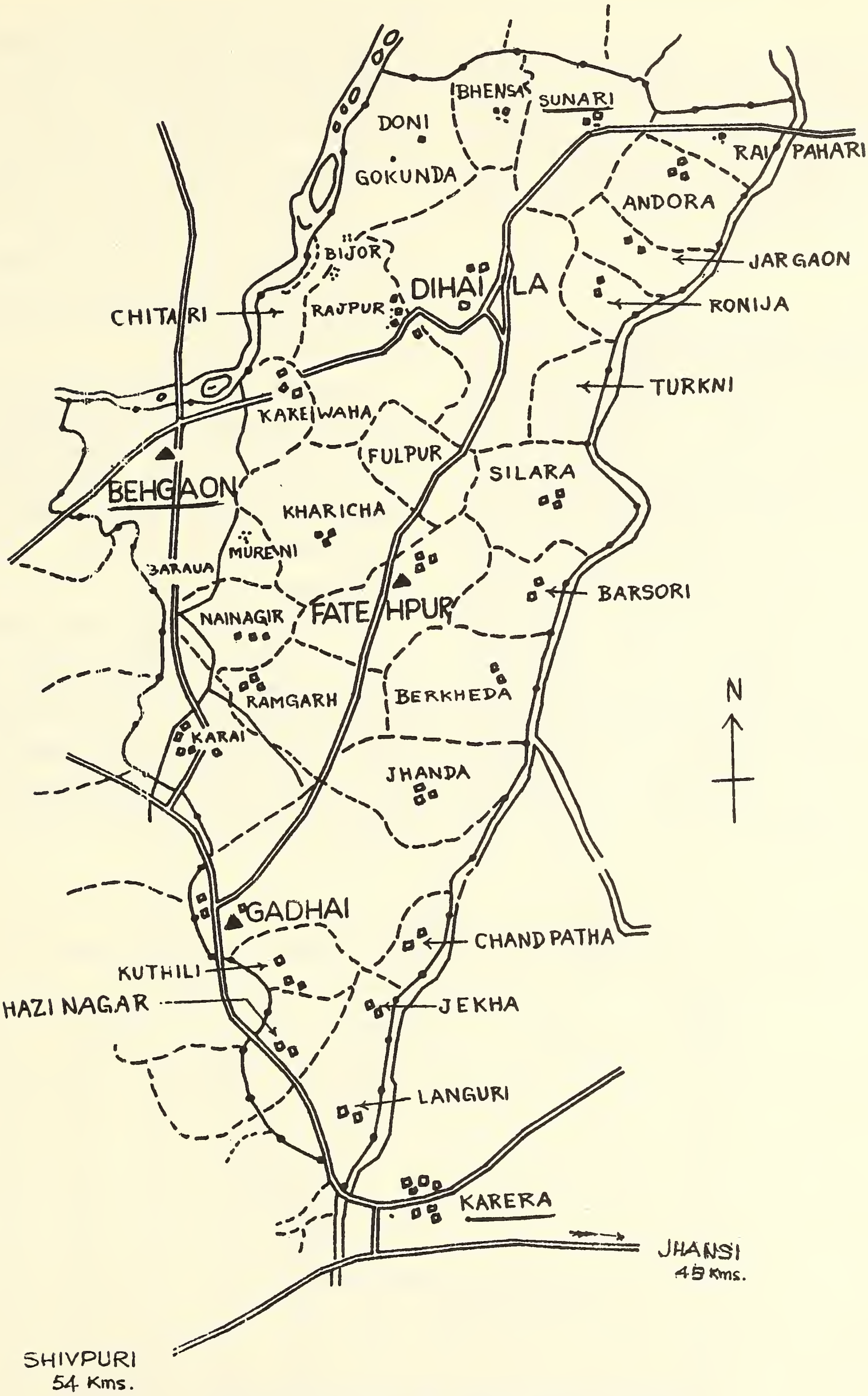

Fig. 2 Map showing the villages inside sanctuary

Livestock:

According to the 1981 census, the cattle population in 32 villages inside the sanctuary is around 36,000, which includes cows, buffaloes, goats and sheep. Other animals such as pigs, dogs, and donkeys are also present. Cattle density is about 178 heads per sq. km.

Land use:

Almost all revenue and private lands are used for cattle grazing. Blackbucks are directly competing for food and are always at loss, due to heavy biotic pressure. Villagers, who have leased out land from the District (Revenue) authorities, often dig wells and construct houses and cultivate crops near the agriculture site. Thus, agricultural fields are interspersed irrationally. Attempt has never been made to cultivate the fields in contiguous areas. Study reveals that unplanned landuse has further shrunken the available land, therefore village land has covered up to 1.66 sq.km, revenue land 52.43 sq.km and private land 148.12 sq. km. The number of wells, hutments etc. constructed in the main study area during the past five years are given in Table 2.

Other activities such as quarrying, fishing, governmental transportation and cow dung collection are regular practices. Human impacts include construction of irrigation canals, electrification of houses and road repairs.

Two crop seasons prevail in the area. The winter or Rabi crops include wheat (*Triticum vulgare*), Bengal gram (*Cicer arietinum*), lentil (*Lens esculentus*). Rainy season or Kharif crops include maize (*Zea mays*), til (*Sesamum indicum*), paddy (*Oryza sativa*), etc.

Seasonal vegetables such as potatoes, radish, ladies finger, etc. are also grown. Wheat is grown over 30.38% of the area, followed by gram (11.54%), maize (10.55%), groundnut (7.71%) and paddy (2.93%). (Source: District statistical data, Shivpuri, 1981).

The Blackbuck:

In 1981, when Karera was declared as a Great Indian Bustard Sanctuary, there were about 150 blackbuck in it. Ranjitsinh (1982), however, reported a population of only 80. Thereafter, the author counted 1169 animals in 1988 (Table 3), and the present population is reported to be 2626 animals (Census 1991). Census data for 1984-88 are given in Table 3.

TABLE 2
FIVE YEARS OF DEVELOPMENT IN CONSTRUCTION WORK IN KARERA GIB SANCTUARY

Village	Total No. of wells in 1981	New wells & hutments (1983		(1984)		(1985)		(1986)		(1987)	
		well	hut	well	hut	well	hut	well	hut	well	hut
Fatehpur	107	2	—	2	1	4	2	2	1	2	1
Silra	60	2	1	1	—	2	1	2	1	3	2
Barsoari	25	1	—	1	1	1	—	2	1	2	1
Kharicha	97	2	1	5	2	5	2	4	2	2	1
Dihaila	40	1	—	1	—	1	—	3	1	2	—
Turkani area	4	2	1	2	1	1	1	1	—	1	1
Rajpur	40	3	1	—	—	3	1	3	1	1	—
Karewah	9	3	2	1	—	—	—	—	—	1	1
Behgawan	34	2	1	3	1	6	2	4	2	2	1
Berkhera	5	2	—	3	1	6	2	2	1	9	4
Total	424	20	7	19	7	30	11	23	10	27	12

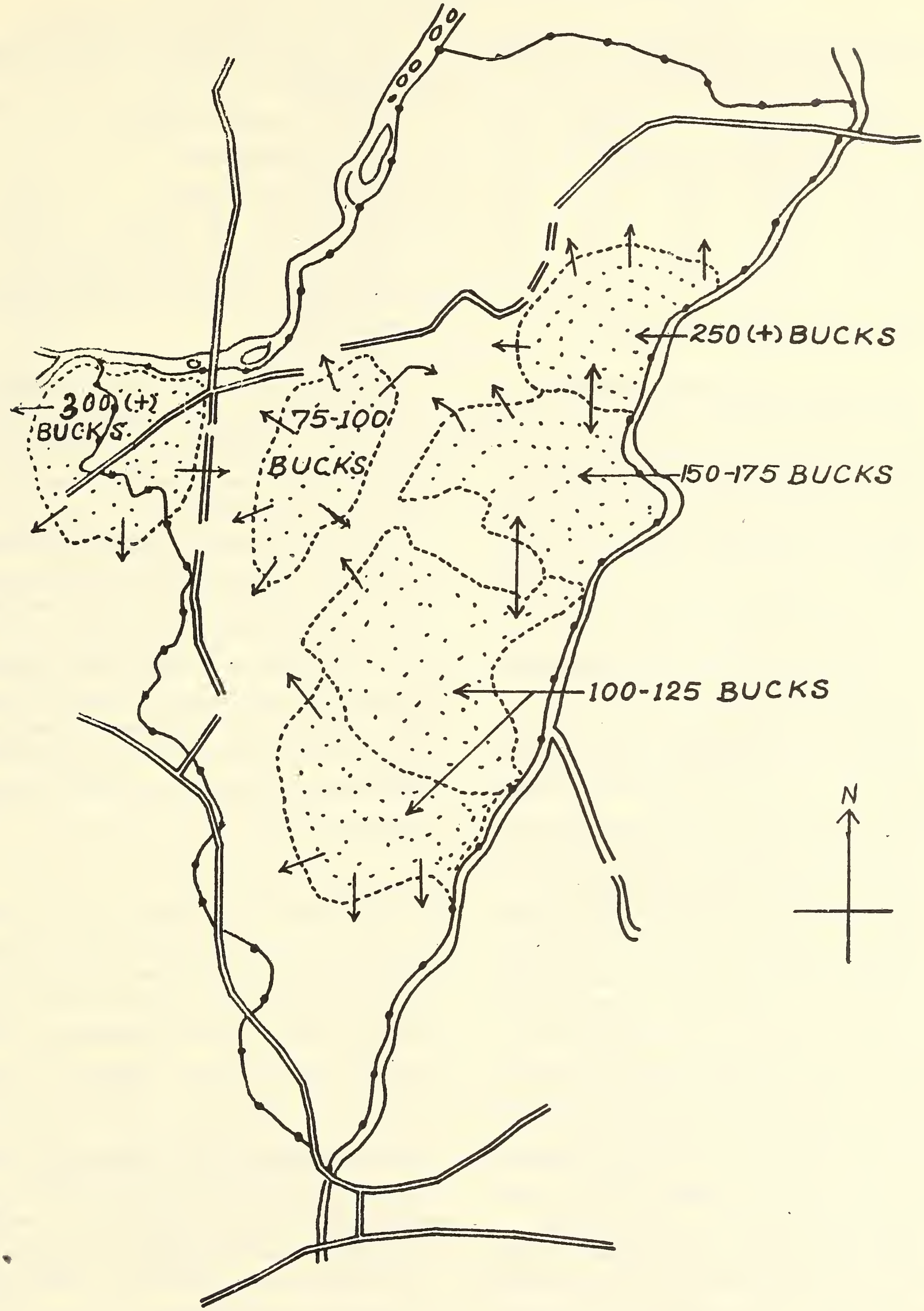

Fig. 3 Map showing distribution of blackbucks and their movement

TABLE 3
CENSUS FIGURES FOR BLACKBUCK IN KARERA, GIB SANCTUARY

Year	Male	Female	Fawn	Unsexed	Total
1984	Census not carried out, but estimated.				187+
1985	45	185	55	21	306
1986	110	205	80	61	456
1987	215	320	140	90	765
1988	279	452	297	141	1169

* See Appendix 1 for graphical representation.

Blackbucks are distributed throughout the sanctuary except for the extreme north and southwest. However, they are less frequently seen on the hills, near the wetlands and areas with black cotton soil. The following are the main areas of their distribution inside the sanctuary (Map 4).

Turkani: This is one of the areas highly populated with blackbucks and is also a core area for the bustards. The Mahuar river in the east forms a natural barrier. This area is about 400 ha with around 250 animals.

Behgawan: This is the largest habitat in the sanctuary for blackbucks, towards the West it extends up to Naraua and Dhamdauli villages, outside the sanctuary. As many as 300 animals are seen here. Animals of this area visit the Bauraua and nearby villages frequently.

Karewah: On the left bank of Kharicha hill, this area has a population of about 100 animals.

Berkhera/plantation: In the southeast of the sanctuary, this is another good area for blackbucks. About 20 ha miscellaneous plantation in this area gives an ideal cover for blackbucks. Almost equal to Turkani in area (along with the plantation of 20 ha), this area is more under pressure because of the Berkhera water body, which is about 104 ha in area. Approximately 200 animals are seen here.

Rasori-Kundpatha: About 200 ha in extent, this area is almost centrally located, and falls around Fatehpur, Silra and Kharicha villages. Due to extensive agriculture, not much area is left barren.

Social structure of blackbuck populations:

The following types of social grouping were observed:

1. Solitary or territorial male,
2. Group of adult males,
3. Group of adult females,
4. Females along with young,
5. Group of sub-adult males,
6. Mixed herd consisting of bucks and does of various ages,
7. Sub-adult females,

I always found the maximum number of animals in the 4th group above. As many as 93 animals were counted in one such group. Ranjitsinh (1982), has, however, recorded 123 heads near Dholi, Gujarat.

In all, 33 groups were observed during the study period. A total of 1028 blackbuck were counted in June 1988, of which 469 were adult and sub-adult males. This lead to a ratio of 1:2.19 in favour of females. Sharma (1989), indicated this ratio for Karera blackbucks as 1:2.17. Prasad (1982), in his studies elsewhere, has mentioned male to female ratio as 1:1.96, and Ranjitsinh (1982), has indicated this ratio for Velavadar (Gujarat) as 1:2.8.

Feeding and crop damage:

Blackbuck in India are mostly graminivorous (Ranjitsinh, 1982; Mungall, 1978). They have also been reported feeding on *Emblica taeriamcottom* (Schaller, 1967), exotic *Prosopis juliflora* (Dharmakumarsinhji, 1967), *Zizyphus jujuba* berries, leaves of *Acacia nilotica,* and ripe fruits of *Eagle marmelos* (Prasad, 1982). At Karera, almost similar type of feeding habits have been observed for natural vegetation. However, I have also observed them feeding rather raiding on *Anogeissus pendula* leaves. These animals were also observed feeding on the agricultural crops raised in and around the sanctuary area (Table 4).

Ranjitsinh (1982), and Prasad (1982), have also reported on crop raiding by blackbucks.

TABLE 4
SEASONAL CROP DAMAGE AT KARERA GIB SANCTUARY BY BLACKBUCK

Common name of the plant	Botanical name	When consumed		
		Summer	Monsoon	Winter
1. Wheat	*Triticum vulgare*	—	—	**
2. Bengal gram	*Cicer arietinum*	—	—	****
3. Mustard	*Brassica junica*	—	—	***
4. Tarmira (Sonha)	*Erue sativa*	—	—	****
5. Lentil (Masoor)	*Lens esculentus*	—	****	**
6. Jowar	*Sorghum halepense*	—	**	*
7. Groundnut	*Arachis hypogea*	—	***	*
8. Mung	*Phaseolous aconitifolius*	*	**	—
9. Paddy	*Oryza sativa*	—	*	*
10. Til	*Sesamum indicum*	*	**	—

— Not cultivated, * Low, ** Medium, *** High, ****Very high

Quantitative data on crop damage by blackbuck were collected during the study period. Main blackbuck areas were frequently visited and information was collected on the basis of personal interview with farmers. Other staff of the sanctuary also gathered such information. These interviews and studies revealed that more crops were damaged in the high blackbuck density areas. A similar problem was observed in Natal, South Africa, where "reed bucks" cause damage to the agricultural crops (pers. comm. R. Putman, 1987). The damage was observed more on the succulent crops, especially the tender shoots and blades. Damage to wheat, jowar and paddy was mostly at the succulent stage. These crops were less preferred when their leaves became coarser. Species-wise feeding preference was found in the following descending order: Lentil <Sonha < Mustard < Bengal gram < Wheat < Jowar < Mung < Til <Paddy. Crop damage in the villages are given in Table 5.

TABLE 5
ESTIMATED CROP DAMAGE BY BLACKBUCK INSIDE THE SANCTUARY VILLAGES

Villages	Areas of distribution	Estimated % of crop damage
Dihaila, Ronija Silara	Turkani	Upto 10%
Fatehpur, Kharicha	Rasori-Kundpatha	Upto 7%
Berkhera, Jhanda	Berkhera (Plantation)	Upto 7%
Behagawan, Baraua	Behagawan	Upto 10%
Karewah, Murheni	Karewah	Upto 5%

In subsequent years, it has been found that crop damage is increasing. Species-wise crop damage estimated by Sharma (1989), is given in Table 6.

Measures taken to manage the blackbuck populations:

After the inception of the sanctuary an evaluation of the habitat and land use was made, and proposals were put forward to deal with this problem.

CAPTURE: Efforts were made in 1987, to capture some of the blackbuck and to shift them to Madhav National Park, Shivpuri. For this, long nylon nets about 2.5 m in height were made and spread (like a corral) over the affected areas. Animals were driven towards the netting site to enclose them, but no success was achieved.

In 1988, Mogia or Pardhi tribals who are traditionally animal trappers by profession, were engaged to catch these animals alive. We were able to catch only one doe, but due to shock it died on the same day within the enclosure. Therefore the operation was stopped.

RAISING ALTERNATIVE CROPS: Proposals made to cultivate agriculture crops similar to those by the farmers in the affected areas, so as to reduce the pressure of blackbuck on the cultivated fields. In 1990-91, an area of 32 ha. was cultivated by the forest department by spending about Rs. 76,000/-. In 13 ha. mung and ramas (a kind

TABLE 6
SPECIES-WISE CROP DAMAGE BY BLACKBUCK

Sl. No.	Name of village	Name of the crops	Calculated % of the damage
1.	Behagawan	Bengal gram	14.22%
		Wheat	13.63%
		Lentil (Masoor)	12.50%
		Taramira (Sonha)	17.64%
		Mustard	15.49%
2.	Baraua	Bengal gram	11.90%
		Wheat	11.45%
		Lentil	12.50%
		Taramira	12.71%
		Mustard	8.82%
3.	Murheni	Bengal gram	13.63%
		Wheat	9.22%
		Lentil	20.00%
		Taramira	—
		Mustard	—
4.	Kharicha	Bengal gram	12.21%
		Wheat	8.44%
		Lentil	21.42%
		Taramira	12.50%
		Mustard	15.00%
5.	Gadhai	Bengal gram	9.58%
		Wheat	9.80%
		Lentil	—
		Taramira	3.33%
		Mustard	—
6.	Jhanda	Bengal Gram	10.27%
		Wheat	2.96%
		Lentil	15.00%
		Taramira	—
		Mustard	—
7.	Niwari	Bengal gram	13.98%
		Wheat	11.50%
		Lentil	15.00%
		Taramira	—
		Mustard	—
8.	Berkhera	Bengal gram	10.23%
		Wheat	13.71%
		Lentil	—
		Taramira	—
		Mustard	6.25%

* See Appendix 2 for graphical representation.

of pulse and bean), were sown and in 19 ha. bengal gram was sown. The success achieved is yet to be evaluated, but the effort has been discontinued.

CANALS: The irrigation department is going to build a major irrigation project in the Sanctuary area. This would lead to a great disturbance in the blackbuck and bustard habitat. Three distributory canals are proposed to pass through the Sanctuary, namely D3, D4 and D5. Diversion of route of one of the irrigation canal D5was carried out with the help of the Irrigation department so that the GIB and blackbuck habitat is safeguarded. Change in the course of canal D3 is yet to be carried out. However, canal D4 may not affect the habitat so much.

ACQUIREMENT: Near Behgawan, 56 ha of revenue land was acquired through the Collector, Shivpuri, in 1986. It was fenced by a cattle-proof trench from one side, to provide a suitable habitat for the blackbuck and bustard.

A proposal for acquiring the "Turkani" (397.5 ha) habitat was sent to the Collector Shivpuri, so as to make this area suitable for bustard and blackbuck. A proposal to enclose this area was also sent to the Chief Conservator of Forests, (Wildlife), Madhya Pradesh, in 1986.

EXTENSION PROPOSED: A proposal for the extension of the Sanctuary towards the western side of Naraua, Dhamdauli, and Gwalipura villages, was also sent to Bhopal, in 1987, to provide alternate habitat for the blackbuck and bustard.

COMPENSATION: To reduce the loss to the villagers, a proposal for provision of compensation for crop damage was also sent in 1988.

BAN ON LEASE OF THE LAND: District revenue authorities were approached not to issue any "patta" (land on lease) to the villagers. Finally, the Collector, Shivpuri, issued an order on 27th September, 1983, not to lease out any land inside the sanctuary area.

SURVEY: The Wildlife Institute of India, Dehradun and Bombay Natural History Society, were approached from time to time to look into this problem and to suggest alternatives. The former, sent their Scientists in 1987. They were appraised of the situation and taken into the sanctuary for survey, unfortunately no solutions have been received so far.

Other possible measures:

Based on past experiences, we can suggest the following:

1. Physical capture of blackbuck and their translocation to Madhav National Park, Shivpuri, or other similar areas could be tried. Apart from efforts made before, rocket netting, drop netting, capture with noose etc. (Gopal, 1992; Giles, 1981; Sale and Berkmuller, 1988) could be effective solutions.
2. Chemical immobilization and subsequent transportation of these animals to sustainable habitats can also be tried. For this, appropriate drugs, such as rompan, ketamine hydrochloride, hellabrun mixture etc. can be used under expert guidance.
3. Fencing of the proposed Turkani area by chainlink fence and bringing the animals inside it by luring them with artificial feed like gram, mahua (*Madhuca indica*), etc.
4. Fencing of the agriculture crops could be another solution, but as the fields are disjunctly distributed, it would be a very difficult task.
5. Creating a blackbuck sanctuary as a "Sanctum santorum" and shifting of the affected villages elsewhere.
6. Fertility control of the animals to reduce the rate of reproduction may be another possibility.
7. As done before, large scale departmental cultivation could also be tried, so that crop raiding on the farmers' cultivation is mitigated. But this is not a long term solution.
8. Culling of the population, if agreed at all the levels, (Putman R., 1984), could be tried.
9. Providing compensation to the villagers for crop damage, but as the number of blackbuck in the sanctuary is increasing, it will not be practical in the long run. However, as compensatory relief it can be tried, to reduce the antagonism from the farmers

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SEXUAL SYSTEM AND POLLINATION ECOLOGY OF *CARDIOSPERMUM HALICACABUM* L. (SAPINDACEAE)[1]

K. Rama Das,[2] C. Subba Reddi,[3] Raju J.S. Aluri[3] and J.B. Atluri[4]

Key words: sexual system, xenogamy, wasps, bees, *Cardiospermum halicacabum*

Cardiospermum halicacabum is a weed perennating through rootstock, and also reproducing through seed. it produces inflorescences on long peduncles in leaf axils in acropetal succession. The inflorescence is a trichasial compound cyme, each cyme consisting of three flowers. Only one flower of a cyme antheses at a time, not necessarily in sequence, reflecting a 'steady state' pattern of flowering. Flowers are either staminate or pistillate, and at any given time both types occur on a plant, facilitating geitonogamy. *C. halicacabum* is also cross-compatible, and the small number of flowers opening daily and limited nectar production compel the floral visitors, both bees and wasps, to fly from patch to patch, thereby accomplishing xenogamy. The wasps *Rhynchium* sp. and *Vespa* sp. are particularly more mobile and assume greater importance as cross-pollinators. The small, white flowers with a yellow nectar guide exhibit wasp flower syndrome. The sexual system with options for both geitonogamy and xenogamy enables this twining weed to survive in changing environments.

Introduction

The information available on the reproductive ecology of Sapindaceae is limited. The studied species include both Neotropical and Paleotropical members. *Cupania guatemalensis* bears first staminate, then usually pistillate and finally staminate flowers; the temporal separation of sexual phases largely facilitates outcrossing. It is primarily pollinated by species of *Trigona* in Costa Rica (Bawa 1977). *Urvillea ulmacea* is self-compatible and temporally dioecious and pollinated by bees in secondary tropical forests in Venezuela (Zapata and Arroyo 1978). *Sapindus emarginatus* exhibits temporal dioecism with the same sequence of sexual phases as that of *Cupania guatemalensis.* It is geitonogamously pollinated by bees and flies and xenogamously by wasps and butterflies in India (Subba Reddi *et al.* 1983). *Litchi chinensis* also exhibits temporal dioecism and is pollinated by insects in India (Khan 1929). Cruden (1988) reports that temporal dioecism may be a common sexual system in Sapindaceae.

Cardiospermum is another genus in Sapindaceae consisting of 23 species. The species are herbaceous tendrilar climbers and distributed chiefly in tropical America and Africa. Two species have been reported to occur in India, *C. halicacabum* and *C. canescens* (Cooke 1902; Anonymous 1950). There appears to be no published reports on the reproductive ecology of the members of this genus. The present study describes the sexual system and pollination ecology of *Cardiospermum halicacabum* which is a major component of the ground vegetation which thrives during the rainy season in the study area. Besides, it has some medicinal value. The root is used as a diuretic, laxative, and for treating rheumatism and nervous diseases. The leaf juice is used as ear drops to cure ear ache and foul smell in the ear. The leaves are rubbed with castor-oil and applied externally as a paste to reduce swellings and tumours (Thammanna and Narayana Rao 1990).

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[2]Department of Botany, Noble College, Machilipatnam 521 001, India.
[3]Department of Environmental Sciences,
[4]Department of Botany, Andhra University, Visakhapatnam 530 003, India.

Material and Methods

The dense patches of *Cardiospermum halicacabum* L. found along roadsides, fallows and at the peripheries of the degraded scrubland in Visakhapatnam (17° 42' N Long and 82° 18' E Lat.), Andhra Pradesh, India were studied. After witnessing the flowering season, observations on the phenology of flowering at population, individual and inflorescence levels were made. To determine inflorescence flowering phenology, 25 mature inflorescences were tagged to record the daily anthesis rate and the duration of flowering life. As this species bears staminate and pistillate flowers within the same inflorescence, their numbers were separately counted each day. From these numbers, the sex ratios for the inflorescence and for an individual plant were arrived at. Whether the anthesis of the staminate and pistillate flowers overlapped or not have also been observed at different phases of flowering. The daily anthesis schedule, anther dehiscence time, mode of dehiscence, determination of pollen production, pollen-ovule ratio, duration of pollen viability and stigma receptivity, flower life-time, nectar secretion, breeding systems, natural fruit set rates, etc., were examined using the methodology given by Aluri and Subba Reddi (1994). The flower visitors were captured and identified by tallying them with specimens already identified by Commonwealth Institute of Entomology, London. Foraging activity, foraging behaviour, forage resources sought, and foraging efficiency of the visitor species were thoroughly observed.

Results

Plant flowering phenology: This is a herbaceous vine reproducing sexually by seed and asexually by vegetative growth. The seeds germinate soon after the southwest monsoon showers in June; they germinate and grow vegetatively at a rapid pace. Perennating rootstock remains underground and becomes active, producing vegetative growth and/or flowering vigorously, as soon as moisture is available in the soil. After 2-3 weeks of vegetative growth, they gradually produce inflorescences and initiate flowering in the 1st week of June. Once flowering begins in the mature inflorescences, it continues until all flowers are anthesed. With the periodic rainfall during the monsoon, new branches originate from the stem and produce new leaves and inflorescences. With the addition of new inflorescences, vigorous blooming in an individual plant extends to November/December. Plants in wet soil flowered even to the end of January. In such soils, the seeds produced in July germinated in the same season, produced a few leaves and immediately started flowering. Within 2-3 weeks, they terminated flowering and withered. Flowering is not observed on days preceded by heavy rains. The inflorescences which completed flowering quickly produced fruit in about 15 days. Soon after fruit production, the fruit-bearing parts become dry. Thus the plant bears some withered branches and some branches in either vegetative phase or flowering phase at the same time. The total duration of the flowering of an individual plant lasts for 8-9 months. The plants in an area and in different areas come to bloom nearly at the same time.

It is observed that summer rains in April/ May also trigger seed germination and subsequent vegetative growth and flowering. Once the plants begin vegetative growth as a response to summer showers, they continue to grow due to subsequent monsoon showers or rain in June.

Inflorescence flowering phenology: The plants produce trichasial compound cymes in the axils of leaves. Each trichasial cyme is subtended above by a pair of tendrils. In a trichasial compound cyme, each cyme bears 3 flowers, and altogether 9 flowers are produced. Once flowering in a trichasial cyme starts it produces 1 or 2 flowers a day until all 9 flowers are anthesed. Within a 3-flowered cyme, only one flower matures at a time. The flowering life of a trichasial cyme is 5-6 days.

Flower morphology and sexuality: The staminate and bisexual flowers are morphologically identical except for the essential organs. The flowers are small (5 mm), pedicellate, white and odourless. The calyx is light green and has four sepals arranged in two rows. The outer two are small while the inner ones are twice as large as the outer ones; all sepals are regulose and concave. The calyx is persistent, even after fruit maturation in bisexual flowers. The corolla is white and contains four obovate petals. They are free and arranged alternately with the sepals; each petal is 2.0-2.5 mm long. Additionally, there are four scales originating inside the petals and covering the vertically held staminal complex/ovary from the base to the top. The two anterior scales are fused to 1/4 of their length from the base and are villous to glabrous. The scales are white except for the apex, which is yellow and quite prominent at a distance to attract flower-visitors. Further, the apices have an appendage which is white, deltoid, villous and deflected towards the anthers situated on the posterior side. The two posterior scales are completely white, free from the base to the top and sparsely villous to almost glabrous giving the appearance of a hood sheltering the staminal complex. These scales do not possess the appendage. Androecium constitutes 8 stamens in both flower types. They are free, aggregated and hooded by the posterior scales. The stamens are of three different lengths. In staminate flowers, the longer three stamens are 2.5 mm long, the two medium stamens 2.0 mm and the three shorter ones 1.5 mm long. All three lengths of stamens are 0.5 mm less and not aggregated in bisexual flowers. In bisexual flowers, the gynoecium consists of a 3-carpelled syncarpous ovary with a short style having 3 stigmas. Each carpel has one locule containing one ovule. The ovary is 3-lobed, obcordate and densely villous. The stigmas are white in colour like the anthers. At a glance, the stigmas give the impression that they are stamens. The stigmas become persistent crowning the fruit apex. There is a disc with 2 broad glands on the side of the posterior scales and two small glands on the side of anterior scales situated at the base of the flower in both staminate and bisexual flowers. This glandular disc secretes nectar and is fully protected by the closed vertical column formed by both anterior and posterior scales.

The stamens in bisexual flowers are not prominent because of their small size and attachment to the sides of the ovary lobes below. They possess pollen-bearing but non-dehiscing anthers. In staminate flowers, the stamens are prominent and possess pollen-bearing dehiscing anthers. Therefore, the apparently bisexual flowers are functionally pistillate, and hereafter mentioned like that. The plants are thus functionally monoecious.

Sex ratios: Each trichasial cyme produces both staminate and pistillate flowers; both flower sexes are produced within a simple cyme. In the simple cyme if the first flower is pistillate, the other two are staminate flowers; if the first one is a staminate flower, the other two are one staminate and the other pistillate. Both flower sexes were produced on the same day but on different cymes and within the same trichasial cyme. There is no staggering of sexual phases. The ratio of staminate versus pistillate flowers in a trichasial cyme is either 1.25:1 or 1:1.25 or 2:1. The first ratio is found in 50% of trichasial cymes, the second in 30% and the third in 20% of the cymes. At plant level, the ratio of staminate and pistillate flowers is 1.2:1 (Table 1). Overall, the observed ratio is biased in favour of staminate flowers. The ratios remained constant throughout the flowering period.

Anthesis and anther dehiscence: Both the flowers open, irrespective of their gender, during 0500-0900 hrs; with a higher frequency (65%) during 0500-0600 hrs at 29-32°C and relative humidity of 70-80% (Table 2). The anthesis is delayed on cool and/or cloudy days; the length of delay from the scheduled time is subject to

TABLE 1
NUMBER OF STAMINATE AND PISTILLATE FLOWERS ON DIFFERENT INFLORESCENCES IN *CARDIOSPERMUM HALICACABUM*

Inflorescence number	No. of flowers per inflorescence	Staminate flowers	Pistillate flowers
1	9	5	4
2	9	4	5
3	9	4	5
4	9	5	4
5	9	5	4
6	9	6	3
7	9	5	4
8	9	4	5
9	9	4	5
10	9	6	3

the degree of coolness, it ranged from 1 to 2 hours. In both flower sexes, anthesis starts with gradual unfolding of petals, which take about 35-40 minutes for complete unfolding. The vertical column comprising anterior and posterior scales and covering the stamen/ovary remains in the same position and the scales do not unfold during the entire period of flower life. In staminate flowers, the anthers dehisce by longitudinal slits an hour after anthesis.

TABLE 2
RATE OF ANTHESIS IN *CARDIOSPERMUM HALICACABUM*

Time (hrs)	No. of flowers anthesed	Anthesis (%)	Temperature (°C)	Relative humidity (%)
2200	—	—	30.5	82
2300	—	—	30.5	82
2400	—	—	30.5	78
0100	—	—	30.5	78
0200	—	—	30.5	76
0300	—	—	29.5	76
0400	—	—	29.0	80
0500	52	34	29.0	80
0600	48	31	30.0	78
0700	26	17	30.5	78
0800	19	12	30.5	76
0900	09	6	31.5	72
1000	—	—	32.0	70
1100	—	—	33.0	70

Nectar characters: The glandular disc present at the base of both staminate and pistillate flowers produces nectar in traces soon after anthesis and is protected by the vertical column formed by the scales.

Pollen characters: Pollen grains of staminate and pistillate flowers are the same except for the size and germinability/viability. Both grains are smooth on exine, without ornamentation, triangular and tricolpate, light and powdery. The size of the pollen grain in staminate flowers is 40-63 μm and that in pistillate flowers is about half of the size of the former. The pollen grains in the pistillate flowers are normally deformed.

The number of pollen grains per anther of staminate flowers averaged 360 (R 340-395), and that per flower came to 2880. In pistillate flowers, an anther produced an average of 175 pollen grains (R 160-188).

Pollen-ovule ratio: The anthers of pistillate flowers are indehiscent. Therefore, their pollen is not considered for calculating the pollen-ovule ratio. At the inflorescence level, the ratio of viable pollen grains (from staminate flowers) per single ovule is either 1200:1 or 768:1 or 1920:1. At the plant level, the P/O ratio is 6136:1.

Pollen viability: The pollen grains of staminate flowers are viable with anther dehiscence. They germinated well in 20-25% sucrose solution with 5 ppm detergent. Viability lasted for 24 hrs. The stored grains after 6 hrs showed 100% germination, after 18 hrs and 24 hrs showed 30% and 10% germination respectively. Thus, the grains appear to remain viable throughout the flower life (Table 3).

Although anthers of pistillate flowers do not dehisce, they were also tested for viability. The grains did not germinate in any of the sugar concentrations from 0 to 60% with or without detergent. Thus, the pollen grains in pistillate flowers are completely sterile.

TABLE 3
RESULTS OF *IN VITRO* OF POLLEN IN *CARDIOSPERMUM HALICACABUM*

Time (hrs)	No. of pollen grains observed	No. of germinated pollen grains	Germination (%)
6	50	50	100
12	40	28	60
18	35	10	30
24	30	03	10
48	25	0	0

Stigma receptivity: The stigmas of pistillate flowers attained receptivity by the time the anthers of staminate flowers release their pollen. The stigmas were viscid and shiny at this time and remained in that state for about 12 hrs. The stigma receptivity was also tested by fruit set. The fresh stigmas and also the 7 hrs old ones yielded 100% fruit set. The 10 hrs old stigmas produced 40% fruit set and 12 hrs old ones gave 10%. The stigmas which were 13 hrs old did not fruit. Therefore, the stigma receptivity in a flower lasted for 12 hours (Table 4).

TABLE 4
RESULTS OF *IN VIVO* STIGMA RECEPTIVITY IN *CARDIOSPERMUM HALICACABUM*

Time (hrs)	No. of stigmas pollinated	No. of flowers set fruit	Fruit set (%)
3	20	20	100
5	20	20	100
7	20	20	100
10	20	8	40
11	20	4	20
12	20	2	10
13	20	0	0

Breeding behaviour: The results of breeding experiments indicated that pistillate flowers do not produce fruit through apomixis. Geitonogamy and xenogamy operate, the former with 100% success and the latter with 66% (Table 5). As the staminate and pistillate flowers anthese at about the same time at the inflorescence level and plant level, geitonogamy is likely to occur. Xenogamy is also operative because the plants occurring in an area and in different areas come to flower nearly at the same time.

TABLE 5
RESULTS OF BREEDING EXPERIMENTS IN *CARDIOSPERMUM HALICACABUM*

Treatment	No. of flowers pollinated	No. of flowers set fruit	Fruit set (%)
Apomixis	30	0	0
Geitonogamy	30	30	100
Xenogamy	30	20	66

Natural fruit set: The intensity of fruiting varied in different phases of flowering. The rate of fruiting corresponds to the degree of foraging activity of the visitors. The fruiting in the initial phase was 80%, followed by 100% during the peak phase of flowering. The fruiting rate gradually declined from 75 to 45% towards the end of the flowering period (Table 6).

TABLE 6
NATURAL FRUIT SET RATES AT DIFFERENT PHASES OF FLOWERING IN *CARDIOSPERMUM HALICACABUM*

Flowering month	Flowers tagged	Flowers set fruit	Fruit set (%)
INITIAL			
July	20	16	80
PEAK			
September	20	20	100
November	20	15	75
FINAL			
January	20	9	45

Flower visitors: There were eight different species of insects foraging at both staminate and pistillate flowers (Table 7). These included bees, wasps, a fly and a butterfly. The species of foragers at two different sites were common between the two sites. But, species appearance at different phases of flowering at each site varied slightly. *Apis* and *Trigona* (bees), *Vespa* (wasp) and *Eristalinus* (fly) were evident throughout the flowering period at the two sites. *Ceratina* (bee)

TABLE 7
FLOWER VISITORS AND THEIR FORAGE TYPE IN *CARDIOSPERMUM HALICACABUM*

Visitor species	Forage type Nectar	Pollen	Region of contact with pollen/stigmas
HYMENOPTERA			
Apidae			
Apis cerana indica	+	+	Head and ventral side
A. florea	+	+	Head and ventral side
Trigona sp.	+	+	Head and ventral side
Ceratina sp.	+	+	Head and ventral side
Eumenidae			
Rhynchium metallicum	+	—	Head and ventral side
Vespidae			
Vespa sp.	+	—	Head and ventral side
DIPTERA			
Syrphidae			
Eristalinus quinquestratus	+	+	Head and ventral side
LEPIDOPTERA			
Lycaenidae			
Euchrysops cnejus	+	—	Proboscis, head and anterior body

TABLE 8
CENSUS OF FORAGERS ON *CARDIOSPERMUM HALICACABUM* DURING THE INITIAL, PEAK AND FINAL PHASES OF FLOWERING
(Flowers under observation 100 at each site)

Forager species	Site I			Site II		
	Initial	Peak	Final	Initial	Peak	Final
Apis cerana indica	250	440	283	300	480	100
A. florea	240	400	198	280	420	160
Trigona sp.	110	220	92	90	104	90
Ceratina sp.	45	80	31	40	56	0
Rhynchium metallicum	98	120	82	100	164	0
Vespa sp.	30	42	18	20	52	10
Eristalinus quinquestratus	10	12	12	28	48	16
Euchrysops cnejus	0	20	6	12	24	0

Site I: Wild habitat behind A.U.R.S. Hostel (WAURSH)
Site II: Wild habitat behind A.U. Healthcare Centre (WAUHC)

and *Rhynchium* (wasp) appeared during the initial and peak phases of flowering only. The unidentified butterfly species foraged at the peak and final phase of flowering at WAURSH site and at the initial and peak phase at the WAUHC site. Overall, the foraging visits of bee species were more than those of wasps, fly and butterfly species taken separately or collectively (Table 8).

The *Apis* species were the first to forage on either flower sexes. They commenced their foraging even before sunrise at 0530 hrs and continued upto 1100 hrs. They resumed from 1430 hrs and ceased by 1600 hrs. Their activity was very brisk during morning hours. *Trigona* and *Ceratina* nearly commenced their foraging activity at the same time from 0830 hrs onwards and ceased foraging by 1500 hrs with occasional visits during 1200-1330 hrs. The wasp species first appeared to forage at the flowers at 0830 hrs and continued until 1500 hrs. They were relatively more active during 0830-1100 hrs and made occasional visits at other times. *Eristalinus* foraged during 0800-1100 hrs and again during 1500-1600 hrs. The butterfly species was active from 0730 hrs foraging now and then until 1500 hrs; thereafter it ceased foraging.

Foraging behaviour: In both flower sexes, the yellow spots on the anterior scales appeared to serve as nectar guides for the flower visitors. Accordingly, the insect visitors approached the flower frontally by landing or hovering on the vertically held posterior scales sheltering the stamen/ovary. The bee species foraged for both nectar and pollen. For collecting nectar, they inserted their proboscids into the floral base from above on the side of anterior scales with yellow spots. After collecting nectar, they withdrew their proboscids from the flower. For collecting pollen, they first held the posterior scales with their legs and collected pollen from the dehisced anthers. In either case, the pollen got deposited on the lower part of the head and the entire ventral side of the bee body. When the medium sized *Apis* species landed and foraged, the flower swung and the insects probing activity resulted in the separation of vertically held scales to some extent. This facilitated collection of floral rewards very easily by these bees. After the departure of these bees, the separated scales did not get back to their original position. Subsequent visits, 2 or 3, by these bees to such flowers led to the near complete removal of pollen in the staminate flowers and the deposition of pollen grains on stigmata in pistillate flowers. *Trigona* and *Ceratina* bees are small in size and their landing or probing behaviour did not result in the separation of scales in fresh flowers. They easily probed the flowers which were visited earlier by *Apis* species. The two wasp species approached the flower on the side of posterior scales and hovered while inserting their proboscides from above through the staminal complex touching the appendages of the anterior scales for collecting nectar. During collection, the ventral side of their body and the lower part of their head were dusted with pollen grains in staminate flowers and if they made subsequent visits to pistillate flowers, the pollen grains were transferred from their ventral surface to the stigmas, effecting pollination. While the wasps foraged at the flower, the scales were not separated to the extent in the case of foraging by *Apis* bees. The fly and butterfly species were ineffective in separating the scales, but both collected floral rewards without disturbing the flower and pollen grains were carried away on the head/ventral surface of the body in the former and on the proboscis, head, anterior/ventral side of the body in the latter. All visitor species moved between staminate and pistillate flowers within and between plants, the inter-plant movement rate varying with each group of insects. All these visitors foraged on both staminate and pistillate flowers without any discrimination.

Foraging efficiency: In a single visit, the bees and the flies collected nectar and pollen in staminate flowers; sometimes, only one reward, nectar or pollen per visit was collected. As the staminate flowers offered two floral rewards and the pistillate flowers only one, the flower visitors spent more time per flower in the former and less time for exploiting nectar in the latter. However, determination of length of time spent in each case became difficult because of morphological similarity of both flower sexes. In general, the time spent per flower by all species was 7-9 seconds except for *Trigona* which spent more time (11.5 seconds) than other visitors. In terms of mobility, the *Apis* species and the wasps were mobile and foraged 7-9 flowers in a unit time while the others foraged 1-2 flowers (Table 9). It indicated that honeybees and wasps are efficient in foraging and in their flight from one flower to another.

TABLE 9

FLOWERS VISITED PER MINUTE AND LENGTH OF A FORAGING BOUT IN SECONDS

Visitor species	Average no. of flowers foraged per minute	Average time spent per flower in seconds
Apis cerana indica	9.0	9.0
A. florea	7.0	8.0
Trigona sp.	1.5	11.5
Ceratina sp.	1.0	9.0
Rhynchium metallicum	7.0	8.0
Vespa sp.	8.0	7.0
Eristalinus quinquestratus	1.5	7.0
Euchrysops cnejus	1.0	8.5

Pollination: The complete overlapping of sex stages of a plant is clearly an adaptation favouring geitonogamy. The almost synchronous flowering in the plants of an area and in different areas provides possibilities for xenogamous pollination. The bees and the fly tended to stay on the same patch and infrequently moved between patches, while the wasps and the butterfly tended to move frequently between patches. This indicated that the bees and the fly are important for geitonogamy, while the wasps and the butterfly are more important for xenogamy.

DISCUSSION

Cardiospermum halicacabum is functionally monoecious. The plants appear annually with the monsoon rains both from the perennial rootstock and from the seed produced after sexual reproduction. The rootstock gives rise to bushy growth while the seed gives rise to a plant which subsequently ramifies. Both forms produce trichasial compound cymes. A mature branch produces inflorescences in the leaf axils; it continues to produce inflorescences in the tender leaf axils. Thus, inflorescence production is in acropetal succession. After maturation and dispersal of fruits in these branches, secondary branches arise from below and they in turn produce inflorescences in acropetal succession. Such branching depends on the availability of moisture. During the dry periods, the mature active flowering branches are at a pause. Thus, depending on the moisture availability, flowering is seen at intervals. This is comparable to the 'episodic' flowering of certain plant species, *sensu* Bullock *et al.* (1983).

Inflorescence is a trichasial compound cyme and produces nine flowers, at the rate of three flowers per cyme, over a period of 5-6 days, and within a three-flowered cyme, only one flower antheses at a time, not necessarily in sequence. This pattern of producing a limited number or few flowers on a daily basis reflects the pattern of 'steady state' flowering, *sensu* Gentry (1974). At any time, both staminate and pistillate flowers are available on the plant, and the staggering of sexual phases which is supposed to be characteristic of Sapindaceae (Bawa 1977, Subba Reddi *et al.* 1983) was not seen. The co-occurrence of the two sexual phases on this functionally monoecious plant might be a strategy for geitonogamous reproduction. Experimental manipulation of selfing through geitonogamy has resulted in 100% fruit, showing that the taxon has adapted to selfing through geitonogamy.

C. halicacabum is a herbaceous twiner weed and a species by its occurrence in situations disturbed by man (Baker 1965). Certain characters are associated with weeds, among which those related to reproduction are: (1) low pollen/ovule ratio with self-pollination, and thus an economy of pollen production; (2) when cross-pollinated this is achieved by a non-specialised flower visitor or wind; and (3) very high seed output (Baker 1955, Mulligan 1965, Allard 1965, Cruden 1973). Mulligan and Findley (1970) found that all the annual weeds they studied were capable of selfing and concluded that selfing is of special adaptive value to annual weeds. Stebbins (1965) while studying the colonising species of the native Californian flora stated that the material he analysed suggested that for an annual weed species, the most adaptive condition is self-fertilisation and for a perennial obligate outcrossing is most often favoured by selection. Bentley (1979) based on her study of the role of heterostyly in the pollination and seed set of *Turnera trioniflora*, a roadside weed of the Amazon basin suggested that a high level of genetic heterogeneity is advantageous for tropical weed plants. The reproductive traits of *C. halicacabum* comply with the above cited weed characters.

C. halicacabum is also compatible to xenogamous pollination, if not of the same level as of geitonogamy, and such pollination in experiments yielded 66% fruit set. In plant species with a provision for outcrossing, the amount of legitimate pollen transfer decreases with each flower visited and 6-10 flowers is the maximum number that can be visited before all pollinations become geitonogamous (Levin *et al.* 1971). Therefore, a flowering strategy with a small number of flowers opening at a given time would maximise cross-pollination and hence fruit set (Cruden 1976). This strategy is adopted by *C. halicacabum* and enables it to achieve cross-pollination and cross-fertilisation with the attendant genetic variability. The small number of anthesed flowers and limited nectar production compel the flower visitors to move from patch to patch, thereby moving xenogamous pollen (Heinrich and Raven 1972, Cruden 1976). The two wasp species (*Rynchium* sp. and *Vespa* sp.) are particularly mobile, and assume importance as cross-pollinators. The small size of the flower with white corolla, and a yellow nectar guide appear to correspond with the wasp pollination syndrome described by Heithaus (1979) and Faegri and van der Pijl (1979).

The hetergeneity of both physical and biotic factors over a local scale in both space and time is being increasingly recognised in tropical environments (Ashton 1969, Bentley 1979). Where environmental heterogeneity is high, it seems that selection would favour a sexual system which produces both the parental genotypes as well as genotypes "pre-adapted" to conditions different from those under which the parent germinated and established (Bentley 1979). The sexual system of the functionally monoecious *C. halicacabum* and its flowering strategy ensuring geitonogamy with possibilities for xenogamy attest to the above prediction.

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COMMUNAL ROOSTING IN COMMON MYNAS *ACRIDOTHERES TRISTIS* AND ITS FUNCTIONAL SIGNIFICANCE[1]

Anil Mahabal[2]

(*With two text-figures*)

Key words: communal roosting, common myna, *Acridotheres tristis*

The common myna *Acridotheres tristis* (Linnaeus) is a familiar urban bird. Throughout the year they roost communally at night in large numbers either independently or forming mixed species roosts. The various communal roosts of mynas situated in and around Pune (Maharashtra) were kept under observation for studying the occupation, abandonment and reestablishment of roosts and roosting trees, and the daily routine of mynas from 1973 to 1976. Three well marked seasons were observed in its annual cycle: the pre-breeding, breeding and post-breeding seasons. The probable functional significance of communal roosting in mynas has been discussed in the paper.

Introduction

Communal roosting and the activities associated with it have been a popular subject studied in a number of avian species (Wynne-Edwards 1962, Braestrup 1963, Siegfried 1971, Zahavi 1971, Gadgil 1972, Tast & Rassi 1973, Ward & Zahavi 1973, Gadgil & Ali 1975, Gyllin & Kallander 1975, Khera & Kalsi 1986) and also in common mynas (Sengupta 1973, Counsilman 1974, Feare 1976, Greig-Smith 1982). The detailed studies on the flock structure, directional routes, population fluctuations, pre-roost gatherings and communal displays, diurnal rhythms in the awakening and roosting activities, intra- and interspecific assemblages during day time and night, mixed roosting and the related social behaviour of common mynas have already been dealt by Mahabal & Vaidya (1989), Mahabal *et al.* (1990), Mahabal & Bastawade (1991) and Mahabal (1992, 1993- a & b).

The common myna *Acridotheres tristis* (Linnaeus), (Sturnidae: Passeriformes) is a familiar urban bird. It is omnivorous and a hole-nester. Mynas are social in their habits. They are generally seen in pairs or in small groups during day time. Throughout the year, they roost communally at night in groups of 100-10,000 birds, either independently or forming a mixed roost along with some other species of birds.

The present paper deals with the observations on the communal roosts and roosting trees, their abandoning and reestablishment, and the probable functional significance of communal roosting of the common myna.

Material and Methods

The studies on common myna were carried out at Pune (18° 30' N lat., 73° 53' E long.) and surrounding areas. Altogether 27 communal roosts of mynas within a radius of 24 km were located (Fig. 1) and censused. Of these, eight roosts were situated in the surrounding areas and the remaining nineteen communal roosts were centrally located within a radius of 8 km. These nineteen roosts were designated as R-I to R-XIX for convenience while recording the observations.

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[2]Zoological Survey of India,
Western Regional Station, 1182/2 Fergusson College Rd, Shivajinagar, Pune 411 005

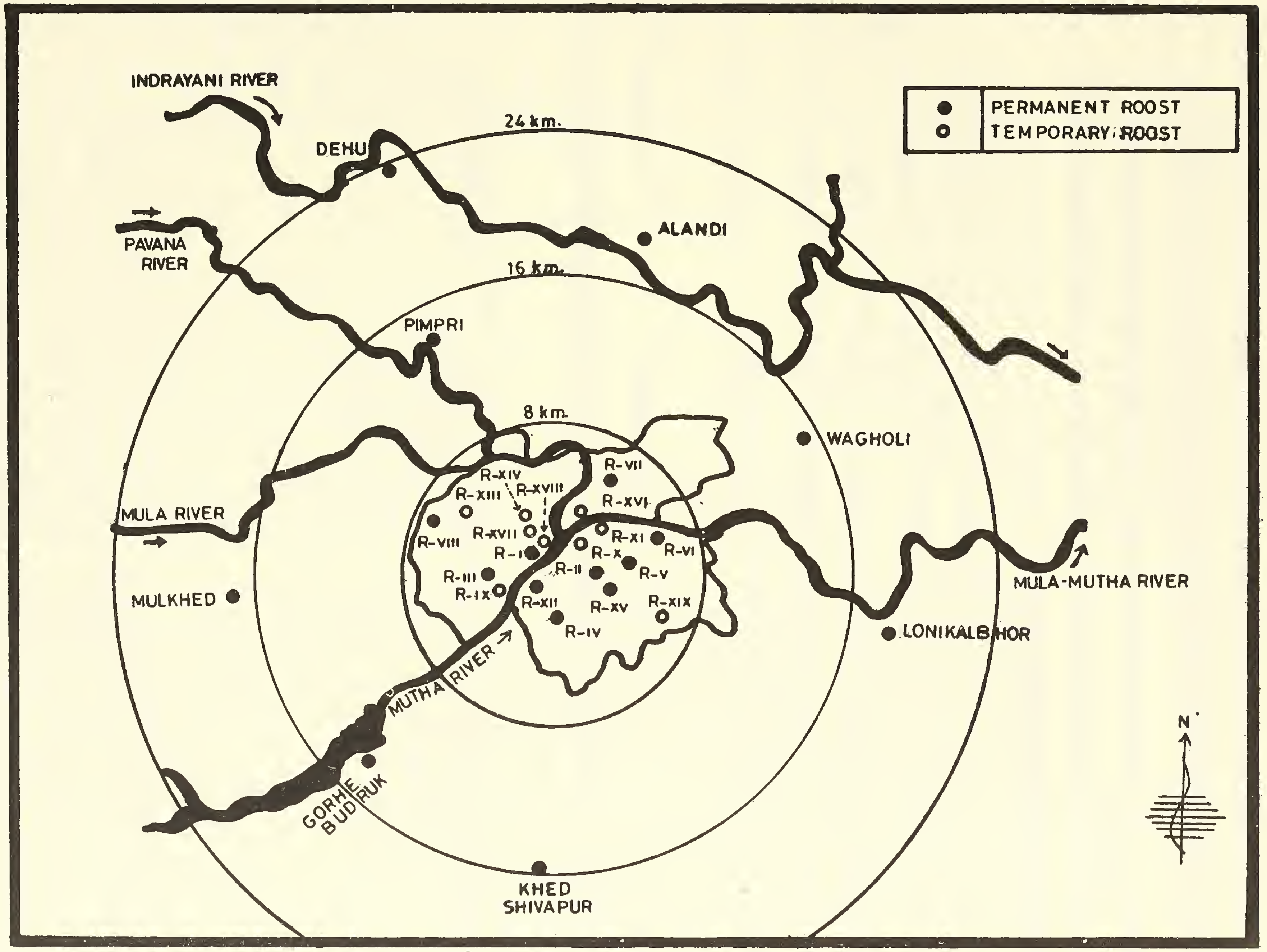

Fig. 1 Locations of communal roosts of common myna in and around Pune . R-I: Police Ground, R-II: St. Vincent, R-III: Film Institute, R-IV: Peshave Park, R-V: Race Course, R-VI: Koregaon Park, R-VII: Yerawada, R-VIII: Pashan, R-IX: Diwagi Metal Works, R-X: Pune Railway Station, R-XI: Bund Garden, R-XII: Vaikunth, R-XIII: N.C.L., R-XIV: Agriculture College, R-XV: Cantonment Hospital, R-XVI: Deccan College, R-XVII: Sancheti Hospital, R-XVIII: Engineering College, R-XIX: Wanwori.

They were censused once a month during June 1973 to August 1976 to study the population, roosting behaviour, roost occupation and abandonment, and the daily routine of mynas. These observations were repeated for confirmation at roost R-IV during August 1980 to July 1981.

Results

Communal Roost and Roosting Trees: Out of the 19 communal roosts observed within city limits, ten roosts were recorded throughout the period of study (permanent roosts). The remaining nine roosts were found to be temporary. They were abandoned frequently or totally during the study period (Fig. 2). At all these sites, mynas have roosted in close proximity with human settlement, on trees of different species at a height ranging between 3.00 and 12.5 m.

Further, it was observed that altogether 75 roosting trees were occupied by mynas at all the nineteen (permanent and temporary) communal roosts located within the city area. The maximum occupation was noticed on banyan (*Ficus bengalensis*) trees (48%) which seem to be the most favourable for roosting. The other trees occupied by mynas were *Mangifera indica* - mango (10.4%), *Cassia siamea* - kassod (10.4%), *Saraca indica* - ashoka (7.8%), *Acacia arabica* - acacia (7.8%), *Delonix regia* - gulmohar (5.2%), *Azadirachta indica* - neem (5.2%), *Tamarindus indica* - tamarind (2.6%) and *Syzygium cumini* - jamun (2.6%). It was also observed that mynas used only a single tree for roosting at each temporary roost, whereas at permanent roosts, they occupied 3 to 16.

Out of the eight communal roosts located in the surrounding suburban areas of Pune city (Fig. 1), at seven places mynas have chosen to roost mostly on trees of *Ficus bengalensis*, whereas at one place, they have roosted inside a factory (Cooper Engineering, Pimpri) on iron structures built near the ceiling. All these roosts were permanent in nautre.

It was noticed that some of the roosting trees at a permanent roost situated within the city area were abandoned temporarily and were again reoccupied during the period of study. The seasonal frequency of abandoning of roosting trees was then calculated by considering all the ten permanent roosts (Table 1) along with their average population during the season. It indicates that in general the seasonal frequency of abandoning of roosting trees was lowest in the post-breeding season and was highest in the breeding season in each year of observation.

Table 1

MEAN FREQUENCY OF ABANDONING OF ROOSTING TREES AND AVERAGE NUMBER OF BIRDS AT TEN PERMANENT ROOSTS

Year	Post-breeding (Aug-Oct)	Pre-breeding (Nov-Mar)	Breeding (Apr-Jul)
1973-74	0.50	1.40	2.10
*Average Number	(17296.70)	(9625.20)	(11637.00)
1974-75	1.60	2.50	3.50
*Average Number	(14591.7)	(12509.20)	(11311.00)
1975-76	2.40	3.80	4.90
*Average Number	(17977.50)	(14819.60)	(13679.50)

*Average number of birds have been compiled from Mahabal *et al.* (1990).

Daily routine: In the annual cycle of Indian myna the following three well marked seasons were observed: pre-breeding (November-March), breeding (April-July) and the post-breeding season (August-October). In general, the daily routine of mynas at a roost is as follows: after a night-long rest, mynas slowly become active in the early morning by vocalizing and vacate the roost around sunrise in the various group-sizes. They spend the day time in the feeding arena in various activities. They start their return journey towards the roosts in the evening, arrive at the roosts around sunset in the various group-sizes and vocalize loudly till they finally retire for a communal night sleep. Further, particularly towards the end of the post-breeding

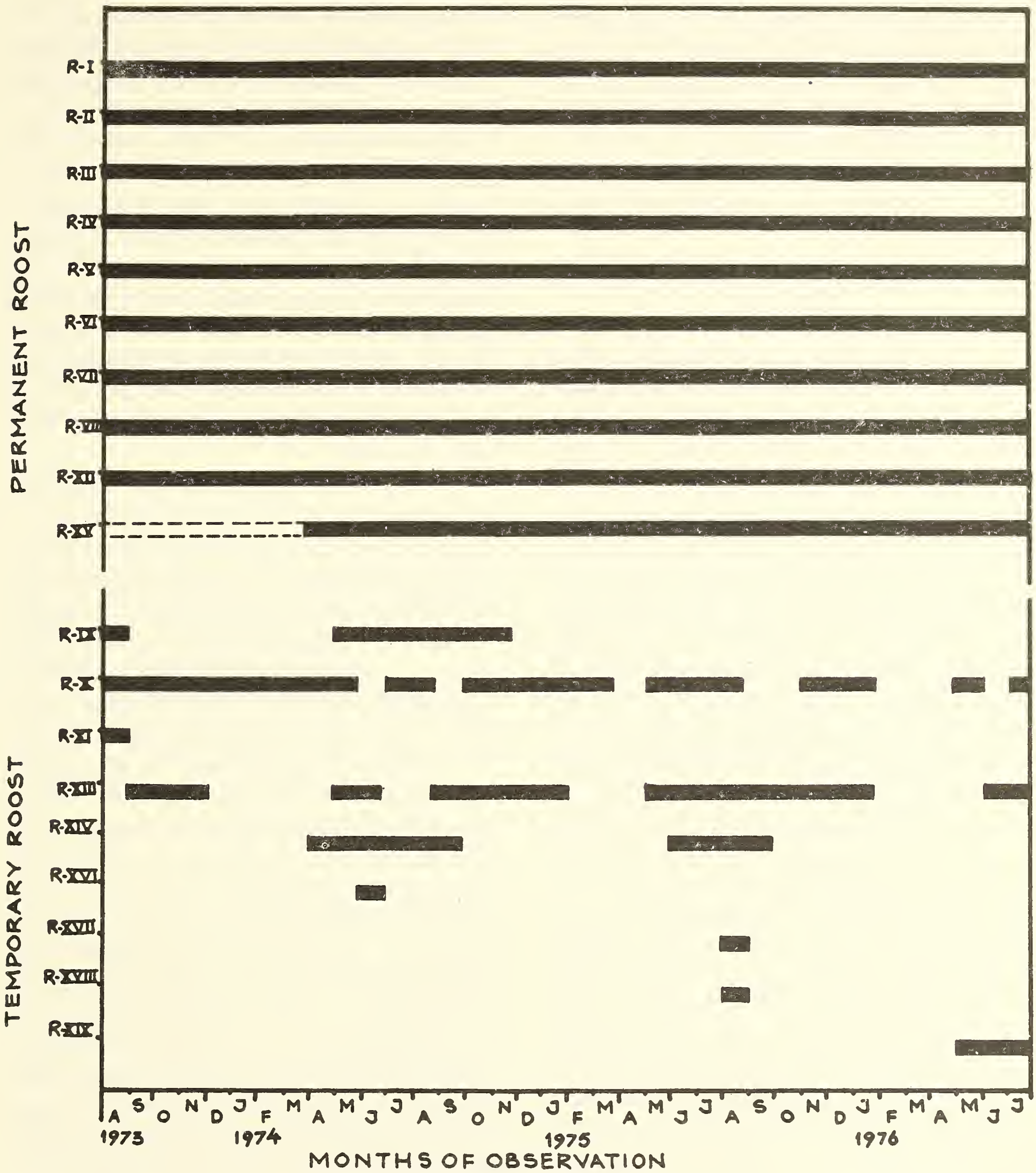

Fig. 2 Periods of occupation of permanent and temporary roosts of common mynas during study period 1973-76.

season (from October) and throughout the pre-breeding season, mynas gather and perform certain movements in the vicinity of the roosts and perform post- and pre-roosting communal displays. However, during the breeding and part of the post-breeding seasons (i.e. April to September), most of them go directly to the roost without performing movements and communal displays.

Discussion

Permanent roosts of mynas have been observed at certain localities since the beginning of this study in 1973, during 1980-81 and are still known to exist there (1994). Some of the roosts have been known to exist for more than 50 years. This indicates that these are traditional roosting sites chosen by mynas, year after year. Counsilman (1974) stated that common mynas occupy a roost continuously for many years in succession. Generally, mynas have roosted in trees during the night, although a roost at Pimpri was found to be inside a factory building. Mynas have also been observed to roost inside railway stations on iron structures at Ambala and Chandigarh (pers. obs.).

Mynas in Pune city have avoided night roosting at highly wooded areas in the town such as the Botanical garden and Empress garden, which have negligible human settlement. At the same time, they have avoided highly congested localities in the city area for roosting. It seems therefore, that they require some optimal density of human population with an open area around the roosting site. Further, why do mynas not stay at a single huge roost, instead of dispersing over a number of roosting sites in the city? This may probably be done to avoid overcrowding. Secondly, dispersing to various roosts is more profitable in order to exploit better feeding spots and also for securing the nearest breeding territories in the breeding season.

The phenomenon of primary establishment, abandoning and re-establishment of roosting trees at a permanent roost seem to be common in mynas. This is probably correlated with the population of mynas in the city area. The total population of mynas increases during the post-breeding season and during this period the frequency of abandoning of the roosting trees is comparatively the lowest. On the contrary, as the population decreases in the pre-breeding and breeding seasons, the abandoning of roosting trees at roosts also become more frequent. Further, it is not clear why mynas abandon temporary roosts frequently or totally. Gadgil (1972) has pointed out that, at mixed communal roosts, abandoning of roosts by *Corvus* sp. is followed by abandoning of roosts by common mynas. Similarly, this may perhaps be applicable to a certain extent in our study on mynas.

Functional Significance of Communal Roosting: There has been a great deal of discussion on the functional significance of communal roosting in various bird species. Even so, this phenomenon is still not fully understood. A number of suggestions and hypotheses have been put forth, among them are a few major hypotheses which have been discussed in the context of our present study on common mynas.

1. **Heat Conservation**: That communal roosts undeniably minimize the loss of heat on cold nights has been suggested by various workers as summarized by Counsilman (1974). Further, he has pointed out that the conservation of heat cannot be a consideration in common mynas as neither are the winters severe in the areas inhabited by them in New Zealand, nor are the birds usually in contact with each other at the roosts. Gadgil & Ali (1975), rejecting the hypothesis on two grounds, have stated that i) communal roosts should be commoner amongst the birds of higher latitudes and altitudes but such is not the case, and ii) the ambient temperature is unlikely to produce vital changes under Indian conditions. Similarly, environmental conditions are quite pleasant in Pune, there are no extreme changes in the ambient temperature, hence this hypothesis may not be applicable in our studies on mynas.

2. **Population regulation**: Wynne-Edwards (1962) hypothesized that communal roosting enables the birds to assess population density, which is then adjusted to the prevailing level of food supply through emigration or adjustment of reproductive rate. Many workers have raised objections to this hypothesis, indicating that it is inconsistent with the principles of natural selection. Counsilman (1974) stated that he does not see how it can be applicable to the myna. Wynne-Edwards (1962) further states that species of dissimilar feeding habits associate in mixed roosting only in rare cases. Gadgil & Ali (1975) while rejecting the hypothesis pointed out that their data does not support the hypothesis as well. The phenomenon of mixed roosting also poses difficulties, as an associate species is more likely to be of dissimilar rather than of similar feeding habits. Similarly, our data show that birds of diverse food habits often associate with common mynas at a number of mixed roosts (Mahabal & Bastawade, 1991). Hence our studies do not support the hypothesis at present.

3. **Feeding efficiency**: Ward (1965), Siegfried (1971), Zahavi (1971), Ward & Zahavi (1973) and many others have suggested that communal roosts serve as centres for the exchange of information regarding the location of food sources and have been evolved for the efficient exploitation of patchily distributed food sources. Gadgil & Ali (1975), Feare (1976) and Greig-Smith (1982) have also supported this theory of information transfer. Ward & Zahavi (1973) have further pointed out that the pre-roosting displays and roost advertisement behaviour are devices for attracting the maximum number of birds at communal roosts. This in turn makes it possible to search larger areas for food and increases the chance of getting good feeding places. The studies on mynas do raise some doubts with respect to this novel hypothesis: i) the roost sites chosen by mynas in Pune city are traditional and occupied year after year. ii) the presence of post-roosting displays in the morning and the complete absence of post- and pre-roosting communal displays over six months from April to September is difficult to explain the theory of roost advertisement for attracting the maximum number of birds at roosts. However, communal displays may have other functions which are dealt in detail by Mahabal (1993b). Counsilman (1974) has also clearly pointed out that common mynas in New Zealand use the roosts for many years and most birds are faithful to a particular roost, therefore daily advertisement is unnecessary. Khera & Kalsi (1986) have stated that pre-roost gatherings of bank mynas (observed only during non-breeding season) did not function as advertising centres. iii) common mynas invariably form mixed roosts with crows, parakeets, egrets, kites and other birds (Mahabal & Bastawade, 1991). The food habits of these associates are totally divergent and it is difficult to imagine that the strictly frugivorous parakeets contribute any information to the strictly carnivorous kites or to the mynas. It was also noticed that the flight, speed, direction and timing of departure and arrival of various species of mixed roosting birds are different from those of common mynas. Hence, the communication of information regarding the location of food sources may not be functioning at interspecific level but it may be possible at the intraspecific level (Mahabal & Bastawade, 1991).

4. **Antipredatory function**: It is inferred that communal roosting enables birds to reduce the risk of predation and serves an antipredatory function (Zahavi 1971, Gadgil 1972, Sengupta 1973, Counsilman 1974, Gadgil & Ali 1975, and Khera & Kalsi 1986). However, Ward & Zahavi (1973) have suggested that communal roosting positively increases the susceptibility to predators and that the information exchange is the only function of communal roost. Gadgil (1972) has stated that the phenomenon of mixed roosting strongly supports the notion of antipredator function. Further, Gadgil & Ali (1975) have indicated that it is more likely that different species of birds roost communally for predator avoidance and pool this advantage by forming

mixed roosts of greater numerical strength. Khera & Kalsi (1986) have also pointed out that bank mynas and associated species at mixed roosts respond readily to each others' alarm calls, which is an efficient antipredator mechanism. This may also outweigh the disadvantage of communal roosts being more conspicuous. Counsilman (1974) has stated that communal sleeping habit protects common mynas more from predators than if they slept solitarily.

Likewise, it is possible that common mynas and their mixed roosting associates have developed a system of antipredatory warning signals (Mahabal & Bastawade, 1991) which increases the awareness of the individual bird and thus affords some kind of protection not only at the roosts at night but also in the feeding area during day time (Mahabal, 1992).

5. **Social significance**: Braestrup (1963) has quoted that the chief survival value of communal roosts consists in reduced mortality during night. This does not necessarily mean that communal roosts have no social significance. Tast & Rassi (1973) while supporting the above statement indicated that probably roosting behaviour functions to synchronize various activities. Gyllin & Källander (1976) have also mentioned that besides the antipredatory function, synchronizing social behaviour may also be important. Various systematic and synchronized behavioural patterns observed in our studies on mynas (Mahabal & Vaidya 1989, Mahabal 1993 a & b) do suggest that the communal roost has social significance.

In conclusion, the data reveal that gathering and flocking tendencies of the common mynas within its own species and with other species of birds during day time and at communal roosts have been evolved not only through mutual attraction but also to get certain benefits out of the social system, particularly the synchro-nization of various activities, avoidance of predation, and information about the food sources, as also indicated by Mahabal (1993a).

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OBSERVATIONS ON THE POST-NATAL DEVELOPMENT OF INDIAN FALSE VAMPIRE BAT *MEGADERMA LYRA* (MICROCHIROPTERA)[1]

R. Subbaraj[2], J. Balsingh[3] and M. Singaravel[2]

(*With two text-figures*)

Key words: *Megaderma lyra*, bats, forearm length, weaning, fledgling stage.

Growth and development of the young *Megaderma lyra* were observed under natural conditions. Forearm length, length of third and fifth fingers were measured as indices of growth rate in *M. lyra*. By the age of 5 to 6 weeks young bats attained about 80% growth characteristics of the adults and were able to fly. Weaning occurred at the age of 2.5 months.

Introduction

In several species of bats, the growth of the body of the young is rapid during early life. The young animals weigh almost as much as the adults when they are about 5 months of age, so that young ones cannot be distinguished from the adults on the basis of the size of the body after this age (Madhavan 1978). The growth curves of certain species of bats such as *Rousettus aegyptiacus* show that individual variations are very slight in the first phase of development. This may be taken as a hint of a strict genetic determination of the neonatal period (Noll 1979). Many qualitative and analytical approaches have been used to describe post-natal growth in insectivorous bats. Some workers have used various kinds of allometric analyses to characterize post-natal growth (Yokoyama *et al.* 1975). Since in many cases growth of forearm length and the fingers can be measured easily and consistently, they have become the characters of choice in most studies on post-natal development (Kunz and Anthony 1982). In general, the length of forearm is stabilized at about 5-6 weeks of age and is close to the adult size (as in *Plecotus townsendii* - Pearson *et al.* 1952; *Nyctalus noctula*-Kleiman 1969; and *Myotis velifer* - Kunz 1973). The growth of the 3rd and 4th fingers occurs at a more rapid rate than that of the 2nd and 5th fingers (Funakoshi and Uchida 1981). In most species of bats, increase of body weight is very rapid during the first four weeks following birth. Birth weight of young is 20% to 25% of the mother's post-partum weight and double by the end of 2nd week (Orr 1970).

Although some aspects of reproduction and sexual cycles such as mating, gestation and embryology of the Indian false vampire bat *Megaderma lyra* (Gopalakrishna 1969) have been studied in detail, post-natal development in this species is poorly understood. We have gathered data relating to growth and development of the young in *M. lyra*. The information given here is based upon bats born in their natural habitat.

Material and Methods

The studies on *M. lyra* were conducted in a temple roost at Krishnapuram (8° 44' N lat, 77° 42' E long - Southern India). Data on growth of *M. lyra* were obtained from the maternity colony of approximately 70 adult females and

[1]Accepted December, 1995.

[2]Department of Animal Behaviour and Physiology,
School of Biological Sciences, Madurai Kamaraj University, Madurai - 625 021, India.
[3]Department of Zoology, St. John's College,
Palayamkottai - 627 002, India.

their young located in the temple during the breeding months (March-June) in 1990. Juvenile bats were captured with a hand-held collecting net along with mothers from the day roost. Each individual was banded with a plastic collar having a coloured bead for individual identification (Balasingh *et al.* 1992). The sex of the young ones was noted, and the presence or absence of an umbilical cord or placenta was recorded. Right forearm length and the length of third and fifth fingers was measured with high precision Vernier calipers. To maximise sample size, juveniles were also collected from other roosts like cow-sheds and unused houses between 1930 hrs and 2100 hrs following the departure of mothers for foraging. After taking measurements of the forearm length and the length of third and fifth fingers, the juveniles were placed back in their respective roosting places, usually before adult females returned from their foraging bouts. On each visit all accessible banded bats were recaptured, and the measurements regarding their growth were taken again.

Results

Post-natal development

Neonates: The young are functionally altricial at birth, but they are extremely large, weighing 23.67% of the mother's postpartum mass. Several juveniles of *M. lyra* were collected with umbilical cords attached. Forearm length of individuals varied between 30.6 and 33.1 mm (x + SD = 31.63 ± 0.9 mm); the length of third finger varied between 41 and 43 mm (x + SD = 41.97 ± 0.7 mm) and fifth finger between 30.2 and 33.1 mm (x + SD = 31.67 ± 1.08 mm). These bats were considered neonates. Infants with long and fresh umbilical cords attached or infants with forearm length less than or equal to the length of the largest umbilical cord attached to the bat were considered to be one-day old (Kunz 1974). The umbilical cord in a newborn baby bat measured 31 mm. The umbilical cord remained

Table 1

MEASUREMENTS OF GROWTH PARAMETERS OF MALE AND FEMALE *M. LYRA NEONATES.*

Forearm length (mm)		III finger (mm)		V finger (mm)	
male	female	male	female	male	female
31.3 (±0.482)	31.3 (±0.573)	42.0 (±0.729)	41.7 (±0.608)	32.3 (±0.647)	32.0 (±0.906)

The numbers in parentheses denote standard deviation.

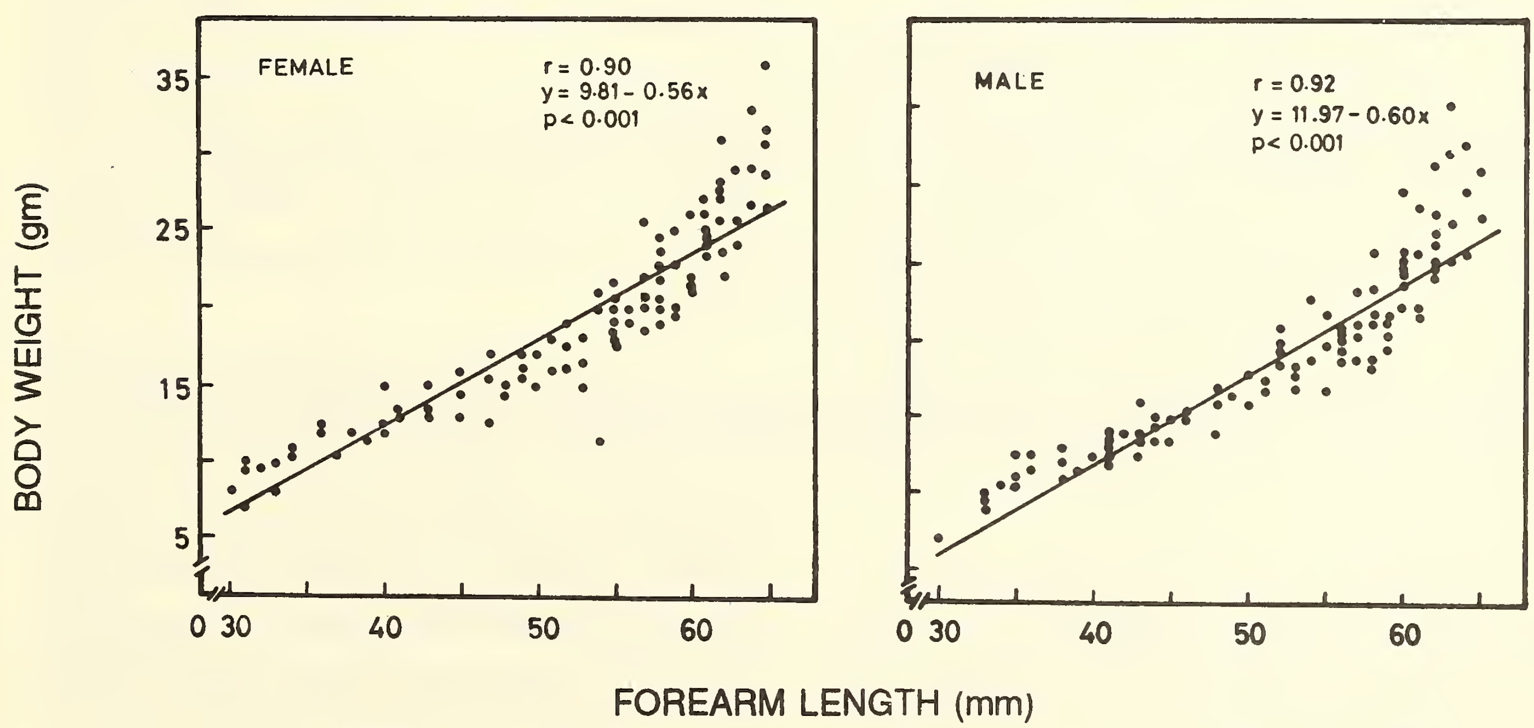

Fig.1. Regression of body weight and forearm length in males and females of *M. lyra*.

TABLE 2

GROWTH PATTERN OF A TAGGED MALE JUVENILE *M. LYRA*.

Date	Body weight (g)	Forearm length (mm)	III Finger (mm)	V Finger (mm)	Stage
15.3.90	8.6 (24.2)	30.6 (46.4)	42.3 (35.3)	31.6 (34.0)	Neonate
20.3.90	12.0 (33.7)	36.0 (54.5)	54.0 (45.0)	41.0 (44.1)	
13.4.90	20.0 (56.2)	55.0 (83.3)	92.0 (76.7)	72.0 (77.4)	
19.4.90	21.1 (59.3)	56.0 (84.8)	95.0 (79.0)	74.0 (79.6)	
21.4.90	21.6 (60.7)	56.0 (84.8)	96.0 (80.0)	75.0 (80.6)	Volant
26.4.90	22.8 (80.1)	60.0 (90.9)	101.0 (84.2)	79.0 (85.0)	
14.5.90	28.5 (80.1)	64.0 (97.0)	110.0 (91.7)	85.0 (91.4)	
27.5.90	30.5 (85.7)	65.0 (98.5)	119.0 (99.2)	89.0 (95.7)	Weaned
Mother bat					
21.4.90	35.6	66.0	120.0	93.0	

Percentage of mother's postpartum measurements are in parentheses.

attached to the baby till it reached a maximum weight of 13 g with maximum forearm length of 38 mm. The length of the third and fifth fingers was 59 mm and 47 mm respectively. The growth parameters measured in male and female bats did not differ significantly (Table 1).

Fledgling stage: Young *M. lyra* began to fledge when they reached 58.85% of the mother's postpartum body weight. The forearm length of the fledglings varied between 55 and 58 mm (x + SD = 56.9 $\pm$ 1.7 mm); the length of the third finger varied between 84 and 96 mm (x + SD = 91.5 $\pm$ 3.5 mm) and fifth finger between 64 and 76 mm (x + SD = 70.8 $\pm$ 3.1 mm). The baby at this stage was able to crawl on the wall, flutter its wings, show free head and ear movements and even attempt to fly a short distance inside the temple roost.

Weaning: Young *M. lyra* did not begin to forage till they reached 80.85% (29.2 - 31.6 g) of the mother's postpartum body weight. The mean body weight at weaning was 30.06 $\pm$ 0.9 g (n=10). The forearm length varied between 61 and 66 mm which is 97.55% of the adult size (x + SD = 63.9 $\pm$ 1.7 mm), the third finger length varied between 105 and 126 mm, which is 97.82% of the adult size (x + SD = 116.9 $\pm$ 6.3 mm) and the length of the fifth finger varied between 84 and 92 mm which is 92.43% of the adult size (x + SD = 88.0 $\pm$ 2.7 mm). The juvenile at this stage is able to fly well. The rate of growth of a tagged individual male *M. lyra* is represented in Table 2 which exhibits a pattern similar to that obtained from cumulative data on several bats.

The body weight and the length of the third and fifth fingers of the juvenile are significantly and positively correlated with forearm length from neonates to weaned young. The correlation coefficients are found to be significant (r-value ranging from 0.90 to 0.97) for both juvenile males and juvenile females (Fig. 1 and 2). Comparison of the body weights and finger measurements with the forearm measurements among juveniles

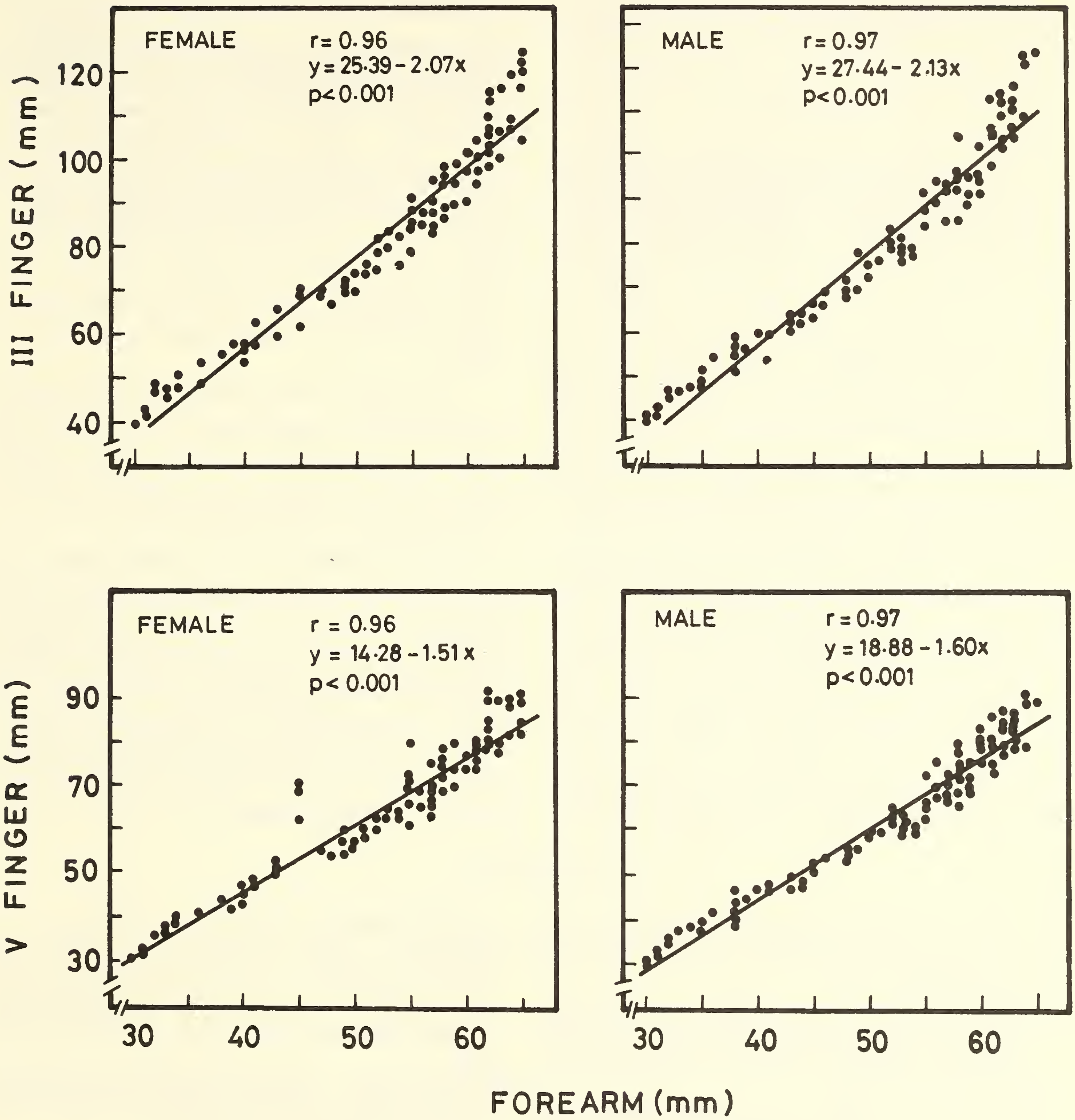

Fig.2. Regression of length of III finger, V finger and forearm length in males and females of *M. lyra*

indicates that the growth of forearm and fingers and gain in body weight is a continuous process from the neonatal period till the weaning is over.

Discussion

The post-natal development of young bats varies from species to species (Orr 1970). Newborn young of *M. lyra* were naked with their eyes closed. The eyes opened at about 5 days after birth and fur formation was not dense. According to the reports of several authors, the eyes opened at different age levels for different species, which varied from a few hours after birth to about 10 days of age (Jones 1967; Gould 1971; Kunz 1971). Interestingly, in the phyllostomid bat *Artibeus planirostris trinitatis* (Jones 1946), the eyes opened at birth and the head, back, forearms and interfemoral membranes were covered with hair. According to Orr (1970), members of the Megachiroptera were more advanced in development than the Microchiroptera at birth. This statement accords with the observation that the eyes of *Cynopterus sphinx* are open at birth. However, Kulzer (1958) reported that the eyes of *Rousettus aegyptiacus* do not of open until the young are 9 days old.

The length of the forearm has been the most consistently measured parameter of growth (Gould 1971; Kunz 1971) and in *M. lyra* the forearm length at the time of birth and at the time of weaning (about 2 1/2 months of age) was 48.3% and 97.5% of the adult measurement respectively. This is in accordance with the development of the forearm length in different species of vespertilionids, such as *Myotis velifer* (Kunz 1971). However, young bats of these species are weaned at the age of 6 weeks. The temporal variations could well be related to interspecific differences in the maturity of the young at birth.

According to Orr (1970), the body weight of newborn bats ranges from 15 to 30% of the weight of non-pregnant adult females, which agrees with our observations and several other reports (Kleiman 1969; Kunz 1971).

Body weight in *M. lyra* was found to be reduced in most of the young bats following the critical period of weaning, since during this stage (between weaning and post-weaning) mothers paid relatively little attention to their young. In addition to the neglect in suckling and reduced lactation among mothers at this stage, young bats had to face difficulties in capturing enough prey due to poor foraging skills.

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NEW DESCRIPTIONS

FIRST REPORT OF GENUS *HEMITAXONUS* ASHMEAD (HYMENOPTERA, SYMPHYTA, TENTHREDINIDAE: SELANDRIINAE) FROM INDIA WITH TWO NEW SPECIES[1]

Malkiat S. Saini and Tajinder P. Saini[2]

(*With eight text-figures*)

The sawfly genus *Hemitaxonus* Ashmead is recorded for the first time from India with the addition of two new species. Described as new species are *Hemitaxonus garhwalensis* from Mandal Uttar Pradesh and *Hemitaxonus kumaonensis* from Ramgarh, Uttar Pradesh. Each species is described and illustrated. A key is provided to distinguish all three Oriental species of the genus.

Introduction

Genus *Hemitaxonus* was erected by Ashmead (1898) taking *Taxonus dubitatus* Norton (by original designation) as its type species from North America. Takeuchi (1928) described a new species *Hemitaxonus formosanus* from Formosa. This was the first report of this genus from the Oriental region. In this paper, two new species are added to it from India, bringing the total number of species from the oriental region to three.

Genus *Hemitaxonus* Ashmead

Hemitaxonus Ashmead, 1898; Konow, 1905; Rohwer, 1911; Enslin, 1914; MacGillivray, 1916; Malaise, 1931; Malaise, 1933; Conde, 1934; Ross, 1937; Takeuchi, 1941; Ross, 1951; Smith, 1966.

Type: *Taxonus dubitatus* Norton. Original designation.

Epitaxonus MacGillivray, 1908; Rohwer, 1911 (=*Hemitaxonus* Ashmead); MacGillivray, 1916; Malaise, 1933.

Type: *Taxonus albidopictus* Norton. Original designation.

Sahlbergia Forsius, 1910; Enslin, 1914 (=*Hemitaxonus* Ashmead).

Type: *Sahlbergia struthiopteridis* Forsius. Monotypic.

[1]Accepted March, 1995.

[2]Department of Zoology, Punjabi University, Patiala-147 002, India.

Description

Based on Smith (1969); this genus is characterised by: Antenna long and slender; second segment globular, as long as wide; third segment subequal in length to fourth segment; sixth segment at least two times longer than wide. Frontal area distinct, enclosing the median ocellus. Post genal carina present. Clypeus slightly emarginate; malar space equal to or slightly wider than diameter of front ocellus. Epicnemium present as flat sclerite, separated from mesopleuron by suture, or present as raised shoulder, separated from mesopleuron by furrow. Forewing with an almost perpendicular anal crossvein; proximal anal cell twice length of distal anal cell; nervulus joins medius apically of middle of discoidal cell. Hindwing with two closed middle cells; anellan cell petiolate or sessile. Tarsal claw simple or with minute inner tooth.

In order to accommodate the new species, the following generic characters have been made slightly broad based: pedicel equal or shorter than its apical width and malar space may be less than diameter of median ocellus.

The terminology of Malaise (1945) and Ross (1937, 1945) has been followed. Holotypes will be deposited in the National Pusa Collections, IARI, New Delhi.

Abbreviations: AT=Apical tooth, CL=Clypeus, EL=Eye length, IATS=Inner apical tibial spur, ICD=Intercenchral distance, IDMO-Interocular distance at the level of median ocellus, ITD=Intertegular distance, LB=Labrum, LID=Lower interocular distance, MB=Metabasitarsus, OATS=Outer apical tibial spur, OCL=Ocello occipital line, OOL=Oculo-ocellar line, POL=Postocellar line, SAT=Sub-apical tooth.

Key to Oriental Species

1. Antennal segment 3 shorter than 4 in ratio 6:7; abdomen auratus; tarsal claw with a minute subapical tooth 2
— Antennal segment 3 & 4 equal; abdominal segments 3-6 reddish yellow; tarsal claw without subapical tooth. ...... *Hemitaxonus formosanus* Takeuchi 1928.
2. Distal 1/3 metafemur yellow; malar space 0.4x diameter of median ocellus; inter & post ocellar furrows merely indicated. ITD:ICD :: 3.5:1.0 Female lancet, saw sheath & tarsal claw as in Figs. 7, 5, 3 .... *Hemitaxonus garhwalensis* sp. nov.
— Distal 2/3 metafemur yellow; malar space 0.6x diameter of median ocellus; inter and post ocellar furrows indistinct; ITD:ICD :: 3.0:1.0. Female lancet saw sheath and tarsal claw as in Figs. 8, 6, 4. .... *Hemitaxonus kumaonensis* sp. nov.

Hemitaxonus garhwalensis sp. nov. (Figs. 1, 3, 5, 7)

Female: Average length 8 mm. Body black, with whitish yellow dorsolateral angles of pronotum, tegula, meso- and metacoxae except their extreme bases, all trochanters and the adjoining parts of all femora, apices of pro- and mesofemora, distal 1/3 of metafemur, anterior aspects of tibiae and tarsi of the 4 front legs; proximal 2/3 femur, tibia and tarsi of hind leg piceous. Abdomen auratus. Wings hyaline, stigma and venation dark brown to black.

Antenna slender, 2.8x head width, scape wider than long, longer than pedicel which is also apically much wider than its length, segment 3 shorter than 4 as 6:7. Anterior margin of clypeus roundly shallowly subemarginate (Fig. 1). Labrum broader than long as 3:1 with bluntly pointed anterior margin. Malar space 0.4x diameter of median ocellus. Supraclypeal area subtriangularly raised with blunt longitudinal carina. LID:IDMO:EL :: 2.0:2.2:2.0; OOL:POL:OCL :: 1.0:1.0:0.8. Frontal area above the level of eyes, supraantennal tubercles insignificant and posteriorly connected with the blunt carina like well defined frontal ridges. Median fovea broad, distinct and divisible into two parts due to a transverse ridge of the elevation of frontal ridges. Upper part of median fovea is U-shaped and flat bottomed, whereas the lower part is open anteriorly and with a distinct pit in its posterior half. In middle frontal ridges laterally connected to inner margins of eyes through a transverse carina. Circum-ocellar furrow distinct, inter- and postocellar furrows merely indicated. Lateral furrows sunken, pit-like, abruptly ending only halfway to hypothetical posterior margin of head. Post ocellar area hump-like, strongly elevated in its anterior half and depressed in its posterior half, wider than long as 2:1. Inner margins of eyes subparallel. Head narrowing behind eyes. Hind orbits carinated only below. Mesoscutellum subconvex, appendage not carinate. ITD:ICD :: 3.5:1.0. Epicnemium subconvex, separated from mesopleuron by a fine furrow. Mesepisternum obtusely raised without carina or acute apex. Subapical tooth of tarsal claw (Fig. 3) much shorter than apical one. Metabasitarsus slightly shorter than all the following joints combined, as 6:7. Saw sheath tapering into a narrow pointed apex (Fig. 5).

Head and thorax smooth, shining, apunctate, except the posterior slope of mesoscutellum that bears isolated punctures arranged in a row. Abdomen subshining, apunctate. Body entirely without pubescence. Lancet with 7 serrulae (Fig. 7).

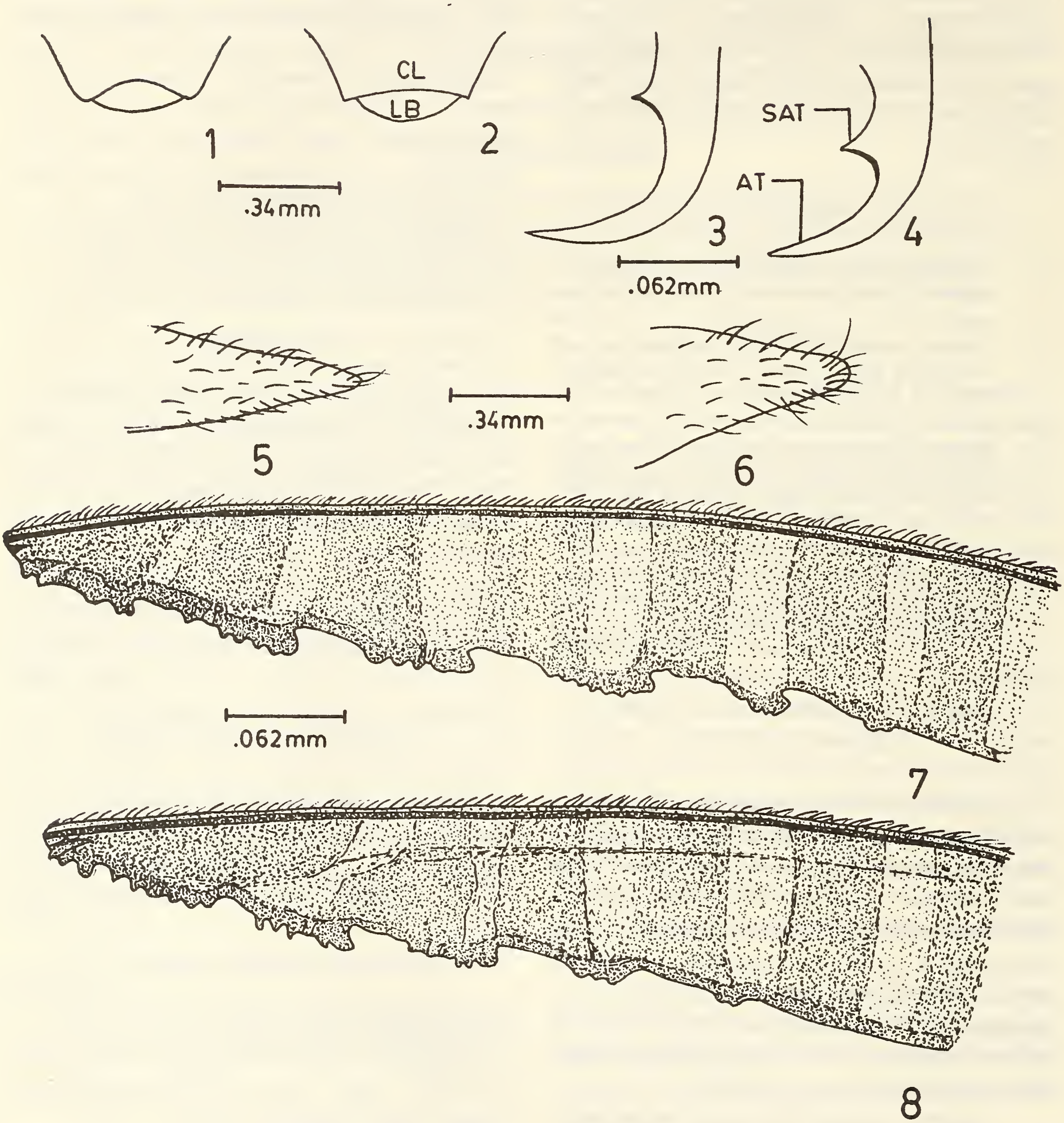
Male: Unknown.

Holotype: Female, Uttar Pradesh; Mandal, 2200 m, 12.vi.1985.

Paratype: 1 Female, same data as holotype.

Distribution: India; Uttar Pradesh.

Etymology: The species is named after the Garhwal hills in which its type locality is situated.



Figs 1-8. Clypeus: 1. *Hemitaxonus garhwalensis*; 2. *H. kumaonensis*.
Tarsal claw: 3. *H. garhwalensis;* 4. *H. kumaonensis*.
Saw sheath: 5.*H. garhwalensis*; 6. *H. kumaonensis* Lancet: 7. *H. garhwalensis*; 8. *H. kumaonensis*.

Hemitaxonus kumaonensis sp. nov.
(Fig. 2, 4, 6, 8)

Female: Length 8 mm. Body black, with whitish yellow - dorsolateral angles of pronotum, tegula, meso- and metacoxae except their extreme bases, all trochanters and the adjoining parts of all femora, apices of pro- & mesofemora, distal 2/3 of metafemur, anterior aspects of tibiae and tarsi of 4 front legs; proximal 1/3 femur, tibia and tarsi of hind leg piceous. Abdomen auratus. Wings hyaline, stigma and venation dark brown to black.

Antenna slender, 2.9x headwidth, scape wider than long, longer than pedicel which is also apically much wider than its length, segment 3 shorter than 4 as 6:7. Anterior margin of clypeus roundly shallowly submarginate (Fig. 2). Labrum concealed beneath clypeus. Malar space 0.6 x diameter of median ocellus. Supraclypeal area subtriangularly raised with blunt longitudinal carina. LID:IDMO:EL::2.0:2.33:2.0,OOL:POL:OCL ::1.0:1.0:0.9. Frontal area above the level of eyes, supra-antennal tubercles insignificant and posteriorly connected with the blunt carina like well defined frontal ridges. Median fovea broad, distinct and divisible into two parts due to a transverse ridge of the elevation of frontal ridges. Upper part of median fovea is U-shaped having flat bottom whereas lower one is open anteriorly and with a distinct pit in its posterior half. In middle frontal ridges laterally connected to inner margins of eyes through a transverse carina. Circumocellar furrow distinct, inter and post ocellar furrows indistinct. Lateral furrows sunken, pit-like, abruptly ending only halfway to hypothetical posterior margin of head. Postocellar area hump-like, strongly roundly elevated in its anterior half and depressed in its posterior half, wider than long as: 2:1. Inner margins of eyes subparallel. Head narrowing behind eyes. Hind orbits carinated only below. Mesoscutellum subconvex, appendage not cainate. ITD:ICD :: 3.0:1.0. Epicnemium subconvex, separated from mesopleuron by a fine furrow. Mesepisternum obtusely raised without carina or acute apex. Subapical tooth at the middle of tarsal claw (Fig. 4), much shorter than apical one. Metabasitarsus shorter than all following joints combined as 5:6. IATS:MB:OATS :: 2.0:7.0:1.8. Saw sheath broadened with blunt apex (Fig. 6).

Head and thorax smooth, shining and apunctate except the posterior slope of mesoscutellum that bears isolated punctures arranged in a row. Abdomen subshining, apunctate. Pubescence negligible. Lancet with 6 serrulae (Fig. 8).

Male: Unknown.

Holotype: Female, Uttar Pradesh; Ramgarh, 1800 m, 19.vi.1991.

Distribution: India; Uttar Pradesh.

Etymology: The species is named after the Kumaon hills among which its type locality is situated.

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FIFTEEN NEW SPECIES OF *FERNA* MALAISE FROM INDIA WITH A REVISED KEY TO THE ORIENTAL SPECIES (HYMENOPTERA, SYMPHYTA, TENTHREDINIDAE: ALLANTINAE)[1]

MALKIAT S. SAINI[2] AND V. VASU

(*With fifty-nine text-figures*)

To the previously recorded four species of genus *Ferna* Malaise from India, fifteen new species are added. The new species described are: *F. indiana, F. chambali, F. nigra, F. naga, F. canalicula, F. acclivata, F. himenderi, F. foveolata, F. emarginata, F. cinguliventris, F. himalayana, F. dutti, F. sagittata, F. brevis* and *F. pupa*. A revised key for the identification of all the Oriental species has been provided.

Key words: new species, *Ferna* key, Hymenoptera, Allantinae, India.

INTRODUCTION

With six new species, Malaise (1961) erected genus *Ferna* taking *F. longiserra* as its type. After more than three decades, only one new species *F. bengalensis* was added by Saini and Deep (1993).

In the present text, fifteen new species are being described and illustrated. Though 3 species have already been recorded from India, i.e., *F. brevigenata* Malaise by Muche (1983) and the remaining two, *F. longiserra* Malaise and *F. punctifossa* Malaise by Saini and Deep (1993), yet *F. bullifrons* Malaise, *F. latifrons* Malaise and *F. acutiserra* Malaise are from the faunistic area of Burma. While preparing the key to the Oriental species, we examined all the species except *F. acutiserra* Malaise, for which a figure pertaining to the ovipositor sheath and some other key characters have been obtained from literature.

The holotypes of the new species are presently in our collections and will be deposited in the Pusa National Collections, Division of Entomology, Indian Agricultural Research Institute (IARI), New Delhi, India, after this work is published.

[1]Accepted May, 1997

[2]Department of Zoology, Punjabi University, Patiala-147002, India.

Abbreviations used in the text are: EL = eye length, IATS = inner apical tibial spur, IDMO = interocular distance at the level of median ocellus, LID = lower interocular distance, MB = metabasitarsus, OATS = outer apical tibial spur, OCL = ocello-occipital line, OOL = ocello-ocular line, POL = postocellar line.

Key to the Oriental species of *Ferna* Malaise

1. Ovipositor sheath acutely triangular in lateral view (Fig. 7) .... *F. acutiserra* Malaise, 1961.
— Ovipositor sheath broadly rounded or roundly pointed in lateral view (Figs. 8-11) 2
2. Post-, inter- and circumocellar furrows absent .... *F. bengalensis* Saini & Deep, 1993
— Post-, inter- and circumocellar furrows distinct 3
3. Mesosternum entirely yellowish white 4
— Mesosternum entirely black 11
4. Median fovea in form of broad, deep, oval pit .... *F. indiana* sp. nov.
— Median fovea broad ditch-like to narrow seam-like 5
5. All tibiae and tarsi uniformly fuscoferruginous .... *F. punctifossa* Malaise, 1961.
— At least base and apices of metatarsi fuscous to black 6
6. All metatarsi entirely fuscous 7
— Only bases and apices of metatarsi fuscous .... *F. chambali* sp. nov.
7. Median fovea deep ditch-like or narrow seam-like in its anterior half and posteriorly not reaching median ocellus 8
— Median fovea deep ditch-like or narrow seam-like and clearly extending to median ocellus 9

8. Tergites 2-8 entirely black except posterior border of tergites 2 and 3 in the middle; postocellar area broader than long as 3:2; median fovea in form of narrow seam; scape 1.4 x its apical width; pedicel slightly shorter than its apical width; segments 3 and 4 as 10:11 .... *F. nigra* sp. nov.

