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CONTENTS

NEW DESCRIPTIONS

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THE BREEDING BIRDS OF OVERA WILDLIFE SANCTUARY, KASHMIR[1]

TREVOR PRICE[2] AND NITIN JAMDAR[3]
(With four text-figures)

The occurrence, abundance and altitudinal ranges for the breeding birds of Overa Sanctuary is documented. Of 117 species recorded near or in the Sanctuary, 89 appear to regularly breed within its boundaries. 51 of these species breed in the fir woodlands and associated ecotones at *c.* 2,400 m, 51 breed in the birch woodlands at *c.* 3,300 m, and 23 species breed above the tree line. The results are discussed in the context of the suitability of the Sanctuary as a bird preserve.

In Kashmir there are currently 54 Sanctuaries and Protected Areas administered by the State's Department of Wildlife Protection. They have been primarily established to preserve wildlife and natural resources, and for use as educational and recreational areas. Additionally other economic ventures, such as agroforestry, may be developed in so far as they do not interfere with conservation goals. Many of the parks have only recently been set aside as protected areas and there is currently a critical lack of the sort of knowledge needed to make planning decisions.

The Department of Wildlife Protection's research resources have of necessity been applied to studies of particular rare species for which several of the reserves have been explicitly set aside, e.g. the hangul (Schaller 1969, Inayat Ullah 1986), the blacknecked crane *Grus nigricollis* (Hussain 1985, Narayan *et. al.* 1987) and the snow leopard *Panthera uncia*. To date there has been no taxon–wide survey of any sanctuary, and complete lists for even the most conspicuous taxa (for example the birds and mammals) are unavailable. In this paper we describe the results of a three year study of the breeding birds of one Sanctuary. We present measurements of species' abundances, altitudinal distributions, and habitat preferences. Our purposes in presenting this information are twofold. First, it will be of use to ornithologists visiting similar habitats (fir–pine– birch woodland) in Kashmir. Second, the results provide baseline data against which population decreases or increases in subsequent years can be assessed. We discuss our results in the context of species' conservation and sanctuary management given the long term goals of the Wildlife Department.

Despite the absence of the sort of quantitative study we will be presenting, Kashmir has been frequently visited by naturalists and ornithologists who provide anecdotal reports on species' occurrence and behaviour (e.g. Dewar 1923, Osmaston 1927, Alexander 1950, Bates and Lowther 1952, Koul 1968, Gauntlett 1972). Much of this previously published work is summarised in Ali and Ripley (1983). Our new observations on breeding behavior are reported in separate publications (Jamdar 1987, 1988, Jamdar and Price *in press*, Price and Jamdar, *in preparation*).

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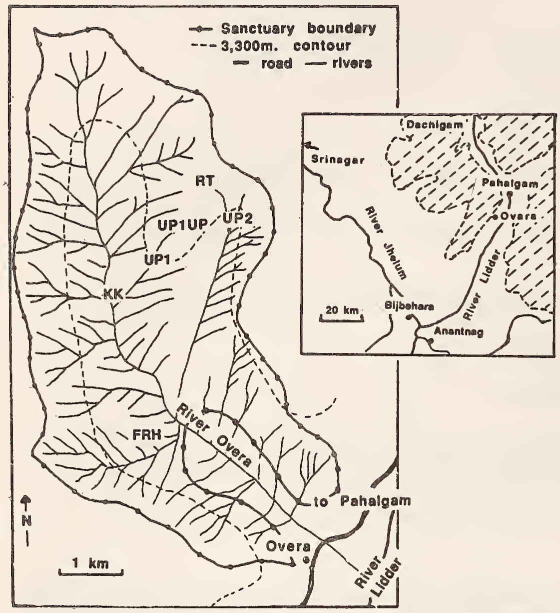

Fig. 1. Map of Overa Wildlife Sanctuary. The dotted line is the approximate 3,300 m contour. The letter captions are acronyms for the study sites (see Tables 1 and 2). The insert map shows the location of Overa in relation to the major local towns, the area above c. 3,000. m is shaded.

Study Location

Overa Wildlife Sanctuary is one of the smallest (33 sq. km) and most recently established (1981) reserves in the state. It is approximately 10 km from the tourist centre of Pahalgam, and 80 km from the state capital, Srinagar (Fig. 1). It is hoped that it will eventually form part of a much larger biosphere reserve. The sanctuary extends from about 2,100 to 4,200 m above sea level. There are three main vegetational types – coniferous forest, birch forest, and alpine pasture. To the south the sanctuary is bordered by the Overa valley, opening into the Lidder valley. This is an agricultural area, although some deciduous trees have been retained. Along the Lidder valley side to the east and west of the sanctuary lie heavily grazed pasture lands and coniferous forest. To the north lies an expanse of high altitude land, also grazed in the summer.

Methods

One or both of us spent May, June and July in each year 1985, 1986, and 1987 at the Sanctuary. We established three main study areas – one at 2,400 m (FRH) and two at *c.* 3,300 m (UPI and UP2, Fig. 1 and Table 1). Altitudes were obtained using an altimeter, standardized to 1,570 m at Dal Lake in Srinagar. We spent most of May at the lower altitude and June and July at the higher locations. We recorded temperature and daily rainfall at these locations. We also occasionally visited locations at 2,800 m and at 3,600 m (KK and RT) to obtain more information on altitudinal distributions of birds. To quantify habitats we established five grids along the altitudinal gradient ranging from 1–4 ha. in size (Fig. 1, Table 2). We counted all trees in each grid, and estimated the area covered by juniper and rhododendron bushes.

Birds were censused by the following methods.

Table 1
OBSERVATION AND TRAPPING INTENSITY AT EACH LOCATION

Location	Altitude (m)	Number of days each month at site (number of net–mornings)								
		1985			1986			1987		
		May	June	July	May	June	July	May	June	July
FRH	2430	28 (41)	16 (9)	15 (26)	15 (4)	3 (4)	4	13 (30)	2 (20)	1
KK	2800	–	3	3	–	–	–	–	1 (10)	1
UP1[1]	3340	–	18	13 (9)	17	27 (18)	16 (20)	17 (52)	25 (20)	15
UP2	3300	–	–	–	15	23	10	11	24	6
RT 3725	–	–	–	–	–	–	–	–	2 (20)	–

Figures in parentheses are the number of nets opened for a morning summed across all mornings in which nets were opened in that month.

Abbreviations: FRH–Forest Rest House. KK–Kanj Kut, a local name for this area of the sanctuary. UP stands for 'up above', with UP1UP meaning above UP1. RT–ridge top.

[1]Includes trapping and observation at UP1UP (altitude 3550 m).

TABLE 2
TREE DENSITY (NUMBERS/HA.) AT VARIOUS ALTITUDES

Site	Silver birch *Betula utilis*	Blue pine *Pinus walli–chiana*	Fir *Abies pindrow*	Horse chestnut *Aesculus indica*	Ash *Fraxinus floribunda*	Cherry *Prunus cornuta*	Maple *Acer stercul iaceum*	Unidentified deciduous	Rhodo-dendron* sq.m	Juniper sq.m.
FRH (4ha)	–	0.5	176	28	5	8	1	5	–	–
KK (4ha)	–	8	155	–	–	7	11.5	–	–	–
UP1 (5ha)	77	2	18	–	–	1	1	–	80	10
UP1UP (2ha)	39	–	–	–	–	–	–	–	375	500
RT (1ha)	–	–	–	–	–	–	–	–	500	3000

Notes: The number of ha. surveyed is given in parentheses. The predominant understory shrubs are *Viburnum grandiflorum* in the valleys alongside the coniferous forest and *Salix denticulata* under the birch. All trees with trunk widths 10 cm. at chest height are included. Birch and cherry often have several trunks from a subterranean bole and these were counted as a single tree.
*Rhododendron and Juniper are estimated approximate areas (in sq.m.) per hectare.

TABLE 3
WEATHER DATA FOR THE HIGH ALTITUDE CAMP (UP1)

Percentage of days with	1985 May	1985 June	1985 July	1986 May	1986 June	1986 July	1987 May	1987 June	1987 July
Sun	?	71	62	56	92	50	56	86	78
Rain, hail, Snow	> 70*	59	46	52	38	44	56	52	39
Hail	?	35	15	> 24	4	0	> 4	21	0
Snow	?	0	0	> 16	0	0	> 19	0	0

We placed up to 10 mist–nets on varying dates at each location (Table 1) and opened them from dawn (*c.* 0600 hrs) until between 1000 hrs and 1200 noon. Captured individuals were weighed and their wing–length measured, using the maximum chord method of Svennson (1975). They were then ringed and released. The average number of individuals of a given species captured per mist net per morning provides a useful index of relative abundances, at least for commoner passerines (Price 1979, Schluter 1982, Martin 1984).

We recorded the number of individuals of each species we observed in a daily log book. Although most of our observations were made casually, we also used two census methods to obtain these data, conducted as follows. First, we estimated the number of singing males in each of five established grids by carefully walking round the grid on between one and five mornings over the three seasons combined. Second, at the low altitude site only, we conducted a regular 2 km post–dawn walk up a small valley running through a fir woodland (from 2,300–2,600 m), recording all singing males heard. We did this at approximately 10 day intervals in 1985 and 1986, and on fewer occasions in 1987.

RESULTS

Vegetation: Typical forest types of Kashmir are described in Champion and Seth (1968). The density of trees in grids at each of five altitudes is given in Table 2. Lower altitudes are dominated by fir, although several deciduous trees are common, particularly along water–courses. The first birch trees are encountered at approximately 3030 m altitude and birch is dominant above 3100 m. Large firs occur up to 3400 m however, and a few small individual fir trees occur up to the tree line (i.e., the upper limit of the birch at about 3550 m). Rhododendron and juniper are first encountered at 3330 m. Rhododendron extends beyond the birch to

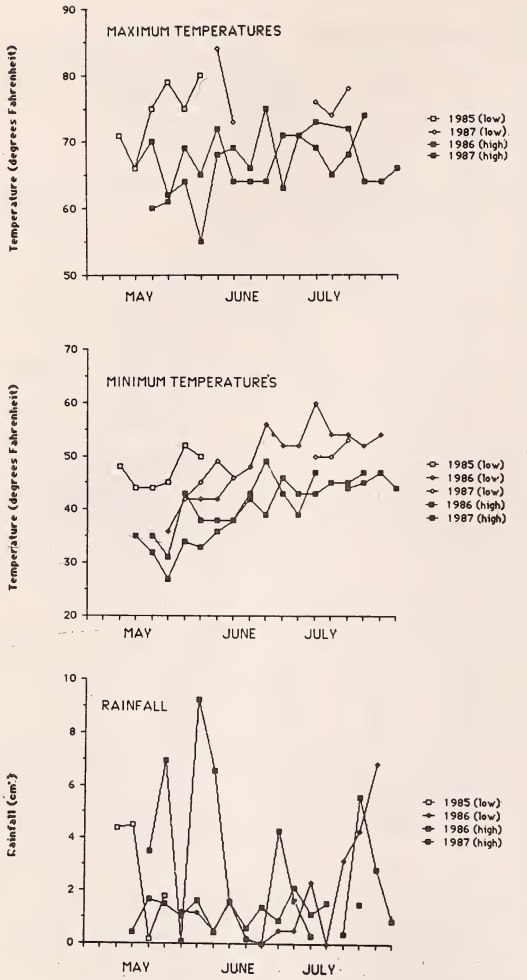

Fig. 2. Climate data for Overa. The upper figure gives the maximum temperature recorded in five day periods from May 1st. Middle figure gives minimum temperatures, lower figure gives rainfall totals, in similar five day periods. Data are not available for all years at all locations. Lines connect points for which data are continuously available.

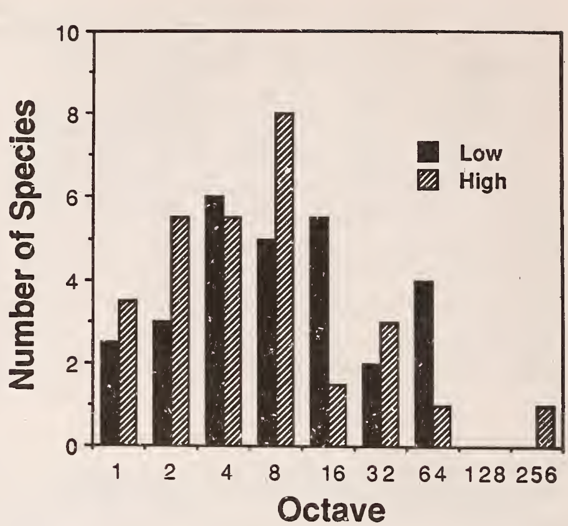

Fig. 3. Species abundance distributions, for passerines only, at the low and high sites. Abundance is the number of individuals captured at each site (from Table 4). The number of species in each abundance class is graphed against abundance class group, or octave:(0–1 individuals, 1–2 individuals, 2–4 individuals etc. up to 128–256 individuals; see Preston (1962). The numbers along the x-axis give the upper bound of each abundance class.

3750 m, and juniper is found up to 3900 m. Above the juniper, and also intermingled with it there is an expanse of pastureland dominated by Alpine flowers. There are thus no abrupt transitions between the various dominant plant forms, except along the sanctuary's lower boundary where the forests abut agricultural land.

Climate: We present available temperature and rainfall data in Fig. 2. The weather at Overa during May–July can be summarized as follows. Each winter most of the sanctuary is under snow for between 3–4 months. The snow persists into May at the higher altitudes, and following the hard winters of 1986 and 1987 a metre of snow was present at the 3,300 m camps throughout May. It only disappeared from these altitudes in June. In 1985 the snow disappeared several weeks earlier: the last snow disappeared from a watercourse in the UP1 area on 15 June in 1985, on about 10 July in 1986, and on 19 July in 1987. Each year at the high altitudes May was typically wet, June was fine, and July was more variably fine and wet (Table 3). Hailstorms may occur at any time (Table 3). For breeding birds at this altitude the climate can be unpredictable, and at times harsh. It is significantly cooler at the higher altitudes than at lower altitudes, and at the low altitudes June and July can be hot (Fig. 2). Although it may rain a great deal at the low altitude, no snow fell below 2,900 m in any year during the study periods.

Bird Occurrence

We have recorded a total of 116 species in or

TABLE 5
NUMBER OF SPECIES BREEDING AT THREE ALTITUDES

Location (altitude, m)	Number	Number shared across two adjacent sites	Number shared across all three sites
FRH(2430)	51		
		26	
UP1(3340)	51		2
		12	
RT(3725)	23		

TABLE 6
DATES OF ARRIVAL OF SPECIES WHICH ARRIVE LATER THAN MAY 1ST

Species	1985	1986	1987
Cuckoo	6 May	5 May	3 May
Small cuckoo	25 May	25 May	7 June
Black bulbul	17 May	5 May	16 May
Sooty flycatcher ·	7 May	26 May	25 May
Largebilled leaf warbler	23 May	18 May	?

near the sanctuary. Of these 16 are primarily associated with the arable land and villages bordering the lower boundary (Appendix 1), and although two (the house sparrow and the dark–grey bush chat) have been recorded breeding within the sanctuary, we do not discuss these species further. Another 11 species were recorded on fewer than three occasions (Appendix 2), and in the light of their uncertain status are also not considered here. This leaves a total of 89 species which appear to breed regularly or occasionally in the sanctuary, and be dependent on the habitats within its boundaries. Habitat associations, measures of abundance, and biometrics of these species are presented in Table 4. We give two different measures of abundance at each of the high and low altitudes. The first is based on mist net surveys and gives a direct estimate of relative density (individuals/mist net/day). For the passerines these values agree well with general impressions of relative abundance, and the grid surveys. The second measure is the proportion of days on which we observed at least one individual of a given speces. The observation and mist net measures are correlated (for passerines captured at least once, $r = 0.5$, $N = 29$, $P < 0.5$ at the low altitude, and the same values: $r = 0.5$, $N = 29$, $P < 0.5$ at the high altitude). The correlation is not strong, and the measures provide different information. The observation measure is not a good indication of relative densities (a single conspicuous individual might be often recorded, even though the species as a whole is rare, as was the case for example at the high altitutde for the strongfooted bush warbler *Cettia montana* and the scalybellied green woodpecker *Picus squamatus*. However it is a good indicator of the chances of seeing a particular species at each of the two altitudes, and should be of use to naturalists visiting this and other similar localities in Kashmir.

In Fig. 3 we show number of individuals trapped for the high and low sites separately, for all Passerines. Species abundance classes are grouped into the histogram by octave (i.e. the first octave graphs all species for which 1 individual was captured, the next octave for which 1 or 2 individuals were captured, the next for 2,3, or 4 individuals and so on. Where two octaves share some boundary numbers (the first two both include one individual for example, the number of species is divided among them). A bell shaped curve indicates the species distributions follow an approximately lognormal distribution, as is usually observed (Preston 1962). Abundances at both the low and high site follow similar distributions, and appear to be approximately lognormal. By this measure, however, the yellowbrowed leaf warbler *Phylloscopus inornatus* is exceptionally abundant. Several species are rare, and to these should be added those recorded extremely infrequently and not included in Fig. 3 (Appendix 2).

Altitudinal distributions: Total bird density at the

TABLE 4
SPECIES' OCCURRENCE AND ABUNDANCE AT OVERA

Species	Scientific name	Status	Ringing		Obsevation		Wing (mm.)		Weight (g.)		Sample size	Altitude m (x1,000)	Habitat
			high	low	high	low	X	Sd	X	sd			
Indian sparrow–hawk	*Accipternisus*	PM		1	13	10	210				1	c–3.3	cb
Buzzard sp.	*Buteo* sp.	BM			47	0						2.8–	bu
Golden eagle	*Aquila chrysaetos*	H			23	8						2.8	u
Griffon vulture	*Gyps himalayensis*	H			66	31							
Bearded vulture	*Gypaetus barbatus*	B			45	8						2.8–	bu
Hobby	*Falco subbuteo*	BM		4	23						c–2.8	c	
Kestrel	*Falco tinnunculus*	P			32	0						3.3–	bu
Monal pheasant	*Lophophorus impejanus*	B		47	0						3–3.5	bu	
Koklas pheasant	*Pucrasia macrolopha*	B		25	33						c–3.2	cb	
Woodcock	*Scolopax rusticola*	B			54	0						3–3.4	cb
Rufous turtle–dove	*Streptopelia orientalis*	B			34	95						c–3.2	c
Cuckoo	*Cuculus canorus*	BM		1	49	84						c–3.2	cb
Himalayan cuckoo	*Cuculus saturatus*	SM			0	10						c	
Small cuckoo	*Cuculus poliocephalus*	BM			53	28						3–3.7	bu
Collared pygmy owlet	*Glaucidium brodiei*	P			10	14						c–3.4	cb
Wood owl	*Strix aluco*	B			32	6						c–3.4	cb
Swift	*Apus apus*	HM			20	28						3.3–	u
Whiterumped swift	*Apus pacificus*	HM		1	1						3.5		
Scalybellied green woodpecker	*Picus squamatus*	P			7	43						c–3.2	cb
Kashmir pied woodpecker	*Picoides himalayensis*	B	5		22	99	131	2.9	68.1	6.1	7	c–3.3	cb
Brownfronted pied Woodpecker	*Picoides auriceps*	P			0	15						c	
House martin	*Delichon urbica*	HM	1		48	1	101		13.2		1	3.3–	u

Species	Scientific name	Staus	Ringing		Observation		Wing (mm.)		Weight (g.)		Sample size	Altitude range m (x 1,000)	Habitat
			high	low	high	low	X	Sd.	X	Sd.			
Nutcracker	*Nucifraga caryocatactes*	B	1	75	0	101						3.1–3.5	cb
Yellowbilled chough	*Pyrrhocorax graculus*	H		0	0							3.6–	u
Redbilled chough	*Pyrrhocorax pyrrhocorax*	H			15	0						3.6–	u
Jungle crow	*Corvus macrorhynchos*	B			91	96						c–3.6	cbu
Longtailed minivet	*Pericrocotus ethologus*	BM	1	1	20	54	90		21.0		2	c–3.3	cb
Black bulbul	*Hypsipetes madagascariensis*	PM			0	51						c	cb
Variegated laughing thrush	*Garrulax variegatus*	B	1	1	84	59	102	2.8	64.0	2.5	4	c–3.5	eb
Streaked laughing thrush	*Garrulax lineatus*	B	2	9	32	93	78	2.2	41.0	2.8	20	c–3.3	eb
Sooty flycatcher	*Muscicapa sibirica*	BM		2	31	44						c–3.3	cb
Rufoustailed flycatcher thrush	*Muscicapa ruficauda*	BM	1	7	1	68	77	2.7	13.3	0.8	15	c–3.2	cb
Kashmir redbreasted	*Muscicapa subrubra*	BM		8	0	81	67.5	2.2	10.5	0.9	19	c–3	e
Whitebrowed blue flycatcher	*Muscicapa superciliaris*	BM	2	6	24	75	63	2.2	8.7	0.3	15	c–3.3	ec
Staty blue flycatcher	*Muscicapa leucomelanura*	BM	2	30	56	90	58	2.9	7.7	0.6	57	c–3.3	ebc
Verditer flycatcher	*Muscicapa thalassina*	SM	0	4								c	
Strongfooted bush warbler	*Cettia fortipes*	BM		4	8	94	56	2.9	10.4	0.7	8	c–3.1	e
Tytler's leaf warbler	*Phylloscopus tytleri*	BM	3	5	74	76	57	2.2	7.2	0.5	30	c–3.3	eb
Tickell's leaf warbler	*Phylloscopus affinis*	BM			69	4	56	1.9	6.7	0.6	5	3.4–	j
Orangebarred leaf warbler	*Phylloscopus pulcher*	BM	5		70	0	56	2.7	6.5	0.5	6	3.3–3.5	r
Hume's yellowbrowed	*Phylloscopus inornatus*	BM	67	5	97	49	56	2.5	6.0	0.4	228	c–3.5	eb
Pallas's leaf warbler	*Phylloscopus proregulus*	BM	7	47	77	93	51	2.8	5.1	0.5	166	c–3.3	c
Largebilled leaf warbler	*Phylloscopus magnirostris*	BM		3	54	55	68	3.3	10.0	1.2	12	c–3.2	w
Greenish leaf warbler	*Phylloscopus trochiloides*	BM	4		62	16	63	3.2	8.3	0.7	16	3.3–3.5	b
Large crowned leaf warbler	*Phylloscopus occipitalis*	BM	6	31	91	99	65	3.0	8.7	0.6	101		
Goldcrest	*Regulus regulus*	B	2	1	21	10	53	5.0			3	c–3.3	c
West Himalayan rubythroat	*Erithacus pectoralis*	PM			37	1	74	22.5			1	3.4	j

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Buzzard sp.	*Buteo* sp.	BM			47	0						2.8–	bu
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Species	Scientific name	Status	Ringing Observation				Wing (mm.)		Weight (g.)		Sample size	Altitude range m (x 1,000)	Habitat
			high	low	high	low	X	Sd.	X	Sd.			
Nutcracker	*Nucifroga coryocotactes*	B	1	75	0	101						3.1–3.5	cb
Yellowbilled chough	*Pyrrhocorax graculus*	H		0	0							3.6–	u
Redbilled chough	*Pyrrhocorax pyrrhocorax*	H			15	0						3.6–	u
Jungle crow	*Corvus macrorhynchos*	B			91	96						c–3.6	cbu
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Streaked laughing thrush	*Gorrulax lineatus*	B	2	9	32	93	78	2.2	41.0	2.8	20	c–3.3	eb
Sooty flycatcher	*Muscicopa sibirica*	BM		2	31	44						c–3.3	cb
Rufoustailed flycatcher thrush	*Muscicapa ruficouda*	BM	1	7	1	68	77	2.7	13.3	0.8	15	c–3.2	cb
Kashmir redbreasted	*Muscicapa subrubro*	BM		8	0	81	67.5	2.2	10.5	0.9	19	c–3	e
Whitebrowed blue flycatcher	*Muscicapa superciliaris*	BM	2	6	24	75	63	2.2	8.7	0.3	15	c–3.3	ec
Staty blue flycatcher	*Muscicapa leucomelonura*	BM	2	30	56	90	58	2.9	7.7	0.6	57	c–3.3	ebc
Verditer flycatcher	*Muscicopa thalassina*	SM	0	4								c	
Strongfooted bush warbler	*Cettia fortipes*	BM		4	8	94	56	2.9	10.4	0.7	8	c–3.1	e
Tytler's leaf warbler	*Phylloscopus tytleri*	BM	3	5	74	76	57	2.2	7.2	0.5	30	c–3.3	eb
Tickell's leaf warbler	*Phylloscopus offinis*	BM			69	4	56	1.9	6.7	0.6	5	3.4–	j
Orangebarred leaf warbler	*Phylloscopus pulcher*	BM	5		70	0	56	2.7	6.5	0.5	6	3.3–3.5	r
Hume's yellowbrowed	*Phylloscopus inornatus*	BM	67	5	97	49	56	2.5	6.0	0.4	228	c–3.5	eb
Pallas's leaf warbler	*Phylloscopus proregulus*	BM	7	47	77	93	51	2.8	5.1	0.5	166	c–3.3	c
Largebilled leaf warbler	*Phylloscopus magnirostris*	BM		3	54	55	68	3.3	10.0	1.2	12	c–3.2	w
Greenish leaf warbler	*Phylloscopus trochiloides*	BM	4		62	16	63	3.2	8.3	0.7	16	3.3–3.5	b
Large crowned leaf warbler	*Phylloscopus occipitalis*	BM	6	31	91	99	65	3.0	8.7	0.6	101		
Goldcrest	*Regulus regulus*	B	2	1	21	10	53	5.0			3	c–3.3	c
West Himalayan rubythroat	*Erithacus pectoralis*	PM			37	1	74	22.5			1	3.4	j

Species	Scientific name	Status	Ringing		Observation		Wing (mm)		Weight (g)		Sample	Altitude range	Habitat
			high	low	high	low	X	Sd.	X	Sd.	size	m (x 1,000)	
Blue chat	*Erithacus brunneus*	BM		29	42	94	75	2.0	16.9	1.5	68	c–3.4	cb
Redflanked bush robin	*Erithacus cyanurus*	BM	20	16	97	18	78	2.9	13.5	0.9	69	3–3.5	cb
Blueheaded redstart	*Phoenicurus caeruleocephalus*	PM			2	0						3.4	b
Bluefronted redstart	*Phoenicurus frontalis*	BM		28	0						3–3.5	bu	
Plumbeous redstart	*Rhyacornis fuliginosus*	B		2	0	70	77		17.7		1	c–2.7	w
Hodgson's shortwing	*Hodgsonius phoenicuroides*	BM			23	3						3.2–3.5	bj
Little forktail	*Enicurus scouleri*	PM			0	5						c–2.9	w
Spotted forktail	*Enicurus maculatus*	PM			0	40						2.9	
Whitecapped redstart	*Chaimarrornis leucocephalus*	BM			13	25						2.8–3.1	w
Blueheaded rock thrush	*Monticola cinclorhynchus*	BM		2	0	43	100	2.1	35.0	2.3	8	c–2.8	c
Chestnutbellied rock thrush	*Monticola rufiventris*	BM			4	0						3.2–3.4	cb
Himalyan whistling thrush	*Myiophonus caeruleus*	BM		1	57	83	167		167.0		1	c–3.3	w
Plainbacked mountain thrush	*Zoothera mollissima*	PM			9	0						3.4–3.7	bu
Smallbilled mountain thrush	*Zoothera dauma*	BM			19	0						3–3.2	c
Blackbird	*Turdus merula*	B			10	0	146		103.0		2	3.5–3.7	u
Greyheaded thrush	*Turdus rubrocanus*	B		1	83	28	137				1	c–3.4	cb
Wren	*Troglodytes troglodytes*	B	7		95	9	47	1.8	8.4	0.6		3–3.7	cbu
Brown dipper	*Cinclus pallasii*	B			0	31						c–2.8	w
Rufousbreasted accentor	*Prunella strophiata*	B	23		89	0	67	2.6	16.0	1.1	37	3.2–3.7	bu
Grey tit	*Parus major*	B		8	0	76	71	3.7	14.9	1.2	13	c–28	ebc
Greenbacked tit	*Parus monticolus*	B		19	0	63	68	2.9	13.4	1.1	31	c–2.8	ebc
Crested black tit	*Parus melanolophus*	B	14	9	89	70	63	2.5	9.0	1.3	3	c–3.3	ebc
Simla black tit	*Parus rufonachalis*	B	3	2	30	34	72	2.3	13.8	1.3	6	c–3.3	cb
Rufous bellied crested tit	*Parus rubidiventris*	B	3		6	0	71		13.1		2	3.3–3.5	b
Firecapped tit	*Cephalopyrus flammiceps*	BM			16	25	56		8.0		1	c–3.3	eb
Whitethroated tit	*Aegithalos niveogularis*	B	2		41	0	59		7.8		3	3.2–3.5	b

Species	Scientific name	Status	Ringing high	Ringing low	Observation high	Observation low	Wing (mm) X	Wing (mm) Sd.	Weight (g) X	Weight (g) Sd.	Sample size	Altitude range m (x 1,000)	Habitat
Kashmir nuthatch	*Sitta europaea*	B			0	31						c–2.8	c
Whitecheeked nuthatch	*Sitta leucopsis*	B	1		29	6	76		14.4		1	c–3.3	c
Kashmir tree creeper	*Certhia familiaris*	B	1		65	0	58		7.6		3	3.2–3.5	cb
Himalayan tree creeper	*Certhia himalayana*	B		3	0	76	69	2.4	9.3	0.4	6	c–3.2	c
Vinaceousbreasted pipit	*Anthus roseatus*	BM			16	0						3.5–	u
Grey wagtail	*Motacilla caspica*	BM		1	0	76	79		15.7		3	c	
Cinnamon tree sparrow	*Passer rutilans*	BM			0	69	70		18.0		1	c	b
Black–and–yellow grosbeak	*Mycerobas icterioides*	B	2		83	51	134		67.0		2	c–3.7	cbu
Whitewinged grosbeak	*Mycerobas carnipes*	P			0	0	116		60.0		1	3.7	u
Redbrowed finch	*Callacanthis burtoni*	B			5	0						2.8–3.7	ebu
Plaincoloured mountain finch	*Leucosticte nemoricola*	B	3		36	0	93.4	2.6	19.1	0.9	8	3.5–	u
Dark rosefinch	*Carpodacus nipalensis*	H		0	0	91		19.8			1	3.7	u
Pinkbrowed rosefinch	*Carpodacus rhodochrous*	B	22	2	77	14	70	1.7	17.7	1.0	38	c–3.7	bu
Whitebrowed rosefinch	*Carpodacus thura*	P	3		9	0	84	3.8	26.7	4.2	7	3–3.7	bu
Orange bullfinch	*Pyrrhula aurantiaca*	B	3		47	25	80	1.3	17.9	0.8	7	3.2–3.5	b
Rock bunting	*Emberiza cia*	B		3	7	51	82	3.4	20.8	1.2	5	c–3.2	g

Status: B–proven breeding by locating nest or recently fledged young. P–breeds, but definitive proof lacking. H–likely to breed at rarely visited higher altitudes (3,700 m). S–singing male noted on 3 occasions, but no evidence of breeding. M–indicates that the species vacates the altitudes covered by the sanctuary completely in winter, according to Ali and Ripley (1983).

Observation: Proportion of days on which species observed at the high altitude camps combined (*c.* 3300 m) (N=224 days) and low altitude camp (*c. 2400 m*) (*N=80 days*).

Ringing: Capture rate (birds/net/day x 100) at the highaltitude (N = 119 net–days) and low altitude (N=130 net days) camps. 1075 individuals were captured in total.

Wing–length and weight means and standard deviations are based on the sample sizes shown in the neighbouring column. Standard deviations are only presented for species with more than three individuals measured.

Altitudinal range: The lowest and highest elevations at which birds were seen during the breeding season (in 1000's of metres). c– occurs to the lower sanctuary limit.

Habitat: b–deciduous (i.e. birch when above *c.* 3100 m). c– coniferous. e–ecotonal (coniferous–decidous). u–above tree–line, including juniper. j–juniper. r–rhododendron w–along watercourses. g–grasslands.

No species name is given for *Buteo* because of difficulties of identification (Ali and Ripley 1983).

Species	Scientific name	Status	Ringing high	Ringing low	Observation high	Observation low	Wing (mm) X	Wing (mm) Sd.	Weight (g) X	Weight (g) Sd.	Sample size	Altitude range m (x 1,000)	Habitat
Blue chat	*Erithocus brunneus*	BM		29	42	94	75	2.0	16.9	1.5	68	c–3.4	cb
Redflanked bush robin	*Erithocus cyanurus*	BM	20	16	97	18	78	2.9	13.5	0.9	69	3–3.5	cb
Blueheaded redstart	*Phoenicurus caeruleocepholus*	PM			2	0						3.4	b
Bluefronted redstart	*Phoenicurus frontalis*	BM		28	0						3–3.5	bu	
Plumbeous redstart	*Rhyacornis fuliginosus*	B		2	0	70	77		17.7		1	c–2.7	w
Hodgson's shortwing	*Hodgsonius phoenicuroides*	BM			23	3						3.2–3.5	bj
Little forktail	*Enicurus scouleri*	PM			0	5						c–2.9	w
Spotted forktail	*Enicurus maculatus*	PM			0	40						2.9	
Whitecapped redstart	*Chaimarrornis leucocephalus*	BM			13	25						2.8–3.1	w
Blueheaded rock thrush	*Monticola cinclorhynchus*	BM		2	0	43	100	2.1	35.0	2.3	8	c–2.8	c
Chestnutbellied rock thrush	*Monticola rufiventris*	BM			4	0						3.2–3.4	cb
Himalyan whistling thrush	*Myiaphonus caeruleus*	BM		1	57	83	167		167.0		1	c–3.3	w
Plainbacked mountain thrush	*Zoothera mollissima*	PM			9	0						3.4–3.7	bu
Smallbilled mountain thrush	*Zoothera dauma*	BM			19	0						3–3.2	c
Blackbird	*Turdus merula*	B			10	0	146		103.0		2	3.5–3.7	u
Greyheaded thrush	*Turdus rubrocanus*	B		1	83	28	137				1	c–3.4	cb
Wren	*Troglodytes troglodytes*	B	7		95	9	47	1.8	8.4	0.6		3–3.7	cbu
Brown dipper	*Cinclus pallasii*	B			0	31						c–2.8	w
Rufousbreasted accentor	*Prunella strophiata*	B	23		89	0	67	2.6	16.0	1.1	37	3.2–3.7	bu
Grey tit	*Parus major*	B		8	0	76	71	3.7	14.9	1.2	13	c–28	ebc
Greenbacked tit	*Parus monticolus*	B		19	0	63	68	2.9	13.4	1.1	31	c–2.8	ebc
Crested black tit	*Parus melanolophus*	B	14	9	89	70	63	2.5	9.0	1.3	3	c–3.3	ebc
Simla black tit	*Parus rufonachalis*	B	3	2	30	34	72	2.3	13.8	1.3	6	c–3.3	cb
Rufous bellied crested tit	*Parus rubidiventris*	B	3		6	0	71		13.1		2	3.3–3.5	b
Firecapped tit	*Cephalopyrus flammiceps*	BM			16	25	56		8.0		1	c–3.3	eb
Whitethroated tit	*Aegithalos niveogularis*	B	2		41	0	59		7.8		3	3.2–3.5	b

Species	Scientific name	Status	Ringing high	Ringing low	Observation high	Observation low	Wing (mm) X	Wing (mm) Sd.	Weight (g) X	Weight (g) Sd.	Sample size	Altitude range m (x 1,000)	Habitat
Kashmir nuthatch	*Sitta europaea*	B			0	31						c–2.8	c
Whitecheeked nuthatch	*Sitta leucopsis*	B	1		29	6	76		14.4		1	c–3.3	c
Kashmir tree creeper	*Certhia familiaris*	B	1		65	0	58		7.6		3	3.2–3.5	cb
Himalayan tree creeper	*Certhia himalayana*	B		3	0	76	69	2.4	9.3	0.4	6	c–3.2	c
Vinaceousbreasted pipit	*Anthus roseatus*	BM			16	0						3.5–	u
Grey wagtail	*Matacilla caspica*	BM		1	0	76	79		15.7		3	c	
Cinnamon tree sparrow	*Passer rutilans*	BM			0	69	70		18.0		1	c	b
Black-and-yellow grosbeak	*Mycerobas icterioides*	B	2		83	51	134		67.0		2	c–3.7	cbu
Whitewinged grosbeak	*Mycerobas carnipes*	P		–	0	0	116		60.0		1	3.7	u
Redbrowed finch	*Callacanthis burtoni*	B			5	0						2.8–3.7	ebu
Plaincoloured mountain finch	*Leucosticte nemoricola*	B	3		36	0	93.4	2.6	19.1	0.9	8	3.5–	u
Dark rosefinch	*Carpodacus nipalensis*	H		0	0	91		19.8			1	3.7	u
Pinkbrowed rosefinch	*Carpodacus rhodochrous*	B	22	2	77	14	70.	1.7	17.7	1.0	38	c–3.7	bu
Whitebrowed rosefinch	*Carpodacus thura*	P	3		9	0	84	3.8	26.7	4.2	7	3–3.7	bu
Orange bullfinch	*Pyrrhula aurantiaca*	B	3		47	25	80	1.3	17.9	0.8	7	3.2–3.5	b
Rock bunting	*Emberiza cia*	B		3	7	51	82	3.4	20.8	1.2	5	c–3.2	8

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No species name is given for *Buteo* because of difficulties of identification (Ali and Ripley 1983).

high and low altitudes was similar (2.24 per net per day and 2.70 per net per day respectively), and at each locality 51 species were thought to breed. However only 26 species were held in common between the two sites (Table 5). There is therefore substantial turnover of species along the altitudinal gradient. Both the high and low altitudes are predominantly woodland: the former mostly birch and the latter mostly conifers. Above the tree line 26 species breed, i.e. species diversity is half that of the wooded areas, and this presumably reflects the loss of structural habitat diversity. Many of the species breeding above the tree line are unique to this area (Table 5) and only two species (the pinkbrowed rosefinch *Carpodacus rhodochrous* and the black–and–yellow grosbeak *Coccothroustes ictirioides* breed across the entire altitudinal range.

Based on shorter surveys at intermediate altitudes we are able to assess the altitudinal range of each species to within 100 m (Table 4). Some species are habitat specialists (e.g. the yellowbrowed leaf warbler in birch, the rubythroat *Erithacus svecicus* in juniper) whereas others respond more to altitude than habitat (e.g. the wren which can be found breeding among high altitude scrub, or in coniferous forest, but does not occur below *c*. 3,000 m).

Migration: Individuals of many species probably leave the Sanctuary extent during the winter. In the status column of Table 4 we list those species which vacate the area totally. According to Ali and Ripley (1983), they form 49% (44 species) of all the species. Many of these species are present in the Sanctuary by May. However, some arrive later than this, and their arrival times are recorded in Table 6. In addition to annual migration there are temporary altitudinal movements due to inclement weather. Thus although the redflanked bush robin *Erithacus cyanuew* was recorded commonly at low altitude in May it does not breed there. Single individuals of this species, the large crowned leaf warbler, *Phylloscopus occipitalis* and the Tytler's leaf warbler *Phylloscopus tytleri* were ringed in May at the low altitude, and subsequently observed in June at higher altitudes. The rosefinches and the plaincoloured mountain finch *Leucosticte nemoricola* are common in May at the high altitude locality, but they largely breed still higher, above the treeline. At least one species, the yellowbrowed leaf warbler, appears to undergo a regular diurnal migration in May, spending the early morning displaying at its future breeding location, and the rest of the day at lower altitudes (Price and Jamdar, *in preparation*).

Breeding Seasons: Our information on the timing of breeding agrees with that of Ali and Ripley (1983). Most species begin building nests in May, and breeding is complete by the middle of July. Documented exceptions are the black–and–yellow grosbeak, the woodcock *Scolopax rusticola* and smallbilled mountain thrush *Zoothera dauma* all of which were observed with fledged young in May, and the redbrowed finch *Callacanthis burtoni* observed nest building in late July.

Comparisons with other localities: Kedarnath Sanctuary lies in the Himalayas of Uttar Pradesh, *c*. 500 km to the southeast of Overa. Green (1986) has recently provided a species list based on three years of casual observation in the Sanctuary. Excluding observations limited to one or two sightings he recorded 101 species as breeding above *c*. 2,400 m compared to the 89 we recorded at Overa. Of the 101 species 54 are also found at Overa. Hence 39% (35 species) of those observed at Overa do not appear to regularly breed at these altitudes at Kedarnath (one of the Overa species was recorded at a lower altitude). This suggests that some species have restricted ranges, and there may be a number of endemics to Kashmir, for which reserves such as Overa could be extremely important.

The results on bird abundance can be compared with a similar study in the tropics, at a dry deciduous forest site in Andhra Pradesh, *c*. 1900 km to the south and at an elevation of 2,300 m (Price 1979). Here 58 species were found to breed at a single forest locality (excluding hawks, owls and other large non–Passerines, (Price 1979). The comparable figures from Overa are 47 species at the low altitude site (including three watercourse species) and 42 species at the high altitutde site. The Kashmir totals are 20–25% lower than those from Andhra. Two species (the blackbird and jungle crow) are held in common between the sites, but both have distinctive subspecies in each area. Total bird density during the breeding season at the Andhra site lies between 0.5 and 1.5 birds per net per day (Fig. 8 of Price 1979), and thus appears to be lower than in Kashmir. The trend of more species

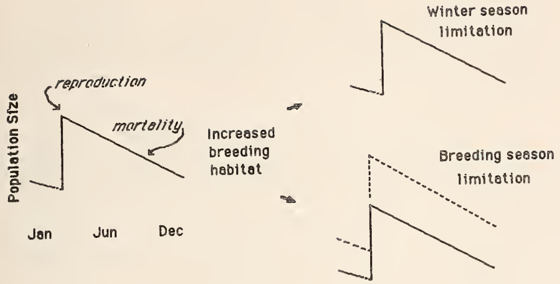

Fig. 4. The effect of increasing, or conserving, breeding season habitat depends on the manner of population regulation. If the population size is mostly regulated by availability of winter season habitat, and density dependent mortality, the increased availability of breeding habitat may have little effect on population size (upper right figure). If the population is mainly affected by density dependent reproductive success, and mortality factors are largely density independent, increased availability of breeding habitat may be very important (lower right figure).

in tropical areas appears to be a general phenomenon (Karr 1971), but bird densities have been rarely compared in this manner.

Discussion

Kashmir's sanctuaries have been established for a number of reasons, one of the more important being species preservation. In this paper we have been concerned with providing as complete a list as possible of bird occurrence and abundance in specific habitats in one sanctuary. We now use this information to assess the suitability of the sanctuary. We now use this information to asssess the suitability of the sanctuary as a wildlife (particularly bird) preserve. First we ask if the Sanctuary is large enough to maintain breeding populations of all species. Second, we discuss the impact of surrounding agricultural land on the Sanctuary. These are questions generally considered in conservation discussions (Gilpin and Soule 1987, Janzen 1987, Wilcove *et al.* 1987). There is concern over loss of habitat in Kashmir (Oza 1980, 1985) and in the Western Himalayas in general (Gaston *et al.* 1981), and several studies in both temperate and tropical regions have shown that loss of Passerine birds occurs as habitat becomes fragmented (Diamond 1984, Wilcove 1985, Blake and Karr 1987). Finally, we consider the extent to which bird populations are limited by the availability of breeding habitat (cf. mortality outside the breeding season). This question is less often considered because it is specific to migratory populations in temperate reserves (as are most of the birds in this Sanctuary).

Sanctuaries are often established with a view to preserving one or two prominent (usually mammalian) species in their natural habitat. One goal of this sanctuary is to conserve large mammals – the black bear *Selenarctos tibetanus*, brown bear *Ursus isabellinus*, hangul *Cervus elaphus* and musk deer *Moschus moschiferus*. Because of its small size, in isolation, the Sanctuary cannot support viable populations of these species. Indeed, although the black bear breeds, it is not clear that the other three species are resident in the Sanctuary. Tracks of hangul and musk deer regularly observed but we have sighted these species and the brown bear on one or two occasions only. The Sanctuary has connections with the much larger Dachigam Sanctuary (*c.*25 km over high altitude pasture land which is uninhabited for much of the year). It therefore acts as an important extension to Dachigam, and will continue to do so if animals do pass between the two protected areas (the extent to which this occurs needs to be established). The value of Overa as a large mammal preserve depends on it not being isolated, and is one of the strongest arguments for the establishment of a biosphere reserve which includes and extends the Sanctuary.

Similar arguments can be made for many of the bird species. Critical population sizes for long term preservation vary with the species but are likely to be greater than several hundred individuals (Soule 1987). Many of the larger species (including the two species of pheasants) would have far less than viable populations if confined to the sanctuary by surrounding areas of unfavourable habitat. Indeed the range of a single pair of golden eagles *Aquila chrysaetos* may be greater than the area covered by Sanctuary. Barriers for bird species may be less formidable than for the mammals. Although some tropical bird species are known to be poor dispersers (Diamond 1980, Karr 1982) many temperate species should have high dispersal rates, since they vacate the sanctuary in winter. Hence exchange between other areas of similar habitat may occur reasonably frequently (the pheasants may be an exception, but this is not known). Since sanctuary size may also affect bird populations through the loss of plants and insects on which they depend, it is clear that the proximity of neighbouring similar habitats will be an important factor in maintaining the flora and fauna of the Sanctuary.

One side of the Sanctuary is bordered by permanent human habitation and people live on the other three sides during the summer months. This may affect the Sanctuary in two ways (Janzen 1987): through loss of individuals which emigrate to unsuitable habitats and through immigration of undesirable elements. The extent to which this is going on needs to be critically assessed, but we noted three aspects of concern. First, there is inevitable encroachment of cattle in the border areas of the Sanctuary, although the central area is kept free of domestic animals. Nevertheless illegal grazing is having a noticeable effect in slowing the recovery of the flora from the days before it was a Sanctuary. In the New World tropics understorey grazing has been shown to adversely affect species diversity (Martin 1974). Second, during our studies of leaf warblers (Price and Jamdar, *in preparation*) we noted intense nest predation due to crows. Some of this predation was undoubtedly due to the crows observing us as we visited nests, and then raiding the nest after we departed but it is likely that crows are at a higher density in the Sanctuary than they would be in the absence of human habitation surrounding it. Recent research on North American songbirds has identified increased nest predation by crows as a cause of decline of several species (Wilcove 1985). A management programme would be justified. Third, there is a danger of forest fires initiated by shepherds. One such fire, consuming several large trees, was observed in May 1985.

India is unique in that it harbours both important breeding and wintering areas for temperate zone migrants. Many considerations will enter into the setting up of any new reserves in the country. Here we ask where they would best be sited if maximizing the survival probability of migratory species was an important goal. The answer depends on where population regulation is most severe (Fig. 4). If populations are most severely regulated by the availability of winter habitat, then clearly a Sanctuary in the wintering grounds would be of more value. On the other hand, suitability of suitable breeding habitat may severely limit reproductive output of a species.

Temperate passerines are subject to density–dependent effects on both reproduction and survival (Lack 1966, Perrins 1979, Arcese and Smith 1987). The prevailing view has been that winter mortality is of prime importance in affecting population size for migrant species. This has been supported by studies in Europe on the cause of recent declines in migratory species (attributable to droughts in the sub–Saharan regions, Winstanley *et al.* 1974, Sims 1985), as well as studies of migrant birds in the winter season (Keast and Morton 1980, Price 1981). However, recent research on North American passerines has suggested that nest predation (i.e. breeding season mortality) due to crows etc. encroaching from surrounding arable land may account for a decline in migratory birds (Wilcove 1985, Wilcove *et al.* 1987).

The evidence suggests that for Himalayan migrants winter mortality may be the prime determinant of population size. First, according to Gaston (1984) several species of small passerine bird are now threatened in the plains of India as a result of habitat loss, but none of these are species breeding in the temperate regions of the Himalayas of Himachal Pradesh. This suggests that a shortage of some habitats may be becoming critical in the plains: these are the wintering grounds for many migrant species. Second, the total area available for over–wintering East Asian birds is severely restricted when compared with species breeding in Europe and North America. Third, the conclusion that food shortage in the winter is a major cause of migrant mortality has been supported by a detailed study in South India (Price 1979, 1981).

If the above reasoning is correct we should find species absent from apparently suitable breeding habitat, and a low density of breeding pairs, as indicated by lack of contiguity of territories. Many species do seem to follow this pattern. In addition to those listed in Appendix 2, which are so scarce in the Sanctuary as to be of uncertain status, more individuals of virtually every species that vacates the Sanctuary in winter may be able to breed in the reserve. Some of the best examples of species with low density in apparently suitable habitat are the bluefronted redstarts *Phoenicurus frontalis*, blueheaded redstarts *Phoenicurus caeruleocephalus*, and the chestnutbellied rock thrush *Monticola rufiventris* (which migrate to the Himalayan foothills and adjoining plains) and the rubythroat, smallbilled mountain thrush, blueheaded rock thrush *Monticola cinclorhynchus* and firecapped tit *Cephalopyrus flammiceps* (which are long distance migrants). The clearest exceptions are the yellowbrowed leaf warbler, the large crowned leaf warbler, the blue chat *Erithacus brunneus* and the redflanked bush robin. These four species, which are at very high density in the Sanctuary, appear to overwinter successfully, and may well benefit from increased breeding habitat. But the overall conclusion is that wintering habitats are in more acute short supply than breeding habitats. Of course, for the resident fauna and flora Overa provides an important year–round Sanctuary.

Our suggestion that there is an excess of breeding habitat for many migratory species needs to be qualified for at least three reasons, which should be further investigated. First, there are few studies of the breeding requirements for any species. Subtle aspects of the habitat may make superficially suitable areas unoccupiable, as we have shown for some species of *Phylloscopus* warblers (Price and Jamdar, *in preparation*). Second, if an area of suitable is isolated it may not be discovered by returning migrants, and hence habitat remains unoccupied. Third, the territory itself may not provide all the requirements for a breeding pair. We have shown that habitat at lower altitudes is necessary for many species which retreat there during inclement weather. Thus preservation of high altitude species requires preservation of habitats over a broad altitudinal range, and not just at high altitudes. This should be an important consideration in reserve management.

Two essential pieces of information are missing in any assessment of the value of this Sanctuary. First, are there specially threatened species for which the Sanctuary may be of particular importance? In the absence of quantitative information from elsewhere in Kashmir this is unknown (indeed in this study we recorded several species not previously known to occur in the area), but there may well be Kashmir endemics with severely restricted ranges. Second, are species disappearing from the Reserve? The answer to this question is obviously needed if we are to assess ways to prevent any loss. We hope this paper will provide the baseline against which further surveys can be measured.

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APPENDIX 1
SPECIES WHICH PRIMARILY OCCUR ALONG THE SANCTUARY'S LOWER BOUNDARY

Species	Scientific name	Ringing		Observation	
		high	low	high	low
Black–eared kite	*Milvus migrans*			0	24
Roller	*Coracias garrulus*			0	0
Hoopoe	*Upupa epops*			0	68
Wryneck	*Jynx torquilla*			1	14
Swallow	*Hirundo rustica*			0	9
Rufousbacked shrike	*Lanius schach*			0	15
Indian myna	*Acridotheres tristis*			0	6
·Jackdaw	*Corvus monedula*			0	0
Whitecheeked bulbul	*Pycnonotus leucogenys*		1	0	24
Collared bush chat	*Saxicola torquata*			0	40
Dark–grey bush chat	*Saxicola ferrea*		1	0	54
White wagtail	*Motacilla alba*			0	29
House sparrow	*Passer domesticus*			0	40
Goldfinch	*Carduelis carduelis*			0	14
Greenfinch	*Carduelis spinoides*		1	0	15
Greyheaded bunting	*Emberiza fucata*			0	18

Notes: See notes to Table 4 for explanation. The observation column includes observations made just outside the sanctuary.

APPENDIX 2
SPECIES RECORDED EXTREMELY RARELY IN THE SANCTUARY

Species	Scientific name	Ringing		Observation	
		high	low	high	low
Booted hawk–eagle	*Hieraaetus pennatus*			2	0
Common sandpiper	*Tringa hypoleucos*			0	1
Snow pigeon	*Columba leuconota*			2	0
Speckled wood pigeon	*Columba hodgsonii*			*	0
Slatyheaded parakeet	*Psittacula himalayana*			0	*
Grey drongo	*Dicrurus leucophaeus*			0	1
Blackbrowed fly–catcher–warbler	*Seicercus burkii*		1	0	1
Magpie robin	*Copsychus saularis*			0	1
Alpine accentor	*Prunella collaris*			1	0
Witherby's tree Pipit	*Anthur trivialis*			*	0
Whitecapped bunting	*Emberiza stewarti*			0	1

See Table 4 for explanation.
*indicates that the species was recorded only once

NOTES ON ESTABLISHED EXOTIC TREES FROM WESTERN GHATS OF MAHARASHTRA[1]

VINAYA S. GHATE AND V.D. VARTAK[2]

A large number of plants have been brought to the areas of Western Ghats of Maharashtra mostly by foreigners right from the days of the Greeks (327 BC.) to modern times. Many such introductions got acclimatized/established in the original flora of the area and now constitute important elements of the present day flora. It is difficult to identify such naturalized species from the original flora on account of their wide distribution and occurrence in the wild. This category of plants needs critical taxonomic investigations. This paper accounts for 35 such established exotic trees having common occurrence and wide distribution. Details regarding the country of origin, probable date or period of introduction and remarks on their establishment and spread have been presented.

INTRODUCTION

The Western Ghats of Maharahstra (15°75' to 21°00' N, 72°75' to 75°00' E) have a peculiar terrain. The eastward sloping terraced plateau, *Desh*, separated from the coastal strip, *Konkan* by the *Western Ghats* or the *Sahyadri*. The local climatic factors coupled with edaphic and geographical features influence the growth and prevalence of vegetation. The flora of the region thus shows diversity and adaptability to the varied climatic conditions.

The same adaptability features of the flora also provide habitat to the exotic elements. A large number of exotic plants were introduced in the area from prehistoric times, either by natural agencies like sea currents or brought by foreign traders or invaders for betterment of human life. The introduction of species, their suitability to the region and spread through natural regeneration accommodated them in the original set of floristic elements. They now grow naturally along with the original elements in such a way that it becomes difficult to trace their regions of origin. Such species sometime create problems for describing the original flora of a region (Chatterjee 1939, 1962; Maheshwari 1962).

Earlier botanists like Cooke (1903–1908), Talbot (1909–1911), Santapau (1953) and others, while describing the flora of this region, intermixed the naturalized exotics with the original flora, separating commonly cultivated exotic species. The systematic studies on these established exotic elements as attempted by Matthew (1969), Maheshwari and Paul (1975) and Sharma and Pandey (1984) are lacking for the study area. The project, therefore, was undertaken to evaluate naturalized exotic trees in isolation from the natural flora.

MATERIAL AND METHODS

The species which, following their immigration or introduction during prehistoric times or in the recent past, became naturalized in the wild flora, have been considered for the present study.

35 established exotic trees having common occurrence and wide distribution in the study area have been described in Table 1. The table includes data on place of origin, probable date of introduction and remarks on their establishment, spread and utility attributes. The data on country of origin have been adopted from Brandis (1906), Bailey (1949), Maheshwari and Paul (1975) and Sharma and Pandey (1984). It may be also mentioned that the time of introduction of species in many cases is difficult to determine, as exact records of their introduction are lacking (Table 1).

DISCUSSION

The flora of an area, its nature, distribution and association of the species, is more or less dependent on peculiarities of terrain and the climatic conditions. Exotics on the other hand are the introductions from abroad. Their survival, growth and spread depend on the suitability of the habitat and adaptability of the species. Some introductions remain restricted, survive in patches and do not grow unless and until specially planted. These isolates, according to Mahabale (1973), are secondary endemics. Some introductions on the other extreme become obnoxious weeds by prolific adaptability. These may be referred to as cosmopolitan species. Some species, however, grow fast, regenerate on their own and find a suitable niche in the natural flora as if they are the natural elements of the region.

The rate of introduction of foreign plants, particularly of the trees, was accelerated in 17th, 18th and early 19th centuries by Portuguese traders and

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European explorers. They brought many plants of economic value, particularly fruit trees and ornamental trees.

In many cases it is difficult to determine the centres of origin as the regions and routes are imperfectly studied. It is particularly true in the case of prehistoric introductions like *Areca catechu*, *Azadirachta indica*, *Borassus flabellifer*, *Cocos nucifera*, *Plumeria rubra* forma *acutifolia*, *Sesbania grandiflora* and *Tamarindus indica*. As per available literature (Brandis 1906, Bailey 1949, Anonymous 1957, Randhawa 1958, 1965 and Santapau 1966) the centres of origin of these species are either doubtful or in alien countries. In agreement with these workers and in view of this uncertainty about the native place, these species are considered as exotics in the present study. The introduction and naturalization of these species is so ancient that they have a great importance in Indian religion and folklore. The task of assigning the original habitat for such species is a formidable one.

Introduction of trees is mostly man--made. However, wide and wild occurrence of species like *Areca catechu*, *Borassus flabellifer* and *Cocos nucifera* along sea coast suggest the probability of their introduction naturally through sea currents and similarity of climate to that of the original home. Now varieties of *Areca catechu* and *Cocos nucifera* also have been developed for inland plantations.

Species like *Anacardium occidentale*, *Ficus carica*, *Manilkara zapota*, *Phyllanthus acidus*, *Psidium guajava* and *Punica granatum* were brought as fruit yielding trees mostly by Portuguese traders in the 16th and 17th centuries. They became naturalized in various regions of the area under study as if they were native to the regions. These regions, namely Konkan for cashewnut (kaju), Gholwad (Thana district) for sapodilla plum (chiku), Bhor–Junnar (Pune district) for fig (anjir) and Ahmednagar district for pomegranate (dalimba), are now important trade centers for commercial production of these fruits. Species like *Phyllanthus acidus* and *Psidium guajava* become so popular that they are present in every home garden.

Species like *Cassia renigera*, *C. siamea*, *Delonix regia*, *Peltophorum pterocarpum*, *Polyalthia longifolia* and *Samanea saman* were introduced as ornamental horticultural trees by European explorers. These novelty introductions now rank first in any plantation programme.

Trees like *Casuarina equisetifolia*, *Eucalyptus globosus*, *Euphorbia tirucalli*, *Leucaena leucocephala*, *Parkinsonia aculeata*, *Pithecellobium dulce* and *Ricinus communis* were introduced and naturalized in connection with soil conservation and afforestation programmes of dry and arid areas. These species are now commonly adopted by forest department in various plantation programmes and have thus become common. Among these successful species, *Euphorbia tirucalli*, *Parkinsonia aculeata*, *Pithecellobium dulce* and *Ricinus communis* proved more adaptable and now occupy any type of habitat including waste lands.

As stated earlier, introductions of trees were mostly man–made. The case of invasion of tree species by accident is not on the record so far as in case of herbaceous weeds (*Parthenium*, *Acanthospermum* etc.). Adaptability features of these introduced species have made them naturalized in the region. However, some of the 35 established species, namely *Areca catechu*, *Cassia javanica*, *C. renigera*, *Casuarina equisetifolia*, *Cocos nucifera*, *Delonix regia*, *Eucalyptus globosus*, *Plumeria rubra* forma *acutifolia*, *Polyalthia longifolia* and *Swietenia mahogani*, do not show self generation in spite of their wide occurrence in the area under study.

In general these naturalised exotic elements are the new ecological isolates. They provide rich potential for research in terms of their adaptability and suitability in varied climatic conditions.

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TABLE 1
ESTABLISHED EXOTIC TREES FROM WESTERN GHATS OF MAHARAHSTRA

Sr. No.	Botanical name (common name)	Nativity/probable date of introduction	Remarks
1.	*Adansonia digitata* L. (Gorakh chinch)	Tropical Africa/ Mughal period	Introduced by Arab traders and Africans employed in Mughal army. Considered to be one of the longest living trees.
2.	*Anacardium occidentale* L. (cashewnut, kaju)	Brazil, South Tropical America, West Indies/ 16th century	Introduced in India by the Portuguese from Brazil. Naturalized all along the west coastal regions of India and forms an important export crop.
3.	*Anona reticulata* L. (bullock's heart, ramphal)	West Indies, Tropical Africa/ Last quarter of 17th century.	Introduced in India for its edible fruit. Now completely naturalized and run wild.
4.	*A. squamosa* L. (custard apple, sitaphal)	West Indies, Tropical America/16th century	One of the first American plants introduced by Portuguese for its edible fruits. Now naturalized and run wild.
5.	*Areca catechu* L. (betel nut, supari)	Nativity doubtful, Malaya/prehistoric period.	Naturalized and cultivated in coastal areas. Also grown inland. Important article of trade.
6.	*Azadirachta indica* A.Juss.(margose tree, neem)	Burma, Asia Minor/ prehistoric period	Naturalized and wild throughout. Natural regeneration plenty. Controversy about the nativity as well as period of introduction.
7.	*Borassus flabellifer* L (tad)	Tropical Africa/ prehistoric times	Naturalized and self-sown throughout coastal regions. Locally used variously.
8.	*Carica papaya* L. (papaya)	Tropical America/ 16th century.	Introduced in India by Portuguese for edible fruits. Naturalized and self-sown throughout the area.
9.	*Cassia javanica* Aubl. (Java cassia)	Java and Sumatra/ probably after 1845.	Introduced in the India first in botanic gardens probably by the British for its ornamental flowers.. Naturalized and now used commonly for avenue plantations.
10.	*C.renigera* Wall. (Burmese pink cassia)	Burma/Late 17th century	Introduced for beautification. Naturalized and very commonly used for avenue plantation.
11	*C. siamea* Lam. (kassod, PWD Tree)	Burma, South East Tropical Asia/ 18th century	Introduced in India, probably by the British, as fast growing ornamental tree, popularized as P.W.D. tree for its common use in roadside plantations.
12.	*Casuarina equisetifolia* Forst, (suru)	Malay, Andaman, Archipelago, Australia/ Late 17th century	Introduced in India probably by the British, as fast growing forest species. Naturalized and cultivated mainly along coastal sandy areas and also inland for ornamentation.
13.	*Cocos nucifera* L. (naral)	Nativity doubtful, said to be native of Cocos Island, Melanesia/ Prehistoric times.	Introduced and wide-spread in coastal areas, appears as if growing wild. Cultivated for its multi-utilitarian attributes.
14.	*Delonix regia* (Hook.f.) Raf. (gulmohar)	Madagascar/About 1840.	Introduced in India probably by the British for its ornamental flowers. Naturalized and now popular as roadside tree.
15.	*Eucalyptus globosus* Labill (Nilgiri) species.	Victoria, Tasmania/1843.	Introduced in India as fast growing timber species. First introduced in hilly areas of Nilgiris, naturalized and spread throughout the country by man.
16.	*Euphorbia tirucalli* L (milk bush, pardeshi thor, shend	East Africa, Ceylon/ probably before 1814	Naturalized and mostly cultivated as hedge plant near villages
17.	*Ficus carica* L. (fig, anjir)	Baluchistan, Afghanistan, South Arabia, West Asia/ probably before 1832.	Brought to India probably by Portuguese traders. Naturalized in parts of Deccan, Particularly Pune area and has become a peculiarity of the region for its edible fruits.
18.	*Gliricidia sepium* Steud (giripushpa)	Central and South America/About 1916.	Introduced in India from Ceylon. First planted in Bombay by Millard. Planted as fast growing hardy species on barren hilly tracts of Maharashtra and become naturalised for the region.
19..	*Leucaena leucocephala* (Lam.) Dewit. (subabhul)	Tropical America/ After 1832.	Introduced in India in British period as fast growing species, spread throughout and now becoming a weed with tremendous natural regeneration.
20..	*Manilkara zapota* (L.) P. Royen (sopodilla plum, chikku	Tropical America, Mexico/ 16th century	Introduced in India by Portuguese traders for its edible fruits. Established in Dahanu- Gholwad areas of Thana District and has become a commercial peculiarity of the region for its fruits.

Sr. No.	Botanical name (common name)	Nativity/probable date of introduction	Remarks
21.	*Melia azedarach* L (bukan–nim, Persian lilac)	Persia, Asia Minor, Baluchistan/	Introduced as ornamental tree, naturalized and commonly used as roadside tree in area under study.
22	*Parkinsonia aculeata* L. (vilayati babul)	Tropical America/ About 1797.	Introduced for afforestation programmes in arid zones of India, to reduce erosion. Naturalized and spread everywhere through natural regeneration.
23.	*Peltophorum pterocarpum* (DC.) Baker ex Heyne (copper pod)	Ceylon, Malay peninsula, Archipelago and N. Australia	Introduced probably by the British as ornamental roadside tree. Now naturalized and commonly used in amenity plantations.
24	*Phyllanthus acidus* (L.) Skeels (harparrevdi, raiavla)	Malay, Archipelago/ Uncertain.	Introduced for its acidic edible fruits. Naturalized and now a common feature of home orchards.
25	*Pithecellobium dulce* Benth. (vilayati chinch)	Mexico/before 1795.	Introduced by Spaniards as protective hedge and for its edible fruits. Naturalized and now growing even in wastelands.
26..	*Plumeria rubra* L forma *acutifolia* Woodson (Pagoda tree, temple tree).	Guatemala, Mexico, Central America/ Prehistoric times.	Introduced probably via China. So naturalized that it has become an important element of temple environment flora.
27.	*Polyalthia longifolia* (Sonner) Thw. (ashok)	Ceylon/Uncertain.	Introduced for its graceful shape and ornamental value. Naturalized and commonly used for avenue plantations.
28.	*Psidium guajava* L. (guava, peru)	Brazil, Mexico/ 17th century.	Brought by Portuguese for its edible fruits. Now established in all parts of country for the fruits. Developed into many horticultural varieties.
29..	*Punica granatum* L. (dalimba)	Iran, Persia, Afghanistan/	Introduced and naturalized from remote antiquity in India. Established in arid regions of Western Ghats of Maharashtra and has become a commercial crop.
30.	*Ricinus communis* L. (castor oil, erand)	Africa, Abyssinia/ Prehistoric period	Introduced as fast growing species for field bunds. Run wild and grows even along barren waste places.
31.	*Samanea saman* (Jacq.) Merr. (rain tree)	Central and southern tropical America/ First half of 18th century.	Introduced probably by the British as fast growing shade tree Naturalized and commonly utilized as roadside tree.
32.	*Sesbania grandiflora* (L.) Poir. (hadga)	Indonesia/Prehistoric period.	Introduction is ancient, as it has a religious value. Naturalized and commonly cultivated along field bunds.
33.	*Sesbania sesban* (L.) Merr. (shevri)	Tropical Africa, Asia.	Introduced as fast growing species for field bunds. Naturalized and self–sown in the area.
34.	*Swietenia mahogani* Jacq. (mahogany)	Jamaica, Central America/1795.	Introduced as a timber tree in India. Naturalized and utilized as timber and beautification tree.
35.	*Tamarindus indica* L. (chinch)	Nativity doubtful, probably Tropical Africa/ very early introduction.	Introduced and naturalized throughout India. Self–sown even in dry waste places. Fruit is important in commerce.

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GENETIC STATUS OF WHITE TIGERS AT NANDANKANAN BIOLOGICAL PARK, ORISSA[1]

A.K. ROYCHOUDHURY[2] AND L.N. ACHARJYO[3]

(With two text–figures)

Using genealogies the inbreeding coefficients of the white tigers at the Calcutta, Delhi and Nandankanan Zoos have been calculated. The white tigers at Nandankanan are less inbred than those at Calcutta and Delhi. Inbreeding does not have much effect on fertility and mortality of the white tigers at Nandankanan. An objective breeding plan for Nandankanan has been given in order to breed white tigers with small values of inbreeding coefficient.

All the white tigers found at the zoos of Calcutta and Delhi in India, Washington D.C. in the U.S.A, and Bristol in England originated from two founder animals, namely Mohan, a white male and Begum, a coloured female. Since these two animals were caught in the forests of Rewa, Madhya Pradesh, India, all their descendants belong to the Rewa lineage. During the last two decades the white tigers of this lineage suffered grevious losses due to the deleterious effects of inbreeding. Matings between close relatives like father–daughter, mother–son, brother–sister etc. practised in the above mentioned zoos resulted in reduced fertility and increased early mortality (Roychoudhury and Sankhala 1979).

There is another lineage of white tigers found at the Nandankanan Biological Park, Orissa (Roychoudhury and Acharjyo 1983). The white tigers born there to a pair of normal coloured tigers have apparently no biological connections with the patriarch of white tigers, Mohan, or with his descendants. As of 20 February 1986, this park had the largest collection of white tigers in India, 8 females and 5 males. It has also 18 normal coloured tigers of which at least one is heterozygous, i.e. carrying a gene for white coat colour. They are all founded by three wild–caught tigers (Pradeep, Sikha and Rani) and one white female (Diana/Subhra) of the Rewa lineage obtained from the Delhi Zoo. Seven white offspring produced by Diana at this Park are the products of a mixture between Rewa and Nandankanan lineages. A number of coloured tigers have been sold or exchanged for animals to three zoological parks and one animal dealer in India. A genealogical chart of the animals is shown in Fig. 1. The dates of births and deaths of the tigers as well as the dates of selling and sending them to different zoological parks are given where available. In this paper we shall discuss the genetic status of the white tigers at Nandankanan.

Degree of inbreeding: At present 19 white descendants of Mohan and Begum are living in India, the USA and England. The inbreeding coefficients of these tigers range from 0.37 to 0.50 with an average of 0.41 ± 0.09 which is slightly higher than the average value (0.39 ± 0.13) of seven white tigers living in Delhi and Calcutta (Table 1). It is therefore clear that all the animals are highly inbred. Among 19 white tigers of the Rewa line, at least four (Neema, Sefali, Barun, and Priya) appear to be infertile. Nothing is known about the reproduction of Seema, Thiana, Akbar II and Nanda. The remaining tigers have produced offspring.

At Nandankanan among 13 white tigers seven are non–inbred, five have an inbreeding coefficient of 0.25 and the one (Diana/Subhra) that had been brought from the Delhi Zoo has an inbreeding value of 0.50. However, the average inbreeding coefficient of all of the white tigers is 0.13 ± 0.05 and it is 0.10 ± 0.04 when Diana is excluded (Table 2). The white tigers at Nandankanan are significantly less inbred than those at the Delhi and Calcutta Zoos.

Genetic contributions of four founders: To preserve the ideal genetic diversity in the tiger population at Nandankanan, all the four founder animals should have equal genetic contributions. From the genealogical chart we can easily calculate the percentage of genes contributed by the founders to each individual. Averaging over all living individuals, the percentages of genetic contributions of four founding animals are determined. It is observed that Pradeep and Sikha have higher genetic

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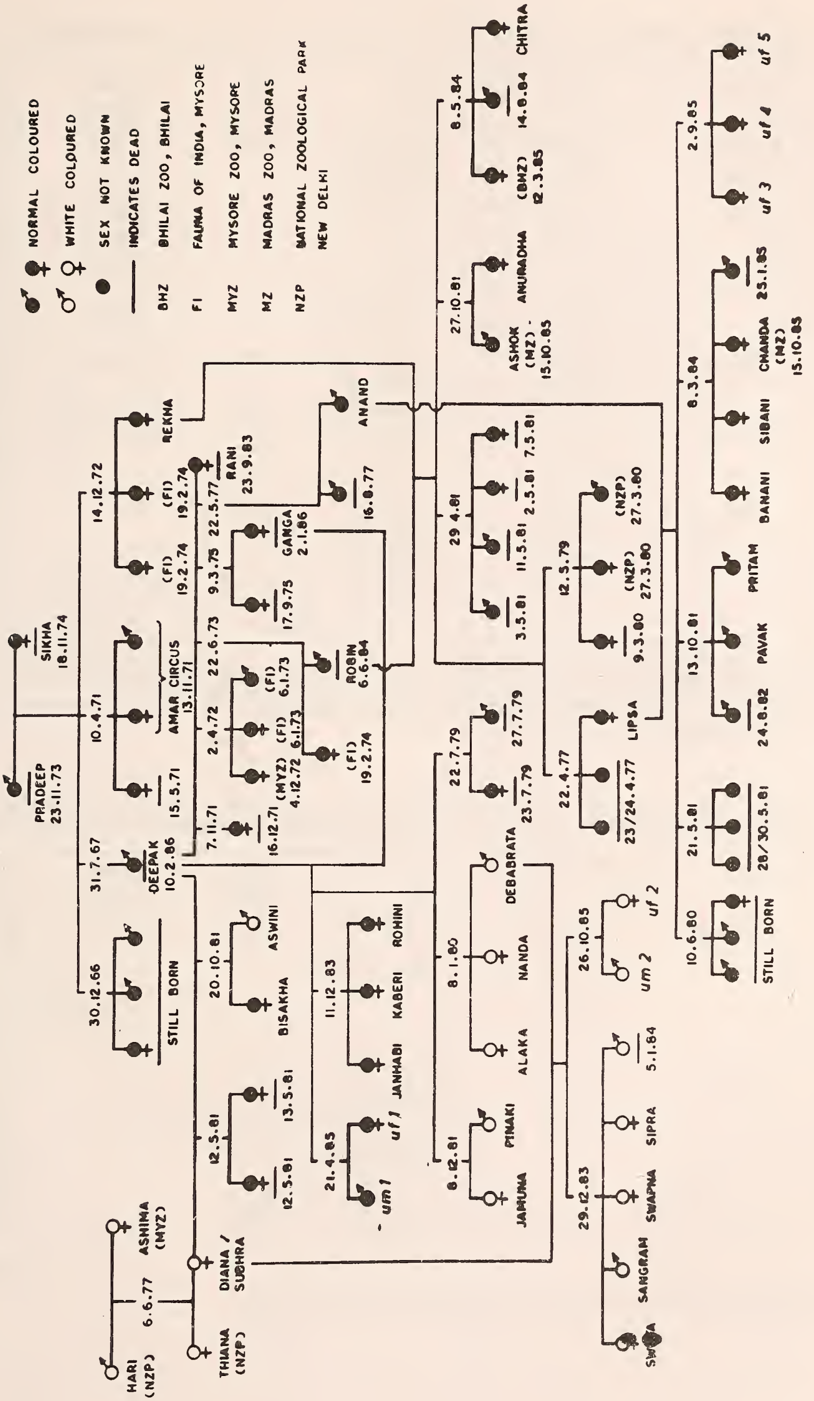

Fig. 1. Geneological chart of tigers at Nandankanan Biological Park

TABLE 1
INBREEDING COEFFICIENTS AND OTHER INFORMATION OF THE LIVING WHITE DESCENDANTS OF MOHAN AND BEGUM

Name	Sex	Sire	Dam	Birth date	Birth place	Present location	Inbreeding coefficient
1. Homa	F	Mohan	Sukeshi	6 Sep 1967	NZPD	NZPD	0.3750
2. Hari	M	Raja	Rani	3 May 1968	"	"	0.3750
3. Ashima	F	"	"	11 Apr 1970	"	MYZ	0.3750
4. Diana/Subhra	F	Hari	Ashima	6 June 1977	"	NBP	0.5000
5. Thiana	F	"	"	"	"	NZPH	0.5000
6. Neema	F	"	"	22 Nov 1977	"	NZPD	0.5000
7. Seema	F	"	"	"	"	KZ	0.5000
8. Vijay	M	"	Homa	6 May 1978	"	NZPD	0.3750
9. Sohrab	M	"	"	"	"	"	0.3750
10. Barun	M	Neeladri	Malini	18 May 1969	CZG	CZG	0.3750
11. Himadri Jr.	F	Himadri	Chandni	28 July 1975	"	"	0.3750
12. Sefali	F	"	"	19 June 1973	"	GZ	0.3750
13. Ranjit	M	Ramana	Kesari	20 June 1974	NZPW	NZPW	0.4062
14. Bharat	M	"	"	"	"	"	0.4062
15. Priya	F	"	"	"	"	"	0.4062
16. Roop	M	Raja	Radha	7 June 1969	NZPD	BZ	0.3750
17. Sumati	F	Champak	Chameli	9 July 1968	BZ	"	0.3750
18. Akbar II	M	Roop	Sumati	16 June.1976	"	"	0.3750
19. Nanda	F	"	Nirmala	7 July 1977	"	"	0.3750
Average							0.406

Abbreviations: BZ: Bristol Zoo, England; CZG: Calcutta Zoological Garden, Calcutta; GZ: Guwahati Zoo, Assam; KZ: Kanpur Zoo, Uttar Pradesh; MYZ: Mysore Zoo, Mysore; NBP: Nandankanan Biological Park, Orissa; NZPD: National Zoological Park, New Delhi; NZPH: Nehru Zoological Park, Hyderabad; NZPW: National Zoological Park, Washington, D.C.

TABLE 2
INBREEDING COEFFCIENTS AND OTHER INFORMATION OF THE LIVING WHITE TIGERS AT NANDANKANAN

Name	Sex	Sire	Dam	Birth date	Birth place	Present location	Inbreeding coefficient
1 Unnamed	M	Debabrata	Diana	26 Oct 1985	NBP	NBP	0
2 "	F	"	"	"	"	"	0
3 Sweta	F	"	"	29. Dec 1983	"	"	0
4 Sangram	M	"	"	"	"	"	0
5 Swapna	F	"	"	"	"	"	0
6 Sipra	F	"	"	"	"	"	0
7 Aswini	M	Deepak	"	20 Oct 1981	"	"	0
8 Jamuna	F	"	Ganga	8 Dec1981	"	"	0.250
9 Pinaki	M	"	"	"	"	"	0.250
10. Alaka	F	"	"	8 Jan 1980	"	"	0.250
11. Nanda	F	"	"	"	"	"	0.250
12. Debabrata	M	"	"	"	"	"	0.250
13 Diana	F	Hari	Ashima	6 June 1977	NZPD	"	0.500
Average							0.134

*NBP: Nandankanan Biological Park, Orissa NZPD: National Zoological Park, New Delhi

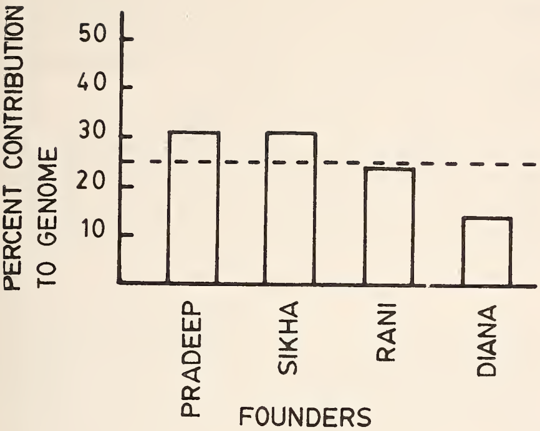

Fig. 2. Genetic constribution of four founders to the tiger population at Nandankanan. The dotted line shows the ideal contribution to the genome, if all founders contribute equally (25%).

contributions than Rani and Diana (Fig. 2). Diana has contributed the least, since she is old and highly inbred.

Inbreeding effects on fertility: The effect of inbreeding on litter size in white tigers of the Rewa lineage at the Delhi and Calcutta Zoos and in white and coloured tigers of the Nandankanan lineage at the Nandankanan Biological Park was examined (Table 3). Cubs with inbreeding coefficients of 0 are classified as non– inbred and those with values greater than 0 as inbred. At the Delhi and Calcutta Zoos, the average litter size of inbred tigresses is less than that of non–inbred ones but the difference is not statistically significant ($p > 0.05$). At Nandankanan, the average litter size is higher in inbred tigresses than in non–inbred ones, but the difference is not statistically significant. Nothing can be said categorically until more data for both inbred and non–inbred births are available.

Inbreeding Effects on Mortality

It has been stated earlier that the matings between close relatives of white tigers at the Delhi, Calcutta, Bristol and Washington Zoos resulted in early mortality. Table 4 shows the number of deaths of offspring for the Rewa and Nandankanan lineages within 30 days after their births for different levels of inbreeding coefficients. It is observed that 10% of

Table 3
LITTER SIZE OF NON–INBRED AND INBRED BIRTHS OF WHITE TIGERS IN REWA LINEAGE (DELHI AND CALCUTTA) AND THOSE OF WHITE AND COLOURED TIGERS AT NANDANKANAN

	Number of cubs in a litter					Mean ± S.D.
	1	2	3	4	5	
Rewa lineage						
Non–inbred births	–	3	5	3	–	3.00 ± 0.23
Inbred births	4	18	6	10	1	2.64 ± 0.17
Nandankanan lineage						
Non–inbred births	2	6	4	–	1	2.39 ± 0.29
Inbred births	–	4	9	2	–	2.87 ± 0.17

Table 4
30 DAY MORTALITY DATA FOR THE OFFSPRING OF TWO LINEAGES OF WHITE TIGERS

Inbreeding coefficient	Rewa lineage		Nandankanan lineage	
	Total No. births	No. of deaths	Total No. births	No. of deaths
0.0	10	1	31	6
0.1250	–	–	15	5
0.1875	–	–	16	6
0.2500	30	8	12	2
0.3750	91	32	–	–
0.4062	4	0	–	–
0.4375	7	5	–	–
0.4687	2	1	–	–
0.5000	22	17	–	–

the non– inbred offspring of Rewa lineage died before they were 30 days old, as compared to 40% of the inbred offspring. The early mortality is increased up to 77% when inbreeding coefficient of the offspring attains 0.5. But at Nandankanan, 19% of the non–inbred offspring died as against 30% in the inbred offspring. In both the lineages, the differences are not statistically significant.

To study the inbreeding effects on mortality of the offspring of the Rewa and Nandankanan lineages, the following standard genetic model is used (Morton *et al.* 1956).

$P = exp\,(-A-BF)$

Where P is the proportion of dead offspring whose inbreeding coefficient is F and, A measures the contribution of non–genetic or environmental causes of death and B the contribution of genetic causes of deaths due to inbreeding. Following Chakraborty and Chakravarti (1977), the estimates of A and B for the Rewa lineage are:

$A = 0.061 \pm 0.077, B = 1.386 \pm 0.282$

Since the standard error of A is larger than its estimate, environment does not seem to have any effect on the mortality of the offspring of the Rewa lineage. But the estimate of B is about five times its standard error, indicating that the inbreeding has a significant role in the early deaths of the offspring.

Using similar type of mortality data for the offspring of the Nandankanan lineage the estimates of A and B are obtained as follows:

$A = 0.241 \pm 0.091, B = 0.589 \pm 0.712$

Unlike the offspring of the Rewa lineage, the effects of inbreeding on early deaths for the offspring of the Nandankanan lineage seem to have a minor role as compared to those of environment.

Breeding Plan

If we know in advance the inbreeding coefficients of the resulting offspring for all possible pairs, an objective breeding plan can be made. A number of workers have calculated the inbreeding coefficients of the resulting offspring for all possible combinations of captive males and females of Sumatran tigers (Ballou and Seidensticker 1982), Indian lions (Smith 1985) and north American white tigers (Murtaugh 1985). We have also calculated the inbreeding coefficients for the offspring of all hypothetical pairings of living tigers at Nandankanan (Table 5).

Table 5

Inbreeding coefficients for the offspring of living white (capital letters), heterozygous (italics) and coloured tigers at the Nandankanan Biological Park

Male / Female	ASWINI	DEBA BRATA	PINAKI	um1	SANGRAM	um 2	Pritam	Pavak	Anand
SUBHRA/ DIANA	0.375	0.	0.	0.	0.375	0.375	0.	0	
ALAKA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
NANDA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
JAMUNA	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Janhabi	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Kaberi	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Rohini	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
Ufl	0.188	0.375	0.375	0.375	0.188	0.188	0.234	0.234	0.250
SWETA	0.281	0.313	0.313	0.313	0.344	0.344	0.177	0.117	0.125
SWAPNA	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
SIPRA	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
UF 2	0.281	0.313	0.313	0.313	0.344	0.344	0.117	0.117	0.125
Bisakha	0.313	0.188	0.188	0.188	0.281	0.281	0.125	0.125	0.125
Lipsa	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Anuradha	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Chitra	0.125	0.219	0.219	0.219	0.109	0.109	0.375	0.375	0.188
Banani	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
Sibani	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 3	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 4	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344
uf 5	0.125	0.234	0.234	0.234	0.117	0.117	0.359	0.359	0.344

The inbreeding coefficients of the offspring can be used as guides in the selection of mates for future breeding of white and coloured tigers. Apart from age and health considerations, the mates are to be selected in such a manner that their offspring will have the least inbreeding coefficient. In this respect Lipsa, Anuradha and Chitra may be ideal partners for the white Sangram or the white unnamed male, for their offspring will have an inbreeding coefficient of 0.11. Since Sangram and the unnamed male (UM2) are not mature, they cannot be paired immediately with these three females. In this analysis we have excluded Rekha, the offspring of Sikha, for she has passed her reproductive period.

Of 40 possible pairings between eight white females and five white males, only two pairs produce offspring with inbreeding coefficient of 0, nine pairs produce offspring with inbreeding coefficient of 0.19 and the remaining pairs produce offspring with inbreeding coefficients varying between 0.28 and 0.38. To breed white tigers with an inbreeding value of 0, Diana should be paired with either Debabrata or Pinaki. But she is too old to produce further offspring. Instead of Debabrata, Aswini or Sangram may be the ideal partner for Alaka, Nanda and Jamuna.

Bisakha, born to Subhra and Deepak, is a heterozygous female. If she is mated with any of the mature white males, namely Aswini, Debabrata and Pinaki, white offspring may appear with a chance of 50% per cent. Matings of Bisakha with the last two white tigers will produce offspring with low inbreeding coefficient (0.19). Four coloured females and one coloured male born to Deepak and Ganga in their last two litters are heterozygous with a probability of 0.67. If they are mated with any white tiger, the probability of obtaining a white offspring is 0.33. It is quite unlikely that both Anand and Lipsa are heterozygous. If they were so, they would have produced at least one white cub out of their 16 cubs in five litters. To examine whether any of them is heterozygous, Anand may be paired with Sweta, Swapna or Sipra, and similarly Lipsa with Aswini or Sangram. If Anand or Lipsa produce at least one white offspring, they will be considered heterozygous. In any case the inbreeding coefficient of their offspring will not be higher than 0.12.

Conclusions

To reduce the levels of inbreeding, white tigers should be allowed to outcross with unrelated normal coloured tigers and the offspring thus produced are to be backcrossed with white tigers, preferably of different lineage. If outcrossing and backcrossing are conducted alternately, avoiding common lineage whenever possible, white tigers can be produced with the lowest possible level of inbreeding. This strategy of breeding in white tigers has been advocated earlier by Murtaugh (1985).

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NOTES ON THE BIOLOGY OF *VARANUS GRISEUS KONIECZNYI* MERTENS SAURIA: VARANIDAE[1]

WALTER AUFFENBERG[2], HAFEEZUR REHMAN, FEHMIDA IFFAT AND ZAHIDA PERVEEN[3]

(With four text–figures)

The present study documents several aspects of the biology of *Varanus griseus koniecznyi* in Pakistan. Adequate material now available makes possible a more detailed description of the morphological features and the geographic distribution of this species than was previously possible. The annual reproductive and abdominal fat cycles are outlined and the common prey organisms identified.

INTRODUCTION

This study was undertaken as part of an extensive research programme involving the varanid lizards of India and Pakistan. It is the second of a series of publications intended to make the results of this work available to biologists. With the exception of a few casual notes (Corkhill 1928), literature contains nothing regarding the biology of this subspecies (a significant unpublished thesis research study on food and burrow use was conducted by Dave (1961) at the University of Rajasthan (see below). Several of the earlier publications (i.e. Smith 1935) that deal with the eastern populations of *Varanus griseus* (now considered to represent the distinctive *V. g. koniecznyi*) include behavioural and other data relating to more western populations now considered as distinct geographic races, so that it is not clear what information pertains to the eastern race and what does not.

Varanus griseus (desert monitor lizard) is distributed from northern Africa to north–central India. Within this large area three geographic races are recognized *V. g. griseus* from Africa to approximately eastern Iran, *V. g. caspius* from the western shores of the Caspian Sea, Turkman and the Iranian Plateau, eastward through Afghanistan and Baluchistan to western Sinkiang Province, China; and *V. g. koniecznyi* from central Pakistan to north–central India.

Varanus g. koniecznyi was described by Mertens in 1954; the type locality is Khorangi, near Karachi, Pakistan. In addition to those morphological features he listed as distinguishing it from its closest geographic conspecific *V. g. caspius*, he included a few other localities. To these he added several more in 1969. Minton (1966) published a few natural history notes, added still more localities in southern Pakistan, and further characterized the subspecies on the basis of a few additional morphological features. Our studies were primarily conducted to better understand the biology of this poorly known subspecies. The study was intended to supply baseline information on distribution, morphology, reproduction and nutrition as an aid to developing a conservation programme for this (and other) monitor species in southern Asia.

The following data were obtained as a result of field work conducted from 1984 through most of 1987 in both countries. Additionally, important museum specimens were examined in both these countries and in Europe and the United States. Total field time was approximately 22 months (India 10, Pakistan 12). Data were obtained from 150 specimens (52 in museums, 98 in the field). All measurements of total length (TOL), tail length (TL) and snout–vent length (SVL) were made to the closest mm; all internal measurements (testes, ova, etc.) were made to the closest 0.1 mm; all weights to the closest 0.1 g.

RESULTS

Distribution: Fig. 1 shows the published literature records as well as those Pakistan localities demonstrated as possessing *Varanus griseus* during the present study. These data make it quite clear that the subspecies *V. g. koniecznyi* is restricted to what is best described as the historic and the present Indus River Valley (see Fig.1). However, within this large area, it is more or less restricted to sandy tracts. This habitat preference has already been mentioned by

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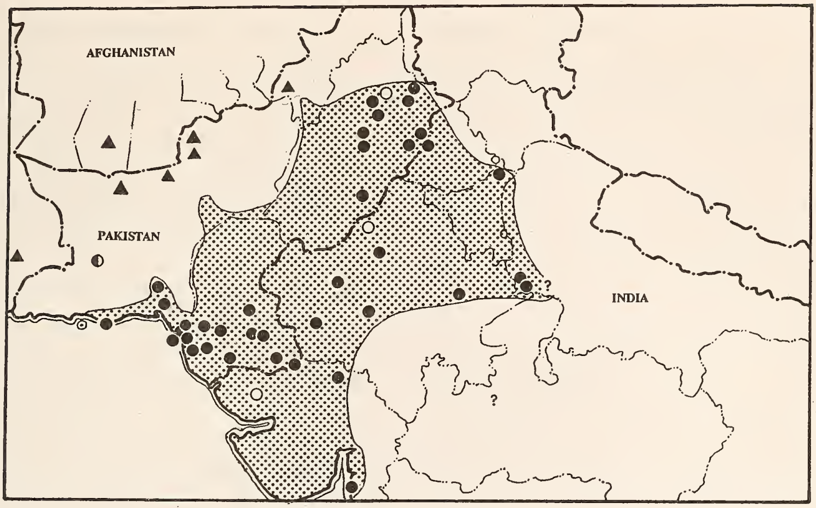

Fig. 1. Locality records for *Varanus griseus koniecznyi*; literature records hollow dots, examined specimens solid dots. Shaded area represents what we believe to be the entire range of the subspecies. The zone of intergradation with *V. g. caspius* along the western border is not yet clear (see text). Only one specimen is considered an intergrade (half solid dot). The traingles represent the closest localities known at present for *Varanus g. caspius*.

Minton (1966); it is rarely found in clay deserts. Common plants noted in areas where *V. g. koniecznyi* were seen during this study are *Acacia jacquemontii*, *Prosopis cineraria*, *Salvadora oleoides*, *Capparis aphylla*, *Leptadenia pyrotechnica*, and *Colligonum polygonoides*.

Localities from which this subspecies are now known and the data source follow:

INDIA. Uttar Pradesh Prov., Sikandra (this study), near Agra (Carlleyle 1869); Dayalbagh (this study), Agra (Boulenger 1885, based on Carlleyle?), Delhi (Jerdon 1870), Oudh (Murray 1884); Maharashtra Prov., Narsingarh (Smith 1932, see text, locality questioned). Gujarat Prov., Surat, (Gleadow 1905), Deesa (ZSI and Smith 1932); Kutch (Stoliczka 1872). Haryana Prov., Ambala; Rajasthan Prov., Bikaner, Barmer and Pugal (Dave 1961), Pokaran (this study), Jodhpur (ZSIJ, Smith 1932 and this study), Jaipur (this study).

PAKISTAN. Baluchistan Prov., Gwador Distr.: Ormara (this study); Quetta Distr., Quetta (ZSD); Las Bela Prov., Bela (this study), Goth Mauladad (Mertens 1969), Uthal (ZSM), Panjgur Distr., Panjgur; Punjab Prov., Jhellum Distr.: Goolpour, 9.6 km Pindo Dadau Khan (this study); Jhang Distr.: Jhang (UMMZ), Rabwah (this study), Bhravi Desert (Minton 1966); Sargodha Distr.: Khewra, nr. Jhellum River (this study); Lahore Distr.: Lahore (Jerdon 1870): 32 km SE Lahore; Kolakhatai; Narang Mandi; Sri Rampura; Changa Manga (all this study), Mianwali Distr.: Salt Range (Theobald 1868). Sind Prov., Badin Distr.: Badin (MCZ and Mertens 1969), Thar Parkar Distr.: (Smith 1932), Islamkot (ZSD), Nagar Parkar (this study), Umarkot (ZSD and this study); Karachi Distr.: Karachi (Minton 1966 and many museum collections), Dabiji (Mertens 1969), Clifton (Minton 1966), 6.4 km E Landhi (Minton 1966), Khar Centre nr. Hab Dam (this study), Sanghar Distr.: Sher Khadra (this study); Thatta Distr.: Jati (Mertens 1969, Jherruck (Mertens 1969), Jungshahi (Mertens 1969 and this study); 4.8 km NE Gharo (Minton 1966); Hyderabad Distr.: nr. Bhalori (Minton 1966), Mirpur Khas (ZSD); Dadu Distr.: nr. Thana Bulla Khan (ZSD, Minton 1966 and this study).

The locality Narsingarh (Smith 1932) requires verification, for it is out of the expected range on zoogeographical grounds. In the most eastern parts of this subspecies range Nikolsky (1907) reports *Varanus griseus* (subsp.?) from SE Iran; but the subspecies represented is probably *V. g. caspius* on the basis of Mertens's record from Iranshah (1956). The western limits of *V.g. koniecznyi* is apparently at the edge of the Iranian Plateau (i.e., the Sulaiman, Bruhai and Kirthar Mountain Ranges in central Pakistan. At the southeastern limit the subspecies ranges into, but not beyond, the Gujarat Plains (Surv. India Maps, pl. 41), and eastward to, but apparently not beyond the Ganga–Jamuna Doab. I have seen a specimen (not captured) from the sandy river bed near Firozabad that I believe represents this species. If correctly identified, it is the most eastern locality known.

Systematics: At an early date the distinctive coloration and pattern of the *Varanus griseus* populations from India had already been reported in the literature (Hardwicke and Gray 1827, Anderson 1898). In 1942, Mertens suspected that the Indian and Pakistani specimens represented an undescribed race on the basis of its colour pattern, but had too few specimens for study to be certain. Additional Pakistan material was made available through collections made by Mr Konieczny. Mertens described the subspecies *V. g. koniecznyi* in the collector's honour in 1954. Unfortunately, Mertens was unable to define the geographical limits at the western edge of the range, for at that time there were no Baluchi specimens with precise locality data.

Today, the situation is hardly better, though Minton (1966) reported a specimen referred to *V. g. caspius* from Chagai District, 17.6 km NW Nushki. It is also presumed that the specimen reported by Wall (1912) from Chitral Distr., N.W.F.P., was also a member of this race. Thus systematists believe the populations along the Afghani–Baluchi border are referable to *V. g. caspius*. It is presumed that those populations between these and those examined from the most northwestern localities in the Indus Valley (Fig. 1) are intermediate, though this has not been proven with the material at hand. Even less is known about the subspecific allocation of populations along the Irani–Baluchi border. Specimens from the middle and eastern part of the Mekkran Coast (Ormara, Uthal, and Bela) are clearly assignable to *V.g. koniecznyi*, and show no evidence of intergradation. However, a single adult from Panjgur, Baluchistan (ZSM 161/1985) is intermediate in body and tail colour pattern between *V.g. koniecznyi* and *V.g. caspius*. The closest undoubted *V.g. griseus* records are in central Iran (Tuck 1971).

A good black–and–white photograph of *Varanus griseus koniecznyi* is provided by Minton (1966) and a coloured one by Auffenberg (1986). The photograph by Pilleri (1970) is not of this species as stated, but of *V. bengalensis bengalensis*, as first noted by Mertens (1971). Detailed descriptions of material then available are provided by Mertens (1954) and Minton (1966). The following short description is based on a much wider selection of specimens available to us in this study:

Tongue long, slender, bifid and retractable into a sheath, Head moderately broad, with a pointed snout, External nares, located near the eye (28–40 % of the distance from the nostril to tip of the snout). Tail rounded in cross section throughout most of its length, longer than snout–vent distance (109–128 % of SVL). Head scales small, polygonal; mid–dorsal body scales small (108–139 scale rows around body), granular above, squarish ventrally.

Dorsal head colour dark grey to black, lighter in the young. Body dull yellow to light grey, speckled with dark grey to black; 3–4 dark grey, greenish grey (to dark brown or black in young) cross bands on trunk, bordered by and sometimes enclosing white to yellow spots. This pattern is sometimes obscured by a long triangular dark grey to black patch that extends from the top of the head over the dorsal part of the neck onto the shoulders, sometimes farther posteriorly. This "cape" is best developed in older individuals, especially from the Indian side of the Thar Desert (photograph in Auffenberg 1986). There is always a dark brown to black stripe extending from the canthus through the ear opening onto the neck and a shorter, narrower one from behind the eye. The base and proximal two thirds of the tail are often crossed with from 8–12 greyish bands; distal third to one half black with a white tip. The limbs are greyish with yellow spots and the ventral surfaces are white, often with dark speckling on the throat.

Corkhill (1928) reports that during early summer the bellies of males have a pinkish cast. Though this is probably correct, we were not able to confirm a seasonal colour change in either sex.

The few Pakistan specimens of *Varanus g. caspius* that are available are similar, but have a longer tail (148% SVL), a higher number of mid–dorsal scales (143) and more body (6–8) and tailgraph (15–17) bands. The body bands are not bordered by lighter spots (photograph in Minton 1966). The distal part of the tail is whitish. Additionally, they reach larger size.

Size and Mass: In the sample of adult *V. g. koniecznyi* measured and weighed in the field during this study (N = 94), female SVL varied from 190–335 mm (N = 39); males 183–365 mm (N = 55). Males were slightly, but significantly larger than females (X male SVL 286.7 ± 34.6 mm, X female SVL 268.0 ± 33.22; t test = 6.5; $p < 0.001$). The proportional difference in SVL between the sexes is less than in all other monitors studied so far. Total length in males varies from 449 to 835 mm, and in females from 412 to 752 mm. The tail is longer than the body, as in most monitor species. There is no significant sexual difference in the proportional length of the tail, the mean SVL/ Tail L (X 1.23 ± 1.0 in males, 1.20± 0.1 in females). Its tip is missing in 11 % of the males and 12.8 % of the females, with no significant sexual difference between them in this regard.

Total weight varied from 62 to 580 g in females (X 250.9 ± 133.1 g) and 85 to 520 g in males (X 296.2 ± 106.0 g).

Among sexually mature adults there is no significant relation between SVL and Wt (best fit with exponential curve, $R^2 = 0.29$), suggesting that total weights vary greatly intra-individually and seasonally. This high variance is probably due to variation in local insect abundance.

Sex ratio: A total of 96 specimens were dug from their burrows in Sind Province, Pakistan. Of these, the sex of twelve was indeterminant (gonadal immaturity). The sex ratio of adults (84) was 58 males to 26 females (2.23:1), which is significantly different ($P < 0.5$) from a 1:1 ratio ($X^2 = 4.4$, 1 df).

Pianka (1968, 1969, 1971), Horn (1980), Pengilley (1981) and Auffenberg (1981) have reported unequal sex ratios in different species of varanid lizards; the latter showed that such ratios may obtain in unhatched eggs as well (though based on small sample size). Studies of still other species have shown that ratios of 1:1 are normal (Auffenberg 1988, Auffenberg *et al.* in press, King and Rhodes 1982, and Auffenberg in MS). King and Green (1979) thought it likely that unequal sex ratios in varanids were the result of differences in activity patterns or levels. That this is likely was suggested by the activity patterns of many captive *V. bengalensis*, in which males were much more active than females of the same age (Auffenberg 1979). Further studies of the same species in the wild (Auffenberg in MS) show that when individuals are excavated from their burrows the sex ratio is 1:1. A recent study of *V. flavescens* in India and Pakistan (Auffenberg *et al.* in press) provides the same 1:1 ratio on the basis of excavated specimens. However, the same capture technique for *V. griseus* (also in Pakistan) shows that this subspecies exhibits a sex ratio favouring males.

Thus, while it seemed for a time that the unequal sex ratios in varanids may be due to bias related to differential activity levels of the sexes, the occurrence of unequal ratios in the eggs of at least some species and the clear presence of unequal ratios in samples taken from refugia suggests that some varanids have equal sex ratios, others do not. When unequal, the ratios favour the males. So far these species favour xeric habitats. Unequal sex ratios in land tortoises inhabiting xeric conditions have also been demonstrated (Auffenberg and Weaver 1969).

Reproductive Cycle: In spite of a number of publications on *Varanus griseus*, there is little information on the reproductive biology of this species in the eastern parts of its range. The data presented below were obtained from specimens originating in both Pakistan and India, representing most of the geographical distribution of this subspecies.

The female reproductive cycle is best studied by examination and measurement of the ovarian follicles. Ovary volume and diameter of the largest ovum both show a dramatic rise in August (Fig. 2). Though there is a drop in October–November, both remain at high levels through January. The ovaries are in a regressed phase (Jacob and Ramswami 1976) from February through July. The smallest female with enlarged follicles (< 3.0 mm diameter) has an SVL of 245 mm, which is taken as the smallest size of mature females. Eggs are ovulated when they are about 10 mm in diameter.

Oviducal eggs were found in 12 females. Collection dates of these individuals were from August 8 to September 15. Shelled oviducal eggs are found from October 13 to September 15. The smallest individual with oviducal eggs has an SVL of 276 mm.

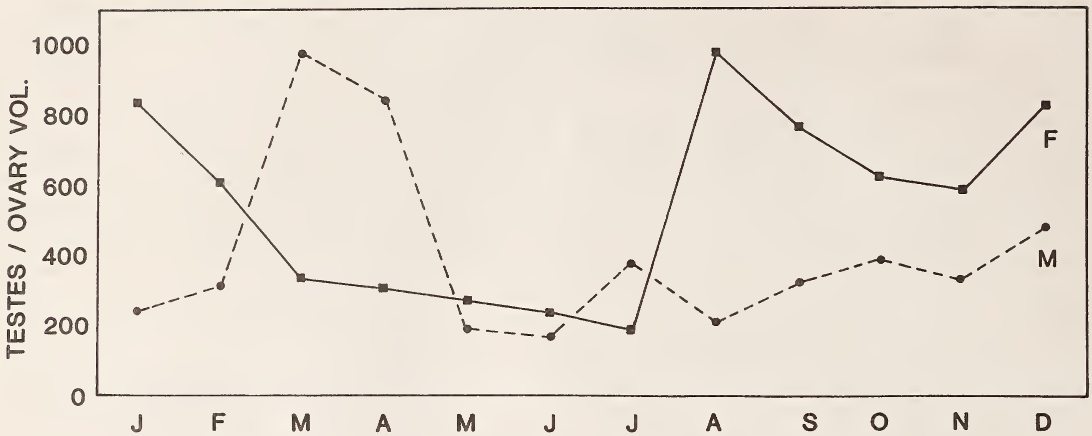

Fig. 2. Seasonal change in ovary and testes volume and the diameter of the largest follicle in *Varanus griseus koniecznyi.*

Clutch size of oviducal eggs ranges from 6–11; luteal bodies remain in the ovary for at least one year, and range in number from 2–15. Thus our evidence from Pakistan suggests that mature females lay from 2 to 15 eggs, with the mean for this area calculated as 8.7 ± 4.3.

Females appear to produce only one clutch per breeding season. All females throughout the subspecies range are synchronous in respect to gonadal activity. The ovaries of individuals with oviducal eggs generally contained both corpora lutea and a number of degenerating ova. We found no evidence that eggs pass through the oviducts of this subspecies as rapidly as suggested by Jacob and Ramswami (1976) for *V. bengalensis*, who reported the presence of mature follicles, and both shelled and unshelled eggs in a single individual. Ovulation occurs mainly in August and September, with continuing slow decrease in ovary volume through January (Fig. 2), after which there is a radical reduction in ovary size March through June. Ovulation in this subspecies is later than that in the sympatric *V. flavescens* (Auffenberg *et al.* in press).

Corpora lutea vary from 2 to 15. There is no significant relationship ($R^2 = 0.01$) between female size (SVL) and number of ovulated eggs (number of corpora lutea).

Testes volume of all males with SVL >250 mm shows a significant seasonal change (Fig. 2). Testes volume is highest in April, gradually becoming more or less smaller in the following months through July. In August there is a dramatic decrease in testes volume, after which it slowly increases through December, followed by a more rapid rise to April.

Varanus g. koniecznyi exhibits a composite reproductive cycle. Males produce sperm during the spring, after they emerge from a period of dormancy (or at least reduced activity) from November through March. Thus testicular recrudescence takes place when ambient temperatures are increasing in spring. Combat takes place May, June and early July (just before the monsoon, which in Pakistan and western India usually begins between mid–July and mid–August). This is suggested both by the presence of combat scars on the shoulders of adult males (see Auffenberg 1988) and combatant pairs during these months. Ovarian activity (as well as courtship and breeding) occurs during August. Most eggs are laid in September, a few in October.

The timing of reproductive activity in this subspecies of monitor is of considerable interest. We have demonstrated that the onset of testicular activity is correlated with increasing ambient temperature. In contrast, ovarian activity is not correlated with temperature, but is greatest during the monsoon season. Because ambient temperature and precipitation are not correlated, the gonadal activity of males and females are asynchronous.

Reproductive activity is controlled by complex environmental cues, including temperature, photoperiod and precipitation (see Duvall *et al.* 1982 for review). Licht (1971) and Marion (1982) have demonstrated that lizard testicular activity is stimulated by increasing temperature. Thus the male desert monitor annual reproductive cycle with spermatogenesis in spring is not surprising. However, the fact that female gonadal activity does not begin until much later in the year is unusual among monitors. Guillette and Sullivan (1985) have demonstrated a similar asynchronous reproductive cycle in male and female iguanid lizards (*Sceloporus formosus*). However, in that case females are pregnant during spring. They point out that pregnancy hormones would block any stimulatory environmental cues (through action of the anti–gonadal hormone progesterone). However, there is no evidence that female *V. g. konieczny*i are pregnant during spring, so that the mechanism inhibiting ovarian activity in females during the earlier part of the year remains unknown.

Unfortunately, we are not certain when the eggs hatch. Minton (1966) collected what he believed to be newly hatched individuals in August and September (SVL 94 mm). Three small specimens (X SVL 102 mm); in collections of the California Academy of Science and M.S. Khan (Rabwah, Pakistan) were collected together during July from the roof of a thatched hut, suggesting they had hatched several weeks previously (sibling hatchling monitors sometimes remain together for some time (Auffenberg 1981, 1988). Thus the current data suggest that *V. g. konieczny*i hatch from July through September (monsoon), further suggesting that incubation takes about 10 months.

This premise requires confirmation from Pakistani and Indian biologists. In Tunisia, Thilenius (1897) reports hatchlings 3 to 4 months after shelled eggs are found in the oviducts. However, his total length measurements of about 30 cm are much too great for young of the year, suggesting that his "hatchlings" were already one season old. Thus there is no information on how long incubation lasts in Tunisia.

The long incubation period suggested for *V. g. konieczny*i is not unique among monitors (though exceptionally long when compared to lizard species in other families), for *Varanus niloticus* requires a similar incubation period in some parts of its range (Cowles 1930). Other workers have demonstrated that the incubation of the eggs of other monitor species may take 4 to 6 months (see Auffenberg 1988 for review). In every case where comparisons are possible, the hatching of monitors seems correlated with the onset of the rainy season, which evidence suggests is also true of *V. g. konieczny*i. This is, of course, the time when insect prey usually reach their highest annual peaks.

Thilenius (1897) suggests the possibility that in Tunisia, female desert monitors may return to the nest near the time of hatching. Auffenberg (1981) repeats a local rural story that the females of *V. komodoensis* do likewise, though he saw no evidence for such behaviour. Additional information on such possible maternal behaviour on the part of adult females would be very important, if confirmed.

Newly hatched monitors of many species are rarely seen in the wild even by professional monitor hunters. We presume this is usually due to their often arboreal habits when young. However, hatchlings of *Varanus griseus* are also rarely caught when compared to adults. The paucity of trees in their usual habitat suggests they are spending their time elsewhere. This is another area in which local biologists can shed much light on – where very young monitors spend most of their time. In contrast, ovarian activity is not correlated with temperature, but is greatest during the monsoon season. Because ambient temperature and precipitation are not correlated, the gonadal activity of males and females are asynchronous.

On the basis of limited growth data on captive *Varanus griseus caspius* (Segeev 1939), *V. g. konieczny*i may become sexually mature at the end of the second year of life, certainly during the third. Thilenius (1897) believes that the larger nominal subspecies may become mature as early as two years, but for most individuals he believes it is 4 or 5 years. They have been known to live in captivity at least ten years (Flower 1925).

Abdominal Fat Bodies. Male and female fat bodies exhibit identical annual cycles (Fig. 3), as they do in the tropical evergreen species *Varanus olivaceus* (Auffenberg 1988). In both sexes of *V. griseus* the fat body weight begins to accumulate during the monsoon season, reaching a peak in September and October. This is directly associated with increased

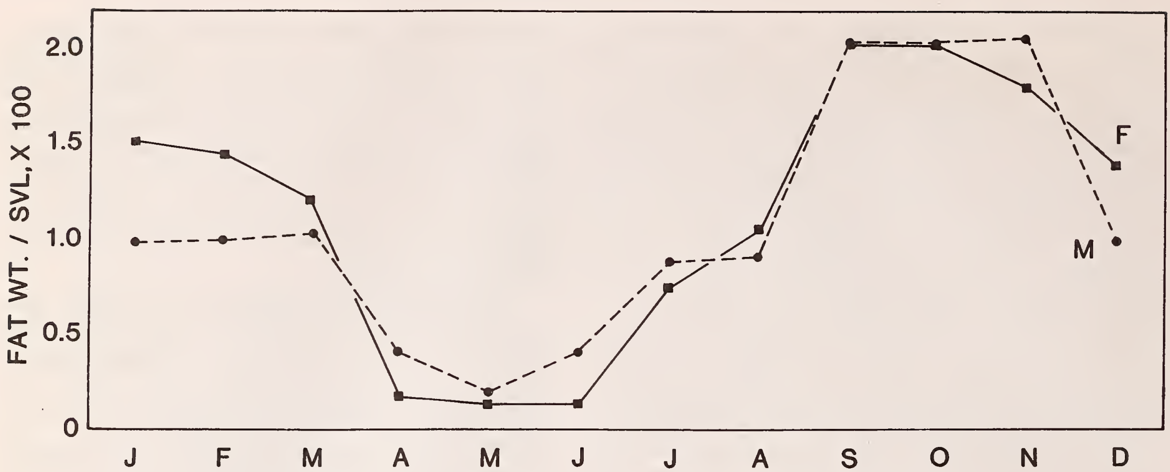

Fig. 3. Abdominal fat body cycles of male (M) and female (F) *Varanus griseus koniecznyi.*

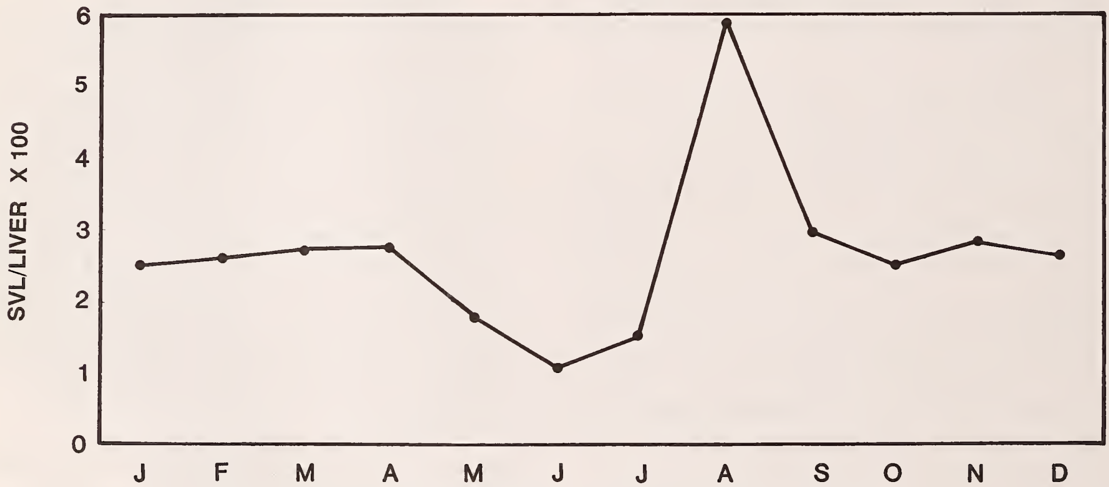

Fig. 4. Annual cycle of proportional liver weight (SVL/Liver Wt g x 100)

abundance of insect prey (Auffenberg, MS). Abdominal fat in both sexes begins to decrease in November, correlated with the beginning of annual dormancy and following egg deposition during August and September. This fat body reduction is later than vitellogenesis, suggesting that the fat bodies in *V. griseus*, as in *V. olivaceus*, are not used for this purpose. The senior author has suggested elsewhere (Auffenberg 1988) that considerable fat is also stored in the tail of varanids and that this varies seasonally. It is possible that caudal fat, rather than abdominal fat is a more important lipid source during vitellogenesis in varanid lizards. Auffenberg and Auffenberg (in press) have suggested that the caudal fat may be the source of some (or all) of the lipids used in vitellogenesis in Philippine scincids as well.

In both sexes abdominal fat weight is least during April, May and June. While it is true that this inverse relationship agrees with spermatogenesis in male desert monitors (most marked in April), it does not agree with vitellogenesis in the female (mainly August).

Thus the weight of abdominal fat in both sexes

TABLE 1
STOMACH CONTENTS OF *Varanus griseus koniecznyi* IN RAJASTHAN, BASED ON DATA PROVIDED IN DAVE (1961)

Food category	Percent of total
Insects	48.0
Non–insect invertebrates	5.0
Amphibians	2.9
Lizards	19.1
Snakes	10.0
Birds	4.2
Eggs (various)	10.8

TABLE 2
STOMACH CONTENTS OF *Varanus griseus koniecznyi* FROM SIND,PAKISTAN BASED ON DATA OBTAINED DURING THIS STUDY

Food category	Percent of total
Centipedes	
Scolapendridae	1.3
Cockroaches	
Blattidae (*Arenarius*)	5.3
Beetles	
Scarabidae	21.1
Tenebrionidae	56.2
Toads	
Bufonidae (*Bufo stomaticus*)	1.3
Reptiles	
Agamidae (*Uromastix hardwickii, Calotes versicolor, Agama* sp.)	7.8
Lacertidae (*Acanthocephalus cantoris*)	1.5
Reptile eggs	4.0
Rodents	
Muridae (*Meriones* cf. *hurrianus*)	1.3

exhibit cyclic changes, with the greatest weight achieved during and immediately after the monsoon season (Fig. 3).

Liver: The pattern of seasonal changes in proportional liver weight has been investigated in *Varanus olivaceus* (Auffenberg 1988) and *V. flavescens* (Auffenberg *et al.* in press). Fig. 4 demonstrates seasonal differences in the weight of this organ in *V.g. koniecznyi*. The annual peak in both males and females is during August, when, in the females, vitellogenesis occurs. However, the fact that liver weight is also highest in males during this same month suggests that greater liver weight is related to increased insect prey abundance during the same month (Auffenberg, unpubl. data). Lowest liver weights occur during May and June, when insect prey are the least abundant.

Food and its seasonal utilization. Several previous workers have reported in a general way on the prey taken by *Varanus griseus koniecznyi.* Corkhill (1928) reported that they fed chiefly on small rodents, lizards, snakes and crickets. Minton (1966) reports that his captives fed on mice, rats, fish, meat and eggs, and small toads. The inference from these reports is that *V. g. koniecznyi* feeds largely upon small vertebrates. However, Dave (1961) provided a long list of prey taken from the stomachs of individuals captured in Rajasthan, India (no indication of number examined). More importantly, his data show that insects comprise the major food category (Table 1).

Food remains were recovered from the stomachs of 75 specimens during this study. All those individuals captured during December through March had empty stomachs and intestines. Our data show that during these three months *V. g. koniecznyi* is usually inactive. Insects are the most common food category taken (82.6%); vertebrates (including their eggs) comprise a small percentage of the total stomach contents (15.9%; Table 2). Thus in both of those studies in which food habits are based on wild caught specimens, insects predominate; vertebrates are not the most common food of this subspecies.

Almost all the prey in Pakistan specimens are partly fossorial. The gerbill, desert cockroaches, centipedes, tenebrionid beetles, toads, and reptile eggs are all most commonly encountered under stones and surface detritus, or in their burrows. It is also highly likely that at least the juvenile *Uromastix hardwickii* were also taken from their burrows. *Acanthodactylus cantoris* regularly hides in burrows and could have been retrieved from holes. However, *Calotes versicolor* was almost certainly taken while on the ground (normally an arboreal form). Scarib beetles are commonly found either on the ground at cow or camel pats, or within pats or the soil beneath them. When the entire spectrum of prey taken is reviewed it becomes obvious that almost all the prey are found below the surface or extricated from beneath debris on the desert floor.

The largest prey taken are *Uromastix hardwickii* – all were juveniles with a mean SVL of 77 mm. One adult desert monitor contained 5 hatchling *U. hardwickii*, two of which appeared to have been eaten the day before, and three the day it was captured. Another adult monitor contained remains

TABLE 3
SEASONAL PREY UTILIZATION IN *Varanus griseus koniecznyi* FROM SIND, PAKISTAN (IN% OF MONTHLY TOTALS)

Prey Type	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Centipedes				1.4		0.5		1.3	8.8			
Beetles				25.0	70.6	93.3	98.9	79.3	78.8	91.7	96.5	
Blattids					17.6				10.1			
Toads										5.9	3.5	
Lizards								18.0	2.3	2.4		
Reptile eggs				50.0	11.8	2.2	1.1					
Rodents				23.6				1.3				

of two hatchlings. Most beetle prey were represented by a number of individuals in each stomach (mean 10.2 per stomach). The mean cockroach length is 10.0 mm; mean beetle length 11.9 mm. Thus the vast majority of the prey eaten are small in proportion to predator length. In spite of prey lists in the literature that tend to emphasize the vertebrate prey of *Varanus griseus koniecznyi*, most prey are small beetles they dig from beneath detritus or from shallow burrows, usually under desert shrubs.

Dave (1961) demonstrates considerable seasonal variation in the prey taken by the desert monitor in Rajasthan, India. He concludes that insects comprise the major prey during July and August; reptiles are eaten primarily in March through April, and eggs (order not determined) in May and June (but no quantitative seasonal data is provided).

Table 3 provides data obtained during the current study on seasonal prey utilization in Sind Province, Pakistan. No food was found in any desert monitor stomachs from December through March. Beetles were taken every month that the monitors were active, varying from about 4 to 96 % of the total monthly items. Lizards were taken only during the monsoon season; reptile eggs mainly before the monsoon. The remainder of the prey categories reflect no obvious pattern. Thus the seasonal utilization of prey in Pakistan is somewhat different from what Dave described in western India.

Utilization. In connection with study of the behavioural ecology of monitor lizards in Pakistan and India during five years by the senior author, there is no clear evidence that this monitor lizard is regularly (if at all) hunted for its leather. This is striking in view of the fact that in appropriate habitats it is rather common. Not once have we seen a leather product (handbag, wallet, etc.) made of its skin in either of these countries. Nor have we noted it among the thousands of confiscated skins ready for processing in tanning establishments. Such skins are always of *Varanus bengalensis* and *V. flavescens* (in Pakistan and western India). The reason seems to be that individuals of both the last two species tend to be concentrated, whereas individuals of the desert monitor, while clearly more abundant on the basis of comparative sizes of the areas inhabited by each, tend to be more widely scattered over the vast sandy arid tracts in which they are found. We found no evidence that the desert monitor lizard is avoided by hunters (though many uninformed rural people believe it is venomous, the professional animal catchers do not).

In general, through both India and Pakistan much of the original preferred habitat of this subspecies remains intact. This is due mainly to its aridity. Some schemes have been proposed in both countries to convert some of these desert lands (where they lie near a major water source) to agricultural land. This will undoubtedly result in some habitat destruction of importance to the desert monitor. However, viewed in broad perspective, such schemes will have little significant effect on the totality of the geographic area in which it exists. Most of this land cannot be irrigated and thus the total range will probably not experience as much significant future modification as the habitats of the other Indo–Pakistani monitor species. In fact, the continued salination (and thus abandonment for agricultural purposes) of marginal desert habitat through hydro–agriculture may, in the long run, match and even exceed the effects of habitat destruction through urbanization and highway construction. However, proof of this remains for the future. These observations suggest that of the three species found in southern arid Asia, *V. g. koniecznyi* is the least threatened.

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PREDATION BY *AQUILA* EAGLES ON NESTLING STORKS AND HERONS IN KEOLADEO NATIONAL PARK, BHARATPUR[1]

RISHAD NAOROJI[2]

(With four plates, and a map)

Large scale predation of chicks in heronries by *Aquila* species during the 1985 breeding season is reported in Keoladeo National Park, which harbours the largest heronry in India. Young of the painted stork *Mycteria leucocephala* which nested successfully in large numbers that year were preyed upon. Their nesting coincided with the influx of *Aquila* migrants. Large and nearly full-grown young in nests and later fledged young on the ground were killed and fed upon collectively by six to eight *Aquila*. Predation was not observed when nesting was unsuccessful in the next two years when drought prevailed. To my knowledge earlier published records of predation by *Aquila* in the subcontinent do not exist. Killing of nestlings was not observed, though unsucessful attempts were. A minimum of 2.5% of the total number of young herons in the main study area were preyed upon.

INTRODUCTION

The Keoladeo National Park has become world famous for its vast numbers of wintering waterfowl. It is also the only wintering grounds of the rare Siberian crane *Grus leucogeranus* in India. A wide variety of waterbirds breed here in the monsoon and post monsoon period. The Park is the winter host of one of the world's largest concentrations of raptors, mainly eagles of the genus *Aquila*. Other species of raptors also breed and winter here.

This paper describes predation by eagles of the genus *Aquila* primarily on nestlings and fledglings of the painted stork. Systematic killing of painted stork young by Pallas's fishing eagle *Haliaeetus leucoryphus* has been previously recorded by Lowther (1949). Ali (1953) mentions heron nestlings taken by the Pallas's and marsh harrier *Circus aeruginosus*, imperial eagle *Aquila heliaca* preying on flamingo *Phoenicopterus ruber roseus* chicks was observed by Ali (1953, unpublished notes).

STUDY AREA

The park is divided into fifteen blocks (of which the relevant blocks are shown in Fig. 1) bounded by man– made dykes, (bunds). The flow of water from the main reservoir (Ajan Bund) is so regulated that different blocks can be flooded as required (Breeden and Breeden 1982). In blocks B, D and L, clusters of mounds support groves of *Acacia nilotica*. These trees provide safe nesting sites for a wide variety of waterbirds during the monsoon when the marsh is flooded.

During my study period, two pairs of Pallas's had established territories in the park. One of these pairs was nesting in D–block and had a large territory in the southeastern part, whereas the other, in LW and N-block, comprised of an adult female and a non-adult male, which were not nesting and were holding a smaller territory in the northwestern part of the park (Fig. 1). Both these pairs were under constant observation and a study of their activity will be published elsewhere.

MATERIAL AND METHODS

My study period lasted from mid September to mid April. I studied the predation presented here, from 27 October to 16 November 1985, 8 January to 20 February 1986, and 8 November 1988 to 3 February 1989. Observations were made using 8 x 40 binoculars from a punt.

RESULTS

Migration schedule of raptors: During the latter half of September, there was an influx of migrant raptors into the park, and by mid October a variety of different species, mainly *Aquila*, were observed. The greater spotted eagle *Aquila clanga* was the most numerous. By late November the eagles had dispersed over the 8 sq. km. of marsh. From then until mid–January, the numbers of migrant raptors were at peak levels. A raptor survey on 3 December 1985 tallied 75 raptors of eleven species which included a total of 49 *Aquila* of the following four species: imperial 10, steppe eagle *A. nipalensis* 8, greater spotted 30, lesser spotted eagle *A. pomarina* 1. The other species were: black-winged kite *Elanus caeruleus* 4, black kite *Milvus migrans govinda* 1,

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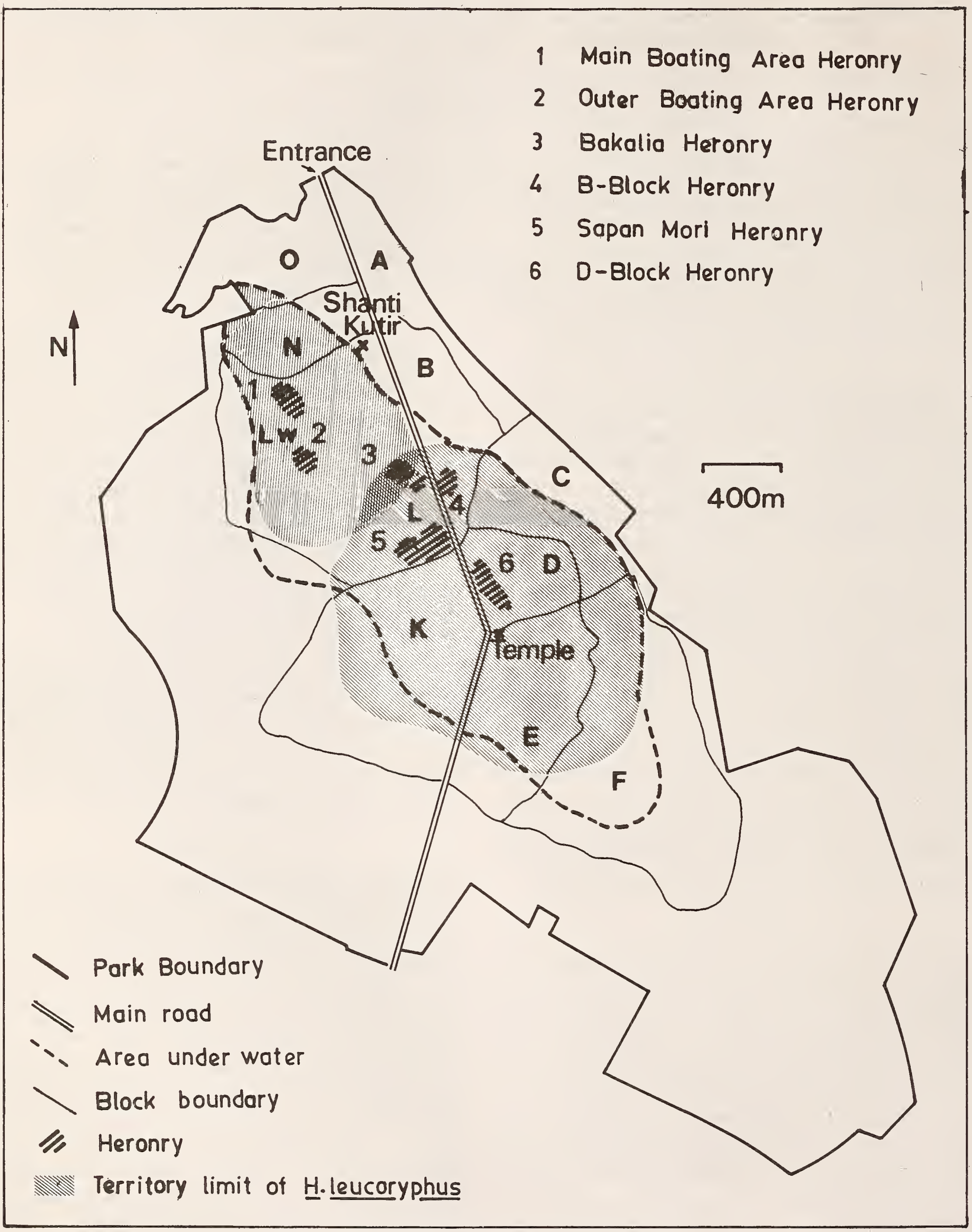


Fig. 1. Map of study area, showing relevant blocks

besra sparrow hawk *Accipiter virgatus* 1, marsh harrier 15, Bonellis's eagle *Hieraaetus fasciatus* 1, Pallas's 2, crested serpent eagle *Spilornis cheela* 2. Several other species of raptors seen regularly during this period were not observed during the two and a half hour survey which was restricted to the marsh.

By the end of January, a marked decline was noticeable in raptor numbers, especially marsh harrier, and *Aquila*, and by early February steppe outnumbered the greater spotted eagles. Whether this was due to an influx of steppe or a departure of many of the greater spotted could not be ascertained. Around 27 February, numbers of all migratory *Aquila* had decreased considerably, though steppe still outnumbered greater spotted. Marsh harriers, greater spotted, steppe and imperial eagles were represented by a few individuals at least till the end of March.

The gradual departure of many raptor migrants after January coincided with a decrease in the number of their prey species such as ducks, coots and moorhens. By late February, painted stork young began leaving the park and they were no longer seen killed. By 5 March, the number of prey individuals had dwindled, and the remaining were leaving the park on their return migration. Aggressive encounters over food and kleptoparasitism were evident between the greater spotted and steppe, among steppe, and between steppe and Pallas's fishing eagles, and these will be discussed in detail in another paper.

Heronries: 15 species of storks, herons and allied species breed in the park (Ali 1953). In 1985 there were five major heronries in the park, three in L-block and one each in D and B–blocks (Fig. 1). L-block contained the largest concentration, with one large heronry at Sapan Mori and another in LW – (sub-divided into the main and outer) around the boating area; scattered *Acacia* between these two large heronries harboured only a few nests, and a small but dense concentration of painted stork nests existed at Bakalia. Average density of nests per mound in the boating area heronry was 42, at Sapan Mori 41, Bakalia 9 and the D–block heronry 5 (Ali and Vijayan 1986).

Seven species, namely little cormorant *Phalacrocorax niger*, shag *Phalacrocorax fuscicollis*, darter *Anhinga rufa*, large egret *Ardea alba*, median egret *Egretta intermedia*, little egret *Egretta garzetta* and openbill stork *Anastomus oscitans* begin nesting around the second week of July. The painted stork usually start in late August or early September, continuing up to November/December. Their peak nesting season, September/October thus coincided with the influx of migrant *Aquila* and other raptors. The painted stork nested socially, mostly among themselves, though sometimes with other species.

Heronry predation: The eagles were opportunists, maintaining no fixed territory, and investigated every jheel for food. They fed at the heronries during the first few weeks of arrival, later shifting to scavenging and kleptoparasitism (on marsh harrier by greater spotted and steppe and sometimes on Pallas's by steppe).

By mid October, the painted stork nests contained young – two to three to a nest of variable age. Predation on stork young continued after the young had fledged. In February and March fledged young still dependent on adults for food, were being killed and on some days as many as four to five bodies were found, with steppe feeding on them along with some greater spotted (Table 1). Most of the predation took place in the large heronry in the boating area. Surprisingly the L–block pair of Pallas's were not observed feeding from the LW-block heronry, though this behaviour has been frequently mentioned for Bharatpur by earlier observers (Ali 1953, Ali and Ripley 1978). A large painted stork colony was observed decimated by a pair of Pallas' where many of the squabs killed were well grown and had only the breast eaten (Lowther 1949). The presence of large numbers of *Aquila* in LW may have deterred the L–block Pallas's pair. Nest predation did not occur at Sapan Mori heronry apparently due to the aggressive nature of the nearby nesting D–block Pallas's pair, which was observed to drive away all raptor intruders from Sapan Mori, where mainly isolated instances of predation were observed by the Pallas's D–block pair.

Among the eagles observed feeding around the heronry, the majority were greater spotted, with four to seven present at once. One steppe was observed on 8 out of 14 days and a single imperial on 6 out of 14 days (Table 1). Out of the 14 days of predation

TABLE 1
PERCENTAGE OF *Aquila* SPECIES FEEDING ON HERONCHICKS AND FLEDGED JUVENILES, DURING THE 1985-1986 SEASON.

Species of Eagle	At the heronry chick stage	Post heronry period juvenile stage
Greater spotted	84.4	38.7
Steppe	8.4	58.1
Imperial	7.2	32.2

The table also reflects the shift in the species composition of the steppe and spotted eagles.

TABLE 2
PERCENTAGE OF PREDATION BY *Aquila* SPECIES

Species preyed upon in 1985	Percentage %
Painted stork	73.5
Cormorant	14.7
Openbill stork	11.8

Painted storks, normally late nesters, were more prone to predation than other heronry species. Late nesters among cormorants and openbill storks were also subject to predation.

observed, on two days six nests of cormorants, on one day four nests of openbill stork, and on seven days 19 nests of painted storks were predated (Table 2). The remaining four days were utilized by the eagles for feeding on leftovers, which were available to them in spite of wastage and feeding by house *Corvus splendens* and jungle crow *C. macrorhynchos*. No adult of the painted and openbill stork, and white ibis *Threskiornis aethiopica* was observed taken by any *Aquila*.

Timing and method of predation: Apparently the heronries were visited early in the morning so that, except for a cormorant squab which I saw being killed by a single steppe, I never observed a kill being made. Even when I visited the heronry at 0600 hrs, half an hour before sunrise, the *Aquila* were already settled and feeding at nests. However, on 26 October 1985, around 0800 hrs, Mr. Rajan Mathur, the deputy Chief Wildlife Warden and Sohanlal, a reliable forest guard, observed in the boating area five greater spotted eat nestlings from five closely placed nests of painted storks on a single *Acacia*. All young were killed and partly eaten.

The method of killing is known only in the case of the cormorant that I saw being killed by the steppe. Four greater spotted were perched on a single *Acacia* where egrets and cormorants were nesting and the top most bird was being mobbed by a marsh harrier. At this time, one steppe flew straight into a cormorant nest (which was a late nest) ousting the adult which flew away. The predator immediately after alighting began defeathering the nearly fledged squab. On this day young cormorants from four other nests were also killed.

A single greater spotted was observed to be unsuccessful in displacing an adult painted stork from its nest (see later). How active were the larger and dominant steppe and imperial in nest predation is not known, though they were seen feeding on nests predated early in the morning, with several greater spotted waiting their turn.

Nests in isolated trees were predated as often as closely placed nests in *Acacia* clumped together. Early mornings, if young from four to five closely packed nests were predated, one greater spotted would be feeding while seven to eight others perched together or singly nearly would be awaiting their turn to feed. If no heronry predation took place in the morning and there were not enough leftovers, the eagles would scatter all over the heronry awaiting an opportunity to find suitable prey or pirate from a marsh harrier.

When fledgelings from a group of nests were killed, and one nest spared, the young from that nest would subsequently be killed.

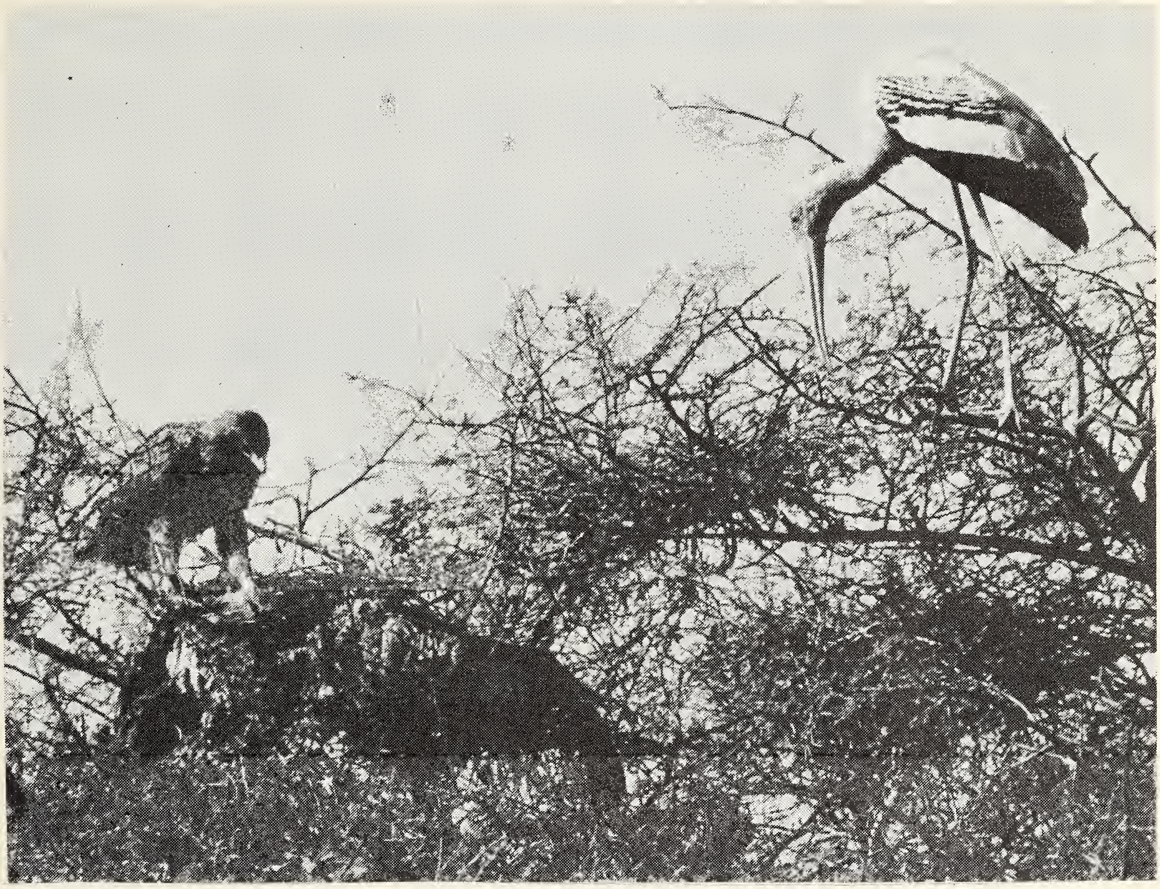
Feeding on predated nestlings: After an average of four to five stork nests, each containing almost fledged young had been predated, 7 to 10 eagles and 15 to 30 crows would feed off the carcasses over two to three days. If undisturbed by crows or other raptors, the eagles would gorge themselves to satiation with crops bulging. At times large numbers of raptors, upto nine of three species, would be gathered, awaiting their chance to feed. By about 1000 hrs usually, all feeding activity would end and the raptors would fly to nearby perches in the shade. If more than two to three nests were destroyed, raptors would sometimes disperse satiated as early as 0800 hrs.

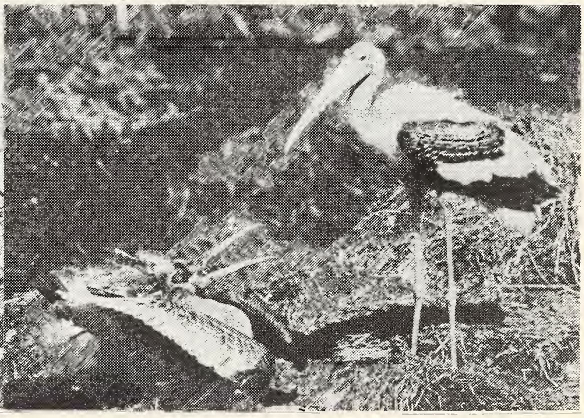
Occasionally, as a consequence of conflicts among predators over a carcass, wastage of food was considerable. While feeding, an eagle might try to take off with a heavy stork young to avoid harassment by crows or from being displaced by another eagle. On many such occasions, the large prey would be dropped into the water before the eagle could get to a safe perch. The following two observations among others illustrate this.

Top: *Aquila clanga* alighting on predated nest displacing the crows.
Bottom left: *Aquila clanga* juvenile mobbed by crow as it feeds on painted stork fledgling.
Bottom right: *Aquila clanga* awaiting its turn to feed is mobbed by crows.

Top: Body of painted stork young hanging out of the nest. Another carcass in the nest is fed upon by crows.
Bottom left: Bold dark juvenile *Aquila clanga* feeding in the heronry.
Bottom right: *Aquila* awaiting their turn to feed in the heronry. *Aq. heliaca* flanked by 2 *Aq. clanga*.

Naoroji: Heronry predation by *Aquila*





Top: *Aquila nipalensis* returns to feed on almost fledged painted stork nestling. Adult stork looks on.

Bottom left: Painted stork adult on its decimated next in protective posture.

Bottom right: Fledged painted stork young begging to be fed on mound away from the main group. Young of this age were also vulnerable to attacks by *Aquila*.

Naoroji: Heronry predation by *Aquila*

Above: *Aquila nipalensis* continues feeding on painted stork young in the jheel after other *Aquila* have left.

Below: Remains of two fledged young painted storks after *Aquila* have fed on the ground.

A steppe alighted on a predated nest but before it could settle down to feed, a greater spotted landed almost on top of it displacing the former which in turn upset the nest, and both stork nestlings fell into the water. On another occasion, two greater spotted alighted together on a nest to feed. One of them, to avoid being displaced, flew off immediately with the carcass of a stork nestling. It stuck the half eaten carcass precariously in the crotch of an *Acacia* 20 m away. However, it subsequently dropped the carcass into the water when disturbed by crows during feeding.

Crows at the predated nests: Usually 11 to 15, and sometimes as many as 20 to 30 house and a few jungle crows were present to exploit heron predation. greater spotted were effectively prevented from alighting on nests by crows on a number of occasions. If an eagle did manage to land on a nest during a frenzied mobbing session (Plate 1), it was often prevented from feeding (Plate 1). When an eagle lowered its head to feed, it was harassed by attacks to the head, pulling of the tail and sometimes by a momentary landing on the back which usually unsettled a raptor considerably, forcing it to fly off and return later.

Mobbing intensity by crows was related to the number of nests predated and number of crows and raptors present on the nest tree (Plate 1). If there were a small number of crows present with four to five nests to feed from and only a few raptors around, the intensity of mobbing would be low and crows would mob only the bird that interfered with their feeding. When an adult painted stork became possessive of its decimated nest and presented an aggressive display, it was mobbed. Many times raptors and crows would feed side by side, the raptor being intermittently mobbed. The crows would then peck at scraps at the edge of the nest, and sometimes even sneak away a morsel between the legs of a feeding raptor, or when the latter's attention was held elsewhere, usually by another mobbing crow or raptor.

Crows would jostle amongst themselves. On two occasions on the same day, a crow lifted its leftfoot and kicked sideways at a jostling neighbour, unsettling the latter which flew off. Crows would continue feeding on the leftovers in nests after the satiated eagles had left (Plate 2) and occasionally even in the evenings. However, their main feeding period was in the morning. If there was no fresh prey in the morning they appeared to wait for the eagles to kill.

Dominance hierarchy among raptors: Greater spotted were the most numerous, but the larger steppe and imperial were clearly more dominant and were observed, on eight and six occasions respectively, feeding relatively undisturbed by the greater spotted early in the mornings. The imperial, though the largest, was shy and would fly off, if disturbed by the approach of boats. Steppe in a similar situation would remain or re-alight later to feed. When satiated, the larger eagles would allow themselves to be displaced by the smaller raptors perched nearby awaiting their chance. Among the more numerous greater spotted, a larger individual would immediately displace a smaller one, which would fly off and wait to displace the larger after it had fed substantially. However, one small, dark juvenile greater spotted, almost black and easily recognisable, was very bold and dominant; it often displaced larger conspecific individuals (Plate 2) and occasionally even a steppe.

Greater spotted frequently displaced each other during early mornings. It was a common sight to see them replacing each other in quick succession at the fresh carcasses in a few nests (Plate 2), with five or more impatient hungry raptors perched on the same or a nearby tree awaiting their turn to feed. Early in the morning, the dominant eagles were hungry and held their ground, aggressively displaying and vocalizing at other nearby eagles awaiting their turn. In 1988 at around 0900 hrs. I observed an adult imperial perched on an *Acacia* above a spotted feeding on a newly fledged grey heron *Ardea cinerea*. The imperial vocalised for about five minutes before displacing the spotted.

Reaction of storks to predators: On two occasions only in 1985 was a painted stork seen using a threat display effectively against a greater spotted and a steppe. In the first case, after feeding for fifteen minutes on a day old carcass at a painted stork's nest, an immature greater spotted flew to an active nest, where the adult painted stork successfully defended its nestling with a typical threat display, namely, wings widespread and mandibles clicking. The eagle countered with a wings spread pose, which was ineffective, the stork refusing to budge. After two minutes the eagle flew back to feed on the stale carcasses. It is possible that if there had been a collective attack by the eagles, the stork's reaction may have been different.

In the second incident, which occurred at 0625 hrs, four *Aquila*, one steppe and three greater spotted were feeding on an *Acacia* where young from six nests were eaten over a period of two days. Three other greater spotted were perched nearby apparently waiting an opportunity to feed. An adult painted stork flew to the *Acacia* and perched near the nest where the steppe was feeding. The stork flew off after 20 minutes, only to return within 10 minutes to drive off the feeding steppe. The stork remained on the nest lunging menacingly with bill stretched towards the nearest eagle and crows, with wings widespread and mandibles clicking. The crows, however, continued to feed nearby at a safe distance. The adult stork probed its partially eaten young with its bill a few times, while lunging repeatedly at the steppe as it flew low over the nest contemplating a landing. An hour later the same steppe landed on the nest ignoring the painted stork which demonstrated threateningly with head raised. The stork did not, however, lunge at the steppe but moved away, while the eagles resumed feeding (Plate 3). Eventually, after remaining perched for some time, the painted stork flew away to settle nearby. Later, the painted stork again returned for a few moments to the nest before flying off to a nearby tree.

In 1988 a spotted was observed at 0905 hrs, perched above an imperial feeding on a grey heron. It suddenly flew to a painted stork nest containing two large young. The young and an adult painted stork perched nearby displayed with much wing flapping and mandibles clicking. The eagle perched on the nest rim flew away after four to six seconds.

These incidents appear to be exceptional since the adult storks usually stood by impassively and watched their chicks being eaten by the eagles. The adult storks (single birds) were occasionally observed to perch motionless above their predated nests for considerable periods after the eagles had left, probing and prodding with their bills their dead young in the nest (Plate 3). This behaviour was observed mainly during the evenings, only on the days the young were killed. Sometimes, while crows and eagles were feeding on freshly killed nestlings, an adult stork would perch on a branch above its nest and watch without interfering for 15 to 20 minutes, sometimes even longer (once over two hours) if undisturbed by the eagles.

Once a dislodged nestling, a survivor from among four predated nests, was found preening unconcernedly near the base of the nest tree, while the eagles fed above on its siblings. It was killed two days later. No contact was observed between the adult stork perched on the *Acacia* and the displaced young while the raptors were feeding. On two separate occasions, an adult openbill stork and white ibis were seen to alight on the very same *Acacia* in which *Aquila* were feeding on painted stork young and watch the proceedings for on a few minutes before flying off.

Predation on newly fledged painted storks: Once the fledged painted storks left their nests, they were still fed by their parents and vulnerable to attacks by *Aquila*. Fledgeling storks would cluster together in large groups on the ground. At this stage, they could fly but not as strongly as the adults. They would leave the groups individually to be fed when their parent alighted nearby, but always away from the main group (Plate 3). After the feed the young storks would rejoin the group. These groups were attacked by the eagles, presumably during the early morning. As in the case of the heronry killings, no actual attack was observed. Predation on the young storks continued during their fledgling period till around 20 February, when they began leaving the park. Fledged painted storks appeared to be one of the main food sources of *Aquila* in 1985/1986 winter, supplemented with food obtained by pirating and to a lesser extent by actual hunting and opportunistic carrion feeding.

From 8 January to 20 February, 11 instances were recorded in L– block (outer and inner boating) and Bakalia area (Map) and one in D–block, involving a total of 14 dead storks and 36 *Aquila* – out of which 12 were greater spotted, 23 steppe and one imperial. In one observation, probably a natural kill, an egret was fed upon by two greater spotted, two steppe and one juvenile imperial. In another observation five dead storks were located in one morning, three in outer boating area and two at Bakalia.

On 31 January 1986, from my hide at Bakalia around 1030 hrs I saw two carcasses of fledged painted stork about 100 m apart. The carcass nearer the hide was fed upon by three steppe and one greater spotted on the ground at the base of a heronry mound. Marsh harriers frequently investigated the feeding *Aquila* and even perched frequently for long periods a few feet above them. The usual dominance hierarchy occurred with repetitive displacement and confrontations already described. A few unusual interactions that occurred on this day are mentioned. While two *Aquila* fed, the nearby eagles awaiting their turn were observed to repeatedly drive off the crows ensuring more food for themselves when they got the opportunity to feed. At 1212 hrs a wild boar *Sus scrofa* foraging nearby approached the eagles and appropriated the kill. The eagles and crows flew away. Ten minutes later a steppe perched above the feeding boar, who left at 1230 hrs. At 1557 hrs the wild boar returned and fed on the remaining scraps. When the kill was later examined at 1628 hrs, only the feathers remained attached to the partly eaten legs. A few days later near the same spot a wild boar was observed driving off a gathering of steppe and greater spotted, scavenging a day old stork kill.

Most of the carcasses would last the *Aquila* two days or more. All prey were found on the ground, except in D–block on 8 January when a young was killed in a nest, probably when resting. The eagles fed in shallow water or where the thickness of grass adequately supported their weight (Plate 4). A fledged painted stork was seen standing motionless on the main road opposite D–block between Sapan Mori and Keoladeo temple, with serious head injuries from which it died a day later. On another occasion in the LW outer boating area four painted storks were lying dead together in shallow water under a low thorny bush where they must have crawled for protection and died, after an attack (Plate 4). I can find no other reason for finding the bodies in such an inaccessible place. On another occasion, four steppe and two greated spotted, one of the fulvous morph, were feeding on a carcass in Bakalia area in L–block under another thorny bush.

After 20 February 1986, killings were rarely observed, as most painted stork had left the park. March onwards the herons and egrets commenced nesting again, mainly in D–block and by mid to late April most *Aquila* had left. On 11 March in D–block, I observed a steppe feeding on the eggs of a grey heron. By mid April after I had left, three remaining *Aquila* – one juvenile imperial and two juvenile greater spotted – ate 38 clutches of purple *Ardea purpurea* and grey herons, so that heronry success was nil in 1986 summer (V. Prakash, pers. comm.). It appears that 1985–1986 was an exceptional year for heronry predation by *Aquila*.

Discussion

The *Aquila*, with the exception of the imperial, were not territorial on their wintering grounds in Bharatpur though they had preferred loafing sites. They are known opportunists (Brook *et al.* 1972, Brown and Amadon 1968, Brown *et al.* 1982, Morel *et al.* 1957), and were observed feeding on all kinds of prey they could find, or easily overcome, such as injured birds and young squabs from the heronry, taking carrion including stranded fish, pirating from marsh harriers and even Pallas's, and doing little active hunting. In a habitat less favourable to opportunism (Paulson 1984), their hunting would probably increase considerably, as they are efficient hunters especially in their breeding haunts (Brown and Amadon 1968, Dementev *et al.* 1966, Steyn 1973). They are versatile and ecologically unspecialized. In their search for food, they visited all areas in the park, though mainly the marshland where most opportunities existed for locating food. In fact their winter movements within the park were apparently governed mainly, if not solely, by the search for food (Newton 1979). Thus, when the heronry is successful it could serve as an important source of easy food for the *Aquila*, who are attracted to the area because of an abundant food supply (waterfowl and other migrant species) and turn to the herons when they are available.

Most of the wintering *Aquila* here are juveniles and subadults, which are known to winter further south than adults (Bijlsma 1983, Brook *et al.* 1972, Christensen *et al.* 1981). A successful heronry could thus ensure a higher rate of survival for the comparatively inexperienced juveniles. Initially the greater spotted was more numerous among the *Aquila* but from February onwards, steppe outnumbered the other raptors (except vultures) and became extremely dominant often in pairs or larger groups. The greatest densities of *Aquila* and other migratory raptors found in the park are in the vicinity of water, and this coincides with the greatest prey-population densities. Species diversity and abundance fluctuates in different years (Ali and Vijayan 1983, 1986) due to many reasons, and it would be interesting to note whether raptor numbers fluctuate correspondingly over a long period.

Most of the heronry killings in 1985 took place in LW where the largest number of nests are concentrated, mainly in boating area and Bakalia but surprisingly not at Sapan Mori. This was probably due to the aggressive nature of the D-block Pallas's pair who were very defensive of their hunting territory as they were nesting. Painted stork nests were predated mostly by the *Aquila* as they nested later than the other monsoon waterbirds, and their young were easy prey for migratory eagles as they offered little or no resistance. Adult painted and openbill storks and white ibis were not taken. Almost fledged and fledged painted stork young are large birds and, considering wastage and sharing prey with at least 15 to 20 crows, four to five carcasses would adequately last a couple of days.

No kills were observed made around sunrise, during the day or the evenings. Thus a reasonable surmise would be that the fledged storks were killed in and out of their nests early in the morning before sunrise or at night. As the peak killing period coincided with moonlit nights it is definitely plausible that the eagles took advantage of bright moonlight. A possible correlation between predation and phases of the moon needs to be investigated. Vultures have been observed in forest feeding in moonlight (Gough 1935, Grubh 1974, Lewis 1940, Livesey 1938, Morris 1935). The black-shouldered kite *Elanus caeruleus* has been recorded hunting at night and active before dawn (Steyn 1971), as have nocturnal group flights of the pale chanting goshawk *Melierax canorus* (Rasa 1986).

The greater spotted, which outnumbered the other *Aquila* species during the heronry period, appeared to do most of the hunting. Probably they drive off the relatively placid adults with advantage of numbers and then attack the large but helpless young. Another factor contributing to this pattern of predation may be the vulnerability of the nests at night as predators are known to synchronize their predatory activity to prey vulnerability (Curio 1976). This may have been of great advantage to the *Aquila* and contributed to their success in taking so many of the large fledglings. Destruction of nests was systematic. Usually only after young from closely packed nests on a single or cluster of *Acacia* were eaten, would the eagles move on to attack occupants of nests in adjacent or nearby trees after killing the few survivors.

Whether the adult painted storks were driven collectively off their nests by greater spotted or other *Aquila* as they brooded their almost fledged young on or near their nests is not known. It appears probable that attacks were directed at the head, as a number of dead fledglings had sustained head and neck injuries. In 1986 due to severe drought only nine adult painted storks were counted and nesting did not occur. There were also fewer *Aquila* and migratory prey species. Most of the raptors that visited the park disappeared after a few days for lack of food opportunities. In 1987, the second consecutive year of prolonged drought, no waterbirds nested. In 1988, due to a good monsoon the heronry was successful though, unlike in 1985, scattered over the park mainly in L–block. Grey herons, egrets and cormorants were predated more frequently than painted stork in the boating area. Raptor numbers were lower than in 1985 and 1986, periodically fluctuating, and mainly concentrated in L– block.

The scale and magnitude of the 1985 heronry predation was not observed. 1985 was undoubtedly a peak predation year when 2433 painted storks nested totalling 1749 nests for the whole park and 1004 in LW (Ali and Vijayan, 1986). According to a forester Bholu Khan (pers. comm.), the systematic and prolonged killings were never witnessed here earlier. Unfortunately no written records exist except for stray observations. It is possible, however, that heronry predation was overlooked. How much these predatory attacks affect breeding success, if at all, as painted storks nest in hundreds, is not clear. My observations which covered the major phase of predation of painted stork young in nests during 1985 indicated a minimum predation rate of 2.5% in LW and 1.4% for the entire park, which would closely match the actual predation.

Heronry success is directly dependent on two main factors: water level and the millions of fish fry that come in with the flood waters. With natural factors unfavourable for the nesting waterbirds, as in

1984 when painted stork numbers were as low as 440 (Ali and Vijayan 1986), predation and consequent disturbance could have a negative effect on the breeding success of vulnerable species. If this systematic killing in the heronry continues, long-term observations on the heronry would shed some light on many interesting points, such as inter-relations between heronry success (the various natural factors contributing to this success) with arrivals of raptors and extent of predation in heronry, mode and timing of attacks and species or combination of species and number of predators involved, main species predated over a number of years, and effect of predation, if any, on heronry success in any given year. This will elucidate the optimum conditions suitable for the destruction of nests by the *Aquila.*

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VOCAL ACTIVITY OF THE INDIAN GRAY MONGOOSE *HERPESTES EDWARDSI EDWARDSII* (GEOFFROY) IN CAPTIVITY[1]

JAGATHPALA SHETTY, GUNAPALA SHETTY AND S.R. KANAKARAJ[2]

(With a text-figure)

Patterns of day and night vocal activity have been studied in a group of Indian gray mongoose *Herpestes edwardsii edwardsii* Geoffroy, with special reference to 'conversation type' of vocalization. The hourly recording of the calls revealed that the mongooses become communicative with daybreak, reaching a maximum by dusk. The vocalization was least or absent during nights. The juveniles were most vocal, the subordinates moderately, and the dominants least vocal. The possibility of vocalization playing a role in their social ranking has been discussed.

INTRODUCTION

Among mongooses vocalization is an important medium of communication in view of their size and the habitat of dense grass and brush which affords limited visibility. Reports on acoustic features of mongooses are scanty and not exhaustive (Ewer 1973, Mulligan and Nellis 1975, Jacobsen 1982). Since there are no reports on the acoustic features of the Indian gray mongoose a detailed study on the day and night patterns of vocal activity of this species has been made.

METHODS

The study group consisted of seven individuals of Indian gray mongoose *Herpestes edwardsii edwardsii* Geoffroy, captured around the environs of Mysore city and quarantined for about 6 months together, during which time a social hierarchy had been established. Based on factors like ability to guard prey, aggression and grooming they were categorised into three groups (Table 1).

During the month–long period of observation the three groups were housed in three cages in a single room. All through they were fed once a day around 1700 hrs with beef and eggs. Water was made available *ad lib.*

Hourly recordings of the calls of 'Conversation type' was made in the 24 hour cycle. A minimum of 8 observations of each hour of the day/night was made at least once in 4 days since continuous observation was not practicable. Though it was possible to record calls of individuals during the daytime, it was difficult to distinguish during nights and therefore scores have been recorded only for groups. The results for all three groups are presented in Fig. 1.

For statistical analysis the 24 hour cycle was divided into 6 units of 4 hours each (Table 2). To bring out the natural trends in vocalization and differences in different groups and also with reference to the time of the day/night, two–way as well as one–way analysis of variance for the number of calls by different groups of individuals have been made.

OBSERVATIONS AND DISCUSSION

The vocal repertoire of the Indian gray mongoose has been observed to include several types of sounds and calls. Most of these were in response to a visual stimulation from outside like responding to provocation, attacking the prey, devouring recently killed prey etc. The type of vocalization selected for detailed analysis in the present study is of 'Conversation type' (Ewer 1973). This category of vocalization was observed to accompany almost any activity, it was non–aggressive and did not depend on any visual stimulation from outside. This type of sound is produced in the throat without opening the mouth as a part of their social communication.

The pattern of vocal activity during a 24 hour cycle was found to be similar for all the three groups of individuals (Fig. 1). They become communicative with the daybreak, reaching the maximum around the time of sunset. During nights vocalization was

TABLE 1
DETAILS OF COMPOSITION OF THREE EXPERIMENTAL GROUPS OF MONGOOSES

Group	Status	Sex	Body weight range (g)
A	Juveniles (2)	Females	165–170
B	Subordinates (3)	Females	620–705
C	Dominants (2)	Males	950–1250

The number in parenthesis indicates the number of individuals in each group.

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TABLE 2
NUMBER OF CALLS OF 3 GROUPS OF MONGOOSES IN 4 HOUR UNITS IN A 24 HOUR CYCLE

Time of day/night	Number of calls (Mean of 8 observations/group/individual ± S.D.)		
	A	B	C
0600–0959 hrs	6.27 ± 0.344	3.73 ± 0.228	1.84 ± 0.168
1000–1359 hrs	21.03 ± 0.550	13.02 ± 0.377	7.02 ± 0.542
1400–1759 hrs	32.17 ± 0.465	23.43 ± 0.302	14.09 ± 0.369
1800–2159 hrs	21.37 ± 1.205	15.68 ± 0.577	5.84 ± 0.375
2200–0159 hrs	1.18 ± 0.203	1.03 ± 0.158	0.10 ± 0.050
0200–0559 hrs	0.46 ± 0.083	0.062 ± 0.028	0.00 ± 0.000

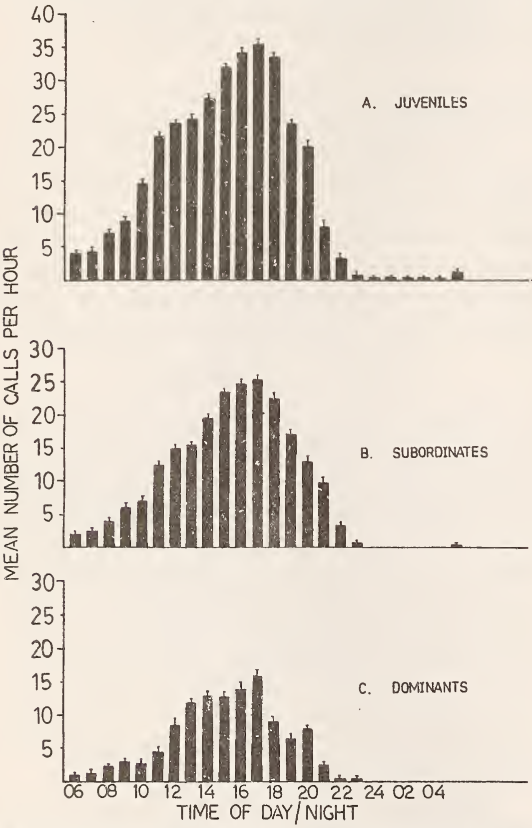

Fig. 1. Number of calls per hour in three experimental groups of mongooses (Mean ± S.D.)

least or completely absent. The juveniles were relatively more vocal, the subordinates moderate and dominants least as represented by the mean number of calls per hour (Table 2).

A two–way analysis of variance has shown that the interaction between the groups and time periods to be highly significant (P< 0.01). A one–way analysis of variance of the number of calls of different groups with respect to the time periods (Table 2) has also shown to be highly significant (P< 0.01). A comparison of three groups during a time period (Table 2) reveal that the difference was highly significant from 0600 to 1759 hrs (P< 0.01) and significant between 1800 and 2159 hours (P< 0.01). There was no significant difference in the number of calls between the three groups during the time period 2200 and 0559 hrs.

The pattern of vocal activity is clearly indicative of the diurnal habit of Indian gray mongoose. The increased vocalization during dusk may be attributed to the time of feeding in captivity in the present study. An innate demand for food due to hunger may be expressed in the form of increased vocalization, more so in the juvenile group. Shipley (1986) has suggested temperature to be a factor influencing the rate of vocalization in elephant seals. But in gray mongoose the data on hand is not indicative of temperature influencing vocalization. The present study denotes the possibility of the conversation type of vocalization in the Indian gray mongoose to be an expression of activity such as exploration and food finding, the juveniles giving greater number of calls than the adults. Vocalization thus may have an important role to play in their social ranking.

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STUDIES ON NESTING AND ARTIFICIAL HATCHING OF THE ENDANGERED RIVER TERRAPIN *BATAGUR BASKA* (GRAY) IN THE SUNDARBANS TIGER RESERVE, WEST BENGAL[1]

ARIN GHOSH[2] AND N.R. MANDAL[3]

(*With a plate*)

Nesting ground of the endangered river terrapin *Batagur baska* was first recorded on the beaches of the Sundarban Tiger Reserve of West Bengal during February–March 1988. Three clutches of eggs were collected from the Mechua beach (Bagmara block) of the National Park. In the hatchery, after 60–66 days of incubation, hatchlings emerged. Average hatching success of 48% was recorded. Artificial hatching of *Batagur* has been done for the first time in India.

INTRODUCTION

Batagur baska has been one of the most exploited estuarine turtles over the centuries and is listed as endangered in IUCN Red Data Book. Four large riverine turtles *Batagur baska*, *Callagur broneoensis*, *Kachuga trivittata* and *Pelochelys bibroni* inhabit the estuarine habitat throughout tropical Asia (Moll 1985). The population of all these four species have been very much depleted over the years. The river terrapin *Batagur* is moderately large, web– footed and is distinctive in having four clawed toes on the forelimb. Moll (1976, 1978, 1980), Siow & Moll (1982) and Tikader & Sharma (1985) have discussed the biology and its exploitation. This terrapin inhabits the lower reaches of major rivers over the tropical mainland of Asia and is reported to be available in Sumatra, Malaysia, Thailand, Bangladesh, Burma and the Sundarbans of India.

Batagur was formerly abundant at the mouth of Hooghly river where they were captured in large numbers (Gunther 1864). Theobald (1868) reported that the terrapin was used as substitute for sea turtle in making turtle soup. In Bangladesh, *Batagur* has recently been discovered in the Sundarbans (Khan 1982, Whitaker 1982). There has been no report of its presence and nesting in India for the last several years. Maxwell (1911) reported the numbers of this river terrapin as declining in Burma. Wirot (1979) pointed out that in Thailand the population has been heavily exploited. In Malaysia the river terrapin is found in the large rivers. The decline in its population is documented by Loch (1950), Mohamed Khan (1964), Moll (1980) and Siow & Moll (1982).

Three clutches of eggs of the *Batagur* were collected during February and March 1988 from the beaches of the Sundarban Tiger Reserve and successfully hatched in the hatchery.

Nesting ground: The nesting ground of the river terrapin was located on the Mechua sea beach (Bagmara block) of the National Park in the course of searching for Ridley turtle eggs. Following the flipper marks on 25 February 1988 a nest was located in the sandy beach 25 m away from the maximum tide water mark. The nest was excavated and 32 eggs were found. The nest chamber was 30 cm deep. The upper layer of eggs was found at a depth of 15 cm. The chamber was flask shaped, the length and width being 27 and 13 cm respectively.

On 3 March 1988 another nest was located 80 m away from the maximum tide water mark. While excavating the nest, 19 eggs were found. The nest was 40 cm deep and the upper sand layer above the eggs was 30 cm thick. The egg chamber was flask–shaped, 18 cm in length and 15 cm in width. On the same date another clutch was located which was 158 m away from the maximum tide water mark. This nest was 45 cm deep and the upper sand layer above the eggs was 30 cm. The length and width of the chamber was 28 and 20 cm respectively. 37 eggs were collected from this nest.

Hatching in hatchery: The eggs of the three nests were marked in the conventional manner on the top pole before transferring them to the transportation bucket and carriage (following Pritchard *et al.* 1982). The eggs were oblong shaped, average dimension 68 x 40 mm and the average weight 70 g. These eggs were transferred with the original sand to the hatchery at Pakhiralaya, where artificial nests

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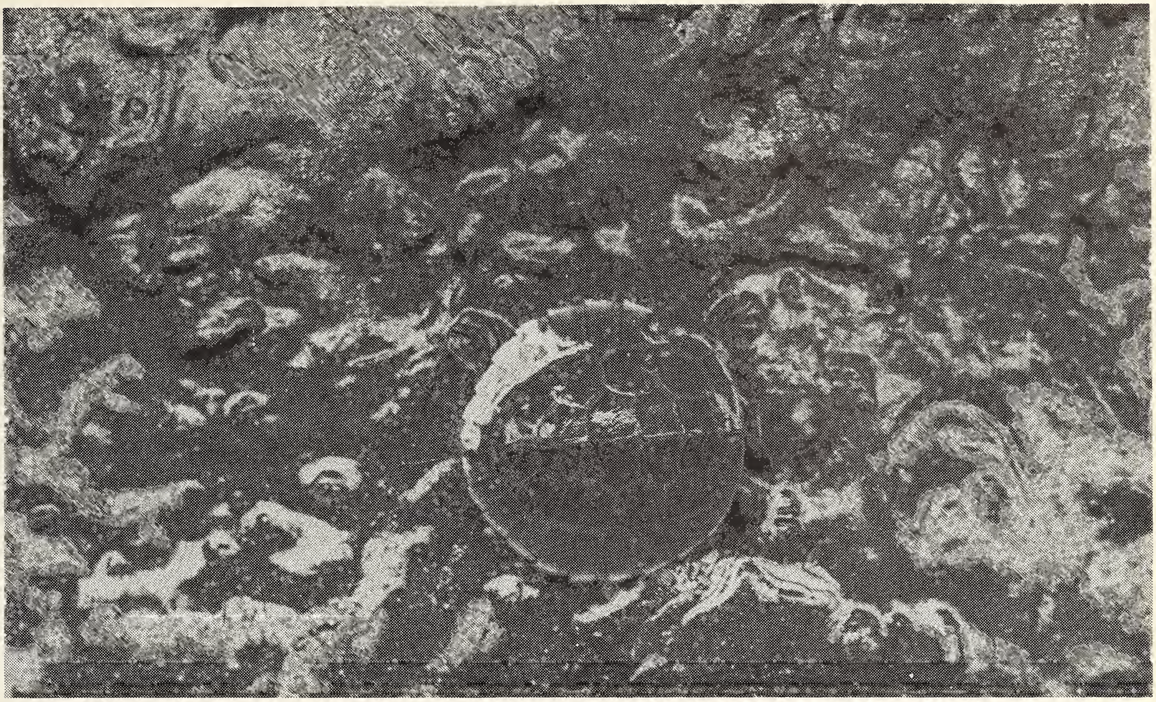

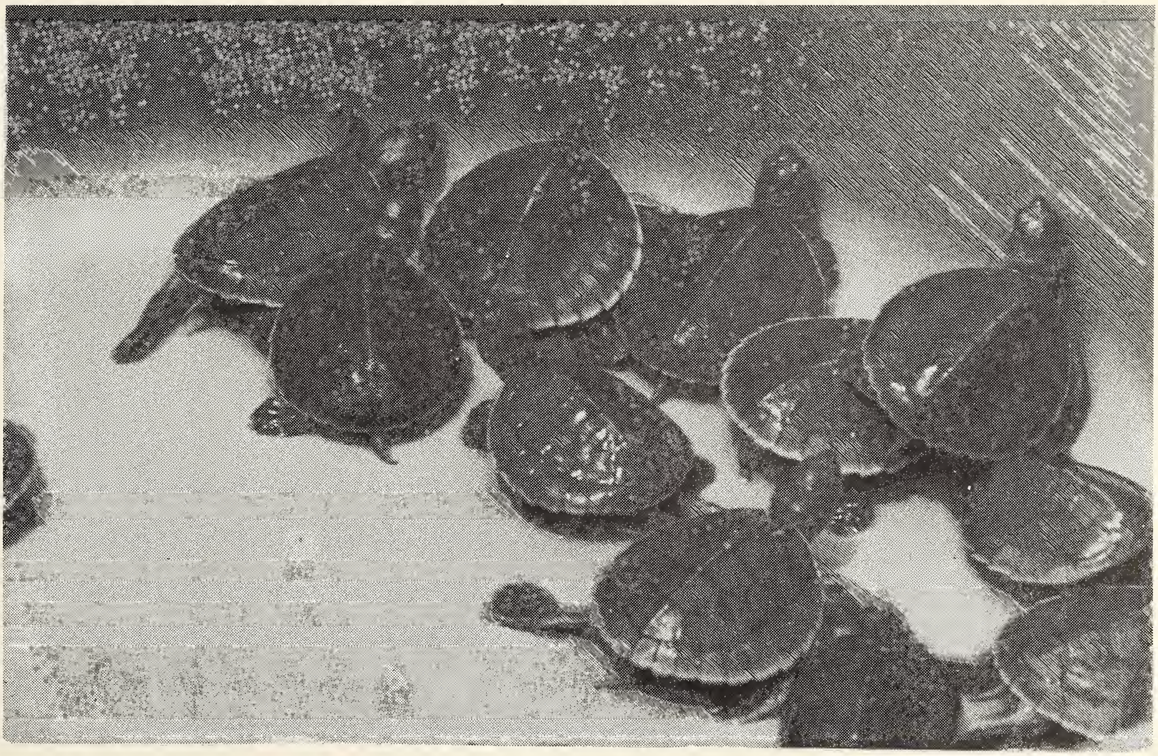

Hatchlings of *Batagur baska* in Sunderbans Tiger Reserve.

were prepared.

Hatching technique: Artificial nests were prepared using the original estuarine soil and sand in a trench of size 3 m x 1.5 m. Nest cavities were scooped out resembling the original one and the eggs were placed in separate clutches as collected. A hollow bamboo pipe was inserted at the centre of each egg chamber for placing a thermometer through the pipe to record the nest temperature. The temperature of air and nest was recorded daily at 3 hr intervals.

The clutch collected on 25 February 1988 containing 32 eggs was marked as Nest I. 19 eggs collected on 3 March 1988 were marked as Nest II, and 37 eggs collected on 3.3.1988 were marked as Nest III.

Hatching: The eggs started hatching in Nest I at 66 days of incubation and in Nest II and III at 61 and 62 days respectively. The temperature records showed the nest temperature remained within 24.7° C to 33.1° C (Table 1).

Hatching behaviour: In Nest–I first hatching took place on 1 May 1988 and one hatchling came out in the early morning on 2 May 1988 at noon; at 2100 hrs. 2 hatchlings emerged and on 3 May 1988 at noon 4 hatchlings came out. From this nest a total of 7 hatchlings were obtained. The other eggs were examined but no sign of embryo formation was noticed. Hatching success in this nest worked out to be 21.9%.

In Nest II one hatchling came out on 2 May 1988 at 0900 hrs. On 3 May 1988 at 0700 hrs one hatchling and at 2100 hrs another hatchling emerged. On 4 May 1988 at 0600 hrs 7 hatchlings, and at 1800 hrs 5 hatchlings emerged. The remaining eggs were unfertilised. In this nest 79% hatching success was achieved.

In Nest III on 1 May 1988 between 0600 to 2100 hrs 15 hatchlings emerged, and on 2 May 1988 at 1900 hrs 2 hatchlings came out. In this clutch 46% hatching was observed.

All the hatchlings were active and healthy; the average weight was 45 g. The shape of the hatchlings was nearly circular. Length and width of the carapace was 6 cm. The total length from snout to tail is 10 cm. Forelimb and hindlimb were 3.5–4 cm in length. The newly hatched hatchlings were kept in the nursery tank, their rearing being especially cared for.

Discussion

Finding of nests of *Batagur* in the Sundarban Tiger Reserve is the first recent record of this species, nesting ground in India. This indicates the presence of *Batagur* in the Hooghly–Matla estuaries, though there is no record available regarding the population density and abundance of this species.

On account of large scale exploitation for its eggs and flesh for food, *Batagur* was over–exploited in Bengal in the mid 19th century. Habitat destruction is also a very important factor for the decline of this terrapin in Malaysia, Thailand and India (Tikader and Sharma 1985). However, in view of the good protection being accorded to the habitat by Project Tiger authorities the terrapin may be able to re–establish itself in its erstwhile habitat.

The nesting of *Batagur* is nocturnal and the nests obtained between February and March coincide with the time of nesting in Malaysia (Moll, 1985). Only 3 clutches were obtained and the number of eggs varied from 19–38 and perhaps only 2–3 females landed on the beach for egg–laying. The

Table 1

Temperature records of the air and the nests of *Batagur*

	0600 hrs		0900 hrs		1200 hrs		15000 hrs		1800 hrs		2100 hrs	
	Air	Nest	Air	Nest	Air	Nest	Air	Nest	Air	Nest	Air	Nest
Nest I												
Mean temp.° C	24.7	27.4	29.0	28.4	32.7	29.2	32.7	29.5	27.4	28.8	25.6	28.2
S.D. ±	1.96	1.96	1.57	1.93	1.77	1.88	1.70	2.03	3.29	1.85	1.54	1.90
Nest II												
Mean temp.°C	24.9	28.1	29.2	28.8	32.8	29.0	33.1	29.8	27.5	29.2	26.1	28.7
S.D. ±	1.87	1.7	1.42	1.56	1.35	1.59	1.51	1.52	3.51	1.44	1.26	1.58
Nest III												
Mean temp.°C	24.9	28.1	29.2	28.8	32.8	29.5	33.1	29.9	27.5	29.6	26.1	28.8
S.D. ±	1.87	1.71	1.42	1.58	1.35	1.60	1.51	1.57	3.51	1.45	1.26	1.58

survey of the beaches of the National Park has been continuing from 1983 for the collection of Ridley's sea turtle eggs, but it is the first time that the *Batagur* eggs have been found.

The hatching results in the present study showed that the incubation period ranged between 60–68 days. Moll (1985) reported that in Malaysia the incubation period is approxi¬ately 90 days. The lower incubation period in the present study may be due to the change of microclimatic conditions and to certain abiotic factors. The hatching success achieved in the 3 nests was 21%, 79% and 44%. This indicates that all the eggs were not fully fertilised or that handling of the eggs killed some of the embryos.

The records of temperature showed very little variation of the nest temperature throughout the incubation period, though there was considerable variation in air temperature.

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REVISED NOMEN CLATURE FOR TAXA IN WYNTER–BLYTH'S BOOK ON THE BUTTERFLIES OF INDIAN REGION – III[1]

R.K. VARSHNEY[2]

[Continued from Vol. 82 (2): 321]

In the earlier two parts of this study (Varshney 1980, *JBNHS 76(1):* 33-40; 1985, ibid. *82 (2):* 309-321) eight families, namely Danaidae, Satyridae, Amathusiidae, Papilionidae, Pieridae, Acraeidae, Lycaenidae and Hesperiidae, have been covered. In the present part, which is the third and last in this series, the remaining two families of Wynter-Blyth's book, namely Erycinidae and Nymphalidae, have been dealt with. The style of presentation is as earlier, e.g. taxa which do not require any change have been left out from the tables.

Family LIBYTHEIDAE

Libytheidae is represented by a single genus, *Libythea*, in South Europe, Africa, America and Indo-Australian region. These butterflies, which have the common name 'The Beaks', are more close to Family Nymphalidae, but differ in their long palpi, which are porrect and beak-like. These are low flying species.

Wynter-Blyth has included *Libythea* in Family Erycinidae. However, modern workers treat this group as a separate family. No change is required in the generic name of the four species. *L. myrrha*, *L. lepita*, *L. celtis* and *L. narina*, included by Wynter-Blyth (1957 : 238-240). However, the author of generic name *Libythea* is Fabricius. Additional information come across is that *L. narina rohini* Marshall occurs in Assam, and *L. geoffroyi* Godart occurs in Burma, in the Indian region.

Family RIODINIDAE

Family Erycinidae of earlier authors is now referred to as Riodinidae. Some other authors call it Nemeobiidae. Wynter-Blyth has treated the taxa of this as well as the preceding family under Erycinidae. This is a small family comprising of species more closely related to the Lycaenidae than to the Nymphalidae. The family is represented on all continents, except Australia, but is predominantly a tropical American family. The butterflies occur locally, flying in sunshine, and their male genitalia shows affinity to the Lycaenids.

I have followed Corbet & Pendlebury (1956, BUTTERFLIES OF THE MALAY PENINSULA, 2nd ed.) and some other works for the revision of names. The changes are given in Table 9. Important changes are found only in the author's name, e.g. author of *Dodona egeon* is Westwood and not Doubleday; and authors of *Abisara kausambi* and *A. savitri* is not Felder, but C. Felder and R. Felder jointly. Peile (1937, A GUIDE TO COLLECTING BUTTERFLIES IN INDIA) shows *Dodona ouida phlegra* Moore as an Indian subspecies.

Family NYMPHALIDAE

About 15 years back I observed, "Unluckily there is no revised monographic study on the Nymphalid butterflies of the country, which is one of the largest families of the group. Whereas Bingham (1905, 1907) and Evans (1932) are old and Wynter-Blyth (1957) inadequate, there the *Fauna* volumes by Talbot (1939, 1947) do not cover this family"

TABLE 9
RIODINIDAE

Page No.		For	Correct
		Subfamily HAMEARINAE	
1.	240	Genus *Zemeros*	Genus *Zemeros* Boisduval
2.	240	*Zemeros flegyas* Crame	*Zemeros flegyas indicus* Fruhstorfer
3.	240	Genus *Dodona*	Genus *Dodona* Hewitson
4.	241	*Dodona dipoea* Hewitson	*Dodona dipoea nostia* Fruhstorfer
5.	242	*Dodona egeon* (Doubleday)	*Dodona egeon* (Westwood)
		subfamily RIODININAE	
6.	243	Genus *Abisara*	Genus *Abisara* C. & R. Felder
7.	244	*Abisara kausambi*	*Abisara kausambi* C. & R. Felder
8.	245	*Abisara savitri*	*Abisara savitri* C. & R. Felder
9.	245	Genus *Taxila*	Genus *Taxila* Doubleday
		subfamily EUSELASIINAE	
10.	246	Genus *Stiboges*	Genus *Stiboges* Butler

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[Varshney and Chanda 1971 (1974), *Indian Mus. Bull. 6 (1):* p. 51]. Unfortunately the situation has not altered as yet.

In the absence of any revisionary study on the Indian Nymphalidae, I have opted for outside sources for the present revision, though I may frankly admit my limitations. Corbet & Pendlebury's THE BUTTERFLIES OF THE MALAY PENINSULA (1956, 2nd ed.) and its latest revision by J.N. Eliot (1978, 3rd ed.) have been consulted extensively. THE BUTTERFLIES OF JAPAN by Kawazoe and Wakabayashi (1980, revised ed.), and ENCYCLOPEDIA OF THE BUTTERFLY WORLD by Smart (1985) were found helpful in many cases. Hemming (1967, *Bull. Br. Mus. (Nat. Hist.) Ent.*, Suppl. 9) has been followed for generic information. Through the courtesy of Lt. Col. J.N. Eliot I got a copy of his monograph on Neptini (Eliot 1969, ibid. *15*) which proved indispensable. However, I could not get D'Abrera's BUTTERFLIES OF THE ORIENTAL REGION Part 2.

There are a large number of changes in the names of taxa of this family from that given in Wynter-Blyth's book (see Table 10). I pointed out some of these changes in an earlier work dealing with the common and scientific names of Indian butterflies (1983, Index Rhopalocera Indica - Part II. *Rec. Zool. Surv. India, Occ. Paper 47*). Notes on the important changes in Table 10 are as follows:

Generic name *Eriboea* Huebner is now treated as a synonym of *Charaxes* on subjective taxonomic basis; as such the former genus is given its next valid oldest name *Polyura* Billberg. One species of it, *schreiberi*, has been changed to *schreiber* in Corbet and Pendlebury (1978), and I could not see the original publication of Godart. *C. polyxena* (Cramer) is preoccupied. Genus *Agatasa* has been formed to receive *Nymphalis calydonia* Hewitson, which is said to be the most beautiful butterfly by some authors. *Prothoe franckii* was first corrected to '*francki*' in their 2nd edition, and then to '*franck*' in the 3rd edition of their book by Corbet & Pendlebury. Smart (1985) has also used the latter spelling, but Hemming (1967) shows that Huebner 1824 proposed genus *Prothoe* with a new species *franckii* (monotypy). I feel that the original spelling should be preserved as per Articles 31-32 of the INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE (1985, 3rd edition). Among the additional species of Charaxinae from the Indian region, not reported by Wynter-Blyth, I have come across two: *Charaxes kahruba* Moore, and *Prothoe regalis* Butler from Assam. Genus *Eulaceura* is reportedly monotypic and Malaysian. Its type-species *osteria* Westwood looks similar to *Limenitis dudu*. The taxonomic status of *E. manipurensis* Tytler (very rare) is not known.

Genus *Apatura* is divided into some subgenera (Smart 1985), which some other authors have used in the generic position, e.g. *Rohana parisatis*, of which the Indian subspecies is *camiba* Moore (vide Peile 1937). *Apatura chevana* has been synonymised with *A. leechi* in Smart (l.c.). The forms or races of any species given in Wynter-Blyth have been generally kept out of the present revision, but when any form is found established as a species group taxon, it has been included, e.g. *Euripus nycteliu*s. *Idrusia* Corbet 1943 is synonym of *Euripus*. Smart (1985) has treated *Diagora* as a subgenus of *Hestina*, but I stick to Wynter-Blyth.

Genera *Calinaga* and *Penthema* have been assigned to Family Satyridae, instead of Nymphalidae, by Smart (1985). He says that formerly these butterflies (of Calinaginae) were considered allied to the Apaturinae (Nym.) and in some respects they fall between the two families.

Euthalia is a large and characteristic genus of Indo- Oriental Nymphalids. Now some of its species are assigned to other genera. The name *Symphaedra* ought to be revived, the type-species of which is a synonym of *Euthalia nais*. It is monobasic and confined to peninsular India. Some other species of *Euthalia* are now put in *Tanaecia* Butler/*Cynitia* Snellen. Corbet & Pendlebury (1956) say that *T. julii* is recorded from Malaya and Sumatra only, but the Malayan subspecies is *T. julii bougainvillei* Corbet. The author of *julii* is Lesson who described *Nymula julii* in a publication of Bougainville 1837. Later Moore 1897 described a new genus *Haramba*, the type-species of which is a synonym of *T. julii*. In my INDEX RHOPALOCERA INDICA - Part II (1983 : p. 17) *Euthalia atala* is an error for *E. patala* (Kollar). *E. garuda* is now treated as *E. aconthea garuda* (Moore), which should not be confused with another subspecies *E. aconthea gurda* (Fruhstorfer) that does not occur in the Indian region. *Euthalia phemius* (Doubleday) is sometimes credited to

Doubleday and Hewitson jointly. This is incorrect. Doubleday 1848 figured and proposed this species in a new genus *Itanus*, but this was however placed in *Adolias*, when the text of *phemius* was 'written' by Westwood 1850. Corbet & Pendlebury (1978) have retained it in *Euthalia*. *E. evalina* in Wynter-Blyth is an error for *evelina*, now put in *Dophla*, and its Indian subspecies is *laudabilis* Swinhoe. Corbet & Pendlebury (1956) report that *E. monina* (F.) occurs from Sikkim to Indo-China; and *E. aconthea* (Cramer) is widely distributed in Ceylon (Sri Lanka) eastwards; both these species are not given in Wynter- Blyth. *E. recta* and *E. teuta* are referred to *Bassarona*, while some other *Euthalia* species treated under *Adolias* by Wynter-Blyth are now referred to *Lexias*, since in the past Oriental species were erroneously placed in *Adolias* due to a mistake over its type-species.

Hemming (1967) shows that *Acontia doubledaii* Westwood 1848, which is the type-species of genus *Neurosigma*, was mistakenly sunk as a homonym and under Article 59 (c) of I.C.Z.N. it is permanently invalid. The replacement name *siva* Westwood 1850 is applicable in its place.

Genus *Limenitis* is a large group of species, in which Kawazoe & Wakabayashi (1980) and Smart (1985) have recognised several subgenera. Here these are treated in generic rank. I took this stand since as early as Bingham (1905, FAUNA OF BRITISH INDIA - BUTTERFLIES, 1st ed., Vol. 1) has used *Auzakia* in generic rank. Accordingly, a number of *Limenitis* species are transferred as follows: *austenia* and *danava* to *Auzakia*, *procris* to *Moduza*, *daraxa* to *Sumalia*, and *zayla* and *dudu* to *Parasarpa*. For *procris* Corbet & Pendlebury (1956) also opined that it merits a separate genus. Further, in their 1978 edition they say that *Limenitis* should not be used for any Oriental species. I am convinced that this group requires more studies, e.g. to ascertain the correct genus of *zulema* Doubleday and *trivena* Moore. Smart (l.c.) put the last species in *Limenitis*, the genus which he considers Holarctic and Oriental.

Pantoporia of Wynter-Blyth and auctorum has been replaced with *Parathyma* by many workers. The true *Pantoporia* is a Neptid genus (see Sl. No. 95-99 in Table 10). The Limenitid *Pantoporia* Auct. has been replaced with *Parathyma* in Peile (1937), Corbet & Pendlebury (1956), Hemming (1967) etc. I have also used *Parathyma* (*Rec. zool. Surv. India, Occ. Paper 31* and *47*). However, Corbet & Pendlebury (1978) and Kawazoe & Wakabayashi (1980) have shown most species of Limenitid *Pantoporia* in *Athyma*, which is followed here. *A. nefte* is Malaysian, and *A. nefte inara* Doubleday is the Indian subspecies. Incidentally it may be noted that *A. jina* Moore is the type-species of genus *Tharasia* Moore 1898.

For *Neptis*, I have followed Eliot (1969) exclusively. Table 10 shows that some *Neptis* species are now placed under *Phaedyma*, *Lasippa* and *Pantoporia*. Wynter-Blyth has not given the name of respective author with any species of *Neptis*. These have been provided here. *Neptis soma* of Evans (1932, IDENTIFICATION OF INDIAN BUTTERFLIES, 2nd ed.) and Wynter-Blyth is *N. nata*, while true *N. soma* is what Wynter-Blyth and others called *N. yerburyi (vide Eliot 1969: p. 68). A number of subspecies are reported in each case from our region. Other notable changes are : vikasi* to *pseudovikasi*, *anjana* to *nashona*, *heliodore* to *tiga camboja*, and *paona* to *bieti paona*. True *antilope* is from China; the species of our region is probably *sylvana*. *N. hordonia* is now well known to represent two species: *P. hordonia* (Stoll) and *sandaka* (Butler), both of which occur from South India to Indo-China, the former in Sri Lanka also.

Corbet & Pendlebury (1978) state that the Indian leaf butterfly is *Kallima paralekta* (Horsfield). We have been calling it as *K. inachus* (Boisduval). Both have the upper side of wings alike, but the former is Malaysian and the latter Indian in distribution. I retain the latter.

Precis is another genus of common butterflies represented in our region. Recent authors divide it into two subgenera: *Precis* and *Junonia*. According to Corbet & Pendlebury's classification, *iphita* and *hedonia* belong to *Precis* and all the rest to *Junonia*. But Smart states that *Precis* has Old World species, mostly Ethiopian, while *Junonia* has American species. Due to these contrasting views I have not adopted these subgenera in Table 10. *P. orithyia* is corrected to *orithya*, following Seitz (1927, THE MACROLEPIDOPTERA OF THE WORLD, 9: p. 522), though I feel that *oritya*, the original spelling given by Linnaeus 1758 should have been preferable. *P.*

hierta Fabricius 1798 is preoccupied by the names *lintingensis* Osbeck 1765, and *oinone* Cramer 1775. However, these names are nomina oblita, and suppressed vide Opinion No. 842 of 1968 of the ICZN. The generic name *Doleschallia* has been erroneously cited as *Dolleschallia* in Corbet and Pendlebury (1978).

Vanessa is yet another large genus found in our region, many species of which are now shifted to other genera. Among the species listed by Wynter-Blyth, *indica* and *atalanta* are still referable to it; *cardui* to *Cynthia*; *canace* to *Kaniska*; *cashmiriensis, urticae* and *ladakensis* to *Aglais*; and *xanthomelas*, *polychloros* and *antiopa* to *Nymphalis*. Some authors have put *egea* under *Polygonia*, though it is reportedly Holarctic in distribution. I have followed Kawazoe and Wakabayashi (1980) for the above assignments. Regarding *Cynthia cardui* my earlier note (1977, *Newsl. zool. Surv. India 3 (1):* 13) may be seen. *Aglais cashmiriensis* is spelt as '*kashmirensis*' in Kawazoe and Wakabayashi, and as '*caschmirensis*' in Smart. I could not see the original publication. According to Corbet and Pendlebury (1978) *Symbrenthia hippoclus* is found in the Papuan subregion of the Oriental Region, and *S. lilaea* occurs from N. India and China to Neomalaya.

Genus *Argynnis* Fabricius is mostly Holarctic and only partially Oriental. The Indian species belonging to it are presently placed in various other genera, namely *Argyreus*, *Argyronome*, *Childrena*, *Issoria*, *Fabriciana* etc. Although not so treated here, *Argynnis kamala* is the type-species of genus *Protodryas* Reuss 1928. *Boloria pales* Schiffermueller has been reported from Sri Lanka by Woodhouse (1949, BUTTERFLY FAUNA OF CEYLON) as *Argynnis pales*, but not included by Wynter-Blyth. Smart (1985) reports *B. pales generator juldussica* Wagner from India. Generic name *Melilaea* in Hemming (1967 : p. 286) is an error for *Melitaea* Fabricius. Corbet and Pendlebury (1978) hint that *M. robertsi* Butler is a synonym of *Tanaecia aruna* (C. & R. Felder).

The name *Atella* Doubleday as given in Wynter-Blyth's book, has long been substituted with *Phalanta* Horsfield, by many workers including Peile (1937, l.c.). Name *Issoria* has been used for two different genera; the true *Issoria* is Argynnid (see Sl. No. 134), while the false *Issoria* of authors has been renamed as *Vagrans* by Hemming 1934. Corbet and Pendlebury (1978) made a mistake by citing '*Vagrans lathonia*' and also stating that *Vagrans* was formerly incorrectly known as *Issoria* Huebner. While their latter statement is correct, the former combination is wrong, as they have changed true *Issoria* there. Table 10 can show this anomaly. The above authors further state that *Vagrans egista* (Cramer) is distributed from India as far as Pacific Is. In that light, *I. sinha* (Kollar) may probably be a synonym of *V. egista*, but it requires confirmation. Name *Cynthia* is also misused for two genera; the true *Cynthia* is now retained for the cosmopolitan 'Painted Lady' butterfly (Sl. No. 116), while the false *Cynthia* of authors is presently replaced with *Vindula* Hemming 1934.

Wynter-Blyth has reported three species of *Cirrochroa* from India : *thais*, aoris and *thyche*. A fourth species *C. mithila* Moore was pointed out by me (1983, l.c.: p. 44). Corbet and Pendlebury (1978) report another species *C. orissa orissa* C. and R. Felder from Burma eastwards. According to Corbet & Pendlebury (1956) *Cethosia hypsea* Doubleday is a common species occurring in S. Burma onwards to Malaysia.

Subfamily name Biblidinae (or Biblinae sensu Smart 1985) is based on type-genus *Biblis* (not found in Indian region) and not on *Biblia*, which is an incorrect subsequent spelling of *Byblia* Huebner. Generic name *Ergolis* Boisduval 1836 has lost to prior name *Ariadne* Horsfield 1929, with which both species of Indian region *ariadne* and *merione* form combination.

Among the additional taxa, not reported by Wynter-Blyth, are two genera: *Yoma* Doherty and *Paduca* Moore. Corbet and Pendlebury (1956) report *Yoma sabina* (Cramer) from Burma eastwards. The range of *Paduca* is from Burma to Malaysia and it is represented by *P. fasciata* (C. & R. Felder) in S. Burma.

Classification

Before ending this series, I consider it would be useful to give a revised classification of butterflies as applicable to our region. This has been followed in a modified way from Corbet and Pendlebury (1978, l.c. revised 3rd ed.) and tabulated in Tables 10A and 10B.

TABLE 10 A
CLASSIFICATION UP TO FAMILIES

Superfamily		Family
I. Papilionoidea	1.	Papilionidae
	2.	Pieridae
	3.	Danaidae
	4.	Satyridae
	5.	Nymphalidae
	6.	Libytheidae
	7.	Stygidae *
	8.	Riodinidae
	9.	Lycaenidae
II. Hesperioidea	1.	Hesperiidae
	2.	Megathymidae *

* Not represented in Indian region

TABLE 10 B
CLASSIFICATION OF INDIAN FAMILIES UP TO SUBFAMILIES

Family	Total No. of subfamilies	Subfamilies
Papilionidae	3	Papilioninae, Parnasiinae, Basoniinae
Pieridae	4	Pierinae, Coliadinae, Dismorphiinae, Pseudopontiinae
Danaidae	2	Danainae, Ithomiinae
Satyridae	4	Satyrinae, Amathusiinae, Morphinae, Brassolinae
Nymphalidae	11	Nymphalinae, Biblidinae, Argynninae, Helioconiinae, Marpesiinae, Limenitidinae, Pseudergolinae, Apaturinae, Charaxinae, Calinaginae, Acraeinae
Libytheidae	–	–
Riodinidae Euselasiinae	3	Riodininae, Hamearinae,
Lycaenidae	7	Lycaeninae, Poritiinae, Liphyrinae, Miletinae, Polyommatinae, Theclinae, Curetinae,
Hesperiidae	3	Hesperiinae, Coeliadinae, Pyrginae

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ADDENDUM

After about an year of submitting the manuscript, I have been able to consult the monumental work of D'Abrera, B. (1985, BUTTERFLIES OF THE ORIENTAL REGION Part II Nymphalidae, Satyridae & Amathusidae. Hill House, Melbourne : 534 pp.). He has covered most of the taxa of our region, with exceptions left such as genus *Melitaea* and many species of *Vanessa* complex. The names used by him in most cases are confirmative to my observations given above. However, since he has given subspecies names, an addendum has become necessary to point out wherever single or in come cases two subspecies names alone are applicable to our region, along with some other revisionary names for Nymphalidae. These are presented below (Table 10C). D'Abrera has not used parenthesis on author's name in eligible cases. Unfortunately I have not been able to correct it in all cases, and a discussion on the reasons for these changes in names is also not possible in this addendum.

TABLE 10

NYMPHALIDAE

Page	No.	For	Correct
		subfamily CHARAXINAE	
1.	143	Genus *Charaxes*	Genus *Charaxes* Ochsenheimer
2.	143-151	Genus *Eriboea*	Genus *Polyura* Billberg
3.	144	*Charaxes polyxena* (Cramer)	*Charaxes bernardus* (F.)
4.	146	*Charaxes fabius* (Fabricius)	*Charaxes fabius cerynthus* Fruhstorfer
5.	147	*Eriboea schreiberi* (Godart)	*Polyura schreiber* (Godart)
6.	150	*Eriboea moorei* (Distant)	*Polyura moori* (Distant)
7.	151	Genus *Prothoe*	Genus *Prothoe* Huebner
8.	151	*Prothoe franckii* Godart	*Prothoe franck* (Godart)
9.	151	*Prothoe calydonia*	*Agatasa calydonia* (Hewitson)
		Subfamily APATURINAE	
10.	152	Genus *Helcyra*	Genus *Helcyra* C. Felder
11.	152	*Helcyra hemina* Hewitson [probably]	*Helcyra superba* f. *hemina* Hewitson
12.	152	Genus *Eulaceura*	Genus *Eulaceura* Butler
13.	152	Genus *Dilipa*	Genus *Dilipa* Moore
14.	153	Genus *Apatura*	Genus *Apatura* F.
15.	154	*Apatura sordida* Moore	*Chitoria sordida* (Moore)
16.	155	*Aatura ulupi* (Doherty)	*Chitoria ulupi* (Doherty)
17.	155	*Apatura chevana* (Moore)	*Apatura leechi* Moore
18.	155	*Apatura parisatis* Westwood	*Rohana parisatis* (Westwood)
19.	156	Genus *Herona*	Genus *Herona* Doubleday
20.	156	Genus *Sephisa*	Genus *Sephisa* Moore
21.	157	Genus *Euripus*	Genus *Euripus* Doubleday
22.	158	*Euripus halitherses* female f. *nyctelius*	*Euripus nyctelius Doubleday*
23.	159	Genus *Diagora*	Genus *Diagora* Snellen
24.	159	*Diagora nicevillei* Moore	*Diagora nicevillei* (Moore)
25.	160	Genus *Hestina*	Genus *Hestina* Westwood
26.	160	Genus *Sasakia*	Genus *Sasakia* Moore
27.	160	*Sasakia funebris* (Leach)	*Sasakia funebris* (Leech)
		Subfamily CALINAGINAE	
28.	160	Genus *Calinaga*	Genus *Calinaga* Moore
29.	161	Genus *Penthema*	Genus *Penthema* Doubleday
		Subfamily PSEUDERGOLINAE	
30.	162	Genus *Dichorragia*	Genus *Dichorragia* Butler
31.	162	*Dichorragia nesimachus* Boisduval	*Dichorragia nesimachus* (Boisduval)
32.	162	Genus *Stibochiona*	Genus *Stibochiona* Butler
33.	162	*Stibochiona nicea* (Gray)	*Stibochiona nicea* (G.R. Gray)
		subfamily LIMENITIDINAE	
34.	162	Genus *Euthalia*	Genus *Euthalia* Huebner
35.	163	*Euthalia lepidea* (Butler)	*Tanaecia lepidea* (Butler)
36.	163	*Euthalia cocytus*	*Tanaecia cocytus* (F.)
37.	164	*Euthalia julii*	*Cynitia julii* (Lesson)
38.	167	*Euthalia garuda* (Moore)	*Euthalia aconthea garuda* (Moore)
39.	172	*Euthalia evalina* (Stoll)	*Dophla evelina* (Stoll)
40.	173	*Euthalia nais* (Forster)	*Symphaedra nais* (Forster)
41.	173	*Euthalia recta* (de Niceville)	*Bassarona recta* (de Niceville)
42.	173	*Euthalia teuta*	*Bassarona teuta* (Doubleday)
43.	174–175	Genus *Adolias* [Huebner]	Genus *Lexias* Boisduval
44.	175	Genus *Parthenos*	Genus *Parthenos* Huebner
45.	175	*Parthenos sylvia* Cramer	*Parthenos sylvia* (Cramer)
46.	176	Genus *Lebedea*	Genus *Lebadea* C. Felder
47.	176	Genus *Neurosigma*	Genus *Neurosigma* Butler
48.	176	*Neurosigma doubledayi* (Westwood)	*Neurosigma siva*
49.	177	Genus *Abrota*	Genus *Abrota* Moore
50.	177	Genus *Limenitis*	Genus *Limenitis* F.
51.	178	*Limenitis austenia* (Moore)	*Auzakia austenia* (Moore)
52.	178	*Limenitis danava* Moore	*Auzakia danava* (Moore)
53.	179	*Limenitis zayla* Doubleday	*Parasarpa zayla* (Doubleday)
54.	179	*Limenitis daraxa* Doubleday	*Sumalia daraxa* (Doubleday)
55.	179	*Limenitis dudu* Westwood	Parasarpa dudu (Westwood)
56.	180	*Limenitis procris* (Cramer)	Moduza procris (Cramer)
57.	183	Genus *Pantoporia* [Auct.]	Genus *Athyma* Westwood
58.	184	*Pantoporia nefte* (Cramer)	*Athyma nefte inara* Doubleday
59.	184	*Pantoporia cama* (Moore)	*Athyma cama* Moore
60.	185	*Pantoporia* selenophora (Kollar)	*Athyma selenophora* (Kollar)
61.	185	*Pantoporia zeroca* (Moore)	*Athyma zeroca* (Moore)
62.	186	*Pantoporia ranga* (Moore)	*Athyma ranga* Moore
63.	187	*Pantoporia opalina* (Kollar)	*Athyma opalina* (Kollar)

Page No.		For	Correct
64.	187	*Pantoporia asura* (Moore)	*Athyma asura* Moore
65	187	*Pantoporia perius* (Linnaeus)	*Athyma perius* (L.)
66.	188	*Pantoporia reta* (Moore)	*Athyma reta* Moore
67.	188	*Pantoporia kanwa* (Moore)	*Athyma kanwa* Moore
68.	188	*Pantoporia pravara* (Moore)	*Athyma pravara* Moore
69.	188	*Pantoporia larymna* (Doubleday)	*Athyma larymna* (Doubleday)
70.	189	*Pantoporia jina*	*Athyma jina* Moore
71.	189	Genus *Neptis*	Genus *Neptis* F.
72.	190	*Neptis columella*	*Phaedyma columella* (Cramer)
73.	190	*Neptis jumbah*	*Neptis jumbah* Moore
74.	190	*Neptis magadha*	*Neptis magadha* C. & R. Felder
75.	190	*Neptis mahendra*	*Neptis mahendra* Moore
76.	190	*Neptis hylas*	*Neptis hylas* (L.)
77.	191	*Neptis soma*	*Neptis nata* Moore
78.	191	*Neptis nandina*	*Neptis nata* Moore
79.	191	*Neptis yerburyi*	*Neptis soma* Moore
80.	194	*Neptis sankara*	*Neptis sankara* (Kollar)
81.	194	*Neptis vikasi*	*Neptis pseudovikasi* (Moore)
82.	194	*Neptis harita*	*Neptis harita harita* Moore
83.	194	*Neptis cartica*	*Neptis cartica* Moore
84.	194	*Neptis anjana*	*Neptis nashona nashona* Swinhoe
85.	194	*Neptis ananta*	*Neptis ananta Moore*
86.	195	*Neptis miah*	*Neptis miah* Moore
87.	195	*Neptis manasa*	*Neptis manasa manasa* Moore
88.	195	*Neptis aspasia*	*Phaedyma aspasia* (Leech)
89.	195	*Neptis nycteus*	*Neptis nycteus* de Niceville
90.	195	*Neptis narayana*	*Neptis narayana* Moore
91.	195	*Neptis radha*	*Neptis radha* Moore
92.	195	*Neptis zaida*	*Neptis zaida* Westwood
93.	195	*Neptis viraja*	*Lasippa viraja* (Moore)
94.	195	*Neptis heliodore*	*Lasippa tiga camboja* (Moore)
95.	195	*Neptis paraka*	*Pantoporia paraka paraka* (Butler)
96.	195	*Neptis hordonia*	*Pantoporia hordonia* (Stoll)
97.	198	*Neptis dindinga*	*Pantoporia dindinga* (Butler)
98.	198	*Neptis aurelia*	*Pantoporia aurelia* (Staudinger)
99.	198	*Neptis paona*	*Pantoporia bieti paona* (Tytler)
100.	198	*Neptis antilope*	[probably] *Neptis sylvana* Oberthur
101.	198	*Neptis cydippe*	*Neptis cydippe kirbariensis* Tytler
		Subfamily MARPESIINAE (CYRESTIINAE)	
102.	198	Genus *Cyrestis*	Genus *Cyrestis* Boisduval
103.	199	Genus *Chersonesia*	Genus *Chersonesia* Distant
104.	200	*Chersonesia rahria* Moore	*Chersonesia rahria* (Moore)
		Subfamily PSEUDERGOLINAE	
105.	200	Genus *Pseudergolis*	Genus *Pseudergoli* C. & R. Felder
		Subfamily NYMPHALINAE	
106.	200	Genus *Hypolimnas*	Genus *Hypolimnas* Huebner
107.	203	Genus *Rhinopalpa*	Genus *Rhinopalpa* C. & R. Felder
108.	203	Genus *Doleschallia*	Genus *Doleschallia* C. & R. Felder
109.	203	Genus *Kallima*	Genus *Kallima* Doubleday
110.	204	*Kallima philarchus* (Westwood)	*Kallima horsfieldi philarchus* (Westwood)
111.	205	*Kallima alompra* Moore	*[probably] Kallima spiridiva* f. *alompra* Moore
112.	205	Genus *Precis*	Genus *Precis* Huebner
113.	206	*Precis orithyia* (Linnaeus)	*Precis orithya* (L.)
114.	208	*Precis atlites* (Johanssen)	*Precis atlites* (L.)
115.	209	Genus *Vanessa*	Genus *Vanessa* F.
116.	210	*Vanessa cardui* (Linnaeus)	*Cynthia cardui* (L.)
117.	212	*Vanessa atalanta* Linnaeus	*Vanessa atalanta* (L.)
118.	213	*Vanessa canace* (Johanssen)	*Kaniska canace* (L.)
119.	213	*Vanessa egea* (Cramer)	*Polygonia egea* (Cramer)
120.	214	*Vanessa* cashmiriensis Kollar	*Aglais cashmiriensis* (Kollar)
121.	215	*Vanessa urticae* (Linnaeus)	*Aglais urticae* (L.)
122.	215	*Vanessa ladakensis* Moore	*Aglais ladakensis* Moore
123.	216	*Vanessa xanthomelas* (Denis & Schiffermueller)	*Nymphalis xanthomelaena* (Denis & Schiffermuller)
124.	216	*Vanessa polychloros* (Linnaeus)	*Nymphalis polychloros* (L.)
125.	217	*Vanessa antiopa* (Linnaeus)	*Nymphalis antiopa* (L.)
126.	217	Genus *Araschnia*	*Genus Araschnia* Huebner
127.	217	Genus *Symbrenthia*	*Genus Symbrenthia* Huebner
128.	217	*Symbrenthia* hippoclus de Niceville	*Symbrenthia lilaea* (Hewitson)
		Subfamily ARGYNNINAE	
129.	219	Genus *Argynnis*	Genus *Argynnis* F.
130.	220	*Argynnis hyperbius* (Johanssen)	*Argyreus hyperbius* (L.)
131.	221	*Argynnis childreni* Gray	*Childrena childreni* (Gray)
132.	221	*Argynnis kamala* Moore	Fabriciana kamala (Moore)

Page No.	For	Correct
133. 222	*Argynnis laodice* (Pallas)	*Argyronome laodice* (Pallas)
134. 222	*Argynnis lathonia* (Linnaeus)	*Issoria lathonia* (L.)
135. 223	*Argynnis jerdoni* Lang	*Clossiana jerdoni* (Lang)
136. 223	Genus *Melitaea*	Genus *Melitaea* F.
137. 223	*Melitaea trivia* Schiff	*Melitaea trivia* Schiffermueller
138. 224-225	Genus *Atella* (Doubleday)	Genus *Phalanta* Horsfield
139. 225	*Atella alcippe* (Cramer)	*Phalanta alcippe* (Stoll)
140. 226	Genus *Cupha*	Genus *Cupha* Billberg
141. 226	Genus *Issoria* [Auct.]	*Genus Vagrans* Hemming
142. 226	*Issoria sinha* (Kollar)	*Vagrans egista (Cramer)*
143. 227	Genus *Cynthia* (Auct.)	*Genus Vindula* Hemming
144. 227	*Cynthia erota* (Fabricius)	*Vindula erota* (F.)
145. 227	Genus *Cirrochroa* Doubleday	*Genus Cirrochroa*
146. 228	*Cirrochroa tyche* Felder	*Cirrochroa tyche* (C. & R. Felder)
	Subfamily HELICONIINAE	
147. 229	Genus *Cethosia*	*Genus Cethosia* F.
	Subfamily BIBLIDINAE (BIBLINAE)	
148. 231	Genus *Byblia*	Genus *Byblia* Huebner
149. 231–232	Genus *Ergolis* [Boisduval]	Genus *Ariadne* Horsfield
150. 231	*Ergolis ariadne* (Johannsen)	*Ariadne ariadne* (L.)

TABLE 10 C
NYMPHALIDAE (SUPLLEMENT)

Sl. No. in Table 10	Page No. in W-B	For	Correct
3a	144	*Charaxes polyxena* race *psaphon*	*Charaxes psaphon* Westwood
3b	144	–do– race *imna*	*Charaxes psaphon imna* Butler
3c	144	–do– races *hemana*, *hierax* and male f. *hindia*	*Charaxes bernardus hierax* Felder
3d	146	*Charaxes durnfordi*	*Charaxes durnfordi nicholii* Distant Grose-Smith
4	146	*Charaxes fabius* (Fabr.)	*Charaxes solon* Fabricius (Fabr.)
5	147	*Eriboea schreiberi* (Godart)	(i) *Polyura schreiber wardii* Moore (ii) *Polyuraschreiber assamensis* Rothschild
6	150	*Eriboea moorei* Distant	*Polyura moori sandakanus* (Distant) Fruhstorfer
6a	150	*Eriboea narcaea* (Hewitson)	*Polyura narcaeus aborica* Evans
11		*Helcyra superba f. hemina* Hewitson	*Helcyra hemina* Hewitson
17		*Apatura leechi* Moore	*Apatura chevana* (Moore)
18a	156	*Apatura parvata* Moore	*Rohana parvata* (Moore)
22	158	*Euripus halitherses* Doubleday	*Euripus nyctelius* Doubleday
37	164	*Euthalia julii* (Bougainville)	*Tanaecia julii* appiades Menetries
37a	164	*Euthalia jahnu* (Moore)	*Tanaecia jahnu* Moore
37b	165	*Euthalia kesava* (Moore)	*Euthalia monina kesava* (Moore)
38	167	*Euthalia garuda* Moore	*Euthalia aconthea* Cramer (Moore)
38a	167	*Euthalia jama* (Felder)	*Euthalia alpheda jama* (Felder) Fruhstorfer
38b	169–171	*Euthalia* [spp.]	*Bassarona* (spp.)
39a	172	*Euthalia evalina* race *evalina*	*Dophla evelina evelina* race *evalina* (Stoll)
39b	172	–do– race *laudibilis*	*Dophla evelina laudabilis* Swinhoe
39c	172	–do– race *derma*	*Dophla evelina derma* Kollar
51	178	*Limenitis austenia* (Moore)	*Bhagadatta austenia* Moore
56a	181	*Limenitis zulema* Doubleday	*Sumalia zulema* Doubleday & Hewitson
56b	181	*Limenitis trivena*	[This essentially Palaearctic Moore species is a frequent visitor in N. India; no change in name]
66	188	*Pantoporiareta* (Moore)	*Athyma retamoorei* Fruhstorfer
67	188	*Pantoporiakanwa* (Moore)	*Athyma kanwaphorkys* Fruhstorfer
68	188	*Pantoporia pravara* (Moore)	*Athyma pravara acutipennis* Fruhstorfer
69	188	*Pantoporia larymna* (Doubleday)	*Athyma larymna siamensis* Fruhstorfer
77	191	*Neptis soma*	*Neptis nata adipala* Moore

Sl. No. in Table 10	Page No. in W-B	For	Correct
79	191	*Neptis yerburyi*	*Neptis yerburii pandoces* Butler
88	195	*Neptis aspasia*	*Phaedyma aspasia falda* Eliot
102a	199	*Cyrestis cocles*	*Cyrestis cocles natta* Swinhoe
104	200	*Chersonesiarahria* Moore	[probably] *Chersonesia intermedia* Martin
107a	203	*Rhinopalpa polynice* (Cramer)	*Rhinopalpa polynice birmana* Fruhstorfer
139	225	*Atella alcippe* (Cramer)	(i) *Phalanta alcippe alcippoides* Moore (ii) *Phalanta alcippe ceylonica* Manders
142	226	*Issoria sinha*	*Vagrans egista sinha* (Kollar) (Kollar)
146	228	*Cirrochroa tyche* Felder	*Cirrochroa tyche mithila* Moore
147a	249	*Cethosia nietneri* race *nietneri*	*Cethosia nietneri nietneri* Felder
147b	249	–do– race *mahratta*	*Cethosia nietneri mahratta* Moore

Certain names given in D'Abrera (1985) have not been followed by me. These are: *Hypolimnas missipus* in place of *H. misippus*, *Vanessa cardui* in place of *Cynthia cardui*, *Argynnis hyperbius* in place of *Argyreus hyperbius*, and generic name *Junonia* in place of *Precis*. I have followed Smart (1985) for these, except *C. cardui*. D'Abrera has cited *Byblia ilithyia* as *'alithyia'* in his text, which is erroneous, as I have checked the original work of Drury 1773 where it is 'ilithyia'.