— Posterior margins of tergites 2-8 yellowish white; postocellar area broader than long as 2:1; median fovea in form of broad, deep ditch; scape as long as its apical width; pedicel 1.3 x its apical width; segments 3 and 4 as 4:5 .... *F. naga* sp. nov.

9. Median fovea in form of deep, narrow seam at least in its anterior 3/4 10

— Median fovea broad ditch-like in its anterior half, posteriorly broad and shallow .... *F. brevigenata* Malaise, 1961

10. Median fovea clearly reaching median ocellus; scape 1.3 x its apical width; segments 3 and 4 as 6:7; POL:OCL:OOL :: 2:2:3 .... *F. canalicula* sp. nov.

— Median fovea very shallowly reaching median ocellus, scape as long as its apical width; segments 3 and 4 as 8:11; POL:OCL:OOL :: 4:4:5 .. *F. acclivata* sp. nov.

11. A transverse band at the most on posteroventral lower 2/3 of mesopleuron (i.e. not touching epicnemium) 12

— A transverse band on lower 1/2 of mesopleuron extending from epicnemium to coxal rim. 14

12. A narrow transverse band on posteroventral 1/2 of mesopleuron present .... *F. himenderi* sp. nov.

— A transverse band on posteroventral 2/3 of mesopleuron present 13

13. Malar space 0.5x diameter of median ocellus; median fovea in form of deep narrow seam extending upto median ocellus; a yellowish white spot present before mesoscutellum; all femora, tibiae and tarsi uniformly fuscoferruginous .... *F. foveolata* sp. nov.

— Malar space 1x diameter of median ocellus; median fovea deep ditch-like in its anterior half, posteriorly broadens and shallowly reaching median ocellus; a spot before mesocutellum missing; all femora, tibiae and tarsi not so .... *F. longiserra* Malaise, 1961

14. All tergites entirely black above 19

— All tergites not entirely black above 15

15. Mesonotal middle lobe entirely black 16

— Sagitated apex of mesonotal middle lobe yellowish white .... *latifrons* Malaise, 1961

16. Malar space 0.5x diameter of median ocellus .... *F. emarginata* sp. nov.

— Malar space 1x diameter of median ocellus 17

17. Posterior margins of some tergites yellowish white 18

— Tergites 2 and 3 entirely yellowish white .... *F. cinguliventris* sp. nov.

18. Median fovea in form of deep, narrow seam extending upto median ocellus; postocellar area broader than long as 3:2- .... *F. bullifrons* Malaise, 1961

— Median fovea broad ditch-like with a median pit in its anterior half, posteriorly broadens and only shallowly reaching median ocellus; postocellar area broader than long as 2:1 .... *F. himalayana* sp. nov.

19. Malar space 0.5x diameter of median ocellus; .... *F. dutti* sp. nov.

— Malar space 1x diameter of median ocellus 20

20. Mesonotal middle lobe entirely black 21

— Sagittated apex of mesonotal middle lobe yellowish white .... *F. sagittata* sp. nov.

21. Median fovea ditch-like in its anterior 1/2 and posterior only shallowly reaching median ocellus; postocellar area broader than long as 3:2; scape and pedicel each as long as its apical width; segments 3 and 4 as 4:5; clypeus roundly incised upto 1/2 of its medial length .... *F. brevis* sp. nov.

— Median fovea ditch-like in its anterior 1/2 and posteriorly not reaching median ocellus; postocellar area broader than long as 2:1; scape and pedicel each 1.3x its apical width; segments 3 and 4 as 8:9; clypeus subrectangularly incised upto 1/2 of its medial length- .... *F. pupa* sp. nov.

Ferna indiana sp. nov.
(Figs. 12, 23, 45)

Female: Unknown.

Male: Colour: Body black; the following areas are yellowish white: clypeus; labrum; mandible barring apex; supraclypeal area extending upto the upper rim of antennal socket; lower 3/4 of inner orbit; hind orbit extending upto temple; extreme posterolateral margins of pronotum; tegula; mesopleuron except dorsal 1/2; metapleuron, except a spot on metepimeron; tergite 9 entirely; deflexed lateral sides of all tergites; all sternites more or less; all coxae and trochanters; all femora except inner dorsal aspects of apical 3/4. Rest of the parts of all legs light brown to fuscous. Wings hyaline; venation including costa, subcosta and stigma fuscous.

Structure: Length 4. mm. Antenna 3.7x head width; scape and pedicel each as long as its apical width; segment 3 shorter than 4 as 4:5; clypeus (Fig. 1) subrectangularly incised upto 1/3 of its medial length; labrum broader than long as 2:1; malar space 1.5x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles and frontal ridges insignificant; median fovea in the form of deep pit in its anterior half and posteriorly not reaching median ocellus (Fig. 45); post-, inter- and circumocellar furrows distinct; lateral furrows distinct, parallel and abruptly ending just before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 3:4; metatibial spurs subequal in length; IATS:MB:OATS :: 5:12:4. Genitalia: penis valve (Fig. 23), gonoforceps (Fig. 12).

Sculpture and pubescence: Head with dense, minute, distinct punctures, surface shining; thorax punctate like head except apunctate appendage, surface shining with general oily lustre; abdomen apunctate, subshining. Body covered with silvery pubescence.

Holotype: Male, Nagaland, Vizho-Razho, 1700 m, 11.v.1993.

Distribution: Nagaland.

Diagnosis: The broad, deep, oval pit-like median fovea; colour pattern of body; broadly rounded ovipositor sheath; distinct post-, inter- and circumocellar furrows and insignificant frontal ridges distinguish *F. indiana* from other species of this genus.

Etymology: The species is named from India, in which the type locality falls.

Ferna chambali sp. nov.
(Figs. 13, 24, 34, 46)

Female: Colour: Body black; the following areas are yellowish white: clypeus; labrum; mandible barring apex; supraclypeal area; broad lower 3/4 of inner orbit; hind orbit extending upto temple; posterodorsal margin of pronotum; tegula; a spot on anterior 1/2 of mesocutellum; parapterum; mesepisternum except anterodorsal aspect; mesosternum; lower 1/2 of metapleuron; deflexed lateral sides of all tergites; all sternites entirely; all legs except apical tip of all tibiae, extreme apices and basis of all tarsi which are fuscous. Wings hyaline; venation including costa, subcosta and stigma dark brown.

Structure: Average length 6 mm. Antenna 3.3x head width; scape as long as its apical width; pedicel 1.5x its apical width; antennal segment 3 shorter than 4 as 4:5; clypeus (Fig. 1) subsquarely incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 1.5x diameter of median ocellus; LID:IDMO:EL :: 7:8:4; head without postgenal carina; supra-antennal tubercles moderate and confluent, with similar roundly raised frontal ridges; median fovea in the form of deep ditch in its anterior half and posteriorly broadly reaching median ocellus (Fig. 46); post-, inter- and circumocellar furrows sharp; lateral furrows deep, parallel and ending abruptly just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 4:3; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joint combined as 4:5; metatibial spurs subequal in length; IATS:MB:OATS :: 3:7:2. Lancet (Fig. 34) having 13 serrulae. Lateral view of ovipositor sheath as in Fig. 9.

Sculpture and pubescence: Head with dense, minute, distinct punctures, surface shining; thorax punctate like head except apunctate appendage, surface shining with general oily lustre; abdomen apunctate, less shining. Body covered with silvery pubescence.

Male: Average length 5.5 mm. Similar to female. Genitalia: penis valve (Fig. 24), gonoforceps (Fig. 13).

Holotype: Female, Uttar Pradesh, Dhanolti, 2200 m, 25.vii.1993.

Paratypes: 7 females, 14 males with same date as holotype.

Distribution: Uttar Pradesh.

Diagnosis: Characteristic shape of median fovea; distinct colour pattern of legs; clear post-, inter- and circumocellar furrows, apically rounded ovipositor sheath; scape as long as its apical width; pedicel 1.5x its apical width and malar space more than the diameter of median ocellus, are some of the characters which distinguish *F. chambali* from other species of *Ferna.*

Etymology: The species is named after Dr. Amrik S. Chambal, who is working on sawfly taxonomy at Punjabi University, Patiala, India.

Ferna nigra sp. nov.
(Figs. 14, 25, 35, 47)

Female: Colour: Body black, yellowish white are: clypeus; labrum; mandible barring apex; a squarish spot on supraclypeal area; lower 1/2 of inner orbit; hind orbit extending upto temple; posterodorsal and extreme posterolateral margins of pronotum; tegula; a spot before mesoscutellum; a spot on mesoscutellum; parapterum; mesepisternum except anterodorsal spot; extreme posteroventral tip of mesepimeron; mesosternum; metepimeron except anterodorsal spot; extreme hind border in the middle of tergites 2 and 3; tergite 9 entirely; deflexed lateral sides of all tergites; all sternites; all coxae and trochanters; all femora except inner dorsal aspects of apical halves. Remaining parts of all legs light brown to fuscous. Wings hyaline, basal 1/2 of stigma fulvous; venation including costa and subcosta piceous.

Structure: Average length 5.5 mm. Antenna 3.7x head with; scape 1.4x its apical width; pedicel slightly shorter than its apical width; segment 3 shorter than 4 as 10:11; clypeus (Fig. 5) subrectangularly incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 1.5x diameter of median ocellus; LID:IDMO:EL :: 2:2:1; head without postgenal carina; supra-antennal tubercles moderate and confluent with similarly roundly raised frontal ridges; median fovea in form of deep narrow seam in its anterior 3/4 and posteriorly not reaching median ocellus (Fig. 47); post-, inter- and circumocellar furrows distinct; lateral furrows pit-like, parallel and ending abruptly well before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one; metabasitarsus shorter than following joints combined as 3:4; metatibial spurs subequal; IATS:MB:OATS :: 3:5:2; Lancet (Fig. 35) having 16 serrulae. Lateral view of ovipositor sheath as in Fig. 10.

Sculpture and pubescence: Head with dense, minute, distinct punctures, surface shining; thorax punctate like head, except apunctate appendage, surface shining with general oily lustre; abdomen apunctate, less shining. Body covered with silvery pubescence.

Male: Average length 5.5 mm. Similar to female. Genitalia: penis valve (Fig. 25), gonoforceps (Fig. 14).

Holotype: Female, Arunachal Pradesh, Bomdila, 2550 m, 7.v.1992.

Paratypes: Aruanchal Pradesh, Bomdila, 2550 m (5 females, 50 males) 7-9.v.1992.

Distribution: Arunachal Pradesh.

Diagnosis: Though *F. nigra* is allied to *F. naga,* it can be distinguished from it as well as other *Ferna* species on the basis of the characteristic median fovea; scape 1.4x its apical width; pedicel a little shorter than its apical width; segments 3 and 4 as 10:11; distinct colour pattern of body; and rounded ovipositor sheath.

Etymology: The species name pertains to the general black colour of the body.

Ferna naga sp. nov.
(Figs. 6, 36, 48)

Female: Colour: Body black; the following areas are yellowish white: clypeus; labrum; mandible barring apex; a spot on supraclypeal area; lower 3/4 of inner orbit; hind orbit extending upto temple; tegula; a spot before mesoscutellum; parapterum; mesepisternum except anterodorsal aspect; posterior margins of tergites 2-8; tergite 9 entirely; deflexed lateral sides of all tergites;

all sternites entirely; all coxae and trochanters; all femora except fuscoferruginous dorsal aspects of apical 1/2; tibiae and tarsi of front four legs except fuscoferruginous posterior parts. Metatibia with somewhat brownish tinge; metatarsi fuscous. Wings hyaline, venation including costa, subcosta and stigma fuscous.

Structure: Average length 5 mm. Antenna 3.2x its apical width; antennal segment 3 shorter than 4 as 4:5; clypeus (Fig. 6) accurately incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 1.5x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles and frontal ridges insignificant; median fovea in the form of a deep ditch in its anterior 3/4 and posteriorly not reaching median ocellus (Fig. 48); post-, inter- and circumocellar furrows sharp, lateral furrows distinct parallel and ending abruptly just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 4:3; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 4:5; metatibial spurs subequal in length; IATS:MB:OATS :: 5:12:4. Lancet (Fig. 36) having 14 serrulae. Lateral view of ovipositor sheath as in Fig. 10.

Sculpture and pubescence: Head with dense minute punctures, surface shining; mesonotum with dense, minute, irregular punctures; surface shining; mesoscutellum with scattered, minute punctures on its posterior part; appendage apunctate, polished; mesepisternum minutely punctured; mesosternum with few scattered, minute punctures, surface shining with general oily lustre; abdomen apunctate, less shining. Body covered with silvery pubescence.

Male: Unknown.

Holotype: Female, Nagaland, Pfutsero, 2100 m, 20.v.1993.

Paratype: 1 female, with same data as holotype.

Distribution: Nagaland.

Diagnosis: *F. naga* comes close to *P. nigra*, but is distinct from it and from other species of this genus by the following characteristic shape of median fovea; distinct colour pattern of body; postocellar area broader than long as 2:1; scape as long as its apical width; pedicel 1.3x its apical width; antennal segments 3 and 4 as 4:5.

Etymology: The species is named after Nagaland, the state in which the type locality falls.

Ferna canalicula sp. nov.
(Figs. 2, 15, 26, 37, 49)

Female: Colour: Body black; the following areas are yellowish white: Clypeus; labrum, mandible barring apex; a square spot on supraclypeal area; lower 1/2 of inner orbit; hind orbit extending upto temple; posterodorsal and extreme posterolateral margins of pronotum; tegula; a spot before mesoscutellum; a spot on mesoscultellum; parapternum; mesepisternum except anterodorsal spot; extreme posteroventral tip of mesepimeron; mesosternum; metepimeron except anterodorsal spot; extreme hind border in the middle of tergites 2 and 3; tergite 9 entirely; deflexed lateral sides of all tergites; all sternites; all coxae and trochanters; all femora except inner dorsal aspects of apical halves. Rest of parts of all legs light brown to fuscous. Wings hyaline, basal 1/2 of stigma fulvous; venation including costa and subcosta piceous.

Structure: Average length 5.5 mm. Antenna 3.6x head width; scape 1.3x its apical width; pedicel as long as its apical width; segment 3 shorter than 4 as ratio 6:7; clypeus (Fig. 2) roundly incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 2x diameter of median ocellus; LID:IDMO:EL :: 2:2:1; head without postgenal carina; supra-antennal tubercles insignificant and confluent with roundly raised frontal ridges; median fovea in form of deep narrow seam distinctly reaching median ocellus (Fig. 49); post-, inter and circum-ocellar furrows distinct; lateral furrows deep, parallel and abruptly ending well before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 2:2:3; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one and without basal lobe; metabasitarsus equal to following joints combined; metatibial spurs subequal in length; IATS:MB:OATS :: 4:8:3. Lancet (Fig. 37) having 14 serrulae. Lateral view of ovipositor sheath as in Fig. 9.

Sculpture and pubescence: Head with a few minute punctures on frontal area, surface shining; thorax with dense, minute, irregular punctures, more conspicuous on posterior slope of mesoscutellum, but appendage apunctate and polished; abdomen microstriated, surface subshining. Body covered with silvery pubescence except on yellowish white parts where it appears to be golden.

Male: Average length 5.5 mm. Similar to female. Genitalia: penis valve (Fig. 26), gonoforceps (Fig. 15).

Holotype: Female, Arunachal Pradesh, Bomdila, 2550 m, 8.v.1992.

Paratypes: Arunachal Pradesh, Bomdila, 2550 m (5 females, 37 males) 7-9.v.1992.

Distribution: Arunachal Pradesh.

Diagnosis: The deep, narrow seam-like median fovea clearly reaching median ocellus; scape 1.3x its apical width; segments 3 and 4 as 6:7; POL:OCL:OOL :: 2:2:3; and distinct colour pattern of the body are the distinguishing characters which separate *P. canalicula* from its allied species *F. acclivata* and other species of the genus.

Etymology: The species is named *canalicula* from the seam-like median fovea reaching median ocellus.

Ferna acclivata sp. nov.
(Figs. 1, 16, 27, 38, 50)

Female: Colour: Body black; the following areas are yellowish white: clypeus; labrum; mandible barring apex; a square spot on supraclypeal area; lower 1/2 of inner orbit; hind orbit extending upto temple; posterodorsal and extreme posterolateral margins of pronotum; tegula; a spot before mesoscutellum; a spot on mesoscutellum; parapterum; mesepisternum except anterodorsal spot; extreme posteroventral tip of mesepimeron; mesosternum; metepimeron except anterodorsal spot; extreme hind border in the middle of tergites 2 and 3; tergite 9 entirely; deflexed lateral sides of all tergites; all sternites; all coxae and trochanters; all femora except inner dorsal aspects of apical halves. Remaining parts of all legs light brown to fusous. Wings hyaline, basal 1/2 of stigma fulvous; venation including costa and subcosta piceous.

Structure: Average length 5 mm. Antenna 3.6x head width; scape as long as its apical width; pedicel as long as its apical width; segment 3 shorter than 4 as 8:11; clypeus (Fig. 1) subrectangularly incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 2x diameter of median ocellus; LID:IDMO:EL :: 3:3:2; head without postgenal carina; supra-antennal tubercles and frontal ridges insignificant; median fovea in form of deep narrow seam in its anterior 2/3 and posteriorly only shallowly reaching median ocellus (Fig. 50); post-, inter- and circumocellar furrows sharp and distinct; lateral furrows shallow, pit-like, diverging backwards and ending well before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one; metabasitarsus shorter than following joints combined as 3:4; metatibial spurs equal in length; IATS:MB:OATS :: 1:3:1. Lancet (Fig. 38) with 15 serrulae. Lateral view of ovipositor sheath as in Fig. 10.

Sculpture and pubescence: Head with dense, minute, distinct punctures, surface shining: thorax punctate like head except apunctate appendage, surface shining with general oily lusture; abdomen apunctate, less shining. Body covered with silvery pubescence.

Male: Average length 5 mm. Similar to female, Genitalia: penis valve (Fig. 27), gonoforceps (Fig. 16).

Holotype: Female, Arunachal Pradesh, Bomdila, 2550 m, 8.v.1992.

Paratype: Arunachal Pradesh, Bomdila, 2550 m (5 females, 84 males) 7 - 9.v.1992.

Distribution: Arunachal Pradesh.

Diagnosis: *F. acclivata* is distinct in having median fovea shallowly reaching median ocellus; scape as long as its apical width; segments 3 and 4 as 8:11; POL:OCL:OOL :: 4:4:5; mesosternum yellowish white; all metatarsi entirely fuscous, and rounded ovipositor sheath. These characters suffice to separate it as a distinct species.

Etymology: The species name pertains to the gradual rise of median fovea in its posterior half.

Ferna himenderi sp. nov.
Figs. (5, 10, 12, 39, 51)

Female: Colour: Body black; the following areas are yellowish white: clypeus; labrum; mandible barring apex; broad lower 1/2 and narrow streak-like upper 1/2 of inner orbit; lower 1/2 and narrow streak-like upper 1/2 of inner orbit; lower 1/4 of hind orbit; spot on temple; posterodorsal margin of pronotum; tegula; a stripe on lower posterior 1/2 of mesopleuron; deflexed lateral sides of all tergites; all sternites entirely; all coxae, trochanters, femora and tibiae; rest of parts of all legs fuscoferruginous to fuscous. Wings hyaline, venation including costa, subcosta and stigma piceous.

Structure: Length 5 mm. Antenna 3.2x head width; scape 1.3x its apical width; pedicel 2x its apical width; antennal segment 3 shorter than 4 as 8:9; clypeus (Fig. 5) subrectangularly incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 1.5x diameter of median ocellus; LID:IDMO:EL :: 5:5:3; head without postgenal carina; supra-antennal tubercles moderate and confluent with similar roundly raised frontal ridges; median fovea in form of deep ditch in its anterior 1/2 and posteriorly broadly, shallowly reaching median ocellus (Fig. 51); post-, inter- and circumocellar furrows sharp and distinct; lateral furrows distinct, parallel and ending abruptly just before hypothetical hind margin of head; postocellar area subconvex, broader than long as 2:1; head narrowing behind eyes; POL:OCL:OOL :: 1:1:1; mesoscutellum sub-convex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 6:7; metatibial spurs subequal in length; IATS:MB:OATS :: 5:12:4. Lancet (Fig. 39) having 12 serrulae. Lateral view of ovipositor sheath as in Fig. 10.

Sculpture and pubescence: Head and mesonotum with dense, minute punctures, surface shining; mesoscutellum with scattered, minute punctures on its posterior part; appendage apunctate, polished; mesepisternum minutely punctured; mesosternum with a few scattered, minute punctures, surface shining with general oily lustre; abdomen apunctate, less shining. Body covered with silvery pubescence.

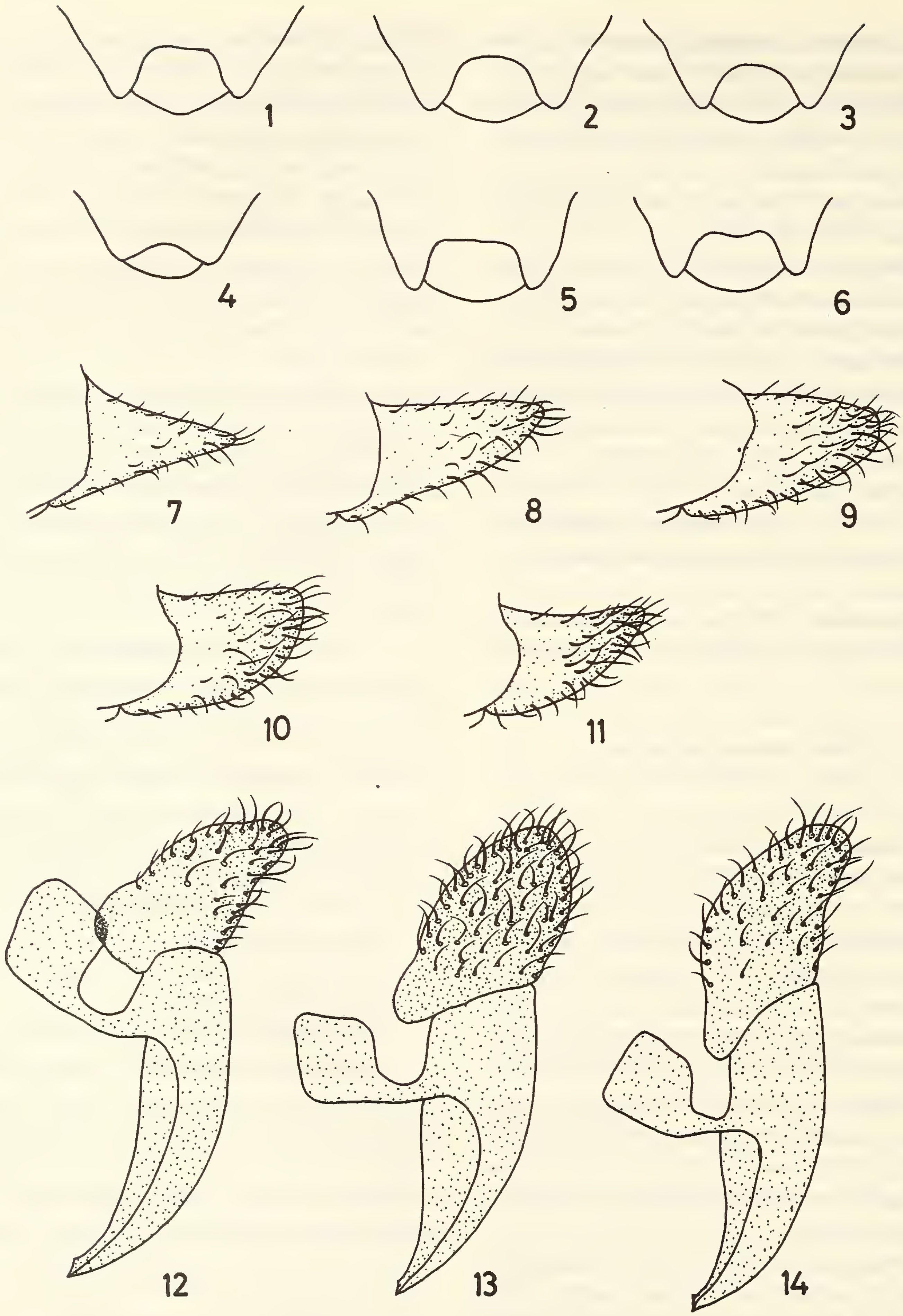
Male: Unknown.

Holotype: Female, Arunachal Pradesh, Bomdila, 2550 m, 9.v.1993.

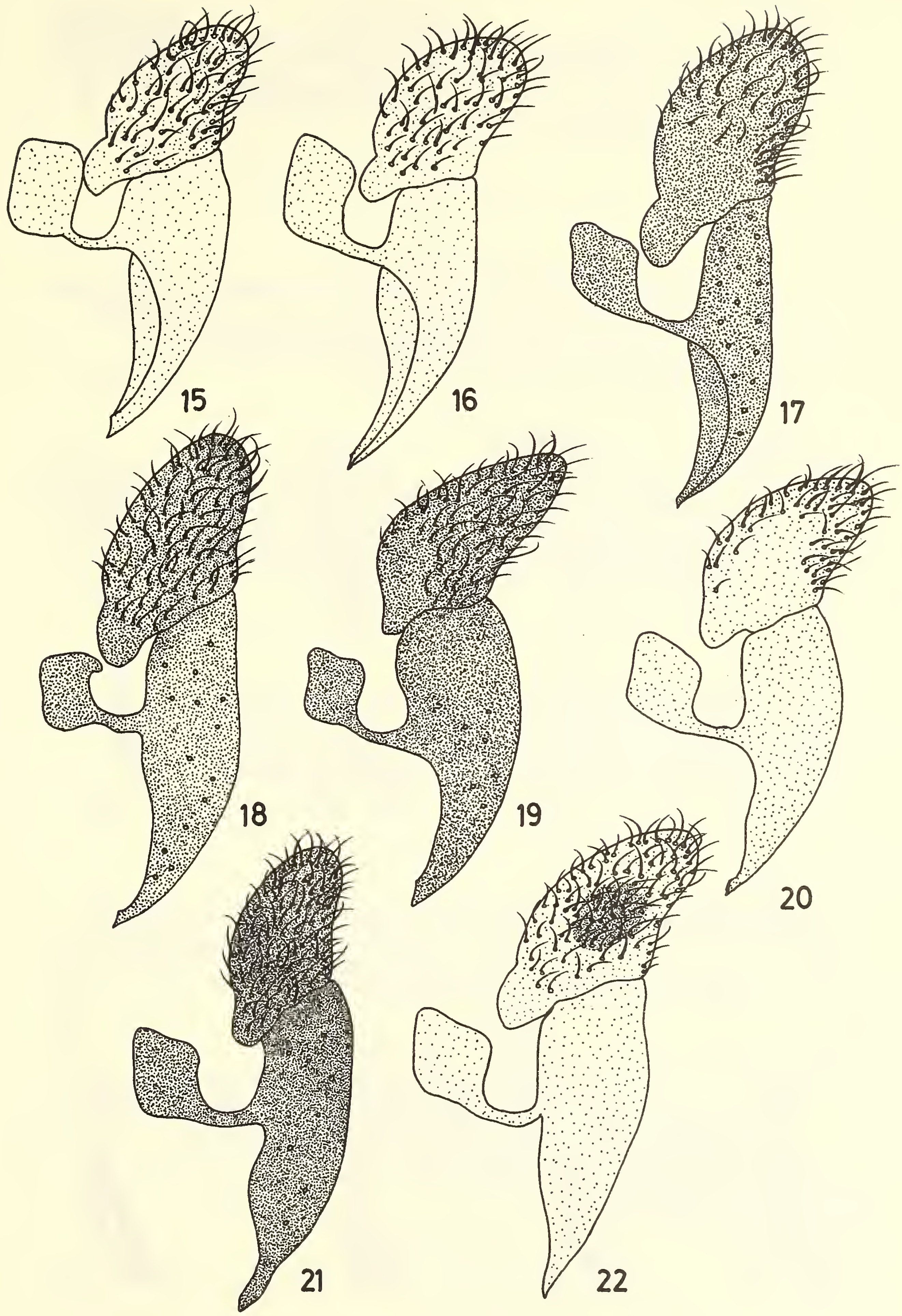
Distribution: Arunachal Pradesh.

Diagnosis: *F. himenderi* is unique in having presence of a transverse band on lower posteroventral 1/2 of mesopleuron; characteristic shape of median fovea; mesosterna entirely black; rounded ovipositor sheath; distinct post-, inter- and circumocellar furrows. These and the ratio of antennal segments 3 and 4; and relative lengths of metabasitarsus and following joints combined, easily differentiate *F. himenderi* from the rest of Ferna species.

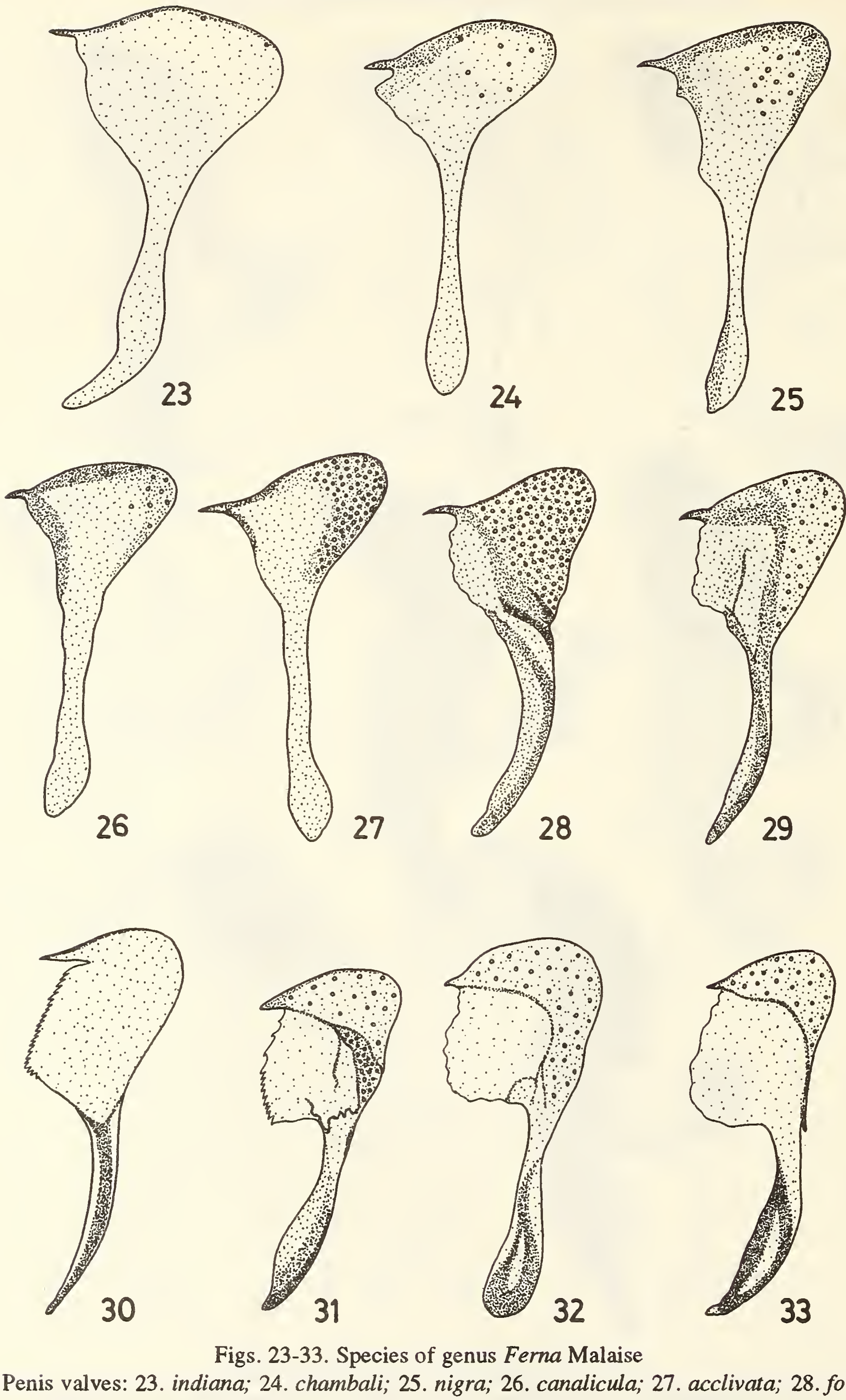
Etymology: The species is named after Mr. Himender Bharti, who is working on sawfly taxonomy at Punjabi University, Patiala.



Figs. 1-14. Species of genus *Ferna* Malaise
1-6. Clypeus & labrum: 1. *acclivata*; 2. *canalicula*; 3. *foveolata*; 4. *emarginata*; 5. *himenderi*; 6. *naga*;
7-11. Lateral view of ovipositor sheath: 7. *acutisera;* 8. *brevis;* 9. *foveolata;* 10. *himenderi;* 11. *himalayana;*
12-14. Gonoforceps: 12. *indiana;* 13. *chambali;* 14. *nigra.*

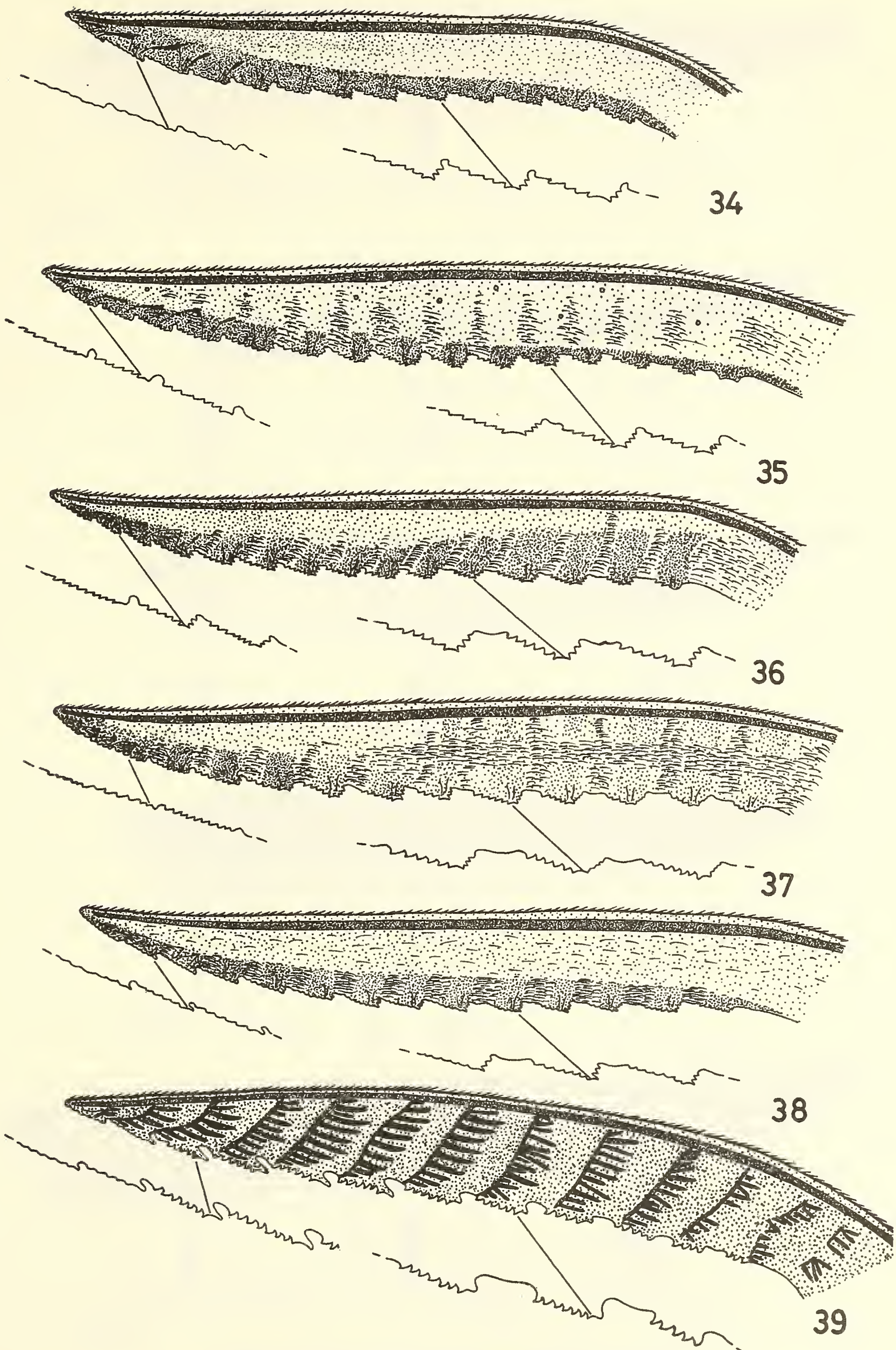


Figs. 15-22. Species of genus *Ferna* Malaise
15-22. Gonoforceps: 15. *canalicula;* 16. *acclivata;* 17. *foveolata;* 18. *emarginata;* 19. *cinguliventris;* 20. *himalayana;* 21. *dutti;* 22. *sagittata.*

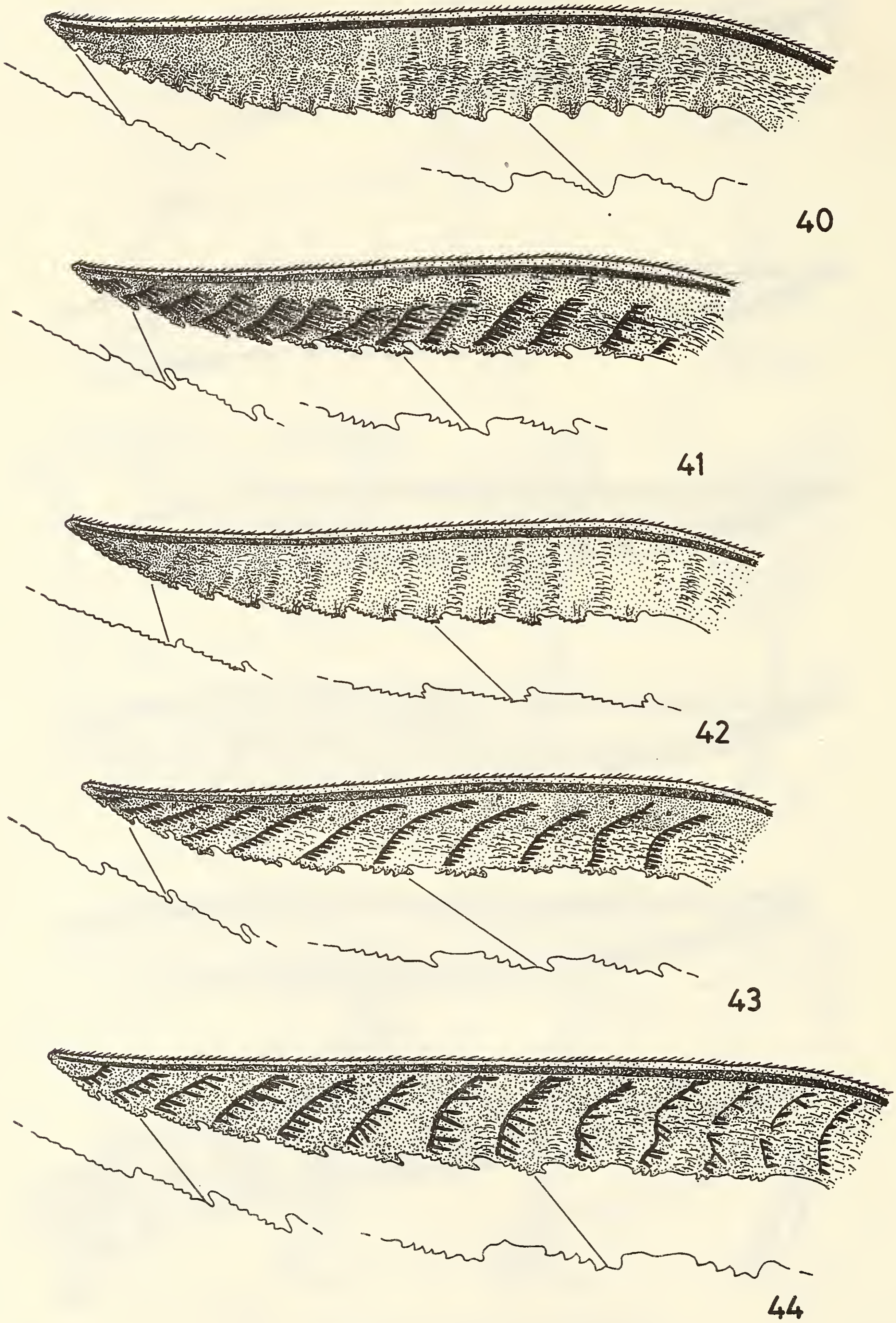


Figs. 23-33. Species of genus *Ferna* Malaise

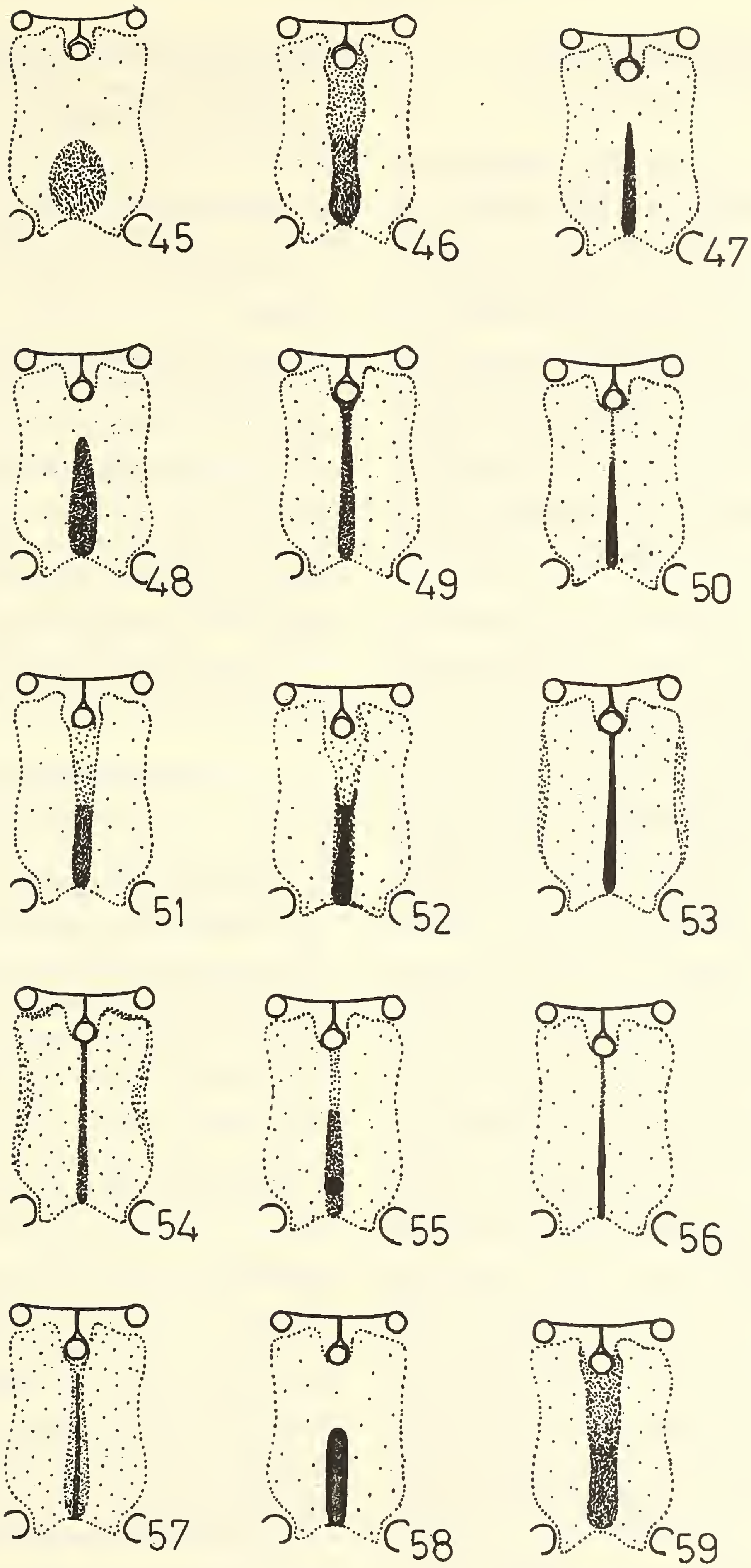
23-33. Penis valves: 23. *indiana;* 24. *chambali;* 25. *nigra;* 26. *canalicula;* 27. *acclivata;* 28. *foveolata;* 29. *emarginata;* 30. *cinguliventris;* 31. *himalayana;* 32. *dutti;* 33. *sagittata.*



Figs. 34-39. Species of genus *Ferna* Malaise
34-39. Lancets: 34. *chambali;* 35. *nigra;* 36. *naga;* 37. *canalicula;* 38. *acclivata;* 39. *himenderi.*



Figs. 40-44. Species of genus *Ferna* Malaise
40-44. Lancets: 40. *foveolata;* 41. *himalayana;* 42. *sagittata;* 43. *brevis*; *44. pupa.*



Figs. 45-59. Species of genus *Ferna* Malaise

45-59. Frontal area of head showing median fovea: 45. ***indiana;*** 46. ***chambali***; 47. ***nigra***; 48. ***naga***; 49. ***canalicula***; 50. ***acclivata***; 51. ***himenderi***; 52. ***brevis***; 53. ***foveolata***; 54. ***cinguliventris***; 55. ***himalayana***; 56. ***dutti***; 57. ***sagittata***; 58. ***pupa***; 59. ***emarginata***.

Ferna foveolata sp. nov.
(Figs. 3, 9, 17, 28, 40, 53)

Female: Colour: Body black; the following parts are yellowish white: clypeus; labrum; mandible barring apex; a square spot on supraclypeal area; narrow inner orbit; tegula; a spot each on meso- and metascutella; a transverse band on lower posteroventral 1/2 of mesopleuron not reaching epicnemium; metepimeron except anterodorsal 1/2; deflexed lateral sides of tergites 2-4; sternites 2-4; all coxae and trochanters. Rest of parts of all legs uniformly fuscoferruginous. Wings hyaline venation including costa, subcosta and stigma fuscous.

Structure: Length 5.5 mm. Antenna long, 3.2x head width; scape as long as its apical width; pedicel 2x its apical width; segments 3 shorter than 4 as 4:5; clypeus (Fig. 3) roundly incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 0.5x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with similar roundly raised frontal ridges; median fovea in form of deep seam in its anterior half and posterior clearly reaching median ocellus (Fig. 53); post- inter- and circumocellar furrows sharp and distinct; lateral furrows distinct, deep parallel and ending just before hypothetical hind margin of head; postocellar area almost flat, broader than long as 5:4; head narrowing behind eyes; POL:OCL:OOL :: 2:3:3; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 8:9; metatibial spurs subequal in length; IATS:MB:OATS :: 3:8:2. Lancet (Fig. 40) with 19 serrulae. Lateral view of ovipositor sheath as in Fig. 9.

Sculpture and pubescence: Head with a few scattered, minute punctures, surface shining; thorax almost apunctate except mesonotum which is punctured like head, surface shining with general oily lustre; abdomen apunctate, shining. Body covered with survey pubescence.

Male: Length 5 mm. Similar to female. Genitalia: penis valve (Fig. 28), gonoforceps (Fig. 17).

Holotype: Female, West Bengal, Darjeeling, 2280 m, 7.v.1993.

Paratype: 1 male, with same data as holotype.

Distribution: India: West Bengal.

Diagnosis: *F. foveolatus* is close to *F. longiserra* Malaise, but can be distinguished by the malar space being 0.5x diameter of median ocellus; characteristic shape of median fovea; distinct colour pattern of the body; ratio of antennal segments 3 and 4, and relative lengths of metabasitarsus and following joints combined.

Etymology: The species name pertains to the characteristic shape of median fovea.

Ferna emarginata sp. nov.
(Figs. 4, 18, 29, 59)

Female: Unknown.

Male: Colour: Body black; the following areas are yellowish white: scape; clypeus; labrum; mandible barring apex; a spot on supraclypeal area extending upto upper rim of antennal socket; broad inner orbit; lower margin of hind orbit; tegula; inner margin of mesonotal lateral lobe adjoining mesonotal middle lobe; anterior 1/2 of mesocutellum; parapterum; a transverse band on lower 1/2 of mesopleuron; lower 1/2 of metapleuron; posterior margin of tergite 2; deflexed lateral sides of all tergites; all sternites entirely; all coxae and trochanters. All femora, tibiae and tarsi of front four legs are fuscoferruginous; metatarsi fuscus. Wings hyaline; venation including costa; subcosta and stigma piceous.

Structure: Average length 5 mm. Antenna 3.7x head width; scape and pedicel each as long as its apical width; segment 3 shorter than 4 as 4:5; clypeus (Fig. 4) subtriangularly incised upto 1/3 of its medial length; labrum broader than long as 2:1; malar space 0.5x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with similarly roundly raised frontal ridges; median fovea in form of deep ditch in its anterior 1/2 and posteriorly reaching median ocellus (Fig. 59); post- inter- and circumocellar furrows distinct; lateral furrows distinct, excurved (bulging) and abruptly ending just before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 2:2:3; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 5:4; metatibial spurs subequal in length; IATS:MB:OATS :: 4:10:3. Genitalia: penis valve (Fig. 29), gonoforceps (Fig. 18).

Sculpture and pubescence: Head with dense minute punctures, surface shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with scattered, minute punctures on its posterior part; appendage apunctate, polished; mesepisternum minutely punctured; mesosternum with a few scattered, minute punctures, surface shining with general oily lustre; abdomen apunctate, subshining. Body covered with silvery pubescence.

Holotype: Male, Assam, Jatinga, 800 m, 7.v.1993.

Paratypes: 2 males, with same data as holotype.

Distribution: Assam.

Diagnosis: The triangularly incised clypeus; malar space equal to half the diameter of median ocellus; entirely black mesosternum and mesonotal middle lobe; characteristic shape of median fovea; ratio of antennal segments 3 and 4, are some of the significant characters which distinguish *F. emarginata* from other species described under the genus.

Etymoloty: As the clypeus is triangularly incised, the species is named *F. emarginata.*

Ferna cinguliventris sp. nov.
(Figs. 19, 30, 54)

Female: Unknown.

Male: Colour: Body black; the following parts are yellowish white: clypeus; labrum; mandible barring apex; a spot on supraclypeal area; narrow inner and hind orbits; posterodorsal and posterolateral margins of pronotum; tegula; a spot on anterior 1/2 of mesoscutellum; a transverse band on lower 2/3 of mesopleuron; lower 1/2 of metapleuron; tergites 2 and 3; deflexed lateral sides of tergites 2 and 3; sternites 2-4 entirely; all legs except all tarsi of four hind legs which are more or less fuscous. Wings hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 4 mm. Antenna 3.3x head width; scape as long as its apical width; pedicel 1.5x its apical width; segment 3 shorter than 4 as 6:7; clypeus (Fig. 3) roundly incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 1x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with similar roundly raised frontal ridges; median fovea in form of deep narrow seam clearly extending upto median ocellus (Fig. 54); post-, inter- and circumocellar furrows sharp and distinct; lateral furrows distinct, parallel and ending just before hypothetical hind margin of head; postocellar area broader than long as 5:4; head narrowing behind eyes; POL:OCL:OOL :: 2:2:3; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one; metabasitarsus shorter than following joints combined as 4:5; metatibial spurs subequal in length; IATS:MB:OATS :: 4:8:3. Genitalia: panis valve (Fig. 30), gonoforceps (Fig. 19).

Sculpture and pubescence: Head with dense minute punctures, surface shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with scattered, minute punctures on its posterior part;

appendage apunctate, polished, mesepisternum minutely punctured; mesosternum with a few scattered, minute punctures, surface shining with general oily lustre; abdomen apunctate, less shining. Body covered with silvery pubescence.

Holotype: Male, Nagaland, Zunheboto, 1874 m, 16.v.1993.

Paratype: 1 male, with same data as holotype.

Distribution: Nagaland.

Diagnosis: The characteristic shape of median fovea; coloured band on abdomen; malar space of the diameter of median ocellus; mesosternum and mesonotal midle lobe entirely black, distinguish *F. cinguliventris* from all the species reported under this genus.

Etymology: The species name pertains to the yellowish white band that covers abdominal segments 2 and 3 completely.

Ferna himalayana sp. nov.
(Figs. 11, 20, 31, 41, 55)

Female: Colour: Body black; the following parts are: yellowish white clypeus; labrum, mandible barring apex; a spot on supraclypeal area extending upto upper rim of antennal socket; broad inner orbit except posterior 1/4; lower 1/3 of hind orbit; a spot on temple; posterodorsal angle of pronotum; tegula; a spot on anterior 1/2 of mesoscutellum; a transverse band on lower 1/2 of mesopleuron; posterior margin of tergites 2-5 and 9; deflexed lateral sides of all tergites; all sternites entirely; coxae, trochanters and femora of all legs. The tibiae and tarsi of front four legs and metatibia except apical 1/4 fuscoferruginous; apex of metatibia and metatarsi fuscus. Wings hyaline, venation including costa, subcosta and stigma -piceous.

Structure: Average length 5 mm. Antenna 3.2 x head width; scape and pedicel each as long as its apical width; segment 3 shorter than 4, as 5:6; clypeus (Fig. 1) subsquarely incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 0.5x diameter of median ocellus; LID:IDMO:EL :: 3:3:2; head without postgenal carina; supra-antennal tubercles moderate and confluent with insignificant frontal ridges; median fovea in form of deep ditch with a minute medial pit in its anterior 1/2 and posteriorly only shallowly reaching median ocellus (Fig. 55); post-, inter- and circumocellar furrows distinct; lateral furrows distinct and abruptly ending just before hypothetical hind margin of head; postocellar area broader than long as 2:1; head narrowing behind eyes; POL:OCL:OOL :: 2:2:3; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobe; metabasitarsus shorter than following joints combined as 6:7; metatibial spurs subequal in length; IATS:MB:OATS :: 4:8:3. Lancet (Fig. 41) having 11 serrulae. Lateral view of ovipositor sheath as in Fig. 11.

Sculpture and pubescence: Head with a few minute punctures, more concentrated on frontal area, surface shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with few scattered minute punctures; appendage apunctate, polished; mesepisternum and mesosternum apunctate, shining with general oily lustre; abdomen apunctate, not as shiny. Body covered with silvery pubescence.

Male: Length 4 mm. Similar to female. Genitalia: penis valve (Fig. 31), gonoforceps (Fig. 20).

Holotype: Female, Uttar Pradesh, Barkot, 2000 m, 28.vi.1992.

Paratypes: Uttar Pradesh, Rana, 1800 m, (2 females), 20.vi.1992; Mastura, 1800 m, (2 females), 25.vi.1992; Auli, 2480 m, (1 male), 27.vi.1992; Barkot, 2000 m. (2 females), 28.vi.1992.

Distribution: Uttar Pradesh.

Diagnosis: The characteristic shape of median fovea; distinct colour pattern of body; postocellar area broader than long as 2:1; and ratio of antennal segments 3 and 4, distinguish *F. himalayana* from other species of the genus.

Etymology: Named after the Great Himalaya, in which the type locality falls.

Ferna dutti sp. nov.
(Figs. 21, 32, 56)

Female: Unknown.

Male: Colour: Body black; the following parts are yellowish white clypeus; labrum; mandible barring apex; a spot on supraclypeal area; narrow inner orbit; lower 1/4 of hind orbit; a spot on temple; posterodorsal margin of pronotum; tegula; a faint spot before mesoscutellum; a spot on mesoscutellum; a transverse band on lower 1/2 of mesopleuron; a spot on metasternum; all legs except tibiae and tarsi, which are light brownish. Wings hyaline, venation including costa, subcosta and stigma dark brown.

Structure: Average length 5 mm. Antenna 3x head width; scape and pedicel each as long as its apical width; segment 3 shorter than 4 as 4:5; clypeus (Fig. 2) roundly incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 0.5x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with similar roundly raised frontal ridges; median fovea in the form of a deep seam in its anterior 1/2 and posteriorly only shallowly though distinctly reaching median ocellus (Fig. 56); post-, inter- and circumocellar furrows distinct; lateral furrows distinct, excurved (bulging) and abruptly ending just before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 1:1:1; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobo; metabasitarsus shorter than following joints combined as 2:3; metatibial spurs subequal in length; IATS:MB:OATS :: 5:12:3. Genitalia: penis valve (Fig. 32), gonoforceps (Fig. 21).

Sculpture and pubescence: Head with a few minute punctures on frontal area, surface shining; thorax with dense, minute, irregular punctures, more conspicuous on posterior slope of mesoscutellum, but appendage apunctate and polished; abdomen microstricted, surface subshining. Body covered with silvery pubescence except for the yellowish white parts where it appears to be golden.

Holotype: Male, Arunachal Pradesh, Nine Mile, 1200 m, 24.v.1993.

Paratypes: 4 males, with same data as holotype.

Distribution: Arunachal Pradesh.

Diagnosis: *F. dutti* is unique in the malar space equal to half the diameter of median ocellus; characteristic shape of median fovea; all tergites black above; presence of a transverse band on lower 1/2 of mesopleuron; mesosternum entirely black. These along with ratio of antennal segments 3 and 4, and scape and pedicel each as long as the apical width are diagnostic.

Etymology: The species is named after the collector, Mr. Dyal Dutt.

Ferna sagittata sp. nov.
(Figs. 22, 33, 42, 57)

Female: Colour: Body black, the following parts are whitish yellow: clypeus; labrum; mandible barring apex; extreme narrow orbit; a faint spot on temple; posterodorsal margin of pronotum; tegula; sagittated apex of mesonotal middle lobe; a spot on mesoscutellum; parapterum; a transverse band on lower half of mesopleuron; lower half of metapleuron; deflexed lateral sides of all tergites; all sternites entirely; all legs. Wings are hyaline; venation including costa, subcosta and stigma piceous.

Structure: Average length 6 mm. Antenna 3.2x head width; scape and pedicel each 1.3x its apical width; segment 3 shorter than 4 as 5:6; clypeus (Fig. 5) subrectangularly incised upto 1/2 of its medial length; labrum broader than long as 3:2; malar space 1x diameter of median ocellus;

LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with roundly raised frontal ridges; median fovea in form of deep broad ditch shallowly reaching median ocellus (Fig. 57); post-, inter- and circumocellar furrows distinct; lateral furrows deep, parallel and abruptly ending well before hypothetical hind margin of head; postocellar area broader than long as 5:4; head narrowing behind eyes; POL:OCL:OOL :: 1:1:1; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one and without basal lobe; metabasitarsus subequal to following joints combined as 6:7 metatibial spurs subequal in length; IATS:MB:OATS :: 4:8:3. Lancet (Fig. 42) having 13 serrulae. Lateral view of ovipositor sheath as in Fig. 9.

Sculpture and pubescence: Head with dense, minute punctures, surface shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with scattered, minute punctures on its posterior part; appendage apunctate, polished; mesepisternum minutely punctured; mesosternum with a few scattered, minute punctures, surface shining with general oily lustre; abdomen apunctate, subshining. Body covered with silvery pubescence.

Male: Average length 5 mm. Similar to female except in the following: deflexed lateral sides of all tergites and sternites entirely black; yellowish white spot present on supraclypeal area Genitalia: penis valve (Fig. 33), gonoforceps (Fig. 22).

Holotype: Female, Arunachal Pradesh, Nine Mile, 1200 m, 24.v.1993.

Paratypes: 3 females, 12 males, with same data as holotype.

Distribution: Arunachal Pradesh.

Diagnosis: *F. sagittata* is unique in having yellowish white sagittated apex of mesonotal middle lobe; malar space of the diameter of median ocellus; all tergites and mesosternum entirely black; rounded ovipositor sheath. These characters and ratio of antennal segments 3 and 4 distinguish this species from other *Ferna* species.

Etymology: The species name pertains to the coloured sagittated apex of mesonotal middle lobe.

Ferna brevis sp. nov.
(Figs. 8, 43, 52)

Female: Colour: Body black, the following parts are yellowish white: clypeus; labrum; mandible barring apex; supraclypeal area; lower 1/3 of inner orbit; a narrow streak on inner margin of eye; lower 1/2 of meso- and metapleura; deflexed lateral sides of all tergites; all sternites; all legs except tarsi more or less. Wings are hyaline, venation including costa, subcosta and stigma light to dark brown.

Structure: Length 4 mm. Antenna 3.2x head width; scape and pedicel each as long as its apical width; segment 3 shorter than 4 as 4:5; clypeus (Fig. 2) roundly incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 1x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without post-genal carina; supra-antennal tubercles insignificant and confluent with roundly raised frontal ridges; median fovea in the form of deep ditch in its anterior 1/2 and posteriorly shallowly reaching median ocellus (Fig. 52); post-, inter- and circumocellar furrows sharp and distinct; lateral furrows distinct, parallel and ending just before hypothetical hind margin of head; postocellar area broader than long as 3:2; head narrowing behind eyes; POL:OCL:OOL :: 1:1:1; mesoscutellum subconvex; appendage not carinate; tarsal claw with subapical tooth shorter than apical one; metabasitarsus shorter than following joints combined as 3:4; metatibial spurs subequal in length; IATS:MB:OATS :: 5:12:4. Lancet (Fig. 43) with 11 serrulae. Lateral view of ovipositor sheath as in Fig. 8.

Sculpture and pubescence: Head with a few scattered, minute punctures, surface shining;

thorax almost apunctate, except mesonotum which is punctured like head, surface shining with general oily lustre; abdomen apunctate, shining. Body covered with silvery pubescence.

Male: Unknown.

Holotype: Female, Sikkim, Gangtok, 1700 m, 6.v.1993.

Distribution: Sikkim.

Diagnosis: The ditch-like median fovea posteriorly shallowly reaching median ocellus; postocellar area broader than long as 3:2; scape and pedicel each as long as its apical width; segments 3 and 4 as 4:5; malar space of the diameter of median ocellus; and all tergites and mesosternum entirely black, distinguish *F. brevis* from its nearest congeneric *F. pupa* and other *Ferna species.*

Etymology: The species name pertains to its comparatively small body size.

Ferna pupa sp. nov.
(Fig. 44, 58)

Female: Colour: Body black, the following parts are yellowish white: clypeus; labrum; mandible barring apex; supraclypeal area; broad lower 1/2 and a narrow streak on upper 1/2 of inner orbit; lower 1/4 of hind orbit; posterodorsal margins of pronotum; tegula; a transverse band on lower 1/2 of mesopleuron; a spot on lower 1/2 of metapleuron; deflexed lateral sides of all tergites; all sternites entirely; coxae, trochanter and femora of all legs. Rest of legs light to dark brown. Wings hyaline; venation including costa, subcosta and stigma dark brown.

Structure: Length 4.5 mm. Antenna 3.2x head width; scape and pedicel each 1.3x its apical width; segment 3 shorter than 4 as 8:9; clypeus (Fig. 5) subrectangularly incised upto 1/2 of its medial length; labrum broader than long as 2:1; malar space 1x diameter of median ocellus; LID:IDMO:EL :: 6:7:4; head without postgenal carina; supra-antennal tubercles moderate and confluent with similarly roundly raised frontal ridges; median fovea in the form of deep ditch in its anterior 1/2 and posteriorly not reaching median ocellus (Fig. 58); post-, inter- and circumocellar furrows distinct; lateral furrows deep, distinct, parallel and ending abruptly well before hypothetical hind margin of head; postocellar area broader than long as 2:1; head narrowing behind eyes; POL:OCL:OOL :: 4:4:5; mesoscutellum subconvex; appendage not carinate; tarsal claw with a subapical tooth shorter than apical one; metabasitarsus shorter than following joints combined as 6:7; metatibial spurs subequal; IATS:MB:OATS :: 5:12:3. Lancet (Fig. 44) having 11 serrulae. Lateral view of ovipositor sheath as in Fig. 8.

Sculpture and pubescence: Head with a few minute punctures, more concentrated on frontal area, surface shining; mesonotum with dense, minute, irregular punctures, surface shining; mesoscutellum with a few scattered minute punctures; appendage apunctate, polished; mesepisternum and mesosternum apunctate, shining with general oily lustre; abdomen apunctate, subshining. Body covered with silvery pubescence.

Male: Unknown.

Holotype: Female, Arunachal Pradesh, Bomdila, 2550 m, 25.v.1993.

Distribution: Arunachal Pradesh.

Diagnosis: *F. pupa* is distinguished by the characteristic shape of median fovea; distinct colour pattern of body; scape and pedicel each 1.3x its apical width; ratio of antennal segments 3 and 4 as 8:9; clypeal incision; and length of malar space.

Etymology: The species is named after the Punjabi University, Patiala (PUP), where this work was carried out.

Acknowledgement

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A NEW SPECIES OF *MACROTYLOMA* (WIGHT & ARN.) VERDC. (FABACEAE) FROM GARHWAL HIMALAYA, U.P., INDIA[1]

R.D. Gaur[2] and L.R. Dangwal

(*With one text-figure*)

While exploring the remote localities of Garhwal Himalaya (Pauri District), some interesting specimens of the genus *Macrotyloma* (Wight & Arn.) Verdc. were collected. Thorough consultation of literature and herbaria at Botanical Survey of India, Northern Circle, Dehradun (BSD) and Forest Research Institute, Dehradun (DD), indicated generic circumscription of *Macrotyloma,* though, quite distinct from the known species, *Macrotyloma sar-garhwalensis* sp. nov. is thus described.

Macrotyloma sar-garhwalensis sp. nov.

Herbae annuae, erectae, non volubiles. Folia pentafoliolata; stipulae magnae, lanceolatae. Calycis tubus longior quam dentibus. Corolla intra calycem inclusa; vexillum apice pilosum, appendices nulli, carina breviter rostrata; stylus deorsum barbatus.

Herba annua pubescens, 15 - 50 cm alta, caule erecto, anguste costato, simplici vel ramoso. Folia imparipinnata, 5-foliolata, *ca* 8 cm longa (petiolo incluso); foliola sessilia vel subsessilia, *ca* 1.8 - 4.5 cm x 0.6 - 1.2 cm, oblonga, lanceolata ad ovata vel elliptica, acuta, vix utrinque pubescentia, manifeste in nervis infra, ad marginemque; foliola lateralia parum obliqua vel non obliqua. Stipilae 4 x 11 mm longae, lanceolatae, utrinque minute pilosae. Inflorescentia axillaris, brevi-pedunculata, fasciculata, flores 1-2, in uno pedunculo communi brevi, *ca* 7 mm longo; pedicellus brevis, *ca* 4 mm longus, pilosulus. Bracteae ovato-lanceolatae, acutae, *ca* 6 mm longae, pilosae ad marginem et in nervis. Calyx pubescens, campanulatus, 10 nervis, *ca* 6 mm longus, tubus longior quam dentes, dentes inaequales. Corolla cremea, intra calycem, inclusa, vexillum ovato-obovatum, apice pilosum, *ca* 6 mm longum; ala angusta, tenuis, *ca* 6 mm longa. Stamina diadelpha (9+1), *ca* 6 mm longa; antherae plerumque, uniformes, dithecae. Gynaecium *ca* 7 mm longum; ovarium pilosum, breviter stipitatum, stylus filiformis, sursum incrassatus, aliquantum S-formis, deorsum barbatus, stigma capitatum cum annulo pilorum. Legumina compressa, breviter curvata, brunnea, *ca* 3 - 5 cm x 0.3 - 0.7 cm, non septata, utrinque minute pilosa cum calyce bracteisque, persistentibus. Semina 4 - 6 in uno legumine, compressa, subquadrato-rotundata, *ca* 4 mm longa lataque, nitida, nigra.

Typus: Sara Village, Pauri District, Uttar Pradesh, 700 m, 17.ix.1994, R.D. Gaur, 12,380A Garhwal Himalayas (Holotypus - GUH); Isotypus: Ibid. R.D. Gaur, 12,380B, Garhwal Himalaya.

Macrotyloma sar-garhwalensis sp. nov.
(Fig. A - K_2)

Annual, erect, non-twining herbs. Leaves pentafoliate; stipules large, lanceolate. Calyx tube longer than teeth. Corolla included within the calyx; vexillum tip hairy, appendages absent; keel shortly beaked. Style bearded on the lower sides of the upper section.

Annual, pubescent, 15 - 50 cm tall herbs, with erect, narrowly ribbed, simple or branched stem. Leaves imparipinnate, 5-foliate, *ca* 8 cm

[1]Accepted June, 1996.

[2]Herbarium and Plant Systematics Laboratory,
Department of Botany, P.O. Box No. 17,
H.N.B. Gahrwal University, Srinagar (Garhwal)-246 174.

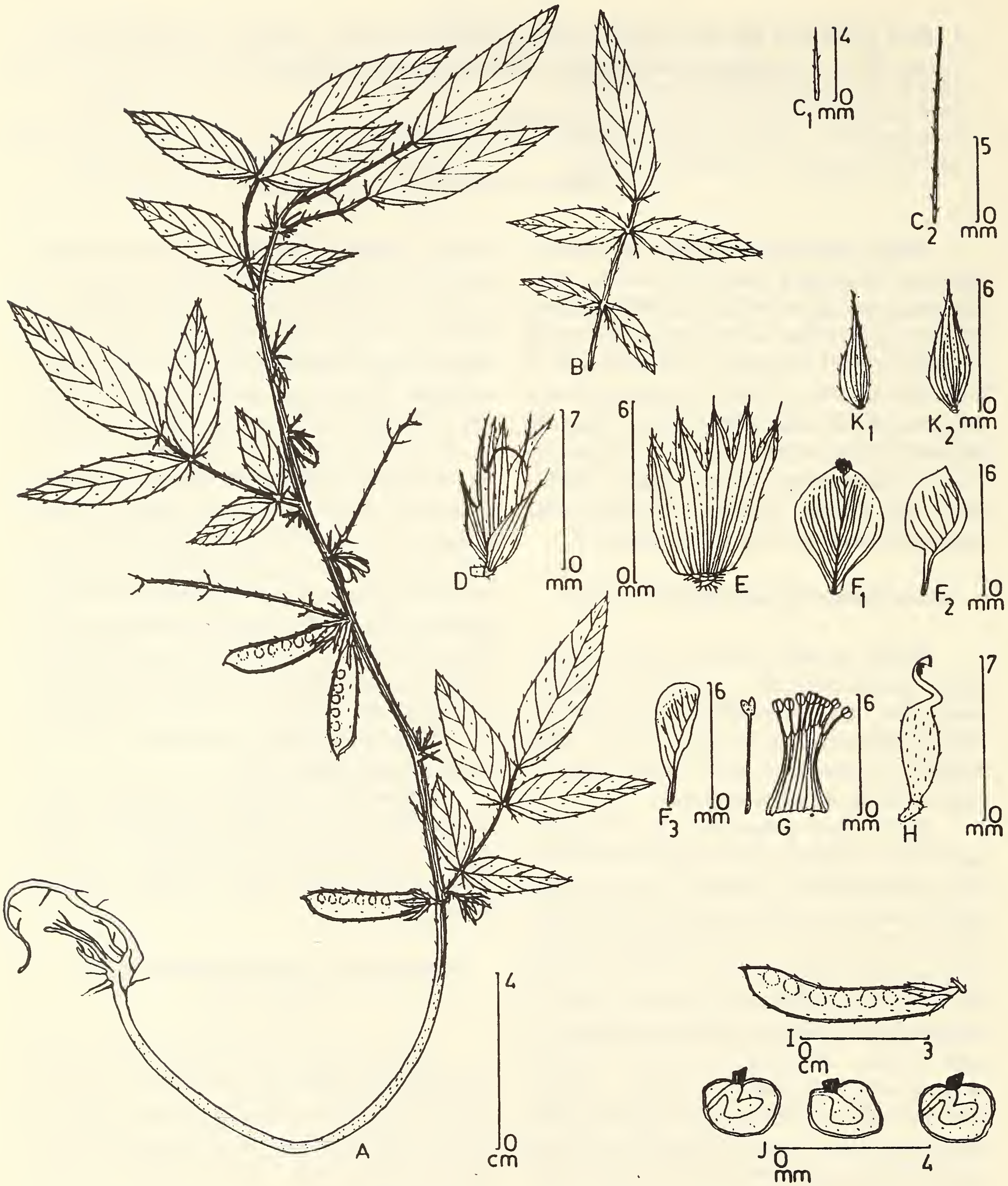

Fig. 1. *Macrotyloma sar-garhwalensis* sp. nov. A. Flowering and fruiting plant; B. Leaf; C_1, C_2. Bracts; D. Flower; E. Calyx; F_1, F_2, F_3. Corolla; G. Stamens; H. Gynaecium; I. Pod; J. Seeds; K_1, K_2. Stipules

long (including petiole); leaflets sessile or subsessile, *ca* 1.8 - 4.5 cm x 0.6 - 1.2 cm, oblong, lanceolate to ovate or elliptic, acute, sparsely pubescent on both surfaces, prominently on nerves beneath and at the margins; lateral leaflets slightly oblique or not. Stipules 4 - 11 mm long, lanceolate, minutely hairy on both surfaces. Inflorescence axillary, short peduncled, fasciculate; flowers 1 - 2 on a short common peduncle, *ca* 7 mm long; pedicel short, *ca* 4 mm long, minutely hairy. Bracts obovate - lanceolate, acute, *ca* 6 mm long, hairy at the margins and nerves. Calyx pubescent, campanulate, 10-nerved, *ca* 6 mm long, tube longer than teeth, teeth unequal. Corolla cream-yellow, included within the calyx; vexillum ovate-obovate, tip hairy, *ca* 6 mm long; wing narrow, feathery, *ca* 6 mm long. Stamens diadelphous (9+1), *ca* 6 mm long; anthers usually uniform, dithecous. Gynaecium 7 mm long; ovary hairy, shortly stipitate; style filiform, thickened upwards, somewhat 'S' shaped, bearded on the lower sides; stigma capitate, with a ring of hairs. Pods compressed, shortly curved, brown coloured, *ca* 3 - 5 cm x 0.3 - 0.7 cm; not septate, minutely hairy on both sides, with a persistent calyx and bracts. Seeds 4 - 6 in a pod, compressed, squarish-round, *ca* 4 mm as long as broad, shining black coloured.

Fl. and Fr.: August - October

Ecology: On exposed grassy slopes, along the edge of crop fields, associated with species of *Desmodium* and *Alysicarpus,* as well as some shrubs.

Etymology: The plant species is named after the type locality, village Sara of Garhwal Himalaya, in Uttar Pradesh, India.

Acknowledgement

We thank Dr. N.C. Majumdar, Dy. Director (Retd), Botanical Survey of India, Calcutta, for the Latin translation.

REVIEWS

1. ILLUSTRATIONS ON THE FLORA OF THE PALNI HILLS. By K.M. Matthew. Published by Rapinat Herbarium, St. Joseph's College, Tiruchirapalli-620 002. pp. i-xlvi + 1-979 (24 x 16 cm), 1996. Price Rs 250.00

This is the 7th book by Rev. Fr. K. M. Matthew on plants of Southern India, four volumes in six parts on "FLORA OF TAMIL NADU CARNATIC" have appeared.

This book has 950 plates representing 914 species, belonging to 448 genera of spermatophytes. Black & white line drawings, are used methodically. The publication of this volume brings the total number of illustrations of vascular plants published by Fr. Matthew to 2630, in Peninsular India, east of the Western Ghats.

The author mentions that he has taken care to name all the introduced plants correctly with overseas collaboration. However, the following identifications of endemic species require rechecking regarding their correct nomenclature:

Plate No. 645. *Actephila excelsa* (Dalz.) Muell.-Arg.

Plate No. 617. *Litsea quinqueflora* (Dennst.) Suresh

Plate No. 646. *Bridelia crenulata* Roxb. (Figs. 1 & 8).

Plate No. 560. *Phaulopsis imbricata* (Forsk.) Sw.

Plate No. 624. *Dendrophthoe falcata* (L.f.) Etting.

Plate No. 625. *Dendrophthoe falcata* (L.f.) Etting.

The book has over 1000 pages, and is priced at Rs 250/-only. It is like a free gift to the reader, considering the current cost of publication. There is no doubt that those who have purchased the earlier volumes of FLORA OF TAMIL NADU CARNATIC, will purchase this book without any hesitation. It is a good addition to my personal library and I would recommend it to all botanists.

M.R. ALMEIDA

2. MAMMALS OF NEPAL, WITH REFERENCE TO THOSE OF INDIA, BANGLADESH, BHUTAN AND PAKISTAN. By Dr. Tej Kumar Shreshtha, 1997. Published by Mrs. Bimala Shrestha, Kathmandu, Nepal. pp. 371 (21.5 x 14 cm). Price not given.

Nepal is a small land-locked country of about 147,181 sq. km, and has a high biodiversity due to its location at the junction of Oriental and Palaearctic biogeographical regions, and high altitudinal variation from the humid terai plains to the lofty Himalayan mountains. Nearly 225 species of mammals, and 800 species of birds have been reported from Nepal. Being the only Hindu country in the world, Nepal has a long history of conservation, and wildlife protection. All religions claim to have conservation and wildlife protection. All religions claim to have a conservation message, but perhaps only Hindu philosophy comes nearest to the modern conservation ethos. Despite being one of the ten poorest countries of the world, Nepal has established some of the finest wildlife reserves in the world, such as the Royal Chitwan National Park, Suklaphanta National Park and Annapurna Conservation Area.

Dr. Tej Kumar Shreshtha's book MAMMALS OF NEPAL has come at the right time when all wildlife, especially mammalian fauna, is under severe threat due to the twin onslaught of habitat destruction and poaching by international gangs. I hope this book will create an interest in the threatened mammals of Nepal.

This 371-page encyclopaedic book covers a wide range of subjects, in chapters entitled *National Parks and Wildlife Reserves in Nepal, History of Mammal Collection,* to *The Important Orders of Mammals.* The major part of the book covers species' descriptions, scientific, English and local names, ecology, behaviour, distribution, habitat, migration (if necessary) and conservation, of each species. Some species which have been studied in detail, such as the Gangetic dolphin *Platanista gangetica* covers 23 pages, while other lesser known species (e.g. slow loris *Nycticebus bengalensis*) has only one page.

The book is full of grammatical and typographical mistakes. Almost every page has one or two mistakes. For instance, all over the book, blackbuck *Antilope cervicapra* is written in two words (black buck) . Similarly, bluebull or nilgai *Boselaphus tragocamelus* is also written in two words (blue bull). In some places, the distance is given in kilometres while in other places, in miles! The language is quite banal ('small brown birds to the most colourful pheasants', p. 1). Captions of pictures were written carelessly, sometimes with incomprehensible English, e.g. 'Inductive Method Game and Shooting in Past', and 'A Horn of Plenty'.

The book is also full of non-scientific statements. For instance, rabbit is included in the diet of the clouded leopard. It should have been hare *Lepus nigricollis* because rabbit *Oryctolagus cuniculus* is not found in Nepal. It is claimed that the 'river systems are much older than the Himalayas' while the prevalent view is that the rivers of Nepal and north India developed after the formation of the Himalayas. So how can they be older than the Himalayas? The wild boar *Sus scrofa* is claimed to be a "ferocious animal", while it is quite a timid animal and runs away at the slightest disturbance. On page 243, the life cycle of swamp deer *Cervus duvauceli* is depicted, in which a male with large antlers is shown feeding milk to a fawn! The doe swamp deer does not have antlers, and the buck swamp deer does not give milk! On page 130, the Himalayan wolf is referred to as *Canis lupus pallipes* (Sykes) while the Himalayan subspecies is actually *Canis lupus chanco* Gray. Interestingly, the photograph is also *of pallipes* while the description is of *chanco.*

There is a profusion of colour and black and white pictures, mostly taken in captivity. Most of the animals are photographed at close range, perhaps to avoid showing cages. Some of the pictures are very dark or out of focus. Pictures taken in the wild are hazy. A picture of the domestic white rabbit is captioned rufoustailed hare (facing page 92). Diagrams are reasonably good.

The book has an impressive list of 355 references, but some important recent references are missing. For instance, the status and description of blackbuck is outdated. Dr. Ranjitsinh's book THE INDIAN BLACKBUCK (Natraj Publishers, Dehra Dun, India), is not quoted. It is claimed that blackbuck (i) "had a wide distribution in the Asian sub-continent" (p. 222), (ii) "blackbucks (*sic*) are very vocal" (p. 225), (iii) "two rivals interlock (225), (iv) "blackbuck (*sic*) seldom drink" (p.226) and (v) "Some isolated population is also known to occur in Kanha National Park and certain Reserves of Orissa in India." (p. 228). All wrong. Blackbuck never had a wide distribution in Asia (they are found only in India, Pakistan and Nepal). It is generally a silent animal, like most mammals. How can they "interlock" their straight horns? Blackbuck regularly drink water and the presence of surface water throughout the year determines its distribution. Blackbuck is still widely distributed in suitable habitats in 13 states of India. These mistakes could have been avoided if recent literature had been consulted.

Despite numerous drawbacks, MAMMALS OF NEPAL is a useful book for conservationists of the Indian Subcontinent. Let us hope that the second edition will be properly edited and checked for scientific accuracy.

ASAD R. RAHMANI

3. AN ANNOTATED CHECKLIST OF THE BIRDS OF THE ORIENTAL REGION - Tim Inskipp, Nigel Lindsey & William Duckworth (1996). pp. 294 (24.5 x 16.5 cm) with one map. Oriental Bird Club, United Kingdom. Price: Not stated.

The book deals with the birds found in the region covered by the Oriental Bird Club, which is larger and of a more geopolitical nature than the actual Oriental Region (i.e., the zoogeograpical Indomalayan region). It is felt that the creation of artificial boundaries which have no zoogeographical significance - and which only serve the interest of the Club - is not warranted. Also sticking to the zoogeographical region would have made the book a more user friendly source of material for future researchers of the Oriental region. It appears that the authors too were aware of the same and hence in the book, have differentiated species that occur in the Oriental Bird Club Region and in the Oriental Region proper.

Clarity is lacking in the demarcation of the boundaries of the Oriental Bird Club Region and the Oriental Region in the map. The map is titled ‘Map of the Oriental Bird Club Region’ and the reader at once presumes that the area demarcated in it by dashes is the region mentioned by the title. But as one goes through the text in the introductory chapter, one learns that the demarcated area is the Oriental Region proper, and the extent of the Oriental Bird Club Region are the areas marked in white. Legends are clearly necessary.

The book summarises the information available on the status, distribution, conservation status, systematics and taxonomy of the birds in the region, from information collected from a wide range of publications. All the information has been in compiled in one publication, which had been lacking till now. The classification of birds is based on the DNA-DNA hybridisation technique, and radical changes confront those not already familiar with the changes. For example, all the flamingos are now regarded as congeneric, and so the lesser flamingo has the scientific name of *Phoenicopterus minor* instead of *Phoeniconaias minor* that one has been used to (page 105).

There is a discussion on the ‘Species Concept’ in the introductory chapter. The English names used for the species follow those of Sibley and Monroe, and since the authors have taken pains to provide the earlier or alternate names, readers unfamiliar with the new names have no reason to complain. The need for a standardised list of English names of birds is brought out by the authors themselves; there is a discussion on this issue; and the suggestions given for deciding on the names are pertinent. On the whole, this is a neatly brought out book, the style of presentation, format and quality of publication are excellent.

RANJIT MANAKADAN

4. THE LEOPARD IN INDIA - A NATURAL HISTORY by J.C. Daniel (1996) Nataraj Publishers, Dehra Dun pp. 228 (21.5 x 16 cm). Price not stated.

Few things bring greater joy to naturalists, more particularly armchair naturalists, than leafing through very old volumes of the *Journal of the Bombay Natural History Society*.

The Journal of those days had a different flavour and was distinguished by articles and notes written by a now-extinct breed of hunterwriters who wielded the rifle and the pen with almost equal dexterity. The enchanting narration is, on occasion, likely to mask the perspicacity of their observation of wildlife. The truth is that many of these shikaris, in the course of their main pursuit, had gained a formidable knowledge of the habits and the temperamental oddities of their quarry, so much so, that very few of the more benevolent naturalists who followed them into the jungle with nothing more than binoculars and cameras have succeeded in adding much substance to what the shikari naturalists had told us about some of the large mammals.

This is nowhere more exemplified than in the case of the leopard which, for some strange reason, has not enthused the field naturalists to the extent the tiger and the lion have. For most of the information on the leopard we have to fall back on the writings of hunter sportsmen of distant decades.

In the book before us, J.C. Daniel has strung together the essential facts about the leopard gleaned from the writings in the *Journal* during a period of over a hundred years. The writers are also nearly a hundred in number. The earliest extract is from an anonymous district collector dating from 1886. The contributions peak during the 1920s and 1930s and taper off thereafter.

This is not a scissors and paste job. The extracts have been collated theme-wise with a great deal of understanding and imagination. The chapter headings like "the leopard and its races". "colour", "skull, size and weight", "the life of the leopard", "the leopard on the hunt", "the leopard and its neighbours", "man-eaters and myths", etc. will show the care taken in the compilation. More than these, the extracts are woven together by Daniel's own interspersed terse and pointed comments which give the whole work an admirable unity. Altogether, the book reads like the work of a single author, the differences in style notwithstanding.

In the concluding chapter on the future of the Indian leopard, Daniel calls for "an intensive study of the leopard in view of the remarkable absence of data on this singular species."

The exhaustive citations at the end of the book will enable the reader to have access to the original writings. And that, to be sure, will be a rewarding experience.

It would have added to the value of the book if brief biographical details had been given of the authors quoted. They were a colourful lot and we would have liked to know more about them.

We need similar compilations on the elephant, the lion and the tiger about all of which a wealth of material exists in the old volumes of the *Journal* and no one is better equipped for the task than Daniel. In fact, the BNHS should seriously think of publishing anthologies of the many fine pieces on a variety of natural history subjects that had appeared in the *Journal* during the last one hundred years. A beginning was made under the stewardship of Daniel himself with the publication of A CENTURY OF NATURAL HISTORY (1983). But much more remains to be done.

B. VIJAYARAGHAVAN

5. INTERNATIONAL LEGAL PROTECTION OF WILD FAUNA AND FLORA. by P. van Heijnsbergen pp.261 (24.5 x 16.5 cm). Price not stated.

Any policy for protection of wildlife without the teeth of law is simply not workable. A legislation passed by the government of a country is a crucial aspect of the policy for protection of wildlife of that country. Some species of wild flora and fauna have wide distribution but, due to political unheavals in the recent past, have been sectioned off in different countries. Countries and international boundaries are however intangible human concepts. Fortunately or unfortunately, wildlife knows no international boundaries. One drawback of this situation is in evolving a uniform global strategy for the protection of wild flora and fauna. There cannot be a single piece of legislation for protection of wildlife in such situations because different countries are involved and are run with different forms of governments. Fortunately there are environmental pressure groups working in different countries and there is a rising awareness amongst the people regarding the importance of protection of wild flora and fauna and of the fact that wild heritage is not a property of one country but it is crucial for survival of the entire mankind. This has forced the governments of different countries to coordinate and form unified plans regarding several aspects of protection of wildlife. These unified plans are to be implemented by the countries concerned through mutual agreements, in legal parlance referred to as conventions and treaties. Needless to state, therefore, the branch of the International Law regarding protection of wild flora and fauna is of extreme importance.

The present book has handled this important and technical subject very ably. The author traces the development of consensus of the international community starting from the London convention of 1900 to the Biodiversity Convention of 1994. The author has also broadly outlined the conventions and treaties regarding migratory species, genetic diversity, ecosystem and habitat protection. Important concepts such as the criteria for determining the status of the species, sustainable development, conservation, have been suitably dealt with. The discussion and the information is to the point and concise. The subject matter is neatly divided into appropriate chapters, paragraphs and headings and demonstrates the organised and analytical approach of the author. The detailed references at the bottom of the page indicate the effort made in researching and compiling the data. The book also has an excellent bibliography for the serious reader to pursue further research on the subject.

Since the subject is technical, the book is written in a textbook manner with appropriately more attention to the accuracy and compilation of data than of language. The book offers an excellent compendium and reference guide to the reader already aquainted with the subject, but is is not so friendly to a complete novice. This may not be a drawback as the book is clearly targeted to the more than casual reader. In all, it is an excellent one-source book on the subject and a good addition to the library.

NITIN JAMDAR

MISCELLANEOUS NOTES

1. LIONS HUNTING A LEOPARD

I have just completed reading the very interesting book THE LEOPARD IN INDIA — A NATURAL HISTORY by J.C. Daniel, which was released on 4th October, 1996 at a function organised in New Delhi by WWF — India. I have interesting information to add which is very much in keeping with contemporary India. During one of my nature camps in the Gir Forest ten years ago, some sixty school boys from Rajkot camping beside Kamleshwar Temple in the Gir Forest were being guided to see a pride of lionesses. As they were walking along the jungle trail, there was considerable commotion among the dried teak leaves, and a leopard rushed towards the children chased by two full grown lions! With the group of humans in front and the lions in pursuit, the leopard, in full view of the boys, scaled a slender leafless teak tree. One of the lions, to the thrill of the boys, stood up on its hind legs against the tree looking up at the treed leopard. Both the lions then sat down below the tree as though to be admired by the ogling humans. Then a sound diverted the lions' attention towards the thickets in the ravine, and the leopard quickly descended from the tree and raced away up the hill. The lions had been distracted by the sound of the lionesses further along the path, which the boys were being taken to see. I myself had been looking at the lionesses. The experience was unbelievable and the discipline of the schoolboys was something to be proud of. Not one lad panicked and the group remained together quietly even as the leopard and the pursuing lions were rushing in their direction. It was heart warming to be surrounded later by the excited youngsters telling me of their great experience. The lionesses were forgotten as we walked back to Kamleshwar in the fading light of the winter sun. All the schoolboys are, today, committed conservationists.

Another frightening and equally notable episode was enacted four years ago. The Surat Nature Club annually arranges a nature camp for school children in the Dang Forest. I was to flag off the camp programme, but for some reason I could not leave Gandhinagar and postponed my visit by a couple of days, only to be advised that the camp had been abandoned, because on the fifth night one of the camp volunteers, just before turning in around midnight, had heard some noise.

On flashing his torch he found a leopard tugging at a blanket from one of the tents. The youth excitedly called his friends to see the cat. The animal dropped what he was tugging at and walked calmly to one side. The volunteers, on examining what the feline was trying to pull out discovered, to their horror, a 12 year old boy, fast asleep in the blanket. The boy, though he had fang marks on his leg where the big cat had got a grip on him, was blissfully unaware of the brush he had with death. What is amazing is that he continues to participate in the Club's activities with the wholehearted approval of his parents and the Dang camps are organised each year and are fully booked! 1996 was the eleventh consecutive year of the camp.

November 19, 1996 LAVKUMAR KHACHER
646, Vastunirman,
Gandhinagar-382 022.

2. THE CLOUDED LEOPARD IN MANIPUR AND NAGALAND

(*With one text-figure*)

The clouded leopard *Neofelis nebulosa* is vanishing from part of its wide range in southern and southeastern Asia mainly due to habitat loss and poaching for its fur. Survey results have

TABLE 1
CLOUDED LEOPARDS RECORDED IN MANIPUR AND NAGALAND, 1988-1996

Date	Locality	Specimen	Remarks
April, 1988	Keilam Hill, Churachandpur district, Manipur	—	Reported from this proposed Wildlife Sanctuary by locals & Forest officials
April, 1988	Yangoupokpi Lokchao Chandel dist. Manipur	—	Reported by locals and Forest officials
February, 1992	Intanki, Wildlife Sanctuary, Kohima dist. Nagaland	—	Reported by locals and Forest officials.
January, 1996	Nungbi, Ukhrul dist. Manipur	—	Reported by locals; not uncommon.
January, 1996	Shirol proposed National Park, Ukhrul dist. Manipur	—	Reported by locals and Forest officials. Occurs up to 2585 m.
January, 1996	Anko Range, Ukhrul dist. Manipur	—	Not uncommon in this inaccessible and little disturbed range on the Indo-Myanmar border.
January, 1996	Makru Reserve Forest, Tamenglong dist. Manipur	—	Reported by locals.
June, 1996	Suruhuto, Zunheboto dist. Nagaland	1 skin	Shot by a local Sema Naga tribal sometime back. The skin examined at DC's bungalow; measured: Head-and-body=95.0 cm; tail = 75.0 cm.
June, 1996	Sukhai, Zunheboto dist. Nagaland	1 skin	Shot by the Sema Naga villagers of Sukhai from the secondary forest on the banks of Tizu river in early 1996.
June, 1996	Dhansiri Reserve Forest, Karbi Anglong dist. Assam	1 skin	Killed by a local Karbi tribal in May, 1996. Dhansiri is contiguous with Intanki of Nagaland.
June, 1996	Satoi, Zunheboto, Tuensang and	—	Reported by locals and Government officials. OccursPhek districts, Nagaland above 2000 m; also at lower elevations.

reported them in recent years from Assam and parts of other states of northeastern India (Choudhury, 1993; Athreya and Johnsingh 1995).

Information on their distribution in Manipur and Nagaland is scarce. During general field surveys for wildlife in Manipur in 1988 and 1996, and Nagaland in 1992 and 1996, I collected information on the species which are summarised in Table 1.

During the surveys, a picture of the clouded leopard was shown to hunters and other knowledgeable villagers and forest officials and its size and habits were explained. While surveys of such elusive animals can never give completely accurate information on the status of the species, the records show that *N. nebulosa* is still widely distributed in the forested areas of Manipur and Nagaland. Shrinkage of habitat and felling have increased their encounters with villagers. In areas such as Ukhrul district, the villagers of the Tangkhul Naga tribe were quite familiar with the cat, and clearly explained to me that it was the 'third' big cat of their area after the tiger *Panthera tigris* and the leopard *P. pardus*, and that it is mainly arboreal and preys mostly on monkeys.

The total potential habitat available for the clouded leopard in Manipur and Nagaland is about 8000 and 4000 sq. km respectively, of which only 185 sq. km in Manipur and 218 sq. km in Nagaland are inside protected areas. The protected areas are Yangoupokpi Lokchao in Manipur, Intanki (202 sq. km), Puliebadge (9.2 sq. km) and Fakim (6.4 sq. km) in Nagaland. Habitat type in the areas listed in Table 1 ranges from tropical moist deciduous and semi-evergreen in Intanki, tropical rain forest in northern Nagaland and southwestern Manipur to subtropical evergreen in the higher

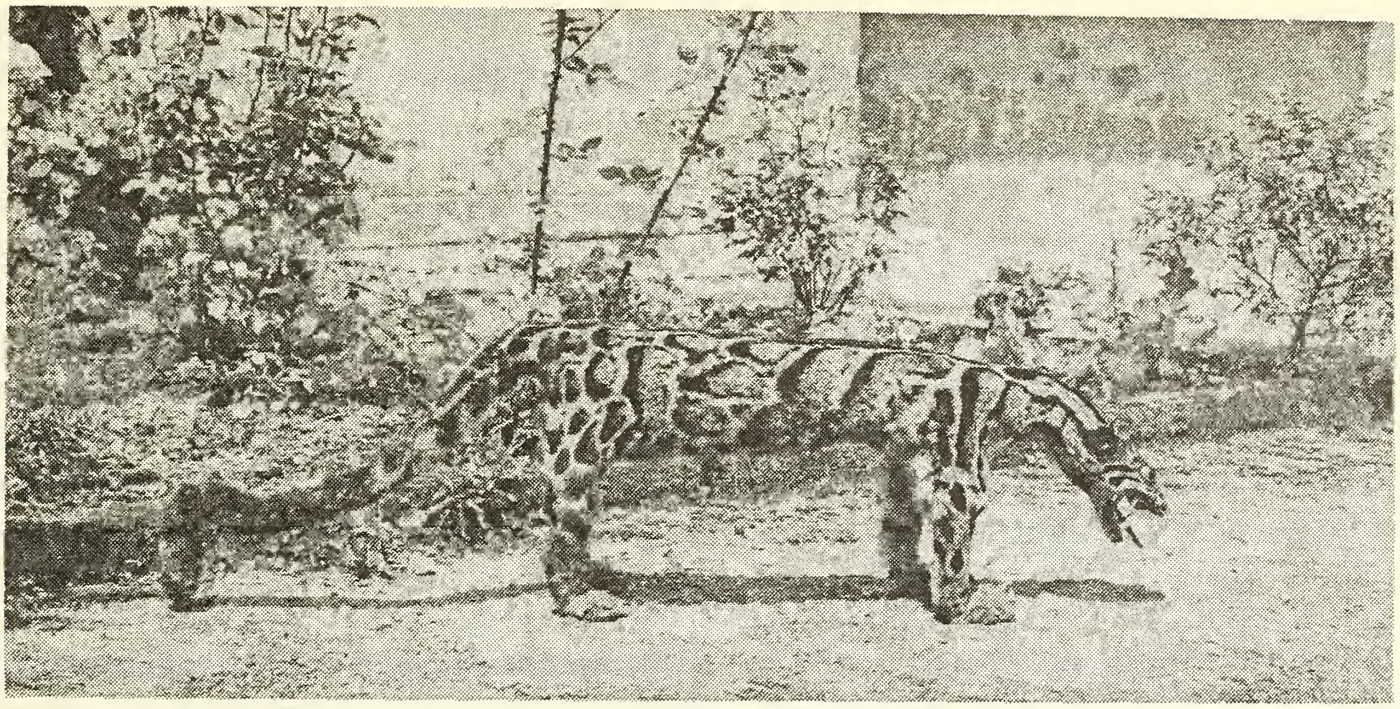

Fig. 1. Clouded leopard photographed in Zunheboto district of Nagaland.

areas such as Shiroi, Satoi and Saramati. The elevation of the recorded localities ranges from 200 m above msl in Intanki to more than 2400 m above msl in Shiroi and Satoi. All over its range in Manipur and Nagaland, the clouded leopard is sympatric with the tiger and the leopard.

The main threat to the species is deforestation, through indiscriminate felling of large and mature trees (where the clouded leopard gives birth to cubs and even hunts) and *jhum* or slash-and-burn shifting cultivation of the hill tribes. These tribes which dominate the entire Nagaland and hilly tracts of Manipur also eat its flesh whenever available.

As the larger part of the forest belongs to local tribes, setting up of protected areas is a difficult task. The proposed National Park at Shiroi and Wildlife Sanctuary at Keilam Hills in Manipur should be declared without further delay. Other areas recommended for protection are, Tolbung-Irangmukh-Vangai-Bongmukh (500 sq. km), Jiri-Makru (99 sq. km) and Anko Range (400 sq. km) in Manipur, and Saramati-Fakim (500 sq. km) and Satoi (100 sq. km) in Nagaland.

ACKNOWLEDGEMENTS

I would like to thank the following: in Manipur, Alauddin Choudhury (father), T. Singh, Chief Wildlife Warden, R.K. Ranjan Singh, S. Muviah and Ibohanbi Singh; in Nagaland, Natwar Thakkar of Nagaland Gandhi Ashram, M.I. Bora, Deputy Commissioner, Zunheboto, Akato Sema, EAC, Zunheboto, Y. Lotha, K. Sohe and Thomas, all of People's Group, a local NGO, and our driver Hakim for their help during the field trip.

February 8, 1997

ANWARUDDIN CHOUDHURY
The Rhino Foundation
C/o The Assam Co. Ltd. Bamunimaidam,
G. Bordola Path,
Guwahati 781 021, Assam.

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3. DEBARKING BEHAVIOUR OF ELEPHANTS, *ELEPHAS MAXIMUS INDICUS* IN VAZHACHAL FOREST DIVISION, KERALA, SOUTH INDIA

Elephants peel off the bark of trees for various purposes. Guy (1967) and Olivier (1978) related debarking to extract water and minerals. Sukumar (1989) observed considerable consumption of bark during the dry season, contrary to the observations of Laws *et al.* (1975). Sivaganesan (1988) pointed out increased mineral content as a possible reason for debarking whereas Croze (1974) observed calcium content in bark as the main reason. However Anderson and Walker (1974) found no relationship between degree of debarking and mineral content of plants. McCullough (1973) described debarking as the response of elephants to a deficiency in essential fatty acids. Sivaganesan (1988) observed debarking and uprooting mainly in lactating and pregnant elephants compared to other individuals. Damiba and Ables (1994) suggest that debarking is self treatment with compounds contained in the bark of trees like *Lannea.* Debarking may be location and situation specific. We studied debarking in 1994-95 in Vazhachal Forest Division while working on habitat utilisation of elephants, covering forests and plantations on which studies were not made earlier.

Vazhachal Forest Division is located in Thrissur and Ernakulam districts of Kerala, south India. The Division, part of which forms the Protected Area Network proposed by Rodgers and Panwar (1988), holds a good population of Asian elephants. The area comes under the purview of Project Elephant and experiences a high tourist influx every year. Observations on debarked trees were made all over the Division. The results are detailed in Table 1. About 36 species were debarked in the Division. Frequent incidence of debarking was found in *Tectona grandis, Acacia auriculiforms, Grewia tiliifolia.* Further studies are required to identify the exact cause of debarking behaviour and to curtail it, because many forest plantations have to be abandoned, or hold low stocks due to elephant damage in combination with *Mikania micrantha* infestation.

March 31, 1997

M.M. ANIMON
Y. CHEERAN JACOB
B.N. NAGARAJ
College of Forestry, Vellanikkara, Kerala 680 654

TABLE 1
LIST OF TREE SPECIES DEBARKED BY ELEPHANTS IN VAZHACHAL FORESTS

Sl. No.	Local Name	Scientific Name	Family	Sl. No.	Local Name	Scientific Name	Family
1.	Teku	*Tectona grandis*	Verbenaceae	13.	Pattippunna	*Dillenia pentagyna*	Dilleniaceae
2.	Elavu	*Bombax ceiba*	Bombacaceae	14.	Chadachi	*Grewia tiliifolia*	Tiliaceae
3.	Acacia	*Acacia auriculiformis*	Mimosaceae	15.	Sesbania	*Sesbania grandiflora*	Fabaceae
4.	Vatta	*Macaranga peltata*	Euphorbiaceae	16.	Veeti	*Dalbergia latifolia*	Fabaceae
5.	Anaviratty	*Laportea crenulata*	Urticaceae	17.	Marotti	*Hypnocarpus pentandra*	Flacourtiaceae
6.	Vaka	*Albizia falcataria*	Mimosaceae	18.	Manimaruthu	*Lagerstroemia reginae*	Lythraceae
7.	Irul	*Xylia xylocarpa*	Mimosaceae	19.	Kumbil	*Gmelina arborea*	Verbenaceae
8.	Venga	*Pterocarpus marsupium*	Fabaceae	20.	Poovam	*Schleichera oleosa*	Sapindaceae
9.	Thalir	*Flacourtia cataphracta*	Flacourtiaceae	21.	Kurangu Manjal	*Mallotus philippensis*	Euphorbiaceae
10.	Athi	*Ficus racemosa*	Moraceae	22.	Pezhu	*Careya arborea*	Lecythidaceae
11.	Nasakam	*Euodia roxburghiana*	Rutaceae	23.	Vattakumbil	*Mallotus albus*	Euphorbiaceae
12.	Madukka	*Xanthophyllum arnottianum*	Xanthophyllaceae	24.	Eucalyptus	*Eucalyptus citriodora*	Myrtaceae

TABLE 1 (*contd.*)
LIST OF TREE SPECIES DEBARKED BY ELEPHANTS IN VAZHACHAL FORESTS

Sl. No.	Local Name	Scientific Name	Family	Sl. No.	Local Name	Scientific Name	Family
25.	Murukku	*Erythrina indica*	Fabaceae	31.	Edampiri	*Helicteres isora*	Sterculiaceae
26.	Malayathi	*Bauhinia racemosa*	Caesalpiniaceae	32.	Encha	*Acacia intsia*	Mimosaceae
27.	Venteku	*Lagerstroemia microcarpa*	Lythraceae	33.	Maruthu	*Terminalia paniculata*	Combretaceae
28.	Nedunar	*Polyalthia fragrans*	Annonaceae	34.	Edana	*Olea dioica*	Oleaceae
29.	Vetti	*Aporusa lindleyana*	Euphorbiaceae	35.	Papita	*Pterocymbium tinctorium*	Sterculiaceae
30.	Malayuram	*Pterospermum reticulatum*	Sterculiaceae	36.	Uthi	*Lannea coromandelica*	Anacardiaceae

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4. VAGINAL PROLAPSE IN A WILD CHITAL, *AXIS AXIS* IN RAJAJI NATIONAL PARK, INDIA.