MAMMALS OF COX'S BAZAR FOREST DIVISION (SOUTH) BANGLADESH, WITH NOTES ON THEIR STATUS AND DISTRIBUTION[1]

S.M.A. Rashid, Anizuzzaman Khan and M. Ali Reza Khan[2]

(*With two text-figures*)

A study was made in the Cox's Bazar Forest Division (South) to gather information on the mammals of that area from May 1982 to December 1983. A total of 1848 man hours were spent in the field. From the study it was revealed that 53 mammalian species occur in this area. They were represented by Order Insectivora (2 species), Order Chiroptera (10 species), Order Primates (8 species), Order Pholidota (1 species), Order Carnivora (18 species), Order Proboscidea (1 species), Order Arctodactyla (3 species), Order Rodentia (9 species) and Order Cetacea (1 species).

Introduction

Cox's Bazar Forest Division (South) (CB), which ranges from Cox's Bazar to Teknaf (the southern–most part of the country) supports a large area of evergreen and semi–evergreen forests. These forests are the habitat of a large number of wild flora and fauna. No detailed study on the mammalian fauna of this area is available in the literature, so the present study was undertaken to explore the mammalian fauna of this area. Some work has been done on the primates and other wildlife Khan (1979, 1980, 1981, 1982a, b, 1984, 1985, 1986, 1987), Khan and Ahsan (1981), Khan and Wahab (1983) and on elephants (Khan 1980b).

The present paper is a result of a 20 month study of the area from May, 1982 to December, 1983 with 1848 hours of field observation.

Study Area

Bangladesh lies between 20°34'to 26°38'N and 88°01' to 92°40'E approx., having an area of about 144,054 sq.km. The present study area lies between Cox's Bazar township and the Teknaf township, within the Cox's Bazar Forest (South) Division of the Government Forest Department. The study area covers an area of 43,197 hectares of which 35,715 hectares is likely to support reserved forests. The quantity of natural forests may not exceed 10,000 hectares (Khan *et al.* 1983). The remaining areas are under a mono-culture of teak (*Tectona grandis*, newly introduced mulberry (*Morus* sp.) and *Eucalyptus* sp. During the last half of the decade, over 5000 hectares of reserved forests have been handed over to the oil-palm (*Elaeis guinaensis*) project for plantations. The area under study comprised evergreen, semi-evergreen and plantations with undulating hillocks of varying heights ranging from 5 m to 200 m above mean sea level and tidal mudflats supporting mangrove forests along the banks of the international Naaf river and the islands. The temperature is more or less uniform throughout the year. The average maximum temperature is *c.* 60°C and the minimum is *c.* 49°C. Average humidity and annual rainfall is about 81.2% and 4060 mm respectively (Anon. 1969).

Habitat

The habitat of the mammals of Teknaf Peninsula, CB, comprises (a) evergreen forests, (b) semi-evergreen forests, (c) plantations and (d) mangrove forests. (a), (b) and (a) are natural, while the plantations are human raised. The floristics of the tropical wet evergreen forests are the chapalish *Artocarpus chaplasha*, telsur *Hopea odorata* chundul *Tetrameles nudiflora*, pitraj *Amoora wallichi*, uriam *Mangifera longipes*, civit *Swintonia floribunda*, toon (*Toona ciliata*) and jam (*Syzygium* spp.), etc. These plants were prevalent in CB prior to 1947 or so, that is before the introduction of the clearfelling operations in this Forest Division. Now-a-days this type is found mostly in the deep valleys or in localities shaded by lofty trees where there is plentiful supply of water, as in the north sub-division of CB.

The tropical semi– or mixed–evergreen forest is the general forest type of the Teknaf Peninsula. It is a dense, many storyed forest of tall trees ranging from 20 m to 45 m, in which the evergreen species predominate in the second or lower canopy. The

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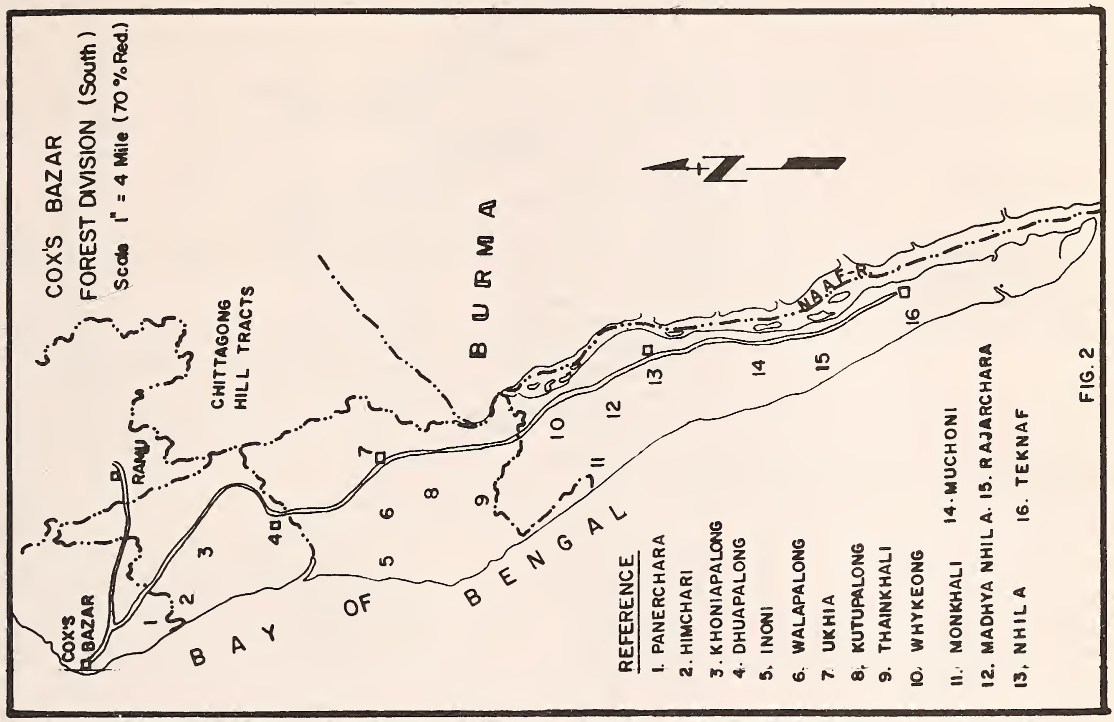
COX'S BAZAR
FOREST DIVISION (South)
Scale 1" = 4 Mile (70% Red.)
CHITTAGONG
HILL TRACTS
BURMA
RAMU
COX'S BAZAR
BAY OF BENGAL
NAAF R.
N
REFERENCE
1. PANERCHARA
2. HIMCHARI
3. KHONIAPALONG
4. DHUAPALONG
5. INONI
6. WALAPALONG
7. UKHIA
8. KUTUPALONG
9. THAINKHALI
10. WHYKEONG
11. MONKHALI
12. MADHYA NHILA
13. NHILA
14. MUCHONI
15. RAJARCHARA
16. TEKNAF

FIG. 2

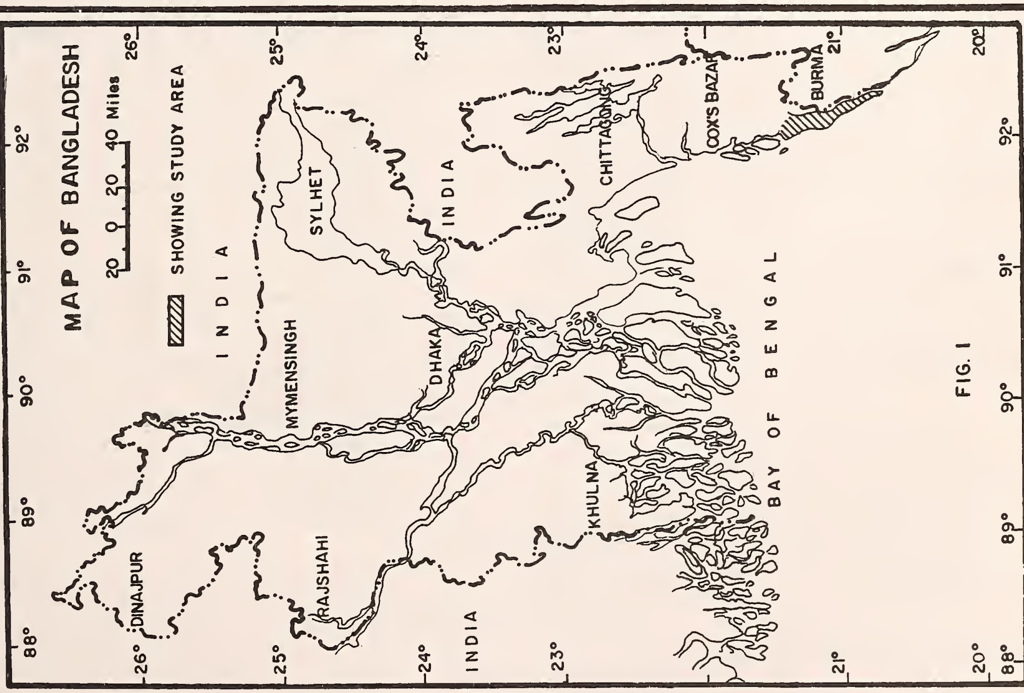
MAP OF BANGLADESH
20 0 20 40 Miles
SHOWING STUDY AREA
INDIA
DINAJPUR
RAJSHAHI
MYMENSINGH
SYLHET
DHAKA
KHULNA
CHITTAGONG
COX'S BAZAR
BURMA
BAY OF BENGAL
88° 89° 90° 91° 92°
26° 25° 24° 23° 21° 20°

FIG. 1

TABLE 1
LIST OF THE MAMMALS OF COX'S BAZAR FOREST DIVISION (SOUTH)

		ORDER: INSECTIVORA		
Family: Tupaiidae	1.	*Tupaia glis*	Malayan tree shrew	R, EG.
Family: Sorocidae	2.	*Suncus murinus*	grey musk shrew	C, WD
		ORDER: CHIROPTERA		
Family: Pteropidae	3.	*Pteropus giganteus*	flying fox	C, WD
	4.	*Rousettus leschenaultii*	fulvous fruit bat	C, WD
	5.	*Cynopterus sphinx*	short-nosed fruit bat	C, WD
Family: Emballonuridae	6.	*Taphozous saccolaimus*	pouch-bearing sheath-tailed bat	UC. WD
Family: Megadermetidae	7.	*Megaderma lyra*	false vampire	C, WD
Family: Rhinolophidae	8.	*Rhinolophus subbadins*	horse-shoe bat	*C, WD*
Family: Vespertilionidae	9	*Pipistrellus coromandra*	Indian pipistrelle	VC, F
	10	*Hesperoptenus tickelli*	Tickell's bat	VC, F
	11	*Scotophilus temmincki*	lesser yellow bat	R, F
	12	*Kerivoula papillosa*	painted bat	R, F
		ORDER: PRIMATES		
Family: Lorisidae	13	*Nycticebus coucang*	slow loris	U C, F
Family: Cercopithecidae, Subfamily: Cercopithecinae				
	14	*Macaca nemestrina*	pig-tailed macaque	C, F (not south of Harikhola
	15	*Macaca fascicularis*	crab-eating macaque	UC, M
	16	*Macaca assamensis*	Assamese macaque	R, F
	17	*Macaca mulatta*	rhesus macaque	C, WD
Subfamily: Colobinae	18	*Presbytis phayrei*	Phayre's leaf monkey	R, EG
	19	*Presbytis pileatus*	capped langur	C, F
Family: Hylobatidae	20	*Hylobates hoolock*	hoolock gibbon	R, F
		ORDER:PHOLIDOTA		
Family: Manidae	21	*Manis crassicaudata*	Indian pangolin	UC, WD
		ORDER: CARNIVORA		
	22	*Canis aureus*	jackal	C, WD
	23	*Vulpes bengalensis*	Bengal fox	C, WD
	24.	*Cuon alpinus*	wild dog, dhole	R, F
Family: Ursidae	25	*Selenarctos thibetanus*	Himalayan black bear	R, F
Family: Mustelidae	26.	*Lutra lutra*	common otter	UC,T
	27	*Aonyx cinerea*	clawless otter	UC, T
	28	*Arctonyx collaris*	hog badger	R, F
Family: Viverridae	29	*Vivera zibetha*	large Indian civet	C, WD
	30	*Viverricula indica*	small Indian civet	C, WD
	31	*Paradoxurus hermaphroditus*	palm civet	R, F
	32	*Arctictis binturong*	binturong	R, F
Family: Herpestidae	33.	*Herpestes auropunctatus*	small Indian mongoose	C, WD
	34.	*Herpestes edwardsi*	common mongoose	C, WD
	35.	*Herpestes urva*	crab-eating mongoose	R, F
Family : Felidae	36.	*Panthera pardus*	leopard	UC, WD
	37.	*Felis viverrina*	fishing cat	C, WD
	38.	*Felis chaus*	jungle cat	C, WD
	39.	*Felis temmincki*	golden cat	R, WD
		ORDER : PROBOSCIDEA		
Family : Elephantidae	40.	*Elephas maximus*	Asian elephant	UC, WD
		ORDER : ARCTODACTYLA		
Family : Bovidae, Subfamily : Caprinae				
	41.	*Capricornis sumatraensis*	serow	R, F
Family : Cervidae	42.	*Muntiacus muntjac*	barking deer	UC, WD

Family : Suidae	43.	*Sus scrofa*	wild boar	VC, WD
		ORDER : RODENTIA		
Family : Scuiridae	44.	*Petaurista petaurista*	large brown flying squirrel	UC, EG
	45.	*Ratufa bicolor*	Malayan giant squirrel	C, WD
	46.	*Calloscuirus pygerythrus*	hoary-bellied Himalayan squirrel	C, WD
Family : Muridae	47.	*Bandicota bengalensis*	Indian mole rat	C, WD
	48.	*Bandicota indica*	bandicoot rat	C, WD
	49.	*Mus booduga*	Indian field mouse	C, WD
	50.	*Mus musculus*	house mouse	C, WD
	51.	*Millardia meltada*	metad, soft-furred rat	R, F
Family : Hystricidae	52.	*Hystrix indica*	Indian porcupine	C, WD
Family : Cetacea	53.	*Peponocephala electra*	melon-headed dolphin	C, mouth of river Naaf.

Abbreviations: C– common, UC– uncommon, VC– very common, R– rare, WD– widely distributed.
EG– evergreen forests, F– forests, M– mangrove forests, T– tidal mudflats

commonest species are baitta garjan *Dipterocarpus scaber*, telya garjan *D. turbinatus*, dulya garjan *D. alatus*, koroi *Albizzia procera*, chuka koroi *A. chinensis*, chapalish, uriam, civit, shimul (*Bombax ceiba* and *B. insignae*, bandarholla *Duabangha grandiflora*, narikeli *Sterculia alata*, etc.

Under the top storey, there is a second storey which ranges from 20 m to 30 m in height, and has a variety of trees, evergreens on the whole predominating. Under the second storey there is another series of trees ranging from 7 m to 18 m in height which include saplings of the first two storeys and adaliya *Meliosma pinnata*, naricha *Moosa ramentacea*, bormala *Callicarpa arborea*, goda *Vitex glabrata*, kestoma and kechua (*Glochidion* spp.), sheora (*Streblus asper*), jalpai (*Elacocarpus* spp.) bela *Semicarpus anacardium*, etc. Bamboo occurs as undergrowth. The commonest species are muli *Melocanna bambusoides*, mitenga (*Bambusa tulda*, kaliserri *Oxytenanthera auriculata*, daloo (*Teinostachyum dullooa*) and orah (*Dendrocalamus longispathus*).

As practically all the accessible areas of the Teknaf Peninsula were subjected to clear–felling or jhoom–(shifting cultivation) – virgin forest is seldom noticed in the peninsula. Due to the removal of virgin forest many areas are now covered with sungrass (*Impereta cylindrica*), bhat (*Clerodendrum infortunatum*), *Lantana camara*, assam lata (*Eupatorium odoratum*), *Melostoma* spp., etc.

The tidal mudflats and the islands of the river Naaf are inundated daily by the high tide. These areas also support the typical mangrove species. The dominant are keora (*Sonneratia apetala*), goria (*Candelia candal*), dhundal (*Xylocarpus obovata*), kankra (*Bruguiera gymnorhyza*), hargoza (*Acanthus ilicifolius*), bola (*Hibiscus tiliaceus*.), gol pata *Nypa fruticans*), kewakanta (*Pandanus odoratissimus*), batul (*Sapium indicum*), hijol (*Barringtonia racemosa*), etc. The climbers included gila lata (*Entada pursaetha*), *Derris*. spp., *Sacrolobus globosus*, etc., and among the grasses uri gash (*Oryza coaretata*), *Pragmites kakra*, *Imperata cylindrica* and *Typha elephantina* were prominent (Anon. 1969).

Observations

During the field work definite transect paths were followed, sometimes in a straight line and sometimes in a zig zag way depending on the topography of the area. Special attention was given to areas which were densely covered by trees and where the visibility was less.

The study of the area from May 1982 to December 1983 revealed the presence of 53 mammalian species. The complete list of the observed mammals along with their status and distribution is given in Table 1. A total of 1848 man –hours were spent in the field for observation.

Status and Distribution

As seen from the list, the mammalian species of the Cox's Bazar Forest Division is represented by 9 orders and 25 families including 3 sub-families.

Order: Insectivora: In this order *Tupaia glis* (Fam.: Tupaiidae) is very rare and is distributed only in the evergreen forested areas of Inoni and Rajarchara whereas *Suncus murinus* (Fam.: Soricidae) is very common and is widely distributed throughout the area. *Tupaia glis* used to visit Nhila rest house frequently in the late 1970s (Khan 1982).

Order: Chiroptera: Among the species of the family Pteropidae, *Pteropus giganteus* is very common, whereas the other two species of the same family are fairly common. All the species are widely distributed. *Taphozous saccolaimus* (Fam.: Emballonuridae), *Megaderma lyra*. (Fam.: Megadermatidae) and *Rhinolopus subbadius* (Fam: Rhinolopidae) are more or less common and are widely distributed. Among the members of the family Vespertilionidae, *Pipistrellus coromandra* and *Hesperoptenus tickelli* are very common and widely distributed among the forested areas, whereas *Scotophilus temmincki* and *Kerivoula papillosa* are rarely met with, the later species restricted only to the forested areas.

Order: Primates: Of the 10 non-human primates recorded so far from Bangladesh, excluding the controversial dsky leaf monkey, *Presbytis obscurus*, eight are found in the forested areas of the Teknaf Peninsula. *Nyctibecus coucang* (Fam. Lorisidae) has been found in the semi-evergreen and evergreen forests of Rajachara, Shilkhali, Roikeong, Inoni and Himchari with one being caught in the Teknaf bazaar. It is uncommon. The family Cercopithecidae is represented by two sub-families. *Macaca fascicularis*. is distributed only in the tidal mudflats and islands of the river Naaf, which supports the mangrove vegetation. *M. nemestrina* and *M. mulatta* are not so uncommon but *M. nemestrina* has not been observed south of Harikhola, Whykeong. *M. assamensis* occurs in small numbers with restricted distribution. *Presbytis pileatus* is common and can be seen occasionally feeding in the semi-evergreen forests. *P. phayrei* is very rare and was seen only twice at Noya Para, Madhya Nhila and at Patwatek, Inoni. They are restricted to dense evergreen forested areas. *Hylobates hoolock* (Fam: Hylobatidae) was observed in the evergreen forests of Inoni and on one occassion the local people informed us that they have seen it at Monkhali.

Order: Pholidota: *Manis crassicaudata* is widely distributed but its population is steadily declining due to poaching. The tribals hunt it for the meat and others seek it for its scaly skin as there is a belief that it has aphrodisiac values.

Order: Carnivora: Among the members of the family Canidae, *Canis aureus*, *Vulpes bengalensis* are quite common and widely distributed whereas he *Cuon alpinus* is rare and was only met twice, once at Madhya Nhila and again at Inoni. *Selenarctos thibetanus*. (Fam.: Ursidae) is also very rare and was met only once at Thainkhali–Monkhali border. Among the members of the family Mustelidae *Lutra lutra* and *Aonyx cinerea* were uncommon and distributed along the tidal mudflats of the river Naaf, *Arctonis collaris* is quite rare and only two specimens were collected during the study period. One specimen was collected in December 1982 from Whykeong, from near human habitations and the other from the semi-evergreen forests of Kutupalong in November 1983. These are the first two specimens collected from Bangladesh. Khan (1985) has already reported it. Skins of both the specimens are deposited in the department of Zoology, University of Dhaka.

The family Viverridae is represented by four species, of which *Viverra zibetha* and *Viverricula indica* are common and distributed widely. On the other hand, *Paradoxurus hermaphroditus* and *Arctictis binturong* are rare and are distributed in forested areas of Rajarchara and Inoni. The members of the family Herpestidae, *Herpestes auropunctatus* and *H. edwardsi* are common and widely distributed but *H. urva* is rare and was twice sighted at Thainkhali. It is restricted to forested areas. The family Felidae is represented by four species. *Panthera pardus* is uncommon but widely distributed. It was sighted twice but pugmarks were seen throughout the forested areas and a number of reports of cattle-lifting by this species were recorded. *Felis temmincki* is very rare and was sighted at Dhumdhumia under Teknaf Beat. The other two species *F. viverrina* and *F. chaus* are common and widely distributed.

Order: Proboscidea: *Elephas maximus* is uncommon but widely distributed. This animal is threatened with extinction from this area. A recent study has shown that there are about 110 individuals in this area. Apart from these there are also about 30 migratory elephants which come from the neighbouring hills of Burma during the winter months (Khan *et. al* 1983).

Order: Arctodactyla: The hoofed mammals are the most threatened animals of this area, since they are under constant hunting pressure. *Capricornis* *sumatraensis* is very rare and was sighted only once in the deciduous forested areas of Madhya Nhila. This species is also on the verge of extinction from this area as well as from Bangladesh. *Muntiacus muntjac* (Fam.: Cervidae) is uncommon but widely distributed. Occassionally hunted by local people from various areas of the forests, this species is also decreasing at a steady rate and if poaching is not stopped the days are not far away when this species will be eliminated from the area. *Sus scrofa* is very common in this area and sometimes it creates havoc by destroying their crops. These are also hunted by the tribals and non-Muslims for meat.

Order: Rodentia: Some variations were noted in the distribution of the family Sciuridae. *Petaurista petaurista* is uncommon and is found only in the dense forested areas. It was sighted at Rajarchara and Inoni. *Ratufa bicolor* is a common species of the area and is mostly seen in the semi-evergreen and deciduous forested areas. *Calloscuirus pygerythrus.* is also very common and is distributed, in the peripheral areas of the forests and is rarely seen in the evergreen forested areas. All the species of the family Muridae found in the area are quite common and widely distributed excepting *Millardia meltada* which is rare and restricted to the forests only. *Hystrix indica* (Fam: Histricidae) is also common and widely distributed in the area but due to large scale killings by the local people in recent days, it is now seldom met. Moreover, it is considered as a menace in the oil-palm gardens where porcupines love to eat the soft root and stem of the plants.

Order: Cetacea: *Peponocephala electra* (Fam.:Delphinidae) is common at the mouth of the river Naaf and sometimes they come upstream even up to Whykeong.

Conclusions

The occurrence of almost 50% percent of the total mammalian fauna of Bangladesh gives a good picture of the forests and some easily demarcated forest ecological habitat. If proper management programmes are taken with practical implementation of the conservation laws, this area will attract a lot of local and foreign tourists. Through wildlife tourism, the Government can the earn considerable foreign currency provided infrastructure for giving some facilities to the tourists is improved.

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BREEDING OF THE COMMON TERN *STERNA HIRUNDO* IN SRI LANKA[1]

THILO W. HOFFMANN[2]

This paper describes a breeding colony of *Sterna hirundo* in Sri Lanka, the first recorded in the Eurasian tropics.

Generally the common tern is regarded as a winter visitor to the coasts of Sri Lanka, both in the dry and wet zone, in irregular but small numbers. Henry (1955) says that it arrives in some years in considerable numbers, but is absent in most. It has been rarely collected only from the northwest and northeast coasts. In recent years I have observed variable numbers of common terns regularly every winter at Colombo and in January 1988, for instance, many thousands were noted in the northwest (Kalpitiya Peninsula) and in the south (Hambantota). On the whole it would appear that the common tern has become a regular winter visitor in fair and sometimes large numbers.

At the end of May 1980 I discovered a breeding colony of this tern on a tiny island of loose coral debris not shown on any map, locally called *Irrachchal* (08°N, 81°E). This little island lies northeast of Thenadi Bay, on the east coast of Sri Lanka, about 5 km north of Valaichchenai. The island is formed by coarse coral debris (mostly stag–horn) and seashells and lies in the centre of a fairly extensive coral reef which runs for several miles in a north–south direction, roughly parallel to the coast about 2.5 km away. There is no vegetation, and the white island, approximately 65 m long and about 15 m at its widest point, is exposed to the elements at all times with frequent changes size, shape and topography as a result of wave action, chiefly during the NE Monsoon (December to February). There are ridges and valleys in its surface, which rise 1–1.3 m over the water level. During the period of the SW Monsoon (May to September) when the terns breed, the sea is normally calm and wave action minimal, with no changes in the topography and shape of the island. A hot dry wind called *kachchan* blows from the landside, the result of the SW Monsoon which then lashes the western coast of Sri Lanka.

I had been visiting this bare and desolate little island for some years for the purpose of goggling. Regularly in June–July each year there were breeding colonies of large crested terns *Sterna bergii*, roseate terns (*Sterna dougallii*, and sometimes little terns *Sterna albifrons*). On 28 May 1980 when I visited the island I noted four large crested terns sitting on one egg each, as well as five nest scrapes with much smaller eggs, all singles, except for one nest which contained two eggs. I left the island and a little later approached it swimming with an underwater camera; in this manner I managed to get very close to about a dozen terns standing close together at the edge of the island just above the waveline. About half of these were clearly roseate terns with beautiful pink–hued underparts, glossy black caps and long, pointed black beaks, vermilion feet and legs. But to my surprise the other six birds had brilliant orange–red beaks' with black tips, though otherwise they were almost identical with the roseates, except for the pink hue; they appeared slightly smaller. I got to within a few feet of the birds, and there could be absolutely no question of their identity, which I subsequently confirmed over and over again: they were common terns in breeding plumage; I can find no record of this stage ever having been noted in Sri Lanka before.

With my Nikonos underwater camera I took colour photographs of both these roseate and common terns and the photographs came out quite well, showing very clearly the different identities of the two species of terns. Later when I walked on the island, the birds took off but some kept circling above and dived at me; these were common terns, the Roseates having flown away on being disturbed. When I left the island, the common terns returned immediately, even before I was back in the water, and settled on the five nests. Until then I had thought that the five nests were those of roseate terns, a regular summer visitor for breeding in Sri Lanka. During the next three days I checked and re–checked and always made the same still surprising observation: the common terns were actually breeding here on this small coral island off the east coast in

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During these same days I observed many terns hovering over hand– operated coastal purse-seines, locally called *madel*, which were then in use along this stretch of the shore, and found that the majority were common terns in breeding plumage with a few large crested and some little. The common terns were quite conspicuous and easily identified with the naked eye on the basis of their coral red and mostly black-tipped bills. The birds also produced the piping, metallic-sounding *twink* (Henry after Legge 1955) as well as the scolding *crarr*, both over the *madels* and on the island.

Nearly one month elapsed until I was again able to visit the east coast and this coral island. During the period 26 to 30 June 1980 I reconfirmed the earlier observations. I counted from the boat 16 large crested and three lesser crested (*Sterna bengalensis*) in breeding plumage (unusual — this species too is a non–breeding winter visitor and summer loiterer), as well as 50 to 60 common terns, all in breeding plumage and all clearly recognisable by their black–tipped red bills; in a few the bill was entirely brilliant red without the black tip. When I went ashore some of the birds took to the air but quickly settled down again on the nests when I crouched behind a ridge of coral debris. I could observe them very clearly through binoculars, the nearest being only about 6 m. away. There were two separate colonies of breeding birds, namely one of some large crested terns (the nests being quite close to each other, most only 30 cm apart), and one of the common terns (individual nests much further apart), but not a single roseate or little tern was present. I watched the birds on the island for about 30 minutes, then got up when they all tok to the air with much noise, in which the clear high *twink* of the common was easily discernible. Several of the common attacked me repeatedly by diving at me.

I counted 41 nests of common terns, all with one egg, except for one which had two; in addition there were seven broken eggs of common with embryo, and two downy chicks, making altogether 50 observed nests. There were also about one dozen abandoned ensts (including the five seen at the end of May) of common terns clearly distinguishable from those of the large crested. In addition, 8 nests with one egg each, three broken eggs and one abandoned nest of large crested terns were found.

It was obvious that the common had started breeding about a month earlier (end May) and most nests had reached the stage where the young would hatch, whereas the large crested were only starting their colony (end June), which conforms with observations made in earlier years. For instance, at the beginning of July 1977 I counted over 200 nests of the large crested tern on this same island. On that occasion I noted for the first time the main natural hazard to these breeding colonies: The white-bellied sea eagle *Haliaeetus leucogaster*, which early in the breeding season had destroyed and partly eaten over 25% of the eggs laid till then.

Two basic ground colours could be distinguished in the eggs of the common terns, one beige-brown, the other pale sepia to pale greenish-beige, all with variable dark brown markings. There was considerable variation in measurements and shapes, some being extremely pointed and longish in shape. Apart from being smaller, they were much darker than those of the large crested which are white or off-white with very variable markings. (I had observed one pure white egg without markings which was very conspicuous against the background, in contrast to the marked ones.)

Most of the nests of the common were lined with feathers and/or seashells (every nest had at least a few feathers and shells), whereas those of the large crested were devoid of any linings or embellishments, and often barely a scrape in the coarse rough coral debris. Most of the nests of the common were between or near relatively large pieces of coral rock, obviously for shelter (shade), all were on ridges, not in depressions, and well away from and above the waves. Both nesting colonies were in an elevated portion at the northern widest end of the island, though later greater numbers of large crested would also nest in the lower portions. With a caliper I measured the 29 common tern eggs which were present at that time. The average was 41.2 x 28.5 mm, which is less (especially in width) than Baker's 41.9 x 30.5 mm in Ali and Ripley (1968–1974), or 41 x 31 as given by Cramp (1985), or 41.3 x 30.5 by Harrison (1975). The most common size was 40 x 29 mm, the smallest 36 x 27 mm, and the largest 47 x 30 mm. The downy chicks were greyish–brown with dark brown and orangy mottling. The eggs of the large crested are, of course, much bigger and easily recognisable at a glance, therefore I did not measure them on this occasion in order to shorten to the minimum the period of disturbance. I had measured large crested eggs the year before, which gave an average of 62 x 42 mm compared with 62 x 43 mm (Cramp 1985) and 60 x 40 mm (Ali and Ripley). The average egg size of the roseate tern is given as 43 x 30 mm (Cramp 1985). The five nests of common terns seen a month earlier (end May) were empty and it would appear that egg laying in the colony was staggered; the same is the case with the large crested which had four nests at the end of May, a dozen at the end of June, over 100 by mid-July, and the maximum of about 150 by the 23rd of July. I took a number of colour photographs of nests, eggs, downy chicks, and of the island. Both species sat on the eggs mainly during the day, particularly at midday when the temperature rises steeply and the eggs must be protected. Towards evening all birds left the island for feeding and to roost on low rocks nearer the shore; I have observed them there throughout the night. In the morning they returned to the breeding colonies on the island.

Throughout the period of observation practically all the nests of common terns contained only one egg each (two being the rare exception). In the literature greater clutch sizes are given: 2 or 3 in Ali and Ripley (HANDBOOK), usually 2–3 (rarely 4) in Harrison (1975), 1–3 (varying between colonies) with means around 2.5–3 in Cramp (1985); in the latter it is also stated that older birds lay bigger clutches and lay earlier in the season. Could it be that this Sri lankan colony was composed mostly of first time breeders (3rd or 4th year) who might have been in Sri lanka for several years or even have hatched here? The smaller width and variable size of the eggs would add weight to this possibility. Or is the single egg per nest conditioned by location and environment?

At the southern tip of Thenadi Bay there is a group of large rocks in the sea forming the end of a promontory called Elephant Point or Arnakallu. On these rocks I observed at the end of June 1980 up to 100 immature common terns, recognisable by the pronounced dark carpal band, with dark feet and dark bills. There were also 10 adult common terns in breeding plumage sitting on these rocks; I could not determine whether these sat on eggs in depressions on the rock surface, but it looked like it. Again many common terns, both in breeding plumage and immatures were seen hovering over and swooping down on purse-seines being pulled in, in order to catch prey escaping from the nets.

By mid–July (12th/13th) all except 12 nests of the common tern (including one with a broken egg and embryo) were empty, but there were over 100 adults in breeding plumage on the island. I also noted two fledglings almost ready to fly, which were probably young of large crested; they were very adept at hiding under large flat plates of coral and most difficult to find. Superficial description: Dark grey feet and bill, head spotted, throat white, back with folded wings shows zig-zag white and black pattern, edge of the short tail white. Many adult common terns were bringing small fish to the island, so there were probably also fledglings of this species hidden under the coarse coral pieces. There were now also over 100 'nests' of large crested terns, as well as 4 roseate and some little terns incubating. By mid–August the little island was deserted, with only some of the scrapes and nests remaining. It would seem that all the common terns (adults and newly raised juveniles) had flown away before the 23 July.

This is a clearly documented case of the breeding of common terns in Sri Lanka, and the only instance known to me where this species has bred in the Asian tropics. According to Cramp (1985), the nearest known breeding areas are at the northern end of the Persian Gulf (*S. h. hirundo*), clearly outside the Tropic of Cancer, and the high–elevation lakes of Tibet (*S.h. tibetana*). According to the same source there are two known breeding areas of *S.h. hirundo* on the West African coast, within the tropics, and some in Central America and the immediately adjoining South American continent (Venezuela), but never before has the species been known to breed so far south in Eurasia.

Unfortunately I have not been able to confirm the breeding of common terns in Sri Lanka during subsequent years due to several factors. In the early 1980s tourism rapidly developed into a major industry in Sri Lanka and hotels were established at Pasikudah Bay only a few kilometres south of the coral island. Despite annual appeals to the hotels, toursits, quite ignorant of the special importance of the little island, were brought there for goggling, spear-fishing and shell collecting. Particularly during the breeding season (which is also the main tourist season) there were daily visits with people trampling over the corals and swimming in the nearby sea, thus disturbing the terns and preventing any attempts by them to breed; this was especially the case in 1981 and 1982. The breeding birds are further disturbed by collectors of coral who illegally remove in sacks boat-loads full for lime burning, and also by collectors of tropical fish for export who operate here during the time of the year.

In July 1981 I observed only seven common terns (and only 20 large crested) in breeding plumage, and there was no sign of breeding of any terns on the island, perhaps due to unusual weather (late SW Monsoon) and the absence of swarms of sprats and sardines, the main food of the terns at this time. Roseate and little terns were also missing. Perhaps the breeding started later for all four species, but I was unable to make further observations that year. Later the ethnic conflict broke out in earnest and it was no longer possible for me to visit the area. But I am fairly convinced that common terns breed in and around Sri Lanka in suitable undisturbed localities. Adult pairs are highly faithful to breeding colonies (Cramp 1985).

This documented discovery in 1980 of a substantial number of common terns in breeding plumage, with nests, eggs and chicks, thousands of kilometres away from the nearest known breeding areas, if confirmed in later years, would add a new breeding resident to the checklist of Sri Lanka and reveal an amazing extension of the breeding range of this species in Eurasia. An exciting prospect when it is considered that since about Legge's time one hundred years ago, there have hardly any additions to the list of resident breeding species, in evident contrast to the list of winter visitors and pelagic birds which grows almost every year by one or several species. A recent probable breeding addition is the greyheaded mynah *Sturnus malabaricus*, and another candidate is the large pied wagtail *Motacilla maderaspatensis*, which I suspect to breed in the northern islands, e.g. Delft.

Worldwide there are three races of the common tern: *S.h. hirundo*, which breeds in a wide geographical band from central and eastern North America through Europe to West Siberia; *S.h. tibetana* which breeds in Kashmir, Tibet, Mongolia and China; and *S.h. longipennis* which breeds in NE Asia and winters from Japan through to Australia (it differs from the other two in blackish bill and legs), all nesting mostly on freshwater lakes. Of the three subspecies only *S.h. hirundo* breeds in or near the tropics (W. Africa, Central America) and also in the Arabian Gulf on bare islands similar to the one described here. The race which visits Sri Lanka in winter is *S.h. tibetana* which breeds on the high-elevation lakes in Tibet and Ladakh. This led me to speculate (Hoffmann 1981) that the breeding colony described in this paper might perhaps belong to the race *S. h. hirundo*. In the original Ceylon Bird Club Notes (1980, May- August: 27–43) the birds are referred to by me as *S.h. tibetana* (with *S.h. hirundo* as a possibility). However, this question must remain unresolved until another breeding colony is found and a specimen can be procured. *S.h. hirundo* (practically not distinguishable from *S.h. tibetana* in the field is a winter visitor and non-breeding summer loiterer to Sind and Baluchistan, but has not been definitely recorded (collected) in India.

In Hoffmann (1984) and also in Hoffmann (1989): the common tern is listed as *S. h. tibetana* on the strength of the observations presented in this paper There have been uninformed comments on my report of this breeding colony of the common tern in Sri Lanka, seemingly based on hearsay and a misunderstanding of my brief reference to this occurrence in the 1980 annual Ceylon Bird Club digest (Hoffmann 1981); the original observations as published in the monthly Ceylon Bird Club Notes were obviously not consulted. Thus it became desirable to present this detailed paper on my observations in 1980.

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AVIAN PROFILE OF A MAN–MODIFIED AQUATIC ECOSYSTEM IN THE BACKWATERS OF THE UJJANI DAM[1]

E.K. Bharucha [2] and P.P. Gogte[3]

(With two plates and four text-figures)

This study highlights the avifaunal aspects of a man–modified aquatic ecosystem in the backwaters of a recently constructed irrigation dam. It uses the bird profile of the area as an indicator of changes in the ecosystem. The study provides a strategy to develop a viable nature conservation scheme in a multiple use area in the backwaters of the Ujjani Irrigation Project.

Introduction

It is commonly believed that dams and irrigation projects are detrimental to the ecology of an area.They are known to submerge large tracts of forests, destroying their diverse plant and animal life, or lead to detrimental changes in the water regime of the area. However, this is not always the case. If carefully managed they can also help in the conservation of nature in a limited sense (Soule 1986). One such example is the Ujjani dam, which has provided a new habitat for a large number of waterfowl and terrestrial birds. We would thus like to point out that if dams must be built for the economic well–being of mankind, selection of the site must be a prime concern so as to minimise ecological damage. After impoundment, careful management must provide natural resources on a sustainable basis for local inhabitants. And finally an attempt must also be made to balance its utilitarian values with the institution of a nature conservation scheme in the newly formed man–modified ecosystem. This last aspect has not been given adequate attention.

This paper demonstrates that by identification of specific conservation goals and careful planning, natural resources can be protected within the existing framework of an irrigation project.

The Ujjani dam was built only eight years ago. Before the dam was constructed, the area consisted of semi–arid marginal agricultural tracts and wasteland on the banks of the Bhima river. A small number of local and migratory aquatic birds were found in patches along the length of the river. Terrestrial birds that fed on surrounding crops and those that used the semiarid wasteland were also present. Today this pattern has changed dramatically and the backwaters of the Ujjani dam at Bhigwan constitute a highly complex wetland ecosystem. This makes it not only an interesting study site, but also provides an insight into what can be achieved around other irrigation projects.

An important factor which emerged during this study was that several abiotic features in the newly established waterbody are still progressively changing. This has produced a series of successional changes in the biotic component of the system. Patterns of wetland utilization and land use, which have been modified by the dam, built in the recent past, have played a considerable role in producing various changes in the ecosystem.

Objectives

The primary objective of this study was to provide a baseline assessment of the present state of the ecosystem in the backwaters of the Ujjani dam at Bhigwan, so that it could be used to formulate a rational and scientific basis for management.

The main aims of this study were:

1. To study the abiotic parameters of the habitat such as its geographical features, the physicochemical properties of water, the depth of the water in different areas, and relate them to avifaunal patterns.
2. To study changes in successive years of biotic features such as planktonic forms, aquatic and semi–aquatic vegetation and their effects on the diversity and population of bird life.
3. To document the avian profile of the area and study habitat utilization by different species of waterbirds.
4. To study land use patterns and the utilization of

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the waterbody by local inhabitants.

5. To define the effects of human utilization of the ecosystem with special reference to its bird life.
6. To assess the ill effects of human interference on the conservation values of the area.
7. To provide management recommendations for the conservation of this wetland.

Methods

This study was conducted over a period of five years (January 1985–January 1990). Regular field trips were made throughout this period at intervals of 15 to 20 days. However, the area has been visited fairly regularly by us since 1979.

Water depth: Water depths were measured during April 1986. The measurements were taken along a transect by dropping a scaled rope at fixed intervals across the lake from the southern bank to the northern bank.

Physicochemical: Four sampling stations were set up along the shore of the waterbody (Fig. 1). The criteria for choosing the respective sites were related to the distribution and movement of waterfowl, especially flamingos. Station A was on the eastern bank, where flamingos were seldom seen. Station B was near Bhigwan township and was not frequented by flamingos. Stations C and D always had flamingos, the former being a feeding area, the latter a roosting site. The physicochemical study of the waterbody consisted of recording dissolved oxygen, alkalinity, pH, and hardness. All the tests, except for hardness, were carried out in the field according to standard methods (APHA, AWWA, WPCF, 1975). Samples were collected in two litre plastic cans and were brought to the laboratory for analysis of hardness. The analysis was done 24 hours after collection. The sampling was done every week in 1987 and 1988.

Plankton: The plankton study consisted of identification of the common phytoplankton and the density of plankton during different seasons. Samples were collected from the four stations and preserved in formalin. Their analysis was done in the laboratory 24 hours after collection.

Botanical: A brief botanical survey of the aquatic and semi–aquatic macrophytes found in the lake and its immediate surroundings was made. Specimens were collected in the field for a herbarium and later identified in the laboratory. Plant density was calculated by the list count quadrat method.

Ornithological: The ornithological study consisted primarily of a study of population dynamics and behavioural ecology of the diverse species of bird life of the area. More detailed behavioural studies of flamingos and nesting terns were also carried out. The status of the water birds was determined on the basis of absolute number of a species in comparison with the population of related species of the same family, as well as by comparing their abundance with other lakes in the area.

Bird counts were carried out around the 15th of January of every year from point A to D. Bird counts were done by two different methods. Actual head counts were done for bird species which were small in number. For fast moving birds or for birds present in large flocks, a section of the flock was counted, using this as a guide to estimate the total number in the flock. Bird behaviour was studied by observing their movements and habits. Hides in the form of cloth sheets, spread over the observer, were used to observe nesting birds. The identification of birds was done using field guides such as A PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUBCONTINENT (Salim Ali, 1983). All observations were made using binoculars (Sears 8x35, 16° wide angle). Photographic documentation was done with a Nikon FE and Nikormat EL with 300 mm telephoto lens or 80 to 210 Vivitar zoom; or an Asahi Pentax with 200 mm or 400 mm telephoto lenses).

Socio–economic: Repeated surveys were done to correlate ecological data with sociological and economic changes in the life of the local people. These periodic surveys were carried out to elicit the people's reaction to the dam, their impressions of the avifauna, and their attitudes towards the impending notification of the area as a sanctuary. During such surveys the people were given an idea of what the local conservation goals were, and informed that notification would not be economically detrimental to them.

Results and Discussion

Study area: Bhigwan is a small township situated on the Pune– Solapur highway 100 km southeast of

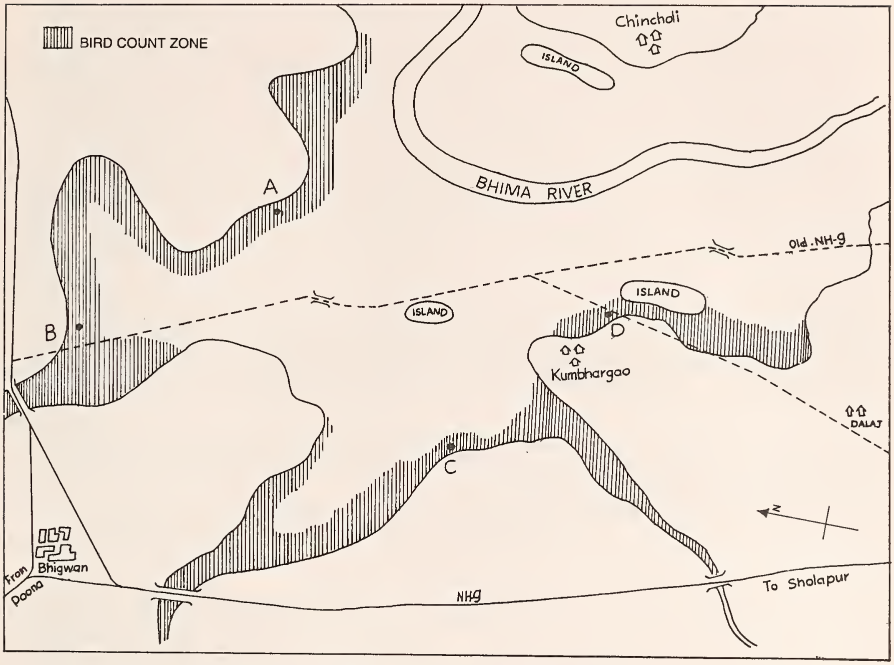


Fig . 1. Map of Bhigwan wetland, showing study area.

Pune, with a population of 4,000–5,000. The large expanse of shallow water is a part of the backwaters of an irrigation dam built across the Bhima river at Ujjani. The waterspread in the backwaters covers a considerable area from Bhigwan to Dalaj (Fig. 1). This shallow area is a favoured habitat for a large number of waders and surface feeding ducks. The original river bed, which is relatively deep, also attracts diving ducks and fishing birds such as terns and gulls.

There are several small settlements on the banks. Bhigwan, which is the largest, is situated just off the Pune–Solapur highway. Another small village, Kumbhargao, is situated on the south bank. Further downstream the submerged village of Dalaj has been split into three settlements called Dalaj 1, 2 and 3. There is a small island off Khanoti, upstream towards the northeast, beside which is another small settlement called Chincholi.

Water depth: One of the important features of this wetland is the large expanse of shallow water. This is due to the fact that much of this inundated land is in the plains (Fig 2). The expanse of the water can be divided into three zones (Odum 1971) (Table 1):

Zone I. The edge of the water close to the shore, which is frequented by waders like stilts, plovers, godwits, sandpipers, shanks, etc. The water level in this area is very shallow, ranging from 0 to 10 cm.

Zone II. The shallow portions where water levels vary up to a depth of 120 cm. This area has a large amount of aquatic plants and is frequented by larger birds like the flamingos, herons, storks, cranes, spoonbills, ibises, and surface feeding ducks.

Zone III. The deep water region where water-depth is greater than 120 cm is commonly frequented by the diving ducks. Flamingos were also seen in feeding parties swimming into deep water on several occasions.

Many birds like gulls, terns, osprey, etc. do not require a specific depth of water to feed in. These birds, which feed by diving into the water, were found in all the three zones. Some specialist species have a specific 'niche' and feed mostly in a single zone, while others are less specific and can use a combination of two or even all three zones. The

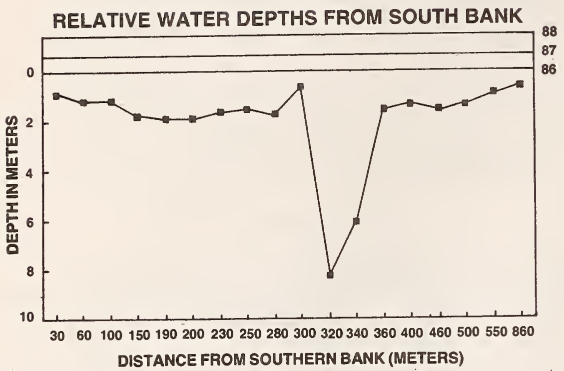


Fig. 2. Water depth in relation to distance from southern bank.

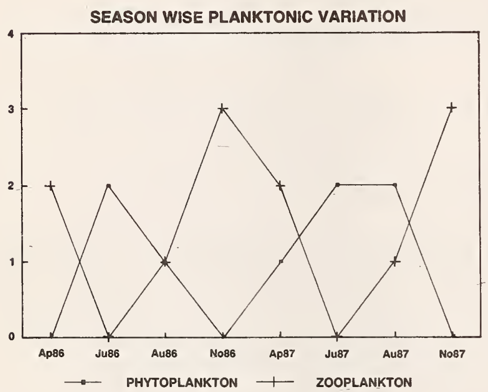


Fig. 3. Season-wise planktonic variations

number of species using individual zones and combined ones is shown in Table 2.

Habitat utilization: The birds are classified according to habitat utilization as aquatic (A) or terrestrial (T). However, certain aquatic species also feed on land, while some of the terrestrial birds utilise aquatic forms of life as an additional source of food (Table 2, Appendix 1).

Table 1

WATER DEPTH

Depth (m)	Distance from southern to northern shore (m)	
0.91	Zone I	30
1.22		60
1.22	Zone II	100
1.83		150
1.89		190
1.89		200
1.66		230
1.52		250
1.70		280
0.61	Zone III	300
8.23		320
6.10		340
1.52		360
1.37		400
1.52		460
1.37		500
0.91	Zone II	550
0.61	Zone I	860

Physicochemical characteristics: In the four sampling stations the physicochemical analyses showed a similarity in the water at stations A and B, which were upstream of stations C and D. At stations C and D the water had a higher pH. These areas were more frequently used by the flamingo to feed in (Table 3).

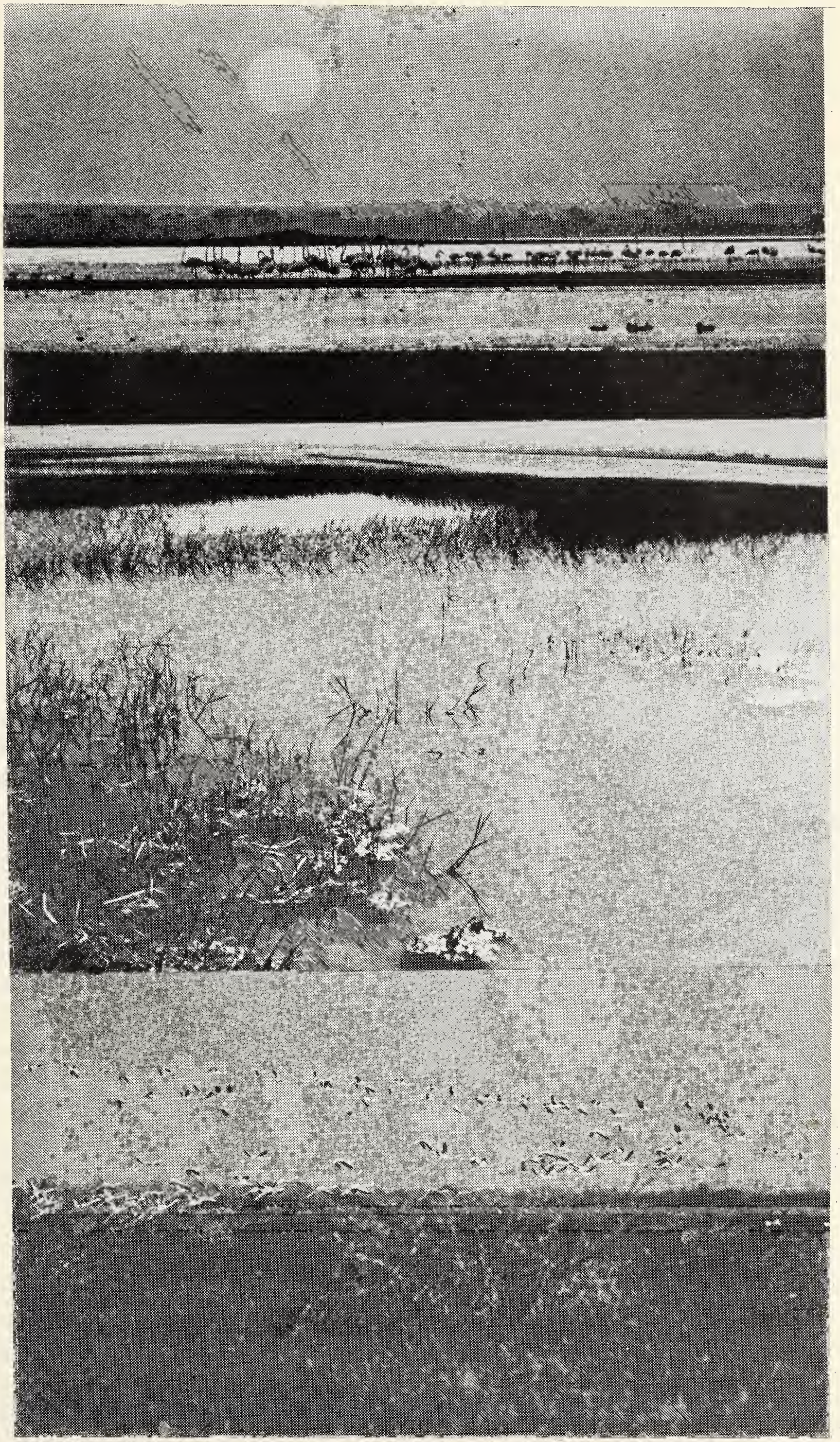
The water is more alkaline than in other lakes in this area of Maharashtra. Apparently this is an important factor that attracts large numbers of greater flamingos to this wetland. Both hardness and dissolved oxygen show high concentrations. As the physicochemical analysis was done over a relatively short period of time its results are only indicative of the abiotic characteristics of the water (Tables 3, 4).

Plankton: The high alkalinity at Bhigwan evidently contributes to the development of specific micro flora and fauna on which various birds survive (Table 5). The seasonal variation observed in the plankton population is shown in Table 6. This

Table 2

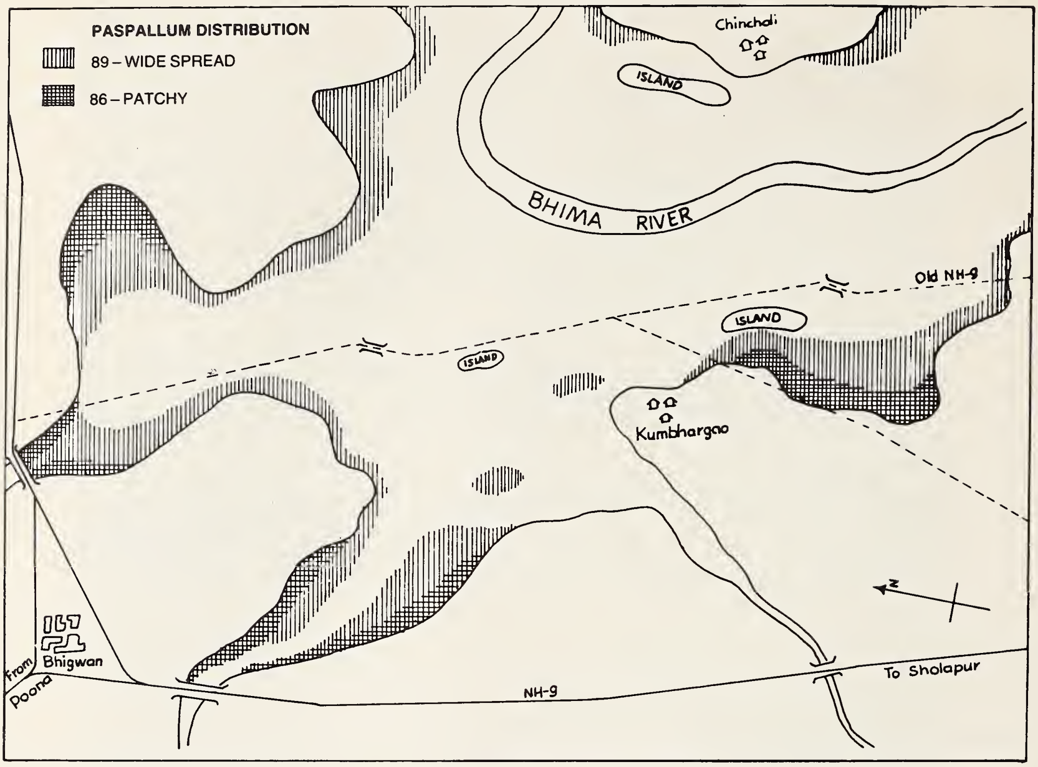
HABITAT BASED DISTRIBUTION OF AVIFAUNA AT BHIGWAN

Feeding zones	Terrestrial	I	II	III	I, II	II, III	I, II, III
Primarily aquatic species A	0	9	0	1	21	13	18
Aquatic & partly terrestrial A (t)	0	1	8	0	0	5	0
Primarily terrestrial T	60	0	0	0	0	0	0
Terrestrial & partly aquatic T (a)	0	1	0	0	0	0	14



Top: *Early period,* mudbanks frequented by flamingos.
Centre: *Transition period,* with growing expanse of *Paspallum.*
Bottom: *Recent period,* with heavy overgrowth of *Paspallum.*

PASPALLUM DISTRIBUTION 86 and '89



MANAGEMENT OF KEY AREAS

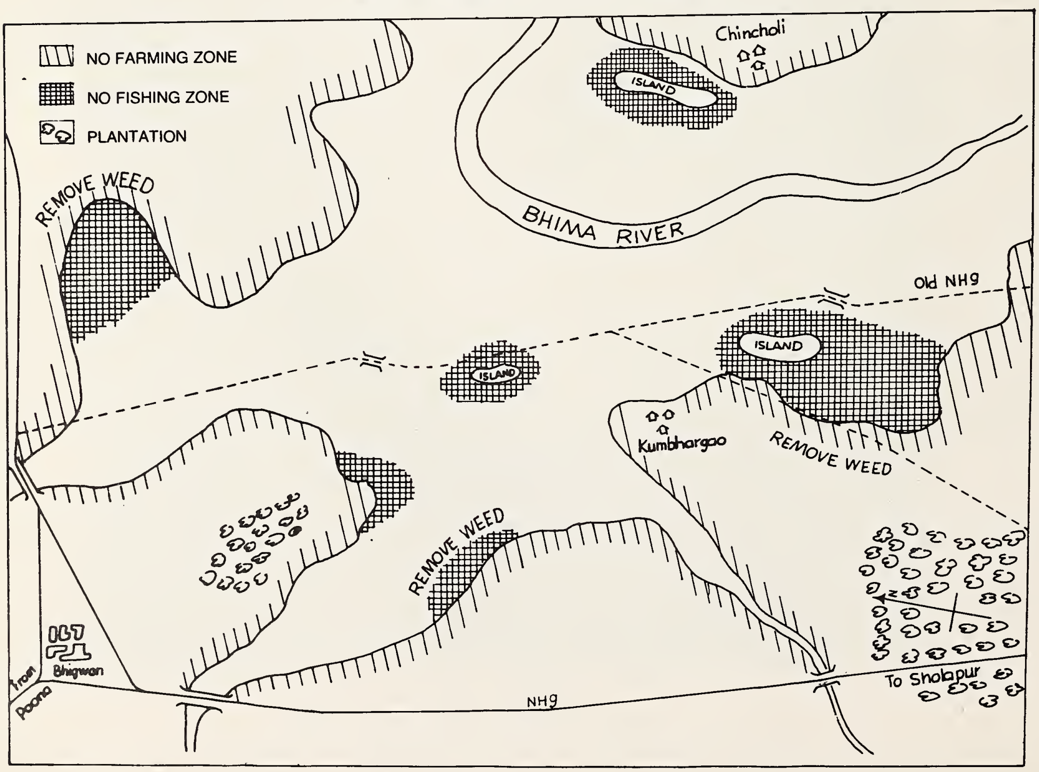


TABLE 3
PHYSICOCHEMICAL CHARACTERISTICS OF WATER

Parameters	A	B	C	D	
pH	7.5	7.2	7.6	7.9	
Dissolved Oxygen	3.7	4.1	3.1	3.6	ppm.
Total Alkalinity	76	87	91	69	ppm.
Hardness	18	124	174	136	ppm.

TABLE 4
COMPARATIVE pH OF NEIGHBOURING WATERBODIES

Waterbody	Min. pH	Max. pH	Average pH
Bhigwan	7.8	8.3	8.0
Kurkumbh	6.5	7.2	6.9
Patas (1)	7.5	7.9	7.7
Patas (2)	7.1	7.7	7.4
Varvand	7.2	7.7	7.5

TABLE 5
MICRO FLORA AND FAUNA

1.	*Anabaena* sp.	9.	*Euglena* sp.	17.	*Synedra* sp.
2.	*Bulbochoeta* sp.	10.	*Navicula* sp.	18.	*Spirulina* sp.
3.	*Cylindrospermy* sp.	11.	*Oosystus* sp.	19.	*Sperocoestoes* sp.
4.	*Celystrum* sp.	12.	*Oodogonium* sp.	20.	*Tetraedron* sp.
5.	*Colestrium* sp.	13.	*Oscillotorias* sp.	21.	*Ulotrix* sp.
6.	*Cosmarium* sp.	14.	*Phormidum* sp.	22.	*Zignima* sp.
7.	*Cladophora* sp.	15.	*Pediastrum* sp.		
8.	*Cymbella* sp.	16.	*Scenedesmu s* sp.		

TABLE 6
PLANKTON DENSITY FOR 1986–87

Planktonic Forms	April 86	June 86	Aug 86	Nov 86	April 87	June 87	Aug 87	Nov 87
1 Diatoms	++	+		+	++	+		
2. Desmids		++	+		+	++	+	
3. Blue green algae	+	+++	+	+	+	++	+++	
4. Protozoans	+	+	++	+	+	+	++	++
5. Rotifers	++			+++	++			+++
6. Crustaceans	++		+	+++	+++		+	+++
7. Insect larvae	++		+	++	++		+	++

+ Traces ++ Present +++ Abundant

TABLE 7
BOTANICAL PROFILE

1.	*Argemon nuscilaca*	11.	*Ipomea aquatica*	21.	*Pavith* sp.
2.	*Amaranthus* sp.	12.	*Limnophila indica*	22.	*Phasotius trilobus*
3.	*Acasia nelotica*	13.	*Lochnera* sp.	23.	*Paspallum* sp.
4.	*Bacopa monnier*	14.	*Nymphoides* sp.	24.	*Rotala tenuis*
5.	*Ceratophyllum demersum*	15.	*Najas minor*	25.	*Trianthemum nonogejha*
6.	*Centaurium roxburghii*	16.	*Ottelia alsinoides*	26.	*Vallisneria speralis*
7.	*Commelina* sp.	17.	*Polygonum glabrum*	27.	*Vinca* sp.
8.	*Gomphrena* sp.	18.	*Potamogeton nodosus*	28.	*Zornia gibbosa*
9.	*Hydrella verticillata*	19.	*Phyla nodiflora*		
10.	*Hopper dichotoma*	20.	*Partaloca alevacea*		

shows that phytoplankton population peaks around June, followed by zooplankton in November (Fig. 3).

The planktonic forms thus show definite seasonal changes in their abundance and density. Water depth and turbidity are the factors that control their population. In the rains when the silt is washed into the waterbody, the turbidity and the water level increases, and there is a sudden fall in planktonic density.

Botanical profile: The profile of the plant macrophytes in the area is shown in Table 7.

Eutrophication and succession: A significant finding was the sudden increase in 1989 in the growth of *Paspallum*, which was uncommon until 1986.

TABLE 8
MACROPHYTIC VEGETATION

Quadrat No.	*Paspallum* per sq.m	Other plants per sq.m
1.	56	33
2.	100	0
3.	121	0
4.	103	2
5.	56	7
6.	62	21
7.	97	5
8.	73	2
9.	88	0
10.	90	0
11.	102	1
12.	91	2
13.	77	17
14.	86	11
15.	62	3
16.	75	2
17.	103	13
18.	81	0
19.	69	6
20.	62	9
21.	50	11
22.	75	13
23.	111	1
24.	100	3
25.	85	5
26.	112	9
27.	63	15
28.	84	12
29.	97	3
30.	57	7
31.	92	6
Total in 31 plots	*Paspallum* 2580, other plants 189	
Percentages	*Paspallum* 93.17, other plants 6.83	

Paspallum was found to be the commonest species (93%) of the macrophytic vegetation along a major part of the shore. It was recorded up to a depth of 0.6 m inside the water at a distance of about 25 m from the shore in the summer of 1988 (Table 8).

AVIAN PROFILE

A checklist of the birds recorded, along with their abundance and seasonal variation, is shown in Table 9. The change in relative abundance is indicated by a + when the population has shown an upward trend and a – if the population was found to drop appreciably during the study period from 1986 to 1989.

The checklist also shows the 'niche' used by purely terrestrial (T) and aquatic (A) species. Those that require a combination of habitat conditions are catagorised as A(t) or T(a).

The aquatic system is divided into three zones – I, II and III according to the depth of the water, as discussed earlier (see Appendix 1).

The profile of aquatic and terrestrial birds shows that during the study period 160 species of birds were recorded (Hussain 1984, Ali 1983, Ali 1986). Out of these 85 (50.3%) were aquatic, and 75 (49.7%) were terrestrial. In 1989 of the 160 species, 65 (40.6%) were migratory, 5 (3.1%) were local migrants while 90 (56.3%) were resident throughout the year.

The species diversity index calculated for January 1987 and January 1988 was 2.01 and 2.08 respectively (Shannon–Weiner formula). In summer the species diversity index calculated for March 1987 and March 1988 was 1.32 and 1.72 respectively. This shows that the population is considerably modified by the influx of migrants in winter.

Between 1986 and 1989 the population of several species was observed to have changed. Among the 26 species that showed an increasing trend in population, 21 had to be reclassified into a commoner category in 1989. Certain birds, however, showed a decline in population. Among the 21 declining species, 15 were found to have become appreciably less common and had to be grouped among the less commoner category.

Those whose population increased were either marsh dependent species or those that are dependent primarily on fish. Those that showed a drop in population were invariably waders, which depend on mudflats for their food.

Comparing the seasonal status of the birds, 18 species that were considered local migrants in 1986 were found to have become resident throughout the year by 1989. Birds that have established nesting colonies during these years figure prominently in this group.

Bird counts: The bird counts were conducted by walking along the periphery of the waterbody. As this covered only a small sector of our study area along the edge of the lake from station A to station B it only indicates the relative abundance of different species through the study period. Table 10 shows annual counts on 15 January from 1986 to

TABLE 9
WINTER BIRD COUNT OF SOME INDICATOR SPECIES CARRIED OUT FOR 4 YEARS ON/AROUND 15 JANUARY IN THE SAME SEGMENT OF THE LAKE.

	Birds	1986	1987	1988	1989
1.	Grey heron	4	7	5	10
2.	Purple heron	8	1	3	12
3.	Smaller egret	7	4	5	3
4.	Openbilled stork	19	3	4	1
5.	Whitenecked stork	1	1	2	–
6.	Painted stork	–	5	8	5
7.	Glossy ibis	16	23	20	45
8.	Spoonbill	53	7	12	–
9.	Flamingo	555	47	–	49
10.	Demoiselle crane	715	220	104	–
11.	Common crane	150	–	–	–
12.	Ruddy shelduck	80	28	15	21
13.	Pintail	163	16	23	34
14.	Wigeons	243	180	78	94
15.	Shoveller	162	7	57	48
16.	Common pochard	59	59	132	187
17.	White–eyed pochard	–	24	78	13
18.	Tufted pochard	–	356	543	651
19.	Cotton teal	–	4	15	24
20.	Coots	290	1077	1342	1524
21.	Osprey	7	2	2	1
22.	Marsh harrier	39	1	5	23
23.	Spotted eagle	1	1	–	–
24.	Herring gull	1	3	2	12
25.	Brownheaded gull	25	10	29	35
26.	Purple moorhen	27	–	54	82
27.	Black–tailed godwit	10	3	15	7
28.	Temminck's stint	17	3	6	21
29.	Blackwinged stilts	54	12	–	–
30.	Little ringed plover	62	55	43	32
31.	Kentish plover	12	31	14	4
32.	Curlew	–	7	–	–
33.	Painted snipe	–	5	4	12
34.	Green sandpiper	9	2	17	2
35.	Spotted sandpiper	4	1	3	14
36.	Common sandiper	11	8	–	3
37.	Green shank	6	1	3	–

TABLE 10
FLAMINGO POPULATION 1986–1989

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	–	–	400	1500	200	100	50	100	50	10	200	300
1987	500	500	1000	1150	100	100	50	10	0	20	50	50
1988	0	50	250	400	43	21	2	0	0	0	0	12
1989	49	14	20	4	2	0	0	0	0	0	0	0

TABLE 11
NUMBER OF NESTS RECORDED DURING PEAK PERIOD OF NESTING SEASON

	Species	1986	1987	1988	1989
1.	River tern	100	250	0	120
2.	Little tern	4	8	0	16
3.	Little ringed plover	5	9	3	4
4.	Kentish plover	1	2	2	1
5.	Small pratincole	11	18	7	14

The total number of nests throughout the nesting season is several times greater, as these figures only indicate the number of active nests counted at one time during the peak period of each year.

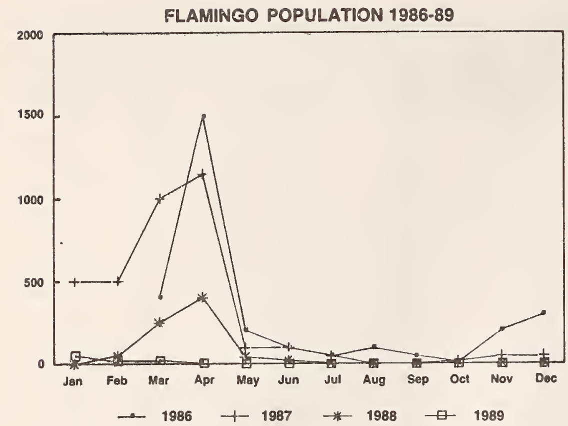


Fig . 4. Flamingo population in 1988–89

1989, of some important indicator species that have been affected by habitat changes.

The Flamingo

At Bhigwan the flamingos feed along the shore and on mud banks. Their major feeding area is in the vicinity of Kumbhargao, which is also one of the roosting places where they spend the night.

It is known that flamingos are highly specialized feeders and occupy a narrow niche within the ecosystem. The greater flamingo is known to feed on both minute plant and animal life that is abundant in certain muddy areas (Allen 1956). As shown earlier, one of the features observed was the high pH values obtained from Bhigwan lake as compared to lakes at Patas, Kurkumbh and Varvand, where the flamingos though present are always found in much smaller numbers. The pH values are between 8 and 9 for Bhigwan, 7 and 8 for Patas and Varvand and between 6 and 7 for Kurkumbh. The factor that attracts the flamingo to Bhigwan is related to the abundance of its specialized food. In all probability some components of this food material must be dependent upon a higher alkalinity.

Population dynamics: The flamingo population showed wide fluctations (Table 10). The main peak period was in February and March (Fig 4). Their lowest numbers were recorded during the monsoon. The bird profile in a wetland is affected not only by the abundance of specific food supply, but also by the ease with which it can be exploited. Even though there is apparently no reason for the flamingo's favoured food sources to have diminished in the lake bed, its accessibility has been decreased by the overgrowth of weeds. This prevents the ease with which the birds can filter their food from the mud. This may be a major contributory factor for the progressive decline of the flamingo population over the last four years (Fig. 4).

The flamingo movements, feeding and roosting sites showed several changes over the study period. In 1986, the flamingos were found almost all over the lake. In 1987 however, they had selected isolated feeding and roosting areas. Only one roosting area was located near Kumbhargao. As the water levels went up drastically during June–July 1987 the movement of flamingos showed a sudden change. They no longer favoured their old feeding sites. However, the roosting sites remained the same. The *Paspallum* grass had by then covered most of their favorite mud banks, used earlier, forcing them to move west, closer to the Pune–Solapur highway. Here they fed on the clear patches of mud and in the deeper part of the lake at the edge of the grass. In late February 1988, the birds were observed going upstream at dusk. This suggested that they had abandoned their old roosting site near Kumbhargao, but still frequented the area to feed in. In 1989 the flocks were smaller and were evidently hard pressed to locate feeding areas.

Courtship display: Between March and July of 1986 and 1987 the flamingo at Bhigwan were seen to perform courtship displays. During displays nearly the whole population congregated in the shallows near Kumbhargao. The males formed small groups with their beaks nearly touching while holding their heads high up in the air and fluffing up their dorsal feathers. A loud croaking accompanied this frantic activity, followed by pairing. Unfortunately, they made no attempt to build nests. An attempt to induce nesting was made by the Forest Department by making mud mounds, but these were washed away by the rains in 1986 and in 1987 they cracked due to lack of moisture, as they were built a little too far inland (Johnson 1982, Rooth 1982).

To induce these birds to breed the mudbanks that they require must be maintained and given protection. At present these mud banks are being encroached upon by the now fast spreading-

Paspallum weed. Measures to check the further encroachment of *Paspallum* would be beneficial to the flamingo, both for feeding and breeding.

Breeding Colonies on Mudbank Islands

As this waterbody is shallow, the silt that is brought down by the river and deposited in it creates constant changes in the configuration of the floor of the lake. In some places these deposits form large mudbanks which emerge out of the water when the lake recedes in summer, thus forming islands.These islands are not permanent as they are submerged in the rains. During the monsoons due to the increase in the rate of flow these mudbanks are either shifted to a different place or disappear altogether. New islands also suddenly appear when the water recedes. When the islands first appear in winter they are covered with algal mats. As soon as the soil dries up weeds and grasses take root. These terrestrial plants slowly start moving outwards as more of the mud bank emerges. In late summer these islands develop muddy bridges with the shore of the lake and are thus invaded by cattle which, feed on the vegetation.

The islands are used by several species of ground nesters as they afford some degree of protection and seclusion, during the early part of the summer (Table 11). All the colonies were dominated by river terns which nest throughout March and into early May. As the number of river tern nests drop in late April, the little terns start nesting. Nests of little ringed plovers and pratincoles were found in different stages of development during the entire nesting period ranging from March to May. A pair of great stone plovers was observed to perform nesting activities but their nest could not be located. Solitary nests of redwattled lapwing, Malabar crested lark and tawny pipit were found along the shore and on the islands when the emergent grass grew denser. The total number of nests during the peak of the nesting season in different years is shown in Table 11. As the islands grow progressively larger with the approach of summer their periphery is gradually colonised. The overall density of river tern nests which was 4/sq. m in the center, was much lower at the periphery with only 0.5/sq. m.

Human Utilization

This wetland is a multiple use area. The primary use of its terrestrial component consists of farming by lift irrigation and grazing of cattle and sheep. The aquatic system is used as a source of water for agriculture and domestic use and for fishing and commuting across the water.

Utilization of aquatic component: The water from the lake is used for a number of purposes such as :

a) Irrigation: The main purpose for the construction of the Ujjani dam was for irrigating agricultural areas downstream. Cultivators on the banks of the backwaters utilize water pumped up from the lake throughout the year.

b) Drinking and bathing: Water is pumped to Bhigwan, Kumbhargao, Dalaj etc. for drinking, bathing and other domestic activities. The lake is also used for washing of domestic animals.

c) Fishing: Fishing has become one of the chief occupations of the people living in the area. Several people have purchased new boats. Fingerlings have been released in the lake and the annual catch has increased significantly. A thriving fishing co-operative has been established in the area.

d) Communication: As old overland routes have been disrupted by the inundation, fishing boats are used to ferry people from place to place.

Utilization of terrestrial component:

a) Agriculture: The land that is exposed during the summer when the water recedes is used for cultivation of cash crops mainly sugarcane. Other crops such as onion, bajra and jawar are also grown. The only species which damages crops off and on is the demoiselle crane. This problem can be minimised if managed carefully (Fog 1982). Land which is now under the jurisdiction of the Irrigation Department is leased to local people for cultivation.

b) Grazing: as the water level drops, the exposed land is covered by grass which is grazed by livestock.

c) Plantations: the Forest Department has selected three plots along the shore for plantation of *Acacia*, *Eucalyptus*, Australian *Acacia* and *Neem* along with some other indigenously occurring trees.

Interaction between resource utilization and conservation goals: Though the utilitarian functions appear to produce a conflict with conservation goals a compromise solution can be worked out. It is

TABLE 12
INTERACTION BETWEEN UTILIZATION AND CONSERVATION

UTILIZATION OF RESOURCES	CONFLICT	ADVERSE EFFECTS ON CONSERVATION GOALS
TERRESTRIAL COMPONENT		AQUATIC COMPONENT
1. Agriculture at waterline on land leased by Irrigation Department		1. Disturbance to feeding and roosting area of waders
		2. Destruction of nesting colonies on islands
2. Overfertilization of crops		3. Rapid eutrophication and formation of thick marsh, reducing wildfowl diversity and population.
3. Uncontrolled grazing		4. Disturbance to wildfowl and dispersal outside refuge
AQUATIC COMPONENT		
4. Fishing and ferrying		TERRESTRIAL COMPONENT
5. Utilization of water for lift irrigation		5. Waterlogging and increasing salinity. Erosion of soil affects micro and macro plant and animal life at edge of the water. Eventually decreases soil fertility. Siltation shortens dam life
6. Poaching of wildfowl		
		6. Degradation of rangeland and desertification, which affects terrestrial avifauna and wildlife. Eventually affects pasture carrying capacity.

neither necessary nor desirable to totally prevent farming or fishing in the whole area. However some control is essential so that key conservation objectives can be achieved. The interactions between utilization and conservation are given in Table 13, which shows the complex interrelationships that lead to conflicts in using and conserving the aquatic and terrestrial components of this wetland.

If a small strip of land about 50 to 100 m in width is not leased for agriculture several conservation goals can be achieved. This would be a small price to pay for a large conservation gain, by reducing disturbance in key feeding, roosting and nesting sites. It would also help in reducing eutrophication and thus prevent the overgrowth of *Paspallum*. The reduced density of the weed and the reappearance of mudbanks would provide multiple niches and increase the diversity of bird life.

Prevention of fishing and ferrying in certain key areas where birds feed in the shallows and stopping the fishermen from using nesting islands to dry nets is another important conservation issue. However, there need be no general ban on fishing throughout the area.

CHANGING PATTERNS IN THE ECOSYSTEM

The changing patterns in the ecosystem show that there is a close relationship between the habitat requirements of avifauna and human utilization.

The environmental changes created by the dam have modified the lifestyle of local people as well as progressively created changes in the 'niches' of various aquatic birds.

During the early part of the study this wetland provided a large amount of food material that the flamingo and other waders found highly suitable. Due to the very gradual slope of the lake floor in the peripheral shallow zone, even a small drop in the water level exposed a wide belt of open mud, rich in food material. The main change in these mud banks is the sudden invasion by *Paspallum* grass that has colonized the shore. This has been highly detrimental to a specialized feeder such as the greater flamingo and other birds that feed by probing for food in the mud.

It is well known that an aquatic ecosystem evolves through several successional stages such as marsh, grassland, woodland, which culminates in a forest ecosystem. However, each transition should take several years. At Bhigwan the surrounding mud flats and the emerging islands which supported little or no vegetation in 1986, suddenly began to harbour patches of *Paspallum* in 1987. Within two years, this grass completely covered the open mudflats and has replaced most of the original vegetation such as *Typha* by 1989. In the recent past the grass has spread over the whole area, both in the surrounding soft moist mud at the periphery of the lake and in the water up to a depth of about 60 cm. Thus today large expanses of what used to be feeding grounds for a variety of waders has been converted into a marsh or grassland ecosystem.

The surrounding area consists of farmlands in which cash crops like sugarcane, as well as jawar, bajra and onions are grown. The farmers in the area use large amounts of fertilizers which are washed into the lake during the monsoons. The surrounding mud banks, which are exposed in summer, are also used for cultivation. These are again submerged, as water levels rise during the rains. As they are heavily fertilized, the residue directly enters the water. This is evidently responsible for the rapid eutrophication within the lake, which manifests itself as: a) large algal mats, b) a thick tangle of aquatic weeds, c) a peripheral zone of the spreading semi–aquatic grass, of which one is the *Paspallum* species, and d) peripheral patches of *Echornia* which have now begun to spread.

The adjacent terrestrial ecosystem supplies large inputs in terms of micro–nutrients into the aquatic ecosystem, resulting in an acceleration in the normal rate of succession. The sequence of interactions are depicted in Table 12.

Any management scheme must thus take into consideration the fact that it is essential to maintain mudbanks and an appropriate water depth, without an overgrowth of any form of macrophytic vegetation. Adequate periods of draw down which expose the mudflats are thus essential to dry off the vegetation and permit recycling of various micro organisms, worms, molluscs and crustacea in the mud (Thomas 1982).

The changes in the avian profile thus indicate how the overall ecological picture has been progressively modified.

In the *Pre–dam period* the Bhima had a seasonal flow. It supported primarily rain dependent crops. Aquatic avifauna had patchy low density populations of the commoner bird species found in Maharashtra.

During the *Early Period* soon after the construction of the dam, the surrounding farmland acquired by the Irrigation Department was mostly fallow. The ecosystem was dominated by the formation of extensive open mudbanks at the edge of the water. As these were progressively colonized by microscopic plankton and later by invertebrates such as worms, molluscs, and crustacea the waders began to increase in number. This also provided the favoured 'niche' of the flamingo.

This was followed by a *Transition Period* with the establishment of a few areas of aquatic and semi-aquatic macrophytes. The peripheral land was now leased to farmers to grow cash crops which were heavily fertilized, leading to progressive eutrophication. This brought about a shift from the predominantly wading species to that of dabbling ducks and marsh birds. The growing expanse of *Paspallum* grass now began to attract more and more coots, moorhens and jacanas.

With the increasing number of fingerlings released by the Fisheries Department there was a rise in the fisheating birds such as gulls and terns. During this period the nesting colonies of tern were established.

The *Recent Period* is characterised by an overgrowth of *Paspallum* that has converted the multi–niche wetland into an extensive single niche marshland. Only the deep water is left open while most of the mudbanks are covered with weeds. The waders and specialist feeders such as the flamingo have thus been drastically reduced. The avifaunal pattern is dominated by increasing numbers of commoner species of marsh birds.

Summary and Conclusions

Bhigwan is a wetland that has an immense conservation potential and thus requires special attention from Government. Unless it is notified immediately and a well formulated management plan drawn up and implemented, the ecosystem will soon deteriorate beyond the point of no return. One of the special features of this wetland is the relatively high pH, and the presence of large mudbanks that in 1986 created an ideal habitat for waders. As a result the flamingo aggregated here in larger numbers than anywhere else in Maharashtra.

The profile of aquatic and terrestrial birds shows that during the study period a total of 160 species of birds was recorded. Of these 85 were aquatic, and 75 were terrestrial.

The species diversity index calculated for January 1987 and January 1988, was 2.01 and 2.08 respectively (Shannon–Weiner formula). In summer the species diversity index for March 1987 and March 1988, was 1.32 and 1.72, which was considerably lower than in winter.

Bhigwan is the only large breeding colony for a variety of ground nesters in Maharashtra. The islands on which a major concentration of breeding occurs are selected by the birds for their seclusion. Unfortunately as the water level drops in summer, the islands develop mud bridges like an isthmus that joins them to the shore of the lake. This produces an influx of cattle that trample the eggs and chicks. The village dogs also predate on them and within a few days all the nests are destroyed.

Our observations have shown that population trends for different avifauna are related to : a) Changes in the habitat and availability of favoured niches; b) Availability and accessibility of specific food sources; c) Presence of secluded nesting sites; d) Extent of disturbance by human activity to feeding, roosting and nesting sites.

It is apparent that this specialized system is undergoing a process of rapid succession and consequently becoming a less specialized one. Even though this may have enhanced the absolute number of birds especially of the commoner marsh species, it has lead to a decrease in certain specialist birds dependent on mudbanks that occupy a very narrow 'niche'. During the study period 26 species became relatively more common, while the population of 21 other species showed a decline.

Habitat suitability has mirrored the changes observed in the avifaunal population. The early period with newly formed mudbanks, gave way place to a multi–niche intermediate period with a very high population of diverse birds and finally a uni– niche marshland with a lower diversity and population of several species.

The point in question is, what should be envisioned as an 'ideal' wetland habitat for Bhigwan. A highly diverse and densely populated mix is what is evidently most desirable. Management should aim at transforming this man–modified ecosystem so that it mimics a natural ecosystem as closely as possible. This can be done if the wetland is managed so as to provide multiple 'niches' for a variety of species. However this may not be easily feasible as the ability to control such a complex system requires careful, constant scientific monitoring. Arresting the process of succession is in itself difficult and to attempt to reverse it, is even more problematic. For instance the influx of *Paspallum* may indeed necessitate an expensive bulldozing operation or provide a major drawdown every summer to dry the weed. Maintaining open mudbanks provides a challenge to the wetland manager. Removal of weed species such as the *Eichhornia* also poses a serious problem.

Controlling the water level is another tool that can be used to manage the aquatic ecosystem. This would necessitate building of bunds and sluices to maintain a specified water level as is done in Bharatpur. Lift irrigation pumps can be used to raise water levels in them. The submerged road and trolley track that extends from the Bhigwan Forest Department Nursery up to Kumbhargao could be used as a foundation to build the bunds. A pilot experiment on these lines could be made near Kumbhargao, where the old road and the banks form a shallow lagoon. Studies could then be instituted to observe how changes in water levels affect various bird species, producing local fluctuations in their population.

Management must attempt to balance the needs of resource utilization and nature conservation. As the specific conflict sources have been identified and key conservation goals specified during this study, it has been possible to evolve a multi–faceted management formula for the wetland.

Management Recommendations

Administrative measures: At present, the entire waterbody is under the jurisdiction of the Irrigation Department of Maharashtra. This wetland, or a part of the backwaters, should be handed over to the Forest Department and notified as a sanctuary. The Forest Department has already accepted our assessment that this is a unique wetland, and has proposed to the Government that it should be notified as a bird sanctuary.

We would like to point out that though the northeastern bank is said to be already notified as the Great Indian Bustard Sanctuary, this has little meaning as this very large sanctuary cannot be protected effectively. We feel that this unmanageably large Sanctuary should be denotified as core areas used by the bustards have now been identified. Once this is done, the area on the northeastern banks of the Ujjani lake would be left without a protected status, as there are no bustards in the area. In view of this, the whole area should be separately notified as a Wetland Sanctuary, rather than being left as part of the Great Indian Bustard Sanctuary.

Land use management around the wetland:

a) *Farming:* As the waterbody stores an enormous quantity of water even through the dry season, the utilization of water for domestic use and irrigation presents no threat to the ecosystem. In fact the irrigated fields attract a large number of gramnivorous and insectivorous birds and provide a habitat for small mammals.

However, farming on the exposed land during the summer draw–down should not be permitted in the immediate vicinity of the shoreline in the backwaters. At present this adds to very rapid eutrophication by the excessive use of fertilizers. Filling this area increases siltation and will shorter the effective lifespan of the Irrigation Project. The local effect of pesticides, which has not been studied, may also be detrimental to the aquatic ecosystem. The continuation of uncontrolled farming in this area will further disturb the probable nesting of flamingos and other ground nesters around the shore. Thus this area at the edge of the water may be constituted into a 'core zone' where disturbance should be minimized. This can only be done if the local people are involved and are made aware of the economic benefits of creating a sanctuary for wildlife tourism and are given job opportunities for its management.

We are given to understand that compensation for these lands has been given to the farmers, and these areas are only leased to them by the Irrigation Department each summer. This practice need not be stopped completely. However, those areas which get totally inundated every year should not be leased out to prevent further ecological changes. This consists of a strip of about 50 to 100 meters in width at the edge of the water.

b) *Control of grazing:* Grazing on the islands where the tern colonies are located should be immediately stopped, as it destroys the large nesting colonies that have been established. Grazing of livestock in the peripheral area poses no threat to the aquatic ecosystem. However, the institution of scientific rangeland management would improve the quantity of locally available fodder. Some areas should be closed by rotation, to permit better rejuvenation of the semi–arid grassland ecosystem. This would also support larger numbers of semi–arid land birds.

c) *Afforestation:* The hill ranges near the waterbody as well as the entire shore, are totally barren. Suitable trees should be planted around the water, a sufficient distance away from it. These trees will serve as roosting and nesting places for birds like storks, herons and egrets. Afforestation of the permanent islands with *Acacia* trees would also help establish nesting colonies of birds, which prefer seclusion and thorny trees to nest in. The trend, at present, is to plant exotic fast growers and attractive flowering trees around the lake. These do not form part of this semi–arid Savannah ecosystem and are detrimental to its ecology. This will reduce the habitat suitability for semi–arid land birds, reptiles and mammals. The aforestation must thus be aimed at recreating a near natural semi–arid area vegetation, with trees such a *Babul* and *Ber*, which are indigenous to the area and also require less economic inputs to grow successfully in the murum soil.

Management of the aquatic component of the wetland:

a) *Fishing:* At present fishing, does not have any adverse effect on the ecosystem. However, fishermen should not be permitted to leave their nets in the shallows for several days, as they trap waterfowl such as ducks, waders and flamingos. Otters are also killed by fishermen. This must be prevented. The nesting islands should be made out–of–bounds for drying of nets or other activities. Movement through the feeding and roosting areas should be through specific routes to minimise disturbance. The species of fingerlings released by the Fisheries Department should contain a smaller proportion of carnivorous fish so as to reduce competition (for molluscs and crustacea) with wildfowl.

b) *Ferrying:* The establishment of specific routes to ferry people from one village to another will reduce disturbance to critical feeding, roosting and nesting sites.

c) *Habitat improvement:* Some isolated areas can be selected to plant *Typha* or other aquatic reeds. These will provide nesting places for resident ducks and waders.

Mudflats that appear and disappear rapidly must be stabilized by controlling the direction and flow of water. This can be done by adding rubble to existing mudbanks to prevent them from being washed away in the monsoon. This will allow more birds to nest regularly. An attempt must be made to allow the large expanses of *Paspallum* grass to revert, to mudbanks This can be done by encouraging grazing by buffaloes and by manual removal for stall feeding. The annual summer draw–down that will occur once the water is fully utilized for canal irrigation downstream, may further help in the control of the unwanted grass by drying during the summer. Opening up the mudbanks by reducing macrophytes in a part of the area would effectively increase the accessibility of food essential for specialized waders.

The wetland can also be managed by building bunds and manipulating water levels as is done in Bharatpur. A small pilot scheme to study the effect should be instituted before going in for any large scale management on these lines (Harrison 1982).

Wildlife Management:

a) *Protection of nesting colonies:* Specific protection should be given to the nesting colonies of terns, pratincoles and plovers on the islands. The land connections that form in summer between the islands and the shore of the lake should be disconnected or closed off with barbed wire fences when the water level drops. Guards must be posted near the islands to prevent damage by villagers, cattle and dogs.

b) *Poaching:* There have been several reports of 'shikar' of birds at the lake. Large numbers of ducks, waders, cranes and even flamingos have been shot. There have also been some cases of trapping of otters which should be looked into and stopped immediately by the Forest Department. Notification as a Sanctuary would effectively prevent this in future.

Wildlife tourism: Currently there are no tourist facilities in this area. If such facilities are provided in a well controlled fashion it will help to improve the economic standards of the local people.

Special problems:

a) *Eradication of Paspallum:* This weed must be removed on a priority basis by repeated manual removal. Reducing the weed density and producing open mudbanks constitutes a major conern. Grazing by domestic buffaloes should be encouraged.

b) *Eradication of water hyacinth:* The invasion by water hyacinth is becoming more evident. This should also be removed on a priority basis before the whole lake is covered by this weed.

c) *Increasing salinity:* During 1989 several areas around the periphery of the water showed signs of salinity. Patches of salt deposits were seen in certain areas and in some cases apart from sugarcane, the yield from other crops is on the decline. This aspect needs further investigation so that the farmers, income is not jeopardised.

d) *Proposal for nuclear and thermal powerplant:* There is a recent proposal to develop a nuclear and a thermal powerplant at Ujjani. The BNHS has been requested to study its impact on the ecosystem. Permission to start work on the project should not be granted till the EIA is completed.

Proposed pilot study: It is essential to build small bunds to impound water at different depths and observe its effects on resource utilization and feeding habits of the different waterfowl. The cycling of nutrients and effects of fertilization and pesticides should also be evaluated. This would help formulate further management principles to improve the habitat suitability for its avifauna and support a larger population with a greater diversity of bird life.

Environmental awareness programs: Conservation consciousness can be best achieved by designing a specific audio–visual programme on the benefits of protecting and managing the wetland as a sanctuary. This can be shown to local people on market days, and to village schools in the area.

Conservation: Though the Forest Department has been considering creating a sanctuary here for several years, the area is yet to be officially notified. It has also been included in the list of proposed Protected Areas in a report for the Department of Environment by the Wildlife Institute of India (Rodgers and Panwar 1988)

If a productive multiple use area and a bird sanctuary are to coexist in this wetland its active management must be done with local involvement. Only then can its conservation objectives be realized on a long term basis.

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APPENDIX 1
BIRDS RECORDED AT BHIGWAN BACKWATERS FROM 1986 TO 1989

Checklist with ecological classification, feeding 'niche', seasonal population dynamics, status, and population trends from 1986 to 1989.

Column 1: Habitat utilization of avifauna: A = Aquatic, T = Terrestrial, A (t) = Primarily aquatic, secondarily terrestrial; T(a) = Primarily terrestrial, secondarily aquatic.
Column 2: Aquatic feeding zone : I = 0 to 10 cm deep (at shoreline) II = 11 to 120 cm (relatively shallow) and III = 120 cm and deeper water.
Column 3: Status and seasonal variations in 1986 (3a) and 1989 (3b) VC = Very Common, C = Common, U = Uncommon, O = Occasional M = Migratory, LM = Local Migratory, R = Resident
Column 4: Population trends : + = Increasing, – = Decreasing

	SPECIES	1	2	3a 1986	3b 1989	4
1.	Little grebe *Podiceps ruficollis*	A	II/III	C/R?	C/LM	
2.	Cormorant *Phalacrocorax carbo*	A	II/III	U/LM	C/LM	+
3.	Indian shag *Phalacrocorax fuscicollis*	A	II/III	U/LM	C/LM	+
4.	Grey heron *Ardea cinerea*	A	II/III	C/LM	C/R	
5.	Purple heron *Ardea purpurea*	A	II/III	C/LM	C/LM	+
6.	Pond heron *Ardeola grayii*	A	IV	C/LM	VC/R?	
7.	Cattle egret *Bubulcus ibis*	T (a)	I	VC/LM	VC/R?	+
8.	Large egret *Ardea alba*	A	I/II	VC/LM	VC/R?	
9.	Smaller egret *Egretta intermedia*	A	I	U/LM	U/LM	
10.	Little egret *Egretta garzetta*	A	I	C/LM	VC/R?	
11.	Painted stork *Mycteria leucocephala*	A	I/II/III	O/LM	C/R	+
12.	Openbilled stork *Anastomus oscitans*	A	I/II/III	VC/R?	VC/R	–
13.	Whitenecked stork *Ciconia episcopus*	A	I/II/III	C/LM	VC/R	
14.	White ibis *Threskiornis aethiopica*	A	I/II/III	C/LM	C/R	–
15.	Black ibis *Pseudibis papillosa*	A	I/II/III	C/LM	C/R	
16.	Glossy ibis *Plegadis falcinellus*	A	I/II/III	VC/LM	C/R	–
17.	Spoonbill *Platalea leucorodia*	A	II/III	VC/LM	C/R?	–
18.	Greater flamingo *Phoenicopterus roseus*	A	II/III	VC/M	C/M	–
19.	Lesser whistling teal *Dendrocygna javanica*	A	I/II	C/M	U/M	–
20.	Ruddy shelduck *Tadorna ferruginea*	A	I/II/III	C/M	C/M	
21.	Pintail *Anas acuta*	A	I/II	VC/M	C/M	–
22.	Common teal *Anas crecca* '	A	I/II	VC/M	C/M	–
23.	Spotbill duck *Anas poecilorhyncha*	A	I/II	C/R	C/R	+
24.	Gadwall *Anas strepera*	A	I/II	U/M	C/M	+
25.	Wigeon *Anas penelope*	A	I/II	U/M	VC/M	+
26.	Gargany teal *Anas querquedula*	A	I/II	C/M	C/M	
27.	Shoveller *Anas clypeata*	A	I/II	VC/M	C/M	–
28.	Common pochard *Aythya ferina*	A	I/II	VC/M	VC/M	
29.	White-eyed pochard *Aythya nyroca*	A	I/II	C/M	VC/M	+
30.	Tufted duck *Aythya fuligula*	A	I/II/III	U/M	VC/M	+
31.	Cotton teal *Nettapus coromandelianus*	A	I/II	C/M	C/M?	
32.	Coumb duck *Sarkidiornis melanotos*	A	I/II/III	U/M	U/M	
33.	Blackwinged kite *Elanus caeruleus*	T		C/R	C/R	
34.	Pariah kite *Milvus migrans govinda*	T (a)	I/II/III	C/R	C/R	
35.	Large Indian kite *Milvus migrans lineatus*	T (a)	I/II/III	C/M?	C/M?	
36.	*Brahminy kite Haliastur indius*	A	I/II/III	U/M	O/M	
37.	Shikra *Accipiter badius*	T		C/R?	C/R	
38.	Sparrow–hawk *Accipiter nisus*	T		C/M	C/M	
39.	White–eyed buzzard–eagle *Butaster teesa*	T		C/R	C/M	
40.	Bonelli's eagle *Hieraaetus pennatus*	T (a)	I/II/III	C/R?	O/R	
41.	Tawny eagle *Aquila rapax vindhiana*	T (a)	I/II/III	U/M	U/M	
42.	*Eastern Steppe eagle Aquila rapax nipalensis*	T (a)	I/II/III	U/M	U/M	
43.	Lesser spotted eagle *Aquila pomarina*	T (a)	I/II/III	C/R?	C/R?	
44.	Greyheaded fishing eagle *Ichthyophaga ichthyaetus*	A	I/II/III	U/M?	U/M?	
45.	Montagu's harrier *Circus pygargus*	T (a)	I/II/III	U/M	C/M	+

	SPECIES	1	2	3a	3b	4
46.	Marsh harrier *Circus aegruginosus*	A	L/II/III	VC/M	VC/M	+
47.	Short–toed eagle *Circaetus gallicus*	T (a)	I/II/III	U/M?	O/R	
48.	Osprey *Pandion haliaetus*	A	III	C/M	C/M	
49.	Lagger falcon *Falco biarmicus*	T		O/R	O/R	
50.	Redheaded merlin *Falco chicquera*	T		C/R?	C/R	
51.	Kestrel *Falco tinnunculus*	T		O/M	O/M	
52.	Grey partridge *Francolinus pondicerianus*	T		C/R?	C/R	
53.	Rock bush quail *Perdicula argoondah*	T		C/R?	C/R	
54.	Common crane *Grus grus*	A(t)	I/II	U/M	U/M	
55.	Demoiselle crane *Anthropoides virgo*	A(t)	I/II	C/M	O/M	
56.	Whitebreasted waterhen *Amaurornis phoenicurus*	A(t)	I/II	U/R?	U/R?	
57.	Moorhen *Gallinula chloropus*	A(t)	I/II	U/LM?	C/R?	+
58.	Purple moorhen *Porphyrio porphyrio*	A(t)	I/II	C/R	VC/R	+
59.	Coot *Fulica atra*	A	I/II	C/R	VC/R	+
60.	Pheasant–tailed jacana *Hydrophasianus chirurgus*	A	I/II	U/R?	VC/R?	+
61.	Painted snipe *Rostratula benghalensis*	A(t)	I	U/M?	VC/R?	+
62.	Blackwinged stilt *Himantopus himantopus*	A	I/II	VC/M	C/R?	–
63.	Great stone plover *Esacus magnirostris*	A(t)	I	C/R	O/R	–
64.	Indian courser *Cursorius coromandelicus*	T		C/R	C/R	
65.	Collared pratincole *Glareola pratincola*	A(t)	I	O/M?	O/M?	
66.	Small Indian pratincole *Glareola lactea*	A(t)	I	VC/R	VC/R	
67.	Redwattled lapwing *Vanellus indicus*	A(t)	I	VC/R	VC/R	
68.	Yellow–wattled lapwing *Vanellus malabaricus*	A(t)	I	VC/R	VC/R	
69.	Golden plover *Pluvialis apricaria*	A(t)	I	U/M	O/M	
70	Ringed plover *Charadrius hiaticula*	A(t)	I	U/M	O/M	
71	Little ringed plover *Charadrius dubius*	A(t)	I	VC/R	VC/R	
72	Kentish plover *Charadrius alexandrinus*	A(t)	I	VC/R	VC/R	
73	Curlew *Numenius arquata*	A(t)	I	O/M	O/M	
74	Blacktailed godwit *Limosa limosa*	A	I/II	VC/M	C/M	–
75	Bartailed godwit *Limosa lapponica*	A	I/II	U/M	O/M	
76	Spotted redshank *Tringa erythropus*	A	I/II	O/M	O/M	
77	Common redshank *Tringa totanus*	A	I/II	U/M	U/M	–
78	Greenshank *Tringa nebularia*	A	I/II	C/M	U/M	–
79	Green sandpiper *Tringa ochropus*	A	I/II	VC/M	C/M	–
80	Spotted sandpiper *Tringa glareola*	A	I	C/M	C/M	
81	Common sandpiper *Tringa hypoleucos*	A	I	C/M	VC/M	+
82	Fantailed snipe *Gallinago gallinago*	A (t)	I	O/M	C/R?	+
83	Sanderling *Calidris alba*	A	I	C/M	C/M	
84	Little stint *Calidris minuta*	A	I	C/M	C/M	
85	Temminck's stint *Calidris temminickii*	A	I	U/M ?	?	
86	Ruff and reeve *Philomachus pugnax*	A	I	C/M	U/M	–
87	Herring gull *Larus argentatus*	A	I/II/III	U/M	C/M	+
88	Brownheaded gull *Larus brunnicephalus*	A	I/II/III	C/M	C/M	
89	Blackheaded gull *Larus ridibundus*	A	I/II/III	U/M	O/M	
90	Whiskered tern *Chlidonias hybrida*	A	II/III	U/R?	C/R	+
91	Gullbilled tern *Gelochelidon nilotica*	A	II/III	C/M	C/M	
92	Caspian tern *Hydroprogne caspia*	A	II/III	C/M	U/M	
93	Indian river tern *Sterna aurantis*	A	II/III	VC/R	VC/R	+
94	Blackbellied tern *Sterna acutrcauda*	A	II/III	C/R?	C/R?	
95	Little tern *Sterna albifrons*	A	II/III	C/R	VC/R	
96	Indian sandgrouse *Pterocles exustus*	T		C/R	C/R	
97	Blue rock pigeon *Columba livia*	T		C/R	C/R	
98	Indian ring dove *Streptopelia decaocto*	T		C/R	C/R	
99	Red turtle dove *Streptopelia tranquebarica*	T		C/R	C/R	
100	Little brown dove *Streptopelia senegalensis*	T		VC/R	VC/R	
101	Roseringed parakeet *Psittacula krameri*	T		Vc/R?	VC/R	
102.	Koel *Eudynamys scolopacea*	T		U/R	U/R	
103	Crow–pheasant *Centropus sinensis*	T		C/R?	C/R	

	SPECIES	1	2	3a 1986	3b 1989	4
104	Great horned owl *Bubo bubo*	T		C/R?	C/R	
105	Spotted owlet *Athena brama*	T		C/R	C/R	
106	Mottled wood owl *Strix ocellata*	T		U/M?	U/M?	
107	House swift *Apus affinis*	T (a)	I/II/III	C/R	C/R	
108	Lesser pied kingfisher *Ceryle rudis*	A	I/II/III	C/R	/R	
109	Common kingfisher *Alcedo atthis*	A	I/II/III	U/M	C/R	+
110	Whitebreasted kingfisher *Halcyon smyrnensis*	A	I/II/III	C/R	C/R	
111	Green bee-eater *Merops orientalis*	T		C/R	C/R	
112	Indian roller *Coracias benghalensis*	T		C/M	C/M	
113	Hoopoe *Upupa epops*	T		C/R	C/R	
114	Small green barbet *Megalaima viridis*	T		C/R	C/R	
115	Maratha woodpecker *Picoides mahrattensis*	T		C/R?	C/R	
116	Redwinged bush lark *Mirafra erythroptera*	T		C/R	C/R	
117	Ashycrowned finch-lark *Eremopterix grisea*	T		C/R	C/R	
118	Rufoustailed finch-lark *Ammomanes phoenicurus*	T		C/R	C/R	
119	Malabar crested lark *Galerida malabarica*	T		C/R	C/R	
120	Collared sand martin *Riparia riparia*	T (a)	I/II/III	U/M	O/M	
121	Dusky crag martin *Hirundo concolor*	T (a)	I/II/III	C/R	C/R	
122	Swallow *Hirundo rustica*	T (a)	I/II/III	C/M	C/M	
123	Wiretailed swallow *Hirunda smithii*	T (a)	I/II/III	C/R?	C/R?	
124	Striated swallow *Hirundo daurica*	T (a)	I/II/III	C/M?	C/M	
125	Grey shrike *Lanius excubitor*	T		C/M	C/R	
126	Baybacked shrike *Lanius vittatus*	T		U/R?	C/R	+
127	Rufousbacked shrike *Lanius schach*	T		C/R	C/R	
128	Black drongo *Dicrurus adsimilis*	T		C/R	C/R	
129	Blackheaded myna *Sturnus pagodarum*	T		C/R	C/R	
130	Rosy pastor *Sturnus roseus*	T		C/M	VC/M	+
131	Common myna *Acridotheres tristis*	T		C/R	VC/R	
132	House crow *Corvus splendens*	T		C/R	C/R	
133	Jungle crow *Corvus macrorhynchos*	T		C/R	C/R	
134	Small minivet *Pericrocotus cinnamomeus*	T		O/R?	O/R	
135	Common iora *Aegithina nigrolutea*	T		C/R?	C/R	
136	Redvented bulbul *Pycnonotus cafer*	T		C/R	C/R	
137	Common babbler *Turdoides caudatus*	T		C/R?	C/R	
138	Large grey babbler *Turdoides malcolmi*	T		C/R	C/R	
139	Indian great reed warbler *Acrocephalus stentoreus*	A (t)	I	C/M	C/M	
140	Booted warbler *Hippolais caligata*	T		O/M	O/M	
141	Lesser whitethroat *Sylvia curruca*	T		C/M	C/M	
142	Magpie-robin *Copsychus saularis*	T		C/R	C/R	
143	Black redstart *Phoenicurus ochruros*	T		O/M	C/M	
144	Indian robin *Saxicoloides fulicata*	T		C/R	C/R	
145	Blue rock thrush *Monticola cinclorhynchus*	T		O/M	O/M	
146	Grey tit *Parus major*	T		C/R	C/R	
147	Tawny pipit *Anthus campestris*	T		C/R	C/R	
148	Yellow wagtail *Motacilla flava*	A(t)	I	U/M	C/M	+
149	Yellowheaded wagtail *Motacilla citreola*	A(t)	I	U/M	C/M	+
150	Grey wagtail *Motacilla cinerea*	A(t)	I	VC/M	C/M	–
151	White wagtail *Motacilla alba*	A(t)	I	U/M	C/M	+
152	Large pied wagtail *Motacilla maderaspatensis*	A(t)	I	C/R	C/R	
153	Purple rumped sunbird *Nectarina zeylonica*	T		C/R	C/R	
154	Purple sunbird *Nectarina asiatica*	T		C/R	C/R	
155	White-eye *Zosterops palpebrosa*	T		C/R	C/R	
156	House sparrow *Passer domesticus*	T		VC/R	VC/R	
157	Baya *Ploceus philippinus*	T		C/R	C/R	
158	Whitethroated munia *Lonchura malabarica*	T		C/R	C/R	
159	Blackheaded bunting *Emberiza melanocephala*	T		C/M	C/M	
160	Redheaded bunting *Emberiza bruniceps*	T		C/M	C/M	

DISTRIBUTIONAL RECORDS FOR CHELONIANS FROM NORTHEASTERN INDIA[1]

INDRANEIL DAS[2]

(With a text-figure)

Distributional records for 10 species of chelonians, based primarily on collections from the northeastern states of Assam and Meghalaya have been presented. These include: Emydidae- *Pyxidea mouhoti*, *Cuora amboinensis*, *Melanochelys tricarinata*, *M. trijuga*, *Geoclemys hamiltonii*, *Kachuga smithii*, *K. sylhetensis*, *K.tentoria*, Testudinidae-*Manouria emys* and Trionychidae-*Lissemys punctata*

INTRODUCTION

The chelonian fauna of the northeastern states of India (Fig. 1) comprises at least 17 species, belonging to 3 families (Table 1). Much of the existing knowledge on the distribution of the group in the region is based on collections that are decades old, scattered in several museums. Literature concerning the region's turtles and tortoises is scanty. Those solely dealing with north eastern India, published in the present century include Chaudhury (1912), Talukdar (1979), Vijaya (1983) and Das (1987).

The present account describes the notable records of turtles and tortoises discovered during a recent (January-February and June- July 1988) survey in the states of Assam and Meghalaya, undertaken by me and supported by the IUCN/WWF. A description of the survey will be found in the final project report (Das 1988).

METHODS

Turtles and tortoises were collected during the survey either by hand or in tangle-nets set in water or from forest villages. At the Manas Tiger Reserve, the chelonian collections made by Mr. S.K. Sarma, Forest Range Officer, Bansbari, were examined. In addition, material at several museums was verified.

The following museum acronyms have been used: BM(NH): British Museum (Natural History), South Kensington, London, England. MHNG: Museum Histoire Naturelle, Geneva, Switzerland. ZSI: National Zoological Collection, Zoological Survey of India, Calcutta, India. ZSI/ER: Zoological Survey of India, Eastern Regional station, Shillong, India.

All material referred to in subsequent sections, except those in the MHNG have been personally verified. ID/NE refers to my north eastern India field number and material collected during the above survey are being deposited at the ZSI.

Nomenclature follows Iverson's (1986) most recent checklist. Scute terminology used are those suggested by Zangerl (1969).

Two or more of the following measurements were taken on each specimen dealt with subsequently:

1. Straight carapace length (SCL): For emydids and testudinids, cervical at carapace midline to posterior edge of 12th marginal; for trionychids, from the cervical, along the medial region to the posterior tip of flap, taken with dial vernier calipers for specimens upto 20 cm, and with steel tape for those exceeding this length.

TABLE 1
LIST OF CHELONIANS RECORDED FROM THE NORTHEASTERN STATES OF INDIA

EMYDIDAE		
1.	*Pyxidea mouhotii*	Assam, Meghalaya, Arunachal Pradesh
2.	*Cyclemys dentata*	Assam, Meghalaya
3.	*Cuora amboinensis*	Assam, Nagaland
4.	*Melanochelys trijuga*	Assam, Nagaland
5	*Melanochelys tricarinata*	Assam, Arunachal Pradesh
6.	*Geoclemys hamiltonii*	Assam, Meghalaya
7.	*Morenia petersi*	Assam
8.	*Hardella thurjii*	Assam, Meghalaya
9.	*Kachuga smithii*	Assam
10.	*Kachuga tecta*	Assam
11.	*Kachuga tentoria*	Assam
12.	*Kachuga sylthetensis*	Assam, Meghalaya
13.	*Kachuga dhongoka*	Assam
TESTUDINIDAE		
14.	*Indotestudo elongata*	Meghalaya, possibly Assam
15.	*Manouria emys*	Assam, Manipur, Meghalaya , Nagaland
TRIONYCHIDAE		
16.	*Lissemys punctata*	Assam, Meghalaya
17.	*Trionyx hurum*	Assam

[1]Accepted

[2]Madras Crocodile Bank Trust, Vadanemmeli, Perur Post, Mahabalipuram Road, Madras 603 104.

Fig. 1. Map of northeast India, showing localities cited in the text. Assam: 1. Manas; 2. Kaziraga; 3. Sibsagar; Meghalaya; 4. Ranikor; 5. Nonghyliem.

2. Curved carapace length (CCL): Taken with a flexible tape.
3. Straight carapace width (SCW): Distance across widest part of carapace, perpendicular to longitudinal body axis, taken with dial vernier calipers for specimens up to 20 cm, and with steel tape for those exceeding this length.

EMYDIDAE

1. **Keeled box turtle** *Pyxidea mouhotii* (Gray1862)

In a recent review of the distribution of this little – known species (Das 1987), I mentioned that, based on museum specimens, it is positively known from the Garo hills of Meghalaya and Deban, Tirap (presently Changlang) district of Arunachal Pradesh, with a possible record from Cachar, Assam, BM (NH) 98°12° 20° 1, registered as from 'Eastern

Assam hills, probably North Cachar, near Barail Range.

Since then I have obtained the following information: Three specimens have been recorded as collected from the Cachar hills by Anderson (1871) and evidently two of these were from the Kapili river of the North Cachar hills. All were presented to the Asiatic Society by Maj. H.H. Godwin-Austin handwritten comments, together with the initials 'J.A.' (= John Anderson?) on blank page between pages 10 and 11 of Theobald (1868) in the library of the ZSI. The zoological collections of the Asiatic Society of Bengal, in 1875, was transferred to the Indian Museum, and in 1916 the collection was handed over to the ZSI, but the 3 North Cachar hills specimens of *Pyxidea mouhotii* cannot be located at present.

2. **Malayan box turtle** *Cuora amboinensis* (Daudin 1802)

Material: 2 examples, from Kaziranga National Park, Golaghat district, Assam. ID/NE 02 : SCL 21.6 cm, CCL 25.3 cm, SCW 14.8 cm. ID/NE 09 : SCL 20.9 cm, CCL 25 cm, SCW 14.3 cm. Both collected by me in January–February 1988.

Moll and Vijaya (1986) reported on a specimen belonging to this species in the collection of the ZSI (Reg. 16690), from Mangaldai, Darrang district, Assam.

The present records further confirm the occurrence of *Cuora amboinensis* in northeastern India. In addition to the Kaziranga material, 3 more examples collected from Manas Tiger Reserve, Barpeta district, Assam, by Mr S.K. Sarma, were verified. An example of the present species, from the 'Gela Bil river, Jorhat, Assam' is reported to be in the collection of the MHNG (Reg. 1557.15). 'Bils' in the region, however, refers to large bodies of standing water.

Anderson (1872a) recorded the species from Samagooting in the Naga hills, now in Nagaland, but this record is not supported by a museum specimen.

3. **Tricarinate hill turtle** *Melanochelys tricarinata* (Blyth 1856).

6 examples of this poorly known emydid were seen at Manas, which were collected from the Bansbari grasslands (Sarma, pers. comm.), within the Tiger Reserve. The distribution given for the species by Smith (1931) is Bisnath plain, Assam; Dafla hills, presently in Arunachal Pradesh; Jalpaiguri district, northern West Bengal and Chaibassa, now in Singhbhum district, Bihar. The ZSI has collections from the localities mentioned in addition to one (Reg. 18391) listed as from 'a few miles from Sonarpur, Assam'.

Moll and Vijaya (1986) collected the species from near the Nepal border in West Champaran district, Bihar, and saw photos of the turtle taken in Nepal's Chitawan National Park. The species has also been reported from Corbett National Park, Nainital and Garhwal districts, Uttar Pradesh by Frazier (1986). There are, in adddition, published records of *Melanochelys tricarinata* from Bangladesh – Mymensingh district (Khan 1982a, 1982b and 1987), Dinajpur (Khan 1982b) and the Cox's Bazar–Teknaf region of Chittagong (Khan 1987). The record of the species from the Sunderbans of West Bengal by Mukherjee (1975) is surprising and erroneous. At Manas, 2 of the captive turtles laid one large egg each on the open ground, in November, but both were broken possibly by the turtles themselves (Sarma, pers. comm.). One of the broken eggs were examined by me and found to be large in size, with a thick, brittle shell. Moll (quoted in Dinerstein *et al.* 1987) believed clutch size in the species to be between 1–3.

4. **Indian black turtle** *Melanochelys trijuga* (Schweigger 1814)

Material: A nearly complete carapace from Lailad village, Nongkhyllem Reserve Forest, East Khasi hills, Meghalaya. Reportedly caught from the adjacent Umtru river. Collected by me in June 1988. ID/NE 18:SCL *c.* 20.5 cm, CCL *c.* 25 cm, SCW 15.8 cm.

To this species, I assign an incomplete carapace, put together from a cluster of disarticulated bones discovered on the roof of a shed in Lailad village, where in the past, it was used as a feeding bowl for dogs. Subspecific allocation is not possible, as the 5 races that are currently recognised are differentiated primarily by their head colorations and the locality falls approximately halfway between the known ranges of the subspecies *indopeninsularis*: northern India and possibly Bangladesh and Nepal, and *edeniana*: almost throughout Burma (Das 1985, Iverson 1986). The Manas records, a collection of 7 individuals made by Mr. S.K. Sarma, had long, black spear-shaped marks on the foreheads, diagnostic of *indopeninsularis*. This extends the range of the subspecies into Assam.

The subspecies *indopeninsularis* was given a rather restricted distribution by Smith (1931), 'Chota Nagpur and Jalpaiguri district, N. Bengal!' Moll and Vijaya (1986) collected it from West Champaran district of Bihar. Dinerstein *et al.* (1987) recorded *Melanochelys trijuga* from western and central Nepal and though a subspecific allocation was not made in either case, *indopeninsularis* seems to be the race involved.

5. **Spotted pond turtle** *Geoclemys hamiltonii* (Gray 1831).

Material: 8 examples, shells and entire specimens, from forest camps and large ponds in Kaziranga National Park, Golaghat district, Assam. ID/NE 04 : SCL 16.6 cm, CCL 18.9 cm, SCW 11.0 cm, ID/NE 06: SCL 32.3 cm, CCL 36.6 cm, SCW 19.6 cm, ID/NE 10: SCL 21.6 cm, CCL 24 cm, SCW 13 cm, ID/NE 14: SCL 19 cm, CCL 21.5 cm, SCW 11.8 cm, ID/NE 15:SCL 19.5 cm, CCL 23 cm, SCW 12.2 cm, ID/NE 16:24.7 cm, CCL 28 cm, SCW 15.2 cm, ID/NE 17:SCL 22.4 cm, CCL 25.6 cm, SCW 13.7 cm, ID/NE 07, plastron only (notch-notch) 18.3 cm; greatest length 19.7 cm. All collected by me between January and February, 1988.

Smith (1931) gave the distribution of *Geoclemys hamiltonii* as from 'Sind to Bengal'. Vijaya (1983) extended the range of the species into Assam, based on photographs of the species taken at Kaziranga. Most of the material reported herein were collected as shells discovered in the vicinity of forest camps, where the turtles were eaten by the human inhabitants. Exceptions include ID/NE 14, a complete articulate skeleton of a female from the bank of Barbeel besides ID/NE 10 and 15, both males, from Mehrbeel and Barbeel respectively, caught in tangle nets set among reed clumps.

The only other locality in Assam from where the species is known is Sonarpur, Kamrup district, (ZSI 18339) collected by L.W. Middleton. At ZSI/ER, a large but poorly preserved and uncatalogued example of the species was seen, which was collected from the West Khasi hills of Meghalaya (Ranikor) by V.T. Darlong on 10 February 1987.

The present records confirm the occurrence of *Geoclemys hamiltonii* in northeastern India.

6. **Brown roofed turtle** *Kachuga smithii* (Gray 1863)

Moll (1987) recently reviewed the biology and distribution of the small riverine species and described a new subspecies, *pallidipes*. During the present investigations, a single example of *K. smithii* was seen at Manas, which was locally acquired by Mr. S.K. Sarma. The dark pigmented limbs and head and large black blotches on the plastron keys this out as the nominate form, *smithii*

Rivers Indus and Ganga are included in the range of the species in general works (Das 1985, Pritchard 1979, Smith 1931), as Chaudhury (1912) in his account of the turtles of the Brahmaputra was not clear whether the brown roofed turtle does in fact occur in this river. Iverson's (1986) distributional map for the species shows a locality in the Brahmaputra, and this is based on the MHNG record cited below (Iverson, pers. comm.): MHNG 1185.27, from Kaziranga; MHNG 1240.55 listed as from the north bank of the Brahmaputra, in the Jorhat area. Since the city of Jorhat is situated in the south bank, the collection locality is presumably opposite Jorhat, across the Brahmaputra, the collection locality is presumbaly across the river, north of Jorhat.

7. **Assam roofed turtle** *Kachuga sylhetensis* (Jerdon 1870)

Material: 1 example, from Kolathua village, Sibsagar district, Assam. ZSI/ER VI/8139 : SCL 7.2 cm., CCL 8.8 cm., SCW 6.0 cm. Collected by J.P. Sati, 12 June 1981.

Moll (1987) in his recent review of *K. sylhetensis* had listed specimens from Cherrapunji (Khasi hills) and Garo hills of Meghalaya and Cachar district of Assam, in India besides the Khasi hills of Sylhet district of Bangladesh, based on material in the BM(NH) and ZSI collections.

The referred material from Sibsagar district in the southern bank of the Brahmaputra, central Assam, extends the range of the species by over 250 km to the north.

In addition, an example of the present species was seen in the collection of Mr. S.K. Sarma in Manas, which was collected from the Rupahi Bhumuk, a perennial stream within the Tiger Reserve. This is the first record of the species from the north bank of Brahmaputra.

8. **Indian tent turtle** *Kachuga tentoria* (Gray 1834)

Material: 3 shells, from Gobrai, Kaziranga National Park, Golaghat district, Assam. ID/NE 11: SCL 5.9 cm, CCL 7.7 cm, SCW 4.8 cm. ID/NE 12: SCL 7.1 cm, CCL 8.1 cm, SCW 5.8 cm. ID/NE 13: SCL 8.6 cm, CCL 9.8 cm, SCW 6.7 cm. All collected by the author in February, 1988.

Moll (1987), in his most recent review of the subgenus *Pangshura*, included the Ganga, Mahanadi, Godavari and Krishna drainages in the distribution of *Kachuga tentoria*, in its 3 subspecies, *tentoria*, *circumdata* and *flaviventer*.

Besides the Kaziranga material referred to, a living juvenile of the present species was seen at Manas, in the collection of Mr. S.K.Sarma. The dark plastral pattern, red markings on the head, black and cream striped rump and absence of pleuro-marginal ring identifies it as the nominate race, which was thought to be restricted to the rivers of peninsular India (Moll 1987).

A third locality for the species from the Brahmaputra is Sibsagar, from where Mr Anwaruddin Choudhury, Extra-Assistant Commissioner, Guwahati, photographed a juvenile which I have verified. It was reportedly found in a channel of the Brahmaputra after the floods in 1988.

These records comprise the first documentation of *Kachuga tentoria* from the Brahmaputra drainage, and puts Assam in the distribution of the species.

Testudinidae

9. **Asian brown tortoise** *Manouria emys* (Schlegel and Muller 1844)

Material: 1 carapace, from Umling village, Nongkhyllem Reserve Forest, East Khasi hills, Meghalaya. Reportedly from Lailad, north of the Nongkhyllem Wildlife Sanctuary: ID/NE 19: CCL *c.* 60 cm, CCW 54 cm. 1 plastron from Nongpoh village, East Khasi hills, Meghalaya. Reportedly from Borhulong, inside the Nongkhyllem Wildlife Sanctuary: ID/NE 20: notch to notch 35 cm, greatest length 40 cm. Both collected by me in June 1988. The above material constitutes the first record of the species, based on actual collection, from Meghalaya. Anderson (1871) noted that 3 examples of *Testudo phayrei* (now considered synonymous with the northern subspecies *Manouria emys phayrei*) were collected from the Cachar hills (Assam) and deposited at the Indian Museum, Calcutta. Subsequently, the Museum's Zoological collection was handed over to the ZSI. At present, there are 2 examples of *M. emys phayrei* from the Cachar hills in the said collection, ZSI 15545 and ZSI 20476, both collected by Maj. H.H. Godwin-Austin. These are apparently the specimens mentioned by Anderson (op.cit.), though the fate of the third is unknown, and it is presumably lost or destroyed.

The first volume of the register of the Asiatic Society of Bengal, now in the possesion of the ZSI, lists no fewer than 6 examples of *'Testudo phayrei'*. ZSI 901-904, are listed as collected from the Cachar hills by Maj. Godwin-Austin in January 1870; ZSI 900, for which no collection data (locality/collector/date) is available and ZSI 983, registered as from 'Assam' by Dr Anderson.

Jerdon (1870) wrote that the species is not uncommon in the hills of North Cachar, from where Godwin-Austin's specimens were obtained. The same authority stated, on information received, that the tortoise extends westwards to the Jaintia hills of what is now eastern Meghalaya. The two shells of *Manouria emys* from the Cachar hills that are currently at the ZSI, as well as the Nongkhyllem material, show characteristics of the northern subspecies, *phayrei*, whose known distribution encompasses northeastern India, Burma, northern and western Thailand, such as a brownish-black shell, small gulars and pectorals that are united. The southern subspecies, *emys*, from southern Thailand, Malaysia and Indonesia possesses a brownish shell, with large gulars and widely separated pectorals.

The Nonghkhyllem carapace (ID/NE 19) shows a hole in the 2nd and 3rd vertebrals, where the animal was burnt to kill it by the Khasia tribals, from whom the carapace was obtained.

Smith (1931) gave the distribution of the species (as *Testudo emys*) in India as 'Assam (Cachar, Naga Hills)'. While the Cachar hills record is supported by the museum specimens cited earlier, the report from the Naga hills is not, and is probably based on Anderson (1872 b) who wrote on a collection of both *'Testudo phayrei'* and *'Manouria emys'* from Lumajooting in the Naga hills, presently in the state of Nagaland. However, Anderson (op.

cit.) believed the two to be indistinct, admitting after a lengthy discussion that 'beyond the variation of the pectorals, they presented no other points of difference'.

One of the five tortoises from the above mentioned locality did possess pectorals that are separated, a character thought to differentiate *Manouria emys emys* from *M. emys phayrei*, suggesting that the 'southern' subspecies *emys*, occurs within Indian limits.

Elsewhere (Das 1985), I have included Manipur in the distribution of the species, and this is based on information provided by the herpetologist, Mr. S. Biswas (pers. comm.), previously of the ZSI and is not supported by a museum specimen. The Nongkhyllem record is the first record of the species from the country in over 100 years, and an extension of range by 100+ km to the northwest.

Trionychidae

10. **Indian flapshell turtle** *Lissemys punctata* (Lacepede 1788)

Material: 1 example from Barbeel, Kaziranga National Park, Golaghat district, Assam. ID/NE 03: SCL 27 cm, CCL 31 cm, CCW 29.5 cm. Collected by the author in January, 1988. 1 example from Ranikor, West Khasi hills, Meghalaya. ZSI/ER VI/8390: CCL 29.1 cm, CCW 24.1 cm. Collected by V.T. Darlong and party, 10-2-1987.

Distributed in Pakistan, northern India, Nepal, Bangladesh and south-western Burma the northern subspecies of *Lissemys punctata punctata* was considered the forma typica, till Webb (1980) showed that the trinomial *punctata* should be correctly applied to the southern subspecies, the *Lissemys punctata granosa* of Smith (1931) and Pritchard (1979) from peninsular India and Sri Lanka. This, amazingly enough, left no name for the widely distributed and familiar yellow-spotted northern subspecies, and Webb (op.cit.) proposed the name *andersoni* for it.

Smith (1931) remarked that the northern subspecies has not been recorded from Assam. Nearly half a century later, Talukdar (1979) reported on a collection of a specimen belonging to this species from Munnabeel, Kaziranga National Park, Assam. Recently, I had the opportunity to verify the material, ZSI/ER VI/500. In addition, one more example (cited above) was collected by me during field work from the same general area. Yet another example from northeastern India examined, ZSI/ER VI/8390, was collected from the West Khasi hills of Meghalaya, close to the Assam border, and is the first record of the species from the state. These material indicate that *Lissemys punctata* is widespread in the Brahmaputra drainage.

I tentatively assign all three examples referred above to *Lissemys punctata andersoni*, as these possess yellow- blotched heads and carapaces. The comparative sizes of the entroplastral callosities which had been used by Smith (1931) in separating the subspecies are highly variable in size even within a single form, sometimes being absent altogether, and this is therefore not a good taxonomic character.

Acknowledgements

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I am grateful to the Director, ZSI, and the Officers-in-charge, Mr. D.P. Sanyal, ZSI Reptilia Section, and Dr. J.R. Alfred, ZSI/ER, for permission and facilities to examine the chelonians in their collections.

Dr. John B. Iverson, Earlham College, Indiana, sent lists of several species at the MHNG. Dr. John G. Frazier, Smithsonian Institution, Washington D.C., made me aware of J.A.'s comments on *Pyxidea mouhotii*.

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LIFE CYCLE OF *PHLYCTENOPHORA INDICA* ANNAPURNA AND RAMA SARMA, A MARINE BENTHIC PODOCOPAN OSTRACOD[1]

C. Annapurna, D.V. Rama Sarma and K. Shyamasundari[2]

(*With two text–figures*)

Introduction

In the course of a study of the systematics and ecology of benthic ostracods inhabiting the marginal water bodies of the east coast of India, adults and juveniles of *Phlyctenophora indica* were seen in considerable numbers, adequate for undertaking a study of its life-cycle. Relatively few living ostracods have been studied in detail in this regard. Innumerable instars of several species are still not traceable to the species with certainty (Kesling 1953).

Inform...on so far published reveals that all the members of the sub-order Podocopa apparently pass through eight larval stages (Claus 1868, Muller 1894, Muller–Cale 1913, Scheerer–Ostermeyer 1940, Kesling 1951). Usually a pair of antennae and mandibles are present in the first instar. Very little is known about the duration of the larval stages and the related environmental parameters.

This is the first attempt to study the development of *Phlyctenophora indica* Annapurna and Rama Sarma, 1985; of the family Cyprididae.

Material and Methods

Adults were picked up from fresh sediments and maintained in the laboratory in sea water of about 28% salinity (ambient salinity) and at temperatures fluctuating between 27°C and 29°C. The specimens were examined every day and instars were separated. A few instars were fixed and preserved in 70% ethyl alcohol at intervals of 24 hours for identification at a later stage while the remaining were allowed to develop. Some of the instars, encountered directly in the field samples, were also fixed for comparison with the instars obtained in laboratory cultures. Only the later stages, namely sixth, seventh and eighth instars were encountered in the field collections, while instars up to the fifth were obtained from those cultured in the laboratory. Thus with the instars obtained in the field together with those cultured in the laboratory, the entire life history could be successfully traced and ages of the instars fixed.

To find the time required for the different larval stages, culture studies were carried out with the ostracods kept together with the sediment in small Petri dishes and maintained as far as possible at temperatures and salinities identical to those of the habitat. A daily close examination of the instars and the time required to reach the next successive stages was made (Table 1).

Results

A scattergram of carapace length versus carapace height plotted on a graph paper was prepared as this is a standard method used for determining the number of instars. Instars of identical developmental stages formed discrete clusters of points (Table 2, Fig. 1) and these clusters fell sufficiently apart, so that the various stages in the sample could be deciphered with considerable ease (Table 2).

The carapaces of adults and of instars are assigned to species on the basis of several criteria such as (1) progressive changes in shape from the youngest instar to adult, (2) progressive thickening of valves (immature valves in *Phlyctenophora indica* are fragile and hence susceptible to breakage), (3) the increasing complexity in ornamentation during ontogeny, (4) a progressive shift in the adductor muscle scar, (5) the hinge structure becoming increasingly complex, (6) posterior part of the valve becoming proportionately longer.

Table 1

Time span for the development of *Phlyctenophora indica*

Stages			Time (days)
I instar	–	II instar	15
II instar	–	III instar	15
III instar	–	IV instar	20
IV instar	–	V instar	20
V instar	–	VI instar	30
VI instar	–	VII, VIII	45

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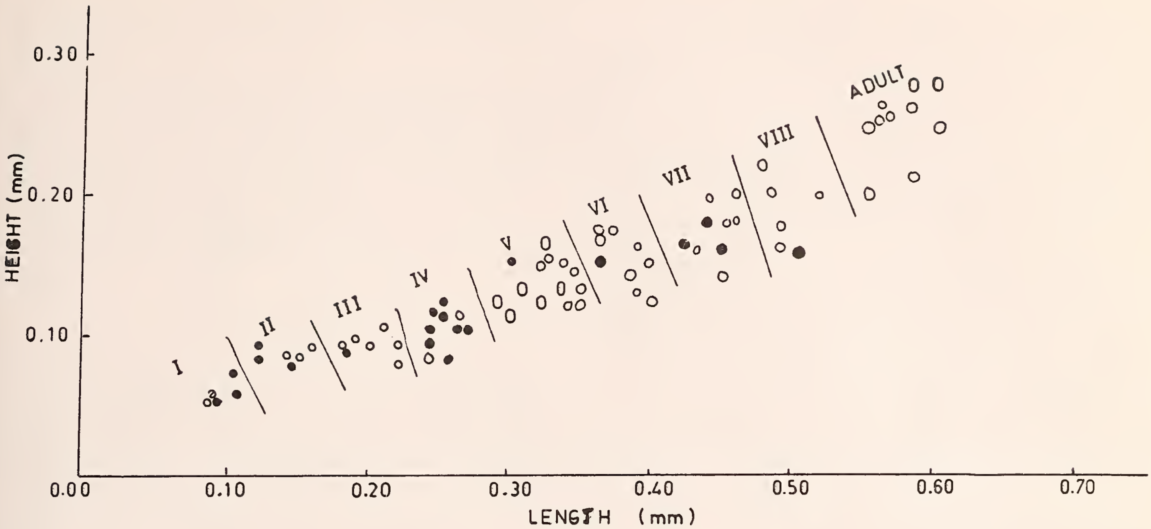

Fig. 1. Length-height distribution of larval stages: O single specimen ● 20 specimens

TABLE 2
AVERAGE SHELL DIMENSIONS FOR INSTARS OF *Phlyctenophora indica* ANNAPURNA AND RAMA SARMA

Instar	Average length mm	Average height mm	No. of specimens examined
First	0.12	0.09	20
Second	0.16	0.08	18
Third	0.23	0.10	11
Fourth	0.28	0.12	40
Fifth	0.36	0.15	60
Sixth	0.43	0.16	15
Seventh	0.50	0.16	20
Eighth	0.53	0.20	20
Adult	0.64	0.26	15

TABLE 3
LARVAL INSTARS OF *Phlyctenophora indica* ANNAPURNA AND RAMA SARMA

Instars	A1	A2	Md	Mx	L1	L2	L3	G	E
I	*								
II	*	•							
III	*	*	•	•					
IV	*	*	*	•					
V	*	*	*	*	•				
VI	*	*	*	*	*	•			
VII	*	*	*	*	*	*	•		
VIII	*	*	*	*	*	*	*	•	*
Adult	*	*	*	*	*	*	*	*	*

* Definitive form
• Rudiment

Description of instars (Table 3, Fig. 2)

First instar: Carapace slightly elongate and moderately compressed. Anterior end rounded, carapace slightly calcareous. Antennule consisting of 4 podomeres with a few moderately elongate setae. Segmentation indistinct.

Second instar: Carapace becomes further elongated and becomes slightly calcareous. Anterior end round. Second antenna appears with 4 podomeres and bristles.

Third instar: Carapace further elongates. Antennule and antenna well developed and rudiments of maxilla and mandible appear.

Fourth instar: Formation of calcareous shell, elongation of carapace continues. Maxilla and mandible develop into definitive structures. Anterior end rounded. Posterior end slightly narrow and triangular. a rudiment of first pair of thoracic legs appears.

Fifth instar: Carapace elongates. Normal pores and marginal pore canals develop. Both antennule and antenna remain the same as in fourth instar but for a slight increase in size. Mandible and its palp assume a definitive form. Maxilla provided with a short and broad masticatory tube beset with some setae. The second rudimentary thoracic leg appears behind the first.

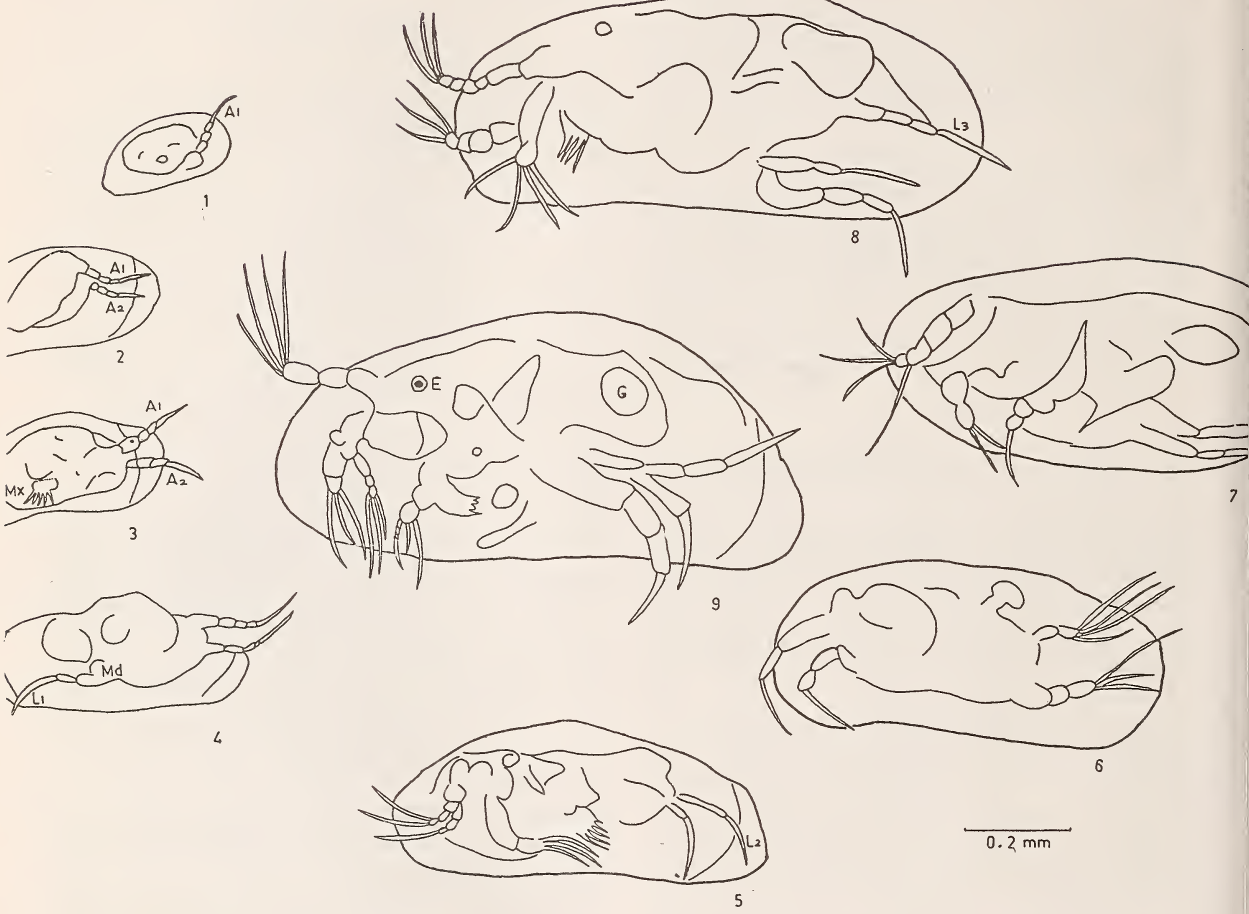

Fig. 2. Life cycle of *Phlyctenophora indica* (Annapurna & Rama Sarma, 1985).
1. First instar; 2. Second instar; 3. Third instar; 4. Fourth instar; 5. Fifth instar; 6. Sixth instar; 7. Seventh instar; 8. Eighth instar; 9. Adult; A1. Antennule; A2. Antenna; Md. Mandible; Mx. Maxilla; L1, L2, L3. Thoracic legs.

Sixth instar: Carapace elongates further. The appendages become elaborate and no new appendages are added.
Seventh instar: This resembles the adult except in size. Third thoracic leg and eyestalk appear.
Eighth instar: All appendages take finite shape. Rudiments of sex organs appear between thoracici legs and posterior part of the body.
Adult: The adult differs from the eighth instar by the development of chitinous appendages. Sex organs form.

General Remarks

The growth of *Phlyctenophora indica* is typically discontinuous. As the body grows, the rigid calcareous shell containing the animal moults, shedding its carapace and replacing it by a new and larger one to accommodate the growing body. After each moult an animal, differing in size and form from the previous stage, emerges. The old appendages may change in form and function and new appendages get added quickly before a carapace is secreted anew. In nature, reproduction of *P. indica* appears to take place throughout the year as evidenced by its appearance in the sediment.

A noteworthy feature resulting from this continuous growth is a change in function of certain appendages which may be used as walking legs in the first two instars and as accessory feeding rogans in the next. Not only is there an increase in the number of appendages in many of the earlier stages, but differentiation of appendages occurs later. In addition, the number and shape of the carapace of various instars changes.

When the adults, holding ripe eggs, were collected from fresh sediments and cultured in the laboratory, the fourth instar emerged after 7 weeks. Attempts to rear them in the laboratory beyond the fourth instar proved futile. However, simultaneous field collections contained sixth instar stage at a time when the fourth instar just appeared in the laboratory cultures.

This observed time lag in the rate of development in laboratory cultures and in nature, may be related to water temperature and food availability, as noticed by Theisen (1966). Hutchins (1947) states that the temperature influences not only its survival but also its reproduction and repopulation.

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NEW DESCRIPTIONS

DESCRIPTION OF A NEW CYPRINID, *BARILIUS DIMORPHICUS* (SUBFAMILY: RASBORINAE) FROM RAJAJI NATIONAL PARK, UTTAR PRADESH[1]

Raj Tilak and Akhlaq Husain[2]

(*With four text-figures*)

Introduction

During a recent survey of Rajaji National Park, Uttar Pradesh, we collected interesting material of a hitherto undescribed species of the genus *Barilius* Hamilton from two localities, namely Song river (upstream near the road bridge) at Satyanarain, Eastern Doon Valley, District Dehra Dun and Ghasi Ram Sot (downstream near causeway) on Chila–Hardwar road, near Chila Forest Rest House, District Pauri–Garhwal, both tributaries of the river Ganga.

Barilius dimorphicus sp. nov.

Description: B. iii, D.II/6–7, P.I/12–13, V.I/7–8, A.III/10–11,C.17–19 (8–10/9), L.1 60–66, L.tr. 12.5/7.5, Predorsals 25–27.

In Head Length: head width 1.67–1.96. Head height 1.10– 1.33. Snout length 3.12–3.67. Eye diameter 3.08– 4.12. Interorbital width 2.72–3.23. Postorbital head length 1.82–2.72. Cleft of mouth 2.27–2.86. Height of dorsal fin 1.31–1.72. Dorsal base 1.79–2.09. Pectoral fin 1.25–1.47. Distance between outer edges of pectoral base 2.12–2.87. Pectoral base to pelvic base distance 1.10–1.38. Pelvic fin 1.73–2.04. Distance between outer edges of pelvic base 3.47–4.60. Pelvic base to anal base distance 1.19–1.61. Anal fin 1.96–2.29. Anal base 1.35–1.69. Length of caudal peduncle 1.17–1.60. Caudal fin (upper lobe) 0.75–0.95.

In Total Length: Head length 4.67–5.44. Body depth 4.59– 5.75. Body width 6.83–10.45. Height of body at anal origin 5.25–6.76. Height of dorsal fin 7.11–8.85. Dorsal base 9.17–10.95. Pectoral fin 6.22–7.19. Pectoral base to pelvic base distance 5.47–6.89. Pelvic fin 8.32–10.45. Pelvic base to anal origin 6.04–7.50. Anal fin 9.74–11.56. Anal base 6.65–8.85. Caudal fin (upper lobe) 4.08–4.79. Predorsal distance 2.32–2.61. Post–dorsal distance 2.71–3.19. Prepectoral distance 3.97–4.48. Post–pectoral distance 1.66–1.98. Prepelvic distance 2.56–2.87. Post–pelvic distance 2.19–2.61. Pre–anal distance 1.86–2.05. Post–anal distance 3.35– 4.11. Caudal peduncle length 6.33–7.93.

In Standard Length: Head length 3.60–4.12. Body depth 3.47–4.05. Body width 5.29–7.69. Height of body at anal origin 3.96–4.70. Height of dorsal fin 5.38–6.47. Dorsal base 7.10–7.80. Pectoral fin 4.78–5.39. Pectoral base to pelvic base distance 4.23–5.32. Pelvic fin 6.40–7.57, pelvic base to anal origin distance 4.68–5.78. Anal fin 7.48– 8.87. Anal base 5.15–6.25. Caudal fin 3.08–3.50. Predorsal distance 1.79–1.95. Post–dorsal distance 2.11–2.25. Prepectoral distance 3.11–3.44. Post– pectoral distance 1.28–1.40. Prepelvic distance 1.95–2.11. Post–pelvic distance 1.70–1.92. Pre–anal distance 1.43–1.53. Post–anal distance 2.61– 3.04. Caudal peduncle length 4.83–5.93.

Other Proportions: Eye diameter 0.90–1.31 in snout length and 1.00–1.37 in interorbital width. Interorbital width 1.55–1.80 and postorbital head length 1.04–1.22 in head width. Distance from snout tip to nostril 1.31–1.63 and distance from nostril to anterior margin of eye 4.50–6.18 in snout length. Length of dorsal base 1.20–1.43 in length of anal base. Length of pectoral fin 0.95–1.20 in pectoral to pelvic distance. Distance between outer edges of pectoral bases 1.16–1.67 in head width and 1.61–2.15 in pectoral to pelvic distance. Length of pelvic fin 1.27–1.59 in distance between pelvic base and anal origin. Distance between outer edge of pelvic bases 1.89–2.40 in head width and 2.69–3.50 in pelvic base to anal origin distance. Least height of caudal peduncle 1.56–1.93 in its length.

Trout–like fish. Body compressed. Lower profile comparatively more arched than upper. Abdomen rounded. Head moderately compressed.

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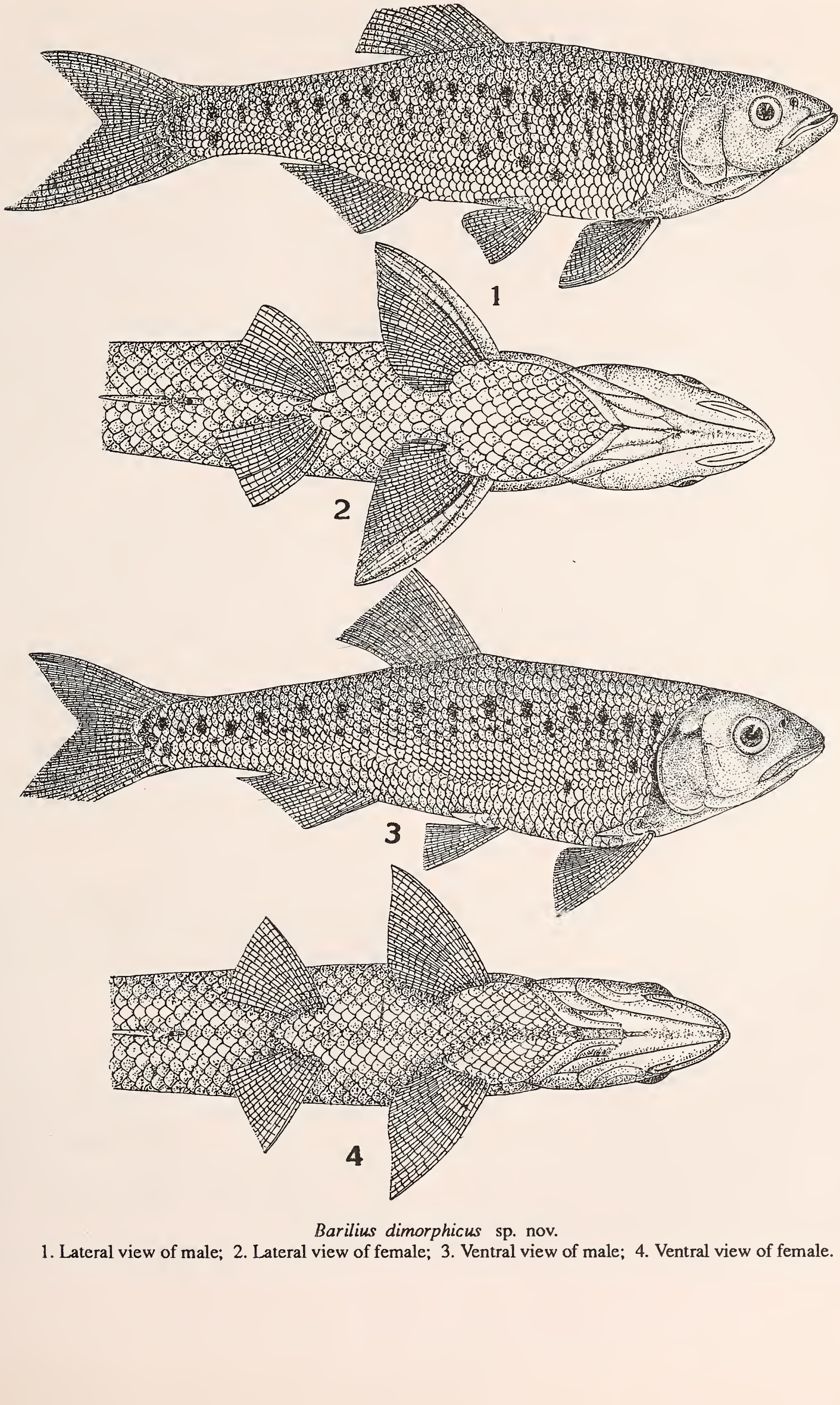

Barilius dimorphicus sp. nov.
1. Lateral view of male; 2. Lateral view of female; 3. Ventral view of male; 4. Ventral view of female.

Mouth terminal, cleft deep, oblique, posterior extremity of maxilla extending to below anterior margin of eye. Rostral margin and lower jaw finely tuberculated; this condition is more prominent in some specimens. Lips thin. Two pairs of barbels present (a minute rostral pair and a rudimentary maxillary pair). Jaws subequal, the lower very slightly longer than the upper; tip of upper jaw with a shallow notch into which the corresponding tip of lower jaw fits; lower jaw without a symphysial knob. Snout obtuse, with a transverse groove or a depression in front but close to nostrils. Nostrils together, simple, distinctly nearer anterior margin of eye than snout tip and almost at level of upper margin of eye. Eyes large, slightly bulging (convex), visible both from dorsal and ventral sides of head. Interorbital space slightly arched. Suborbital ring of bones wide, especially the 3rd which is the deepest and comparatively narrower than the opercular width.

Dorsal fin short, margin almost cut; and when folded against body, the tips of anterior rays not reaching tip of last ray. Its longest ray (the last undivided ray) much shorter than body depth below and at anal origin, slightly shorter than pectoral fin and slightly longer than pelvic fin and longest ray of anal fin. Tip of last dorsal ray extending to middle of anal base. Dorsal origin midway between the pelvic and anal bases, much nearer caudal base than tip of snout; it is almost midway between middle of eye and caudal base. Pectorals shorter than head, their tips pointed or nearly so. Pectoral length somewhat variable, generally not reaching pelvic base but in some examples, it does so and may even extend slightly beyond the origin of pelvic base. 1st branched ray of pectoral ossified in mature males. Axillary scale of pectoral fleshy, slightly longer than the diameter of eye. Pelvics shorter than pectorals, margin (posterior extremity) notched. Outer unbranched and 1st branched rays of pelvics equal in length and extend to below anterior 1/3rd of dorsal base. The last two branched rays thickened and almost fused at base. Pelvic fin distinctly not reaching anal opening (which lies at anal base origin), falling short of a distance almost equal to eye diameter. Axillary scale of pelvic thin, longer than the axillary scale of pectoral and extending beyond pelvic base. Anal origin just below the base of last dorsal ray; fin margin concave. Last anal ray shortest (almost equal to eye diameter), reaching almost middle of caudal peduncle. Anal fin base longer than that of the dorsal. Caudal peduncle narrow, distinctly longer than high. Caudal fin's deeply forked, the fork extending to more than half the fin's length (lower lobe); lobes pointed, lower caudal lobe distinctly longer than the upper and also the head length. Upper lobe generally shorter than head length (sometimes equal). Scales minute (visible to naked eye). In some large specimens, the margin of scales of upper region, especially the anterior part, are studded with prominent tubercles, imparting to the surface a rough texture. This is a secondary sexual character of males. Lateral line complete, curved downward, passing below the mid line of caudal peduncle.

Coloration: Silvery. Body with 2–4 irregular rows of bluish–black spots of varying sizes. These spots are generally vertically oval. The rows of spots do not generally extend below the lateral line. The spots of the uppermost row (14–16 in number) are the biggest. Head and body dorsally darkish. Eyes with blackish pupil and golden iris. Dorsal fin greyish except its upper corner which is whitish. Pectoral, pelvic and anal fins are also whitish. Caudal fin greyish, lower lobe more so.

Sexual Dimorphism: In mature males, the margin of scales on anterior region of body (below and in front of dorsal) are studded with fine tubercles. The lower jaw and the area between the mandibles and branchiostegal rays are covered with tubercles which are spiny in nature. The first branched ray of pectoral fin is ossified and strongly developed. The females lack these characters

Holotype: 185 mm total length, 140 mm standard length. Song river near its union with Teenpani nala, Satyanarain, Eastern Doon Valley, Rajaji National Park, Dist. Dehra Dun, Uttar Pradesh. 13 September 1987. Raj Tilak and Akhlaq Husain. Regd. No. ZSI/NRS/F–728.

Paratypes – A. 5 examples, 115–171 mm total length, 81–133 standard length. Other data same as of Holotype. Regd. No. ZSI/NRS/F–729.

Paratypes – B. 7 examples, 104–147 mm total length, 80–111 mm standard length. Locality same as of Holotype and Paratype – A. 14 September 1987. Raj Tilak and Akhlaq Husain. Regd. No. ZSI/NRS/F–730.

Paratypes – C. 2 examples. 94–112 mm total length, 75–76 mm standard length. Ghasi Ram Sot Stream, near Chila Forest Rest House, Chila–Hardwar Road, Rajaji National Park, District Pauri–Garhwal, Uttar Pradesh. 12 September 1987. Raj Tilak and Akhlaq Husain. Regd. No. ZSI/NRS/F–731.

Barilius dimorphicus sp nov. is closely related to *Barilius tileo* Hamilton – an Eastern Indian form, but can be easily distinguished from it in a number of characters, especially in the extent of maxilla and lepidosis as per the details given below:

1. Lower jaw slightly longer, when the mouth is closed, in *Barilius dimorphicus*, (vs. upper jaw slightly longer, when the mouth is closed, in *Barilius tileo* Hamilton–Hamilton 1822, Day 1878, 1889).
2. Posterior extremity of maxilla reaching anterior margin of eye (vs. reaching to beneath the middle of eye – Day 1878, 1889).
3. Two pairs of minute barbels (rostral and maxillary) present (vs. devoid of tendrils according to Hamilton 1822; barbels very rudimentary or entirely absent – Day 1878, 1889).
4. Eye diameter 1.00–1.37 times in interorbital width (vs. 1.50 times – Day 1878, 1889).
5. Dorsal fin midway between middle of eye and caudal base (vs. midway between hind edge of eye and caudal base – Day 1878, 1889).
6. Pectoral fin generally longer than head excluding the snout (vs. as long as head excluding the snout – Day 1878, 1889).
7. Caudal fin with 17–19 rays (vs. 20 rays – Day 1878, 1889).
8. 60–66 scales in lateral line (vs. 70–75 scales – Day 1878, 1889).
9. 12.5 rows of scales between dorsal fin and lateral line (vs. 14 rows of scales – Day 1878,1889).
10. 25–27 rows of scales before the base of the dorsal fin (vs . 30 rows of scales – Day 1878, 1889).
11. 185 mm in total length (vs. attaining at least 127 mm = 5 inches in length – Day, 1878, 1889).
12. Distribution: Rajaji National Park (Dehra Dun and Pauri– Garhwal districts, Uttar Pradesh) (vs. Kosi river – Hamilton 1822; Bengal and Assam – Day 1878, 1889).

In the same locality, in the Ganga and its tributaries there is a similar looking species, *Raiamas bola* Hamilton which differs from the new species in the deep cleft of the mouth. The cleft of the mouth extends posteriorly up to anterior margin of eye in *B. dimorphicus* whereas it reaches beyond the posterior margin of the eye in *R. bola*. They also differ greatly in the number of lateral line scales on body (60–66 in *B. dimorphicus* vs. 88–94 in *R. bola* – Day 1878, 1889).

ACKNOWLEDGEMENTS

We thank the Director, Zoological Survey of India, Calcutta, for encouragement and facilities and the Director, Rajaji National Park, for cooperation.

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TWO NEW SPECIES OF THE GENUS *PUNTIUS* HAMILTON (PISCES: CYPRINIDAE) FROM INDIA[1]

K.C. JAYARAM[2]

(*With two text-figures*)

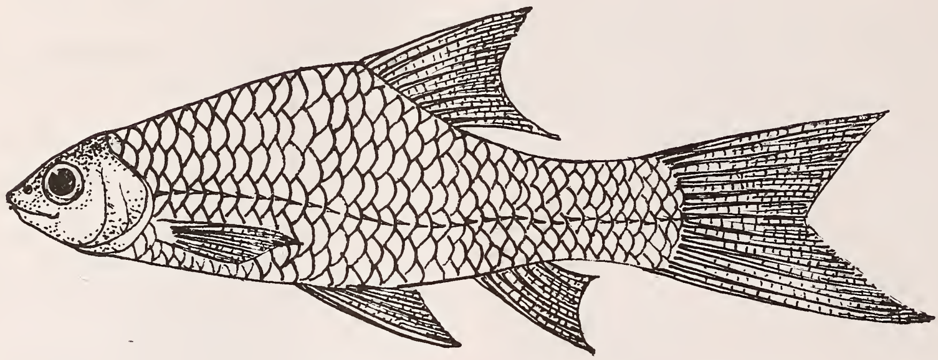

Fig. 1. *Puntius nangalensis* sp. nov.

While studying the Cyprinid fishes of the subfamily Cyprininae, I came across two undescribed species in the collections of the Zoological Survey of India, Calcutta. These are described here as new. The name *Puntius* is now applied for all 'barbs' of South Asia and *Barbus* for those of West Asia and Europe. The genus as now revised by me comprises of 54 species, classified under 10 groups, each group with complexes of species. This revision is under publication elsewhere.

Puntius nangalensis sp. nov.

Specimens studied: ZSI, F. 4841/2, Holotype, 27.5 mm SL, Nangal lake, Punjab fisheries department (with a name label *Puntius mitrai* Menon); 1 ex., 24.0 mm Sl., Paratype; 9 exs., 22.0 to 28.0 mm SL., same data.

Diagnosis: A deep bodied fish without any bands or blotches, with no barbels, dorsal ray osseous, serrated, lateral line incomplete ceasing after 7 or 8 scales and with 31 to 33 scales.

Description: D. I-II, 6-8; P. i, 12-13; V. i, 7-8; A. i-ii, 5; C. 14-15; LL. 31-33.

Dorsal profile convex, with a good rise up to dorsal fin base. Head conical, head length 3.14 to 4.19, body depth 3.12 to 3.69 in standard length. Head width 1.67 to 2.33, height of head at occiput 1.11 to 1.49, snout 2.00 to 4.00 in head length. Eyes large, superior, 2.00 to 4.00 in head length, 0.80 to 1.25 in interorbital width and 0.80 to 1.50 in snout length. Mouth subterminal, its width greater than inter-nostril distance. Lips thin, plain. No barbels.

Dorsal fin inserted nearer tip of snout than caudal base. Last unbranched dorsal ray osseous, finely serrated, first branched dorsal ray elongated. Dorsal fin base greater than least depth of caudal peduncle. Pectoral fins extending to pelvic fins; latter not reaching anal opening. Anal fin when laid flat not reaching root of caudal fin. Least depth of caudal peduncle 1.25 to 1.83 in its length. Lateral line incomplete, ceasing after 7 or 8 scales from anterior.

Scales: PDS 12 or 13; pre–anal 12 to 14; pre-pelvic 6 to 8; between LL and dorsal fin base 5 to 5 1/2; between LL and pelvic fin base 5 1/2 to 6;

TABLE 1
ADDITIONAL DATA ON *Puntius nangalensis* SP. NOV.

TL/Head length	3.87 to 5.60, N = 10
TL/Body depth	3.64 to 4.67, N = 10
SL/Pre–dorsal	1.73 to 2.18, N = 11
SL/Pre–anal	1.41 to 1.69, N = 10
SL/Pre–pelvic	2.00 to 2.64, N = 10
LH/LCPD	1.07 to 1.49, N = 9
LH/HCPD	1.62 to 2.33, N = 11
LH/Dorsal fin base	1.49 to 2.00, N = 11
LH/Width of mouth	3.00 to 4.00, N = 10

[1]Accepted December 1988.

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TABLE 2
COMPARISON OF *P. nangalensis* WITH ITS CLOSELY RELATED SPECIES

Character	*P. apogon* (Val. 1842)	*P. guganio* (Ham. 1822)	*P. punjabensis* (Day 1871)	P. nangalensis sp. nov.
TL/LH	5.25	5.0–5.5	5.5	3.87 to 5.60
TL/BD	3.25	3.5 3.5	3.64 to 4.67	
LH/Eye	3.5 to 4.1	3.3-3.5	5.33	2.00 to 4.00
IOW/Eye	1.00 to 1.25	0.90-1.00	1.3	0.80 to 1.25
Snout/Eye	0.76-0.88	1.00	1.3	0.80 to 1.50
LL	Complete	Incomplete, ceasing after 5 or 6 scales	Incomplete	Incomplete, ceasing after 7 or 8 scales
LL scales	36–38	36-39	43	31–33
PDS	12–15	15	14	12 or 13
LL/Dorsal	6 1/2– 7 1/2	8–9	8	5 to 5 1/2
LL/Pelvic	5–5 1/2	5 1/2–6	4 1/2	5 1/2 to 6
LL/Anal	5 1/2	6	3 1/2	3 1/2 to 4 1/2
Circumpeduncular	13-14	10	9 or 10	12 or 13
Barbels	Nil	Nil	Nil	Nil
Dorsal spine	Osseous, serrated	Osseous, serrated	Weak, articulated	Osseous, serrated
Pre-anal	21	21	25	12 to 14
Pre-pelvic	6-8	9	12	6 to 8
Distribution	Burma to Malay Archipelao	INDIA: Ganga, Brahmaputra, Yamuna drainage, Uttar Pradesh, Madhya Pradesh, Bihar, W. Bengal. Orissa, also Madras . Bangladesh	INDIA: Jabalpur, Madhya Pradesh, Bihar PAKISTAN: Sind Lahore, Baluchistan	INDIA: Nangal Lake, E. Punjab

between LL and anal fin base 3 1/2 to 4 1/2; circumpeduncular 12 or 13.

Gill Rakers: 5 + 12

Size: 37.0 mm TL

Colour: Uniformly brown all over, body diaphanous over pectoral area, each scale with a small black dot, a faint dark longitudinal streak along lateral line seen.

Distribution: INDIA: Nangal Lake, E. Punjab.

Related to *P. guganio* but differing from it in having a less deep body, larger eyes, less number of lateral line scales, coloration (Table 2) besides a more northern distribution.

The material was found in the reserve type collections of ZSI, Calcutta, labelled *Puntius mitrai* Menon. I have searched the entire literature and find that this name is a *nomen nudum*. Hence it is described with a new name.

Puntius afasciatus sp. nov.

Specimens studied: F. 2985/2, ZSI, Holotype, 50 mm SL., Vellakaravi and Vathakad village, Nagercoil, Tamil Nadu (with a name label *P. melanampyx kanniyakumarei* Menon & Sareen).

Diagnosis: A deep bodied fish without any vertical bands, last unbranched dorsal ray weak and smooth, and a complete lateral line with 22 scales, dorsal fin with 9 branched rays, four barbels.

Description: D. I, 9; P. 15; V. i, 8; A. ii, 5; C. 16; LL. 22.

Dorsal profile steeply arched, ventral profile gently. Head short, conical. Head length 3.57; body depth 2.70 in standard length. Head width 1.75; height of head at occiput 1.16; snout 3.50 in head length. Snout plain, smooth. Eyes large 3.68 in head length, 1.31 in interorbital width and 1.05 snout length. Mouth subterminal, narrow, its width less than inter-nostril distance. Lips thin, plain. Two pairs of barbels.

Dorsal fin inserted nearer caudal base than tip of snout. Last unbranched dorsal ray weak, smooth. Dorsal fin base greater than least depth of caudal

TABLE 3
ADDITIONAL DATA ON *Puntius a fasciatus* SP. NOV.

TL/Head length	4.29
TL/Body depth	3.24
SL/Pre-dorsal	1.92
SL/Pre-anal	1.35
SL/Pre-pelvic	1.96
LH/LCPD	1.55
LH/HCPD	1.75
LH/Dorsal fin base	1.40
LH/Width of mouth	1.12

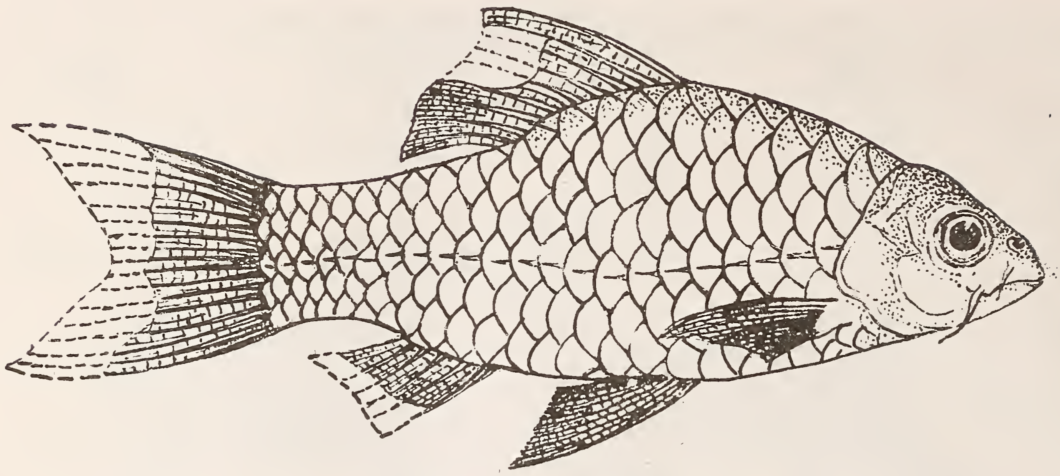

Fig. 2. *Puntius afasciatus* sp. nov.

peduncle. Pectoral fins not extending to pelvics; latter not reaching anal opening. Anal fin when laid flat reaches root of caudal fin. Least depth of caudal peduncle 1.12 in its length. Lateral line complete.

Scales: PDS 6; pre-pelvic 6; pre-anal 12; between LL and dorsal fin base 4 1/2; between LL and pelvic fin base 2 1/2; between LL and anal fin base 2 1/2; Circumpeduncular 10.

Gill Rakers: Not taken

Size: 60 mm TL

Distribution: INDIA: Nagercoil, Kan-

TABLE 4

COMPARISON OF THE '*fasciatus*' COMPLEX OF SPECIES OF *Puntius*

Characters		*P. fasciatus fasciatus* (Jerdon), 1849, p. 305	*P. fasciatus pradhani* Tilak, 1973, p. 97	*P. afasciatus* sp. nov
1.	Number of barbels	Four	Four	Four
2.	Last unbranched dorsal ray	Weak, articulated	Weak, articulated	Weak, smooth
3.	Lateral line	Complete	Complete	Complete
4.	LL Scales	18 to 20	19 or 20	22
5.	PDS	6 to 7	6 or 7	6
6.	LL/Dorsal	3 to 3 1/2	3 1/2 to 4	4 1/2
7.	LL/Pelvic	2 1/2 to 3	2 1/2 to 3	2 1/2
8.	LL/Anal	2 1/2	2 1/2 to 3	2 1/2
9.	Circumpeduncular	8 to 10	11 or 12	10
10.	Pre-anal	11	10 to 13	12
11.	Pre-pelvic	4 or 5	5 or 6	8
12.	Gill Rakers	4 + 10	4 + 7	–
13.	SL/LH	2.67 to 3.69	3.20 to 3.58	3.57
14.	SL/Body depth	2.68 to 3.30	2.50 to 2.86	2.70
15.	LH/Eye	3.05 to 3.75	2.83 to 3.42	3.68
16.	LH/Snout	2.50 to 3.75	2.43 to 2.87	3.50
17.	IOW/Eye	1.00 to 1.28	1.14 to 1.28	1.31
18.	Snout/Eye	1.00 to 1.43	0.83 to 1.14	1.05
19.	LCPD/HCPD	1.00 to 1.38	1.00 to 1.44	1.12
20.	Width of mouth	equal to IND	equal to IND	less than IND
21.	Dorsal fin base	greater than HCPD	greater than HCPD	greater than HCPD
22.	Colour	3 vertical bands	5 vertical bands	Nil
23.	Distribution	Western Ghats	Goa	Nagercoil, Tamil Nadu

IND = Inter-nostril distance.

niyakumari Dist., Tamil Nadu.

Differs from *fasciatus fasciatus* in absence of colour bands, in having 9 branched rays in dorsal fin and 22 scales on lateral line (Table 4).

The material which forms the basis of this new species was present in the reserve type collections of ZSI, Calcutta, under the name *P. melanampyx kanniyakumarei* Menon & Sareen. I have made extensive enquiries and also searched literature and find that this name was never published and thus becomes a *nomen nudum.* The spcies is therefore described as new.

ACKNOWLEDGEMENTS

Thanks are due to Department of Environment, Government of India for a brief assignment as an Emeritus Scientist of the Zoological Survey of India during which this revision was completed, and to the Director, Zoological Survey of India for facilities. The drawings were executed by Sri. D. Sengupta, Zoological Survey of India, Madras, and manuscript typed by Sri B. Hanumantha Rao of Krishna River Project, Zoological Survey of India.

A NEW GENUS *PSEUDOPAGIOPHLOEUS* OF WEEVIL (CURCULIONIDAE: HYLOBIINAE) FROM INDIA[1]

H.R. PAJNI, SUKESHA SOOD AND P. KAMAL TEWARI[2]

(*With two text–figures*)

A weevil collected during April 1978 from grass in Arunachal Pradesh is assigned to a new genus *Pseudopagiophloeus* and is described.

Pseudopagiophloeus gen. nov.

Type species: *Pseudopagiophloeus divergus* sp. nov.

Head with a depression just behind posterior margin of each eye. Antennal club slightly shorter than funicle, pubescent. Pronotum with basal and apical margins bisinuate, ocular lobes developed. Prosternum with its anterior margin deeply sinuate. Elytra with humeral angles rounded, impressed posteriorly. Femora clavate at apex; tibiae with external fringe of corbal oblique, premucro present. Metasternum short. Intercoxal process between hind coxae acuminate. Spiculum ventrale of female genitalia with its anterior arm long and transversely expanded at free end. Coxites broad but narrow at base; styli slightly longer than broad, strongly sclerotized.

The new genus comes close to genus *Pagiophloeus* Fst. of the tribe Hylobiini and agrees with it in possessing a long antennal club and in the oblique position of corbels. The overall appearance of the body, the rigid surface of pronotum and the furcate apices of elytra are also shared by the majority of the species of *Pagiophloeus* Fst. with this genus. However, the presence of mucro and the extension of the anterior end of the spiculum ventrale into lateral processes clearly separates the new genus from the genus *Pagiophloeus* Fst., in which tibiae are always without a mucro and anterior end of spiculum ventrale is simple. In fact, the structure of spiculum ventrale forms a very unique character, which the genus shares only with the genera *Niphades* Pasc. and *Niphadonyx* Dalla Torre.

Pseudopagiophloeus divergus sp. nov.

Head piceous, small, deeply and coarsely punctate, with a depression on posterior margin of eyes; frons almost as broad as base of rostrum; eyes brownish–black, lateral, almost in level with surface of head, rostrum piceous, almost as long as pronotum, narrowed to middle and broadened towards apex; surface of rostrum with 2 lateral deep furrows in basal half and two distinct median furrows which stop short of lateral furrows, broadly and coarsely punctate, punctures smaller and closer at apical broadened part, each puncture with a short yellow scale, scales being absent near apex; scrobes long, oblique, broadened posteriorly, their upper margins touching the lower margins of eyes. Antennae fuliginous, long, inserted a little away from apex of rostrum; scape long, its surface punctate and beset with pale yellow setae; funicle longer than scape, 7–segmented, segments 1 and 2 longer than broad, 3 to

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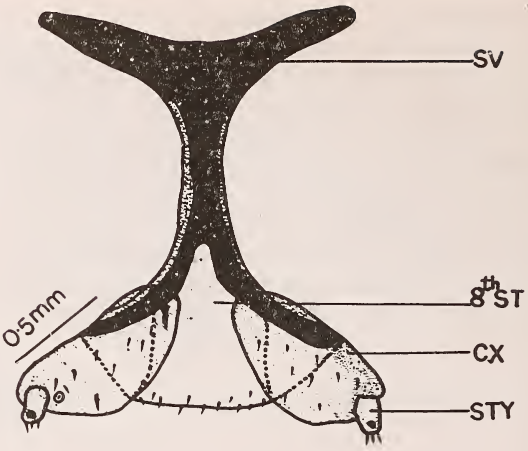
1.



2.

Psuedopagiophloeus divergus sp. nov. 1. Adult, 2. Female genitalia.

6 long but shorter than preceding two, 7 shorter than broad and distinct from club; club long, pubescent, oval, 3–segmented.

Pronotum almost as long as broad, broadest a little before middle and narrowed towards apex, constricted near apical margin, its basal and apical margins bisinuate, ocular lobes well developed; surface of pronotum rugosely punctate and tuberculate, tubercles less distinct near apex, with an indistinct middle keel near apex. Scutellum piceous, transverse, closely punctate and furnished with yellow scales. Elytra piceous, broader than base of pronotum at shoulders, humeral angles well developed, their apices separately acuminate and strongly furcate, posterior callosity distinct; surface of each elytron marked with broad punctures forming indistinct striae; intervals narrower than striae, tuberculate, interval 3 with a pair of tubercles immediately below scutellum, beset with a few yellow scattered scales. Legs piceous, long, punctate, beset with pale yellow setae; femora clavate, toothed ventrally; tibiae very slender, uncinate, armed with a premucro, external fringe of corbel oblique; tarsi spongy underneath, with segment 3 strongly bilobed and 5 very long, claws separated. Thoracic sternites piceous, closely punctate, furnished with yellow setae; prosternum with its anterior margin deeply sinuate and fringed with yellow setae; mesepimeron broad; metasternum coarsely punctate, its head broader than posterior visible part. Abdominal sternites piceous, sparsely and finely punctate, each puncture beset with a yellow seta, its intercoxal process between hind coxae acuminate; sternite 1 almost as long as 2.

Female genitalia with coxites broad, narrow at base and abruptly broadened at middle, uniformly and weakly sclerotized, each with long setae near apex; styli slightly longer than broad, cylindrical, highly sclerotized, each with many long setae at apex, spiculum ventrale Y–shaped, with free end extended transversely on either side, its middle arm longer than broad basal arms, not uniformly sclerotized.

Body length 18.0 mm; Body breadth 5.4 mm; Rostrum length 3.4 mm; Rostrum breadth 0.8 mm.

Material examined: Holotype 1 female; Grass; 30 April 1978; Khasi hills, Arunachal Pradesh; H.R. Pajni, Material deposited in the Entomological Section, Zoology Department, Punjab University, Chandigarh.

The species is named after the characteristic shape of the apices of elytra, which are acuminate and distinctly divergent.

ACKNOWLEDGEMENTS

We are grateful to the Indian Council of Agricultural Research and the United States Department of Agriculture, for financing a 5 year project on family Curculionidae under which this work has been carried out. Thanks are also due to Dr Sen–Sarma, Forest Entomologist, Forest Research Institute, Dehra Dun and Dr. R.T.Thompson of the British Museum (Natural History), London, for permitting comparison of our material with their collections. The liberal loan of unidentified material from Dr. Sen–Sarma of Forest Research Institute, Dehra Dun is also thankfully acknowledged. We thank the Chairman, Department of Zoology, Punjab University, Chandigarh, for laboratory facilities.

TWO NEW SPECIES BELONGING TO THE GENUS *ALLOPHLEPS* BERGROTH (CICADELLIDAE: HOMOPTERA) FROM INDIA[1]

V. RAMA SUBBA RAO[2] AND USHA RAMAKRISHNAN[3]

(With eighteen text–figures)

Two new species of the *Allophleps* Bergroth are described *A. delhiensis* with the Aedeagal shaft bifurcated ventrally near gonopore into a shorter pointed process and *A. menoni*, with the bifurcated process tooth–like.

The genus *Allophleps* was erected by Bergroth in 1920 and was known only by its type species, *A. inspersa* Bergroth till Pruthi in 1936 added another species, *A. indica* from India. Datta (1988) redescribed *A. indicus* Pruthi. Hence it is represented by only two species, and two new species are being described here. Based on the Indian species, generic characters have been suitably modified.

Colour stramineous. Vertex with or without ventral sub– marginal fuscous line and dorsal marginal spots.

Head wider than pronotum. Vertex shorter than the breadth between the eyes. Forewings with four apical and three ante– apical cells, the outer ante–apical cell either narrow and pointed at apex or divided into two or more cells by supernumerary cross veins. Posterior femoral setal pattern 2–2–1.

Pygoferal lobes uniformly broader for two–thirds length, then abruptly narrowed into subacute apex and macrosetae on postero–dorsal area, a pair of strap–like pygofer processes from mesodorsal edge directed ventrad. Subgenital plates triangular with submarginal macrosetae and marginal filamentous setae. Connective linear, arms closely apposed, stem fused with aedeagus. Style with slightly curved and pointed apophysis; pre–apical lobe angulate with minute setae. Aedeagus long bifid sub–apically; gonopore sub–apical.

The Indian species of the genus may be separated by the following key.

1. Aedeagal shaft bifurcated ventrally near gonopore into shorter pointed process 2
— Aedeagal shaft bifurcated ventrally, just below the gonopore into a tooth–like short process .... *A. menoni* sp. nov.
2. Outer ante–apical cell of forewing secondarily divided into two or more cells .... *A. delhiensis* sp. nov.
— Outer ante–apical cells of forewing narrow and pointed at apex but not divided .... *A. indicus* Pruthi

Allophleps delhiensis
(Figs. 1–9)

Colour: Colour stramineous without any spots.

Form: Head wider than pronotum. Vertex shorter than the length between the eyes. Ocelli marginal close to the eyes. Face broader than long. Pronotum longer than vertex. Fore wings longer than the body, with four apical and three ante–apical cells, the outer ante–apical cell secondarily divided into two or more cells, the number of cells not constant even in the left and right wings of the same specimen.

Male genitalia: Shape and setosity of pygofer as in generic description; its processes extending beyond ventral margin, their apices curved caudad. Valve with posteriorly produced rounded margin. Subgenital plates and styles also as mentioned in the genus. Aedeagus thin, elongated, bifurcated ventrally near genopore into shorter pointed process, shaft apex also pointed, dorsal apodeme curved apicad of the shaft, gonopore sub–apical and dorsal.

Second abdominal apodemes well developed, extending into sternum III.

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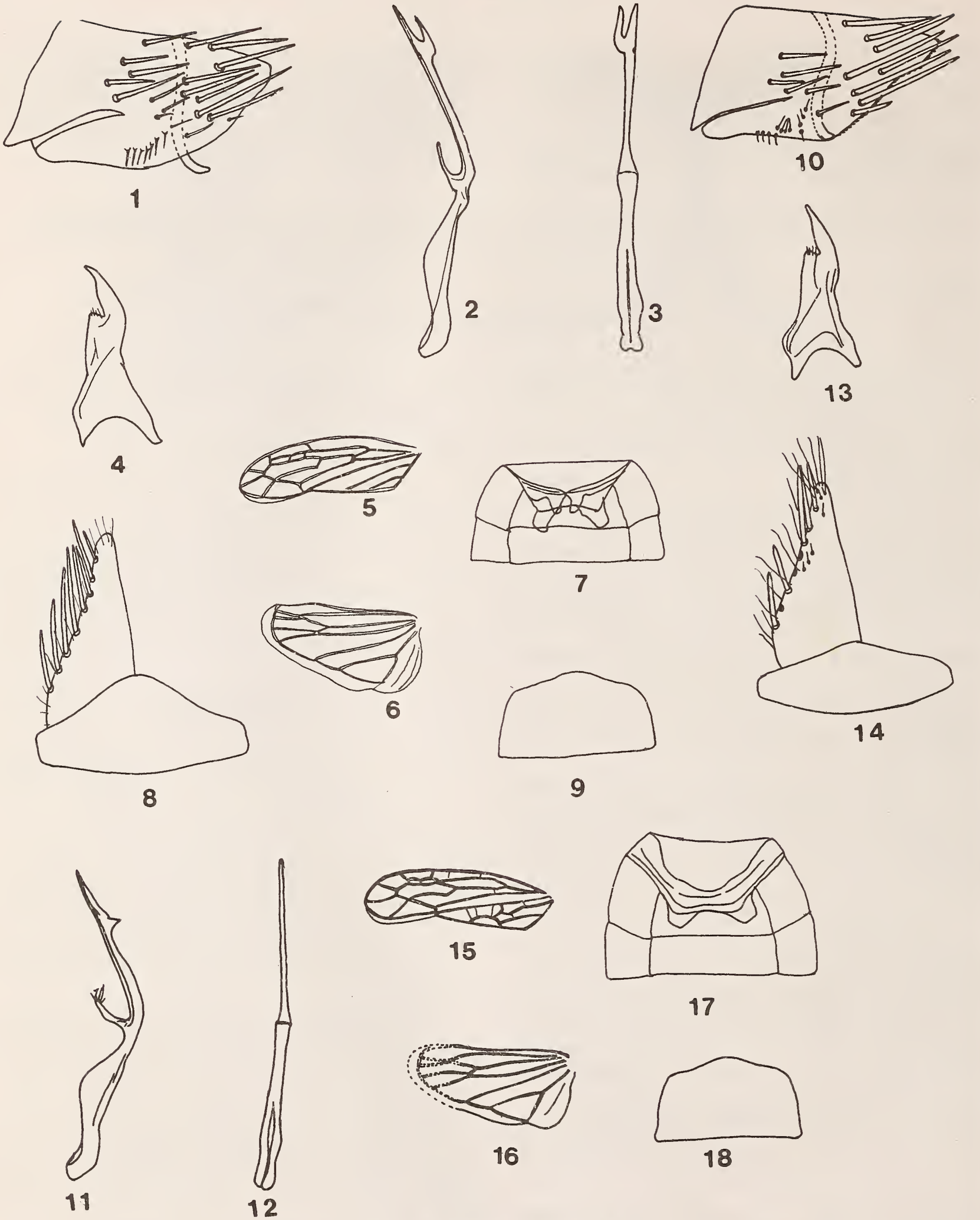

Figs 1–9. *Allophleps delhiensis* sp. nov.
1. Pygofer, lateral view; 2. Aedeagus, lateral view; 3. Aedeagus, dorsal view; 4. Style; 5. Forewing; 6. Hind wing; 7. Abdominal opodemes; 8. Valve and subgenital plate; 9. Female sternum VII.

Figs. 10–18. *Allophleps menoni* sp. nov.
10. Pygofer, lateral view; 11. Aedeagus, lateral view,; 12. Aedeagus, dorsal view; 13. Style; 14. Valve and subgenital plate; 15. Forewing; 16. Hind wing; 17. Abdominal apodemes; 18. Female sternum VII.

Female sternum VII rounded and slightly produced at the posterior margin.

Measurements (in mm) of Male (Female):

Head, width 1.05 (1.10); vertex, width 0.50 (0.50), length 0.35 (0.40); pronotum, width 0.95 (0.98), length 0.45 (0.45); scutellum, width 0.65 (0.70), length 0.45 (0.50); total length including fore wings 3.75 (3.95).

Types: Holotype, Male – Delhi, inside lamp dome, 30 April 1965, R. Menon; Paratypes, 1 Male, 5 females, same data as holotype; deposited at National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi 110 012, India; 2 females will be deposited at British Museum (Natural History), London.

This species is similar to *indicus* in the shape and bifurcation of apex of aedeagus and connective, but differs in the shape of subgenital plates and styles. Outer ante–apical cell of forewings is divided into two or more cells in this species but in *indicus* it is not divided.

Allophleps menoni sp. nov.
(Figs. 10–18)

Colour: Stramineous. Vertex with three pairs of light brown spots on the anterior margin and a fuscous submarginal ventral line; a pair of pale sunken spots basally one on each side of coronal suture. Face with pale striae laterally. Scutellum with pale brown spots at basal angles. Fore wings fuscous with some dark brown pigment deposited in the cells.

Form: Form and wing venation as given in the genus.

Male genitalia: Pygofer, valve, subgenital plates, connective and styles as given in the genus and are similar to that of the previous species. Aedeagus linear, elongated, shaft bifurcated into tooth–like short process before the gonopore; dorsal apodeme less curved; gonopore sub–apical and dorsal.

Second abdominal apodemes well developed, extending into sternum III.

Female sternum VII with much more produced posterior margin.

Measurements (in mm) of Male (Female):

Head, width 0.95 (1.00); vertex, width 0.40 (0.45), length 0.35 (0.35); pronotum width 0.85 (0.90), length 0.40 (0.45); scutellum, width 0.55 (0.60), length 0.35 (0.43); total length including fore wings 3.4 (3.8).

Types: Holotype, Male – Delhi, inside lamp dome, 30 April 1965, R. Menon; paratypes, 2 Males, 3 females, same data as holotype deposited at National Pusa Collection, Indian Agricultural Research Institute, New Delhi – 110 012, India; 2 Males, 2 females will be deposited at British Museum (Natural History), London.

This species is similar to the previous species in respect of pygofer, valve, subgenital plates, connective and styles, but differs in aedeagal shaft. The coloration and spotted pattern are also different.

Acknowledgements

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A STUDY ON THE INDIAN SPECIES OF *PLUTARCHIA* GIRAULT (HYMENOPTERA : EURYTOMIDAE)[1]

T.C. NARENDRAN AND R. PADMASENAN[2]

(With twenty–nine text–figures)

The Indian species of *Plutarchia* have been studied. Six new species, namely *Plutarchia bengalensis, Plutarchia carinata, Plutarchia hayatii, Plutarchia keralensis, Plutarchia malabarica*, and *Plutarchia marginata* are described. A dichotomous key for the identification of Indian species of *Plutarchia* is provided.

The little known genus *Plutarchia* was erected by Girault (1925) with the type–species *Plutarchia bicarinativentris* Girault from Queensland, Australia. Walker (1860) described a species, namely *Plutarchia indefensa*, from Sri Lanka. Subba Rao (1974) reported this species from India and described a new species from Nigeria. During our studies on Eurytomidae of India we come across six remarkable species which are new to science. These are described below.

The following abbreviations are used in this paper: BMNH: British Museum (Natural History), London; DZCU: Department of Zoology, University of Calicut; OOL: Ocellocular length; POL: Postocellar length; m: marginal vein; pm: Postmarginal vein; st. stigmal vein.

KEY TO INDIAN SPECIES OF *Plutarchia* GIRAULT

1. Propodeum with a median carina (Figs. 2, 11, 16, 22, 27) 2
— Propodeum without a median carina (Fig.6) 6
2. Dorsal length of second gasteral tergite more than 2.2.5 x first tergite 3
— Dorsal length of second gasteral tergite less than 2.2.5 x first tergite 4
3. POL more than 3 x OOL; exposed part of ovipositor sheath subequal to dorsal length of epipygium; gaster as in Fig. 18 .... *Plutarchia bengalensis* sp. nov.
— POL 2.2 x OOL; exposed part of ovipositor sheath dorsally distinctly shorter than epipygium; first gasteral tergite very small and fused to the second dorsally; marginal vein small and broad as in Fig. 3; gaster as in Fig. 1 .... *Plutarchia marginata* sp. nov.
4. Gaster subequal to thorax; venation brownish; dorsal length of epipygium 2x dorsal length of ovipositor sheath; gaster as in Fig. 24 .... *Plutarchia keralensis* sp. nov.
— Gaster distinctly shorter than thorax; other characters not as above 5
5. Stigmal vein shorter than marginal; dorsal length of epipygium 1.5 x ovipositor sheath; POL more than 12.5 x OOL; gaster as in Fig. 29 .... *Plutarchia hayatii* sp. nov.
— Stigmal vein longer than marginal; dorsal length of ovipositor sheath subequal to epipygium; POL 2 x OOL; gaster as in Fig 13 .... *Plutarchia carinata* sp. nov.
6. Scape luteous; venation brownish; marginal vein longer than stigmal .... *Plutarchia indefens a* (Walker)
— Scape brownish black except lower one third; marginal vein shorter than stigmal; venation testaceous; gasteras in Fig. 8 .... *Plutarchia malabarica* sp . nov.

Plutarchia marginata sp. nov.
(Figs. 1–3)

FEMALE: Length: 2.31 mm. Black; scape except apical one third dorsally, fore and mid tibiae, all trochanters, apices and bases of fore and mid femora, fore tarsus, apex of ovipositor sheath brownish; apical one third of scape dorsally, pedicel, fore and mid femora except bases and apices, hind femur, hind tarsus and mandibles blackish brown; mid coxa and flagellum brownish black; mid and hind tarsi and venation testaceous. Wings hyaline, pubescence whitish.

Head dorsally 1.77x as broad as long, anteriorly 1.35x as broad as high; densely umbilicately punctured on vertex and frons; punctures shallower than those on thorax, interstices shagreened; on lower face punctures confluent into shallow grooves separated by raised striae radiating from depressed clypeal margin; malar space shagreened. Frons convex but not bulging; scrobe deep, slightly shagreened, its lateral sides carinate; front ocellus located outside scrobe; pre and postorbital carinae well developed, a single row of piliferous punctures present in between these carinae and eye margin. Lower edge of toruli at about halfway between median ocellus and emarginate mouth margin; malar sulcus absent. POL: OOL – 100:45; eye length:malar space – 100:83. Antenna 11153; scape just reaches the lower level of median ocellus; first

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funicular segment the largest, segments 2–5 subequal in length; club slightly longer than the combined length of preceding two segments combined.

Thorax umbilicately punctured, interstices shagreened; about 1.21x as long as mesoscutum broad, 1.16x as long as high; pronotal collar carinate dorsolaterally, ecarinate medially, its posterior margin slightly concave, its lateral part carinate anteriorly; its collum shagreened. Tegula aciculate at hind margin; propodeum vertical, its median area flat with a median carina and two submedian carinae as seen in Fig. 2. Mesopleuron with faint horizontal striation on upper mesepimeron, lower mesepimeron and mesepisternum reticulate, epicnemial area with a single row of piliferous puncta. Fore coxa with a single diagonal groove; hind tibia with seven backwardly directed spines dorsally. Forewing 2.08x longer than broad; m: pm: st – 77:100:96.

Gaster 1.2x thorax; 2.1x as long as broad, 1.54x as long as high; petiole very small, seen only in dissected specimen; second gasteral tergite the largest, dorsally 2.65x first, its surface microsculptured as in Fig. 1; first tergite very small and fused to second dorsally, it bears two strong carinae dorsolaterally; dorsal length of epipygium about 1.16x those of ovipositor sheath.

MALE: Unknown.

Host: Unknown.

This species differs from the rest in having a short broader marginal vein, first gasteral tergite very small and fused to the second dorsally, it occupies only a very small portion of gaster anteriodorsally.

Holotype: Female. INDIA: Kerala, Malampuzha, January 1986, T.C. Narendran *et al.* (DZCU).

Plutarchia malabarica sp. nov.
(Figs. 4 – 8)

FEMALE: Length: 1.39–1.93 (Holotype 1.93 mm). Black; head and thorax with short silvery pubescence; antenna except the base of scape, fore and hind femora except bases and apices, middle of mid and hind tibiae brownish black; base of scape, apex or ovipositor sheath and mandibles blackish brown; in mid and hind tibiae the colour changes towards the tips from brownish black to blackish brown, to brown and to yellow at the extreme tip; bases and apices of fore, mid and hind femora, fore tibia, and fore tarsus yellowish brown; mid and hind tarsi, venation testaceous. Wings hyaline; pubescence whitish.

Head dorsally 1.62x as broad as long, anteriorly 1.32 x as broad as high; shallowly and umbilicately punctured on vertex; punctures on lower face confluent into shallow grooves separated by raised striae radiating from depressed clypeal margin; malar area shagreened. Frons convex but not bulging; front ocellus located outside scrobe; pre and postorbital carinae faintly indicated, indistinct on the dorsal side of the eye. Lower edge of toruli at half distance between median ocellus and emarginate mouth margin; malar sulcus absent. OOL:POL – 31:100; eye length: malar space – 100:89. Antenna 11153; scape reaches a little below the level of front ocellus; funicular segments subequal in length, first funicular segment a trifle longer than the rest.

Thorax shallowly umbilicately punctured, punctures more prominent than on head; interstices narrow; about 1.75x as long as mesoscutum broad, 1.53x as long as high; pronotal collar slightly carinate on anteriolateral margin, ecarinate medially, its posterior margin slightly concave, its lateral part carinate anteriorly; its collum shagreened. Tegula smooth and shiny, aciculate at hind margin. Propodeum vertical, its median area flat and without a median carina (Fig. 6). Mesopleuron with faint horizontal striation on upper mesepimeron, lower mesepimeron and mesepisternum reticulate; epicnemial area with a single row of piliferous punctures. Fore coxa with a narrow diagonal groove. Forewing length 2.3x width; m: pm: st – 75: 100:83.

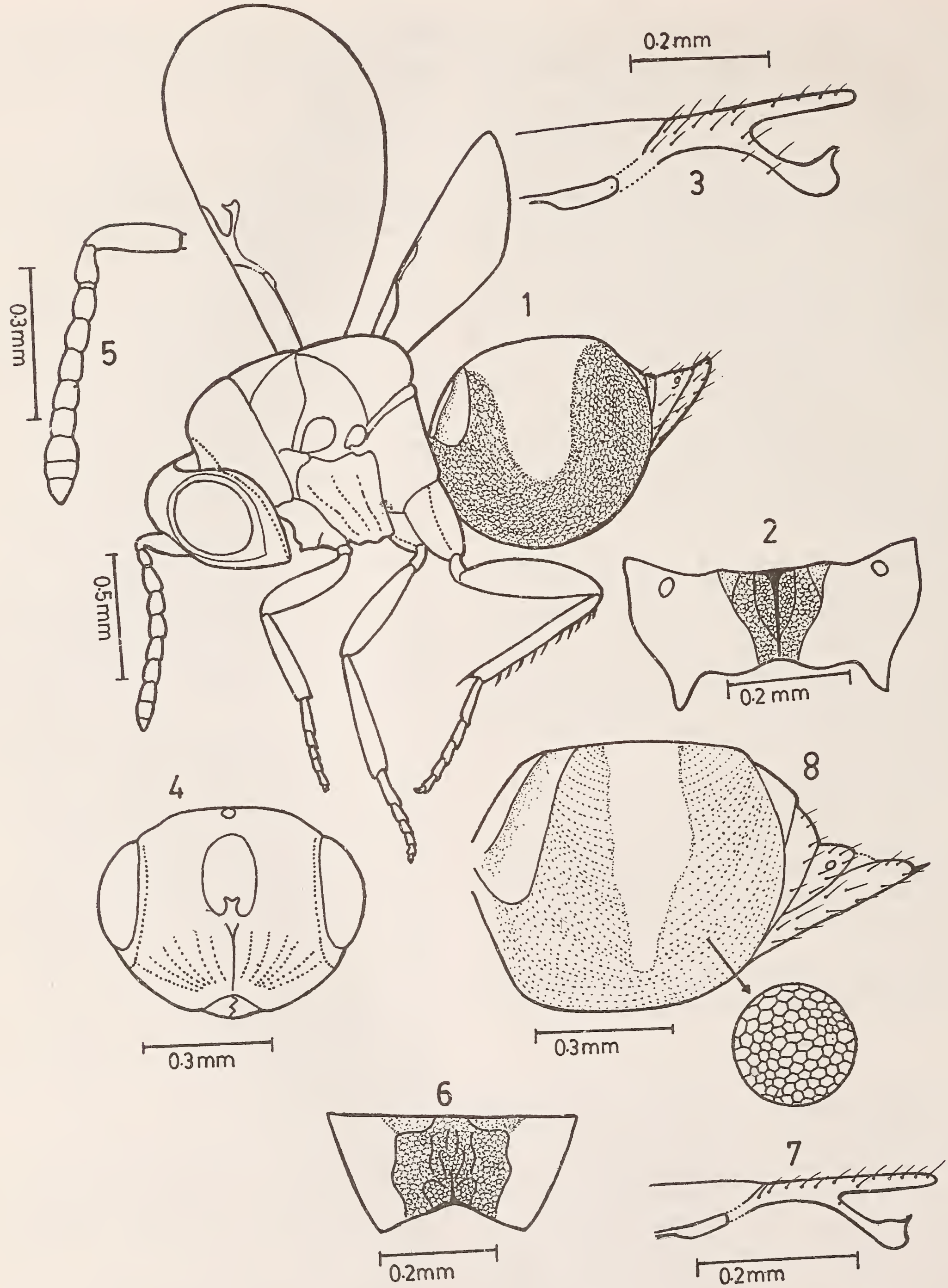
Gaster 1.33x thorax, 2.17x as long as broad, 1.61x as long as high; second gasteral tergite the largest, its dorsal length 1.5x the first, its surface microsculptured as in Fig. 8.

MALE: Unknown.

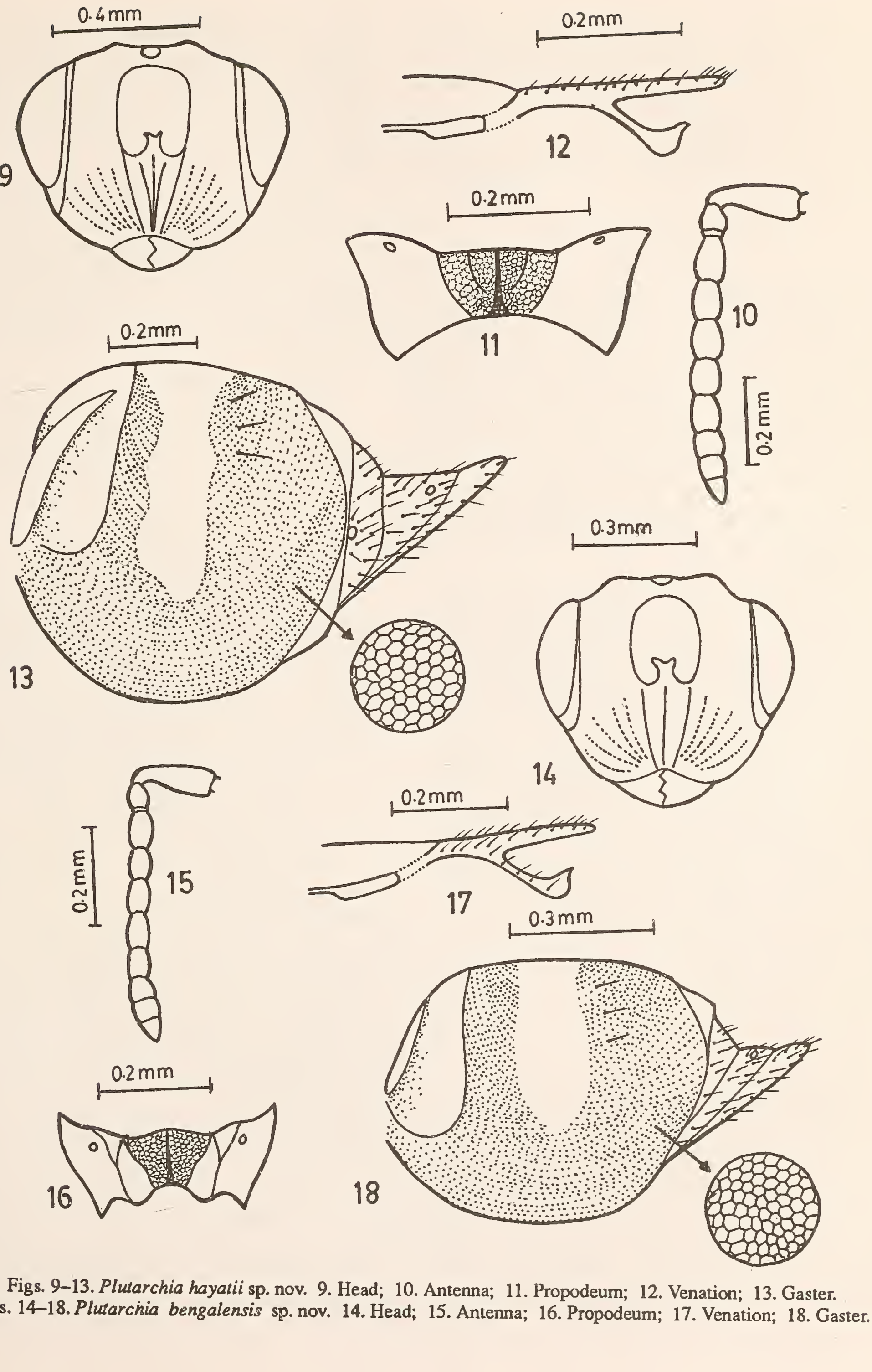
Host: Unknown.

This species resembles *Plutarchia bengalensis* in general appearance but differs from it in the following characters: 1. Propodeum without a median carina, 2. Upper two thirds of scape brownish black, 3. Slightly longer marginal vein.

Holotype: Female. INDIA: Kerala, Neeleswaram (Kasargod), 26 February 1988, Narendran



Figs. 1–3. *Plutarchia marginata* sp. nov. 1. Body profile; 2. Propodeum; 3. Venation.
Figs. 4–8. *Plutarchia malabarica* sp. nov. 4. Head; 5. Antenna; 6. Propodeum; 7. Venation; 8. Gaster.



Figs. 9–13. *Plutarchia hayatii* sp. nov. 9. Head; 10. Antenna; 11. Propodeum; 12. Venation; 13. Gaster.
Figs. 14–18. *Plutarchia bengalensis* sp. nov. 14. Head; 15. Antenna; 16. Propodeum; 17. Venation; 18. Gaster.

et al. Paratypes: 2 females. Same data as for holotype; 1 female: INDIA: Kerala, Payyanur, 26 February 1988, Narendran *et al.*; 1 female. INDIA: Kerala, Kadakkattupara (Nr. Calicut University), 9 November 1988, Narendran *et al.*; 1 female. INDIA: Kerala, Kallayi, 24 June 1987, Narendran *et al.* All types at DZCU.

Plutarchia hayatii sp. nov.
(Figs. 9 –13)

FEMALE: Length: 2.16 mm. Black; head and thorax with white pubescence; lower two thirds of scape, all trochanters, base and apex of fore femur, fore tibia and tarsus, mid femur, mid and hind tibiae except bases and apices, apex of ovipositor sheath brownish; upper one third of scape, pedicel mandibles blackish brown; bases and apices of mid and hind tibiae yellowish brown; mid and hind tarsi and venation testaceous; flagellum, middle region of fore femur, hind femur and tegulae brownish black. Wings hyaline.

Head dorsally 1.85 x as broad as long, anteriorly 1.29 x as broad as high; shallowly umbilicately punctured excluding malar space, latter shagreened, on lower face these punctures confluent into shallow grooves separated by raised striae radiating from the depressed clypeal margin. Frons convex, not bulging; scrobe deep, slightly shagreened, its lateral sides carinate; front ocellus located outside scrobe; pre and postorbital carinae present, a single row of piliferous punctures present between these carinae and eye margin. Lower edge of toruli at half distance between median ocellus and emarginate mouth margin; malar sulcus absent; POL:OOL – 100:37, eye length:malar space – 100:70. Antenna 11153; scape reaches a little below the median ocellus; first funicular segment largest, segments 2–5 subequal; club slightly longer than the preceding two segments combined.

Thorax densely umbilicately punctured, interstices shagreened; about 1.34x as long as mesoscutum broad, 1.23x as long as high; pronotal collar slightly carinate anteriolaterally, ecarinate medially, its posterior margin slightly concave, lateral part carinate anteriorly, collum shagreened. Tegula slightly striate reticulate at hind margin. Propodeum steep with a flat median area containing a median carina and two incomplete submedian carinae as in Fig. 11. Mesopleuron rugosopunctate with horizontal striation on mesepimeron and mesepisternum, epicnemial area slightly raised and contains single row of piliferous puncta. Fore coxa with a narrow diagonal groove. Forewing 2x longer than wide; m:pm:st – 83:100:70.

Gaster 1.3x thorax; petiole very short, not seen in undissected specimens; gaster 2.55x as long as broad, 1.46x as long as high; second gasteral tergite the largest, its dorsal length 1.5x those of first; epipygium dorsally 1.6 x ovipositor sheath; surface of second gasteral tergite microsculptured as in Fig. 13.

MALE: Unknown.

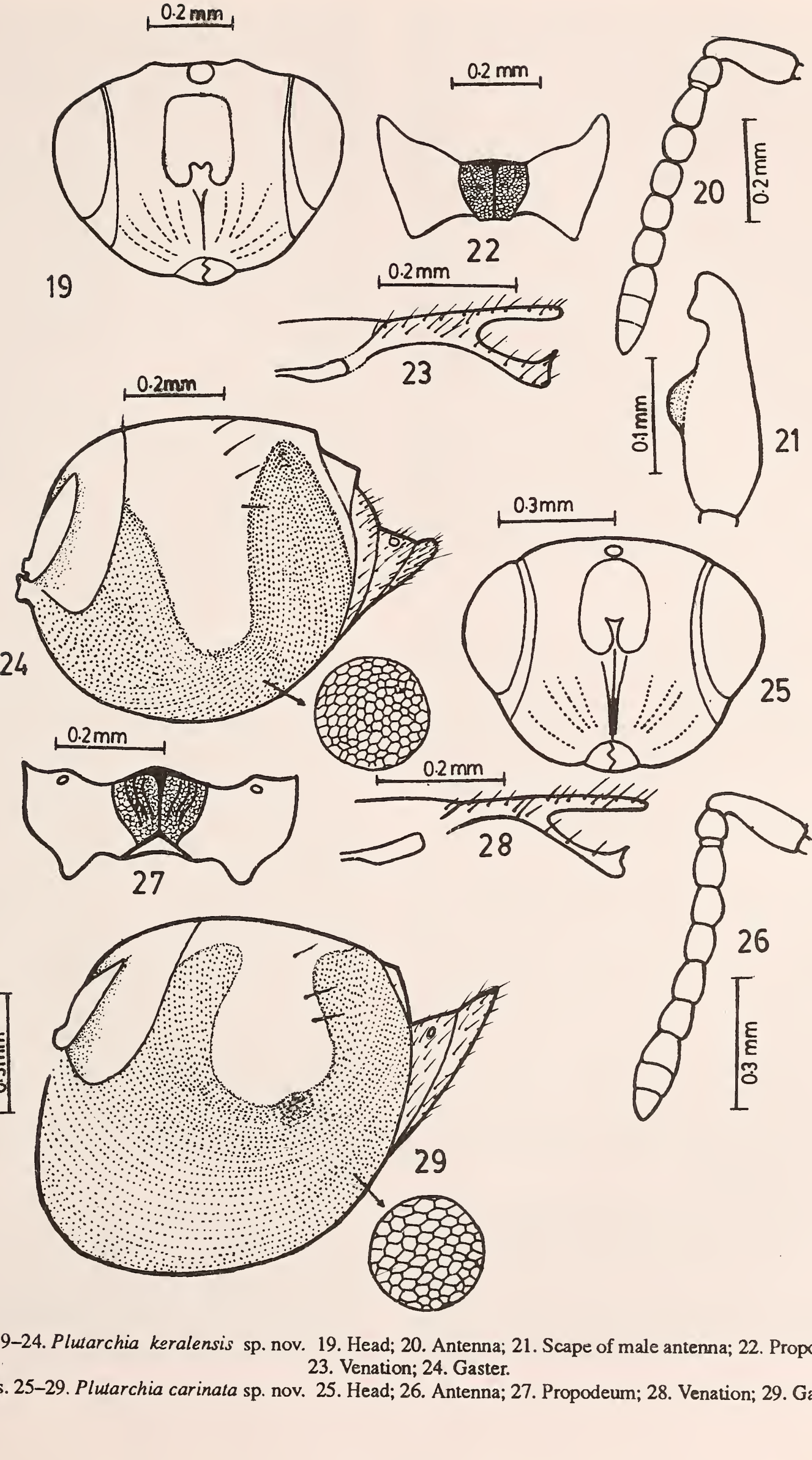
Host: Unknown.

Holotype: Female. INDIA: Uttar Pradesh, Aligarh, 31 May 1987, M. Hayat., (DZCU).

Plutarchia bengalensis sp. nov.
(Figs. 14–18)

FEMALE: Length: 1.75 mm Black; head, thorax, and tip of abdomen with short silvery pubescence; upper half of scape, pedicel, mid and hind coxae, mandibles, tegulae, fore, mid and hind femora except apices, hind tibia except base and apex blackish brown; flagellum brownish black; trochanters brownish; lower half of scape, fore and mid tibiae, fore tarsus, apex of ovipositor sheath yellowish brown; mid and hind tarsi and venation testaceous. Wings hyaline, pubescence whitish.

Head dorsally 1.62 x as broad as long, anteriorly 1.18x as broad as high; shallowly umbilicately punctured on frons and vertex, on lower face these punctures confluent into shallow grooves separated by raised striae radiating from depressed clypeal margin; malar space shagreened. Pre and postorbital carinae present, a single row of piliferous punctures present in between these carinae and eye margin. Frons convex, not bulging; scrobe deep and smooth, its sides carinate; front ocellus located outside scrobe. Lower edge of toruli at about halfway between median ocellus and emarginate mouth margin. POL:OOL – 100: 29; eye length: malar space – 100:76. Antenna 11153; scape reaches a little below the lower level of median ocellus, funicular segments except the first subequal in length, first a trifle longer than the rest; club slightly longer than the preceding two segments combined.



Figs. 19–24. *Plutarchia keralensis* sp. nov. 19. Head; 20. Antenna; 21. Scape of male antenna; 22. Propodeum; 23. Venation; 24. Gaster.

Figs. 25–29. *Plutarchia carinata* sp. nov. 25. Head; 26. Antenna; 27. Propodeum; 28. Venation; 29. Gaster.

Thorax shallowly umbilicately punctured, punctures more distinct than those on head, interstices narrow, shagreened; about 1.36x as long as mesoscutum broad, 1.28x as long as high; pronotal collar carinate anteriolaterally, ecarinate medially, posterior margin slightly concave, lateral part carinate anteriorly, collum shagreened. Tegula smooth, its hind margin aciculate. Propodeum vertical, its median area flat with a median carina as in Fig. 16. Mesopleuron with horizontal striation on upper mesepimeron; lower mesepimeron and mesepisternum reticulate; epicnemial area with a single row of piliferous punctures. Fore coxa with a narrow diagonal groove. Fore wing length 2x its width; m: pm: st – 60:100:80.

Gaster 1.2x longer than thorax; 2.15x as long as broad, 1.47x as long as high; petiole very short, concealed; second gasteral tergite the largest, dorsally 2.47x longer than first; surface of second gasteral tergite microsculptured as in Fig.18.

MALE: Unknown.

Host: Unknown.

Holotype: INDIA: West Bengal, 28 September 1983, S.S. Islam, (DZCU).

This species resembles *Plutarchia malabarica* in general appearance but differs from it in having a median carina on propodeum, in having a shorter marginal vein and coloration of antennal scape.

Plutarchia keralensis sp. nov.
(Figs. 19–24)

FEMALE: *Length:* 1.52 – 2 mm (Holotype: 1.72 mm). Black; head, thorax and tip of abdomen with white silvery hairs; scape except the apical one third dorsally, all trochanters, bases and apices of fore and hind femora, base and apex of hind tibia, apex of ovipositor sheath and venation brownish; apical one third of scape dorsally and pedicel blackish brown; antenna except scape and pedicel, mid and hind coxae, fore femur, hind femur, fore and mid tibiae yellowish brown. Wings hyaline, slightly infumated, pubescence brownish.