From November 1992 to May 1993, I was studying habitat use by the chital (*Axis axis*) in Dholkhand, Rajaji National Park, India. On 31st January, 1993 (morning), I saw a group of 20 chitals, including 3 fawns, foraging on a hillock. One doe had vaginal prolapse. The size of the prolapsed mass was about that of a cricket ball. The doe's normal belly suggested that it was not pregnant. No fawn attended the female during the 20 minutes of my observation.

The vagina and also the uterus can get reversed and protrude out through the vulva during advanced pregnancy or when approaching parturition. This condition is called vaginal prolapse or ballooned vagina (Banerjee 1991). Retention of placenta or weakening of the peritonial muscles or dystokia may cause this (Sankar 1990). It makes parturition difficult and can cause temporary or even permanent sterility (Banerjee 1991).

Sankar (1990) who reported recto-vaginal prolapse in a wild chital in Sariska Tiger Reserve concluded that animals in such condition may have poor chances of survival. I have seen two domestic dogs with vaginal prolapse. Both were emaciated, never regained health even after months, before they were put down.

The doe I saw was in fair physical condition. I could not monitor it to confirm its recovery. However, Dr. P.K. Malik (WII, pers. comm.) opined that if the prolapsed mass was as small as that which I saw, there were chances of its natural retraction and the animal regaining health.

I thank Dr. P.K. Mailk for a useful discussion on this aspect. I also thank an anonymous referee for comments on an earlier draft of this note. The observation was made during a study funded by WII and IUCN.

April 10, 1996

SHRIDHAR. D. BHAT,
Forestry Degree Programme,
Banavasi Road,
Sirsi (N.K.)
Karnataka, India-581 401.

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5. COMMENTS ON A NEWLY BORN GAUR (*BOS GAURUS*)

On morning of 28th August, 1995 my field assistant Mr. Kunmari and I were walking through a mixed deciduous forest patch in Mudumalai Wildlife Sanctuary for a routine bird census. At 0930 hours we were on a rock at 10 m observing birds, when I heard a strange sound coming from a bush below. A few seconds later, a single gaur (cow) came out of a lantana bush and started grazing about 100 m from where I was. Since I was on the top of the rock, it did not notice me. I silently approached the animal with my camera to get a closer shot of it. When I was just 50 m away, it lifted its head and stared at me, but continued grazing. This surprising behaviour of not being alarmed, tempted me to find out the reason.

All my previous encounters with gaur had suggested that the gaur is extremely shy and sensitive to even the slightest disturbance. I halted there and continued observing it. Scanning the area, I noticed a calf (resembling a domestic cow's calf) struggling to stand up, about 10 m away from the adult gaur. My experienced field assistant told me that it was the calf of a gaur. Our talking disturbed the gaur and it ran with an alarm call. In a few seconds, the gaur disappeared from our vicinity (c. 100 m radius). We approached the calf to get a close look and found that it had been delivered only a few minutes earlier. Fresh placenta and blood were on the grass. The calf could not move and was staring at us. It had a pale reddish brown coat with bluish eyes. After about 15 min it tried to run but could not balance its hind limbs and fell down often, but somehow managed to go behind a nearby bush. During this period, there was no vocalization either from the cow or the calf. I looked around the delivery site and noted some habitat features. It was a dry deciduous forest close to a dry stream. The shade in the area was moderate, shrub cover low and the ground was almost fully covered with grass. *Tectona grandis* and *Anogeissus latifolia* were the dominant trees and the terrain was slightly undulating. The gaur had given birth on the grass patch. According to Schaller (1967) and Prater (1971), female gaurs separate from the herd when the calf is born and remain with it, feeding it till the calf is able to accompany it to rejoin the herd. I could not find any gaur herd even after a 3 km walk around the site. After a gap of 15 days, I sighted one herd of gaur in the same place consisting of 4 adult bulls, 8 adult cows, 3 sub adults and 6 calves. All the calves were of the same age. Prater (1971) reported that the gaur gives birth all around the year but there could be a peak at some seasons. As many small calves were sighted during August and September, this may be one of the peak birth seasons for gaur in Mudumalai Wildlife Sanctuary.

January 27, 1995 V. GOKULA
Division of Avian Ecology, Sálim Ali Centre for Ornithology and Natural History, Kalampalayam P.O. Coimbatore-641 010.

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6. RANGE EXTENSION OF THE KASHMIR FLYING SQUIRREL (*HYLOPETES FIMBRIATUS* GRAY)

The Kashmir flying squirrel (*Hylopetes fimbriatus*), belongs to the Family Sciuridae. It has a distributional range from north Punjab and Kashmir, eastwards to Simla in Himachal Pradesh (Corbett and Hill 1992). Ellerman (1961) and Prater (1980) describe two races of the Kashmir flying squirrel from the western Himalayas, *H.f. fimbriatus* and *H.f. baberi*. The race *H.f. baberi* is considered a different species by Corbett and Hill (1992).

Table 1
EXTERNAL MEASUREMENTS OF *HYLOPETES FIMBRIATUS* FOUND AT BALMORAL (RANIKHET)

Sex	Head & Body (cm)	Ear (cm)	Tail (cm)	Hind-Foot (cm)	Fore-Foot (cm)
Male	26.9	3.4	29.0	8.5	6.1

A dead specimen of an adult male Kashmir flying squirrel was recovered from Balmoral site in Ranikhet (29° 29' N, 79° 26' E), Kumaon, Uttar Pradesh, on 8th May, 1995. The general morphological characters and the measurements of certain body parts were noted down.

The general colour of the dorsal surface of the body was brownish-black with whitish underparts. The squirrel had distinct brown pinnae and a thick, hairy brownish black tail. Each hind and forelimb had four functional toes almost of same size, the fifth toe being small. Each toe had distinct claws. The soles were bare with a spongy pad below each toe. The measurements of the body parts taken are given in Table 1.

On the basis of the above characters the species was identified as the Kashmir flying squirrel (*Hylopetes fimbriatus*). The species is endemic to the western Himalayas (Prater 1980). Thus the occurrence of the Kashmir flying squirrel in Ranikhet extends the range of the species by about 300 km.

March 22, 1997 MOHD. KHALID S. PASHA
Wildlife Institute of India P.O. Box. 18, Chanrabani Dehra Dun (UP) - 248 001.

INTESAR SUHAIL
Centre of Wildlife & Ornithology Aligarh Muslim University Aligarh (UP) - 202 002.

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7. CATTLE EGRET *BUBULCUS IBIS* FEEDING ON BABY RATS

The cattle egret *Bubulcus ibis* has been associated with grazing cattle, seizing insects disturbed by their movements (Ali 1979). The role of this bird in the biological control of white grubs during ploughing operations has been documented by Parasharya *et al.*, (1994). The egret is known to follow ploughs and tractors (Kushlan 1978) with restricted foraging close to the heronry during the breeding season. In addition to many species of insects, the egret eats frogs, lizards, etc. (Ali 1979).

In the morning of 17th November, 1995, one of the fields of the Millet Research Station, Jamnagar was being ploughed. The crop raised in this field in the previous *kharif* season was bajra (*Pennisetum glaucum* (L)). We noticed cattle egret (21), black drongo *Dicrurus adsimilis* (6), bank myna *Acridotheres ginginianus* (2), common myna *A. tristis* (2), rosy pastor *Sturnus roseus* (2) and house crow *Corvus splendens* (3) following the tractor. All of them were busy eating the insects exposed by the tractor. A good number of egrets (5 to 10) always followed the tractor very closely. Once we observed that 5 of the egrets suddenly stopped following the tractor and stood gazing at one place. After a few seconds, one of the egrets stepped forward and picked up something black in colour, about 3 cm long, moved about a metre away and swallowed it. A few seconds later, another egret did the same. As we approached, the egrets moved away a few metres. We saw a litter of golden coloured rats attached to the postero-ventral part of the abdomen of an adult rat, probably it was suckling. When the adult rat ran away from us, the infant got detached from its mother. The egret came and picked up the infant and swallowed it. Approximately 10 min later, at another place in the same field, an egret was observed feeding on a young rat caught from the furrow. This time three house crows tried unsuccessfully to pirate it. The hesitation by the egrets in catching the baby rats (the first three feeding attempts described) must have been due to the infants being attached to their mother.

As the fields are ploughed by tractor, the exposed rats with young ones hardly get time to escape, and fall prey to the egrets. Crows also follow the plough and being quite bold can catch rats. It is believed that owls and other birds of prey are the main avian predators of rats in agricultural fields. But our observation suggests that during ploughing the egret could be the major predator of rats, thus playing an important role in pest control.

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K.L. MATHEW
K.V. PETHANI
Millet Research Station
Gujarat Agricultural University
Jamnagar-361 006, Gujarat.

D.N. YADAV
Department of Biological Control
Gujarat Agricultural University
Anand-388 110, Gujarat.

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8. NEST BUILDING ACTIVITIES OF THE FLAMINGO (*PHOENICOPTERUS ROSEUS*) AT SHAHWADI (AHMEDABAD)

The flamingo (*Phoenicopterus roseus*) is a resident, nomadic, locally migratory or extralimital migrant in part, for the Indian subcontinent (Ali and Ripley 1983), with a famous breeding ground at the Flamingo City, about 12 km from the Nir Bet outpost in the Great Rann of Kutch (Hussain 1991). It is known to breed in thousands depending upon the actual conditions of inundation of its breeding ground in the Rann (Himmatsinhji 1991).

The nesting of the greater flamingo was observed near Shahwadi, a suburb located on the outskirts of southern Ahmedabad in 1992[1]. The study area is, a part of the wasteland which is filled either with rain water or the waste water of nearby industrial (mainly textile) units. These units release their effluents into the village ponds, canals and agricultural fields, replacing the fields by temporary/permanent pools of alkaline waters and fallow land, thus unintentionally creating habitat for flamingos.

From April 1992, to the first week of August 1992, a colony of flamingo, comprising hundreds of individuals, was found at Shahwadi. There were no juveniles. The variation in the population of the flamingo at Shahwadi can be seen in Table 1. The number of flamingos in the colony was reduced considerably by the end of July. In the second week of August, the colony was abandoned. However, a few individuals stayed at Shahwadi even after the emigration of their colony from Shahwadi. The variation in the number of such stray individuals is shown in Table 1.

[1]The author had photographed the "nest" mounds but the photographs are not of printable quality

Table 1
NUMBERS OF THE GREATER FLAMINGOS AT SHAHWADI (AHMEDABAD)

Date of Count (1992)	Number of Flamingos	Remarks
19th April	662	Total count
25th May	1000	Estimate
3rd July	755	Total count, One lesser flamingo present
12th July	730	Total count
26th July	425	Total count
2nd August	300	Total count
9th August	nil	Colony abandoned
13th August	2	Adults, feeding
23rd August	13	Adults, all feeding
7th Septmber	11	Adults, all feeding
13th September	11	Adults, all feeding
25th September	8	Adults, all feeding
27th September	nil	Stray individual might have departed
10th November	nil	Stray individuals, might have departed

Nesting Activities: From 3rd July to 2nd August, 1992, 10 flamingos were found displaying and nesting. Observations on construction activities of these individuals accompanied by the breeding display confirmed the mud structures as nests. We were aware of the flamingo's habit of constructing feeding mounds which are superficially suggestive of their breeding colonies (Abdulali 1964).

Observations on nests and nesting activities:

i) About twelve mounds of mud were present amidst the shallow water.

ii) Of these, about nine were clustered together, whereas others were located away from the cluster.

iii) The spot where the cluster of nests was located, was not densely covered with grasses, hedges or other macrophytic vegetation.

iv) Some of the nests were conical in shape while others were cylindrical. The shape of a few mounds was irregular. Depression at the top of the nests (concave and cylindrical) could not be seen because we did not approach the nests closely to avoid disturbance.

v) On nests, individuals were found either sitting, standing, displaying or busy shaping the nests.

Nest construction: Standing on top of the nest, the flamingo moved its beak on the top of the nest, describing an arc, it also moved its beak along the flank of the nest in linear up and down manner. To shape the nest with its legs, it would stand on top of the nest, the neck would be bent down so that the beak was brought in contact with the top of the nest. Then, with the beak as a centre (pivot) the bird would move the beak along the rim at the top. During this circular movement it was seen trampling or pressing down the top of the nest by raising its feet one after another.

About two to eleven individuals were present at Shahwadi on different occasions after the emigration of their colony (Table 1). One can rightly doubt that the individuals staying behind at Shahwadi, even after the departure of the colony, would breed at the site. However, from 13th August to 25th September, neither nest shaping nor breeding display were observed among these birds. They were remarkably silent and always busy feeding in the rapidly drying waters. They were always seen away from the nests. Moreover, the birds were absent on subsequent visits on 27th September and 10th November, 1992.

August 11, 1993

KETAN S. TATU
Research Student, Department of Botany,
University School of Sciences,
Gujarat University,
Ahmedabad-380 009.

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9. CONTAMINATION IN EGG SHELLS OF HIMALAYAN GREYHEADED FISHING EAGLE *ICHTHYOPHAGA NANA PLUMBEA* IN CORBETT NATIONAL PARK, INDIA

A study of the breeding biology of resident raptors of Corbett National Park, Uttar Pradesh, India was undertaken during the years 1990 to 1993. The Park is situated in the lower Himalayan foothills known as the Sivaliks within the Bhabar tract, between 29° 31' and 29° 35' N, lat., 70° 41' E. long. According to Ali and Ripley (1978), the Himalayan greyheaded fishing eagle *Ichthyophaga nana plumbea* extends from the lower foothills upto 2400 m, optimally between 1000 to 1500 m in western Himalayas and under 1000 m in the eastern Himalayas. The middle reaches of the Ramganga river flow through most of the Park. The topography is undulating, varying in altitude from 200 to 1000 m, which is the preferred range and habitat of the species. The Park is one of the strongholds of the species in India. In Kumaon the species was never seen above 1000 m and prefers rivers with forested banks. Sibley and Monroe (1990) treat it as a separate species *Ichthyophaga humilis*; now widely accepted. Kumaon comprises the four hill districts of Almora, Nainital, Udham Singh Nagar and Pithoragarh in northern Uttar Pradesh 29° N, 80.1° E and 30.1° N, 80.5° E.

From 1991 - 96 the greyheaded fishing eagle bred unsuccessfully. Eggs from seven nests monitored during this period did not hatch, while three nests hatched, young ones were either found dead in the nest, or disappeared within a week of hatching. Eggshell fragments which were collected from one nest in April 1991, were deformed. Thinner than normal eggshells, were analysed in the U.S. by Dr. Robert W. Risebrough of The Bodega Bay Institute, California. Since no yolk remnants or membrane fragments remained on the shell, a quantitative analysis that could be compared with data in the literature was not possible. Nevertheless, a number of organochlorine compounds were detected; their ratios provide clues to the local contamination pattern in the area inhabited by the eagles.

The parent DDT compound, that is the insecticidal ingredient, p,p'- DDT, constituted 36% of the DDT compounds measured; the amount of o,p'- DDT, the minor ingredient in the original DDT mixture, was 10% that of p,p'-DDT. The relatively high amounts of these two compounds indicate recent DDT applications in local or nearby areas; the evident thinning of the shell is most likely an effect of DDE, usually the principal metabolite of DDT in the environment and the compound considered primarily responsible for shell thinning. PCB congeners and dieldrin were detected, but at relatively low levels of about 6% and 2%, respectively, of the total DDTs. The dieldrin levels, however, are significant. Dieldrin, which is highly toxic to birds of prey, has been implicated in the population decline of raptors in Europe and North America (Cooke *et al.* 1982, Newton 1979, Risebrough 1989, 1994). Shell Chemicals, the manufacturers, have stopped its manufacture and sale anywhere in the world. Locally, it is most likely derived from aldrin, which until recently atleast, has been widely used in northern India. These contaminants could have been passed on only through the prey base, which for this species is solely fish. The presence of these contaminants in the local riverine food web is, therefore, a plausible cause of atleast some of its unsuccessful breeding attempts, in Corbett National Park.

On the higher reaches of the Ramganga, the densely populated hillsides are covered with intensely terraced cultivation. Information obtained from agricultural supply shops and farmers indicate that pesticides are used on a large scale, in order to control agricultural pests. The contaminants probably run off into the water system during the heavy monsoon which the region experiences.

The burgeoning human population especially along hillstreams and rivers is having a direct impact on the fishing eagle; through over-fishing (using several illegal methods such as extensive use of pesticides to poison fish and dynamiting upstream beyond the Park's northern boundary), damming of rivers and degradation, or complete destruction of riverine forest, directly affecting the species through loss of nesting habitat. Monitoring the reproductive success of the local population of the eagle in Corbett is continuing and the results of subsequent analysis for organochlorines is being carried out.

The species is probably seriously threatened at Corbett and likely to be similarly affected throughout its range in India. Besides the negative impact from chemical contamination, this mainly sedentary species is fully dependent on the Himalayan riverine system and further at risk due to loss of habitat and disturbance in the upper limits of its range.

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October 28, 1995

RISHAD NAOROJI
Godrej & Boyce Mfg. Co. Ltd.
Godrej Bhavan, 4A, Home Street,
Mumbai 400 001,
India.

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10. A RECORD OF PALLAS' FISHING EAGLE *HALIAEETUS LEUCORYPHUS* FROM SPITI VALLEY (H.P.)

In June, 1995 a live subadult specimen of the Pallas' fishing eagle was recovered from "Shego" at an altitude of about 3800 m in the Spiti valley, of Lahaul Spiti dist., Himachal Pradesh, India. This is the first record of the species in Spiti Valley and probably the first record in the Indian Trans-Himalayan region.

The individual was recovered by local villagers from "Shego forest" which is about 7 km from the Park headquarters, Kaza. Shego forest is a high altitude cold desert area situated on the banks of the river Spiti. Poplar, willow trees and *Hippophae* bushes are the main vegetation of the forest. The local villagers informed that the bird was chased by two crows on the bank of the river, and was running with spread wings. When the villagers captured it, it was not in a position to fly, because of a leg injury. Its right leg, specially the talon, was infected and the infection had spread all over the leg. One of the villagers took it home and applied some medicine on the bird's leg. After 35-40 days of capture he consulted the local Veterinarian, who gave a Gentamycin injection and recommended regular draining of the pus. Unfortunately,the eagle died 6-7 hrs after the Gentamycin dose. Some researchers from WII Dehradun on tour to this area confirmed it's identity. Its morphometric measurements are summarized as under:

Length of stretched wings: 154 cm
Length of body (Beak to tail) 92 cm

The skin is preserved and kept in the office as record.

November 9, 1995

B.S. RANA
Director
Pin Valley National Park,
Kaza, Lahaul Spiti dist.
Himachal Pradesh 172 114.

11. REDLEGGED FALCON *FALCO VESPERTINUS* IN GUJARAT

Despite watching birds for over half a century, the sighting of a new bird is exciting. Perhaps, the excitement is all the more rewarding when one has almost exhausted most of the possibilities on one's home turf. On Friday, 2nd February, 1996 I added a female redlegged falcon to my list.

I was walking along the northern shoreline of the Poshitra Bay on Beyt island at the mouth of the Gulf of Kachchh. The sun was touching down on the western horizon in front of me when, what I took for a kestrel flew low over me. Since birds of prey are becoming rare and seeing one is a joy, I stopped to watch the bird, hoping it would hover. Instead, it glided low over me and alighted atop an euphorbia clump - the rays of the setting sun fully illuminating it. I immediately realised that here was no familiar kestrel, the overall colour was much darker, the upper plumage was a dark grey. Unfortunately, I could not see the legs. The bird was smaller than the kestrel and from time to time gently bobbed its head. A couple of years earlier Pradeep Pandya, a knowledgeable birdwatcher from Rajkot, had recorded a small flock of this falcon in Saurashtra. February is too late for an outward migration to Africa and possibly a little early for the return passage, so it is possible that a few of these rather uncommon birds do winter along the coast.

April 4, 1996

LAVKUMAR KHACHER
646, Vastunirman,
Ganghinagar, Gujarat-382 022.

12. NESTING OF THE LESSER FLORICAN DURING THE SOUTHWEST MONSOON

To reproduce successfully, birds should do so when environmental conditions are most favourable (Earle 1981). Breeding seasons are, however, fixed for most species and the optimal time for nesting and therefore breeding success is determined by the presence of adequate cover for nesting and hiding the young, and the availability of adequate food. The optimal nesting period in a species would have also evolved to fall within the breeding season when adverse environment influences eg. snow storms or floods, are least likely.

The lesser florican *Sypheotides indica* breeds during the southwest monsoon (Jerdon 1864, Ali and Ripley 1969, Dharmakumarsinhji 1950), immigrating into western India at the onset of the monsoons and begins emigrating in early October (Sankaran 1991, Sankaran *et al.* 1992). Like all other species of bustards, the lesser florican is a ground nester. The nest in this family is a simple scrape in the ground without any nesting material added, and the behaviour associated with nest building is absent (Osborne *et al.* 1984).

Due to the nesting habitat, long grass, florican nests are very difficult to find, more so due to the secretive behaviour and cryptic coloration of the hens. Because this species is endangered, intensive nest searches were not undertaken, and nest location was mainly through chance flushing of incubating hens in the field; therefore data is limited

The majority of the data was collected at grasslands around Sailana in Ratlam district, Madhya Pradesh, and the rest at Rampura-Movalia-Kalitalai grasslands near Dohad in Panchmahal dist., Gujarat. The study extended over 475 days between July 16 and October 6, 1985; June 22 and October 10, 1986; June 16 and October 1, 1987; June 24 and October 6, 1988; August 5 and October 1, 1989. Six nests were located (2 in 1985 and 4 in 1986) at Sailana, and 3 nests were seen at the proposed Lala Bustard Sanctuary near Nalliya, Abhdasa Taluka, Kutch dist.

Clutch size & Incubation period: Of the 9 nests recorded in this study, one had five eggs, four had four eggs and four had three eggs each (Table 1). The incubation period was ascertained from one nest and was 21 days. The male played no role in the incubation of the eggs. The chicks, were precocial, nidifugous and covered in a short, plush-like, highly cryptic down.

Nest location: The nests were located either at the periphery or well away from male territories (Table 1). All nests found, barring one, were in tall grass (> 20 cm) in the grassland. One nest was found in a stunted, unweeded maize field. This (the only one to be) was preyed upon, possibly by crows.

Behaviour of female on the nest: While on the nest, female lesser floricans, did not flush unless almost trampled upon. They preferred to avoid detection by sitting tight on the eggs. Thus even a known nest with an incubating female is unnoticeable, from as close as 3 m or even less. The tendency of the females not to flush or move away at the sound of approaching danger enables the tribals of the area to trap females by throwing a net or a basket over an incubating hen. The female with the young stays on in the grassland until mid or end November, as evidenced by stray sighting and/or flushing records.

Nesting period: The nesting phase lasts about eight weeks in the breeding season of the lesser florican. Nesting began in the first week of August and all eggs had hatched by the last week of September (Table 1).

As grass growth rates and insect abundance is dependent on the distribution and quantum of rainfall, the temporal availability of both food and cover, and thus optimal nesting conditions, varied between years, with the 1986 breeding season háving suitable conditions 5 to 7 weeks before that of 1985.The southwest monsoon shows considerable interannual variation (Shukla 1987) and correspondingly interannual variations are seen in grass growth rates, grass heights and as a result of this in insect abundance (Sankaran 1991).

The rainfall regime of both 1985 and 1986 varied considerably at the Naulakha grassland (average annual rainfall 1090 mm). In 1985, the rains commenced about 5 weeks late and the quantum of rainfall was subnormal (-50.9%). In 1986, the monsoon began on time and the quantum was excessive (+49.03%). Thus availability of adequate cover and food varied by nearly a month between these years. The average annual rainfall of Kutch is about 250 mm. In 1989, about 400 mm, 50% was in July.

The Lesser Florican nested between early August and September end, in three years, 1985, 1986 & 1989, and at different sites, western Madhya Pradesh and Kutch, with temporal variations in resource availability. What then are the conditions, other than availability of food and nesting habitat that influences the onset of egg laying in the lesser florican?

TABLE 1

NESTING DATA ON THE LESSER FLORICAN

Year	Date found	Date last egg laid	Date hatched	No of eggs	Dist (m) from male	Habitat
1985	16 Sep.	2 Sep.	23 Sep.	4	115	Grassland
1985	19 Sep.	31 Aug.	21 Sep.	3	>150	"
1986	28 Aug.	30 Aug.	20 Sep.	4	114	"
1986	30 Aug.	—	—	3	>500	Cropfield
1986	5 Sep.	21 Aug.	14 Sep.	4	100	Grassland
1986	17 Sep.	6 Aug.	27 Sep.	4	75	"
1989	16 Sep.	27 Aug.	17 Sep.	5	>500	"
1989	16 Sep.	27 Aug.	17 Sep.	3	>500	"
1989	2 Aug.	1 Aug.	22 Aug.	3	>150	"

NB: For 1989, all dates estimated from an assumed hatching date of one day after unhatched clutch was last seen.

In normal southwest monsoon conditions, the rains peak in the last two weeks of July. Until early August there are frequent spells of rains when it can rain for two or three days continuously. Thus the risk of inundation of the nest is high until mid-August. Females commence laying at such a time that the risk of loss of eggs through inundation or bad weather is reduced. Thus females begin egg laying only in early August, with a peak a little later, and avoid the majority of the rains of the southwest monsoon. Heavy rains are brief from mid-August, and barring the early nesters, most others effectively minimise the risk of nest inundation.

Several studies have shown that inundation or bad weather comprises a significant proportion of factors that destroy eggs and nests (Shipley 1984, Warriner *et al.* 1986). Thus females have adapted to nest when the probability of bad weather is least.

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December 20, 1995 R. SANKARAN
Bombay Natural History Society
Shaheed Bhagat Singh Road,
Mumbai 400 023

Present Address:
Sálim Ali Centre for Ornithology &
Natural History
Kalampalayam P.O.,
Coimbatore 641 010

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13. THE RELATION BETWEEN BUSTARD BODY SIZE AND DISPLAY TYPE

(*With two text-figures*)

The variation in body size within the family Otididae is extreme. The smallest species (lesser florican *Sypheotides indica*) weighs about 0.5 kg (wing length 180-248 mm) while the largest species Kori (*Ardeotis kori*) weighs over 10 kg (wing length 629-761 mm) and the heaviest great bustard (*Otis tarda*) can weigh over 15 kg. Bustard display types are also varied and include both ground and aerial displays.

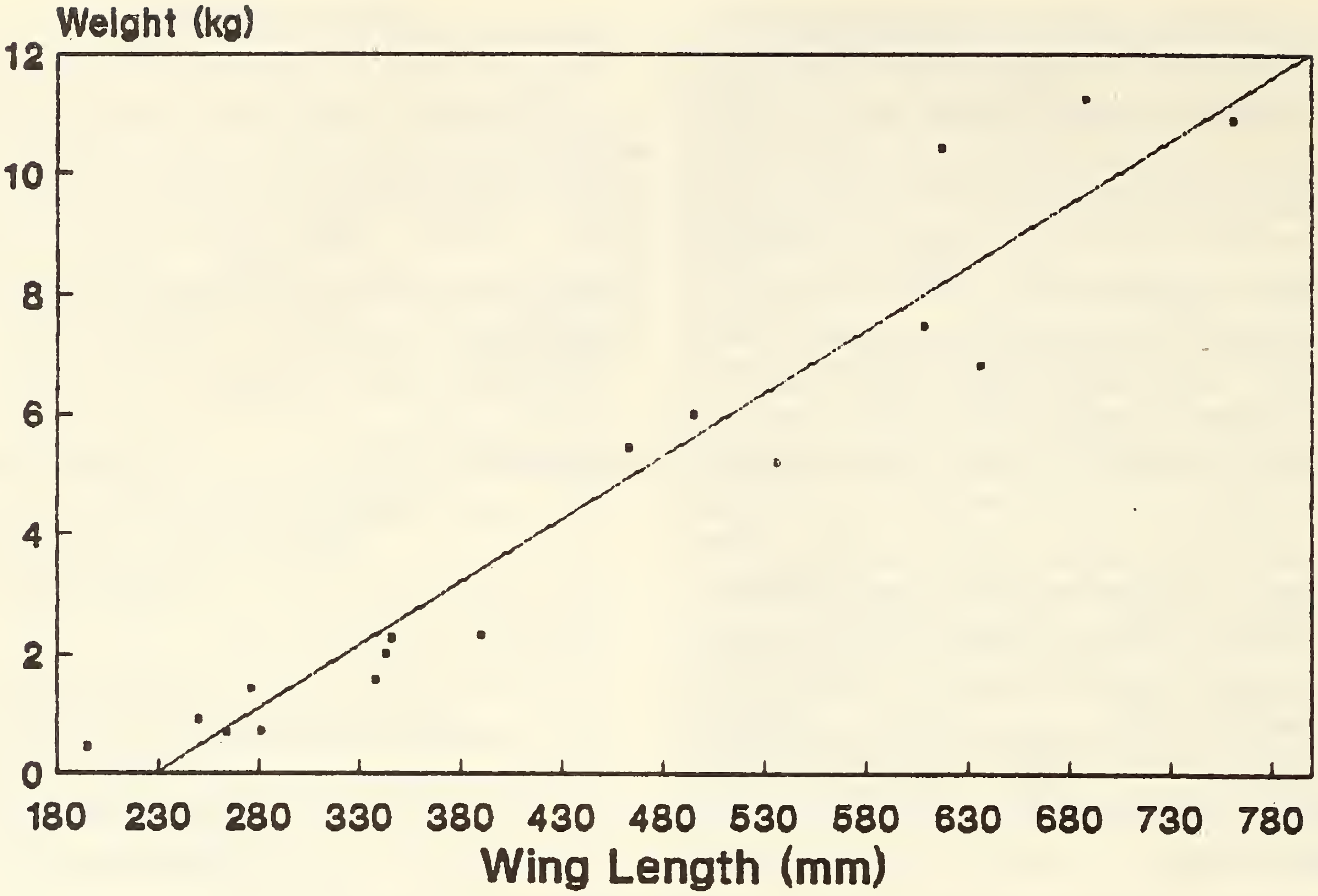

Fig. 1. Bustard wing length and body weight

In this analysis of bustard body size and display type, all data has been extracted from Ali and Ripley (1969), Cramp and Simmons (1980), and Collar *et al.* (1986). The use of body weights in the analysis was unsatisfactory because variation in available data was large (± 50% of the mean). Body weights are variable and dependent on several factors such as season, availability of food and condition of the bird. Wing length, however, shows less variation (± 20% of the mean), and once birds reach adulthood, wing length becomes more or less fixed and unless in moult, will not vary in response to extrinsic factors. Both wing length and body weight are indicators of body size, and body weight is directly correlated to wing length (Fig. 1). Thus, in this analysis, wing length is used as a measure of body size.

Bustard attraction displays are divisible into two groups, namely aerial displays and ground displays. Aerial displays can be further classified into two types, based on the duration and the type of display. The first is the jumping type of display. This is of very short duration, e.g. lesser florican one second jump, little bustard *Tetrax tetrax* half second jump, (Shulz 1985), and consists of a brief vertical display leap. The other type of aerial display is a display flight that lasts for 6 or more seconds and consists of a short or extended flight from one point to another. This type of display is seen in the black bustard *Eupodotis afra,* buff crested bustard *Eupodotis ruficrista* (?) and black bellied bustard *Eupodotis melanogaster* (Osborne *et al.* 1984) and the Bengal florican *Houbaropsis bengalensis.*

A distinct correlation is seen between body size and display types. The small bustards have aerial displays, with the smallest of these having a jumping display, those species with increased body size having flight displays, and beyond this body size all bustards have ground displays (Fig. 2). This analysis also shows that the Bengal florican and the black bellied bustard are at the

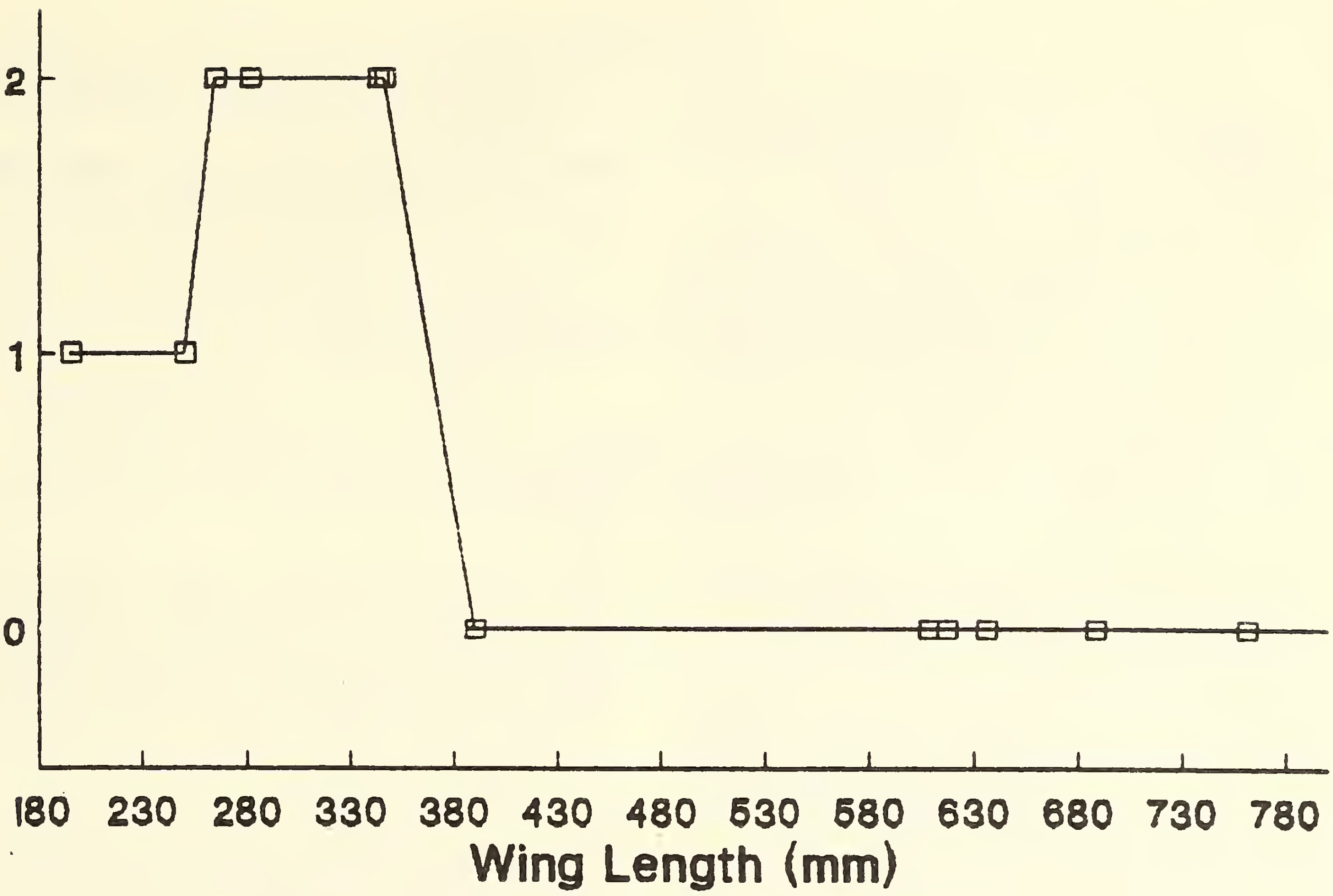

Fig. 2. The relation between bustard wing length and display type

1 = Jumping display; 2 = Flight display; 0 = Ground display

size threshold beyond which all bustards have ground displays. The next large species i.e. the houbara is 12-15% larger than the black bellied bustard and only has a ground display.

The Bengal florican, being at the body size threshold of aerial displays, has few and sporadic displays. This bustard also has a distinct ground display, the neck fluff display. A ground display is also seen in the black bellied bustard (pers. obs., Cramp and Simmons 1980). At the other extreme of the size scale is the lesser florican, which has very frequent display jumps and no distinct ground displays. It is most probable that in bustards body size plays a strong role in the type of displays seen. The smallest bustards have short display leaps that are made very frequently, larger species have longer flight displays, and as body size increases, frequency of displays reduces. Ridley *et al.* (1985) also suggest that a short leap is associated with greater frequency. Beyond a certain size threshold, all bustards have ground display.

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December 20, 1995

R. SANKARAN
Bombay Natural History Society,
Shaheed Bhagat Singh Road,
Mumbai 400 023.

Present Address
Sálim Ali Centre for Ornithology &
Natural History
Kalampalayam P.O.,
Coimbatore 641 010

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14. FLOCKING AND COURTSHIP DISPLAY IN REDWATTLED LAPWING (*VANELLUS INDICUS*)

The redwattled lapwing *Vanellus indicus* is one of the most common bird species found in and around Kota (25° 10' N, 75° 52' E), in Rajasthan. There are always a couple of lapwings permanently present near open drains, sewage nullahs, shallow pools & margins of tank. When the water dries up, they are quite capable of living on dry sunbaked land; they even nest and breed in April-May, when the temperature ranges between 38°C to 45°C in this part of India. Ali and Ripley (1987) write in their 'COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN' that redwattled lapwings do not form large flocks (6-12 birds only), there is no mention of any courtship display. This note is to report a different behaviour pattern, which I have observed.

Large congregations of redwattled lapwings ranging from 26 to over 200 individuals, were seen flocking on large open drains, nullahs, pools and tanks. In this paper the term *flocking*, does not include loose congregations of birds which remain scattered on wetlands, but is strictly limited to the gathering of birds, where they stand closely packed apparently doing nothing. Incidentally, redwattled lapwings breed in Kota mainly from April to September, and a good number of eggs and chicks can be seen during this period. Just before commencement of breeding in April, I have seen large flocks near waterbodies. The number of individuals in a flock varied from 37 to 62 during February-March. These flocks are usually seen on the margins of waterbodies early in the morning, the birds then disperse to feed nearby, but flock together once the feeding is over.

Courtship display is not a very elaborate affair in redwattled lapwings but still it is attractive. The male bird presents itself in the best possible manner to the probable mate. The male bird flies off, circles the area a few times giving a different call, and returns a little later near a prospective female. After alighting a few feet away, the male raises its head, fluffs its breast feathers, so the white abdominal and contrasting black front are presented to the female. Only the little black head, red wattles and bill are seen over the puffed up breast. The bird looks upright and proud. In shuffling steps, the male approaches the female and circles around it a few times. If the female is responsive it lowers its head to about 45° from the ground and lets the male come close, otherwise the female flies off or moves away, putting an end to the advances of the eager male. The male bird tends to repeat this with different females, also many males (3-4) may be displaying close to each other with females in audience. Once the pair formation has taken place birds become highly aggressive and noisy. They become territorial and actively defend their territories against all creatures including grazing cattle, other birds, snakes, dogs and man. The redwattled lapwings while defending their territory rise towards the sky noisily and suddenly swoop down or circle over the intruder in their territory. Both male and female birds take part in this act; mostly it becomes contagious and other nesting pairs also get involved in raising a racket to scare away any possible predator.

October 27, 1995 RAKESH VYAS
2-P-22, Vigyan Nagar, Kota-324 005.

15. PLAY FEEDING BY THE GULL-BILLED TERN *GELOCHELIDON NILOTICA* (GMELIN)

The fishing technique of terns is a simple process involving only capturing and engulfing. Before engulfing, the fish is arranged in head-foremost position (Ali and Ripley,1981). Interestingly, a gullbilled tern (*G. nilotica*) was observed feeding in a slightly different manner — a manner which can be called 'play-feeding', rather than the simple engulfing technique.

The tern was observed in flight with a captured fish on 31st December, 1995 at 0800 hrs in Dombivli, Thane dist. Maharashtra. As usual, the quarry was held vertically in head-foremost position. Instead of swallowing it, the bird dropped the fish and immediately caught it. Resuming its flight, it again released the fish and allowed it to descend for about one metre. After catching the prey in the air, the bird went a little higher and the play was repeated. But this time the bird was unable to catch the fish in the first attempt. Somehow it managed to grab the fish after a fall of 2-3 m and finally engulfed the fish without any more play.

Significantly, the only group of birds that have been seen to play in a convincing manner are the crows, especially the ravens. These are with the highest intelligence of all avian species (Desmond Morris,1990).

It is also likely that the kind of play mentioned above may not be an established trend, but just an opportunistic display by *G. nilotica.*

July 10, 1996 MAHESH SABNE,
NAYAN KHANOLKAR
S.R. NAYAK
Bombay Natural History Society,
S.B. Singh Road, Mumbai 400 023.

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16. BREEDING RECORD OF GREATEARED NIGHTJAR (*EUROSTOPODUS MACROTIS*) AT SIRUVANI HILLS, TAMIL NADU

The greateared nightjar *Eurostopodus macrotis* was recorded nesting in Tamil Nadu for the first time at the foothills of Siruvani during the first week of May 1995. C.V. was on routine nest search, as a part of project work on the breeding strategies of birds in a tropical moist deciduous forest at Siruvani, Coimbatore, Tamil Nadu. Suddenly a bird was flushed and flew into a bush nearby. The surrounding places were checked and two eggs were seen on the bare ground but without any lining, surrounded by dry leaves. The eggs were pale yellow with a few black spots on them. After 15 min the bird came back to the nest and started incubating. A closer look helped in identifying the bird as the greateared nightjar. This nest was about 50 m from a river. After two days, one more nest of the same species with eggs on dry leaves, was spotted near a road, and human habitation (100 m). The canopy cover above both the nests was more than 80% and distance between the two nests was about 1 km. The breeding season of this species is recorded as March and April (Ali and Ripley 1983). The entire nesting cycle could not be studied since the eggs in both nests were predated before hatching, probably by a mongoose *Herpestes* sp. present in the area.

The greateared nightjar is mostly distributed in the Kerala part of Western Ghats and breeding has been recorded only in Kerala. Most part of the Siruvani lies in Kerala and the habitat is similar. The greateared nightjar has been sighted at Top Slip Manapalli in Anaimalai hills of the Western Ghats of Tamil Nadu by Perennou and Santharam (1988). Ours is the first confirmed record of this bird breeding in Tamil Nadu.

April 3, 1996

C. VENKATRAMAN
LALITHA VIJAYAN
Sálim Ali Centre for Ornithology and Natural History, Kalampalayam P.O. Coimbatore-641 010.

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17. FOOD OF COMMON GREY HORNBILL *TOCKUS BIROSTRIS* (SCOPOLI)

The common grey hornbill *Tockus birostris* (Scopoli) is reported to be a resident species, subject to local movements depending on the fruiting season. It is found in open but well-wooded country with a scattering of *Ficus* trees (Ali and Ripley, 1983) and is replaced in the heavy rainfall areas of Western Ghats, north to Mumbai and Sri Lanka, by the Malabar grey hornbill *Tockus griseus* (Ali 1979). In Bombay district, *Tockus birostris* is found in the Sanjay Gandhi National park and adjoining areas. The different types of fruit consumed by common grey hornbill *Tockus birostris* were studied by observation and analysis of the droppings of the bird at the nest.

Observations were made in Sanjay Gandhi National Park (19° 8' to 19° 21' N, 72° 53' to 72° 58' E) in the Bombay suburban district. The area largely consists of tropical moist deciduous forest (Champion and Seth 1968).

A nest was located on an *Erythrina stricta* Roxb. tree, amidst tall trees such as *Bombax ceiba* Linn., *Holoptelia integrifolia* Planch., *Haldinia cordifolia* (Roxb.) Ridsale, *Terminalia crenulata* Roth, *Grewia tiliaefolia* Vahl and *Tectona grandis* Linn.f. The ground cover was largely bare except for some growth of *Haplanthodes tentaculatus* (Linn.) Mujumdar and *Rostellularia procumbens* (Linn.) Nees.

Most of the plants shed their foliage as winter starts and are ready to bear flowers and fruit. The fruiting season lasts till summer which also coincides with the breeding season of *Tockus birostris.* Fruits of *Grewia tiliaefolia* Vahl, *Sterculia urens* Roxb., *Streblus asper* Lour., *Lannea coromandelica* (Houtt.) Merrill, *Cansjera rheedii* J. Gmelin, *Ficus* spp. are the main source of food for the adult and young of *Tockus birostris* (Scopoli).

Observations were made during the breeding season of *Tockus birostris* i.e. from March to June in 1987 and 1988. In 1987 thirty and in 1988 forty-two samples were analysed. The excreta of the imprisoned female and chicks are usually ejected directly through the narrow slit with considerable force (Ali and Ripley 1983, Hussain 1984), and accumulate at the base of the tree. Samples of the fresh faeces along with the food material which fell during regurgitation and also while feeding the female and chicks, were collected between 0800 hrs and 0830 hrs during the breeding season. The samples were collected from the top layer of the heap of excreta. The material was brought to the laboratory for identification. It was washed 4-5 times in cold water to separate out the partly digested food material from the dirt. The material thus obtained was then placed on blotting paper and dried with the help of an air blower. Later it was identified and then cross checked with by referring to the available literature and material. The food samples were classified into different categories depending upon the status such as seed cover, entire seed, seeds along with cover, fruit fragments, entire fruit and fragments of fruits along with seeds.

The phenology of the vegetation was sampled in a 1.5 km radius from the nesting site. The trees were regularly observed and the fruit-ing status was noted as 'fruiting' and 'non-fruiting.'

Fruits of 13 species of plants, namely *Cansjera rheedii* J. Gmelin, *Carissa carandas* Linn., *Cordia dichotoma* Forst. f., *Ficus* spp., *Grewia tiliaefolia* Vahl, *Lannea coromandelica* (Houtt.) Merrill, *Manilkara hexandra* (Roxb.) Dubard, *Morinda tinctoria* Roxb., *Securinega leucopyrus* (Will.) Muell-Arg., *Sterculia urens* Roxb., *Streblus asper* Lour., *Syzygium cuminii* (Linn.) Skeels and *Zizyphus mauritiana* Lam. were utilized by *Tockus birostris* as food. Insects, molluscs and scorpions were also part of the diet. The bird preferred small fruits. Table 1 shows that partly digested or sometimes undigested seeds were egected in the faeces, on three instances entire fruit was found in the faecal matter, but considering the size of the fruit, we feel that the fruit might have escaped or was purposely rejected while feeding the female and the chicks. Similar behaviour has been reported by Hall (1918).

Streblus asper was most preferred (17.6%) and was consumed in larger numbers (Table 2) followed by *Carissa carandas* (15.7%), *Lannea coromandelica* (13.7%), *Cansjera rheedii* (10.8%), *Ficus* spp. (9.8%) and *Grewia tiliaefolia* (9.3%).

TABLE 1

STATUS OF THE FOOD MATERIAL FOUND IN THE EXCRETA OF *TOCKUS BIROSTRIS* (SCOPOLI)

No.	Food plant	SC	ES	SWC	FF	EF	FFS
1.	*Cansjera rheedii*	*	*		*	*	
2.	*Carissa carandas*		*				
3.	*Cordia dichotoma*		*				*
4.	*Ficus* spp.						*
5.	*Grewia tiliaefolia*		*			*	
6.	*Lannea coromandelica*		*				
7.	*Manilkara hexandra*		*				
8.	*Morinda tinctoria*				*		
9.	*Secrunigea leucopyrus*		*				
10.	*Sterculia urens*		*				
11.	*Streblus asper*		*	*			
12.	*Syzygium cuminii*		*			*	
13.	*Zizyphus mauritiana*		*				

SC = seed cover ES = entire seed

SWC = seed with cover FF = fruit fragments

EF = entire fruit FFS = fragments of fruits and seeds

ANIMAL MATTER:

1.	Pila sp.	Broken shell
2.	Scorpion	Sting
3.	*Sternocera chrysidioides*	Thorax

The aril above the seeds of *Sterculia urens* was consumed by the bird, inspite of the follicles having stinging hairs.

The larger fruits were consumed in smaller quantity (Levey 1987) as compared to smaller fruits, e.g. *Zizyphus mauritiana* (1.0%), *Syzygium cuminii* (2%), *Morinda tinctoria* (2.5%) and *Manilkara hexandra* (2.5%) (Table 2). The bird probably finds it difficult to feed upon the larger fruits, so they are not preferred. Table 2 gives the phenology of the food plants and from the size of the fruits taken it can be stated that small sized fruits are preferred. This also supports Ridley's statement that bird dispersed fruits are usually small, fleshy and edible (Ridley 1930).

The mollusc *Pila* sp., an unidentified scorpion and the beetle *Stenocera chrysidioides* were also a part of the diet.

TABLE 2
PHENOLOGY OF THE FOOD PLANTS

No.	Food plant	Type	Ht (m)	Fruiting season Mar	Apr	May	Jun	Fruit size (cm)	% of fruit consumption
1.	*Cansjera rheedii*	St	8	*	*	*	*	0.5 — 1 long	10.8
2.	*Carissa carandas*	S	5-6		*	*	*	0.5 — 0.8 long	15.7
3.	*Cordia dichotoma*	T	20-35		*	*	*	0.5 — 1 long	5.4
4.	*Ficus* spp.	T	10-30	*	*	*	*	0.5 — 1 long	9.8
5.	*Grewia tiliaefolia*	T	10-33			*	*	0.5 long	9.3
6.	*Lannea coromandelica*	T	14-22		*	*	*	0.3 — 0.4 dia.	13.7
7.	*Manilkara hexandra*	T	25-38			*	*	1 — 1.3 long	2.5
8.	*Morinda tinctoria*	T	6-10		*	*		0.75 — 1.5 dia	2.5
9.	*Securinega leucopyrus*	S	4-6			*		0.2 — 0.3 dia	2.5
10.	*Sterculia urens*	T	20-38	*	*			0.3 — 0.4 long#	7.4
11.	*Streblus asper*	T	8-22	*	*	*	*	0.3 — 0.4 dia.	17.6
12.	*Syzygium cuminii*	T	20-35	*	*	*	*	0.7 — 1.6 long	2.0
13.	*Zizyphus mauritiana*	T	3-7				*	0.5 — 0.8 dia.	1.0

St - Straggler, S - Shrub, T - Tree, # - Size of seed, Ht - Height

Ali and Ripley (1983) recorded the breeding period to be from January to April whereas Hall (1918) recorded-breeding period as April at Batala in Punjab. The birds nested on *Erythrina stricta* Roxb. Earlier they have been recorded nesting on *Syzygium cuminii* (Linn.) Skeels by Hall (1918).

Lowther (1942) on his observation at the nest of *Tockus birostris* at Etawah and Cawnpore (Kanpur) in Uttar Pradesh has recorded the male feeding female and chicks with pipal (*Ficus religiosa*) and banyan (*Ficus bengalensis*) figs, berries of *Ixora* sp., crumpled up green leaf, nim (*Azadirachta indica*) berries, blood-sucker lizard (*Calotes versicolor*), locust, pods of bean, tamarind (*Tamarindus indica*) pods and olive branches, whereas Hall (1918) has recorded jamun (*Syzygium cuminii*) berries, pipal figs (*Ficus religiosa*), green leaf and black ants. Ali (1979) has recorded large insects and young mice apart from all the regular food items. Lint and Lint (1981) on their observations on diet of hornbills in captivity have observed that apart from fruits, berries, insects and rodents, frogs, snails, eggs and baby chicks were readily accepted by the bird.

In the Sanjay Gandhi National Park five species of *Ficus* are present, e.g. *Ficus racemosa* Linn., *F. religiosa* Linn., *F. exasperata* Vahl, *F. hispida* Linn.f. and *F. arnottiana* Miq. The figs in the faecal samples were not whole, therefore it is difficult to identify species of *Ficus* involved.

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October 28, 1995

NEELAM PATIL
NARESH CHATURVEDI
VITHOBA HEGDE
Bombay Natural History Society,
Hornbill House, Dr. Sálim Ali Chowk,
Opp. Lion Gate, Mumbai-400 023.

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18. UNUSUAL FEEDING PATTERN AND DIET OF CRIMSONBREASTED BARBET (*MEGALAIMA HAEMACEPHALA*)

When the green barked Mexican cotton trees (*Chorisia speciosa*) are in bloom, they attract a variety of nectar feeding birds. On 17th February, 1995 (0840 hrs), a crimsonbreasted barbet joined a party of such birds. For a few seconds, it kept watching, then moved towards a bunch of creamish white flowers on an over-hanging branch near its perch. Soon it pecked at a flower and managed to pluck one of the thick inch long petal. Finding it difficult to eat, the bird adopted an unusual feeding pattern. The plucked petal was placed on the branch and held underfoot, the fragments were torn with the bill and eaten. Since the bird was not well adapted to this pattern of feeding, most of the fragments fell to the ground. In this manner it fed on three petals on that day and repeated this behaviour for the next two days.

The food and feeding pattern of the species has been described in HANDBOOK (Ali and Ripley, 1987, Vol. 4, pp 300) as "banyan, pipal and other wild figs, various drupes and berries, occasionally moths and termites captured in clumsy aerial sorties." The nectar, petals or other parts of the flowers have not been mentioned in the diet of the species.

November 9, 1995

A.M.K. BHAROS
27 MIG, Indravati Colony,
Raipur-492 001.

19. DE-TICKING BY A HOUSE CROW (*CORVUS SPLENDENS*)

While returning from the Asian Waterfowl Census on 14th January, 1996 at about 1145 hrs near Goregaon creek a Mumbai suburb, I saw a resting buffalo and a house crow hopping near the mouth of the buffalo and picking something from its jaws. The buffalo made no attempt to drive away the crow. On close observation I found that the crow was de-ticking the buffalo.

I have seen cattle egrets (*Bubulcus ibis*) de-ticking a walking or sitting buffalo many times, but I do not recall this behaviour in a house crow.

July 10, 1996

V.K. PARALKAR
Manav Kalyan Society,
B 2/3 Bangur Nagar,
Goregaon (W), Mumbai-400 090.

20. A PECULIAR FOOD FINDING HABIT OF HOUSE CROW *CORVUS SPLENDENS* (VIELLOT)

One fine morning in November 1993, at Himayatnagar, Hyderabad, I had the opportunity to observe a pair of house crows *Corvus splendens* (Viellot) from a porch at about 0700-0800 hrs. The pair alighted in a hurried manner on a small temple tree (*Plumeria acutifolia*) and searched for something, as if they had hidden some food material earlier. To my great surprise one of the crows pulled out the semi-dried sticky latex of the temple tree and devoured it quickly.

Since my landlords required fresh flowers of this plant for their daily *puja* (worship) they used a long bamboo stick to remove the flowers. While doing this many branches of this weak plant broke easily and the latex oozed out profusely to seal the injury, by covering the broken tips. It could easily be guessed from the food habits of these birds that their intelligence might have prompted them to acquire knowledge of the availability of the latex on these plants. They may have chosen the latex as an easy source of food. Later I noticed that these crows regularly visit temple trees, specially after the winter leaf-fall, which might be helping them to locate the semi-dried latex easily due to the bareness of the branches. It had become part of their daily food finding activity.

June 4, 1996

D.B. BASTAWADE
Zoological Survey of India,
Freshwater Biological Station,
1-1-300/B, Ashok Nagar,
Hyderabad-500 020.

21. SMALLER GREY CUCKOO-SHRIKE (*CORACINA MELASCHISTOS*) SIGHTED AT PILLUR FORESTS, NILGIRI HILLS, TAMIL NADU

Pillur forest is situated on the southeastern slopes of the Nilgiris and supports a moderately disturbed dry mixed-deciduous forest. While surveying the forest for small carnivores, I saw a smaller grey cuckoo-shrike (*Coracina melaschistos*).

On 28th September, 1995 around 1100 hrs, I was walking along the road to Neeralipallam weir. At about 200 m from the Parali Valve House, I saw a smaller grey cuckoo-shrike, perched upright on a branch in the lower canopy of a tree. It was dull in plumage and looked to me like a smaller version of a female fairy bluebird in silhouette. When I got close to it, it flew over me to a nearby tree, and perched facing me, now in good light. It was dark grey all over with black wings, darker eye-stripe and faintly barred underparts.

This species is an altitudinal migrant in the Himalayas, wintering in the Terai and the adjacent plains, and straggling in the Peninsula as far as Karnataka (Ali and Ripley, 1987 COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, OUP.). There are no previous records of this species from Nilgiris or Tamil Nadu in literature.

February 5, 1996

T.R.K. YOGANAND
Sálim Ali Centre for Ornithology and Natural History,
Kalampalayam P.O.
Coimbatore-641 010. Tamil Nadu.

22. GOLDMANTLED CHLOROPSIS (*CHLOROPSIS COCHINCHINENSIS*) FEEDING ON RAW POTATO CHIPS

On 16th March, 1995, a pair of goldmantled chloropsis was seen foraging amongst the foliage of a mango tree (*Mangifera indica*). The male flew away and returned after a few seconds, holding a raw potato chip. These were spread over an adjacent roof for drying in the sun.

The chip was held in the bill and repeatedly struck on the tree branches resulting in its breaking into several pieces which fell on the ground. The last remaining portion was eaten.

In the HANDBOOK (Ali and Ripley, 1987 - Vol. 6, pp 408) the food of the species has been mentioned as insects, berries, wild figs, and nectar of a variety of flowers.

February 5, 1996 A.M.K. BHAROS
27, MIG, Indravati Colony,
Raipur-492 001, M.P.

23. POSSIBLE FEEDING ON AN UNHATCHED EGG BY YOUNG ONE OF REDVENTED BULBUL (*PYCNONOTUS CAFER*)

A pair of redvented bulbuls (*Pycnonotus cafer*) made a nest above a tube light in my room in Sangli, Maharashtra. The nest was completed in four days, and the first egg laid on 10th May, 1990. The second and third eggs were laid on subsequent days. After the third egg was laid, both the birds incubated the eggs for 24 hrs. Close observation was possible from 16th May, onwards. The bird that sat on the nest at night was presumed to be a female. Every evening another bird that did not sit on the nest at night used to spend an hour or more with the female, sitting on the nearby grill of the window or a hook on the roof of the hall. At dusk (about 1900 hrs) he generally moved out of the hall and roosted on a nearby bush (*Nyctanthes arbortristis*).

Looking at the nest, normal movement of people in the room or other noises did not provoke any response from the incubating bird. It is interesting to note that from the very first day of incubation the female did not show any sign of fear except that she raised her head when we were too noisy, which happened frequently.

The duration of incubation was reduced from 30th May, onwards. The male stopped sitting on the nest, formerly he used to fill the gap in incubation, when the female left the nest for food. The incubation was completely stopped from 1st to 8th June. The male did not visit the nest at all from 1st to 9th June, but the female visited it atleast thrice a day and sat on the eggs for 45-50 min before flying off.

On 9th June, at 2000 hrs the female came and sat on the nest upto 2300 hrs. In the morning at 0700 hrs, she was still there. After some time she went out of the room, close observation revealed another egg in the nest. After 19 days of incubation and a gap of 28 days, the fourth egg was laid by the same female. Incubation was again regular till 20th June.

On 21st June, one chick was seen; on 22nd June, at 0900 hrs one more egg showed signs of hatching. In the evening I found it had also hatched and there were two chicks. The former chick was much bigger than the latter. The remaining two eggs did not hatch.

On 23rd June, one egg disappeared without any trace. The next day at 1730 hrs when the parents were out I examined the nest. The older chick occupied more space and the smaller one was sandwiched between it and the edge of the nest. The second thing which I observed was quiet interesting. There was a big bulge on the throat of the older chick. The skin at the throat had no feathers and at the bulge the skin was so stretched that it was almost transparent. I felt the bulge with my fingers; it was round and hard, similar to an egg. Due to the transparency of the skin I could observe the brown blotches on it. I suspect it was the remaining egg in the nest. After 15 min there was no bulge at the throat, as the egg went down into the stomach.

On 29th June, in the morning I saw the smaller chick dead on the floor with two holes in it. One in the ribs on the right side of the sternum keel, the second one on the abdomen, with some part of its intestines bulging out. There is no evidence to show what had happened. Finally, on 5th July the larger chick fledged.

July 10, 1996

HEMANT A. DHAMKE
39/308, S.T. Nager,
Bajaj Tempo Colony,
Pimpri, Pune-411018.

24. POSSIBLE COMMUNAL NESTING IN THE WYNAAD LAUGHING THRUSH *GARRULAX DELESSERTI DELESSERTI* (JERDON)

The Wynaad laughing thrush, *Garrulax delesserti*, occurs in southern Western Ghats, in humid rain forest with dense understory (Ali 1968, BIRDS OF KERALA). This bird lives in flocks.

On 18th April, 1994, about 4 km from Thekkady on the Mangaladevi road, in Periyar Tiger Reserve, in a semi-evergreen forest, I came across a flock of 16 birds in the morning. They were foraging on the ground "rummaging amongst the mulch", turning over dead leaves, and uttering chattering calls.

At 0950 hrs I saw one bird followed by another flying to an isolated 4 m tall *Actinodaphne hirsuta* tree with a rootlet in its beak. Two more birds were seen following immediately, one with a rootlet and another without. I saw a nest under construction, about 3 m high on the central fork of one branch of the tree. The birds were adding nesting material to it, and building a cup shape. The nesting activity continued until 1150 hours. Three birds were bringing the nesting material and the fourth, always accompanied them without any material. The nest building birds seemed to be unconcerned about my presence. Other members of the group were foraging about 5 m away. The birds disappeared through a dense thicket at 1155 hrs and could not be traced. I could come back to the place only after 2 days and the nest was found damaged.

October 27, 1995

V.J. ZACHARIAS,
Periyar Tiger Reserve,
Thekkady, Kerala.

25. FEEDING BY ROSEFINCH *CARPODACUS ERYTHRINUS* (PALLAS) ON APHID SECRETION

The usual food of rosefinch (*Carpodacus erythrinus*) includes mostly seeds (of weeds, millet, linseed, vetch, *Polygonum*, bamboo, etc.), flower buds, fruits and berries such as mulberry, raspberries, wild cherries, banyan and pipal figs, *Lantana, Maesa, Trema*; also nectar of *Erythrina, Salmalia, Butea, Woodfordia* and other blossoms. There is a single record of insects (Ali and Ripley, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. 10, pp 165, 1974). Witherby, Jourdain, Ticehurst and Tucker, in HANDBOOK OF BRITISH BIRDS Vol. 1, pp 89, 1938 mention young birds taking insects and larvae. In an openwooded grove near Dombivli (Dist. Thane, Maharashtra), a migratory flock was observed feeding on aphid secretion which was present on immature fruits of *Holoptelea integrifolia.*

The aphid-laden young green samaroid fruit of *H. integrifolia* show sweet, sticky droplets of the honey dew secreted by aphids on the seed wings. It is commonly observed that ants attend aphid infested plant parts for this secretion and in turn defend the aphids in a symbiotic relationship. However, it was interesting to see the birds visiting these fruits for the honeydew not only once but regularly for about half a month (late January, 1994). Birds were observed daily, either between 0630 to 1000 hrs or between 1700 to 1830 hrs. Though there are many trees of *Holoptelea* in the area, most birds of the flock used to swarm on one or two selected aphid-rich trees. One or at the most two days were taken by the birds, which was dependent on the fruit numbers to finish up the majority of the fruits. These fruits from which the sweet honey dew had been removed had fallen to the ground at the base of the tree. Then, though a few birds lingered on the same tree, most of them shifted to nearby trees. Later, due to the scarcity of fresh young fruits (and consequently honey dew), and due to full blooming of *Salmalia malabarica, Erythrina indica* etc., the birds turned to these trees.

Though it is reported that various flower buds form part of the regular diet of the rosefinch (Ali and Ripley 1974), they were never observed taking flower buds of *H. integrifolia.* Because of the large number of aphids, the birds got "aphid cluster" on their beak-commissures and were seen to clean their beaks by rubbing them on the stem after feeding on one or two fruits. It is however quite possible that the aphids might have been swallowed along with the secretion.

While making observations, some points arose which remain unresolved. These are:

1. The only other bird visiting the fruits apart from finches were some warblers which made occasional visits more for aphids than for the honey dew. The common rivals of the rosefinch for flower nectar such as drongos, mynas, crows etc., which compete for the nectar kept away from this sweet honey dew. Considering this, it is possible that *Carpodacus erythrinus* might have chosen this peculiar food to avoid competition.
2. Though *Carpodacus erythrinus* serves as an agent in cross pollination when it visits flowers for nectar (Ali 1932), such chances are completely excluded here as:
   i) Flowers are pollinated by wind (anemophilous).
   ii) Birds visit the tree only after the flowering is almost over and fruits are formed on which the exudate is present.
3. Feeding by the rosefinch can be disadvantageous to the tree if it causes premature fall of the fruits.

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February 5, 1996 NAYAN V. KHANOLKAR
'Pitrusmruti', Near R.B.J. Colony, Shastri Nagar, Dombivli (W), Dist. Thane.

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26. ON THE SYSTEMATIC POSITION OF THE SPECIES *POLYPEDATES PLEUROSTICTUS* (AMPHIBIA: RHACOPHORIDAE)

The 47 species of Indian tree frogs of the family Rhacophoridae are accommodated in three genera viz., *Philautus* (32 species), *Polypedates* (3 species) and *Rhacophorus* (12 species). While studying the amphibians of southern Western Ghats, (Ravichandran, 1992), I had the opportunity to examine and describe 11 species of *Philautus*, 2 species of *Polypedates* and 3 species of *Rhacophorus*. Study of five species, *viz*. *Polypedates cruciger* Blyth, *P. maculatus* (Gray), *Rhacophorus lateralis* Boulenger, *R. malabaricus* Jerdon and *R. pleurostictus* Gunther described under the last 2 genera revealed that *pleurostictus* shows closer affinities to species of the genus *Polypedates* than to those of *Rhacophorus*. Hence the generic differences are enumerated and the status of *pleurostictus* is discussed here.

The genus *Polypedates* Tschudi, 1838 was erected to accommodate moderate to large tree frogs, characterized among other features by smooth shagreened skin, the skin of the skull being co-ossified either to frontoparietals, nasal or squamosal bones in many species, dermal ornamentations generally being absent, and with fingers usually webbed only at the base, whereas *Rhacophorus* Kuhl and Van Hasselt, 1822 included species with slender body and narrow waist, with the skin of head never co-ossified to the skull, dermal ornamentation usually present and the fingers and toes fully webbed. The species *pleurostictus* is characterised by a broad and smooth body, fingers with rudiments of web at base, absence of dermal folds on forearm and tarsus, all diagnostic features of the genus *Polypedates*.

The generic status of this species has been debated. It was assigned to genus *Polypedates*. Later Boulenger (1882) who differentiated the two genera *Rhacophorus* and *Polypedates* on the basis of the extent of the interdigital web, and others like Inger and Dutta (1986), Daniel and Sekar (1989) included it under the genus *Rhacophorus*.

On the basis of a detailed study of the relative development of the interdigital webbing, presence or absence of dermal folds on forearm and tarsus, size of tympanum and general coloration of *Polypedates* and *Rhacophorus* dealt with under five species *viz*., *Polypedates cruciger*, *P. maculatus*, *Rhacophorus lateralis*, *R. malabaricus* and *R. pleurostictus* it is felt that *pleurostictus* shows closer affinities to *cruciger* and *maculatus* belonging to the former genus to which it is now transferred as originally done by Gunther, thereby retaining only *malabaricus* and *lateralis* under *Rhacophorus*. This view agrees with the characteristics of the two genera drawn by Lien (1970) on the basis of the study of osteology, morphology and coloration, though he did not suggest the generic transfer.

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June 4, 1996

M.S. RAVICHANDRAN
Zoological Survey of India,
Southern Regional Station,
100, Santhome High Road,
Chennai-600 028,
Tamil Nadu.

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27. SEX RATIO OF HILLSTREAM SNOW TROUT, *SCHIZOTHORAX PLAGIOSTOMUS* HECKEL (TELEOSTEI, CYPRINIDAE) IN THE UPLAND RIVER MANDAKINI OF GARHWAL HIMALAYA

(*With two text-figures*)

Sex ratio changes are used as an indicator of population behaviour, catch composition and fecundity. Considering its importance, little information on this aspect is available for Indian fishes (Pantulu 1961, Bhatt 1993, Nautiyal 1994). The present study is an attempt to describe the sex ratio of an economically important and dominant snow trout species *Schizothorax plagiostomus* Heckel in relation to three water parameters (total water discharge, water velocity and water temperature) of the glacier-fed upland river Mandakini in Chamoli dist. of Garhwal Himalaya, Uttar Pradesh.

Adult *S. plagiostomus* were collected from the glacier-fed high altitude Mandakini river, covering a stretch of about 30 km (Fig. 1). Specimens were randomly sampled every month from January 1991 to December 1992 at four sites - Bheri (1020 m), Chandrapuri (827 m), Agustmuni (760 m) and Tilwara (724 m). In view of its breeding twice a year, catch data of *S. plagiostomus* had been computed in terms of sex, breeding and non-breeding season. The numerical figures of males and females, during breeding and non-breeding season, are first pooled together and then separately expressed as a percentage of the total catch of each year. The ratio of M : F (M - number of males, and F - number of females) during different seasons denotes the corresponding sex ratio.

The water condition parameters of river Mandakini, *viz.*, total water discharge (m^3/ sec), water velocity (m/sec) and water temperature (0°C), during corresponding study period, obtained from U.P. Irrigation Department Srinagar Garhwal (as measured at Chandrapuri, Fig. 1), were converted into mean monthly values for the corresponding seasons.

We studied 4601 adults (3110 males and 1491 females) caught at four sampling sites. Sample size, as expressed in percentage of total catch during two years, does not indicate any relationship with sex ratio (Fig. 2).

S. plagiostomus breeds twice a year, clearly intercepted by well defined non-breeding season:- first March, April and May, and second August, September and October. During the study period, a consistent pattern of sex ratio change in *S. plagiostomus* was observed. It was found as 2.66:1 (January, February 1991), 2.29:1 (March, April, May 1991), 2.24:1 (June, July 1991), and the lowest value of one breeding cycle 2.03:1 (August, September, October 1991; second breeding season). It again rose to 2.90:1 (November, December 1991, January, February 1992), 2.28:1 (March, April, May 1992; first breeding season), 2.16:1 (June, July 1992), and again the lowest 1.59:1 (August, September, October; second breeding season) followed by an abrupt rise 2.35:1 (November, December 1992). It is, therefore, evident that males predominate the adult population of *S. plagiostomus*. The sex ratio remains higher during the first breeding season (March, April and May) and lowest during second breeding season (August, September and October) (Fig. 2).

The water condition parameters have their own bearing on the sex composition of *S. plagiostomus*. Adult males comprised the lowest sex ratio when monthly mean values of water parameters were at their peak - total water discharge (155.34 m^3/sec., 170.63m^3/sec.), water velocity (1.805m/sec., 1.919m/sec.) and water temperature (15.05°C, 15.8°C) during second breeding season (August, September, October 1991 and 1992 respectively). Higher values of sex ratio were found during first breeding season (March, April, May 1991 and 1992 respectively) when mean monthly values of water condition parameters of river Mandakini just commenced a rising trend from the lowest monthly mean

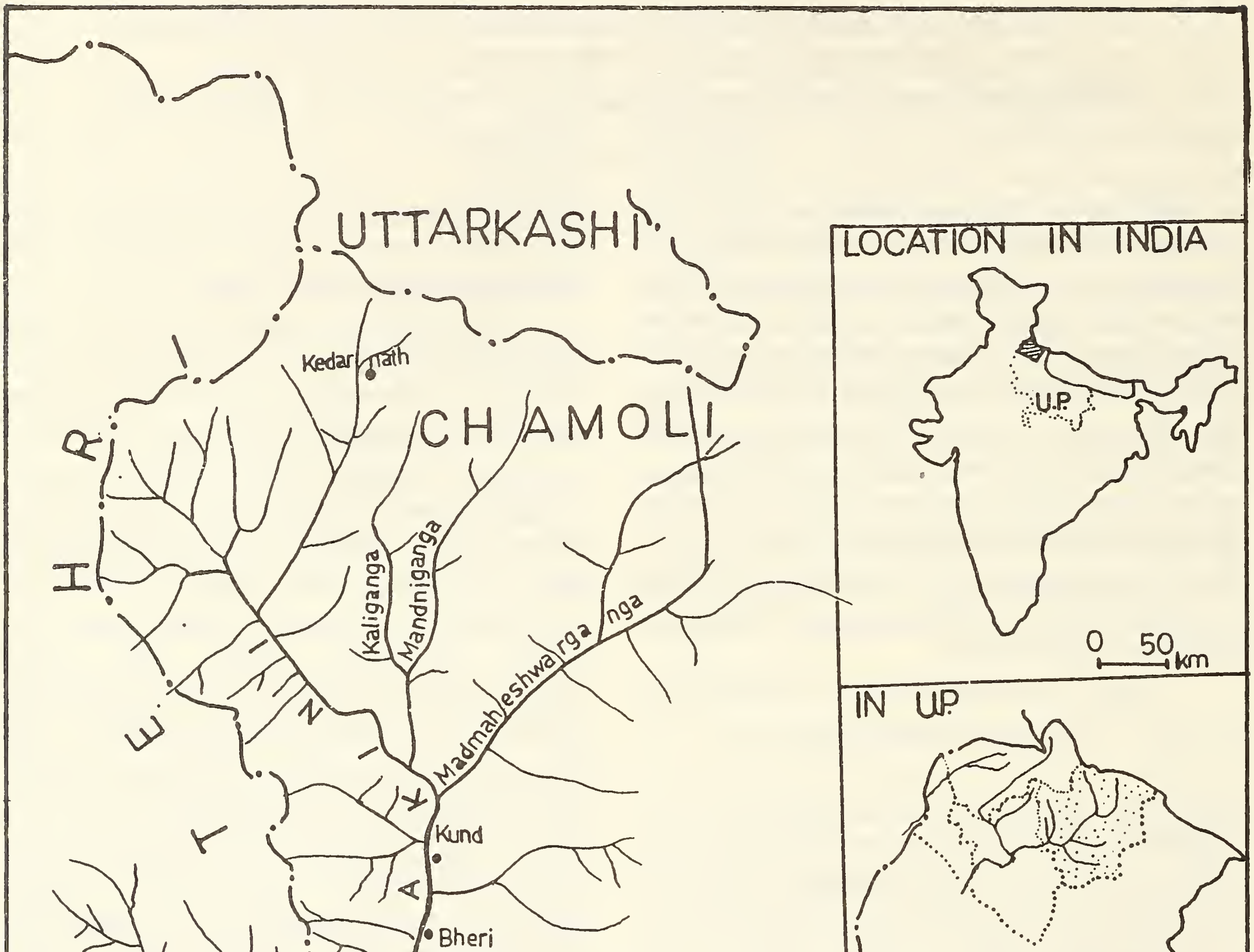

Fig. 1. Location of the sampling sites on the river Mandakini

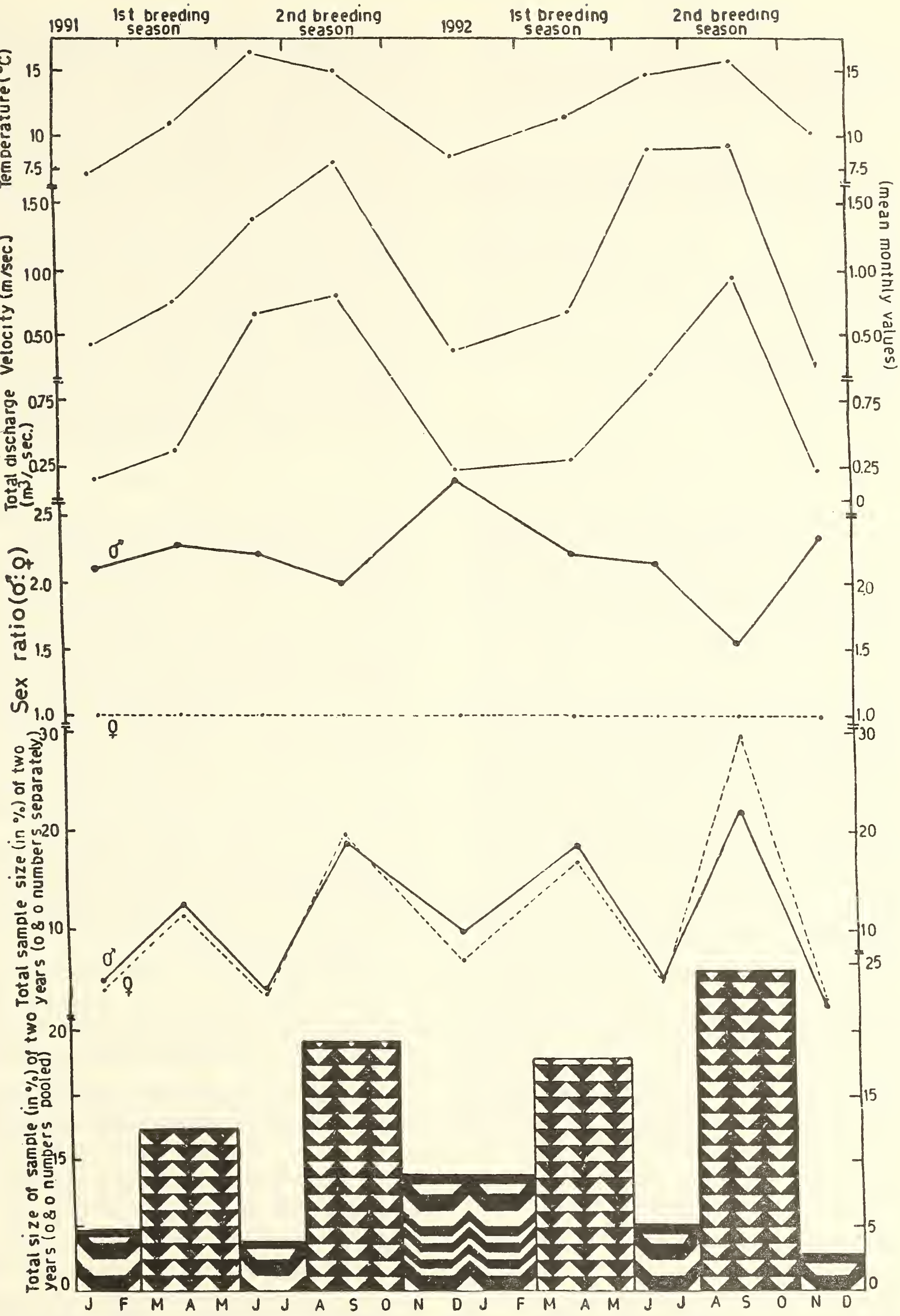

Fig. 2. Sex ratio of *Schizothorax plagiostomus* in relation to sample size (male and female numbers pooled and separately) and water parameters (total discharge, velocity & temperature) during breeding and non-breeding seasons for 1991, 1992 (in the river Mandakini)

values during extreme winters. Thus, sex ratio in *S. plagiostomus* somehow has an inverse relationship with the values of water parameters.

Discussion

Nikolskii (1980) mentioned that optimum sex ratio in nature is close to 1:1 in adult part of the population but it may be far from this in particular age and size groups; males usually predominate in younger groups because they tend to mature earlier and live less longer. Thus, optimum sex ratio may vary drastically as a result of being affected by numerous factors.

Sex composition and sex ratio of fish population have been investigated in a number of European fishes, *viz., Huso dauricus* (Soldatov 1915), North Caspian roaches (Monastyrskii 1940, *Leuciscus idus* (Soloveva 1960), coal fishes (Mironova 1961), sea perch (Freund 1961), coregonids (Titova 1962), roaches and carp beams (Demin 1962) to mention a few. However, the pattern of variation in the sex ratio is not generalised because no single factor accounts for such a change in all classes. Different factors cause the sex ratio to change in different cases. Females predominate in fishes of low fecundity such as *Pomatoschistus caucasicus* where the male is larger than the female but males are fewer in number (Koblitskaya 1961). Females also predominate in many other cases where a male produces several batches of sperms but female produces only one batch of ova. Conversely, in other cases, males predominate, e.g., *Platessa platessa* (Wimpenny 1953), *Pseudosciana corcea* (Chen Ju Fen 1962). Again, in many cases, different population of species residing in different regions exhibit different sex ratio, e.g. *Carassius auratus gibelio* in Chinese and Japanese waters has a ratio of 1:1 but in Amur river the ratio is 0.48:1 (Nikolskii 1956).

In the present investigations, the sex ratio of *S. plagiostomus* was never close to the optimum 1:1 during either breeding or non-breeding season. Males predominate throughout the year. The changes in the sex ratio seem to follow a consistent pattern, i.e. higher during the first breeding season when values of aquatic parameters of river Mandakini just begin to rise from the lowest values of extreme winter, and lowest sex ratio during second breeding season when values of water parameters would be at their peak. It may be presumed that, starting from late February onwards, the potential sexually mature brooders begin upstream pre-spawning migration from lower stretches of larger glacier-fed rivers (like Ganga, Alaknanda etc.) to their smaller glacier-fed tributaries (like the Mandakini) in the upper reaches. While doing so, the males lead this upstream migration, followed by females. Earlier arrival of male brooders changes the sex ratio drastically in local populations at a particular spawning/breeding locality. The first breeding season is followed by the non-breeding period (June, July). From July onwards, the upstream migration of potential and/or rest of brooders, especially to smaller spring-glacier fed tributaries, commences again which further alters the sex ratio to its lowest values during the second breeding season (August, September, October). It is possibly because an earlier departure of males from potential spawning/breeding sites has already started. This is the time when values of aquatic parameters touch their zenith. The breeding process of one year smoothly passes through to the next year, thus maintaining and repeating the periodicity of the process.

Higher sex ratio during the first breeding season may result from (1) late arrival of females and early arrival of males, (2) fresh recruitment of new batches of subadults into male brooders, (3) difficulties encountered by female brooders during upstream migration because of their full grown belly, and lower water discharge of the river. Otherwise the conditions are conducive for spawning and breeding as a result of rising temperature and moderate water velocity, and (4) vulnerability of females to their predators and other natural hazards. Possibly, environmental conditions during the first breeding season favour the male part of the population while females are favoured during second breeding season.

Nautiyal (1994) found that alteration in the sex ratio of *Tor tor* is initiated by the pre-spawning migratory phase itself in the brooder population only. Moreover, at a particular spawning site, the brooder males tend to be in surplus number and stay longer; the brooder females tend to leave the spawning site soon after spawning. This causes a change in the sex ratio which has its own adaptive significance for the control mechanism of reproduction and sex composition of a reproducing population (Nikolskii 1980). More information on sex ratio and sex composition of population-related species of schizothoracids from other hillstreams would present a total picture.

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N. SINGH
Zoology Department,
P.O. Box 83,
HNB Garhwal University,
Srinagar Garhwal 246 174,
U.P, India.

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28. ON THE SPECIFIC IDENTITY OF *OMPOK BIMACULATUS* (SILURIFORMES: SILURIDAE)

(*With one plate*)

The genus *Ompok* Lacepede is currently represented by four species in the Indian region *viz. O. bimaculatus* (Bloch), *O. malabaricus* (Val.), *O. pabda* (Ham. Buch.) and *O. pabo* (Ham.

Buch.). *O. malabaricus* is restricted to the western face of the Western Ghats, while the other species are present throughout India and are widely distributed in the Oriental region. These species are mostly distinguished by the relative lengths of the maxillary barbels and the anal ray count; the maxillary barbels are longest in *bimaculatus*, followed by *malabaricus*, *pabda* and the smallest in *pabo*.

Hamilton-Buchanan (1822) distinguished 5 species under the genus *Silurus* (referable to *Ompok*) based on maxillary barbel length and the number of anal fin rays - *pabda* (A. 54), *cechra* (A. 67), *carnio* (A. 69), *duda* and *pabo* (A. 73), the long barbels reaching mid body in *canio* and *duda*, beyond pectoral in *pabda* and *cechra* and no further than head in *pabo*. Day (1877), observing wide variations in anal ray counts in *bimaculatus* (A. 60-75), considered *cechra*, *canio* and *duda* its synonyms. He further distinguished the species on the basis of the shape of the caudal fin and the fusion or otherwise of anal fin with caudal; the same was also followed by Misra (1976) in his revisionary work.

Talwar and Jhingran (1991), who considered *sindensis* and *gangeticus* synonyms of *bimaculatus*, while basing their key on maxillary barbel length and anal ray count indicated that the latter in *bimaculatus* varies in number from 57-58. Their figure, on the contrary, shows 76 rays. Their book 'INLAND FISHES OF INDIA AND ADJACENT COUNTRIES" being currently followed by several fish taxonomists may lead to misidentification of the species, for a fish with long maxillary barbel and an anal ray count of more than 63 may be taken for *O. malabaricus*.

If one were to follow Talwar and Jhingran (1991), the anal rays in *bimaculatus* should vary in number from 47-75, since *sindensis* has 47 rays according to the original author and in *gangeticus* it varies from 70-78 (Misra, 1976). On the basis of studies carried out on specimens collected recently from Manimuthar in Tamil Nadu and Brahmaputra in Assam (Plate 1) and observations made by earlier workers like Day (1875-78) and Misra (1976), it is apparent that in *bimaculatus* the number of anal rays varies from 60-75. Though Talwar and Jhingran (1991) treated *sindensis*, which has 47 anal rays, as a synonym of *bimaculatus*, yet in all likelihood this and *gangeticus* may be valid species because, unlike in *bimaculatus*, in the other species the anal is united to the caudal. Besides, there is wide disparity in the number of anal rays in typical *sindensis* in relation to *bimaculatus*. But their exact systematic position should await further studies on more material.

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K. REMA DEVI,
K.G. EMILIYAMMA,
Zoological Survey of India,
Southern Regional Station,
100, Santhome High Road,
Chennai 600 028.

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PLATE 1

Lateral view of *Ompok bimaculatus* (Bloch), 171.0 mm TL, F. 4709 ZSI/SRS

Edinburgh and London. vii + 405 pp., 39 pls.
MISRA, K.S. (1976): The Fauna of India and Adjacent Countries. Pisces (Second Edition) Vol. III. Teleostomi: Cypriniformes; Siluri. Delhi xxi + 367 pls. xv.
TALWAR, P.K. & A.G. JHINGRAN (1991): Inland Fishes of India and Adjacent Countries. Vol. 2. Oxford & IBH Publ.Co. Pvt. Ltd. 1158 pp.

29. HABITAT AND NECTAR RESOURCE UTILISATION BY BUTTERFLIES FOUND IN SIRUVATTUKADU KOMBEI, PALNI HILLS, WESTERN GHATS

(*With one text-figure*)

Siruvattukadu Kombei is a valley covering roughly 80 sq. km in the northeastern section of the Palni Hills in the Western Ghats, between 10° 21' to 10° 25' N lat. and 77° 36' to 77° 44' E long. (Fig. 1). The mean altitude of the valley is 750 m above msl. Siruvattukadu Kombei comprises the watershed of the perennial stream Seradipallam and receives nearly 1000 mm of rainfall every year. The main forest types in the area are moist deciduous, semi-evergreen, riparian mixed and dry deciduous (Sustainable Development Program, 1992). The forest habitat is now patchy due to conversion to agriculture and other human impacts.

Though there have been 2 earlier studies that recorded the butterfly life of the Palni Hills (Evans, 1910; Ugarte and Rodericks, 1960), Siruvattukadu Kombei has never been explored for its butterfly fauna, on account of being isolated from the rest of the Hills. In the dry season of 1992 (February to June), I carried out a survey of the butterfly fauna of Siruvattukadu Kombei by identifying species, recording their nectar-feeding relationships and presence/absence in various habitat types. Four major habitat types in the valley were chosen for systematic sampling. Species were identified following Wynter-Blyth (1957), Satyamurti (1966), and Varshney (1979, 1985).

Butterfly Diversity: 105 butterfly species were recorded, out of which 13 were Papilionids, 7 Satyrids, 21 Nymphalids, 1 Erycinid, 17 Pierids, 14 Hesperids, 6 Danaids, 25 Lycaenids and 1 Acraeid.

The total butterfly species count is a high fraction (42%) of the 248 that have been recorded from the Palni's so far. One species, the Tamil Oakblue, was a new record for the Palni Hills. Many more species are likely to be discovered, since the present study covered only one dry season.

HABITAT AND NECTAR RESOURCE UTILISATION

Lime plantations were the dominant agricultural land-use in the area. Lime trees were planted in regular rows with scattered cultivated trees such as silk-cotton (*Bombax ceiba*), jackfruit (*Artocarpus heterophyllus*) and banana (*Musa sapientum*). The notable feature of the plantations was their variety of herbaceous weeds such as *Stachytarpheta indica, Tridax procumbens, Leucas aspera, Sida* spp. and *Acanthospermum hispidum*, whose flowers attracted large numbers of butterflies. In addition, the agricultural fields were surrounded by thickets of *Lantana camara* which were flowering throughout the study period and appeared to be an important source of nectar for several butterfly species (Table 1).

The common butterfly species were those that appeared restricted to open and degraded agricultural land, including the Papilioni,-Lime Swallowtail, Nymphalids such as the Yellow Pansy, Blue Pansy and Peacock Pansy and numerous Pierids such as Emigrants (Common, Mottled and African). The Indian Skipper and the Ceylon Ace were the only Hesperids seen in the plantation habitat and seemed confined to it. Lycaenids such as the Lime Blue, the Peablue, Common Silverline and Lesser Grass Blue were quite common in the plantation habitat and were not spotted in any other habitat.

Apart from these sedentary species, forest species like the Blue Mormon and Common

TABLE 1
OBSERVATIONS ON NECTAR-FEEDING IN BUTTERFLIES

BUTTERFLY SPECIES	PLANT SPECIES OF: AGRICULTURAL & RIPARIAN ZONES									FOREST ZONE										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Polydorus hector	+				+	+			+											
Polydorus aristolochiae					+					+										
Papilio crino															+					
Papilio demoleus					+	+														
Papilio polytes	+			+	+	+						+								
Papilio polymnestor	+				+							+			+					
Graphium doson					+					+										
Graphium agamemnon	+				+					+			+				+			
Graphium nomius						+														
Ypthima philomela						+							+							
Eriboea athamas															+					
Neptis hordonia											+			+						
Hypolimnas bolina										+										
Hypolimnas misippus						+														
Precis hierta						+														
Precis iphita	+				+	+							+	+		+				
Precis orithyia						+														
Atella phalantha	+				+															
Cupha erymanthis													+							
Neptis jumbah															+					
Euripus consimilis					+															
Precis lemonias	+			+		+														
Libythea lepita					+															
Cepora nerissa						+														
Eurema hecabe				+		+						+								
Appias albina						+														
Colotis etrida						+														
Leptosia nina																				+
Catopsilia crocale				+	+	+					+	+					+			
Catopsilia pyranthe						+					+	+					+			
Catopsilia florella	+										+	+					+			
Delias eucharis																+				
Lambrix salsala						+							+							
Halpe homolea			+	+		+														
Spialia galba						+														
Celanorrhinus leucocera												+						+		
Tagiades japetes															+					
Coladenia indrani									+											
Danaus chrysippus	+			+	+	+					+									
Danaus genutia	+			+	+	+				+										
Euploea core	+			+	+	+				+			+	+	+		+		+	
Danaus aglea										+							+			
Danaus hamata					+					+									+	
Danaus limniace	+			+		+								+	+				+	
Castalius rosimon						+														

TABLE 1 (*contd.*)
OBSERVATIONS ON NECTAR-FEEDING IN BUTTERFLIES

BUTTERFLY SPECIES	PLANT SPECIES OF: AGRICULTURAL & RIPARIAN ZONES									FOREST ZONE										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Castalius ethion						+														
Zizeeria otis								+												
Catachrysops strabo						+														
Celastrina carna					+															
Jamides bochus	+												+							
Syntarucus plinius						+														
Jamides celeno						+														
Zizula gaika						+														
Chilades laius		+	+			+														
Freyeria trochilus		+				+														
Syntarucus jesous						+														
Lampides boeticus				+		+	+													
Acraea violae					+	+														

KEYTO PLANT SPECIES;
1: *Asclepias currassavica*
2: *Parthenium* sp.
3: *Leucas aspera*
4: *Stachytarpheta indica*
5: *Lantana camara*
6: *Tridax procumbens*
7: *Abutilon* sp.
8: *Mimosa pudica*
9: *Tamarindus indica*
10: *Mastixia* sp.
11: *Pongamia pinnata*
12: *Albizzia odoratissima*
13: *Pavetta indica*
14: *Psychotria* sp.
15: *Terminalia arjuna*
16. *Gardenia obtusa*
17: Uniden. Acanthaceae
18: *Xanthoxylum rhetsa*
19: *Strychnos potatorum*
20: *Murraya paniculata*

NOTE: '+' sign indicates feeding relationship was observed

Banded Peacock were often seen venturing far away from the forest edge, feeding on *Lantana* at the edge of fields. These species, being more mobile than most forest dwelling species, use the nectar resource available in more open habitats too and could cross open areas to reach other forest fragments. All the Danaids, except the Glassy Tiger, were very common in the agricultural fields feeding avidly on the abundant flowers of *Stachytarpheta indica*.

Stream bank habitat consisted of alternating rocky terrain and sand banks, along which grew scattered clumps of grasses and shrubs. In some places the stream banks were shaded over with riparian tree species such as *Pongamia pinnata, Terminalia arjuna* (upto 25 m), *Mangifera indica* and *Maytenus emarginata*. In more open areas, shrubby species such as *Solanum torvum, Asclepias currassivica* and *Lantana camara* grew on the sandbanks. These two types of habitats (i.e. shaded and open stream bank) had distinct communities. *Asclepias currassivica, Terminalia arjuna* and *Pongamia pinnata* appeared to be important nectar source for butterflies in the stream bank habitat.

This habitat was found to be the richest in the number of butterfly species. 79% of the total number of butterflies seen during the study were recorded from this zone. Some of the rarest species of this area, such as the Common Leopard, Staff Sergeant, Common Map, Suffused Snowflat, Water Snowflat and Blue Oakleaf were seen alighting here on shady, moist streambanks. These species were found mainly or exclusively in this zone, in addition to some Lycaenids such as the Peacock Royal and Indian Sunbeam.

In slightly more open areas, Common Sailors, Tailed Jay, Great Orangetips and Emigrants (all three species) joined large groups of Bluebottles to mud-puddle on open sand-

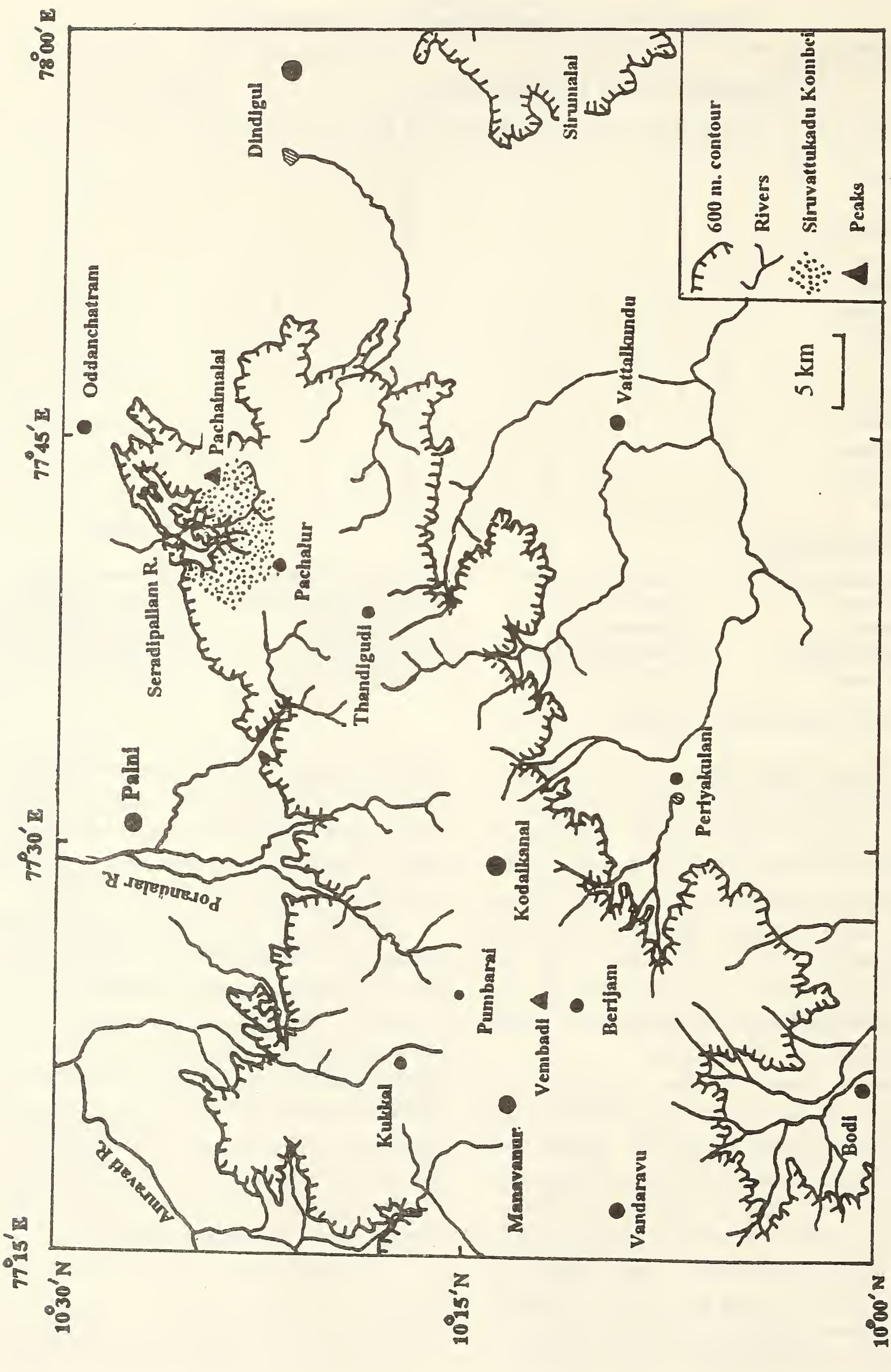

Fig. 1. Location of Siruvattukadu Kombei in the Palni Hills (adapted from Oates 1978)

banks. A few Spot Swordtails were observed occasionally in these groups. The Common Beak was frequently seen in these areas. It was interesting to note that very few Danaids were seen mud-puddling here or elsewhere. The Painted Courtesan was sometimes seen in agricultural streamside patches. The Red Pierrot was always seen flying weakly amongst low-growing patches of *Bryophyllum* spp. (its food plant) on damp sandbanks. It was perhaps the most sedentary species encountered during the study.

Thus the stream bank appeared to be the most important habitat for most of the species seen in Kombei, including the open area species, forest and generalist species. These butterflies gathered here in large numbers in the dry season, possibly because this was the only habitat where the males could replenish their mineral needs by mud-puddling. Therefore, if a quick inventory of the butterfly fauna of an area is desired, the best place to start in would be the stream bank zone.

During April and May, 1 km of the riparian area was filled with thousands of Common Crows, Dark Blue Tigers and some Glassy Blue Tigers. Swarms of butterflies flew up when one walked through this area and every leaf was covered with butterflies. It appeared to be a migration but no directional movement was seen. The butterflies lingered on for nearly four weeks and fed continuously on the flowers of *Terminalia arjuna* which were trees, in full bloom then.

Moist deciduous forest was present on most of the hill slopes around the valley. It was dominated by the canopy species *Miterophera heyneana, Alphonsea sclerocarpa, Celtis wightii, Sapindus emarginata* and *Diospyros melanoxylon.* Shrubs such as *Murraya paniculata, Pavetta indica, Tarenna asiatica* and *Canthium parviflora* occurred commonly in the understorey.

Common along the forest paths were Satyrids such as the Baby Fivering, Glad-eye Bushbrown and Dark-brand Bushbrown, the Papilionids Blue Mormon and Crimson Rose and the Nymphalid Chocolate Pansy. Rarer species in this zone were the Psyche, Yamfly, Angled Pierrot and Southern Indian Rustic. White-fourrings were often seen feeding on horse and donkey dung on the trails and the Tamil Oakblue was seen flashing across the forest paths frequently. The Common Banded Peacock was infrequent during the study period, but towards the end , a group of freshly emerged adults were seen settling on a wet patch on a forest path. *Gardenia obtusa, Strychnos potatorum* and *Albizzia odoratissima* were major nectar sources for butterflies in the forest during the study period.

In the **riparian moist deciduous forest,** the understorey was dominated by *Murraya paniculata* and *Canthium parviflora* while trees such as *Mangifera indica* and *Miterophora* were prominent in the top canopy. This habitat was found to be vegetationally quite similar to other forests of the area. Consequently, the butterfly life was also similar to that in the moist deciduous forest transects. The flowering shrub *Pavetta indica* was common in this zone, and on one tree, the flowers appeared to be monopolised by the Mormon, which was once seen chasing off other butterflies.

It was found that Siruvattukadu Kombei harbours several species of butterflies that are rare and reportedly confined to good quality deciduous and evergreen forest, such as the Spot Swordtail, Redspot Duke, Common Banded Peacock, Water Snowflat, Chestnut Bob and the Common Nawab. The fauna also includes several other species that are endemic to the Indian subcontinent such as the Common Map, Glad-eye Buchbrown, Common Birdwing, Baron and the Blue Oakleaf (Larsen, 1987a, b, c and Wynter-Blyth, 1957). Endemics constitute nearly 25% of the fauna discovered so far and most of these were found to avoid man-modified habitats .

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GHAZALA SHAHABUDDIN
School of Environment,
Duke University,
Durham, NC-27708, U.S.A.

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30. FIRST RECORDS OF SUBFAMILY TENTHREDININAE (HYMENOPTERA : TENTHREDINIDAE) FROM INDIA

(*With nine text-figures*)

The genus *Colochelyna* with its type species *C. magrettii*, was erected by Konow in 1898. It was represented by three species from southeast Asia, excluding India. Now, with *C. magrettii* recorded from Nagaland, the genus has extended its limits to India as well. Similarly, *Tenthredo sauteri* (Rohwer) previously recorded from Taiwan, Burma and Tonkin and *Tenthredo kingdonwardii* Malaise from China and Burma, are now reported from India.

Colochelyna magrettii Konow, 1898
(Fig. 5)

Female: Average length: 16 mm. Body dark reddish-brown except antennae, tibiae and tarsi of all legs. The following parts are black: furrows above the clypeus and of mesonotum, mesoscutellar appendage, metanotum, mesepimeron, mesepisternum except a spot in the centre, metapleuron, propodeum except extreme posterior margin, 2nd and 3rd abdominal tergites, coxae, trochanters, and basal halves of all femora. The labrum, an irregular spot covering frontal area, and extreme posterior margin of propodeum with deflexed sides are white. Wings with a darker shade along anterior margin of forewings. Venation blackish, costa and stigma fulvous.