Head dorsally 1.76x as broad as long, anteriorly 1.38x as broad as high; umbilicately punctured on vertex and frons, on lower face these punctures confluent into shallow grooves separated by raised striae radiating from depressed clypeal margin. Frons convex but not bulging; scrobe deep, slightly shagreened posteriorly, lateral side carinate; front ocellus located outside scrobe; pre and postorbital carinae present, a single row of piliferous punctures present between these carinae and eye margin. Lower edge of toruli at about halfway between median ocellus and emarginate mouth margin; malar space shagreened; malar sulcus absent. POL:OOL 100:40; eye length:malar space – 100:86. Antenna 11153; scape just reaches the lower level of median ocellus; first funicular segment slightly longer than the rest, segments 2 – 5 subequal in length; club slightly longer than the preceding two segments combined.

Thorax umbilicately punctured, interstices narrow, shagreened; about 1.33x as long as mesoscutum broad, 1.26x as long as high; pronotal collar carinate dorsolaterally, ecarinate medially, its posterior margin slightly concave, its lateral part carinate anteriorly, its collum shagreened. Tegula aciculate at hind margin; propodeum vertical, its median area flat, reticulate, with a median carina as in Fig. 22. Mesopleuron horizontally striated on the upper mesepimeron, reticulate on lower mesepimeron and mesepisternum, epicnemial area with a single row of piliferous puncta. Fore coxa with a narrow diagonal groove. Forewing length 2.4x its width; m: pm: st – 95: 91: 100.

Gaster a trifle over the length of thorax, twice as long as broad, 1.44x as long as high; petiole short, concealed: first gasteral tergite bears two strong dorsolateral carinae, the latter bears a rectangular projection anteriorly; second gasteral tergite the largest, its dorsal length about 1.94x the first, its surface microsculptured as in Fig. 24; dorsal length of epipygium twice that of ovipositor sheath.

MALE: 1.76 – 1.85 mm. Resembles female in almost all characters except the following: 1. antennal funicle six–segmented; scape blackish brown on its upper half, brownish basally, ventrally it bears a knob–like projection as in Fig. 21; gaster petiolate, petiole longer than hind coxa, gasteral body very small.

Host: Unknown.

This species resembles *Plutarchia indefensa* (Walker) in having infumated wing with brownish venation, differs from it in having a median carina on propodeum, in having 2 subglobose gasters. The male of this species can be distinguished from that of *P. indefensa* in having six funicular segments on antenna, in having a knob–ike projection on the ventral side of scape. It also resembles *P. marginata* in general appearance but differs from it in having an infumated wing with brown venation and in the nature of carina on propodeum and in the measurements of gasteral tergites.

Holotype: Female. INDIA: Kerala, Silent Valley, 9 December 1987, Narendran *et al*. (DZCU).

Paratypes: 1 Female. Same data as for holotype; 8 Females and 3 Males. INDIA: Kerala, Kadakkattupara (Nr. Calicut University), 9 November 1988, Narendran *et al.*; 1 Female. INDIA: Kerala, Valiyakavu (Pathanamthitta), 25 December 1988; 2 Females. INDIA: Kerala, Idikki, 1 December 1988, Narendran et al.; 1 Female. INDIA: Kerala, Edayar (Cannanore), 30 October 1988, Narendran *et al.*; 1 Female & 1 Male. INDIA: Kerala, Pyyannur, 26 February 1988, Narendran *et al.*; 26 Females and 9 Males. INDIA: Kerala, Kumarakom, 29 November 1988, Narendran *et al.*. All types at DZCU.

Plutarchia carinata sp. nov.
(Figs. 25–29)

FEMALE: Length: 2.17 mm. Black; head thorax and tip of abdomen with short silvery pubescence; lower half of scape, pedicel, mid and hind trochanters, apex and base of mid femur, bases and apices of mid and hind tibiae, apex of ovipositor sheath brownish; upper half of scape, flagellum, fore and hind femora except bases and apices, hind tibia except base and apex, mid and hind coxae brownish black; fore trochanter, bases and apices of fore and hind femora, middle region of mid femur and mid tibia blackish brown; fore tarsus yellowish brown; mid and hind tarsi, venation yellowish; Wings hyaline, pubescence whitish.

Head dorsally 1.89x as broad as long, anteriorly 1.33x as broad as high; umbilicately punctured on vertex and frons, on lower face these punctures confluent into shallow grooves separated by raised striae radiating from depressed clypeal margin; malar space shagreened. Frons convex, not bulging, scrobe smooth, deep, its lateral sides carinate; pre and postorbital carinae present, a single row of piliferous punctures present in between these carinae and eye margin. Lower edge of toruli at about halfway between median ocellus and emarginate mouth margin; malar sulcus absent. POL: OOL – 100:52; eye length : malar space – 100 : 77. Antenna 11153; scape reaches a little above the lower level of median ocellus; first funicular segment slightly longer than the rest; segments 2–5 subequal in length; club slightly longer than the preceding two segments combined.

Thorax umbilicately punctured; interstices shagreened; about 1.41x as long as mesoscutum broad, 1.21x as long as high; pronotal collar carinate anteriolaterally, medially ecarinate, its posterior margin slightly concave; lateral part of propodeum carinate anteriorly, its collum shagreened. Tegula smooth, aciculate on hind margin; propodeum flat with a strong median carina and three submedian carinae as in Fig. 27. Mesopleuron with horizontal striation on upper mesepimeron; lower mesepimeron and mesepisternum reticulate; epicnemial area with a single row of piliferous puncta. Fore coxa with a narrow diagonal groove. Forewing length 2.1x its width; m: pm: st – 84: 100:92.

Gaster 1.17x longer than thorax; petiole very short and concealed; 1.85x as long as broad, 1.25x as long as high; second gasteral tergite largest, its dorsal length 1.48x first; surface of second gasteral tergite microsculptured as in Fig. 29.

MALE: Unknown.

Host: Unknown.

This species resembles *P. marginata* in general appearance but differs from it in having a slender long marginal vein, in the nature of carinae on propodeum, and in the measurements of gasteral tergites.

Holotype: INDIA: Tamil Nadu, Siruvani, 27 September 1987, Narendran *et al.*, (DZCU).

Plutarchia indefensa (Walker)

Eurytoma indefensa Walker, 1860, Ann. Mag. nat. Hist. 6: 358, Female. Sri Lanka (BMNH).

Subba Rao (1974) has given a good redescription of the female of this species. This species resembles *Plutarchia keralensis* in general appearance but differs from it in having luteous scape, elliptical gaster and propodeum without a median carina.

MALE: 1.7 – 2.5 mm. Resembles female except in having a plumose antenna with brownish black scape and five funicular segments, and in having a small gaster with a petiole longer than hind coxa.

The male of this species closely resembles that of *Plutarchia keralensis* but can be distinguished from the latter by the antenna which has a five-segmented funicle and a scape devoid of knob-like projection.

Host: Melanagromyza spp. (Subba Rao 1974)

Distribution: Sri Lanka; INDIA: Namkum, Tamil Nadu (new record for Tamil Nadu), Uttar Pradesh (new record for Uttar Pradesh), Kerala (new record for Kerala).

Materials examined: 1 Female. INDIA: Uttar Pradesh, Aligarh, 19 November 1984, M. hayat; 1 Female. INDIA: Kerala, Amalagiri (Kottayam), 28 November 1988; Narendran *et al.*; 2 Females. INDIA; Kerala, Calicut University Campus, 1 February 1986, 2 June 1987, Narendran *et al.*; 1 Female. INDIA: Tamil Nadu, Coimbatore, Sept. 1987, Narendran *et al.*; 1 Female. INDIA: Kerala, Kallayi, 24 June 1987, Narendran *et al.*; 2 Females and 7 Males. India: Kerala, Kalkandi (Nr. Silent Valley), 13 December 1987, Narendran *et al.*, 1 Male. INDIA: Kerala, Kumarakom, 28 November 1988, Narendran *et al.*; 1 male. India: Kerala, Malampuzha, 11 December 1987, Narendran *et al.*; 2 females. INDIA: Kerala, Mukkali (Nr. Silent Valley), 13 December 1987, Narendran *et al.*, 15 Females and 1 Male. INDIA: Kerala, Parambikulam, 22 December 1985, Narendran *et al.*; 1 Male. INDIA : Kerala, Payyannur, 26 February 1988, Narendran *et al.*; 1 Female. INDIA: Kerala, Silent Valley, 30 December 1988, Narendran *et al.*. All types at DZCU.

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A NEW SPECIES OF GENUS *PAREVASPIS* RITSEMA (HYMENOPTERA : APOIDEA : MEGACHILIDAE : ANTHIDINAE) FROM INDIA[1]

VIRENDRA KUMAR[2] AND V.K. TIWARI[3]

(*With five text-figures*)

The genus *Parevaspis* Ritsema from the Indian region is represented by only one species,namely *Parevaspis carbonaria* Smith (Bingham 1897 and Michener 1965). In this paper a new species, *Parevaspis baijalii*, is described from Bombay, (India).

Parevaspis baijalii sp. nov.
(Figs. 1-5)

MALE: Integument of head and thorax rough and not shining, abdomen shining; facial pubescence white, rest of body having few scattered white hairs; integument black.

Head wider than the median length; inner eye margin convergent below and slightly incurved at median area; clypeus triangular, broadly protuberant and coarsely punctured; supraclypeal area elevated and with a prominent 'Y' shaped carina, lower arm of carina touching the apical margin of clypeus, upper bifurcated arms reach up to antennal sockets level; width of parocular area equal to the basal width of clypeus; subocellar area flat, punctured and bare; vertex margin straight and incarinate; genae

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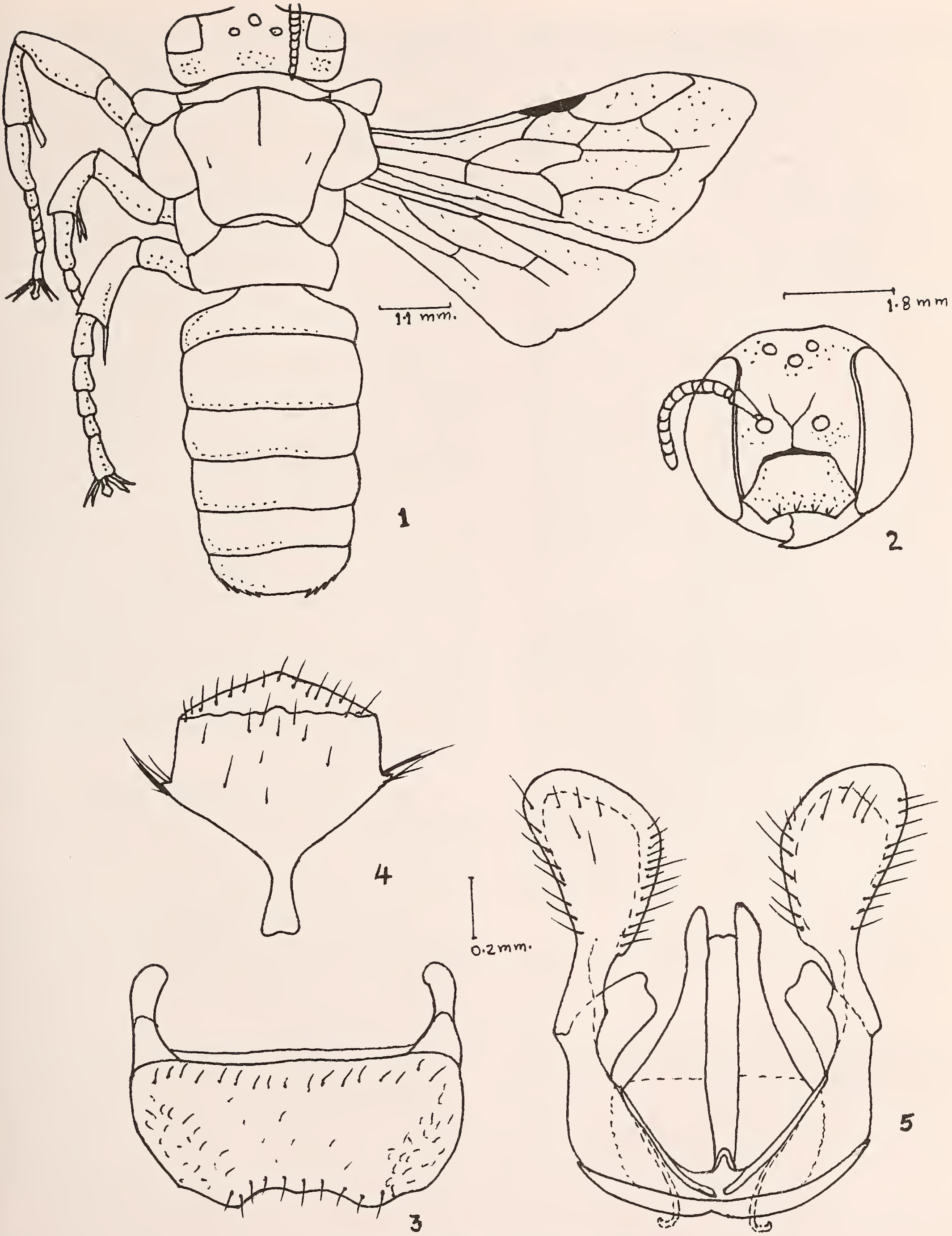

Figs. 1–5. *Parevaspis baijalii* sp. nov. (Male)
1. Adult, full dorsal view; 2. Head front view; 3. Sternum 6th; 4. Sternum 8th; 5. Genitalia.
(Dots on Figs. 1 & 2 indicate pubescence).

narrowed below and hypostomal area with short white pubescence; mandible tridentate with wide interspace between second and third tooth.

Pronotal lobe expanded laterally, anterior ridge subcarinate; scutum flat, broadly protuberant anteriorly, with coarsely deep punctures; median line distinct, parapsidal lines much short; notauli inevident; scutellar surface with coarsely pits like deep punctures, posterior margin broadly arched and ridge like; mesepisternum minutely punctate, with few pale yellow hairs and a complete carina on antero-lateral surface; median length of propodeal triangle about twice that of median groove below; wing colour clear hyaline, with apical fuscous margin, veins black to piceous, first recurrent vein is far from base and second reaches beyond the apex of second cuboital cell; coxae and trochanter normal with long white hairs on inner margin; femora broadly cylindrical, angulated and ventro-apically notched; tibia ventrally carinate and with a fringe of short pale bristles; outer surface of leg with short white hairs.

Basal tergum concavity margin carinate and with ferrugenous pubescence; apical margin of tergites with smooth area and rudimentary fringe; tergites 2-5 with unexposed pregradular area and graduli; post gradular area exposed; 6th tergum with broadly arched apical margin, laterally finely serrated and slightly blunt at apex; apical margin of 7th tergum slightly declivous at midline, broadly imerginate and testaceous brown; 6th sternum exposed with invaginate apical margin and incurved medially; 8th sternum pentagonal, apical lobe obtusely angulated, fringe with few fine bristles, basal part narrowed and produced into a broad stalk.

Gonocoxite medially constricted; gonostylus broadly dilated, fan-shaped, with long fringe; penis-valve flattened, triangular with narrow apex; penis membranous.

Measurements: (in mm): Total length 9.6; eyes: length 2.70, lateral width 1.4; clypeus : median length 1.1, basal width 1.2, apical width 1.7; antennae : length of scape 0.9, pedicel 0.25, flagellar segments I-0.20, II-0.30, XI-0.40; labrum : median length 0.8, basal width 0.9, apical width 0.75; mandible : length of dentate and lower margin 0.60 and 0.90; scutum : median length 2.4, maximum width 3.0; forewing: total length 7.0; tergites I- VII, relative median width 1.6, 2.1, 2.1, 2.0, 2.0, 1.6 and 0.5.

FEMALE: Not known.

Material Examined: Holotype : male, *Solanum* sp. Bombay (National Park), 16 June 1985. (V.K.) deposited in I.A.R.I., New Delhi . Paratypes : 2 males with same data, in the collection of the Deptt. of Entomology, Agra College, Agra.

The new species is close to *P. carbonaria* Smith. However, *P. baijalii* sp. nov. can be distinctly separated from *P. carbonaria* by : "facial pubescence white; both the recurrent veins are not equidistant; hypostomal area is broadly elevated and with few white pubescence; median carina of mesepisternum absent; apical margin of 6th sternum is medially incurved; sternum 8th pentagonal in shape, apical lobe obtusely angulated, basal part with long hairs and elongated; penis-valves triangular with narrow apex".

This species has been named after Dr. H.N. Baijal, Head of the Zoology Department, Agra College, Agra.

ACKNOWLEDGEMENT

We thank Dr H.N. Baijal, Head of the Zoology Deptt., Agra College, Agra, for providing necessary facilities.

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A NEW SPECIES OF THE GENUS *SIRTHENEA* SPINOLA (PIRATINAE- REDUVIIDAE- HETEROPTERA) FROM THE COROMANDEL COAST, INDIA [1]

C. MURUGAN AND DAVID LIVINGSTONE[2]

(*With a text-figure*)

A new species of the genus *Sirthenea* Spinola, namely *Sirthenea nigripes* sp. nov. (Reduviidae : Heteroptera) from the Coromandel Coast of India has been described and illustrated.

INTRODUCTION

The genus *Sirthenea* Spinola can be identified from all other genera of Piratinae by their well formed tibiarolium on the fore tibiae alone and by their extraordinary elongation of the ante–ocular area, carrying the antennae forward, farther in front of the eyes. Distant (1904) recorded only one species, namely *Sirthenea flavipes* (Stal) from the Oriental region. Apart from this species, Villiers (1969) described yet another species (*S. rapax*) from the Ethiopian region. The present species from the Coromandel Coast of the Indian peninsula is a new addition, bringing two from the total species under this genus from India.

This new species is based on a single specimen collected by light trap by Mr. G. Ravichandran from Sunabeda, Koraput District, Orissa on 19 June 1987 at an elevation of 950 MSL, temperature 25°C and humidity 70%.

Sirthenea nigripes sp. nov.

MALE: macropterous; elongate; length 18 mm, width across the pronotum 4 mm and across the abdomen 3 mm; piceous; legs pale fuscous, anterior lobe of the pronotum, dorsal and ventral surface fuscous; a longitudinal dark streak extending from beneath the antennal socket up to the base of the articulation of the rostrum conspicuous; entire sternum, scutellum, posterior lobe of pronotum, major part of the corium and membrane piceous.

Head: elongate; ante-ocular area more than twice as long as the post – ocular area; antennal socket more dorsally located, far removed from the eyes; frons, clypeus, lorum etc. setaceous; ocelli wide apart, reddish brown, encircled by piceous ring; ocellar prominence smooth; collar short and narrow; scape slightly incrassated, very short, almost half as long as the pedicel and not exceeding the anterior limit of clypeal prominence; second segment of the rostrum almost four times as long as the first segment and almost twice as long as the very slender, acutely pointed third segment.

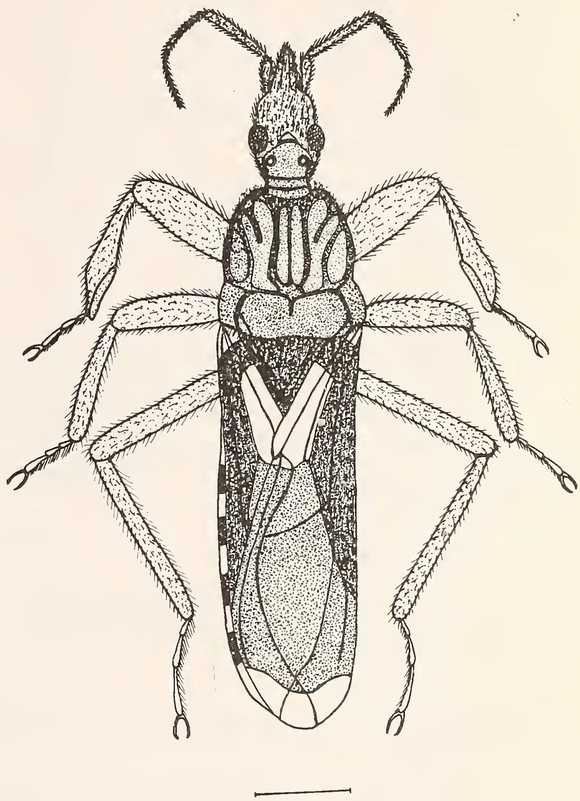

Fig. 1. *Sirthenea nigripes* sp. nov.

Thorax: anterior lobe of the pronotum almost twice as long as the posterior lobe; the sulcations include, one on either side of the median longitudinal fissure, another oblique one outer to it, extending al-

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most up to the posterior limit of the anterior lobe and a short, more shallow one in between these two; anteriorly, the sulcations expand, being lined by fine setae; antero-lateral tubercles obscure; posterior lobe with discal prominence demarcated on either side of the median longitudinal furrow, a transverse fissure delineating the two lobes fairly deep; scutellum piceous, acutely pointed apically and laterally compressed and dorsally flattened; hemelytra with an ochraceous spot at the distal end of the clavus, confluent with a similar spot on the corium; both corium and clavus basally ochraceous; the membrane basally piceous, apically ochraceous and translucent; legs concolorous; femora only slightly longer than the coxae, both laterally compressed, forming a ventral setaceous keel; fore tibiae almost as long as the femora; tibial pad more apically differentiated, anteriorly extending upto the tip of the first tarsomer; mid and hind tibiae without any trace of a pad; mesosternal carination prominent, metasternum foveated at the posterior margin.

Abdomen: with ochraceous spots on the connexivum, mid ventral keel of the abdominal segments brownish ochraceous except at the pregenital and genital segments; first abdominal sternite ochraceous throughout.

This species closely resembles *Sirthenea flavipes* in the pattern of formation of its carinations and sulcations of the anterior lobe of pronotum and characters of the head and segments of the appendages. However, it can be readily recognised from *S. flavipes* by its small size and by the coloration of the corium, clavus and the sulcations of the anterior lobe of pronotum (black in *S. flavipes* and fuscous concolorous with the rest of the anterior lobe of the pronotum in *S. nigripes* sp. nov.); legs in the former ochraceous and in the latter pale fuscous.

The type is for the present deposited in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Acknowledgements

We are grateful to the authorities of the Bharathiar University, Coimbatore, for providing facilities, and to the Department of Science and Technology, New Delhi, for financial assistance during the course of the investigation. Thanks are due to the Director, Zoological Survey of India, Calcutta, for placing at our disposal their reduviid collection for comparison and to Mr. G. Ravichandran for making available the specimen with the collection data for the present description.

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TWO NEW SPECIES FROM NORTH EASTERN INDIA (ORTHOPTERA : ACRIDIDAE)[1]

Kharibam Meinodas and Shaikh Adam Shafee[2]

(With eight text-figures)

Two new species of the subfamily Acridinae from northeastern India, viz. *Odontomelus manipurensis* and *Pargaella champhaiensis* are described and illustrated. Further, occurrence of the genera *Odontomelus* Bol. and *Pargaella* Bol. is reported for the first time from the Oriental region.

Odontomelus manipurensis sp. nov.
(Figs. A-E)

MALE: Head (Figs. A,B) brownish, strongly oblique, distinctly longer than pronotum; vertex convex; fastigium of vertex slightly longer than wide, depressed, with median and lateral carinulae; fastigial foveolae absent; antennae slightly widened basally, much longer than head and pronotum together, inserted in front of lateral ocelli; frontal ridge compressed between antennae, with carinae

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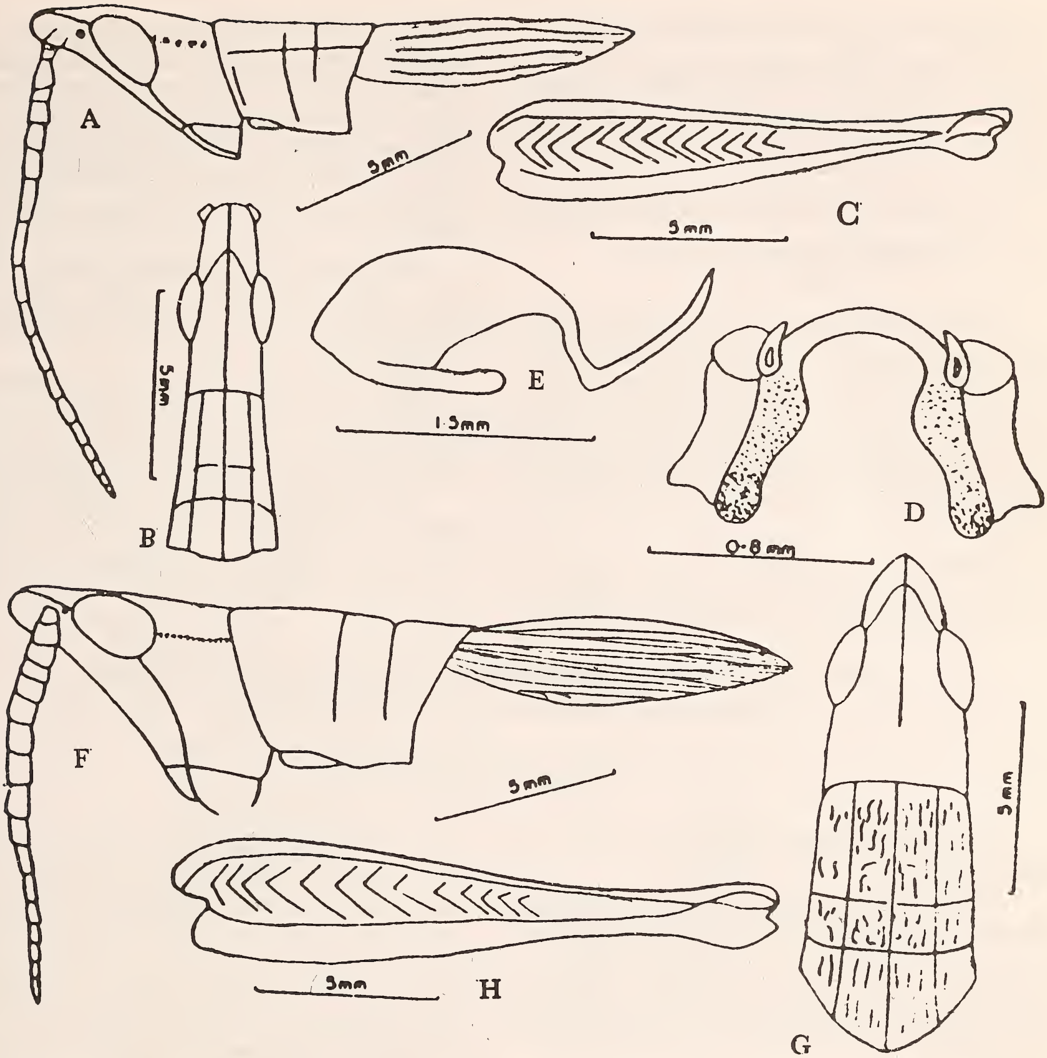

New species from northeastern India. Figs. A–E *Odontomelus manipurensis* sp. nov. F–H *Pargaella champhaiensis* sp. nov.

almost parallel, slightly divergent before reaching clypeus.

Thorax brownish; pronotum (Fig. B) long with well developed median and lateral carinae, median carina crossed by posterior transverse sulcus; tegmina and wings short, never reaching beyond the third abdominal segment; mesosternal interspace open; hind femur with knee passing slightly beyond the apex of abdomen, upper basal lobe slightly longer than lower basal lobe, external apical spine of hind tibia absent.

Abdomen brownish, carinate above; tympanum well developed; supra-anal plate triangular with a mid-longitudinal groove; cerci long, tubular; epiphallus (Fig. D) with bridge narrow, ancorae short, lophi lobiform; aedeagus (Fig. E) with apical valve curved upward.

Body length: 22-24 mm.

The new species differs from *Odontomelus usambaricus* Ramme in the knee of hind femur reaching slightly beyond apex of abdomen; antennal segments 7 to 14 much longer than wide; tegmina reaching beyond the third abdominal segment.

Holotype: Male, from grass, Waithou, Manipur, 20 June 1983, Kh. Meinodas. Preserved specimen deposited at present in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Paratype: 1 Male (Same data as for holotype).

Pargaella champhaiensis sp. nov.
(Figs. F-H)

FEMALE: Head (Figs. F, G) brownish, slightly shorter than pronotum; fastigium of vertex with distinct median and lateral carinulae; fastigial foveolae indistinct; frontal ridge narrow, shallowly sulcate, with carinulae slightly divergent downwards; vertex with indistinct mid-longitudinal carinula; antennae slightly ensiform, shorter than head and pronotum together.

Thorax brown; pronotum (Fig. G) with fine median and lateral carinae; dorsum rugose in prozona, longitudinal carinulae in metazona; median carina crossed by posterior transvere sulcus; metazona about one-half the length of prozona, posterior margin obtusely angular; mesosternal interspace open, as long as wide; tegmina and wings short, never reaching beyond third abdominal segment; hind femur with knee never extending beyond tip of abdomen; external apical spine of hind tibia absent.

Abdomen brown, supra-anal plate long with mid-longitudinal groove basally; cerci short, tubular; subgenital plate with egg- guide long.

Body length: 30 mm.

The new species is closely related to *Pargaella luctuosa* Bolivar, but differs from it in the knee of hind femur not extending beyond the tip of the abdomen, and by the presence of lanceolate tegmina.

Holotype: Female, from grass, Champhai Tasar farm, Mizoram, 12 July 1983, O. Kupera. Preserved specimen deposited at present in Zoological Museum, Aligarh Muslim University, Aligarh, India.

A NEW SUBSPECIES OF *DENDROBIUM PANDURATUM* LINDL. (ORCHIDACEAE) FROM SOUTHERN INDIA[1]

R. GOPALAN AND A.N. HENRY2
(With four text-figures)

Dendrobium panduratum Lindl. subsp. **villosum** subsp. nov.

Dendrobium panduratum. Lindl. subsp. *panduratum* affinis, sed sepalis dorsalibus ellipticis, obtuso-mucronatis, sepalis lateralibus obtuso-mucronatis, petalis super medianum fimbriatis; lobis lateralibus labii, basibus midlobi et discis intus villosis differt.

Allied to *Dendrobium panduratum* Lindl. subsp. *panduratum* but differs in: dorsal sepal elliptic, obtuse–mucronate; lateral sepals obtuse-mucronate; petals fringed above the middle; and lip-lateral lobes and base of midlobe, and disc villous within.

Epiphytic or lithophytic herbs; pseudobulbous stems 3–15 cm long, elongate, flat, narrowed at base, broader towards apex; young leafy stem arises from the anterior side; mature (old) leafless flowering stem enclosed by sheath (sometimes with one or two leaves at apex). Leaves 1–10 x 0.2–1.5 cm, linear-lanceate, sessile, acute, membranous. Flowers white in terminal or axillary, zigzag, 2–7 flowered racemes up to 8 cm long; bracts minute, ovate. Dorsal sepal 7–8 x 2.5–3 mm, elliptic, obtuse- mucronate, 3–veined, gland-dotted; lateral sepals 9–10 x 2.5–3 mm, falcatly ovate-lanceate, obtuse-mucronate, 5–veined, gland–dotted. Petals *c.* 7 x 2 mm, oblanceate, acute, margin fringed above the middle, 3–veined, gland–dotted. Lip *c.* 10 x 6 mm, panduriform, 3–lobed; lateral lobes small, acute, incurved, villous within, 3–veined, veins branching at apex; midlobe *c.* 4 x 5 mm, broadly ovate or orbicular, irregularly crenulate, undulate, acute and recurved at apex, villous at base within, 5–veined; disc thick, villous within, 5–veined, outer veins branched; mentum *c.* 4 mm long, spur–like, straight or slightly incurved; 2–lobed at tip. Column *c.* 6 x 1 mm, 3-toothed, operculum attached to the middle; pollinia 4, in pairs, waxy. Ovary with pedicel 5–8 mm long. Fruits

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globose. (Figs. 1-4).

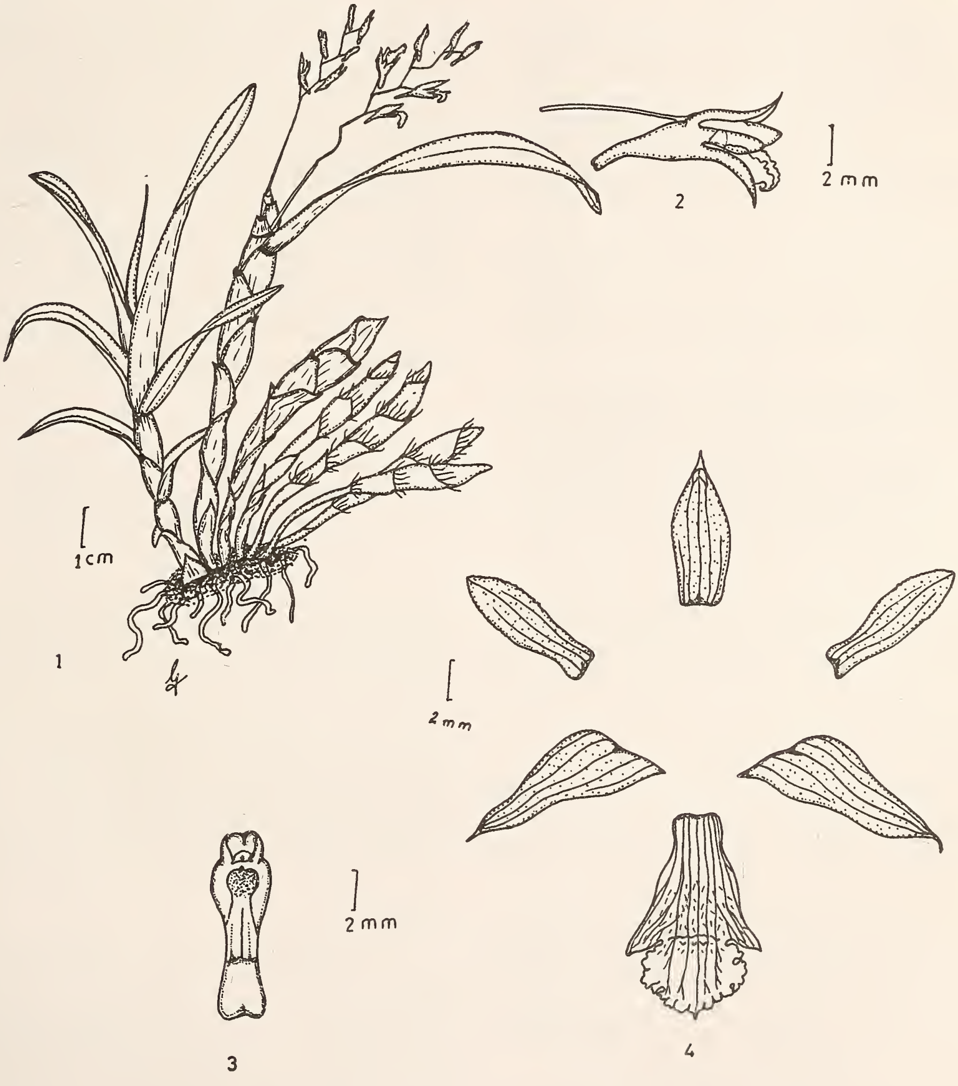
Holotype (Gopalan 88699, CAL) and isotypes (Gopalan 88699, MH– acc. no. 144695-144701) were collected at Inchikkuzhi in Kannikatty R.F., Tirunelveli Kattabomman District, Tamil Nadu, on 20 September 1988.

We are thankful to Dr N.P. Balakrishnan, Scientist 'SE' for encouragement and to Dr V.J. Nair, Scientist 'SD', for the Latin translation.

KEY TO THE SUBSPECIES OF *D. Panduratum* LINDL.

Dorsal sepal oblong-lanceolate, acuminate; lateral sepals acuminate; petals not fringed above the middle; lip and disc glabrous .... sub sp. *panduratum*
(*Distrib.*:Sri Lanka)

Dorsal sepal elliptic, obtuse-mucronate; lateral sepals obtuse-mucronate; petals fringed above the middle; lip - lateral lobes and base of midlobe, and disc villous within .... sub sp. *villosum*
(*Distrib.*: Southern India)



Figs. 1–4. *Dendrobium panduratum* Lindl. subsp. *villosum* Gopalan & Henry
1. Habit; 2. Flower; 3. Rostrum from front; 4. Sepals, petals and lip spread out from front.

REVIEWS

THE INDIAN BLACKBUCK by M.K. Ranjitsinh. Natraj Publishers, Dehradun, 1989. 156 pp, with 25 monochrome and 2 coloured plates. Rs. 250.

As any other species of Indian wildlife, the blackbuck, that magnificient symbol of India's indigenous fauna, has a declining fortune, swamped as it is by an ever increasing human population encroaching and destroying the natural habitats of the subcontinent. This book by Ranjitsinh relates the history of its survival and discusses what the future holds for the species. In the process the author has reviewed all that has appeared in published literature from the time of the Emperor Babur to the present day. Ranjitsinh is perhaps the best qualified to undertake such a review. A member of the Indian Administrative Service, he is atypical of those guardians of the red tape and is more at home in the wilderness than in the musty corridors of power.

The two main areas he had studied intensively, the Velavadar and Kanha National Parks , are illustrative of optimal and suboptimal habitat for the species. The environmental parameters in both habitats have been discussed in detail.

The physiology, distribution and status; group structure, birth and mortality; food and feeding habits; social behaviour; courtship and reproduction; relationship with other species; blackbuck and cheetah; and finally conservation and future of the species are discussed, based on the author's wide experience of the species correlated with the published data of other workers.

The blackbuck could be the best subject for intensive management. The population is widespread, often isolated, abundant in pockets and just holding its own elsewhere. The high reproductive capacity of the species enables it to respond effectively to protection. This is a blessing as well as a curse: in well protected areas the ever increasing population becomes a human interest conflict problem. Selective culling may be necessary and pragmatic. The dilemma is that if the total population is considered the species is still endangered; but in particular areas expanding populations are counterproductive to its conservation and require to be thinned.

A very useful and instructive monograph, recommended to all those interested in wildlife ecology.

J.C. DANIEL

PROCEEDINGS OF THE SYMPOSIUM ON ENDANGERED MARINE ANIMALS AND MARINE PARKS. Edited by E.G. Silas. Marine Biological Association of India, Cochin, 1988. pp. xli + 508 (25 x 18 cm), with many plates and illustrations. Price Rs. 500/-

Some 200,000 kinds of plants and animals are estimated to inhabit the world oceans. As these do not observe international boundaries and move freely, they are more uniformly distributed than the terrestrial species. People, therefore, tend to believe that the threat of extinction is less in these marine species. This is as wrong a notion as the naive belief that the volume of water in the seas and oceans being so huge, one can, with impunity, dump one's sewage and industrial wastes therein. It is fairly recently that people have woken up to the threat posed to many living marine resources from unscientific commercial exploitation and increasing damage to the marine habitat from human activities and other economic interests. The human population explosion, and the consequent need for increased food resources, coupled with 'development' of the coast and of new ocean resources, have led to an equally rapid growth of concern regarding overexploitation of our marine resources.

With a view to disseminating current knowledge and apprising institutions, both governmental and NGOs, of the need to do something about this grave situation, the Marine Biological Association of India organized this symposium in 1985. It is the sixth in a series of such symposia. (Earlier ones were on Scombroid fishes, Crustacea, Mollusca, Corals and coral reefs, and Coastal aquaculture.) It is up to the high standard that we have come to expect from the Association and succeeds very well in presenting the current status of this important range of subjects. A total of 60 papers delivered at the symposium form the basis of this text. These papers are grouped under four headings: Marine Mammals; Estuarine and marine reptiles; Other marine vertebrates and invertebrates; and Marine parks, sanctuaries, reserves, zoos and oceanariums.

There are 23 papers in the first category. The first paper, by John G. Frazier titled 'What is endangered?', though placed under 'marine mammals', is of a general nature and helps to answer the non-specialist's query on the definition of an endangered species. Eleven papers in the first category are concerned with whales. Even the wildlife enthusiasts among Indians are not conversant with this group, knowledge being generally restricted to cursory reports on occasional strandings of whales on our coasts which, being headlined in the newspapers, receive immediate but short-lived attention. It is not surprising, therefore, that the vast majority of papers on whales are by foreign scientists. In fact I was astonished to find four papers by India workers, until I browsed through them, to find that two of them were by non-residents based in U.S.A. and Brazil. While Silas *et al.* have done a good job of studying the food of a specimen of sperm whale stranded at Tranquebar, the remaining paper by a scientist from India is very sketchy, and appears to have been written solely for presenting at the symposium.

Of the five papers dealing with lesser Cetaceans, three are by Indian scientists. There are four papers on dugongs. Of these, the one by Silas and Fernando should make every Indian hang his head in shame, dealing, as it does, with the sordid tale of human avarice and utter callousness and impotence of the authorities that be, of a harmless creature with as much a right to life as any of us. It is not that the killing is done to fill an empty belly, or even to pit our skill against a dangerous beast like a tiger or a shark. The butchery of an innocent vegetarian, and the secrecy with which its flesh is shared would place the perpetrators of this heinous crime in a class with the worst of criminals, murderers and smugglers. And this happens in the land of *ahimsa!*

Of the 16 papers in the category of estuarine and marine reptiles, the vast majority are on turtles. The three dealing with captive rearing prove that we have come a long way in achieving succcess. The influence of incubation temperature on sex determination of turtles is also well brought out here. Kar gives an excellent picture of the present status of the highly endangered saltwater crocodile in Orissa, the only place, apart from the Sunderbans, on the Indian mainland where this reptile is found. Whitaker's paper is of a more general nature, but is notable for its coverage of the water monitor lizard.

The 14 papers under "Other marine vertebrates and invertebrates" cover a heterogenity of animals ranging from fiddler crabs and pearl oysters to hemichordates and sea-eagles. Some of the papers at the end of this category cannot be strictly included under "endangered". For example, Reza's paper deals more with the effect of pollution due to an oil spill. James' paper, although excellent as a taxonomic review of 95 echinoderms from the Gulf of Mannar, loses its value when he tries to justify it by giving the isolated example of depletion of just one species. Again, Azariah and Pillai's coverage of a hemichordate deals with the toxic effects of its body extract on a polychaete worm – excellent as a physiology paper but included here only because the animal itself is 'protected'. The paper by Vodden and Thomas on cleaning oiled birds deserves species mention as it is written from the humane or animal welfare point of view.

Thirteen papers are grouped in the fourth category. While the establishment of a national park in the Gulf of Kutch and a proposed park in the Gulf of Mannar are fully justified, the proposal for one at Malvan-Vengurla appears to be far fetched, and more a result of vying with other states for a status symbol or showpiece. Such marine parks would be more attractive and effective at Andaman-Nicobar and Lakshadweep.

In view of the great spread of interest about marine life and conservation, these proceedings provide a refreshing approach to the problems attendant upon them. The nonspecialist, who desires to find ready access to facts and figures, can gain some understanding about the subject material of present concern to conservationists, even though some of the papers may be difficult for him to understand. For the specialist, on the other hand, there is a considerable amount of material which he will find of interest, and useful summaries of the present state of knowledge. The shoddy proof–reading does not detract from the overall value.

B.F. CHHAPGAR

THE WEALTH OF INDIA, RAW MATERIALS. VOL. IA (Revised Edition). Edited by Shri Y.R. Chadha and 27 others. Publication and Information Directorate, CSIR, New Delhi, 1985. pp. lx + 54 (29 x 22 cm), 84 figures, 11 plates. Price: Rs. 200/ (Not indicated on the book).

This is the first volume of the revised second edition of Wealth of India series, which was started in 1948 and completed with eleven volumes in 1976. Since the publication of the first volume immediately after independence, there have been tremendous additions to the knowledge of natural resources of our country, which is reflected in the increase in the number of pages from 142 to 513 under the alphabet A in this volume. It was pointed out by reviewers of concluding volumes of the first edition that with the large time lag between the first and the final volume there was a tremendous difference in the amount, type and quality of information published, and it was high time that whole series was revised in the light of new information. This volume of revised series therefore serves a commonly felt need.

Although the series is supposed to furnish information about resources from the plant and animal kingdoms as well as the mineral wealth of India, more than 95% of

Name earlier used	Corrected name in this volume
Abutilon asiaticum G. Don	*Abutilon indicum* (L.) Sweet
Acacia arabica Willd.	*Acacia nilotica* Delile ssp. *indica* (Benth.) Brenan
Acacia concinna DC.	*Acacia sinuata* (Lour.) Merrill
Acacia caesia W. & A.	*Acacia torta* (Roxb.) Craib
Abroma Jacq.	*Ambroma* Linn. f.

the entries deal with plant resources only, which is evident from the fact that this first volume includes information on 198 genera of plants, with merely 6 entries about minerals. The old concluded series had information on 5000 plant species belonging to 1,730 genera, 48 animals and animal products and 74 minerals. In fact, while reviewing the first volume of the earlier series in *Blumea*, Dr. C.J.J. Van Steenis had rightly pointed out that 'Wealth of India' Raw Materials series was only the revision of 'Dictionary of Economic products of India' by Sir George Watt.

Instead of revising the entire work in the fashion presently undertaken, it would have been perhaps more appropriate and economical to supplement the earlier volumes, periodically updating the information. With the publication of this first volume of the revision, the old volumes are rendered out-dated and useless, and as a result the old series has already made its way to second-hand booksellers on the pavements of Bombay. In contrast, the data presented in the volumes of 'Dictionary of Economic Products of India' remains unrevised and the original volumes still retain their importance and value among book rarities.

The present revision is not only rich in information, but also corrects the nomenclature of many species in the light of present understanding, although it is not fully up-to-date. Some nomenclatural corrections from earlier series brought up-to-date in this volume are shown in the table above.

However, the name used in this volume *Adina cordifolia* (Roxb.) Hook.f. ex Brandis, is now corrected as *Haldinia cordifolia* (Roxb.) Ridsdale in recent taxonomic works.

The later volumes of the earlier series have been well received by experts from both India and abroad; the present volume also keeps up the tradition of good work, and deserves praise. I have no hesitation in saying that this series would be the best source of cumulative information on all aspects of our natural resources, particularly the vegetational wealth; it is recommended for research organisations, colleges, schools and also individual users.

M.R. ALMEIDA

MISCELLANEOUS NOTES

1. OVERLAPPING DISTRIBUTION OF CAPPED LANGUR *TRACHYPITHECUS PILEATA* AND PHAYRE'S LEAF MONKEY *T. PHAYREI*

(*With a text-figure*)

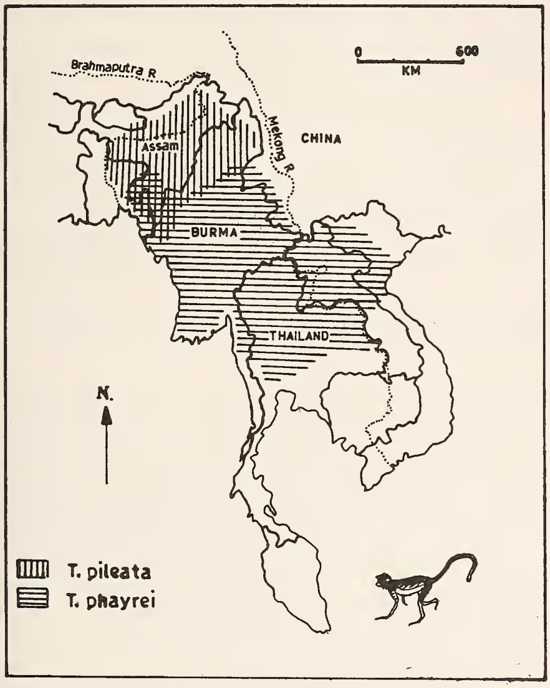


Fig.. 1. Distribution of capped langur and Phayre's leaf monkey. Note the zone of sympatric distribution.

The capped langur *Trachypithecus pileata* Blyth is the commonest of the leaf monkeys found in the forests of northeast India. Outside India it is found in Upper Burma and Bangladesh. In Bhutan, although it was an unrecorded species (Eudey 1987), I observed a group in the Manas Wildlife Sanctuary (eastern bank) on 20 October 1985. This 400 sq.km sanctuary in Bhutan is contiguous with the Manas Tiger Reserve in Assam.

Phayre's leaf monkey *T. phayrei* Blyth is the most extensively distributed leaf monkey of continental Southeast Asia (Fooden 1976). However, in India its range is a small one, covering parts of Assam (Cachar and Karimganj districts), Tripura and also perhaps Mizoram. It is also found in eastern Bangladesh.

The most interesting question in the distribution of these two neighbouring species of langurs is whether they are sympatric or allopatric. Fooden (1976) mentioned that capped langur is strictly allopatric with Phayre's leaf monkey. However, later surveys showed that in some areas these two are sympatric. In the forests of Cachar (south of Barak river) and Karimganj districts of Assam, I have found them sympatric (Choudhury 1989).

Moreover, I have also observed them resting together without any antagonistic behaviour towards each other. Once a group of capped langurs were seen chasing away a group of Phayre's leaf monkeys while the latter were busy feeding. The capped langurs then started feeding at the same spot (some even on the same *Ficus hispida* figs). The locality was Damchara, *c.* 1.5 km west of Nagorhgena (24°17' N, 92°30'E) in the Innerline reserve forest of Cachar. In Nagorhgena also both the species were found together.

In Tripura, and maybe both in Mizoram and eastern Bangladesh both the species could be sympatric. There is a possibility of a little overlap in the Chin Hill region of Burma. There are two specimens in the American Museum of Natural History, one each of capped langur and Phayre's leaf monkey. The capped langur specimen was collected from Mt. Victoria of Chin Hill (21°14'N, 93°55'E) and the Phayre's leaf monkey from Dudaw Taung of Magwe (21°05'N, 94°19'E, Fooden 1976).

August 30, 1989 ANWARUDDIN CHOUDHURY

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2. A HUNTING TECHNIQUE OF THE JUNGLE CAT *FELIS CHAUS*

Over the last few years, while working at Royal Chitwan National Park in Nepal and Bandhavgarh National Park in Madhya Pradesh, I have been able to observe, at close quarters, a number of stalks and hunts conducted by jungle cats *Felis chaus*, and have learnt something of the different methods they use.

One technique is what may be called the 'vertical assault'. This seems to be almost exclusively employed against prey lurking in small, dense thickets like a clump of dead bamboo, a bunch of high grass or a bush. When alerted by some sound or movement to the presence of a potential prey in such a place, the cat cautiously approaches the edge of the thicket and then sits, still and intent, until it spots its intended victim and identifies it. Once located, the cat gathers its hindquarters under it and launches itself high into the air, sometimes as much as a metre, to descend almost vertically upon its startled prey which is caught as it seeks to escape.

The advantage of this 'vertical assault' over other techniques seems to be that, apart from overcoming the barrier presented by dense vegetation, the very suddenness of the descent serves to startle and confuse the prey and flush it out of the thick cover, thus rendering it more vulnerable. Every time that I have actually seen the prey animal it has always been after the attack, never before.

Although I have seen several successful and unsuccessful attempts, I have got a clear look at the kill on only six occasions. They have all been small rodents barring one instance when I saw a common bustard quail *Turnix suscitator* escape from between a cat's paws.

August 4, 1989 HASHIM N. TYABJI

3. OCCURRENCE OF DOBSON'S LONG-TONGUED FRUIT BAT *EONYCTERIS SPELAEA* (DOBSON, 1971) (CHIROPTERA:PTEROPODIDAE) IN MEGHALAYA

The Dobson's long-tongued fruit bat *Eonycteris spelaea* (Dobson), although recorded from Kumaon, Uttar Pradesh (Bhat 1968), Andaman Islands (Bhattacharrya 1975), Darrang District, Assam (Ghose and Bhattacharya 1977); coastal Karnataka (Bhat *et al.* 1980) in India, has hitherto not been reported from the rest of the country (Blanford 1891, Andersen 1912, Ellerman and Morrison-Scott 1951, Tate 1947).

Recently, I obtained two females from the hills of northeast India (near La-ilad Forest Rest House, E. Khasi Hills, Meghalaya, alt. *c.* 350 m) on 17 May 1989 between 0300 and 0400 hrs in a mist-net set between plantains near cultivation. The smaller of the two females, a young adult, was pregnant and had two spots on the chest instead of teats. A single embryo (12 mm) was present in the right horn of the uterus. Both the females had projecting para - anal glands. Bhat *et al.* (1980) mentioned that it is polyestrous and breeds throughout the year.

One female from Siju cave (360 m), Garo Hills, Meghalaya, (S.W. Kemp & B.N. Chopra, Feb. 1922) present in the National Zoological collection of India at the Zoological Survey of India was also identified as *Eonycteris spelaea* (Dobson), by Shri P.K. Das, Scientist - 'SD', Zoological Survey of India, Calcutta, who has allowed me to report it in this paper.

Measurements (in mm): 2 (Khasi Hills) and 1 (Garo Hills): *External*: Head and body 92, 102, – ; tail 14, 15,– ; forearm 68, 70, 70.5; ear 18, 18, – ; tibia 28, 30,– ; foot and claw 16, 19, – ; wing span 370, 400, – ; *Skull*: Total length 34, 35.4, 35.5; zygomatic width 19, 20, – ; cranial width 14, 15, 14.9; cranial height 11.2; 12.2, – ; width of cranial rostrum 7, 7.6,– ; maxillary width ($m^1 - m^1$) 8.3, 9.2, 8.9; upper tooth row ($c - m^1$) 12, 13, 12.4; lower tooth row ($c - m_2$) 13, 13.5, 13.1; mandibular length 26, 27, 26.4.

Distribution: India, Burma, Thailand, Laos, Vietnam, Cambodia, Malaysia, Indonesia and the Phillipines.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India, and the Officer-in-Charge of this Regional Station for providing facilities for this work. My sincere thanks are also due to Shri P.K. Das, Scientist 'SD', Zoological Survey of India, Calcutta, for providing measurements of the Garo Hills specimen.

November 10, 1989 Y.P. SINHA

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4. OCCURRENCE OF *PIPISTRELLUS CAMORTAE* MILLER,1902 (CHIROPTERA :VESPERTILIONIDAE) IN THE ANDA MAN ISLANDS, WITH COMMENTS ON ITS TAXONOMIC STATUS

While examining the alcohol-preserved specimens of pipistrelline bats present in the National Zoological Collections of India at the Zoological Survey of India, Calcutta, I came across a specimen of *Pipistrellus* misidentified as *Miniopterus schreiberi*; locality: Andamans; donor: Major A.R. Anderson, I.M.S.; date of entry : 25-11-04. No other detail was available from the register. However, the specimen is a female. The specimen was finally identified as *Pipistrellus camortae* Miller, 1902.

Pipistrellus camortae was described by Miller (1902) from Kamorta (=Camorta) Island of the Middle Nicobar group of islands, Andaman and Nicobar Islands. Since then it has also been reported from Great Nicobar Island (Hill 1967) and Car Nicobar Island (Soota and Chaturvedi 1980). Additional specimens of this bat have been reported from Camorta Island, Great Nicobar Island and Car Nicobar Island by Hill (1967), Saha (1980), and Hill and Harrison (1987), respectively. Thus, *Pipistrellus camortae* is so far known only from the Nicobar group of islands. The present specimen, therefore, extends the distributional range of *Pipistrellus camortae* much northwards to the 'Andamans' (=Andaman Islands).

Though no precise locality is available for the specimen under discussion, its donor, Major A.R. Anderson, belonged to the Indian Medical Service, and was posted at Port Blair from where he sent some other species of bats as well to the Indian Museum, Calcutta. Thus, the place of origin of the present specimen is probably Port Blair (or some other place near it), South Andaman islands.

Miller (1902), while describing *Pipistrellus camortae*, compares it with the Javan *Pipistrellus abramus* (Temminck 1840) and remarks, *Pipistrellus camortae* appears to be a well-marked species related more closely to *P. abramus* than to any other'. Tate (1942) believed that the species may be a relatively unspecialised member of the *abramus* group. Following Tate, Ellerman and Morrison-Scott (1951) kept *Pipistrellus camortae* as a species under the *abramus* group. Hill (1967), in his account of the bats of the Andaman and Nicobar islands, however, considers *camortae* as a subspecies of *Pipistrellus javanicus* (Gray 1838). Soota and Chaturvedi (1980) have studied six specimens of *P. camortae* (from Car Nicobar Island), including the baculum of one specimen. They have also compared the data (forearm, upper cheek teeth row and baculum) available in literature with respect to *Pipistrellus abramus, P. camortae, P. javanicus* and *P. paterculus* Thomas, 1915, with their data on *P. camortae*, and have come to the conclusion that while the forearm and cheek teeth row of *P. camortae* show their affinity to *P. abramus, P. camortae* should be treated as a separate species on the basis of its baculum. In their comprehensive study of the bacula of pipistrelline bats in general, Hill and Harrison (1987) have provided diagrams of the bacula of *P. abramus, P. camortae, P. javanicus* and *P. paterculus*, and have considered *abramus, javanicus* and *paterculus* as distinct species, with *camortae* as a subspecies of *P. javanicus*.

Under the circumstances, a fresh review of the taxonomic status of *Pipistrellus camortae* Miller was thought necessary.

Agrawal and Sinha (1973) studied the baculum of a specimen of a pipistrelle from Indawagyi lake, Burma, which they identified as *Pipistrellus abramus paterculus* Thomas. They found the baculum of their specimen having the 'shaft doubly curved'. This study has formed the basis of Soota and Chaturvedi's (1980) statement that the baculum of *P. paterculus* also is doubly curved, like that of *P. abramus*, as has been stated by Thomas (1928). However, on the basis of the material (including the original material seen by Thomas) in the collections of the British Museum referred to *paterculus*, Hill and Harrison (1987) stated that this species has a relatively straight baculum. According to these authors, the specimen from Indawagyi lake, Burma, mentioned earlier, should perhaps be referred to *Pipistrellus abramus*.

When diagrams of the baculum of *Pipistrellus camortae, P. javanicus* and *P. peguensis* given by Sinha (1969), Agrawal and Sinha (1973), Soota and Chaturvedi (1980), and Hill and Harrison (1987) are compared, the baculum appears to be similar (more or less straight) in all three species. In details, however, the baculum of *P. camortae* differs equally from those of *P. javanicus* and *P.*

TABLE 1
EXTERNAL MEASUREMENTS OF *Pipistrellus camortae* MILLER, 1902

Authority & Locality	No. of specimens & Sex	Fa	Tl	E	Tr	Tb	F & Cl	Remarks
Miller (1902)	1 M	31.6	30.0	–	3.0	12.0	6.8	Holotype
* Camorta	1 F	32.0	32.0	–	4.0	11.6	6.6	Paratype
Hill (1967)	4 M	31.3–	–	–	–	–	–	Range of 4 specimens
*Great Nicobar	1 unsexed	32.7	–	–	–	–	–	(sex not mentioned, but probably all females)
Soota & Chaturvedi								
(1980)	1 M	32.0–	33.0–	10.0–	–	11.4–	6.0–	Range of 6 specimens
*Car Nicobar	5 F	34.0	36.0	12.0	–	13.8	8.0	
Saha (1980)								
Great Nicobar	2 F	31.0,	32.5,	10.0,	–	12.5,	–	Weight 4.5 gm each
		32.0	33.5	10.5	–	13.0	–	
Present report								
*Andaman Islands	1 F	32.4	–	10.3	5.2	12.0	7.3	Tail not measurable

*First reports

TABLE 2
CRANIAL MEASUREMENTS OF *Pipistrellus camortae* MILLER, 1902

Authority & Locality	No. & sex of specimens	*l*	*cb*	$c\text{-}m_3$	$c^1\text{-}c^1$	*iw*	*zw*	*cw*	*ml*	$c\text{-}m_3$	Remarks
Miller (1902)	1 M	12.6	12.0	5.0	–	3.6	9.0	–	10.0	5.0	Holotype
*Camorta											
Hill (1967)	3 (sex not	–	–	4.6	–	–	–				
*Great Nico-	mentioned			4.7,							
bar & Camorta				4.7							
Soota & Chatur-											
vedi (1980)	1 M, 5 F	12.7–	12.3–	4.7–	4.2–	3.9–	8.4	6.5–	9.8–	5.0–	Zygomatic
* Car Nicobar		13.0	12.5	5.0	4.6	4.0		6.8	10.0	5.1	width of 1 specimen only
Present report	1 F	12.8	12.4	4.8	4.7	3.7	–	7.1	9.8	5.0	
*Andaman Islands											

*First reports

peguensis. Further, the baculum of only two specimens of *P. camortae* have been studied so far. This, of course, is not sufficient to establish the range of variation in the structure and dimensions of the baculum.

It would, therefore, appear that there is no justification for considering *camortae* as a subspecies of *Pipistrellus javanicus*. On the basis of data available so far, the best course would be to treat *P. javanicus*, *P. camortae* and *P. peguensis* as closely related species. In fact, Hill and Harisson (1987) have already made a move in that direction by placing *P. paterculus* and *P. peguensis* just after *P. javanicus*, in that order, under *Javanicus* subgroup of *Pipistrellus* group, in the classification of the Vespertilioninae proposed by them.

External and cranial measurements of the specimen of *Pipistrellus camortae* from the Andaman Islands together with those of this species available in literature are appended in Tables 1 and 2 respectively.

August 8, 1989 P.K. DAS

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5. FIVE-STRIPED SQUIRREL *FUNAMBULUS PENNANTI* (WROUGHTON) KILLING BIRDS

The five-striped squirrel *Funambulus pennanti* (Wroughton) usually feeds on fruits, nuts, young shoots, buds and bark. They visit flowering trees to lap nectar and also feed on seed pods. Insects are taken whenever they are come across, and occasionally the eggs of birds form a part of their diet. Prater (THE BOOK OF INDIAN ANIMALS) brands them as persistent nest robbers.

I have observed five-striped squirrels capture, kill and eat birds in the Luni village, district Jodhpur, Rajasthan. On 25 July 1989, I saw a female squirrel capture a redvented bulbul *Pycnonotus cafer* by its tarsus while the bird was feeding on the ground. The bulbul struggled, but was soon subdued. The squirrel clambered up a *neem* tree with the victim, placed it on a branch and began feeding from the ventral side. Having taken some bits, the squirrel left its prey and scampered away.

On 29th July and 12th August, I came across two more such instances. In the first a whitecheeked bulbul *Pycnonotus leucogenys* was the victim, and on the latter occasion it was a house sparrow *Passer domesticus*. In both these instances the bird was not eaten.

In all the three instances, the squirrels involved were females.

September 14, 1989 JUGALKISHORE TIWARI

6. HERONRIES IN RAIGAD DISTRICT, MAHARASHTRA— A PRELIMINARY SURVEY

A survey of the avifauna of Raigad district of Maharashtra was undertaken during the rainy season in July 1987. This district is situated in the western part of Maharashtra (18° 19' N, 70° to 73°35'E). The annual rainfall of the district is between 2600 mm and 3600 mm. The main agricultural crops are rice and ragi.

During the survey, a number of heronries and breeding populations of the pond heron *Ardeola grayii* (Sykes), cattle egret *Bubulcus ibis* (Linnaeus), little egret *Egretta garzetta* (Linnaeus) and median egret *Egretta intermedia* (Wagler) were noticed in different places (Table 1). According to the system of classification of heronries described by Singh and Sodhi (1985), the heronries in Raigad district can be classified as follows. All the heronries were very close to human settlement and hence they are 'associated' type of heronries. The nesting of egrets

TABLE 1
NUMBER OF NESTS OF BREEDING HERONS AND EGRETS AT DIFFERENT LOCATIONS IN RAIGAD DISTRICT

Location of heronry		Number of nests				
town/village	taluka	pond heron	cattle egret	little egret	median egret	Total
Panvel town	Panvel	35	42	60	12	149
Shirdhon village	–do–	36	35	6	–	77
Palaspa village	–do–	10	8	18	–	36
Apta village	–do–	12	18	14	2	46
Karjat town	Karjat	–	10	14	4	28
Neral	–do–	–	20	33	4	57
Uran town	Uran	–	11	12	15	38
Pen town	Pen	6	12	–	3	21
Shaha baj village	Alibag	7	100	25	–	132
Roha town	Roha	44	32	10	5	91
Kolad village	–do–	37	4	23	–	64
Nagothana village	–do–	5	38	22	–	65
Mangaon town	Mangaon	6	4	2	–	12

and herons was observed mainly on trees such as tamarind *Tamarindus indica* Linnaeus, mango *Mangifera indica* Linnaeus and some *Ficus* sp. and hence they are 'tree' type of heronries. All the observed heronries were of 'loose' type, except at Kolad and Nagothana village, where they were 'compact' heronries.These were 'mixed' heronries, either on a single tree or on scattered trees in a small area. All these heronries seem to be small or medium-sized.

At most of the heronries, either construction of nest and/or incubation of eggs was in progress, whereas at a few heronries there were nestlings. Besides the breeding birds at the nest, a number of egrets and herons were feeding in the paddy fields in the immediate vicinity of the heronries.

At Roha town, two pairs of little cormorant *Phalacrocorax niger* (Vieillot) were found to be nesting very close to the breeding colony of cattle egret.

The egrets and herons occur in large numbers in Panvel, Karjat, Uran, Alibag, Pen and Roha talukas of the district, whereas hardly any heronries were observed in the southern part of the district, consisting of Mangaon, Shrivardhan, Mhasla, Mahad and Poladpur talukas.

I am thankful to the Officer-in-charge, Zoological Survey of India, Western Regional Station, Pune, for providing necessary facilities.

June 29, 1988 ANIL MAHABAL

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7. FEEDING ASSOCIATION BETWEEN JACKAL *CANIS AUREUS* (LINNAEUS) AND TWO SPECIES OF EGRETS AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

The feeding associations between African birds and mammals have been discussed in detail by Dean and MacDonald (1981). They described both commensalistic and mutualistic feeding associations. In the commensalistic type of association, the birds mostly followed the mammals for their food as the mammals' movement or presence provided them some sort of 'beating effect' to flush their prey. In the mutualistic associations described, in which both were benefited, the birds directed the mammals to the source of food.

On field duty on 5 May 1988 at 0625 hrs in the Muniappan Lake area of the Point Calimere Wildlife Sanctuary, Tamil Nadu, I saw a jackal *Canis aureus* feeding along with some waterbirds in the lake. The water was restricted to a pool in the middle of the lake, with a depth of *c.* 25 cm. There were about 25 large egrets, 40 little egrets, 22 pond herons and 40 brownheaded gulls feeding together in the water. Moreover, two whitebreasted kingfishers and five house crows were seen perched on the power lines. Apart from these, three whiskered terns and three brahminy kites were seen hovering. Among these birds, the jackal was in the middle, encircled by the egrets which formed a 'Vigilance circle'. As it was quite unusual to see a jackal among the birds. I approached close to the spot, hid, myself behind a nearby bush and started observing their feeding behaviour. Though the jackal was very close to the birds they were neither afraid nor did they fly off. They were feeding complacently along with the jackal. The jackal every now and then plunged its head into the water, grabbed the fishes (*Tilapia mossampica*) and ate them. Whenever it got a bigger fish it took it to the land, held it between its paws and tore it to pieces, ate it, and went back into the water for more fish. As and when the jackal fished the egrets were alert and they also started picking up fish from the periphery of the jackal's action. Obviously, the jackal's every fishing attempt formed a 'beating effect' that enabled egrets to get more fish. The tail of the jackal was raised while it was feeding in the water. Around 0655 hrs another jackal came to the site. This time also the birds made no attempt to fly away, but moved back a little, making a wider circle large enough to accommodate both the jackals. The second jackal entered the water, smelt the back of the first jackal and it also started fishing in the same way. Every time a jackal took a big fish to the land to devour, the left-overs were successfully picked up by the house crows (commensalistic feeding association). But most of the time the jackals ate the prey in the water. The hovering brahminy kites and whiskered terns were also seen fishing frequently. At 0745 hrs one of the jackals with its stomach full came out of the water and stood at the water edge. Shortly thereafter the other jackal came out of the water, and both moved into the jungle. Subsequently on 6 June (one jackal between 0630 hrs and 0750 hrs), on 7 June (two jackals between 0720 to 0740 hrs) in similar feeding associations were observed at the same site.

Schaller (1967) recorded the presence of scales of minnow-like fishes in the droppings of the jackal, but was not certain whether the fishes were caught or scavenged. The observations of the fishing behaviour of jackals at

Point Calimere confirms their ability to fish whenever conditions are suitable. Even though the jackals are predators of birds (Schaller 1967, and Prater 1980) it is interesting to note that in spite of their close proximity to the birds like egrets, herons and gulls they ignored them. Instead there existed a feeding relationship between them in which both were benefited in getting food, hence a mutualistic association. At Point Calimere Sanctuary during the rainy season many of the low lying areas inside the forest go under water in which the bigger waterbirds like egrets and storks feed in flocks. Hence it may have helped the jackals to learn this technique of fishing in association with waterbirds. Further study on the feeding ecology of the jackal would reveal more interesting results.

July 9, 1988 P. BALASUBRAMANIAN

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8. BREEDING OF EGRETS IN KERALA

According to Salim Ali in THE BIRDS OF KERALA (1969), breeding of the large egret (*Ardea alba*), the median egret *Egretta intermedia*, and the little egret *Egretta garzetta* has not been recorded in Kerala. Prof. K.K. Neelakantan later reported the breeding of the little egret in Kanyakulangara, near Trivandrum. (See 'Keralathile Pakshikal', (Malayalam), Kerala Sahitya Academy, 1986). I have, in August-September, 1987, seen both the median egret and the large egret nesting, in the company of the little egret and some other birds, in Nooranad in Alleppey district, and in Panamaram in Wynad district.

Nooranad is a small town, 15 kms. south of Kayamkulam. 32 big trees standing in some office premises on the Kayamkulam - Punalur road had been colonised by the birds. A large majority of the nests–about 2,500–belonged to the little cormorant *Phalacrocorax niger*, and the night heron *Nycticorax nycticorax*, which were also rare breeders in Kerala. Among them were more than a hundred nests of little egrets, and a few dozen nests of median egrets and large egrets. On 5 September, I got the opportunity to observe very closely and photograph one occupied nest each of the median and the large egrets. There were half-grown nestlings in both the nests and one of the parent birds was sitting in each nest. Local people said that the heronry in Nooranad was 7 years old. Unlike in other parts of Kerala, the people of Nooranad guard the breeding birds from poachers and egg-pickers.

At Panamaram, in north Kerala, the heronry was established on a few bamboo clumps on the banks of the Panamaram river, a tributary of the Kabani. There were about 50 nests of Little egrets and 4-5 nests of little cormorants. By the time I discovered the heronry on 2 September, most of the fledgelings had left their nests and were perched on bamboos or on branches of on a big tree standing nearby. But, luckily, I could observe one nest of the large egret with two full grown nestlings, and two nests of the median with one nestling each. These chicks were being fed by their parents.

During the nesting season of 1985 (July-September), I saw three nests of large egrets on a tree standing in the busy bus stand at Meenangadi, also in Wynad district. Pond herons *Ardeola grayii* nest regularly in large numbers on a few Indian coral trees around Meenangadi town. But the large egret did not return to nest in Meenangadi during 1986 or 1987.

Thus, the breeding of the median and the large egrets is not altogether absent in Kerala, and the nesting of the little egret is not as rare as it was thought to be.

April 12, 1988 P.K. UTHAMAN

9. WEIGHT OF WHITENECKED STORK *CICONIA EPISCOPUS*

On 11 December 1985, while carrying out ecological studies at Tezpur in Assam we received a fresh dead specimen of the white necked stork. The bird measured as follows:

Wing 470 mm, Bill 182 mm, Tarsus 190 mm, Tail 210 mm. It was an adult male.

The weight of the bird was 2,185 gms. The stomach was empty. There is no known record of the weight of the bird in the available literature.

October 7, 1988 PRAKASH RAO
S. MURALIDHARAN

10. AGGRESSIVE BEHAVIOUR OF BLACKNECKED STORKS TOWARDS CRANES

During our visit to Bharatpur Bird Sanctuary, Rajasthan, in the last week of December 1986, we saw aggressive behaviour of the blacknecked stork *Ephippiorhynchus asiaticus* towards the Siberian cranes *Grus leucogeranus* and Sarus cranes *Grus antigone* in particular and other large waterbirds in general. A pair of blacknecked stork approached all big birds and if they did not move off immediately, started hustling them. While the Siberian cranes immediately moved away, the Sarus cranes resisted. The storks then displayed and started moving slowly towards the cranes. The Sarus cranes did challenge by calling out a few times and also displayed, but eventually retreated and flew off. However, one of the three pairs of sarus did not yield to the threat behaviour of the storks for quite some time, but eventually flew upwards. The storks chased the pair and even succeeded in pecking and plucking off feathers from one of the cranes' back. With that ended the resistance from all the birds. The storks, after flying around other roosting or feeding birds and making them take to flight, settled down and started displaying again.

D.P. BANNERJEE
S.P. BAVDEKAR
May 15, 1987 V.K. PARALKAR

11. STATUS OF GREYLAG GOOSE *ANSER ANSER* IN GUJARAT : A RE-EVALUATION

(*With a text-figure*)

Introduction

The eastern greylag goose *Anser anser rubrirostris* Swinhoe is a palaearctic species wintering from the Mediterranean countries to China. It is abundant during winter in the northeastern states of India but, it becomes rare in Madhya Pradesh and is absent in states further south (Ripley 1982). It has been reported to occur in a small numbers in north Gujarat (Ali and Ripley 1983). Its occurrence in Gujarat, particularly from Kutch, comes from an early publication of Palin (1904) and a report by Vijayrajji in 1930 (Ali 1954). Though Ali (1954) himself never came across this species in Gujarat during his surveys in 1944-45, he has reported that Aldrich had recorded them near Pariej and Chittersumba of Kheda district during the winters of 1931-32 and 1939 respectively. Since then, there is no report of its occurrence from Gujarat, which apparently led Ali and Ripley (1983) to consider it as a rare visitor to the state. Only recently Parasharya *et al.* (1986) reported sighting of more than 100 geese from Kheda district and opined that the geese might be visiting their preferred habitat in Gujarat, but that such habitats may not have been surveyed by ornithologists. Here, we report recent sightings of the greylag goose *Anser anser* from different parts of Gujarat state and discuss its present status.

Methods

After the first accidental sighting of the geese (Parasharya *et al.* 1986), we carefully checked major reservoirs of Kheda district during winter months from 1984-85 to 1987-88. Other sightings outside Kheda were recorded during casual birdwatching trips to the respective reservoirs. Census data of first and second Asian waterfowl census from Gujarat state were referred to confirm the bird's status in other parts of the state where personal confirmation was not possible. A few birdwatchers were also contacted to learn about recent sightings of the bird in their areas.

Results

The number of greylag geese sighted from November 1984 to January 1988 at different places in six districts of Gujarat is given in Table 1. The largest flock (401) observed was at Wadhawana of Baroda district by Nitin Pandya (pers. comm.). Such a big flock was not reported from

Table 1
RECENT SIGHTINGS OF THE GREYLAG GOOSE IN GUJARAT

District	Place	Date	No. of geese
Ahmedabad	Nalsarovar	23 Nov. 1984	20
Baroda	Wadhawana[1]	Jan. 1988	401
Kheda	Dakor	24 Dec. 1985	100 +
	Goblaj	14 Jan. 1986	20
	Pij	18 Nov. 1986	60
	Pariej	20 Nov. 1986	157
		16 Jan. 1987	56
	Kanewal	17 Nov. 1987	23
		16 Jan. 1988	78
	Narda	20 Nov. 1986	5
		25 Dec. 1987	45
		26 Jan. 1988	12
	Anand	19 Jan. 1988	11
Mehsana	Thol	21 Dec. 1985	104
Sabarkantha	Idar	5 Dec. 1986	2
Surendranagar	Muli[2]	Jan. 1987	7

[1]Recorded by Nitin Pandya, [2] Recorded by Narendrasinh Zala

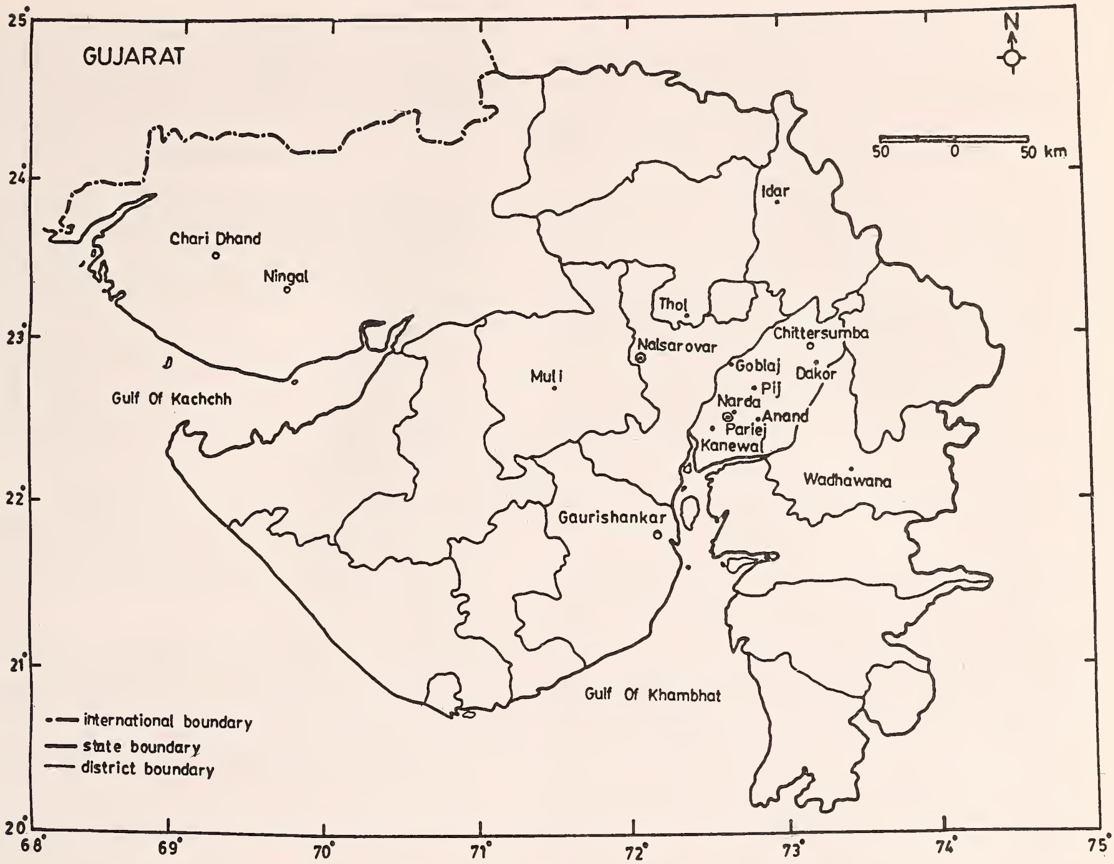

Fig. 1 Map of Gujarat showing locations where the greylag goose was recorded. Closed circles represent locations of present sightings, open circles show sites of old pulished records.

elsewhere. However, a large number (100 +) of the geese were found wintering in Ahmedabad and Kheda districts also. it was seen only in fewer numbers in Sabarkantha and Surendranagar districts. Although the size of the flock observed at the reservoirs of Kheda district varied each year, the data indicated that they regularly visited the well irrigated parts of the state in winter. All the places where the goose has been sighted in Gujarat are mapped in Fig. 1.

Discussion

The greylag goose was regularly captured and brought to the Ahmedbad Municipal Zoo by the trappers from Nalsarovar region (Babubhai, pers. comm.). Enquiries with the trappers confirmed that the geese visit the area regularly. The present review confirms that the geese visit intensively irrigated areas of Ahmedabad, Baroda and Kheda districts, where the river canal system for irrigation is well established since long. An irrigated agroecosystem seems to be a preferred habitat of the wintering geese. It seems possible that the geese would winter in the other parts of Gujarat mainland where extensive irrigation facilities through canals from perennial rivers exist.

The geese are seen rarely in lesser numbers in Saurashtra and Kutch. The species is not included in the checklist of birds of Saurashtra by Dharmakumarsinhji (1955). Only once, two birds were seen at Gaurishankar lake at Bhavnagar in the early seventies (Shivabhadrasinhji, Pers. comm.). Although two of us (B.M.P. & L.R.) spent several years in Saurashtra and Kutch, we never came across this species. Several other birdwatchers of the region also substantiate this; the only exception is a record from Muli (Narendrasinh Zala, pers. comm.), where 7 geese were seen in January 1987. All these observations indicate that the geese avoid the semi-arid regions of the state —Saurashtra and Kutch.

It is difficult to say whether the presence of geese in large numbers in the central part of Gujarat mainland is the recent phenomenon. It must be taken into consideration that the number of resident ornithologists in Gujarat mainland was negligible and the rarity of sight records for the goose in earlier years may be a reflection of this. The presence of geese at a reservoir is subject to wide diurnal fluctuation in winter, so that their presence, when in small numbers, in a region would be recorded only under intensive birdwatching. On the other hand, it is also possible that the frequency of the goose in Gujarat may have actually increased in recent years. Reports from Europe reveal that the population of the greylag goose has increased in recent years (Owen 1980, Karel and Pallantova 1985). An increase in the population density of the bird would make its presence more prominent in our fields. Such a situation would also force the geese to invade and exploit newer areas within their wintering grounds and thereby increase the frequency of site records.

Acknowledgements

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B.M. PARASHARYA
J.F. DODIA
K.L. MATHEW
November 1, 1988 LALSINH RAOL

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12. BLACKWINGED KITE *ELANUS CAERULEUS VOCIFERUS* (LATHAM) AT 3650 M IN SIKKIM

On 7 May 1987, while we were on our way to the high altitude lake Menmoitso (3450 m) in east Sikkim to collect botanical specimens, we halted at Sherathang (3650 m) to get a better look at a pigeon–sized bright white bird of prey with black wingtips, hovering ahead of our jeep. It was perfectly at home in the open snowcovered landscape where the only visible vegetation was small tufts of soggy primulas under drippy rock overhangs. The time was 1000 hrs and the weather was quite sunny. A good look at its typical wing–upraised 'stationary hovering' followed by a couple of hesitant 'parachute descents' of a few metres (after which it flew off to rest on a rocky slope) confirmed it to be blackwinged kite *Elanus caeruleus*. After resting for a few moments, it took flight at the noise of our jeep as we moved ahead and flew out of sight.

This bird is not mentioned in BIRDS OF SIKKIM (1962) by Salim Ali. The compact edition of HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (1983) by Ali and Ripley states that it occurs "from the Himalayan foothills (from *c.* 1600 m) and *terai*, south to Kanyakumari; upto *c.* 1200 m in the peninsular hills. Nepal, chiefly *terai* and lowlands but recorded at *c.* 1370 m. (Biswas)."

Hence the above sighting proves not only a status record but also an altitude record.

March 24, 1988 USHA GANGULI–LACHUNGPA

13. INTERACTION OF HONEY BUZZARD *PERNIS PTILORHYNCUS* WITH FANTAIL FLYCATCHER *RHIPIDURA ALBICOLLIS* AND REDWATTLED LAPWING *VANELLUS INDICUS*

On 9 June 1988 at around 1700 hrs. I was at the bund built the previous year beyond Milak Talai in Ranthambhore National Park, Rajasthan. On both sides of the bund there is a small quantity of water among the rocks in spite of the unprecedented drought conditions this year. As our jeep approached the bund a honey buzzard flew off a tree parallel to the vehicle and settled with its back towards us on a branch of *kadam* tree beyond the water.

On a nearby branch of the same tree was a fantail flycatcher. It was disturbed by the honey buzzard and attacked it vigorously by striking it on its back in three successive swoops. Surprisingly, this had no effect at all on the bigger bird. The fantail flycatcher became even more aggressive; it sat on the honey buzzard's back and pecked away with its beak vigorously. This, too, did not evoke any response and the fantail flycatcher flew off. It repeated the manoeuvre twice in quick succession before it gave up, as all the while the honey buzzard paid no attention whatsoever to its tormentor.

While the fantail flycatcher remained agitated on the nearby branch, the honey buzzard turned around to face our jeep and the water. There was a redwattled lapwing with one fledgeling on the water's edge. The honey buzzard swooped down from the tree towards them. The mother took off and intercepted the honey buzzard in mid–air and deflected its flight. The latter returned to its perch on the same *kadam* tree. In a few moments it repeated the swoop to meet with the same response from the lapwing. This time the honey buzzard flew off to settle on a tree a considerable distance away. I then moved on.

Lapwings are well known for being extremely aggressive and will attack anything if they feel threatened. On one instance in 1985, I observed a lapwing attacking a tigress twice on the edge of Padam Talao in this very park because the latter had decided to settle too close to the former's fledgelings. As such, its behaviour towards the honey buzzard cannot be considered unexpected or particularly unusual. However, the repeated attacks of a fantail flycatcher are a different matter altogether, particularly when, as in this case, it had no apparent reason to be so agressive, apart from the fact that the honey buzzard had settled too close to its own favoured perch.

I visited the bund successively on 10, 11 and 12 of June. The honey buzzard was not noticed, though I was informed by the forest department staff that one was usually to be found in the vicinity of the bund. Nor was fantail flycatcher seen. The lapwing with its fledgeling was, of course, very much present.

June 25, 1988 DIVYABHANUSINH

14. ROOSTING AND FEEDING OF HARRIERS IN SECUNDERABAD, ANDHRA PRADESH

In November 1986 and October 1987 observations were made on the feeding and roosting habits of some harriers in a protected grassland area *c.* 1 sq.km in Secunderabad (17°27'N, 78°28'E) almost 10 km NNE of Hyderabad. Feeding habits of three harriers (*Circus* spp.) were studied in the winters of both 1986 and 1987, but roosting only in 1987.

Montagu's (*C. pygargus*), pale (*C. macrourus*) and marsh (*C. aeruginosus*) harriers fed along with pariah kites and kestrels on insects, chiefly grasshoppers. Most of the time from daybreak to sundown the harriers flew low over the grassland area, dipping every now and then, catching grasshoppers perched on some raised hard surface, and fed on them as fast as they could. Some of the larger grasshoppers eaten by harriers and kites in the study area included the long–horned ones like *Mecopoda elongata* and *Conocephalus indicus* as well as short–horned ones like *Demodocus* and *Cyrtacanthacris* species. Kestrels, kites and harriers also fed on medium–sized grasshoppers like *Gastrimargus*, *Hieroglyphus* and *Acrida* species.

Several other birds like crows, mynas and egrets also feed on medium and large sized grasshoppers. But what attracted us in harriers, especially the Pale and Montagu's is the way they catch and feed on them. They are specialists at the job – very agile in catching a grasshopper, cutting it open and skillfully removing the alimentary canal, legs (except the trochanter and femur portions), as well as wings, and swallowing the rest of the body. Pariah kites, kestrels and marsh harriers were seemingly rather slow and lacked in neat execution. Very often these birds left out only the horny portion of the legs (tibia) and tarsus, that too of the mid and hindlegs. Cattle egrets are known to swallow the full insect. About sixty grasshoppers (most of them intact) were once got from the stomach of a cattle egret, the carcass of which was obtained from the Bombay airport.

All the harriers of the area roosted on the ground among tall grass. The study area had tall grass (*c.* 120 cm), short grass (*c.* 60 cm) and bare patches. At dusk these birds settled among the tall grasses away from the fence and compound wall of the protected area, possibly to avoid areas of human activity.

Four Montagu's and four pale harriers roosted in twos, interspersed by a marsh harrier almost three metres apart. Observations made elsewhere show that marsh harriers as a rule roost in short grass or on bare ground. Some of the common grasses in the roosting area are *Heteropogon contortus*, *Cymbopogon martinii*, *Chrysopogon fulvus*, *Dichanthium annulatum*, *Dichanthium caricosum*, *Eragrostis tenella*, *Eragrostis bifaria*, *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Panicum antidotale*, *Paspallidum geniculatum* and *Digitaria ciliaris*. Some of the sedges in the study area are *Cyperus iria* and *Kyllinga colorata*. The tall grasses probably afforded the protection the harriers needed from natural enemies.

S.M. SATHEESAN
September 1, 1989 PRAKASH RAO

15. JUNGLE CAT *FELIS CHAUS* AND GREY JUNGLEFOWL *GALLUS SONNERATII*

Ladan lies in the hilly tract about 125 km west of Udaipur in Rajasthan. On 2 June 1988, at about 0830 hrs we were crossing a ravine in Ladan forest, when we came across a group of four grey junglefowl, consisting of a cock and three hens, feeding about 90 m away. Taking advantage of the bushes in between us and the bunds, we reduced this distance to about 55 m without disturbing them.

The birds were feeding, gradually moving away from us. Suddenly they stopped feeding and looked intently towards a bush about 20 m away from them on slightly raised ground. The cock, which was in the rear, advanced and stopped just ahead of the group.

We scanned the area with binoculars and saw a jungle cat *Felis chaus* crouching in the bush. Its entire body except the head was concealed by a low bush and it was slowly moving its head in a clockwise direction. In doing so it was also stirring some of the leaves of the bush.

The cock became curious and advanced a few steps towards the bush; the other birds followed suit. In this fashion, slowly, the birds reached within 4 to 5 metres of the bush. The cat stopped its head movement and darted towards them. Before the birds realized the danger it had landed on one of the hens. The other birds scattered and flew away in different directions. Within seconds the cat disappeared into the bushes with its prey.

RAZA TEHSIN
September 17, 1988 FATEMA TEHSIN

16. HOVER–FLY *ERISTALIS* SP. AMONG THE STOMACH CONTENTS OF GULLBILLED TERN *GELOCHELIDON NILOTICA* (GMELIN)

The carcass of a juvenile male gullbilled tern *Gelochelidon nilotica* (Gmelin) was collected from Santacruz at Bombay on 24 August 1982. This bird had in its stomach three cockroaches *Periplanetta americana*. Two fishes, one freshwater species *Puntius sophore* and the other marine *Pseudosciaena sina*, two chelicerae of a small-sized crab as well as pupae (1.5 cm long body and 3 cm long stigmata) of a hover–fly *Eristalis* sp. Larvae of the genus *Eristalis* and some others live in water or submerged in filth and have their breathing stigmata at the end of very long, extensible tubes so as to reach the surface while the animal is feeding.

During the monsoon of 1982 a small flock of 12–15 gullbilled terns were flying over ponds and puddles in Santacruz area several times for two days. On 23 August 1982, some of these terns were dipping into these shallow water bodies, possibly to swoop on the larvae, pupae or adults of some insects such as those found in the stomach of the tern reported above.

September 17, 1988 S.M. SATHEESAN

17. BREEDING OF THE RIVER TERN *STERNA AURANTIA* IN KERALA

Salim Ali did not include the river tern *Sterna aurantia* in his BIRDS OF KERALA (1969) as he did not come across it anywhere during his survey of Travancore and Cochin. But from 1944 to 1951 when I used to spend a couple of weeks every September and December, and 2 to 3 months between April and July, at Kavassery (Palghat Dist., Kerala), I often came across this tern in the Gayatri river. It was recorded in almost every month between April and December. In some years the blackbellied tern was also seen. The first published record of these two terns from Kerala is that of Dr. A.J. Gaston (*J. Kerala Nat. Hist. Soc. 1979, p. 28*) who found them in 1978 near Cheruthuruthi in the Bharatpuzha river. However, the breeding of the river tern has not so far been reported from Kerala.

On 16 February 1987, on a small, low, circular islet close to the dam at the Malampuzha reservoir *c.* 15 km north of Palghat town, a number of river terns and small swallow–plovers *Glareola lactea* were flying about and calling constantly. The terns were chasing and harassing every crow and brahminy kite that ventured near the islet. A closer look showed that about a dozen river terns were squatting in the middle of the islet with a larger number of pratincoles sitting around them. The way the terns sat at the centre of the islat, each bird at the same distance from the nearest ones and the tireless, noisy, persistent pursuit of crows and kites reminded me of the various occasions when in the 1940s, I had watched river terns and swallow–plovers nesting on the islands in the Godavari at Rajahmundry. However, owing to the distance, the glare, and the fact that all the terns on the island were probably incubating, we were not able to see eggs or nestlings, which alone would have been positive proof of their nesting.

In the hope of obtaining firm evidence of the breeding of these birds, I went again to Malampuzha on 2 March 1987 with Namassivayan and P.K. Uthaman. But, owing most probably to the intrusion of some persons into the islet, all the birds had deserted the place.

In May 1988 river terns in ones and twos were seen occasionally fishing in a tank and a river close to my home at Kavassery and flying off to the south whenever they had secured a small fish. As the only reservoir in that direction was that of the Mangalam Dam (*c.* 11 km south of Kavassery), I went to the reservoir on 1 June with Mohanan Vandali. On a island close to the shore we found six river terns and some 25 small swallow–plovers, which showed great agitation when we waded to the island. On the island we came across a number of half–shells and at one spot a large quantity of crushed fragments of the terns' eggs. The dessicated carcass of a juvenile was also found. Our attention was then caught by some large splotches of white faecal matter, and as we walked towards it the terns displayed intense agitation. These splotches were at the edge of a circular patch of thick grass and shrubs that capped the flat top of the island. Searching in the dense vegetation, Mohanan spotted a juvenile tern lying close to a heap of boulders. It was about seven inches long. It had so pressed itself into a shallow depression that its back and wings looked absolutely flat. The growing primaries and the short tail were pale grey, the wing coverts buff with subterminal blackish chevrons. The bill was dull ochre–yellow.

We left the place as quickly as possible in order to save the birds further anxiety. We found no evidence of the breeding of the pratincoles on that island, but, as all of them had flown to a much larger island a kilometre away over which some terns were flying, we thought that the pratincoles could have been nesting there along with some terns.

This, to the best of my knowledge, is the first record of the breeding of the river tern in Kerala. I am grateful to Mr Jamal of Mudappallur for arranging this trip to the Mangalam dam.

June 21, 1988 K.K. NEELAKANTAN

18. BEHAVIOUR OF SOUTHERN SPOTTED OWLET *ATHENE BRAMA BRAMA* (TEMMINCK) AND JUNGLE CROW (TEMMINCK) AND JUNGLE CROW *CORVUSMACRORHYNCHOS* AT POINT CALIMERE, TAMIL NADU

On 10 June 1988 at 1210 hrs I heard the distress call of a whitebreasted kingfisher *Halcyon smyrnonsis* near the fence of our office campus at the Point Calimere Wildlife Sanctuary, Tamil Nadu. I went in the direction of the call and noticed a jungle crow *Corvus macrorhynchos* perching on a *Thespesia populnea* tree holding a whitebreasted kingfisher in its bill. The kingfisher continued calling and with its flapping wings tried to extricate itself from the predator's clutches. The call of the kingfisher was high pitched; I saw one of the three spotted owlets *Athene brama* perched on a nearby *Madhuca longifolia* tree, fly at the jungle crow and its prey. When the spotted owlet flew close to the jungle crow, it dropped the kingfisher to the ground and changed its perch. The spotted owlet then returned to its earlier perch. The wounded kingfisher was still alive and was slowly crawling towards cover at the base of the *Thespesia* tree, but the crow caught the kigfisher again and perched in the same tree. Once again the spotted owlet flew at the crow, which dropped its prey immediately. The owlet again returned to its earlier perch. When the owlet left, the crow picked up the prey and perched on the same tree. It was joined by another jungle crow and the crows complacently started pecking and tearing at the prey though the kingfisher was calling in distress. This time, the spotted owlet made no attempt to mob the crow, probably being frightened by the presence of the second crow.

It is clear that the attempts by the owlet to mob the crow were a reaction to the distress call of the kingfisher rather than an effort to grab the prey. Probably, as the spotted owlet was with its family, the distress call of the kingfisher might have motivated a defence reaction. On both the occasions when the kingfisher was dropped to the ground, the owlet made no attempt to go near it.

July 5, 1988 P. BALASUBRAMANIAN

19. BIRD–AIRCRAFT COLLISION AT AN ALTITUDE OF 2424 M OVER THE SEA

According to reports from the Indian naval authorities in INS Virat, at about 2100 hours on 10 October 1987, an aircraft cruising 30 nm west of Dabolim (Goa) over the Arabian Sea at a speed of 400 knots and altitude of 2424 m was hit by a medium– sized bird. After detailed macroscopic and microscopic examination of the bird strike remnants sent to us, we identified the bird as a Kashmir roller (blue jay) *Coracias garrulus.*

Not much data on migration or ringing is available on this bird. According to Ali and Ripley (1983) Kashmir rollers migrate during day time, chiefly in the morning before noon and later throughout the day. From the above data we understand the bird must have been flying at night at an altitude of 2424 m and probably was on its autumn migration from east–northeast to west–southwest, which generally occurs during mid August to early October. This bird is not recorded so far to be flying at this altitude.

This data was collected as a part of the work in the BNHS project on Bird Hazards at Indian aerodromes and Bird Hazard Research Cell, both sponsored and funded by AR & DB, Defence Ministry, Government of India.

October 13, 1988 S.M. SATHEESAN

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20. OCCURRENCE OF LONG–CLAWED SKYLARK *ALAUDA GULGULA DHARMAKUMARSINHJI* IN CENTRAL INDIA

(*With a text–figure*)

Fig. 1 Long–clawed skylark

During the Society's bird ringing camp at Karera Bustard Sanctuary (25°30'N, 78°12'E), Dist. Shivpuri, Madhya Pradesh between 6 January and 28 March 1988, 35 eastern skylark *Alauda gulgula* were ringed. Interestingly on 19 February 1988, while ringing was in progress a skylark with an unusually long hindclaw was noticed. We checked the claw measurement and compared it with the other skylarks trapped that day. We were then under the impression that the bird was just a skylark *Alauda gulgula* like the others we were netting but with an abnormal hindclaw. The bird was ringed with BNHS ring A202640 and released after noting all the physical parameters such as wing, bill, tarsus and tail length. While compiling the ringing data we identified it as of the subspecies *A.g. dharmakumarsinhji* Abdulali 1975. The race had been separated from the other races *A.g. gulgula* and *A.g. punjaubi* mainly on the basis of the long hind claw. The hind claw length of this subspecies has been given as ranging from 17.5 – 24 mm with an average of 20.2 mm. The bird which we ringed had a claw length of 22 mm and the following other measurements:

Wing 93 mm, bill 15 mm, tarsus 23 mm, tail 56 mm, weight 25 g.

Seven specimens of this race, all from Kutch area of Gujarat, were described by Abdulali as *A. gulgula dharmakumarsinhji*. Hence it is of interest to note that the bird has been recorded beyond its known range. At the same time it cannot be ruled out that the bird can be a resident somehwere in the neighbourhood from where it strays or migrates. In due course, when sufficient number of birds are reported from this area, the range of the subspecies can be described with certainty.

Mr Humayun Abdulali, who desribed this subspecies, when approached for his comments agreed with our conclusions. We thank him for his help.

July 9, 1988 K.K. MOHAPATRA
PRAKASH RAO

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21. OCCURRENCE OF HAIRCRESTED DRONGO *DICRURUS HOTTENTOTTUS* (LINNAEUS) IN POINT CALIMERE, TAMIL NADU

On 10 November 1987, while ringing the forest birds near the old Forest Rest House at Point Calimere, Tamil Nadu, we identified a haircrested drongo *Dicrurus hottentottus* along with a catch of five Indian grey drongos. The haircrested drongo was ringed and the measurements are as follows.

Wing 161 mm; bill (from skull) 39 mm; tarsus 25 mm; central tail 130 mm, outer tail 134 mm; weight 82 g.

Sugathan (1982), Jamdar (1987) and Sugathan *et al.* (1987) recorded 243 species of birds from Point Calimere. Though 16,830 forest birds were ringed under the BNHS ringing programme (1980–1986), the haircrested drongo has been neither ringed nor sighted earlier.

V. NATARAJAN
P. BALASUBRAMANIAN

September 27, 1988

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22. REAPPEARANCE OF *STURNUS VULGARIS* LINNAEUS IN KUTCH

One of the authors, while birdwatching at Devisar *jheel* (north of Bhuj, Kutch) on 9 November 1988, came across five starlings. On two subsequent visits to the *jheel* by SNV and some members of the Pelican Nature Club of Kutch on the 11th and 13th two and three starlings respectively were observed. He visited Devisar on 18 November and noted 50 ± birds. Four of them were seen first, and after they flew away 14 more came and settled on a tree, while in–between a flock of 30 ± were seen flying across. The birds under observation came and perched on stunted *Prosopis juliflora* standing at the edge of the *jheel* with a lush growth of reeds and other vegetation cropped short by buffaloes. The starlings would come down to the ground to feed among the clumps of reeds and would fly up frequently to their perches, a habit typical of this species.

Sturnus vulgaris, though commoner in Sind, across the border, is a rare cold weather visitor to Kutch, Saurashtra and perhaps also to the adjoining areas of north Gujarat. The Salim Ali survey of Kutch in 1943–44 failed to meet with this species. As far as we are aware, the bird has not been recorded here since they were seen by Capt. C.D. Lester, who mentions having seen about a dozen of them on 27 December 1895 (*JBNHS 10* p. 331, Jan. 1896), and he again came across seven of these birds at Padhar village (about 10 km east of Bhuj) on 23 February 1896. Thus the recent occurrence of *Sturnus vulgaris* perhaps follows after a gap of a few years short of a century; and hence this note for the sake of information and record.

HIMMATSINHJI
S.N. VARU
N.N. BAPAT

November 30, 1988

23. ALTITUDINAL RANGE EXTENSION OF THE BRAHMINY MYNA *STURNUS PAGODARUM* IN CHUSHUL, LADAKH

During the survey of the blacknecked crane *Grus nigricollis* conducted by the BNHS from July to November 1987, I came across a small party of four brahminy myna *Sturnus pagodarum* (Gmelin) in a willow plantation (*Salix* sp.) in Chushul, Ladakh (34° 35'N, 78° 43'E, altitude 4,419 m). They were seen regularly till the third week of September. This species was also seen during August – October 1986.

Its altitudinal range has been recorded as 3000 m by Ripley (SYNOPSIS, 1982). An exceptional extralimital sight record near the Hanley monstery, Ladakh, about 90 km southeast of Chushul (32° 47'N, 79° 04'E, altitude 4340 m), has also been reported by Ripley (op. cit.)

The above sighting indicates an altitudinal range extension of the species in the arid region of Ladakh. This is probably because of afforestation willow plantations by the Jammu and Kashmir forest department.

October 13, 1988

S. ASAD AKHTAR

24. EXTENSION OF BREEDING RANGE OF BROWN FLYCATCHER *MUSCICAPA LATIROSTRIS*

The known breeding range of the brown flycatcher *Muscicapa latirostris* in India consists of three disjunct areas: the Eastern Himalayas, the Vindhya range, and the southern part of the Western Ghats, and it is suspected to breed in parts of the Eastern Ghats (Ali and Ripley 1983). This bird was first observed in the Gir forest in Gujarat in March 1966 (Raol 1966), though it was recorded from the Dangs forest (also in Gujarat) earlier (Ali 1955). Thereafter, the bird has been seen occasionally, and these observations were believed to be of wintering or migrating birds. On 28 May 1988, Jamal Ahmed Khan and I were walking a transect in the Amla and Khokhara forest blocks of the Gir Lion Sanctuary in Gujarat, for ungulate counts, when I came across an adult brown flycatcher. It was in the upper canopy of a *Ficus* tree, foraging for insects in small aerial sallies. After a few flights, it flew to a branch on which a young bird was perched. The adult fed the young one. The fledgling was capable of flying and it took to flight immediately following the feed. Then it remained on a nearby branch calling out to the parent. The adult moved off into a neighbouring tree to forage. There were no signs of any other fledglings or a second parent in the vicinity.

The present observation further extends the breeding range of the brown flycatcher to the Gir forest in Gujarat.

June 25, 1988 TAEJ MUNDKUR

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25. AN UNUSUAL NESTING SITE OF THE SUNBIRD

(With a text-figure)

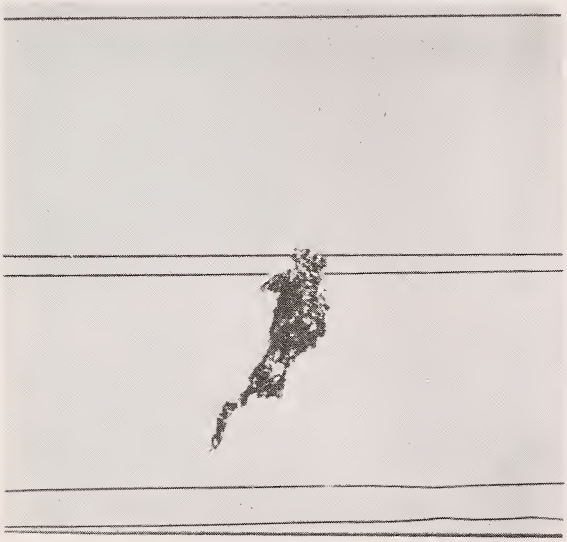

Fig. 1. Sunbird nest on telegraph wire

According to Ali and Ripley (1983) the nest of the purple sunbird *Nectarinia asiatica* is generally suspended on a twig within a couple of metres from the ground, mainly in some bush or a low tree. They have also collated some unusual nest site records like punkah-pulling rope, hanging electric wire of portico lamp in regular use, rafter in veranda, pendant flush-tank chain in temporary disused lavatory, etc. To these unusual nesting site records, fully exposed telephone wire should now also be included. On 21 May 1988, outside the Dudwa National Park in Uttar Pradesh, on Dudwa-Pallia road, we saw an old (?) sunbird nest suspended from the telephone wire (Fig. 1). It was about a metre from the pole, and was built on the middle wire, among the five wires. The nest was complete, with a small porch-like protection over the entrance. It was about 5 m from the ground and fully exposed. After two days we found the nest about one metre from its earlier position. The knot from which it was suspended must have become loose, so the nest moved away with the strong wind (there was a mild storm on 22 May). We are not sure whether or not the sunbird was successful in raising the chicks, but from the condition of the nest it appeared that it was untouched by a predator. We are also not very sure about the identity of the sunbird species but we think the nest was built by a purple sunbird *Nectarinia asiatica*, as this species is commonly seen in the Park.

July 9, 1988 ASAD R. RAHMANI
RAVI SANKARAN

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26. RANGE EXTENSION OF THE SPANISH SPARROW *PASSER HISPANIOLENSIS* (TEMMINCK)

While banding birds at the Karera Bustard Sanctuary (25°30'N, 78° 12'E) in Madhya Pradesh, we ringed several Spanish sparrows *Passer hispaniolensis* (Temminck) between 10 January and 25 March 1988. A total of 44 birds (15 males, 29 females) were ringed. Several large flocks of these birds were seen in wheat and sugarcane fields at Fatehpur and nearby areas in the sanctuary.

According to Ali and Ripley (HANDBOOK, Comp. Ed., 1983), the Spanish sparrow is a winter visitor to India and has a range extending from the plains of Punjab and Haryana, south to northeastern Rajasthan (Bharatpur-27°14'N, 77°32'E).

The occurrence of the species in Karera further extends the range of the bird south by approximately 200 km from its known range.

K.K. MOHAPATRA
October 15, 1988 PRAKASH RAO

27. FLOWER PETALS OF *CROTALARIA JUNCEA* OBSERVED FROM HALF BUILT NESTS OF *PLOCEUS BENGHALENSIS*

At the 'helmet' stage of the construction of the nest, a quantity of wet mud or cowdung is daubed thickly along the edge of the helmet —analogous to the nape portion — into which brightly coloured scarlet or orange flowers or flower–petals (*Lantana*, *Lagerstroemia*) are implanted (Ali & Ripley 1983).