Antenna slightly compressed, 2.0 x head width, segment 3 distinctly longer than 4 as 6:3. Clypeus slightly rounded, with a faint indication of incision in middle. Labrum small, convex, with a conical anterior margin. Malar space almost equal to the diameter of median ocellus. LID: IDMO: EL :: 3.1 : 4.0 : 3.0, OOL : POL : OCL :: 2.5 : 1.0:1.7, Frontal area above the level of eyes;

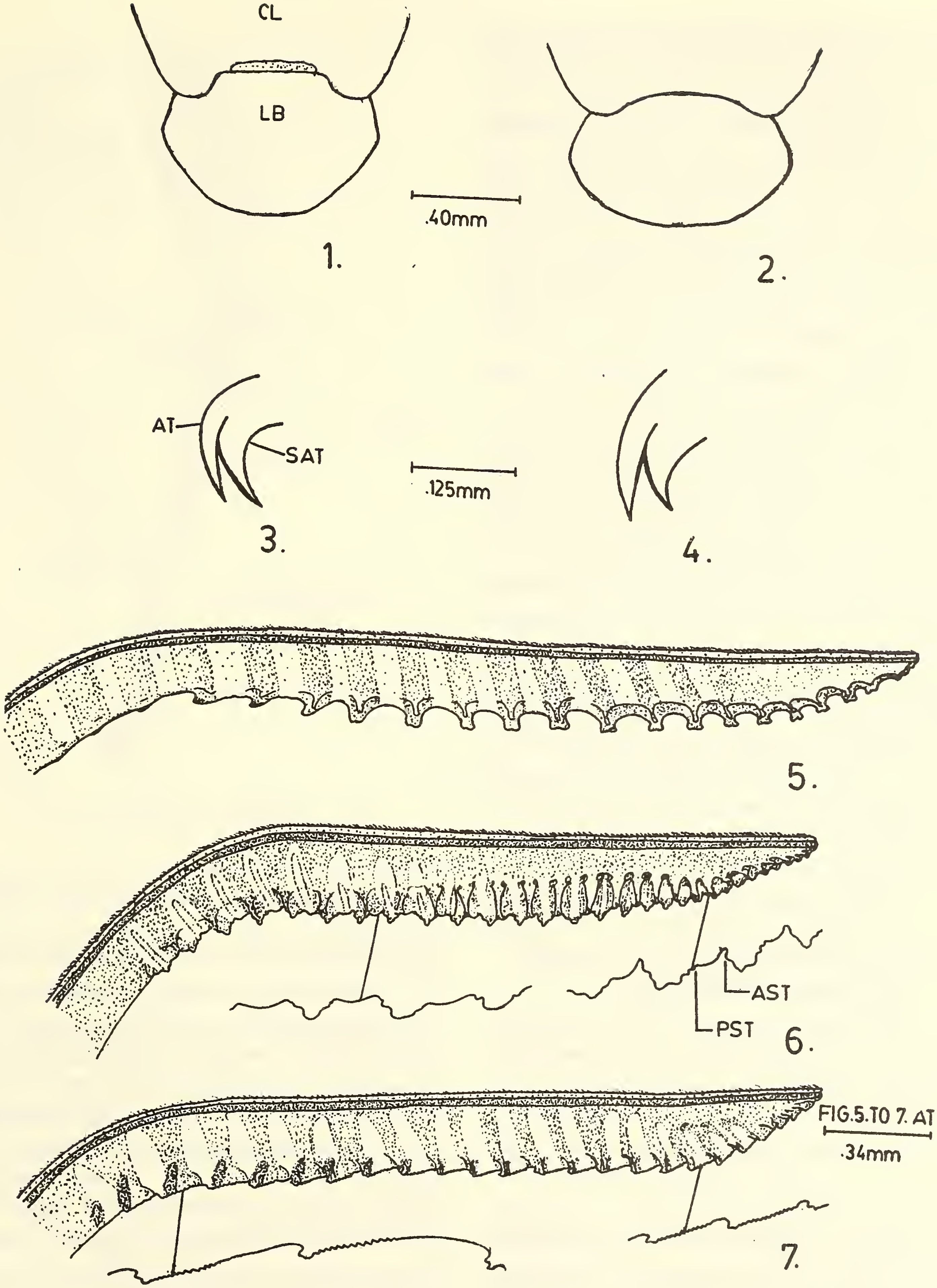

Fig. 1-7: 1. Clypeus and labrum of *T. sauteri*; 2. Clypeus and labrum of *T. kingdonwardii*; 3. Claw of *T. sauteri*; 4. Claw of *T. kingdonwardii*; 5. Lancet of *C. magrettii*; 6. Lancet of *T. sauteri*; 7. Lancet of *T. kingdonwardii*.

supra-antennal tubercles and frontal ridges wanting. Median fovea indistinct. Circum-, and interocellar furrows distinct, postocellar furrows sharp. Lateral furrows deep, but not reaching hypothetical posterior margin of head. Postocellar area convex, broader than long as 4:3. Scutellum elevated, subconical with rounded apex. Appendage without carina. ITD : ICD :: 2.5 : 1.0. Mesosternal thorns wanting. Metabasitarsus shorter than following 3 joints combined. IATS: MB : OATS :: 2.0 : 5.1 : 1.5.

Head covered with large and shallow punctures, frontal area almost apunctate. Pro- & mesonotum minutely and densely punctured as compared to head, punctures becoming larger in size on scutellum, mesoscutellar appendage and postmesonotum which are comparatively coarsely and densely punctured. Mesopleura and metapleura uniformly covered with minute, shallow punctures. Propodeum with large, scattered punctures around the median split and lateral ends, thus leaving a polished and almost apunctate space in the middle of each half. The following tergites opaque with coarse, distinct, dense punctures, strongly contrasting with the polished and apunctate areas of propodeum. Female lancet as in Fig. 5 with 22 flat serrulae.

Holotype depository: NR Stockholm.

Specimens examined: 2 females, Nagaland, Zunehebotto, 1875 m. 14.v.1993.

Population variation: None.

Discussion: The genus earlier reported by Malaise from Burma with species *C. magrettii*, now represents the first record from India.

Tenthredo sauteri (Rohwer, 1916)
(Figs. 1, 3, 6)

Female: Length: 9.5 mm. Body black, the following are yellowish-white: labrum and clypeus except irregular spots in middle, mandibles except apices, spot covering supraclypeal area, inner orbits, supra-antennal tubercles and laterally extending upto upper eye

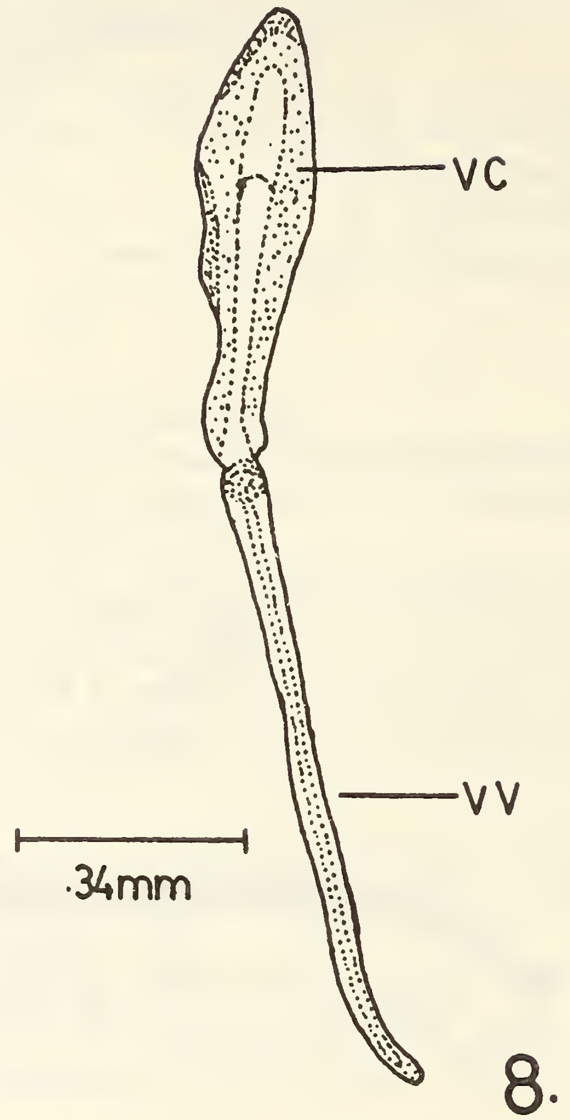

Fig. 8. Penis valve of *T. kingdonwardii*

corner, spot on hind margin of eye turning into narrow stripe and extending upto temples, posterolateral angles of pronotum, tegula, V-shaped spot in the centre of mesonotal middle lobe, mesoscutelum except its posterior 1/3rd, appendage, spot on mesepimeron, spot along anterolateral convexity of mesepisternum, spot in middle of propodeum, small spots in middle of last 2 abdominal tergites. Light yellowish-brown areas include lateral deflexed sides of propodeum, 2nd abdominal tergite, some dorsal aspects of 4th and 5th abdominal tergite with lateral deflexed sides along sternites, anterior aspects of proleg except bases of coxae, extreme proximal end of coxae, trochanters, tibiae and entire posterior aspects of tarsi of pro- and mesoleg, metaleg except bases of coxa, femora, tibia and tarsus which are reddish -brown. Wings

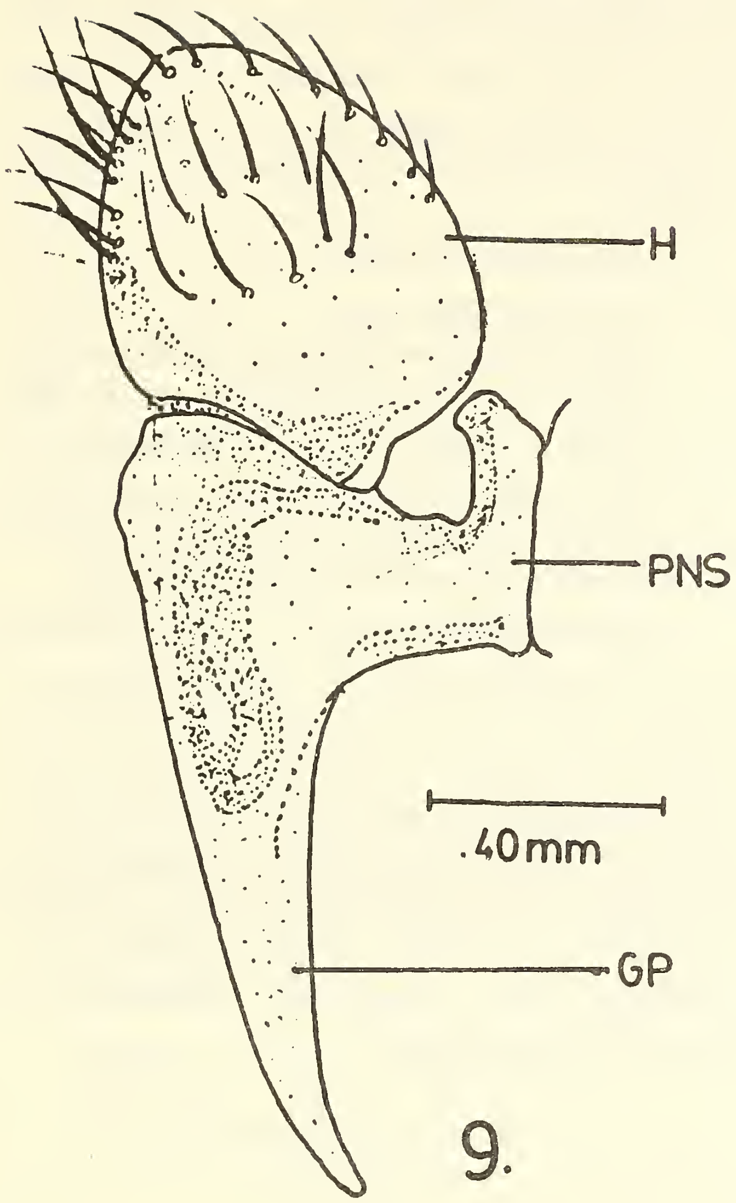

Fig. 9. Gonoforceps of *T. kingdownwardii*

hyaline, costa and stigma yellowish-brown, rest of the venation dark brown.

Antenna cylindrical, compressed in latter half, 2.4x head width, segment 3 shorter than 4 as 3:3.5. Clypeus (Fig. 1) roundly incised upto 1/3rd of its medial length with broad acute lateral teeth. Labrum almost rounded but with sub-acuminate anterior margin, as long as broad. Malar space distinctly shorter than diameter of median ocellus. LID : IDMO : EL :: 2.0 : 3.1 : 3.0; OOL : POL : OCL :: 2.5 : 1.0 : 1.7. Frontal area below level of eyes. Supra-antennal tubercles elevated and merging into flat frontal ridges. Median fovea deep in anterior half and with a raised bottom in posterior half. Circum-, inter- and postocellar furrows distinct. Lateral furrows narrow, deep slightly excurved and reaching hypothetical posterior margin of head. Postocellar area only a little wider than long, almost quadrate. Head elongate and narrowing behind eyes. ITD : ICD = 3.0 : 1.0. Scutellum elevated into a low pyramid with an acute and longitudinally compressed thorn, its appendage without carina. Mesosternal thorns lacking. Apical tooth of claw slightly shorter than subapical one (Fig. 3). Metabasitarsus equal to following 3 joints combined. IATS : MB : OATS :: 1.2 : 2.5 : 1.0.

Head shining, apunctate. Mesonotum covered with minute and isolated punctures. Mesoscutellum with few punctures on its posterior slope, its appendage almost apunctate. Mesepisternum punctured like mesonotum along convexity. Metanotum apunctate. Propodeum and remaining tergites shining, but with a few patches of scattered punctures on the posterior aspects. Lancet as in Fig. 6 with 27 serrulae, having 1-2 AST and 1-3 PST.

Holotype depository : USNM Washington.

Specimen examined: 1 female, West Bengal, Pashok, 1600 m, 19.v.86.

Discussion : This species was recorded by Malaise from Burma and Taiwan. The collection of a female specimen from Pashok (West Bengal) represents the first record from India.

Tenthredo kingdonwardii Malaise, 1945
(Figs. 2, 4, 7, 8 9)

Female: Average length; 8.5 mm. Body moss green, the black parts include antenna above, narrow stripes outer to frontal ridges, partly obliterated traces of ocellar spots, seams of mesonotal lobes, spots on posterior and outer extremities of mesonotal lateral lobes, stripe dividing meso- and metanotum, anterior and posterior seams of propodeum, a stripe on lateral aspect of femora and extreme basal parts of tibiae of all legs. 2nd to 9th abdominal tergites ferruginously red. Wings yellowish hyaline, costa and stigma light green, rest of venation dark.

Antenna slightly compressed in distal half, 1.5 x head width, segment 3 and 4 as 2:1.1. Clypeus (Fig. 2) narrowly incised with triangular lateral teeth. Labrum small, broader than long with a rounded anterior margin. Malar space equal to diameter of median ocellus. LID : IDMO : EL :: 2.0 : 2.5 : 1.75; OOL : POL : OCL :: 3.0 : 1.0 : 2.0. Frontal area almost at level of eyes. Supra-antennal tubercles and frontal ridges very low and confluent, without any interruption. Median fovea narrow, shallow and with a rounded median ridge along the bottom. Circum-, inter- and postocellar furrows distinct and very faintly sunken. Lateral furrows sharp, deep and reaching hypothetical hind margin of head. Postocellar area broader than long as 4 : 3. Head dilated behind eyes. ITD : ICD :: 3.0 : 1.0. Mesoscutellum with anterior face quite horizontal and on the same level as mesonotum, the hind face mostly abruptly falling away. The elevated apex of mesepisternum with a faint indication of short dorsoventral carina. Mesosternum lacking thorns. Apical tooth of claw subequal to subapical one (Fig. 4). Metabasitarsus shorter than following 3 joints combined. IATS : MB : OATS :: 1.0 : 2.5 : 0.75.

Head with very minute, rather dense, setigerous punctures with short black hair, but with hardly any microsculpture; lacking oily lustre, mesonotum likewise. Mesoscutellum with large and shallow puncutres. Mesepisternum almost apunctate. Metascutellum and appendage with few punctures. Propodeum and tergites shining and faintly microstriated. Lancet (Fig. 7) with 25 serrules having 2 AST and 12-13 PST.

Male - Average length: 8 mm. Similar to female except H-shaped black ocellar spot on frontal area, mesopleural suture black, meso- and metaleg entirely black on posterior aspects except coxae; black stripe on the anterior margin of 2nd tergite; 5th to 9th abdominal tergites ferruginously red; clypeus more deeply incised.

Penis valve: Fig. 8.

Gonoforceps: Fig. 9.

Holotype depository: British Museum

Specimen examined: 2 females 2 males, Uttar Pradesh, Chopta - 3000 m. 26.vi.89.

Discussion: The species *T. kingdonwardii* was reported by Malaise from Burma and China and extends its distribution to India as well.

Abbreviations: AST - anterior subbasal teeth, AT - apical tooth, CL - clypeus, EL - eye-length, ICD - intercenchri distance, IDMO - interocular distance at level of median ocellus, ITD - intertegular distance, LB - labrum, LID - lower interocular distance, OCL - oculo-occipital line; OOL - oculo-ocellar line, POL - postocellar line, PST - posterior subbasal teeth, VC - valviceps, VV - valvura, GP - gonostipes, H - harpe, PNS - parapenis.

Acknowledgement

We thank USPL-480 for financial assistance, and co-operating Scientist Dr. D.R. Smith, USNM, Washington, DC., for his valuable suggestions.

August 20, 1996

M.S. SAINI
HIMENDER BHARTI
Department of Zoology,
Punjabi University,
Patiala-147 002.

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31. NEW SYNONYMIES OF SOME INDIAN *TENTHREDO* LINN. (TENTHREDINIDAE : HYMENOPTERA)

In this note we suggest synonymies pertaining to some Indian *Tenthredo* Linn. species. The holotypes of these species were studied and after physical examination and detailed studies of external genitalia, barring minor colour differences, which are considered as population variations, the following are established as senior synonyms:

1. *T. darjeelingensis* (Singh *et al.* 1985, West Bengal, Darjeeling, Ghum, 2280m, 30.iv.80, Holotype) Senior synonym of *T. manii* (Singh and Saini, 1988. Uttar Pradesh, Mandal, 2300m 16.vi.85, Holotype).
2. *T. harpeata* (Singh *et al.* 1985, Himachal Pradesh, Narkanda 2750m, 20.vi.81, Holotype) Senior synonym of *T. jalouriensis* (Singh and Saini, 1987a, b, Himachal Pradesh, Jalouri pass, 3000m, 27.v.84, Holotype).
3. *T. okutanii* (Singh et al. 1985, Himachal Pradesh, Manali, Kothi, 2674m, 18.vi.80, Holotype) Senior synonym of *T. corrugatocephala* (Singh and Saini, 1987a, Uttar Pradesh, Gobind Dham, 3300m, 21.vi.85, Holotype).
4. *T. serraflata* (Singh *et al.* 1985, Himachal Pradesh, Manali, Kothi, 2485m, 19.v.80, Holotype) Senior synonym of *T. khajiari* (Singh and Saini, 1987b, Himachal Pradesh, Khajiar, 1800m, 21.vii.83, Holotype).
5. *T. trunca* Konow, 1908. The holotype was not available but a specimen compared with the holotype was provided by kind courtesy of Dr. Devinder Singh, Zoology Dept., Punjabi University, Patiala, bearing labels Himachal Pradesh, Narkanda, Baghi Road, 2080m, 21.v.84. Senior synonym of *T. labrata* (Singh *et al.* 1986, Himachal Pradesh, Manali, Kothi, 2674m, 20.vi.82, Holotype).

September 13, 1995

MALKIAT S. SAINI
HIMENDER BHARTI
Department of Zoology,
Punjabi University,
Patiala 147 002, Punjab.

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32. FRESH WATER SNAILS OF SOUTHERN RAJASTHAN

The Aravalli range is the principal and dominant mountain range of Rajasthan. Its widest part is confined to southern Rajasthan. This part of the State comprises the districts of Banswara, Bhilwara, Chittorgarh, Dungarpur, Rajsamand, Sirohi, and Udaipur. Southern Rajasthan receives highest rainfall in the State, i.e. 600 mm to 1100 mm annually. The Aravalli ranges in southern Rajasthan provide extensive catchment to many rivers like the Som, Mansi-vakal, Banas, Ahar, Bedach, Khari, Mahi, and Sabarmati. A large number of dams and lakes and other water bodies are confined to southern Rajasthan. Among them, Mahi dam, Pichhola, Fatehsagar, Rajsamand, Jaisamand, Gabsagar, etc., are some important large water bodies. Many famous wildlife sanctuaries like Sitamata, Fulwari Ki Nal, Kumbhalgarh, Mt.Abu, Jaisamand are confined to southern districts. All these provide suitable habitat to land snails. However, nothing is known about fresh water snails of southern Rajasthan.

A list of the fresh water snails of southern Rajasthan is given below:

Order: Mesogastropoda
Family: Viviparidae

1. *Bellamya bengalensis* f. *typica* (Lamarck): Shell ovate. Commonly occuring in dams and larger lakes. A large number of dead snails can be seen at the water line of the big lakes.

Family: Bithyniidae

2. *Gabbia orcula* var. *producta* (Nevill): Common in stagnant water of lakes. Shell ovate and looks like a miniature *Bellamya.*

Family: Thiaridae

3. *Thiara* (*Melanoides*) *tuberculata* (Muller): Shell elongated. Collected from stagnant water, attached to the substratum. Uncommon.

Family: Lymnaedae

4. *Lymnaea (Pseudosuccinea) acuminata* f. *typica* (Lamarck): Shell ovately oblong, slightly thick and smooth in appearance. Commonly appears in flowing water of hill streams after rains. It was also collected from wells bordering the hill streams. It can be seen either floating or attached to some substratum.

Family: Planorbidae

5. *Indoplanorbis exustus* (Deshayes): Shell discoidal. Common in lakes.

6. *Gyraulus convexiusculus* (Hurton): Shell discoidal and looks like a flattened disc. Common in stagnant water of lakes.

Order: Stylommatophora
Family: Ariophantidae

7. *Macrochlamys indica* (Godwin-Austen): Shell discoidal, with convex upper surface. During the monsoon it is seen crawling in damp and moist places in gardens, forest floor etc. Common.

ACKNOWLEDGEMENTS

I thank K.V. Surya Rao, Scientist, ZSI, Calcutta, for identification of the snails.

June 4, 1996

SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol (F.) Dist. Udaipur-313 702,
Rajasthan.

33. *CORYDALIS PSEUDO-JUNCEA* LUDLOW (FUMARIACEAE): A NEW RECORD FOR INDIA

(*With one text-figure*)

During recent plant exploration in the alpine zones of Garhwal Himalaya, I collected a few interesting specimens of *Corydalis* DC. from Kauri Pass alpine zone (Garhwal Himalaya). These specimens, after thorough checking of literature, were identified as *Corydalis pseudo-juncea* Ludlow. They were sent to Magnus Liden, Goteborg who has revised *Corydalis* in Nepal.

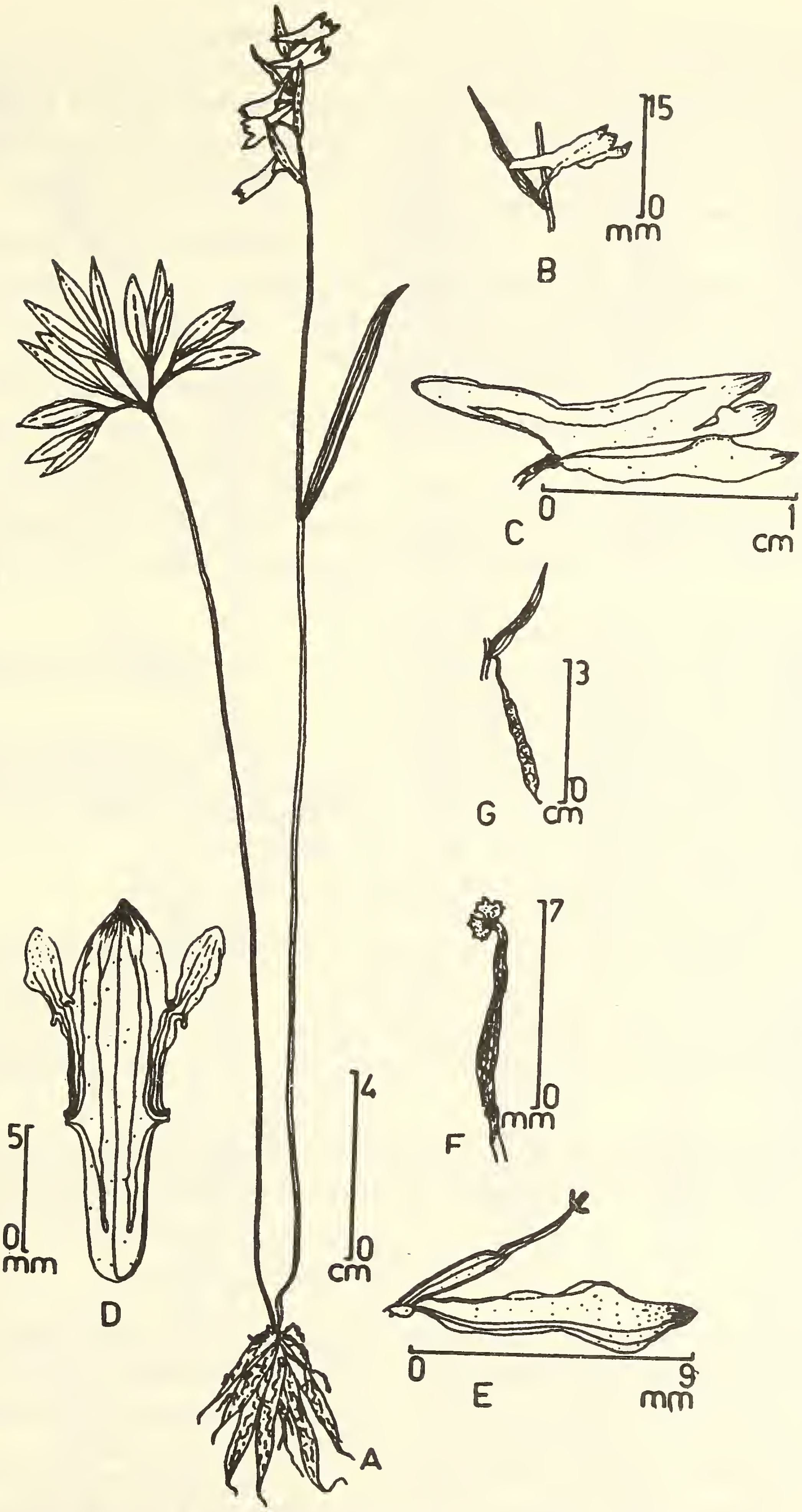

Fig. 1. *Corydalis pseudo-juncea* A. Flowering plant; B. Flower with bract; C. Flower; D. Posterior petal spread open; E. Anterior petal; F. Carpel; G. Fruit.

He confirmed the identity of these specimens as *Corydalis pseudo-juncea* Ludlow. Ludlow and Stearn (1975), described this species from Nepal but it has not been recorded from the Indian Himalaya. The recent collection is of phytogeographic interest, and represents a new record from India.

A detailed description, line diagram and habitat of the species are given to facilitate identification. The voucher specimens are maintained at Herbarium, Department of Botany, H.N.B. Garhwal University, Srinagar (Garhwal), India (GUH).

Corydalis pseudo-juncea Ludlow. in *Bull. Br. Mus. nat. Hist. (Bot.) 5(2)*: 62-64. t, 11. 1975; Liden, *Bull. Br. Mus. nat. Hist. (Bot.) 18(6)*: 477. t, 4. 1989.

Slender erect herbs. Storage roots tuberous, fusiform, sessile. Stem slender, erect, glabrous, 10-40 cm long, green. Radical leaves 1-2, with long (upto 20 cm) filiform petioles, biternate with long leaflets; leaflets glabrous, lanceolate, acute, 1.0-2.5 cm long; cauline leaf solitary, sessile, in upper part of stem, linear, acute, 1.0-6.0 x 0.2-0.4 cm. Racemes few (2-6) flowered. Bracts linear, acute, erect, longer than pedicels, 0.8-1.8 cm long. Flowers on 0.4-0.8 cm long pedicels, lemon yellow, 1.0-1.6 cm long, not tipped with dark purple; sepals minute, caducous; posterior petal 15 mm long (including 7 mm spur), dorsal crest very narrow, anterior petal upto 9 mm long. Ovary linear 7.0 x 10 mm; stigma bilobed, papillose. Fruit linear on deflexed pedicel, 20-22 mm long including 2.5 mm style, 8-10 seeded (Fig. 1).

Fl. & Fr.: June-July.

Habitat: Alpine pastures, among tufts of grasses on gentle slopes or small grassy gullies. Usually solitary 3250-3350 m above msl.

Distribution: Alpine zones of West Nepal, South Tibet, Garhwal Himalaya (India).

Specimen Examined: India, Garhwal Himalaya, Kuari Pass area, 3250 m, vi. 1988, D.S. Rawat 19,902 (GUH); Garhwal Himalaya, Kuari Pass area, 3350m, vi. 1995, D.S. Rawat 26,101 (GUH).

ACKNOWLEDGEMENT

I thank Dr. Magnus Liden, Goteborg, Sweden for confirming the identity of the species. Financial assistance from UGC, New Delhi is also acknowledged.

January 19, 1996 R.S. RAWAT

Herbarium & Plant Systematics Laboratory, Department of Botany, P.B. 86 H.N.B. Garhwal University, Srinagar (Garhwal)-246174, India.

34. *CONYZA JAPONICA* (THUMB.) LESS. (ASTERACEAE): AN ADDITION TO THE FLORA OF ANDHRA PRADESH

(*With one text-figure*)

During the floristic studies on Asteraceae in Andhra Pradesh, *Conyza japonica* (Thumb.) Less. was collected from Anantagiri and Araku valley of Visakhapatnam dist. The identification was confirmed with the help of literature and herbaria (MH & CAL). Gamble (1921) reported it from Mahendragiri hills of erstwhile Madras Presidency which is now a part of Orissa state. As it was not reported so far by earlier workers, it is reported as a new distributional record from Andhra Pradesh. Detailed description, line drawings, phenology and distribution are provided.

Conyza japonica (Thumb.) Less., Syn. Comp. 204. 1832; *FBI* 3: 258. 1881; Gamble, 682.1821; R.R. Rao *et al. Fl. Ind. Enum.-Ast.* 27. 1988. *Erigeron japonicum* Thumb. *Fl. Jap.* 312. 1784.

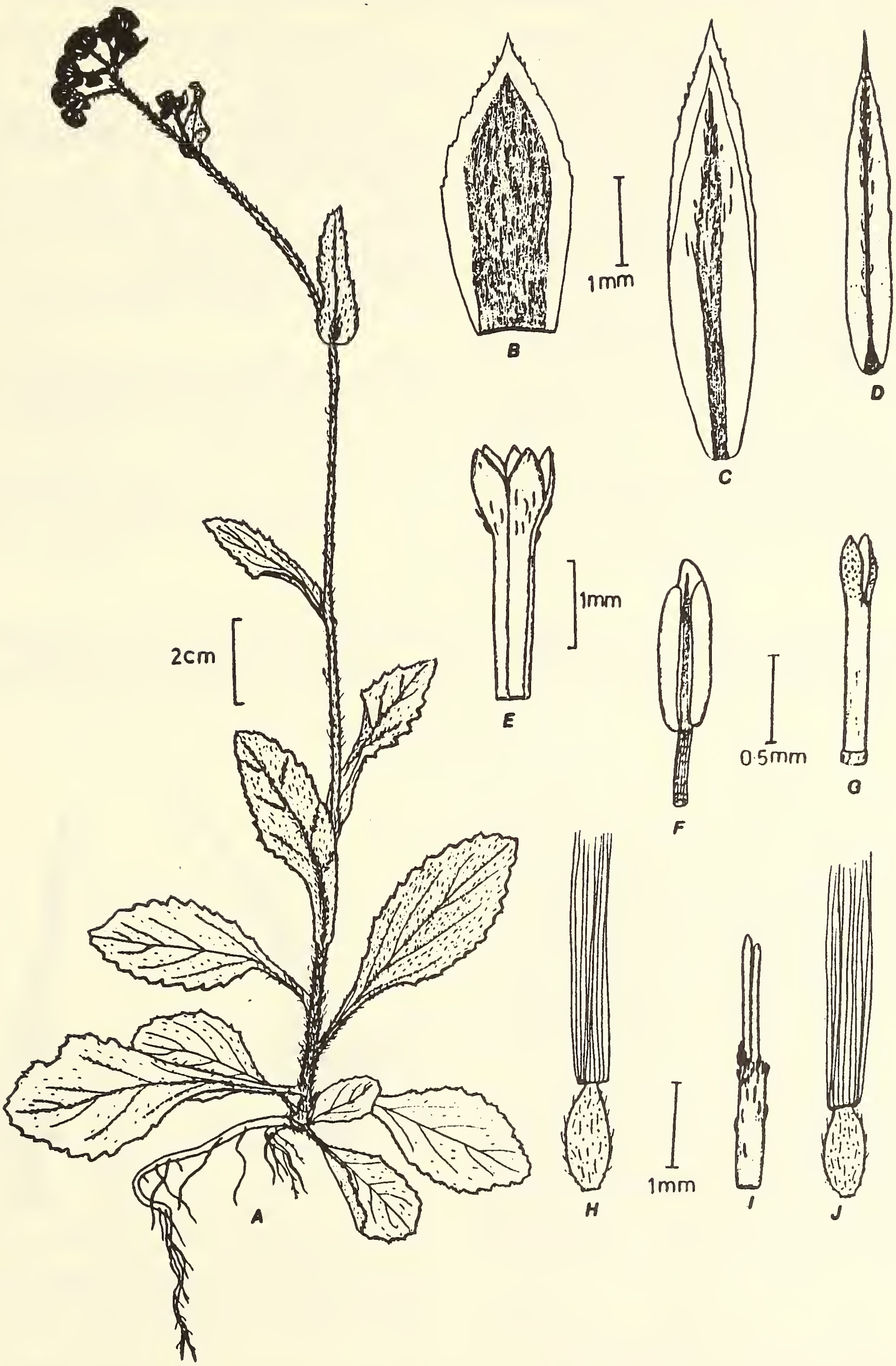

Fig. 1. *Conyza japonica* (Thumb.) Less. A. Twig; B, C & D. Outer, middle and inner involucral bracts; E. Bisexual floret; F. Anther; G. Style; H & J. Achene with pappus; I. Female floret.

Erect herb, grows to 40 cm, unbranched. Leaves simple, alternate, rarely form a rosette at base, sessile, obovate or oblong-elliptic, 2-6 x 1-2.5 cm, base attenuate in lower leaves, auricled in upper ones, serrately dentate, apiculate. Heads few in terminal corymbs, yellow, 6 mm, heterogamous, not rayed; peduncle to 1 cm. Involucral bracts 26, 4-seriate, outer ovate-elliptic, acute, tapering; inner ones oblong-lanceolate, acuminate. Receptacle slighlty raised, concave, 3 mm across. Female florets around 280, filiform, corolla 3 mm, pubescent with colleters; style 3 mm, exerted to 1.5 mm. Bisexual florets around 16, 3-3.5 mm, 5-lobed, lobes ovate, sub-acute to obtuse. Stamens 5, linear-oblong, 1 mm, obtuse at base. Style 2.5 mm, style branches acute. Pappus of 20-24 uniseriate, white, setose hairs, united at base forming a ring. Achenes elliptic or obovate, 1-1.5 mm, muricate and unicellular hairy.

Ecology: Garden weed, open hill slopes at high elevations, rare.

Fl: Nov-Feb.

Distribution: A.P.: Visakhapatnam (Araku valley), CPR 9993.

INDIA: Jammu & Kashmir, H.P., U.P., Meghalaya, Arunachal Pradesh, Karnataka, Mizoram, Orissa, Gujarat.

WORLD: Pakistan, Nepal, America.

January 15, 1996

C. PRABHAKAR RAJU
Department of Botany, S.S.B.N. College
Anantapur-515 001.

R.R. VENKATA RAJU
Department of Botany, S.K. University
Anantapur-515 003.

35. UNUSUAL NUMBER OF SEPALS AND PETALS IN FEMALE FLOWERS OF *BAUHINIA MALABARICA* ROXB. (LEGUMINOSAE: CAESALPINIOIDEAE)

(With one text-figure)

Bauhinia malabarica Roxb. belongs to *Bauhinia* subgen. *Elayuna* sect. *Piliostigma* (Wunderline *et al.*, Biol. Skr. Dan. Vid. Selsk. 28: 18. 1987). Recently I observed that in a few of the female flowers, collected from a tree of this dioecious species cultivated in division 21 of the Indian Botanic Garden, Howrah, the sepals and petals were unusual in number. There were four sepals and four petals instead of the usual five. All other floral features were, however, similar to those flowers with five sepals and five petals. The presence of four sepals and four petals in a flower has neither been reported in this species nor in any other member of the subgenus *Elayuna* so far.

A voucher specimen (14.xi.1995, *Bandyopadhyay* 18366), collected from the tree with female flowers having usual and unusual number of sepals and petals, has been deposited in CAL.

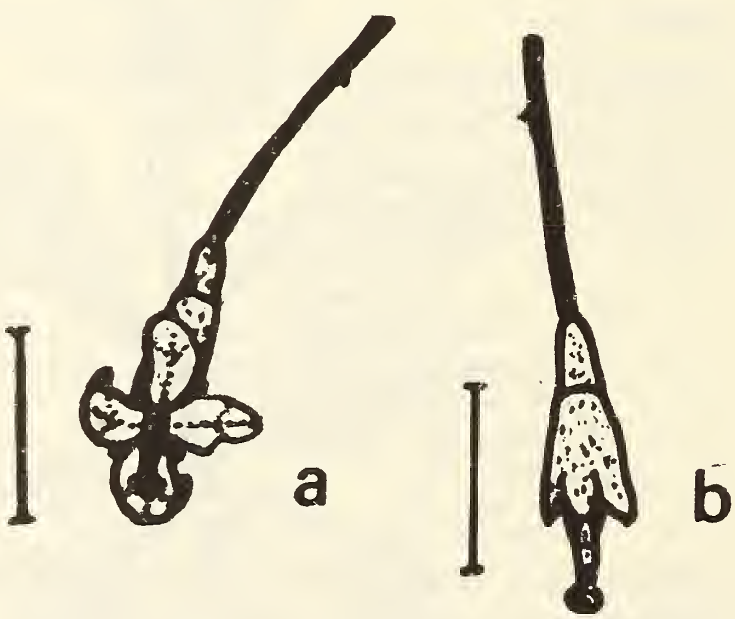

Fig. 1. *Bauhinia malabarica* Roxb.: a. A female flower with unusual number of sepals and petals; b. petals removed from the flower to show sepals. (Scale = 1 cm).

January 19, 1996

S. BANDYOPADHYAY
Botanical Survey of India,
P.O. Botanic Garden, Howrah 711 103.

36. NATURAL BRANCHING IN PAPAYA (*CARICA PAPAYA* L.)

Papaya (*Carica papaya* L.), native of tropical America, now widely spread in the tropics around the world, is a popular fruit and is also used to make fruit salad and all kinds of desserts. The fruit contains about 10% sugar, a number of vitamin A, some vitamin C and acts as a mild laxative. From the latex of unripe fruits papain is obtained; this is used as a tenderizer for meat, in the textile industry and for medicinal purposes (Foyet, 1972).

The papaya is normally a small unbranched soft wooded tree, almost a herb (Chandler, 1958) with latex vessels in all parts. Sometimes, due to an accident or injury in the apical part of the tree, branching takes place (Rao, 1991). In 1992, at the Central Agricultural Research Institute, Port Blair, a few papaya trees were planted in the Residential area/Research Farm. One of the trees after giving an economic yield (250 fruits/tree) for two years produced five side branches under natural conditions, and all the five branches are bearing leaves and fruits, (each branch having 12-15 good sized fruits). It is worth noting that branching has taken place naturally, hence could be of great economic value and advantage.

January 19, 1996

D.B. SINGH
M.A. SURYANARAYANA
Central Agricultural Research Institute,
Port Blair - 744 010, A&N Islands, India.

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37. A NOTE ON *UTRICULARIA AUSTRALIS* R.BR. LENTIBULARIACEAE, IN SOUTH INDIA

(*With one text-figure*)

Utricularia australis R.Br. was collected from Tirumala hills of Chittoor district Andhra Pradesh, during botanical explorations. Review of literature and Indian herbaria revealed that this taxon is very rarely seen in the hills of South India. It was earlier reported by Saldanha and Nicholson (1976) from the hills of Karnataka State. Janardhanam and Henry (1992) reported that the turions (condensed axis bearing densely modified foliar segments as winter buds) were not seen in the Indian specimens of this taxon. However, the turions were observed in our specimens (Fig. 1). Based on its rare and limited distribution in South India, a taxonomic analysis was made to facilitate easy identification.

Utricularia australis R.Br. Prodr. 430. 1810; Gandhi in Saldanha & Nicolson, Fl. Hassan 563. 1976; Taylor in Steenis, Fl. Males. I. 8: 299. 1977 & in Kew Bull. Add. Ser. 14: 598. f. 184. 1989. Janadhanam and Henry in Bladder worts of India 1992. *U. flexuosa* sensu Clarke in Hook. f. Fl. Brit. India. p.p. quoad syn. *U. australis* R.Br., non Vahl 1804.

Rhizoids usually absent; stolons upto 25 cm long, filiform, terete. Foliar organs dichotomous, traps numerous on nodes and foliar segments. Flowers in racemes, calyx lobes subequal, ovate-oblong; corolla yellow, prominently gibbous at base; stamens 2; ovary globose, glandular; stigma 2-lipped, lower lip deltoid, ciliate along margin.

Ecology: Rare at high altitudes.

Fl. & Fr.: September - January.

Specimens Studied: Japali Pond, Tirumala hills (Chittoor dist., A.P.). MHR & MC

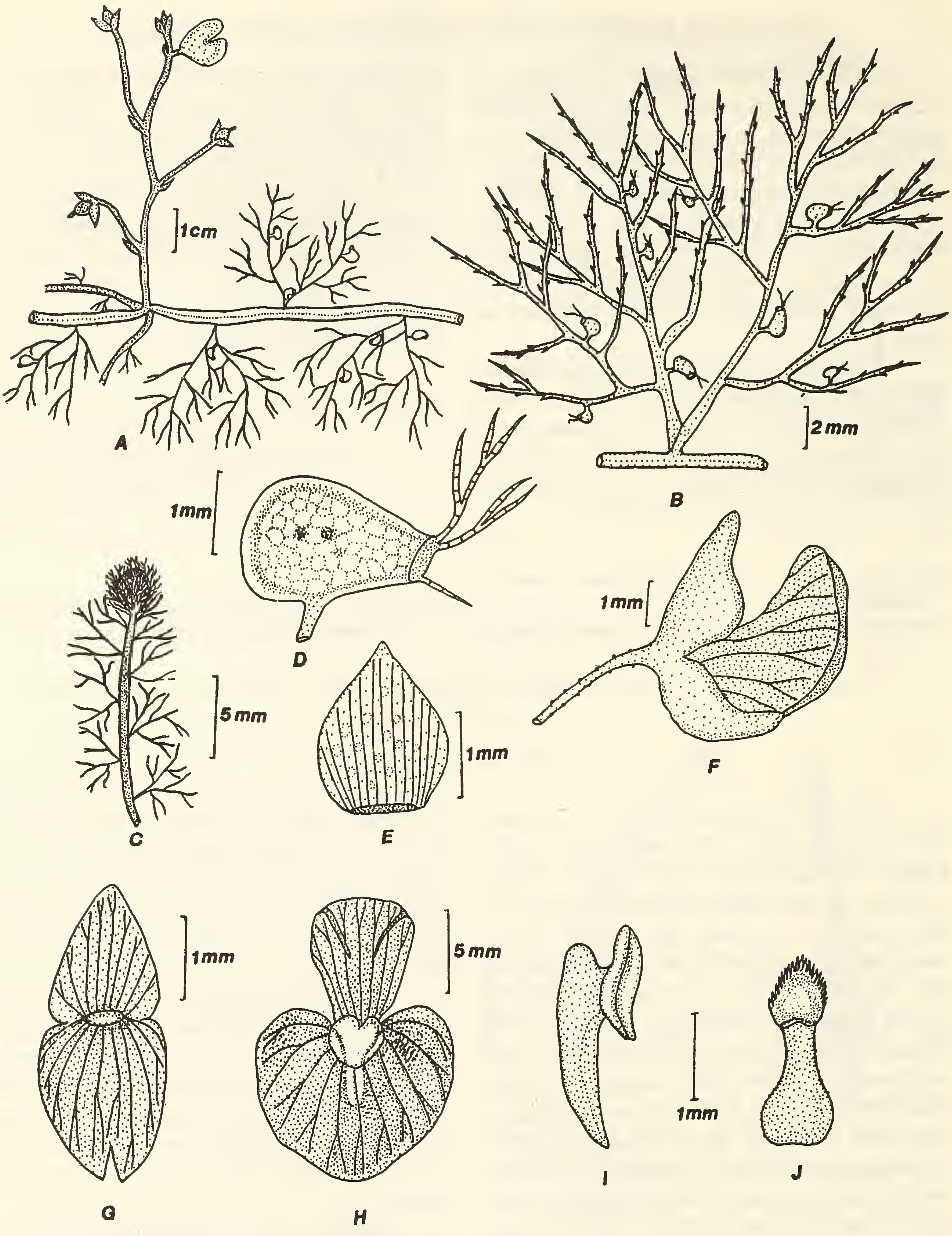

Fig. 1. *Utricularia australis* R. Br. A. Habit; B. Foliar organ; C. Turion; D. Trap; E. Bract; F. Flower; G. Calyx; H. Corolla; I. Stamen; J. Pistil.

14505; Arkalgud (Hassan dist., Karnataka), CJS 11079.

ACKNOWLEDGEMENTS

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M. CHENNA KESAVULU
M. HEMAMBARA REDDY
R.R. VENKATA RAJU
Department of Botany,
Sri Krishnadevaraya University,
Anantapur-515 003,
Andhra Pradesh.

38. FIRST RECORD OF *PERISTYLUS MONTICOLA* (RIDL.) SEIDENF (ORCHIDACEAE) FOR INDIA FROM ANDAMANS

Peristylus monticola (Ridl.) Seidenf. previously known from Indonesia, the Philippines, New Guinea and Malaya has been located from Andaman Islands and reported for the first time from India. The genus *Peristylus* Bl. holds over 70 species of which over 28 species occur in India (Sathish Kumar and Manilal, 1994) and 3 species viz. *P. mannii* (Reichb. f.) Mukerjee, *P. monticola* (Ridl.) Seidenf and *P. parishii* Reichb. f. in Andaman-Nicobar Islands. *P. monticola* was collected by me from Saddle Peak of North Andaman and grown in my personal collection. The occurrence of this rare species in Andaman Island extends its known range of distribution to India.

Peristylus monticola (Ridl.) Seiden. & Dansk Bot. Arkiv. 31, 3: 35. t. 13. 1977; Seidenfaden & Wood Orch. Malay Pen. Singapore 103. t. 42. 104. 1992.

Terrestrial herbs, *c.* 50 cm high. Leaves oblong-lanceolate, 3-10 x 1-3 cm. Spikes 20-40 cm long. Flowers small, greenish-yellow. Spur as long as the sepals and petals.

Rare, in moss-covered hilly slopes, grows along with *Actinostachys digitata* (L.) Wall. ex Hook., *Eria muscicola* (Lindl.) Lindl., *Porpax elwesii* (Reichb. f.) Rolfe, etc.

Specimen examined: INDIA: North Andaman, Lower-Saddle Peak; + 600 m, 24.xi.1993, P.V. Sreekumar 16436 (PBL)

June 15, 1996

P.V. SREEKUMAR
Botanical Survey of India,
Andaman & Nicobar Circle
Post Box No. 692, Haddo,
Port Blair 744102.

REFERENCE

SATHISH KUMAR, C. & K.S. MANILAL (1994): A catalogue of Indian Orchids. Bishen Singh & Mahendra Pal Singh, Dehradun.

39. ON THE PERIANTH BRISTLES IN *SCHOENOPLECTUS CORYMBOSUS* (ROTH EX ROEM. & SCHULT.) J. RAYNAL

(*With one text-figure*)

The genus *Schoenoplectus* is differentiated from the other genera of Cyperaceae by a complex of different characters. There is no single common character in all the species of this genus by which it can be separated from the other genera. The characteristics of this genus are the spirally arranged glumes and the style not articulated with the ovary. However, these are common characters in many genera of Cyperaceae, hence it is not a natural genus. A

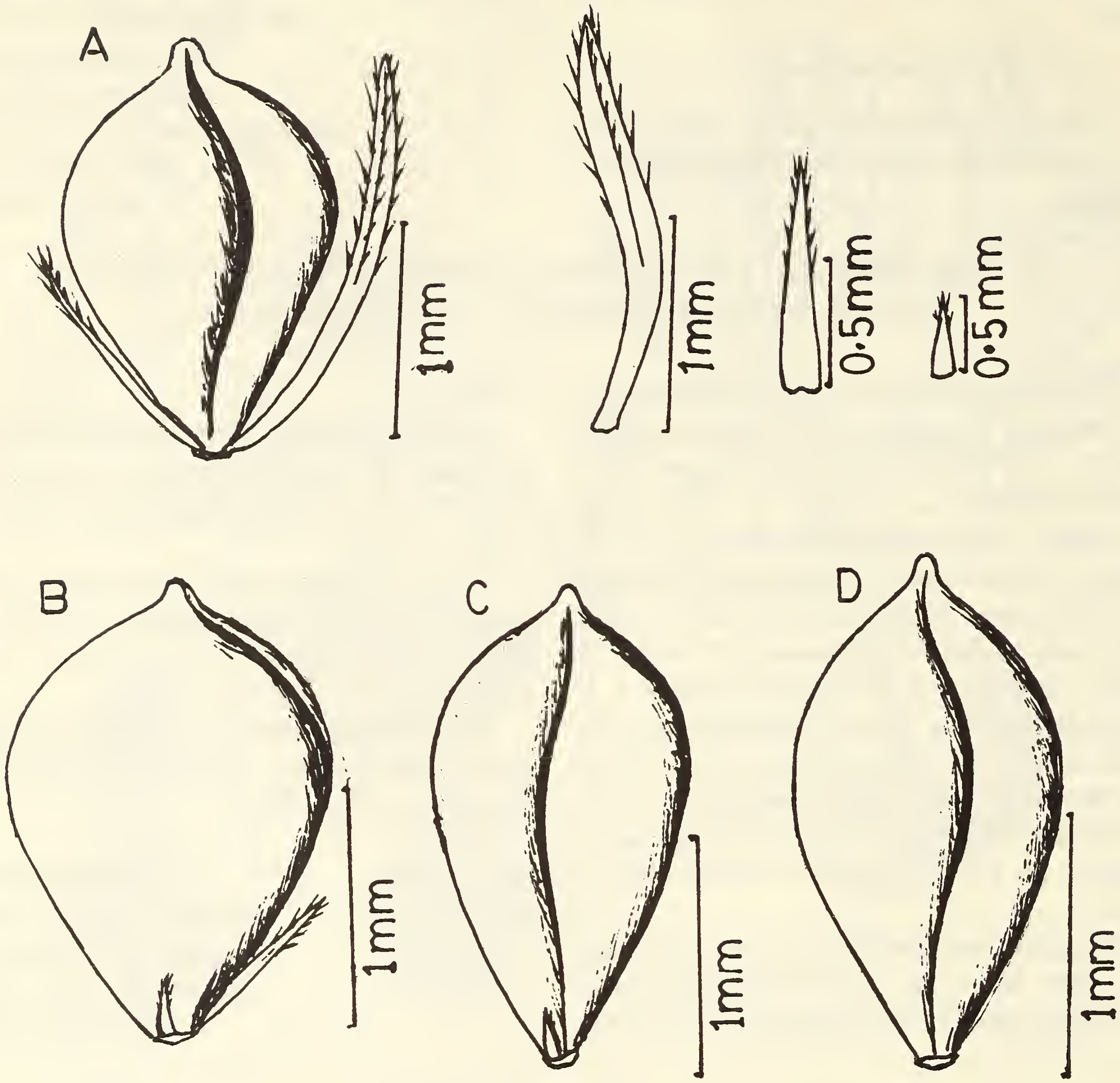

Fig. 1. *Schoenoplectus corymbosus* (Roth ex Roem. & Schult.) J. Raynal
A. Obovoid nut with well developed bristles; separated bristles;
B. Flat inner face of the nut with smallest bristle; C. Nut with a single rudimentary bristle;
D. Ellipsoid nut without bristles.

natural genus has atleast some characters common to all its species, viz. *Bulbostylis* has the persistent button like style base on the nut. *Fimbristylis* has the deciduous style base articulated with the nut and *Eleocharis* has the dilated style base articulated with the ovary, which is persistent on the nut. Hence these are considered to be natural genera and *Schoenoplectus* an artificial genus.

At times certain characters are highly variable within a species (not only in *Schoenoplectus*) and often such variations can also be found within individuals .The presence of hypogynous bristles in *Schoenoplectus corymbosus* is one such variable character. All the earlier workers have reported that bristles are absent in this species. But a careful study of some specimens from Maharashtra and Gujarat revealed that this character is highly variable. In these specimens three, quite unequal bristles were found. These are linear-lanceolate, acute at the apex and antrorsely scabrous (retrorsely scabrous in most Indian species) on the upper half. The longest bristle varies from much smaller than to equaling the length of the nut. It is somewhat broad and glume-like, membranous, 0.5 - 2 mm long. The smallest bristle is usually minute, scale-like, upto 0.5 mm long, and is found opposite to the broadest face of the nut. In some cases only a single, rudimentary, scale-like bristle was found. Also, there are specimens in which perianth bristles are absent.

Another interesting observation is that whenever well developed bristles are present the nut is obovoid to broadly obovoid, but if the bristles are absent the nut is ellipsoid. An intermediate stage between ellipsoid and obovoid is found when the bristle is very small or rudimentary.

Considering the highly variable nature of this character, the possibility of proposing a new taxon even at infraspecific level for the plants with perianth bristles was not considered, because even on a single specimen the nuts were found to be with or without bristles. This abnormal behaviour is recorded, especially for taxonomists, because the perianth bristle is considered an important character in the family Cyperaceae.

Acknowledgement

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V.P. PRASAD,
N.P. SINGH
Botanical Survey of India, Western Circle,
7, Koregaon Road,
Pune-411 001.

40. LABORATORY EVALUATION OF NATURAL RESISTANCE OF BAMBOOS TO TERMITES

Natural resistance of timbers to insects and other biological agencies is attributed to physical and chemical properties of the wood (Sandermann and Dietrichs, 1967 and Sen-Sarma *et al.*, 1975). Bamboo is a versatile natural forest resource, which is known to play a very important role in the economy particularly of countries lying in the southeast Asian-Pacific region.

Natural resistance of felled and converted wood, to insects and other biological agencies, is attributed to physical and chemical characteristics of timbers. Bamboos though endowed with a hard and highly refractive outer rind, unlike timbers, lack chemical characteristics which impart resistance of high category.

Notwithstanding its versatility and high utility value, authentic data on the natural resistance in bamboos is lacking. Except for the pioneering work of Mishra and Rana (1992), there is no data on the assessment of natural resistance of bamboos to insects. In this paper, results of laboratory evaluation of comparative natural termite resistance of 13 species of bamboos against the test termite *Microcerotermes beesoni* Snyder are presented.

We tested material from 13 species of bamboos growing within the New Forest campus of Forest Research Institute, Dehra Dun. The samples were taken at 50 cm, or more above the ground. The test blocks (2.0 x 2.0 x 1.0 cm^3 size) were prepared from the internodal portion of these samples and oven dried at 85°C after smoothening the cut surface. Since uniform size of the test blocks could not be obtained due to varying thickness of the wall, the percent weight-loss in test blocks was calculated on the basis of weight and total area of test block.

The samples were exposed to the termites, *Microcerotermes beesoni* Snyder following the standard procedure developed at this Institute

(FRI). Classification of bamboos into various categories was done as for timber by Sen-Sarma *et al.*, 1975).

Percent wt. loss	Resistance class
0 - 6	Very resistant (Class I)
7 - 16	Resistant (Class II)
17 - 30	Moderately resistant (Class III)
31 - 50	Poorly resistant (Class IV +)
51 - and above	Perishable (Class IV -)

The results are presented in Table 1. Among the various species of bamboos tested, maximum damage was observed in *Bambusa tulda* (wt. loss 67.31%) and minimum was recorded in *B. nutans* (23.40%), closely followed by *Dendrocalamus strictus* (wt. loss 25.63%), *B. balcooa* (27.42%), *D. giganteus* (28.66%) and *Ochlandra travancorica* (29.82%). The termite resistance quality of these species is comparable specifically to the heartwood of some of the moderately resistant and economically important primary timber species. *e.g. Anogeissus latifolia, Garuga pinnata, Shorea robusta,* etc. The termite resistance of *D. calostachyus. B. vulgaris* f. *waminii, Oxytenanthera albociliata* and *D. membranaceus* is similarly comparable to timber species such as *Acrocarpus fraxinifolius, Pterospermum acerifolium, Quercus leucotrichophora,* etc.

The outer rind of bamboo seems to be highly resistant and refractive in nature, as the timber damage in most of the test samples had taken place in the cut end portion and in some cases through the inner layer. The chemical analysis of various portions of bamboo reveals occurrence of a high percentage of ash and silica in the outer rind (Semana *et al.* 1967 and Espiloy, 1983) which perhaps is responsible for its natural durability as well as strength (Sanyal, *et al.*, 1988).

Similarly, the destructured reconstituted boards from bamboo (*Dendrocalamus strictus*), using phenol formaldehyde adhesive, is highly resistant to termites under laboratory conditions and is comparable to some of the more durable timber species such as *Acacia catechu, Cedrus deodara, Dalbergia latifolia* and *Tectona grandis.*

Notwithstanding some of the moderately resistant bamboo species the untreated bamboos, in general, are destroyed in a short span of time when exposed to actual field conditions. The causes are found in the chemical constituents and felling period of various species. The presence

TABLE 1

NATURAL TERMITE RESISTANCE OF BAMBOOS (MEAN OF 4-7 SAMPLES)

Name of species	Thickness (cm)	Percent weight loss		Resistant class
		Range	Mean	
1	2	3	4	5
1. *Bambusa balcooa* Roxb.	1.15	0.99-63.27	27.42	III
2. *B. nutans* Wall.	0.58	2.04-38.74	23.40	III
3. *B. tulda* Roxb.	1.65	5.37-100.00	67.31	IV-
4. *B. vulgaris* var. *striata* Holturn	1.02	11.64-100.00	58.25	IV-
5. *B. vulgaris* f. *waminii* (Brandis)	1.63	6.55-81.20	36.05	IV+
6. *Dendrocalamus calostachyus* Kurz.	1.15	3.21-61.22	31.32	IV+
7. *D. giganteus* Munro	1.70	2.17-62.55	28.66	III
8. *D. hamiltonii* Nees & Arn.	1.50	7.23-92.10	59.74	IV-
9. *D. longispathus* Kurz.	1.65	8.40-96.51	60.07	IV-
10. *D. membranaceus* Munro	1.45	8.11-100.00	48.58	IV+
11. *D. strictus* Nees	1.00	2.98-73.52	25.63	III
12. *Ochlandra travancorica* Benth.	1.45	6.28-57.03	29.82	III
13. *Oxytenanthera albociliata* Munro	1.00	2.98-89.52	48.37	IV+

of higher quantity of carbohydrates, especially the starch content and soluble sugars makes the bamboo relatively more susceptible to insects/termites (Beeson, 1941; Roonwal and Thapa, 1960 and Suthoni, 1988). In addition, the bamboos under field conditions are infected by a large number of fungi, thus making them highly susceptible to insect attack (French, 1978; Shukla *et al.*, 1978 and Tyagi *et al.*, 1984).

October 16, 1995

S.C. MISHRA
M.L. THAKUR
Forest Research Institute, Dehra Dun 248 006.

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41. NEW DISTRIBUTIONAL RECORDS OF PLANTS FROM ORISSA

In the course of our studies on flora of Orissa, a number of plants were collected from different parts of the state. 5 angiospermic taxa collected recently, were identified with the help of relevant taxonomic literature and consultation of authentic herbarium specimens at Central National Herbarium, Howrah (CNH) as *Aristolochia tagala* Cham., *Sauromatum venosum* (Aiton) Kunth., *Spermacoce mauritiana* Osea Gideon ex Verdc., *S. latifolia* Aubl. and *Spilanthes iabadicensis* Moore. Scrutiny of literature revealed that these species have not been reported from Orissa. Updated nomenclature, phenology, ecology, citation of specimens studied and useful notes on them are presented below. All the materials have been deposited in the Herbarium of Regional Plant Resource Centre, Bhubaneswar.

Aristolochia tagala Cham. Linnaea 7: 207.t.5.f.3.1832; Haines, Bot. Bihar & Orissa 786.1924. *A. acuminata* Roxb. *Fl. Ind.* 3:489.1832, non Lam. 1783. *A. roxburghiana* Klotzsch, *Monatsber. Deutsch. Akad. Wiss.* Berlin 596.1859; Hook.f., *Fl. Brit. India* 5:75.1886 (Aristolochiaceae)

Fl. & Fr.: Throughout the year.

Ecology: Occasional, climbing on trees and shrubs in semi-evergreen forests.

Specimens examined: Sanaghagra, Keonjhar district, 20.xi.95, B.K. Mohapatra 563.

Haines (*l.c.*) suspected that the species occurs in Purneah, Bihar, but he actually did not collect the plant. Thus, the occurrence of the taxon in Keonjhar district is a new distributional record for Orissa.

Sauromatum venosum (Aiton) Kunth, Enum. Pl.3:28.1841; Nasir in *Fl. West Pak.* 120:14.1978. *Arum venosum* Aiton in *Hort. Kew.* 3:315,1789. *Sauromatum pedatum* (Willd.) Schott & Endl. *Melet. Bot* 17,1832; Nicolson in *Fl. Hassan Dist.* 789.1976. *S. guttatum* (Wall.) Schott in Schott & Endl. *Melet. Bot.* 17.1832; Haines, Bot. Bihar & Orissa 862.1924. (Araoeae)

Fl.: June-July. **Frs.**: August-November.

Ecology: Locally abundant in open rocky jungles, often found in rock crevices.

Specimens examined: Sanaghagra, Keonjhar district, 22.xi.95, S.C. Jena 5718.

According to Haines (*l.c.*), it is commonly found in Chotanagpur, Bihar at an elevation of about 333 m. The present report of its occurrence in Sanaghagra of Keonjhar district extends the range of distribution of the species to Orissa.

Spermacoce mauritiana Osea Gideon ex Verdcourt, Kew Bill. 37:547.f.26-32.1983; Sivarajan *et al. Proc. Ind. Acad. Sci.* (Plant Sci.) 97 (4): 356. 1987. *Borreria repens* DC. Prodr. 4:544.1830, non *Spermacocerepens* Willd. ex Cham. & Schlecht. (1828) nes Sesse & Moc. (1893) nec Larranaga (1923). *S. decandollei* Deb *et* Dutta, *J. Econ. Tax. Bot. 5(5)*: 1044. 1984, *nom. superfl.* (Rubiaceae)

Fl. & Fr.: Throughout the year.

Ecology: Rare, in moist shady localities and forest floors in association with *Mitracarpus villosus, Spermacoce articularis* and other herbaceous elements.

Specimens examined: Sanaghagra, Keonjhar district, B.K. Mohapatra 5636, 3.xi.95; Ekamrakanan (RPRC) campus, Bhubaneswar, Khurda district, 28.xi.95, P.C. Panda 4198.

Spermacoce latifolia Aublet, *Hist. Guiane Frtan* 1:55.t. 19.f.1.1775; Sivarajan *et al. Proc. Ind. Acad. Sci. (Plant Sci.) 97(4)*: 355.1987; Deb & Dutta, *J. Econ. Tax. Bot. 5(5)*: 1050.1984. *Borreria latifolia* (Aublet) K. Schum, *Mart. Fl. Bras. 6(6)*: 61.1888. *B. eradii* Ravi *J. Bombay nat. Hist. Soc. 66(3)*: 539.t.1.f-1-10.1970 (Rubiaceae)

Fl. & Fr.: August-November

Ecology: Occasional, a weed in moist wastelands and rocky soils in post-monsoon period.

Specimens examined: Sanaghagra, Keonjhar district, 3.xi.95., R.K. Moharana 5292: Ekamrakanan (RPRC) premises, Bhubaneswar, Khurda district, 12.xi.95, P.C. Panda 4290.

Though Sivarajan *et al.* (*l.c.*) described the flowers as pink, all the plants collected by us always had white flowers.

Spilanthes iabadicensis A.H. Moore in *Proc. Amer. Acad. Arts.* 42:542.1907; Griersonin Dassanayake & Fosberg, *Rev. Handb. Fl.Ceylon 1*: 221. 1980; Verma *et al. Fl. Raipur, Durg & Rajnandgaon* 204.1985 (Asteraceae)

Fl. & Fr.: October-January.

Ecology: Occasional, a weed in moist wastelands

Specimens examined: Sanaghagra, Keonjhar district, 3.xi.95, B.K. Mohapatra 5296.

Spilanthes iabadicensis A.H. Moore can be distinguished from *S. calva* DC. by its having achenes with fragile pappus bristles and ciliate margins and from *S. paniculata* Wall. ex DC. by smaller capitula, smaller achenes and weak pappus bristles. Probably the only report of its occurrence in India is by Verma *et al. (l.c.)* from Bhilai in Madhya Pradesh.

June 15, 1996

P.C. PANDA
B.K. MOHAPATRA
P. DAS
Taxonomy & Conservation Division,
Regional Plant Resource Centre,
Bhubaneswar-751015, Orissa.

42. ADDITIONS TO THE FLORA OF HIMACHAL PRADESH FROM KULU DISTRICT

The most comprehensive work dealing with the flowering plants of Himachal Pradesh is by Chowdhery and Wadhwa (1984). It enumerates 3134 taxa from this north-west Himalayan State. Subsequently, at least 37 publications have appeared, We are engaged in the systematic survey of the flora of Kulu dist. since 1988. Extensive and intensive botanical explorations of this district during 1988-1992, with sporadic subsequent visits, have resulted in the collection of 930 species of spermatophytes distributed among 504 genera of 126 families. In this paper we present 32 species which are additions to the flora of Himachal. The arrangement of the families is after Hooker (1872-1897). All the specimens cited here are conserved in the herbarium of the Punjabi University, Patiala.

RANUNCULACEAE

Ranunculus sardosus Crantz

Growing among rocks in wet places, 1100-1500m.

Fl. & Fr.: March-April.

Larji, D.S. Dhaliwal 16350.

PAPAVERACEAE

Papaver macrostomum Boiss. & Himet ex Boiss.

Common weed in cultivated fields, 1500-2700m.

Fl. & Fr.: April-June.

Shoja, D.S. Dhaliwal 16351.

CRUCIFERAE

Raphanus raphanistrum Linn.

Common weed in wheat fields, 1200-1800m.

Fl. & Fr.: March-May.

Aut, Banjar; D.S. Dhaliwal 15582, 15999 & 16078.

CARYOPHYLLACEAE

Arenaria edgeworthiana Majumdar

On sandy rocks, 3000-4000m.

Fl. & Fr.: July-September.

Rohtang, D.S. Dhaliwal 15368.

Crastium fontanum Baumg. subsp. *membranaceum* (Edgew. & Hook.f) M. Sharma

Common weed of cultivation, 1200-2000m.

Fl. & Fr.: March-June.

Aut, Kulu; D.S. Dhaliwal 15566, 16070.

BALSAMINACEAE

Impatiens reidii Hook.f.

On alpine slopes, 3000-3500m.

Fl. & Fr.: August-September.

Beas Kund, D.S. Dhaliwal 15477.

PAPILIONACEAE

Lespedeza juncea (Linn. f.) Pers. var. *variegata* (Camb.) Ali

Common in moist and marshy places, 1200-1500m.

Fl. & Fr.: July-October.

Bhuntar. D.S. Dhaliwal 16110.

Medicago laciniata (Linn.). Mill.

Common in agricultural fields, orchards and wasteland, 1200-1500m.

Fl. & Fr.: April-June.

Bhuntar, Bajaura; D.S. Dhaliwal 15858, 16016.

Pueraria phaseoloides Benth.

A climber in the forests, 1200-1500 m.

Fl. & Fr.: Not seen throughout the course of this study.

Bhuntar, D.S. Dhaliwal 16331.

ROSACEAE

Potentilla fruticosa Linn. var. *rigida* (Wall. ex Lehm.) Wolf. Common at high altitudes on rocks, 3000-4000m.

Fl. & Fr.: July-September.

Rohtang Pass, Jalori Pass; D.S. Dhaliwal 15434, 16343.

Rubus nepalensis (Hook.f.) Kuntze
On open slopes and among shrubs, 2000-2500m.
Fl. & Fr.: May-July.
Dhundu, D.S. Dhaliwal 16291.

ONAGRACEAE

Oenothera affinis Cambess
Common on dry slopes and in wasteland among apple orchards, 1800-2200m.
Fl. & Fr.: June-September
Jarri, Naggar; D.S. Dhaliwal 16306, 16409.

UMBELLIFERAE

Bupleurum atroviolaceum (Schulz) Nasir
On shaded rocks, 2500-3500m.
Fl. & Fr.: July-September.
Jalori Pass, D.S. Dhaliwal 15357.

Pleurospermum angelicoides (DC.) Clarke
Among rocks and open slopes, 3000-4000m.
Fl. & Fr.: August-September.
Beas Kund, D.S. Dhaliwal 15846.

VALERIANACEAE

Nardostachys grandiflora DC.
On alpine slopes, 3000-4000m.
Fl. & Fr.: June-August.
Jalori Pass, D.S. Dhaliwal 16202.

Valeriana stracheyi Clarke
On rocky banks and cliffs, 2000-3000m.
Fl. & Fr.: June-August.
Jalori Pass, D.S. Dhaliwal 15876.

COMPOSITAE

Artemisia absinthium Linn.
In forest clearings and near cultivated fields, 2000-3000m.
Fl. & Fr.: July-September.
Jalori Pass, D.S. Dhaliwal 16294

Aster himalaicus Clarke
Common on alpine rocks and open slopes, 2500-4000m.
Fl. & Fr.: August-October.
Beas Kund, Rohtang, Kothi, D.S. Dhaliwal 15495, 15999, 16138.

Coreopsis lanceolata Linn.
Common and gregarious on dry hill slopes and in wasteland 1200-1800m.
Fl. & Fr.: April-June.
Solang, D.S. Dhaliwal 16264.

Dubyaea hispida (D.Don) DC.
Among shrubs and on rocky slopes in forests, 3000-3500m.
Fl. & Fr.: August-September.
Jalori Pass, D.S. Dhaliwal 16271.

Erigeron annuus Pers.
In moist shady places in forests and on rocky slopes, 2000-3000m.
Fl. & Fr.: May-September.
Rahla Fall, Kothi; D.S. Dhaliwal 15311, 16127.

Onopordum acanthium Linn.
In wasteland, orchard and forest, 2000-2500m.
Fl. & Fr.: June-September.
Manali, Naggar; D.S. Dhaliwal 15771, 16059.

Tricholepsis karensium Kurz
On open dry slopes, 1000-2000m.
Fl. & Fr.: September-October.
Sainj, D.S. Dhaliwal 18031.

PRIMULACEAE

Androsace delavayi Franch.
On stony alpine slopes in dry areas, 3000-4000m.
Fl. & Fr.: June-July.
Jalori Pass (Serolsar lake), D.S. Dhaliwal 16427.

BUDDLEIACEAE

Buddleia madagascariensis Lam.
In shrubberies and on wasteland slopes, 1000-2000m.

Fl. & Fr.: March-May.
Bhuntar, D.S. Dhaliwal 15864.

BORAGINACEAE

Myosotis alpestris Schmidt
On exposed alpine slopes, 3000-4000m.
Fl. & Fr.: June-August.
Beas kund, Jalori Pass; D.S. Dhaliwal 15572, 15703.

SOLANACEAE

Physalis peruviana Linn.
In moist shady places and orchards, 1000-1500m.
Fl. & Fr.: August-October.
Bhuntar, D.S. Dhaliwal 16183.

SCROPHULARIACEAE

Euphrasia simplex D.Don
On alpine slopes, 3500-4000m.
Fl. & Fr.: May-June.
Beas kund, D.S. Dhaliwal 16445.

LABIATAE

Nepeta raphanorhiza Benth.
A weed in orchards or dry situations, 2500-3500m.
Fl. & Fr.: May-September.
Kothi, D.S. Dhaliwal 15400.

SPARGANIACEAE

Sparganium erectum Linn. subsp. *stoloniferum* (Graebn.) Hara
Common in marshy places and along rice fields, 1000-1800m.
Fl. & Fr.: May-July.
Raison, D.S. Dhaliwal 15895.

CYPERACEAE

Cyperus cuspidatus HBK.
Common on wasteland slopes, 1100-1800m.
Fl. & Fr.: June-August.
Larji, D.S. Dhaliwal 1649/

GRAMINEAE

Isachne himalaica Hook.f.
Common in wet places, 1000-2000m.
Fl. & Fr.: September-October.
Bhuntar, D.S. Dhaliwal 16205.

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June 17, 1996

M. SHARMA
D.S. DHALIWAL
Department of Botany,
Punjabi University,
Patiala-147002.

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ERRATA

Vol 93(2): page 300, for last paragraph "13, Himalayan Blackbreasted Sunbird (*Aethopyga saturata saturata*): This bird was seen by me several times in winter (February 1994 for instance) in Gidakom valley (Alt. 2400 m). The HANDBOOK states that this bird winters in Sikkim below *c.* 1000 m and in the western Himalayas between 500 and 1500 m."

Read: "13. Himalayan Blackbreasted Sunbird (*Aethopyga saturata saturata*): Voice described by me on 2-7-89 in Lhuntsi: Tr-trrrr, the last note lower pitched than the first and also a *tsi-tsi.*
14. Himalayan Cinnamon Tree Sparrow (*Passer rutilans cinnamomeus*). This bird was seen by me several times in winter (February 1994 for instance) in Gidakom valley (Alt. 2400 m). The HANDBOOK states that this bird winters in Sikkim below *c.* 1000 m and in the western Himalayas between 500 and 1500 m."

Vol 94 (1): page 122 line 6, for "The highlights of this discovery is that its closest relatives are found east of the Indus Basin"

Read: "The highlight of this discovery is that its closest relatives are not found east of the Indus Basin".

Vol. 94 (2): page 391, The Executive Editor regrets the publication of the photograph of the badly mounted specimen of the clouded leopard.

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BREEDING BIOLOGY OF THE GREAT PIED HORNBILL (*BUCEROS BICORNIS*) IN THE ANAIMALAI HILLS OF SOUTHERN INDIA[1]

Ragupathy Kannan[2] and Douglas A. James[3]

(*With one plate and two text-figures*)

Key words: hornbills, *Buceros bicornis*, Western Ghats, breeding, food, behaviour.

A great pied hornbill nest was observed for 183 hours in 1992 and 1993 in southern India. A total of 3,104 food items were delivered by the parent hornbills to the nest inmate(s), of which 2,265 (72.9%) were fig fruits. At least nineteen species of fruit and 7 species of vertebrate food were delivered to the nest. Fruit predominated in the food delivered throughout the nesting period, with more fruit in the initial than in the later stages. More animal food was delivered after the chick hatched than during incubation. Male nest visitation rate increased steadily through the weeks, reached a peak just after the chick hatched and then declined. Visitation rate was uniform through the morning hours, and no visits were made in the afternoon. Incubation period was 38 days. The entire nesting cycle lasted 102 days, shorter than in the northern population. It is hypothesized that females moult most of their feathers for thermoregulation and/or for space saving to increase variation in cavity choices.

Introduction

Although the great pied hornbill (*Buceros bicornis*) is fairly widespread in its distribution across south and southeastern Asia, little is known about its breeding biology in the wild. There have been some investigations in Thailand (Poonswad *et al* 1983, 1986, 1987; Tsuji *et al* 1987, Poonswad and Tsuji 1994), but none elsewhere, including peninsular India. The birds being large and conspicuous have inspired several useful anecdotal notes in the past (Tickell 1864, Hume 1890, Bingham 1897, Baker 1927, Ali 1936) but their excessively shy disposition, overall scarcity, and the largely inaccessible nature of the terrain they inhabit has probably impeded more detailed investigations. Captive breeding attempts around the world have provided additional information (Stott 1951, Poulsen 1970, Healy 1979, Choy 1978, 1980; Golding and Williams 1986) and some anecdotes of young hornbills as pets further contributed to our knowledge (Phipson 1898, Prater 1921, Ellison 1923). This paper describes observations made in 1993 on a single nest in southern India at the Anaimalai hills in the southern section of the Western Ghats (around 10°25'N lat.; 76°50'E long.). Supplementary information from other nests in the locality have also been included, with some data from the nest in 1992. This study focused on the duration and displacement of

[1]Accepted March, 1996.
[2]Present Address: Department of Biology, Westark Community College, Fort Smith, Arkansas 72913, U.S.A.
[3]Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701 U.S.A.

different phases of the unique nesting cycle, and the changes in the quantity and quality of food delivered to the nest inmate(s) by the parent(s) during these phases.

The population of great pied hornbills in southern India, which extends all along the Western Ghats from 18°N lat.,74°E long. (Ali and Ripley 1987), to the southern tip of the peninsula, is endangered, due to problems ranging from fragmentation of the wet forest habitat (Chattopadhyay 1985) to poaching of squabs and adults from nests (Alan Kemp and J.C. Daniel, pers. comm.; Ali and Ripley 1987). The species is included in Schedule I of India's Wildlife (Protection) Act, 1972 (CSE 1982).

Study Area

The study was conducted in Karian Shola, a patch of Southern Tropical Wet Evergreen Forest (Champion and Seth 1968) at an elevation of 750 m. For a description of vegetation, topography and wildlife of the area see, Vijayan (1979). The evergreen part of the forests comprise about 600 ha but the adjoining areas are covered by open forests, bamboo hill forests and teak plantations totalling 900 sq. km. The evergreen forest tract extends across two wildlife sanctuaries in different states: the Parambikulam Sanctuary in Kerala and the Indira Gandhi Sanctuary in Tamil Nadu. The nest, which was the subject of this study, was located about 100 m on the Kerala side of the inter-state border.

Methods

Observations were made from a camouflaged ground hide built about 20 m from the base of the nest tree. Field assistants helped in data collection. The nest was observed using 10X binoculars and occasionally an 8 to 32X zoom spotting scope. All activities of the birds were recorded using a micro-cassette recorder and later transcribed. Observations totalled 183 hrs. Most of the observations were made in 6 hr periods staggered throughout the breeding cycle. Except for three days in which the observations lasted into the afternoon, all observations were in the period between 0700 and 1300 hrs. Observations were not conducted past 1300 hrs because it was found that parental visitation virtually ceased in this period.

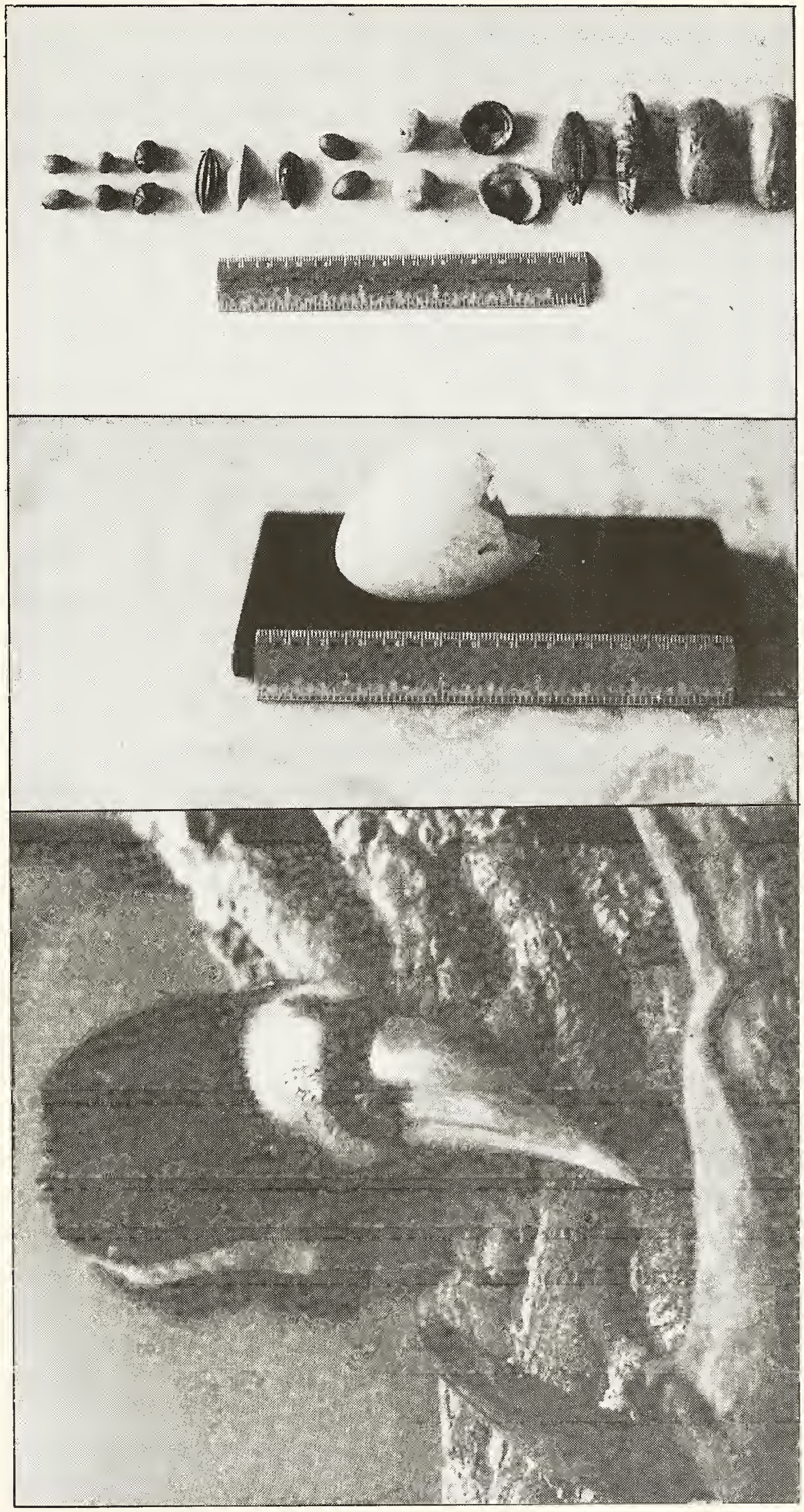
Seeds and other remains from the faecal debris beneath the nest (the midden) were regularly examined, collected, and identified as far as possible. Seeds were identified by the first author. Some of the seeds were identified by germinating them in a seedling nursery maintained in the camp. Those that were difficult to identify were sent to the Royal Botanic Gardens in England for identification and confirmation. Feather samples collected from nest middens at the base of nest trees were identified by an expert in the USA. Fresh weights of animal food delivered were obtained from Spector (1956). Statistical analyses were performed using SAS routines (SAS 1985) available on the IBM 4381 mainframe computer at the University of Arkansas: Analysis of Variance (ANOVA) with Duncan's Multiple Range, and Chi-square analysis.

Samples of hornbill cavity entrance plaster were collected for analysis to compare with soil and faecal matter. The analyses were conducted at the Department of Horticulture and Forestry, and the Agricultural Services Diagnostic Laboratory, University of Arkansas.

Observation and Discussion

Pre-nesting courtship

Great pied hornbills are a monogamous and territorial species (Kemp 1979). The first instance of courtship feeding of a female by a male was observed on 5th September, 1991. This was nearly five months before the female became sealed inside the study nest for the 1992 season. The courting pair was first seen with six other conspecifics on a fruiting *Ficus* tree. After one



a

b

c

a. Seeds collected from the midden excreta at the base of the nest tree. b. Portion of egg discarded after hatching of chick, collected at the midden. c. Hornbill chick a few weeks after emergence from the nest cavity (courtesy of Bronx Zoo).

of the feeding bouts, the male flew to the top of a huge tree and was shortly joined by the female, which alighted on a branch about a metre below the male. The male then regurgitated something, presumably a fig, and offered it to the female perched below, which accepted it. Similar courtship feeding events were noted five times more that year. During one of the events, the male and female grappled with each other with bills locked, and emitted clapping sounds. Courtship feeding has been observed in Thailand (Poonswad *et al.* 1983, 1987) but the grappling behaviour was hitherto unknown. There is one very unusual record of mass "lek" like courtship behaviour in this species from southern India (Hutton 1986). No sign of male aggression towards rival males was observed.

The birds became exceptionally vocal after January. The breeding pairs indulged in vocal duets during the breeding season more than in the non-breeding season. The duets were performed mostly in the immediate vicinity of the nest. The following sequence of events characterized the duets: the male emitted a series of loud, resonant "kok" sounds, at a frequency of about one every other second, each "kok" uttered with head jerked back and bill pointing upwards. After three or four "koks", the female, which was invariably perched in a nearby branch, started a similar series of calls, with each "kok" emitted just prior to, or after, those of the male. This quickly became a mixture of hoarse roars and "barks" emitted by both birds in unison. Although the mixture of calls uttered in unison seemed haphazard, it was predictable, and remained unchanged through the season. Despite the commonness of these duets, they are not mentioned in the literature. This is possibly because they can easily be mistaken as the vocalizations of a single bird. Indeed, the synchrony in the calls and the difficulty in observing the birds through the lofty vegetation made it impossible to ascertain exactly the individual contribution of each bird in the duet.

The Nest, Clutch and Young

The nesting cavity was on a lofty *Alseodaphne semecarpifolia* (Lauraceae) tree in deep evergreen forest. Particulars of the nest site were: tree diameter, 72 cm; tree height, 35.15 m; nest cavity height, 17 m; cavity orientation, 242°; nearest human settlement, 1.5 km.

The cavity entrance was nearly circular in shape. Twenty three other nests located in the Anaimalai hills between 1991 and 1992 and information from 23 nests in Thailand (Poonswad *et al.* 1987) indicate a propensity of the birds to select a vertical slit entrance, with a width just wide enough for the casque of the female to enter. Just 4 out of 23 nests in Thailand and 6 out of 24 in the Anaimalai hills had circular entrances. At the present nest, there was a knob-like projection on the trunk on one side of the entrance, which provided a convenient perch for the male during nest visits. The male thus presented his profile while feeding the nest inmates, thereby greatly assisting the viewer in visual identification by the viewer of food material delivered. In the absence of such a perch site at other nests, the male was observed clinging on to the bark of the tree like a woodpecker, using the tail as a brace.

The nest and its contents could not be examined closely due to inaccessibility. Just one chick fledged in both the years of the study. Ali and Ripley (1987) reported that the clutch size in this species is "usually 2, sometimes 1", and Baker (1932) found that as many as 3 eggs could be laid on rare occasions. However, studies of other hornbills elsewhere have generally indicated that clutch size usually exceeds fledgling number, with the supernumerary eggs either not incubated, or their nestlings succumbing to sibling competition or parental neglect (Kemp 1971, 1976 as cited in Leighton 1986). Therefore, although no inferences can be made regarding the clutch size in the present study, it is possible that more than one egg was laid. Shortly after the chick hatched in 1993, the female discarded a large piece of egg shell, which we recovered from the midden. The shell was dirty white and coarse textured.

Entrance Sealing

In both the 1991-92 and 92-93 seasons, the birds were first seen making short visits to the nest in early December, more than two months before the female bird became sealed in the cavity. Such early visits to the nest were seen at another nest in the same area. According to the local people, the parent birds clean the nest cavity by removing debris during these visits. This is supported by the appearance of old feathers beneath the nest cavity after inspection visits by the adult hornbills. The birds are exceptionally shy during such visits and may abandon a nest site if disturbed then. In December 1991, when the first author visited one of the nests, the parent birds became aware of his presence below the nest. Thereafter, the nest site was abandoned for that year (1992). However, the nest was reoccupied and was successful the subsequent year.

The actual sealing of the nest cavity entrance was not observed in either nesting season. By the second week of February, the female was ensconced inside the cavity. A small chunk of the wall broke loose and fell down sometime before 17th March, 1992, and this afforded an excellent opportunity to observe the female in the process of repairing the damage. The bird exclusively used its own excreta as a cementing material, with no mud deliveries from the male. Use of mud has been reported in the past for great pied hornbills (Stott 1951, Poulsen 1970, Ali and Ripley 1987). The bird turned around and deposited its excreta at the rim of the hole (instead of squirting it out as it usually does), and proceeded to apply portions of the excrement with its bill onto damaged area of the wall, using the flat side of the bill very much as a mason's trowel. The tapping sound produced by the bill as it plastered the sealing material was heard from below the tree. The female repaired the wall continuously until the wall was reconstructed. The wall had a mosaic of colours as the repairing was in progress. The dried intact sections were dark brown, and the wet "cement" was green and yellow. By the end of March the entire wall was complete, dry and uniformly brown.

Chemical analysis of the broken chunk of cavity entrance plaster that fell to the midden (Table 1) showed that the plaster closely matched the chemical composition of chicken and cattle faecal material (Spector 1956, Gerry 1968, Carey *et al.* 1993) and was very different from the nitrogen, total ash, and organic content of tropical soil (Sanchez 1976). This showed that the original plaster used to seal the cavity opening was also wholly faecal matter without an admixture of the soil reported in the past (see above). Thus, the original plaster was the same as what consti-

TABLE 1

COMPARISON OF HORNBILL PLASTER WITH FAECES AND TOP SOIL COMPONENTS (PERCENTAGES).

	Chemical element composition						Total ash	Total organic
	P	K	Ca	Mg	S	N		
Hornbill plaster	0.2	2.1	1.5	0.3	0.2	2.0	15.0	85.0
Chicken faeces	1.3	1.2	2.9	0.6	0.8	5.0	17.0	83.0
Cattle faeces	0.7	1.7	2.9	0.6	0.2	2.0	5.0	95.0
Tropical soil						0.2	96.0	4.0

tuted the repair work. (Chicken faecal matter was included in Table 1 to represent a bird, and cattle manure was added to characterize an animal with a vegetarian diet to compare with the fruity, mainly vegetarian diet of the hornbill.)

After the female left the cavity, the entrance was resealed exclusively by the young (which was 43 days old when the female left - see Figure 2). It was observed to use its excreta as the sealing compound, with no mud deliveries from the parents. The manner in which the young sealed the entrance was similar to that employed earlier by the female. It spent several hours of the day constantly tapping the wall.

Portions of the broken wall were collected from the midden below the nest and examined. The fragments had the consistency of cork and were uniformly embedded with hundreds of tiny fig seeds. Fig seeds occurred in all the 10 other nest-walls (from different nests) examined in the two seasons. The seeds apparently play an important role in holding the structure together, much like gravel in a concrete mix. (**Note**: This information about the great pied hornbill using excreta as sealing compound is what I (RK) reported to Kinnaird and O'Brien (1993), and not what they attribute to me concerning the Indian pied hornbill, *Anthracoceros albirostris*).

Feeding

At least 19 species of fruits and 7 species of vertebrates were delivered by the parent hornbills to the nest inmate(s) (see Appendix). A total of 3,104 food items were delivered by the male during the 155 hours of observation in the 1993 season. Of these, 2,265 (72.9%) were fig fruits, indicating the importance of the *Ficus* taxa during the breeding period. The study in Thailand also showed a predominance of figs in the breeding diet. Fifty-seven percent of the food items were figs in that case (Poonswad *et al.* 1987). Tables 2 and 3 show the pattern of food delivery during the three different phases of the nesting cycle, i.e., female only in cavity, female and young in cavity, and young only in cavity.

TABLE 2

DELIVERY OF FRUIT BY PARENT GREAT PIED HORNBILLS TO NEST OCCUPANT(S) DURING 1993

	Delivery rate per day*							
	Number of Items				Dry weight (gm)			
In Nest Cavity	Large figs	Small figs	Non figs	Total	Large figs	Small figs	Non figs	Total
Female only	0^{a}	$94^{a,b}$	88.6^{a}	182.6^{a}	0^{a}	12.22^{a}	NA	$12.22^{a,b}$
Female + Young (early)	14.5^{a}	205.7^{a}	53.5^{a}	273.7^{a}	20.1^{a}	26.7^{a}	NA	46.8^{a}
Female + Young (late)	22.2^{a}	8.2^{b}	6.6^{a}	37^{b}	30.8^{a}	1.06^{a}	NA	31.86^{a}
Young only	1.66^{a}	$37.5^{a,b}$	9.8^{a}	48.9^{b}	2.3^{a}	4.85^{a}	NA	7.15^{b}

*0700 to 1300 hrs

[a,b]Reading vertically down the nesting phases, the means with the same letter(s) are not significantly different (Duncan's Multiple Range Test, á=0.05)

NA (not available)

For comparison, the female-young phase was further split as early and late for the analysis (Table 2). Figs were classified as "large" (>20mm diameter) and "small" (<20mm diameter).

The total number of fruit items delivered per day (Table 2) was significantly more in the female-only and the early part of the female-young phases than in the later phases of the cycle (ANOVA; $F_{3,16}$=6.78, P=0.003). Because figs predominated in the food, an analysis was done on the numbers and weights of figs delivered. The number of small figs delivered was significantly different between the early and late periods of the female-young phase, but no significant difference was found between the phases for the number of large figs or non-figs delivered (Table 2). Since fig numbers were confounded by different sizes and varying water content, fig dry weights were considered. Dry weights were obtained in the field for various species of figs by recording weights of sun-dried figs. No significant difference was found between the phases for the dry weights of large figs or small figs delivered per day. However, the total figs delivered in grams dry weight per day was significantly higher in the female-young (early and late) phase than the young-only phase (ANOVA; $F_{2,17}$=3.76, P=0.04) (Table 2).

Since fruit alone may not furnish the protein required for early fledgling growth, animal food is frequently used by frugivores to supplement the fruit diet of their nestlings (Skutch 1945, Welty 1982, Faaborg 1988). In this study, arthropods, reptiles, birds, and mammals were delivered to the nest occupant(s) (Table 3), arthropods throughout the nest cycle and the vertebrates more sporadically. An analysis of the total wet weights of animal food delivered per day (Table 3) showed that significantly greater amounts (χ^2_2=24.08, P<0.005) were delivered when the young and female were in the nest than when either the young or female were alone in the cavity. Such an increase in the delivery of animal food after the hatching of the chick has been reported in the past for hornbills of different species (Poonswad and Tsuji 1989).

TABLE 3
DELIVERY OF ANIMAL FOOD BY PARENT GREAT PIED HORNBILLS TO NEST OCCUPANT(S) DURING THE 1993 SEASON.

	Wet weight (gm/day*)				
In nest	Arthropods	Reptiles	Birds	Mammals	Total
Female only	.06	0	12	0	12.06
Female + young	.84	5.55	11	27.7	45.09
Young only	.21	16.64	0	0	16.85

*0700 to 1300 hrs

An overview of the food delivery data indicates that the hornbill nest occupants are given more fruits in the early part of the breeding period than in the later period, and animal food is delivered in increased quantities in the later part of the cycle. Results of phenological studies conducted concurrently in the study area showed a community peak in fruit production in the later part of the breeding cycle (April-May). This peak is brought about by the synchronous fruiting of several deep forest trees of the families Annonaceae, Myristicaceae, and Lauraceae. These fruits are relatively more nutritious than those produced by open forest trees (McKey 1975, Leighton and Leighton 1983) and were delivered by the parent hornbills to the young nestling at this time. It appears, therefore, that the reproductive cycle of the hornbill is synchronised with the community peak in fruit production. Thus, the phase when nutrition is needed the most, after the chick is hatched, coincides with peak fruit availability. The fact that animal food is delivered more at this time than in other phases, along with the overall preponderance of figs in the diet, suggests that a combination of high-quality fruits, figs, and animal matter is essential to meet the nutritional requirements of the growing chick. The nesting and fledging of Great Pied Hornbills during the time of high fruit resource availability supported the findings of Leighton and Leighton (1983) and Leighton (1986) on Bornean hornbills. African *Tockus* hornbills, which feed mainly on arthropods, also breed during periods of high animal prey abundance (Kemp 1976).

Food was delivered by regurgitation except for the larger animal items, which were always carried in by the bill. The maximum number of fruits delivered in one load was 232, all small figs. Regurgitation resulted from pumping actions of the neck, and the fruits came out rapidly one by one, sometimes in twos and threes. Often, some of the fruits fell on the rim of the cavity, bounced off and accumulated in the midden at the base of the tree. These fruits were collected and examined, thus greatly facilitating confirmation of the material delivered by the male hornbill. After each visit, the male invariably flew to a nearby branch and wiped the bill by rubbing it against the boughs, before flying away for another consignment. Both female and young begged noisily, their quivering bill tips appearing at the cavity entrance, during the visits of the male. The begging was more vociferous each time the male appeared with large animal prey. The male was always seen to deliver the food directly to the female and not to the young (despite the young begging as actively as the female). It is presumed that the female in turn feeds the young, but how this happens could not be determined.

On 9th March, 1993, the male delivered 11 ripe *Strychnos nux-vomica* (Loganiaceae) fruits to the sealed-in female. The female later excreted the silvery discoid seeds which were collected from the midden. Bisset and Choudhury (1974) reported the occurrence of the CNS toxin strychnine in the pulp of ripe *Strychnos* fruits. Gamble (1922) reported that the toxin occurs in both pulp and seed, and that it is included in the diet of hornbills and monkeys. Janzen (1983) compiled evidence of such fruit traits and suggested that toxic fruits may be a regular component in the diet of some frugivores and seed-eaters (Munn 1994).

The male was seen and heard hunting for animal food in the vicinity of the nest more frequently after the chick hatched out than before hatching. It foraged in large trees, hopping from branch to branch, tearing down large flakes of dead bark in search of animal prey. Flakes of bark were held at the bill tip, examined for prey, and discarded; geckos or arthropods flushed from beneath the bark were caught, flicked up into the air, and gulped down. Larger prey were thrashed against the boughs to incapacitate them. Even in captivity, a breeding male actively pursued and captured a wild blackbird to feed its mate at nest (Golding and Williams 1986). In March 1992, when the open forests adjoining the study area were in flames, a male great pied hornbill was seen flying from a burning area towards the nest with a snake in its bill. The tendency of the male to investigate tree cavities regularly for animal prey is evident by the fact that this study yielded six incidences of the male hornbill delivering a Travancore flying squirrel (*Petinomys fuscocapillus*) to the nest. One of these records was based on the recovery of a partially eaten carcass from the midden. These squirrels are nocturnal, and spend the day sleeping in cavities. The great pied hornbill's habit of capturing animals from tree cavities has also been reported by Wood (1927) in which the hornbill devoured a brood of mynas from a hole, unperturbed by the attacks by the parents. In the present study, the male was seen delivering two altricial fledglings and one adult bird, and two other bird species were identified from the feathers collected at the midden (Appendix). The in creased carnivorous habit of the hornbill in the nesting season makes it a feared predator in the forests. The male was frequently harassed by a pugnacious pair of racket-tailed drongos (*Dicrurus paradiseus*) in the vicinity of the nest. The hornbill seemed unperturbed by these attacks most of the time, but occasionally snapped at the

TABLE 4
DURATION OF MALE FEEDING VISITS TO NEST (MINUTES) OVER THE THREE DIFFERENT PHASES OF THE NESTING CYCLE.

In Nest cavity	Time spent at nest (Means ± SD)
Female only	4.43±1.93[a]
Female and young	3.7±2.21[a,b]
Young only	2.4±0.91[b]

[a,b] Means with the same letter are not significantly different (Duncan's Multiple Range Test, á=0.05);
SD = Standard deviation

drongos.

The mean duration of male visits to the nest was significantly different between the three main phases of the cycle (ANOVA, $F_{2,48}$=3.65, P=0.033) (Table 4). The male spent the greatest amount of time at the nest when the female was incubating, and the least amount of time when only the young was in the cavity. The mean time spent was significantly higher in the female-only phase than in the young-only phase (Table 4). No significant difference was found in the mean time spent in the female-young phase in comparison with either of the other two phases. This trend can be explained by the distinct difference in the time required for fruit and animal deliveries. The male spent an average of 4.12±2.12 minutes for each visit in which only fruit food was delivered (N=36), and 2.25±1.13 minutes for each visit in which only animal food was delivered (N=12). Since fruit predominated in the first half of the cycle, the male had to spend more time regurgitating the loads of fruit. Animal food deliveries, which increased in the latter half of the cycle, were usually done in a

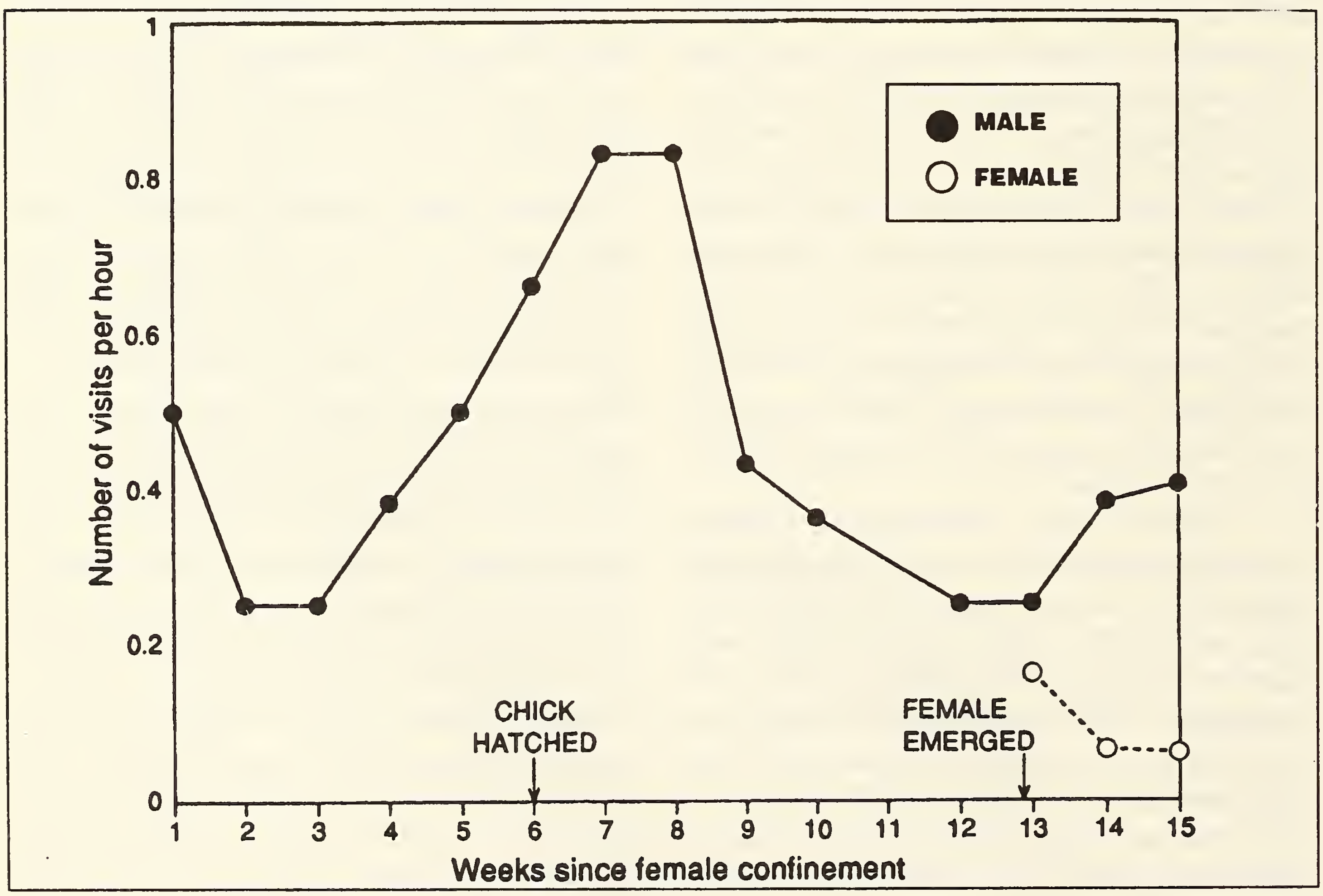


Fig. 1. Nest visitation rate by parent great pied hornbills during the 1993 season.

piece-meal manner and hence were of relatively short duration.

The male visitation rate to the nes increased steadily through time during the initial phase of the nesting cycle, reached a peak just after the hatching of the chick (6th week), and then progressively decreased as the chick developed (Fig. 1). This steady decline in feeding frequency may be a naturally evolved strategy of the parent to encourage the nearly fledged young to leave the nest (Welty 1982) before the onset of the monsoon (see later). The slight increase in male nest visitation rate as the chick neared fledging (Fig. 1) was because the male remained in the immediate vicinity of the nest in this period, and made frequent, short visits to the nest with relatively smaller amounts of food than earlier. From the 13th week onwards, after the emergence of the female, the provisioning responsibilities were shared by both the parents, but only to a very limited extent by the female. She seemed very weak after the three months of confinement. An increase in nest visitation rate after hatching was also reported by Poonswad and Tsuji (1989) for wild, and Choy (1980) for captive great pied hornbills. The former study also documented the general decrease in visitation rate (Fig. 1), as the chick aged.

Although no signs of non-human predation of hornbill nests was detected in the two years of investigation, the fact that the birds became exceptionally wary and circumspect at the advent of, and during, the breeding season indicates that human predation pressure may be a major influence on hornbill breeding behaviour. The decline in male visitation rate and duration of visits at nest after the hatching of the chick may at least be partly explained as precautionary responses against betrayal of nest to human predators.

Most of the nest provisioning was done in the morning hours. Male visitation virtually ceased in the afternoon. The male usually made one feeding visit to the nest late in the evening just prior to his roosting. The morning visitation frequencies out of a total of 57 visits were: 0700-0800 hrs, 21.0%; 0800-0900 hrs, 15.7%; 0900-1000 hrs, 22.8%; 1000-1100 hrs, 14.0%; 1100-1200 hrs, 17.5%; 1200-1300 hrs, 8.7%. This pattern of visitation supported the hypothesis of equal visitation rates through the morning hours (χ^2_5=4.368, P>0.05). Due to the distance from the nest, observations of the nest could not begin earlier than 0700hrs. It is possible that at least one visit occurred shortly after day break each day. Fresh excreta was often found at the midden at 0700hrs.

Nest sanitation

The confined female, and later on the chick too, ejected excreta with force through a slit in the partially sealed cavity opening. The excrement accumulated in a wide area near the base of the tree. These middens and the undigested seeds therein, were an important source of information on the identity of food delivered to the nest inmates. Ant swarms and rodent pellets were often seen in the middens, suggesting regular seed removal by these agents. The midden emitted a distinct fruity odour. The young bird was not observed to expel the excreta until it was 2 weeks old. Since the female spent a considerable amount of time cleaning the nest by throwing out debris, it is presumed that the female threw out the faecal matter of the young during this time.

Fledging

The chick left the nest cavity on 28th May after 65 days of confinement (Fig. 2). The actual emergence of the chick from the nest was not observed, but a local tribesman reported that he saw one of the parent birds tear down the wall of the nest to help the chick come out. The chick remained in the vicinity of the nest, perched sedately in a nearby tree and provisioned by both parents, for several hours after emergence from the nest. It was seen preening continuously and occasionally snapping at the air (after insects?).

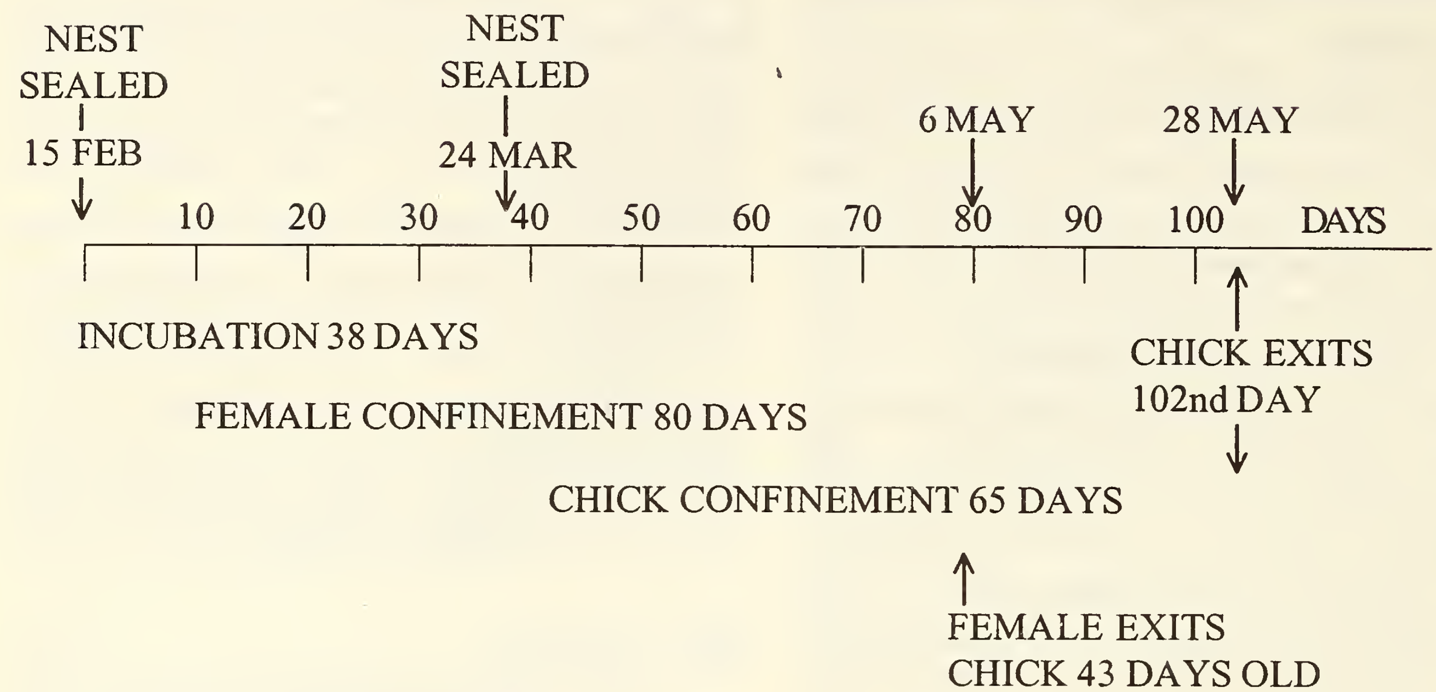


Fig. 2. Nesting schedule of the great pied hornbill during the 1993 season.

It begged actively when the parents were nearby. The bill was yellowish, with the upper mandible tinged with red, and had no casque. The eyes were yellow. The bird appeared tidy and well groomed, but occasionally moved clumsily between branches. The parents roared agitatedly at the slightest sign of human intrusion in the area. Neither the parents nor the young were seen the next day in the area, and it was not possible to visit the area from then on. A radio-tracked chick in Thailand remained within 2 km of the nest for several months after fledging (Tsuji *et al.* 1987). Studies of the similar, forest dwelling *Buceros rhinoceros* in Borneo (Leighton 1986) indicate that the young may stay with and be fed by the parents for upto six months after fledging.

Moult

The rectrices of the female, which could be seen through the cavity entrance just before the ejection of excreta, remained intact throughout the breeding cycle. However, the 4 or 5 large flight feathers (some of them soiled and unkempt) removed from beneath the nest indicate at least a partial moult. Tickell (1864) and Ali and Ripley (1987) reported a complete simultaneous moult of all flight feathers (rectrices and remiges) by the confined female, whereas Poonswad *et al.* (1983) recorded females with both a complete moult and no moult at all of flight feathers. It appears, therefore, that the extent of this moult is variable.

There are possible explanations for the complete or near-complete moult of breeding female great pied hornbills. Since the breeding occurs in the hot season and because the female is sealed in the nest cavity, such a moult may help the bird to maintain optimal body temperature without the risk of overheating. The maximum temperature recorded in the study area during the months of February, March and April 1993, the period the female was sealed in, was 32.2, 32.2, and 34.4° C respectively. Another possible explanation can be the scarcity of large nest cavities, which imposes a constraint on the breeding of these birds. This problem may be solved by the moulting of all or most of the feathers by the confined female resulting in body size reduction. Such a size reduction may increase the variety of choices from available cavities. This hypothesis is consistent with the

TABLE 5
DURATION OF THE DIFFERENT PERIODS (NUMBER OF DAYS) OF THE BREEDING CYCLE: A COMPARISON WITH PREVIOUS STUDIES.

Nest status	Present Study 1992	Present Study 1993	Previous studies	Captive (C) or Wild (W)	Place & Source
Incubation	38	38	40	W	Thailand, Poonswad *et al* (1987)
			38	C	U.K.,Golding & Williams (1986)
			40	C	Singapore, Choy (1980)
Female in nest cavity	53	80	114-134	W	Thailand, Poonswad *et al* (1987)
			112	C	Singapore, Choy (1980)
			77	C	U.K.,Golding & Williams (1986)
Age of young when female exits cavity	16	43	35+	C	U.K., Golding & Williams (1986)
			37-69	W	Thailand, Poonswad *et al* (1987)
			±15	W	India, Ali and Ripley (1987)
Young in nest cavity	NA	65	70+	C	U.K., Golding & Williams (1986)
			72-96	W	Thailand, Poonswad *et al* (1987)
			96	C	Singapore, Choy (1980)
Entire nest cycle	NA	102	±140	W	Thailand, Poonswad *et al* (1987)
			110	C	U.K., Golding & Williams (1986)
			138	C	Singapore, Choy (1980)

NA (not available)

fact that adult female great pied hornbills are slightly smaller than males (Ali and Ripley 1987). (Because only a few of the moulted flight feathers were found beneath the nests, it is assumed that the female uses the other moulted feathers to line the nest cavity.)

Nesting Schedule

The entire nesting cycle in 1993 took 102 days from female confinement to chick emergence from the nest (Table 5, Fig. 2). Assuming that the egg is laid shortly after female confinement, the incubation period was estimated to be 38 days in both the years the nest was studied (Table 5). The date of hatching was assumed to be the day the presence of the chick was first detected by hearing begging calls or seeing its bill at the cavity entrance. The length of incubation agreed closely with that found in previous studies, but the female confinement period was strikingly short for the present nest in both years compared with most of the previous studies (Table 5). This seems to indicate that female great pied hornbills in southern India may stay in the nest cavity for a shorter time than their northern conspecifics. Could it be that an incomplete moult enabled the birds to stay in for a shorter time? Possibly, the pressure of the comparatively frequent predation by indigenous people in the southern Indian range than elsewhere has shortened the female's stay in the nest, thus reducing its period of vulnerability (V. Santharam, pers. comm.). Early emergence of the female could also indirectly benefit the young by enhancing its provisioning and thus hastening its own emergence from the nest cavity. In 1992, the female left the nest when the young was just 16 days old, corroborating the findings of Ali and Ripley (1987) (Table 5). The duration of the young's stay in the nest was also shorter in this study than in all the previous studies. A comparison with studies on the wild population in Thailand (Table 5) indicates that the length of the entire cycle might be shorter in the southern than in the northern populations. In this study, in the southern range of the hornbill, the length of the nesting cycle certainly was shorter than in other studies (Table 5, Fig. 2).

Monsoon patterns could also explain the reason for the apparently short nest cycle in the southern population. Birds that nest in tree cavities, as well as ground nesting species, must complete their parental duties before the onset of the southwest monsoon (Ali 1979). This monsoon brings most of the rains to the Indian subcontinent, beginning in early June in southwestern India, and sweeping across the subcontinent in a northeasterly direction. Heavy rainfall thus occurs several weeks earlier in southern India than elsewhere, making it important for birds to finish nesting before the end of May, thus evading the disruption caused by extensive heavy rains and high winds.

Implications for conservation

The extended breeding cycle and slow rate of recruitment of great pied hornbills makes them an example of K-selected species and thereby renders them vulnerable to extirpation. The undoubted requirement of mature, deep forest trees with natural cavities large enough for occupation by the female and the chick imposes severe constraints on breeding opportunities, especially in the wake of the heavy deforestation and selective removal of large trees for timber in the peninsular Indian range. Poaching by locals of the helpless female, and more often the squab, from the nest, which was found to be regular in some areas of the range (Kannan 1993, 1994), could seriously affect densities and recruitment rates in those areas. Removal of fig trees to feed captive elephants engaged in lumbering operations, which occurs regularly all over the range, could limit foraging opportunities for hornbills. Given the preponderance of figs in the breeding diet, along with the keystone characteristics of the fig taxa (Kannan 1994), the importance of conserving fig trees cannot be overemphasized in any conservation scheme to maintain hornbill populations

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APPENDIX

List of fruit and vertebrate taxa delivered by parent great pied hornbills at the nests in 1992 and 1993.

I. FRUITS:

Family Moraceae:

1. *Ficus mysorensis*
2. *Ficus tsiela*
3. *Ficus* sp.

Family Lauraceae:

4. *Persea macarantha.*
5. *Alseodaphne semecarpifolia*
6. *Litsea oleoides*
7. *Cinnamomum* sp.
8. *Beilshmedia wightii*
9. *Beilshmedia bourdilloni*

Family Ebenaceae:

10. *Diospyros montana*

Family Loganiaceae:

11. *Strychnos nux-vomica*

Family Myristicaceae:

12. *Myristica* sp.

Family Annonaceae:

13. *Polyalthia* sp.

Family Bixaceae:

14. *Scolopia crenata*

Family Sapotaceae:

15. *Chrysophyllum* sp.

Family Sapindaceae:

16. *Filicium decipiens*

Family Burseraceae:

17. *Canarium strictum*

Family Elaegnaceae:

18. *Elaegnus conferta*

Family Oleaceae:

19. *Olea dioca*

II. VERTEBRATES:

Reptiles	:	1. Snake
		2. Lizard (Agamid)
		3. Lizard (Gecko)
Birds	:	1. Barred Jungle Owlet *Glaucidium radiatum*
		2. Grey-fronted green pigeon *Treron pompadora**
		3. Collared scops owl *Otus bakkamoena**
		4. Unidentified yellow feather
		5. Unidentified altricial fledglings
Mammals	:	1. Flying Squirrel *Petinomys* sp.

* feathers recovered from midden

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STATUS OF INDIAN GREY WOLF *CANIS LUPUS PALLIPES* AND ITS CONSERVATION IN MARGINAL AGRICULTURAL AREAS OF SOLAPUR DISTRICT, MAHARASHTRA[1]

Satish Kumar[2] and Asad R. Rahmani[3]

(*With two text-figures*)

Key words: Indian grey wolf, *Canis lupus pallipes,* status, conservation, Solapur, Deccan, Maharashtra

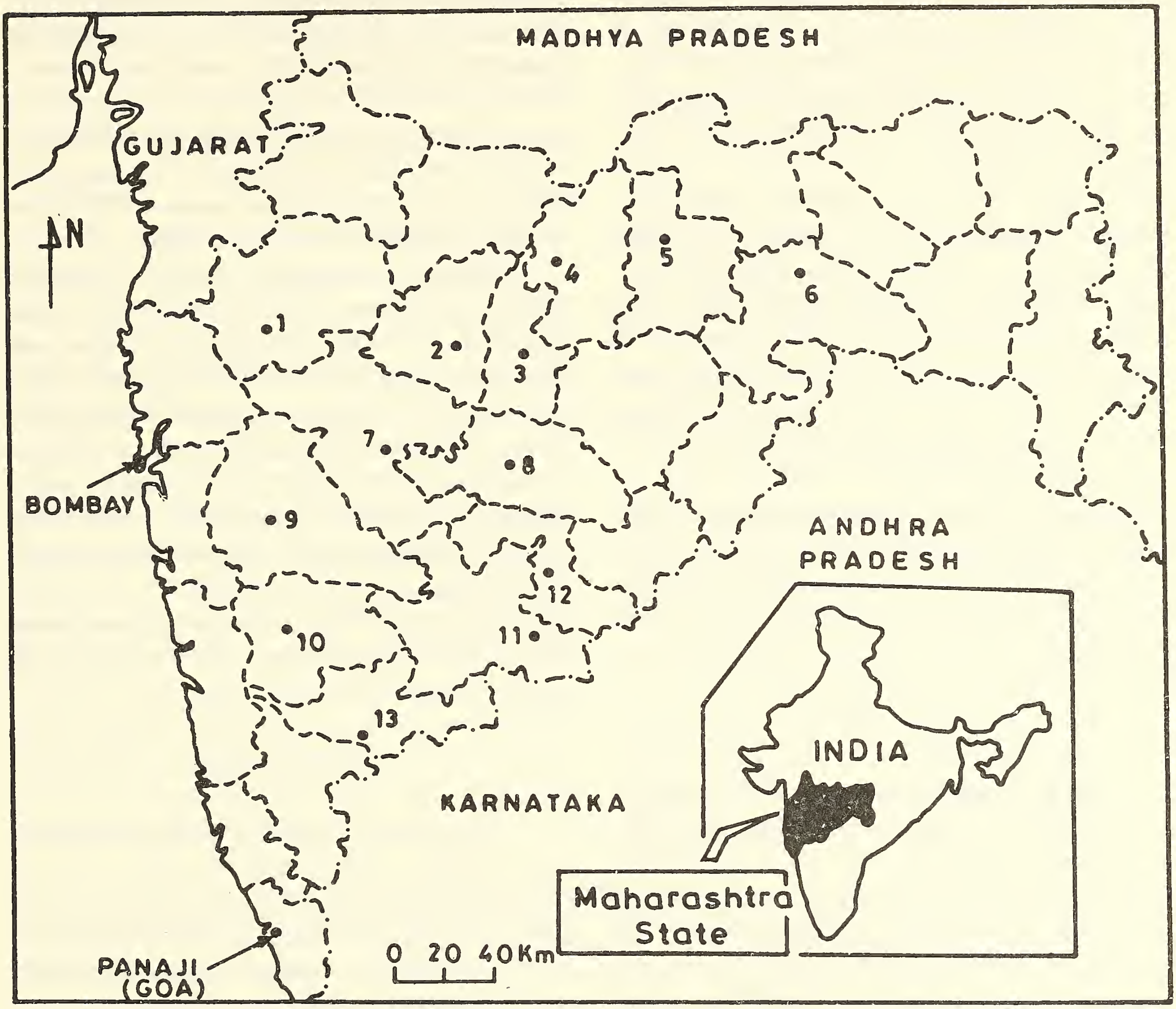
We conducted ecological and behavioural studies on the Indian grey wolf *Canis lupus pallipes* for three years in an area of 30 sq. km. at Nannaj in the Jawaharlal Nehru Great Indian Bustard Sanctuary in Maharashtra. After establishment of the Bustard Sanctuary, good protection was given to all wildlife, resulting in an increase of blackbuck *Antilope cervicapra,* which constitutes the major wild prey of the Indian grey wolf. The Sanctuary falls in marginal agricultural areas, with numerous villages and settlements. Therefore, wolf-human conflicts are common, chiefly because of wolf depredation on livestock. Under conservation and soil protection schemes, the State Forest Department has raised more than 500 plantation plots in Solapur district alone. These plantation plots range from 15 to 500 ha and provide excellent cover during summer to the wolf and its prey. These forest plots also serve as undisturbed denning sites. As the Sanctuary mainly comprises a mosaic of crop fields, grazing lands, plantation plots, and settlements, crop damage by increasing numbers of blackbuck is a volatile issue. We have suggested the following conservation measures for the protection of wolves: (i) better protection of the core areas, (ii) protection of the denning sites, (iii) livestock compensation for wolf depredation to reduce wolf-man conflict, (iv) translocation of blackbuck from locally-abundant areas to other suitable unoccupied habitats in the Sanctuary, where the wolf may also colonize. (v) Some measure of compensation for crop-damage by blackbuck should be worked out to reduce human-blackbuck conflict.

Introduction

There are two subspecies of wolf in India, the Indian grey wolf (*Canis lupus pallipes*) and the Tibetan wolf (*Canis lupus chanco*). The Indian grey wolf (henceforth called wolf in this paper) is found in the plains of central, western, and peninsular India, in isolated pockets in the states of Rajasthan, Bihar, Madhya Pradesh, Gujarat, Maharashtra, Karnataka and Andhra Pradesh. In Maharashtra, the wolf is distributed in small pockets of semi-arid areas comprising Nasik, Aurangabad, Jalna, Buldana, Akola, Yavatmal, Ahmednagar, Beed, Pune, Satara, Solapur, Osmanabad and Sangli (Fig. 1).

C. l. chanco is found at high altitudes in the Himalayas in Kashmir, Lahaul Spiti and Sikkim, and Trans-Himalayas (Ladakh and Sikkim) from 3000 to 4000 m. This subspecies is fairly common in Ladakh and is reported to take a heavy toll of livestock and kill large numbers of Tibetan gazelle (*Gazella picticaudata*) and wild sheep (*Ovis ammon hodgsoni*). These wild antelopes and sheep are killed frequently during winter when they descend to lower altitudes because of heavy snowfall (Ganhar, 1979).

[1]Accepted May, 1996
[2]Centre of Wildlife and Ornithology
Aligarh Muslim University, Aligarh 202 002, India.
[3]Present Address: Bombay Natural History Society.
Hornbill House, S.B. Singh Road, Dr. Sálim Ali Chowk, Mumbai 400 023.



Key

1.	Nasik	8.	Beed
2.	Aurangabad	9.	Pune
3.	Jalna	10.	Satara
4.	Buldana	11.	Solapur
5.	Akola	12.	Osmanabad
6.	Yavatmal	13.	Sangli
7.	Ahmednagar		

Fig. 1. Map showing the districts of Maharashtra inhabited by the grey wolf.

The habitat of wolf in India is semi-arid dry grasslands, scrublands, grazing land and rocky low hills. The grazing lands lie mainly in the marginal agricultural areas. There is tremendous livestock pressure on these areas because of the continuous increase in livestock, which to some extent contributes to the decline of the wolf's prey.

Except for the preliminary surveys by Shahi (1982) and studies on wolf in Velavadar National Park in Gujarat (Jhala 1991, Jhala and Giles, 1991), there is lack of information on the ecology of this subspecies in other areas of its distribution, while on the Tibetan wolf, nothing exists on its ecology and population estimates in India (Mech, 1982). The present paper is a part of the larger studies conducted on the ecology of the wolf in the Jawaharlal Nehru Great Indian Bustard Sanctuary, Nannaj, Solapur and our objective is to investigate and provide basic information on the status of the wolf population.

Study Area

Solapur, with an area of 15,017 sq. km is one of the largest districts of Maharashtra, both in terms of area and human population. It lies in the interior Deccan and is typical of the plateau. The climate is dry and the maximum temperature varies from 25°C in winter to 44°C in summer. Average annual precipitation is erratic and varies from 500 to 724 mm. The year to year fluctuation in rainfall distribution makes the area drought prone.

The terrain is gently undulating, typical of the Deccan. The cropfields are restricted, by and large, to the valleys between the plateau. The habitat is a mosaic of scrubland, grazing land, agriculture fields, human habitations and man-made plantations. Large-scale plantations are being raised by the State Forest Department in all the sub-divisions. The main purpose is to check soil erosion, provide firewood for local people, fodder for cattle and to provide vegetational cover to soil. These plantations are being made under different agencies such as Drought Prone Areas Programme (DPAP), District Rural Development Agency (DRDA), Employment Guarantee Scheme (EGS), and Tree Planting Scheme (TPS). The chief mountain-passes (ghats) in the district are: Yedshi ghat in Barshi, Waghola and Bodki in Karmala, Chinchgaon in Madha. Gurvad and Phaltan range in Malshiras and the Khanapur-Jat hills in Sangole.

The main crops are sorghum *Sorghum bicolor,* sunflower *Helianthus annus,* wheat *Triticum aestivum,* sugarcane *Saccharum officinalis,* groundnut *Arachis hypogea* and various pulses. There are orchards of grape *Vitis vinifera* and Indian plum *Zizyphus mauritiana* orchards in the areas which are under well-irrigation. Sorghum and sugarcane are the main crops in irrigated areas. The dominant grasses include *Aristida* spp., *Sehima nervosum, Heteropogon contortus, Dichanthium annulatum* and *Chrysopogon fulvus,* interspersed with scattered scrubland.

Methodology

We conducted a survey of the wolf and its prey in Solapur and its adjoining districts during November-December 1993. Information on the presence of wolf, breeding, number, natural prey, livestock density, and public attitude were taken on a set proforma through enquiring and/or by ground surveys. Forest Department personnel, villagers, particularly shepherds, were interviewed. Information collected from people was cross-checked by ground surveys by looking for scats and tracks, and sightings or howling. Those areas where wolf presence was not expected, such as intensive agriculture areas, were not surveyed intensively. In such areas, the crop is harvested twice a year and the area is always occupied and frequented by humans. To avoid over estimation, the queries with one source about wolf numbers were tallied with information gathered from other sources in a particular area.

The maximum possible information was sought from shepherds about the frequency of wolf sighting in a particular area, constancy of the pack-size, and wolf breeding in the area. If we found evidence of denning in a particular area, we accompanied the informer up to the den sites and the necessary information was collected.

All the eleven sub-divisions (*tehsils*) of Solapur district were surveyed thoroughly and the areas wherein wolf presence was known to us were checked with intensive search operations by looking for tracks and scats (as sighting is rare). The sub-divisions are: Akkalkot, Barshi, Karmala, Madha, Malshiras, Mohol, Mangalvedha, North Solapur, Pandharpur, Sangole and South Solapur. Malshiras, Sangole and Barshi *tehsils* have steep hills and the rocks are in the form of medium to large-sized boulders. Akkalkot, Pandharpur, Mangalvedha and Madha have the largest agriculture belts, thanks to the development of irrigation facilities. The crops are also irrigated from the river Bhima in these sub-divisions. These areas have incurred heavy increase in cultivated area and the grasslands are continuously being converted into crop fields because of improved irrigation facilities.

In addition to the revenue land and grazing land, plantations totalling 5,125 ha were surveyed. A distance of 2,776 km was covered by vehicle during the survey and indirect evidence of wolf was found. These plantations were dispersed over a large area of grassland and crop fields.

The wolves found within 20 km radius around villages were considered as one pack moving over these areas. This was tallied/confirmed with the number of wolves seen in these villages also (i.e., if the same number of wolves was sighted around 4-5 villages, it was considered as one pack). Altogether, 398 people were interviewed about the wolves and their whereabouts.

Results and Discussion

The wolf is present in all sub-divisions of Solapur (Fig. 2). The results of the survey for population estimates and density in different areas are given in Table 1. Solapur district supports a minimum population of 53 and maximum of 85 wolves. Out of these figures, the packs that are present along the district boundaries (e.g., with Ahmednagar, Satara, Sangli and Osmanabad) and the state border (Karnataka) contribute to populations of either side. Much of the range is

Table 1

APPROXIMATE DENSITY OF WOLVES AND POPULATION OF NATURAL PREY IN SOLAPUR SUB-DIVISIONS

Subdivisions	Area** (km^2)	Wolf Numbers	Density (km^2)	Natural prey: Blackbuck	Natural prey: Chinkara
Akkalkot	169.26	5-8	0.04	30-50*	—
Barshi	246.09	6-7	0.03	100-120*	(2)
Karmala	278.71	5-9	0.03	400-500* (300-400)	(11)
Madha	287.77	2-4	0.01	200-250*	—
Malshiras	362.05	7-12	0.03	Not known	(2)
Mangalvedha	169.26	2-4	0.02	Not known	—
Mohol	229.38	6-8	0.03	2000* (500-550)	—
Pandharpur	219.21	2-4	0.01	about 500 (76)	—
Sangole	164-98	7-10	0.05	Not known	—
Solapur North	242.03	7-12	0.04	1000-1200* (700±)	—
Solapur South	151.86	4-7	0.04	150-200* (182)	—

* represents the numbers supplied by the local people and the Forest Department

** wolf habitat or area available to wolves

Numbers in parentheses represent our observations

Fig. 2. Map showing the distribution of grey wolf in the subdivisions of Solapur District, Maharashtra

inhabited by low pack sizes. The largest pack size comprised of 12 wolves and smallest of two individuals. The low pack size is probably because of the high human populations in such areas and disturbance. Moreover, the natural prey base and livestock (goat and sheep) are also low in these areas. There was no constancy in the pack size in any area of the wolf range as reported by other workers. For example, the Nannaj pack that was followed for behavioural studies did not remain constant over the year (Kumar unpubl. data). Most sightings during winter were of only two animals. We presume that this might be a result of more activity of the alpha pair of a pack, or the only pair (lone pair) of an area, searching for denning sites.

The blackbuck (primary prey of the wolf) is in low numbers in most of the wolf range areas of Solapur, except Mohol and North Solapur sub-divisions which harbour large populations of blackbuck (Table 1). Indian gazelle or chinkara (*Gazella bennetii*) was seen only in three sub-divisions of Solapur (Table 1) in extremely low numbers.

Six dens were located with the help of shepherds and watchmen of the Forest Department. In addition, there was one den along the periphery of a plantation at Sohale in Mohol, wherein the wolves were denning over the years. However, this den got destroyed because of a check-dam that came up in the area in 1993. Likewise, a den was destroyed around Katphal (Sangole) plantation because of the irrigation canal (called Nira) that made its way through the den. In 1992, two pups were seen by a forest guard at the same den. We were told that this den was also being used for many years by wolves.

About 12-15 years ago, the wolf disappeared from Achegaon and surrounding villages in South Solapur and Narliwadi and surrounding areas of Sangole tehsil, apparently because of agricultural expansion and change in cropping pattern. For the same reason, the range of the wolf has shrunk in Mangalvedha and Madha tehsils. Breeding was noticed only in Akkalkot, Madha, Malshiras, Sangole and North Solapur tehsils, which still have extensive areas under marginal cultivation.

After being bitten by a wolf in 1991, a young shepherd of Jalbhavi village died in September 1993 due to rabies. There was a pack of 14 wolves in 1991 in this village area. In recent years, this is apparently the first and only case of human casualty by the wolf in Solapur district.

Conservation

Malshiras, Sangole, North Solapur and Akkalkot are the best areas for the long term survival of the wolf because of availability of prey and denning sites. Among these areas, Malshiras and Sangole have steep hills along adjoining districts and have massive rock boulders. The soil under these boulders has a soft texture which helps the wolves to excavate it for making dens. According to local people and also our observations the wolves use the same dens year after year. The livestock population in each of these ranges is more than 20,000, which provides regular food.

The wolf is a highly endangered species, protected under the Wildlife (Protection) Act, 1972, but till now, not much has been done for its protection, mainly because of its reputation as a livestock destroyer, and in some areas as a child-lifter. Fortunately, in Solapur district, no case of child lifting has been reported as far as we know, but its so-called sheep and goat depredation makes it an unpopular animal. During the survey, all the people interviewed responded with a negative attitude towards wolf conservation.

Despite continuous persecution by human beings, the wolf has the resilience to survive, chiefly due to its adaptability and intelligence. The wolf, like the Great Indian bustard *Ardeotis nigriceps* and blackbuck, has responded positively to conservation measures (in the form of plantation and grassland plots developed under various schemes). However, this has not reduced human-wolf conflict — the ultimate victim of which is invariably the wolf. It is a complex issue, without an easy solution. Nevertheless, we recommend the following steps which might minimize human-wolf conflict and increase the wolf's chance of survival:

(1) Adequate compensation for wolf depredation of livestock.
(2) Translocation of blackbuck from locally-abundant areas to other suitable unoccupied habitats.
(3) To reduce human-blackbuck conflict, compensation for crop-damage by blackbuck.
(4) Special protection to denning sites and core areas which are generally occupied by wolves.
(5) Development of large grassland and plantation plots, especially around denning sites used regularly by wolves.
(6) Intensive studies on the movement, dispersal, habitat requirements and general ecology of the wolf in Maharashtra, using modern techniques of radio-telemetry and marking.
(7) Regular wolf census in Maharashtra, at least once in two years.

Acknowledgement

We are grateful to the Forest Department, Solapur, and the Wildlife Division (Western Circle), Pune for their help during the survey. We also thank Dr. Jay Samant, ex-Director, BNHS, and Prof. A.H. Musavi, former Chairman, Centre of Wildlife and Ornithology (AMU) for facilities. The Grassland Ecology Project was funded by the U.S. Fish & Wildlife Service (USFWS) and sponsored by the Ministry of Environment, Forests & Wildlife, Govt. of India. We are thankful to them, especially to Mr. David Ferguson (SFCP Coordinator), USFWS.

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ORCHIDS OF HIGH WAVY RECOLLECTED[1]

N. Sasidharan,[2] K.P. Rajesh and Jomy Augustine[3]

Key words: orchids, High Wavys, Periyar Tiger Reserve, *Odontochilus rotundifolius, Bulbophyllum agastyamalayanum, B. xylophyllum.*

The High Wavy Mountains are remarkable for their endemic flora, particularly orchids. Among the 34 orchids reported by Blatter in 1928, some of them could not be located and are considered as possibly extinct, mainly due to habitat degradation. This paper deals with 64 species of orchids including all the species reported by Blatter, except *Chrysoglossum halberii* Blatt., *Odontochilus rotundifolius* Blatt. relocated. *Bulbophyllum agastyamalayanum* Gopalan & Henry is reduced to *B. xylophyllum* Par. & Reichb.f. Distribution analysis and relevant notes are provided.

Introduction

The High Wavy mountains or the Varushanad Hills, towering more than 1500 m above msl are steep and high spurt hills, extending North East from Kumily at the eastern junction of Cardamom Hills and Pandalam Hills to Andipatti Hills of Madurai district, Tamil Nadu. Except for the south western junction, bordering the Idukki district of Kerala, the High Wavys are entirely in Tamil Nadu. Parts of the High Wavy Mountains, Manalar, Vellimala and Brook's peak lie adjacent to the Periyar Tiger Reserve, Idukki district, Kerala.

During plant exploration in 1917 by Blatter and Halberg, 34 species of orchids under 19 genera, including 3 new species and 1 new variety, were collected. The new taxa described were *Chrysoglossum halbergii, Eria pseudoclavicaulis, Odontochilus rotundifolius* and *Dendrobium nutans* var. *rubrolabris.* Among the 34 species, 14 are endemic to the Western Ghats.

Parts of the High Wavy in Tamil Nadu have been cleared for raising plantations of cardamom, coffee, tea and other cash crops. Owing to the restricted distribution and habitat degradation, the 3 new species described by Blatter from the High Wavys could not be relocated and placed under various threat categories (Henry *et al.* 1979). Though *Eria pseudoclavicaulis* has been relocated from Panniyar forests and Nyamkkad, Anamudi (Abraham & Vatsala, 1981); from Munnar, Idukki district and Agastyamalai, Trivandrum district (Sasidharan *et al.* 1990), the other two species *Chrysoglossum halbergii* and *Odontochilus rotundifolius* could not be located and are considered to be possibly extinct (Nayar and Salary, 1988).

Observations

The area bordering the High Wavy Mountains in the Periyar Tiger Reserve is undisturbed and supports dense vegetation. During our studies on the flora of Periyar Tiger Reserve, we were able to collect 64 species of orchids from the region adjoining the High Wavys in the Periyar Tiger Reserve, including all the orchids except *Chrysoglossum halbergii* reported by Blatter (1928). The orchids collected are listed below with relevant notes. The specimens cited are deposited in the Kerala Forest Research Institute Herbarium (KFRI). The abbreviations *NS, JA,* and *KPR* denote the names of collectors *N. Sasidharan, Jomy Augustine*, and *K.P. Rajesh* respectively.

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[1]Accepted February, 1997

[2]Non Wood Forest Products Division,
Kerala Forest Research Institute, Peechi-680 653, Kerala.
[3]Present Address: Dept. of Botany, St. Thomas College, Pala, Kottayam, Kerala.

List of Orchids:

1. ***Aerides maculosa*** Lindl.
Rare, in evergreen forests. Endemic to southern Western Ghats. *JA & KPR 15364.*

2. ***Anoectochilus rotundifolius*** (Blatt.) Sathish & Rasm.
Odontochilus rotundifolius Blatt.
Very rare in evergreen forests. Endemic to southern Western Ghats. *JA 13779.*

Note: This species reported from the High Wavys by Blatter (1928) based on the collection made in 1917 had not been collected since then. Balakrishnan (1966) transferred it to *Anoectochilus rotundifolius* (Blatt.) Balakr. There was no report of this species for a long period and it was considered extinct (Henry *et al.* 1979); Ahmedullah and Nayar, 1987; Nayar and Sastry, 1987). Recently, Gopalan (1993) published a new species under a new genus, *Aenhenrya agastyamalayana,* from Agastya-malai Hills, Tamil Nadu. After critical studies and discussion with Dr. C. Sathish Kumar, TBGRI, it was found that *Aenhenrya agastyamalayana* and *Odontochilus rotundifolius* are the same. Thus the present collection is a rediscovery from the type locality after a long lapse. For a detailed discussion refer to Sathish Kumar and Rasmussen, 1997.

3. ***Anoectochilus elatus*** Lindl.
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 13124.*

4. ***Brachycorythis splendida*** Summerh.
Occasional in grasslands. Endemic to southern Western Ghats. *JA 14061.*

5. ***Bulbophyllum aureum*** (Hook.f.) J.J.Sm.
rare in evergreen forests. Endemic to southern Western Ghats. *JA & KPR 17089.*

6. ***B. elegantulum*** (Rolfe) J.J. Sm.
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 13713, 13745.*

7. ***B. fischeri*** Seidenf.
Cirrhopetalum gamblei Hook.f.
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 15018.*

8. ***B. fuscopurpureum*** Wight
Rare in evergreen forests. Endemic to southern Western Ghats. *JA & KPR 15036.*

9. ***B. kaitense*** Riechb.f.
Rare in evergreen forests. Endemic to southern Western Ghats. *NS & JA 15017.*

10. ***B. macraei*** (Lindl.) Reichb. f.
Rare in evergreen forests. Southern Western Ghats and Sri Lanka. *JA 13777.*

Note: This was considered endemic to Sri Lanka until recently reported from Tamil Nadu (Srinivasan & Chitra, 1989). The present collection is a new record for Kerala.

11. ***B. neilgherrense*** Wight
Fairly common in evergreen forests. India and Bangladesh. *JA 14726.*

12. ***B. xylophyllum*** Par. Reichb. f.
Bulbophyllum agastyamalayanum Gopalan & Henry syn. nov.
Rare in evergreen forests. Indo-Malayan. *JA & KPR 14474.*

Note: The similarity of *B. agastyamalayanum* Gopalan & Henry and *B. xylophyllum* Par. & Reichb.f., was commented on by Sathish Kumar and Manilal (1994). Gopalan and Henry (1993) described the new species as allied to *B. hymenanthum* Hook.f., which belongs to section **Aphanobulbon** Schltr., characterised by "inflorescence one to few flowered or with a lax flowered rachis" (Seidenfaden, 1979). *B. xylophyllum* Par. & Reichb. f., belongs to the section **Globiceps** Schltr., characterised by "inflorescence a densely packed head of many small dark coloured flowers". Studies with our collections from Periyar Tiger Reserve an Shenduruny Wildlife Sanctuary, Quilon district, [*NS 11371* (KFRI)] and with the type specimen *Gopalan 96220* (MH), shows that *B. agastyamalayanum* belongs to Section **Globiceps** and is no different from *B. xylophyllum.* Hence *B. agastyamalayanum* Gopalan & Henry is synonymised with *B. xylophyllum* Par. & Reichb. f. The present collection extends the distribution range of the species of Kerala.

13. ***Calanthe masuca*** (D.Don) Lindl.
Fairly common in evergreen forests. Indo-Malayan. *JA 12601, 13981.*

14. ***C. triplicata*** (Willem.) Ames
Occasional in evergreen forests. Indo-Malayan. *JA 13772.*

15. ***Coelogyne breviscapa*** Lindl.
Occasional in evergreen forests. South India and Sri Lanka. *KPR 14365.*

16. ***C. nervosa*** A. Rich.
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 13863.*

17. ***Dendrobium anamalayanum*** Chandrb. *et al.*
Fairly common in evergreen forests. Endemic to southern Western Ghats. *JA & KPR 15362.*

18. ***D. herbaceum*** Lindl.
Common in evergreen forests. Endemic to southern Western Ghats and Bihar. *JA 13149.*

19. ***D. microbulbon*** A. Rich.
Rare in evergreen forests. Endemic to southern Western Ghats. *JA & KPR 14408.*

20. ***D. nutantiflorum*** Hawkes & Heller
D. nutans Lindl. var. *rubrolabris* Blatt.
Rare in evergreen forests. Southern Western Ghats and Sri Lanka. *JA & KPR 15016.*

21. ***Diplocentrum recurvum*** Wight
Fairly common in evergreen forests. Southern Western Ghats and Sri Lanka. *JA 15218.*

22. ***Disperis neilgherrense*** Wight
Rare in evergreen forests and grasslands. Indo-Malayan. *JA 13773.*

23. ***Epipogium roseum*** (D. Don) Lindl.
Occasional in evergreen forests. Indo-Malayan. *JA 13165.*

24. ***Eria nana*** A. Rich.
Rare in evergreen forests. Endemic to southern Western Ghats. *KPR 16873.*

25. ***E. pauciflora*** Wight
Common in evergreen forests. Endemic to southern Western Ghats. *JA 13980.*

26. ***E. pseudoclavicaulis*** Blatt.
Fairly common in evergreen forests. Endemic to southern Western Ghats. *JA 13973.*

27. ***E. reticosa*** Wight
Rare in evergreen forests. Endemic to southern Western Ghats and Himalayas. *JA 14001, KPR 16874.*

28. ***Gastrochilus acaulis*** (Lindl.) O. Ktze.
Saccolabium pulchellum Fischer
Occasional in evergreen forests. South India and Sri Lanka. *JA 17853.*

Note: Seidenfaden (1988) comments that all the plants known by the names *Saccolabium nilagiricum* Hook.f., *Vanda pulchella* Wight, *Gastrochilus pulchellus* (Wight) Schltr., *G. nilagiricus* (Hook. f.) O. Ktze., *G. calceolaris* (J.E. Sm.) D. Don., and *G. indicus* Garay from South India are ***G. acaulis*** (Lindl.) O. Ktze.

29. ***Habenaria barnesii*** Summerh.
Rare in grasslands. Endemic to southern Western Ghats. *JA 17880.*

30. ***Habenaria multicaudata*** Sedgw.
Rare in evergreen forests. Endemic to southern Western Ghats. *KPR 14344.*

31. ***Kingidium niveum*** Sathish
Rare in evergreen forests. Endemic to southern Western Ghats. *KPR 16885.*

32. ***Liparis cespitosa*** (Thou.) Lindl.
Rare in evergreen forests. Indo-Malayan. *JA 13967.*

33. ***L. elliptica*** Wight
Rare in evergreen forests. Indo-Malayan. *JA & KPR 14477.*

34. ***L. viridiflora*** Lindl.
Occasional in evergreen forests. Indo-Malayan. *JA 17843.*

35. ***L. walkeriae*** Grah.
Rare in grasslands. Southern Western Ghats and Sri Lanka. *JA 14006.*

36. ***L. wightiana*** Thw.
Common in grasslands. Southern Western Ghats and Sri Lanka. *JA 14007.*

37. ***Malaxis rheedei*** Sw.
Fairly common in evergreen forests. India and Sri Lanka. *JA 14073.*

38. ***Oberonia anamalayana*** Joseph
Rare in evergreen forests. Endemic to southern Western Ghats *JA 13677.*

39. ***O. arnottiana*** Wight
Rare in evergreen forests. India and Sri Lanka. *KPR 16879.*

40. ***O. bicornis*** Lindl.
Rare in evergreen forests. South India and Sri Lanka. *JA & KPR 14406.*

41. ***O. brunoniana*** Wight
Occasional in evergreen forests. Endemic to southern Western Ghats. *JA 12983.*

42. ***O. denticulata*** Wight
Occasional in evergreen forests. Indo-Malayan. *J. 12982.*

43. ***O. ensiformis*** (J.E. Sm.) Lindl.
Common in evergreen forests. Indo-Malayan. *KPR 16886.*

44. ***O. longibrateata*** Lindl.
Rare in evergreen forests. Southern Western Ghats and Sri Lanka. *KPR 14317.*

45. ***O. santapaui*** Kapad.
O. lindleyana Wight
Common in evergreen forests. Endemic to southern Western Ghats. *JA 13988, 13989.*

46. ***O. sebastiana*** Shetty & Vivek.
Occasional in evergreen forests. Endemic to southern Western Ghats. *JA 12972, KPR 14312, 16878.*

47. ***O. verticillata*** Wight
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 17854.*

48. ***O. wightiana*** Lindl.
Occasional in evergreen forests. Southern Western Ghats and Sri Lanka. *KPR 16875.*

49. ***Papilionanthe subulata*** (Koenig) Garay
Common in evergreen forests. Southern Western Ghats and Sri Lanka. *JA & KPR 15026.*

50. ***Peristylus aristatus*** Lindl.
P. stenostachys Krzl.
Rare in evergreen forests. India, Sri Lanka and Nepal. *JA 14147.*

51. ***P. densus*** (Lindl.) Sant. & Kapad.
Rare in evergreen forests. Indo-Malayan. *JA 14142.*

52. ***Phreatia elegans*** Lindl.
Rare in evergreen forests. India and Sri Lanka. *JA 13951.*

53. ***Robiquetia josephiana*** Manilal & Sathish
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 13970.*

54. ***Satyrium nepalense*** D. Don
Common in grasslands. Indo-Malayan. *JA 12181, 13190.*

55. ***Seidenfadeniella chrysantha*** (Wight) Sathish
Saccolabium filiforme Lindl.
Rare in evergreen forests. Southern Western Ghats and Sri Lanka. *JA & KPR 15361.*

56. ***Sirhookera lanceolata*** (Wight) O. Ktze.
Josephia lanceolata Wight
Common in evergreen forests. Southern Western Ghats and Sri Lanka. *JA 12331.*

57. ***S. latifolia*** (Wight) O. Ktze.
Occasional in evergreen forests. Southern Western Ghats and Sri Lanka. *JA 13982.*

58. ***Spiranthes sinensis*** (Pers.) Ames
Spiranthes australis Lindl.
Rare in grasslands. Indo-Malayan. *JA 14988.*

59. ***Tainia bicornis*** (Lindl.) Reichb. f.
Occasional in evergreen forests. Southern Western Ghats and Sri Lanka. *JA 13433.*

60 ***Trias bonaccordensis*** Sathish
Rare in evergreen forests. Endemic to southern Western Ghats. *JA 13433.*

61. ***T. stocksii*** Benth. ex Hook. f.
Occasional in evergreen forests. Indo-Malayan. *JA 13165.*

62. ***Zeuxine cladestina*** Bl.
Rare in evergreen forests. Indo-Malayan. *JA & KPR 14873.*

63. ***Z. gracilis*** (Breda) Bl.
Z. blatterii Fischer
Rare in evergreen forests. Indo-Malayan. *JA & KPR 14821.*

64. ***Z. longilabris*** (Lindl.) Benth. ex Hook f.
Occasional in evergreen forests. Indo-Malayan. *JA 13628.*

Conclusion

The distribution analysis reveals that among the 64 species, 24 are endemic to the southern Western Ghats, *Dendrobium herbaceum* extends to Bihar and *Eria reticosa* upto Himalayas. The Indo-Sri Lankan elements are 19 and Indo-Malayan 18. The orchids of High Wavys, especially the endemics, have a narrow distribution range; and as many as 12 endemics are considered rare and a few critically endangered.

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GROUP SIZE AND COMPOSITION OF INDIAN PEAFOWL (*PAVO CRISTATUS*) IN AN AGRO-ECOSYSTEM AT ALIGARH, UTTAR PRADESH[1]

Shahla Yasmin[2]

(*With two text-figures*)

Key words: *Pavo cristatus*, group size, group composition, social organization, photoperiodic length.

Variation in group size and composition of Indian peafowl (*Pavo cristatus*) was investigated in an agro-ecosystem at Aligarh during 1993-94. The area included a patch of scrubland and plantation surrounded by a vast expanse of crop fields. There was significant seasonal variation in group size and significant difference in group size between 'closed' habitat (scrubland and plantation) and 'open' habitat (crop fields). This was attributed to social organization and difference in availability of food between the two habitats. Seasonal variation was found in group composition too. This was attributed to the reproductive pattern and social organization of peafowl.

Introduction

The variation in group size is considered as part of the species' adaptation to its environment (Southwell 1984). This variation could be due to habitat structure, spatio-temporal distribution of food and predation pressure (Barrette, 1991). The Indian peafowl (*Pavo cristatus*) is common and widely distributed in the Indian subcontinent. However, very little work has been done on its ecology. Trivedi (1993) has observed that group size of peafowl varies due to habitat structure and spatial distribution of food. As resource abundance changes with changing season, variation in group size is expected between the seasons as well. Since peafowl has adapted well to human-altered environment, it would be interesting to study its grouping pattern in such an environment. This paper investigates variation in group size and composition in a peafowl population living in an agro-ecosystem.

Study Area

The study area was located on the outskirts of Aligarh town (27° 30' N, 79°40' N). It included scrubland and plantation (area=14.5 ha) surrounded by a vast expanse of crop fields on one side and human habitation on the other. The scrubland had natural vegetation comprising *Azadirachta indica, Holoptelia integrifolia, Dalbergia sissoo* and *Cordia dichotoma, Capparis sepiaria* was the shrub cover. The plantation had certain fruit and ornamental trees such as *Mangifera indica, Psidium guajava, Emblica officinalis, Syzigium cuminii, Morus alba, Putranjiva roxburghii, Pongamia glabra, Bombax ceiba, Polyalthia longifolia,* and *Delonix regia.* The ground cover in the scrubland comprised *Panicum antidotale, Achyranthes aspera, Chenopodium album, Setaria verticillata, Cenchrus ciliaris, C. alia, Teramnus labialis* and *Pluchea lanceolata.* The ground cover in the plantation was dominated by *Dichanthium annulatum, Pluchea lanceolata* and *Cynodon dactylon.* A crop field was located about 50 m from the scrubland and was planted with wheat (*Triticum aestivum*), mustard (*Brassica campestris*) and potato (*Solanum tuberosum*) during winter; vegetables during summer; bajra (*Pennisetum typhoides*), jowar (*Hordeum vulgare*) and maize (*Zea mays*) during monsoon.

Aligarh experiences a tropical monsoon type of climate. January was the coldest month with maximum and minimum temperatures

[1]Accepted February, 1995

[2]Centre of Wildlife & Ornithology, Aligarh Muslim University, Aligarh-202 002
Present address: Zoology Department, Science Block, Patna Women's College, Bailey Road, Patna-800 001

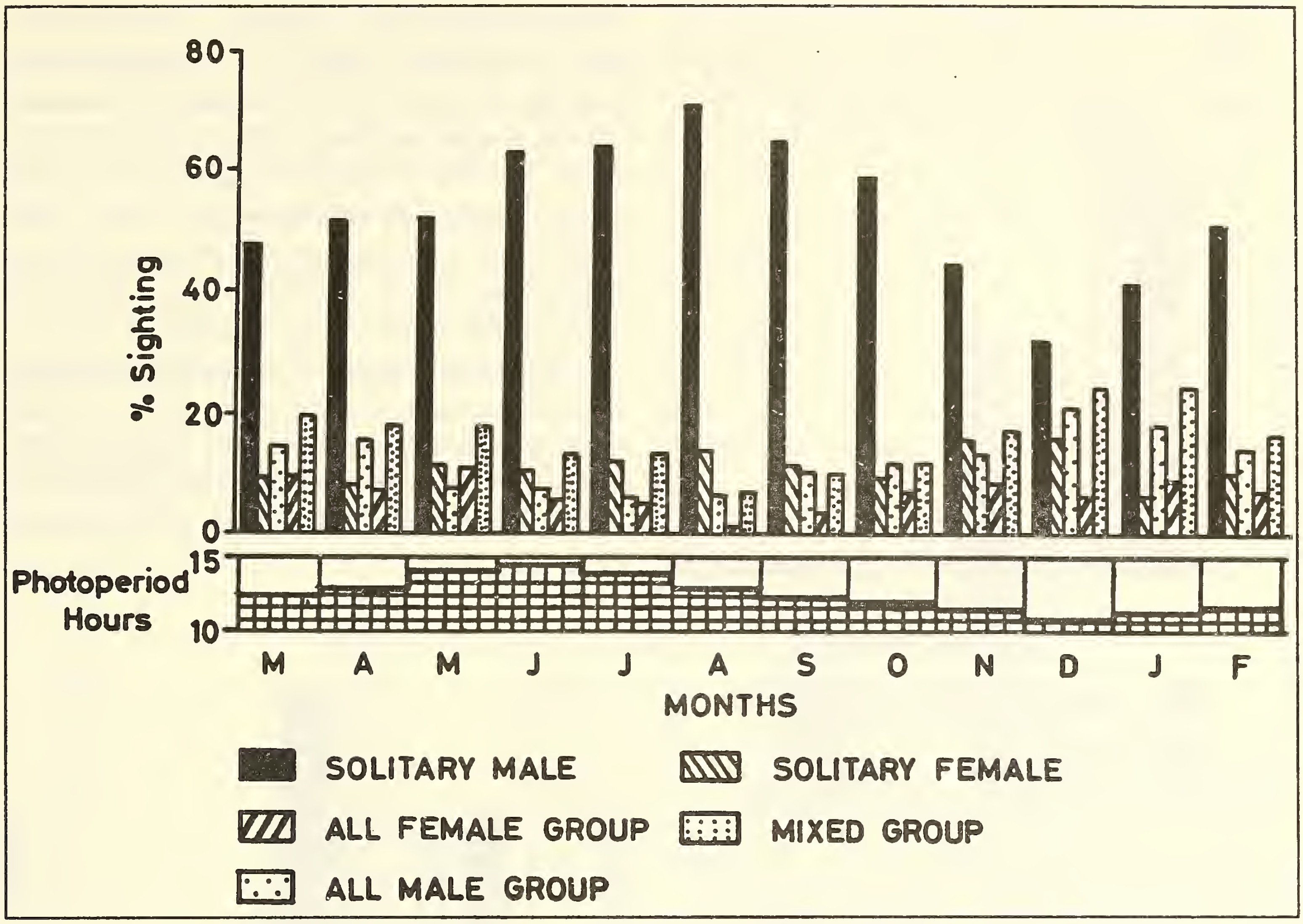

Fig. 1. Seasonal variation in group composition of peafowl.

20.6°C and 7.9°C respectively. May was the hottest month with maximum and minimum temperatures 41.4°C and 24.3°C respectively. Average rainfall was 5.325 mm in winter, 18.05 mm in summer and 150.97 mm in monsoon.

Methods

Between March 1993 to February 1994 data on group size were collected while studying the habitat utilization pattern of the peafowl. The peafowl population within the study area fluctuated between 40-67 with the minimum in January 1993 and the maximum in May 1993. Median group size was calculated for different seasons. Summer season comprised March-June, monsoon comprised July-October and winter months were November-February. During analysis, the data from scrubland and plantation were pooled and compared with that of the crop fields. Data from scrubland and plantation were pooled to see whether the group size varied significantly between a 'closed' habitat (scrubland and plantation) and an 'open' habitat (crop fields). Extension of the median test (Siegel, 1956) was used to compare the group size of peafowls in 'closed' and 'open' habitats. Chi-square was used to test the seasonal variation in group composition. Spearman rank correlation (rs) was used to measure the relationship between the photoperiodic length and proportion of solitary males per month. Photoperiodic length was calculated from sunrise and sunset data.

Results

Group size: The median group size of peafowl was one in all the three seasons. There

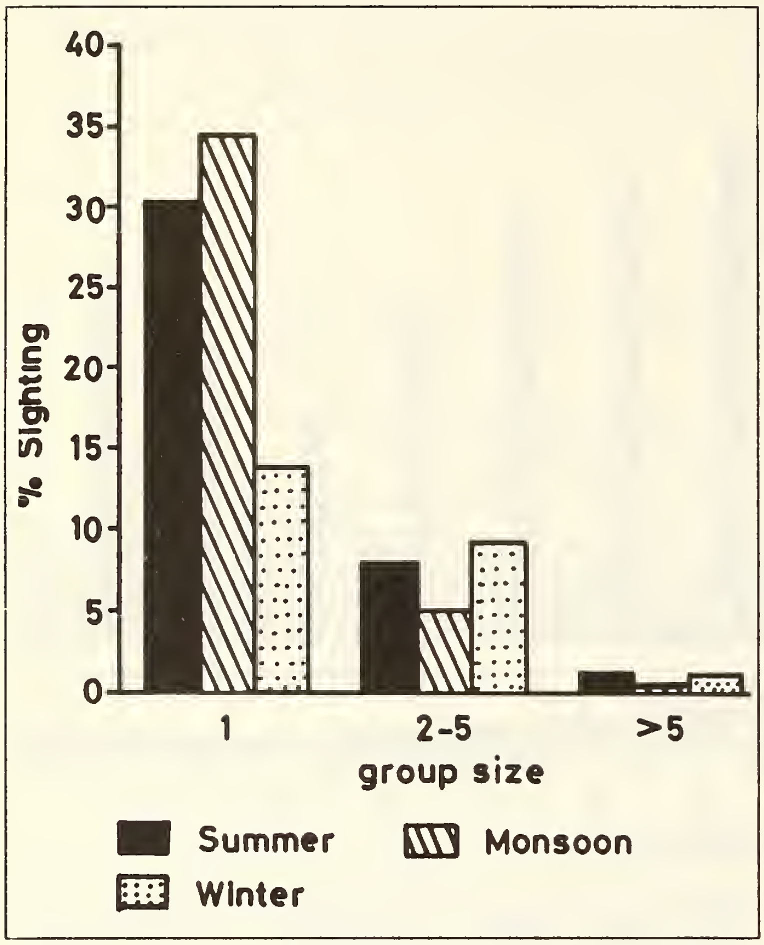

Fig. 2a. Grouping pattern of peafowl, adult male

was significant seasonal variation in group size (χ^2 = 73.01, d.f. = 2, P<0.001). The variation in group size between 'closed' area 'open' area was also significant (χ^2 = 30.49, d.f. = 1, P <0.001). Solitary birds were seen more in the closed area (70% of 1828 groups) than in the open area (34.9% of 358 groups).

Group composition: The group composition changed seasonally (χ^2 = 84.3, P<0.001, d.f. = 8). The proportion of solitary males was positively correlated to the average photoperiodic length per month (rs = 0.59, P<0.05). Three age classes of males could be differentiated on the basis of train elaboration and plumage differentiation. All the three age classes of males showed difference in grouping pattern (Fig. 2a-d).

Adult males: Total sightings of adult males were 1209. 78.7% occurred singly and 21.3% in groups. They formed 32.9% of groups with adult males, 28.7% with females, 25.9% with sub-adult males, 8.1% with immature males, 13.9% with sub-adult females, 3.1% with immature males and females, 2.3% with sub-adult and immature males, 5.4% with sub-adult, immature males and females. Single adult males showed a seasonal change (G = 9.952, P<0.01, d.f. = 2). The occurrence of adult males in groups did not vary seasonally (G = 1.377, NS). During the breeding period the proportion of single males was 30-34% which dropped to 13.9% in the non-breeding period (Fig. 2a).

Sub-adult males: Total sightings of sub-adult males were 532. Of them 43.4 occurred singly and 56.6% in groups. They formed 35.2% of groups with females, 22.3% with adult males, 11.6% with sub-adult males, 4% with immature

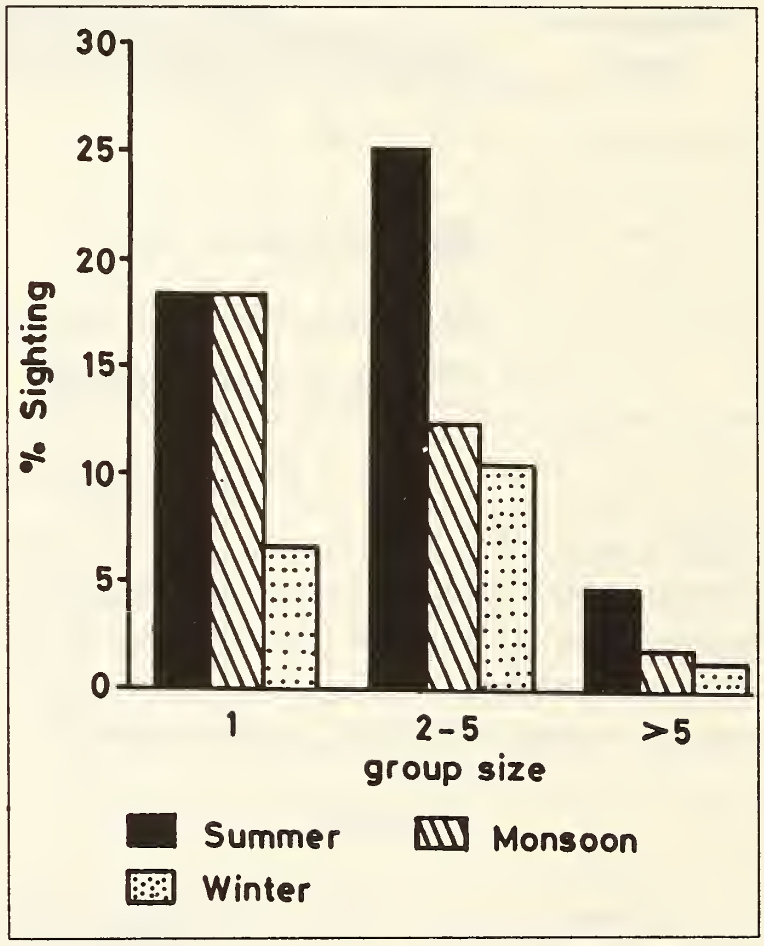

Fig. 2b. Grouping pattern of peafowl, sub-adult male

males, 11.9% with adult males and females, 9.3% with immature males and females, 2% with adult males and immature males and 4.6% with adult males, immature males and females. Single sub-adult males showed a seasonal change (G = 7.384, P<0.05, d.f. = 2) and their occurrence in groups also varied seasonally (G = 9.258, P<0.01, d.f. = 2) (Fig. 2b).

Immature males: Total sightings of immature males were 228. Of them 19.7% occurred singly while 80.7% occurred in groups. They formed 43.2% of groups with females, 12.6% with immature males, 11.5% with adult males, 6.6% with sub-adult males, 15.3% with sub-adult males and females, 4.4% with adult males and females, 3.3% with adult males and sub-adult males, 7.7% with sub-adult males, adult males and females. There was no seasonal variation in the occurrence of immature males either as singles (G = 1.093 NS) or in groups (G = 2,962, NS) (Fig. 2c).

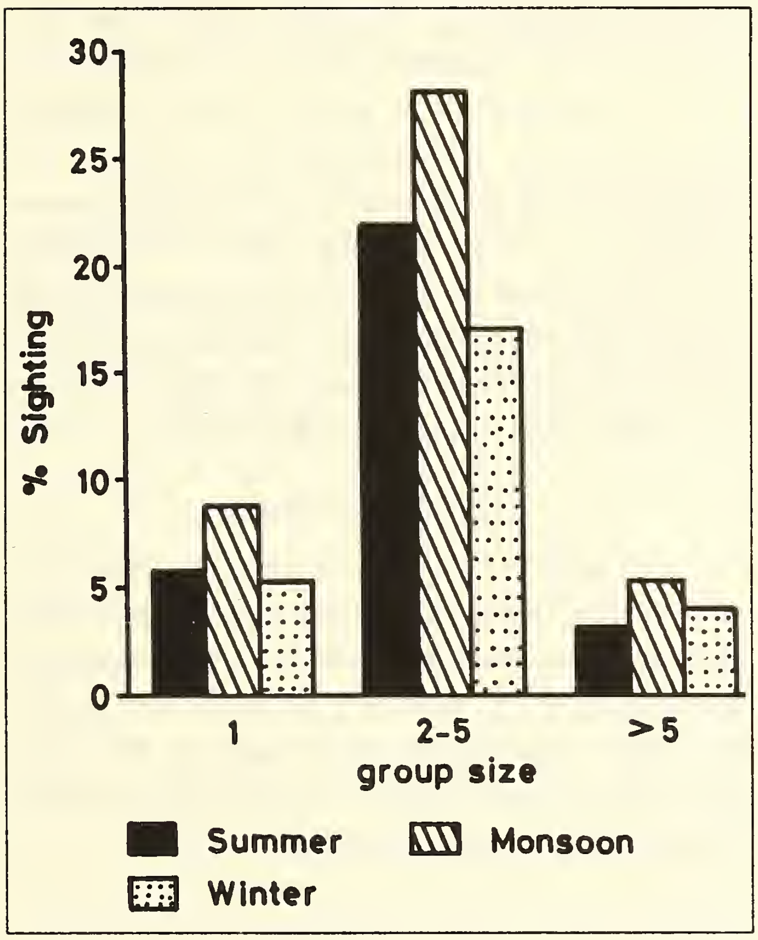

Fig. 2c. Grouping pattern of peafowl, immature male

Females: Total sightings of females were 721. 34.8% of females occurred singly while 65.2% occurred in groups. They formed 27.9% of groups with females, 22.6% with sub-adult males, 16.8% with immature males, 15.7% with adult males, 7.7% with adult males and sub-adult males, 6% with sub-adult males and immature males, 1.7% with adult males and immature males and 3% with adult males, sub-adult males and immature males. There was no seasonal variation in the occurrence of females as singles (G = 1.088 NS) or in groups (G = 4,934, NS) (Fig. 2d).

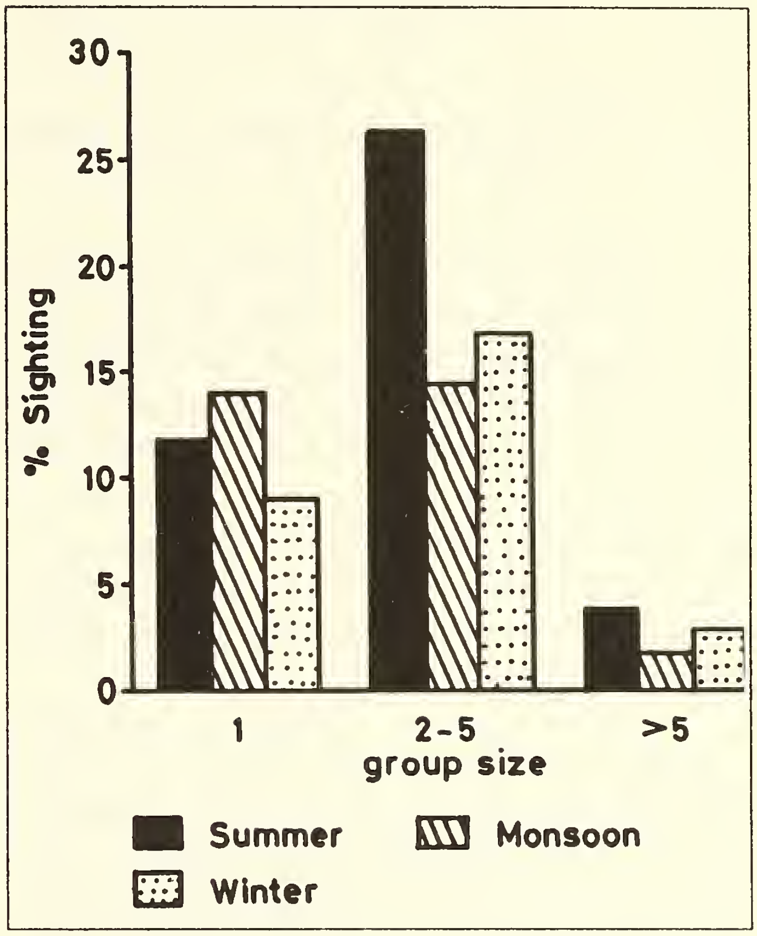

Fig. 2d. Grouping pattern of peafowl, female

Discussion

The high seasonal variation in group size of peafowl can be attributed to the social organization. All the age and sex classes were observed to be temporarily associated, except for the females and chicks, which had a strong bond. Species with a closed family unit structure exhibit a constant group size whilst those with an open structure exhibit large seasonal changes (Rodgers, 1977). Peafowl exhibits an open membership social structure. The seasonal variation in group size did not appear to be governed by the availability of food, as the species did not face "resource crunch" due to the presence of crop fields around the study area. The variation of group size between the 'closed' and 'open' habitats could be explained by the structural differences of the two habitats and the difference in the availability of food between the two habitats. While the crop fields provide a perennial supply of food, there is scarcity of food during summer in the 'closed' habitat (Yasmin, unpubl. data). Occurrence of greater proportion of groups in the open habitat suggests an anti-predator strategy in response to structural differences in the two habitats, but at the same time feeding by 'local enhancement' (Hinde, 1961) is also important in peafowl because birds were seen flying directly from roost and joining the feeding flocks in the crop field. Clark and Mangel (1984) suggest that birds flock in response to patchy distribution of food rather than in response to predation pressure. I find that peafowls aggregate in the crop fields in larger group size mainly because of high food availability and partly due to increased vigilance.

The seasonal variation in group composition could be influenced by the reproductive pattern and social organization of peafowl. The adult males might have the tendency to remain solitary due to aggressiveness. When the birds were baited on wheat in the non-breeding season (February), usually the females and sub-adult males fed amicably, with some sporadic fighting. However, when the adult male arrived, it invariably pecked the sub-adult males away. There was an increase in the males' solitary behaviour during the breeding season as the males established territories (i.e. from June-September). The monthly variation in solitary behaviour of males in response to monthly photoperiodic length suggests that photoperiod acts as a cue for the onset and offset of breeding season. The sub-adult males showed grouping pattern intermediate between that of adult males and immature males. They showed seasonal change in both solitary behaviour and formation of groups. This was probably because sub-adults tend to establish territories and display near adult males as well as join the female groups while the latter visit lek. The immature males and females did not show seasonal change either as singles or as groups. This was probably because immature males and females tend to live in groups for at least one year and there was a tendency of broods to be together. The females became solitary in the post-mating season because of egg laying and incubation. The proportion of mixed groups rose in the postbreeding season in winter when the adult males had undergone moulting and abandoned lek and the females had brought out the chicks.

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ON A SURVEY OF THE GANGES RIVER DOLPHIN *PLATANISTA GANGETICA* OF BRAHMAPUTRA RIVER, ASSAM[1]

R.S. Lal Mohan[2], S.C. Dey, S.P. Bairagi and S. Roy[3]

(*With a plate and five text-figures*)

Key words: Ganges river dolphin, *Platanista gangetica*, Brahmaputra, population estimate, mortality, ecology, behaviour, depletion of population, recommendations.

Population of Ganges river dolphin, *Platanista gangetica* in the river Brahmaputra from South Salmara to Sadiya is estimated to be 400. Annual mortality is about 60. The river was divided into 6 sectors and the population of dolphins in each sector was studied. Size range, distribution in relation to depth and distance from the bank, fishing activities, relation between dolphins and river terns, behaviour, resident populations and depletion of fish stock were studied.

Introduction

The Ganges river dolphin, *Platanista gangetica* is distributed in the rivers — Ganges, Brahmaputra and Meghana river systems. It is known as 'susu' in Hindi and 'shihu' in Assamese. Anderson (1878) published a detailed observation of its biology, anatomy, behaviour and ecology. About a hundred years after his work, Pilleri (1970, 1980), a Swiss scientist made a detailed study on its embryology, sonar mechanism and ecology. He could capture a few specimens from Brahmaputra. Kasuya (1972) transported four dolphins to Japan and made observations on its behaviour. Kasuya and Haque (1972) conducted a study of the population of the river dolphin, *P. gangetica* of Bangladesh rivers and estimated its population to be about 770. Jones (1982); Mohan (1989, 1992, 1994a,b, 1995); Mohan *et al.* (1993); Gupta (1986); Rao *et al.* (1989); Shrestha (1989); Reeves and Brownell (1989); Reeves *et al.* (1993); Sinha (1991, 1992); Hussain *et al.* (1993); Smith *et al.* (1994, 1995) and, Reeves and Leatherwood (1995) studied various aspects of the Ganges river dolphins of India and Nepal.

Gupta (op. cit.) counted 59 dolphins in the Ganges and its tributaries. Mohan (op. cit.) observed 21 dolphins in the Ganges from Kanpur to Farakka barrage and estimated its population to be about 600 in the Ganges. Sinha (op. cit.) recorded 217 and 109 Ganges river dolphins in 1992 and 1993 respectively between Buxar and Farakka barrage at the confluences of various tributaries of the Ganges. Rao *et al.* (op. cit.) studied the population of river dolphins of Chambal river and estimated the number as 40. But our information on the Ganges river dolphins of Brahmaputra is far from satisfactory. Hence this study was undertaken.

Material and Methods

The survey of the tributaries of the river was conducted from October 1992 to June 1993[4]. The larger tributaries like Teesta, Manas, Subansiri, Dihang, Dibong (upto Boling) Luit (upto Teju) on the northern bank and Jingiram, Kulsi, Kalong, Dhansiri, Disang, Dihing, Noa-Dihing on the southern bank were surveyed.

The main stream of the river was surveyed from 15th February to 18th March, 1993. The

[1]Accepted February, 1997

[2]Conservation of Nature Trust, Calicut-673 005,

[3]Department of Zoology, Guwahati University, Guwahati, Assam.

[4]However, the authors were visiting the resident populations for the last four years.

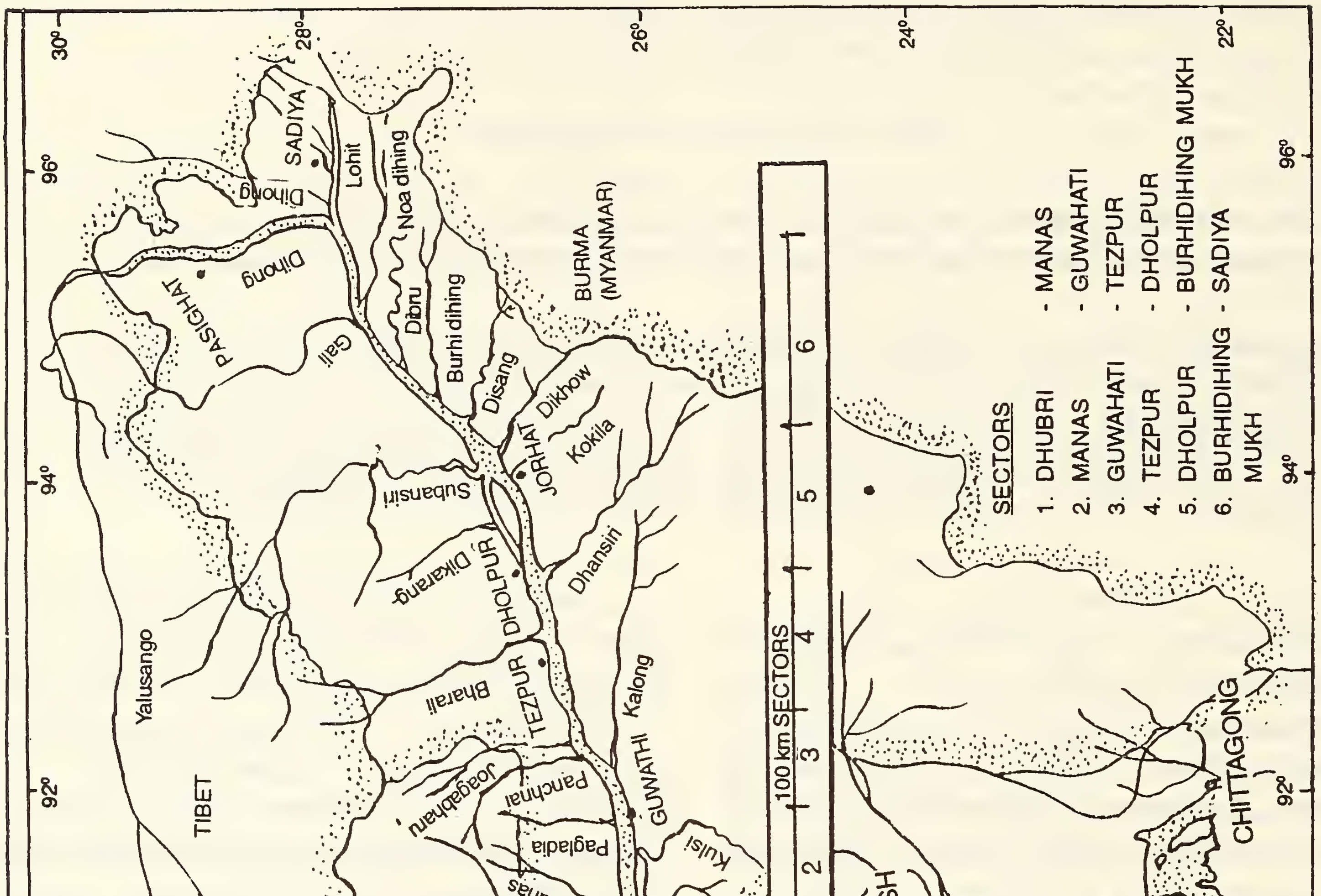

Fig. 1. River Brahmaputra with its main tributaries indicating the 100 km sectors of the study.

river was divided into the following 6 sectors, each covering about 100 km (Fig. 1)

Sector 1 South Salmara to Goalpara
'' 2 Goalpara to Guwahati
'' 3 Guwahati to Tezpur
'' 4 Tezpur to Dholpur
'' 5 Dholpur to Buridihingmukh
'' 6 Buridihingmukh to Sadiya.

Both the south and north banks of the main stream were studied. Apart from the population estimate, physical parameters such as temperature, transparency, depth and fisheries of the river were also observed.

A 30 ft (9 m) boat fitted with an 8-HP outboard engine was used for the survey. Observations were made by the investigators seated on the deck with binoculars, and camera fitted with 200 mm zoom lens. Whenever dolphins were sighted, the site of surfacing was approached and the following data were collected:

1. Depth of water
2. Distance from shore
3. Fishing activities
4. Surfacing time
5. Length of the dolphins

Dolphins measuring below 1 m were considered as calves, 1 to 1.75 m as adolescents and more than 1.75 m as adults. No attempt was made to segregate males and females in the field, though the adult females can be distinguished by their longer curved beaks. Precautions were taken not to recount or miss the dolphins. When the dolphins were sighted, their number was determined by the following criteria:

1. Number of dolphins surfacing simultaneously.
2. Number of dolphins surfacing within an interval of 5 sec at a distance of more than 10-20 m from each other.
3. Size of the dolphins.

The boat stayed at the site of surfacing for at least 30-40 minutes for counting the numbers. At least 3 counts were taken by each investigator on a well defined proforma. The number of dolphins in the area was determined after scrutinising the data from all the investigators. As most of the sightings were recorded from the confluences of the tributaries, more attention was paid whenever river mouths were reached. The river tern, *Sterna aurantia* was found in association with the dolphins and it was considered as an indicator species. Invariably, the river dolphins were observed in their neighbourhood.

Number and types of fishing nets and their catches were also observed. Upstream journey was taken along the southern bank, while the northern side was covered during the return journey. It was not possible to follow a direct path as sand bars blocked the navigation route and the boat often got grounded, imposing great hardship on the observers. It was difficult to extricate the boat from the sand bar. The boatmen were good navigators and they could cruise the boat very carefully through the deeper parts where there was just sufficient water to keep the boat afloat.

As the study was undertaken during the dry season, (March-April) the tributaries were dry and most of the dolphins had come to the main stream and were found in deeper waters.

A 12-hour schedule was followed from 0600 hours to 1800 hours without any break. Nights were spent in the boat anchored near the 'chars' or the river islands guarded by the stengun wielding security personnel of the Assam Police. The upstream journey took 13 days while downstream was covered in 9 days.[1]

Observations

[1]Considering the width of the Brahmaputra, the area to be covered, and the extent to which visual observations are possible, there are great constraints in the survey to make it truly quantitative.
The Brahmaputra cannot be surveyed in all months due to strong currents and cyclonic winds. Photo-identification, mark recovery and telemetric studies are not possible for these animals owing to their behaviour; they can neither be caught nor tamed. Methods used for terrestrial animals and the marine dolphins and whales cannot, therefore, be used for river dolphins.
The survey thus brings out only an indicative picture and cannot project a hundred per cent enumeration, which, under the circumstances, is near impossible.

Physical features: Transparency of the river was observed with the help of a Sechi disc. Three observations were taken at 10 km intervals and mean values of each station were recorded. In the first 100 km downstream, transparency was 20 cm. It was 40 cm, 45 cm, 48 cm, 57 cm and 65 cm in sectors 2, 3, 4, 5 and 6 respectively.

Water temperature was taken at 50 cm depth at intervals of 10 km during the daytime, and varied from 15°C-28°C. In the lower reaches, the temperature ranged from 23°C-28°C in sectors 1 to 4. Temperature varied from 18°C-23°C in the 4th and 5th sector. It dropped to 15°C-17°C in the 6th sector.

1. Dolphin Population: During the cruise from South Salmara to Sadiya, 266 dolphins were observed. The population density was analysed for each 100 km sector of the river, covering a distance of 650 km (Fig. 1). The maximum number — 58 dolphins were observed in the 3rd sector from Guwahati to Tezpur. The lowest number of 23 dolphins were observed in the last sector between Tengapani (Burhidihingmukh) and Sadiya. Water level was very shallow in this sector during the time of observation, and we could observe vast exposed areas. Population of dolphins in the first 300 km stretch was 53/100 km whereas it was only 35/100 km in the upper 300 km sector. The average number of dolphins observed per 100 km was 44 only, i.e. 0.44/km.

In the first sector from South Salmara to Goalpara, 47 dolphins were observed. The rivers Jingiram, Gangadhar, Gadaghar, Sankosh, Jinari, Moramanas and Manas become confluent with the main stream in this region. The second sector from Goalpara to Guwahati had a population of 54 dolphins. The rivers Krishnai, Singri, Dudhani, Puthimari, Kulsi and Pagaldia are in this sector. In the 3rd sector from Guwahati to Tezpur, 58 dolphins were observed. The confluence of Kalong river had a herd of dolphins. The tributaries Mangaldai, Rangapani, Dhansiri Panchnai, Belsiri, Jiagabharu, Kalong and Digru flow through this sector. The 4th sector extended from Tezpur to Dholpur. In this sector we observed only 34 dolphins. The tributaries Bharali, Baraganga, Burai, Salang from the northern bank and Diphlu and Dhansiri from the south bank meet the main stream. The 5th sector was from Dholpur to Burhidihingmukh. 45 dolphins were observed here. In this sector many large tributaries are present. Important among them are the Dikrang, Subansiri, Kakadonga, Dikho, Disang and the Burhidihing. The last sector from Burhidihingmukh to Sadiya had only 28 dolphins. The main tributaries in the sector are the Dibru, Noa-dihing from the south bank and Simen, Dibong and Dihang from the north bank (Fig. 2).

About 60% of the dolphins were found along the north bank from South Salmara to Guwahati, while from Guwahati to Sadiya 42% were along the north bank, 56% along the south bank and 2% dispersed in the main stream. Taking all the factors and the extent of the river into consideration, the total population in the river may not be more than 400 from south Salmara to Sadiya.

2. Size range: The size group of dolphins was studied based on their length. As it was not possible to measure the dolphin by conventional methods because the studies were made 'in situ', they were classified into calves, adolescents and adults based on its length upto 1m, 1-1.75 m and 1.75 m and above respectively.

It was observed that 57% were adults, 30% adolescents and 13% calves (Fig. 3). When the data was analysed sectorwise, it was found that the adults formed 75%, followed by 17% adolescents and 8% calves in the first sector; 59% adults, 37% adolescents and 4% calves in the second sector; 60 adults, 22% adolescents and 18% calves in the third sector; 45% adults, 40% adolescents and 15% calves in the fourth sector; 51% adults, 38% adolescents and 11% calves in the fifth sector; 54% adults, 25% adolescents and 21% calves in the sixth sector. It may be mentioned that adults were predominant in almost all sectors (Fig. 4). Only in the 6th sector were the calves more than 20%. Distribution of

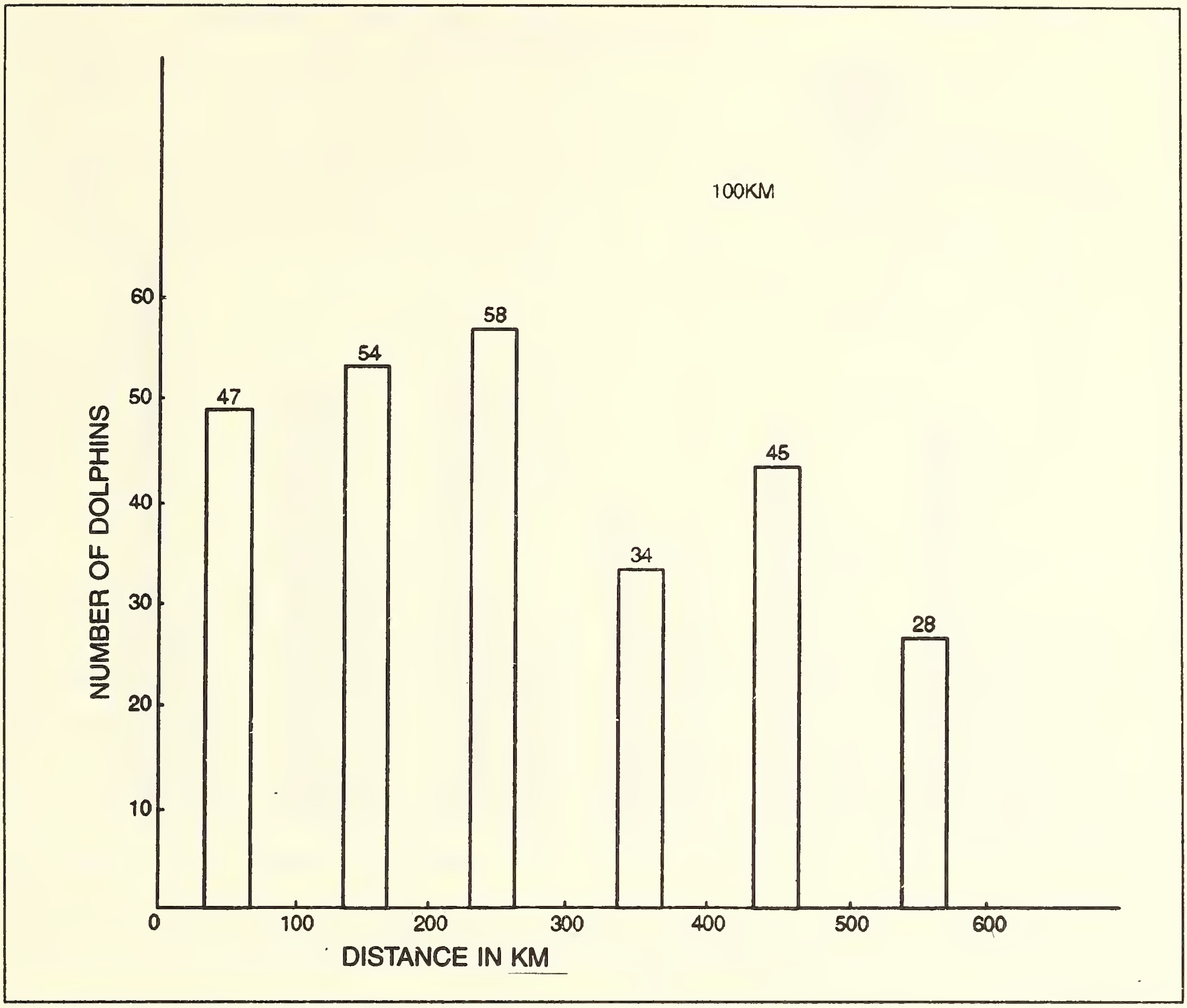

Fig. 2. Number of Ganges river dolphins observed in the River Brahmaputra

adults did not present a uniform trend. They were found in greater numbers in the first 100 km sector. Adolescents were found in greater numbers in the second sector, while more calves were found in the fourth sector.

3. Distribution of river dolphins in relation to depth: 40% of the dolphins were observed in 3.0 to 4.9 m depth and 27% were found in 7.0 to 8.9 m depth. Only 12% were found in the shallow waters of 1.0 to 2.9 m. Deeper water of 5 to 6.9 m harboured 18%, and only 3% were found in 9 to 15.9 m or more. The data was analysed in relation to the distribution of calves, adolescents and adults. The favoured depths for adults and adolescents were 3.0 to 4.9 m whereas calves were found in greater numbers in 7.0 to 8.9 m, indicating their preference for deeper waters. This observation was supported by the occurrence of calves of the dolphin in Khahalgon in Ganges, where the calves were observed in 25-30 m deep waters.

4. Occurrence of dolphins in relation to distance from the bank: 66% of the river dolphins were found 1 km from the bank, 22% from 1 to 2 km and only 12% were found beyond 3 km from the bank. The size groups were also analysed to find whether there was any preference to distance from the bank. Here again, the adults, adolescents, and calves showed preference to near-bank areas.

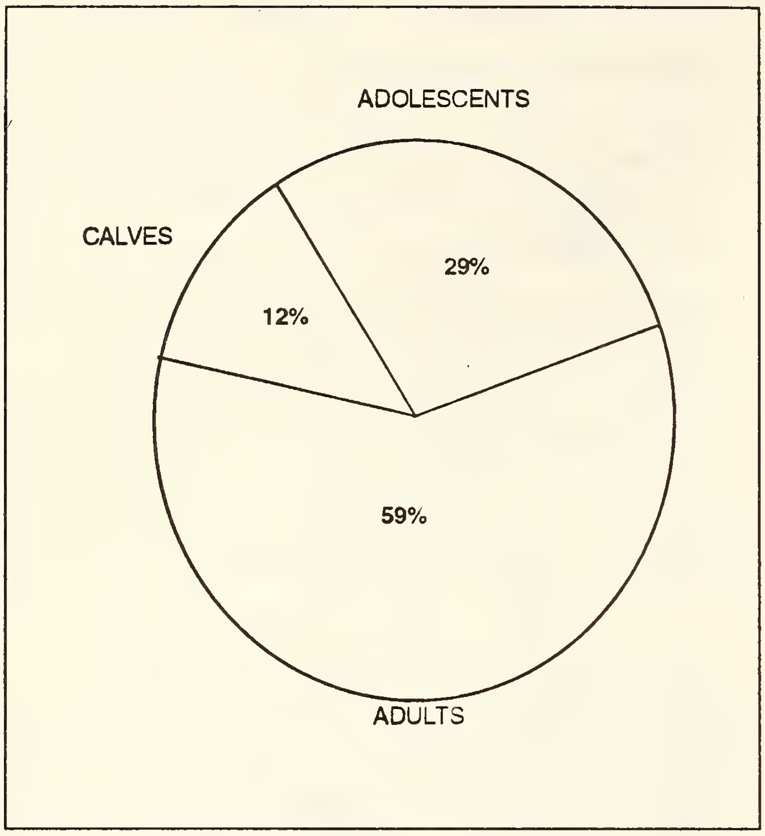

Fig. 3. Percentage of adults, adolescents and calves of Ganges river dolphins in the River Brahmaputra

5. Occurrence of dolphins in relation to fishing activities: The river dolphins were found in larger numbers where there was fishing activity, which in turn, depended on the concentration of fishes in an area. In one instance, fishermen were seen splashing the surface water with oars to chase away dolphins taking away fishes from the net. Dolphins were also found in the vicinity of human activities like bathing ghats and washing ghats. They were seen surfacing 5 to 10 m away from where children were bathing. Young dolphins were found close to human activities.

6. River tern as an indicator species: The river tern (*Sterna aurantia*) was associated with the river dolphin. Very often dolphins could be located with the help of river terns. The terns fly over the surfacing dolphins and catch fishes that jump due to the disturbance caused by the dolphins. In a few instances, the terns were found to snatch fish from the beaks of the dolphins. Of the total number of terns observed, 26% were associated with river dolphins. On one occasion, about 31 terns were noticed, however, they were usually found alone. But flocks of 10-13 were observed at the confluences of the river Kalong. The terns were found feeding on fishes. 16 river terns were observed along with the river dolphins at the confluences of the Subansiri river. Birds were found hovering over the dolphins. Dolphins were observed at a distance of about 1-15m from the terns, indicating their close relationship.

7. Behaviour: The river dolphins were found alone in pairs or in units of 3 comprising an adult male, a female and a calf. A school of 10 dolphins was observed at the confluence of Kalong river, and 15 dolphins were found at the confluence of Subansiri. Large dolphins more than 2.4 m long were solitary.

Various modes of surfacing were observed. The most common was the appearance of the beak followed by the melon and the anterior part of the body. This mode of surfacing was common when the animal was not feeding. In another mode, the beak was exposed at 30° to 45° followed by the body. Here the body was more exposed. Adult dolphins surfaced in this way. Very often, dolphins surfaced while projecting the melon to breathe. In this mode of surfacing, the body was hardly exposed. While feeding, dolphins were observed to chase the fishes, vigorously splashing their caudal flukes. The calves and adolescents were seen leaping over the surface of the water, exposing their entire body. This behaviour was usually seen in the late afternoon. An adult dolphin was once seen to leap over the surface in the Mihi bheel of Kaziranga National Park. The 'leaping' was found to be more frequent in calves, especially between 1430 and 1600 hrs.

8. Surfacing Interval: Interval of surfacing ranged from 10 sec. to 90 sec. The calves surfaced more often than the adults. But surfacing time was highly variable. Various factors such as depth of the river, current flow, food availability, and other factors like fishing activities and human disturbances influenced the surfacing of the dolphins.

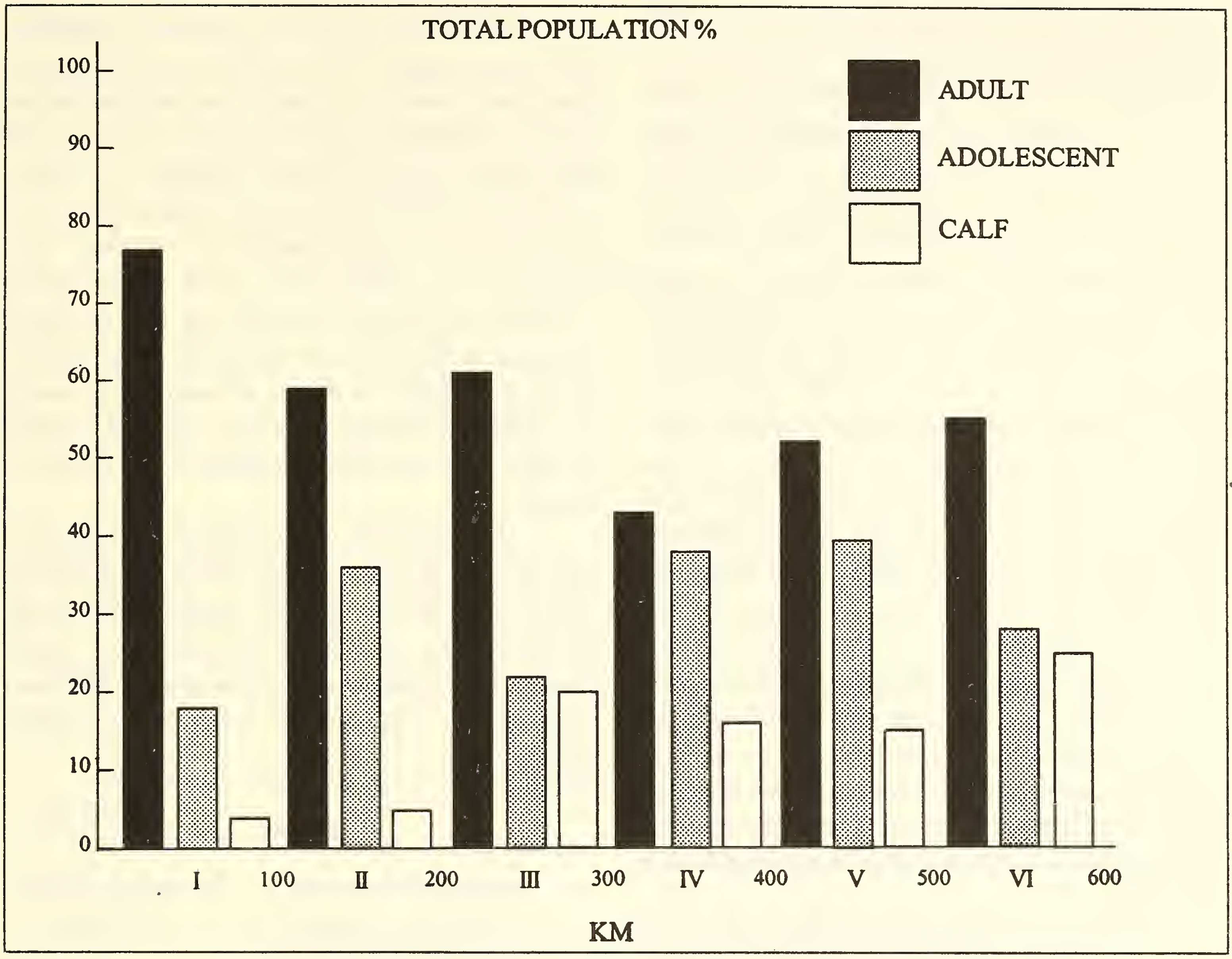

Fig. 4. Distribution of Ganges river dolphins in each sector of the River Brahmaputra

The breath of the dolphins had a foul smell, which was more keen on windless days in small rivers like Kulsi. The smell was similar to the breath of cows. It was pungent in bigger dolphins.

9. Resident populations: When the river dolphins were found throughout the year in a river without migrating back into the main stream during the dry months, they were considered as a resident population. Such populations were found in Kulsi river, Subansiri river and in Mihi bheel. Historically, many tributaries of Brahmaputra harboured resident populations of dolphins. But due to human disturbance such as fishing, sand extraction and pollution, such populations were not found in the tributaries. In Bhagdoi river, a river dolphin population was found in the 1960s when Dr. Pilleri visited the area. He captured six dolphins from there in his attempt to transport them to Switzerland. But all of them died. When the senior author visited the river in 1993, no dolphins were found in the river and the river was silted and almost dry with less than 30 cm of water.

a) Kulsi river dolphin population:

Kulsi river is located at 92° 30' - 93° 31' E and 26° 0' - 26° 10' W. It is one of the southern tributaries of Brahmaputra. River dolphins were found near the village Kukurma which is about 35 km from Guwahati. The river originates from the Meghalaya hills and meanders through a distance of about 120 km before meeting the main stream near Nagarbera. About 25 dolphins were found in the river sector of about 2 km in 1993. They were found in two areas adjacent to the deeper parts of the river. One sector was found north of the road bridge and the other on its south. The population consisted of 64.3% adults, 25% adolescents and 9% calves. But the river was degraded due to sand extraction. About 100 lorry loads of sand were extracted daily for at least 250 days in a year. The removal of the sand has its ill effects like increase in turbidity, soil erosion along the banks, reduction in the productivity and silt formation in the downstream areas. There was over-exploitation of fishery resources also. For our study, the Kulsi river was divided into 9 sectors, each covering about a kilometre. Dolphins took refuge in deeper areas during the lean period, foraging in the adjacent areas where there was an abundance of fish. Mohan (1996) has reported 61 species of fishes and 4 species of prawns from the Kulsi river. But with the change in the morphology of the river due to sand extraction, the habitat of dolphins was seriously affected. Dolphins were not harmed by the local people as they feel that killing them would invite bad luck.

b) Resident population of Subansiri river:

Subansiri is one of the fast, turbulent northern tributaries of the Brahmaputra bordering the northern bank of the Majuli Island. It originates from Tibet, having an annual discharge of more than 20 million cusecs. The area between Subansirimukh and Dikrangmukh had a population of about 25 river dolphins. During the 1950 earthquake which caused large scale land slides and seismic explosion, large numbers of dolphins died in the river. The river bed also had aggraded to about a metre, causing severe flood during the rainy season. Here dolphins were killed by the 'Mising' tribes for their meat. They were often brought to the Jingramukh fish market.

c) Resident population of 'Mihi bheel' of Kaziranga National Park:

Mihi bheel was located inside the Kaziranga National Park. The 'bheel' was about 5 sq. km in area, fringed by wetland vegetation and water plants. The middle portion of the bheel was about 6 m deep. The marginal areas were so shallow that one-horned rhinoceros and swamp deer were seen wading. As it was located in the protected area, the bheel was very rich in fish. Large numbers of 'chital' fish (*Notopterus chitala*) were seen in the bheel 'surfacing', especially during the evening resembling that of river dolphins. Nearly three hours were spent in the river rowing in a small, 5 m dinghy covering the entire bheel. We could observe only one large dolphin of about 2.4 m length.

10. Mortality of dolphins: It was estimated that in 1993-1994 about 60 dolphins were killed accidentally or intentionally in the Brahmaputra. Enquiries revealed that many were killed from Malka Char (South Salmara) to Goalpara followed by Jorhat to Dibrugarh (Table 1).

TABLE 1

Malkachar to Goalpara	15
Goalpara to Guwahati	5
Guwahati to Tezpur	5
Tezpur to Jorhat	10
Jorhat to Dibrugarh	12
Dibrugarh to Sadiya	10
Total	57

The dolphins were killed mainly for their meat and oil. 'Mising' tribals relish dolphin meat, while in the lower reaches from Malkachar to Goalpara it was mainly killed for its oil which was used for the preparation of bait for the catfish *Clupisoma garua* (Mohan and Kunhi, 1992). The oil is used for the preparation of medicines for rheumatism and also for pain in the joints.

A mortality curve (Fig. 5) highlights the impact of mortality on the river dolphin population.

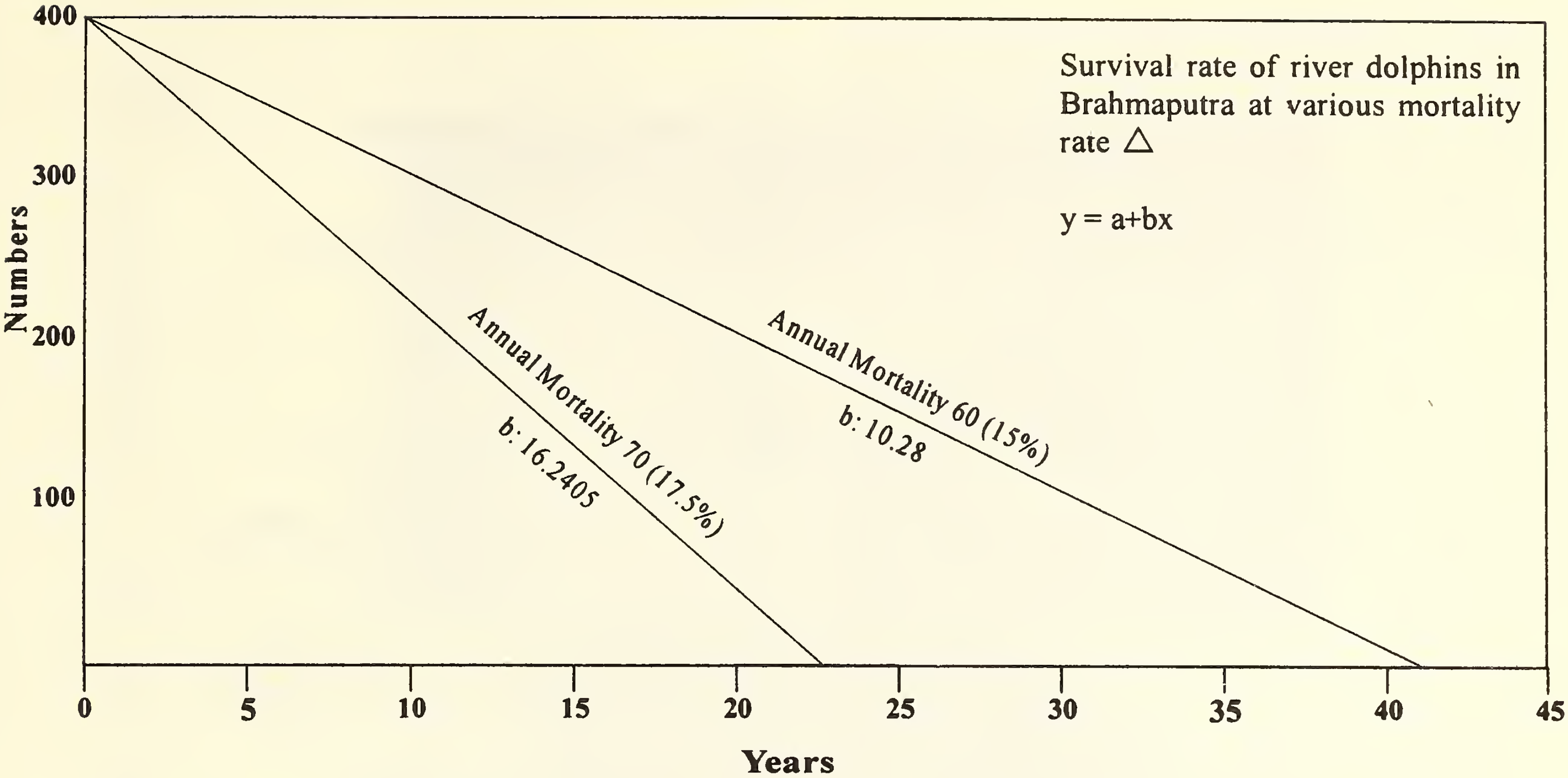

Fig. 5. Mortality curve of river dolphin population of the River Brahmaputra for the year 1993

The following data was used for the calculation:

Total population (estimated)	:	400
Calves	:	48 (12%) (Recruitment)
Adults	:	236
Adolescents	:	116

Though the actual number observed in the main stream was 266, due to the river span which is about 8 km in some areas, there was a possibility of missing some of them in each sector. Hence it was estimated that there may be 400 dolphins in the river from South Salmara to Sadiya.

Status of its population with a mortality of 60 and 70 numbers annually was calculated using the formula:

$y = a + bx$, where x is the years and y the number

It was observed that if the mortality was 60 numbers, the population would last for 38.5 yrs, and if the mortality is 70 numbers annually, the population will last only for 23.7 yrs.

11. Major threats to the dolphin population in Brahmaputra: The major threats faced by the river dolphins of Brahmaputra are habitat loss, gill nets, poaching and fish stock depletion.

The Brahmaputra and its tributaries are highly silted and most of the tributaries run dry during summer. Though Brahmaputra is a mighty river with a drainage basin of 2,20,057 sq. km and receives about 60 tributaries it becomes shallow and not navigable during summer.