I had earlier observed flowers of *Acacia nilotica*, *Cucumis melo* var *momordica*, *Momordia dioca* and *M. balsamia* in half built nests of *Ploceus benghalensis* (Sharma 1985, 1986).

In August 1987, while studying the effect of drought on the breeding success among different species of weaver birds, I came across three half built nests of *P. benghalensis* on clumps of *Saccharum munja* near village Badli in Alwar district, with yellow coloured flower petals of *Crotalaria juncea* implanted in the wet bed of dung inside the egg chambers of the half built nests.

I observed a blooming, irrigated *Crotolaria juncea* crop in a field hardly 50 m away from the breeding colony, near a hamlet. The whole of the nearby area did not have any wild monsoon plants like *Cucumis melo* var. *momordica*, *Momordica dioica* and *M. balsamia* due to unusual drought during 1987.

Perhaps due to scarcity of wild yellow flowers, cocks of blackthroated weaver birds used the yellow flowers of irrigated agricultural crops like *C. juncea*.

September 26, 1987 SATISH KUMAR SHARMA

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28. TERRITORIAL BEHAVIOUR OF MALE GHARIAL *GAVIALIS GANGETICUS* IN THE NATIONAL CHAMBAL SANCTUARY, INDIA

(*With a text-figure*)

During the breeding season a 6 m long male gharial *Gavialis gangeticus* fought with a male of equal length but tolerated a younger and smaller male in the same breeding area. Observations related to this are reported below.

Gharial populations in the National Chambal Sanctuary (NCS) are annually monitored by undertaking on-boat surveys from downstream. The surveys are normally carried out during January- February when the gharial breeding season commences. In this season, behaviour related to breeding are (a) congregation of breed-

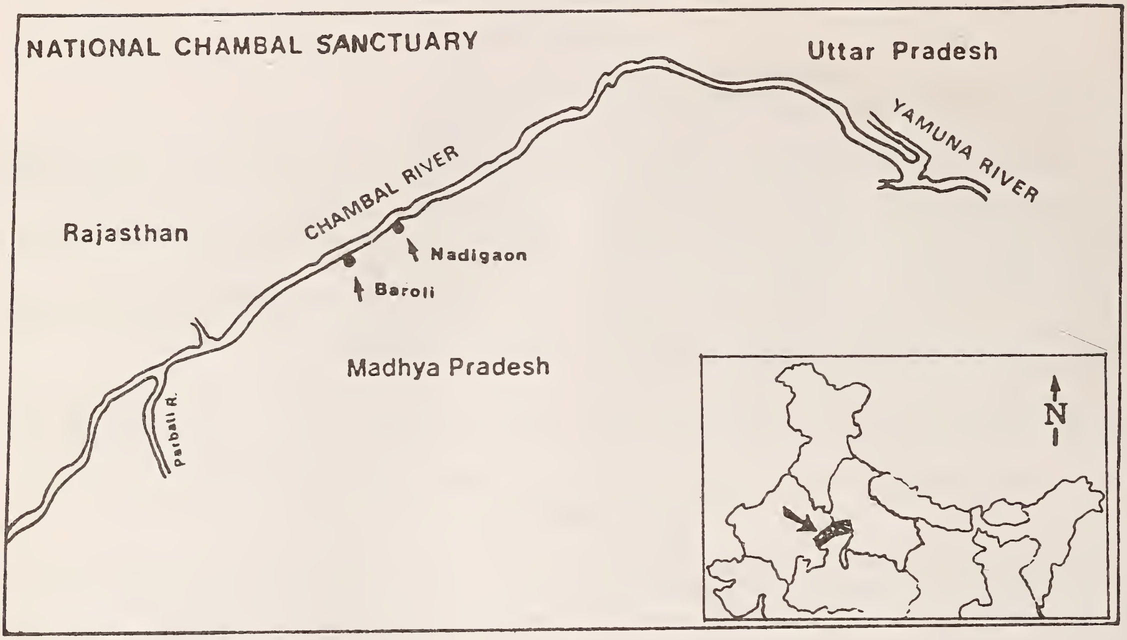

Fig. 1. Map of National Chambal Sanctuary. Arrows show nesting sites where two male gharial showed territorial behaviour.

ing groups near traditional or potential nesting sites and (b) courting.

The communal nesting site located in the uppermost reaches of the NCS during 1984 was at Baroli, which is 57 km downstream from the Chambal-Parbati confluence (Fig. 1). During the course of the next annual survey, on 18 February 1985, a group of 6 females and one male gharial was sighted at 1600 hrs at Baroli. The next morning we confirmed the presence of 13 female gharials, but could not locate the male.

While continuing our survey from Baroli towards Nadigaon (downstream) we located 2 more females. At the Nadigaon communal nesting area, located 17 km downstream from Baroli, we saw two equal sized (6 m) male gharials engaged in a fight. Their snouts, including the *gharas*, had numerous injuries and appeared pink and red from the distance. The fight included side-to-side surfacing and then sudden leaping up above the water surface with audible clashing of the snouts held vertically upwards. Noises included nasal hissing and water splash. This was followed by either submergence or resurfacing. Resumption of the fight was usually after a lapse of about 5 minutes. After observing the fight for an hour we left the place to continue the survey. We were informed by the villagers that the fight had started two days earlier.

On 28 February 1985, we found one of the injured resident males back at Baroli. The male was seen continuously for the 6 days we stayed there.

Discussion

Gharial are usually extremely tolerant of smaller conspecifics in close proximity in the wild (Bustard and Maharana 1981). While studying the ecology of gharial in the Mahanadi river, Singh (1978) reported that males are territorial during the breeding season. Occasionally, the territoriality will end with fatal consequences. Bustard and Maharana (1981) reported that a resident 3 m male in a breeding enclosure at Nandankanan Biological Park, Orissa, was killed (though without any apparent external injury) by another 3.85 m male introduced during the breeding season. However, two young male gharial along with 8 females were present in a rearing enclosure at Kukrail Crocodile Rehabilitation Centre, Lucknow, Uttar Pradesh, where they bred for the first time during 1985 (Basu, pers. comm.). Observations from Kukrail and Tikerpada (Orissa) on gharial and our experience from captive management of the mugger *Crocodylus palustris* suggest that irrespective of sex, equal sized crocodilians may tolerate each other if they have grown up together from the hatchling stage.

From the incident narrated in this note, it appears that the resident male at Nadigaon had first travelled upstream and entered the territory of the male at Baroli. The reason may be for mating and the cue leading to the presence of a large group of females upstream may be chemical. Such chemical communication has been suggested for mugger (Singh 1979). The territorial male at Baroli may have chased the intruder until they travelled 17 km downstream to Nadigaon where we noticed them fighting. Under whatever circumstances the males may have met, it is clear that equal sized males are strongly territorial during the breeding season. Singh (1985) mentioned that the minimum distance between two males occupying their own territories was 5 km in Chambal.

Rao (1988) reported that a young male about 5 m in length was sighted in October 1986 at the Baroli nesting site. Thereafter, it was seen sharing the river stretch with a large male and participating in hatchling attendance. However, the males basked at places separated by a distance of around 500 m. It is presumed that, since the new male was small and young, the old resident male was tolerant of it and allowed it to join the breeding population at Baroli.

Permitting a younger male in the breeding population at a particular area may bear a survival significance because, after the death of the resident large male, breeding will continue until a more vigorous/territorial male takes over the area. As per available records, one 7 m male gharial was killed at Baroli during January 1983. It is not known whether the 6 m male now present at Baroli had replaced the dead male or had succeeded it in the hierarchical order after living with it for some years.

In conclusion, it is seen that an old gharial male may allow a younger male to join its breeding group but at the same time maintain its territory with other breeding males of different groups. From these observations, it is suggested that introducing a new breeding male into an established adult group should be done with caution. It is safer to add a younger male than an older or smaller male.

ACKNOWLEDGEMENTS

We thank the Chief Conservator of Forests (Wildlife), Madhya Pradesh, for necessary facilities, Director, Wildlife Institute of India, Dehradun, for financial assistance, Mr. D. Basu of Uttar Pradesh Forest Department for information and the field staff of National Chambal Sanctuary (Madhya Pradesh/Uttar Pradesh/Rajasthan) for accompanying us on the survey

L.A.K. SINGH
R.J RAO
November 18, 1989

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29. TWO FRESHWATER TURTLES OF THE GENUS *KACHUGA* FROM ASSAM

(With a text–figure)

I report here the collection of two roofed turtles of the genus *Kachuga* from the state of Assam.

In 1987, I was given a carapace (Fig. 1) of a roofed turtle by a Mishing (formerly Miris) fisherman of Disangmukh (94°30'E) in the Sibsagar district of Assam. Disangmukh is on the banks of the Brahmaputra river, near the confluence of the Disang river with that of the Brahmaputra. The turtle may have been caught from either of the rivers. Later on it was tentatively identified as a brown roofed turtle *Kachuga smithii* (Gray, 1863). It measured 18.7 cm (straight carapace length) and 13.7 (straight carapace width). It may well be an undescribed subspecies of *K. smithii*. So far as the available work goes, the eastern known limit of the species is Bengal (Das 1988, Moll 1987).

Moll comments on the species, "Based on the height of the shell, I would tentatively support your identification of *K. smithii*. However, it would help to see the plastron. The high spine on the 3rd vertebral scute is unusual. Also the second vertebral tends to be shaped similar to that of *K. tecta*. The specimen is sufficiently unusual that I cannot be positive of the species".

On 25 October 1987, while on a bird survey in the flooded Fulai–Dighali *beel* in Pani-Dihing area of Sibsagar district, I collected another species of the genus *Kachuga*, the Indian tent terrapin *Kachuga tentoria* Gray, 1834. It was given to me by the local fishermen and was released after examination and photography. The

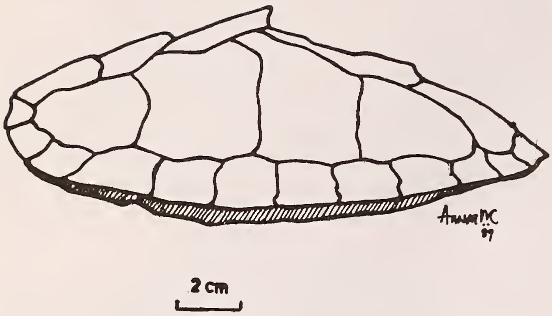

Fig. 1. Carapace of *Kachuga smithii*, lateral view

specimen was a young one, with a carapace length (straight) of 7.0 cm. Although the area is a complex of *beels* (ox–bow lakes and depressions) and *jans* (channels), during my visit it was virtually a part of the Brahmaputra river, following the devastating floods in 1987 that breached many embankments along the river. The typical race of *Kachuga tentoria*, to which my turtle was subsequently assigned, was not noted as occurring in the Brahmaputra by Smith (1931). However, Das (1988) reported finding the form in the Manas Tiger Reserve in Assam's Barpeta district and in the Kaziranga National Park in Nagaon and Golaghat districts of the same state, but within the drainage of the Brahmaputra. My records thus further confirm the existence of the species in the Brahmaputra river.

Locally, both species are called *dora kacho*, while the shell is referred to as *solong*.

I thank Indraneil Das of Calcutta for identifying *Kachuga tentoria*, Dr. E.O. Moll for commenting on the possible *Kachuga smithii*, Prabhat Yien of Disangmukh for donating the carapace of *Kachuga smithii* and Puran Das of Jailgaon for extending help during the Fulai–Dighali trip.

November, 12 1989 ANWARUDDIN CHOUDHURY

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30. A SURVEY OF FRESHWATER TURTLES OF GUJARAT

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

Introduction

Information available on the reptilian fauna of Gujarat with respect to their systematics and regionwise distribution is scant. The literature reveals that few herpetologists e.g. Stoliczka (1872) and McCann (1938), have attempted the study of reptiles and amphibia of Kutch. Acharya (1949) and Kapadia (1951) listed the reptiles from Gujarat, Daniel and Shull (1963) have listed the reptiles from Gujarat region and Sharma (1982) made a study of reptiles of Gujarat. As a part of studies on reptilian fauna, a survey of freshwater turtles of Gujarat was undertaken during the years 1987 and 1988. (In the year 1987–88 Gujarat suffered a severe drought and most of the rivers and water reservoirs went dry. It was thus a favourable time for getting information about turtles.)

The river systems of Narmada, Tapi, Mahi, Sabarmati, Ambika, Purna and Shetrunji and the perennial water reservoirs were surveyed. Information was collected on the habitat, biology, vernacular name, natural history, water pollution, myths and beliefs etc., from local fishermen and tribal people.

A few turtles were kept alive for feeding and breeding behavioural studies at Sayaji Baug Zoo, Vadodara.

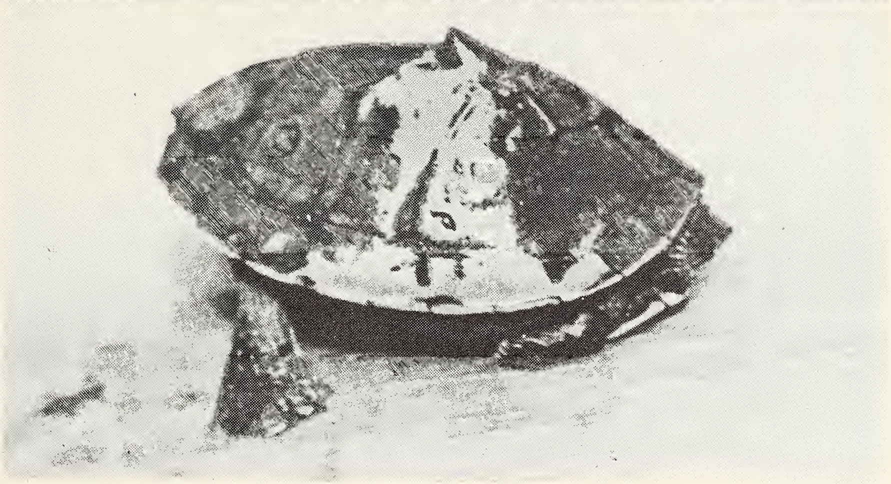
The specimens were measured with vernier callipers and tape measure and weighed with a spring balance. Measurements taken include curved carapace length (CL), curved carapace width (CW), plastron length (PL), and height of shell (H), weight (W).

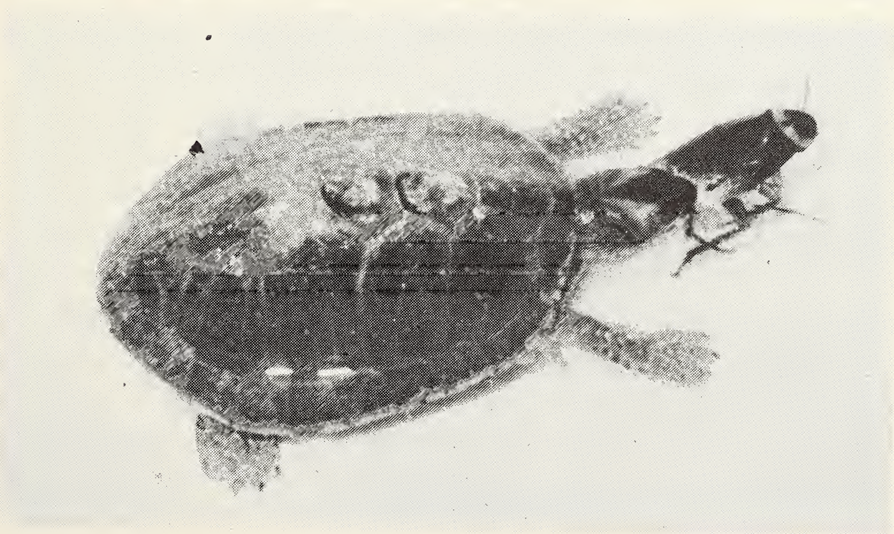
Physiography of Gujarat: Gujarat is conveniently divisible into (i) Saurashtra and Kutch, (ii) north Gujarat and (iii) south Gujarat. Kutch and the north and northwest borders of north Gujarat are a desert, while Saurashtra is less arid; the rest of Gujarat is semi–arid.

Big river s like Sabarmati, Mahi, Narmada, and Tapi flow throughout the year in north and south Gujarat regions.

Turtles and the culture of Gujarat: There is a stone turtle in the temple of Lord Shiva, symbolizing the Yamuna river. Turtle worship can be seen in many parts of Gujarat.

Turtle–meat and eggs are used as food by some of the Gujarati tribals. The Waghari, Bhoi, Dangi, Koli, Pad-





Top: Costo-periferal fontanelles in shell of male *Kachuga tecta*.
Centre: Fungus infection on carapace of *K. tecta*.
Bottom: Cockroach eating *K. tecta*.

har and Harijans believe that turtle meat is good for health and increases fertility in men. The farmers keep live turtles in wells and water tanks as they keep the water clean.

Results

The following species of freshwater turtles were recorded. The colour, measurements and other descriptive data given here are from live specimens.

Family: Emydidae

Peninsular black turtle *Melanochelys trijuga trijuga* (Schweigger).

Material:

1. CL 7.80 cm, CW 6.60 cm, PL 6.40 cm, H 2.93 cm, W O.086 kg. Gira river, near Dhuldha Village, Dist. Dangs, 25 Jan. 1987, Coll. K.P. Bhatt.
2. CL 8.80 cm, CW 6.33 cm, PL 7.30 cm, H 1.36 cm, W 0.095 kg. Bardipada, Dist. Dangs, 20 Sept. 1987, Coll. K.P. Bhatt.
3. CL 24.9 cm, CW 21.7 cm, PL 20.7 cm, H 8.8 cm, W 1.745 kg. Dhuldha Village, Dist. Dangs, 18 Aug. 1988, Coll. K.P. Bhatt.
4. CL 23.8 cm, CW 21.3 cm, PL 20.8 cm, H 8.1 cm, W 1.622 kg, Dhuldha Village, Dist. Dangs, 22 Aug. 1988, Coll. K.P. Bhatt.

Description: Carapace moderately depressed and tricarinate. Colour light brown in young, darker in adults. Head brown with pale reticulation, upper jaw pale and bicupspid. Feet dark with enlarged scales, digits well webbed. Underparts of neck and limbs creamy yellow.

Distribution: Gujarat: tributary of Ambica and Purna rivers, Ahwa, Dangs district. Elsewhere: peninsular India (Das 1985).

Indian roofed terrapin *Kachuga tecta* (Gray)

Material:

1. CL 8.8 cm, CW 6.0 cm, PL 7.0 cm, H 2.15 cm, W 0.125 k.g (Mahi river, near Lunawada, Dist. Panchmahals, 20 Feb. 1987, Coll. Aspibhai Driver.
2. CL 9.0 cm, CW 6.60 cm, PL 7.50 cm, H 2.20 cm, W 0.130 kg. Mahi river, near Lunawada, Dist. Panchmahals, 16 March 1987 Coll. Aspibhai Driver.
3. CL 21.0 cm, CW 18.9 cm, PL 18.0 cm, H 9.30 cm, W 1.150 kg. Sabarmati river, near Indroda village, Dist. Gandhinagar, 23 May 1988, Coll. R.V. Vyas.
4. CL 23.0 cm, CW 19.8 cm, PL 18.6 cm, H 10.0 cm, W 1.350 kg. Sabarmati river, near Koba village, Dist. Gandhinagar, 25 May 1988, Coll. D. Matang.
5. CL 10.7 cm, CW 7.55 cm, PL 8.30 cm, H 2.8 cm, W 0.150 kg. Sabarmati river, near Indroda village, Dist. Gandhinagar. 20 Dec. 1988, Coll. J. Golaniya.

Description: Carapace elevated with flat sides and a strong median keel with second vertebral shields longer than the third. Carapace olive brown with red and black bordered

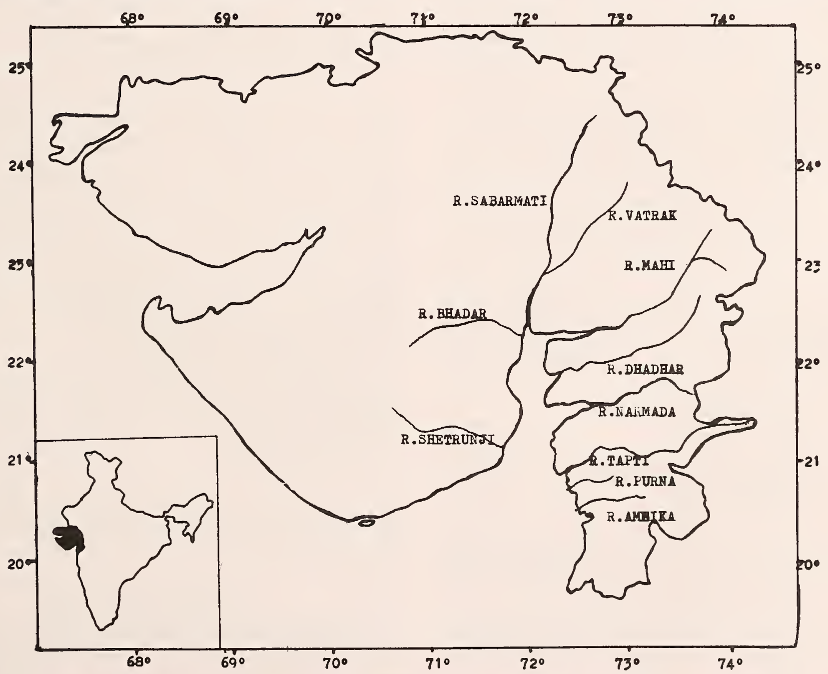


Fig. 1. Map of Gujarat showing major rivers. Inset figure shows location of Gujarat state in India.

dorso–median keel, a yellow border on marginal, cervical shield black. Black spot or thick line on the joint of each pleural scute and four small black spots on corner of the last (5th) vertebral scute. The plastron yellow–orange with 2–3 black markings on each scute, a black spot on each inguinal and axillary scute. A dark orange-red mark on the border of the anal scute. The head with a large orange–yellow crescent–shaped mark, mandible orange, neck dark olive with yellow stripes, limbs dark with yellow spots, yellow vertical stripes on rump.

Distribution: Gujarat: Sabarmati and river systems of Mahi. Reported by Moll and Vijaya (1986) from the Narmada river. Elsewhere: Indus, Ganga and Brahmaputra rivers and their tributaries (Moll 1987).

We observed some of the specimens eating insects like crickets, cockroaches, ants and moths in captivity. The largest specimen recorded by Smith (1933) was 32.0 cm. Female was also recorded by us from the Sabarmati river near Koba village, Dist. Gandhinagar, Gujarat. The Gujarati name is "Rangin Kachab".

Pinkringed tent terrapin *Kachuga tentoria circumdata* (Mertens)

Material:

1. specimen; CL 9.60 cm, CW 8.10 cm, PL 9.0 cm, H 4.33 cm, W 0.085 kg. Tapi river, near Surat, Dist. Surat 20 July 1988, Coll. K.P. Bhatt.

Description: Carapace elevated with flat side and a strong median keel; third vertebral shield longer than the second. Carapace olive brown with a light pink colour ring around pleuro–marginal junction, dorso–median keel pink with black border. Plastron yellow with large black blotches on each scute. Head olive brown with a pink broken band on the occipital region and pink postocular spot, a much smaller pink mark located at dorsal posterior edges of eye. Neck with indistinct stripes, limbs olive with unclear yellow spots. Dark olive and cream coloured vertical stripes on rump region.

Distribution: Only a single specimen was collected from the Tapi river near Surat, Dist. Surat. Elsewhere: the western and central drainage of the Ganga river (Das 1985, Moll 1987).

Family: Trionychidae

Indian flapshell turtle: *Lissemys punctata punctata* (Bonnaterre)

Material:

1. CL 21.50 cm, CW 21.00 cm, PL 19.50 cm, H 7.35 cm, W 1.600 kg. Gaurishankar lake, Bhavnagar, Dist. Bhavnagar, 18 Jan. 1987, Coll. R.V. Vyas.

2. CL 10.00 cm, CW 10.20 cm, PL 9.90 cm, H 3.30 cm, W 0.155 kg. Tapi river, near Surat, Dist. Surat, 13 March 1987, Coll. K.P. Bhatt.

3. CL 24.50 cm, CW 24.00 cm, PL 22.20 cm, H 8.80 cm, W 2.100 kg. Raja Rani talao, Vadodara, Dist. Vadodara, 12 April 1988, Coll. K.B. Mali.

4. CL 22.00 cm, CW 22.00 cm, PL 20.00 cm, H 8.20 cm, W 1.850 kg, Vishvamitri river, near Vadodara, Dist. Vadodara, 15 Sept. 1988, Coll. R.V. Vyas.

Description: Carapace convex and oval, olivebrown with numerous dark green or black spots, which disappear with age. Plastron pale yellow or light orange. Head greenish with three oblique streaks and a black bar from eye to angle of mouth. Digits well webbed.

Distribution: Gujarat: Very common in the ponds and rivers of Gujarat state. Elsewhere: Peninsular India (Das 1985).

Most common species in Gujarat. Normally Vaghari and other tribes use it as food. Farmers like to keep it in wells and watertanks. The local name is *Pani no Kachabo*.

Ganges soft–shell turtle *Trionyx gangeticus* Cuvier

Material:

1. CL 44.00 cm, CW 33.00 cm, PL 26.50 cm, H 13.50 cm, W 11.5 kg. Vishvamitri river, near Vadodara, Dist. Vadodara, 5 March 1986, Coll. R.V. Vyas.

2. CL 71.00 cm, CW 56.00 cm, PL 49.50 cm, H 17.50 cm, W 23.0 kg. Talao of Harni village, Dist. Vadodara, 10 Sept. 1987, Coll. R.V. Patel.

3. CL 77.00 cm, CW 63.50 cm, PL 55.00 cm, H 21.50 cm, W 26.5 kg. Mahi river, near Sinthrot, Dist. Vadodara, 25 Oct. 1987, Coll. R.V. Vyas.

4. CL 36.00 cm, CW 32.00 cm, PL 19.50 cm, H 7.50 cm, W 3.8 kg. Narmada river, near Bharuch, Dist. Bharuch, 2 Feb. 1988, Coll. Kasambhai Koli.

Description: Carapace low and oval, old specimens with deep vertebral groove. Carapace dark olive–green, no markings on the shell in adults. Head dark greenish with 3 – 5 oblique streaks and a black bar from eye to the nape, on each side. The head markings are entirely lost in very old specimens. Plastron pale yellow, sometimes light pinkishwhite. Limbs olive green. Underparts of neck and limbs skin light yellow colour.

Distribution: Gujarat: Very common in Mahi, Narmada and Tapi rivers. Also found in Sabarmati, Purna and Ambika rivers. Elsewhere: river systems of Ganga, Mahanadi and Indus.

The meat and eggs are used as a food by Bhoi, Waghari and other fishermen. Live turtles are kept in temple tanks for religious purposes. The local name is *Moti Kachab* or "Kachher".

Summary and Discussion

Five species of freshwater turtles contained in four genera belonging to two families are recorded from Gujarat. All the five species are commonly found in south

Gujarat, where big rivers flow throughout the year. Only *L. punctata* is found all over Gujarat.

We have recorded for the first time new localities of *Kachuga tecta* and *K.t. circumdata* from the rivers Sabarmati, Mahi and Tapi. The freshwater turtles *Trionyx leithii*, *T. hurum* and *Chitra indica* are mentioned in lists of reptiles by Acharya (1949) and Kapadia (1951) from the temple tank of Dakor village, Kheda district, and rivers of south Gujarat, but during the survey we have not found any of these species from Gujarat state. *T. leithii* is known to be restricted to the rivers and reservoirs of peninsular India, but the other species may well occur.

ACKNOWLEDGEMENTS

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B.H. PATEL

June 29, 1989

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31. NOTES ON THE LAND TORTOISES OF BANGLADESH

The elongated tortoise *Indotestudo elongata* and Asian giant tortoise *Manouria emys* are the two land tortoise species reliably reported to occur in the Republic of Bangladesh. The sight record of the Indian star tortoise *Geochelone elegans* from Dhaka district, cited by Jayakar and Spurway (1966), is curious and has not been confirmed either by collection or subsequent sightings. In fact, the known natural distribution of the aforementioned species has been shown by Frazier (1987 and in prep.) to encompass eastern Pakistan and northwestern India, as well as southern peninsular India and Sri Lanka, in two well marked clusters. The present note is based on data on the identity and distribution of the two land tortoise species, obtained during a survey of the chelonians of Bangladesh.

The elongated tortoise has been reported from Pablakhali in the Chittagong Hill Tracts of southeastern Bangladesh by Khan (1987). During fieldwork at the West Bhanugach Reserve Forest, Moulvi Bazar (formerly a part of Sylhet District), in north eastern Bangladesh, a slightly damaged carapace (field number ID/BGD 01; now in the collection of the Zoological Survey of India, Calcutta) was obtained on 11 January 1989, from a Khasia village at Lawachara. The animal was reportedly locally caught and consumed by the villagers about a month previously. Locally, the species is called 'hunro' by the Khasia tribesmen. *Measurements:* SCL 23.8 cm, CCL 27.7 cm, SCW 15.9 cm, CCW 23.7 cm.

West Bhanugach Reserve Forest, where the elongated tortoise is reportedly uncommon, comprises 27 sq.km of degraded forests, scrublands and plantations.

Another example of this species, a male, was seen in mid January 1989, at a menagerie in Srimangal town in the same district, which was reportedly caught at Patrokhola, in a natural forest within a tea estate. The animal had bright pink patches on the head, a condition found seasonally in male tortoises of the genus *Indotestudo* and thought to play a role in sex– and species–recognition during the breeding season (Auffenberg 1964). These records indicate the existence of the elongated tortoise in northeastern Bangladesh. The nearest locality to this from where the species has been recorded is Tura, in the West Garo Hills, Meghalaya, India, mentioned in a review of nematodes by Baylis and Daubney (1922 : 304).

The other land tortoise species of Bangladesh, the Asian giant tortoise *Manouria emys* is as poorly documented from the country. Khan (1982) put the Chittagong Hill Tracts, which has been recently subdivided into 3 districts, in the distribution of the species. On a visit to the museum of Dhaka University's Zoology Department, I had the opportunity to verify the material, collected by Prof. K.Z. Husain in 1965 (see Husain 1979), on which Khan's (*op.cit.*) record was based. An account of the expedition during which the specimen was collected from the Rangkhyang Reserve Forest, presently in the Bandarban Hill Tracts district, has been given by Husain (1967).

The shell (CCL 60 cm+; nuchal slightly damaged anteriorly) is raw umber in colour, the scutes nearly translucent and the gulars long and projecting – conditions that key out the nominate subspecies *emys*, while the subspecies *phayrei* has a blackishbrown shell, with smaller gulars. In the nature of its pectorals, it is intermediate between the 2 subspecies – in *emys*, these are widely separated, but in *phayrei*, they meet on the midline, making a broad contact. In the present specimen, the pectorals narrow towards their contact points and barely touch each other. I therefore consider the specimen to be a *Manouria emys emys – M. emys phayrei* intergrade, as might occur in areas where both forms naturally occur.

This research was supported by the Fauna and Flora Preservation Society, London. I thank the Bangladesh Forest Department for logistical support to conduct the study and Mr. Syed Abdul Rahaman, Conservator of Forests, for permission and facilities. Assistance during fieldwork was rendered by Mr. Abdul Wahab Akonda, Senior Research Officer, Forest Department, and Mr. Abdullah Al–Javed, Graduate Student, Life Science Institute, Jahangirnagar University. Mr. Mohammed Ghulam Mustafa, Postgraduate Student, Department of Zoology, Dhaka University, provided generous help in Dhaka, especially while studying the chelonians at the University Zoological Museum.

March 15, 1989

INDRANEIL DAS

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32. ONSET OF BREEDING SEASON IN SOME ANURAN AMPHIBIANS OF DHARWAD, KARNATAKA

Observations on the onset of the breeding season of *Polypedatus maculatus*, *Tomopterna breviceps*, *Microhyla ornata* and *Rana limnocharis* have been made since 1985 around Karnataka University campus, Dharwad, Karnataka. Many tropical and sub–tropical anurans spawn responding to monsoon rains (Lofts 1984). Breeding coincided with the onset of the southwest monsoon in *Bufo melanostictus*, *Ramanella montana*, *T. breviceps*, *Rana tigerina*, *Rana cyanophlyctis*, *R. limnocharis* and *P. maculatus* at Sanjay Gandhi National Park, Borivali, Bombay (Gnanasekar 1986). In 1985 and 1986 at Dharwad, onset of breeding in the above species coincided with monsoon rains. However, in both these years there was no consistent heavy rainfall in April and May. There was heavy pre–monsoon rainfall in the last week of May in 1987, with the result that we could record the individual advertisement calls of *T. breviceps* and *P. maculatus* fromthe banks of several ponds. In April 1988 there were heavy showers for about five days regularly in the evening. We could record individual and chorus advertisement calls of *T. breviceps*, *P. maculatus*, *R. limnocharis*, and *Microhyla ornata*. Female *P. maculatus* and *T. breviceps* were brought from the breeding ground and injected with heteroplastic pars distalis pituitary homogenate at 2200 hrs. After eight hours, i.e. at 0600 hrs the next morning, both species had spawned in the laboratory. Based on the advertisement calls in all the above species and spawning response to pars distalis extract in some, it is suggested that at Dharwad the breeding season begins much before the monsoon rains, if heavy premonsoon rains occur.

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May 21, 1988

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33. AMPHIBIAN (ANURA) SPECIES AND THEIR ALTITUDINAL DISTRIBUTION IN NORTHEAST INDIA

Studies on altitudinal distribution of amphibians (Anura) have not been undertaken in any form in the country. Pillai & Chanda (1976) published an account of the distribution pattern of anuran amphibians from Meghalaya, Assam, Arunachal Pradesh and Manipur in northeast India. Chanda (1986, unpublished) made a comprehensive study of the amphibian (Anura) fauna of northeast India. In this paper, an attempt has been made to analyse the distribution of amphibian species of northeast India on an altitudinal scale. Out of 54 species presently known (Chanda 1986, unpublished) from northeast India, the greatest number of species occur between 500 m and 1500 m, while the diversity gradually diminishes from 2000 m and above, and only one species, which is common at all elevations, has been recorded at 3000 m (Table 1).

The following points are interesting to note: At *c.* 500 m 11 species, viz. *Philautus kempiae*, *Megophrys boettgeri*, *Rana leptoglossa R. hexadactyla*, *Uperodon globulosum*, *Micrixalus borealis*, *Philautus garo*, *Chirixalus doriae*, *Rana khasiana*, *Microhyla rubra* and *Pedostibes kempi* are mostly restricted. Between *c.* 500 m – 1000 m 9 species, viz. *Rana tigerina*, *R. garoensis*, *Rhacophorus jerdonii*, *Theloderma asperum*, *T. moloch*, *Rhacophorus bipunctatus*, *R. tuberculatus*, *Leptobrachium hasseltii* and *Philautus argus* are mostly restricted. Between *c.* 500 m – 1500 m 9 species, viz. *Rana danieli*, *R. erythraea*, *R. livida*, *R. mawphlangensis*, *R. malabarica*, *Rhacophorus nigropalmatus*, *Microhyla berdmorei*, *Megophrys parva* and *Amolops afghanus* are restricted while two species *Rana cyanophlyctis* and *R. limnocharis* occur between *c.* 500 m – 2500 m. One species *Bufo melanostictus* is restricted *c.* 500 m – 3000 m. A group of 16 species, viz. *Rana alticola*, *R. assamensis*, *R. bilineata*, *R. gerbillus*, *R. laticeps*, *R. garoensis*, *Philautus cherrapunjiae*, *P. andersoni*, *p. annandalei*, *P. shillongensis*, *Rhacophorus leucomystax*, *Bufoides meghalayana*, *Hyla annextens*, *Scutiger sikkimensis*, *Microhyla ornata*, *Amolops formosus*, appear to be restricted in their altitudinal gradient of *c. 1000 m – 1500 m.* Besides, four species: *Rana mawlyndipi*, *Philautus shyamrupus*, *Bufo himalayanus*, *Pterorana khare* are restricted at *c.* 1500 m, and *Rhacophorus naso* and *Chirixalus simus* at *c.* 1000 m.

The exact cause for this diversified altitudinal variation of amphibian (Anura) species in this region is not quite clear. However, it may be presumed that distribution of food species and physiological condition play an important role in their altitudinal distribution.

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S.K. CHANDA

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34. ON THE FISH RESOURCES OF UJNI WETLAND, PUNE, MAHARASHTRA

(With a text-figure)

In India a few attempts have been made to study the various aspects of wetlands (Pandit 1982, Pandit and Fotedar 1982, Ali and Vijayan 1983, Adoni and Saini 1984, Yousuf *et al.* 1986). These studies relate to the physico-chemical properties of water, its plankton population, the macrophyte community or a combination of one or two of these aspects, but no comprehensive study exists. Recently a steering committee for the development of

TABLE 1
ALTITUDINAL DISTRIBUTION OF ANURANS IN NORTHEAST INDIA

Species	500m	1000m	1500m	2000m	2500m	3000m
Bufo melanostictus (Schneider)	+	+	+	+	+	+
Rana cyanophylyctis (Schneider)	+	+	+	+	+	–
Rana limnocharis (Boie)	+	+	+	+	+	–
R. danieli Pillai & (Chanda)	+	+	+	–	–	–
R. erythraea (Schlegel)	+	+	+	–	–	–
R. livida (Blyth)	+	+	+	–	–	–
R. mawphlangensis (Pillai &Chanda)	+	+	+	–	–	–
R. malabarica (Tschudi)	+	+	+	–	–	–
Rhacophorus nigropalmatus (Boulenger)	+	+	+	–	–	–
Microhyla berdmorei (Blyth)	+	+	+	–	–	–
Megophrys parva (Kuhl & V. Hass.)	+	+	+	–	–	–
Amolops afghanus (Gunther)	+	+	+	–	–	–
Rana tigerina Daudin	+	+	–	–	–	–
R. garoensis Boulenger	+	+	–	–	–	–
Rhacophorus jerdonii (Gunther)	+	+	–	–	–	–
Theloderma moloch (Annandale)	+	+	–	–	–	–
T. asperum (Boulenger)	+	+	–	–	–	–
Leptobrachium hasseltii (Tschudi)	+	+	–	–	–	–
Philautus argus Annandale	+	+	–	–	–	–
Rhacophorus bipunctatus (Ahl)	+	+	–	–	–	–
R. tuberculatus (Anderson)	+	+	–	–	–	–
Philautus kempiae (Boulenger)	+	+	–	–	–	–
Megophrys boettgeri (Boulenger)	+	–	–	–	–	–
Rana leptoglossa (Cope)	+	–	–	–	–	–
Rana hexadactyla (Lesson)	+	–	–	–	–	–
Uperodon globulosum (Gunther)	+	–	–	–	–	–
Micrixalus borealis (Annandale)	+	–	–	–	–	–
Philautus garo (Boulenger)	+	–	–	–	–	–
Chirixalus doriae (Boulenger)	+	–	–	–	–	–
Pedostibes kempii (Boulenger)	+	–	–	–	–	–
Rana khasiana (Boulenger)	+	–	–	–	–	–
Microhyla rubra (Jerdon)	+	–	–	–	–	–
Rana alticola Boulenger	+	–	–	–	–	–
R. assamensis (Sclater)	–	+	+	–	–	–
Rana bilineata (Pillai & Chanda)	–	+	+	–	–	–
R. garoensis (Boulenger)	–	+	+	–	–	–
R. laticeps (Boulenger)	–	+	+	–	–	–
Philautus cherrapunjiae (Roonwal & Ripalani)	–	+	+	–	–	–
P. andersoni (Ahl)	–	+	+	–	–	–
P. annandalei (Boulenger)	–	+	+	–	–	–
P. shillongensis (Pillai & Chanda)	–	+	+	–	–	–
Polypedates leucomystax (Kuhl)	–	+	+	+	+	+
Bufoides meghalayana (Yazdani & Chanda)	–	+	+	–	–	–
Hyla annectens (Jerdon)	–	+	+	–	–	–
Scutiger sikkimensis (Blyth)	–	+	+	–	–	–
Microhyla ornata (Dum. & Bibron)	–	+	+	–	–	–
Amolops formosus (Gunther)	–	+	+	–	–	–
Rana gerbillus (Annandale)	–	+	+	–	–	–
Rhacophorus naso (Annandale)	–	+	–	–	–	–
Chrixalus simus (Annandale)	–	+	–	–	–	–
Rana mawlyndipi (Chanda)	–	–	+	–	–	–
Philautus shyamrupus (Chanda & Ghosh)	–	–	+	–	–	–
Bufo himalayanus (Gunther)	–	–	+	–	–	–
Pterorana khare (Kiyasetuo & Khare)	–	–	+	–	–	–

wetlands has been established at the central level which selected 16 wetlands of national importance in different states. Ujni wetland in Pune district of Maharashtra is one of them.

Since no comprehensive work has been done on its flora and fauna, a project was taken up from 1984 as a part of a long term ecological study of the Bhima river ecosystem. The present report covers a survey of the fish and fishery of Ujni wetland.

Ujni wetland: Ujni wetland has been formed by construction of a dam on the Bhima river at Ujni (Fig. 1), about 140 km southeast of Pune, Maharashtra (17°54' to 19°24' N, 73°19' to 75°10'E). Bhima, the major river of Pune district and a part of the Krishna rivers system, rises from the crest of the Western Ghats near the famous temple of Bhimashankar and flows southeast. On its way it is joined by Bhama, Indrayani, Mula–Mutha and Ghod river (all originating from the Western Ghats), finally flowing into a reservoir at Ujni.

Ujni wetland is spread over an area of about 357 sq. km, with a maximum length of 134 km and a maximum width of 8 km. The gross catchment area covers over 14,856 sq.km. This wetland is located in the rain–shadow region of the Western Ghats and receives an annual rainfall of about 500 mm which falls mainly in August and September. The temperature ranges from 12°C to 35°C. Since the completion of the dam in 1980, irrigation water is readily available, leading to cultivation of cash crops like sugarcane and groundnut. One 12 MW hydroelectric power plant is now under construction.

Methods of Collection: Cast and bag nets were used for collecting the fish samples. Fish landing sites at Saha, Bhigwan and Khanota were also visited regularly. The collecting stations from where regular fish samples were obtained are given in Fig. 1.

Fish and Fishery

The systematic account of the fish fauna is given in Table 1 and has been adopted after Greenwood *et al*. (1966). In the present survey 42 species of fish belonging to 14 families have been recorded. The wetland has proved to be a good fishing ground with an annual catch of about 450 tonnes. The State Fisheries Department has set up a fish farm near Ujni Dam where fish seed of major carps are being raised to fingerling stage before stocking the wetland. During 1988–89 over two lakh seeds of major carps were released in this wetland.

The State Fisheries Department has regulated fishing operations by handing them over to two cooperative societies (situated in Ujni and Indapur). These societies issue licences to individual fishermen, hire out boats and nets at nominal rates. Loans are also given to the fishermen for purchasing their own gear. The fishermen use gill nets (surface) varying from 50 m to over 1 km in length. The meshes range from 30 mm to 100 mm. These nets have floats as well as sinkers. The bottom set nets are not used because of submerged tree stumps and weeds. Long lines (used for catching catfishes and snakeheads) are not in much use. Departmental fishing is done on a very limited scale.

In Ujni the freshwater grey mullet *Rhinomugil corsula* (Ham.) has been noticed in very large numbers. Prad-

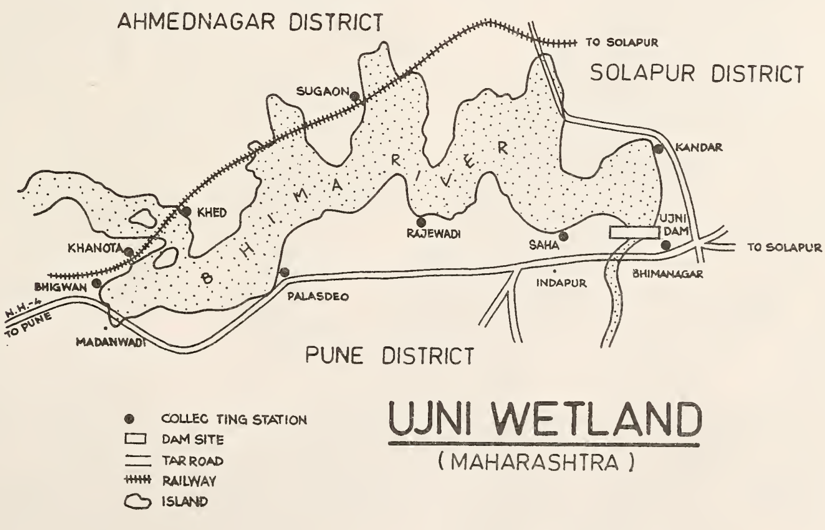

Fig. 1. Location of Ujni wetland

TABLE 1

FISH FAUNA OF UJNI WETLAND

Class : Pisces, Subclass : Teleostomi

Order Osteoglossoformes Family Notopteridae

1. *Notopterus notopterus* (Pallas)

Order Cypriniformes Family Cyprinidae

2. *Salmostoma boopsis* (Day)
3. *Rasbora* (R.) daniconius (Ham.)
4. Danio (D.) aequipinnatus McClelland
5. *Barilius bendelesis* (Ham.)
6. *Puntius conchonius* (Ham.)
7. *P. kolus* (Sykes)
8. *P. sophore* (Ham.)
9. *P. ticto ticto* (Ham.)
10. *Osteobrama vigorsii* (Sykes)
11. *O. neilli* (Day)
12. *O. cotio cunma* (Day) Some specimens show remarkable difference from the known description of the species. Further studies are in progress.
13. *Schismatorhynchus (n) nukta* Sykes
14. *Labeo kawrus* Sykes
15. *L. rohita* (Ham.)
16. *L. calbasu* (Ham.)*
17. *L. boggut* (Sykes)
18. *Cirrhinus mrigala* (Ham.)*
19 *C. fulungee* (Sykes)
20. *Catla catla* (Ham.)*
21. *Cyprinus carpio carpio* Linn.*
22. *Ctenopharyngodon idella* (Val.)*
23. *Garra mullya* (Sykes)

Family Cobitidae

24. *Noemacheilus botia* (Day)
25. *N. denisonii* (Day)
26. *Lepidocephalus* (Lepidocephalichthys) *guntea* (Ham.)

Order : Siluriformes Family : Bagridae

27. *Mystus bleekeri* (Day)
28. *Malabaricus* (Jerdon)
29. *Aorichthys seenghala* (Sykes)
30. *Aaor* (Ham.)

Family: Siluridae

31. *Wallago attu* (Sch.)
32. *Ompok bimaculatus* (Bloch)

Order : Atheriniformes Family : Belonidae

33. *Xenontodon cancila* (Ham.)

Family : Cyprinodontidae

34. *Aplocheilus lineatus* (Val.)

Family : Poecilidae

35. :*Gambusia affinis* (Baird & Girard)

Order : Channiformes Family : Channidae

36. :*Channa marulius* Ham.
37. :*C. orientalis* (Schn.)

Order : Perciformes

Family : Chandidae

38. :*Chanda nama* (Ham.)

Family : Cichlidae

39. :*Tilapia mossambica* Peters

Family : Mugilidae

40. :*Rhinomugil corsula* (Ham.)*

Family : Gobiidae

41. :*Glossogobius giuris giuris* (Ham.)

Order : Mastacembeliformes Family : Mastacembelidae

42. : *Mastacembelus armatus* (Lacepede)

*Introduced species

han and Singh (1984) reported it for the first time from Bhima river. Earlier this fish was known from the Brahmaputra (Day 1889) and Kaveri (Menon and Jayaram 1977) river systems.

Since spawn and fry were initially procured from Calcutta for releasing in Ujni wetland, it is quite possible that small numbers of *Rhinomugil* spawn or fry might have come along with carp fry. Similar accidental stocking of this fish has been reported from Krishnagiri and Sathaanur reservoirs in Tamil Nadu (Ranganathan and Natarajan 1969). Like other mullets (Mugilidae), this fish swims in shoals near the water surface with its eyes, head and anterior portion of the body out of water. This aerial vision, which is an adaptive feature, gives it a fair chance of escaping enemies and capture. As a result very few were caught in gill nets. The fish catch shows predominance of species like *Osteobrama, Channa, Wallago, Mystus* and major carps.

Recent fish catches have shown the presence of *Tilapia*, and exotic species from Africa. As this fish adversely affects the growth and production of carps, its presence is a matter of concern. Our ongoing studies on the fish diversity and ecology will throw more light on the impact of such introduced species on the local ones.

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December 15, 1989

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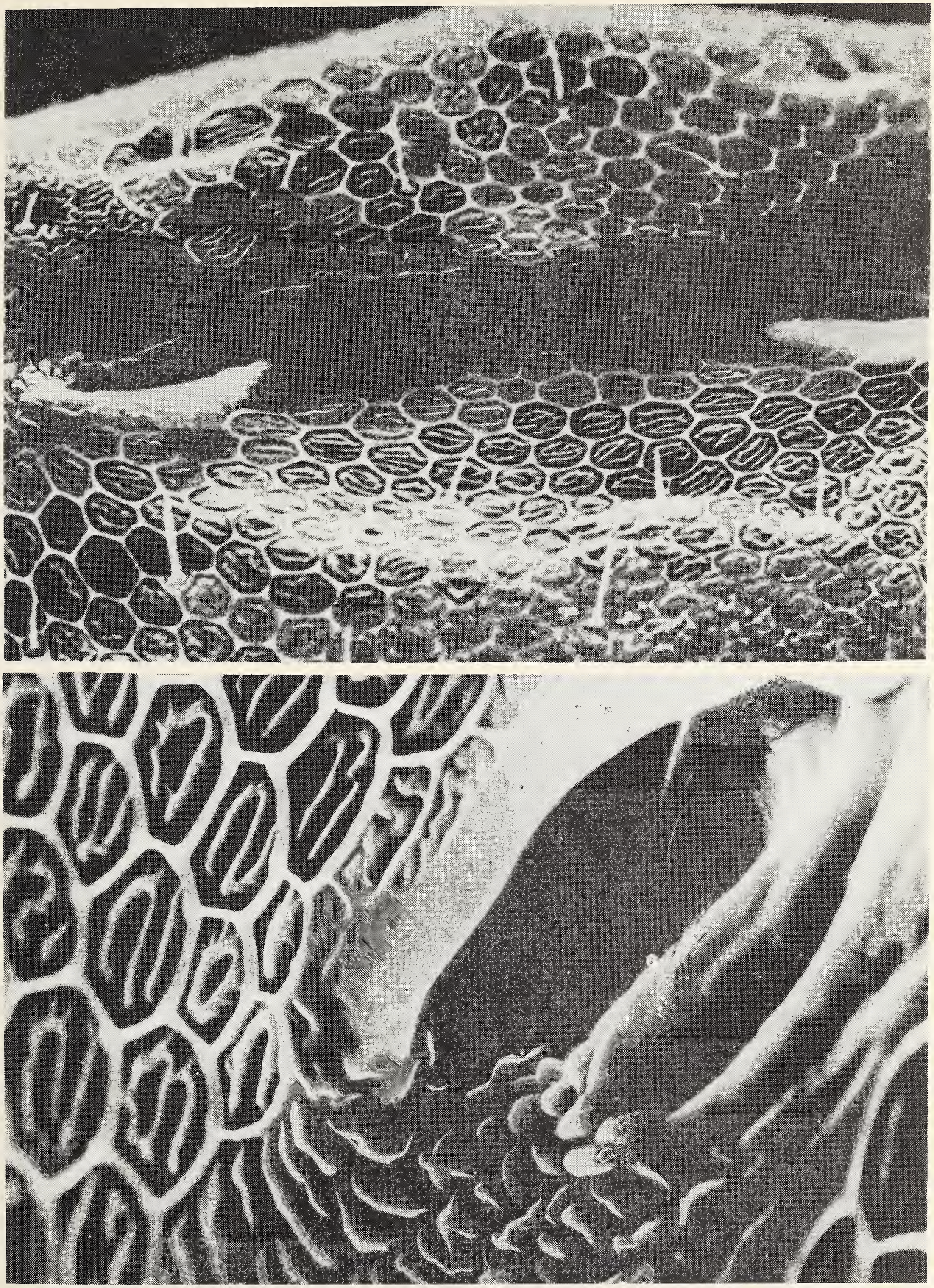

Scanning Electron micrographs of scent gland opening of nymphs of *Nysius vinitor*. Above: Two openings. Below: Openings surrounded by thickened cuticle.

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35. MORPHOLOGY OF THE SCENT GLANDS OF THE RUTHERGLEN BUG, *NYSIUS VINITOR* BERG. (HEMIPTERA – LYGAEIDAE)

(*With a plate and two text–figures*)

INTRODUCTION

Most of the insects belonging to the order Heteroptera form social aggregations, which may result in severe localized damage to agricultural crops. Therefore, knowledge of the mechanisms involved in the formation of these aggregations might be useful. Investigations were carried out with the Rutherglen bug *Nysius vinitor* B., a polyphagous insect pest, in Australia. Preliminary experiments in the laboratory indicate that the individuals of these bugs are attracted to the odours of the neighbouring individuals of the same species, and the tendency to aggregate was drastically decreased when the antennae were amputated or the openings of the abdominal scent glands of the larvae were blocked with liquid paper (Ramesh, unpublished). Giles (1958), Remold (1963), Gilby and Waterhouse (1965), Youdewei (1966), Baker and Kembell (1967), Games and Staddon (1973) observed similar behaviour with different insect species belonging to the order Heteroptera. In order to understand the behaviour of bugs to scent secretions fully, knowledge of the morphology of glands and their functioning is essential.

MATERIAL AND METHODS

Insects used in this study were obtained from laboratory cultures, maintained at 25° ± 2° C. The insects were fed on cracked sunflower seeds and with water from a moistened pad of cotton. The morphology of scent glands was studied from dissections of various stages i.e. second to fifth instar nymphs and adults.

RESULTS AND DISCUSSION

MORPHOLOGY

Scent glands of nymphs: In the nymphs of each instar there are two abdominal glands situated on the mid–dorsal abdominal line (Fig. 1A). The glands are open on the dorsal surface with two visible black dumb–bell shaped spots. Each of these two spots consists of elongated slits surrounded by the thickened cuticle (Fig. 1C and Plates 1 & 2). The glands are simple orange- red coloured sacs, situated just beneath the cuticle and above the gut, and opening directly to the exterior between abdominal segments IV and V, V and VI. The posterior gland is 2–2 1/2 times as large as the anterior gland (Fig. 1 B).

Scent glands of adults: Adults of both sexes have two scent glands on the ventral side of the thorax (Fig. 2D), which open at the base of the hind coxae by means of small pores through which the secretions pass into a narrow, ridged groove (Fig. 2E). The chitin on both sides of this groove is raised to form a characteristic lip. At one end of these lips, another raised stand of chitin, also surrounding a groove, extends to the lateral dorsal line just below the wings. These grooves provide a large surface area which according to Imms (1958), retains the secretion while it evaporates.

FUNCTIONS

The position and morphological characteristics of the scent glands of the nymphs of *N. vinitor* differ from those of adults. The anterior and posterior glands of nymphs are not similar in size (Fig. 1B). The scent gland secretions have a characteristic smell and evaporate from the surface of the cuticle within a few seconds. Observations on the behaviour of the nymphs of *N. vinitor* suggest separate function for these two glands. For instance, before nymphs rubbed their tarsi together or used them to clean their antennae, they were often seen passing them over the opening of the anterior gland. It is likely that in this way the insects spread the aggregating pheromone produced by the scent glands all over the body. When the nymphs are disturbed or pinched with a pair of forceps, they secrete a drop of thick liquid from the anus, which is spread over a large area at their back with hind tarsi. Then the nymphs (larvae) eject posterior gland secretions which spread over the anal secretion coating which was formed earlier. Anal secretion may here help in the retention of secretion of the

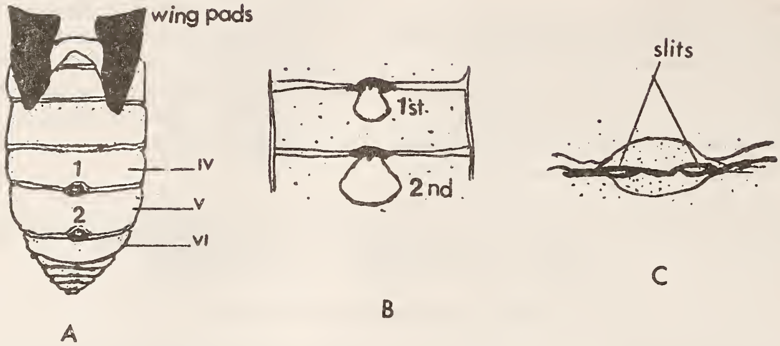

Fig. 1. Dorsal abdominal scent glands of nymphs of Nysius vinitor. A: Position of gland openings B: First and second glands C: Gland opening, to show slits.

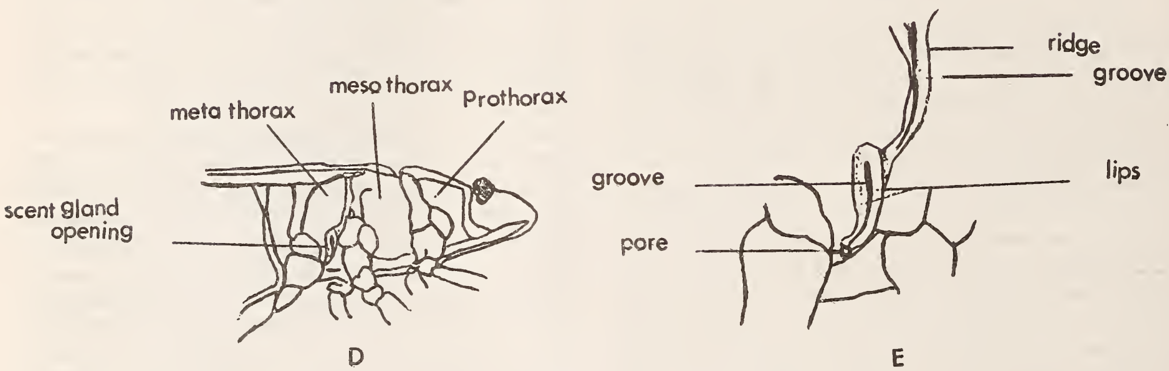

Fig. 2. Adult scent gland of *Nysius vinitor* D: Position of gland E: Gland opening, to show groove.

posterior gland. Nymphs exhibit this type of behaviour whenever an aggressor disturbs them. The secretion from the posterior gland therefore, appears to have a defensive function. The adults also secrete from their scent glands when disturbed.

ACKNOWLEDGEMENTS

I wish to thank my supervisors, Professor T.O. Browning and Dr. Roger Laughlin, for their valuable guidance during this study. I am thankful to the University of Adelaide, South Australia, for awarding URG fellowship. This work was conducted at the Department of Entomology, Waite Agricultural Research Institute, South Australia.

April 20, 1989 P. RAMESH

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36. BEHAVIOUR OF THE INDIAN TORTOISESHELL BUTTERFLY *AGLAIS (VANESSA) CASCHMIRENSIS* (KOLLAR) IN THE HIMALAYA

The Indian tortoiseshell *Aglais caschmirensis* (Kollar) (Nymphalidae) is one of the most common butterflies of the Himalaya, seen from Kashmir to Assam at altitudes of 1000 m to 4200 m. It is one of the most well adapted butterflies, found in different types of terrain from cultivated areas to open forest glades and alps of the high altitudes.

I have seen this species in several parts of the Himalaya. While photographing and watching butterflies in Sikkim, I came across an interesting aggressive and territorial behaviour of this butterfly.

On 7 November 1980 around 1100 hrs I was walking along the path near Tashiding monastery. On one side there were fields of buckwheat; the other side was part of Tashiding monastery. At the edge of the field along the path was an oval stone (0.75 m x 1 m). The tortoiseshell was sitting on the stone with its wings open and body parallel to the sun's rays and facing away from the sun, about 0.6 m away from the path.

A large silverstripe *Childrena childerni* (Gray) came from the front (west). When it was about 2 m away from the tortoiseshell, the tortoiseshell dived at it and chased it about 10 m, then turned back and settled in the same manner. As soon as it settled a common jester *Symbrenthia hippoclus* de Niceville came from the west. It was also chased away in a similar manner, after which the tortoiseshell returned and settled in the same position. After about 2 minutes, although nothing could be seen coming from the west, the tortoiseshell went out as if chasing something (I do not know if there was something which I could not see) and took a semicircle and came back and settled in such manner that its body was perpendicular to the sun's rays and was facing south. It slowly went on turning till its body became parallel to the sun's rays and it was facing away from the sun.

A red admiral *Vanessa indica* (Herbst) came from the rear. When it was about 1.5 m from the tortoiseshell, the latter flew ahead and turned back and chased away the red admiral. It also chased one common silverstripe *Fabriciana kamala* (Moore) and a bee (probably a bumble bee). All the butterflies which were attacked were within the buckwheat field. A common jester which was flying along the path passed the tortoiseshell about 1 m away from the butterfly, but was not attacked. I was also about 2 m away from it was not disturbed by my presence. On the basis of these observations I concluded that the butterfly had a territory in the buckwheat field, with an area of about 4 m radius around the three side of the rock, which was its look–out point with the path forming the fourth side of the boundary. Any intruder within this area was chased out. This whole episode took about 25 minutes.

After observing this incident I became interested in this species and have been on the look–out for such behaviour. After the Sikkim trip I have visited several other parts of the Himalaya, viz. Pindari glacier region in October 1981, Kashmir in 1982, Himachal Pradesh in May 1983 and Gharwal in June 1983 and 1984. Usually these butterflies were seen above 2000 m and other species were very few. I did not observe any aggressive behaviour. During the 1983 Garhwal trip on the slopes of the nearby mountains in Dokriyani glacier region around 3600 m there were a large number of tortoiseshells. I watched their behaviour for about an hour and the observations were as follows:

I chose a small patch of 1000 sq. m, which consisted of several species of wild flowers like *Anemone obtusiloba*, *Caltha palustris*, *Primula denticulatum*, *Taraxacum officinale*, *Gentian* spp. etc. Several species of butterflies like the Indian tortoiseshell, yellow swallowtail *Papilio machaon* Linnaeus, dark clouded yellow *Colias electo* Linnaeus, cabbage whites *Pieris* spp., queen of Spain fritillary *Issoria lathonia* (Linnaeus) etc. were feeding on the wild flowers. There were about four *A. caschmirensis* in that area. Different species visited the same flowers or even flew within a few centimetres of each other. On one *Gentian* inflorescence there were both yellow swallowtails and tortoiseshell feeding together and they were less than 1 cm away from each other. No aggressive behaviour was obsered. The queen of Spain fritillary showed some aggressive behaviour.

Do the altitudinal variation and geographical differences influence the behavioural pattern or is it dependent on the availability or non–availability of food and mates?

It would be very interesting to study the behaviour pattern of this species in more detail in different environmental conditions and altitudes.

Janurary 30, 1989 MEENA HARIBAL

37. NEW RECORD OF *MICROTROMBIDIUM SAHARANPURI* DHIMAN AND MITTAL (ACARINA – TROMBIDIIDAE – MICROTROMBIDINAE) PARASITIZING GREEN BOTTLE FLY *LUCILIA CAESAR* L. (DIPTERA – CALLIPHORIDAE)

The green bottle fly *Lucilia caesar* L. frequently occurs at carrion and excrement, particularly during summer and rainy months, May to September, in the northwestern districts of Uttar Pradesh. Earlier, Dhiman and Dhiman (1981) recorded *Microtrombidium* sp. parasitizing Indian house fly *Musca domestica nebulo* and Dhiman (1983) made some ecological studies on it. Later, Dhiman and Mittal (1985) identified it as a new species, *M. saharanpuri*. Recently, at Saharanpur this mite species has been observed parasitizing *Lucilia caesar*. Further studies have revealed that only six legged reddish larvae are parasitic while eight legged nymphs and adults of the mite are free living, feeding on the eggs of green bottle and house flies as well as on soil microarthropods. The main attachment points of the larval mite on the host body were the head, haustellum, cervical membrane, wing axillaries, coxal joints of legs, veins of wing, pleuron, intertergal and intersternal membranes of abdomen and the genital part. Observations on load of larval mite per host indicated that a maximum of 16 and a minimum of larvae are carried by a fly. Field catches of the green bottle flies were made to record the percentage of parasitization. The data are presented in Table 1, which indicates that maximum parasitization of 42.66% occurs during July and the minimum of 19.23% in May. The probable reason for parasitization of green bottle flies is that these flies frequently occur in association with house flies on carrion and human and animal excrement. The mite also breeds in the same environment. Hence, after hatching the larvae crawl over the body of the host. At first they cling to the legs and then migrate to a suitable feeding site on the host body. One to three mite larvae has no marked influence on the host but more than four larvae influence the body activities.Heavily parasitized (with 10 to 16 mite load) flies become weak and unable to make the usual quick flight.

Table 1
PARASITIZATION PERCENTAGE IN FIELD CATCHES OF *Lucilia caesar L.*

Date of catch	No. of flies caught	No. of infested	Parasitization Percentage
5 May 1987	52	10	19.23
10 June 1987	64	18	28.12
16 July 1987	82	29	35.36
22 Aug 1987	75	32	42.66
12 Sept. 1987	56	18	32.14
15 Oct. 1987	38	11	28.94

We are thankful to the Principal and Head of the Zoology Department, M.S. College for necessary laboratory facilities and to Dr. G.D. Garg for his valuable suggestions.

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R.K. SINGH
September 23, 1988 R. KUMAR

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38. MOSQUITOES OF DIV

The Union Territory of Div is a small island in the Arabian sea, near the southern coast of Gujarat. It has an area of 40 sq.km, has one town and five big villages and a population of 35,000. It is bounded on three sides by the sea and by a creek on the north, separating it from the mainland of Gujarat. The topography is generally flat, and a large part is rocky and barren. The climate is sultry. Important crops are *jowar* and *ragi*. Annual malaria incidence in Div has been more than 2 since 1975. DDT was sprayed from 1965 to 1971 under a public health programme and BHC is being sprayed since 1972.

Information on the mosquito fauna of Div is scanty. Only 3 species of *Anopheles*, viz. *A. stephensi*, *A. subpictus*, *A. vagus* and *Culex* spp. were recorded earlier (J.S. Khamre, unpublished report, 1982). There has been no other information on the mosquito fauna of Div island. A mosquito survey was therefore done between 28 September 1983 and 4 October 1983 to determine the mosquito fauna and their relative abundance. The results are summarised here.

Adult mosquitoes that were resting indoor, outdoor and biting man and cattle were collected from 0600 to 1000 hrs and again from 2000 to 2400 hrs by suction tube method. Collections were made from cattle sheds, human dwellings, mixed dewellings, other man-made structures and from shrubs surrounding and nearby cattle sheds and human dwellings. Larval survey was also done in underground tanks, wells, cement tanks, water pools, drums, etc. and the larvae were held in cages until emergence. Adult mosquitoes were identified by using the keys of Christophers (1933), Barraud (1934), Puri (1955) and Rao (1981).

The results of the mosquito collections are given in Table 1. A total of 725 mosquitoes were collected belonging to 3 genera: (i) 664 specimens of genus *Anopheles* consisting of 5 species, (ii) 55 specimens of genus *Culex* consisting of 3 species and (iii) 6 specimens of genus *Armigeres*. *Anopheles subpictus* (82.5%) was the most prevalent species which was collected more during day collections, followed by *A. culicifacies* (6.9%) which was collected only in day collections. *Culex quinquifasciatus*, *C. gelidus* and *C. tritaeniorhynchus* together formed only 7.6% of the total collections.

TABLE 1
RESULTS OF THE MOSQUITO COLLECTIONS IN DIV

Species collected	No. collected	PMHD
Anopheles annularis Van der Wulp, 1884	9	0.31
A. culicifacies Giles, 1901	50	1.65
A. stephensi Liston 1901	1	0.03
A. subpictus Grassi, 1899	598	20.27
A. vagus Donitz, 1902	6	0.20
Culex gelidus Theobald, 1901	18	0.61
C. quinquifasciatus Say, 1823	21	0.71
C. tritaeniorhynchus Giles, 1901	16	0.54
Armigeres sp.	6	0.20
Total	725	

Anopheline fauna of Div includes the well-known malaria vectors *A. annularis, A. culicifacies* and *A. stephensi* incriminated in some parts of the country. Panicker *et al.* (1981) have recently incriminated *A. subpictus* as the vector of malaria in the coastal villages of southeast India. *C. tritaeniorhynchus* is the main vector of Japanese encephalitis in India, though *C. gelidus* can also play a role in transmission of the disease.

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M.B. KALIWAL

August 27, 1988J

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39. *JATROPHA GOSSYPIFOLIA* L. AND *JATROPHA CURCAS* L.– NEW HOST PLANTS FOR THE LONGHORNED BEETLE *STHENIAS GRISATOR* FB. (CERAMBICIDAE: COLEOPTERA)

The longhorned beetle *Sthenias grisator* is a main pest of grape vine and has also been reported to attack other plants such as casuarina, mango, jack, croton, cacao, bougainvillea, oleander, erythrina, rose, *Morus indica*, and *Tabernoemontana alba* (Maxwell-Lefroy 1909, Fletcher 1914, Nayar *et al.* 1981). During the months of July and August 1988 the adults of this beetle attacked the two species of *Jatropha*, namely *Jatropha gossypifolia* and *J. curcas* occurring at Point Calimere Wildlife Sanctuary, Tamil Nadu. The beetles, which are generally known as stem girdlers, have powerful mandibles and cut the base of the main stem as well as branches by ringing them completely by biting through the bark. The beetles are nocturnal, sluggish, cryptically coloured and hide under the fork of stems during the day. They girdle the stem so as to arrest the flow of sap, thus killing the branches. The eggs are laid and the larvae tunnel and live in the girdled twigs, which provide suitable food free from sap (Fletcher 1914). The life cycle is said to be more than a year (Mani 1968).

Jatropha gossypifolia L., is a very common small shrub. *Jatropha curcas* L., which is larger, is of occasional occurrence in Point Calimere (Balasubramanian 1982). Both species are medicinally important and the latter is valuable commercially also as its seeds are used in the extraction of 'Jatropha oil' (Nadkarni 1926).

200 individuals of *Jatropha gossypifolia* were examined for the infestation. Stems ranging from 5 to 10 cm in diameter were girdled. In plants with no branches or few branches the main stem was girdled, and hence the whole plant dried up. In the case of plants with many branches, mostly, the branches are girdled and the plant stays alive. About 62 individuals were attacked by the beetles, of which 17 were completely dead. In the case of *Jatropha curcas*, out of 30 individuals examined, 10 were infested, but none dead. *Sthenias grisator* is a serious pest to the two *Jatropha* species, especially *J. gossypifolia*. The two plants are hence reported as new hosts of this beetle.

Control: Swabbing the base of the main stem or branches with BHC 0.1% solution (Nayar *et al.* 1981) and collection of beetles and destruction by fire of girdled twigs (Fletcher 1914) are suggested remedies for infestation.

My sincere thanks are due to Mr. J.C. Daniel, Curator, Bombay Natural History Society, for his encouragement.

September 3, 1988 P. BALASUBRAMANIAN

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40. NEW RECORDS OF CLADOCERA OF KEOLADEO NATIONAL PARK, BHARATPUR -- III.

(*With two text-figures*)

Little is known regarding the occurrence of different species of Cladocera of Rajasthan. So far only 20 species of this order have been recorded from this region. The important previous papers on Cladocera of Rajasthan are those of Biswas (1964), Nayar (1971) and Venkataraman (1988). Biswas (1964) recorded a new species and Nayar (1971) recorded 17 species of Cladocera. The material for the present study was collected from the Keoladeo National Park, Bharatpur (27° 7.6' to 27° 12.2' N, 77° 29.5' to 77° 33.9' E) from July 1984 to May 1985. The collections revealed two new records, (1) *Grimaldina brazzai* Richard, 1892 and (2) *Guernella raphalis* Richard, 1892 in addition to the species recorded earlier (Venkataraman 1988).

Family Macrothricidae Baird, 1843.
Genus Grimaldina Richard, 1892
1. *Grimaldina brazzai* Richard, 1892 (Fig. 1)

FEMALE: Body size 0.72 – 0.83 mm, breadth 0.60 – 0.66 mm. Shape quadrangular oval. Head small, eye large, ocellus small and situated closer to the rostrum than to the eye. Antennules long, slender and slightly narrow distally; 10–12 transverse rows of spinules; a group of long sensory setae at the apex. Antenna slightly more than half the body length. Postabdomen rather larger, bilobed with broadly rounded preanal margin. Anal margin armed with two groups of five long, sharply pointed spines. Preanal corner armed with one to two spines and followed by a series of short spinules proximally. Claw rather long, with two basal spines.

This is the first record of the occurrence of this species in Rajasthan; it agrees with the previous description of the species by Sars (1901), Harding (1957) and Idris (1983).

Genus *Guernella* Richard, 1892
2. *Guernella raphalis* Richard, 1892 (Fig. 2)

FEMALE: Body length 0.40 – 0.43 mm, breadth 0.33 – 0.35 mm; shape slightly oval. Head rounded anteriorly and concave ventrally; eye rather large, ocellus situated closer to the apex of rostrum. Antennules rather large and broad, with lateral setae and rows of setules. Valves with polygonal reticulation, ventral margin rounded and serrated without setae. Postabdomen broad proximally, narrow distally and without anal denticles. Claw rather short without basal spine.

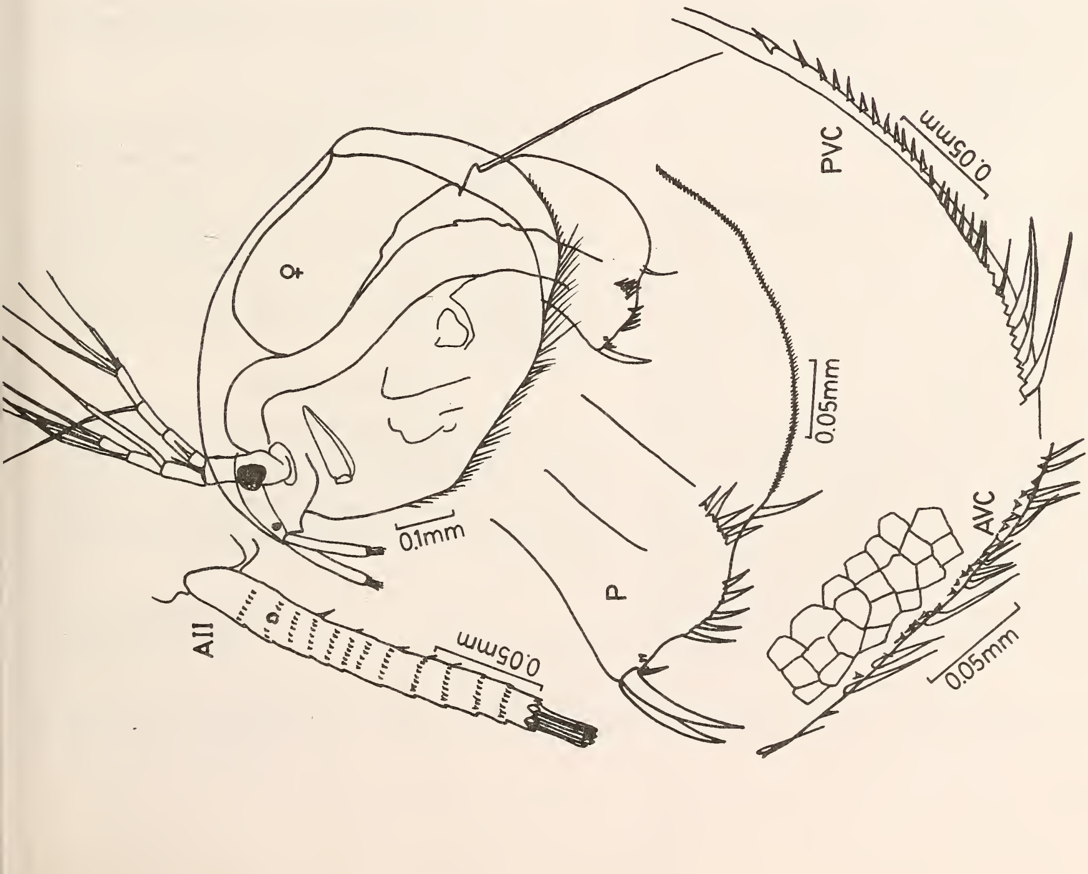

Fig. 1. *Grimaldina brazzai*, female
AII - antennule; P - postabdomen; AVC - anteroventral margin; PVC - posteroventral margin

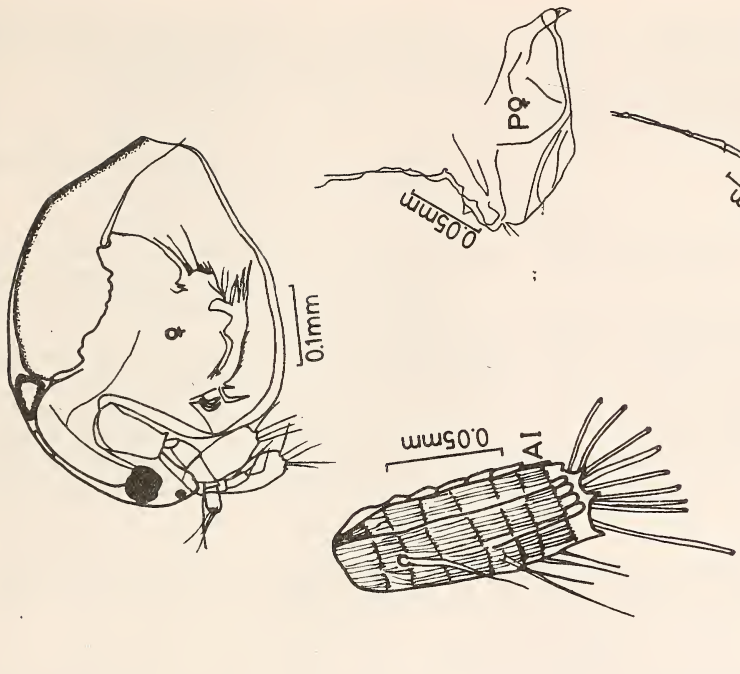

Fig. *Guernella raphalis*, female
AI - antennule; P - postabdomen; AVC - anteroventral margin.

Distribution: Common and occurring in all types of habitat.

This is the first record of the occurrence of this species in Rajasthan, and it agrees with the previous description of the species by Smirnov (1976) and Idris (1983).

I thank Mr. C. Sivasubramanian, B.N.H.S. Bharatpur, for his kind help in collecting the organisms, and Dr. T.M. Haridasan for his encouragement.

July 6, 1989

K. VENKATARAMAN

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41. *MONADENIUM HETEROPODUM* N.E. BR. (EUPHORBIACEAE) – AN EXOTIC IN THE PROCESS OF NATURALIZATION IN INDIA

(*With a text-figure*)

Monadenium Pax is a genus of succulent plants belonging to the family Euphorbiacea, represented by about 47 species, distributed in East and South Tropical Africa (Bally 1961, Jacobson 1978). Hitherto, it has not been reported in India (Hooker 1872–97). One species was found growing in red loamy soils of Secunderabad and Hyderabad.

Monadenium heteropodum (Pax) N.E. Br. Fig. 1 Succulent, stem 50 cm tall, 3–4 cm thick with stout tubercular branches. Tubercles prominent, smooth, not grooved, base rhomboid–quadrangular, varying in size and shape. Leaves spatulate, glabrous, succulent undulate apice, 25 x 50 mm, seated on prominent rhomboid tubercle, rosulate. Leaf–scar armed with prickles. Inflorescence axillary from terminal leaves, simple dichasium; consisting of one precocious central cyathium androeceous, gynoecium reduced. Lateral cyathia bisexual, zygomorphic, involucre cup–like, truncate at the top and open on one side. Involucre gland with thickened rim, inside with 5 lobes, fringe–toothed. Stamens arranged in five groups opposite to the lobes of the involucre, mingled with a few filiform bracteoles. Ovary pedicellate, surrounded by stamens, exserted from the opening in the frontal parts of the involucre and recurved, becoming erect in the last stage of maturity; 3– celled with one ovule, pendulous. Styles 3, free, shortly bifid, stigmas thickened. Voucher specimen: KSR 306A, Secunderabad; deposited in the Herbarium, School of Life Sciences, University of Hyderabad.

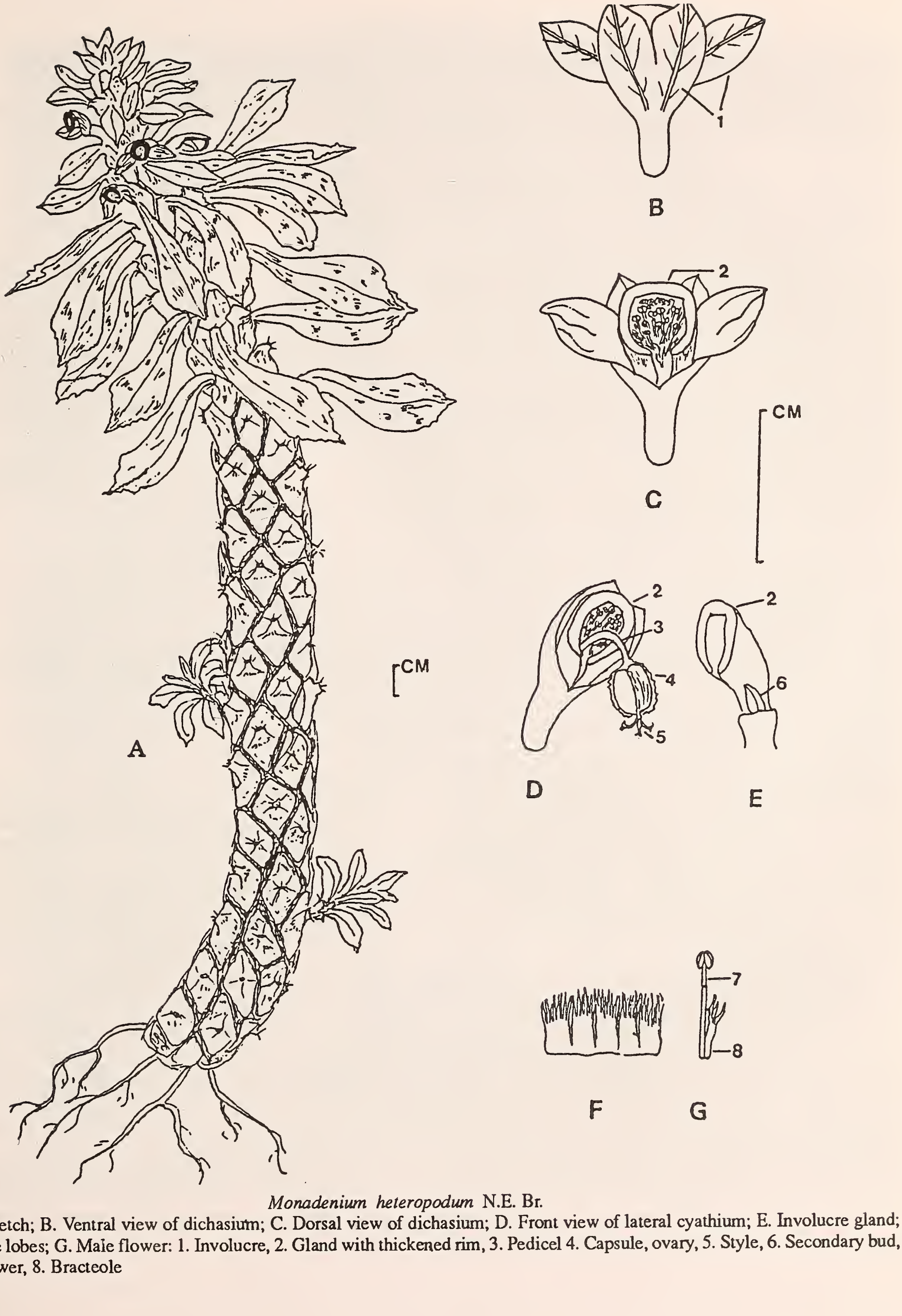
Monadenium heteropodum (Pax) N.E. Br. was previously known only from Tanzania (Jacobsen 1978). The present record is interesting from the fact that several exotic Euphorbiaceous taxa like *Euphorbia milii* Desmoul, *E. tirucalli* L., *Synadenium grantii* Hk.f., *Euphorbia pulcherrima* Willd. and *Pedilanthus tithymaloides* Poir. have become naturalized in India. *Monadenium heteropodum,* having effective vegetative propagation, may rapidly spread and get naturalized in the flora like other Euphorbiaceous species.

ACKNOWLEDGEMENTS

We are grateful to Dr. Dan H. Nicolson, Smithsonian Institution, Washington DC, USA, and Mrs. S. Carter Holmes, Royal Botanical Gardens, Kew, U.K., for valuable comments on this manuscript and the Dean, School of Life Sciences, University of Hyderabad, for providing necessary facilities.

February 16, 1989

K. SESHAGIRI RAO
M.N.V. PRASAD



Monadenium heteropodum N.E. Br.

A. Habit sketch; B. Ventral view of dichasium; C. Dorsal view of dichasium; D. Front view of lateral cyathium; E. Involucre gland; F. Involucre lobes; G. Male flower: 1. Involucre, 2. Gland with thickened rim, 3. Pedicel 4. Capsule, ovary, 5. Style, 6. Secondary bud, 7. Male flower, 8. Bracteole

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42. ABNORMAL FLOWERING OF *CARYOTA URENS* L. (ARECACEAE)

(With a plate)

A fish–tail palm *Caryota urens* L., family Arecaceae (Palmae), in the Andhra University Botanical Garden, Waltair, Andhra Pradesh, lost its crown during a cyclonic storm. After one year, the inflorescence arose during November–January, from the sides of the trunk very close to the top (Plate).

According to Blatter (1926), branching is rare occurrence in palms, except in the genus *Hyphaene*. It is often caused by injury to the terminal bud, as in *Phoenix sylvestris* (L.) Roxb. (wild date), where the apex is continuously tapped for toddy. The multiple branching due to the terminal bud being struck by lightning in wild date has been recorded by Field (1908). In other cases branching takes place consequent to the replacement of flowering buds by leaf–buds, which develop into shoots. In the present case abnormal flowering was formed instead of vegetative branches. This type of abnormal flowering is apparently due to physiological or ecological factors.

P. VENKANNA
G.M. NARASIMHA RAO
J.B. RAJU

September 6, 1989

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43. *ENTADA PUSAETHA* DC.(MIMOSACEAE) – NEW DISTRIBUTIONALRECORD FROM GUJARAT

(With a text–figure)

During the course of intensive explorations in the vicinity of Dharampur forests in Bulsar district, Gujarat, under the the Botanical Survey of India's District Flora Scheme, I came across an enormous tendrillar liana in vegetative condition. The presence and nature of tendril accompanied with the 2–pinnate leaves identified it according to Cooke's flora (1901–1908) as *Entada pursaetha*. To the best of my knowledge, this is the only Indian tendrillar mimosoid.

Entada pusaetha DC. so far has not been reported from Gujarat (Shah 1978, Raghavan *et al.* 1981). It has also been confirmed from the literature survey and from my visits to Blatter Herbarium, Bombay, and BSI(WC) herbarium, Pune, that this species was collected neither from Gujarat nor from any of the northwest districts (Nasik, Dhule, Jalgaon and Thane) of Maharashtra, which are adjacent to the present locality. The present report from the southeast hilly region of Gujarat supports its extended distribution from the Sahyadri hills in the Western Ghats.

Sahni (1980) stated this taxon as being 'perhaps the largest climber in the world'. Santapau (1953) estimated the length of this species as 'well over 1500 m." As the complete description of this species is given by Cooke (1901–1908), only an illustration (Fig. 1) is provided here.

Though this species has a wide distribution in central and eastern Himalayas, Sikkim, East Bengal, Bihar, Orissa, Deccan and Western Ghats (Chopra *et al.* 1956) it has recently been reported that this taxon is on the verge of extinction (Vartak 1983), threatened (Rao and Reddy 1983), becoming rare (Gupta and Dakshini 1983) and scarce (Sahni 1980) in different parts of India.

Recent workers, except Matthew and Britto (1983), report this Indian taxon under *E. pursaetha* DC. While the latter report it under *E. rheedii*. According to Henry and Chandrabose (1980), Brenan appears to have been the first to unite *E. pursaetha* DC., *E. rheedii* Sprengl and *E. monostachya* DC. and adopt the name *E. pursaetha* DC. for the combined species.

The specific epithet *pursaetha*, a typographical error, given in most of the Indian Floras, should be spelt as *pusaetha* (pus = name of the liana; aetha = etta = seed).

Abnormal flowering of *Caryota urens* L.

Fig. 1. *Entada pusaetha* DC., illustration based on the specimen (ASR 3591) collected from Barpuda in Dharampur Forests.

ACKNOWLEDGEMENTS

I am grateful to late Prof. G.L. Shah and Prof. Inamdar for guidance; BSI, Howrah, for financial help. My sincere thanks are due to the authorities of Blatter Herbarium, Bombay, and BSI (WC) herbarium, Pune, for allowing me to refer to the specimens.

March 14, 1989

A.S. REDDY

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44. ON THE ENDEMIC STATUS OF THREE WILD LEGUMES WITH SPECIAL REFERENCE TO THEIR DISTRIBUTION IN WEST BENGAL[1]

Revisionary studies on three genera, namely, *Smithia* Ait., *Geissaspis* W. & A. and *Zornia* Gmel. in India reveal some of their members to be endemic. Among these endemics, *Smithia grandis* Baker, *Geissaspis cristata* W. & A. and *Zornia quilonensis* Ravi also occur in West Bengal, although this has not been mentioned in literature on endemic plants of India. The present communication deals with the endemic status and general distribution of the above three taxa with special reference to West Bengal. Taxonomic interpretations are also included wherever required.

Recently concluded revisionary studies on the three genera, namely *Smithia* Ait., *Geissaspis* W. & A. and *Zornia* Gmel. have shown that in the Indian subcontinent the above 3 genera were represented by 12, 2 and 1 species and some infraspecific taxa respectively (Baker 1876). Since then addition of new species and new records of known species have been made from time to time. Subsequently, the Indian region has changed greatly both in size and ecological conditions. Presently, the above three genera are reported in the Indian context to comprise 15, 2 and 3 species and some infraspecific taxa respectively. Among these, 9 species and 1 variety of *Smithia*, 2 species of *Geissaspis* and 1 species of *Zornia* have been estimated to be endemic.

A study on the legume flora of West Bengal reveals endemic taxa *Smithia grandis* Baker, *Geissaspis cristata* W. & A. and *Zornia quilonensis* Ravi as their distribution extended to West Bengal. Studies on the endemic status of these genera have never been attempted in detail. Ahmedullah and Nayar (1986) published an account of endemic plants of India. Unfortunately, only *Zornia quilonensis* has been included in the list and is reported to occur only in Kerala, while the other two species are overlooked. This may be the result of insufficient field study and taxonomic misinterpretations.

The present communication deals with the critical assessment of the endemic status and general distribution of the aforesaid three leguminous plants in the light of critical taxonomic as well as thorough field studies. Details of their distribution in West Bengal are also recorded.

Smithia and *Geissaspis* are drought loving plants and are more frequent in drier areas. *Smithia grandis* is the only shrubby member of the herbaceous genus *Smithia* and grows vigorously in grasslands at the edge of swamps. This endemic species generally occurs along the sub–Himalayan tracts of eastern India and extends from Darjeeling in West Bengal, Sikkim to Assam and lower Khasi hills of Meghalaya up to 1,800 to 2,000 m. In West Bengal this species has been reported from Darjeeling tarai, Kuprail tarai, Lalltung on the Bengal border, Mahakalguri of Alipur Duar and on the Tista sand bank of Jalpaiguri.

Geissaspis cristata is a unique natural species in its characteristic leafy, spathulous, large orbiculate, ciliate bracts covering the whole flower, which distinguishes the species as well as the genus from the allied genus *Zornia*. This species is common in forests along streams, and also in open dry grasslands. Apparently endemic to the tropics and subtropics of India, it is found in Maharashtra, Karnataka, Goa, Kerala, Tamil Nadu, Andaman & Nicobar Islands and West Bengal. In its type locality (i.e., in peninsular India) the overall habit does not vary much, but in Kerala, Andamans and in some places of Maharashtra it is a very small, prostrate herb with very small leaflets and is often confused with its allied species *G. tenella*. The only specimens (Bengalia, Circa Calcuttam 1836 – 38 *John W. Helfer* 493 and 165) deposited at CAL constitute its records of distribution in West Bengal. In a sense the species is very occasional in this locality.

Usually the identity of *Zornia quilonensis* is confused with the Ceylonese species *Z. walkeri* Arnott in general habit but it differs in having narrow oblong and often orbicular, similar leaflets and 6–jointed pods having bristles with continuous retrorsely hairs. The species is endemic to southern and southwest India, being distributed in Kerala, Tamil Nadu, Karnataka and West Bengal. This species was originally described from peninsular India as *Z. angustifolia* var. *oblongifolia* W. & A. This fact was overlooked by subsequent workers, and as a result the same plant was again described in 1969 from Kerala as a distinct species with the name *Z. quilonensis*. However, the later name is maintained here according to rules (vide

[1]An abstract of this paper is included in the proceedings of 76th Session (Botany Section) of the Indian Science Congress Association 1989.

Art. 60 ICBN). This plant was collected from Digha in West Bengal (Digha, Mednapur coast, 24 Aug. 1966 *A.K. Mukherjee E4468 – CAL)* and misidentified as *Z. diphylla* (L.) Pers.

March 31, 1989 ARABINDA PRAMANIK

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45. NEW RECORDS OF SOME FERNS FOR KUMAUN HIMALAYA (WESTERN HIMALAYA)

Pangtey and Punetha (1987) published an updated list of Pteridophytic flora so far known from Kumaun Himalaya based on their own collections and on previous reports. They recorded, in all, 251 species of ferns from the entire Kumaun Himalaya ranging from 300–4500 m altitudes. During 1988, we made several more collection trips, especially in fern–rich areas, which resulted in the collection of a fairly large number of specimens. On identification, 5 species belonging to 5 genera and 4 families turned out to be new to the fern flora of Kumaun Himalaya. All the available previous published records indicate that these species have neither been collected nor reported from Kumaun Himalaya so far. Voucher specimens are housed in the Herbarium, Department of Botany, D.S.B. College, Kumaun University, Naini Tal.

Family : OSMUNDACEAE

1. **Osmunda japonica** Thunb., Fl Jap. 330. 1784; Panigrahi & Dixit, J. Indian bot. Soc. 48 : 97. 1969; Dixit, Census Indian Pterid. 27. 1984.

An infrequent fern in Kumaun Himalaya. It grows between 2000 – 2250 m on humus rich soil near wet areas in scrub jungles, open places, road edges.

Specimens examined: Kumaun : Almora district, Khati en route Pindari glacier (YPSP 138); Pithoragarh district, Munsiari (Gori Valley) (YPSP *s.n.*)

Previous Distribution: India (Garhwal, Assam and Meghalaya), Bhutan.

Panigrahi and Dixit (1969) were the first to record this fern from western Himalaya from Garhwal without giving any definite locality, based on the collection made by Mackinnon. The present authentic collection of this species from Kumaun Himalaya confirms its existence in Western Himalaya. But its occurrence in Garhwal needs to be confirmed because it has not been collected again by subsequent workers from Garhwal after Panigrahi & Dixit (1969).

Family : ASPLENIACEAE

2. **Asplenium capillipes** Makino, Bot. Mag. Tokyo 17: 77. f. 1–3. 1903; Dixit, Census Indian Pterid. 116. 1984; Khullar & Sharma, J. Bombay nat. Hist. Soc. 82(2) : 463 , 1986.

An extremely rare fern in Kumaun Himalaya that grows on tree crevices where a little soil gets deposited and also in rock crevices around 2300 m.

Specimens examined: Kumaun : Almora District, below Jatoli *en route* Sundardhunga glacier (SSS 1179).

Previous Distribution: India (Garhwal), China, Japan, Bhutan.

This interesting fern is reported earlier only from China and Japan. But it has not been recorded from Tibet so far. Later, H. Ito (in Hara 1971) reported it from Bhutan. However, the first authentic collection of this fern was made by Khullar and Sharma (1986), who collected it from Yumnotri (Uttar Kashi District) in Garhwal (Western Himalaya). The collection of this species from Kumaun Himalaya indicates that it is being collected from India after Khullar & Sharma (1986). Thus it extends its distributional range eastward to Kumaun Himalaya. It is very likely that this fern may be found to occur throughout the Himalayan regions of India, if exhaustive and careful collections are made.

Family : ATHYRIACEAE

3. **Athyrium rubricaule** (Edgew.) Bir, Nova Hedw. 4 : 169. t. 12 – 13. 1962; Dixit, Census Indian Pterid. 128. 1984. *Asplenium filix–femina* var. *retusa* subvar. *rubricaulis* (Edgew.) Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1 : 492. t. 59. f. 2. 1880.

Rather rare fern that grows in open places and humus rich forest floors between 2200 – 3000 m.

Specimens examined: Kumaun : Almora District , Khati en route Pindari glacier (SSS 1275); Phurkia en route Pindari Glacier (SSS 1291).

Previous Distribution: India (Kashmir, Sikkim), Bhutan.

Bir (1962) recorded this fern from Gulmarg (Kashmir) in northwestern Himalaya. The present collection thus extends its eastward distribution to Kumaun from Kashmir. However, there is no report of this fern from other sectors of northwestern Himalaya between Kumaun and Kashmir.

Family : DRYOPTERIDACEAE

4. **Dryopteris barbigera** (Hook.) O. Ktze., Rev. Gen. Pl. 2 : 812. 1891 subsp. *komarovii* Fraser – Jenkins, Bull. Brit. Mus. Nat. Hist. 14: 209. 1986.

A rare fern of the high altitude regions of Kumaun. It grows on gentle alpine slopes and meadows between 3200–3700 m.

Specimens examined: Kumaun : Almora district, Sundardhunga glacier (SSS 1199).

Previous distribution: India (Kashmir to Garhwal).

5. **Nothoperanema hendersonii** (Bedd.) Nakaike, Enum. Pterid. Jap. 239. 1975; Dixit, census Indian Pterid. 155. 1984. *Lastrea hendersonii* Bedd., Ferns Brit. India Suppl. 17. t. 377. 1876. *Nephrodium spectabile* Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1 : 526. 1880. *Lastrea spectabile* (Clarke) Bedd., Handb. Ferns Brit. India 257. 1883.

A rather rare fern in the Kumaun Himalaya. It usually grows in dark shaded humus rich forest floors and moist–shaded situations between 1500–2500 m.

Specimens examined: Kumaun : Pithoragarh district, Kukrouli (SSS 628); Almora district, below Jatoli en route Sundardhunga glacier (SSS 1249).

Previous Distribution: India (Khasi Hills and Shillong), Nepal, China, Taiwan, Thailand.

This species is being reported for the first time from northwestern Himalaya from Kumaun.

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S.S. SAMANT
April 4, 1989 Y.P.S. PANGTEY

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THE PAST AND PRESENT DISTRIBUTION OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS) IN INDIA[1]

ASAD R. RAHMANI AND RANJIT MANAKADAN[2]

(*With two text-figures*)

The Bombay Natural History Society started a five year project in 1981 which was later extended by a year to study the ecology and distribution of the great Indian bustard *Ardeotis nigriceps*. The project was funded by the U.S. Fish and Wildlife Service and sponsored by the Ministry of Environment and Forests, Government of India. This paper describes the present and past distribution of the bustard in India.

STUDY PERIOD

The study started in April 1981 with a preliminary survey of Rajasthan and Maharashtra. In August the same year, a field station was established at Nanaj, Solapur district, Maharashtra, where ecological studies were conducted till December 1984 (Ali and Rahmani 1982-84). Another field station was started in May 1982, at Karera Bustard Sanctuary, Shivpuri district, Madhya Pradesh, and studies continued till the end of 1986; but monitoring of the bustard population went on till the end of 1987. A third field station was established in 1985 at Rollapadu, Kurnool district, Andhra Pradesh, and work continued till December 1987.

Surveys: In order to determine the present distribution of the bustard, extensive surveys were done in the states where the bustard is known to exist. The results of the surveys till 1983 have been given elsewhere (Rahmani and Manakadan 1985). Two major surveys were done in Gujarat (Rahmani 1985) and three in Rajasthan. In addition to this, frequent short surveys were done in the states where we had field stations (i.e. Maharashtra, Madhya Pradesh and Andhra Pradesh) and the results were published in various reports (Ali and Rahmani 1982–84, Manakadan and Rahmani 1986). After receiving some information on bustard sightings in Tamil Nadu, a short survey was done in June 1986 (Rahmani and Manakadan 1988b).

Obviously, the states where we had the field stations were more thoroughly searched than other states where we could not spend much time. In order to cover this gap, two major surveys were organised for Gujarat (in March 1982 and January 1984) and a watch was kept on the bustard while surveying for the lesser florican *Sypheotides indica* in January 1985 and August 1987. In spite of Rajasthan having the largest bustard population in the country, we could not get permission from the State Government to do intensive studies. However, three major surveys were organised in Rajasthan (March 1983, January-February 1986 and January 1987) but we still could not cover all the bustard areas. We could have perhaps surveyed Rajasthan much better if we had a field station. Among the six states where the bustard is found, Karnataka could not be surveyed properly mainly due to our preoccupation in other

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Fig. 1 Former distribution of the great Indian bustard. (Based on literature review till 1980).

areas. There must be many more bustard populations in Karnataka yet to be discovered.

Methodology

As the surveys were more a search than population sampling, a simple visual count method was applied. The bustard is present in pockets and in seemingly perfect bustard habitats it was often not seen, so sampling a small area and then extrapolating to the whole bustard area of the country (hundreds of thousands sq. km) would have given erroneous results. For example even in western Rajasthan where the bustard is seen from Bikaner to Barmer, it is not distributed uniformly, so population sampling methods could not be applied. The chief aim of these surveys was to search and visually count the birds.

Most of the field work was done in the early mornings and late evenings when the birds are most active. Data on sex ratio, flock size, habitat utilization, time of the day, weather conditions and crop pattern of the area were recorded in the proforma. In addition to taking data, intensive publicity for the protection of the bustard was done in all the areas visited and posters were distributed. Wherever we had distributed the posters, during our subsequent visits we got better response from the locals, as a result of which in some areas we could see more birds compared to our earlier visits.

Results

State-wise results of the surveys are given below. All the data is based on our surveys, unless stated otherwise. For comparison, past records of the bustard are given in Appendix 1, and shown in Fig 1.

Madhya Pradesh

About a hundred years ago, the great Indian bustard was possibly a common bird in open scrublands of Madhya Pradesh, especially in the northwest region of the state. Bevan (1868) reported that trappers catch them in the neighbourhood of Gwalior (where the bustard is still found: see below), and Barnes (1886) found it "fairly common" in Neemuch district. In this century, there were only a few records prior to 1980, mainly because of lack of ornithologists working in the state, especially in bustard areas. Deeks (1935) saw a bustard in Sagar district and Ali (1939) though he did not see any bustards during his ornithological work in central India, recorded its presence from Gwalior and Shivpuri districts (Appendix 1). Interestingly, during his bird collection trips, Ali (1939) did not see any bustard near Narwar and Surwaya, which are very close to Karera where the present bustard sanctuary is located. Ali (1970) based on Dharmakumarsinhji's figures reported 400 bustards to be present in Madhya Pradesh, but cautioned that the figure was 'much too high'. To Dr Salim Ali's personal enquiry, the Chief Conservator of Forests, Madhya Pradesh, simply said 'It is not seen'! Nevertheless, Ali (1970) added that it is possible for a few fugitive birds to exist in Gwalior areas (Esagarh, Shivpuri, Morena). His optimism was not unfounded because in 1980, P.K. Naik, the then Director of the Madhav National Park, Shivpuri, found a few bustards near Fatehpur village about 20 km from Karera. Later Hassan (1980) did another survey of the area and saw two birds between Fatehpur and Dihaila villages and some birds near Ghatigaon village in Gwalior district. Dr Salim Ali visited the area the same year and proposed bustard sanctuaries near Karera and Ghatigaon which were declared in 1981.

Between 1982 and 1986, we studied the bustard at Karera (Rahmani 1988) and also surveyed nearby areas. Apart from Karera, we have seen the bustard in the Ghatigaon Bustard Sanctuary and in Pohri area. We also found positive evidence of bustards near Chhatipur and Panna. Good bustard habitat is present in Guna and parts of Biora districts but we could not get any evidence of its occurrence there. It is also likely that a few bustards may still survive in Raipur district. Bharos (pers. comm.) wrote to us in 1985 saying that the bustard was found in good numbers between Tilda S.E. Railway and Khora on Pallari road, which was and still is suitable for the bustard. He saw three: one big (male?) and two smaller (females?) in 1965 and saw footprints of another big bustard. He also mentioned the local name *Humma*. Unfortunately, we could not go to Raipur and enquiries from the Forest Department did not give any conclusive evidence about its present status in Raipur district. Perhaps a few birds are still present there.

During our stay at Karera between 1982 and 1986 we thoroughly surveyed Shivpuri and Gwalior districts, and later did a brief survey of Panna district in January 1988. As mentioned earlier, apart from the Karera area we saw bustards in the Ghatigaon Bustard Sanctuary and in Pohri area, and found positive evidence near Chhatipur and Panna. Detailed descriptions of Karera, Ghatigaon and Pohri are given elsewhere (Ali and Rahmani 1982–84, Rahmani and Manakadan 1988a).

Rajasthan

Old records state that the great Indian bustard was plentiful in Rajasthan (Jerdon 1864, Barnes 1886, 1891, Blanford 1898, Baker 1929). Blanford (1898), included the whole of Rajasthan and eastern Sind (Pakistan) as the distributional range of the bustard. The birds were regularly seen or shot in Sind (Hume 1873, Butler 1878). Hume (1890) reported that upto 100 bustard eggs were collected by Khan Nizam-oo-din Khan from Bikaner region.

Keeping in view the large number of bustards in the Thar desert in olden days, there are comparatively few recent records of shooting or sightings of this bird. Out of the 78 references on the bustard from 1834 to 1975, the Thar desert accounts for only fifteen and the figures in some of these references are either repeated or quoted from the earlier references. The comparative scarcity of first-hand reports of the bustard in Rajasthan reflects more on the remoteness of the area and consequent lack of recorders than on the actual scarcity of the species. Surprisingly, there is no mention of Jaisalmer district in old records, where the maximum number of bustards now occur. Once the district became easily accessible to naturalists, bustard sightings became common. Prakash and Ghosh (1963, 1964) saw "appreciable numbers" of bustards in the Ramdeora region of Jaisalmer district.