The severe earthquake of 1950 had elevated or aggraded the river bed, and caused extensive landslides in the northeastern hills and in the river Subansiri. Huge fissures had developed through which sand and silt soaked with water were ejected in many places. The river water was laden with heavy minerals which rendered it black. The sulphur content of the water was so high that it was declared unfit for consumption. The extraordinary shock of the earthquake with the seismic explosion had caused heavy mortality of fishes and dolphins. The river Brahmaputra had changed its course near Dibrugarh. Even today, some eyewitnesses testify to the drifting of large numbers of fishes and river dolphins in the river after the earthquake. Unfortunately there is no official or scientific data on the fishes or the number of dolphins killed in the earthquake.

a) Gill nets:

Gill nets of various mesh sizes are operated in the river. The large gill nets with mesh size of 8-12 cm having a depth of about 3 m and length 50-100 m are called 'fasi jals'. They are dangerous to the dolphins as they get entangled in them. These nets are in greater numbers in Dibrugarh, Neematighat, Silghat, Tezpur, Guwahati, Goalpara and Dhubri. About 20 'fasi jals' were operated south Salmara and Goalpara, 30 between Goalpara and Guwahati, 15 from Guwahati to Tezpur and about 40 between Tezpur and Dibrugarh (Table 2.) The dolphins get entangled in the nets when they try to feed on the fish caught in the nets. It has been observed that the fishermen splash the surface of the water with oars to scare away the dolphins.

b) Poaching:

River dolphins were killed by harpoons. One two or three pronged harpoons were used (Plate 1, Fig. 1). A harpoon unit consists of a wooden pole and a harpoon attached to a strong rope. A harpoon is fitted tightly to the pole. Fishermen throw the harpoon on the dolphin from the boat when the dolphins surface. The harpoon plunges deep into the flesh of the dolphin and gets released from the pole. The exhausted dolphin is then dragged to the boat and killed. Deep wounds were seen in the harpooned dolphins (Plate 1, Figs. 1 & 2). Nearly 20-25 dolphins are killed by harpoons annually. 'Bin' fishermen of Bihari origin, Bangladeshi fishermen from lower Assam and the 'Mising' tribes of upper Assam are experts in using the harpoons. The 'Mising' tribals consume the meat whereas the Bihari fishermen and Bangladeshi fishermen use the flesh and blubber to extract oil for the preparation of fish bait.

c) Depletion of fish stock:

TABLE 2

Types of Nets		No. of Nets
Native Names	English Names	
Fasi jal	Gill nets	113
Dheki jal	Lift nets	83
Boralia jal	Khati jal with pockets	102
Asra jal	Cast net	1000
Shangla jal	Clap net	2500
Thela jal	Scoop net	1500
Kapda jal	—	120
Tanalagi jal	Pocket nets	120
Rosor Uta jal	Gill net with 2 ropes	50
Current jal	Drift net with monofilament webbing	120
Beng jal	Triangular net supported by bamboo frame	500
Bor jal or Maha jal	Large Drag seine net	60
Othal jal	Cast net variant, operated from a boat by 2-3 persons	100
Paa jal	`X' shaped net operated from a boat	100
Khora jal & Tongi jal	Rectangular nets	200
Poloh, Sepa, Jalko Poloya	Traps	5000
Kanta	Hooks and line	1000's

In recent years the fish catch in Brahmaputra has declined to a great extent (Yadava and Chandra 1994). There was a steep increase in the number of crafts and gear including the harmful net 'Kapda' jal made of mosquito webbing (Plate 1, Fig. 3). This net was used extensively from Dhubri to Sadiya though it was banned by the State Government. These nets removed the fry and fingerlings of almost all the species including the major carps. The small fishes *Aspidoparia morar, A. jaya,* and *Chela atpar* were also caught in the net.

Table 2 indicates the number of nets observed during the cruise.

Further the 'Mohildhar system' of leasing out the riverine areas to individuals based on auction has caused great harm to the fish resources, as the lessees are interested only in exploitation without any concern for conservation or augmentation of the fishery resources. Though the lessees sign an agreement that they will stock the rivers with spawn and fry, it is not followed in practice.

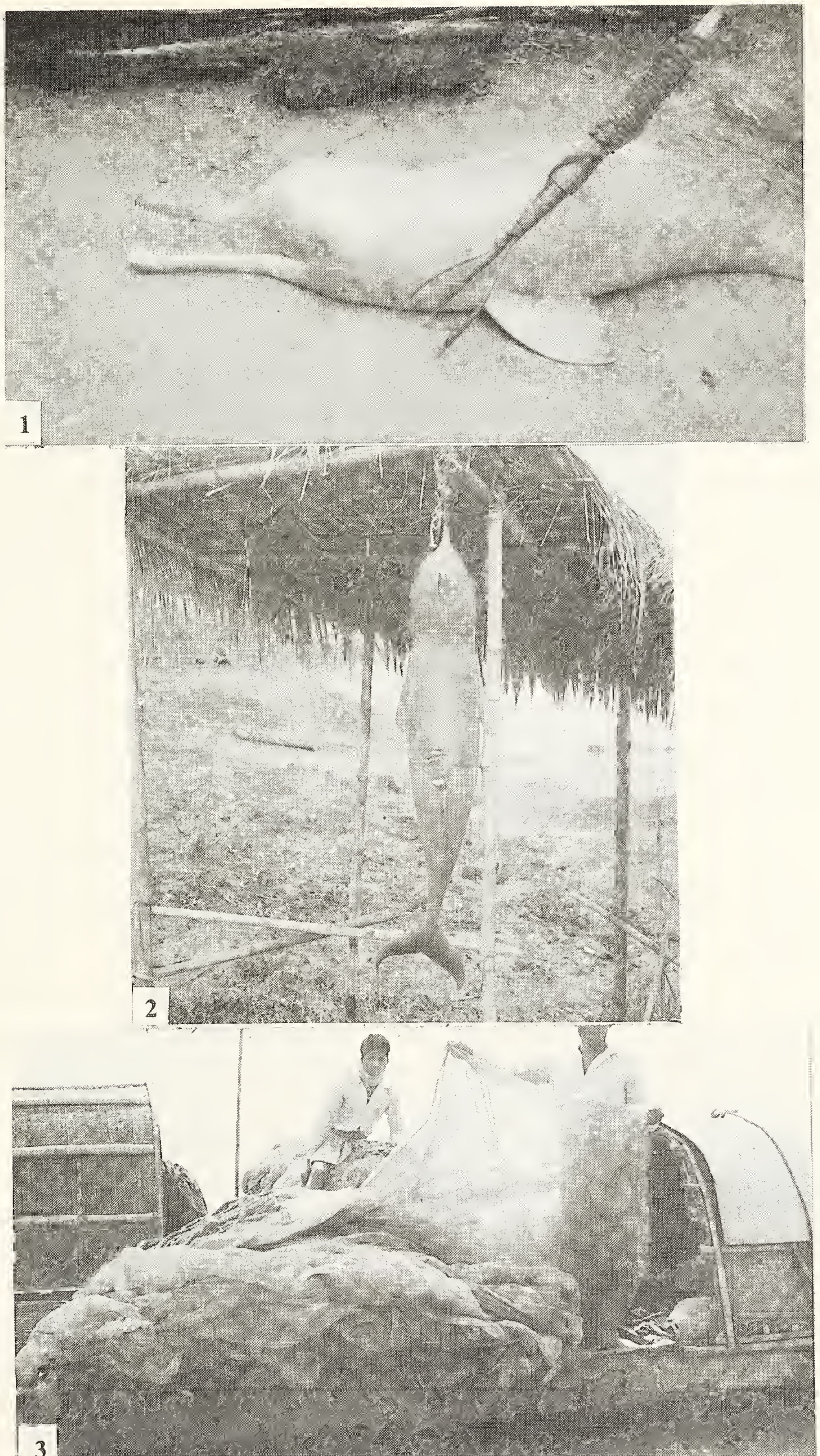

Fig. 1. River dolphin *Platanista gangetica* with harpoon;
Fig. 2. Harpooned Ganges river dolphin, Note the harpoon marks;
Fig. 3. The banned 'kapda jal' made of mosquito webbing used extensively in the river Brahmaputra.

Discussion

All the species of river dolphins are threatened all over the world due to various human activities. Habitat degradation, navigation and fishing activities have driven the river dolphins of the Yangtze river, (*Lipotes vexillifer*) to near extinction. Though the status of the Ganges river dolphin may not be as bad as *L. vexillifer,* its mortality rate causes serious concern.

The total population of the Ganges river dolphins in the river Brahmaputra can be assumed to be about 400. If the population is dissected the adults will be about 236 (59%), adolescents 116(29%) and the calves 48 (12%). If we consider the sex ratio as 1:1, the breeding population (females) will be about 118 (50% of the adult population). Though we have no information on the potential breeders of the population, it may be about 70% as has been calculated for other dolphins. In that case the number of potential breeders may be about 82. As they calve in alternate years, (Brownell 1984) the recruitment per year will be 41 or 10.25% of the population. It was observed that the mortality in gill nets and poaching ranged from 12.5% to 15%, which was too high to maintain a sustainable population.

Various methods were suggested for the survey of the dolphins in the river systems (Smith *et al.,* 1995). But it will not be possible to follow a uniform method in all the rivers as the topography and the morphology of the rivers are not the same. In the present study, the direct method was followed, as the width of the river is about 8 km in some places.

Kasuya and Haque (1972) found that 90% of the dolphins sighted were solitary individuals. They do not mention any gregarious schools. In the present study also, 70% were solitary individuals, 20% in pairs, 8% in threes and 2% in a school of more than 10 dolphins. Such schools were observed at the confluences of the tributaries with fast current. Such schooling behaviour may be attributed to the availability of food and not to any gregarious behaviour.

It had been observed in the marine dolphin *Cephalorhynchus commersoni* (Commerson's dolphin) that they got entangled in the nets not because they did not detect the fishing nets but because they did not always use their sonar mechanism or when they tried to feed on the fishes caught in the nets (Evans *et al.,* 1988). Many investigations have been made on the interaction of dolphins and gill nets and ways and means suggested to reduce dolphin mortality in gill nets (Dawson 1994, and Goodson *et al.* 1994). But no satisfactory device has been made so far to reduce the gill net entanglement.

Very little information is available on the lactating Ganges dolphin (Brownell 1984). According to a fisherman at Dihingmukh (upper Assam), a dolphin of length 2.3 m got entangled in a gill net. When it was transferred to the boat the milk got squeezed from the mammary glands and spilt in the boat. Two days after the incident, a calf was caught from the same vicinity. The dolphin was caught in April before the onset of monsoon.

Study of the fishery of the river is essential as fish constitute the major food item of river dolphins (Anderson 1879, Shrestha 1989, and Sinha 1992). From Assam, 129 species of fish were reported by Yadava and Chandra (op. cit.) and 119 species by Mohan and Rema Devi (1997). During the cruise, about 80 species of fish were collected from the main stream and 40 species were obtained from Kulsi river. Due to various human activities the fish production of the river has come down in recent years and Assam gets most of its requirement of fish from other states. Little detailed monitoring of the fish production is carried out. The catch statistics are available only from Guwahati and Jorhat (CIFRI, 1989-1990). In 1989-90 the total fish landings in both the centres were 247 tons and 36.4 tons respectively. Fish catch should be monitored at least from Dhubri, Goalpara, Guwahati, Tezpur, Jorhat, Sibsagar, Kamalbari, Dibrugarh and Sadiya to study the trend of fish landings.

Conclusion

Considerable progress has been made in recent years on the study of the river dolphin population of the Indian subcontinent. Population estimate is available for the major river systems. The total population of the river dolphins in India may be about 1000 and that of Bangladesh about 800. According to IUCN criteria, any mammalian species having a population below 2500 should be included in the endangered list. As the total population of *P. gangetica* is below 2000, the species should be included in the endangered list. At present the species is listed under vulnerable category according to the IUCN Red Data book. If the present mortality rate continues, the future is bleak and it may become extinct or cease to be a sustainable population within 50 years.

A high profile public awareness programme involving the local fishermen and the 'mohildhars' is essential to save the dolphins. Though the replacement of dolphin oil by fish oils in the preparation of catfish (*Clupisoma garua*) bait will reduce poaching pressure, gill net entanglement continues to be a major problem for dolphins. With the increase in the number of gill nets, the conflict between dolphins and fishermen is bound to increase. One of the best options to save them is to ban gill nets in areas where a large number of dolphins are found. The resident population of dolphins in rivers like Kulsi can be saved if soil extraction is stopped and further degradation of the river prevented.

Acknowledgements

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PROPOSED TAXONOMIC REVISION OF SOME IMPORTANT PENAEID PRAWN GENERA (CRUSTACEA : DECAPODA) OF KONKAN COAST (WEST COAST OF INDIA) [1]

D. I. Pathan and D. R. Jalihal [2]

(*With fifty-three text-figures*)

Key words : taxonomic revision, penaeid prawns, *Penaeus (Fenneropenaeus) merguiensis, Metapenaeus (?) dobsoni, Metapenaeus kutchensis, Parapenaeopsis stylifera, Acetes indicus, Acetes sibogae* complex.

During the faunistic study of penaeid prawns of the Konkan coast (west coast of India), represented by 29 species belonging to 3 families and 9 genera, several taxonomic problems were encountered. In depth systematic studies have indicated the need for the following taxonomic revisions : (1) *Penaeus (Fenneropenaeus) merguiensis* De Man 1888: The Australian/Pacific Ocean form assigned to this species differs from the typical Afro-Asian/Indian Ocean form at specific, or atleast subspecific level. (2) *Metapenaeus dobsoni* (Miers, 1878): One of the oldest proposals of assigning *M. dobsoni* as a genotype of *Mangalura* is further strengthened by its distinctiveness when compared with the remaining species of *Metapenaeus*, except *M. joyneri* (Miers, 1880). (3) *Metapenaeus kutchensis* George, George & Rao, 1963 : It is a valid species and not a synonym of *M. affinis* (H. Milne Edwards, 1837). (4) *Parapenaeopsis stylifera* (H. Milne Edwards, 1837): *P. stylifera* s.s. is a widely distributed species along both coasts of India and exhibits considerable variation in the number of fixed spines on telson. Both *P. coromandelica*/*P. stylifera coromandelica* (from east coast of India) and *P. stylifera cochinensis* (from southwest coast of India) should be treated as its junior synonyms only. However, all the remaining species of *Parapenaeopsis* differ from this genotype in several features, warranting independent generic status. (5) *Acetes indicus* H. Milne Edwards, 1830 : The morphological variations between Indo-Burmese and East Asian forms are not size-linked but are indicative of distinct geographic stocks, thereby justifying a separate nomenclature for the latter form. (6) '*Acetes sibogae* Hansen, 1919 complex': A thorough revision of *A. sibogae* complex is essential for understanding the extent/degree of inter and intraspecific variations among its members. Nevertheless, the Konkan material differs from all the remaining west coast forms assigned to *A. sibogae* but is identical with widely separated coastal Andhra Pradesh (east coast) material, and both together may eventually require a separate taxonomic status.

Introduction

The small maritime town of Ratnagiri (Konkan belt of Maharashtra State, west coast of India) is one of the major penaeid prawn landing, processing and export centres in India. The prawn fishery of this area is multigeneric and multispecific. Yet, surprisingly, information available on it is very scanty despite the fact that systematics of this group is not only essential in determining species-wise exploitable resources, but also applies to processing industry, aquaculture etc. The present investigation was, therefore, initiated with the twin objectives of (i) Systematic treatment of penaeid prawn resources of Konkan, particularly for the benefit of carcinologists, research workers, fisheries

[1]Accepted April, 1997.

[2]College of Fisheries (Konkan Agricultural University), Ratnagiri 415 629, Maharashtra.

scientists etc. and (ii) To formulate a field-key for the benefit of industry personnel, suppliers, fishermen and prawn farmers of the region.

Detailed systematic study revealed that the prawn fauna of Konkan region is represented by 29 species belonging to 3 families and 9 genera. However, several taxonomic doubts arose while carrying out detailed analyses of individual species. It was strongly felt that at least some species need nomenclatural revisions and these are dealt with in the present paper.

1. *Penaeus (Fenneropenaeus) merguiensis* De Man, 1888

Penaeus merguiensis De Man, 1888 : 227 (Type locality : Mergui archipelago, Burma/ Myanmar) ; *Penaeus indicus* - Bate, 1888 : 248 (NON H. Milne Edwards, 1837); *Peneus indicus* var *merguiensis* - Alcock, 1905 : 515; *Peneus merguiensis* - Schmitt, 1926 : 360; NOT *Penaeus merguiensis* - Racek,1955 : 221 (= a new form ?); *Penaeus (Fenneropenaeus) merguiensis* - Perez Farfante, 1969 : 466.

Material examined : 1523 males (80 to 160 mm) and 1716 females (75 to 190 mm) collected at Mirkarwada and Sakhartar Fish Landing Centres as well as in and around Konkan Krishi Vidyapeeth's Brackish Water Fish Farm (BWFF) from April 1989 to December 1991.

Remarks : *P. (F.) merguiensis* is the most important commercial species with good culture prospects along the south Konkan coast. The Konkan specimens, like all other Afro-Asian / Indian ocean material belonging to *P. (F) merguiensis*, possesses a distinct gastro-orbital carina as in De Man's type specimens from Mergui Archipelago (Alcock, 1906; Kubo, 1949; Hall, 1956, 1962; Cheung, 1960; Joubert, 1965; Chong and Sasekumar, 1982). This carina, however, is totally lacking in the individuals from Australia and Philippines/Pacific Ocean, assigned to the same species (Dall, 1957; Hall, 1962; Racek and Dall, 1965; Grey *et al.*, 1983). The present investigation has further revealed that the two forms also differ in several other characters as shown in Table 1.

TABLE 1

COMPARISON OF AFRO-ASIAN / INDIAN OCEAN (= TYPICAL) FORM OF *PENAEUS (FENNEROPENAEUS) MERGUIENSIS* DE MAN, 1888 WITH THAT OF AUSTRALIAN & PHILIPPINES / PACIFIC OCEAN FORM ASSIGNED TO IT.

Characters	Afro-Asian / Indian Ocean (= Typical) form	Australian & Philippines / Pacific Ocean form
1. Gastro-orbital carina	Present .	Absent.
2. No. of cicatrices on 5th abdominal segment:	2	1
3. Petasma :		
(A) Structure / Shape:	Stout, blunt and squarish.	Slender, pointed anteriorly and triangular.
(B) Distomedian projection:	Short, stout, bent laterally and subequal to ventral costa.	Slender, straight and distinctly longer than ventral costa.
(C) Distal spines of ventral costa :	Situated away from distomedian projections.	Situated just below distomedian projections.
(D) Tip of ventral costa	Ending in a prominent denticle.	Smoothly rounded without denticle.
4. Distal piece of appendix masculina	With numerous stout spines.	Without spines but with only long setae.
5. Thelycum :		
(A) Anterior process:	Covering posterior process completely.	Covering posterior process only partially (anteriorly).
(B) Posterior process:	A distinct, short, triangular piece.	A long piece with a narrow, elongated neck.

Even the larvae of the above two forms exhibit several important differences including number of nauplius stages during their metamorphosis (Raje and Ranade, 1972 ; Motoh and Buri, 1979).

In view of these differences, the Pacific Ocean stock merits a separate taxonomic status.

2. ***Metapenaeus (?) dobsoni*** (Miers, 1878) (Figs. 1-20)

Penaeus dobsoni Miers, 1878 : 302 {Type locality : Mangalur (= Mangalore) coast, Karnataka State, India} ; *Mangalura dobsoni* Miers, 1878 : 303 ; *Metapenaeus dobsoni* - Nobili, 1903 : 3 ; *Metapeneus dobsoni* - Alcock, 1906 : 21 ; *Penaeopsis dobsoni* - De Man, 1911: 60 ; *Metapenaeus dobsoni choprai* - Nataraj, 1942 : 468 .

Material examined : 1547 males (12.5 to 63.5 mm) and 1720 females (16.5 to 82.5 mm) collected from Mirkarwada Fish Landing Centre as well as in and around BWFF from April, 1989 to December, 1991.

Remarks : *M. dobsoni* is one of the most widely distributed and extensively studied penaeids. However, its generic status has created quite a lot of controversy. Miers (1878), the original author, observed that his species was quite unique in possessing (1) Triangular distal segment of mandibular palp (2) Slender third maxilliped (3) Rudimentary 5th pereiopods. But since his collection lacked males, he refrained from assigning it to the proposed new genus *Mangalura* (named after the type locality Mangalore, Karnataka State). This name remained unused until Burkenroad (1963a) pointed out its priority over the more popular generic name *Metapenaeus* of Wood-Mason and Alcock (1891). However, this generated a controversy since Holthuis (1962) had recommended to the International Commission on Zoological Nomenclature (ICZN) suppression of such unfamiliar names under its plenary powers, with a view to safeguarding the continuity of well established names to avoid unnecessary confusion. Burkenroad (1963b) responded by proposing to revise the genus *Metapenaeus*. Holthuis (1963), therefore, modified his recommendation based on which the ICZN, in its 1969 Addendum, included both *Metapenaeus* (Name No. 1829) and *Mangalura* (Name No.

TABLE 2

COMPARISON OF *METAPENAEUS (?) DOBSONI* (MIERS, 1878) WITH THE OTHER FIVE SPECIES OF *METAPENAEUS* (INCLUDING *M. BREVICORNIS*) OCCURRING ALONG THE KONKAN COAST

Characters	*Metapenaeus* (?) *dobsoni* (Miers, 1878)	Other species of *Metapenaeus* from the Konkan coast
1. FINGER / PALM		
(A) First cheliped:	0.40 to 0.60	1.30 to 2.00
(B) Second cheliped:	0.30 to 0.50	1.20 to 2.10
(C) Third cheliped:	0.20 to 0.40	0.90 to 1.60
	(i.e. Fingers distinctly shorter than even half of Palm.)	(i.e. Fingers distinctly longer than entire Palm.)
2. THIRD MAXILLIPED:		
(A) Dactylus:	More than 2/3 rd of (0.70 to 0.90-times) Ischium.	Less than 2/3 rd of (0.30 to 0.60 times) Ischium.
(B) Merus:	Longer than (1.30 to 1.60-times) Ischium.	Shorter than (0.60 to 1.00-times) Ischium.
3. ABDOMEN:		
(A) Pleura of first segment	Protruding anteriorly.	Anteriorly straight, without any protrusion.
(B) Fourth segment:	With 1 cicatrix.	With NO cicatrices.
(C) Fifth segment:	With 1 cicatrix.	With 3 cicatrices.

TABLE 2 (contd)

COMPARISON OF *METAPENAEUS (?) DOBSONI* (MIERS, 1878) WITH THE OTHER FIVE SPECIES OF *METAPENAEUS* (INCLUDING *M. BREVICORNIS*) OCCURRING ALONG THE KONKAN COAST

Characters	*Metapenaeus* (?) *dobsoni* (Miers, 1878)	Other species of *Metapenaeus* from the Konkan coast
(D) Sixth segment :	With 1 cicatrix.	With 4 or 5 cicatrices.
4. ROSTRUM:		
(A) Distal gap Distance between last two teeth	More than 5	Less than 5.
5. ANTENNULE :		
(A) Upper flagella:	Shorter than (0.70 to 0.94 times) lower flagella	Longer than (1.01 to 1.32 times) lower flagella.
(B) Number of non aesthetasc bearing segments on upper flagella:		
(I) Males:	Less than 3.	More than 4.
(II) Females:	Less than 8.	More than 9.
6. MANDIBULAR PALP:		
(A) Distal segment:	Triangular in shape.	Quadrangular in shape.
7. FIRST MAXILLA PALP :		
(A) Distal segment:	Long, slender and bearing a strong apical spine.	Short, stout and bearing a few apical hair-like setae.
8. ZYGOCARDIAC OSSICLE:		
(A) Number of teeth in Upper row :	17 to 20	10 to 15
(B) Number of teeth in Lower row:	20 to 27	07 to 16
9. THIRD PEREIOPOD (CHELIPED) BASIAL SPINE:	Exhibits sexual dimorphism - simple in females but in males modified into a strong elongated barbed structure extending beyond ischium	Does not exhibit sexual dimorphism - simple and similar in both sexes.
10. FIFTH PEREIOPOD:		
(A) Females:	In specimens above 75 mm, invariably broken (during copulation?) and represented only as a rudimentary structure.	Well developed, as in males, irrespective of size.
(B) Males:	Merus with TWO triangular teeth - both without any basal notch.	Merus with ONLY ONE spine or tubercle (of varied size and shape) - with a distinct basal notch.
11. DORSAL ASPECT OF PETASMA:	Inner margins of distolateral projections with a pair of spinulose hooks.	Inner margins of distolateral projection without any spinulose hooks.
12. COXAL PLATES OF FOURTH PEREIOPODS :	Extended into hood-like projections over anterior plate of thelycum.	Simple, smooth and not forming hood over anterior plate of thelycum.
13. UROPODS:		
(A) Outer margin of exopod:	Similar in both sexes - straight without any basal concavity.	Straight in females, but in males with a deep or shallow basal concavity.
(B) Colouration :	Distally with fluorescent yellow colouration.	Without any fluorescent yellow colouration.

1830) in its official list of Zoological Generic Names but without giving *Mangalura* precedence over *Metapenaeus*.

Unfortunately Burkenroad could not complete his proposed revision and the issue of giving validity to the generic name *Mangalura* has remained unattended. This is only possible by designating its genotype. The present observations clearly indicate that *M. dobsoni* should be designated as a genotype of *Mangalura* since it distinctly differs in more than 20 characters (Table 2, Figs. 1-20) from all the remaining 5 species of *Metapenaeus* inhabiting the Konkan coast *viz. M. brevicornis* (H. Milne Edwards, 1837), *M. moyebi* (Kishinouye, 1896), *M. monoceros* (Fabricius, 1798), *M. affinis* (H. Milne Edwards, 1837) and *M. kutchensis* George, George and Rao, 1963.

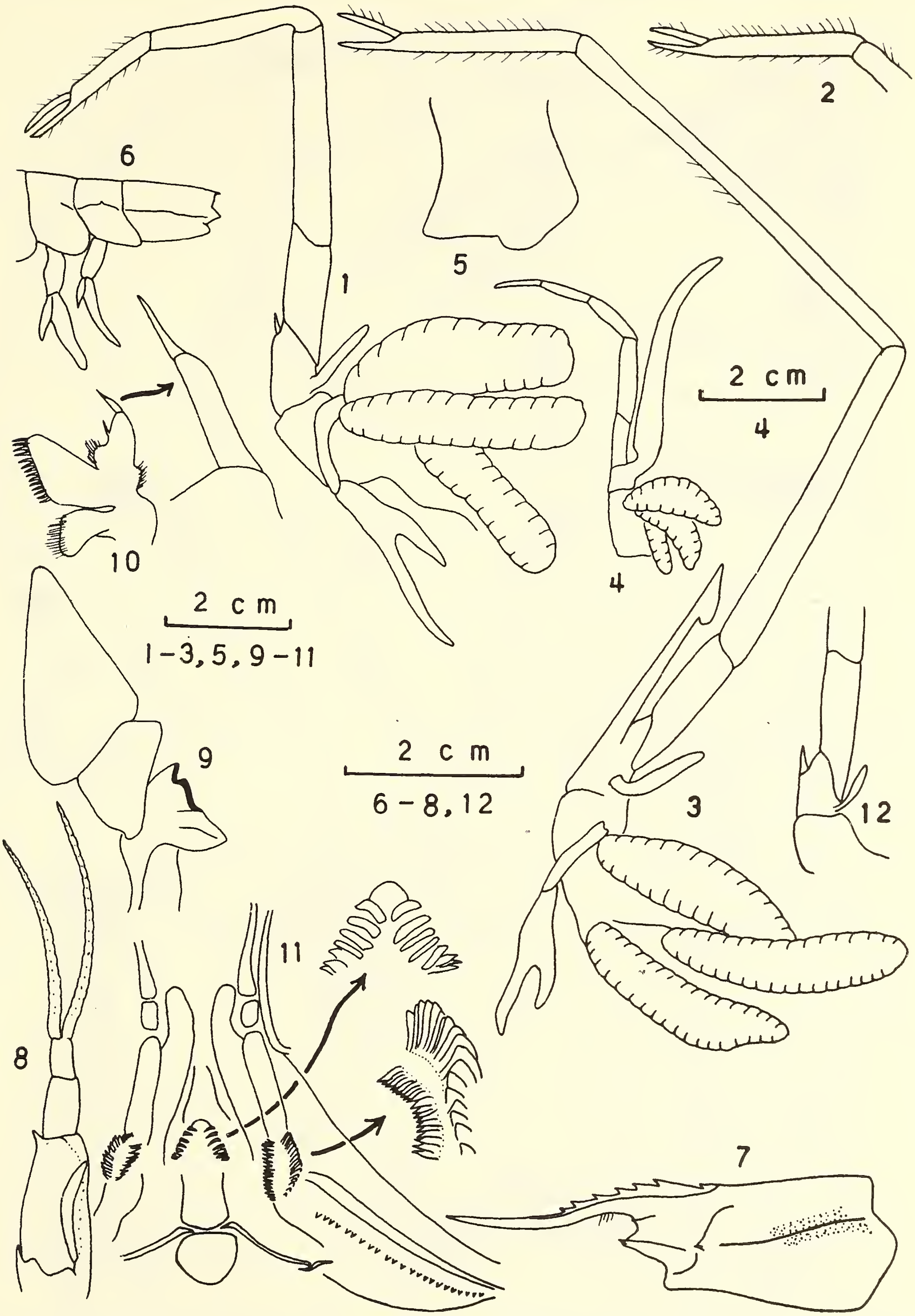
Whether these differences are restricted only to *M. dobsoni* proper or they hold true for the entire *M. dobsoni* complex which includes species like *M. joyneri* (Miers 1880), *M. brevicornis* (H. Milne Edwards, 1837), *M. lysianassa* (De Man, 1888) and *M. tenuipes* Kubo, 1949 (cf. Racek & Dall, 1965; Miquel, 1982), is rather difficult to surmise at present, unless all these species are extensively studied. The present investigation has clearly revealed that atleast *M. brevicornis* is closer to the remaining species of *Metapenaeus* than to *M. dobsoni*. In fact, only *M. joyneri* is close to *M. dobsoni* in possessing (1) Characteristic barbed basal spine on 3rd cheliped of male (2) Lateral plates of thelycum partially covering the median plate (3) A blunt (hook-like ?) projection dorsally along inner margin of distolateral projection of petasma (Miquel, 1982, Fig. 41 p.100 and Liu *et al.*, 1986, Fig. 110 p.179).

In view of the above, it is hereby proposed to revalidate *Mangalura* Miers, 1878 by designating *M. dobsoni* as its genotype and including *M. joyneri* under that genus.

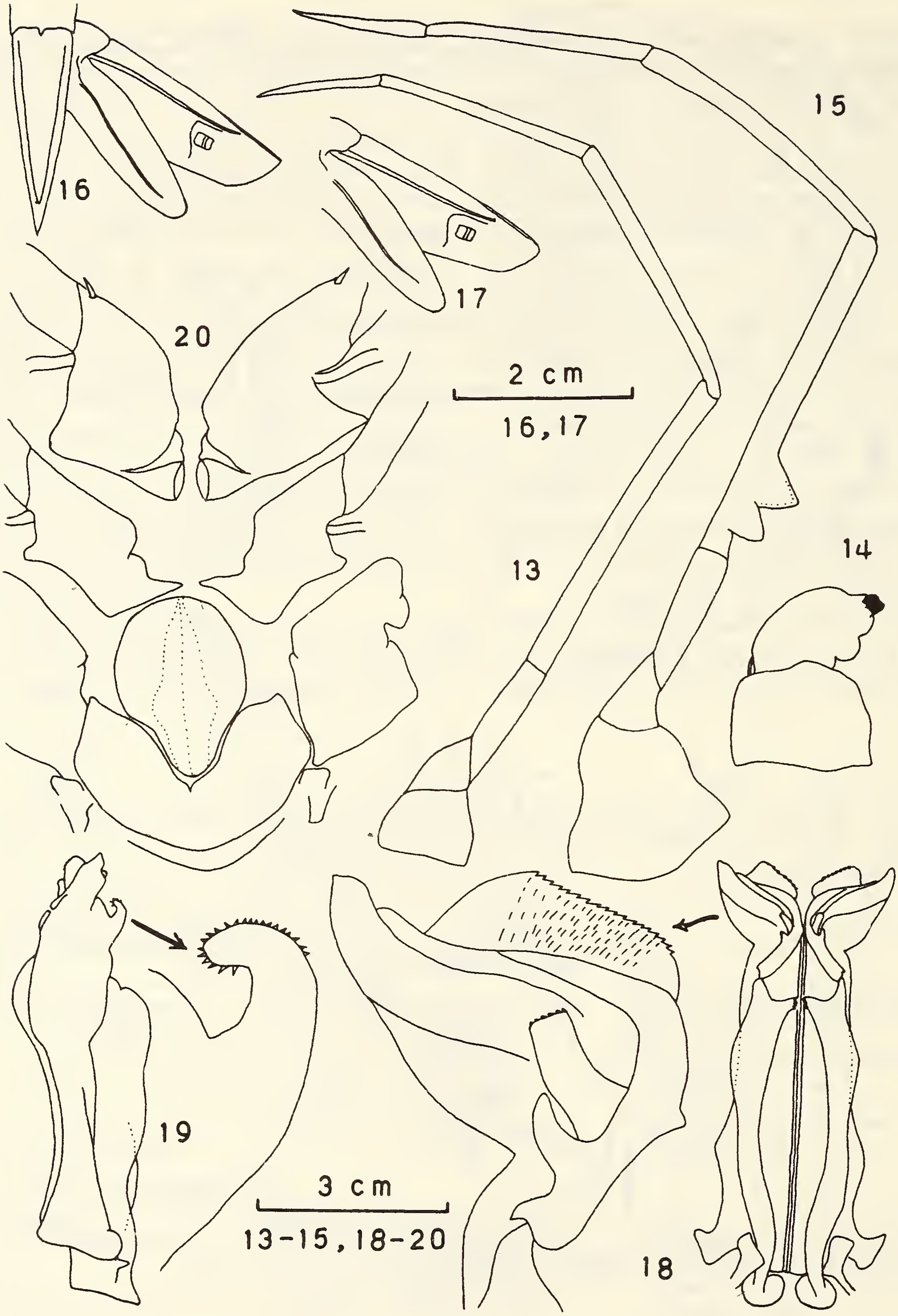
TABLE 3

COMPARISON BETWEEN *METAPENAEUS KUTCHENSIS* GEORGE, GEORGE & RAO, 1963 AND *M. AFFINIS* (H. MILNE EDWARDS, 1837)

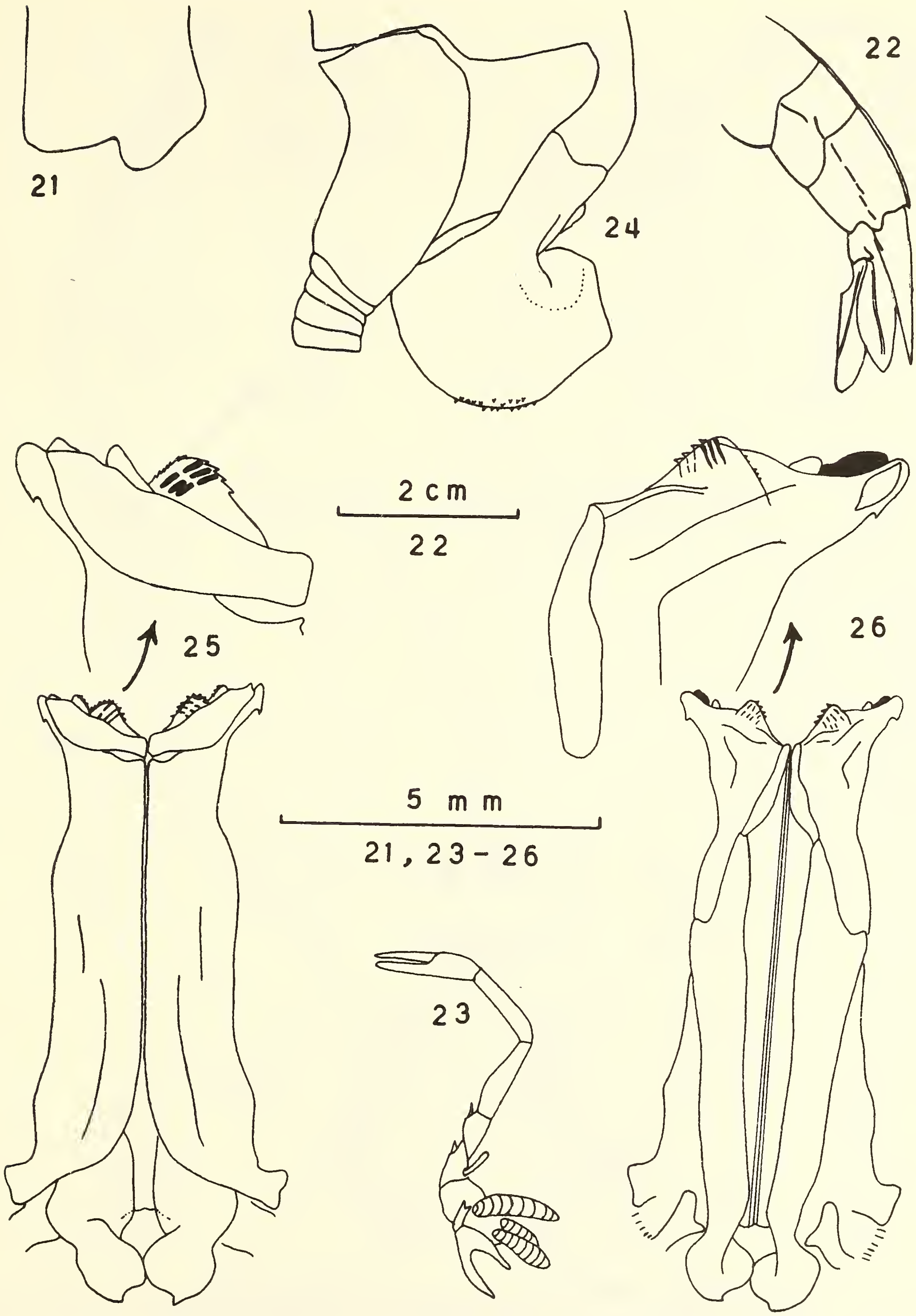
Characters	*Metapenaeus kutchensis* George *et al.*	*M. affinis* (H. Milne Edwards)
1. Abdomen		
(A) Pleura of Ist segment:	Conspicuously projecting ahead forming an acute angle behind median notch.	Broadly curved behind median notch.
(B) Cicatrices on 6th segment:	Distal 2 cicatrices arranged at lower level than proximal 3 cicatrices.	All 5 cicatrices arranged almost in a continuous line.
2. Ischium of first periopod:	Invariably with a distinctly sharp spine.	Without, or either with a blunt or distinctly sharp spine.
3. Meral tooth of fifth pereiopod in male:	Straight and without basal notch.	Bent down and with a basal notch.
4. Distomedian projections petasma:		
(A) Structure / Shape:	Smaller than or subequal to distolateral projections, thereby partially exposing their apical openings ventrally	Larger, extendng beyond or completely covering distolateral projections along with their apical openings ventrally .
(B) Channel between dorsal and ventral lobes:	Rather shallow.	Very deep.
5. Apex of anterior plate of thelycum:	Mostly concave or depressed and without bunch of cilia.	Mostly rounded, rarely depressed, and with characteristic bunch of cilia.



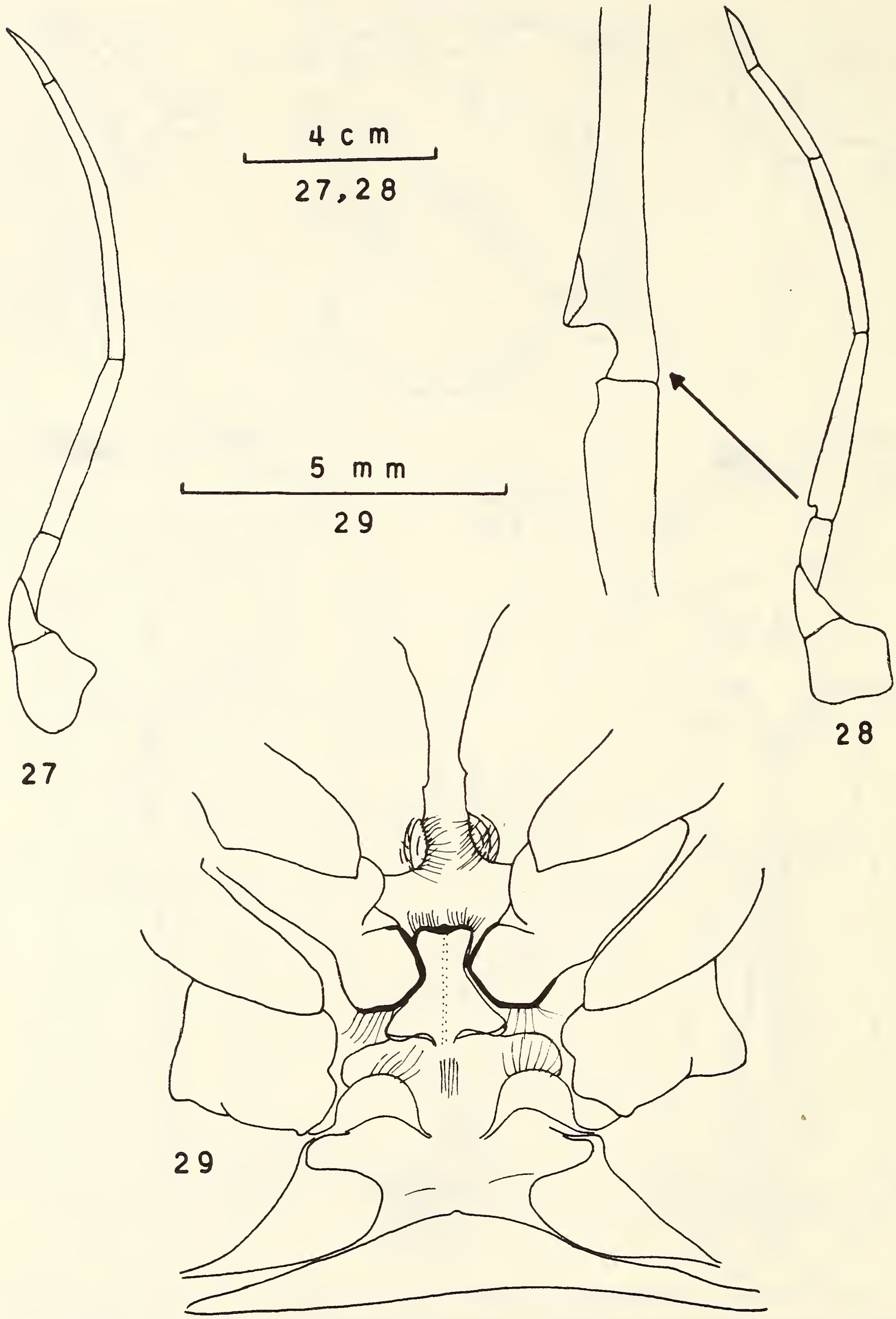
Figs. 1-12. *Metapenaeus* (?) *dobsoni* (Miers, 1878): 1. first pereiopod; 2. second pereiopod (fingers & palm); 3. third pereiopod of male; 4. third maxilliped; 5. pleura of first abdominal segment; 6. fourth to sixth abdominal segments; 7. carapace + rostrum (lateral view); 8. antennule; 9. mandible; 10. first maxilla; 11. gastric mill; 12. third pereiopod of female (basal portion).



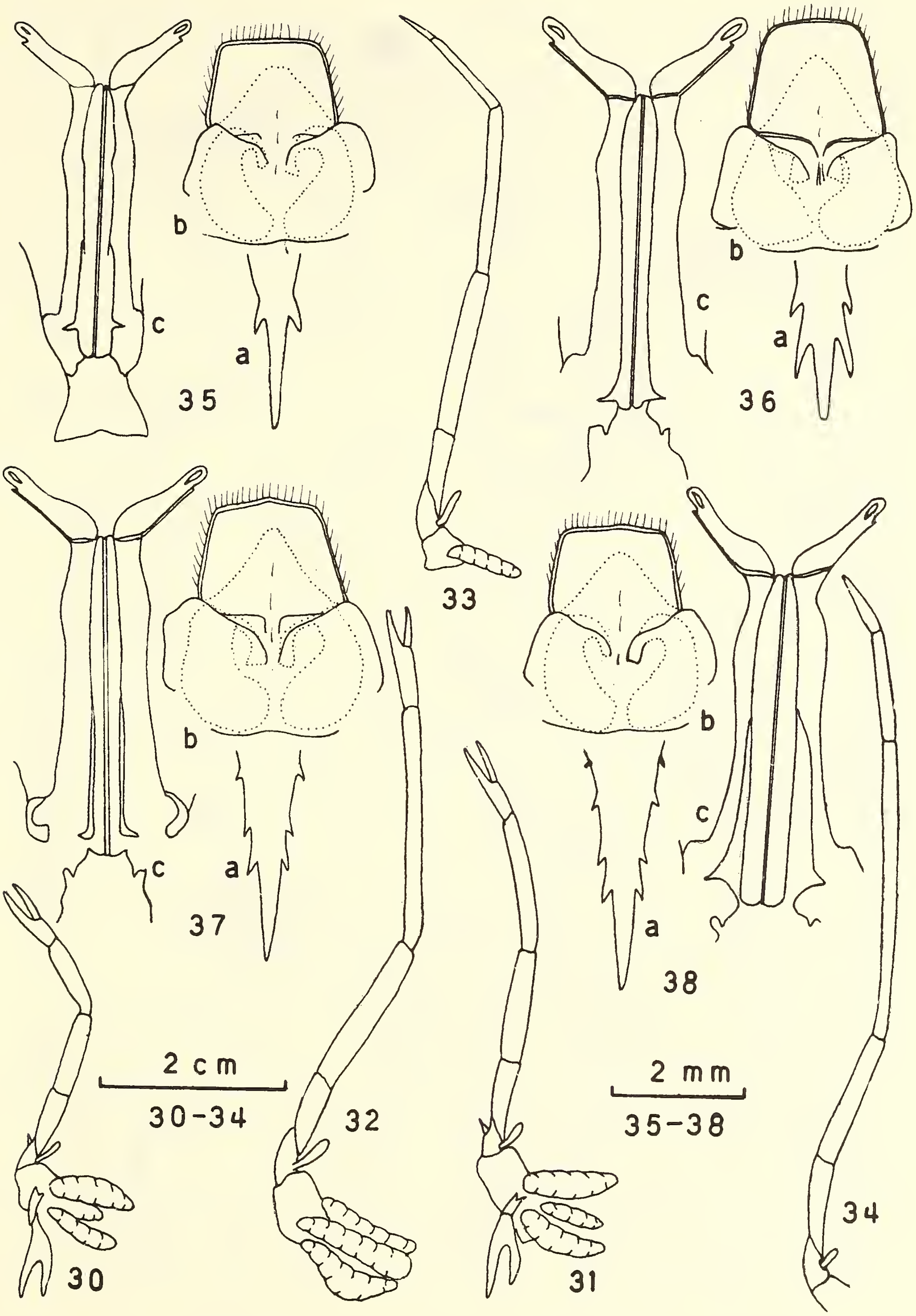
Figs. 13-20 *Metapenaeus* (?) *dobsoni* (Miers, 1878): 13. intact (unbroken) fifth pereiopod of female; 14. broken / rudimentary fifth pereiopod of female; 15. fifth pereiopod of male; 16. telson + uropods of male; 17. uropods of females; 18. petasma (dorsal view); 19. petasma (lateral view); 20. thelycum.



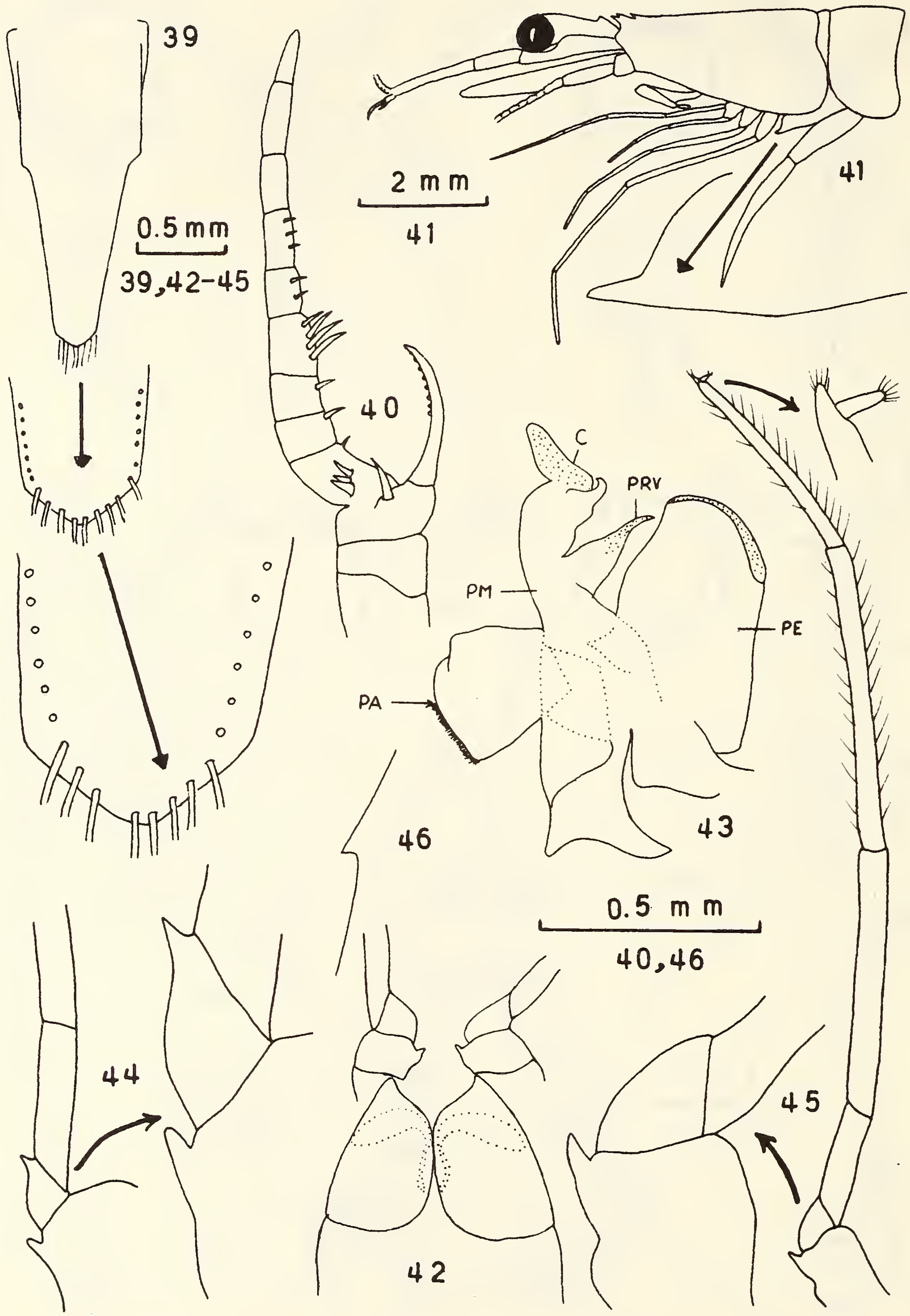
Figs. 21-26. *Metapenaeus kutchensis* George, George & Rao, 1963: 21. pleura of first abdominal segment; 22. fifth & sixth abdominal segments; 23. first pereiopod; 24. appendix masculina; 25. petasma (ventral view); 26. petasma (dorsal view).



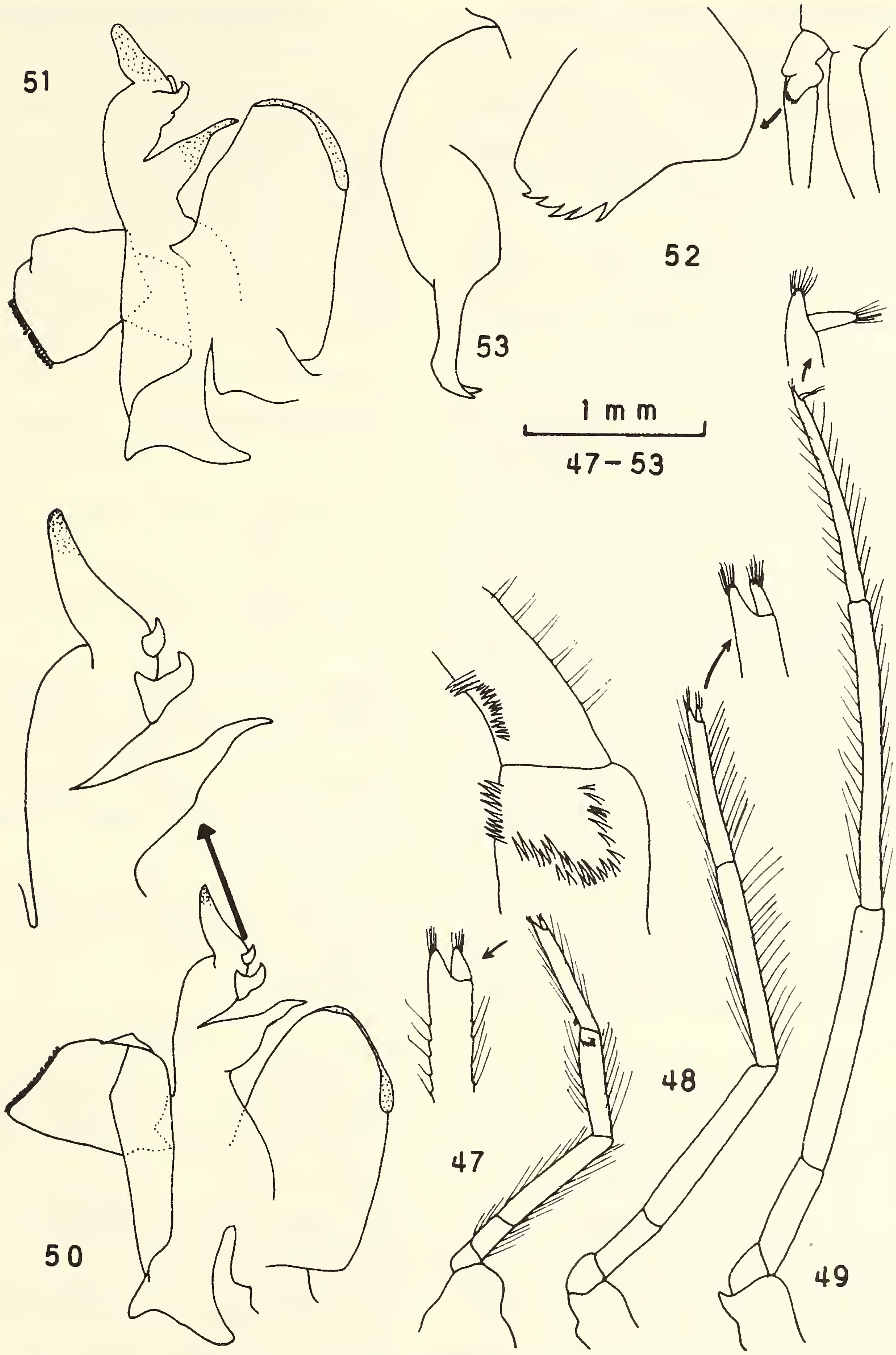
Figs. 27-29. *Metapenaeus kutchensis* George, George & Rao, 1963: 27. fifth pereiopod of female; 28. fifth pereiopod of male; 29. thelycum.



Figs. 30-38. *Parapenaeopsis stylifera* (H. Milne Edwards, 1837): 30. first pereiopod; 31. second pereiopod; 32. third pereiopod; 33. fourth pereiopod; 34. fifth pereiopod; 35. specimens with 1 pair of fixed spines on telson; 36. specimens with 2 pairs of fixed spines on telson; 37. specimens with 3 pairs of fixed spines on telson; 38. specimens with 4 pairs of fixed spines on telson; a. telson; b. thelycum; c. petasma.



Figs. 39-46 *Acetes sibogae* (?) Hansen, 1919: 39. telson; 40. lower antennular flagellum of male; 41. genital coxa of male (lateral view); 42. genital coxa of male (dorsal view); 43. petasma (improper mounting-distal / second falcate spine completely hidden); 44. third pereiopod of female (basal portion): 45. third pereiopod of male; 46. exopod of uropod showing outer spine; C, capitulum; PA, pars astringens; PE, pars externa; PM, pars media; PRV, processus ventralis.



Figs. 47-53. *Acetes sibogae* (?) Hansen, 1919: 47. first pereiopod; 48. second pereiopod; 49. third pereiopod; 50. petasma (proper mounting-showing both falcate spines clearly); 51. petasma (improper mounting-distal / second falcate spine partially hidden); 52. appendix masculina; 53. appendix masculina (lateral view).

3. ***Metapenaeus kutchensis*** George, George & Rao, 1963
(Figs. 21-29)

Metapenaeus affinis Alcock, 1906:20 (part); *Metapenaeus kutchensis* George, George and Rao, 1963 : 284 (Type locality : Gulf of Kutch, Gujarat State, India).

Material examined: 5 males (118.5 to 123 mm) and 5 females (122.5 to 136.5 mm) collected from New Ferry Wharf, Mumbai (= Bombay), on 24th November, 1990.

Remarks: The specific status of *M. kutchensis* was rather uncertain for nearly two decades mainly owing to the confused systematic position of *M. affinis* (H. Milne Edwards, 1837), its closely allied species (Mistakidis, 1968). Based on the original description and figures, Miquel (1982) had synonymised it with *M. affinis* during his revision of the genus *Metapenaeus*. But later, the examination of the holotype of *M. kutchensis* convinced Miquel (1983) that the two are really distinct species, differing from each other mainly in (1) thickness of petasma (2) configuration of petasma (3) shape of meral tooth of fifth pereiopod of males. The present study has shown that while 2 & 3 above are really valid, the same is not true for the character number 1. In fact, the two species can now be readily distinguished based on other additional characters (Table 3, Figs. 21-29).

In view of the above findings, it is now clear that figures of thelycum and petasma attributed to *M. affinis* by Alcock (1906) and Kubo (1954), actually belong to the present species. This is not at all surprising since all the specimens studied by Kubo (1954) and part of the material examined by Alcock (1906) originated from Karachi (Pakistan), very near to the Gulf of Kutch from where *M. kutchensis* was originally described (George *et al.*, 1963; George, 1980). *M. kutchensis* has also been reported from Mumbai by Kagwade (1978), who redescribed it on the basis of larger specimens.

4. ***Parapenaeopsis stylifera***
(H. Milne Edwards, 1837)
(Figs. 30-38)

Penaeus styliferus H. Milne Edwards, 1837 : 418 {Type locality: Around Mumbai (= Bombay), Maharashtra State, India}; *Penaeopsis styliferus* - Bate, 1881 : 183; *Parapenaeopsis styliferus* - Nobili, 1903 : 4; *Parapeneopsis stylifera* - Alcock, 1906 : 36; *Parapeneopsis stylifera* var. *coromandelica* - Alcock, 1906 : 37; *Parapenaeopsis stylifera* - DeMan, 1911:9; *Parapenaeopsis coromandelica* - Hall, 1962 : 27; *Parapenaeopsis stylifera stylifera* - Racek & Dall, 1965 : 98; *Parapenaeopsis stylifera coromandelica* - Racek & Dall, 1965 : 98; ? *Parapenaeopsis stylifera* var. *cochinensis* George, 1973 : 420; *Parapenaeopsis mumbayensis* - Aravindakshan, 1996 : 32.

Material examined: 2517 males (32.5 to 97.5 mm) and 2832 females (91.5 to 118.0 mm) collected at Mirkarwada and Sakhartar Fish Landing Centres and Ratnagiri fish market from April 1989 to December 1991; 6 males (60 to 84 mm) and 3 females (96 to 105.5 mm) collected at Alibag fish market (Raigad district) on 26th February, 1991.

Remarks: *P. stylifera* s.s. distinctly stands apart from all the remaining species of *Parapenaeopsis* (Alcock, 1901) in possessing fixed spines on telson (Menon, 1956 ; Dall, 1957; Hall, 1962 ; George, 1969a,1980; Burukovskii, 1982; Grey *et al.* 1983; De Freitas, 1984 ; Miquel, 1984). However, it is the number of these very spines which has created a lot of confusion.

The crux of the problem is whether the variety *P. stylifera coromandelica* of Alcock (1906), supposedly an inhabitant of the Bay of Bengal (along Coromandel coast) and east of it and characterised by at the most 2 pairs (usually only 1) of telson spines is 1. A synonym of *P. stylifera* (cf. George, 1969a, 1974, 1980) or 2. A subspecies of *P. stylifera* (cf. Racek & Dall, 1965; Ravindranath, 1989) or 3. A separate species (cf. Hall, 1962 ; De Bruin, 1965; Holthuis, 1980; Miquel, 1983).

Examination of an extensive series of material in the present study has clearly shown that the geographical isolation of the two forms, with their so called hybridization zone situated somewhere along the Kerala coast (southwest coast of India), as postulated by Ravindranath (1989), is not acceptable since the entire range of the telson spines (i.e. 1 to 4) is represented in the Konkan (northwest coast of India, which incidentally is very near to the type locality, Mumbai) specimens as under:

Number of telson spines (Pairs)	Percentage frequency
1	12%
2	23%
3	61%
4	04%

The number of telson spines, therefore, cannot be treated as a valid character for separating the two forms.

According to Racek & Dall (1965), *P. stylifera coromandelica* possibly also differs in possessing less number of rostral teeth i.e. 4 to 6 + 1 (epigastric). However, even this appears to be rather improbable since the rostral formula in the Konkan specimens is quite variable, being 3 to 6 + 1 (epigastric).

As already suggested by Racek and Dall (1965), apart from the above two features, i.e. number of telson spines and rostral formula, which in our opinion merely represents geographical variations, the two forms cannot be segregated by any other morphological characters including structure of petasma and thelycum (Figs. 35 - 38a, b & c). This observation is in complete agreement with that of George (1969a, 1979, 1980) who was indeed right in synonymising Alcock's form from the Coromandel coast with *P. stylifera* (H. Milne Edwards, 1837).

While he was able to settle the issue of Alcock's variety, George (1973) created his own new variety *viz. P. stylifera cochinensis* based solely on 15 males from the inshore waters of Cochin (Kerala). However, the size of specimens as mentioned by him i.e. the total length of merely 7.2 to 9.0 mm, appears to be indeed quite strange.

TABLE 4

COMPARISON OF *PARAPENAEOPSIS STYLIFERA* (H. MILNE EDWARDS, 1837) WITH THE OTHER FOUR SPECIES OF *PARAPENAEOPSIS* (?) COLLECTED ALONG THE KONKAN COAST

Characters	*P. stylifera* (H. Milne Edwards, 1837)	Other species of *Parapenaeopsis* (?) Konkan
1. Colour in fresh condition:		
(A) Transverse bands:	Absent.	Present.
(B) Sexual dimorphism:	Present.	Absent.
2. Fixed spines on telson:	Present.	Absent.
3. Distal unarmed portion of rostrum:	Present in both sexes.	Absent in both sexes or present only in females.
4. Fingers of Chelipeds:		
(A) First and Second chelipeds:	Shorter, being less than 1.5 (1.0 to 1.5) times palm.	Longer, being more than 1.5 (1.5 to 2.2) times palm.
(B) Third cheliped:	Shorter than (0.8 to 0.9 times) palm.	Longer than (1.0 to 1.6 times) palm.
5. Distolateral projection of petasma:	Longer than distomedian projection and directed laterally.	Generally shorter than distomedian projection and if longer, directed inwards but not laterally (as in *P.*(?) *cornuta*).
6. A well developed leaf-like apical process on appendix masculina :	Present.	Absent.

In all probability this might be the result of a typographical error since it is almost impossible to conceive such small individuals even with traces of petasma or appendix masculina. Nevertheless, the figures of petasma and appendix masculina as given by George (1973, Fig. 1, b & d, p.422), completely tally with those of early developmental stages (approximately 45 mm size) of *P. stylifera* proper (Tirmizi, 1968, Fig. 2a-c, p. 195). This proves that George's Cochin specimens are merely young ones of *P. stylifera* as already pointed out by Ravindranath (1989).

Recently, Aravindakshan (1996) inferred that all the material known earlier from Mumbai (= Bombay) under the name *Parapenaeopsis stylifera* (H. Milne Edwards, 1837) actually belongs to a new species namely *P. mumbayensis* Aravindakshan, 1996. According to him, the new species is unique in possessing a : (1) Telson with lateral spines increasing in size distally (2) Uropods not tipped white (3) Abdomen with dorsal carination beginning from 4th segment onwards (4) Rostrum with 5 or 6 teeth.

However, all these four features fall well within the intraspecific variations exhibited by *Parapenaeopsis stylifera*, the type locality of which is Mumbai itself, a fact apparently overlooked by Aravindakshan (1996). Hence *P. mumbayensis* is synonymized under *Parapenaeopsis stylifera* herewith.

Another important aspect, which needs to be particularly stressed, is that *P. stylifera* distinctly differs from all other species assigned to the genus *Parapenaeopsis* (Alcock, 1901) in possessing well developed fixed spines on the telson, which are quite discernible even to the naked eye. In the present study it is found to differ in at least 8 important features, from the remaining 4 species assigned to the genus *Parapenaeopsis* {*viz. P. acclivirostris* Alcock, 1905, *P. cornuta* (Kishinouye, 1900), *P. sculptilis* (Heller, 1862) and *P. hardwickii* (Miers, 1878)} occurring along the Konkan coast (Table 4).

These differences are strong enough to suggest a separate taxonomic status for the remaining species and NOT for *P. stylifera* since it is not only the genotype but also the oldest known member of the genus *Parapenaeopsis*.

5. ***Acetes indicus*** H. Milne Edwards, 1830

Acetes indicus H. Milne Edwards, 1830 : 351 (Type locality : Gangetic delta, India); *Acetes spiniger* - Hansen, 1919 : 43;? *Acetes indicus* - Achuthankutty & George, 1973 : 143.

Material examined: Numerous specimens purchased from Kalyan fish market {Thane district, near Mumbai (= Bombay)} on 6th May, 1990 : males (14.5 to 27.0 mm) and females (22.0 to 32.5 mm).

Remarks: Amongst the sergestids collected during the present study, *A. indicus* is by far the largest species. Although the original description by H. Milne Edwards (1830) is quite vague, it has been described in great detail by De Man (1917), Hansen (1919), Omori (1975) and Ravindranath (1980). Though all these workers have pointed out the presence of a characteristic needle-like process ventralis in the males of this species, Achuthankutty & George (1973) erroneously described it as lacking that process.

Nevertheless, two types of males, based on entirely different features, have been noted by Omori (1975) who was able to recognise a 'Large Form' (17.5 to 25.0 mm) belonging to the samples from East Asia as against the typical 'Small Form' (15.5 to 19.5 mm) from the Indo-Burmese region. He found several differences between the two forms, which are enlisted in Table 5.

The males in the present material, though size-wise (14.5 to 27.0 mm) definitely fall into Omori's 'Large Form', are in complete agreement with all the characters of his ' Small Form ' except No. 1 of Table 5. In this respect, they are identical with the specimens from coastal Andhra Pradesh (Ravindranath, 1980). Further,

TABLE 5

COMPARISON BETWEEN THE TYPICAL INDO-BURMESE FORM (= OMORI'S 'SMALL FORM') OF *ACETES INDICUS* H. MILNE EDWARDS, 1830, WITH THE EAST-ASIAN FORM (= OMORI'S 'LARGE FORM') ASSIGNED TO IT

Characters	Typical Indo-Burmese / 'Small form	East-Asian / 'Large Form'
1. Antennal scale:	Failing to reach tip of 2nd segment of antennular peduncle.	Extending beyond 2nd segment of antennular peduncle.
2. Lower antennular flagellum of male:		
(A) Clasping spine:	Long, slender, sharply curved and with only one row of tubercles	Short, stout, smoothly curved and with two rows of tubercles.
(B) Main branch:		
(i) First segment:	Without any spinules.	With one spinule.
(ii) Fourth segment:		
i) Armature:	With 6-8 spinules arranged only along distal 2/3rd of segment	With 8-10 spinules along its entire margin.
ii) Length:	Distinctly shorter than combined lengths of two preceding segments (i.e. 55-60 : 100).	Subequal to combined lengths of two preceding (i.e. 85-102 : 100):.
3. Petasma:	Without any traces of pars astringens.	With a vestigial pars astringens.
4. Appendix masculina:	With 2 hooks.	With 3 hooks.

it is seen that the Indo-Burmese form is characterised by sculpture of its capitulum, which is covered with numerous spinules as against that of its eastern counterpart which only bears a few apical spinules (Kemp, 1917; Hansen, 1919; Omori, 1975; Ravindranath, 1980 and pers. obs.).

All the above differences indicate that, although material at the disposal of Kemp (1917) and Hansen (1919) contained a few East-Asian specimens (= 'Large Form'), their good drawings are definitely based on the Typical Indo-Burmese specimens (= 'Small Form'). According to Omori (1975), "The differences between these two forms may be largely due to the difference at maturity". This, however, seems to be rather doubtful in our view as the differences between them are certainly not size-linked. On the contrary, they represent specific geographic stocks which may even warrant a separate taxonomic status for the East-Asian 'Large Form'.

6. ***Acetes sibogae*** (?) Hansen, 1919 (Figs. 39-53)

Acetes sibogae Hansen, 1919 : 38 (Type locality : Bay of Bima and Bawean island, Indonesia); *Acetes erythraeus* - Kemp, 1917 : 51 (part); *Acetes sibogae* - Burkenroad, 1935 : 126; ? *Acetes australis* - Colefax, 1940 : 345 ; ? *Acetes sibogalis* - Achuthankutty & George, 1973 : 139; ? *Acetes sibogae sibogae* - Omori, 1975 : 61; ? *Acetes sibogae sibogalis* - Omori, 1975 : 66; ? *Acetes sibogae australis* - Omori, 1975 : 68 ; *Acetes vulgaris* - Achuthankutty, 1975 : 469; ? *Acetes orientalis* - Achuthankutty & Nair, 1976 : 233.

Material examined: 12 samples containing numerous specimens collected from Zadgaon creek, Ratnagiri, from April 1989 to May 1991 : males (14.5 to 29.0 mm) and females (16.5 to 29.5 mm).

Remarks: *A. sibogae* s.l. is a highly variable species, the true status of which has been confused by the creation of several species and subspecies as much as by the relegation of some really distinct species under it. In fact, both Omori (1975,1977) and Ravindranath (1980) have extensively discussed this problem of *A. sibogae* complex to which presently several nominal species like *A. australis, A. sibogalis, A. orientalis* etc. have been assigned, besides relegation of forms like *A. vulgaris.* Perhaps, this confusion seems to be due to inadequate observations or understanding of taxonomic features. For example, the number of falcate spines on petasma (Fig. 50) which is a specific feature was apparently wrongly observed (due to improper mounting as in Figs. 43 & 51) by Ravindranath (1980) as evident from his Fig. 9c & d, p. 268. On the other hand, undue importance given to features like number of segments on lower antennular flagellum, nature of third thoracic sternite of females etc. by authors like Achuthankutty & George (1973) and Achuthankutty & Nair (1976) seems to have led to the erroneous creation of different species.

The present material, when compared with the available literature, is found to be identical only with Ravindranath's (1980) description based on an east coast form from coastal Andhra Pradesh, in exhibiting a characteristic sexual dimorphism of the basial spine of third pereiopod (found only in these two forms) which is present and well developed in females but absent in males (Figs. 44, 45). Although Ravindranath (1980) seems to doubt the taxonomic validity of this spine (since he found it to be present in one male specimen of 18.8 mm), Pathansali (1966) had already stressed its diagnostic value at species level. In the present study, this spine is consistently absent in a large series of males examined.

The similarity of the present material with the widely separated east coast form, instead of any of the so far known west coast forms, clearly proves that the nature of presence or absence of basial spine of third pereiopod is of definite specific value and cannot be simply ascribed to geographic variation.

The Ratnagiri material (along with Ravindranath's specimens from east coast of India) further differs from the remaining forms in the following:

1. Pars astringens distinctly smaller than pars externa.
2. Tips of capitulum beset with several minute spinules (Figs. 43, 50 & 51).

The Ratnagiri and Andhra Pradesh specimens, therefore, merit distinct taxonomic identity.

Acknowledgements

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CAUSES OF DESTRUCTION OF NESTS OF WEAVER BIRDS IN RAJASTHAN[1]

Satish Kumar Sharma[2]

Introduction

Three species of weaver birds, namely *Ploceus benghalensis, P. manyar* and *P. philippinus* are found in Rajasthan (Sharma, 1991a). All these species generally initiate nesting from June-July and their breeding activities end in September-October. By that time, nests are deserted by the adults with juveniles. New nesting is started only next year in the monsoon, i.e. after nearly 8-9 months.

The abandoned nests are destroyed by various agencies and considerably fewer nests remain intact at the commencement of the next monsoon.

Study Area

To evaluate the nest destruction trend, I conducted a study in Alwar and Udaipur districts, in different habitats. Three sites were selected in Alwar district and one in Udaipur as follows:

1. Site A: Tatarpur mixed plantation 'A', consisting of 20 ha undulating sand dunes. *P. philippinus* and *P. benghalensis* were found breeding there. *Acacia senegal* was preferred most for nesting by *P. philippinus*. Nests of *P. benghalensis* were invariably present on *Saccharum bengalense*. Though the area was fenced in by the Forest Department, browsing by goats and camels, lopping by local people for fodder, fencing material and fuel-wood were the major threat to *Acacia senegal*, which prevails round the year, specially in winter from January to February. *Saccharum bengalense* is harvested in winter for thatching roofs and making ropes.

2. Site B: A stretch of 1000 x 50 m (i.e. 5 ha) area confined to the bed of Nahavani river near Harsora Dam. It is a seasonal river, but due to seepage of water from the dam, this portion remains wet even in summer. Luxuriant growth of *Typha angustata* and *T. elephantina* can be seen in the river bed where *P. manyar* breeds. Repeated grazing and trampling by cattle round the year is a major threat to this habitat. During winter, *Typha* is harvested by the locals for rope making and thatching their houses. The stems and leaves are cut near ground level, bundled and carried to nearby villages and hamlets. Nests of the striated weaver bird *P. manyar*, present on *Typha*, are pulled out by the locals before making the bundles of cut stems and leaves.

3. Site C: 20 old wells within a radius of 5 km near village Tatarpur were selected. Various species of bushes and trees growing on the walls of the wells were found to provide suitable sites for the nests of *P. philippinus*. No apparent threat to the nests was recorded.

4. Site D: A stretch of 100 ha of agricultural land dotted with wild date palm (*Phoenix sylvestris*) was selected between the village Jara-Pipla and Koliyari in Udaipur district. Only one species of weaver bird, namely *P. philippinus*, occurs in this locality. It preferably nests on *P. sylvestris*. The wild date palm is an important tree for domestic use in this locality. Leaves of these plants are harvested during February for making brooms, mats etc. During March and April, fire is put to the stems of younger palms to burn off the scaly parts.

Methodology

Three sites in Alwar district, namely, Tatarpur mixed plantation (site A), Nahavani River-bed (site B), and old wells of Tatarpur (site C) were surveyed from October 1983 to June 1984 while Jara-Pipla-Koliyari agricultural land

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[1]Accepted January, 1995.

[2]Range Forest Officer, Aravalli Afforestation Project, Jhadol (F), Dist. Udaipur 313 702.

in Udaipur district (site D) was studied from October 1992 to June 1993. Counting of nests at all the sites was done in the last week of every month. Various factors were identified which were found responsible for the destruction of nests.

Results

From the observations at different sites it was concluded that many biotic and abiotic agencies are responsible for destruction of nests. Biotic factors include human and bovine activities. Lopping off twigs of trees, harvesting of *Saccharum bengalense, Typha elephantina* and *T. angustata* for thatching and rope making; harvesting of *Phoenix sylvestris* leaves for making brooms, mats etc., pulling out nests for domestic use and fire were listed as nest destructive activities of human beings. Grazing, trampling and wallowing of buffaloes in wet areas, i.e. habitat of *P. manyar,* were noted as major bovine nest destructive activities. Abiotic factors like wind and hailstorms were also found responsible for destruction of nests.

It was concluded from the data that different quantum of destruction of nests takes place in different habitats. Nest colonies present in wells were more secure than all the others. The nest destruction trends in different habitats are given in Tables 1 and 2.

Discussion

1. Old wells provide maximum security to the nests while grasses and reeds are the most unsafe habitats for nests after the breeding period.

2. Maximum destruction of nests occurs during winter i.e. from December to February.

3. Biotic factors like man and his cattle are responsible for destruction of a major percentage of nests of weaver birds.

4. Tribals of Udaipur district traditionally put fire to stems of young wild date palms (*Phoenix sylvestris*) to burn the persistent leaf bases, to make the trunk smooth for climbing. During this process the nests may catch fire.

5. Same habitats may provide different levels of safety to nests of different species as is evident in site 'A'. This site proved safer to *P. philippinus* but most unsafe to *P. benghalensis.*

Half-built intact nests of *Ploceus philippinus* are pulled out from host trees to use them as baskets in and around village Tatarpur. The "chin-strap" of a nest is gripped so that it hangs upside down like a basket. Such baskets are used by women and children to collect the ripe fruits of *Zizyphus nummularia* and *Cucumis melo* var. *agrestis.* Destruction of half-built nests for this purpose is generally done from November to January when the fruits of *C. melo* var. *agrestis* and *Z. nummularia* ripen.

It has been shown by many workers that abandoned nests of weaver birds play an important role in protection and conservation of many small wild animals such as the longtailed tree mouse *Vendeluria oleracea* (Ali and Ambedkar, 1956), *Mus* sp. (Regupathy and Davis, 1984), painted bat *Kerivoula picta* (Sharma, 1991a), Indian field mouse *Mus booduga* (Akhtar and Tiwari, 1992), whitethroated munia *Lonchura malabarica* (Ali, 1931; Ambedkar, 1970), house swift *Micropus affinis* (Kirkpatric, 1950), spotted munia *Lonchura punctulata* (Sharma, 1987), and some arthropods (Sharma, 1991b).

The longtailed tree mouse (*V. oleracea*) lives in the abandoned nests of *P. benghalensis, P. manyar* and *P. philippinus* whenever an opportunity arises. This species enters the abandoned nests with the commencement of winter. Abandoned nests of weaver birds are used by the mice to give birth to blind and furless baby mice. Mice families pass the winter there snugly. So long as the mouse family remains inside the nest, predators can hardly reach them. Thus nests of weaver birds enhance the population of the longtailed tree mouse (Ali and Ambedkar, 1956; Sharma, 1988, 1991c).

TABLE 1

DESTRUCTION OF NESTS OF THREE SPECIES OF WEAVER BIRDS IN DIFFERENT HABITATS

Study area	Species of Weaver birds	Initial No. of intact nests on host vegetation	No. of intact nests									Percentage of intact nests (= %age of habitat safety
			Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	
Tatarpur mixed plantation (site A)	*P. philippinus*	109	109	109	102	94	91	89	87	81	80	73.3
" "	*P. benghalensis*	41	41	37	32	22	22	0	0	0	0	0.0
Nahavani River bed (site B)	*P. manyar*	917	911	888	701	502	111	92	12	10	8	0.8
Old wells of Tatarpur (site C)	*P. philippinus*	338	338	338	338	337	337	335	325	324	320	94.2
Jara-Pipla-Koliyari Agricultural land (site D)	*P. philippinus*	76	76	76	70	59	17	7	4	4	4	5.2
	Total intact nests	1481	1475	1448	1243	1014	578	513	438	419	412	
	Total destroyed nests in the month	—	6	27	205	229	436	65	75	19	7	

Table 2
CAUSES OF NEST DESTRUCTION IN SURVEYED LOCALITIES

Study area	Species of Weaver birds	Nests destroyed Number	%	Number of nests destroyed by different causes*							
				1	2	3	4	5	6	7	8
Tatarpur Mixed Plantation (site A)	*P. philippinus*	29	26.60	19	—	—	—	—	10	—	—
" "	*P. benghalensis*	41	10.00	—	29	2	—	—	10	—	—
Nahavani river bed (site B)	*P. manyar*	909	99.12	—	505**	400**	—	—	—	—	—
Old wells of Tatarpur (site C)	*P. philippinus*	18	5.32	—	—	—	—	—	—	—	18
Jara-Pipla-Koliyari Agricultural land (site D)	*P. philippinus*	72	94.23	—	—	—	65	3	—	4	—
	Total destroyed nests			19	534	402	65	3	20	4	18

*Causes of destruction: 1. Lopping, 2. Harvesting of leaves and stems of *S. bengalense*, *T. angustata* and *T. elephantina* for thatching and rope making, 3. Grazing and/or trampling of reeds and grasses, 4. Harvesting of leaves of wild date palm, 5. Fire, 6. Pulling out, 7. Wind, hailstorm, 8. Unknown

**Estimated by extent of the grazed and trampled area (nearly 2.8 ha) and area brought under harvesting for leaves (nearly 2.2 ha).

Painted bats (*Kerivoula picta*) use the ceiling of the helmets of *P. philippinus* for roosting. Due to growing demand for fuel-wood, most of the old and dried trees have been hacked down, with the result that several cavity nesting birds, mammals and other animals have no suitable site for making nests or roosts. Bats are probably using helmets of baya as roosting places owing to scarcity of roosting sites (Sharma, 1986).

Various species of munias such as whitethroated munia *Lonchura malabarica* habitually utilize old nests of *P. benghalensis* and *P. philippinus* (Ali and Ripley, 1983; Sharma, 1991 a) for laying eggs. The spotted munia (*L. punctulata*) also utilizes the old nests of *P. philippinus* (Sharma, 1987).

Many insects like the cotton bug *Dysdercus cingulatus*, spiders like *Plexippus paykullii, Marpissa* sp., *Sparassus* sp., *Scytodes* sp., etc. not only pass winters in abandoned nests but multiply there (Sharma, 1991b). In warm weather, arthropods live in different niches, but with the onset of winter, they hide themselves in safer places to pass the cold season. Abandoned nests of weaver birds are utilized as 'inns' by insects and spiders for wintering. Some of them breed in the nests. Many spiders were observed with eggs and hatched young with them in the nests. More than one type of spider was found wintering and breeding together in the same nest. The ceiling of the nest is the most preferred site for Arthropods to take shelter during the winter season. The ceiling being the most massive part of the nest, provides the greatest insulation to the wintering poikilothermic arthropods. Insects like the mason-wasp *Eumenes petiolatus* attach the characteristic clay brood-nests on ceilings of the helmets of weaver birds (Sharma, 1991a).

All these animals of smaller size described here may enter the nests of weaver birds. Using nest entering capability as a parameter, animals may be categorised into two groups — Entrants and Non-entrants. House crows and jungle crows are of larger size and cannot enter the nests, hence they fall in Non-entrant group, which seek the nests when they are 'alive' i.e. inmates are living or at least present inside. Entrants prefer an empty or deserted nest, but they may encroach upon an occupied nest also. They enter the weaver bird's nest through existing openings or by making *denovo* holes in any suitable part of the nest. Entrants may utilize nest cavities variously for breeding, wintering, roosting, hibernation and escaping predation. Destruction of abandoned nests of weaver birds deprive many small animals of shelter.

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THE ECOLOGY AND DISTRIBUTION OF ALCYONACEANS AT MANDAPAM (PALK BAY, GULF OF MANNAR), SOUTH INDIA[1]

V. Jayasree and A.H. Parulekar[2]

(*With one text-figure*)

Key words: Alcyonacea, distribution, Mandapam, Gulf of Mannar

New distribution records for 27 species of Alcyonaceans are given. These include major genera *Sinularia* (12 spp.), *Lobophytum* (7 spp.), *Sarcophyton* (6 spp.), *Dampia* (1 sp.) and *Nephthya* (1 sp.). The factors that influence the distribution of corals, such as temperature, sedimentation and currents on this reef are discussed.

Introduction

Mostly the coral reefs of fringing type are found in the Palk Bay and Gulf of Mannar on the southeastern coast of India. These are chiefly located around various islands between Tuticorin and Rameswaram in the Gulf of Mannar and Palk Bay at Mandapam. The reef lies between 79° 27' 40" to 79° 8' E long. and 9° 17' N lat. (Fig. 1). The Palk Bay is a shallow basin with an average depth of 9 m, with mainly muddy bottom at inshore regions and depth ranges from 1 to 5 m. In spite of some investigations of South Indian coral reefs (Foote, 1889; Walther, 1891; Thurston, 1895; Sewell, 1935; Pillai, 1969, 1971) our knowledge, particularly of Octocoral fauna, is scanty. The only literature available on this part of the Indian Ocean is Hickson (1906), Pratt (1906), Thomson and Henderson (1906), Thomson and Simpson (1909).

Material and Methods

Alcyonacean coral material was studied from collection made by N.I.O, Goa, Andhra University, Waltair and I.I.C.T. Hyderabad during May 1993 to February 1994 by SCUBA diving under the D.O.D. National Project on "Development of Potential Drugs from the Sea." Some environmental and hydrological parameters such as temperature and salinity were recorded.

All the specimens reported are preserved in 70% methanol and deposited in the Marine Biology Museum and Taxonomy Reference Centre at the National Institute of Oceanography, Goa.

Results

Major environmental and hydrological conditions show that the study area receives both the southwest and northeast monsoons. Rain is moderate to heavy during October to mid-December, with occasional gales. The average atmospheric temperature varies from 25°C to 31°C with maximum and minimum in May and January respectively.

The surface temperature of the waters of Palk Bay varies from 24.6°C to 29.1°C, with the lowest and highest in January and April respectively. The salinity is low during January, gradually rising to the maximum in November, followed by a decline in December. It varies from 33 to 36 ppt. The tidal range is usually within an amplitude of one metre. The Palk Bay remains calm during most months except at the onset of

[1]Accepted February, 1996

[2]National Institute of Oceanography, Dona Paula, Goa 403 004, India.

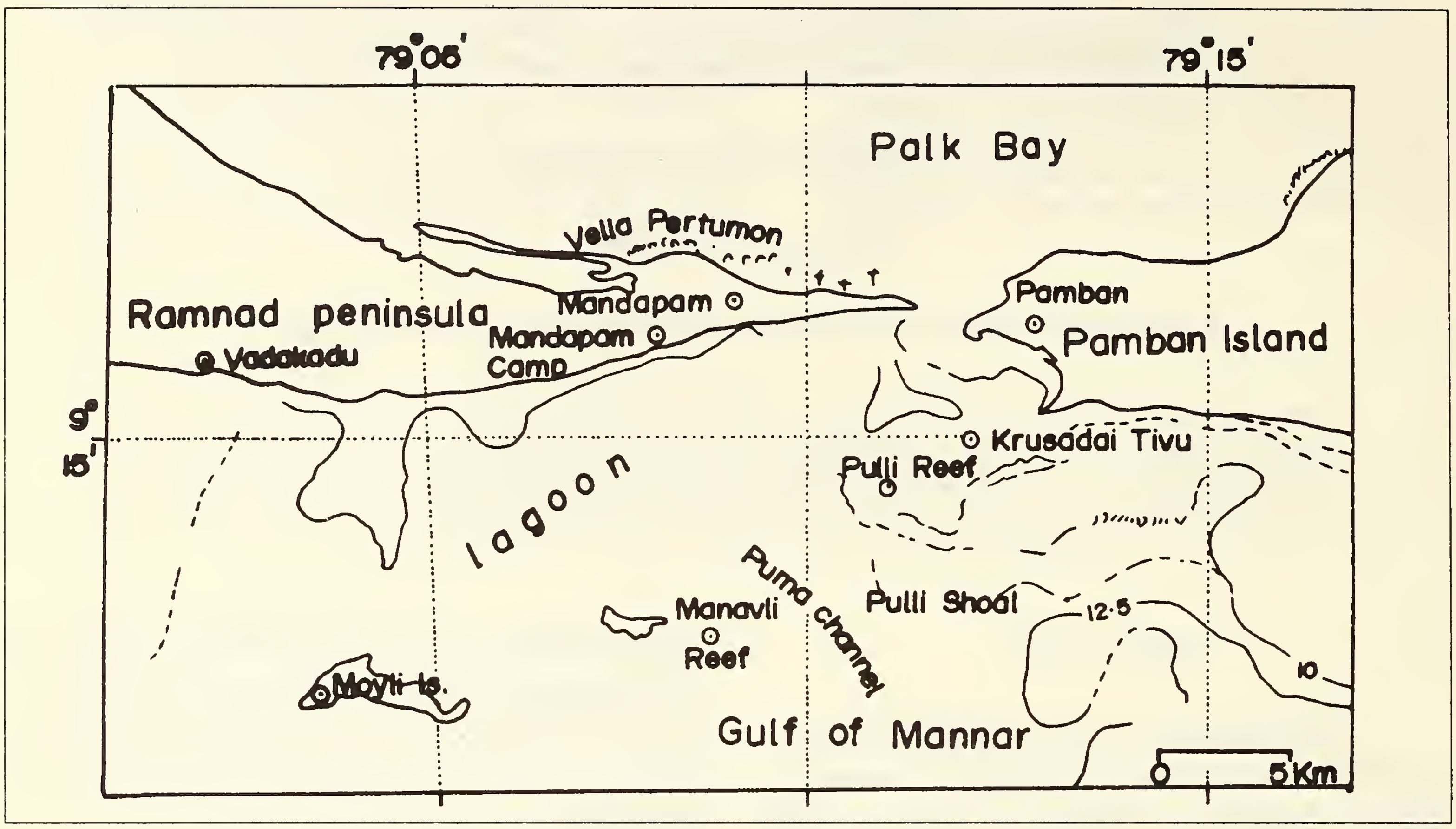

Fig. 1. Collection sites in Gulf of Mannar

the northeast monsoon, when turbulent conditions prevail. No fresh water inflow dilutes the sea near Mandapam.

The study material comprises 27 species which are listed in Table 1. Most of them are new geographical records for this part of the Indian Ocean.

The most abundant and dominating genera in the study area are *Sinularia dessecta* and *S. leptoclados*. The species *Sinularia leptoclados* is well known from numerous Indo-Pacific sites (Verseveldt, 1980). The most common *Lobophytum* spp. are *Lobophytum crassum* and L. *pauciflorum. Sinularia manaarensis* in Krusadai Island confirms its exclusive occurrence (Verseveldt, 1980). In the genus *Sarcophyton, Sarcophyton elegans* and *S. trocheliophorum* were the most frequent soft corals.

The reefs in the Gulf of Mannar are the most diverse in soft corals compared with other parts of the Indian Ocean (Pillai, 1971). The present study shows the accumulation of numerous alcyoniids in shallow water. It is also reported that a marked difference in the species diversity is found in deeper areas (Benayahu, 1985). This survey also reveals the presence of nephtheids and patchy assemblages of *Sinularia brassica* and *S. abrupta,* confirming earlier findings. The rare occurrence of these species could be due to their low reproductive potential and short-distance dispersal of planulae. Another major factor which influences alcyonacean distribution could be the availability of a firm substrate suitable for the settlement of planulae. Depth distribution and zonation of different species is determined by biotic and abiotic factors (Dineson, 1983). The present survey also indicates a particular species of soft coral which forms colonies in different reefs. Also, the frequent occurrence of a particular species in these areas suggests resistance to wave action, temperature and salinity variations, tidal influence and sedimentation. These reefs also provide good light penetration and tidal currents which

TABLE 1

SPECIES AFFILIATION OF ALCYONACEANS IN GULF OF MANNAR

PLACE	DATE	DEPTH	TAXONOMIC IDENTIFICATION	AVAILABILITY
Off Krusadai Island	25.06.93	2 m	*Lobophytum sarcophytoides*	Frequent
Vadakadu Rameswaram	20.06.93	3 m	*Sarcophyton trocheliophorum*	Frequent
Vadakadu Rameswaram	20.06.93	2 m	*Sarcophyton crassocaule*	Frequent
Off Manauli Island	23.07.93	2 m	*Sinularia dissecta*	Frequent
Off Pulli Island	23.06.93	2 m	*Sinularia polydactyla*	Frequent
Off Pulli Island	23.06.93	2 m	*Sinularia abrupta*	Frequent
Moyli Island	24.06.93	2 m	*Sinularia leptoclados*	Frequent
Moyli Island	24.06.93	2 m	*Sinularia hirta*	Frequent
Krusadai Island	25.06.93	1 m	*Sinularia dissecta*	Frequent
Krusadai Island	25.06.93	1 m	*Sinularia manaarensis*	Frequent
Krusadai Island	25.06.93	2 m	*Lobophytum pauciflorum*	Frequent
Krusadai Island	24.01.94	3 m	*Lobophytum crassum*	Abundant
Mandapam	27.01.94	3 m	*Sarcophyton cherbonneri*	Frequent
Krusadai Island	27.01.94	3 m	*Sarcophyton elegans*	Frequent
Mandapam	27.01.94	3 m	*Sinularia exilis*	Frequent
Mandapam	27.01.94	3 m	*Sarcophyton stellatum*	Frequent
Mandapam	26.01.94	3 m	*Sinularia intacta*	Frequent
Mandapam	26.01.94	3 m	*Lobophytum ransoni*	Frequent
Mandapam	26.03.94	3 m	*Sinularia grandilobata*	Frequent
Tuticorin	03.01.94	Deep sea	*Sinularia brassica*	Abundant
Tuticorin	04.01.94	Deep sea	*Sinularia abrupta*	Rare
Tuticorin	04.01.94	Deep sea	*Dampia poecilliformes*	Rare
Tuticorin	05.01.93	Intertidal	*Lobophytum compactum*	Rare
Mandapam	27.01.93	3 m	*Lobophytum variatum*	Frequent
Krusadai Island	27.01.93	3 m	*Lobophytum latilobatum*	Frequent
Krusadai Island	—	3 m	*Sarcophyton glaucum*	Abundant
Mandapam	26.01.94	3 m	*Sinularia granosa*	Frequent
Off Mandapam Island	23.06.93	2 m	*Sinularia granosa*	Frequent
Off Mandapam Island	23.06.93	2 m	*Sinularia erecta*	Frequent
Tuticorin	14.02.93	2 m	*Nepthya sp.*	Rare

enrich the water with plankton (Klenker *et al.*, 1976). The frequency of appearance of soft corals could be based on differences in life history or reproductive nature. Also, it is suggested for the soft coral genera of family Xeniidae, that the successful inhabitance in Red Sea is achieved by asexual reproduction and high fecundity (Benayahu and Loya, 1984b).

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RECENT TRENDS IN PROTECTION OF HARVESTED BAMBOOS FROM GHOON BORERS[1]

M.L. Thakur and R.S. Bhandari[2]

In India, harvested bamboos suffer in varying degrees, from different species of ghoon borers at the felling site and under storage conditions. Severely infested bamboos are often reduced to heaps of dust, causing a colossal loss in revenue to the growers and the industry. Protection of bamboos has been an important thrust area of forest research since World War II. The Forest Research Institute, Dehradun, has played a pioneering role in developing appropriate technologies for protecting bamboos from insects both for short (prophylactic treatment) as well as long duration (preservative treatment).
This paper discusses the results of some of the recent researches carried out at the Forest Research Institute, particularly on the use of synthetic pyrethroids which, though easily biodegradable, have been found highly effective as prophylactic measures against ghoon borers.

Introduction

Bamboo, commonly referred to as green gold, is one of the most important and precious non-wood forest raw materials. According to one estimate (Tewari, 1992), roughly 14 million ha of the earth's surface is covered with bamboo forests, a major portion (*ca* 80%) of which occurs in Asia with 65 genera (14 endemic) and 900 species. India perhaps is one of the leading countries with an average annual production of nearly 3.23 million tonnes (Pathak, 1989). In fact India with nearly 23 genera and 125 species, both indigenous and exotic, is considered to be one of the largest bioreserves of bamboo gene pool in the world, occupying roughly an area of 10.23 million ha. Thus, the need to propagate and protect such a vast and precious natural resource needs no further emphasis.

Borers of felled and stored bamboos

In India, all species of bamboo suffer in varying degrees, from insect pests and other biological agencies at the felling sites, during transportation, storage and even as finished products in use. While none of the 40 and odd species reported by Singh and Bhandari (1988), Mathew and Nair (1988) and 15 species of termites (Thakur, 1988) cause direct mortality in green standing bamboos, coleopteran borers (*ca* 32 species) are principally responsible for serious infestation and economic loss in the field and in stored bamboos. The most important among them are the common ghoon borers (3 species) of the genus *Dinoderus (viz. D. brevis, D. minutus* and *D. ocellaris), Heterobostrychus aequalis* and *Sinoxylon anale* (Coleoptera:Bostrychidae) and one species of Cerambycid borer, *Stromatium barbatum.*

Incidence of borer damage in bamboos

Except for some recent work on 13 species of bamboos at Forest Research Institute, Dehra Dun, no authentic data are available on the natural durability of most bamboos. However, it is acknowledged that bamboos, in general, are highly susceptible and are easily attacked by insects (borers and termites) and fungi. This is especially true in tropical countries, where high temperature and humidity are ideal for insect infestations.

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[1]Accepted October, 1995

[2]Forest Research Institute, P.O. New Forest,
Dehradun 248006.

The felled bamboos remain in storage for varying periods, from one month to a year or even more. It is in these storehouses that the harvested and stored bamboos, if not protected adequately, are likely to be infested, often seriously, by insect borers, and reduced to heaps of powdery dust, causing considerable loss in revenue to the growers and to industry.

Some laboratory and field case studies have revealed over 22% loss in wood substances in one year, with a resultant *ca* 10% fall in unbleached kraft yield during storage (Guha and Chandra, 1979). Such losses can be brought down to around 7% by suitable treatment. However, losses in the field or open storage in timber depots are invariably much higher because of hot and humid conditions prevailing in most parts of the country (Kumar *et al.*, 1985). Though data on such losses are not always available, it is presumed that it must be quite high, particularly at sites with poor storage conditions, where losses upto 30-40% of the stock have been reported (Kumar, 1977). In another study, carried out recently by FRI at Jaffrabad Forest Dept, (U.P.) (unpublished data) nearly 40% (0.15 million kodis) of the stacked bamboo revealed very high incidence of borer attack, with a resultant nett loss of approximately 4.6 million rupees to the department.

Protection of bamboo against ghoon borers

The enormous demand for bamboo poles during the Second World War and their proven susceptibility to biodegradation, is an important question for the protection of bamboos, more particularly from ghoon borer attacks. The then Entomology Branch of Forest Research Institute was assigned this problem. Since then, FRI has been playing a pioneering role in developing economically appropriate control measures. The Entomology Division has, however, been concentrating only on prophylactic measures for protecting bamboos at the felling site or the storage depots.

The traditional strategies

Beeson (1941) published detailed life histories and control measures of major ghoon borers, *viz. Dinoderus brevis, D. minutus* and *D. ocellaris.* Gardner (1945) published a detailed note on the biology and control of bamboo borers. After independence Roonwal and Chatterjee (1951), Roonwal *et al.* (1959), Singh and Bhandari (1988), Thakur (1988), Mathew and Nair (1988) and more recently Thapa *et al.* (1992) have dealt with this problem extensively, particularly on the nature and incidence of damage with appropriate control measures, some of which being currently under use, are discussed:

The Safe Felling Period

There is strong circumstantial evidence that the susceptibility and attraction of bamboos to ghoon borer attack depends primarily upon the age and season of felling, as also due to presence of starch, certain soluble carbohydrates and proteins, which are the essential food component of the developmental stages of Bostrychid and Lyctid borers. It is perhaps due to this very low starch concentration in flowered bamboos that they are more resistant to ghoon borer attack (Tewari and Singh, 1979).

Studies carried out by various investigators (Beeson, 1941; Gardner, 1945 and Mathur, 1958) indicated considerable variation in starch content in various species of bamboos in different localities, and a corresponding variation in their susceptibility to borer attack. The dictum that cold winter months are the best period for felling bamboo is only partially true, as it does not guarantee complete immunity from borers. The low incidence of infestation is due to a low and less active borer population during this period. This dictum has relevance perhaps only to southern India and possibly in localities where *Dendrocalamus minutus* is a predominant species (Beeson, 1941).

In northern India (Western U.P.), the best period for felling is between the end of monsoon (i.e. end of August) to the end of December, though in Doon Valley (*D. brevis*) the dates differ slightly. Here, borer attack is least on fellings carried out during late summer (mid June) to early monsoon (end of July). The incidence is low between mid October to end of December. The bamboos felled during the first five months, especially those of March and April, are prone to severe borer damage. Northwest India, comprising the states of Punjab, Himachal Pradesh and Jammu (J&K) has *Dendrocalamus ocellaris* as the predominant species. The safest felling period is May and December, but the felling schedules carried out from end of October to mid January are also fairly good, a practice schedule which is even now in vogue in this part of the country. It is believed that the starch content of the wood at this time is extremely low, almost nil or in traces.

Water soaking

It is a common belief among the forest dwellers that soaking bamboos in water, for a varying period, imparts immunity against ghoon borers and *Lyctus* attack, as a result of leaching of starch, soluble sugars and other substances in bamboos. In view of this, a series of experiments were conducted at the FRI and it was concluded that water immersion for 12 weeks or so protects bamboos from Bostrychid borers. However, this treatment does not provide any protection against *Lyctus* attack.

Culm baking procedure

Baking of culms is a customary practice in certain areas of the country. The procedure involves coating of culms with rape seed oil and then heating them over the fire for a varying period. This process also leads to straightening of the culms. Experiments revealed that this heat treatment results in fixing of the starch in the tissues and, if performed soon after felling, can check natural starch depletion. Prolonged heating for a period of six hours or so renders the culms immune to borer attack due to reduction in moisture content (upto 0-5%) which is insufficient and too low to support Bostrychid larval development (Gardner, 1945).

Chemical control

Notwithstanding the several attempts to protect bamboos from borer attack in the past, the problem persists in challenging form and the bamboos continue to suffer serious insect attack both at the felling site and under storage conditions. The FRI has been conducting experiments to evolve a suitable protection umbrella against insect borers infesting felled bamboos in depots.

Prophylactic spray of 0.33% BHC in kerosene oil provided protection to bamboos against all categories of borers in stacked bamboos, however a dosage of 0.5% BHC in kerosene oil was found to be the most effective prophylactic (Roonwal and Chatterjee, 1951; Roonwal *et al.*, 1959).

In subsequent years, salts and toxic chemicals of later generations were introduced. Prophylactic treatment of stacked bamboos with 1% lindane, 3% boric acid + borax (1:1), 3% boric acid + zinc chloride were reported to be effective against post-harvest insect attack. It was also reported that dip treatment of green bamboo culms for varying period in chemical solutions of the above compounds was more effective than simple spray treatment and that it should be carried out before the summer monsoon (Tewari and Singh, 1979).

Current trends

The discovery of synthetic pyrethroids, a highly effective yet easily biodegradable group of insecticides, further revolutionised pest control technology. Recently, Thapa *et al.* (1992) have

TABLE 1

SUMMARY OF OBSERVATIONS ON GHOON BORER ATTACK ON TREATED AND CONTROL (UNTREATED) BAMBOO STACKS AT THREE DIFFERENT LOCALITIES

Month of observation & period of experiment	Degree of ghoon attack																										
	Cypermethrin									Fenvalerate								Endosulfan							Control		
	0.1% in diesel oil			0.2 % in diesel oil			0.4 % in diesel oil			0.1 % in diesel oil			0.2 % in diesel oil			0.4 % in diesel oil		0.5 % in water			1.0 % in water		1.5 % in water				
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C′	A	B	A	B	C	B	C	B	C	A	B	C
April 88	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F	4F
June 88	4L	4L	4F	4L	4F	4F	4L	4L	4F	4L	4L	4F	4L	4L	4F	4L	4L	4L	3F, 1L	4F	4F	4F	4F	4F	4L	4L	4L
August 88	4M	4H	4L	4M	1F, 3L	1F, 3L	4L	1L, 3MH	2F, 2L	4MH	4H	4L	4MH	2M, 2H	1F, 3L	4H	4L-M	4L	4M-H	4L	4M-H	4L	3L-M, 1H	1F, 3L	4F	4H	4H
October 88	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H	4H

Abbreviation used:

F: Free L: Light M: Moderate H: Heavy

Replications (each treatment): Four

Localities: A: Jaffarabad (U.P.)

B: Chandimandir (Chandigarh)

C: Jagadhri (Haryana)

concluded that while fenvalerate, when applied in doses of 0.4% e.c. formulation in diesel oil failed to protect bamboos from ghoon borer attack, the other synthetic pyrethroid, cypermethrin, proved fairly effective at the same dosage and provided protection to bamboos stored in open for about 4-5 months until the monsoon when the insecticides are likely to get washed out from the smooth surface, leaving little residue on the culms. Similarly, endosulfan (35 e.c.), when sprayed at dosages of 0.75-1.5% concentration in diesel oil with a small quantity of sticker (triton) is reportedly effective against borer attack for the same period as synthetic pyrethroids. More experiments have been laid for increasing the efficacy of the prophylactic treatments by adding some commercially available sticking agents such as teepol, triton, Neogen PEN and Neogen PAN, molasses, etc. to cypermethrin spray emulsions. Though final data are still under analysis, indications are that the use of Neogen PEN and molasses, added to cypermethrin, can give adequate protection for about a year to bamboo stored in the open.

Discussion

Investigations carried out at the FRI have indicated that methods such as soaking, sap displacement or diffusion treatments, etc., if carried out as per the specified schedules, are simple, cheap and quite effective for protection of bamboo. The prophylactic treatment is of temporary nature and is suitable for protecting bamboo in storage, before it is put to use. The efficacy of the treatment wanes and is proportional to the period of storage. The incidence of borer attack tends to increase with passage of time as a result of decrease in residual toxicity of the insecticide. Thapa *et al.* (1992) have recommended stacking of bamboos under temporary shed for longer and safe storage. Further innovative trials to improve storage conditions in depots are, however, necessary.

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SUBSOCIALITY IN DUNG BEETLES *COPRIS REPERTUS* WALKER AND *COPRIS INDICUS* GILL. (COLEOPTERA: SCARABAEIDAE)[1]

K. Veenakumari[2] and G.K. Veeresh [3]

(*With one plate*)

Key words: *Copris repertus. C. indicus,* nesting, parental care, bisexual cooperation.

Nesting behaviour of *Copris repertus* and *C. indicus* were studied in the laboratory. Male-female cooperation and parental care were observed in both the species. Earthworms belonging to *Dichogaster* sp. were found to feed on the dung in the brood balls. Some atypical behaviour, like extension of brood chamber, etc. was observed in *C. repertus.* Biology of *Copris repertus* was also studied in the laboratory.

Introduction

Subsociality has been found in some genera of Scarabaeinae of which *Copris* is one. Nesting behaviour of several species of *Copris* have been studied in detail (Fabre, 1897; Halffter and Matthews, 1966; Rommel, 1961, Paik, 1976; Halffter and Edmonds, 1982; Klemperer, 1982a, 1982b). Arrow (1931) has reported 34 species of *Copris* in India. So far, the behaviour of none of these has been studied. An attempt has been made to study two commonly occurring species of *Copris, C. repertus* and *C. indicus*, which have variations in their nesting patterns.

Material and Methods

Adult beetles attracted to cow and sheep dung in pastures were collected and brought to the laboratory. They were separated sex-wise based on morphological characters.

To study the nesting structure, large cubic dealwood boxes of 0.9m sides were used. These were filled with moist soil, on top of which fresh cowdung was dropped. The beetles were then released into this box. The box was covered with wooden planks. After about two weeks, one wall of the box was ripped open and the soil was sliced vertically with care, to study the nest architecture.

Nesting pattern and bisexual cooperation were studied in glass cages measuring 60 x 44 x 3 cm^3). Glass walls were fixed 3 cm apart into a three sided wooden frame with grooves. Soil was filled into this cage and on top of this fresh cow dung was deposited. The beetles were then released into the cage, and the top of the cage covered with wire mesh to prevent the escape of beetles. Observations such as feeding, nest building and ball making, etc., were periodically taken.

Results

Copris repertus: The adults of *C. repertus* emerged during the month of May. This species was found to be attracted to both cow and elephant dung. After their emergence they fed initially within the dung pat and later made shallow food burrows. Using their clypeus and fore tibiae, an oblique tunnel was excavated. They scooped soil with the clypeus, brought it out

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[1]Accepted March 1994

[2]C.A.R.I., P.B. No. 431, Junglighat, Port Blair, Andamans 744103.

[3]Vice-Chancellor, University of Agricultural Sciences, Bangalore 560065.

carrying it above their head and threw it onto the surface. Later this tunnel was filled with dung which was brought from the surface. The beetle separated a little mass of dung from the dung pat on the ground surface and moved backwards into the tunnel with the rear end first. Then it turned and packed the dung into the tunnel. This food burrow was either single or branched, and was occupied by a single occupant, either a male or a female. The beetles fed on the stored dung for one or two days and later abandoned it in search of new dung pats. The old food burrows were found to contain left over dung and faecal matter. These food burrows were 5-6 cm deep. Apart from these burrows, a long horizontal tunnel about 2-3 cm was constructed beneath the soil surface, which measured 9 - 12 cm long and ended in a vertical drop of 20 - 40 cm. This was filled with dung in which the beetles were present. Most probably this was used for breeding.

When newly emerged beetles were introduced into cages with soil and dung, they entered the soil immediately after feigning death for a minute or two. They made food burrows and fed on the dung. Later they were not seen to engage in brood construction even though there was enough dung. But when the same beetles were removed and put afresh into rearing cages with soil and fresh dung they started constructing brood chambers.

Those beetles which were released in cages (with soil+no dung) immediately entered the soil. When fresh dung was dropped later into these cages the beetles did not come up for feeding on the dung, but made individual cells and remained inactive. Even after a lapse of two months, these beetles were found alive in the same condition.

After the feeding period (10-15 days) they started constructing brood chambers at an average depth of 17.53 (10-30) cm. The brood burrow consisted of a tunnel of diameter 1.73 (1.5-2.2) cm which ended in a wider brood chamber. The female worked in the lower portions of the brood burrow, while the male restricted himself to the upper portion. During the process of digging the tunnel, the female scooped the soil, lifted it over her head and carried it half way along towards the burrow of the tunnel from where the male would take the soil from her and throw it onto the surface. The average amount of soil excavated was 172.53 (84.4-237) g.

Later, once a brood chamber had been constructed at the base of the tunnel, the male and the female commenced filling it with dung. The average dimensions of the brood chamber were 8.08 x 9.16 x 9.29 cm^3.

The male, working on the surface, separated a fragment of dung using his clypeus and forelegs and brought it to the female who waited near the entrance of the tunnel. She received it from him with her forelegs and moved down the tunnel rear end first, till her abdomen touched the wall of the chamber. Then she climbed over the fragment, took a 180° turn, and packed the dung against the wall of the chamber using her clypeus and forelegs. In a similar manner, the entire chamber was packed with dung. To collect dung of volume 1.0 x 8.9 x 1.8 cm^3 they took 20 minutes. During the entire process, whenever the male refused to do his share of work, the female coaxed him by butting him with her clypeus, after which he resumed the work. In one instance, when the male never returned after he went to bring the dung, the female waited for some time and then went up to find him resting near the entrance. She butted him so fiercely that he fell directly into the brood chamber after which he scurried back to the surface to resume his work of bringing dung.

After filling the chamber with dung (Fig. 1) the female excavated soil around the dung mass and made it a free mass of dung. This soil was partly thrown on to the surface and partly used for closing the tunnel; by doing so the female excluded the male, which was found in a small cell near the tunnel from then onwards.

Later, the female kneaded the accumulated mass of dung into a smooth, big mass, in which she laid several eggs. A small protuberance in the dung mass indicated the presence of eggs (Fig. 2). She separated a mass of dung along with an egg and made a brood ball. All the brood balls were similarly constructed. The mean number of eggs laid per female was 6 (3-9). The brood balls were spheroids (Figs. 3 & 4) The average diameter and weight of the brood ball was 3.77 ± 0.62 cm and 21.92 ± 11.45 g, n = 25, respectively. During the initial stages, these brood balls were devoid of a soil coating around them. Later, a thin layer of soil was applied by the mother onto each one of them. The mother kept constantly moving the balls and changing their position, which prevented the growth of the fungus on them. The mother guarded the brood against predators till the young ones emerged.

In those cages where more than one pair of beetles was released, only one pair constructed a brood chamber, while the others made food burrows and remained in them for the rest of the time.

When the brood balls were interchanged, the mother beetles showed no inhibiting behaviour, but accepted and took care of them. In another instance, two mother beetles were found in a single nest in which six brood balls and 236 g of dung mass were present.

In yet another case, a female had made a brood chamber which contained six brood balls and had extended the chamber into another small chamber in which two more brood balls were present.

Moisture played a crucial role in larval development, because many brood balls which were kept open had shrunken and shrivelled larvae which finally died. As the moisture percentage in the dung decreased it became progressively less palatable for the larva.

Twenty five pairs of beetles which were released in cement pots of dimensions 30 x 45 x 45 cm^3 produced smaller brood balls of average diameter and weight 2.67 ± 0.22 cm, and 10.73 ± 46 g, n = 22 respectively, as compared to the average diameter (3.77 cm) and weight (21.92 g) of normal brood balls formed in deal wood boxes of dimensions 0.9 x 0.9 x 0.9 m^3. Two eggs were laid in one of the smaller brood balls.

In ten cases, the entire brood was destroyed by earthworms *Dichogaster* sp. (Oligochaeta: Megascoleidae: Octochaetinae). In place of the brood, a mixture of dung, soil and excreta of earthworms was present. The mother beetles were found 10-12 cm away from the destroyed brood. Ten broods had larvae along with 2-3 earthworms present in the same ball.

The adults of *C. repertus* stridulated, making screeching noises by the in and out movements of their abdomen. During this process a sort of creamish white liquid oozed out of the anal opening. The larva produced a scratching noise, when the brood balls were touched. When such brood balls were opened it was seen that the scratching noise was the result of the scraping of the inner wall of the brood ball with the larval mandibles.

The brood balls had an egg chamber on top, with the egg glued to one end. The egg was elongate and creamy white. There was a fibrous network on the top of the egg chamber. The larvae lacked the noticeable projection or the hump, unlike the larvae of *Onthophagus* sp. (Fig. 5).

The third instar larva constructed its cocoon using its own excreta. The larva became pale and had an emptied gut by the time it completed cocoon construction. The pupa was creamy yellow initially, turning golden brown with advance in time.

Newly formed adults were chestnut red and stayed in the brood ball for 4-5 days. It took about 8-10 days for the complete melanization of the adults. The adults emerged by cutting a hole in the brood ball (Fig. 6) and then entered the soil.

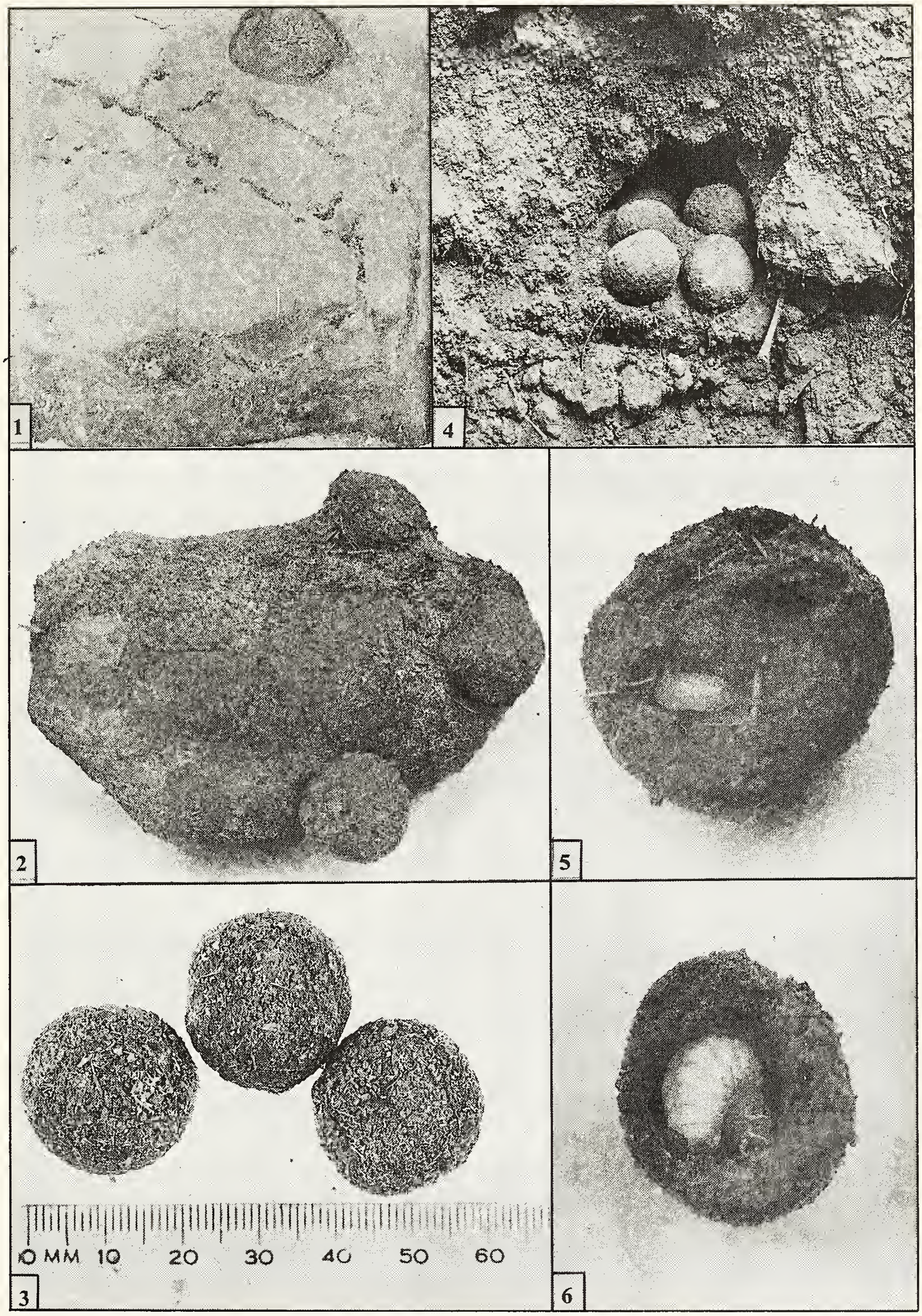

Fig. 1-6. *Copris repertus* Walker
1. Free mass of dung collected by the female for the brood chamber; 2. Small protuberances on the dung mass indicating the presence of the eggs; 3. Brood balls; 4. Nest with brood balls.
5. Second instar larva in the brood ball;
6. Emergence hole made by the newly formed adult in the brood ball.

The number of days taken for completing the different life stages is presented in Table 1 and the measurements of different life stages in Table 2.

TABLE 1
NUMBER OF DAYS TAKEN FOR EACH LIFE STAGE OF *C. REPERTUS*

Egg	N	Min.	Max.	Ave.	S.D.
Egg	6	7	10	8.83	1.16
Total larval period	6	39	42	40.5	1.22
Pupa	9	24	29	26.77	1.56
Total life cycle	6	70	81	77	1.53

TABLE 2
DIMENSIONS OF DIFFERENT LIFE STAGES OF *COPRIS REPERTUS* (IN MM.)

		N	Min.	Max.	Ave.	S.D.
Egg stage I	L	11	6.0	7.0	6.7	0.2
	B	10	3.0	4.0	3.4	0.4
Egg stage II	L	10	6.5	8.0	7.0	0.4
	B	10	4.0	5.0	4.5	0.3
Larva I instar		8	15.5	22.5	19.5	2.4
Larva II instar		12	29.0	40.0	32.8	3.2
Larva III instar		20	38	49.0	44.0	2.7
Pupa	L	20	16	23.0	19.9	1.7
	B	20	10.0	15.0	12.5	1.2

The mother beetle was found always moving over the brood balls, taking care of them. In all cases, whenever the brood balls were stacked in two tiers, she immediately made more place near the lower layer, and placed all balls in a single layer so that she could tend each one of them.

The mother beetles were found to break the brood balls into small fragments if the larva inside the particular brood ball was dead, whereas she repaired those brood balls (when they were broken) if they contained a live larva.

Some atypical behaviour exhibited by these beetles is mentioned below:

When an extra mass of dung was provided to a mother beetle, she used it to make more brood balls.

In one instance, when two pairs of beetles were released in a single cage, both the females prepared brood balls together in a single chamber; and finally one female chased away the other female and tended all the brood balls by herself. The other female stayed in a cell 2 cm away from the brood chamber.

In three cases, the mother beetles tended the brood balls for five days, after which they extended the brood chamber by further digging about 8 cm away and made a separate chamber and shifted all the brood balls into it and tended them.

Copris indicus: These beetles were attracted mainly to sheep dung, even though they were occasionally collected in cow and elephant dung.

C. indicus' behaviour is very similar to that of *C. repertus* but for a few aspects.

Adult beetles emerged during the month of June. They made shallow food burrows (7-8 cm) and fed on the dung they buried. By the end of June to beginning of July they started constructing burrows. Construction of the brood burrow involved both the male and the female.

The pattern of construction of the brood burrows varied from that of *C. repertus.*

In the laboratory, when the beetles were provided with sheep pellets, they behaved in the following manner. The female in cooperation with the male initially dug an oblique tunnel, which was very similar to that of the food burrow. The male carried the individual sheep pellets with his forelegs and walked to the entrance of the tunnel. Then he handed over the pellet to the waiting female who carried it into the tunnel. Similarly, they packed the tunnel with sheep pellets. Next, the female came out and dug a similar oblique tunnel adjacent to the first one, and the male and female filled this new tunnel also with sheep pellets. On an average, a pair of beetles carried 21 (14.1 g) sheep pellets (n = 14). After this, the female dug around the packed mass of dung, and made a chamber with dung in the center. The female broke each sheep pellet and kneaded all of them into a cylindrical mass, of average dimensions 3.8 x 2.35 cm. The brood burrows were constructed at a depth of 17.7 (8.0-27.0) cm; the average weight was 9.39 (6.35 - 23.45) g.

The average dimensions of the brood chamber were 5.6 x 7.8 x 2.0 cm^3 in the cages.

There was difference in the egg laying behaviour. The female separated a part from the dung mass and made a spheroid and then laid an egg in it unlike *C. repertus*, which lays eggs in the dung mass and then makes the brood balls. On an average the female made 3 (2-4) brood balls. The average diameter of the brood balls was 2.3 (1.8-2.8) cm and the average weight was 6.69 (3.2 - 11.11) g.

The female coated the brood balls with soil later. Then the female stayed with the brood balls, periodically cleaning and moving them and stayed with the brood till the young ones emerged. The average number of days taken to complete the life cycle was 56 days.

When two pairs of beetles were released in a cage of dimensions 22 x 25 x 2 cm^3 both the females made their nests at a distance 9 cm apart.

When brood balls of *C. repertus* were given to a mother beetle of *C. indicus* she broke open the balls and killed the larvae. Similar events occurred when the brood balls were exchanged the other way also.

Discussion

Nidification pattern III is characterized by the following factors - spacious underground chamber with a mass of dung which will be converted into brood balls; brood balls have a shell of clay; cooperation between the male and female in nesting; parental care (Halffter and Matthews, 1966). Both *Copris repertus* and *C. indicus* exhibit similar behaviour hence fitting into nidification pattern III.

The sequence of egg laying and brood ball making differs from species to species. In case of *C. repertus* it lays eggs in the dung mass and then separates that part of dung along with an egg and converts it into a brood ball as seen in *C. lugubris* and *C. incertus*, whereas *C. indicus* first separates a part of the dung and converts it into a brood ball and then lays an egg in it as in case of all other *Copris* except *C. lugubris* and *C. incertus* (Halffter and Matthews, 1966). It was also observed that restriction of space resulted in the reduction of the size of the brood balls.

The female beetles guard the brood against attack by predators and also prevent fungal growth on the brood balls by regularly moving them and cleaning them. In the present study one brood was completely destroyed by earthworms and the mother beetle was not able to defend the brood.

Adults of *Copris repertus* stridulated like other species of *Copris* (Halffter and Edmonds, 1982). This sound may be produced as suggested by Halffter and Edmonds (1982), for intersexual communication and for communication between the mother and the larva.

Atypical nesting behaviour in *Copris lunaris* has been reported by Klemperer (1982a). In the present study, some atypical nesting behaviour was also observed in *Copris repertus*, such as preparation of an extra brood chamber to house the brood balls and preparation of extra brood balls when extra dung was provided. This atypical behaviour in these beetles must be either due to addition or omission of some components or factors in the nesting as suggested by Klemperer (1982b).

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THE CONSERVATION OF THE POTENTIALLY ENDANGERED IRRAWADY RIVER DOLPHIN *ORCAELLA BREVIROSTRIS* IN CHILKA LAGOON, ORISSA, INDIA[1]

P. Dhandapani[2]

Key words: Conservation, dolphin *Orcaella brevirostris*

As per the list of 'IUCN Threatened Species Categories', the Irrawady River dolphin, *Orcaella brevirostris* Gray, 1966, falls under 'Insufficiently known' species. Considering its localisation within restricted areas and habitats as a thin population over an extensive range, this species is recommended to be brought under 'Rare' category, particularly in the Indian subcontinent.

As assessment of the present status of Irrawady River dolphin in Chilka lagoon, India, indicates that the deteriorating ecological condition, entangling in gill nets and drag nets, and wanton killing for oil have driven this localised population almost to the brink of extinction.

In order to perpetuate this species in Chilka lagoon, it is emphasised that, in addition to regulating the operation of gill nets and drag nets to prevent accidental capture, breeding of a protected population in a constantly monitored seminatural impoundment set in its natural habitat is the only alternative to restore the population to its erstwhile status.

Introduction

Orcaella brevirostris was first identified from a skull collected from the Visakhapatnam Harbour, Bay of Bengal, out of a collection brought by Sir Walter Elliot. Owen (1866) tentatively identified it as *Phocaena brevirostris,* but it was Gray (1866) who described it properly and placed it under a new genus *Orcaella.* Later Anderson (1878) found these dolphins in large numbers in the Irrawady River of Burma (Myanmar), as far as 1500 km away from the open sea, hence the common name.

Global Status

The global distribution of *Orcaella brevirostris* is along the coastal regions of Bay of Bengal, Malay Archipelago and Indo Australian waters; in the river systems of Ganges, Brahmaputra, Irrawady, Mekong and Mahakam; and in the brackish waters of Chilka lagoon (Owen, 1866; Anderson, 1878; Annandale, 1915; Blanford, 1891; Morzer Bruins, 1966; Tas' an *et al.* 1980; Lyall, 1981; Aminul Haque, 1982 and Dhandapani, 1992).

These dolphins were found in freshwater rivers, lakes, brackish water lagoons and muddy estuaries. But their occurrence in open seas has hardly ever been reported, which could be due to their habit of not exposing themselves much above the water surface to avoid detection. Or, as Dudok Van Heel (1981) indicates, they were 'forced' to take shelter or refuge in the inshore, estuarine and backwater regions.

Presently in the Indian subcontinent, *Orcaella brevirostris* is met with only in three localities, the Chilka lagoon, the inshore and estuarine regions of the Orissa Coast and in the Brahmaputra estuarine network of Bangladesh

[1]Accepted November, 1995.

[2]Marine Biological Station. Zoological Survey of India, 100 Santhome High Road, Chennai 600 028, India.

(Annandale, 1915; Aminul Haque, 1982; James *et al.* 1989; and Dhandapani, 1992). Thus it can be inferred that the habitat niche of this dolphin is mainly in isolated pockets of the extensive coastal regions. Such localisation within restricted coastal pockets which are situated bordering the Bay of Bengal, Malay Archipelago and Indo-Australian waters rightly places this species in the 'Rare' rather than 'Insufficiently known' category of the IUCN Red List (1988).

It is to impress upon the nations bordering the Bay of Bengal the need to protect and perpetuate this species of dolphin, that a proposal is presented here. It is based on a case study of a particular population that is found to be "endemic" in Chilka lagoon.

Status in Chilka Lagoon

Annandale (1915) was the first to report the occurrence of *Orcaella brevirostris* in the Chilka lagoon. He stated that this species was found in large numbers in the outer channel at all times of the year in fresh as well as saltwater, in parties of three or four. He added that in Satpara the individuals were frequently observed rolling over and over on a shelf of sand at the margin of the lake. But the animals, though apparently abandoning themselves to play, slipped into deeper waters instantaneously at the slightest movement ashore. About the behaviour of parties of dolphins off Ghantasila and Barkul Point Chilka lake, Annandale (1915) stated that 'the Cetaceans would often rush in straight towards the rocks, as if about to land upon them.'

Such a pleasing sight which Annandale enjoyed is a dream now. Dhandapani (1992) indicated the alarming status of this dolphin in Chilka lagoon. He sighted only five dolphins during a six month survey in the lake, and among these two were dead. The local fishermen and the officials of the Orissa Fisheries Department estimated that not more than twenty Irrawady River dolphins, which are known as 'Bashiyya Magar' (oil yielding dolphin) in Oriya, exist presently in Chilka lagoon.

The present reduced status of the dolphin in the Chilka lagoon is the result of seventy-seven years of neglect of the lagoon. It calls for attention to the factors that caused such a drastic reduction of its population. Evidently, the changing physiography of the lagoon and human interference with the environment were responsible.

Changing Physiography of the Lagoon

A review of the literature indicates that the lake was orignally a part of the sea, and was rendered shallow by deposits from the mouth of Mahanadi and silt carried up the Bay (Blanford, 1872).

In his introduction to the 'Fauna of Chilka Lake', Annandale (1915) casually mentions that in the dry seasons the depth (?) rarely exceeds 2.4 m at the southern end and 1.2 m at the northern end. The deepest sounding was near Kalidai Is., measuring 3 m. He added that during flood season the depth increased by 3 m or 3.6 m uniformly.

According to the recent Expedition Report of the ZSI, the bathymetric data collected during flood season near the Kalidai Is. showed a maximum depth of approximately 2.8 m which according to Annandale was 4.5 m during his time. This indicates that silt deposition has taken place to an extent of 1.8 m during the past seven decades. I observed the deposits of very loose sand in the northern sector of the lake to a depth of 3-3.6 m which is due to river deposits. Such an unbelievably rapid rate of reduction in depth during the past seven decades has obviously left the Irrawady dolphin with a shrunken and shallow lake habitat.

Secondly, the immense growth of vegetation over an extensive area has reduced the waterspread portion of the lake considerably. According to Annandale (1915) 'in most parts of the lake the aquatic vegetation was scanty except in a few sheltered bays where a species of *Potamogeton* was present'. Sudarshana (1992), while estimating the rate of growth of vegetation in Chilka lagoon from the Remote Sensing Data of IRS IA, reveals a startling reduction in the waterspread area at the rate of 23.42 sq. km over five years between 1984 and 1989 for emergent vegetation. But the submerged vegetation showed a slower rate of 5 sq. km over five years. Unfortunately, no comparative data is available for the previous years. Such a drastic reduction of space both horizontally and bathymetrically would obviously have created a non-conducive and discouraging environment for the Irrawady River dolphin and thus contributed to the decline of their population.

Human Interference in Chilka lagoon

Chilka lagoon is the major fish producing centre of Orissa. Different species of mullets, prawns and mudcrabs form major constituents of the lake fauna. Traditionally, fishermen living in and around Chilka lagoon use different types of fishing gear pertaining to a particular kind of fishery. Notable among these are the gill nets and drag nets which are used for capturing mullet and prawns that are, incidentally, the food of these dolphins. Lured by the entrapped shoal of fish, these dolphins get entangled in the gill nets and drag nets, thus meeting with accidental death. Such a tragedy strikes them not only in Chilka lagoon but also in the inshore and estuarine regions of the Orissa coast (James *et al.* 1989).

The Irrawady dolphins are hunted for their oil, hence the Oriya name 'Bashiyya Magar' (oil yielding dolphin). Annandale (1915) narrates the sequence of hunting as follows: "out in the channel they commonly follow boats, and we were told that there was a man living in Satpara who could call them upto his boat and spear them for the sake of their oil which, in Orissa as in other parts of India, is regarded as a cure for rheumatism, applied externally."

Apart from the causes assigned above, it is the changing physiography of the lake and human interference (Annandale, 1915; Sudarshana, 1992; Dhandapani, 1992) that causes depletion in the population of the species in Chilka lagoon, thus necessitating the recognition of *Orcaella brevirostris* as a potentially endangered dolphin.

Conservation Methods

Two major factors that govern the existence of the Irrawady River dolphin in Chilka lagoon, i.e. human interference and changing physiography, need to be controlled to restore the dwindling population.

It is not possible to completely prevent the use of drag nets or gill nets in Chilka lagoon, as it would interfere with the traditional rights of the local fisherfolk and would hamper fish supply for local consumption, thus creating a socio-economic problem. Therefore, it is more advisable to try educating the illiterate fisherfolk as follows:

1. to protect these dolphins as they drive the fish shoals into their nets,
2. to prevent killing of the dolphins for their oil, which is believed to be a cure for rheumatism, and introduce them to other medical remedies.
3. to operate their fishing gear, particularly the gill nets and drag nets, by hauling them at quick intervals so as to release these dolphins, if captured by accident, back into the lake.

Perpetuation of the species by providing a suitable niche is possible only by installing a constantly monitored seminatural impoundment at a proper location in Chilka lagoon. The data collected during the recent survey by ZSI in Chilka lagoon indicates that the bay that lies between Barkul Point and Pathra is most suitable for conversion into a habitat for the Irrawady dolphin for the following reasons:

1. The bay between Barkul Point and Pathra covers an area of 20 sq. km.
2. The depth in this area, except near the shore, is 2 m, suitable for the free movement of dolphins and fish shoals.
3. Aquatic vegetation is comparatively less, and can be easily removed if necessary.
4. Water temperature varies from 25° to 32°C; and the salinity varies from 7 to 14 ppt which is a congenial brackish-water environment for this population of the brackish-water dolphin.
5. This area is always under the watchful eyes of INS Chilka, an establishment which is keen on protecting the fauna of Chilka lagoon.

Conclusion

The time is ripe to take up protection, conservation and perpetuation of *Orcaella brevirostris,* the Irrawady River Dolphin, in the Chilka lagoon, since this population may never get another opportunity for recovery unless immediate remedial measures are initiated.

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NEW DESCRIPTIONS

FIRST RECORD OF GENUS *STRONGYLOGASTER* DAHLBOM (HYMENOPTERA: SYMPHYTA TENTHREDINIDAE: SELANDRIINAE) WITH TWO NEW SPECIES FROM INDIA[1]

Malkiat S. Saini and Tajinder P. Saini[2]

(*With six text-figures*)

With the description of two new species, the genus *Strongylogaster* Dahlbom is recorded for the first time from India. The new species are *Strongylogaster hepaticolor* sp. n from Ghyagi (Himachal Pradesh) and *Strongylogaster smithi* sp.n from Narkanda (Himachal Pradesh). The detailed description, collection data and diagnostic features of each species is given. A key is provided to distinguish the Oriental species of this genus.

Introduction

Genus *Strongylogaster* was erected by Dahlbom (1835) taking *Tenthredo cingulata* Fabricius (subsequent designation by MacGillivray, 1908) as its type species. Ross (1937) synonymized by *Thrinax* Konow 1885 under this genus. Malaise (1963) in his key to the world genera of Selandriinae treated *Thrinax* Konow, 1885 as a separate genus. But Smith (1969) again followed Ross (1937) and synonymized *Thrinax* under *Strongylogaster*.

As far as the Oriental region is concerned, Rohwer (1916) reported a species of *Thrinax* i.e *T. formosana* from Formosa, and Malaise (1961) two other species of *Thrinax birmana* and *Thrinax sino-birmana* from Burma. However, keeping in view the present status of *Thrinax* and following Smith (1969), the species described by Rohwer (1916) and Malaise (1961) are brought under *Strongylogaster* Dahlbom 1835. In the present communication two new species i.e. *Strongylogaster hepaticolor* sp.n. and *Strongylogaster smithi* sp.n. are added. A workable key to all five Oriental species of this genus is provided.

Genus *Strongylogaster* Dahlbom

Tenthredo subgenus *Strongylogaster* Dahlbom, 1835; Hartig, 1837.

Strongylogaster, Costa 1859, Thomson 1870, Andre 1879, Cresson 1880, Cameron 1882, Cameron 1883, Konow 1887, Dalla Torre 1894, MacGillivray 1894, Konow 1905, MacGillivray 1908, Enslin 1914, MacGillivray 1916, Enderlein 1920, Yuasa 1922, Ross 1937, Takeuchi 1941, Berland 1947, Ross 1951, Zhelokhovtsev 1951, Benson 1952, Lorenz and Kraus 1957, Burks 1958, Malaise 1963.

Type: *Tenthredo cingulata* Fabricius. Designated by MacGillivray, 1908.

Thrinax Dalla Torre 1894, Konow 1905, MacGillivray 1908, Enslin 1913, MacGillivray 1916, Rohwer 1916, Yuasa 1922, Ross 1937 (= *Strongylogaster* Dahlbom; Takeuchi 1941, Berland 1947, Zhelokhovtsev 1951, Malaise 1961, 1963.

Type: *Strongylogaster contigua* Konow. Designated by MacGillivray 1908.

Pseudotaxonus Costa 1894, Enslin 1914, Ross 1937 (= *Strongylogaster* Dahlbom) Takeuchi 1941, Berland 1947, Malaise 1963.

Type: *Tenthredo filicis* Klug, Monotypic.

Polystichophagus Ashmead 1898, Konow 1905 (= *Strongylogaster* Dahlbom; Enslin 1914 (= *Pseudotaxonus* A. Costa)

Type:*Tenthredo filicis* Klug. Original designation.

Prototaxonus Rohwer, 1910; Malaise, 1933; Ross, 1937; (= *Strongylogaster* Dahlbom).

Type; *Prototaxonus typicus* Rohwer. Monotypic.

Description: According to Smith (1969) this genus is characterized by antenna filiform;

[1]Accepted May, 1995

[2] Department of Zoology, Punjabi University, Patiala-147 002 India.

second segment disc like, wider than long; third and fourth segments subequal in length; segments beyond third gradually decreasing in length. Postgenal carina present; clypeus very shallowly to deeply emarginate; malar space narrower or wider than diameter of front ocellus. Epicnemium present as narrow raised shoulder, separated from mesepisternum by furrow. Tarsal claw simple or with small or large inner tooth; basal lobe absent. Forewing with anal crossvein present or absent. Hind wing with anellan cell sessile or with short petiole.

The terminology of Malaise (1945) and Ross (1937 & 1945) has been followed. Holotypes will be deposited in National Pusa Collections, IARI, New Delhi after this work is published.

Abbreviations: AT = apical tooth, CL = clypeus, EL = eye length, IATS = inner apical tibial spur, ICD = intercenchral distance, IDMO = interocular distance at the level of median ocellus, ITD = intertegular distance, LB = labrum, LID = lower interocular distance, MB = metabasitarsus, OATS = outer apical tibial spur, OCL = ocello-occipital line, OOL = oculo-ocellar line, POL = postocellar line, SAT = sub-apical tooth.

Key to Oriental Species

1. Clypeus, labrum, trochanter, femur and tibiae of meso- and meta legs not yellow 2
— Clypeus, labrum, trochanter, femur and tibiae of meso- and meta legs yellow .. *Strongylogaster formosana* (Rohwer, 1916)
2. Postocellar area twice as broad as long 3
— Postocellar area twice as broad as long or broader than long at most in ratio of 3:2 4
3. Scutellum with 4-5 large punctures on its posterior slope; base of costa and brachius pale; 3rd and 4th abdominal tergites entirely whitish yellow in female and whitish yellow beneath in male .... *Strongylogaster birmana* (Malaise, 1961)
— Scutellum not punctate; costa and brachius brown; 3rd and 4th abdominal tergites reddish in female only in middle above and below, but, in the male, the two segments are reddish with only a rounded black spot on each deflexed side of tergites .... *Strongylogaster sinobirmana* (Malaise, 1961)
4. Postocellar area almost as long as broad; hind orbits distinctly carinated; median fovea not divisible into 2 halves; malar space 1x diameter of median ocellus; apex of stigma yellow; scape below, clypeus more or less, postocellar area, mesonotal middle lobe except its anterior border, mesoscutellum appendage and metascutellum fuscoferruginous .... *Strongylogaster hepaticolor* sp.n.
— Postocellar area broader than long as 3:2; hind orbits carinated only below; median fovea divisible into 2 halves by a transverse ridge; malar space 0.8x diameter of median ocellus; stigma black; scape, clypeus, post-ocellar area and thorax black .... *Strongylogaster smithi* sp.n.

Strongylogaster hepaticolor sp. n.
(Figs. 1, 3, 5)

Female : Average length 11 mm. Body black, and the following fuscoferruginous: scape below, clypeus more or less, postocellar area, middle lobe except its anterior border, area anterior and lateral to mesoscutellum, mesoscutellum, appendage, metascutellum broad posterior margin of tergites 2-8, 9 entirely, posterior margin of all sternites. Yellowish white areas include posterior and postero-lateral angles of pronotum, tegula, distal half of metacoxa, metatrochanter, apices of all femora, four front tibiae entirely, proximal 1/3 meta-tibia, probasitarsus. Rest of legs fuscous. Wings yellowish hyaline, costa and apex of stigma yellow, rest of stigma and venation fuscous.

Antenna filiform, 2.2 x head width, scape broader than long, pedicel disc-like, shorter than its apical width and scape, segment 3 shorter than 4, ratio 7:8. Clypeus convex, anterior margin shallowly emarginate (Fig. 1). Labrum broader than long as 3:1 with rounded anterior margin. Malar space 1x diameter of median ocellus. Supraclypeal area subtriangularly raised with blunt longitudinal carina. LID:IDMO:EL :: 2:2.3:1.7; OOL:POL:OCL :: 2:1:1.9. Frontal area above level of eyes and surrounded by low and blunt ridges starting from lateral ocelli. Supra-antennal tubercles insignificant, posteriorly continuous with similar frontal ridges. Median fovea shallow with uneven bottom and continuous upto middle supra-antennal pit. Circum-, inter-, and postocellar furrows distinct. Lateral furrows sunken, diverging posteriorly and abruptly ending halfway to hypothetical posterior margin of head. Postocellar area subconvex, almost as long as broad. Inner margins of eyes subparallel. Hind orbits short, narrowing behind eyes and distinctly carinated. Mesoscutellum flat, appendage not carinate ITD:ICD :: 4:1. Epicnemium narrow, distinct and separated from mesopleuron by a distinct groove. Mesepisternum obtusely raised without carina or acute apex. Subapical tooth of tarsal claw much shorter than apical one (Fig. 3). Metabasitarsus distinctly shorter than all following joints combined in the ratio 3:4. IATS:MB:OATS :: 2:7:1.9.

Head on and around frontal area rugose with dense and irregular punctures. Temples and posterior orbits only sparsely punctate. Mesonotal middle lobe with large, dense, and distinct punctures except along median suture. Mesonotal lateral lobes almost apunctate, except a few isolated punctures on the inner side adjoining mesonotal middle lobe. Mesoscutellum with a few distinct, scattered punctures on its anterior slope and a row of similar punctures along its posterior border. Mesepisternum with large, deep, pit-like distinct punctures and the distance between punctures equal to diameter of each puncture. Mesosternum with very minute, shallow punctures. Abdomen minutely and shallowly punctate, subshining. Body covered with a mixture of silvery and golden pubescence. Lancet with 12 serrulae (Fig. 5).

Male: Unknown.

Holotype: Female, Himachal Pradesh; Ghyagi, 2500 m, 29.v.1984.

Paratypes: Himachal Pradesh: Narkanda, 2700 m, (2 females) 24.v.1984; Kothi, 2700 m, (1 female), 2.vi.1984; Kufri, 2500 m, (1 female) 23.v.1984.

Population variation: The colour of scape and clypeus may be fuscoferruginous to black, metafemur may be entirely yellow.

Distribution: India: Himachal Pradesh.

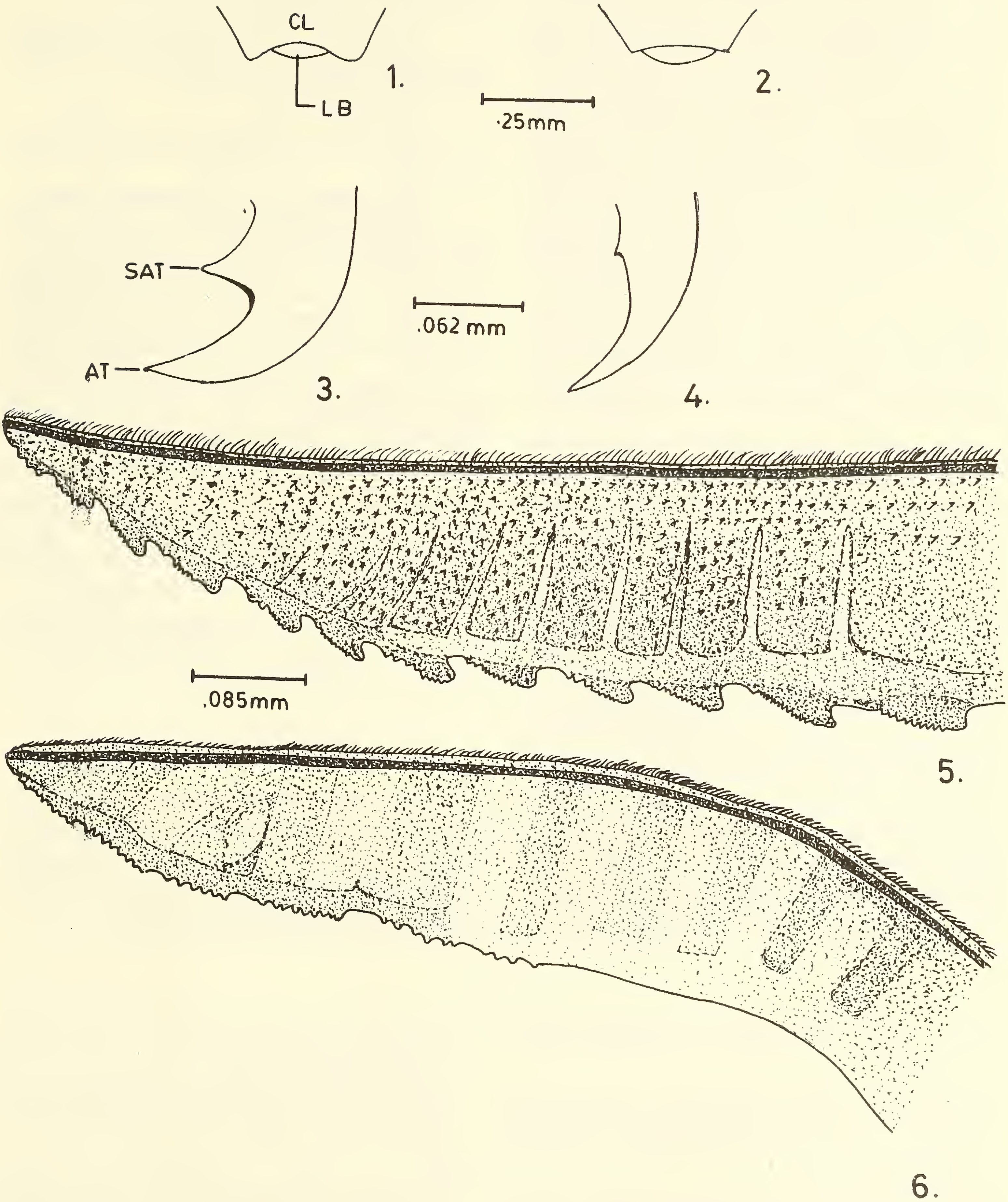
Diagnosis: *Strongylogaster hepaticolor* exhibits some similarity with *Strongylogaster birmana*, but it can be clearly distinguished from the latter by the fuscoferruginous colour of scape, clypeus, meso- and metanotum, broad posterior margin of all tergites and all sternites (scape, clypeus, meso- and metanotum black; 3rd and 4th abdominal segments entirely yellow in female, yellow beneath in the male in *Strongylogaster birmana*); large, dense and distinct punctures on mesonotal middle lobe and mesepisternum (only 4-5 large punctures on posterior slope of mesoscutellum in *Strongylogaster birmana*). Postocellar area as long as broad (twice as broad as in *Strongylogaster birmana).*

Etymology: The species name is based on its dominating liver brown colour.

Strongylogaster smithi sp.n.
(Figs. 2, 4, 6)

Female: Length 11 mm. Body black, with whitish yellow broad dorsolateral angle of pronotum, tegula, extreme posterior margin of tergites 1-7 and sternites 1-6, apices of all femora, tibiae and tarsi of four front legs and proximal 1/3 metatibia. Rest of metatibia and metatarsal joints fuscous. Wings hyaline, stigma and venation brownish black.

Antenna filiform, length 2.1x head width, scape as long as its apical width, pedicel half the length of scape as well as of its apical width, segment 3 and 4 as 7:8. Clypeus convex, anterior margin almost truncate (Fig. 2). Labrum broader than long as 3.5:1, with rounded anterior margin. Malar space 0.8x diameter of median ocellus.



Figs. 1-6. Clypeus: 1. *Strongylogaster hepaticolor* sp. n.; 2.*Strongylogaster smithi* sp. n. Tarsal Claw: 3. *Strongylogaster hepaticolor* sp. n.; 4. *Strongylogaster smithi* sp. nov. Lancet: 5. *Strongylogaster hepaticolor* sp. n.; 6: *Strongylogaster smithi* sp.n.

Supraclypeal area subtriangularly raised with blunt longitudinal carina. LID:IDMO:EL :: 2:2.4:1.8; OOL:POL:OCL :: 1.3:1:1. Frontal area at the eye level surrounded by low and blunt ridges starting from lateral ocelli. Supra-antennal tubercles low and posteriorly continuous with similar frontal ridges. Median fovea divisible into two halves by a transverse ridge of the magnitude of frontal ridges, anterior half with a deep semicircular pit almost of the size of median ocellus and posterior half with an uneven bottom having three parallel longitudinal carinas. Circum-, inter- and postocellar furrows distinct. Lateral furrows distinct, diverging backwards, and abruptly ending halfway to the hypothetical posterior margin of head. Postocellar area convex, with a median longitudinal groove and broader than long, as 3:2. Inner margins of eyes subparallel. Hind orbits short, narrowing behind, carinated only below. Mesoscutellum flat, appendage not carinate. JTD:ICD=3.5:1. Epicnemium subconvex, separated from the mesopleuron by a distinct furrow. Mesepisternum obtusely raised without carina or acute apex. Tarsal claw with a very minute subapical tooth (Fig. 4). Metabasitarsus shorter than all following joints combined as 4:5. IATS:MB:OATS::2:7.5:1.9.

Head distinctly, minutely and densely punctate on and around frontal area: temples and hind orbits apunctate, subshining. Mesonotum and mesopleuron apunctate and shining; meso-scutellum apunctate, except a few large and distinct punctures along its posterior border. Abdomen finely cross-striated, subshining. Pubescence negligible. Lancet with 7 serrulae (Fig. 6).

Male: Unknown.

Holotype: Female, Himachal Pradesh: Narkanda, 2700m, 25.v.1984.

Paratype: None.

Population variation: Single specimen examined.

Distribution: India: Himachal Pradesh.

Diagnosis:This species is characterized by the median fovea divisible into 2 halves by a transverse ridge, clypeus truncate, thorax almost apunctate, abdomen finely cross-striated and tarsal claw with a very minute subapical tooth. Though quite distinct, still it can be compared and demarcated from *Strongylogaster hepaticolor* as follows: Postocellar area broader than long as 3:2 in *S. smithi* (Postocellar area almost as long as broad in *S. hepaticolor*); scape, clypeus, postocellar area and thorax black in *S. smithi* (scape, clypeus, postocellar area and thorax fuscoferruginous in *S. hepaticolor*).

Etymology: The species is named after Dr. D. R. Smith of USNM, Washington, an authority on sawfly taxonomy.

ACKNOWLEDGEMENTS

We are grateful to Dr D.R. Smith, Systematic Entomology Labroratory, USDA, Washington, D C, for his valuable suggestions. Thanks are also due to US, PL-480, and ICAR, New Delhi, for financial assistance.

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HYGROPHILA BENGALENSIS MANDAL, BHATTACHARJEE ET NAYEK SP. NOV. — A NEW SPECIES OF *HYGROPHILA* BR. FROM 24-PARGANAS (S), WEST BENGAL.[1]

S.K. Mandal[2], Aloke Bhattacharjee[3], and Ajit Kumar Nayek[4]

(*With nine text-figures*)

Frutex annuus, *ca.* 1 m longa; caulis erectus, parum quadratus, longitudinaleter striatus, ad nodus tumidus, internodia longa, *ca.* 3.5-4.0 cm, minus ramosa glabra. Folia simplicia, opposita, decussata; obovata ad elliptico-lanceolata, 3.5-4.0 x 0.7-1.0 cm, ad marginem undulata cum pilis marginalibus, sessilia vel minute stipitata; nervi 5-6 paribus, infra plus prominenti. Inflorescentia axillaris cymosa, paniculata; bracteae bracteolaeque lineari-oblongae, obtusae, minute pilosae in area marginali. Flores regulares, bisexuales, 2.0-2.4 cm, subsessiles, flavi. Calyx 5-lobatus, tubularis, usque ad 1/3 longitudinis divisus, lobi lineares, subequales, acuminati, ad apicem cum caespite pilorum, intus hispida, 5-nerves, 0.7-0.8 cm, viridis, calyx fruetifer divisus usque ad basin, lobi aequales, lanceolati, raphides manifestae praesentes, intus pilosa. Corolla bilabiata, limbus profunde bilabiatus, lobi 5, aequales, subovati, 2.2-2.4 cm, pubescentes, flavi. Stamina 4, didynama, 2 stamina posteriora 12 mm longa, 2 anteriora 6 mm longa, anthera 2 mm, oblonga, 2-locularis, inaequalis, dorsifixa, filamentum deorsum pilosum. Ovarium oblongum, 5 mm, sursum minute pilosum, stylus longus, *ca.* 1.5 cm, gracilis, minute pilosum; stigma lineare, articulatum, 2-4 mm longum. Capsula 1.5-2.0 cm longa ad dimidium inclusa in calyce persistenti, minute pilosa, suturae 2, longitudinaliter dehiscens, 2-locularis. Semina 24-30, alternatim disposita, affixa cum retinaculis unciformis, ovoidea, minute arillata ad apicem, ventraliter incisurata, 0.8-1.2 mm, testa minute pilosa.

Hygrophila bengalensis Mandal, Bhattacharjee et Nayek differt a *H. salicifolia* Nees foliis obovatis ad elliptico-lanceolatis, marginibus undulatis, floribus flavis, calyce persistenti cum pilis marginalibus, stylo longo, gracili, stigmate longo, articulato, seminibus 24-30, alternatim dispositis per retinacula curvata unciformes affixis, ad apicem minute arillatis, et ventraliter incisuratis, testa cumpilis lanatis mucilagineis.

Description

Annual shrubs, upto 1 m long; stem erect, slightly squarish, longitudinally striated, swollen at the nodes, internode long, about 3.5-4.0 cm, less branched, glabrous. Leaves simple, opposite decussate, obovate to elliptic-lanceolate, 3.5-4.0 x 0.7-1.0 cm, margin undulate with marginal hairs, sessile or minutely stalked; vein 5-6 pairs, more prominent on the lower surface. Inflorescence axillary cymose panicle; bracts and bracteoles linear-oblong, obtuse, minutely hairy on the marginal area. Flower regular, bisexual, 2.0-2.4 cm, subsessile, yellow. Calyx 5-lobed, tubular, divided upto 1/3 of its length; lobes linear, subequal, acuminate, tuft of hair at apex, inner side hispid, 5-nerved, 0.7-0.8 cm, green, in fruit calyx divided upto the base, lobes equal, lanceolate, prominent raphide present, inner side hairy. Corolla-limb 2-lipped, lobes equal, sub-ovate, 2.2-2.4 cm, pubescent, yellow. Stamen 4,

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[1]Accepted 15th June, 1996

[2]Central National Herbarium, Indian Botanic Garden, Howrah-711103.
[3]Botanist, HQ., P-8 Brabourne Road, BSI, Calcutta-700 001.
[4]Research Scholar, BSI P-8 Brabourne Road, Calcutta-700 001.

Fig. 1-9. *Hygrophila bengalensis* Mandal, Bhattacharjee et Nayek, sp. nov.
1. Flowering twig; 2. Fruiting twig; 3. Dorsal surface of calyx; 4. Calyx showing hairs on ventral surface; 5. Flower — corolla split open; 6. Ovary with persistent calyx; 7. Gynaecium with articulate stigma; 8.Fruit; 9. Seed.

didynamous, posterior 2 stamens 12 mm and anterior pair 6 mm; anther 2 mm, oblong, 2-celled, not equal, dorsifixed, lower portion of the filament hairy. Ovary oblong, 5 mm upper portion minutely hairy; style long, about 1.5 cm, slender, thin, minutely hairy; stigma linear, articulate, 2-4 mm long. Capsule 1.5-2.0 cm long, half-way included within persistent calyx, minutely hairy, sutures 2, dehiscent longitudinally, 2-chambered. Seeds 24-30, alternately arranged, attached with hook-shaped retinacula; seeds ovoid, minutely arillated at the top, ventrally notched, 0.8-1.2 mm, testa minutely hairy (visible by absorbing in moisture).

The species is allied to *Hygrophila salicifolia* Nees but differs from it by the leaf-shape being obovate to elliptic lanceolate with undulated margins, flower yellow, persistent calyx with marginal hairs, long slender style with long articulate stigma, seeds 24-30 alternately arranged, attached by curved hook-shaped retinacula. Seeds mainly arillated at the top and ventrally notched. Testa with mucilaginous woolly hairs.

Locality

Gorkhara, Sonarpur, 24-Parganas (South), West Bengal, Coll. S.K. Mandal 30.i.1996. Holotype field No. 1216/A deposited in the CAL (Central National Herbarium). Isotype field No. 1216/B - D also deposited in the same Herbarium.

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We are grateful to Dr. P.K. Hajra, Director, Botanical Survey of India and Dr. Debika Mitra, Scientist 'SE', Central National Herbarium for encouragement and valuable suggestions.

REVIEWS

1. FAUNAL DIVERSITY IN THE THAR DESERT: GAPS IN RESEARCH

By A.K. Ghosh, Q.H. Baqri and I. Prakash. Scientific Publishers, Jodhpur, India pp 410 (21 cm x 14 cm) Price not mentioned.

This book is an outcome of the expert meeting organised by the Desert Regional Station of the Zoological Survey of India, Jodhpur and local chapter of the Indian National Science Academy.

It is a compendium of papers presented by various zoologists who had worked on desert fauna. The Thar desert is spread over 28 districts of four states i.e. Rajasthan, Punjab, Haryana and Gujarat. Though there are earlier publications on this subject, the book covers a good number of publications on the faunal diversity of Thar Desert.

There are 41 chapters dealing with invertebrate and vertebrate fauna of the desert. While most of the chapters are compiled from published literature, there are some papers based on original work, like "Geographical diversification of human Plasmodia and malaria syndrome in the Thar desert and Anopheline vectors of Malaria in the Thar desert", where the impact of canal-based irrigation and seepage water has been studied. The papers "Changing Avifauna of Thar Desert" also provides information on the impact of Indira Gandhi Nahar Pariyojna (IGNP) on Ecology of the area resulting in new habitats and increase in bird diversity, but at the cost of some of the rare desert avifauna.

"The ecological transformation of rodent fauna" gives in detail how the IGNP has affected the habitat, whereby rodent species like *Mus musculus*, for instance, have reverted to the crop fields habitat.

The chapters on invertebrate fauna provide biodiversity of each phylum i.e. Protozoan, Freshwater sponges, Platyhelminthes and Acanthocephala, Nematodes, Annelids, Acarina (ticks and mites), Crustaceans and Insects. Chapters 14 to 28 describe the diversity of insect fauna in the Thar. Unfortunately the chapters are arranged haphazardly, not as per insect orders. Therefore, to get information on Coleoptera of Thar Desert, one has to refer to Chapter 17: Orthoptera and Coleoptera, Chapter 23: Stored Grain Pests and Chapter 24: Aquatic Beetles. It would have been easier if all information on one order had been put together as part of one Chapter, with each paper marked as a section.

There are also contradictions in the number of species mentioned in the Chapter "Insect Diversity" and information given under separate Orders. For example on page 135, the number of Dictyoptera species found in Indian desert is given as 20 out of 297 found in India. However, on page 16 under Dictyoptera, it is mentioned that over 175 species are found in India out of which 9 are listed in the paper. In fact, there are 10 species mentioned in the paper.

It appears that most of the work cited is from Jodhpur, Bikaner, and other districts of Rajasthan and the information on faunal diversity of Thar Desert, covering Punjab, Haryana and Gujarat is very scanty. Besides, the mammal fauna of the Thar there is one chapter each on Jodhpur langurs, Eco-behavioural diversity and on city dwelling rhesus and langurs.

A chapter on avenues of faunal research in the Thar desert and information on gaps in researches for particular groups given at the end of each chapter is very useful for all researchers and students of zoology interested in working on the biodiversity of the Thar Desert. ☐

NARESH CHATURVEDI

2. TURTLES AND TORTOISES OF INDIA by Indraneil Das, published for World Wide Fund for Nature-India at Oxford University Press, Bombay, 1995. pp i-ix+176 (21.5 cm x 13 cm) 34 colour photographs and some line drawings. Price Rs.150.00.

This is Indraneil Das's third book on turtles and tortoises of the Indian subcontinent and it firmly establishes his status as the authority on the testudines of the region.

The armoured reptiles, turtles and tortoises are, inspite of their protective armour, as endangered as any other group of animals; perhaps more so in some aspects of their life cycle. All the thirty-four species of marine, freshwater and land tortoises have been described in detail. Each description has notes on taxonomy, morphology, colour, size, sexual dimorphism, subspecies if any, names, distribution, habitat, behaviour, diet, reproduction, status and conservation and pertinent references.

The book is therefore a comprehensive account of the species one is likely to encounter in the subcontinent.

All the species are illustrated in colour though the colour reproduction can be considerably improved. They are as now presented, an object example of the advantage of good colour drawings over indifferent reproductions of photographs.

This book as well as his INDIAN TURTLES: A FIELD GUIDE have been published by the WWF and they are to be commended on the choice of author and subject. □

J.C. DANIEL

3. ETHNOBIOLOGY IN INDIA — A STATUS REPORT by P. Pushpangadan, Published by Ministry of Environment & Forests, New Delhi. 1994. pp i-ix + 1-68 (24 cm x 16 cm) Price not mentioned.

This report is an overview of the work done under the 'All India Research Project on Ethnobiology' which was launched in 1982. Its first phase ended in 1988, covering about 65% of the tribal areas in the country. 24 different research centres in the country participated in the programme. The book includes the following chapters:

1. Genesis of the project, 2. Overview of the project, 3. Tribal settings in India, 4. State of the art of Ethnobiology, 5. Aims & objectives of the project, 6. Ethnobotany — Some observations 7. Archaeobotany, 8. Ethnozoology, 9. Research — Future and 10. Coordination work

The foreword of the book is written by Mr. Rajamani, the then Secretary, Ministry of Environment & Forests, Govt. of India.

Chapter 6 on Ethnobotany gives the following important ethnobotanical figures:

1. Over 9500 wild plant species are used by tribals for various requirements.
2. 7500 wild plant species are used by tribals for medicinal purposes.
3. About 950 new claims about plants are made which are worthy of scientific scrutiny.
4. About 3900 wild plant species are used as edible plants by tribals.
5. About 800 entries of new utilities have been recorded.
6. About 250 entries on new utilities are worthy of further research.
7. About 525 wild plant species are used for fibres and cordage of which about 50 are promising for commercial exploitation.
8. Out of 400 plant species used as fodder about 100 are worth recommending for wider use.
9. Out of 300 wild plant species used by the tribals as piscicides and pesticides, 175 hold promise as safe biopesticides.

Actual lists of plants in the above analysis are not given in the booklet. However, a few endangered and threatened plants of India are listed.

Perhaps the final report on this project will throw some light on the real achievements of the project. □

M.R. ALMEIDA

4. THE ATLAS OF ENDANGERED SPECIES. Edited by John A. Burton, with a foreword by David Bellamy. Quarto Publishing Plc. U.K. 1991. pp 256. (22.3 x 28.6 cm). Hardback price £16.99, with colour photographs of endangered species and habitats, distribution maps of endangered species and maps indicating biogeographic regions of the world, climatic regions and pollution and population profiles of the world, a map of protected areas around the world, list of endangered wildlife, International Conventions and a selection of International Conservation Organisations.

The indepth effort by a team of nineteen specialist contributors, including Tim and Carol Inskipp who are considered experts on Nepalese ornithology, is worthwhile as it provides most of the relevant information on endangered species along with their distribution and causes of their decline under one covei, though in certain sections the effort appears to be cursory and lacks depth.

The surveys of the seven key biogeographic areas of the world identify the endangered animals and plants in these regions and the problems they face. Various corrective measures currently under way in various countries, the successes and failures of the conservation movement and an agenda for individuals is given.

The dangers of taking liberties with Island ecosystems has been dramatically illustrated by pertinent examples, like the introduction of the brown tree snake *Boiga irregularis*, a venomous bird and egg predator on Guam in the Marianas Islands, where in the 1970s almost all of the 18 native birds became extinct because of this snake. One of its most spectacular victims was the endemic and flightless Guam rail whose population on the island plummeted from over 80,000 individuals in 1968 to zero in 1988 ! Similarly, the introducion of herbivores like the domestic goat has played havoc with island ecosystems like the Pinta island in the Galápagos, increasing from just three individuals to around 20,000 in 12 years ! These catastrophes highlight the dangers of treating island ecosystems casually. Beware the 'development' activities and attempts at species introduction in the Andaman & Nicobar Islands.

Unfortunately, the information provided on some species is highly erroneous. The gaur has been described as "This cattle has been domesticated and there are feral as well as wild populations, including around 50,000 in Arunachal Pradesh, India" ! Kanha National Park, where a good population of the Gaur exists, has not been mentioned. The Park, located in Central India, has been erroneously placed in the Deccan plateau, south India ! The editors have repeated ad nauseam the magic figure of 40,000 tigers in 1930, which is misleading in the absence of any supporting evidence. Similarly, the orangutan's decline has been attributed to malaria, without mentioning the source of information, while the more obvious pet trade, poaching and habitat loss have been overlooked. Some of the information is definitely not convincing. References should have been cited.

Certain species like the blacknecked crane *Grus nigricollis* and the Japanese crowned crane *Grus japonensis*, have not been covered. The endangered raptors on the Indian subcontinent like the lesser spotted eagle *Aquila pomarina* and the lesser fishing eagle *Ichthyophaga humilis* have not been mentioned. No information has been provided on the Asiatic cheetah *Acinonyx jubatus*, a small population of which exists in the Fars region of Iran. Surprisingly, except for being listed as an endangered species, no mention has been made of the precarious situation of the Manipur brow antlered deer *Cervus eldi*, a small population of which survives on the 40 sq. km Keibul Lamjao, the world's only floating National Park. Only 100 individuals of this species reportedly survive in the Park located in the 300 sq. km Loktak lake in Manipur.

The chapter 'Conservation in Action' is cursory and does not give a proper feedback on the efforts which resulted in the network of protected areas around the world. Practical suggestions have been made with regard to tackling the numerous conservation issues confronting us. The advice to involve politicians and shortlist the environmentally sensitive amongst them for elections is very timely. This approach is the key to most of our environmental problems as has been recently demonstrated with regard to the tiger and the denotification of protected areas in India.

In spite of some glaring shortcomings, the book with its over three hundred maps and some spectacular pictures of endangered animals and their habitats is a must for libraries and concerned citizens. □

S. ASAD AKHTAR

5. UNDERSTANDING BIODIVERSITY: LIFE, SUSTAINABILITY AND EQUITY, by Ashish Kothari. Tracts for the Times Series No. 11 Published by Orient Longman, New Delhi. 1997. pp i-xv +161 (21.5 x 13.5 cm) Paperback price Rs. 75.00.

Ashish Kothari is one of India's leading environmentalists and a spokesperson for human rights, especially tribal rights. He has a deep appreciation and understanding of the problems of wildlife conservation vis-a-vis tribal aspirations to improve their living conditions. In this highly readable book he succinctly advocates that the two *cannot* be separated. Ashish is highly critical of the Biodiversity Convention which he thinks favours developed countries at the cost of developing countries. He suggests some changes which he thinks will give further impetus to bio-rich countries to save their biodiversity.

Although all the six chapters are good, I particularly liked the fourth chapter *People, Patents, Profits* which gives new information on the controversial topic of patent laws and intellectual property rights. The language of the book is simple and sometimes colloquial ("pay through the noses" (*sic*), p. 75). It contains some interesting information, e.g. "The entire coffee industry of Latin America comes from seven plants taken from Yemen a thousand years ago, and one plant taken to Java less than 300 years ago." At the end of the book, Kothari has given 'Notes' for each chapter, containing published references and unpublished official documents. There are only a few spelling mistakes e.g. *seet* instead of *seed* (p. 156). I strongly recommend this book to all who are interested in the conservation of the rich biodiversity of India. Hardcore wildlife lovers may not agree with Ashish's prescription for saving India's wildlife by opening up protected areas for so-called participatory management. Nevertheless, the book is worth reading for wildlifers. □

ASAD R. RAHMANI

MISCELLANEOUS NOTES

1. DISTINGUISHING KILLS OF TWO LARGE MAMMALIAN PREDATORS IN SPITI VALLEY HIMACHAL PRADESH

Predation by wild carnivores on livestock is an important issue that the protected area manager needs to address. In areas where there are two or more sympatric carnivores, one problem is how to attribute a particular kill to a particular carnivore species. Spiti Valley in H.P. is one such area where at least two carnivores predate on the livestock; the snow leopard *Panthera uncia* and the Tibetan wolf *Canis lupus chanco*. While the snow leopard occurs throughout the valley, Tibetan wolf is restricted to the left bank of the Spiti river.

The valley harbours two protected areas — Kibbar Wildlife Sanctuary and Pin Valley National Park on the left and right banks of the Spiti river, respectively. Pin Valley largely consists of steep snow covered mountain peaks, deep valleys and alpine pastures. Kibbar, in addition, consists of rolling slopes of the Tibetan plateau. Among mountain ungulates, Himalayan ibex *Capra ibex sibirica* forms the only wild prey base in Pin Valley, while Kibbar Sanctuary harbours ibex as well as bharal *Pseudois nayaur.*

As mentioned earlier, while only the snow leopard occurs in Pin Valley, the Kibbar Sanctuary has both the snow leopard and the Tibetan wolf.

Local livestock contributes substantially to the prey base and is a frequent victim of the predators. Among these are the domestic yak, horse, donkey, churu (cow-yak hybrid), sheep and goat. As a manager of these protected areas from 1992 to 1995, I recorded more than 350 cases where local people had applied for compensation for killing of their livestock by wild carnivores. In almost all cases where eye-witnesses were absent, the locals attributed the kills to the snow leopard. Casual interviews of the local people indicated that they consider the snow leopard as their main enemy, and the wolf to a lesser extent. This is really worrying since the snow leopard is the largest Trans-Himalayan felid. This magnificent apex predator is highly endangered and considered as the flagship species for conserving the Trans-Himalayan ecosystem. I, therefore, found it important to ascertain the predator species responsible for killing livestock in each case.

I examined about seventeen cases where eye-witnesses or other evidence confirmed the predator species. Of these, eleven kills were definitely made by the snow leopard and six by the Tibetan wolf. Examination of these kills showed that the snow leopard had killed relatively larger species like the yak, horse, donkey etc. Sometimes it entered the cowsheds and killed all the animals inside, small or large. Such incidents are reported mostly from remote localities. The snow leopard mostly attacked the upper region of the prey's neck. Wolf attacks were usually lower and often resulted in puncturing the jugular vein. Wolves were involved in surplus killing which were usually sheep and goat, whereas the kills of the snow leopard appeared to be according to its requirement.

Interestingly, many kills were recovered as headless carcasses, and later these were confirmed by the villagers as wolf kills. In earlier days, local people used to raid the dens of the wolf to destroy or remove the pups during the breeding season. During this operation the villagers had noticed that the denning sites often had several heads of their prey. They believe that the heads are taken by wolves to their den to train the pups.

Eventhough the result of this preliminary study are in no way conclusive, simple natural history observations of kills can help us in making educated guesses about the predator species.

February 8, 1997

B.S. RANA
Divisional Forest Officer,
Spiti Forest Division, KAZA,
Lahaul Spiti (H.P.)-172 114

2. OCCURRENCE OF THE RUSTYSPOTTED CAT (*FELIS RUBIGINOSA*) IN ORISSA

(*With one text-figure*)

Two (one male and one female) rustyspotted kittens (*Felis rubiginosa*) were collected from the road leading to Bhramarbadi village in Daringbadi block (Balliguda Forest Division) in Phulbani dist. on 16th February, 1995 evening, by the Sub-Collector and Sub-Divisional Police Officer of Balliguda Sub-division and received at the Nandankanan Zoological Park, Orissa, on 18th February, 1995 through the good offices of the Divisional Forest Officer, Balliguda.

These were mistakenly identified as leopard cat kittens, with their eyes open and an estimated age of about 3-4 weeks. The kittens were initially kept in a well ventilated wooden box and then shifted to an enclosure with dimensions 1.85 x 1.65 x 2.0 m^3. They were fed with minced goat meat for a few weeks followed by goat meat. Unfortunately the male died on 29th March, 1995. By August 1995, the female kitten had matured and revealed the characteristic size and colour pattern described for the rustyspotted cat by Prater (1971) (Fig. 1). However, she also died on 15th October, 1995. The systematic list of mammals from Orissa reported by Das *et al.* (1993) does not include the rustyspotted cat. This is the first record of the occurrence of this rare species of lesser cat in Orissa.

Fig. 1. Female rustyspotted cat in Nandankanan Zoological Park

Reviewing the literature on the occurrence of the rustyspotted cat, Chakraborty (1978) states that this interesting cat is recorded only from certain localities in southern India, Sri Lanka and Seoni in Madhya Pradesh. He further states that one female specimen of the rustyspotted cat was collected from Udhampur (Jammu and Kashmir) on 16th October, 1975 during the faunistic survey.

It occurs in southern India and along the western ghats upto the Dangs in south Gujarat (Prater, 1971; Saharia, 1981; Gee, 1964). Sightings of this lesser cat in Gir Wildlife Sanctuary and National Park, and Shoolpaneshwar Sanctuary in Gujarat have been reported in recent years (Pathak, 1990; Chavan *et al.* 1991). Tehsin (1994) reported the sightings of this rare cat for the first time near Udaipur (Rajasthan) in July, 1992. This species has also been reported in Panna dist., Madhya Pradesh (Digveerendrasinh, 1995).

The present observation and the observations of other workers on the occurrence of the rustyspotted cat suggest that the species has a much wider range of distribution in India than was believed earlier.

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L.N. ACHARJYO
House No. M-71, Housing Board Colony, Baramunda, Bhubaneswar-751 003.
K.L. PUROHIT
Range Officer, Nandankanan Zoological Park, Bhubaneswar.
S.K. PATNAIK
Director
Nandankanan Zoological Park, Mayur Bhawan, Janpath, Sahidnagar, Bhubaneswar-751 007.

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3. LEOPARD (*PANTHERA PARDUS*) ATTEMPTING TO PREY ON INDIAN GIANT SQUIRREL (*RATUFA INDICA CENTRALIS*)

It was the morning of 5th June, 1995 at Satpura National Park (MP) when my driver suddenly halted our van on seeing a huge bamboo rhizome off the road. As we descended from the vehicle to examine the rhizome we heard the alarm call of a giant squirrel (*Ratufa indica centralis*) from a distance of about 20 m. Following the direction of the very loud call, we spotted the squirrel on the trunk of a huge *Adina cordifolia* tree, lying motionless and calling continuously. After a second appeared a leopard (*Panthera pardus*) from the other side of the tree. The leopard was balancing himself very gingerly on the tree trunk right behind the squirrel. The squirrel swiftly went to the other side of the tree with the leopard following it. This chase continued two more times around the tree. Finally, the squirrel took a bold leap forward and jumped on to an adjacent *Terminalia tomentosa* tree and then to the next tree and disappeared. The leopard did not pursue it further as he jumped and vanished into the thick undergrowth below. Various predators seem to be a perpetual threat to giant squirrels. Raptorial attacks on giant squirrels have been reported earlier. Borges (1986) and Joshua and Johnsingh (1994) have reported black eagle (*Ictinaetus malayensis perniger*) attempting to predate on the giant squirrel. Datta (1993) and I have also observed a crested hawk eagle (*Spizaetus cirrhatus cirrhatus*) trying to attack a giant squirrel. Hutton (1949) had observed the Nilgiri marten *Charronia gwatkinsi* (Horsfield) feeding on giant squirrel. Leopards are known to be opportunistic feeders and occasionally feed upon arboreal prey such as langurs, but the giant squirrel does not seem to be such an easv prey.

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PRACHI MEHTA
Senior Research Fellow,
Wildlife Institute of India, Post Box 18,
Chandrabani, Dehra Dun-248 001.

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4. OCCURRENCE OF THE BROWN PALM CIVET IN THE WET FOREST OF KALAKAD MUNDANTHURAI TIGER RESERVE, TAMIL NADU

The Western Ghats harbour many rare and endemic fauna. However, distribution, status and ecology of many of them remain unclear. In this note, the occurrence and status of the brown palm civet (*Paradoxurus jerdoni*) in the evergreen forest of Kakachi (*c.* 1250m) in the Kalakad Mundanthurai Tiger Reserve of south India is discussed.

The brown palm civet (*Paradoxurus jerdoni*) is endemic to the Western Ghats and is an inhabitant of the high elevation forests (Jerdon, 1874). Though not considered as rare as the endangered Malabar civet (*Viverra civettina*), very little is known about its status or distribution in the Agasthyamalai region of the southern Western Ghats (Ashraf *et al.* 1993).

In the Kakachi-Upper Kodayar area of the KMTR, the brown palm civet appears to be fairly common. Over the six years (1990-1996) of our stay in Kodayar, we have sighted this animal more than ten times during the night and only twice during the day. Recently in April 1996, we sighted an individual in the canopy of the evergreen forest, basking in the sunshine at noon and later eating the flowers of *Cullenia exarillata* until late in the afternoon. This animal was lethargic even in our presence and was probably sick.

Our sightings of the civet have mostly been on or near flowering or fruiting trees during the night. They regularly feed on the flowers of *Cullenia exarillata* and ripe fruits of *Elaeocarpus munronii* and *Palaquium ellipticum* whenever available and probably serve as an important seed disperser in this area.

The civets breed in this area in summer. A pair of new born young of this civet was found deep inside the forest at Kakachi in May 1992. We noticed the pups because of their yelping call. They were in the litter, blind and probably not more than a week old. There was no sign of injury, but unfortunately our attempts to rear them failed. Like the adults in the area, the pups also had a white tipped tail.

Being nocturnal and restricted to the dense forest of the evergreen and moist deciduous type, the brown palm civet has rarely been sighted. We observed that it is an important contributor to the dynamics of tree regeneration in the wet forest. Hence, continued protection of the species and its habitat is very essential.

ACKNOWLEDGEMENT

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T. GANESH
29, Chetty Street,
Pondicherry 605 001.

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5. TIBETAN GAZELLE *PROCAPRA PICTICAUDATA* IN SIKKIM, INDIA

Sikkim, India's smallest state, lies between 27°5' to 28°9' N lat. and 87° 59' to 88° 56' long. covering an area of *c.* 7000 sq. km. It is wedged in between the Himalayan kingdoms of Nepal in the west and Bhutan in the east, and bounded by Tibet in the north and the Indian state of West Bengal in the south.

The Tibetan gazelle is found in Sikkim only in the trans-Himalayan north at *c.* 5000 m altitude. It is a trans-border migrant coming from across the international border between India and Tibet (China), and roaming the Chho Lhamo plateau. This high altitude cold desert holds several lakes, forming the source of the river Tista which is the main river in Sikkim. It is also the most important grazing area for most of Sikkim's yaks, sheep and goats.

Surveys over the last five years usually in the peak season of July-August showed that the animal is not common like the resident breeding Himalayan marmot *Marmota bobak* or the woolly hare *Lepus oiostolus.* Along with the southern *Kiang* or Tibetan wild ass *Equus kiang polyodon,* it inhabits this high altitude grassland region and can be sighted in groups of 10-15 animals even during winter but may not be sighted regularly each year.

During an intensive survey of the area in July-August 1995, gazelles were seen for the first time in six years at relatively closer distances than before in various places. On 28th July, 1995, we sighted nine gazelles at Chho Lhamo (5099 m) near a group of four adult and two young *kiang* but they were very shy and fled even from a distance of *c.* 500m. 10 were then sighted at Chhulung La (5447 m) in the valley where it is possible to get very close to *nayan* or the great Tibetan sheep *Ovis ammon hodgsoni.* A skin with horns was also recovered from this place. It was later handed over to the Forest Department. We saw two at Bamcho La the same same day, but they were the last of the herd which had gone across the border on hearing the sound of our jeep. 11 gazelles were then seen at Kongra La (5133 m). In one day we saw 33 gazelles on the Chho Lhamo plateau. In all areas the animals were extremely shy and wary.

Local *dokpas* or the nomadic Tibetan graziers call the gazelle *raakon* and are familiar with the animal. Reporting on wild and domestic livestock movements, they said that in winter the yaks are taken to Olo (5568 m) near Khungyami La on the northeastern border of Sikkim for two months; but the sheep stay at Keraang, Chho Lhamo for almost three months grazing the grass growing due to the blowing away of snow by the wind. All *kiang* go across the border into Tibet but upto 200 *nayan* and 20 Tibetan gazelles live with the yak herd during this lean period. A herd of yak includes upto 3000 females and 400 males. During this period they are also preyed upon by the Tibetan wolf *Canis lupus chanco.* It was estimated from discussions that around 100 Tibetan gazelles occur precariously in this region.

The entire area, being on the international border, is heavily patrolled by the Indian Army posted in the region. It is a rich storehouse of grasses, sedges and innumerable medicinal plants. Availability of water on the Sikkim side only has made it the last stronghold of several rare and endangered species of mammals other than the Tibetan gazelle protected under the Wildlife (Protection) Act, 1972 (as amended upto 1991). These are mainly the southern *kiang, nayan,* snow leopard, lynx and Tibetan wolf. The wetlands and grasslands in the region also serve many species of migratory water fowl and are home to various breeding birds. It is vital to declare a transborder protected area in this threatened habitat at the earliest.

I am extremely grateful to Brigadier Kanbargimath and Major Vivek Muthana of the Indian Army for their assistance during this survey.

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USHA GANGULI-LACHUNGPA
Project Officer (WL)
Sikkim Forest Department Deorali,
Gangtok 737 102,
Sikkim, India.

6. *SARCOCYSTIS* COULD BE A THREAT TO BARASINGHA, *CERVUS DUVAUCELI BRANDERI*

Sarcocystosis has come to be recognised comparatively recently as a serious disease of practically all categories of domestic animals throughout the world (Dubey *et al.* 1989) including India (Shah and Chaudhry, 1994). This disease is named after the protozoan genus *Sarcocystis,* some of whose species cause considerable morbidity (including abortion) and mortality especially in young animals like sheep, goat, cattle and pig (Levine, 1985).

Sarcocystis has a typical coccidian life-cycle with one exception in that it involves two hosts having prey-predator relationship. Herbivores and omnivores act as prey animals in which the asexual stages of the parasite develop. This includes the most commonly encountered stage through which this infection is largely recognised which is known as the "sarcocyst". Since this stage occurs as a cyst mostly in the cardiac and striated muscles of the infected animals, the predators (carnivores) acquire this infection by feeding on the infected muscles. Now the parasite in the carnivorous host remains confined to the small intestine and results in the formation of sporocysts enclosing four sporozoites, i.e. it undergoes sexual reproduction. The sporozoites are voided in the faeces of the predators in large numbers and remain viable in the open for a considerable period of time because of the protective wall of the sporocyst. Prey animals pick up these sporozoites while grazing. Thus the life-cycle is linked between the two hosts. However, hardly any attention has been paid in India, (unlike some countries of America, Europe and Africa) to this infection in the wild. The present note is probably the first report of *Sarcocystis* infection in barasingha (*Cervus duvauceli branderi*) which is a hard ground swamp deer found only in Kanha National Park, M.P., India.

An adult female barasingha was found dead in the Kanha National Park, M.P. in the month of February 1994. Histopathological examination of various organs collected was conducted. Microscopic examination of the cardiac muscles revealed the presence of sarcocysts of *Sarcocystis* of varying sizes. The pathogenicity of this infection is quite evident in domestic animals and it is responsible for a great loss to the livestock industry in the form of abortion and mortality in young animals. The occurrence of *Sarcocystis* infection in barasingha suggests that it could be one of the reasons for the decline in the population of this threatened species. A detailed study is needed to determine the prevalence and effect of this infection on the existing population of barasingha.

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A.B. SHRIVASTAV
R.K. SHARMA
R.K. CHAUDHRY
College of Veterinary Science and Animal Husbandry
Jabalpur-482 001, M.P.
RAJESH GOPAL
Field Director, Kanha National Park, M.P.

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7. HABITAT PREFERENCE OF INDIAN BUSH RAT, *GOLUNDA ELLIOTI GUJERATI* IN THE ARAVALLI MONTANE ECOSYSTEM

The Indian bush rat, *Golunda ellioti* is spread from the Peninsula to Punjab and northwestern Assam in India, Sri Lanka and Pakistan. Very little is, however, known about the bush rat. During our studies on the community ecology of small mammals in the Aravalli ecosystem —a DST-INSA sponsored project— bush rats were collected along with 13 more sympatric species from the Abu hill and in association with 11 species on the main Aravalli range extending from Abu Road to Beawar in Rajasthan during 1993-1995. Both these hilly tracts are separated by an 11km wide valley through which the western Banas river flows. Trapping procedures and ecology of the Aravallis have been reported earlier (Prakash *et al.* 1995).

The Indian bush rat is small (head and body 120 mm, tail 90-103 mm, body weight 47-60 g), essentially inhabiting forests and scrublands (Blanford, 1888-91). It is a slow moving rodent, and follows distinct pathways or runways amidst bushes and hedges. Being diurnal its movements can easily be observed.

Habitat Preference: Contrary to Blanford (*loc. cit.*) the bush rat was trapped by us from five habitats out of a total of seven. It did not occur in thickly vegetated rocky region and the hill-top grassland. Irrespective of the altitude of Abu hill, it preferred two habitats: crop field (37.4%) and runnel (35.3%), the scrubland being its next preferred habitat (18.2%). The river bank and sparsely vegetated rocky habitats were found to be inhabited by 5.0% and 4.0% bush rats respectively. On the low hills of the main Aravalli range, the golunds were collected only from three localities and three habitats out of 5 localities and 5 habitats. Their most preferred habitat was rocky terrain with sparse vegetation cover (44.4%) and crop field (33.3%). Scrubland supported only 22.2% golunds.

Altitudinal Preference: The frequency of occurrence of bush rats in two major montane zones varied considerably:

	Abu Hill %	Aravalli Range %
Foothills	39.39	66.67
500-600m	00.00	11.11
1000-1100m	14.14	22.22
1500-1600m	46.46	Altitude not present

The maximum number of bush rats were trapped at the highest altitude on Abu hill, but on the main Aravalli range their preferred altitude was the foothills. In the Abu hills, crop fields were the most preferred by these rodents but on the Aravalli range they were most abundant in rocky habitat with sparse vegetation cover. The Cheppaberi locality, situated on Abu hills at 500 m elevation did not harbour *G. ellioti*. In the Abu hills their preponderance at 1500-1600 m altitude was maximum in the runnel (52.2% of total collection from that elevation) followed by crop field (45.7%). Likewise in the foothills the bush rats were relatively more abundant on the river bank. Their predominance in the runnel and river bank may be due to a higher soil moisture regime which sustains green vegetation, especially *Cynodon dactylon*, all the year round on which they feed.

Relative Abundance and Conspecifics: The Abu hill is a wildlife sanctuary and is well vegetated; though illegal grazing continues yet it is relatively less disturbed as compared to the main Aravalli range. Being low in altitude, the main range of the Aravallis receive poor monsoon precipitation, resulting in a lower floral diversity; besides the whole terrain has been encroached by *Lantana camara*, the thickets of which provide shelter to *Golunda ellioti*. Because of the spinous stems of lantana, the mongoose, *Herpestes edwardsii*, which is fairly common, is probably unable to predate upon the rodent. These may be plausible reasons for their greater density over the Abu hill compared to that on the Aravalli range.

Out of the 14 species of small mammals collected from Abu hill, the relative number index of bush rats was third, first and second being *Cremnomys cutchicus* (rock rat) and *Suncus murinus sindensis* (house shrew). On the main Aravalli range, however, its relative index number was fifth *C. cutchicus*, *S. murinus*, *Tatera indica* and *Millardia meltada* were found to be more abundant. At 500-600 m and 1000-1100 m altitude, *Mus phillipsi*, *M. platythrix* and *M. saxicola* were the major conspecific small mammals. *Bandicota bengalensis* has also ascended the hills in small numbers and coexist mainly in crop fields.

Breeding Season: Pregnant female bush rats were collected from February to November. Litter size varied from 4 to 11 (ave. 7.3).

In conclusion the Indian bush rat, *Golunda ellioti gujerati* appears to be a very successful species which has a wide distribution in India, Sri Lanka and Pakistan. The genus *Golunda* is considered to be among the older faunas, differentiated in the Peninsular land mass and it is surmised that it was distributed from Peninsula to Aravallis even before Himalayan uplift. Ryley (1913) had found it common at Mt. Abu but at present it is very abundant on the Abu hill. Apparently, the northward migration of *Golunda ellioti* is continuing. On the Abu hill it is one of the most abundant small mammals out of 14 species collected by us. On the Aravalli range, density is lower as conjecturally it is still encroaching over the denuded hilly terrain. The northwesterly migration theory on the bush rat is further confirmed from our ecological studies on desert rodents. This rodent was not collected in the mammal survey of the Thar Desert undertaken during 1952-54 (Prakash 1955, 1962). However, 20 years later during our ecological survey of the rodents of the Thar desert (Prakash *et al.* 1971) undertaken during 1969-70, *Golunda ellioti* were collected from Sirohi and Pali districts bordering the Aravalli range. Apparently they had ventured in this region in recent years. Further west, Taber *et al.*(1967) did not collect it from Lyallpur region and Roberts (1977) reported it from the rice fields in the coastal regions of lower Sind and remarked that it has a restricted occurrence in Pakistan.

One of the major reasons for the northward invasion by *Golunda ellioti* is the creation of conducive environmental conditions through the expansion of irrigated agriculture throughout northern India especially in Gujarat and parts of the Thar Desert. In the Rajasthan desert the irrigated cropping area has almost doubled during the last two decades due to overexploitation of ground water and the advent of the Indira Gandhi Canal and its tributaries. Irrigation changes the sub-soil moisture regime which then sustains weeds and green shrubs all the year round. The longer availability of green food adds to the nutritive intake of food by animals and reproductive potential enhances. The bush rat, delivers 5 to 10 young (average litter size 6.6) in the Rajasthan desert (Prakash, 1971) whereas its range on the Aravallis increases from 4 to 11 (average 7.3). Thus the species is not able to advance its recruitment potential in the more favourable ecological conditions but probably its survival and longevity has also become superior.

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July 27,1996

ISHWAR PRAKASH
PARTAP SINGH
Desert Regional Station,
Zoological Survey of India,
107, Kamla Nehru Nagar,
Chopasani Road,
Jodhpur-342 009, Rajasthan.

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8. THE MALABAR SPINY DORMOUSE (*PLATACANTHOMYS LASIURUS*) IN THE KALAKAD MUNDANTHURAI TIGER RESERVE, TAMIL NADU

The spiny dormouse is a small, beautiful rodent, smaller than the house rat but with a very characteristic bushy tail tip. Also called the pepper rat, it is endemic to the Western Ghats; found mostly in the southern Western Ghats but can occur as far north as Shimoga (Rajagopalan, 1968). It is the only representative of the genus in India (Jerdon, 1874). This rodent has not been recorded from the Kakachi areas of KMTR but occurs at a lower elevation at Bonakadu in the same reserve (Webb-Peploe, 1947) and is probably common in higher forest even elsewhere in the reserve.

Being a nocturnal arboreal animal, it was very rarely seen by us during the day, due to its versatile ability to climb any twiners and branches with minimum disturbance and maximum speed. Evidence of this animal was first noticed during my studies on seed predation in Kakachi when many fruits and seeds were seen removed overnight. Prolonged nocturnal observations on seed and fruit piles gave the first sighting of the dormouse.

The animal appears to be abundant in the area, judging by the fruit removal from many trees within a few acres. There is no other nocturnal rodent with this uncanny ability to pick seeds even from fruits twice its own size. It also has the habit of hoarding seeds, and rarely forages on the ground. Our preliminary studies indicate that such foraging behaviour of the dormouse could have significant effect on tree recruitment through seed predation.

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I thank J.C. Daniel, BNHS, for identifying the spiny dormouse. The project was funded by a TERI-MacArthur grant.

March 22, 1997 T. GANESH
29, Chetty Street, Pondicherry-605 001.

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9. FIVESTRIPED SQUIRREL *FUNAMBULUS PENNANTI* WROUGHTON, A PREDATOR OF *HELICOVERPA ARMIGERA* HB. (LEPIDOPTERA: NOCTUIDAE)

The gram pod borer *Helicoverpa armigera* Hb. (Lepidoptera: Noctuidae) is one of the most destructive pests of many important crops with ubiquitous distribution. It is highly polyphagous and is distributed widely over the tropic and subtropic areas of nearly 63 countries (Boadley, 1977). Although voluminous work has been done on invertebrate predators and parasites of *H. armigera* in India (Achan *et al.* 1968, Rao, 1974), little information is available on its avian and mammalian predators. We studied the predation of the fivestriped squirrel *Funambulus pennanti* Wroughton on *H. armigera.*

The common squirrel or fivestriped squirrel *Funambulus pennanti* Wroughton was observed feeding on the pupae of *H. armigera* by digging out the soil in a gram (*Cicer arietinum* L.) field (Parasara, 1989). Inability of *Helicoverpa* larvae to go deep in the hard soil is reported by Jayaraj (1981), however, in other soil types *Helicoverpa* larvae pupate at a depth of 2.5 to 7.5 cm (Haseman, 1915) and over wintering pupae reach a depth of 10 to 15 cm (Bishop, 1929).

This squirrel is a granivorous rodent (Barnett and Prakash 1975, Prater 1974). However, occasional insectivory has been reported, Krishnaswami and Chowhan (1956) studied the gut content of 36 squirrels and found remains of lac insect *Kerrica lacca* (Kerr.), termite, ants, beetles, moths, wasp, louse, mite and lepidopteran larvae. Recently, Tiwari (1990) has reported predation of birds by the fivestriped squirrel but there is no report of it as a predator of *Helicoverpa armigera* Hb.

At Gujarat Agricultural University, Anand (22° 32' N and 73° E) Gujarat, the soil is sandy loam. Paddy *Oryza sativa* is grown as a monsoon crop, with the gram crop being raised in this paddy land in the winter. The soil becomes very hard after the first irrigation. A population of fivestriped squirrel occurs here.

4-5 squirrels were observed regularly visiting the gram crop. The squirrels were observed digging out the soil and feeding on larvae and pupae of *Helicoverpa.*

We also kept a squirrel in a cage of 9" x 9" x 9", and studied its food preference and feeding capacity under laboratory conditions.

The squirrel was provided with 25 each of large 5th and 6th instar larvae, medium sized 3rd and 4th instar larvae, small sized 1st and 2nd instar larvae, and pupae of *Helicoverpa,* larvae of rice grain moth *Corcyra cephalonica* Stainton, wet gram seeds and green pods of gram simultaneously in separate petri dishes on two consecutive days during the morning. The sequence of consumption of each item was noted to determine preference.

The squirrel was kept hungry overnight (12 hrs) and then offered the pre-weighed 50 number of different items to determine its feeding capacity. Feeding capacity was estimated on 4 different days using different food items and time taken to consume each item was recorded.

To determine predation on pupae, 10 pupae of *Helicoverpa armigera* were buried 1 cm deep under moist soil in 9" x 9" area and covered with a cage having no bottom. The squirrel was put inside and within an hour dug out seven pupae using its forelegs, confirming its ability to search out pupae in the field.

Abbreviations used:

G_1 = *Helicoverpa* small sized larvae (1st and 2nd instar).
G_2 = *Helicoverpa* medium sized larvae (3rd and 4th instar).
G_3 = *Helicoverpa* large sized larvae (5th and 6th instar).
CL = *Corcyra cephalonica* Stainton larva
HP = *Helicoverpa* pupa
WGS = Wet gram seeds
GPG = Green pods of gram

TABLE 1
FEEDING CAPACITY OF THE FIVESTRIPED SQUIRREL *F. PENNANTI*

Date of study	Sr. No of offerings	Food items	Number offered	Number consumed	Wt. consumed (g)	Time taken (min)	Remarks
1st day (18.2.90)	1	G_3	50	50	15.80	6.50	
	2	G_3	50	00	00.00	-	
	1	CL	50	50	2.95	2.00	
	2	CL	50	50	2.95	2.00	
	3	CL	50	50	2.95	2.30	
	4	CL	50	50	2.95	3.30	
	5	CL	50	50	2.95	6.00	
	6	CL	50	46	2.71	15.00	Time increased with satiation
		Total	350	346	33.26	37.10	
2nd day (19.2.90)	1	G_3	50	50	15.80	5.35	
	2	G_3	50	34	10.74	18.00	
	1	G_2	50	50	8.50	3.00	
	1	G_1	50	12	1.03	20.00	
	1	WGS	50	1	0.36	-	Stopped eating and started moving around on satiation
	2	GPG	50	0	0.00	-	
		Total	300	147	36.44	46.35	
3rd day (20.2.90)	1	WGS	50	50	17.83	5.40	
	2	WGS	50	50	17.83	9.00	
	3	WGS	50	9	3.21	20.00	
	1	GPG	50	00	0.00		
		Total	200	109	38.87	34.40	
6th day (23.2.90)	1	HP	50	50	14.68	14.30	
	2	HP	50	38	11.16	22.00	
		Total	100	88	25.84	36.30	

Note: Weight of 50 numbers: G_1 = 4.300 g, GPG = 23.860 g.

It was observed that out of all the items made available to the squirrel, the first preference was for CL, probably due to its soft body. The second preference was for G_3 followed by G_2, HP and WGS. Only three G_1 were accepted,GPG were not taken when larvae were offered.

To determine the total weight of a particular item 50 numbers were weighed. All the experiments were conducted twelve hours after depriving the squirrel of food. It was provided with 100 G_3 (50 x 2) and 300 CL (50 x 6). It consumed 50 G_3 and 296 CL within 37.10 min. on the first day (Table 1). Thus, it consumed a total of 33.26 g animal food at a stretch. Similarly, on the second day it consumed 147 *Helicoverpa* larvae including all the larval types except that G_1 was not eaten much. Out of 50 G_1 only 12 were accepted. It consumed a total of 36.44 g food including 0.36 g WGS. On the third day the squirrel was provided only WGS and it consumed 38.87 g within 34.40 min. The same squirrel was provided only HP on the sixth day. It consumed 88 (25.84 g) out of 100 HP within 36.30 min.

Body weight of the captive male squirrel was 127g, whereas another female weighed 101 g. Therefore, morning food consumption ranged between 20.3 to 30.6% of its own body weight.

The dead moths *Corcyra cephalonica* were discarded every morning. Several squirrels came regularly to feed on these *Corcyra* in the company of mynas *Acridotheres tristis* and *Sturnus pagodarum*, jungle babbler *Turdoides striatus* and house sparrow *Passer domesticus*.

Vegetarian food habits of the squirrel are well-known (Prater, 1974) and one would expect them to damage gram pods, but we found that insect food was preferred over vegetarian food when both were offered. In the absence of insect food, the squirrel subsisted on equal weight of gram seed. The weight of food consumed did not differ significantly over three subsequent days (33.26 to 38.86 g.) However, when the pupa of *Helicoverpa* was given alone, consumption was significantly low.

The squirrels prefer animal food, as against plant material when available in equal proportion. Predation on *H. armigera* Hb., regulates its population at larval and pupal stage, in gram crop at least and several other crops which are infested by *Helicoverpa*.

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June 25, 1996

U.A. PARASARA
B.M. PARASHARYA
K.L. MATHEW
AICRP on Agricultural Ornithology, Gujarat Agricultural University, Anand-388 110.

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10. COLOUR VARIATION IN POPULATIONS OF THE GRIZZLED GIANT SQUIRREL *RATUFA MACROURA*

The grizzled giant squirrel (*Ratufa macroura*) is slightly smaller than the Malabar giant squirrel (*Ratufa indica*). Adults weigh approximately 1.5 kg. The tail is grizzled in black and white. The ventral side of the tail has a distinct creamish median line running from base to tip. From the forehead till the middle of forelimbs, there is a brownish black patch. A small creamish patch is present on the forehead. The ears are short and tufted. Forelimb and hindlimb extremities are black in colour. The dorsal side is greyish black and underparts creamish. The lower side of the mouth is a light pinkish colour. The tail is slightly longer than the body. Males have pendulous scrotal sacs, while in lactating females, three pairs of mammary glands can be seen (Prater, 1948).

Until now three sub-species of *Ratufa macroura* have been described: *Ratufa macroura macroura* from Sri Lanka, *Ratufa macroura melanochra* also from Sri Lanka, and *Ratufa macroura dandolena* from Sri Lanka and Southern India (Ellerman, 1961).

The following colour variation has been observed in wild populations of *Ratufa macroura* in South India

1. The best-known population, from Srivilliputhur, conforms to the description given above, with the dorsal side a uniform light greyish brown colour. The shoulder patches were distinct.

2. The animals found in Chinnar Wildlife Sanctuary, in the southwestern corner of the Palnis have a dark back, reddish brown in colour. The crown is also reddish brown.

3. A recently discovered squirrel population in moist deciduous forest at Siruvattukkadu Kombai, Northern Slope East (10° 22' N - 10° 24' N lat; 77° 40' E-77° 43' E long.), is as dark as the Chinnar population, with distinct dark shoulder patches (Sharma, 1992).

Specimens of *R. macroura* were examined in the collection of the Bombay Natural History Society (BNHS). The specimens were collected between 1913-1948 from Sri Lanka, Salem-Coimbatore and the Palnis.

The specimens from Tamil Nadu (South India) were grouped together in three categories conforming to the areas listed above. The same colour variations were observed. There is also a size difference, with the specimens from Salem-Coimbatore being larger than Palni specimens (Table 1).

TABLE 1

Locations	Head-Body max. (cm)	Tail max. (cm)
Salem-Coimbatore	95.5	101.6
Eastern Palnis	87.0	95.2

Since the grizzled giant squirrel is an endangered species strictly protected by law, collection of more material to confirm the subspecific status is problematic. Recording of vocalisation may prove to be an efficient technique to gauge the extent of separation between the three populations.

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March 22, 1997,

NEELU SHARMA
WWF-India, J & K State Office,
59, A/B, Gandhi Nagar,
Jammu-180 004.

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11. A LARGE COMMUNAL ROOST OF BLACKWINGED KITES *ELANUS CAERULEUS*

The blackwinged kite *Elanus caeruleus* is found single or in widely scattered pairs, and roosts communally at night in leafy trees (Ali & Ripley, HANDBOOK Vol. 1, pp 53, 1987).

However, on 4th August, 1995, around 1730 hrs on the way near village Bihejhar, Raipur district, Madhya Pradesh, a large congregation of about 35 birds was seen perched on electric lines and flying over a portion of a mulberry plantation in a silk farm. Some of the birds were observed surveying the plantation below.

The birds were using the electric wire as a pre-roosting site. Although communal roosting has been recorded, birds in such large numbers have not been reported.

February 14, 1996

A.M.K. BHAROS
27, MIG, Indravati Colony,
Raipur (M.P.).

12. RECORD OF CHIR PHEASANT, *CATREUS WALLICHI* ABOVE 4545 METRES IN THE WESTERN HIMALAYAS

On 9th October, 1995, we were on our way to Dhum-Dhar-Kandi Pass from Rishikesh, Uttar Pradesh. About 0.75 km before Dharoadhari (alt. 4848 m), the conventional site for Camp-1 of Black Peak expeditions, we came across a pair of chir pheasants, *Catreus wallichi.* The location (31.03° N & 78.34° E) is immediately before the meeting point of Kalanag Icefall and Bandarpunch Glacier that was about 300 m below us. The Survey of India contour map showed the altitude of the location to be above 4545 m. It was before the sliding zone to the South of Sargarohini - IV peak. The terrain was boulder-strewn rocky slope intermingled with grass patches. The chiefly buffy white and pale rusty upperparts, overall size, closely barred graduated tail with black and ashy grey and prominent crest were unmistakable. Their blackish abdomen, rounded wings and the long graduated tail were conspicuous in flight. The pair flew over us and settled on the slope 100 m above the foot-trail. They were alternatively crouching and leaping up as they moved along the slope chuckling noisily. There was a male and a female, as indicated by the difference in their size. I have seen chir pheasants earlier at lower altitudes (*c.* 3030 m) but never at this altitude. I used 8x30 binoculars for my identification.

According to Sálim Ali & S.D. Ripley, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, OUP, Delhi, (1983) chir pheasants are resident in the Himalayas between *c.* 1400 and 3500 m altitude. My record from a much higher altitude of over 4545 m might indicate that these birds are distributed over a larger area than is presumed at present.

July 27, 1996

SUCHITRA GHOSH
Senior Lecturer in Zoology,
Bangabasi College,
19, Prof. R.K. Chakraborty Lane,
Calcutta-700 009

13. ADDITIONAL COOT (*FULICA ATRA* LINN.) BREEDING SITE RECORDS FROM ANDHRA PRADESH, INDIA

Ali and Ripley (1983) state that coot *Fulica atra* Linn. is a resident as well as a common and abundant winter visitor to India especially on larger jheels in northern India. It breeds sporadically in peninsular India during July to August, and further south, the season is from November to December.

During the last two decades coot numbers

TABLE 1

COOT *FULICA ATRA*, BREEDING SITE RECORDS FROM ANDHRA PRADESH

District	Tank/Site	Category
Karimnagar	Gaderu Cheruvu	Perennial
	Ghanpur Cheruvu	Non-perennial
Nizamabad	Pedda Cheruvu	Perennial
Kamareddy	Pedda Cheruvu	Non-perennial
	Dichipally Cheruvu	Non-perennial
Medak	Uppalavahi Cheruvu	Non-perennial
	Akkanapet Cheruvu	Non-perennial
Sangareddy	Manjira	Reservoir
Ranga Reddy	Medchal Pedda Cheruvu	Non-perennial
	Athvelly Cheruvu	Non-perennial
	Railapur Cheruvu	Non-perennial
	Gundla Cheruvu	Non-perennial
	Dhulapally Cheruvu	Non-perennial
	Enkryal Cheruvu	Non-perennial
	Edulabad Cheruvu	Non-perennial
Mehboobnagar	Sarla Sagar	Non-perennial
	Koila Sagar	Non-perennial
	Chegunta Cheruvu	Non-perennial
Nalgonda	Pendlipakala	Reservoir
	Thummalaguda	Perennial
	Vemulakonda	Perennial
	Atmakur	Non-perennial
	Chada	Non-perennial
West Godavari	Kolleru	Perennial
Srikakulam	Navpadha	Swamps
Kurnool	Kanigiri	Reservoir
	Talamudipi	Non-perennial
Nellore	Nelapattu	Non-perennial
	Guduru Cheruvu	Non-perennial
	Vemula Cheruvu	Non-perennial
	Dindiole Cheruvu	Non-perennial
	Nagole Cheruvu	Non-perennial
	Petlur Cheruvu	Non-perennial
	Linga Samudram	Non-perennial
	Retlapalli Cheruvu	Non-perennial

have been steadily increasing in the Indian subcontinent. Perennou (1993) reports >95% increase of coot in Pakistan, summarising sixteen (16) years data. The same is the case in India, as revealed by annual reports of the Asian Wetland Bureau Midwinter Waterfowl Counts (Mundkur and Taylor, 1993).

Breeding site records of coot in India were reported by Betham (1902), Inglis (1902), Dalgliesh (1907), Dharmakumarsinhji (1947), Khacher (1977), Navarro (1980), Anjaneyulu (1991), Himmatsinhji *et al.* (1991), Nadarajan *et al.* (1993), Vijaya Kumar (1994), Vijaya Kumar and Choudhury (1994) and Balachandran (1994).