Ali (1970), quoting Dharmakumarsinhji's data, stated that nearly 500 bustards must be present in Rajasthan. Considering the present population, the figure appears to be an underestimate. With the increase in environmental awareness and development of interest in natural history, more and more sightings of the bustard were reported (e.g. Prakash 1980, Kapoor and Bhatia 1980, Saxena and Sen 1980, Rathore 1980 and Bharat Singh 1980). It is not known whether the spurt in bustard sightings was due to an increase in the number of birds or to more diligent searches. Perhaps both the factors were responsible for sightings of the bustard in widely separated areas like Kundanpur near Kota (Bharat Singh 1980), Shonkhaliya near Ajmer (Rathore 1980), Sudasari, Khuri and Dhanana in Jaisalmer (Kapoor and Bhatia 1980), Bhinmal in Jalore and Diyatra in Bikaner (Vyas *et al.* 1980). Data upto 1980 was presented during the International Symposium on Bustards held at Jaipur, the proceedings of which were published as a book (Eds. Goriup and Vardhan 1980).

Our surveys, as well as data collected from different sources, reveal that presently the bustard is found in 11 districts: Jaisalmer, Barmer, Jodhpur, Bikaner, Pali, Jalore, Ajmer, Bhilwara, Tonk, Kota and Sawai Madhopur. Out of the 11 districts we have seen bustards in five: Jodhpur, Jaisalmer, Bikaner, Ajmer and Kota (Table 2)

Gujarat

Dharmakumarsinhji (1957, 1962 a,b) did pioneer work on the ecology, behaviour and distribution of the bustard in Gujarat, especially in the Kathiawar peninsula. According to him (1957): "In the past it was found throughout this peninsula except in the forest areas of Gir, Girnar and Barda Hills, and there was practically no grassland (*Vids*) where it was not seen. Droves of 30 to 40 individuals could be observed in certain suitable habitats for most of the year". Large tracts of grasslands were seen in Okhamandal, Junagadh, Nawanagar, Bhavnagar, Jasdan, Wadhwan, Rajkot, Virpur, Bagasra, Bhawas, Wankaner and Morvi (Dharmakumarsinhji 1978).

The bustard was not uncommon in the Kutch district in the 19th century (Stoliczka 1872, Hume 1873) but later Ali (1945) found it to be rare. The birds breed in the Kutch district during the monsoon. (Baker 1929, Vijayraji 1943, Ali 1945, Himmatsinhji 1984, pers. comm.). An albino bustard was sighted near Mandvi (Vijayrajji 1926).

A marked decline in the population of the bustard in Gujarat was noted by Dharmakumarsinhji (1978) during his surveys in 1970–71 for the Worldwide Fund for Nature-India. He reported the last stronghold of this species in Kathiawar to be in Jamnagar district, close to Okhamandal "where a staunch Iyer community allows no trespassing on their lands and the birds seem to realize this protection". A few birds may be seen on the Panchal plateau and in the Rann borders where formerly they were not uncommon. Later, Sinha (1980) reported a further decline in the number of the bustards in Gujarat and through his questionnaire and enquiries found the bustard to be restricted to Jamnagar district and perhaps Rajkot and Bhavnagar districts. According to Sinha (1980), Lavkumar Khacher estimated the bustard population in Gujarat to be about 75 birds, while M.A. Rashid, the Chief Wildlife Warden (retd.) estimated it to be around 50 birds. At present, the bustard is definitely recorded only in two districts of Gujarat, i.e. Jamnagar and Kutch. A few birds exist in other districts like Surendranagar and Rajkot (Table 3).

Maharashtra

There is some literature regarding the former status of the bustard in Maharashtra. The bustard appears to have been quite common in this state. Robert Mansfield in the now defunct 'Oriental Sporting Magazine' says he shot no less than 961 bustards between 1809 and 1829 in the neighbourhood of Ahmednagar. Davidson and Wendon (1878) and Fraser (1881) also provided some interesting information. The bustard is no longer present in its former numbers, but still survives in some parts, and fortunately is making a comeback in areas where grassland enclosures are established under the Drought Prone Areas Programme (DPAP). Solapur, Ahmednagar, Aurangabad, Osmanabad, Beed, Kolhapur and Pune are the districts where the bustard has been seen during the last 8–10 years (Table 4). Unconfirmed reports indicate their occurrence in Nagpur and Nasik districts.

Andhra Pradesh

Old records indicate the presence of the bustard in the 'dry districts' of Andhra Pradesh (Hume and Marshall 1879, Blanford 1898). Burton (1953) mentioned seeing a drove of 13 birds east of Guntakal junction. Elliot (1880) and Tostems (1887) acknowledged their presence in Kurnool district.

Till very recently, little was known about the present status of the bustard in Andhra Pradesh. Pushp Kumar (1980) offered a rough estimate of 15 birds for the whole state, based on information gathered mainly from hunters. Then, in August 1982, a few birds were sighted by the Forest Department near Rollapadu and Banganapalle in Kurnool district. Subsequently the bustard was also located by the Forest Department or by us at Nellibanda, Peddapadu, Siruvella, Palakurti, Malligeli in Kurnool district; Hanimireddy-palli in Anantapur district, Chevalla and Shamshabad in Rangareddy district (Table 5). There are unconfirmed reports of their presence in some parts of Mahboobnagar district.

Karnataka

There is no clear picture of the status and distribution of the great Indian bustard in Karnataka. There are unconfirmed reports of its occurrence in Bijapur, Raichur, Dharwad, Bellary, Chitradurgha, Tumkur, Hassan, Kolar and Mysore districts, but the bustard is definitely known to exist only in Dharwad district (Table 6).

Discussion

Limitations of the study: In order to estimate the number of a patchily distributed, rare species, it is important to know its complete ecology and especially its movements and home range, to avoid duplication in counting. A serious limitation in our work was that we could not study the local or long distance movements(?) of the bustard because we were not allowed to mark the birds in sufficient numbers. Therefore, we do not know whether the same individuals were seen in different places or they were different birds. An in-depth study of the home range using colour bands and radio telemetry would have been useful to extrapolate the population figures.

Present distribution: Mukherjee in 1973 estimated the bustard to occupy only 1.7% of its former range. In the absence of data on the home range and movements, it is difficult to compare the area occupied by the bustard in the olden days and now. Moreover some of the older distributional records are so vague, e.g. 'Saurashtra' or 'Deccan' that they cannot form a basis for any comparative studies. Even now the bustard is found in 'Saurashtra' and 'Deccan', though certainly in much reduced numbers.

As can be seen from the maps showing the former and present distribution of the bustard (Figs. 1 and 2), the area of distribution has not shrunk much, especially in the central part of its distributional range. Only the density of the bustard has gone down (Goriup and Vardhan 1980; this study). For instance, based on available literature, the bustard was reported from five districts of Madhya Pradesh, i.e. Gwalior, Shivpuri, Neemuch, Sagar and Raipur (Fig. 1). It is still present in Gwalior and Shivpuri and possibly also in Raipur. In addition, we found it in Panna district, and we suspect it is present in Guna district which adjoins Shivpuri and still retains extensive open scrubland. Thus, as far as Madhya Pradesh is concerned, the range of the bustard has not decreased much. Similarly, in Maharashtra out of the 11 districts from which it was reported (Fig. 1), it is now definitely seen in five, and possibly in six districts. Its population has gone down much, hence few sight records, but the extent of distribution in Maharashtra has just halved. In Rajasthan, Gujarat and Andhra Pradesh the bustard is seen in almost all the dry districts as in the olden days.

Reduction in the distributional range of the bustard is markedly seen in the peripheral areas of its former range like Uttar Pradesh, Orissa and Tamil Nadu. From Orissa, there was only one record, i.e.

Fig. 2. States and districts having bustard populations, ● Breeding records ■ Other records

Sambalpur (Appendix 1) (Raipur is now in Madhya Pradesh). We do not know whether the bustard survives there or not as we do not have any recent information. Similarly, in Tamil Nadu either the bustard is totally extinct or has become extremely rare (Rahmani and Manakadan 1988b). Even in the past the bustard may not have been very common in Tamil Nadu (the erstwhile Madras Presidency) or was on the decline even during the early part of this century. Therefore, its disappearance from Tamil Nadu was only a question of time since its habitat was being altered at an accelerated rate.

The greatest reduction in the range of the bustard is seen in the north, i.e. Uttar Pradesh, Haryana and Punjab. It was a resident bird in all the three states (Haryana was earlier part of Punjab). Eggs were collected (e.g. from Sirsa; Oates 1902) or the birds were seen throughout the year (e.g. in Muzzaffarnagar; Butler 1880) in this region. The bustard was seen as far north as Ferozepur in Punjab and

TABLE 1
STATE – MADHYA PRADESH

Name of the Area	District	Size (sq.km)	No. of bustard (Estimate in brackets)	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
1. Karera Bustard Sanctuary	Shivpuri	202	25-30	1982-86	Y	Degraded open scrub, crop fields, wetlands	Overgrazing and spread of cultivation	Blackbuck, chinkara, wolf, fox, jackal, raptors	Pers. observ.
2. Narwar	Shivpuri	–	6	May 1983	Y	-do-	-do-	-do-	-do-
3. Chhatipur	-do-	–	4-5, one chick caught in May 1981 by villagers	1981	Y	-do-	-do-	Wolf, jackal, fox, possibly chinkara	-do-
4. Pohri	-do-	–	8 (10-15)	1984	Y	-do-	-do-	-do-	-do-
5. Boodha village, 44 km from Pohri on Mohana Road	-do-	–	–	10 Oct. 1984	N	-do-	-do-	–	A few bustards were seen earlier, but none by us.
6. Ghatigaon Bustard Sanctuary	Gwalior	512	6 hens	Nov. 1986	Y	-do-	Overgrazing	Blackbuck, chinkara, cheetal, wolf (?), jackal, fox	Pers. observ.
			1 hen with chick	Jan. 1983	–	–	–	–	Forest Dept.
			1 male, 7 hens (15-18)	June 1985	–	–	–	–	Pers. observ.
7. Gunnaur-Pedeu 22 km from Panna	Panna	–	Feather collected (5-10?)	Jan. 1988	Y	Degraded open scrub, crop	-do-	Blackbuck, chinkara (?)	Pers. observ.

TABLE 2
STATE – RAJASTHAN

Name of the area	District	Size (sq.km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area: Y/N	Habitat type	Major threat	Major fauna	Source
1. Sonkhaliya Closed Area	Ajmer	17	30 (80-100 ?)	Jan. 1986	Y	Open scrub forests, crop field	Spread of agriculture and *Prosopis*	Nilgai, chinkara, (rare), wolf	Pers. observ., Forest Dept.
2. Sorson Closed Area	Kota	*c.* 10	8(15-20)	Aug. 1984	Y	-do-	Stone quarrying	Blackbuck, chinkara, wolf, jackal, fox	-do-
3. Outside Ranthambore Tiger Reserve	Sawai-Madhopur	–	1	June 1988	N	–	–	–	Sharma, V.D. (1988, pers. comm.)
4. Diyatra–Khitolie	Bikaner	–	3 cocks 12 cocks	6 March 1983 21 Jan. 1986	Y	Light scrub, sand dunes, crop fields	–	Chinkara, houbara (in winter)	Pers. observ.
5. Bethnoke plot	-do-	2.5	(10-20 (?))	22 Jan. 1986	Y	-do-	–	-do-	-do-
6. Jhajhu–Siana	-do-	–	2 adult and 3 subadult cocks	22 Jan. 1986	Y	-do-	–	-do	-do-
7. Gajner Sanctuary	-do-	26	Occasional	–	N	Open woodland, stony ground and wetland	–	Blackbuck, chinkara, nilgai, jackal, fox.	-do-
8. Bap	Jodhpur	–	11 3 males	8 Mar. 1983 Jan 1986	Y	Grassland, sandy area, crop fields	–	Chinkara	Pers. observ. -do-
9. Nausar plot	-do-	–	11	Dec. 1985	N	Open scrub	–	Chinkara	Forest Dept.
10. Dhawa Closed Area	-do-	470	8 3	Jan. 1986 7 Feb. 1986	N –	–	–	Chinkara, blackbuck, wolf, jackal	Forest Dept. Goyal, S.P. and Ghosh, H.C. (1986, pers. comm.)
			1	8 Feb. 1986	–	–	–	–	Pers. observ.
11. Sam in D N P	Jaisalmer	8	3 3 males (15–6)	March 1983 Jan. 1986	Y Y	Typical dune area	None	Chinkara, houbara, desert fox, and Indian fox	–do– –do–

TABLE 2 (Contd.)

Name of the area	District	Size (sq.km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area: Y/N	Habitat type	Major threat	Major fauna	Source
12. Sudasari, DNP	Jaisalmer	7	6	Mar. 1983	Y	-do-	-do-	-do-	-do-
Between Sam and Sudasari		–	25 (50-80)	Jan. 1986	Y	-do-	-do-	-do-	-do-
13. Khuri-Tejsi in DNP	-do-	–	10	Jan. 1986	Y	-do-	-do-	-do-	-do-
14. Miyajlar in DNP	-do-	5	3-5	Jan. 1986	Y	-do-	-do-	-do-	Forest Dept. pers. observ.
15. Khinya	Jaisalmer	–	13	Mar. 1983	Y	Typical sandy area	None	Chinkara, houbara, desert fox , Indian fox	Pers. obser.
			8	Jan. 1986	–	-do-	Habitat alteration due to IGNP *	-do-	-do-
16. Akalpur	-do-	–	20-30	Mar. 1983	–	-do-	-do-	-do-	Forest Dept.
17. Devekot-Rasla	-do-	–	11 (30-40)	–	Y	-do-	None	-do-	Sharma, V.D. (1986) pers. observ.
	–	–	2 cocks	4 Feb. 1986	Y	-do-	-do-	-do-	pers. observ.
18. Sankara	-do-	–	1 cock	5 Feb. 1986	Y	-do-	-do-	-do-	-do-

* Indira Gandhi Nahar Project DNP = Desert National Park Y/N = Yes/No

TABLE 3
STATE – GUJARAT

Name of the area	District	Size (sq. km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
1. Kakerbet grassland near Bhatia village	Jamnagar	–	1 immature male 4 hens	12 Jan. 1984	Y	Overgrazed grass-land, crop fields	Overgrazing, spread of *Prosopis*	–	Pers.. observ.
2. Gowane, 50 km from Jamnagar on Kalyanpur road	-do-		None (4-5)	Jan. 1984	?	Undulating terrain	Overgrazing, poaching	–	Col. Jadeja (pers comm. 1984)
3. Mahadevia veedi	-do-	–	2	Monsoon 1983	–	–	–	–	Col. Jadeja (pers. comm. 1984)
4. Khangarpur-Mehmana veedis	-do-	–	3	Jan. 1985	–	–	–	–	-do-
5. Ghoghera Talab	-do-	0.25	3	Jan. 1985	–	–	–	–	-do-
6. Hadmatia in Kalyanpur taluka	-do-	–	2 hens	20 Aug. 1986	–	–	–	–	Meshru (1986 *in litt.*)
7. Dadle grassland near Hingolgarh	Rajkot	–	None	Feb. 1982	–	Protected grassland	–	Wolf (?), lesser florican	Pers. observ.
8. Velavadar National Park	Bhavnagar	18	None	Feb. 1982 Jan. 1984 Jan. 1985	–	-do-		Blackbuck, wolf, lesser florican	Pers. observ.
9. Vani on Virangam Rajkot rail tract	Surendra Nagar	–	1	24 Dec. 1985	–	–	–	–	T. Mundkur (1986) pers. comm.
10. Badamoiti, Godhra & Don villages in Mandvi taluka	Kutch	–	1 cock	Jan. 1984	–	Grassland and cultivation	Overgrazing and habitat alteration	Houbara in winter	Pers. observ.
11. Layaja village 15 km from Mandvi on Naliya road	-do-	–	5	Jan. 1985	–	-do-	-do-	-do-	Forest Dept.
12. Bhada and Panchatia villages west of Mandvi	-do-	–	Few	Jan. 1985	–	Grassland	-do-	-do-	Local villager
13. Mamaya and Kanak-pur villages on Kothara Mothada road, Abdase taluka	-do-	–	3 hens, 2 juveniles 4	17 June 1987 16 Oct. 1987	Y –	– –	– –	– –	Chhabra (*in litt.*) 1988 -do-

TABLE 3 (Contd.)

Name of the area	District	Size (sq. km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
14. Chota Bhitara 30 km fromDhordu in Banni Udina village	-do-	840	Nest	1984	–	–	–	–	Local villagers
			4	1 Feb. 1985	–	–	–	–	-do-
15. Nanda bet in Little Rann of Kutch	Kutch	–	1 cock	12 Nov. 1986	–	–	–	–	Forest Dept.

TABLE 4
STATE – MAHARASHTRA

Name of the area	District	Size (sq. km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
1. Nanaj plots and surrounding areas	Solapur	*c.* 50	20-25 (25-30)	1981-84	Y	Undulating terrain, grassland, crop fields	–	Blackbuck, wolf	Pers. observ.
			35-40 (50-55)	1989	–	–	–	–	Pers. observ.
2. Karmala plot	-do-	*c.* 2.5	4 cocks, 3 hens (10-15)	1981-84	Y	-do-	–	Blackbuck, chinkara	-do-
3. Mirajgaon plot	-do-	1	1-2	1981	Y	-do-	Overgrazing	–	Forest Dept.
4. Madha plot	-do-	1	8	1981-82	–	-do-	-do-	–	-do-
5. Boramani plot	-do-	0.75	2	–	–	-do-	-do-	–	-do-
6. Gangaiwadi (Kasegaon) plot	-do-	2	1 cock 2-3 hens	1986–88	Y	-do-	–	Blackbuck, wolf, fox	Forest Dept. and pers. observ.
7. VRDE near Arangaon	Ahmednagar	2.4	8	1982	–	Totally protected grassland plot	Spread of exotic trees like Subabul	–	Forest Dept. and pers .observ.
8. Chapedgaon plot	-do-	–	1	26-Sept. 6 Oct. 1983	–	-do-	Overgrazing	–	Forest Dept. and pers. observ.
9. Virgaon plot	Aurangabad	0.18	4	1983-84	Y	-do-	–	–	-do-
10. Sirajgaon	-do-	0.25		1983-84	–	–	–	–	-do-
11. Chausala, near Osmanabad boundary	Beed	–	1	Sept. 1983	–	–	–	–	Local villagers
12. Mouze-Aste, Paranda taluka	Osmanabad	–	4	25 July 1984	–	–	–	–	Forest Dept.
13. Khadrapur in Shirole taluka	Kolhapur	–	2	May-July 1987	–	–	–	–	Gaekwad (1988, *in litt.*)
14. Jejuri, 24 km southeast of Pune on Saswad Rd	Pune	–	2	17-18 Mar. 1986		–	–	–	Nalvade (1988, *in litt.*.)

VRDE = Vehicle Research and Development Establishment

TABLE 5
STATE – ANDHRA PRADESH

Name of the area	District	Size (sq.km)	No. of bustards seen (estimate in brackets)	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
1. Rollapadu bustard Sanctuary	Kurnool	6	40-50 (50-100)	1985–88	Y	Grassland	None	Blackbuck,	Pers. observ. Wolf
2. Banganapalle	-do-	–	1 cock (15 ±)	Nov. 1985	Y	Cultivated fields	–	–	Pers. observ., Forest Dept.
3. Nellibanda, 60 km from Kurnool	-do-	–	2 cocks	March 1985	–	-do-	–	–	Pers. observ.
4. Peddapadu, 5 km from Kurnool on Bellary Road	-do-	–	Footprints seen (5-6)	1985–87	Y (?)	-do-	–	–	-do-
5. Siruvella, 25 km from Nandyal towards Cuddapah	-do-	–	2 cocks and numerous foot prints	May 1986	–	Open scrub	Poaching (?)	–	Pers. observ.
			30	Monsoon 1986	–	–	–	–	Forest Guard
6. Palakurti on Gudur-Kodmur Road	-do-	–	5	–	–	–	–	–	Local villagers and trappers
7. Hanimireddy-palli, 30 km from Anantapur on Kalyandurg Road	Anantapur	11	6	1987	Y	Open woodland	Habitat alteration by tree growth	–	Forest Dept.
8. Shamshabad	Ranga-Reddy		–	2 shot 1983	–	–	Poaching	–	Taher S. (1985, pers. comm.)
9. Chevalla near Vikarabad	-do-	–	A few seen every monsoon	–	–	Grassland and agricultural fields	Poaching (?)	–	Taher, S. (1985, pers. comm.)

TABLE 6
STATE - KARNATAKA

Name of the area	District	Size (sq.km)	No. of bustards	Date of visit	Breeds in the area Y/N	Habitat type	Major threat	Major fauna	Source
1. Ranebennur Blackbuck Sanctuary	Dharwad	119	1 territorial cock, 5 hens	Feb. 1982	Y	Undulating terr ain, introduced Eucalyptus	Overgrazing	Blackbuck, Wolf	Pers. observ.
			2 hens, 2 chicks	Feb. 1984	–	–	–	–	-do-
			10	26 Feb. 1989	–	–	–	–	Forest Dept.
2. Guttal Plantation	Dharwad	1200 acres	1 cock, 1 hen, 1 egg	1982	Y	-do-	–	–	Forest Dept.
			2 territorial cocks, 6 hens	Feb. 1984	–	-do-	–	–	Pers. observ.
			1 male, 3 hens	July 1984	–	-do-	–	–	-do-
3. Tulsigeri and Govinkoppa plantation in Bagalkot range	Dharwad	–	3	1986	–	–	–	–	Forest Dept.
4. Pagededinne, Sindhanur Taluka	Raichur	–	6	–	–	Cultivated fields	–	–	A villager reported seening 6 bustards in his field a few years ago.
			None	Aug. 1985		–	–	–	Pers. observ.
5. Batkurki and Varchagal villages on Ramdurga and Jhamkhanda	Bijapur	–		1981-82	–	Cultivated fields	–	–	A villager reported seeing bustards in the summer of 1981-82.
6. Bilgi	Bijapur	–	1	15 July 1988	–	–	–	–	Desai, M.R. (1988, pers. comm.)
7. Yediyar area	Tumkur	–	1 male (Trapped for Mysore Zoo)	1987	?	–	–	–	Karanth, U. (1987, pers comm.)
8. Rampura village, 4 km from Raichur	Raichur	–	2	Sept. 1989	–	–	–	–	Mohiuddin (1989, pers. comm.)

Saharanpur in Uttar Pradesh (Fig. 1). It has totally disappeared from Punjab and Haryana and the northern parts of Uttar Pradesh mainly because of poaching and alteration of its grassland habitat. Punjab and Haryana are semi–arid (average annual rainfall less than 700 mm) and hence perfectly suitable for the bustard. However, owing to the development of irrigation projects, the open scrublands and grasslands have been converted into croplands. These two states have now become the granary of India and practically no area is left for the bustard and other denizens of the grasslands. Similarly the plains of Uttar Pradesh are now more or less covered by cropfields, especially in the fertile northern belt from Saharanpur to Lucknow (where the bustards was earlier seen, Fig. 1). There are still some chances of sighting bustards in the southern parts of the state, namely in Agra, Etawah, Banda, Lalitpur and Jhansi districts which still have some open scrublands with marginal dryland crops. In such areas bustards can come from adjoining Madhya Pradesh. Moreover, on both sides of the interstate border, crops suitable for bustards (Bengal gram *Cicer arietinum*, groundnut *Arachis hypogea*, taramira *Eruca sativa*, wheat *Triticum* spp. and mustard *Brassica campestris*) are grown and the bustard can move to these parts in search of food.

Comparing the old sight/hunting records in Uttar Pradesh and Rajasthan (Fig. 1), it appears that the bustard was more common in Uttar Pradesh than in Rajasthan, because there are more records from the former than the latter (13 in U.P. v. 9 in Rajasthan). This discrepancy is mainly because of a very high human population in Uttar Pradesh, and hence more recorders, not due to high bustard density. As reported earlier, the Thar Desert was a comparatively remote area in the early part of this century, thus few naturalists or hunters could go there, resulting in fewer records in spite of the Thar being the major stronghold of this species.

Numberof the bustards: As reported earlier, without knowing the home range and movements of the bustard, it is not easy to estimate the number because we do not know how far they move and whether the same birds are seen in different places or they are different individuals. If the bustard does not move, say from Rajasthan to Andhra Pradesh, then the number of bustards may be between 1500 and 2000, with Rajasthan having more than half the number (Table 7).

However, if the birds can move long distances, up to a thousand kilometres or more, and the same individuals are seen in many places such as Rollapadu, Nanaj and Sudasari then the population is very low, perhaps less than 500. The number of bustards at Nanaj (Rahmani and Manakadan 1986) and at Rollapadu (Manakadan and Rahmani 1989) varies from season to season with maximum numbers being seen during the monsoon period and minimum in late winter and summer. In contrast, in Sudasari in the Desert National Park we were told that the maximum number of bustards (even up to 70) are seen during the hot summer months of May and June, and less during the monsoon (mainly the breeding birds?). The most plausible explanation is that during summer the bustards are attracted to the waterhole of Sudasari and come from the nearby areas in search of water. However, in the absence of ringing data we cannot overlook the possibility of bustards coming from far off places such as Nanaj or Rollapadu, especially when they are not seen there in summer.

The question is: where do most of the bustards of Rollapadu go in summer? (only 5 to 10 are seen in summer unlike 50 to 60 during early monsoon). Do they move to other states or spread out in the

TABLE 7
STATE-WISE POPULATION ESTIMATE OF THE GREAT INDIAN BUSTARD

State	Districts	Population estimate
1. Rajasthan	Jaisalmer, Barmar, Bikaner, Pali, Jalore, Bhilwara, Ajmer, Tonk and Sawai Madhopur.	500-1500
2. Gujarat	Jamnagar, Surendra Nagar, Kutch, Rajkot (?)	20-30
3. Madhya Pradesh	Shivpuri, Gwalior, Panna, Raipur (?), Guna (?)	50-100
4. Maharashtra	Solapur, Ahmednagar, Aurangabad, Pune, Kolhapur, Beed	70-100
5. Andhra Pradesh	Kurnool, Anantapur, Ranga Reddy, Mehboobnagar (?)	100-150
6. Karnataka	Dharwad, Tumkur, Bijapur, Mandhya (?), Raichur	30-40
	Total	770-1920

nearby areas? Unseasonal showers and cloudy weather conditions even during summer result in temporary immigration of some bustards to the grasslands of Nanaj and Rollapadu, indicating that the birds were in the vicinity.

Nonetheless, long distance movement of the bustard cannot be ruled out especially when many other species of bustards such as the houbara *Chlamydotis undulata* (Ali and Ripley 1969, Cramp and Simmons 1980, Mian 1984), little bustard *Tetrax tetrax* and great bustard *Otis tarda* (Cramp and Simmons 1980), lesser florican *Sypheotides indica* (Baker 1921, Ali and Ripley 1969, Dharmakumarsinhji 1950) show migratory tendency. A Kori bustard *Ardeotis kori* wing-tagged in South Africa has been recorded in southern Kenya (P. Goriup 1988 pers. comm.).

Perhaps the great Indian bustard also moves between the two arid areas of India, i.e. the Thar Desert and the Deccan Tableland. Unless we mark bustards and study their movement by radio–telemetry, we may never know the exact population of the bustard in India, and until we know its complete ecology and movements, we may never be able to evolve a long-term conservation strategy for this endangered species.

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APPENDIX 1
A LITERATURE REVIEW OF THE OCCURRENCE OF THE GREAT INDIAN BUSTARD (Till 1980)

S. No.	Place	No. of birds/ status	Dates	Reference
A.	UTTAR PRADESH			
1.	Jallalnugger (Oudh)	'sometimes seen'	–	Irly, L.H. 1861
2.	Kheri district	'procurable in 2 places'	–	Tweedie, M. 1878
3.	Mozuffernugger	'always to be found'	–	Butler, F.W. 1880
	Roorkee to Ghazeeabad	'are to be found'		
	Meerut district	'believed to extend'		
	East of Deobund	'seen during the rains'		
4.	East of Mozuffernugger	16	Winter	Wilson, F. 1880
5.	12 miles from Gurmukhtesar	1	5 June	Rayment, G.M. 1894
6.	Orai (Jalaun district)	3 seen	–	Gudlestone, M.A. 1911
7.	Mirzapur district	a few generally seen	Rains, Nov. and in March	Allen, G.O. 1919
8.	Mirzapur (south)	a nest; 'birds present throughout the year' (as many as 5 or 6)	Aug. 1943	Lowther, E.H.N. 1949
	Tundha (Agra Dist.)	1 shot	1925	
9.	Jhansi	A fine male	January 1956	Ganguli, U. 1975.
B.	PUNJAB AND HARYANA			
1.	Sirsa	Eggs collected	June, July, Aug.	Oates, E.W. 1902
2.	12 miles from Sirsa	1 killed	Hot months	Heath, R.H. 1905
3.	Ferozpore	2 seen drinking	15 May 1912	Jones, R.T. 1912
4.	Ludhiana district	'not likely to be found now'	–	Whistler, H. 1919
5.	Near Bhatinda (Bikaner state)	1 male, 2 females shot	Feb. 1906	Aitkin, A.B. 1912
C.	MADHYA PRADESH			
1.	Morar (Gwalior)	'native trappers-catch them in the neighbourhood'	–	Bevan, R.C. 1868.
2.	Neemuch	'fairly common'	Egg found in July	Barnes, H.E. 1886
3.	Saugor (Sagar)	1; 'very rare in these parts'	15 July 1934	Deeks, E.P. 1935.
4.	Esagarh (Gwalior) near Mohana; along Deharda Esagarh Road along Pachchar-Esagarh, near Sarushkein; West of Gwalior near Tighara and Pagara; near Jaura in Morena dist.; along Shivpuri-Pohri road	becoming increasingly rare and greatly persecuted by shikaris		Ali, S. 1939
5.	Between Tilda S.E. Railway and Khorora on Pallare Road in Raipur district, Chhattisgarh area	1 shot 3 seen; 'found in good numbers'	1960 or 61 1965	Bharos, R.R. (pers. comm.)
D.	RAJASTHAN			
1.	Sambhur Lake	Never seen personally; reported shot by Railway engineers	–	Adam, R.M. 1873
2.	Sambhur Lake	2 —1 shot	mid-Feb.	Adam, R.M. 1874
3.	Further north of Mt Abu in Rajpootana	'Tolerably plentiful'	–	Butler, E.A. 1876
4.	Jodhpur	'Uncommon'	–	
5.	Rajpootana	'Plentiful'	–	Barnes, H.E. 1891
6.	Pokaran (Jaisalmer)	'A bird caught'	Aug. 1970	Gupta, P.D. 1974
7.	Ramdeora (Jaisalmer)	'Appreciable numbers '	–	Prakash, I. & Ghosh, P.K. 1963
8.	Shahpura (Bhilwara)	14	winter 1974	Kumar,S. (1986, pers. comm.)

Appendix 1 (Contd.)

S. No.	Place	No. of birds/ status	Dates	Reference
E.	GUJARAT			
1.	Kutch	Not common	–	Stoliczka, F. 1872
2.	Kathiawar	'Common'	–	Lloyd, J.H. 1873
3.	Kathiawar	'Very common'	–	Butler, E.A. 1876
	Kutch	Uncommon		
4.	Sorath Prant (Kathiawar)	'50 close to headquarters alone'	–	Carter, J.R. 1912
5.	Northwest of Kutch (Mandvi)	9 birds (one albino)	30 Jan. 1926	Vijayraji, Maharaja Kumar 1926
6.	Kutch	'A small chick'	11 Oct. 1942	Vijayraji, Maharao 1943.
7.	Kutch	Resident, not common or abundant.	–	Ali, S. 1945
		Egg (Baker's record)	January	
8.	Jasdan (Kathiawar)	'Some birds, a nest and eggs'		
		'More or less vanishing from Kathiawar	–	Jasdan, Shree Yuvraj of, 1947
9.	Gowane (Jamnagar)	'Up to 30'	Till 1962	Jadeja 1984 (pers. comm.)
10.	Nerona village near Banni (Bhuj)	7	1967	Himmatsinhji, M.K. 1985 (pers. comm.)
	Bhadra, Lakhpat	A male and female		-do-
	Malia, Dhrangadhra and Wankaner	2 to 4 birds each	Middle of 1970s	-do-
	Dhaneti (Bhuj)	1 shot	1946	-do-
F.	MAHARASHTRA			
1.	'Dukhan' (Deccan)	'Common'	–	Sykes, W.H. 1834
2.	Ahmednagar district	'Becoming scarce'	–	Fairbanks, S.B. 1876
3.	Deccan	'Common and breeds'	–	Davidson, C.S. and Wendon, C.E. 1878
4.	Miraj, Sholapur	'Common'		Butler, E.A. 1881
	Nagar (Ahmednagar)			-do-
	Poona	'Also occurs'		
5.	Malegaun	80-100	*c.* 1840	Fraser, T.G. 1881
6.	Dhulia	'Nesting'		
	Deccan	'Found in considerable numbers'	–	Simcox, A.H. 1913
7.	Ahmednagar Dist.	961 shot by Col. Mansfield	between 1808-1833	Elliot, W. 1880
	Scindaghi (Solapur)	2 displaying males and several hens	12 Oct 1829	-do-
	'South of Kistna'	A hen with a 2 egg nest	–	-do-
8.	Aurangabad (Vijapur) Parbhani Nander	2 males shot	20 Oct. 1924	Ali, S. 1934
9.	Ahmednagar-Manmad (Vambori)	200-300	1923	Tyabji, F.H.B. 1952
	Kotagaon station (25 miles from Manmad)	400	1926	-do-
10.	Araugaon (east of river Mendhaka)	2 birds	6 Oct. 1966	Dangre, B.J. 1966
G.	ANDHRA PRADESH			
1.	Guntakal towards Gazerapally	17 birds (13 in one flock)	between 1893 and 1895	Burton, R.W. 1953
2.	Banganapiliny	Falconry practised	–	Elliot, W. 1880
3.	Hyderabad State (including Hyderabad, Farahabad, Borgampad, Nelipaka, Poloncha, Narsampet and Asifabad)	'Not met with by the Survey'	–	Ali, S. 1934
4.	Kurnool District	'Often to be had in the cold season'	–	Tostems, C.A. 1887

APPENDIX 1 (Contd.)

S. No.	Place	No. of birds/status	Dates	Reference
H.	ORISSA			
1.	Burga (Sambalpur)	One pair (one collected)	–	Ball, V. 1876
	Raipur (now in Madhya Pradesh)	'Occasionally met with'.	–	
2.	Sambalpur, South of Makandi, Raipur	–	–	Ball, V. 1878
I.	KARNATAKA			
1.	Raidroog near Bellary	12	–	McMaster, A.C. 1868
2.	Belgaum	Occurs	–	Butler, E.A. 1881
3.	Ten miles west of Bangalore	1	–	Baker, H.R. and Inglis, C.M. 1930
	Seringapatan and Cannanore Neighbourhood of Nellore	A couple of them	Jan. 1910	-do-
4.	Mysore District	3 shot by Major Phythian-Adams	–	Ali, S. 1934
	Near Nelmangalam (40 miles from Mysore city)	1 shot by Mr. Van Ingen	Jan. 1940	-do-
	Hiiriyur–Chitaldrug	'Occur sparingly'	-do-	-do-
	Around Huliyar	'Eminently suitable terrain'		
5.	Kondajji near Davanagere (Chitradurga dist.)	3	1975	Karanth, U. (1985, pers. comm.)
6.	Bukkapatna, Sira taluka (Tumkur district)	some	1973	(Seen by S.K. Varadaraj, retired Chief Wildlife Warden)
7.	Ranebennur Blackbuck Sanctuary Dharwad	15, plus an egg	May 1976	Neginhal (1980)
J.	TAMIL NADU			
1.	Samayapuram, 10 miles north of Trichinopoly	A male shot and preserved	25th Feb.	Leigh, C. 1924
2.	Madura district	'Bustards are occasionally met with' (Nelson's Gazetteer in 1868) 'Near extinction now'	–	Nichols, E.G. 1945
3.	3 miles west of Arupacottah	Shot one and saw 7 or 8 Also 'repeatedly seen eight or ten of a morning near the same place which is on the borders of Madura and Tirunelvelly' 'Come to these plains (in Tinnevelly and Madura) about Sept./Oct.'	Some years ago	Tostems, C.A. 1887
4.	Plains	'Occasionally met with'	–	Hamilton, D. 1892
K.	PAKISTAN (SIND)			
1.	Kurrachee	One shot	–	Hume, A.O. 1873
	Thar and Parkur districts	'Not very uncommon'		
2.	Greater part of Sind	Very rare	–	Butler, E.A. 1876
3.	Thar and Parkur districts	'Common'	–	Butler, E.A. 1878
	Lower Sind	'Occurs occasionally'	–	
	Indus (near Hyderabad)	One shot	–	
4.	Thar and Parkar districts	5 obtained for Museum	–	Priestly, E. 1911
5.	Manthar (Bahawalpur)	'A pair"(?); said 'to be rare here'	–	Ali, A.S. 1940
6.	Sind	'Declining rapidly'	–	Holmes, D.A. and Wright, J. O . 1968.

RESULTS OF A PILOT SALTWATER CROCODILE *CROCODYLUS POROSUS* SCHNEIDER RESTOCKING IN BHITARKANIKA WILDLIFE SANCTUARY, ORISSA[1]

S.K. KAR[2] AND H.R. BUSTARD[3]

(With two text-figures)

This paper describes the rehabilitation of the saltwater crocodile *Crocodylus porosus* Schneider into the river systems of Bhitarkanika Wildlife Sanctuary, Orissa, as a part of the Conservation Programme of the species using 'grow and release' techniques. The first pilot release was carried out in April/May 1977 with a release of 15 crocodiles of 1.2 m length (approx.) into the wild. Movement, dispersal and their adaptability in nature was recorded. A few released crocodiles created a problem—so-called 'man and crocodile conflict'– which has been overcome to a great extent by capturing and again releasing them in suitable release sites away from human habitation.

INTRODUCTION

Bustard (1974) and Daniel and Hussain (1975) both referred to the area which is now the Bhitarkanika Wildlife Sanctuary and mentioned the problems facing the saltwater crocodile population inhabiting the area. The State Government of Orissa acting through the State Forest Department in 1975 initiated a conservation programme to conserve and study the saltwater crocodile. The first action taken was to gazette the area as a sanctuary (Kanungo 1974). Bhitarkanika Wildlife Sanctuary was gazetted on 22 April 1975.

It was realised that unless the wild population was strengthened by release of captive-reared crocodiles into the wild, recovery of the seriously depleted population would either not occur or would be delayed.

A programme of active management was taken up in which saltwater crocodile eggs were collected from the wild as soon as laid for hatchery incubation. The resultant young were reared to a size of 1-1.2 m prior to release back into well protected areas of the natural habitat.

Bustard (1975) gives an account of the early work in developing the saltwater crocodile Research and Conservation Centre at Dangmal within the Bhitarkanika Wildlife Sanctuary and points out the key management objectives. De Waard (1975) also stressed the importance of protection and management in this sanctuary. A detailed survey carried out in the creeks and river of this 141.0 sq. km sanctuary between 1 December 1976 and 31 January 1977 indicated the presence of only 29 adult crocodiles (Kar 1981, Kar and Bustard 1981, 1989). Recruitment was also extremely poor, only six individuals being recorded between the length 1.8 and 2.2 m. The present paper describes the first pilot release carried out in April/May 1977. The release site selected was unsuitable which makes it important to document reasons for and the consequences of this choice.

MATERIAL AND METHODS

Selection of release site: It is crucial that the release site(s) be chosen with care in order to select ideal areas of the natural habitat, free from disturbance, of all sorts, where it would be possible to re-establish a sizeable crocodile population. The first release site was selected at Dangmal creek which runs immediately behind the Centre and is very close to Dangmal village.

Timing of release: Crocodiles were released several months prior to the onset of the monsoon, in order to ensure that they had adequate time to become familiar with the habitat before the annual floods. Two crocodiles were released late on 25 April 1977, three on 26 April 977 and ten on 5 May 1977.

Selection of crocodiles to be released: Size of the crocodiles for release is the most important parameter as the release of crocodiles from captivity to the wild involves change from the limited surroundings of the yearling pool (4 x 4 x 1 m depth) to a vast area. In order to maximise future survival in the wild, the crocodiles selected for release were 1-1.2 m in total length. At this size they are able to protect themselves from most potential enemies.

Marking of crocodiles: Prior to release, all

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crocodiles were tail scute clipped for subsequent recognition. The standard method adopted by the Government of India/FAO/UNDP-assisted Project Crocodile Breeding and Management was used. One side scute of the first double row of scutes (beginning at the single row of posterior scutes) was clipped to signify the year of release and here it signifies the first year release. For successive years the scute immediately anterior to the scute clipped in previous years and so on is clipped to designate year classes. The scute on the left side is clipped in the case of females and the corresponding scute on the right in the case of males. The scute cuts easily and cleanly near the base using a sharp knife and generally there is little bleeding. Antiseptic is applied to the wound. Such cut scutes do not regenerate. In the year 1977 all the crocodiles for release were females so the left side of double row scute was clipped for all 15 crocodiles (Fig. 1.)

The whole creek from the mouth to the saline embankment was divided into 10 sections each 0.3 km in length. The point of release was designated as 'O' and upstream towards the blind end the sections were numbered + 1, + 2, + 3, + 4, + 5, + 6, + 7. Downstream from the release point to the mouth of the creek the sections were marked –1, –2, –3 (Fig. 2).

RESULTS

The released crocodiles were monitored regularly in order to record data on their movements and behaviour in the wild. Both day and night observations were carried out on the released crocodiles. Night time was chosen for detailed monitoring as all individuals could readily be seen after dark using a 5 cell torch or spotlight.

All census work reported here was carried out by boat, no other method being practicable due to the dense mangrove forest fringing the creeks. Local country boats used in the normal protection patrols within the sanctuary, were employed for the census. These vessels are eight metres overall and are crewed by three boatmen – two on the oars and one on the rudder. One of us (S.K.K.) operated the light source.

At night the tapetum of the crocodiles' eyes reflected light, enabling individuals floating on the water surface (the normal alert posture after dark) to be sighted on distances of over 0.5 km with a powerful spot.

Surveys in tidal rivers and creeks irrespective of whether they are conducted by day or by night are greatly affected by the state of the tide. When the tide is high, crocodiles will be missed

a) by day because the basking mud banks will be inundated and any crocodiles which have emerged will be within the vegetation zone where they are likely to be missed,

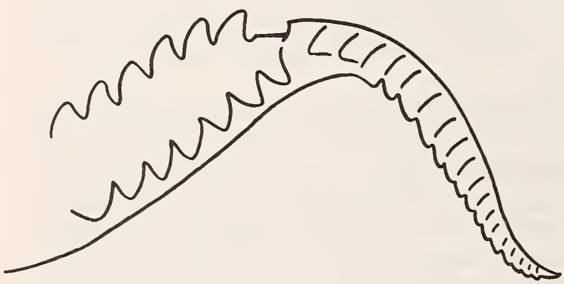

Fig. 1. Details of distal portion of *C. porosus* tail to show the clipping code used to indicate sex and year class.

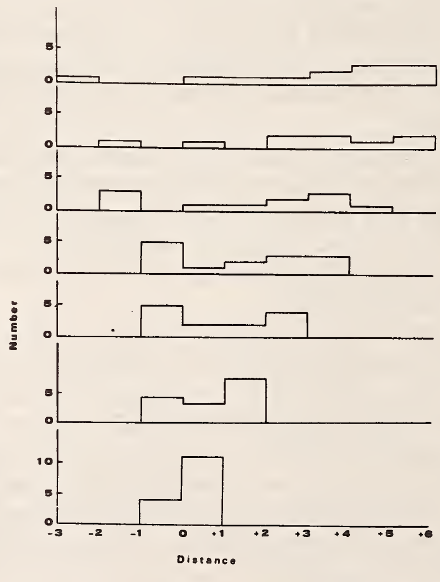

Fig. 2. Dispersal of yearling crocodiles returned to the wild in 1977. Each unit of distance represent 0.3 km. The figure shows the dispersal in succeeding months commencing one month after release and should be read from the bottom upwards.

TABLE 1
MONITORING RESULTS FOR 1977 RELEASED CROCODILES

Date of monitoring	Number of crocodiles observed in different places A	B	C	Total Number	Location in relation to release site	Remarks
30 May 1977	4	11	–	15	–1 to 0 and 0 to +1	Found in a limited place.
15 June 1977	4	10	–	14	–1 to 0, 0 to + 1, +1 to 2	Gradually moving towards the blind end.
1 July 1977	5	8	–	13	–1 to 0, 0 to + 1, +1 to 2, +2 to +3	-do-
15 July 1977	5	9	–	14	–1 to 0, 0 to + 1, 1 to 2, 2 to 3, 3 to 4	-do-
30 July 1977	3	8	–	11	–2 to + 1, –1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5	3 crocodiles were observed moving towards the main river.
15 August 1977	1	8	–	9	–2 to –1, –1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6	Crocodiles close to blind end of creek.
30 August 1977	1	11	–	12	–3 to –2,–2 to –1, –1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6	-do-
15 September 1977	2	10	–	12	–3 to –2, –2 to –1,–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6	-do-
30 September 1977	1	9	–	10	–2 to –1, –1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7,	Almost near the blind end.
15 October 1977	1	8	–	9	-do-	-do-
30 October 1977	–	8	–	8	–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5 5 to 6, 6 to 7	3 crocodiles went into Bhitarkanika river.
15 November 1977	–	7	–	7	-do-	-do-
30 November 1977	1	7	–	8	-do-	-do-
15 December 1977	1	8	–	9	–1 to 0, 0 to 1, 1 to 2 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7	-do-
30 December 1977	1	7	–	8	-do-	Limited to Dangmal creek.
30 January 1978	1	7	4	12	-do-	4 entered into paddy fields close to Dangmal village
28 February 1978	–	6	4	10	–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7, and in the paddy field.	-do-
31 March 1978	1	7	4	12	-do-	-do-
30 April 1978	1	7	4	12	-do-	-do-
31 May 1978	–	6	4	10	-do-	-do-
30 June 1978	1	6	4	11	-do-	4 crocodiles are caught from paddy field and released in Ganjeikhia creek.

TABLE 1 (Contd.)

Date of monitoring	Number of crocodiles observed in different places A	B	C	Total Number	Location in relation to release site	Remarks
31 July 1978	1	4	4	9	–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7, and in the paddy field	4 crocodiles were caught from paddy field and released in Ganjeikhia creek.
31 August 1978	1	7	4	12	–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7, and Ganjeikhia creek.	-do-
30 September 1978	1	5	6	12	-do-	Other 2, excluding Ganjeikhia, 4 entered the paddy field.
31 October 1978	–	5	7	12	-do-	1 more entered into the paddy field.
30 November 1978	1	3	7	11	-do-	-do-
31 December 1978	1	4	7	12	–1 to 0, 0 to 1, 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7.	5 crocodiles in the Dangmal creek plus 4 in Ganjeikhia creek plus 3 in the paddy field.

A-Release point to blind end of the creek, B-Release point to mouth of the creek, C-Crocodiles available in Ganjeikhia creek and paddy fields.

b) by night because smaller crocodiles (less than 2 m) usually remain close to the creek-banks. When the tide is high the reflection of their eyes may be hidden by overhanging vegetation. If the tide has flooded the bank, these crocodiles may be in the vegetation zone itself. In either situation the eye reflections are likely to be missed. Accordingly all surveys were carried out when the tide was half or less, i.e. when there was a drop of at least 1.5 m from the fortnightly high tide level.

In night survey work it is important to carry out the surveys during the darker phases of the moon. Nights on which work can be completed prior to the moon rising are best. When the moon is visible and there is little or no cloud cover, good results cannot be expected. With a moon more than one quarter full, since the spotlight is less effective under such conditions, the crocodiles are more likely to detect the approaching vessel (and hence not permit close approach).

Crocodiles were monitored between 1900 and 2300 hrs. Except for four occasions when the 6 volt spotlight was used, the rest of the time the crocodiles were monitored using a five-celled torch. Although the spotlight rendered the crocodiles' eyes visible from a much greater distance than with the 5-cell torch there was no difference in the total number observed using the two methods.

Staff were trained so as to be able to bring the dinghy very close to the crocodiles when sighted without disturbing them. Complete silence was observed.

The behaviour of the released crocodiles differed from wild crocodiles in the distance to which the dinghy could approach. The released crocodiles, for at least 4-5 months, permitted approach to within 1 m. They appeared less sensitive to disturbance than wild juveniles. About 10-15% of the crocodiles were positively identified from their scute clipping. In the muddy waters of Bhitarkanika, it is only when the crocodile keeps the tail portion slightly above the water and also permits approach to within 2–3 m that such positive identification is possible when they are in the water. The remaining crocodiles were monitored only from knowing their behaviour.

The first monitoring of the released crocodiles took place on 30 May 1977. All 15 were sighted within 1-0 and 0-1, that is, within a distance of 0.6 km (Table 1 and Fig. 2). Then up to the end of the year (31 December 1977), these crocodiles were regularly sighted at approximately fortnightly intervals, and upto 31 December 1978 at monthly intervals. As can be seen from Table 1 and Fig. 2, the crocodiles showed a strong tendency to move progressively upstream separately towards the

TABLE 2
SIZE OF RELEASED CROCODILES AT THE TIME OF RECAPTURE

Crocodile number	Date of release	Date of recapture	Period between release and recapture	Size of Crocodiles At release Length (m)	At release Weight (kg)	At recapture Length (m)	At recapture Weight (kg)	Remarks
7	5 May '77	9 May '78	1 year, 4 days	1.07	3.82	1.1	3.78	Weight decrease 2.3%
2	25 April' 77	11 May '78	1 year, 16 days	1.09	3.95	1.14	4.33	Weight increase 9.6%
10	5 May '77	18 May '78	1 year, 13 days	1.00	2.90	1.03	3.35	Weight increase 15.5%
14	5 May '77	23 May '78	1 year, 18 days	0.99	3.04	1.03	3.00	Weight decrease 1.3%

saline embankment bisecting the creek. On 30 September 1977, ten crocodiles were sighted and these were scattered from –2 to +7, that is, some had already reached the area of the embankment (Fig. 2). On 30 December 1977, eight crocodiles were sighted and these were distributed from – 1 to +7. In the month of January 1978, it was reported by the people of Dangmal village, that four crocodiles were in the paddy fields and while monitoring on 30 January 1978 this was confirmed. A total of 12 crocodiles were located, including four which had escaped into paddy fields.

In the month of June, four crocodiles were caught from the paddy fields and were released into Ganjeikhia creek, a small (2.5 km) associated creek of Bhitarkanika river which ends blindly in the Bhitarkanika Reserve Forest. This creek has no resident adults at the present time and only two naturally occurring juveniles of 1.1 -1.4 m (Kar and Bustard 1989). The four crocodiles were released in the middle portion of the creek. In the same month (30 June 1978) seven crocodiles were sighted in Dangmal creek, distributed from –1 to +7. In the month of September, two more entered into the paddy fields from Dangmal creek and while the creek was searched on 30 September 1978, only six were found distributed from –1 to +7. In the month of October 1978, a released crocodile was seen in a pond which belongs to Bengali speaking settlers of Dangmal. In December 1978, both Dangmal creek and Ganjeikhia creek were searched to locate the position of released or re-released crocodiles. In Dangmal creek only five crocodiles were reported and those were distributed from –1 to +7. In Ganjeikhia creek all four re–released crocodiles had settled down in the middle portion of the creek. A total of 12 crocodiles, including these four, were found up to the end of the year 1978, including the three crocodiles which were found in the paddy fields. The remaining released crocodiles were not sighted; they had probably gone into the main river.

Survival: Of the 15 crocodiles released in 1977, 12 (80%) are known to have definitely survived after two years. The whereabouts of the remaining three are not known. However, there is no evidence to suspect that they have been lost from the population. The four crocodiles recaptured from the paddy fields and relocated in Ganjeikhia creek were reweighed and measured at the time of capture. The data given in Table 2 indicate that little growth had taken place in one complete year in nature (mean length increase 3.57 cm). Furthermore, two individuals showed weight increases of 9.6 and 15.5%, the other two showed very small weight loss over the year. It is not known to what extent these reflect their entering the unnatural habitat of the paddy fields. Hence, the data should be treated with caution as they may not be typical of the growth of those released individuals which remained in the usual creek habitat.

DISCUSSION

The pilot restocking exercise underlined the importance of choosing the release site most carefully. The site selected in 1977 was unsuitable for a number of reasons. Particularly, it allowed ready access of the released crocodiles through a sluice in the saline embankment into the unnatural habitat of paddy fields where, naturally, the crocodiles came into close contact with people. A major management objective for the sanctuary is to separate people and crocodiles as far as possible.

However, the release offered an excellent opportunity, due to the small size of the creeklet chosen and its proximity to the Research Centre, for data collection on post-release dispersal and especially on survival.

The 1977 release also took place late (in late April and May) whereas the ideal time for release is the end of the winter, around mid February. The late release may also have contributed to the entry of animals into the paddy fields due to the floods coming before they had fully settled down and become familiar with the geography of the release site.

The crocodiles had been released into a creek bisected by a saline embankment. There was good river habitat on the upstream side of the embankment but the adjoining lands had been cleared for paddy cultivation. The paddy fields form a rich source of prawns, the favoured article of diet both in captivity and in the wild for juvenile crocodiles up to at least 1.5 m (Kar 1981). The regular flow of water in and out of the paddy fields to the creek carries large numbers of these prawns, which proved attractive to the juvenile crocodiles, encouraging them to migrate to the upstream portion of the creek above the saline embankment. Once there, in the absence of the normal mangrove cover, they entered the paddy fields.

To sum up, the crocodiles were liberated into an artificial situation which they would never encounter under normal circumstances in the wild. They showed what was considered to be an abnormal response to this in gradually migrating up the creek, eventually entering into the paddy fields. We have no records of saltwater crocodiles ever occurring naturally in paddy fields in Bhitarkanika.

The normal movement pattern of crocodiles in their second year is to gradually move down the creek from the site where they entered the creek as hatchlings. This dispersal pattern is continued in the third year (Kar 1981).

The results described in this paper have to be taken into account in planning future release. Whereas some creeks are bunded with a sluice in the wall of the embankment resulting in two way water flow, other creeks have not been bunded and have a blind end. Of the seven major creeks of the Bhitarkanika block, four are bunded and three (on the Bhitarkanika island side) have blind ends.

The results of the 1977 release clearly show the disadvantages of carrying out major releases in bunded creeks. Quite apart from the released crocodiles showing abnormal behaviour under such conditions, they are brought into close contact with people, because the creeks have been bunded for agricultural purposes. The natural creeks, terminating in a blind end, have none of these disadvantages. In future, therefore, it is recommended that releases should not be carried out in bunded creeks.

The survival of the 1977 year class – 80% are definitely known to have survived after two years, with the possibility that the other individuals had also survived – is an excellent vindication of the 'rear and release' technique if any vindication is required.

Acknowledgements

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A PRELIMINARY ECOLOGICAL SURVEY OF ALGUAL SPRING, SARISKA TIGER RESERVE, RAJASTHAN[1]

W.A. Rodgers[2]

(With two plates & five text-figures)

The value of the dry deciduous forest biomes for wildlife is often determined by the presence of moister valley situations with permanent water sources. This paper describes one such valley site within the dry hill slope forests of Sariska Tiger Reserve. The valley and spring provide water, evergreen shade and cover, and fruit and fodder resources to a wide variety of mammals and birds. Plant species diversity is much higher than in the surrounding forest. Despite the importance of these sites, they rarely attract the management attention they deserve. Riverine vegetation cover is diminishing as seedlings fail to survive due to pressure from people and their livestock and larger individuals are cut and lopped. Some simple management inputs are suggested to restore these important communities.

Introduction

The wildlife carrying capacity of the dry deciduous forests of western and central India is largely determined by the number and distribution of moister valleys with their perennial water springs. These sites, which offer greater amounts of dry season cover and food (including nutritious fruits), as well as water, are thus key areas for management. All too often such areas attract the attention of human settlement and their attendant domestic stock. A village or cattle camp at a spring site makes it unavailable for most wildlife, but even casual human use may greatly reduce the spring's effectiveness as a wildlife refuge. Undergrowth cutting, heavy grazing, lopping and tree felling will reduce cover, restrict woody plant regeneration, reduce diversity and allow accelerated erosion and water loss.

Despite the obvious importance of these key areas they have received little attention in India's scientific literature. The typical species and size class composition of the vegetation, with discussion on patterns of diversity and regeneration, has not been described. Their importance as a habitat for animals and birds has not been documented outside the popular wildlife writings.

Recent ecological studies in Sariska Tiger Reserve, Alwar District, Rajasthan, show the importance of perennial springs and streams for wildlife. Their natural vegetation cover of a greater greenness and species diversity than the surrounding deciduous woodlands means they offer a greater wealth of habitat components to a wider variety of vertebrate and invertebrate animals than the more sterile artificial water points of recent management (Rodgers, unpublished observation). In November 1987, I had the opportunity to investigate an isolated water source in the main core area of Sariska, Algual Spring (Fig. 1). Botanical and ornithological expertise of scientists and members of the Bombay Natural History Society and Wildlife Institute of India allowed the rapid documentation of the floristic structure and composition, and avifauna at that period. This paper describes the results of this survey.

Study Site

Sariska Tiger Reserve of some 800 sq. km lies in the ancient Aravalli mountain range of western India. The highly dissected topography typically consists of steep sided plateaux divided by narrow rocky valleys. Geologically the area is a complex of the Delhi and Aravalli precambrian crystalline and metamorphic rock systems of quartzites, conglomerates, grits, granites and schists.

The area is semi–arid, annual rainfall averaging some 600 mm in a typical ten week July-September monsoon season. There is thus little significant rain for nine continuous months. Rainfall in 1986 and 1987 was much below normal and the whole region was suffering from a major drought.

The vegetation is briefly described by Parmar (1985). The plateau slopes are covered with a *Boswellia serrata–Anogeissus pendula* forest, and the flatter tops bear a more mixed dry deciduous cover. The broader valleys have an open woodland of

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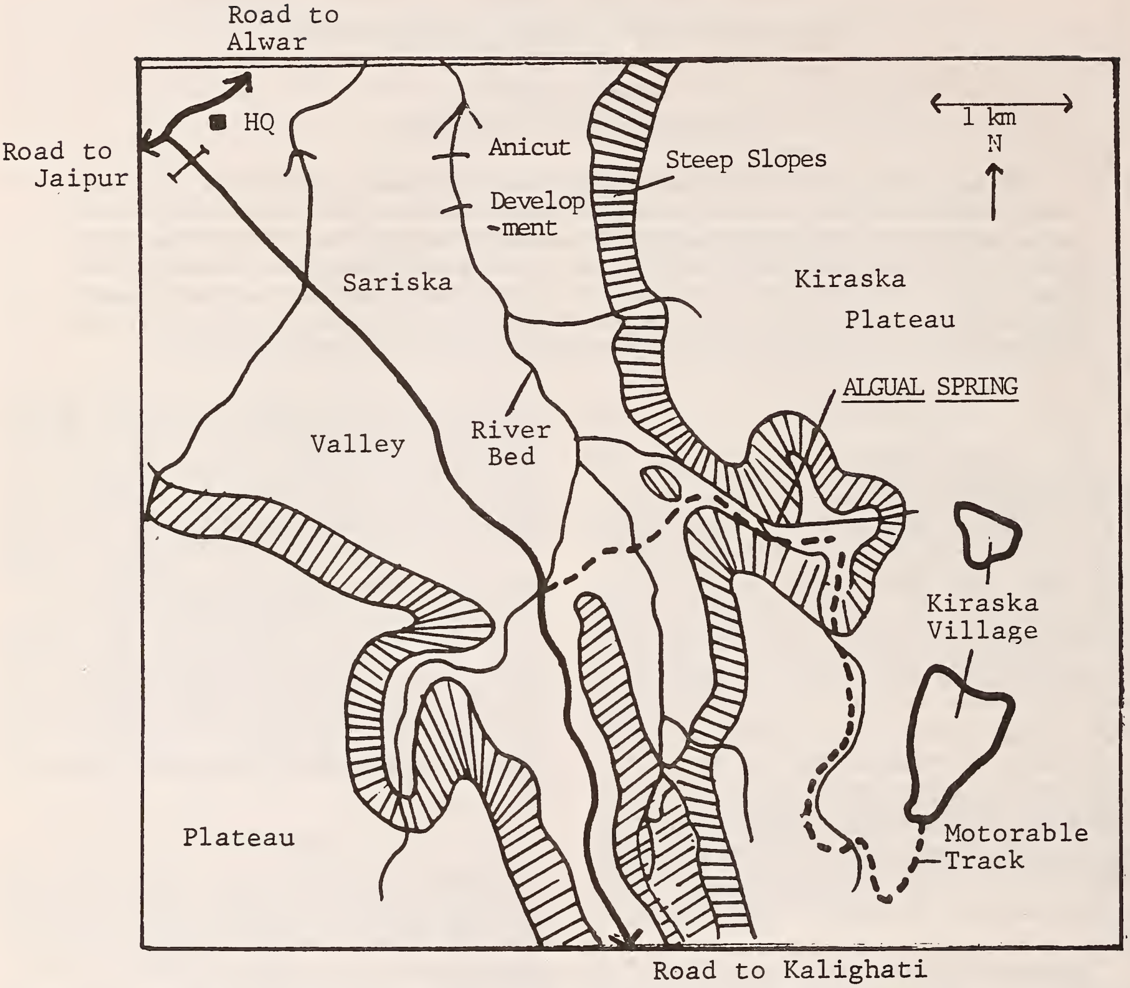


Fig. 1. Location of Algual Spring in Sariska Tiger Reserve, Alwar District, Rajasthan.

Acacia – Zizyphus – Butea on alluvium, degenerating to a *Zizyphus – Acacia – Capparis – Balanites* scrub where over–used or on gravel deposits. Steeper gorges may have perennial streams with a more evergreen *Phoenix – Ficus* mixed species riverine community.

Management as a major wildlife sanctuary and more recently as a Tiger Reserve has allowed the development of a large core area in which human and livestock exploitation is prohibited. The village of Karnawas and cattle camps at Slopka and Kalighati have been resettled, allowing a great increase in wildlife numbers and sightability. Seven more settlements are awaiting such movement, a process to be given priority now that National Park status has been approved.

The study site is illustrated in Fig. 2. Algual Spring is an isolated water source on the western foot of Kirashka plateau. The nearest alternative permanent water sites are all 2-3 km away: a tank at Kirashka village, a spring at Bharthari Mandir (now with settlement) and a small spring at Tarunda below the Kankwarhi plateau. At Algual water flows from 2-3 small springs and continues for about 100 m along a well defined stream bed with a distinct riverine vegetation cover up to 10 m wide. In the

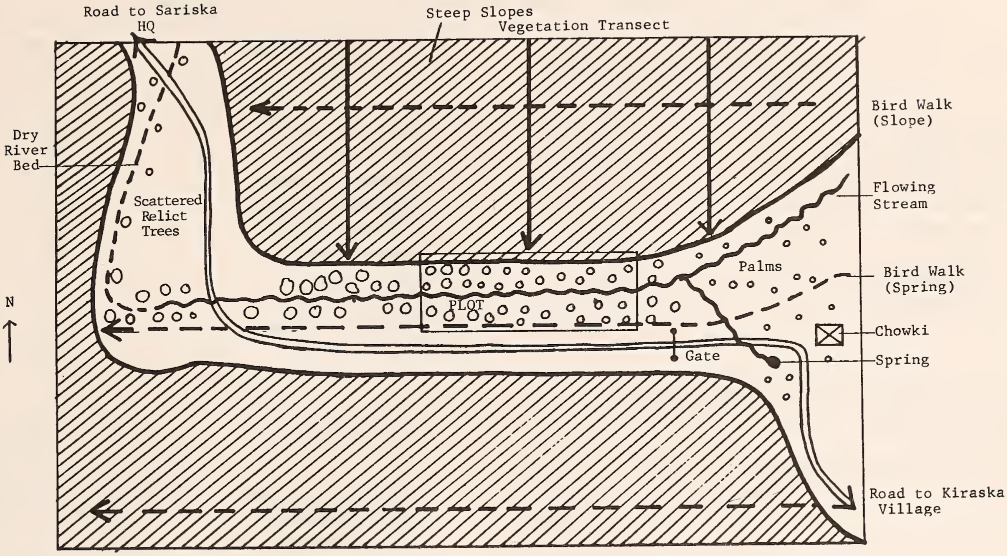


Fig. 2. Generalised diagram of Algual Spring and surroundings.

monsoon, temporary flood levels may reach 1.5 m above the stream bed for very short periods. Old ruins (a chowki and small shrine, plus demarcating walls) testify to the use of the spring in the Maharaja's time. In 1987 management has created a barrier to prevent cattle from Kirashka village (1-2 km away) gaining access to the lower spring in the dry season. The barrier and stricter controls on vegetation cutting etc. were enforced by a semi-permanent guard post at the spring. However, the barrier was broken in November 1988 and remains open to date.

Methods

The vegetation of the hill-valley system was initially surveyed by three parallel transects running down slope perpendicular to the stream. At approximately 20 metre intervals (25 paces) the vegetation and slope characteristics were described as follows: The nearest 5 trees (>3 m height) were identified and categorised into 1 m height classes. The nearest 5 shrubs (woody plant <3 m) were identified and shrub cover estimated in three classes. Dominant herb layer species were noted. Slope was subjectively described as precipitous, very steep, gentle or flat. Rock frequency was described as above 2/3 of ground cover, 2/3 -1/3 and below 1/3. Tree canopy cover was expressed as dense, medium or open.

The stream side vegetation was surveyed in more detail by a 30 x 10 m plot laid along and on either side of the stream. This plot was demarcated into 12 internal 5 x 5 m sub-plots, numbered north 1-6 and south 1-6. Within each sub-plot all woody plants with a girth of 10 cm or more at breast height were enumerated to allow profile description. Non-woody plants were assessed as present or absent in each sub-plot following a careful search. Woody plant data collected were: species, girth (of each stem), total height, canopy height (first foliage), canopy spread each side of the central stem along the plot long axis. Cutting signs and snags (hollows, holes etc.) were searched for. Plants that were not identifiable were collected for later identification.

Mammal presence was based on our past observations, pugmark collections, and identification of scat and tracks along the valley. Obvious drinking sites were identified and soil smoothed to facilitate track recognition on later days.

Bird presence and abundance were assessed by a series of formal bird walks on the afternoon of 29 November and morning of 30 November. Walks

TABLE 1
PLANT SPECIES COMPOSITION OF HILL SLOPE FORESTS ABOVE ALGUAL SPRING

A) Trees (n = 154) Species	Frequency %	Mean Height (m)	B) Shrubs (n = 240) Species	Frequency %
Boswellia serrata	31	13	*Grewia flavescens*	62
Anogeissus pendula	31	10	*Anogeissus pendula*	21
Euphorbia neriifolia	15	6	*Bauhinia racemosa*	5
Acacia catechu	10	7	*Euphorbia neriifolia*	3
Bauhinia racemosa	5	6	*Wrightia tinctoria*	3
Wrightia tinctoria	5	3	*Acacia catechu*	2
Diospyros melanoxylon	3	13	*Zyzyphus* spp.	1
Lannea coromandelica	1	8	*Capparis decidua*	1
			Capparis sepiaria	1
			Ficus tomentosa	1
			Dendrocalamus strictus	1

C) Ground layer plants prominent in the dry season:

Chloris dolichostachya | *Aristida funiculata*
Barleria prionitis | *Actinopteris radiata*

D) Dominant species of the monsoon:

Acalypha ciliata | *Alloteropsis cimcina*
Bidens pilosa | *Blainvillea acmella*
Chrysopogon montanus | *Cleome viscosa*
Corchorus aestuans

TABLE 2
ABUNDANCE PARAMETERS FOR WOODY PLANTS (GIRTH 10 CM GBH) IN ALGUAL SPRING STUDY PLOT

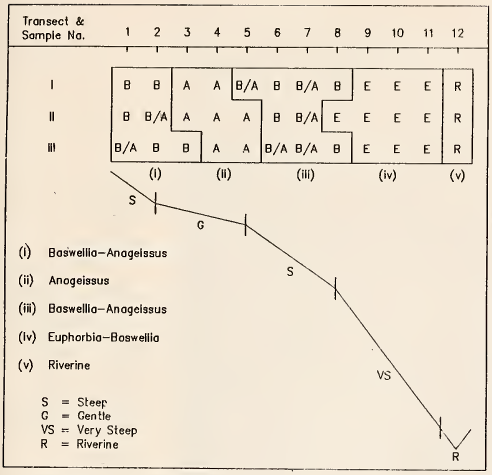
Species	N	%	(Density stems ha)	Basal area (sq.m/ha)	%	Regeneration
Phoenix sylvestris	20	49	670	44.1	33	++
Mallotus philippensis	6	15	205	1.7	1	++
Anogeissus pendula	3	7	96	3.9	3	++
Holoptelea integrifolia	2	5	68	3.0	2	0
Syzygium cuminii	3	7	96	22.4	17	++
Ficus glomerata	2	5	68	32.0	24	+
Grewia ? tilaefolia	2	5	68	0.1	0	0
Butea monosperma	1	2	27	20.9	16	0
Cordia dichotoma	1	2	27	3.7	3	+
Capparis sepiaria	1	2	27	0.1	0	+
Total	41	100%	1352	131.9	100%	

TABLE–3A
GIRTH CLASS FREQUENCY FOR *Phoenix sylvestris*

Girth Class (cm)	10-29	30-49	50-69	70-89	90-109	110-129	130-149	150-169	170+
%	0	5	10	45	30	5	0	5	(1 dead)

TABLE 3B
GIRTH CLASS FREQUENCY FOR ALL STEMS OF ALL INDIVIDUALS ENUMERATED

Girth Class (cm)	10-29	30-49	50-69	70-89	90-109	110-129	130-149	150-169	170-181	190-209	210+
%	24	7	9	28	15	4	0	24	2	0	7



i) *Boswellia – Anogeissus*
ii) *Anogeissus*
iii) *Boswellia – Anogeissus*
iv) *Euphorbia – Boswellia*
v) Riverine
S = Steep; G = Gentle;
VS = Very Steep; R = Riverine

Fig. 3. Vegetation and slope patterns to the north of Algual Spring. 12 sample points, along 3 parallel transects. See text for details.

were undertaken by experienced ornithologists along transects parallel to the stream; along the stream itself, and in the dry woods on the northern and southern slopes.

RESULTS

1. VEGETATION

Hillside vegetation: The features of the hillside vegetation are depicted in Fig. 3, and species frequencies given in Table 1. The slopes are dominated by an open *Boswellia* woodland to 13 m high, over a lower *Anogeissus pendula* layer with some *Acacia catechu, Bauhinia racemosa* and *Wrightia tinctoria.* The shrub layer which is sparse on the rocky ridge and denser on the slopes is totally dominated by *Grewia flavescens* with some *Anogeissus* regeneration. No *Boswellia* seedlings or saplings were seen here (or elsewhere in the reserve). The ground is extensively rocky with large boulders and slabs. Soil is largely removed, remaining in small pockets. A sparse herb layer is dominated by occasional tussocks of *Chloris* and *Aristida* with conspicuous *Barleria prionitis* to 0.5 m. Many other more ephemeral herbs were not obvious at this stage in the dry season. The dry fern *Actinopteris radiata* was frequent in rocky crevices. Some 10% of *Boswellia* trees had conspicuous *Dendrophthoe falcata* parasites (Loranthaceae).

Nearer the stream the slopes become very steep with a greater proportion of woody candelebra *Euphorbias* in the underwood layer to 10 m. The bamboo *Dendrocalamus strictus* is heavily cut over and now rare. A cross section is shown in Fig. 4. *Boswellia, Wrightia* and *Lannea* were totally

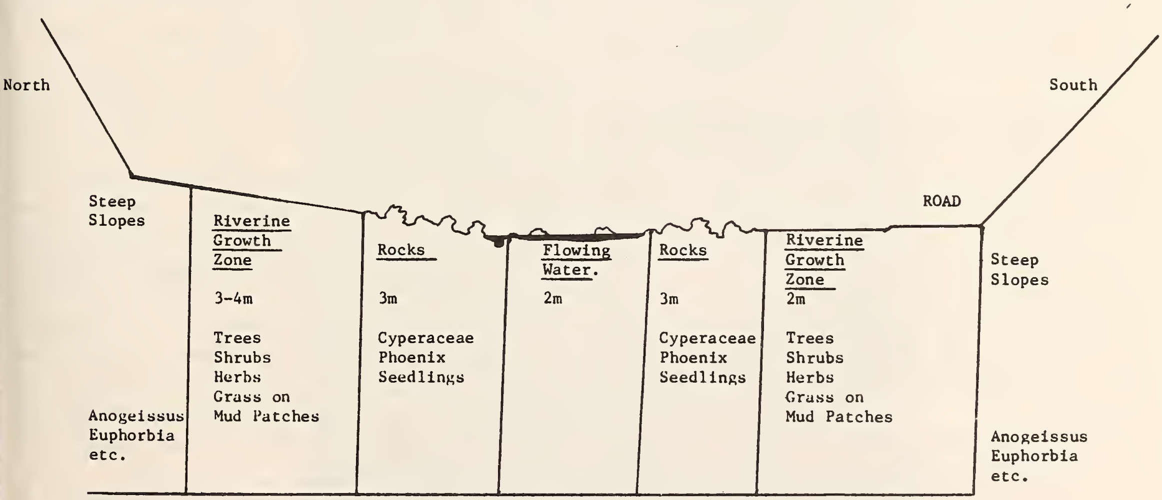


Fig. 4. Generalised cross section of Algual Spring showing major vegetation zones.

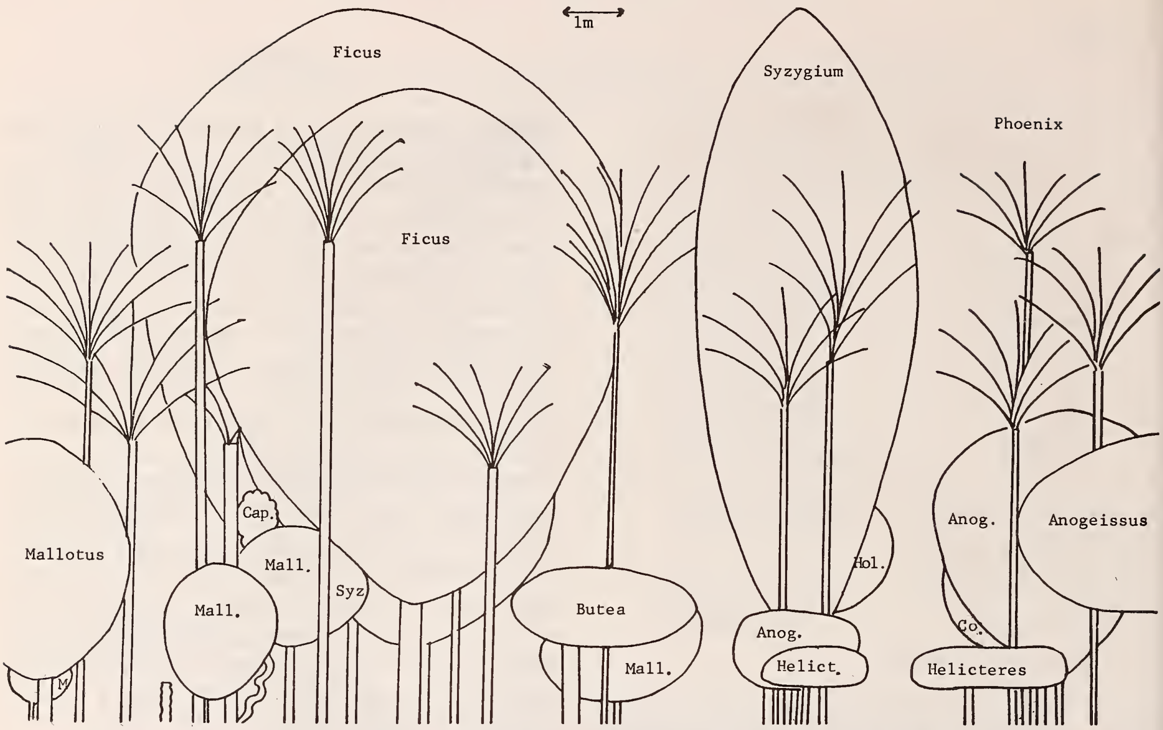


Fig. 5. Profile diagram of part of Algual Spring riverine vegetation viewed from north. Drawn to scale. See text for details.

deciduous, *Anogeissus* was rapidly losing leaf cover, *Acacia*, *Bauhinia* and *Diospyros* still retained a green canopy. *Grewia* lost most leaves early that year, probably due to the drought.

Riverine vegetation: Three facies could be recognized: a pure *Phoenix sylvestris* stand, a mixed stand with shrub layer, and an open stand of relict single trees with no shrubs. Our studies were in the mixed stand.

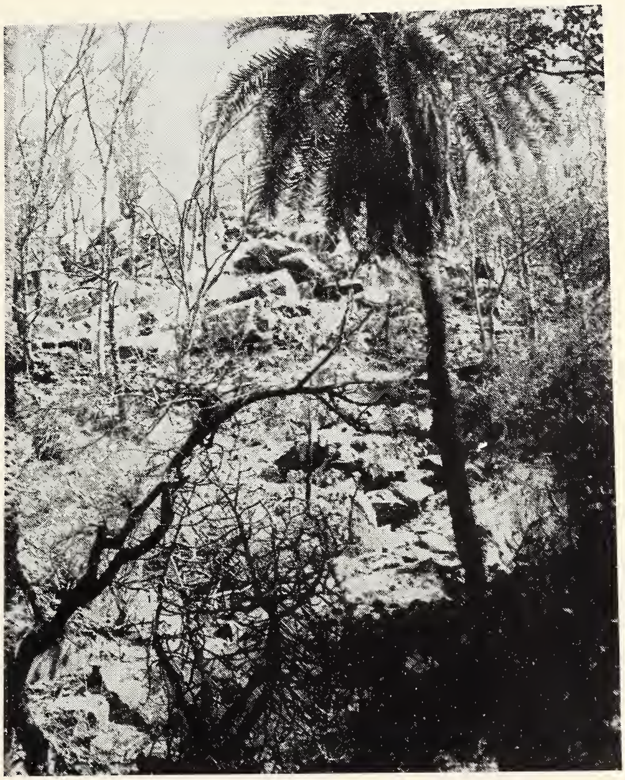
The profile diagram (viewed from the north) is shown in Fig. 5. The separation into an underwood layer to 8 m high and a canopy layer of palms and bigger trees from 10-18 m is quite distinct. The shrub layer is sparse, most members are tree saplings. There is only one liane, *Capparis sepiaria*. The diagram does stress the way fruit trees *Ficus*, *Syzygium* and *Phoenix* dominate the canopy. It is necessary to stress the narrowness of the community, averaging less than 15 m wide including the stream (Fig. 5.).

Abundance parameters are given in Table 2. *Phoenix* comprise almost half of all individuals at 49%, followed by *Mallotus* at 15%. The total density figure for trees above 10 cm gbh is 1367 individuals per hectare, a low figure for moist tropical forest. Basal area values are dominated by *Phoenix* (33%) with other major contributions by the few large individuals of *Ficus* (32%), *Syzygium* (22%) and *Butea* (21%). The overall value of 131.9 sq. m/ha is high, reflecting the number of large old trees that a productive riverine community can support.

The population of *Phoenix* trees shows a unimodal girth class frequency with a distinct peak around the 80-100 cm girth class (Table 3). There are no young trees or saplings. The abundant regeneration was all in the small (<20 cm high) seedling class. Table 3b shows the relatively low proportion of stems in the smaller size categories and the numerical dominance of larger individuals.

All woody species except *Butea* and *Holoptelea* showed some regeneration. For *Phoenix*, *Anogeissus*, *Mallotus* and *Syzygium*, seedlings were frequent. Other woody species represented in the seedling/sapling stages were *Grewia*, *Helicteres*, *Wrightia*, *Bauhinia*, *Flacourtia*, *Mitragyna*, *Cassia*, and *Linnea* (Table 6).

Over half the woody species are considered as fruit trees for frugivorous birds (*Phoenix*, *Ficus*,



Above: General view of country around Algual Spring looking northwest. Note rocky slopes with *Euphorbia* in foreground and leafless *Boswellia* behind. *Anogeissus* slopes in rear left.
Below: General view from shaded evergreen spring up slope to the north into open deciduous *Boswellia-Anogeissus* slopes.

Above: Phoenix sylvestris grove in the spring area. Note relatively bare ground, and low capability of stream bed to withhold monsoon water flow.
Below: Typical view of spring interior. *Ficus glomerata* (leaning into centre from left) is a major fruit source. Small *Mallotus* in rear centre. Note poor ground cover.

TABLE 4
FREQUENCY OF FRUITING TREES, CUTTING PRESSURE ETC.

Fruiting species	6/10	
Fruiting individuals	29/41	
Cut individuals	6/41	(6/21 non palms)
Lopped individuals	2/41	(1 *Butea*, 1 *Mallotus*)
Individuals with hollows, holes, snags.	5/41	(5/21 non palms)

Syzygium, *Grewia*, *Cordia*, *Capparis*) and these species contribute 70.7% to the total number of individuals (Table 4). Of the remainder, 2 species (another 22%) are major forage species, *Mallotus* and *Anogeissus*. Six out of the 21 non-palm individuals (29%) showed signs of branch cutting and two trees had been lopped for fodder. Five trees had major snags (hollows and holes) for animal and bird shelter.

TABLE 5
CANOPY DIVERSITY. ALL WOODY SPECIES AND INDIVIDUALS IN ALGUAL SPRING STUDY PLOT

Height (m)	Species	Individuals	% Fruit tree Individuals
0–2	3	6	0
2–4	6	13	31
4–6	7	10	63
6–8	7	14	67
8–10	4	15	100
10–12	3	12	100
12–14	3	11	100
14–16	3	5	100
16–18	2	3	100
18–20	0	0	–

Table 5 shows the canopy to have its highest

TABLE 6
PLANT SPECIES FREQUENCY OF OCCURRENCE IN ALGUAL SPRING STUDY PLOT GROUND LAYER

Species (Woody elements)	Frequency (x/12)	Species	Frequency (x/12)
		Grasses and sedges	
Anogeissus pendula	10	*Chloris dolichostachya*	6
Phoenix sylvestris	8	*Fimbristylis* sp.	4
Ficus glomerata	7	*Cynodon dactylon*	3
Grewia flavescens	6	*Dicanthium annulatum*	2
Syzygium cuminii	5	*Dactyloctenium aegyptiacum*	2
Mallotus philippensis	5	*Eragrostis tenella*	2
Helicteres isora	4	*Cyperus nutans*	2
Wrightia tinctoria	3	*Paspalidium flavidum*	1
Bauhinia racemosa	3	*Echinochloa colonum*	1
Flacourtia indica	4	*Aristida funiculata*	1
Capparis sepiaria	2	*Apluda mutica*	1
Mitragyna parvifolia	1	*Setaria verticillata*	1
Cassia fistula	1	Herbs	
Wrightia tomentosa	1	*Dicliptera roxburghiana*	9
Ichnocarpus frutescens	1	*Barleria prionitis*	5
Acacia sp.	1	*Cassia tora*	4
Celastrus paniculatus	1	*Corchorus acutangulus*	3
Lannea coromandelica	1	*Sida rhombifolia*	3
		Sida ? acuta	3
Species seen outside the plot		*Cardiospermum halicacabum*	2
Terminalia arjuna		*Rungia parviflora (pectinata)*	2
Diospyros melanoxylon		*Achyranthes bidentata*	2
Zizyphus mauritiana		*Phyllanthus urinaria*	2
		Euphorbia hirta	2
		Peristrophe bicalyculata	2
		Leucas mollissima	2
		Adiantum incisum	2
		Blumea lacinata	1
		Abutilon ramosum	1
		Triumfetta ?	1
		Bidens pilosa	1
		Plumbago zeylanica	1
		? Ipomoea pes-tigris	1
		? Commelina oblonga	1
		? Urena lobata	1

TABLE 7
MAMMAL SPECIES KNOWN TO FREQUENT ALGUAL SPRING

Species	Notes
Tiger *Panthera tigris*	Male + female from pugmarks
Panther *Panthera pardus*	
Jungle cat *Felis chaus*	
Jackal *Canis aureus*	
Hyaena *Hyaena hyaena*	
Toddy cat *Paradoxurus hermaphroditus*	Frequent droppings
Small Indian civet *Viverricula indica*	
Common mongoose *Herpestes edwardsii*	Seen in 1987
Ruddy mongoose *Herpestes smithi*	Seen in 1987
Chital *Cervus axis*	
Sambar *Cervus unicolor*	
Nilgai *Boselaphus tragocamelus*	
Chousingha *Tetraceros quadricornis*	One pair seen in 1985 and 1986
Wild boar *Sus scrofa*	
Domestic cattle *Bos indica*	
Five striped palm squirrel *Funambulus pennanti*	
Indian porcupine *Hystrix indica*	
Common langur *Presbytis entellus*	
(Bats, smaller rodents and insectivores were not searched for.)	

species diversity in the middle storeys, 4-8 metres. All trees above 8 m are fruit bearing species.

Herb layer sampling in November revealed a total of 50 species. This total includes 18 shrubs and woody seedlings, 12 grasses and sedges and 20 forbs. Much of the ground cover was running water, rock or gravel. One small area had a herb-rich *Cynodon* turf. Shrubs were infrequent – *Grewia*, *Helicteres* and *Capparis*. *Dicliptera roxburghiana* and *Barleria prionitis* were the commonest herbs. No climbing or epiphytic herbs were seen; grasses were heavily grazed.

2. Animals

Table 7 lists the 18 species of larger mammals known to frequent Algual Spring. Nine mammalian carnivores illustrate the importance of infrequent water sources for these animals. Jackal *Canis aureus* and toddy cat *Paradoxurus hermaphroditus* droppings were frequent. Herbivore tracks were dominated by sambar *Cervus unicolor*, although cattle tracks obscure most evidence to the east of the gate. One pair of chousingha *Tetraceros quadricornis* were seen at the spring in 1985 and 1986.

25 species of birds were enumerated on the census walks, 23 of which were found within the riverine vegetation. Details are given in Table 8. There is a difference in bird use of the vegetation types at different times of day. In the afernoon the hot dry woodlands were almost devoid of bird life, in great contrast to the spring. In the early morning, however, the spring was in shadow and many birds were seen in the warm sunshine on the south-facing wooded slopes. Many bird species are largely frugivorous or otherwise dependent on moister forest for insect food.

Discussion

Several points warrant further discussion; firstly, a methodological note. Useful ecological data can be collected in short intensive surveys by teams of capable naturalists. As such expertise does exist in India, then quantitative information can be obtained on a variety of plant and animal communities which urgently need documentation and conservation. Robust survey techniques are available which allow the development of baseline descriptions for future monitoring and the analysis of component variables.

Of primary interest in this Algual study is the great difference between the extensive deciduous dry woodlands of the slopes and the extremely restricted, largely evergreen moister forest around the spring. There is a sharp transition, defined by topography and moisture availability. Differences include species composition (but many woodland species do occur in the spring forest, e.g. *Anogeissus, Grewia, Wrightia*) but equally important are structure and deciduousness. The principal fruit trees of the spring are absent from the woodland.

Data show the spring does have a greater diversity of fauna and flora than the surrounding woodland. The paucity of water in the overall region stresses the importance of Algual to the wildlife community of Sariska.

Nearly all woody species of the spring show some tendency to regenerate, but size class frequencies suggest that biotic pressures have prevented regeneration for many years now. Much of this pressure has been due to people and their livestock. Relict trees and large gaps in the forest continuity suggest that pressures have long exceeded establishment.

The management authority of Sariska will have to take even greater initiatives to maintain and restore these riverine communities. Whilst posting watchmen can reduce cattle and pole cutting it may

Table 8
BIRD SIGHTINGS WITHIN ALGUAL SPRING FOREST AND ON ADJACENT HILLSLOPES

	Spring		Hill side		
Bird Species	PM	AM	PM	AM	Water/Fruit Dependence
Indian whitebacked vulture	1	1		3	
Red spurfowl	1				
Common peafowl	4	1			
Redwattled lapwing	1				++
Yellowlegged green pigeon	145	25			++
Roseringed parakeet	6	9		10	+
Whitebreasted kingfisher		P		1	+
Lesser goldenbacked woodpecker	1	1			
Grey shrike	P				
Whitebellied drongo	2			2	
Indian tree-pie	4	1		5	
Scarlet minivet		P			
Redvented bulbul	13	2	p	2	
Jungle babbler	3			8	
Greyheaded flycatcher	2			1	
Whitebrowed fantail flycatcher	1				
Lesser white throat		2			
Leaf warbler	1				
Black redstart		P			
Indian robin	2				
Grey tit	1			1	
Greynecked bunting		P			++
Indian roller				1	
Black drongo				2	
No. of species	17	12	1	11	
No. of individuals	188 +	42 +	few	36	
Combined species	29		12		
Combined individuals	230		40		

have its own problems of polluting waters by soap etc. Management must do two things. Firstly, reduce all pressure on the riverine forest, if necessary by removable fencing, allowing larger animals only limited access to water and shade. This can be done in sections, say one third of the water course at a time. Secondly, canopy gaps should be closed, by protecting natural regeneration and by planting selected indigenous tree species including figs, palms and other fruit bearers.

Algual is not unique to Sariska; there are several similar sites, all requiring similar levels of management input. The present efforts of management to provide additional water sources by developing anicuts is to be welcomed, but it will be many years before their surrounding vegetation supports the same diversity of wildlife as the natural riverine forest.

Acknowledgements

This paper has resulted from the efforts of many people, especially the 25 scientists and members of the Bombay Natural History Society who participated in the Habitat Workshop at Sariska. My colleagues at the Wildlife Institute helped in the field and commented on earlier drafts. I thank Messrs A.J.T. Johnsingh, N.L. Prasad, V.B. Sawarkar and S. Goyal; and Dr. E. Bharucha from BNHS.

Mr. K. Saini, Director of Sariska National Park, and the staff gave hospitality and support. Dr N.L. Prasad supplied the photographs.

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SCALING MODELS FOR FLIGHT PATTERNS AND SEXUAL DIMORPHISM IN RAPTORS[1]

RAMANA M. ATHREYA AND VIJAY A. SINGH[2]

(With five text-figures)

We set up simple models to analyse two basic flight patterns: gliding and flapping. We present scaling arguments to explain a feature common to raptors, namely that the female of the species is larger and heavier than the male. Our scaling arguments assume two variables to be fundamental: (i) the weight W which is strongly correlated with the length L; (ii) the wing length L_W. We present and analyse the available data on raptors to confirm our scaling arguments.

INTRODUCTION

It is a feature common among raptors, that the female of the species is larger and heavier than the male. The obvious source for this dimorphism seems to be the fact that the female birds have to carry eggs for a while. A heavier bird will be able to bear a temporary increase in weight better than a lighter one as the percentage increase is smaller for the former.

The other pointer is that it is only among raptors that the female is larger than the male. In all other birds, as a rule, in case of a disparity in sizes, the male bird is larger. This seems to indicate that the habits of raptors are in some way related to this peculiarity; that this is an adaptation to the needs of speed and endurance which are so very important in hunting. This view is buttressed by the fact that raptors like kites and vultures which do not hunt, or at any rate hunt prey which demand little speed and agility, do not show this anomalous dimorphism. In fact, in case of a difference in size, the male bird is larger. In this paper we propose to investigate this anomalous feature of raptors using an elementary scaling model.

Many problems in science defy a detailed explanation from first principles. It is often sufficient to understand a complex phenomenon by using simple qualitative arguments or rules of thumb. Here we illustrate the use of a special mode of argument, viz. scaling.

The two basic flight patterns are gliding and flapping and we develop scaling models for each of them. The data is discussed along with a brief description of the method of analysis. The results obtained are presented and discussed.

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SCALING

One way of understanding a natural phenomenon is to solve the equations that one obtains on the application of basic laws of nature to that system. However, most systems in nature, particularly biological ones, are complex and the data is often sketchy and incomplete, so that obtaining exact solutions is very time consuming and unfeasible, if not altogether impossible. Even without solving the equations exactly one can obtain a great deal of knowledge by qualitative methods and application of simple rules. Scaling is one such method (Haldane 1956, Stanley and Ostrowsky 1986)

Scaling involves the study of variation of properties and characteristics of a system depending on some specific feature. A successful application of scaling needs:

(i) Development of an appropriate physical model describing the system to a sufficient degree of accuracy.

(ii) Identification of the basic independent variables of the system which are sufficient to determine the required characteristics. These required characteristics are termed dependent variables.

(iii) A basic knowledge of physics and data analysis.

Consider the following examples which illustrate the methodology of scaling:

1. Heat loss, surface area and volume: Let the characteristic length of a system be 'L'. For a cube this will be the length of an edge while for a sphere it corresponds to the diameter. The surface area 'S' of the cube is $6L^2$ while that of the sphere is πL^2. The volume 'V' of the cube is L^3 while that of the sphere is $\pi L^3/6$. The surface area is proportional to

L^2 while the volume is proportional to L^3. We say that the surface area scales as the square of L while the volume scales as the cube of L. So the ratio of the surface area to the volume scales as:

$S/V \approx L^2/L^3 \approx 1/L$ ....(2a)

In what follows ≈ will indicate both 'approximately equal to' and 'proportional to'.

Consider the heat balance in animals (Lin 1982). The amount of heat produced is proportional to the mass of the body which is proportional to the volume (assuming that the density of animal tissues is the same for all animals). The amount of heat lost is proportional to the surface area. So

Heat lost/heat produced $\approx S/V \approx 1/L$ .... (2 b)

A large L and hence low surface to volume ratio is very beneficial to animals wishing to conserve heat. Large animals are better at withstanding colder temperatures. The reason why animals tend to huddle during cold spells is that the large group, in effect, forms a system with a large L and is more efficient in conserving heat.

2. Running speed and leg length: Consider the model of a running animal. Each leg, in the course of a stride, comes to rest on the ground before pushing off. The work done by the leg in pushing off the ground is converted into the kinetic energy of the body. The work done by the leg is equal to the force it exerts against the ground multiplied by the distance travelled during each stride. The force exerted is proportional to the number of muscle fibres running parallel to the leg, which is proportional to the cross sectional area of the leg. The length of each stride is proportional to the length of the leg. If 'd' is the diameter of the leg, 'L_{leg}' its length, 'm' the mass of the animal and 'v' its speed then

Kinetic energy $= mv^2/2 \approx d^2L_{leg}$ ....(2c)

Now, the legs also bear the body weight (Lin 1982). The maximum weight that any object can bear is equal to the product of the maximum compressive stress σ that it can withtand and its cross sectional area. σ is a constant for a given material and since animal tissues are approximately the same, we have

$M \approx \sigma d^2 \approx d^2$ ....(2d)

i.e. heavier animals need to have legs with larger diameter to cope with their weight. With this result, eqn (2c) simplifies to

$v^2 \approx L_{leg}$ ....(2e)

So all other factors such as shape and special adaptations being equal, an animal with longer legs will be capable of running faster, with eqn (2e) governing the relative speeds.

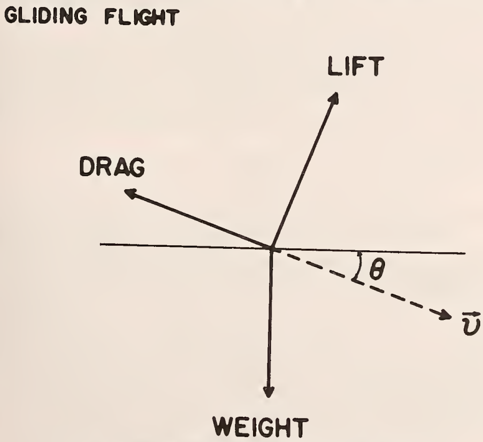

Fig. 1. Force diagram for the gliding model. The velocity vector of the bird is v.

Models

In our analysis we will assume that the two fundamental variables governing the flight of raptors are:

(i) The body weight 'W' which is strongly correlated with the body length 'L_b' and (ii) The wing length 'L_w'.

The relation between these two determines the dominant flight mode of the bird.

Gliding flight: Consider a bird gliding with a velocity 'v', making an angle θ with the horizontal. The bird is under the action of three forces: its weight 'W', the lift 'L' and the drag 'D' (Fig. 1).

The weight acts vertically downwards. The lift and drag are aerodynamic forces produced on account of motion through air. The lift is always perpendicular to the velocity while the drag acts in a direction opposite to the velocity.

Under conditions of equilibrium

$D \cos\theta = L \sin\theta$ ....(3a)

$W = L \cos\theta + D \sin\theta$ ....(3b)

When θ is not equal to zero these equations yield

$L (\cos^2\theta + \sin^2\theta) = W \cos\theta$

i.e. $L = W \cos\theta$ ....(3c)

The lift is related to the velocity by

$L = (C_l\, \rho\, v^2 A_w)/2$ ....(3d)

where C_L is the coefficient of lift which is independent of v but is dependent on the shape of the wing, ρ is the density of air and A_w is the area of the wing. Eqns (3c) and (3d) imply that

$v^2 A_w \approx W \cos\theta$ ....(3e)

Since the area scales as the square of the wing length, we have

$W \cos\theta \approx v^2 L_w^2$ .... (3f)

The minimum 'v' which satisfies this relation is called the stalling speed. Any bird moving slower than this will go into an uncontrolled fall.

As the area of the wings increases, the stalling speed decreases. So a bird with larger wings will be able to scan a given area more thoroughly.

Further, for a given speed (greater than the stalling speed), the factor cos θ increases with an increase in wing area and hence the dip angle θ decreases. So a bird with a larger wing span will be able to travel farther for the same loss in height, i.e. the efficiency of gliding (also called the glide ratio, it being the ratio of the horizontal distance travelled to the loss in height in the meantime) increases.

Eqn (3e) also explains the mode of hunting of such birds. They glide effortlessly high up in the sky on broad wings. As soon as their quarry is sighted, they sweep their wings back and go into a near vertical dive. The sweeping back of the wings decreases their effective area and so the angle of their dive increases. This steep descent helps them to achieve a very high speed in a short while which gains them precious seconds over their prey.

Flapping or powered flight: In this case, the bird generates a thrust by beating its wings to cancel the drag force and maintains a constant level flight with a speed sufficient to produce a lift force to balance the weight. Fig. 2 depicts the forces involved.

The thrust generated by the wing is the rate at which it imparts momentum to the surrounding air. It is equal to the product of the mass of air pushed by the wing during each stroke, the velocity imparted to the air, and the frequency of wing beat.

The mass of air is proportional to the volume covered by the wing during each stroke which scales as the cube of the wing length. The velocity imparted is the speed at which the wing moves. This is proportional to the product of the length of each wing beat and the frequency. The length of the wing beat is proportional to the wing length. If 'f' is the frequency, then

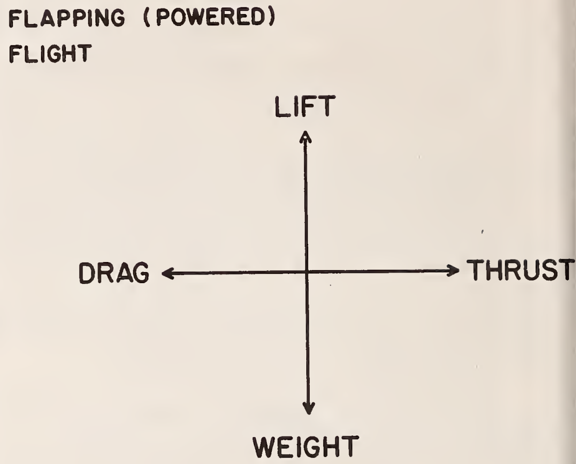

Fig. 2. Force diagram for flapping (powered) flight.

$T \approx L_w^3 \times L_w f \times f$

$\approx L_w^4 \times f^2$ ....(3f)

The drag force is similar in form to the lift and is given by

$D = (C_d \rho v^2 A_{cw})/2$ ....(3g)

where C_d is the coefficient of drag and A_{cw} is the cross- sectional area of the wing.

Equating the thrust and the drag, we obtain

$v^2 L_w^2 \approx L_w^4 f^2$

i.e. $v \approx L_w f$ .... (3h)

This form makes sense for any velocity arising from the motion of limbs — whether legs or wings. Intuitively it seems that the velocity must be proportional to the length of the limb and the frequency with which it is moved to and fro.

In fact if we assume that the wing is a simple oscillator, its natural frequency is inversely proportional to the square root of its length and so eqn (3 h) simplifies to

$v \approx L_w / \sqrt{L_w} \approx \sqrt{L_w}$

i.e. $v^2 \approx L_w$ ....(3i)

which is identical to eqn (2e) which describes running speeds. With the thrust and drag cancelling each other, only the lift and weight have to be considered. This situation is similar to a level gliding flight, i.e. eqn (3c) with θ = 0. θ = 0 is not possible unless the bird is generating sufficient thrust or an external force like a thermal current is aiding it.

Using eqn (3d) with L = W and using eqn (3i), we obtain

$W = (C_L \rho v^2 A_w)/2$

$W \approx v^2 L_w^2$

i.e. $W \approx L_w^3$ ....(3j)

A comparison of the equations for gliding, eqn (3e), and for flapping, eqn (3j), indicates that for a given weight a flapping bird needs a smaller wing to maintain flight.

An interesting feature is that greater wing area makes for greater stability while smaller wing area makes for greater manoevrability. Birds like accipiters which have small wings can swerve and dodge at high speeds and are more often than not encountered inside wooded areas. Birds belonging to the genera *Aquila, Buteo, Circus, Haliaeetus* etc. which have long and broad wings restrict themselves to open grasslands, bare hillsides and water bodies where high gliding efficiency is more essential than manoeuvrability. The hawk-eagles belonging to the genera *Spizaetus* and *Hieraaetus* are a very interesting lot, having combined the best of both worlds.

The falcons, the fastest hunters in the air, have developed an ingenious method of improving their speed. According to eqn (3i) an increase in wing length improves the velocity. But since there is a decrease in the frequency of wing beat with increase in length the effect is reduced. Falcons have developed long and slim wings which curve backwards sharply halfway through. So while the actual wing length which pushes against the air is large, the effective wing length which determines the frequency is small. Thus they have the advantage of both a long wing and a high frequency of wing beat which gives them exceptionally high speed and agility.

Material and Methods

The data was obtained from Grzimek (1978) Barnes (1981) and Ali and Ripley (1983).

Table 1 lists the data we obtained. The information collected are:

(i) L_b^* = length of the body from beak tip to tail tip.

(ii) L_t = length of the tail.

(iii) L_w = winglength as measured from the wing shoulder to tip of the longest primary feather.

(iv) S_w = wingspan, being the maximum distance between the wingtips.

(v) W =body weight.

(vi) a, b = dimensions of the eggs; 2a and 2b being the longer and shorter sides of the rectangle containing the egg.

(vii) p =number of eggs laid.

The measurements from (i) to (v) were noted separately for male and female birds.

The eggs were approximated as ellipsoids of revolution with the sides of the rectangle constituting the major and the minor axes (Fig. 3).The volume of the ellipsoid is given by

$V=(4\pi b^2 a)/3$ ....(4a)

The density of chicken eggs was calculated by weighing them and calculating their volume in the above fashion. The raptor egg volumes were multiplied with this density to obtain their weights.

Those measurements which were unavailable but essential for our model were calculated from the least error average of the available data. They are suitably marked in Table 1.

The data was analysed using the method of linear regression. Since the aim is to obtain the indices of the scaling laws, the natural logarithm of the quantities were used. The scaling power appears as the slope of the linear log– log plot.

Results and Discussion

The results of the analysis of the data of Tables 2 and 3 show the variation of the body weight 'W' with the length of the body disregarding the tail 'L_b' ($L_b = L_b^* - L_t$). This was used to fill the gaps in the weights of the male and female birds respectively.

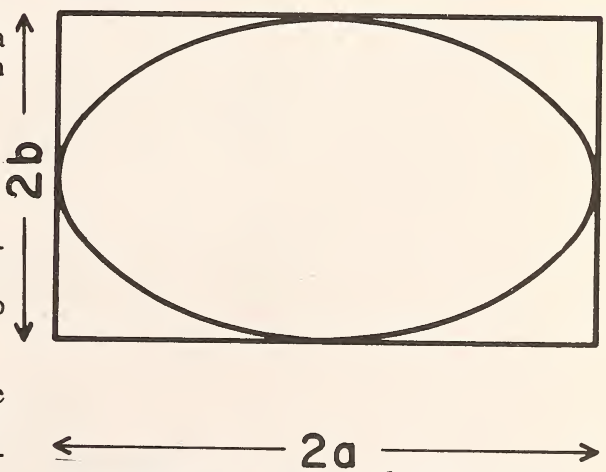

Fig. 3. Ellipsoidal approximation for the volume of the egg. See text eqn. (4a).

TABLE 1
REPRESENTATIVE DATA ON RAPTORS.

Raptor	Body length Lb* (cm) M-F	Wing length L_w (cm) M-F	Wingspan S_w (cm) M-F	Weight W (g) M-F	Tail length L_t (cm) M-F	Body length excluding tail L_b (cm) M-F	Volume of egg (cm^3)	Mass (egg) (g)
Golden eagle	90.0-100	64.3-68.0		3463-4459	32.5-35.8	57.5-64.8	155.0	319.3
Golden eagle		64.3-68.0	202.5-220.0	3800-5500				
Black eagle	69.0-81.0			1000-1600	32.1-35.0	36.9-46.0		
Greater spotted eagle	66.0-74.0	51.6-54.8	167.5-177.5	1800-2200	25.0-26.3	41.0-47.7	103.8	213.8
Greater spotted eagle	65.4-70.5	49.5-52.7		1386-1584	27.4-29.8	38.0-40.7	95.3	196.4
Imperial eagle	81.0-90.0	58.8-61.8		3103-3630	26.2-30.6	54.8-59.4	112.5	231.8
Imperial eagle	79.0-84.0	59.4-64.1	192.5-207.5	3000-3500			112.5	347.7
Imperial eagle	74.9-79.5	55.6-60.3	184.15-196.9					
Tawny eagle	63.5-70.5	49.5-54.0	160.7-181.0	1291-1634	26.7-29.2	36.8-41.3	98.5	203.0
Lesser spotted eagle	61.0-66.0	48.8-50.1		1500-1800	23.9-25.9	37.1-40.1		
	61.0-66.0	48.8-50.1	152.5-165.0	1500-1800			53.6	55.2
Common buzzard	46.0-56.0	37.7-42.2	120.0-140.0	750-1000	18.0-23.7	28.0-32.3	63.2	130.1
Long legged buzzard	57.8-63.8	42.7-48.3	138.7-150.2	996-1287	25.1-26.6	32.7-36.9	72.4	223.7
Whitebellied sea eagle	66.0-71.0	55.8-59.7		1781-2230	23.4-23.4	42.6-47.6	114.7	236.3
White bellied sea eagle	67.9-76.2	53.3-58.4	188.0-213.4	1819-2171	24.9-29.2	43.0-47.0	114.7	236.3
White-tailed sea eagle	79.0-95.0	68.0-74.3	220.0-240.0	3800-5500			128.6	397.3
White-tailed sea eagle	91.0-101.6	61.0-69.0		4038-5319	29.2-30.5	61.8-71.1	128.6	397.3
Pallas's fishing eagle	76.2-84.1	54.6-59.7	195.6-212.1	2212-2460	29.2-34.3	47.0-49.8	114.9	355.2

The underlined numbers are calculated values
M: Male; F: Female. .