Nadarajan *et al.* (1993) confirmed coot sporadicity in peninsular India and reported first observations of coot chicks in a waterbody near Kazipet Railway station (*c.* 18° 59' N & 79° 29' E), Warangal district in Andhra Pradesh. In recent years, we have recorded coot breeding in a number of large and small perennial and non-perennial waterbodies of Andhra Pradesh. Most breeding sites were recorded during our regular field surveys in various parts of Andhra Pradesh.

A brief note on the recorded breeding sites is given in Table 1. Most of the breeding records were at non-perennial tanks with abundant growth of Ipomoea. Only at 60% of sites were the nests located, while at other sites only coot chicks were seen.

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July 10, 1996

C. SRINIVASULU
BHARGAVI SRINIVASULU
V. NAGULU
V. VASUDEVA RAO
Wildlife Biology Section
Department of Zoology,
Osmania University,
Hyderabad 500 007.

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14. RECENT SIGHTINGS OF SPECKLED PICULET (*PICUMNUS INNOMINATUS* BURTON) IN PAKISTAN

Roberts (1991) describes the speckled piculet in Pakistan as extremely rare and local, occurring in deciduous forest at low elevations, at only a few sites. The speckled piculet has been recorded in the Murree Hills and Margalla Hills, near Islamabad, and the Malkandi Reserve in the Kaghan Valley, NWFP. Breeding has been recorded in Pakistan, egg-laying taking place from early to mid-May and brooding lasting only 11 days.

Details of recent sightings

1. Margalla Hills, Islamabad: During a week long stay in Islamabad in May 1994, we spent several days birding in the nearby Margalla Hills, an area of dry deciduous scrub forest (600 m above msl). During one of these visits on 11th May, 1994, PW drew PB's attention to a very vocal male speckled piculet feeding in the bare branches of a small tree. Both observers saw the bird well and were already familiar with the species from elsewhere in its range.

There are only two previous sightings of this species in the Margalla Hills (singles in July 1977 and April 1982), despite fairly extensive coverage by birders over a number of years (Roberts, 1991). Roberts (1991) concludes that the species must be an occasional visitor to the Margalla Hills and this sighting therefore constitutes only the 3rd published record of speckled piculet at this site.

2. Palas Valley, District Kohistan, (35° 30' N 72° 40' E): Whilst walking up the main river valley in Palas Valley, Kohistan dist. (1300 m above msl) on 22nd May, a very vocal pair of speckled piculets were located by DS, low down

in a *Quercus baloot*. On closer examination, a nest-hole was located in one of the smaller branches. Calls from within indicated the presence of young.

This is the first record of this species for the Palas Valley and represents a slight north-westerly range extension in Pakistan.

This small woodpecker is often overlooked in mixed species flocks (Ali and Ripley, 1983) and may in fact be commoner than it appears to be throughout its range in Pakistan. It would seem likely that suitable areas in the foothills of the western Himalayas hold undetected breeding populations.

ACKNOWLEDGEMENTS

The authors would like to thank their colleagues Naeem Ashraf and Abdul Ghafoor, of the Himalayan Jungle Project, for their help whilst working in Palas Valley.

June 3, 1996

P.J. BENSTEAD
N.J. BEAN
D.A. SHOWLER
P.A. WHITTINGTON
Beaver House,
Norwich Road,
Reepham, Norwich NR10 4JN

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15. MIMICRY BY GREY DRONGO *DICRURUS LEUCOPHAEUS*

In my orchard at Vashishta, 3.5 km up the valley above the now overcrowded hill station of Manali in Himachal Pradesh, I have the pleasure of the company of several mid-altitude Himalayan birds. Among these are a couple of pairs of rather aggressive, highly visible and vocal grey drongos *Dicrurus leucophaeus*. On the morning of 9th May, 1996 while walking to the house I heard Iora-like piping whistles. To my astonishment and delight, I traced the sounds to a drongo perched atop a pear tree. The bird continued the whistles which almost sounded like tentative attempts at mimicry — not sure of itself the bird burst into its metallic, challenging calls to pause and then try out the whistles, some longer and more high pitched than others, sounding like the familiar Ioras warming up to full vocalisation in late March and April. It is at this time that the grey drongos are coming into prenuptial vigour just prior to leaving the plains. Both Ioras and drongos share the common flower-laden coral, flame of the forest and other trees during that period.

July 10, 1996

LAVKUMAR KHACHER
646, Vastunirman,
Gandhinagar-382 002.

16. RECORD OF THE SIGHTINGS AND BREEDING OF PIED MYNAH *STURNUS CONTRA* AT LAHORE

The HANDBOOK (Ali and Ripley, 1987) reported the pied mynah (*Sturnus contra*) as missing west of a line from about 76°E (Ludhiana and Hissar) thus excluding Pakistan from its distributional range. However, Dr. Rees Davies reported it to T.J. Roberts as far back as 1965. This and subsequent records by Z.B. Mirza in 1982 and Dr. Mubashir Hasan in 1985, all from

Lahore and its surrounding area made Roberts include it in his book THE BIRDS OF PAKISTAN (1992) as a rare and local visitor to this country. No record of its breeding in Pakistan has ever been given.

However, detailed observation over a period of six years has revealed it to be an uncommon but regular breeding visitor to the environs of Lahore. I have sighted the bird over thirty times and found it to have been breeding in some five cases. The nests are built either in electric poles or in trees. Young were observed to have been raised in three cases. In a sighting in 1993, the nest was built on an electric pole at a height of about 6 m. It was a rag-tag collection of grasses, pieces of cloth and other material. The two young left the nest by 21st August, 1993. They could fly well and accompanied their parents, both of whom fed them.

The pied mynah can easily be seen around the well-wooded suburbs of Lahore. I have found the bird in all months of the year except the colder ones and very late in January, which probably indicates that it is an early breeding visitor to Lahore, staying on till the end of the rains.

July 10, 1996

SYED ALI MURTAZA
1-H, Gulberg III, Lahore.

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17. NEW RECORD FOR BLACKTHROATED JAY *GARRULUS LANCEOLATUS* (VIGORS) IN KASHMIR

The blackthroated jay *Garrulus lanceolatus* (Vigors) is reported from Pakistan, from Chitral through the outer ranges and valleys of the western Himalayas through Kashmir to Nepal (HANDBOOK OF THE BIRDS INDIA AND PAKISTAN. Ali and Ripley, 1987). It is locally common in Pakistan in the Takht-i-Suleiman range, Shingar range, and Torghar range, as well as in Dir and Swat through Murree and Hazara dist. into Kashmir (THE BIRDS OF PAKISTAN, Vol. 2, T.J. Roberts, 1992). This jay has not been recorded in the Gilgit region of Kashmir North.

We observed individuals and small flocks of blackthroated jays in the Tangir and Khanbari Valleys from 8th August to 15th August, 1995. These side valleys are in Chilas dist. 35° 24' N lat. and 74° 11' E long.) on the northwest side of the Indus River. The birds were sighted at *ca.* 2000 m elevation, flying and perching among streamside walnut and fruit trees. Indigenous tree species at this elevation included *Quercus baloot* and *Pinus gerardiana.*

These valleys are somewhat contiguous with the Swat Range, so the discovery of this species in the Chilas region should not come as a great surprise. However, possibly due to a lack of research in this area, the species was not previously recorded in this part of Kashmir.

June 4, 1996

PETER ZAHLER
NAEEM I. DAR
KARIM AKHTAR
P.O. Box 896
Lee. MA 01238, USA

18. YELLOWBROWED BULBUL *HYPSIPETES INDICUS* (JERDON) IN THE KOLLI HILLS (TAMIL NADU), EASTERN GHATS

The yellowbrowed bulbul *Hypsipetes indicus* (Jerdon) (Ali and Ripley, 1983) is known to occur only in the evergreen biotope of the Western Ghats south of Belgaum and Goa and in Sri Lanka. It is known to affect sholas, coffee-shade trees and edges of thick jungles.

Recently, this species has been reported from Mamandur forests (Santharam, 1991) in Chitoor district of Andhra Pradesh, Santharam (1991) also mentions S.A. Hussain seeing the yellowbrowed bulbul at Tirupathi Hills.

I would like to report another sighting of the yellowbrowed bulbul from outside its range. As part of the Tree Shrew Project funded by World Wildlife Fund - US through World Wide Fund for Nature - India (Tamil Nadu State Office), I happened to visit Kolli hills which is a compact block of hills with steep slopes comprising an area of 490 sq. km south of Salem. It was during my stay at Solakkadu (1200 m above msl; 11° 18' N, 78° 21' E) on 8th March, 1992, that my attention was drawn to the very familiar double note which was heard a few times before I saw a pair of yellowbrowed bulbuls moving amidst the foliage of the trees flanking the road through the shola. All the sightings were in dense forests. These bulbuls were seen many times during the day.

It is interesting to note that all sightings of the species outside its known range are from hill ranges in the Eastern Ghats. Though I stayed at Yercuad situated in the Shevaroys for almost six months and used to walk through coffee-estates regularly, I never encountered this species. It would be worthwhile to map the distribution of the species outside its designated range.

June 3, 1996

S. KARTHIKEYAN
24, Opp. Banashankari Temple,
8th Block, Jayanagar P.O.
Bangalore-560 082.

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19. INDIAN ROBIN (*SAXICOLA FULICATA*) FORAGING IN THE LIGHT OF FLUORESCENT LAMPS

On 29th June,1995, inside the control room of a 220 kv grid substation at Raipur, unusual behaviour of the Indian robin was observed between 1930 to 2130 hrs.

The large control room was well illuminated by fluorescent lamps which had attracted a large number of insects. A male Indian robin which was roosting inside this control room for the last few days, perched on the edge of the ventilator, and time and again performed short aerial sallies to capture the winged insects and returned to the perch. It moved from one ventilator to another several times in about two hours. Occasionally, a female house sparrow (*Passer domesticus*) also joined it.

This act of the Indian robin was seen to be repeated on two subsequent days but on these days the sparrow was absent.

Foraging by the Indian robin in the light of fluorescent lamps till 2130 hrs has not been recorded in the literature and is rather unusual.

October 27, 1995

A.M.K. BHAROS
27, MIG Indravati Colony,
Raipur, (M.P)

20. WINTERING RANGE AND TIME EXTENSION OF HODGSON'S BUSH CHAT *SAXICOLA INSIGNIS* GRAY IN INDIA

(*With one text-figure*)

The Hodgson's bush chat *Saxicola insignis* Gray is a rare and little known winter visitor to India occurring mostly in the Gangetic plains of Uttar Pradesh and Bihar, ranging from Ambala in the west to northern Bengal in the east. Also found in the Nepal *terai* and Sikkim foothills, it has not been recorded east of Jalpaiguri *duars* (which extends to 89° 50' E long.). *S. insignis* is reported to arrive in October and leave in March or early April for its breeding grounds in the mountains of Kazakhstan and Mongolia (Sálim Ali and S.D. Ripley, 1983 HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN. Oxford University Press, Mumbai).

During our stay at the Manas Wildlife Sanctuary 26° 40' to 26° 50' N lat. and 90° 50' to 91° 25' E long. in the Barpeta dist. of Assam, we saw this migratory bird every year between 1986 and 1989. A few of these birds were first seen in March 1986 at the Kasimdaha grasslands near Basbari. The collared bush chat *S. torquata* is the most common chat of these vast open grasslands dominated by *Saccharum narenga* and *Imperata cylindrica,* interspersed with tall elephant grass and very few trees, where we were studying the Bengal florican *Houbaropsis*

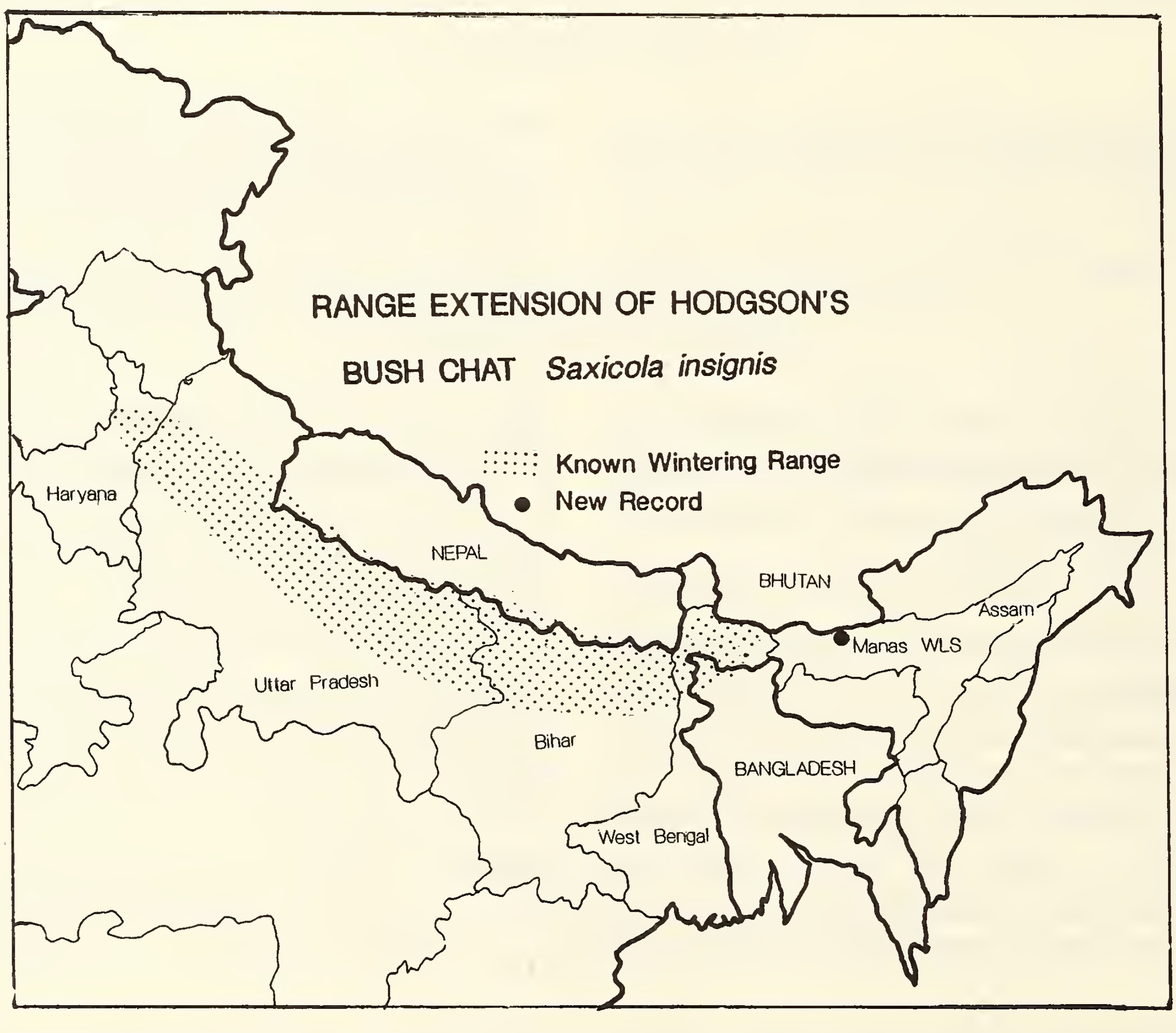

Fig. 1. Range extension of Hodgson's bush chat *Saxicola insignis*

bengalensis. This is the first record of *S. insignis* for northeastern India and the state of Assam.

S. insignis, though similar in appearance to *S. torquata,* can be distinguished from the latter by its bigger size, larger white wing-patch and white throat *contra* black; in the males the black of the head tapers to a very thin black line on the nape in *insignis,* whereas the whole breadth of the nape in *torquata* is black. With a little practice we were able to tell even the females of the two species apart. They kept singly or in loose pairs, perching on the top of low (*c.* 75 - 150 cm) grass or shrubs and often going to the ground to feed. The same patch of grassland was occupied by them for days and they defended these small territories by chasing away any intruding *torquata.* Photographs of these birds were taken.

In 1986, the last bird was seen on 24th April, which is a wintering time extension for *S. insignis* in India as Ali and Ripley (1982) have recorded 10th April as the previous last date. In 1987, the first bird was seen on 28th February in the same area and they remained there till the fourth week of April. However, in 1988, we did not see the birds in that area till the third week of April when a few were also seen in similar grasslands at Kapurpora on the Manas river. In 1989 too, they were first sighted in April and disappeared within a couple of weeks. Since the bird is quite rare, it is possible that we could have missed some individuals wintering in areas not frequented by us in the last two seasons.

Our sightings indicate that *S. insignis* are passage migrants through Manas Wildlife Sanctuary on their way back to the breeding grounds. Unlike *S. torquata*, they do not appear here in September-October. However, a few individuals stay in Manas between end February and April during the spring migration.

This note was prepared while working under the BNHS Endangered Species (Florican) Project. We wish to thank Ms. Joanna van Gruissen who helped us at Manas in 1986.

July 10, 1996 GOUTAM NARAYAN
LIMA ROSALIND
Bombay Natural History Society,
Hornbill House, Shaheed Bhagat Singh Road,
Mumbai-400 023.

21. HERPETOFAUNA OF PHULWARI KI NAL WILDLIFE SANCTUARY, RAJASTHAN STATE

Phulwari Ki Nal Wildlife Sanctuary is situated in Udaipur district at the southernmost end of the state. The flora of the sanctuary is mainly deciduous. Phulwari ki Nal is among the lesser known sanctuaries of India, but it is rich in floral and faunal diversity. Except for Sharma (1995), we have little knowledge about the herpetofauna of this sanctuary. McCann (1946) has recorded nearly 17 reptilian species from Mt. Abu, Phulwari ki Nal. In the present paper, the reptiles seen from 1986 to August 1995 in this sanctuary are listed below:

Family: CROCODYLIDAE

(1) ***Crocodylus palustris*** Lesson: Once very common in the Mansi-Wakal river, the main and principal river of the sanctuary, now rare. During rainy season, it sometimes becomes visible in the receding water. At present their nearest known habitat is Jhadol Dam. Perhaps they also breed there. I saw three in and around the sanctuary area from July 1993 to July 1995.

Family: EMYDIDAE

(2) ***Kachuga tecta*** (Gray): Seen in the Mansi-Wakal river. Very common in lakes of the district. It likes to sit on emergent outcrops specially during winter.

Family TRIONYCHIDAE

(3) ***Lissemys punctata*** Lacepede: Uncommon, seen in wells and ponds. Flesh is consumed by tribals for treatment of tuberculosis.

Family: TESTUDINIDAE

(4) ***Geochelone elegans*** (Schoeff): Common, locally called 'Bhumi-kachba'. Kept as a pet by many tribal families.

Family: GEKKONIDAE

(5) ***Hemidactylus flaviviridis*** Ruppell: Common. Locally called 'Vishamra'. Can be seen on outer walls of the tribal houses after sunset. Sometimes seen in crags also.

(6) ***H. brooki*** Gray: Common.

(7) ***Eublepharis macularis*** Blyth: A specimen was collected from the outskirts of the sanctuary.

Family: AGAMIDAE

(8) ***Calotes versicolor*** (Daudin): Very common, locally called 'kangetia'. Heavy casualties are seen on the road during rainy season as many are run over by vehicles. Its flesh is applied on toe injuries by natives.

(9) ***Sitana ponticeriana*** Cuvier: Common, specially confined in open pockets. This species is a fast runner on ground. Besides many males, a gravid female was recorded during August 1994.

Family: CHAMAELEONIDAE

(10) ***Chamaeleon zeylanicus*** Laurenti: Common, locally known as 'Halanviya'. Natives kill it whenever seen, as they believe it can cause leprosy by licking.

Family: SCINCIDAE

(11) ***Mabuya carinata*** (Schneider): Common, amongst the fallen dry leaves of *Madhuca indica.* Usually found on forest floor, fields and near tribal hutments. Locally called 'Nagarbamni' i.e. female of head 'brahmin', and hence protected by the people.

(12) ***Ophisops jerdoni*** Blyth: Very common in hilly area, prefers flat hill tops. It lives beneath fallen dry leaves of *Madhuca indica*. During winter generally seen from 11 am to 2 pm outside its hide-out, moving on forest floor amongst the ground flora. Common in the upper reaches of Madri R.F. and Som Ist R.F. which are at the outskirts of the sanctuary and are rich in this species.

Family VARANIDAE

(13) ***Varanus bengalensis*** (Schneider): Very common. Bagged by *jogis* (mendicants) for fat extraction during rainy season. Most adults are infested by a tick *Aponomma gervoisi* (Lucas). The sub-adults of *Varanus* are known as 'Chandan-goh' in the area and people consider them more 'venomous' than any snake and hence kill them.

Family: TYPHLOPIDAE

(14) ***Ramphotyphlops bramina*** (Daudin): Common, seen under logs, stones, and moist soil. Locally called 'kana'.

(15) ***Typhlina acutus*** (Dum & Bibr.): One specimen was collected from a water tank into which it had fallen during the night.

Family: BOIDAE

(16) ***Python molurus*** (Linnaeus): Commonly occur along the banks of the Mansi-Wakal river. One female incubating eggs was observed at 'Bolna Parda' hill near 'Birothi' area. Locally called 'Agar' or 'Ajgar'. Since the trident-like mark on the head symbolizes the trident of Lord Shiva, the snake is protected by local people.

(17) ***Eryx conicus*** (Schneider): Common. Because it looks similar to the saw-scaled viper, it is considered venomous and killed.

(18) ***E. johnii*** (Russell): Locally called by many names like 'Dhanrai', 'Andhboga', 'Dumbi' etc. One adult specimen was collected from Panarwa-kotra road. Two trampled sub-adults were collected on the road after monsoon rains of 1994 at the outskirts of sanctuary.

Family: COLUBRIDAE

(19) ***Lycodon aulicus*** (Linnaeus): Common.

(20) ***L. striatus*** (Shaw): Uncommon.

(21) ***Oligodon taeniolatus*** (Jerdon): Three collected under stones and a fourth was found trampled on Panarwa-Kotra Road.

(22) ***O. arnensis*** (Shaw): Two specimens were observed under stones from two different sites.

(23) ***Amphiesma stolata*** (Linn.): Very common. A mating pair was observed on 2nd July, 1994, on a foot-path.

(24) ***Macropisthodon plumbicolor*** (Schneider): Very common. Hatchlings appear in rainy season. It is very common in forest nurseries and lives beneath poly-bags containing seedlings.

(25) ***Xenochrophis piscator*** (Schneider): Very common, locally called 'Dindu' by bhils, and 'Diwad' by kathodies. During fish catching operation with specially made bamboo baskets, this species of snake is also trapped along with fishes by tribals. It is present in almost all the wells, nullahs, ponds, dams etc. of the area.

(26) ***Elaphe helena*** (Daudin): Common.

(27) ***Ptyas mucosus*** (Linn.): Uncommon.

(28) ***Dendrelaphis tristis*** (Daudin): Common. During summer it is seen on medium sized *Acacia leucophloea* trees. Frequent in areas having vegetation in crown contect or crown overlapping stages. One was seen hibernating in a hole near a wooden post on the verandah of a house.

(29) ***Psammophis leithi*** Gunther: One specimen was collected from a bush.

(30) ***Ahaetulla nasutus*** (Lacepeda): Collected one from Dharawan Reserve Forest.

(31) ***Boiga trigonata*** (Schneider): Common. *B. forstenii* (Dum. & Bibr.) though recorded in the Mt. Abu area by McCann (1946) was not seen in Phulwari ki Nal.

Family: ELAPIDAE

(32) ***Bungarus caeruleus*** (Schneider): Common.

(33) ***Naja naja*** (Linn.): Locally called *'Nagin', 'Gogaji', 'Kala Hamp'* (samp) ('s' is pronounced as 'h' by natives). It is a sacred and protected snake in the area. Nomadic *kalbelias* used to display it in cities and rural areas to earn a living.

Family: VIPERIDAE

(34) ***Vipera russelli*** (Shaw): Uncommon.

(35) ***Echis carinatus*** (Schneider): Very common, locally called 'Kankariwala'. It prefers open rocky areas.

SUMMARY: 35 species of reptiles containing 30 genera belonging to 17 families have been recorded from Phulwari Ki Nal Wildlife Sanctuary. After taking measurements, animals were released at the same site at which they were captured.

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I thank Dr. R.C. Sharma, Z.S.I. Jodhpur, for identification of many of the snakes and lizards. I am very grateful to Dr. A.K. Sanyal, Scientist, Z.S.I. Calcutta, for identification of ticks.

January 7, 1996 SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadhol (F.), Dist. Udaipur (Raj.), 313 702.

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22. REPTILES OF PERIYAR TIGER RESERVE, KERALA

Forty-five species of reptiles including two species of testudines, (in two families) 13 species of lizards (in 4 families) and 30 species of snakes (in 5 families) have been recorded in Periyar Tiger Reserve. Seven species of lizard and 26 species of snakes have been collected, of which

TABLE 1
REPTILIA OF PERIYAR TIGER RESERVE

Scientific Name	Common Name	Status	Habitat	Distribution in India
Order TESTUDINES				
Family EMYDIDAE (Fresh water)				
1. *Melanochelys trijuga* (Schweigger)	Terrapin	Common	Lake	Throughout Indian subcontinent
Family TESTUDINIDAE (Land)				
2. *Indotestudo forstenii* (Schlegel & Muller)	Travancore Tortoise	Uncommon	MD	Western Ghats
Order SQUAMATA				
Sub order SAURIA (Lacertilia)				
Family GEKKONIDAE				
3. *Cnemaspis indica* (Gray)	Dwarf Forest Gecko	Common	MD	Western Ghats
4. *C. kandiana* (Kelaart)	"	"	SE	India, Sri Lanka
5. *Hemidactylus brooki* Gray	Spotted House Gecko	Common	MD	Throughout Indian Subcontinent
6. *H. frenatus* Schlegel	Southern House Gecko	Uncommon	—	"
Family AGAMIDAE				
7. *Calotes versicolor* (Daudin)	Garden Lizard	Common	MD	"
8. *C.elliotti* Gunther	Spotted Tree Lizard	Uncommon	E/SE	Western Ghats
9. *C. rouxi Dum. & Bibr.*	Forest Calôtes	Rare	SE	Western Ghats
10. *C. calotes* (Linnaeus)	Green Callotes	Uncommon	MD	"
11. *Draco dussumieri* Dum. & Bibr.	Flying Lizard	Common	MD/SE	S.W. Ghat Eastern India (Disjunct)
Family SCINCIDAE		Common	MD	Throughout subcontinent
12. *Mabuya carinata* (Schneider)	Common Skink	Common	MD/SE	Western Ghats
13. *M. beddomii* (Jerdon)	—	Uncommon	—	Western Ghats, Sri Lanka
14. *M. macularia* (Blyth)	—	Uncoomon	SE	Throughout Indian subcontinent
Family VARANIDAE				
15. *Varanus bengalensis* (Schneider)	Monitor Lizard	Common	MD/SE	Indian subcontinent
Suborder SERPENTES (Ophidia)				
Family TYPHLOPIDAE				
16. *Rhamphotyphlops braminus* (Daudin)	Common Worm-Snake	Common	MD	Throughout Indian subcontinent
Family UROPELTIDAE				
17. *Uropeltis elliotti* (Gray)	Elliot's Uropelt	Common	SE/MD	Western Ghats, Eastern Ghats.
18. *U. ocellatus* (Beddome)	Anaimalai Uropelt	Common	E/SE	Western Ghats

Table 1 (*contd.*)
REPTILIA OF PERIYAR TIGER RESERVE

Scientific Name	Common Name	Status	Habitat	Distribution in India
19. *Plectiurus perroteti* Dum. & Bibr.	—	—	—	—
Family Boidae				
20. *Python molurus* (Linnaeus)	Indian Python	Uncommon	MD	Throughout subcontinent
Family Colubridae				
21. *Elaphe helena* (Daudin)	Common Trinket Snake	Uncommon	MD	Throughout subcontinent
22. *Coluber mucosus* (Linn.)	Rat Snake	Uncommon	MD/SE	Throughout subcontinent
23. *Oligodon arnensis* (Shaw)	Common Kukri Snake	Uncommon	MD/SE	Throughout subcontinent
24. *O. taeniolatus* (Jerdon)	Russel's Kukri Snake	Uncommon	—	Western Ghats
25. *Dendrelaphis tristis*	Common Indian Bronzeback	Uncommon	MD/SE	—
26. *Chrysopelea ornata* (Shaw)	Golden tree snake	Uncommon	MD/SE	—
27. *Lycodon aulicus* (Linnaeus)	Common Wolf Snake	Uncommon	—	Throughout subcontinent
28. *Amphiesma stolata* (Linne)	Buffstriped Keelback	Common	MD/SE	"
29. *A. beddomiei*	Beddome's Keelback	Rare	—	Western Ghats
30. *A. monticola* (Jerdon)	Yellow Collared Forest Keelback	—	—	"
31. *Macropisthodon plumbicolor* (Cantor)	Green Keelback	Uncommon	MD	Throughout India
32. *Xenochrophis piscator* (Schneider)	Checkered Keelback	Common	Lake/ Marsh	Throughout India, S.E. Asia.
33. *Xylophis stenorhynchus* (Gunther)	Striped Small-headed Snake	Uncommon	—	South India
34. *Boiga dightoni* (Boulenger)	Dighton's Cat Snake	Uncommon	MD	S. Western Ghats
35. *B. ceylonensis* (Gunther)	Ceylon Cat Snake	Uncommon	MD/SE	Western Ghats, Eastern Ghats, South Western Ghats
36. *Ahaetulla perroteti* (Dum. & Bibr.)	Bronze-headed Whip	Uncommon	SE/MD	Western Ghats
37. *A. dispar* (Gunther)	—	—	—	"
Family: Elapidae				
38. *Bungarus caeruleus* (Schneider)	Common Krait	Uncommon	MD	Throughout India
39. *Naja naja* (Linn.)	Indian Cobra	Common	E/MD	Throughout Indian subcontinent
40. *Ophiophagus hannah* (Cantor)	King Cobra	Rare	E/SE	S.W. Ghats, Sri Lanka, S.E. Asia (Disjunct)

TABLE 1 (*contd.*)
REPTILIA OF PERIYAR TIGER RESERVE

Scientific Name	Common Name	Status	Habitat	Distribution in India
Family: VIPERIDAE				
41. *Vipera russelli* (Shaw)	Russel's Viper	Uncommon	MD/SE	Throughout Indian subcontinent
42. *Hypnale hypnale* (Merrem)	Humpnosed Pit Viper	Uncommon	MD/SE	Western Ghats
43. *Trimeresurus macrolepis* Beddome	Largescaled Pit Viper	Rare	E/SE	S. Western Ghats
44. *T. malabaricus* (Jerdon)	Malabar Pit Viper	Rare	E/SE	Western Ghats
45. *T. gramineus* (Shaw)	Bamboo Pit viper	Uncommon	E/SE	S. Western Ghats

Abbreviations:
E — Evergreen
MD — Moist Deciduous
SE — Semi Evergreen

13 species of snakes are endemic to the Western Ghats. These include 4 species of pit vipers; *viz. Trimeresurus macrolepis, T. malabaricus, T. gramineus* and *Hypnale hypnale.* The King Cobra *Ophiophagus hannah* also occurs in Periyar.

According to the literature, a rich fauna of reptiles occurred in Kerala (Boulenger 1892, 1894, 1896, Ferguson 1895, 1903, Wall 1906, Smith 1931-43, 1949, Hutton 1948, Whitaker 1978, Daniel 1983, Murthy 1981, 1990). But very little is known about their present status. Reptiles in Kerala are threatened with poaching, wanton killing and habitat destruction.

Periyar Tiger Reserve, a portion of the erstwhile Cardamom Hill Reserve, is situated on the Western Ghats in the Idukki district of Kerala between 9° 16' and 9° 40' N lat. and from 76° 55' to 77° 25' long. It is bordered on the north by Peermedu Taluk of the Idukki dist., in the west and south by Kottayam and Pathanamthitta dist., and in the northeast, east and southeast by Madurai and Thirunelveli dist. of Tamil Nadu. It has an area of 777 km. Altitude ranges from 700-2019 m and several peaks rise above 1600 m. The terrain is undulating. The Periyar Plateau has about 50 km width on the Western Ghats. Though it is called a plateau, it consists of a chain of hills, separated by valleys, sometimes 300 m deep. On the eastern and northern sides, along the crestline at about 2000 m elevation, runs the state boundary. The elevation drops to about 200 m on the eastern side of the crestline. The Periyar plateau is drained by Mullayar and Periyar rivers which join together at Mullakudy, forming the Mullaperiyar river. Periyar Lake was formed by the construction of a dam across this river, in 1895. It has an area of about 26 sq. km.

Periyar has a humid climate with temperature varying from 15° - 31°C and an average rainfall of 2500 m. July has the heaviest rainfall. November to January are cool, and March and April are the hottest months.

The following types of vegetation have been identified in the reserve *viz.* the tropical evergreen forest (305 sq. km), tropical semievergreen forest (275 sq. km), moist deciduous forests (100 sq. km), grasslands (12 sq. km), eucalyptus plantation (55 sq. km), and reeds (5 sq. km). Savannah type vegetation occurs in several areas. The high hills are covered with grasses.

Reptiles were collected from January-December 1992-94, preserved in 5% formaline, and brought to the laboratory for identification.

Two species of testudines, *Varanus*, rat snake and King cobra were not collected. We also received dead snakes from local people, including tribals and firewood collectors.

Forty-five species of reptiles in 11 families were recorded in Periyar Tiger Reserve (Table 1).

Testudines (Turtles and Tortoises)

This group is represented by 2 species, the pond terrapin *Melanochelys trijuga* and the Travancore tortoise *Indotestudo forstenii.* The terrapin is often seen basking on logs or rocks in the lake.

Lizards

Thirteen species of lizards have been recorded from Periyar. These include species such as *Cnemaspis indica, Calotes elliotti, C. rouxi* and *Mabuya beddomii* which are endemic to the Western Ghats, and the flying lizard *Draco dussumieri,* an Indo-Malayan element in southern Western Ghats. *Calotes* is a major prey of birds like the shikra *Accipiter badius,* while *Mabuya* is preyed up on by the jungle cat *Felis chaus* and *Varanus* by the tiger.

Serpentes

Thirty species of snakes have been recorded from Periyar during this study. Of these 13 species are endemic to the Western Ghats. The King cobra is rare in the Reserve.

Acknowledgements

I am grateful to Mr. C. Radhakrishnan, Deputy Director, Zoological Survey of India for his help and to Mr. T.M. Manoharan, Chief Conservator of Forests (Wildlife) for encouragement.

October 11, 1996

V.J. ZACHARIAS
Dept. of Zoology
St. Joseph's College, Devagiri,
Calicut-673 008, Kerala.

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23. RECORD OF LEITH'S SOFTSHELL TURTLE, *ASPIDERETES LEITHII* (GRAY), (FAMILY TRIONYCHIDAE) FROM NILAMBUR, KERALA

Five species of testudines were recorded from Kerala excluding the marine species. They include the Indian pond terrapin (*Melanochelys trijuga*), Indian star tortoise (*Geochelone elegans*), Travancore tortoise (*Indotestudo forstenii*), Cochin forest cane turtle (*Geoemyda silvatica*) and the Indian flapshell turtle (*Lissemys punctata*). Leith's softshell turtle has been reported from a number of localities by Daniel (1983), Tikader and Sharma (1985) and Kalaiarasan *et al.* (1992). This turtle is endemic to Peninsular India (Das 1991). Das (1995) gives the locations of occurrence of the species in Madhya Pradesh, Maharashtra, Karnataka, Andhra Pradesh, Orissa and Tamil Nadu.

A specimen of Leith's softshell turtle was obtained from Chaliyar river at Edavanna in Nilambur, Malappuram District, Kerala in March 1994. The river has an approximate width of 150 m and a depth of about 2 m at the collection site. The river bottom was sandy with granite boulders. The flow rate was moderate at the time of collection.

The specimen had a dark olive green carapace with a light central region. The bony carapace was 46 mm in length and 62 mm width. The margin of the carapace had numerous yellow spots and round markings. The central region of the carapace had light coloured longitudinal striations. The plastron was white in colour and 55 mm in length. The shell height of the specimen was 14 mm.

Leith's softshell turtle is a little known species of the genus *Aspideretes.* According to Smith (1931) and Pritchard (1979), the carapace of the young is adorned with four to six rather well defined ocelli or a pattern of eyelike concentric circles. This character was not observed in this specimen. The present observation is the first record of *A. leithii* from Kerala.

February 8, 1997

JOSEPH THOMAS,
C.P. SHAJI
P.S. EASA
Division of Wildlife Biology,
Kerala Forest Research Institute,
Peechi-680 653,

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24. THE OCCURRENCE OF THE COMMON TREE FROG *POLYPEDATES MACULATUS* (GRAY, 1834) (FAMILY RHACOPHORIDAE) IN RAJASTHAN

According to Daniel and Sekar (1989), Inger and Dutta (1986), Mansukhani and Murthy (1964), McCann (1942), Sharma (1992, 1995 a,b) nine species of amphibians *viz.*

Occidozyga cyanophlyctis Schneider, *O. hexadactyla* (Lesson), *Limnonectes limnocharis* (Gravenhorst), *Hoplobatrachus tigerinus* (Daudin), *Tomopterna breviceps* (Schneider), *Microhyla ornata* (Dum. & Bibr.), *Uperodon systoma* (Schneider), *Bufo melanostictus* Schneider and *B. stomaticus* Lutken have been recorded from Rajasthan.

On 12th December, 1995, at about 1400 hrs a new frog was caught from Bansi Forest Range Office campus, on the outskirts of Sitamata Wildlife Sanctuary in Udaipur district. When captured, it was sitting quietly on the upper edge of a window panel, with all four legs drawn up well under its body. The tips of all its digits were dilated into discs. It was identified as *Polypedates maculatus* (Gray). Its snout-vent length was measured as 45 mm and hind legs were 68 mm. Its weight was nearly 5 gm.

Sitamata Sanctuary has very luxuriant tree growth. Many pockets possess a shady and humid environment round the year which may provide a suitable habitat to *Polypedates maculatus* and other species of frogs.

ACKNOWLEDGEMENTS

I am very grateful to Mr. Ram Niwas Ojha, Forester, Aravalli Afforestation Project, Range Bansi, for helping me to collect frogs including *Polypedates maculatus.* I wish to thank the authorities of the Department of Forests, Rajasthan, for encouragement.

May 8, 1995 SATISH KUMAR SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol Dist. Udaipur (Raj.)-313 702.

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25. THE OCCURRENCE OF *BUFO STOMATICUS* AND *UPERODON SYSTOMA* IN HARYANA STATE

Five species of amphibians, namely *Occidozyga cyanophlyctis, Limnonectes limnocharis, Hoplobatrachus tigerinus, Microhyla ornata, Bufo melanostictus* have been recorded from Haryana. Recently, I observed two more, taking the total to seven species.

On 4th September, 1995, I saw many *Bufo stomaticus* feeding under electric lights at Sultanpur Bird Sanctuary and at Garhi Harsaru railway station nearly 4 km south of the sanctuary in Gurgaon district. I also observed a trampled specimen at Manesar turn on Pataudi-Gurgaon road, hardly a kilometer away from Garhi Harsaru railway station.

On 5th September, 1995, I collected one subadult of *Uperodon systoma* from short grass cover near a rain water pool at Paoti village (Rewari district) along the road. It was sitting at the edge of the pool and was seen by torch light. Further south, one more specimen was collected at Bizwar Chauhan village in Alwar district, Rajasthan.

November 6, 1995

S. K. SHARMA
Range Forest Officer,
Aravalli Afforestation Project,
Jhadol Dist.,
Udaipur,
(Rajasthan) 313 702

26. OCCURRENCE OF THE PIG-FACED FILE-FISH *PARAMONACANTHUS CHOIROCEPHALUS* (BLEEKER) (PISCES: PLECTOGNATHI) AT MUMBAI

(*With one text-figure*)

The occasional finding of fishes and other marine animals at Mumbai, where they do not normally live, has been discussed earlier in this Journal (Chhapgar and Deshmukh, 1964; Chhapgar and Jatar, 1968). Chhapgar (1978) has also recorded the occurrence of two leather-jackets, *viz Osbeckia* (formerly *Alutera*) *scripta* (Osbeck) and *Alutera monoceros* (Linnaeus) from Mumbai. A single specimen of file-fish was brought alive to the Taraporevala Aquarium on 9th September, 1995, and lived there for over a month. It was later identified as *Paramonacanthus choirocephalus* (Bleeker).

Description: Dorsal profile of snout slightly concave, that of back between the two dorsal fins horizontal. Gill opening slightly oblique, its upper end below hind border of eye.

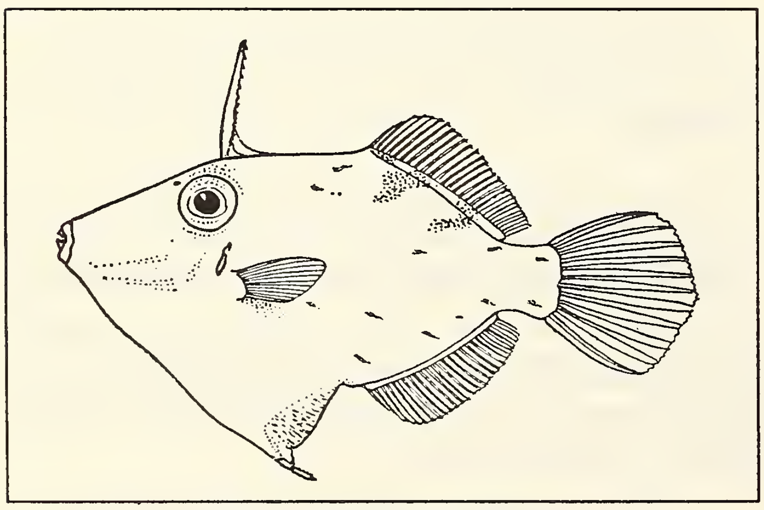

Fig. 1. Pig-faced file-fish, *Paramonacanthus choirocephalus*

First dorsal spine above hind border of eye. Anterior border of dorsal spine rough, with many (over 60) tiny upward pointing spinules, posterior border with two rows of slightly longer and stronger downward pointing spines. Origin of anal fin below 2nd dorsal fin, both these fins hyaline. Pelvic shield with a movable spine at its end.

Colour earthy brown with an irregular blackish patch below 2nd dorsal fin.

Morphometry.- D I + 27, P 12, A 27, C 12.

Total length	81 mm
Standard length	66 mm
Length of head (mouth to gill-cover)	22.8 mm
Length of snout (mouth to anterior border of orbit)	16.8 mm
Distance from mouth to base of pelvic spine	32.7 mm
Diameter of eye	6.9 mm
Diameter of orbit	8.4 mm
Supra-orbital width	6.0 mm
Height of body (between origins of 2nd dorsal and anal fins)	29.0 mm
Depth of body (from origin of dorsal spine to pelvic flap)	36.5 mm
Length of dorsal spine	17.0 mm
Length of base of 2nd dorsal fin	18.5 mm
Height of 2nd dorsal fin	8.0 mm
Length of pectoral fin	7.8 mm
Length of base of anal fin	14.5 mm
Length of caudal fin	15.5 mm
Length of caudal peduncle	9.8 mm
Height of caudal peduncle	8.2 mm

Height of body 2.3 in standard length, 2.8 in total length. Head 2.9 in standard length, 3.6 in total length. Eye 3.3 in head, 2.4 in snout, and slightly more than inter-orbital space. Height of 2nd dorsal fin 1/2 in length of snout. Length of caudal peduncle 1.1 in depth. Pectoral fin about equal to distance between eye and lower end of pectoral fin base.

Discussion: While Smith (1953) has separated the leather-jackets (*Alutera, Osbeckia* and *Pseudalutarius*) into the family Aluteridae, Fraser-Brunner (1941), Munro (1955), De Beaufort and Briggs (1962), and Jones and Kumaran (1980) have clubbed them with the file-fishes into a common family Monacanthidae. And while the others have placed file-fishes into 20 genera, De Beaufort and Briggs (loc. cit.) have assigned them to *Monacanthus* separating only *Alutera, Oxymonacanthus, Paraluteres, Pseudaluteres* and *Psilocephalus.*

The genus *Paramonacanthus* can be distinguished from *psilocephalus* (= *Anacanthus*) by the absence of a fleshy barb on the lower jaw, and from *Acanthaluteres, Alutera, Amanses, Hanomanctus, Navodon, Osbeckia, Paraluteres* and *Thamnaconus* in having a movable pelvic spine. It differs from *Oxymonacanthus* in the absence of a long snout ending in a dorsal mouth, from *Pervagor* in having the dorsal spine originating behind the middle of the eye, and from *Laputa* in not having two rows of 8-12 strong downwardly directed spines on the anterior face of the dorsal spine. It differs from *Stephanolepis* in having a smooth skin with minute scales.

Paramonacanthus choirocephalus can be distinguished from *P. oblongus* (= *barnardi* of Fraser-Brunner) in having a shorter, deeper body — depth 2.3 times in length in the former, 2.8 times in the latter.

Fraser-Brunner (loc. cit.) created a new species, *P. horae,* based on specimens from the east coast of India, Andaman Is, and Maldives, mainly on the grounds that it has 12 rays on the pectoral fin, as against 14 in *P. choirocephalus.* But De Beaufort and Briggs have clarified that the holotype and other specimens in Bleeker's collection all have only 12 rays. (Jones and Kumaran also mention 12 rays, Munro gives counts only for the dorsal and anal fins, while Day mentions 13 rays.)

Paramonacanthus choirocephalus has been previously recorded from Chennai, eastern coast of India, Andaman Is., Lakshadweep Is., Sri Lanka, Thailand, Malaysia and Indonesia eastwards. This is the first record from Bombay (=Mumbai).

Acknowledgements

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May 26, 1997

B.F. CHHAPGAR
Taraporevala Aquarium, Mumbai.
S.B. MULEY
Assistant Fisheries Development Officer, Sangli.

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27. *PIERIS BRASSICAE* LINNAEUS (LEPIDOPTERA: PIERIDAE) IN DELHI

There are numerous records of the Large Cabbage White (*Pieris brassicae* L.) from the plains adjoining the Himalaya. It appears sporadically and has been recorded from Amritsar (Sanders 1930), Peshawar and Fatehgarh (Peile 1937), Lucknow, (Rhé Philipe, 1902) and "E. Bengal, Behar" (Maxwell-Lefroy 1909).

Recently, Rose and Venkatesh (1995) bred the species in Patiala from eggs collected locally.

Donahue (1967) predicted the appearance of this butterfly in Delhi. On 10th April, 1996, I found a female *brassicae* beside the road south of Yusuf Sarai in New Delhi. The specimen is worn and the abdomen is flaccid, indicating that oviposition had taken place. On 13th April, 1996, I saw a male of the species in a private garden in Defence Colony and on 15th April, 1996, another male in the company of *Catopsilia pyranthe* L. at Dhaulakuan, in the scrub at the intersection of Ridge Road and Sardar Patel Marg.

In India, it has been suggested that these insects migrate from the hills for the cold weather and early hot weather, breed on cultivated Cruciferae and return to the hills for the summer, although no return flight has been observed (Maxwell-Lefroy, 1909; Wynter-Blyth, 1957).

Female butterflies of this species, fertilised but without mature eggs, are capable of travelling 400 km without food in a few days. The stations on the plains where *brassicae* has been recorded, i.e. Peshawar, Amritsar, Patiala, Lucknow and now Delhi, are well within the dispersal range from Himalayan breeding grounds.

However, perusal of the literature concerning the early stages of this butterfly and its appearance on the plains of India indicate several gaps in our knowledge.

Several authors have observed that this insect breeds freely on cruciferous plants in the plains during the cold weather and early hot weather. It has been recorded on the wing between late October and late May but there are no records between June and early October. Presumably, the weather is too warm during this period. This observation has led to the assumption that *brassicae* is only a sporadic migrant on the plains.

In other parts of its range, this butterfly is known to be capable of surviving severe and prolonged winter conditions in the pupal stage. There is no work on the tolerance of the diapausing pupae to severe summer conditions experienced on the plains of India. If it is proved that the pupae cannot tolerate the heat, then the traditional explanation of the appearance of this insect on the plains will hold true. On the other hand, if pupae can survive the summer heat, it indicates the need for work to clarify whether *brassicae* is actually a resident on the plains or a sporadic migrant. In any event, we have an insect that is either repeatedly attempting colonisation but failing, or has established a very tenuous foothold on the plains, so tenuous that when compared with its fecundity in the hills and the cooler parts of its range, its scarcity has led to the impression that it is a migrant.

April 15, 1997

PETER SMETACEK
Jones Estate, Bhimtal,
Nainital,
U.P.-263 136.

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28. THE NOTODONTID MOTH *CYPHANTA CHORTOCHLORA* HAMPSON IN KUMAON, NORTH INDIA

The taxon *Cyphanta chortochlora* was described by Hampson (1892) from a male specimen. The distribution is given as "Himalayas". The use of inverted commas stresses the uncertainty of the specimen's origin. In the same work, the range of the genus *Cyphanta* Walker, which includes another species, *C. xanthochlora,* is given as Sikkim, implying that Hampson believed that *C. chortochlora* occured there.

Three specimens of *C. chortochlora* have been recorded from Jones Estate in the Bhimtal valley, Nainital district. The elevation is *ca.* 1500 m above msl. The data on the specimens, all males, is as follows:

26.ix.1991; 28.ix.1995; 29.ix.1995. Forewing length 2.5 cm.

Further specimens were observed but not collected. A specimen was collected in Joshimath, Garhwal, at an elevation of 2300 m in August, but the specimen was destroyed in storage by museum beetles.

Besides matching Hampson's description, the specimens examined have the following additional features; the forewing is excised along the dorsum beyond the brown mark on the inner basal area, much in the manner as the genus *Calyptra* (Noctuidae) but unlike the other member of the genus, *Cyphanta xanthochlora*. In addition to the black speck at the end of the cell of the forewing, there is a smaller black speck in the middle of the cell and an incomplete series of black specks along the termen, those on the upper half more prominent.

On the underside, the dark postmedial line is obscure on the forewing of one specimen but prominent on both the other specimens. The cilia of the forewing are green and of the hindwing ochreous.

The flight is fluttering, unlike the swift and purposeful flight of most Notodontids.

April 15, 1997

PETER SMETACEK
Jones Estate, Bhimtal,
Nainital 263 136
Uttar Pradesh

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29. A NEW NAME FOR *HECALUS MORRISONI* RAMASUBBARAO & RAMAKRISHNAN

Ramasubbarao and Ramakrishnan (1990) published three new species, *Hecalus ghaurii, H. morrisoni,* and *H. pusae*. Perusal of literature revealed that the name *Hecalus morrisoni* is already occupied in the revision of the tribe Hecalini from Korea by Kwon and Lee (1979). As per the ICZN, *H. morrisoni* Rao and Ramakrishnan (1990) is a primary junior homonym of *H. morrisoni* Kwon and Lee (1979). Hence, a new name is proposed here for this species.

Hecalus paraumballaensis Ramasubbarao and Ramakrishnan nom. nov.= *Hecalus morrisoni* Ramasubbarao and Ramakrishnan in *Oriental Insects, 24*: 389,1990.

This species is named as *paraumballaensis* since its male genitalia is very much like that of *H. umballaensis*.

ACKNOWLEDGMENT

I thank Dr. A. Viraktamath, University of Agricultural Science, Bangalore, for the recognition of this primary homonym and for valuable comments.

April 17,1996 V. RAMASUBBARAO
Dept. of Entomology, Agricultural College
Khammam dist.
Aswaraopet -507 301
(A.P.).

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30. OCCURRENCE OF THE SPIDER CRAB *RHYNCHOPLAX ALCOCKI* KEMP (BRACHYURA: HYMENOSOMATIDAE) IN THENGAPATTANAM ESTUARY

(*With one text-figure*)

A large number of specimens of the crab *Rhynchoplax alcocki* have been collected by Gravely (1927) from Cochin, Alleppey and Paravur backwaters of Kerala. Chopra and Das (1930) reported that the genus *Rhynchoplax* is common in the backwaters of Kerala. Kemp (1917) gave the systematic descriptions of the different species of *Rhynchoplax* collected from Cochin backwaters and Portuguese India. Our description of *Rhynchoplax alcocki* is based on specimens collected from Thengapattanam estuary in Kanyakumari district, Tamil Nadu. Four specimens of *Rhynchoplax alcocki* were found on stone pavements encrusted with small filamentous algae and calcareous tubes of the polychaete *Serpula* sp., on the southern side of the estuary about 1 km away from the bar mouth.

Distinguishing features: The carapace is ovate in outline, width at the broadest median part being 4 mm. The surface of the carapace is demarcated by two median hexagons antero-posteriorly, and the lateral hexagons are not distinctly visible. The length and maximum width of the carapace are almost equal.

The rostrum is trilobed, the median lobe being larger and with a rounded apex.

The eyes are large and more or less rounded anteriorly and narrowing posteriorly. A short, sharp tooth is present on the antero-lateral border of the carapace.

The chelipeds are not compressed. The length and width of the palm are almost equal. The length of the dactylus is greater than that of the palm. The fingers do not gape. Three teeth are visible on the upper margin of the merus. Carpus bears a tubercle on the antero-dorsal surface.

The first walking leg has four teeth at the posterior margin of the dactylus, including the apical one. The second to fourth have twelve teeth each and long hairy setae along the margin.

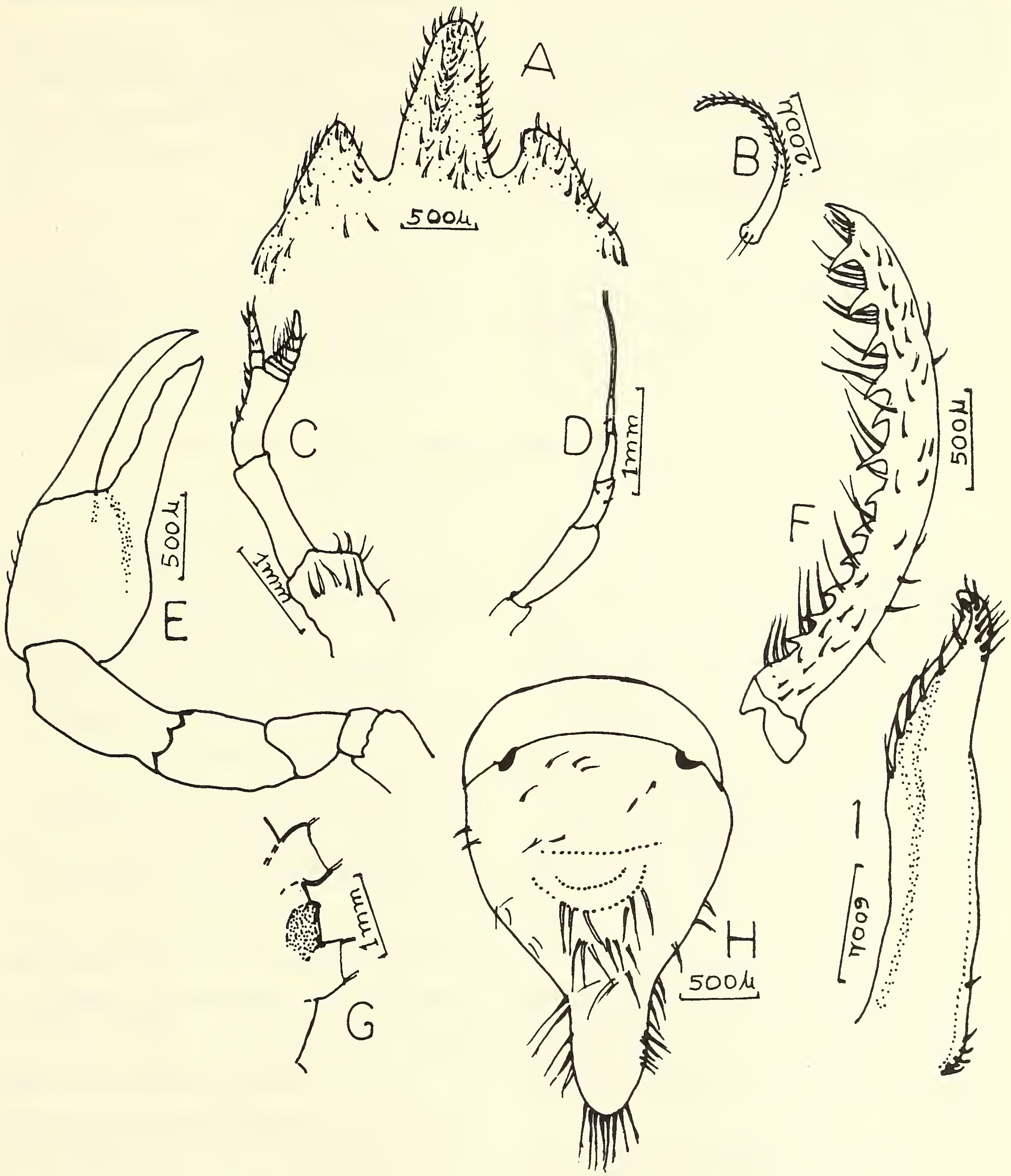

Fig. 1. *Rhynchoplax alcocki* Kemp. A. Rostrum; B. Single seta enlarged; C. Antennule; D. Antenna; E. Cheliped; F. Dactylus of 4th walking leg;
G. Lateral wall of the carapace showing the tooth between the chela and the 1st walking leg;
H. Abdomen; I. Gonopod.

The terminal segment of the abdomen is longer than the basal and not pointed as in *Rhynchoplax woodmasoni*.

The male gonopod is not considerably curved at its distal end. The curved end is very short. A row of setae on the interior external and distal margin is present.

Based on the characters, the present specimen is an immature male. Kemp (1917) detailed the adult and juvenile structural changes.

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L. PRABHADEVI
G. SARASWATHY AMMAL
Department of Aquatic Biology & Fisheries, Beach P.O., Thiruvananthapuram - 695 007, Kerala.

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31. RECORD OF *TRIOPS* (CRUSTACEA: BRANCHIOPODA: NOTOSTRACA) FROM PUNE, MAHARASHTRA

During a survey of temporary rain-water pools of Pune we came across some tadpole shrimps, *Triops*, in a large pool on the Alandi road (about 15 km from Pune Station). We could collect only a couple of live specimens in August 1995 but there were several fragments of carapaces around, suggesting a large population in July. The same pool also contained a large population of fairy shrimps (*Streptocephalus dichotomus*) and clam shrimps (species not identified) which are known to be prey animals for *Triops*. The pool was at least 1.5 metres deep in the centre and contained muddy and turbid water.

Fox (1949) and Williams (1987) have dealt with nomenclature and habits of this interesting animal, known earlier as *Apus*. Though *Triops* has been reported from Panchgani (Karande and Inamdar 1959), it has not been reported from Pune.

Tiwari (1951) had discussed taxonomic status and listed Indian species of tadpole shrimps, which included what he considered to be two new species. Shanbagh and Inamdar (1968) have pointed out that *Triops* is an archaic genus that has been evolutionarily stagnant since the Triassic period. They have also remarked on its rarity, having been recorded only from nine localities in India — from Kashmir in the Himalayas to Tirunelveli (Madras) in the south.

Sanjeeva Raj (1971), citing the work of Longhurst (1955), stated that there are only 4 valid species of the genus *Triops*, although more than 40 species had been described the world over. This is so because the genus is notorious for tremendous variation in external morphology. In India there are only two species — *Triops cancriformis* (Bosc) and *T. granarius* (Lucas). The former is mainly found in the Himalayas while the latter is found in the rest of India (at least south of Panchgani in Satara, Maharashtra). Surendra Nath considered *Apus kashmiriensis* Das to be a synonym of *T. cancriformis* (Surendra Nath 1979, 1985).

One of our college students, Mr. Sachin Ranade, observed hundreds of *Triops* in a stone quarry at Talegaon (on Pune - Mumbai road), on 28th June, 1996 and collected two poorly preserved specimens. All four specimens (two from Alandi road and two from Talegaon) have a carapace length of about 9 mm and total length (excluding furca) of about 13.5 mm.

Most of the taxonomic characters of our specimens agree well with the description of *Triops granarius* as given by Sanjeeva Raj (1971). Our specimens are however almost half the size reported by Sanjeeva Raj (18-20 mm median carapace length: 9 mm in our sample). A few salient features of the four specimens are: carina on carapace prominent but without terminal spine, spine in the sulcus 44, dorsal surface of the posterior region of carapace with fine denticles, fifth endite of first thoracic leg projects beyond hind end of carapace; number of exposed segments behind sulcus 9, apodal segments 9; these segments possess 9 dorsal and 8 or 9 ventral prominent, chitinised, brown spines; telson broader than last abdominal segment with two median spines, 3 setal spines and 2 transverse spines at posterior margin; lateral margin of telson spiny with 5 prominent spines; furca (12 mm) longer than carapace length.

We thank our M.Sc. students, especially Neelesh Rane and Sachin Ranade, who took part in surveying nearby ponds. Thanks are also due to the authorities of Modern College for encouragement and for providing facilities.

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H.V. GHATE
NAGRAJ SHETTY
Department of Zoology, Modern College, Pune-411 005.

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32. LIFE-HISTORY OF A SUCCINEID SNAIL *SUCCINEA DAUCINA* (PFEIFFER)

Succineids are found in meadows or on the banks of rivers, streams and lakes or in water. From these habitats they move on to neighbouring crop fields for feeding on agrihorticultural plants (Rigby 1965, Valovirta 1967, Lahdesmaki 1970, Godan 1983). Some of them are known to serve as intermediate hosts of cestode and trematode parasites of birds and cattle (Enigh *et al.* 1957, Godan 1983). India is represented by 25 species of Succineidae, belonging to five genera (Gude 1914, Rao 1925, Hora 1925) but information on the natural history of these snails is confined only to *Indosuccinea semiserica* (Gould) (Raut and Ghose 1984, Raut 1986). Recently, we had the opportunity to collect some live *Succinea daucina* (Pfeiffer) specimens from amongst the vegetation at the edge of a pond located in village Gopal chak, Contai, West Bengal, India. They were cultured in the laboratory and some aspects of their life-history were studied.

A total of 45 individuals measuring 6.1-9.0 mm in shell length and 3.9-6.0 mm in shell breadth were released into a culture container 45 x 20 x 30 cm in size. The container was filled with loose soil in such a fashion that the depth of the soil was 15 cm in one half of the container, sloping down gradually in the other half to 5 cm at the opposite wall. Pond water was poured into the container so that the whole of the slope was filled with water up to a level equivalent to the 15 cm deep adjacent soil area. Thus, the maximum height of the water column at the extreme point of the slope i.e. where the soil depth was minimum (5 cm) was 10 cm. A few plants of *Pistia stratiotes* were kept inside the container, both on the water and soil surfaces so as to simulate natural conditions for the snails. From time to time, water was sprayed on the soil as well as on *P. stratiotes* plants to maintain a humid environment inside the container. Since these snails were seen to feed on *P. stratiotes* in their natural habitat, no other food was offered to them.

The snails thrived well and deposited eggs on the soil surface as well as on the leaves of *P. stratiotes* within a few days. The eggs were kept under observation. On 15th February, 1994 seventeen newly hatched individuals were selected for the proposed study. These newly hatched snails were released into a separate container with similar specifications to the culture container. The snail culture was kept fresh by changing water and *P. stratiotes* plants at regular intervals. To record the growth rate, measurements of shell length, shell breadth and total body weight were taken at intervals of seven days. Age of attainment of sexual maturity, egg-laying potential, mortality and longevity of the snails was recorded.

The newly hatched (zero-day old) *S. daucina* of 1.0-1.5 mm (mean 1.1 + 0.09 SE) shell length, 0.5-1.0 mm (mean 0.6 + 0.09 SE) shell breadth and 0.25-0.5 mg (mean 0.3 + 0.05 SE) body weight grew to 6.0-7.0 mm (mean 6.25 + 0.22 SE) 3.5-5.0 mm (mean 4.0 + 0.29 SE) and 32-41 mg (mean 35.75 + 1.67 SE) in shell length, shell breadth and body weight respectively during the period of 12 weeks. The snails began egg-laying at age 94 days. Of the 17 snails only 4 survived up to the age of oviposition. These 4 individuals produced 8 egg capsules containing a total of 20 eggs. The number of eggs varied from 1-5 per capsule. The eggs were transparent and round, usually 0.72 mm in diameter. They were clearly visible through the gelatinous, colourless capsule. The egg-laying snails survived up to the age of 157 days (maximum). Production of eggs was confined to a period of 15 days from the date of deposition of the first capsule. Of these 4 snails, 2 aestivated on June 4, 1994 (i.e. at the age of 110 days) while the other 2 died prior to aestivation. Of the 2 aestivated individuals one died on 17 June, 1994 and the other became active on 8 July, 1994 and died on 21 July, 1994. The eggs required 13-18 days (mean 14.93 + 0.14 SE) for hatching. Out of 20 eggs, 11 (55%) were successful in giving rise to young snails.

According to Rao (1925) succineids are truly amphibious, pseudo-amphibious or strictly terrestrial. Terrestrial forms resort to aestivation to overcome adverse climatic conditions (Rao, 1925; Hora, 1925; Raut, 1986). Since *S. daucina* live in close contact with water and are also able to aestivate (even though they have the opportunity to go into water) it is probable that they are on an evolutionary pathway to leading true terrestrial life.

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June 4, 1997

S.K. RAUT
T.K. MISRA
S. DAS
Ecology and Ethology Laboratory,
Department of Zoology,
University of Calcutta,
35, Ballygunge Circular Road,
Calcutta-700 019.

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33. RARE OCCURRENCE OF VEGETATIVE LEAFLET OUTGROWTH ON THE LEAF OF MUSTARD *BRASSICA CAMPESTRIS* (BRASSICACEAE)

The leaves of mustard are raised in Mizoram as a vegetable locally, called as "Antum". On 15th June, 1996. I saw in Kolasib market of Aizawal district, outgrowths of leaflets on the dorsal surface of mustard leaf. On careful observations, I found some more mustard leaves with quite a large number (i.e. 5 to 10) of leaflet outgrowths, with maximum length of 11 mm. The leaflet outgrowths were more towards the margin of the leaf than the centre and around rachis. At Kolasib market this leafy vegetable is brought from Kolasib, and the surrounding area.

Mustard is propagated by germination of seed only, and to the best of my knowledge this growth, in the form of outgrowth of leaflets is peculiar and of rare occurrence, and hence worthy of record.

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DAYA NAND HARIT
Government Kolasib College,
Kolasib-796 081,
Mizoram.

34. RECORD OF *ABUTILON RANADEI* WOODROW & STAPF IN AN AREA OTHER THAN TYPE LOCALITY

Abutilon ranadei Woodr. et Stapf (Malvaceae), an endemic and rare species was collected and reported by Woodrow (1897) and Cooke (1901) from Ambaghat of Ratnagiri district in Maharashtra. Since then there was no report on its occurrence, which made Ahmedullah and Nayar (1986) conclude that it may be extinct. However, recently Mistry and Almeida (1989) collected the species from its type locality. Due to rarity and narrow range of distribution the species has been declared as endangered in the Red Data book (Nayar and Sastry, 1990). In 1993, it was collected from the famous Vasota fort in Koyna valley of Satara district. This is the first record of its occurrence in an area other than the type locality and about 100 km away from it. About 50 plants were observed on hill slopes around Vasota. It grows in association with *Carvia callosa* (Nees) Bremek. As it is an endangered species, some attempts have been made to grow the species in the Botanical Garden of Shivaji University, Kolhapur.

Abutilon ranadei has great ornamental value. It has large, elegant, showy flowers with pale purple prominent veins on orange-yellow petals. The easiest way to conserve it is by domestication and introduction as an ornamental plant in gardens.

Flowering and fruiting of the species is observed during January to March.

Specimen (MPB-5829) has been deposited in the Herbarium, Department of Botany, Shivaji University, Kolhapur.

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March 19, 1996

M.P. BACHULKAR
Department of Botany, Vivekanand College, Kolhapur 416 003 (MS).
S.R. YADAV
Department of Botany, Shivaji University, Kolhapur 416 004 (MS).

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35. ON TWO UNRECORDED SPECIES OF *FAGONIA* TOURN. EX L. FROM MAHARASHTRA

During botanical explorations in Dhule district, Maharashtra, two interesting and noteworthy plants were collected. These were identified as species of *Fagonia* Tourn. ex L. (Zygophyllaceae) hitherto unrecorded from Maharashtra. They are being reported as additions to the flora of the state. These are not only new records for the state but also interesting from the phytogeographic point of view as these species have been previously recorded from Rajasthan. This report shows their wider distribution.

The correct nomenclature, diagnostic characters, habitat, phenology, critical notes and key to the species now recorded from Maharashtra are given. The voucher specimens are deposited in the herbarium of the College. They are enumerated here.

1) ***Fagonia bruguieri*** DC., Prodr. 1: 704.1824; Boiss., Fl. Orient. 1: 905. 1867; Edgew. & Hook.f. in Hook.f., Fl. Brit. India 1: 425.1874; Hadidi in Candollea 21:21.1966; Ghafoor in Nasir & Ali, Fl. W. Pak. 76: 11.1974; Shetty & Singh, Fl. Rajasthan 1:162.1987.

A prostrate to suberect, branched undershrub, branches quadrangular, sulcate, striate, glandular-pubescent, internodes upto 1.4 cm long. Leaves opposite, glandular-hairy, 3- and 1- foliolate, leaflets ovate-oblong, sometimes slightly falcate, fleshy, long mucronate, 0.4-1.5 cm long, the mid-leaflet the longest, petioles upto 0.5 cm long. Stipular spines straight, rarely slightly curved, glandular-pubescent, upto 1.6 cm long. Flowers small ± 1.1 cm across, hypogynous, pale pink, fading white, solitary, axillary, pedicel upto 0.5 cm long; sepals 5, green, ovate-triangular, obscurely 3-nerved, nerves branched, glandular-hairy, acute, upto 0.4 cm long, persistent; petals 5, distinct, spathulate, clawed, upto 0.8 cm long, obtuse, mucronate, veins dichotomous; stamens 10, upto 0.4 cm long, glabrous, anthers yellow, oblong, dithecous, dorsifixed, dehiscence longitudinal, pollen grains spherical; pistil 5-carpellate, ovary pubescent, style glabrous, tapering, stigma simple. Capsules pyramidal, 0.4 x 0.3 cm, pubescent, separating into five 1-seeded cocci when dry, tipped with persistent style.

D.A. Patil: Borvihir 608, Kusumba 1192

2) ***Fagonia schweinfurthii*** (Hadidi) Hadidi (in Osterr. Bot. ed. 2. 2.121: 273.1973) ex Ghafoor in Jafri & El Gadi, Fl. Libya 38: 31.1977; *F. indica* Burm. f. var. *schweinfurthii* Hadidi in Rech.f., Fl. Iran 98: 6.t.6.1972; Ghafoor in Nasir & Ali, Fl.W.Pak. 76: 19.1974; Shetty & Singh, Fl. Rajasthan 1: 163.1987.

A prostrate to suberect undershrub, internodes terete, striate, 1-2 cm long, glandular-pubescent. Leaves opposite, 3- and 1- foliolate, leaflets linear-lanceolate, 1-2 cm long, mid-leaflet the longest, glandular-hairy, petioles 0.5-1.0 cm long. Stipular spines 1.0 cm long, straight, glandular-hairy. Flowers small, hypogynous, pinkish, 1.0 cm across, pedicel 0.4 cm long, sparsely glandular-hairy to glabrous; sepals ovate, 0.3-0.4 cm long, sparsely glandular-hairy, persistent; petals 5, free 0.4-0.6 cm long, obtuse; stamens 10, 0.4 cm long, anthers yellow, dithecous, dehiscence longitudinal; pistil 5-carpellate, ovary pubescent, style glabrescent, 0.7 cm long, stigma simple. Capsule pyramidal, 0.4 x 0.4 cm, separating into five 1-seeded cocci when dry, tipped with persistent style, pubescent.

D.A. Patil: Nandre 1431: Bhilwad 1592

Phenology: Both the species flower and fruit mostly from September to May.

Both the species are found particularly in Dhule and Sakri taluka of the district. They are sympatric and grow on gravelly soils. They are found as roadside weeds, on wasteland, fallow lands and even as crop weeds. They form small, spiny cushions, and are generally avoided by livestock. The lower 3-foliolate leaves of the main stem-axis are not generally observed later in the life-span of these taxa, and hence one may mistake them for 1-foliolate leaves. The glandular leaf hairs slough off with age and render them glabrous. The capsules start dehiscing from below and then separate into 1-seeded cocci. The latter being light are dispersed by wind.

Dr. Karthikeyan of Western Circle, BSI, Pune, informed us of the rare occurrence of *F. indica*, Burm.f. (=*F. cretica* Linn.) in Maharashtra, particularly from the drier parts of the districts *viz.*, Ahmednagar, Pune and Satara. It is not found in Dhule dist. but the species described above are common here. However, these are not reported from Gujarat (Shah 1978) except *F. indica.* Apart from *F. indica.* the other two species mentioned in the present communication occur in Rajasthan (Shetty and Singh, 1987). Hooker (1875) described only two species from India and remarked "Species variously estimated from 2 or 3 to 30, being variable and difficult to define". This remark and the present report stress the necessity for a careful search in the field and herbaria for more data on distribution of these species elsewhere in Maharashtra, Gujarat and Karnataka.

Key to the species of *Fagonia* from Maharashtra:

1. Internodes 4-angular; spines longer than the leaves .... *F. bruguieri*
1. Internodes terete; spines equal to or shorter than the leaves 2
2a. Lower leaves 3- and upper ones 1- foliolate .... *F. schweinfurthii*
2b. All leaves 1- foliolate .... *F. indica*

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June 15, 1996

D.A. PATIL
P.G. Department of Botany,
L.K. Dr. P.R. Ghogrey Science College,
Dhule-424 005, Maharashtra.

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36. NOTES ON THE OCCURRENCE OF *WAHLENBERGIA HOOKERI* AND *ANISOCHILUS VERTICILLATUS* IN TAMIL NADU

During botanical exploration in Mudumalai Wildlife Sanctuary, Nilgiris, the authors came across the plant species which were not collected by earlier workers. Henry *et al.* (1987) did not include these species in the FLORA OF TAMIL NADU, India. ser. I: Analysis. Hence these species are dealt with here. These species are poorly represented in MH. To facilitate identification of these species a brief description is given.

Wahlenbergia hookeri (C.B. Clarke) Tuyn in Fl. Males. ser. 1.6:116. 1960. *Cephalostigma hookeri* C.B. Clarke in Hook. f., Fl. Brit. India 3: 429. 1881; Gamble, Fl. Pres. Madras 738. 1921 (Repr. ed. 519. 1957) (Campanulaceae).

Slender erect herbs, 10-20 cm high, hispid. Leaves 2-3.5 x 0.5-1 cm, elliptic-oblong, lanceolate; crenate-serrate along margin, acute-obtuse at apex, sparsely hairy. Panicles terminal, 10-15 cm long; pedicels filiform, 0.5-2 cm long; bracts tooth-like. Calyx tube campanulate, lobes 5, glabrous, persistent. Corolla lobes 5, pale blue, oblanceolate. Stamens 5, filaments dilated at base. Capsules 2-valved, loculicidal, glabrous. Seeds many, ellipsoid, trigonous, brown.

Fl. & Fr.: September-December; in moist shady places.

Specimen examined: Jenubaribetta, Doddagatti. *D. Stephen* 97991, 13.xii.1991.

Note: This is one of the rare plants. Though Gamble (*l.c.*) reported this species from Western Ghats there is no specimen in MH. Henry *et al.* (1987) does not include this species in the FLORA OF TAMIL NADU, India. ser. I: Analysis. Hence this species is an addition to the FLORA OF TAMIL NADU.

Anisochilus verticillatus Hook. f., Fl. Brit. India 4: 629. 1889: Gamble, Fl. Pres. Madras 1128. 1924 (Repr. ed. 788. 1957) (Labiatae).

Herbs or subshrubs, 0.5-1 m high; root stock woody; stems grooved, pubescent. Leaves 1.5-4.5 x 0.2-2 cm, whorled, sessile, elliptic-oblong, oblanceolate, entire or shallowly crenate along the margin, acute at apex, silky hairy; nerves 4-5 pairs. Spikes terminal, cylindrical, 7-12 cm long; bracts lanceolate. Calyx 2-lipped; upper lip 3-toothed, lower truncate, villous. Corolla white, 2-lipped, lower lip decurved, glandular. Stamens 4, didynamous. Styles bifid. Nutlets 4, ovoid.

Fl. & Fr.: August-October in open grasslands.

Specimen examined: Boleguda. *D. Stephen* 97927, 15.x.1991.

Note: Gamble (l.c.) reported its occurrence based on Beddome's collection from Hyderabad and Meebold's collection from Mysore. But there is no specimen from Tamil Nadu in MH. Hence the present collection is the first report from the state.

ACKNOWLEDGEMENTS

Dr. D. Stephen is grateful to the Director, Botanical Survey of India for providing a fellowship under the Flora of India Scheme and to the Joint Director, Botanical Survey of India, Southern Circle, Coimbatore for all facilities.

June 15, 1996 D. STEPHEN
Senior Research Fellow, SACON. Kalampalayam, Coimbatore-641 010.
E. VAJRAVELU
Emeritus Scientist, Botanical Survey of India, Coimbatore-641 003.

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37. A NOTE ON THE IDENTITY AND DISTRIBUTION OF *HYDROLEA ZEYLANICA* (L.) VAHL VAR. *ERECTA* HAINES (HYDROPHYLLACEAE)

(*With one text-figure*)

The family Hydrophyllaceae is represented by 22 genera and about 275 subcosmopolitan species, with greater concentration in dry Western and Northern America (Mabberley, 1987). Of these, 20 species of the genus *Hydrolea* L. are known to occur in the world especially in southeast Asia, Africa and tropical America. In India, a single species, namely *Hydrolea zeylanica*, is found throughout the country, mostly in moist situations around ponds, tanks, ditches, irrigation canals, in rice fields and other wetlands.

Haines (1922) described an infraspecific taxon under *Hydrolea zeylanica* based on his collections from Purneah, Bihar and distinguished his new variety *H. zeylanica* (L.) Vahl var. *erecta* Haines from the type (var. *diffusa* sensu Haines) by its erect habit, longer leaves and non-glandular inflorescence. He remarked that this erect form is a very pretty plant when in full bloom. I collected a large number of specimens belonging to both the varieties from different parts of Orissa, studied their morphological characters and is of the opinion that *H. zeylanica* (L.) Vahl var. *erecta* Haines is undoubtedly a distinct taxonomic entity. It can be distinguished from var. *zeylanica* as per the following consistent key characters:

Erect herbs, leaves narrowly lanceolate, acuminate, glaucous beneath, cauline leaves reflexed. Inflorescence and calyx pubescent, never glandular .... var. *erecta*

Diffuse or procumbent herbs, rooting at nodes, leaves broadly lanceolate to elliptic-lanceolate, acute, not glaucous beneath. Inflorescence and calyx densely glandular-pubescent .... var. *zeylanica*.

Nomenclature, brief description, phenology, ecology and distribution in respect of *H. zeylanica* var. *erecta* is presented below. The occurrence of the taxon in Orissa is a new distributional record.

Hydrolea zeylanica (Linn.) Vahl var. ***erecta*** Haines Bot. Bihar & Orissa 2:571.1922 (Fig.1)

Erect herbs, 20-60 cm high, glabrous below. Inflorescence cymose, terminating the

Fig. 1. *Hydrolea zeylanica* var. *erecta*.
Herbarium specimen

elongate lateral branches or panicled by suppression of leaves, pubescent, never with glands, calyx pubescent, lobes lanceolate, acuminate, apex greenish, distinctly nerved. Ovary 2-celled, ovules many, styles 2, distinct. Capsule ovoid-ellipsoid, septifragal, enclosed by the calyx lobes.

Fl. & Fr.: August-November.

Ecology: Occasional; in swamps, ditches and muddy places associated with *Ludwigia* spp., *Sphenoclea zeylanica*, *Monochoria hastata* and some aquatic grasses and sedges.

Material examined: Nilagiri, Balasore district (Orissa), 14.ix.1995, *P.C. Panda* 4297.

Distribution: Bihar and Orissa. Most likely to occur in other coastal states of India.

I also collected specimens of *Hydrolea zeylanica* var. *zeylanica* having pure white flowers from Ranpur mals, Nayagarh district, Orissa (Field No. *Panda* 5491) where a large population was observed in flowering condition. This white flower colour of *H. zeylanica* is a new record and is of taxonomic and ecological interest.

ACKNOWLEDGEMENT

I thank the Director, Regional Plant Resource Centre, Bhubaneshwar for facilities provided.

June 15, 1996

P.C. PANDA
Taxonomy & Conservation Division
Regional Plant Resource Centre
Bhubaneshwar-751 015,
Orissa.

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38. *HELIOTROPIUM BACCIFERUM* FORSSK. VAR. *TUBERCULOSUM* (BOISS.) KAZMI — A NEW RECORD FOR RAJASTHAN

(*With one text-figure*)

While revising the family Boraginaceae from the Indian subcontinent the authors observed that specimens of *Heliotropium bacciferum* Forssk. collected from Rajasthan are not actually *H. bacciferum*. On critical examination, they turned out to be

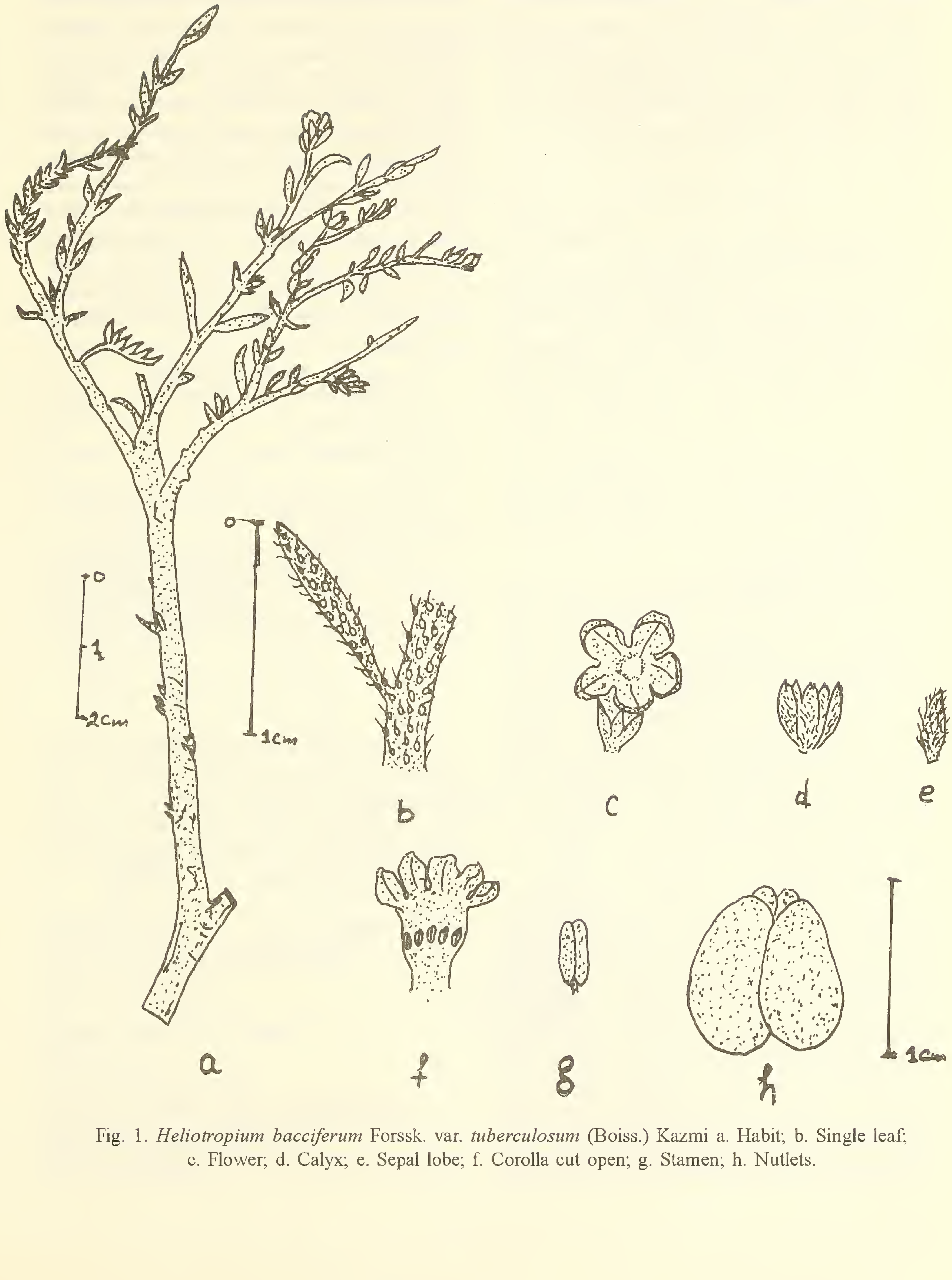

Fig. 1. *Heliotropium bacciferum* Forssk. var. *tuberculosum* (Boiss.) Kazmi a. Habit; b. Single leaf; c. Flower; d. Calyx; e. Sepal lobe; f. Corolla cut open; g. Stamen; h. Nutlets.

H. bacciferum Forssk. var. *tuberculosum* (Boiss.) Kazmi. Since the identity of this plant is often confused and no illustrative account exists in the available literature, a short description with nomenclature, distribution and ecological notes along with a key to the varieties is given.

Key to the varieties

1a. Drupes more than 3 mm across with simple or bilobed corky cells on the back. .... *H. bacciferum* var. *suberosum*

1b. Drupes less than 2 mm across, with verrucose or warty cells on the back 2

2a. Leaves flat, more than 5 mm broad, both surfaces of leaf covered with trichomes usually not arising from tuberculate bases. .... *H. bacciferum* var. *bacciferum*

2b. Leaves terete, upto 3 mm broad, covered on both surfaces mostly with stout trichomes, distinctly arising from large, white, tuberculate bases. .... *H. bacciferum* var. *tuberculosum*.

Heliotropium bacciferum Forssk. var. ***tuberculosum*** (Boiss.) Kazmi, Jour. Arn. Arb. 51: 162. 1970. *H. undulatum* Vahl var. *tuberculosum* Boiss. Diagn. Pl. Orient 1(2): 89. 1849. *H. tuberculosum* (Boiss.) Boiss. Fl. Orient. 4: 147. 1875. *H. kotschyi* Bunge., Reliq. Lehman 404. 181. *H. bacciferum* Forssk. subsp. *tuberculosum (*Boiss.) H. Riedl in Oesterr. Bot. Zeitschr. 113: 167. 1966; Riedl in Rechinger, Fl. Iranica 48: 20. 1967.

Vernacular name: Punjabi: Jali misala; Gujarati: Pipal buti.

Perennial, branched, procumbent-decumbent or erect herbs or undershrubs with woody rootstock; younger parts covered with tuberculate based trichomes; older stems and branches give white dotted, glandular appearance. Leaves sessile to subsessile, alternate, terete, 0.5-1.5(3) x 0.1-0.3 cm, narrowed at both ends, margins undulate to revolute, covered on both surfaces with white tuberculate based trichomes intermixed with simple hairs. Inflorescence 1-2.5 cm long, bearing a few closely set sessile, ebracteate, white flowers. Calyx divided up to the base, densely clothed with trichomes outside. Corolla tubular, pubescent outside, glabrous within. Corolla tubular, pubescent outside, glabrous within. Anthers inserted at or below the middle, yellow, sessile, oblong. Stigma conical, shortly bifid at the apex, obscurely pubescent with indistinct stigmatic ring. Drupe depressed globose, covered by persistent calyx lobes, *ca.* 2 mm across; nutlets 4, in two pairs, margins more or less winged, line of separation of the paired nutlets not conspicuous. Nutlets glabrous, warty or rugulose on the back.

Fl. and Fr.: March-September.

Distribution. India: Rajasthan, Gujarat, Punjab, Maharashtra.

Extralimital: West Pakistan, Iran, Iraq and Australia.

Ecology: In saline to sandy loamy soils or in rocky habitats.

Material examined: Harchandory, Jaisalmer 10.iii.1977, coll. B.V. Shetty 3491 (BSJO); Shivbani tank, Bikaner, 11.iii.1975, coll. G.P. Roy 1701 (BSJO).

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June 15, 1996

P.M. PADHYE
BSI, Andaman & Nicobar Circle, Port Blair-744 102.
Present Address: BSI, Arid Zone Circle, Jodhpur.

R.P. PANDEY
BSI, Arid Zone Circle, 775/80 Subhash Nagar, Khema Ka Kuan, Pal Basani Canal Link Road, Jodhpur-342 008.

39. CRITICAL NOTES ON THE ORCHID *PHALAENOPSIS CORNUCERVI* (BREDA)

(With one text-figure)

The occurrence of the species *Phalaenopsis cornucervi* (Breda) Bl. & Reichb. f. in Andaman Islands was reported by Lakshminarasimhan and Ray (1991). A critical examination of the specimen quoted by the authors (P. Lakshminarasimhan & L.N. Ray, 15199-PBL) with relevant literature and the specimens authenticated by Dr. G. Seidenfaden reveals that the plant attributed to that report is actually *Kingidium deliciosum* (Reichb. f.) Sweet, a close relative of the genus *Phalaenopsis* Blume. Recently Ray *et al.* (1996) reported the occurrence of *Kingidium deliciosum* (Reichb.f.) Sweet in Andaman islands based on a fresh collection Sreekumar et Ray, 16473-PBL) from Richie's Archipelago. This plant could be easily distinguished from *Phalaenopsis cornucervi* by the presence of a sac on the lip and 4 pollinia, while the latter possesses only 2 pollinia and also has a flattened rachis of inflorescence. Hence, the real occurrence of *P. cornucervi* in Andaman is doubtful, although Kurz (1876) reports it from

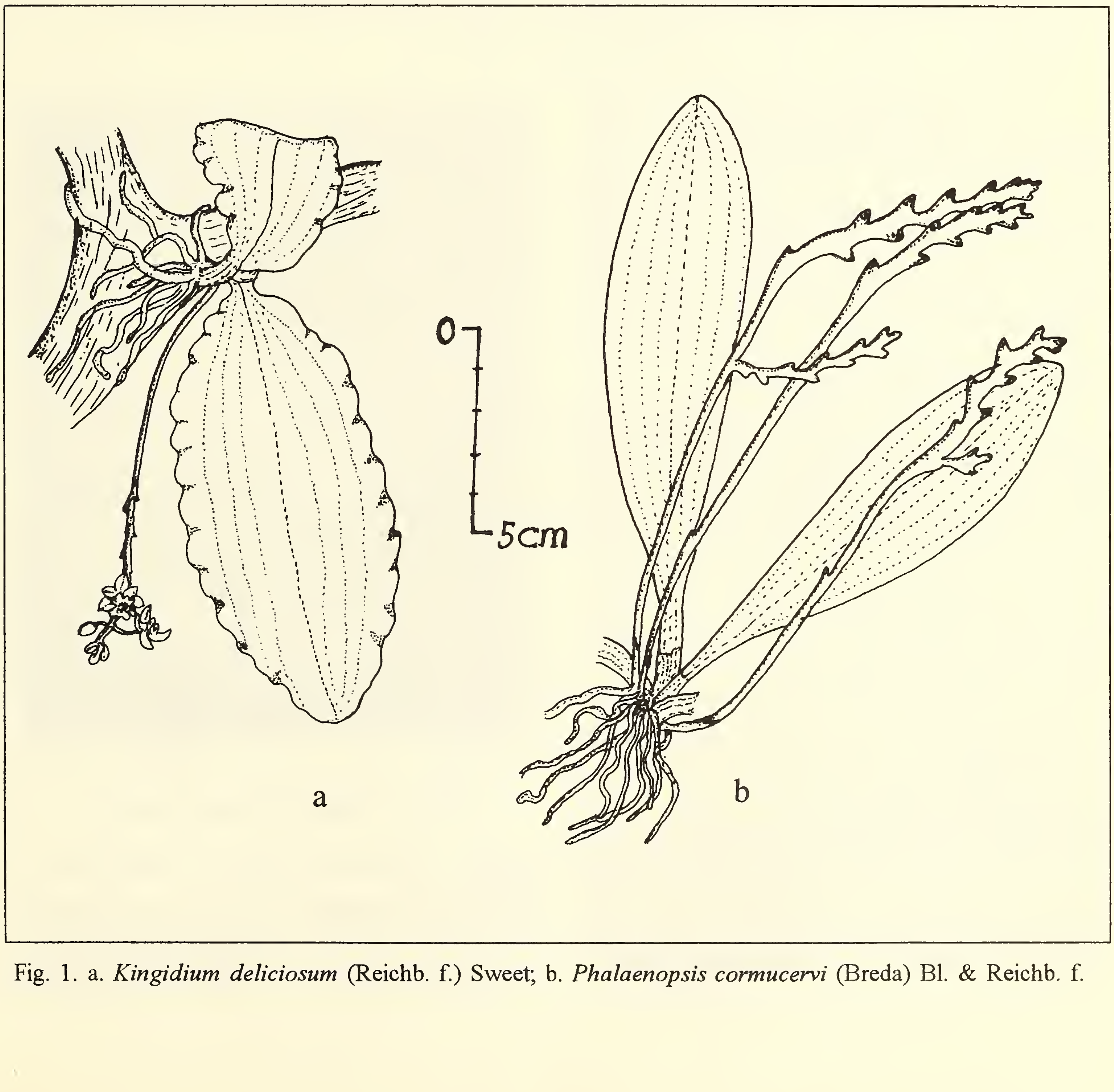

Fig. 1. a. *Kingidium deliciosum* (Reichb. f.) Sweet; b. *Phalaenopsis cormucervi* (Breda) Bl. & Reichb. f.

Nicobar Islands, for which no specimens are available in Port Blair. A comparative habit sketch is provided here to distinguish both these taxa.

I would like to express my sincere thanks to Dr. P.K. Hazra, Director, Botanical Survey of India, Calcutta and Dr. P.S.N. Rao, Scientist 'SD' Botanical Survey of India, Port Blair, for encouragement and facilities.

October 12, 1996

P.V. SREEKUMAR
Botanical Survey of India,
Andaman & Nicobar Circle,
P.O. Box 692,
Haddo, Port Blair-744 012.

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RAY, L.N., P.V. SREEKUMAR & P.M. PADHYE (1996): Two new records of Orchids for Andaman Islands. *J. Bombay nat. Hist. Soc. 93(1)*: 123-125.

40. DOUBLE FRUITING IN PINEAPPLE — A RARE PHENOMENON

(With one text-figure)

The pineapple *Ananas comosus* (L.) Merr. belonging to family Bromeliaceae is one of the most important commercial fruits of the world. It is believed to have originated in Brazil, from where it spread to other tropical parts of the world. The fruit, having a characteristic pleasant flavour, is a good source of vitamin A and B and is fairly rich in vitamin C and minerals like calcium, magnesium and iron.

During the vegetative phase of the pineapple, the stem produces compacted internodes and leaves. Under natural conditions, flowering is irregular and is marked by an increase in diameter of the meristem, one year or more after planting, which then produces a series of expanded floral organs and longer internodes. After this, the diameter again decreases until purely vegetative leaves are produced which, with the short starchy stem, forms the top of the fruit or inflorescence. Under natural conditions, the pineapple plant produces single multiple fruit with one or more crowns. After a particular stage of fruit development the growth of the crown ceases and remains dormant unless it is detached for propagation and other purposes. During my visit to a pineapple plantation at the Central Agricultural Research Institute, Research Complex, I noticed that in one plant of pineapple var. Kew, two months after emergence of inflorescence and fruit formation, one more inflorescence and fruit emerged/

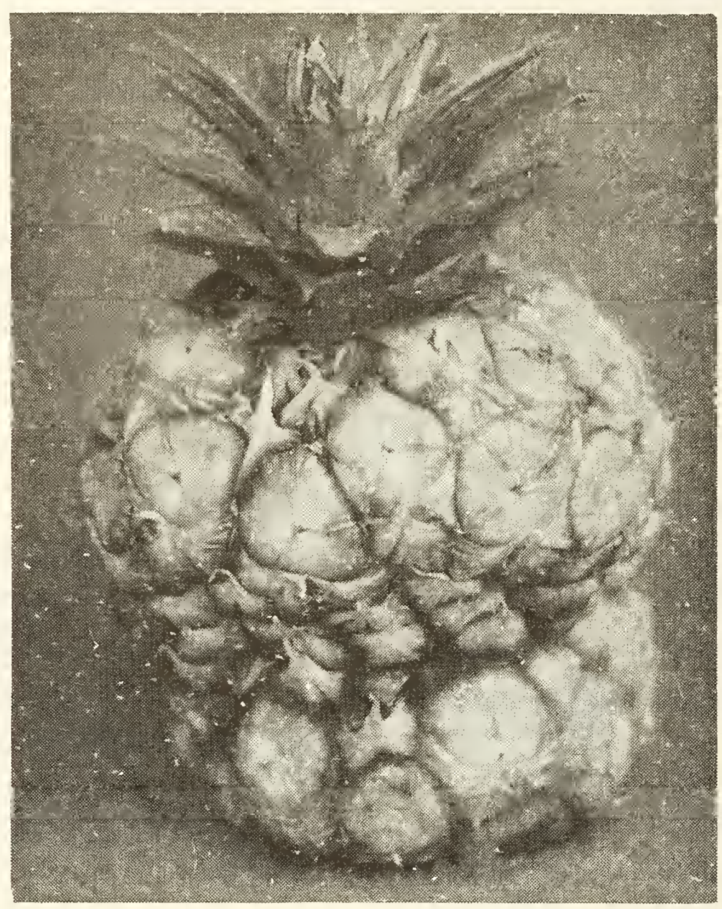

Fig. 1. Double fruiting in pineapple.

developed from the crown of the same fruit having multiple crowns. Both the fruits on a single peduncle developed and ripened simultaneously, thus giving the appearance of a single fruit in late stage. Whatever the cause may be, this phenomenon is rare and needs further study on nutritional, cytogenetic and physiological aspects.

October 12, 1996 D.B. SINGH
Central Agricultural Research Institute
Port Blair-744 101.

41. *POA NEPHELOPHILA* BOR — A NEW RECORD TO INDIA FROM GARHWAL HIMALAYA

(With one text-figure)

During plant explorations in Garhwal Himalaya, some interesting specimens of *Poa* were collected from Yamnotri in Uttarkashi district. Critical analysis of the specimens of the species as well as perusal of literature confirmed the identity of the species as *Poa nephelophila,* so far known from Myanmar (Burma), hitherto not reported from India (Bor 1960, Rajbhandari 1991).

The present communication pertains to the detailed description and illustrations of the species, along with short notes on its distribution, and collector's Herbarium number. The voucher specimens are deposited in the Herbarium, H.N.B. Garhwal University, Srinagar (GUH).

Poa nephelophila Bor in Kew Bull. 1948: 140. 1948; in *J. Bombay nat. Hist. Soc. 50:* 819. 1952; GBCIP. 558.1960; Rajbhandari *In* The Himalayan Plants (ed. Ohba & Malla) 2: 222. 1991.

Annual, glabrous grasses; culms erect or ascending from the geniculate base, 20-38 x 0.15 cm, leafy; nodes 2-3, shining. Leaves flat, linear-acuminate, 10-12 x 0.3-0.5 cm, glabrous on the margins and both surfaces or minutely scabrid, with rounded base, dark-green in colour; sheaths 6-16 cm long, glabrous ligules rounded at the apex, 1.1-1.2 mm long, outer surface glabrous. Panicles pyramidal, 8-12 x 2-3 cm; branches spreading, smooth, lower branches 4; spikelets oblong, 5.5 mm long, 4-6 flowered. Lower glumes elliptic-oblong, acuminate, 1.8 mm long, 1-nerved, margins hyaline, keel scabrid above; upper glumes elliptic, acute or acuminate, 2.5 mm long, 3-nerved, margins hyaline, keel ciliate to the basal half or more, remainder scabrid; paleas elliptic, oblong, 2.5 mm long, with long ciliate keels. Stamens 3; anthers 0.6 mm long. Ovary ovoid, glabrous.

Fl. & Fr.: September-October.

Rare - on alpine slopes, associated with other grasses and herbs.

Specimen examined: Yamnotri (Uttarkashi) 3300 m; D.C. Nautiyal; GUH 14917.

Distribution: Previously the plant was reported from Burma, Chimlipass, above 3300 m (Bor, 1990).

This is a very leafy species closely resembling robust forms of *Poa annua* L. However, it mainly differs in having 4 lower panicle branches and ligules 1.1-1.2 mm long, (*Poa annua* has 1 or 2 lower panicle branches and ligules measures 1.5-3 mm long).

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June 15, 1996 R.D GAUR
D.C. NAUTIYAL
Department of Botany,
H.N.B. Garhwal University, Srinagar-246 174,

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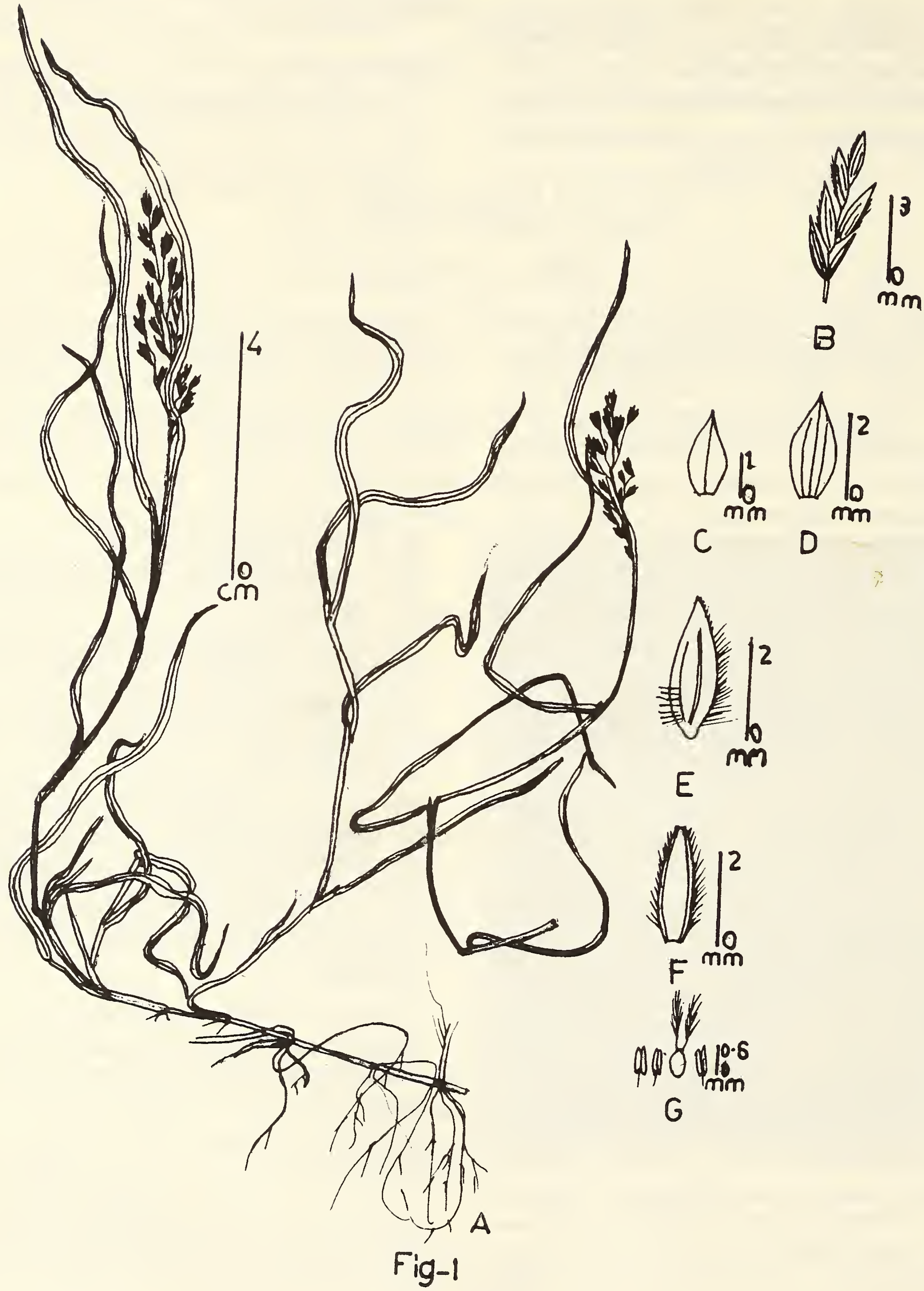

Fig. 1. *Poa nephelophila* Bor A. Plant; B. Spikelet; C. Lower glume; D. Upper glume; E. Lowest lemma; F. Palea; G. Anthers, ovary, styles and stigmas.

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