TABLE 2
DATA USED TO FIND THE RELATION BETWEEN BODY WEIGHT AND BODY LENGTH FOR MALE RAPTORS

Species	W (g)	L_b (cm)
Golden eagle	3463	57.5
Black eagle	1000	36.9
Greater spotted eagle	1500	841.0
Imperial eagle	3113	54.8
Lesser spotted eagle	1800	37.1
Common buzzard	750	28.0
Bonelli's hawk eagle	1600	42.4
Booted hawk eagle	700	28.0

Ln W= 0.765 + 2.199 Ln L_b; Correlation coefficient γ= 0.9803
W=Body weight; L_b= Body length.

TABLE 3
DATA USED TO FIND THE RELATION BETWEEN WEIGHT AND BODY LENGTH FOR FEMALE RAPTORS

Species	W (g)	L_b (cm)
Golden eagle	4459	64.8
Black eagle	1600	46.0
Greater spotted eagle	2200	47.7
Imperial eagle	3630	59.4
Lesser spotted eagle	1800	40.1
Common buzzard	1000	32.3
Bonelli's hawk eagle	2000	45.0
Booted hawk eagle	900	31.5

Ln W = 0.428 + 2.118 Ln L_b; Correlation coefficient γ = 0.979
W = Body weight; L_b = Body length.

The results are:

(i) For males: Ln W = – 0.853 + 2.199 Ln L_b
Correlation coefficient = 0.980

(ii) For females: Ln W =– 0.482 + 2.118 Ln L_b
Correlation coefficient = 0.979

Table 4 shows the variation of the wingspan S_w with the wing length L_w. This was used to fill the gaps in the data concerning the wing lengths. The result is:

S_w= 2.173+3.202 L_w
Correlation coefficient = 0.988

This is an ordinary plot (and not a log– log one).

Figs. 4 and 5 deal with the variation of the wing length with weight for flapping and gliding birds respectively.

The ratio of the wing lengths of the male and female birds was plotted against the ratio of the weights of the male and female + eggs in order to ensure as far as possible that species-specific characteristics are eliminated. Else it may lead to changes in the scaling power, the origins of which are beyond the complexity of our model.

A markedly better correlation was obtained when the combined weight of the female and the eggs was used as compared to that obtained when only the weight of the female was used. It appears that the female grows wings larger than what is essential to accommodate her own weight. The female bird possesses more wing power, weight for weight compared to the male. However they appear to be on an equal footing when the female bird is carrying eggs. This seems to bear out our assumption that the anomalous dimorphism is indeed related to the eggs. We were unable to establish any relation between the weight of the female and that of her eggs.

The two groups for which our models were tested consisted of the hawks (genus *Accipiter*) and the hawk-eagles (genus *Hieraaetus*) on one hand and eagles and buzzards on the other.

The hawk-eagles are among the finest of hunters among birds, mixing within them a very efficient blend of hawk-like (flapping) and eagle-like (gliding) features and emphatically justify their English nomenclature. For one, they are much larger than the true hawks. Their wings in relation to their weight are larger than those of hawks but smaller than those of eagles. Thus they are capable of fast flight as well as sustained gliding.

In our results, it is evident that they fit into both groups. But we have classified them with the hawks as the ratio of their wing length to body length is closer to hawks than to the eagles and buzzards.

We have obtained a scaling power of 3.325 for the hawks and hawk-eagles whereas the flapping model predicts an exponent of 3.00. For the eagles and buzzards we have obtained an exponent of 2.041 while our theoretical value is 2.00

These fits between the theory and the actual values are rather flattering but the scatter in the plot leaves much to be desired. One problem is that we need to augment our data base.

The biggest and a very serious problem encountered in the course of this work was the collection of data. The data available in the extant literature is very sketchy and rarely is the difference in values for male and female birds specified. Often data from two different sources have had to be spliced to obtain a full picture. While care has been taken to ensure that some justification exists for such an action, a few inconsistencies and spurious information have been impossible to avoid.

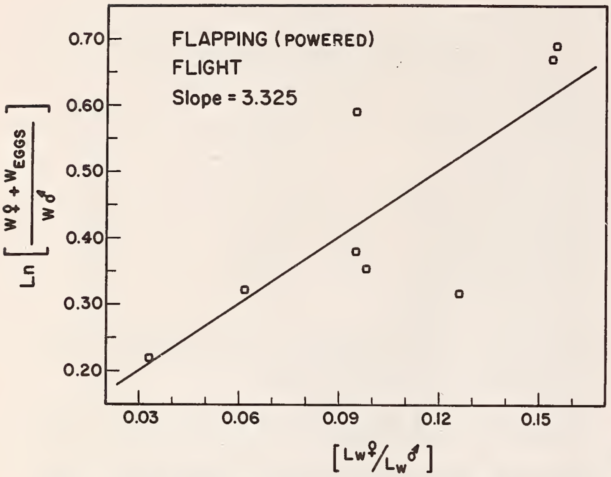

Fig.4. Log-log plot of weight versus wing length for accipiters and hawk-eagles (also see text).
The plot yields Ln (W) = 0.086 + 3.325 Ln (Lw).
Standard deviations for x-and y-axes are 0.0414 and 0.1725 respectively. The correlation coefficient is 0.9095.

TABLE 4
WING SPAN VERSUS WING LENGTH FOR BOTH MALE AND FEMALE RAPTORS

Species	S_W (cm)	L_W (cm)
Golden eagle	202.5	62.6
Golden eagle	220.0	68.0
Greater spotted eagle	167.5	51.6
Greater spotted eagle	177.5	54.8
Imperial eagle	184.2	55.6
Imperial eagle	196.9	60.3
Tawny eagle	160.7	49.5
Tawny eagle	181.0	54.0
Lesser spotted eagle	152.5	48.8
Lesser spotted eagle	165.0	50.1
Common buzzard	120.0	37.7
Common buzzard	140.0	42.2
Long legged buzzard	138.7	42.7
Long legged buzzard	150.2	48.3

$S_W = 2.173 + 3.202\ L_W$; Correlation coefficient $\gamma = 0.988$
S_W = Wing span, L_W = Wing length.

The purpose of this paper is to introduce a new method of understanding sexual dimorphism in birds. We have shown that in spite of various constraints and approximations, it is powerful enough to lead to results which make physical and physiological sense. But a detailed analysis with a large data base is desirable.

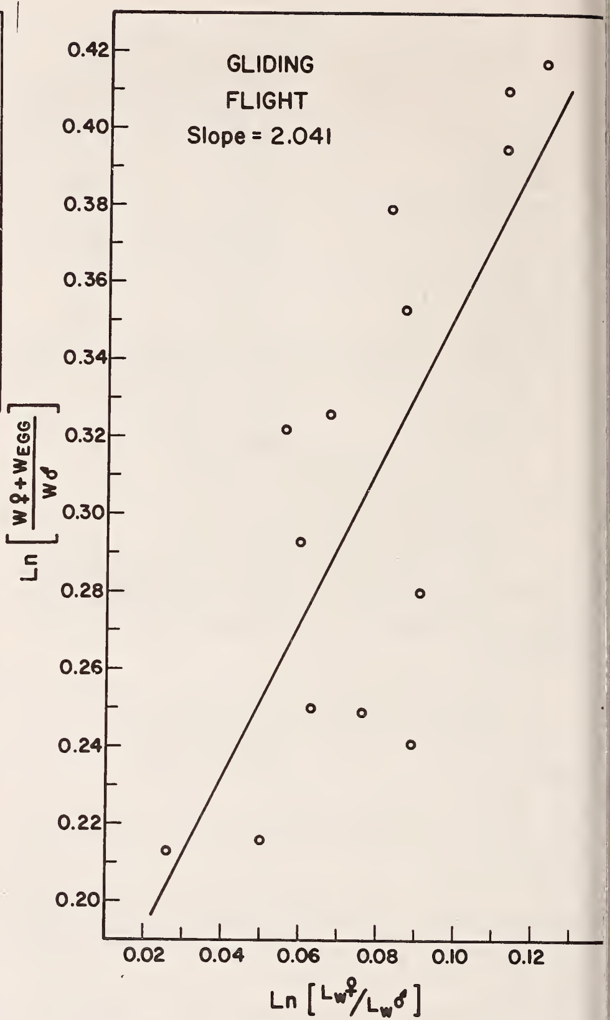

Fig. 5. Log–log plot of weight versus wing length for eagles and buzzards (also see text).
The plot yields Ln (W) = 0.15 + 2.041 Ln (Lw).
Standard deviations for x-and y-axes are 0.026 and 0.069 respectively. The correlation coefficient is 0.767.

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POLYMORPHISM IN *ACANTHASPIS SIVA* DISTANT (REDUVIIDAE: HETEROPTERA), A PREDATOR OF THE INDIAN HONEY BEE[1]

DUNSTON P. AMBROSE[2] AND DAVID LIVINGSTONE[3]

(With two text-figures)

Acanthaspis siva Distant is a reduviid existing in four different morphs, namely (a) unbanded legs without thoracic spots, (b) banded legs without thoracic spots, (c) banded legs with thoracic spots, and (d) unbanded legs with thoracic spots. Inter and intra morph breeding experiments in the laboratory established the existence of polymorphism in this species. The morph with unbanded legs without thoracic spots appears to be the most biologically successful one and the morph with unbanded legs with thoracic spots, the least successful. The existence of polymorphism in *A. siva* seems to be a non–mutational, non-adaptive trend in evolution, an equivalent of antogenetic evolution.

INTRODUCTION

A. siva has very striking variations among individuals occurring in the same microhabitat that would compel a museum taxonomist to place them comfortably in different species altogether. *A. siva* exists in four different morphs, namely: unbanded legs without thoracic spots (A), banded legs without thoracic spots (B), banded legs with thoracic spots (C), and unbanded legs with thoracic spots (D) (Fig. 1). Distant (1902) described only the morph A of *A. siva*. The present report deals with the biological diversity exhibited by the morphs of *A. siva*.

MATERIAL AND METHODS

A. siva is entomosuccivorous, polyphagous, crepuscular, alate, black with creamy white spots at the base of corium, middle and apex of the membrane as well as at the connexivum. It is found in the scrub jungles, semi-arid zones and tropical rain forest in concealed microhabitats (Ambrose 1980). Adults and nymphal instars of all the four morphs of *A. siva* were collected from Salem semi-arid zone in Tamil Nadu. They were reared in the laboratory (temperature 30-32°C, humidity 80-85% and photoperiod 11-13 hrs.) separately in plastic containers (8 x 6 x 4 cm) on house-flies and camponotine ants. Morphometric analyses of eggs, nymphal instars, adults and spermatophore capsules were carried out. Six pairs of adults of each morph were maintained separately to study the oviposition pattern and hatchability. Records of number of batches of eggs and eggs per batch were maintained and each batch of eggs was allowed to hatch in individual containers. Hatching percentage of individual batches of eggs was calculated and the longevity of adults recorded. An index of oviposition days was calculated as a percentage ratio of egg laying days to the total adult longevity of the females (Ambrose 1980). Records on incubation and stadial period, nymphal mortality, nymphal weight and their camouflaging efficiency were calculated separately in the four morphs. Camouflaging efficiency of different stages of nymphal instars was measured by calculating the particle carrying capacity index (= Particle weight ÷ Nymph weight). The nymphs were weighed immediately after eclosion and ecdysis and after they gathered the camouflaging material. Sex ratio and the distribution of morphs among the progeny were calculated.

OBSERVATIONS AND DISCUSSION

Size and shape: Morphometric analyses of eggs, nymphal instars and adults did not show any perceptible variations. But morph A ejected the largest spermatophore capsule and morph C the shortest. The shape of the capsule also varied among the morphs (Table 1, Fig. 2).

Oviposition pattern: Morph A and D females lived longer. Morph B females exhibited the shortest life span (Table 2). The pre-oviposition period was longer in morphs with longer life span and shorter in morphs with shorter life span. Long lived females registered higher fecundity rates than short lived ones. Morph C recorded the lowest fecundity. Highest index of oviposition days was recorded in the morphs A and D. Index of oviposition days had

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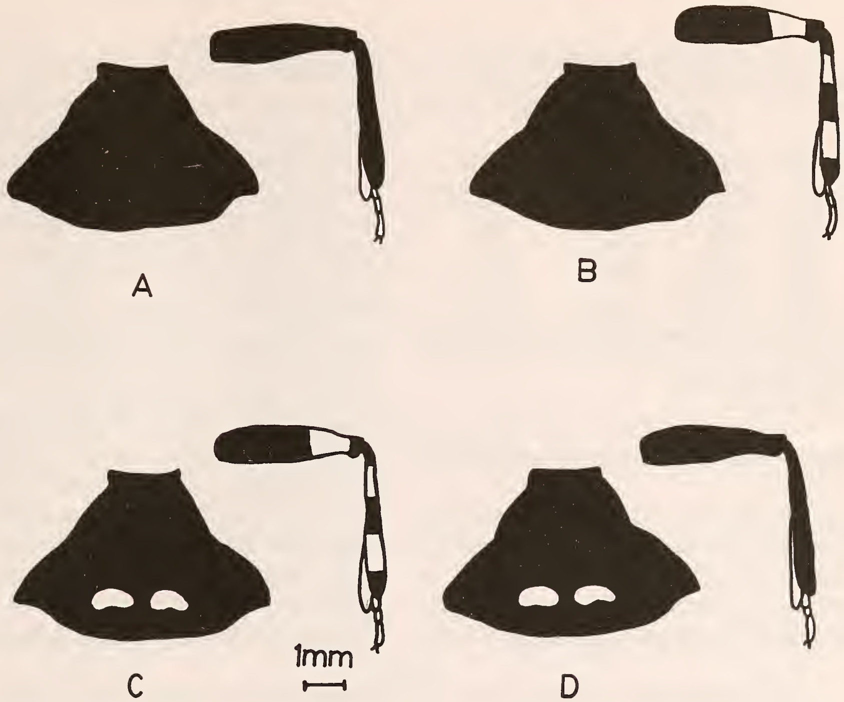

Fig. 1. Prothoracic shield and legs of four different morphs of *A. siva*
A. Unbanded legs without thoracic spots; B. Banded legs without thoracic spots;
C. Banded legs with thoracic spots; D. Unbanded legs with thoracic spots.

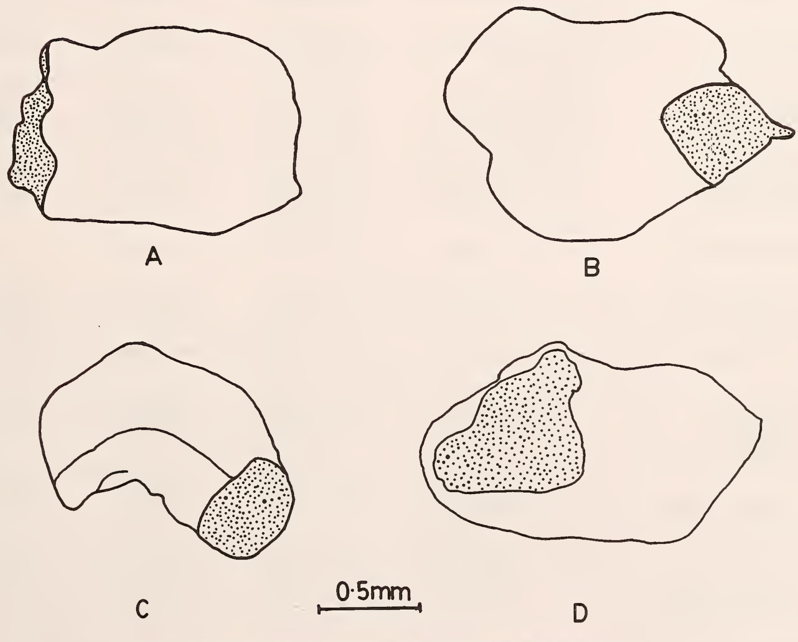

Fig. 2. Spermatophore capsules of four morphs of *A. siva*.

TABLE 1
POLYMORPHIC DIVERSITY IN MORPHOMETRY OF SPERMATOPHORE CAPSULE IN *A. Siva* (*N* = 6)

Morphs	Spermatophore capsule				
	Length	Width	Exit length	Exit width (broader end)	Exit width (narrower end)
A	1.24	0.69	0.47	0.34	0.09
B	1.27	0.55	0.25	0.57	0.05
C	1.36	0.26	0.33	0.98	0.03
D	1.2	0.47	0.7	0.7	0.15

A = unbanded legs without thoracic spots; B = banded legs without thoracic spots; C = banded legs with thoracic spots; D = unbanded legs with thoracic spots.
All measurements in mm.

direct correlation with adult longevity and fecundity.

Hatchability: Hatchability had direct correlation with the fecundity rate in morphs A, B and C. Highest and lowest hatchability were recorded by morphs A and D respectively and this can be correlated with the highest and lowest frequency of 100% hatching respectively.

Incubation period: Morphs A and D recorded the shortest and longest incubation periods respectively (Table 3). Morph A with higher hatchability and shorter incubation period and morph D with poor hatchability and longer incubation period are biologically significant. Similar results have been observed in the different ecotypes of *Acanthaspis pedestris* Stal (Ambrose 1980).

Stadial period: Morph A had the longest stadial period and the morph C the shortest (Table 3). Interestingly, morph A had the shortest incubation period and the longest stadial period.

Nymphal mortality: Nymphal mortality was recorded as follows: morph A 63.2%, morph B 69.2%, morph C 36.5%, morph D 69.2%. The relatively short stadial period of morph C may be one of the reasons for its having the lowest nymphal mortality. Morph D, with fewer nymphs, recorded the highest nymphal mortality and this might be one of the reasons for its low level of population in different

TABLE 2
POLYMORPHIC DIVERSITY IN OVIPOSITION PATTERN AND HATCHABILITY IN *A. siva*

	MORPHS			
	A	B	C	D
Adult female longevity in days	141.5 ± 41.5	88.4 ± 19.3	109.0 ±11.2	140 ± 37.8
Pre–oviposition period in days	32.8 ± 1.5	24.2 ± 3.5	30.8 ± 3.3	34 ± 2.5
Index of oviposition days	36 ± 4.5	29.5 ± 1.8	31.6 ± 3.0	33.9 ± 2.6
Total number of batches of eggs laid	52.0 ± 8.0	35.2 ± 6.7	29.8 ± 6.3	44.0 ± 6.0
Total number of eggs laid	209.7 ± 40.0	146.4 ± 39.8	134.1 ± 36.6	160 ± 41.4
Average number of eggs per batch	4.0 ± 0.5	4.9 ± 0.2	4.8 ± 0.3	2.16 ± 0.4
Minimum number of eggs per batch	1.0 ± 0	1.0 ± 0	1.0 ± 0	1.0 ± 0
Maximum number of eggs per batch	17.2 ± 1.8	28.5 ± 2.4	13.8 ± 1.5	17.0 ± 5.4
Total number of nymphs hatched	81.0 ± 7.9	59.0 ± 14.2	40.0 ±18.0	23.0 ± 6.2
Hatching percentage	43.3 ±12.9	30.0 ± 8.1	29.6 ± 9.3	14.8 ± 3.6
Age range in which 0% hatching recorded	47.0 ± 12.5 to 137.0 ± 14.0	30.2 ± 4.5 to 84.2 ± 18.0	30.1 ± 6.0 to 68.0 ± 12.0	38.0 ± 4.2 to 142.0 ± 42.8
Age range in which 100% hatching recorded	50.2 ± 8.5 to 109.3 ± 9.0	34.8 ± 5.0 to 91.7 æ 21.6	39.2 ± 3.3 to 58.9 ± 12.3	34.0 ± 3.6 to 55.0 ± 7.6
Frequency of 0 % hatching	25.3 ± 8.0	17.7 ± 5.2	18.7 ± 3.0	38.0 ± 6.8
Frequency of 100 % hatching	11.3 ± 2.0	5.1 ± 3.2	3.4 ±1.2	2.1 ± 1.6

TABLE 3
POLYMORPHIC DIVERSITY IN INCUBATION AND STADIAL PERIODS IN *A. siva*

Morphs	Incubation period	Stadial period (Days) I-II	II-III	III-IV	IV-V	V-Male	V-Female	I-Adult
A (144)	17.1	17.3	15.6	15.7	19.9	28.4	29.2	95.9
	±0.1	±0.4	±0.5	±0.3	±0.2	±0.5	±0.6	±1.5
B(70)	21.2	16.6	14.3	15.8	18.5	28.2	29.9	93.8
	±0.3	±0.5	±0.6	±0.5	±0.4	+1.2	+1.9	+2.9
C(121)	21.7	16.3	12.3	13.5	17.2	23.3	23.5	82.9
	±0.2	±0.1	±0	±0	±0.1	±0.2	±0.1	±0.2
D(25)	23.9	14.4	13.5	14.3	18.4	26.8	26.8	87.3
	±0.3	±0.6	±0.9	±0.6	±0.6	±0.6	±1.3	±1.2

(Number in parantheses indicate the number of observations.)

TABLE 4
POLYMORPHIC DIVERSITY IN NYMPHAL WEIGHT AND WEIGHT OF CAMOUFLAGING PARTICLE CARRIED AND THE CARRYING CAPACITY IN *A. siva*

Instars	Morphs	Nymphal weight (mg)	Camouflaging particle weight (mg)	Carrying capacity
	A	1.8±0.3	3.6±0.3	2.8±0.5
	B	2.2±0.3	4.9±0.9	2.9±0.9
First	C	1.1±0.1	6.2±2.5	6.8±2.7
	D	1.0±0	13.0±6.0	13±6.0
	A	3.4±0.7	5.3±0.9	1.9±0.4
	B	3.1±0.3	6.6±0.5	2.6±1.4
Second	C	4.3±0.2	8.0±1.0	1.85±0.2
	D	4.2±0.4	7.7±1.0	1.96±0.3
	A	6.2±0.6	13.8±1.5	2.1±0.2
	B	7.9±0.6	16.8±1.9	2.4±0.3
Third	C	9.5±0.6	17.5±0.6	1.9±0.2
	D	10.0±2.0	11.3±0.3	1.3±0.4
	A	22.3±1.3	26.6±3.3	1.2±0.2
	B	20.9±2.0	25.6±4.0	1.3±0.2
Fourth	C	25.2±2.1	34.8±0.3	1.4±0.1
	D	23.0±2.9	36.7±4.4	1.7±0.3
	A	48.9±4.8	55.7±9.7	1.1±0.2
	B	56.4±3.9	61.2±3.7	1.1±0.1
Fifth	C	52.2±5.4	55.0±11.8	1.3±0.1
	D	55.5±1.8	70.0±9.6	1.3±0.2

habitats surveyed.

Camouflaging: The first instar of morph D recorded the highest carrying capacity which was directly proportional to the camouflaging efficiency (Ambrose 1980). It may be an evolving adaptation to protect the nymphs from the threat of cannibalism as they recorded the lowest hatchability and highest nymphal mortality (Table 4).

Adult longevity and sex ratio: In all morphs the females lived longer than the males. (72.6±24.9 and 161.3±18.9; 49±11.3 and 105±10.2; 43 and 80.4 ±6.5; 32 and 70.2±16.2 days of adult longevity of males and females respectively of morphs A, B, C and D). Both males and females of morphs A and D registered the highest and lowest longevity respectively. The population of morph B was slightly female biased (male:female = 0.9 : 1.0) and the population of morphs A and C were slightly male biased (1.0 : 0.8), whereas the population of morph D was not sex biased. In the field, generally the population was male biased.

Morph distribution among the progeny: The inter and intra morph breeding experiments were carried out in the laboratory from 1 to 3 generations. The progeny from the inter morph breeding experiments did not follow any particular genetic pattern. The progeny of morph A was A = 47.9%; B = 40.4% and C = 11.7%; and that of B was A = 21.7%, B = 51.7% and C = 26.6%. The parents of morph C gave birth to 15.9% A, 30.5% B and 53.6% C morph offsprings. The offsprings of morph D were of A and B = 37.5% each and D = 25%. The progeny of morphs A, B and C were more like that of parental type. From the parents of morph D, not even a single parental type progeny emerged. The other three morphs (A, B and C) also failed to give the progeny of the D morph type.

Observations on the different biological parameters of different morphs collected from a single habitat reveal that intraspecific variations could prevail in abundance even though they belong to similar ecological conditions. Breeding experiments in between morphs of same habitat provide sufficient reasons to suggest that such intraspecific variations are not strictly genetic. Mayr (1963 and 1969) briefly defined polymorphism as variability within a population. Ford (1937) explained polymorphism as "the occurrence together in the same habitat at the same time of two or more distinct forms of the same species in such proportions that the rarest of them cannot be maintained by recurrent mutation". The rare occurrence of the morph D both under laboratory conditions as well as natural habitat conditions indicates that the segregation phenomenon does not occur in the Mendelian fashion. Therefore, the random occurrence of such morphs without any relation to environmental or genetic feedback is an example of a non-mutational, non-adaptive trend in evolution, an equivalent of "antogenetic" evolution of Simpson (1969). However, the adaptive significance of a particular morph in a given habitat cannot be ruled out as evidenced by the morph A with higher longevity, fecundity, hatchability and more abundant presence in the field. This morph appears to have acquired successful characters as they are found in larger proportions in the natural population as well as in the laboratory bred population. Unfortunately, no information is available on the morph variation in reduviids except Louis' (1974) preliminary observation on *Rhinocoris* sp. The present study establishes the existence of 4 different morphs in this species. Further investigation is required to understand this phenomenon of polymorphism better.

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OBSERVATIONS ON THE DEVELOPMENTAL STAGES OF TADPOLES OF THE MALABAR GLIDING FROG *RHACOPHORUS MALABARICUS* JERDON, 1870 (ANURA : RHACOPHORIDAE)[1]

A.G. SEKAR[2]

(*With three plates and three text-figures*)

The ontogeny of the Malabar gliding frog *Rhacophorus malabaricus* was studied by rearing tadpoles from the egg stage. Metamorphosis took 68 days to complete. The juveniles were of the same colour as the substratum and quite distinct from the green of the adult. The tadpoles were carnivorous by preference.

INTRODUCTION

The Malabar gliding frog *Rhacophorus malabaricus* is distributed in the evergreen forests of the Western Ghats of India from Ponmudi Hills, Kerala, to Goa (Daniel and Sekar 1989). It is arboreal in habit, and has a cryptic green coloration. It can glide over a distance of 10 m (Ayyangar 1915). According to Ferguson (1904) this frog is common in the low country of the Travancore region of Kerala and sometimes enters houses. The breeding season commences with the SW monsoon and lasts from June to November (Ferguson 1904). The breeding call is syllabilised as *truk—truk—truk*. Amplexus is axillary in this species (Abdulali and Sekar 1988). The female makes a foam nest attached to the leaves of a tree or a shrub overhanging a pool (Ferguson, op. cit.)

The development of amphibian tadpoles in the Indian region has been scantily investigated. So far, literature is available only for such anuran species as *Rana tigerina* (McCann 1932), *Rana cyanophlyctis* (Mohanty-Hejmadi and Dutta 1979), *Microhyla ornata* (Padhye and Ghate 1989), *Polypedates maculatus* (McCann 1932, Mohanty-Hejmadi and Dutta 1988). Existing literature on tadpoles of *Rhacophorus malabaricus* (Ferguson 1904, Inger *et al.* 1984) is largely confined to general remarks on the field biology, including description and location of the eggmass and feeding behaviour of the larvae. There has been no previous study of tadpole development in *Rhacophorus malabaricus*. The present study focuses on the development of the tadpoles of *Rhacophorus malabaricus* under laboratory conditions.

MATERIAL AND METHODS

A pair of Malabar gliding frogs (male 61.7 mm SV length and female 81.3 mm SV length), which were in amplexus on a bamboo shoot 2 m above the ground, was collected at 2200 hrs in Volpoi forest, Goa, in July 1989. This is a moist deciduous forest type with evergreen patches. The pair was kept in a dry plastic jar of 5 litre capacity. The female made a foam nest which was transferred to another jar containing water. The eggs (approximate number more than hundred) started developing in the foam nest. The nest was brought to Bombay and kept in an aquarium tank (30 x 15.5 x 15 cm) at room temperature (28-35° C). The tadpoles were fed chopped earthworms. Different stages were preserved in 10% formalin. Some tadpoles were kept separately to observe their feeding behaviour.

OBSERVATIONS

DEVELOPMENTAL STAGES

The observations made on the development of the tadpoles are given chronologically.

Embryonic stage: 20 July 1989 – The male and female made the foam nest at 0100 hrs. This was exactly like the foam nest of *Polypedates maculatus* in colour and texture (Sekar 1986). The eggs distributed in the foam nest were cream coloured and spherical in shape. Average diameter = 2.76 mm. (S.D. = ± 0.1 mm; n = 10).

21 July 1989 – Age 34 hrs: Embryos had developed and were hatched, the larvae were wriggling and emerging from the foam nest.

Hatching stage: 22 July 1989 – Age 56 hrs: Average total length of the hatched tadpoles = 8.73 mm (S.D. = ± 0.45; n = 7); body length 3.73 mm; tadpoles hatched out and settled at the bottom of the jar and

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were motionless (more larvae were struggling to come out of the nest); tadpoles bore conspicuous yolk sac; no gills were visible and eyes were apparently well developed.

23 July 1989 – Age 83 hrs: Average total length = 11.88 mm (S.D.= ± 0.15; n = 10) body length 3.88 mm; tadpoles still motionless; dorsally pigmented with brown; ventrally white; belly with yolk; tail muscle and fins also pigmented.

Feeding stage: 24 July 1989 – Age 4 days, 11 hrs: Average total length =13.7 mm (S.D. = ± 0.51; n = 6); body length 4.8 mm; tadpoles very active and come to the surface; oral disc formed but without beak and horny teeth; the intestine was in early stages of formation; belly white in colour.

25 July 1989 – Age 5 days: Average total length = 16.48 mm (S.D. = ± 0.63; n = 5); body length 5.48 mm; oral disc developed with beak, but no horny teeth; the coiled intestine was white in colour.

30 July 1989 – Age 10 days: Average total length = 17.84 mm (S.D. = ± 0.53; n = 5); body length 6.2 mm; oral disc with beak and rows (2:3 + 3/3) of developed teeth; the intestine dark brown in colour; spiraculam visible clearly; started feeding on chopped earthworms.

Pre-hindlimb stage: 2 August 1989 – Age 13 days: Average total length = 18.7 mm (S.D. = ± 0.69; n = 5); body length 6.9 mm; tadpoles dorsally intensely pigmented with brown except around the eye; ventrally transparent.

4 August 1989 —Age 15 days: Average total length = 20.17 mm (S.D. = ± 0.71; n = 5); body length 7.57 mm; tadpoles voraciously fed on the meat of earthworms; they were very definitely carnivorous.

12 August 1989 – Age 23 days: Average total length = 21.5 mm (S.D.= ± 1.21; n = 3); body length 8.6 mm; no remarkable changes.

20 August 1989 – Age 31 days: Average total length = 31.6 mm. (S.D.= ± 0.73; n = 3); body length 11.6 mm; dorsally brownish yellow; ventral skin transparent; ventrally the heart beat was seen clearly; vent dextral.

Hindlimb bud stage: 29 August 1989 – Age 40 days: Average total length = 38.0 mm (S.D. = ± 1.57; n = 3); body length 13.0 mm; hindlimb bud developed and measured 3.0 mm in length.

1 September 1989 – Age 43 days: Average total length = 40.0 mm (S.D. = ± 1.24; n = 3); body length 15.0 mm; hindlimb bud measured 4.5 mm in length.

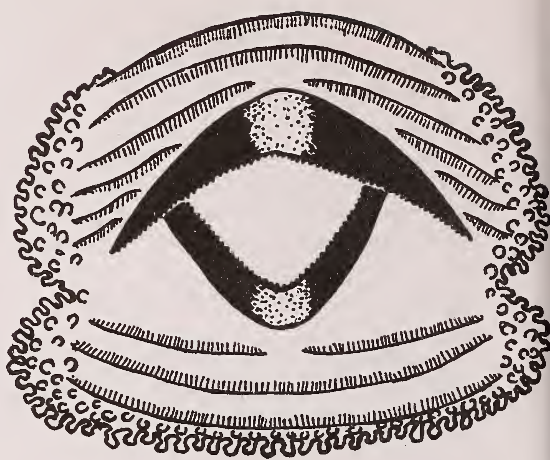


Fig .1. Mouth of *Rhacophorus malabaricus* tadpoles.

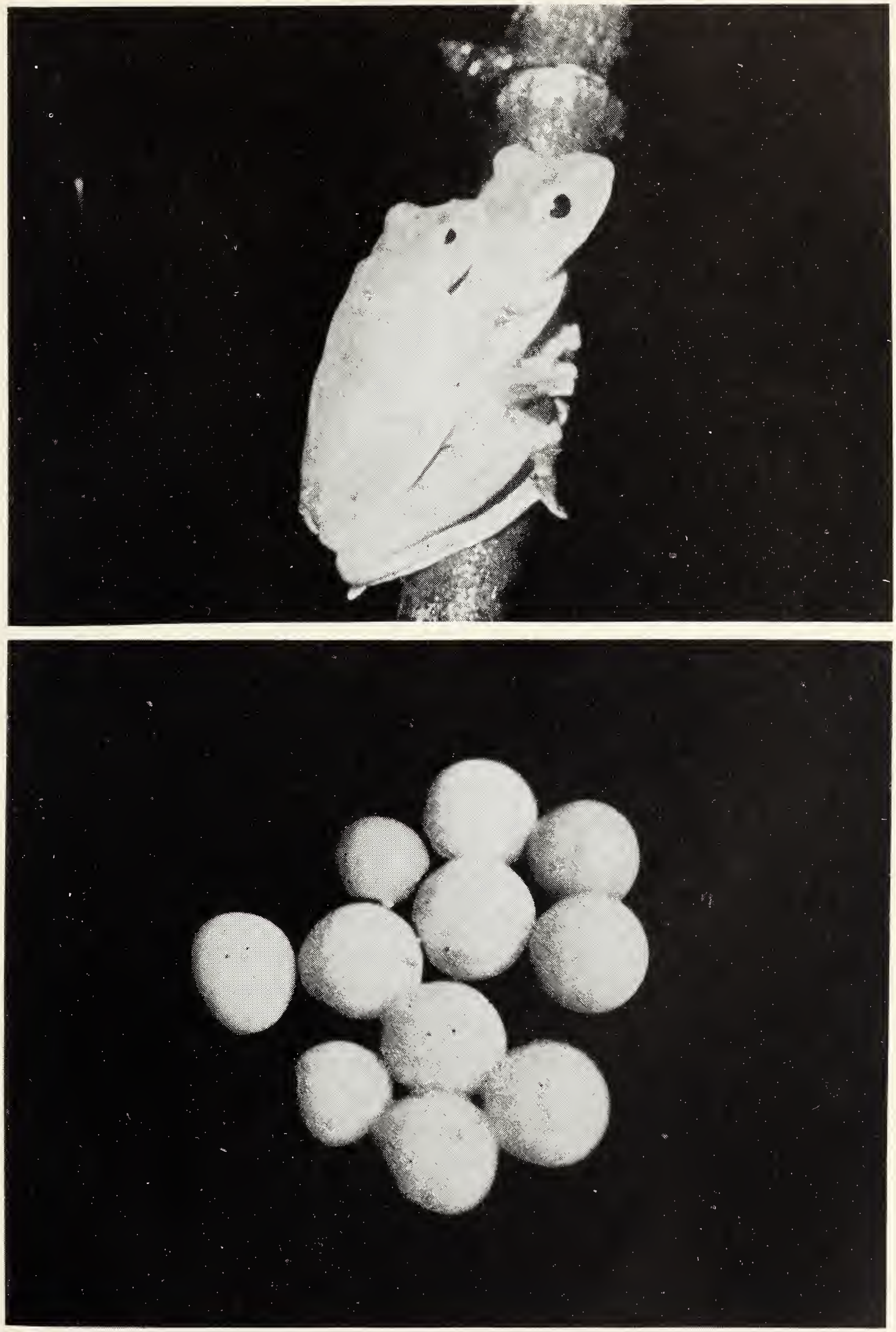
Hindlimb stage: 7 September 1989 – Age 49 days: Average total length = 41.0 mm (S.D. = ± 0.44; n = 3); body length 16.0 mm; hindlimb measured 10 mm in length; toes black in colour; webs between toes yellow.

12 September 1989 – Age 54 days: Average total length (41.0 mm) and body length (16.0 mm) remained same; body skin became opaque; in colour yellowish brown dotted with dark brown or black. Dental formula of the oral disc was 2 : 4 + 4/1 + 1 : 2 (Fig. 1) The hindlimb well developed and with a length of 19.0 mm; thighs barred; forelimbs visible through the transparent ventral skin.

Forelimb stage: 14 September 1989 – Age 56 days: No change in length; tadpole had attained the forelimb stage; the oral disc with horny teeth had disappeared and the mouth was as in a normal frog; the abdominal region was narrow; the behaviour was notably different from the hindlimb staged tadpoles; quiescent, not swimming actively, resting at a corner of the tank; they did not feed on the mashed earthworms; the colour of the body was yellowish brown with dark brown or black dots.

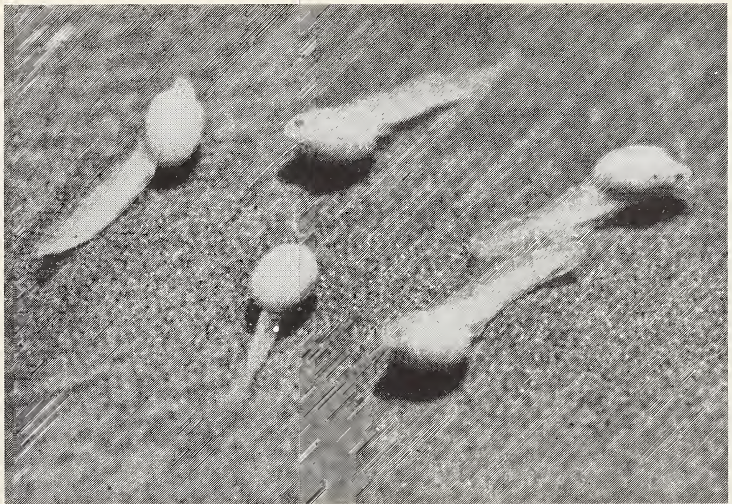
23 September 1989 – Age 65 days: Total length 21.0 mm; the tadpoles had nearly lost their tails and become froglets with only a rudiment of the tail, measuring 5.0 mm; froglets came out of the water and clung to the wall of the tank; toes fully webbed.

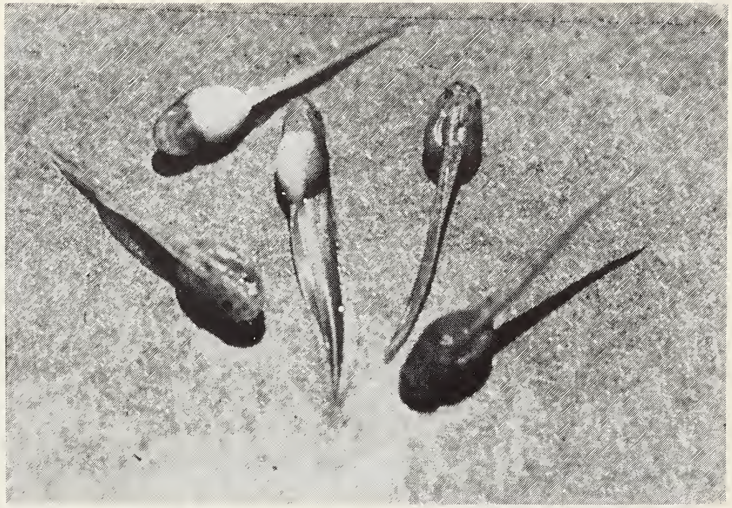
Metamorphosed froglet stage: 26 September 1989 – Age 68 days: Average total length = 16.0 mm (S.D.



Above: Rhacophorus malabaricus pair in amplexus
Below: Eggs collected from the foam nest

Sekar: Tadpoles of *Rhacophorus malabaricus*





Above left: Age 56 hrs, total length 8.73 mm, hatched tadpoles . *Right:* Tadpoles in feeding stage.
Below: Tadpoles in hindlimb stage.

Above: Froglet with rudiment of tail.
Below: Completely metamorphosed froglet

=± 1.0; n = 3); the froglets had lost all external signs of tail and had completely metamorphosed into a replica of the adult except in size and colour; the colour of the froglet was yellowish brown with black dots; thighs barred; toes fully webbed; web yellow.

Feeding behaviour: Tadpoles kept separately for feeding behaviour observations were offered algae, chopped cabbage, non-spicy sausage, pieces of mutton, white of boiled egg, chopped earthworms, crushed snail flesh and pieces of bread. Of these, the sausage, mutton, snail flesh and earthworms were aggressively fed on by the tadpoles. The boiled egg was occasionally eaten whereas algae, cabbage and bread were rarely consumed. They were highly responsive to animal matter. They also fed on dead conspecifics.

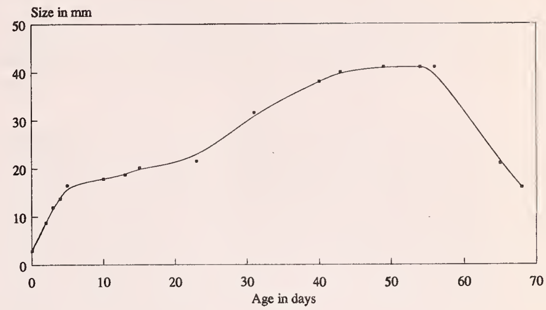


Fig. 2. Growth curve for tadpoles of *Rhacophorus malabaricus* up to metamorphosis.

Discussion

The tadpoles took 68 days to complete metamorphosis, which is a longer duration than that for the related species Ceylonese tree frog *Rhacophorus cruciger cruciger*, which completes its metamorphosis in 49 days (Morgan-Davies 1958) or for the Indian tree frog *Polypedates maculatus*, which completes its metamorphosis in 55 days (Mohanty-Hejmadi and Dutta 1988). However, these animals may grow faster in nature than under laboratory conditions. The growth curve (Fig. 2) is similar to that for other anuran larvae (Mohanty–Hejmadi and Dutta 1988). The tail reached a maximum length of 25 mm in 40 days, maintained the same length for 16 days and was resorbed completely within 12 days. The body, however, grew up to 16 mm in 49 days and maintained this length until the tail was resorbed (Fig. 3). The maximum tail length of 46.67 mm in a tadpole collected from a forest pool which was recorded by Inger *et al.* (1984) was not observed in this study.

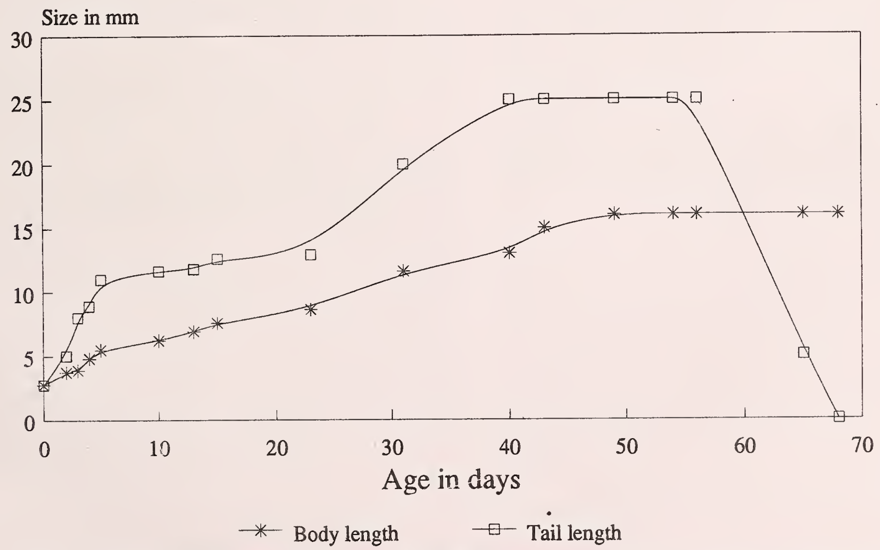


Fig. 3. Relative growths of body and tail of tadpoles of *Rhacophorus malabaricus* up to metamorphosis.

The gills were not visible at 56 hrs. At this time larvae were just hatched and emerged from the foam nest. This observation supports Ferguson's (1904) report that the eggs hatched within the foam nest and the tadpoles fed within the nest until the external gills were absorbed. They then dropped out of the nest.

Ferguson (op. cit.) reported that the colour of the living tadpoles was purple, closely dotted with dark brown. But in the present study it was observed that the colour of the living tadpoles was yellowish brown dotted with dark brown. The length of the body and tail agree with Ferguson's description. He reported that the tadpoles were carnivorous, which was also confirmed in this study. The tadpoles of the Malabar gliding frog clearly preferred meat and mostly avoided vegetable matter while feeding.

The metamorphosed froglets lacked the green colour of their parents. They emerged with a colour closely similar to that of the ground, i.e. yellowish brown dotted with dark brown and barred thighs as in land frogs of the genus *Rana* (Boulenger 1920). They may live on the ground for a short period until becoming arboreal and only then acquire the cryptic green body colour of more mature frogs.

Acknowledgements

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STRATEGIES OF BROODING AND PARENTAL CARE AND INFLUENCE OF STRESS CONDITIONS IN THE LABORATORY IN *HETEROPODA VENATORIA* (ARANEAE: HETEROPODIDAE)[1]

K. VIJAYALAKSHMI AND S. SIVARAMAN[2]

(With a text-figure)

The mode of egg sac construction in *Heteropoda venatoria*, brood care and release of young ones showed that parental care is well evolved in this species of hunting spider. Egg sacs were constructed by mated and non-mated females, but the non mated females discarded the brood sac or ate it within 24 hours of construction of the sac. Brooding females tolerate each other. Maternal care is essential for tearing open the sac and prevention of dessication of eggs. Recognition of sac by the female does not exist and advancement of release of the second sac could be done by the removal of the sac from the female. Parental care in *H. venatoria* is primarily to prevent dessication of eggs and for protection from enemies. Since eggs undergo normal development in laboratory conditions (temperature 28 ± 2.5° C, relative humidity 70-85%) mass rearing of these useful predators could be taken up.

INTRODUCTION

Parental care is found to a great extent in spiders. Maternal care is very common in the vagabond families like Thomisidae, Salticidae, Gnaphosidae, Clubionidae and the females guard the egg sacs until they hatch (Turnbull 1973). Pisauridae carry their egg sacs wherever they wander. Lycosid egg sacs are attached to the spinnerets. The egg sacs of web building spiders receive scant attention from their mothers with the notable exception of Theridids, Pholcids, Agelenids and Eresids. Thus parental care is evolved at different levels among the various groups of spiders.

Heteropoda venatoria is a cosmotropical house spider which is a natural predator of the cockroach and other pests. They do not construct webs to capture prey. The prey capture mechanism is one of attack and capture (Vijayalakshmi 1986).

These spiders produce silk mainly to construct egg sacs to avoid dessication and attack by enemies. Besides, the female mates only once and receives the entire supply of sperm during that mating (Robinson 1975). So great care has to be afforded to reduce mortality and propagate the species. Hence maternal care is of great significance in this species. *Heteropoda venatoria* are reported to carry their brood sac firmly against their sterna with the help of pedipalpi till such time they release their young ones (Bhattacharya 1941, Ross *et al.* 1982).

In the present study the behaviour strategies during brood care, mode of egg sac construction, egg laying, brood care and release of young of *H. venatoria* were observed Experiments were designed to understand phenomena like mutual tolerance among two brooding females, the role of the mother in brood care, development of the young in the absence of the mother, recognition of her own egg sac by the mother and the changes in the egg laying pattern by the removal of egg sac soon after construction.

MATERIAL AND METHODS

In order to observe egg sac construction, egg laying, brood care and release of young ones the females were observed under different conditions. This was done in order to find out variations, if any, in the nature of brooding. The spiders were maintained in closed cylindrical transparent plastic chambers (20 cm height and 15 cm diameter) with lids having two holes. One plugged with cotton was used to introduce the prey. The other carried a long glass tube with a broad mouth wrapped with filter paper at a bottom to hold water, and was used to maintain relative humidity (70-85%). The spiders were maintained at room temperatures of 28 ± 2.5° C and fed 24 hours prior to the commencement of the predation experiments. The following females were observed individually for their brooding habits.

i) Females laboratory reared from egg stage onwards and mated in the laboratory;

ii) Females collected from houses as subadults

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that eventually moulted into adults, and were mated in the laboratory;

iii) Females collected from the houses and left without mating.

These females were provided with abundant prey (cockroaches – *Periplaneta* sp.) after mating and also after release of young ones to provide for the excess energy required for these phases (Vijayalakshmi 1985).

Besides, certain experimental stress conditions were provided to observe the responses of such brooding females. Experiments conducted, results obtained and inferences are presented in Table 2.

Observations and Results

Behaviour prior to construction of the egg sac: On completion of mating the females fed voraciously. The spinnerets become enlarged and active, exhibiting increased deposition of silk. Prior to egg sac construction many attachment points were marked throughout the experimental chamber. Peculiar rotations of the terminal portions of the abdomen were observed and silk threads were extended from various points in the chamber irregularly. Such behaviour by the relatively active female lasted for about 3 days. Onset of egg sac construction finally occurred after one week (Fig. 1 a, b).

Method of egg sac construction and egg deposition: The abdomen of the female rotated continuously and extruded silk to form a disc several layers thick. This disc had a hold on the surface of the container. The epigynal plate expanded and the pale yellowish eggs were released layer upon layer at regular intervals. The number of eggs varied from 96 to 406. The basal plate of the sac was constructed first. The lid for the sac was constructed in a similar manner to that of the basal plate. The sac was picked up by the female and held firmly with the chelicerae and pedipalps on the ventral side. The 1st and 3rd pair of legs were also used for gentle tapping. Freshly constructed sacs had a pinkish tinge. During preening the sac was left on the floor for a short while; if disturbed preening was stopped and the sac grabbed.

Release of the young ones from the sac: Around the 14th to 16th day of brooding an expansion was observed in the sac. By the 16th to the 23rd day the female tore open the seam of the sac by holding with the chelicerae on top and the 3rd pair of legs at the bottom. Initially one or two spiderlings came out through the slit, and rested on the sides of the sac. In a day or two they started moving about and more spiderlings came out every day. Between days 2 and 7 all the young ones came out (96 to 406 in-

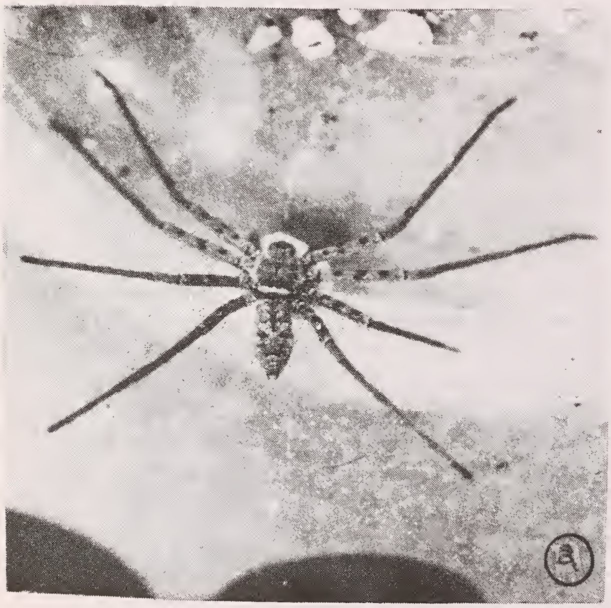

Fig. 1. Female *Heteropoda venatoria* holding egg sac: a. Dorsal view; b. Ventral view.

dividuals) and even after release the empty sac was still carried about by the female for a further period of 1 to 4 days before being discarded. The young had already undergone the 1st moult inside the sac and the exuviae were observed in the egg sac. In the spiderlings the spinnerets were active and they climbed up and jumped down by using draglines and extended threads for dispersal.

Feeding during brood care: Right from the time of construction of egg sac up to the release of young ones and the discarding of the sac the female did not feed. After the release of the young, the female broke the long period of starvation and fed voraciously. If at this stage the females were not provided with enough prey they died.

Cannibalism: Intense cannibalism was noted amongst young ones of the first instar but no cannibalism was noted between the mother and the spiderlings.

Construction of subsequent egg sacs without **mating:** It was observed that the females do construct egg sacs without mating. Virgin females were also observed constructing sacs. Table 1 provides data for these observations. It is evident from the table that when the adult females were reared from the egg stage in the laboratory and not given an opportunity for mating, they still constructed egg sacs with or without eggs at periodical intervals and when they contained unfertilized eggs they were eaten by the female with or without egg sac.

Another observation was that the females which constructed sacs with viable eggs might construct subsequent egg sacs without viable eggs which were discarded or eaten up. It has also been observed that the female which kept constructing egg sacs with unfertilized eggs, when mated, constructed egg sacs with viable eggs subsequently. Also, observations have been made where the female failed to construct a proper egg sac; it was in the form of a patch of silk attached to the wall of the container and eggs were released on the floor of the container. A female that had been mated once also constructed three egg sacs subsequently with viable eggs without any further mating.

Discussion

One of the biotic factors that influence predation is brooding and maternal care of the females. In *Heteropoda venatoria* the females do not predate during brooding. However, they feed voraciously before and after brooding. The amount of feeding greatly deviates from the normal during such pre and post brooding phases.

The voracious feeding of the female before the construction of the sac probably provides for storing energy for egg development, construction of egg sac and long period of starvation when brooding.

The brood sac construction does not take place if the females do not feed after copulation. Feeding after copulation is necessary for the second phase of yolk accumulation. An expansion of the egg sac before the spiderlings moult to the first instar is observed in *H. venatoria* as also in some wolf spiders (Fuji 1978).

As in many related families of wandering spiders, maternal care is better developed in *H. venatoria* than in many web weavers that abandon the egg sac after construction. *Heteropoda* do not construct any web either for prey capture or retreat. Since the egg sac is exposed to greater risk of dessication and attack by enemies, it is tough and thick with several layers of silk. The female holds it firmly until the release of young.

It is evident from earlier studies that there is a great variation in the number of egg sacs (Table 3). Studies of some workers (Ross *et al.* 1982) give an indication of the time taken to construct the egg sac after copulation. It is 12-14 days which is twice the time recorded during the present study. Also the duration of brooding is lengthened. The number of young collected in the laboratory is much less than the ones observed in the present study.

That the females do not cannibalize their young could be due to the fact that the size of the emerging 1st instar nymphs is too small for capture by the adult.

In *Metaphiddipus galathea* (Horner and Starks 1972) it was observed that the gravid female which was not allowed to mate constructed an egg sac and deposited infertile yolk-like material in which individual 'eggs' appeared to run together. These infertile masses were deposited continuously at approximately the same intervals that other females deposited fertile egg sacs. Once these females were mated they produced viable eggs.

In *H. venatoria* construction of egg sacs with unfertilized eggs and those without eggs could be interpreted as the result of hormonal imbalance.

TABLE 1

OBSERVED VARIATIONS OF THE BROOD SAC AND ITS FATE IN MATED AND NON–MATED FEMALE *Heteropoda venatoria*

Female	Successive state of female	Mated (M) Non-mated (N.M.)	Description of brood sac	Fate of egg and sac	Size of sac
I.	1. Adult reared from egg stage in the lab.	N.M.	Whitish thin sac with few eggs.	Eaten up in 24 hrs.	
	2. Adult reared from egg.	N.M.	Patch of silk, no eggs.	Discarded.	
II.	1. Captured adult female with brood sac.	M.	Pinkish white, broad, complete with eggs.	Release of young ones (322) in 16 days.	2.05 cm
	2. Construction of brood sac after 19 days.	N.M.	Incomplete, thin walled, no eggs.	Discarded within 24 hrs.	
	3. Construction of brood sac after 14 days.	N.M.	Complete, papery, no eggs.	Eaten up in 24 hrs.	
	4. Construction of brood sac after 20 days.	N.M.	Complete with few eggs.	Eaten up in 24 hrs.	
III.	1. Female captured in field constructed brood sac after 4 days.	May be N.M.	Pinkish white, broad, complete with eggs.	Eaten up in 24 hrs.	
	2. Construction of second sac after 14 days.	N.M.	Pinkish white, broad, complete with eggs.	Eaten up in 24 hrs.	
	3. Female mated with male 10 days later.	M. Lab.	Pinkish white, broad, complete with eggs.	Release of (205) young ones in16 days.	1.8 cm
IV.	1. Female captured with brood	?	Pinkish white, broad, complete with eggs.	Release of young ones in 16 days.	1.5 cm
	2. Construction of egg sac after 20 days.	N.M.	Pinkish white, broad, complete with eggs.	Held it for 14 days eggs eaten up and sac discarded.	
V.	Female captured with bulging abdomen.	?	Incomplete brood sac in the form of patch of silk stuck to the wall of container. Eggs released on floor of container.	Eggs dried in 24 hrs.	
VI..	1. Captured adult female with brood sac	?	Pinkish white, broad, complete with eggs.	Release of (407) young ones in 18 days.	2.5 cm
	2. Construction of egg sac after 11 days.	N.M.	Pinkish white, broad, complete with eggs.	Release of (325) young ones in 17 days.	2.1 cm
	3. Construction of egg sac after 32 days.	N.M.	Pinkish white, broad, complete with eggs.	Release of (204) young ones. Discarded sac on 11th day. Eggs were isolated. Isolated eggs undergo normal development.	1.95 cm

TABLE 2
EXPERIMENTAL OBSERVATIONS AND INFERENCE ON BROODING

Expt. No.	Objective	Experiment	Observation	Inference
1.	For observation of interaction and tolerance of brooding females.	Allowing two adult females which had constructed the egg sac on the same day into the same chamber.	Avoid each other, and settle down and continue with normal sequence of brooding.	Brooding females can tolerate each other.
2.	To study the importance of maternal care of the egg sacs.	Egg sac isolated from mother within (i) 24 hrs. of construction, (ii) after expansion, (iii) after tearing open had begun.	Spiderlings in the 1st 2 sacs died at various stages of hatching and moulting, in the absence of induced tearing open. In the last one young ones emerge when tearing was done manually.	Maternal care is important for expansion and tearing open of sac.
3.	To study the dependence of egg development upon brood sac and the microhabitat.	(i) Eggs isolated within 24 hrs. of laying and sandwiched between cotton in small vials providing the same microhabitat.	Eggs undergo normal development and moult into first instar nymphs.	Primary function of maternal care is prevention of dessication of eggs.
		(ii) Eggs kept as such in vials.	Eggs dry up.	
4.	To understand the capacity of female to recognize her egg sac.	Female deprived of its egg sac provided with a foreign and same sac.	They accept both without any distinction.	Recognition of its own sac does not exist.
5.	To study if expansion of sac and tearing open and release of young ones is a programmed behaviour.	Egg sacs of same age and different ages exchanged amongst brooding mothers.	The schedule of expansion, tearing open and release of young is adjusted according to the age of the egg sac and not the mother's own sac.	The steps in brood care are not a programmed behaviour.
6.	To study if the egg sacs can be recognised from fakes.	Brooding females were deprived of their egg sac and provided with various substitutes like (i) empty egg sac. (ii) cork rolled paper. (iii) non-brooding females and males were also provided with the artificial materials.	Brooding females hold it for a while and discard it. Non–brooding females grab it and immediately discard it.	Brooding females do have the capacity to distinguish between the full egg sac and fakes. Holding the fakes for a while indicates instinctive behaviour associated with brooding. Non-brooding females mistake the movement of objects for the movement of prey. Fakes are recognised at once and discarded.
7.	Study if subsequent egg laying can be advanced by removing the sac.	Egg sacs were removed from females soon after construction.	Subsequent egg laying was considerably advanced.	Advancement in release of second egg sac might be due to rescheduling of the next phase in the hormonally regulated reproductive cycle.

However, the construction of egg sacs by virgin females was also observed in *H. venatoria* and this was attributed to an artificially imposed mating schedule (Ross *et al.* 1982). Acts of ecdysis and reproduction are accompanied by an increased activity of groups of neuro-secretory cells in the protocerebrum and chelicerae of certain groups of spiders. (Legendre 1956). The role of neurosecretory cells has also been described (Yoshikura and Takaho 1972).

In the light of such observations it may be suggested that hormonal imbalance could be the major factor governing premating egg laying, rather than artificial imposition of mating in the absence of a male. Moreover, the presence of a fertilized brood sac in the clutches of a female prolongs the release of new egg sacs and this is advanced by forcible removal of sac after a day (vide expt. 7).

It is interesting to note that females differentiated between fertilized and unfertilized eggs within 24 hours of egg deposition and were observed to eat only the unfertilized ones. The drying of unfertilized eggs may bring in loss of weight. Minute vibrations could be caused by cellular proliferation of the mass of eggs. These are probably detected by the female. It has been reported that the vibratile sense organs of the abdomen are very well specialised in spiders (Barth 1972).

The eating of eggs prevents the wastage of unfertilized eggs in *H. venatoria*. The eaten unfertilized eggs might be recycled by some mechanism. When this very same female is later mated normal development of eggs occurs.

Construction of more than one egg sac after a single mating has been observed in *Metaphiddipus galathea* (Horner and Starks 1972). It is suggested that they receive a large number of sperms in one single mating and store them in spermatheca for further use. The same mechanism could be operating in *H. venatoria* as they are able to construct more than one egg sac with viable eggs subsequent to a single mating.

The reduction in the size of the successive brood sacs and number of eggs could be due to the successive release of eggs. They decrease corresponding to the decreasing availability of sperms. Such a situation is also observed in *Cupiennius* (Melchers 1963).

The experiments conducted gave the reactions of *H. venatoria* under stress which may also occur in the natural habitat.

Experiment 1: Mutual tolerance of females with egg sacs is quite advantageous. The females though avoiding each other do not attack or kill each other presumably due to the risk of losing their own sac.

Experiment 2: From experiments where the egg sacs were not torn open but were left as they were to develop after isolation from the mother, it was indicated that tearing open of the egg sac and release of the young ones is an important function in the maternal care of the egg sac. A similar function to the mother was attributed in *Pardosa astrigera* (Fuji 1978)

Experiment 3: Eggs when isolated from the female within 24 hours of construction of the sac undergo normal development in the laboratory when provided with the same microhabitat. Thus it is clearly indicated that the maternal care exhibited by *H. venatoria* has the primary function of preventing dessication of eggs and secondarily affording

TABLE 3

DETAILS OF OBSERVATIONS ON BROODING STRATEGIES OBSERVED BY VARIOUS AUTHORS IN *H. venatoria*

Author (Year of publication)	Country	No. of eggs/sac	Size	Prebrooding duration (after copulation) till formation of brood	Brooding duration
1. Bonnet, P. (1930)	New Guinea	207	–	Not mentioned	Not mentioned
2. Bhattacharya, G.C.(1941)	India	Not mentioned	–	-do	-do-
3. Sekiguchi, K (1944)	Japan	188-436	1.27 cm	-do	-do-
4. Ross, J. *et al.* (1982)	Florida, USA	400 (in field) 277 (in lab.)	2.54 cm 1.5 cm	12-14	32 days
5. Vijayalakshmi, K.* (1985)	Madras, India	96-406	2.5 cm	3-7 days	16-23 days

*Present work.

them protection from enemies.

Experiment 4: Females accept their egg sacs or a foreign egg sac without the ability to distinguish between them. The female spider cannot recognize her own egg sac. In Lycosid spiders the spiderlings of another species are also readily accepted and will settle down on the back of their 'stepmother' (Engelhardt 1964). The level of recognition is of limited nature.

Experiment 5: The schedule of tearing open of the egg sac in the present study was delayed or advanced to suit the moulting of the first instar nymphs. It is possible that such a stimulus to tearing response is provided by the active running movement of the young ones that begins just after moulting (Fuji 1980). Observations clearly indicate that these spiders regulate the egg sac tearing and expansion behaviour and that it is not a programmed behaviour.

Experiment 6: Though the female could not differentiate between its own and other sacs it definitely has a capacity to differentiate between a full and an empty sac. The acceptance of the empty sac, piece of cork, and paper for a while is a clear indication that 'holding an object' is an instinctive behaviour in the brooding females. Individual spiders whose egg sacs were forcibly removed pick up and carry about various substitutes such as pieces of cork, waste paper or cotton, a small empty snail shell, rabbit dropping etc. (Bristowe 1958, Savory 1977, Gertsch 1979, Fabre 1913). Non-brooding females and males accept these objects only when the objects are in motion. The motion might be mistaken for the movement of the prey, but the immediate rejection of it clearly indicates that it at once distinguishes between a prey and a fake and also that it does not have the instinctive 'behaviour of holding' like the brooding female individuals.

Experiment 7: The advancement in release of second egg sac by the removal of the first, might be to reschedule its next phase. This could be attributed to the complete control of egg laying by females only after mating; the release of unfertilized eggs might be due to imbalance in the total reproductive cycle of a virgin female. Moreover, a single mating in the life span of a female is an important phase in the hormonal regulation and neurosecretion of these spiders.

Eggs develop in the absence of the brood sac when provided with the same microhabitat. Moreover, females release more brood sacs successively in a short duration when the sacs are removed. These aspects can be suitably adopted in mass rearing while using them in biocontrol programmes. The brood sacs could be isolated from the mother as and when they are constructed in the laboratory and maintained under controlled laboratory conditions.

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NEW RECORD AND DESCRIPTION OF *AETHALOTUS HORNI* BREDDIN (INSECTA : HETEROPTERA : LYGAEIDAE) WITH ITS IMMATURE STAGES FROM NORTHEAST INDIA[1]

A. MUKHOPADHYAY, P. ROY AND S. DAS[2]

(*With twelve text-figures*)

Aethalotus horni Breddin is recorded for the first time from northeast India on a new host plant, *Calotropis procera*. A detailed description of the species and its nymphs is provided.

In the oriental region *Aethalotus horni* Breddin is known from Puttalam and Anuradhapuram in South India and Ceylon (Sri Lanka) (Distant 1910). In addition Chatterjee (1937) reported it from Madras. Subsequent records were from North Salem, Aiyur, Jawalagiri-Madras and North Coorg, Fraserpet, Mysore and Coorg (Bhasin 1953). The specimens studied from the plains of district Darjeeling in northeast India are found to be slightly larger, with a different colour pattern than those recorded from peninsular India (pers. comm., W.R. Dolling 1985) and require a redescription. Besides some changes in morphological character and colour of the species, its establishment and breeding activity on a new host plant, *Calotropis procera* in this region, compared to its report from sandalwood plantations of south India (Chatterjee 1937) facilitated a study of its immature stages.

The descriptions of all the life stages and adult are based on fresh specimens collected from the campus area of North Bengal University, District Darjeeling, West Bengal from the local host plant, *Calotropis procera*.

Redescription of adult (Fig. 1): Body slender, oblong, greyish black with fine adpressed pilosity. Head triangular, yellowish red; tylus obtusely pointed exceeding juga; eyes rounded, shortly stalked with red crescent marking at base in some, separate from anterior pronotal margin; ruby red ocelli closer to lateral eyes than to one another, streaky brown marking anterior to ocelli; antennae black with fine pilosity; antennifers inconspicuous with a couple of red dots at base; labium reaching hind coxae, first labial segment exceeding base of head.

Thorax with pronotum blackish having two longitudinal sordid yellow streaks extending along anterior margin, lateral margins sinuately concave in the middle, basal margin slightly elevated, moderate punctation more or less uniformly sparsed, deep black calli at anterio-lateral margins; scutellum triangular blackish with apex pale translucent; pleura yellowish red, finely pubescent, punctate; sternum brown, non-uniform pubescence; legs sordid white with blackish tint, coxae pale with few hairs, femora pale with proximal blackish patches punctate, tibiae slender, darkish uniform hair, tarsi darkish, pretarsus with typical claws and arolia without hairs; forewing blackish with fine grey decumbent pubescence, membrane hyaline, exceeding abdominal tip in female and just touching or passing in males; innermost of the five veins forked anteriorly, clavus impunctate excepting few along inner margin, corium with uniform insignificant punctures and vein-like thickening along subcostal margin; hind wing with well developed veins excepting faint hamus and second anal, radius does not reach margin, secondary veins absent, anal lobe separated prominently along anal fold (Fig. 2).

Abdomen ventrally yellowish green with adpressed hair; posterior segments darker in male and pale in female; connexival margin sometimes visible laterally; margins of sternites and genital segments with some larger hairs; male genitalia with pygophore protruding externally; aedeagus (Fig. 3) with phallosoma moderately pigmented brownish yellow without any process, bottom area partly transparent, conjunctiva short, narrowly distinguishable, ejaculatory reservoir complete, wings leaf- like, vesica at base circularly symmetrical but apically slender with 2 1/2 coils of helicoid process, a small part of the gonoporal process remain free, ring sclerite in secondary gonoporal region, basal apparatus resembles dog–bone; paramere with

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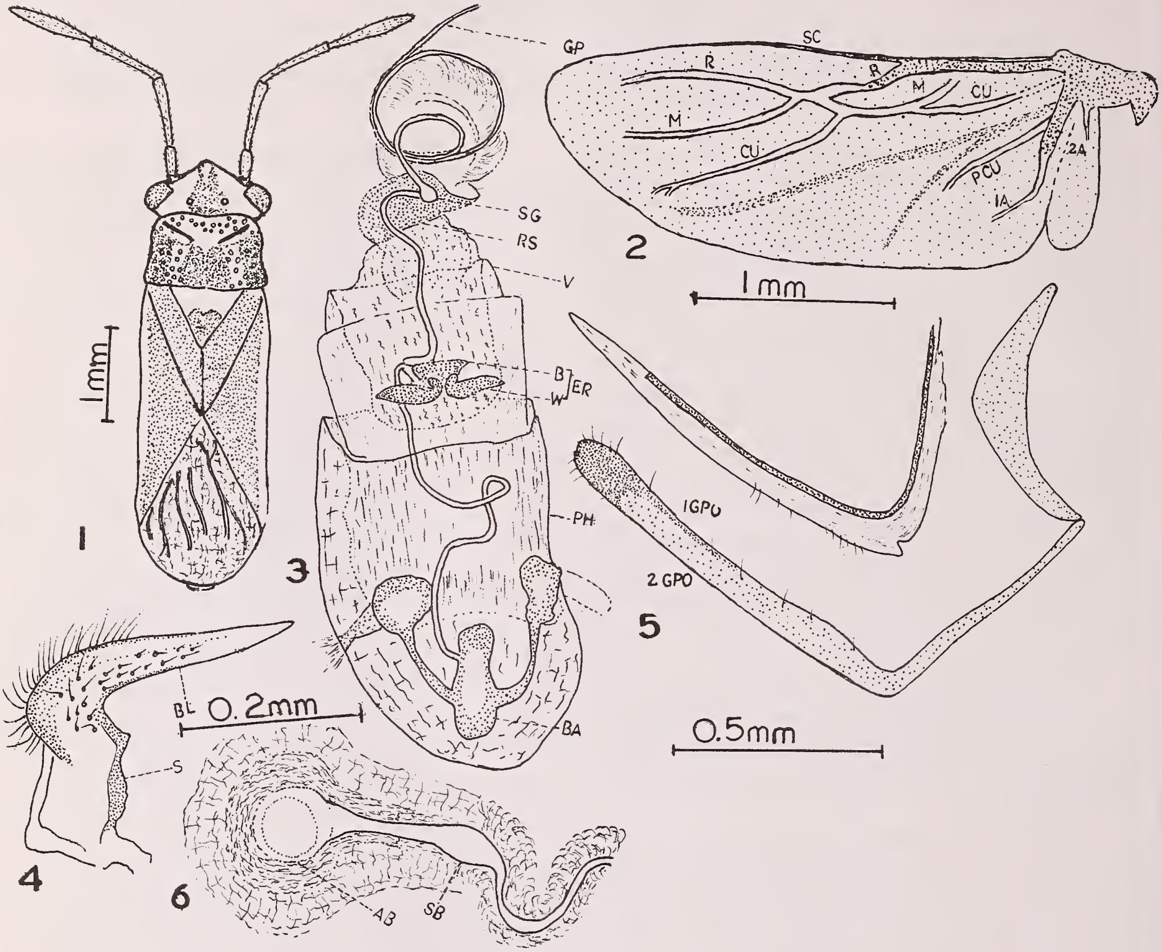

Fig 1-6. *Aethalotus horni* Breddin
1. Dorsal view of adult male; 2. Hind wing of male showing venation; 3. Aedeagus; 4. Right paramere;
5. Ovipositor showing 1st and 2nd gonapophysis (separated); 6. Spermatheca.
Abbreviations: AB, Apical Bulb; 1A, 1st Anal; 2A, 2nd Anal; B, Body; BA, Basal Apparatus; BL, Blade; Cu, Cubitus; ER, Ejaculatory Reservoir; GP, Gonoporal Process; 1.G.P.O., 1st Gonapophysis; 2GPO, 2nd Gonapophysis; M, Median; PCU, Post Cubitus; PH, Phallosoma; R, Radius; RS, Ring Selerite; S, Shank; SB, Sub-basal part; SC, Sub Costa; SG, Secondary Gonopore; V, Vesica; W, Wing.

sickle shaped blade making almost a right angle with shank (Fig. 4), rough hair more on dorsal angular bent than rest; female genitalia with 1st and 2nd gonapophysis (Fig. 5) of ovipositor not well demarcated, 1st ramus dark brown, traversing about 3/4th length of 1st gonapophysis, 2nd ramus pale yellow ending in hairy black apex of the blade-like 2nd gonapophysis; spermatheca (Fig. 6) with bulbous apical part enclosed in a mass of brownish tissue extending along with sub–basal saccoid part through a short slender duct.

All measurements, with ranges in parentheses are in millimetres and are based on at least ten observations.

Measurements: Total body length male 4.01(3.95-4.15), female 4.82 (4.6-5.05); maximum width (across pronotum) male 1.06(1.05-1.1), female 1.23 (1.2-1.35); head length male 0.58 (0.5-0.65), female 0.67 (0.6-0.7); head width (across eye) male 1.18 (1.15-1.2), female 1.34 (1.3-1.4); interocular width male 0.81 (0.8-0.85), female 0.93 (0.9-1); antennal segment I male 0.25(–), female 0.255 (0.25-0.3), II male 0.70 (0.6-0.75), female 0.73 (0.7-0.75), III male 0.69 (0.65-0.75), female 0.72 (0.7-0.75), IV male 0.81 (0.75-0.85), female 0.86 (0.7-0.9); labial length male 1.82 (1.75-1.85), female 2.05 (1.95-2.1).

Description of Immature Stages

Fifth instar (Fig. 7): General coloration green, females appear slightly larger than males, body linear in outline with fine pilosity.

Head pale with tint of light brown; viewed from top wider (across eyes) than long; tylus subacutely protruding, slightly exceeding juga; antennifers just produced; vertex region slightly arched; buccular area a little swollen; eye chocolate brown, stalked separate from pronotal margin; ocellus red; dilute brown markings extending at base of head, anterior to ocelli, in tylus and antennifer regions; antenna brown fuscous, segment IV longest, II and III subequal, finely pilose; labium green with a central brown axial marking, tip of segment IV mostly brown, just passing or reaching hind coxae, segment I just reaching base of head.

Thorax with pronotum twice as broad as long, anterior and posterior margins nearly straight with slight concavity, lateral margins insignificantly explanate and slightly wavy, a pair of shiny narrow straight calli; legs greenish with tint of brown shade at the lateral side of femora, part of tibiae and tarsi; fore femora without spine but small warty structure at distal end; mesothoracic wing pads green with scanty hair, explanate margin, extending up to middle or end of III abdominal tergum.

Abdomen in general green; two dark brown spots between IV-V, V-VI tergal segments preceded and followed by other light brown and white patches along mid-dorsal line; connexivum well marked with a light greenish yellow colour; very fine decumbent hairs all over abdomen; females with a broad patch of shiny oblong plate in the ovipositor region.

Measurements: Total body length 3.92 (3.6-4.15); maximum width (across pronotum) 1.12 (1.05-1.25); head length 0.69 (0.6-0.8); head width (across eye) 1.16 (1.1-1.2); interocular width 0.78 (0.7-0.85); antennal segement I 0.25 (–), II 0.63 (0.6-0.65), III 0.64 (0.6-0.7), IV 0.77 (0.7-0.8); labial length 1.81 (1.75-1.85).

Fourth instar (Fig. 8): Similar in form to 5th instar, coloration pale green; impression of ocelli obscure; wing pads extend up to half the length of abdominal tergum I, less green than that of 5th instar; brown markings along the mid-dorsal line dilute and less prominent; sexes not easily distinguishable by seeing genital segments.

Measurements: Total body length 2.79 (2.5-3.1); maximum width (across pronotum) 0.90 (0.85-0.95); head length 0.56 (0.55-0.6); head width (across eye) 0.94 (0.9-0.95); interocular width 0.69 (0.65-0.75); antennal segment I 0.22 (0.2-0.25), II 0.51 (0.5-0.55), III 0.51 (0.5-0.55), IV 0.62 (0.55-0.7); labial length 1.53 (1.45-1.6).

Third instar (Fig. 9): General form and coloration similar to 4th instar; tiny mesothoracic wing pad obtusely triangular; mesonotum with a pair of brown streaky markings parallel to the pronotal calli; mid-dorsal brown markings of abdomen very light excepting two around dorsal scent glands; connexivum well marked out, partly explanate with prominent yellowish marking; abdomen with fine hair.

Measurements: Total body length 2.23 (2.1-2.35); maximum width (across pronotum) 0.77 (0.75-0.85); head length 0.47 (0.45-0.5); head width (across eye) 0.79 (0.75-0.8); interocular width 0.57 (0.55-0.6); antennal segment I 0.18 (0.15-0.2), II 0.405 (0. 4-0.45), III 0.43 (0.4-0.45), IV 0.49 (0.45-

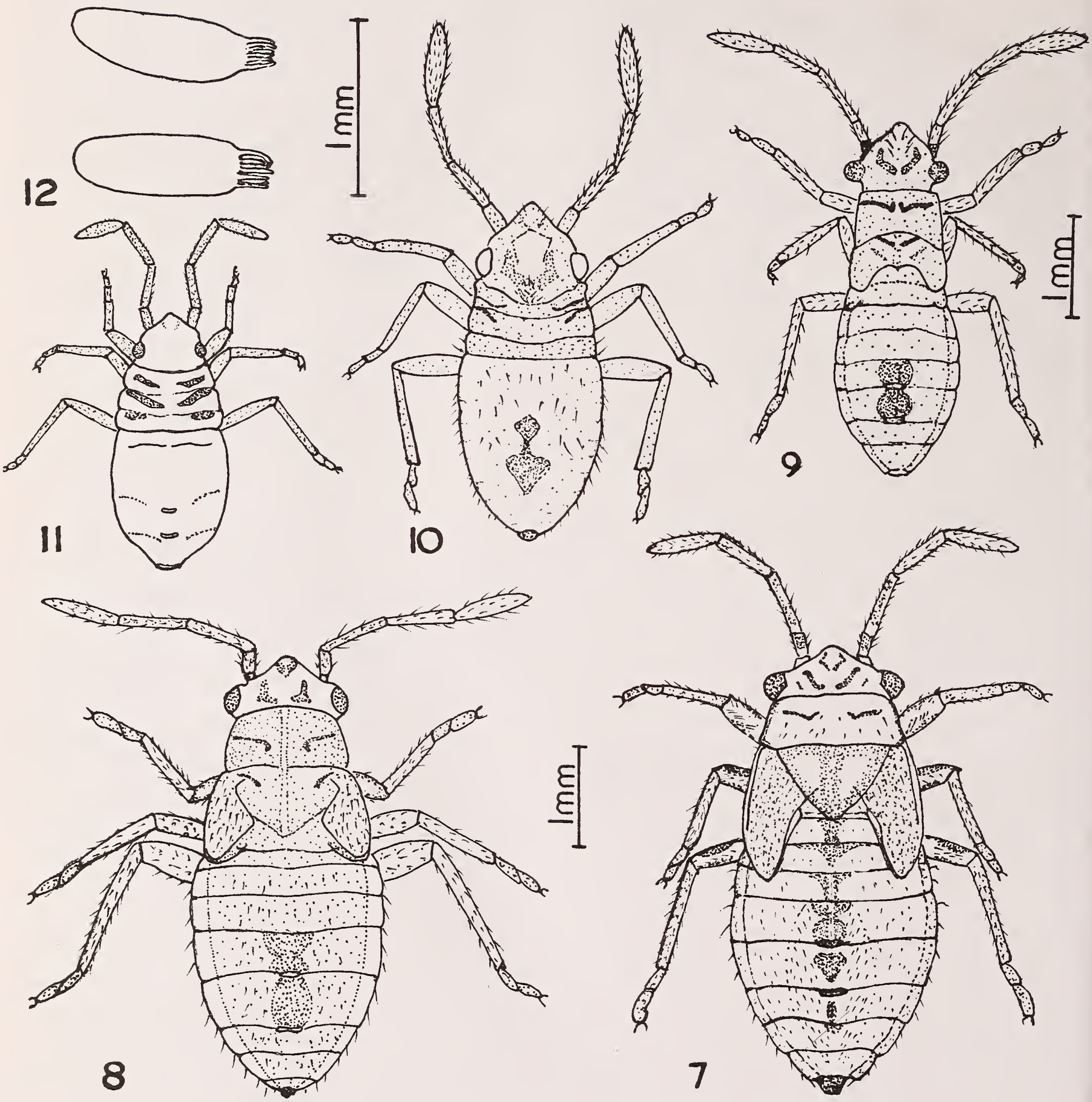

Fig. 7-12. *Aethalotus horni* Breddin
7. Fifth instar nymph; 8. Fourth instar nymph; 9. Third instar nymph; 10. Second instar nymph; 11. First instar nymph; 12. Eggs.

0.55); labial length 1.31 (1.25-1.35).

Second instar (Fig. 10): Sordid yellowish green; head pale yellow with dilute brown markings; distal end of antennal segment IV whitish; dark brown mesonotal markings (calli) as prominent as that of prothoracic; connexivum slightly explanate; dorsal abdominal scent gland area yellowish brown with a darker tint around orifice; labium reaching or just passing abdominal segment I.

Measurements: Total body length 1.75 (1.55-1.95); maximum width (across pronotum) 0.58 (0.55-0.6); head length 0.41 (0.4-0.45); head width (across eye) 0.6(–); interocular width 0.43 (0.4-0.45); antennal segment I 0.15 (–), II 0.34 (0.3-0.35), III 0.35 (–), IV 0.42 (0.4-0.45); labial length 1.01 (0.95-1.05).

First instar (Fig. 11): Sordid yellow with a tint of green; head prominently yellow, labium passing abdominal segment I; pro, meso, and metathorax with transverse pairs of black markings, dorsal abdominal scent gland area light reddish–yellow in colour; abdominal tip with a prominent brown marking, ventrally presence of a blackish blot of some internal organ.

Measurements: Total body length 1.47 (1.3-1.6); maximum width (across pronotum) 0.47 (0.45-0.5); head length 0.34 (0.3-0.4); head width (across eye) 0.46 (0.45-0.5); interocular width 0.35 (0.3-0.4); antennal segment I 0.13 (0.12-0.15), II 0.27 (0.25-0.3), III 0.28 (0.25-0.3), IV 0.32 (0.3-0.35); labial segment 0.82 (0.75-0.9).

Egg (Fig. 12): Pearly white, shiny with obscure decumbence, cucumber shaped with slight curvature, caudal end slightly tapered, mature orange red with eye spots of ensheathed embryo, micropylar processes long, slender, slightly swollen in the middle and extending broadly up to the tip, micropylar processes 10 to 11.

Measurements: Length 1.29 (1.15-1.4); width 0.402 (0.4- 0.42).

Acknowledgements

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AN ANALYSIS OF SOME EXTERNAL FACTORS IN THE SEXUAL PERIODICITY OF THE INDIAN BAT *MEGADERMA LYRA LYRA* (GEOFFROY)[1]

A. Gopalakrishna and N. Badwaik[2]

(With five text-figures)

The breeding habits of *Megaderma lyra lyra* have been studied from different localities in India at different latitudes with markedly different climatic factors, such as temperature, rainfall, humidity and duration of the day. The species breeds once in a year almost synchronously in all the localities, the date of copulation advancing only by a few days towards lower latitudes. Evidently, the breeding pattern of this species is genetically determined, and external factors do not seem to play a significant role.

Introduction

Most species of Indian bats, whose reproductive habits have been studied so far, breed once a year in a sharply defined season. The different species, however, breed during different seasons in the year. Thus, while some species mate during March-April and experience pregnancy during the following months (Gopalakrishna 1947, Gopalakrishna *et al.* 1985, Kumar 1965, Sapkal and Khamare 1984), several species mate during November-December and gestation follows immediately (Ramakrishna 1951, Ramaswamy 1961, Gopalakrishna and Rao 1977, Gopalakrishna and Madhavan 1978, Madhavan *et al.* 1978, Madhavan 1981). A few species like *Pipistrellus ceylonicus chrysothrix* (Madhavan 1971), *Tadarida aegyptiaca* (Sandhu 1986) and *T. plicata* (Pendharkar 1982) mate in June–July at the commencement of the monsoon. *Rousettus leschenaulti* (Gopalakrishna and Choudhary 1977) and *Cynopterus sphinx* (Sandhu and Gopalakrishna 1984, Sandhu 1984) breed twice a year in quick succession, once during November–December and a second time during March–April. *Taphozous longimanus* (Gopalakrishna 1954, 1955), *Pipistrellus dormeri* (Madhavan 1978) and *P. mimus* (Gopalakrishna *et al.*1975) breed throughout the year.

All the above mentioned studies have been made by examining specimens of a given species in a given locality. Hence, it has not been possible to explore the possibility of the influence, if any, of external factors on the breeding behaviour of these animals. India, being a vast country (Fig. 1) extending from about 8°N to over 37°N latitude and having several mountain ranges, thick forests and deserts, has a wide range of climatic and ecological conditions in different parts of the country. An evaluation of the effect of external factors on the reproductive behaviour of bats can only be made provided the breeding habits of the same species are studied in different parts of the country and under different climatic and external factors. The present work has been undertaken precisely with this view. *Megaderma lyra lyra* has a wide distribution and is, therefore, an ideal species whose reproductive behaviour in different parts of the country with wide variations in climatic and ecological conditions may help in understanding the possible influence of external factors on the reproduction of this species in particular and of Indian bats in general.

Material and Methods

The present studies have been conducted on specimens of *Megaderma lyra lyra* collected at and near Bangalore (12° 58'N, 77° 35'E), Srirangapattana (12° 26'N, 76° 43'E), Aurangabad (19° 53'N, 75° 20'E), Nagpur (21° 09'N, 79° 07'E) and Agra (27°10'N, 78°02'E). The locations for study have been so chosen as to represent a wide range in latitude (from 12° 26' to 27° 10' N) with a view to ensuring a wide range of natural seasonal climatic conditions, and within a very small range in longitude (from 75° 20' to 79° 07'E). Other factors such as altitude, occurrence within a short distance of forest, desert, or mountain have also been taken into consideration while choosing the geographical areas for this study. Since the breeding behaviour of this species is identical in Bangalore and Srirangapattana, and since the climatological characters of these two places do not differ significantly, the climatic

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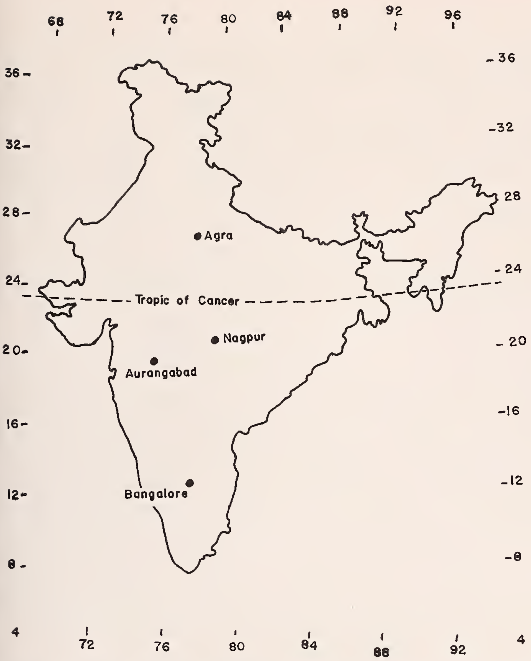


Fig. 1. Map of India showing locations where the reproductive habits of *Megaderma lyra lyra* have been studied.

factors of only Bangalore are included in this report.

The climatic and solar factors which have been considered here are: maximum and minimum temperature, percentage relative humidity, rainfall and duration of the day (sunrise to sunset). The data were obtained through the courtesy of the meteorological department, Government of India, and from the publication entitled "Climatological and solar data for India" by the Central Building Research Institute, Roorkee, Uttar Pradesh.

General Notes on *Megaderma lyra lyra*

This species normally roosts in underground tunnels, deep dungeons of old forts and dark recesses of old temples, deep natural and artificial caves, tunnels of discarded mines and deep, dark wells. In one or two places near Nagpur a few specimens were found hanging from the ceiling in dark grain godowns and old cowsheds. These were most probably temporary places of roosting adopted by the specimens which had been disturbed from their usual roosting places either due to breaking up of the original roost or due to mining and blasting activities carried out nearby. This species is specially scotophilous and avoids places where there is much light. This peculiar habit is also evident from the fact that they do not emerge from their roosting places until quite some time after sunset and until darkness nearly sets in. They return to the roost at least two to three hours before sunrise. During moonlit nights their foraging time is considerably abbreviated – from about 2300 hrs to about 0200 hrs only.

In all the places, where these bats have been studied for the present report, the roosting places were invariably near a water source, either in the form of a river or a canal or a large tank. It appears that this species selects a dark place near a constant source of water for roosting. The presence of water appears to ensure a certain degree of humidity in the roost, and this appears to be a natural requirement for this animal.

Megaderma lyra lyra is a semicarnivorous bat and feeds on smaller vertebrates like lizards, frogs, small birds apart from large bodied insects (Brosset 1962). This bat sometimes attacks other smaller bats and is sometimes cannibalistic (pers. obs.). No other smaller bat species was ever noticed among the specimens of *Megaderma lyra lyra* in any of the places from where these specimens were examined. Brosset (1962), however, mentioned that a few other species were associated with *Megaderma lyra lyra* at Elephanta and Pattadakal. This is a very uncommon feature, and probably a few specimens of *Megaderma lyra lyra* might have invaded the roosts of other bats for foraging or, conversely, some specimens of other species may have accidentally strayed into the roosting places of *Megaderma lyra lyra*. On a few recent visits to these places one of the present authors (A.G.) noticed the presence of *Megaderma lyra lyra* in these localities but invariably the specimens remained separate from the other species, either in a separate cave (as in Elephanta) or in a separate temple building (as in Pattadakal).

This species mates in November in all the localities and pregnancy follows immediately. Deliveries in the colony occur during the latter half of April. The young ones are weaned at an age of 35 to 40 days. The adults are sexually inactive during the rest of the year. Table 1 gives the data regarding the various phases of the sexual cycle of this bat in the four localities.

Climatological Factors

From Figs. 2a-d, which give the maximum and

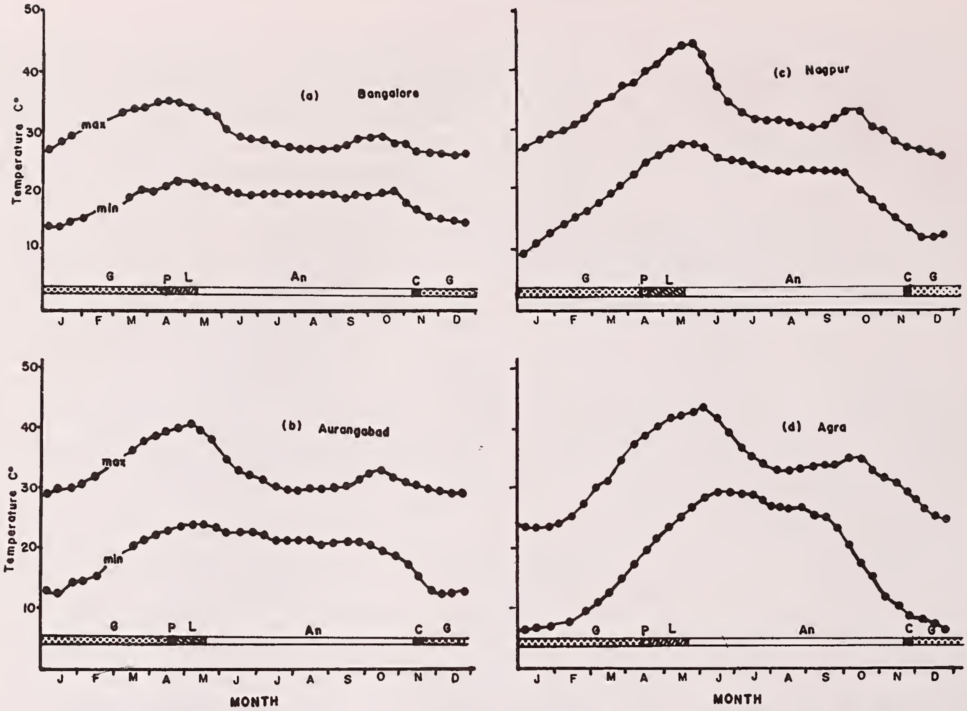
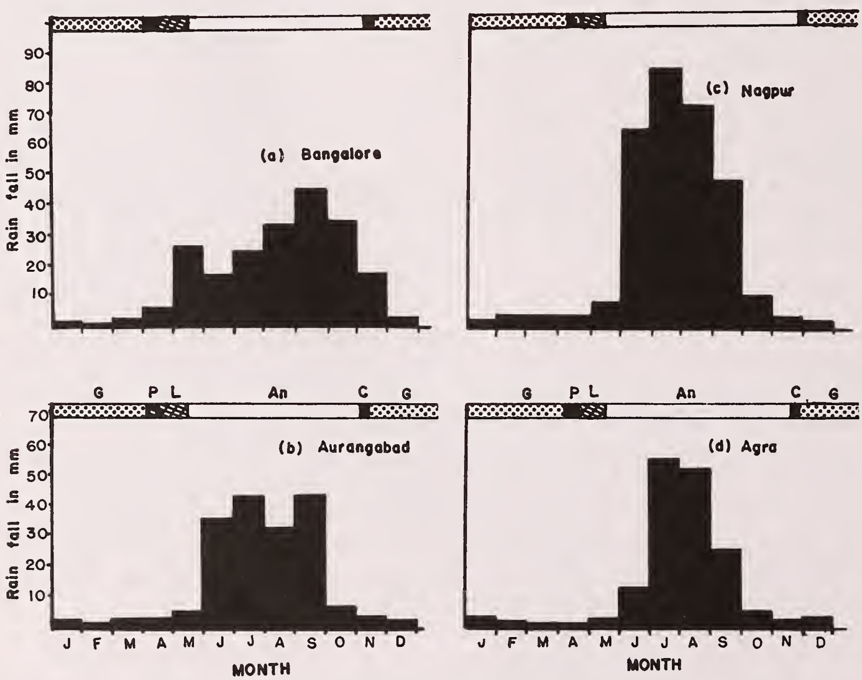


Fig.2. (a–d) Maximum and minimum temperatures at different localities recorded on 5th, 15th and 25th of each month. An: anoestrus; C: copulation; G: gestation; L: lactation; P: parturition.



Figs. 3 (a – d) Monthly rainfall in different localities. Legends as in figures 2a-d.

TABLE 1
VARIOUS PHASES OF THE SEXUAL CYCLE NOTICED IN THE PRESENT STUDIES IN DIFFERENT LOCALITIES

Locality	Earliest date of conception	Earliest date of delivery	Lactation	Anestrous period
Bangalore	14 November (unfertilised egg)	13 April	Up to about 20 May	Latter part of May to middle of November.
Aurangabad	18 November (2-celled embryo)	15 April	-do-	-do-
Nagpur	24 November (4–celled embryo)	17 April	Up to about 23 May	Latter part of May to last week of November.
Agra	26 November (4–celled embryo)	20 April	Up to about last week of May	Last week of May to last week of November.

minimum temperatures in the four localities for the whole year, it is evident that there are marked differences not only in the temperature but in the difference between the maximum and minimum temperature in the different localities on any given date. Whereas Bangalore experiences a nearly equable climatic condition without much variation in the range of temperature (difference between daily maximum and minimum) throughout the year, the other localities, especially Nagpur and Agra, experience severe summer, relatively cold winter and considerable variations in the range of temperatures during the year.

Figs. 3 a-d show the monthly rainfall and Fig. 4 shows the percentage of atmospheric humidity in the four localities. These factors also present wide variations in the quantum as well as time relationships in the different localities. Fig. 5 illustrates the duration of the day, which varies considerably in the four places during different days of the year. Examination of Table 1 reveals that the basic breeding pattern of this bat is nearly the same in all the localities, there being only a slight advancement of the various phases towards the lower latitudes. The entire range of difference in the various phases of the reproductive cycle between the lowest and the highest latitudes is about 8 to 10 days (Gopalakrishna and Badwaik 1989).

DISCUSSION

Baker and Baker (1936) and Baker and Bird (1936) were perhaps the first who made an attempt to relate reproduction to external factors in bats while studying the breeding habits of some bats in New Hebrides. They reported that *Pteropus geddiei* and *P. eotinus* among fruit bats and *Miniopterus australis* and a few other insectivorous bats at New Hebrides breed in a sharply defined season once a year. They were unable to draw any relationship between climatic factors and breeding habits because an almost unvarying tropical rain forest precluded the effect of any external factor on the breeding habits of the bats which experience a well defined annual sexual cycle. Working on Indian bats Gopalakrishna and Sapkal (1986) and Gopalakrishna and Badwaik (1989) noticed that even among species inhabiting the same locality, while some bats had a strict reproductive periodicity, a few breed throughout the year. Further, among the species mentioned in the first category the reproductive pattern differs considerably. For example, *Miniopterus schreibersii fuliginosus* and *Rousettus leschenaulti* live in the same roost in Mahabaleshwar but present very different breeding habits. Several such instances have been reported already (Gopalakrishna and Sapkal 1986). All these investigations were made on one-species-one-location basis except *Megaderma lyra lyra* (Gopalakrishna and Badwaik 1989). Hence it was not possible to draw generalised conclusions on the effect of environmental factors on the breeding habits of bats.

The work of Dwyer (1963a, b, 1968, 1970) on some Australian vespertilionids revealed that there was significant difference in the breeding habits of the bats he studied between lower and higher southern latitudes. Whereas the duration of the delay of implantation of the blastocyst increased towards higher southern latitudes in *Miniopterus schreibersii blepotis*, the breeding season of *Myotis adversus* was longer at lower latitudes.

The present study has revealed that *Megaderma lyra lyra* studied at different parts of India with considerable variations in climatic and ecological conditions breeds nearly at the same time of the year

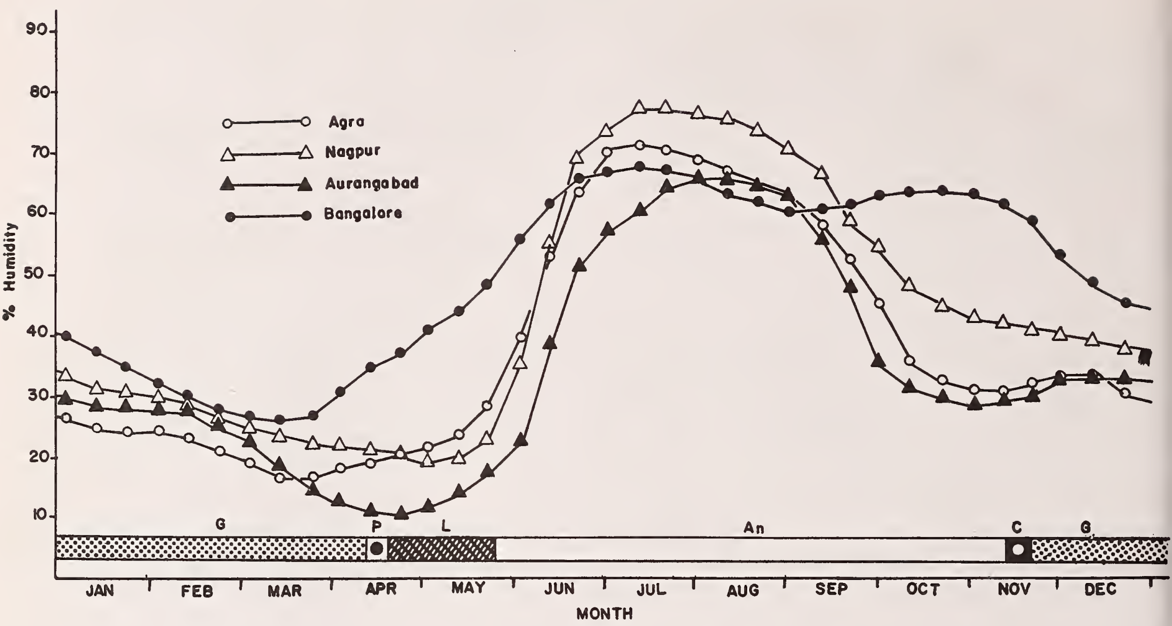


Fig. 4. Relative humidity in the four localities recorded on 5th, 15th and 25th of each month. An: anoestrus; C: copulation; G: gestation; L: lactation; P: parturition.

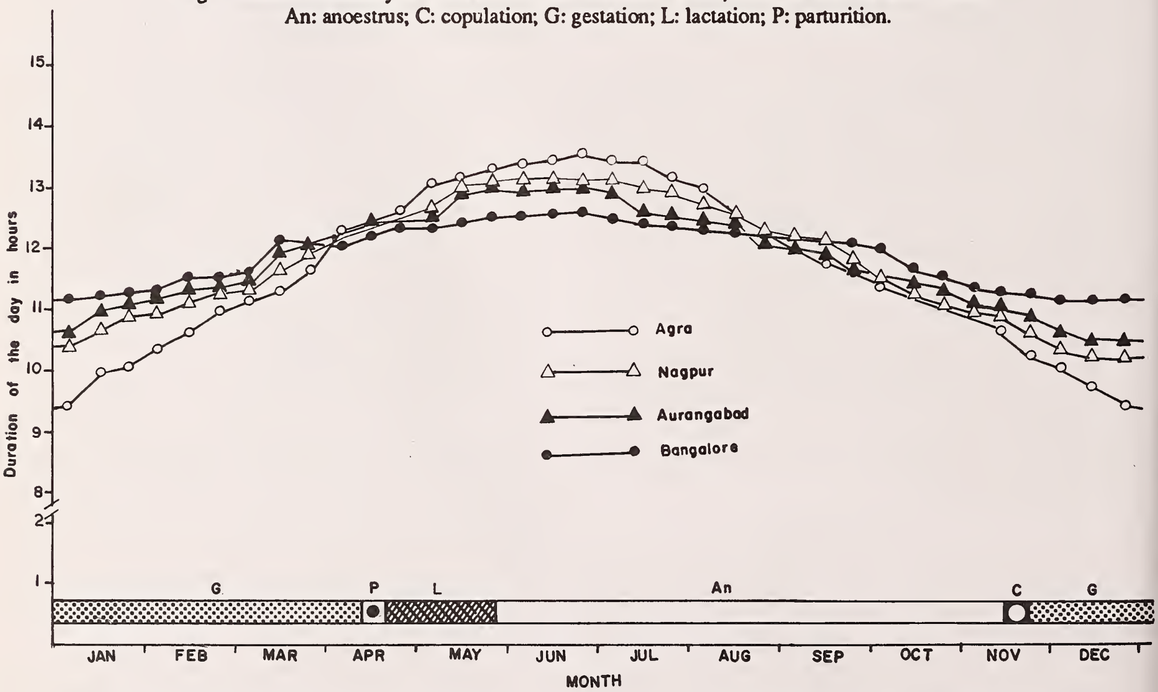


Fig. 5. Duration of the day on 5th, 15th and 25th of each month as calculated from sunrise to sunset in all the localities. Legends as in Fig. 4.

in all the places – copulation occurring in the third or fourth week of November and deliveries taking place in the third or the fourth week of the following April. There is no evidence of any delayed implantation of the blastocyst nor of retarded development of the embryo at any place where this species has been studied. The only Indian bat whose reproductive behaviour has been investigated from different parts of India is *Rhinolophus rouxi* from Bangalore and Khandala (Ramakrishna and Rao 1977). While this species has normal development of the embryo at Bangalore, the embryo has retarded early development and delayed implantation of the blastocyst at Khandala. This is the only Indian bat in which there appears to be some influence of external factors on reproduction.

The proximity of *Megaderma* roosts to a perennial water source partially obviates much variation in relative humidity in the roost. Secondly, in all the places the bats live nearly in darkness. Further, they emerge from their diurnal haunts considerably after dusk and return to the roost much before dawn. Thus, it appears that sunlight may not play a significant role in the sexual periodicity of this species. It has been already mentioned that temperature changes do not alter the basic breeding pattern. The only slight change is that the date of onset of breeding activity is advanced by a few days towards lower latitudes. This is, however, not very significant.

In *Megaderma lyra lyra* no single external factor or combination of factors brings about a major change in the season of onset of sexual activity and the course of embryonic development. Further, this species breeds nearly at the same time in all the places in spite of marked variable environmental conditions. Evidently, the reproductive rhythm of this bat is genetically determined and the influence, if any, of external factors is not very significant.

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TICKS (ACARI: IXODIDAE) COLLECTED ON CHELONIANS (REPTILIA) FROM INDIA AND BURMA[1]

J.G. Frazier[2] and J.E. Keirans[3]

An account of three species of hard ticks (Ixodidae) found on three species of chelonians in India and Burma is given. Data are presented for each tick species including: numbers of ticks, host, locality, and other collection information. In addition, the primary synonymy and published records for each species are briefly reviewed. Two new host records are reported, and a previously reported range extension of 3,000 km is confirmed.

Introduction

During a study (by J.G.F.) of chelonians in India and Burma, ticks were collected opportunistically from wild and captive specimens. Two species of land tortoise (Testudinidae), one from India and one from Burma, and a terrapin (Emydidae, Batagurinae) in India were found to harbour ticks. Although in years past there has been active work on ticks in India (Sharif 1928, Miranpuri and Gill 1983), it was not possible to get local identifications of these parasites, and they were identified by a specialist (J.E.K.) at the Museum Support Centre, Smithsonian Institution, where the National Tick Collection (formerly deposited in the Rocky Mountain Laboratory [R.M.L.]) is housed. Collection data on tick, host, date, locality, and collection numbers are given in Table 1.

Tick Species

Amblyomma clypeolatum Neumann
Amblyomma clypeolatum Neumann 1899
Amblyomma atrogenatum Nuttall & Warburton 1908
Amblyomma zeylanicum Neumann 1908

This tick species was orginally described by Neumann (1899) from 6 males found on a tortoise of unknown species and locality. Nuttall and Warburton (1908) described *A. atrogenatum* from 6 males collected on a specimen of the star tortoise *Geochelone elegans* (Schoepf), sent from India to the Zoological Gardens, London. Later Keirans and Brewster (1981) selected a lectotype for *A. atrogenatum* from Nuttall and Warburton's specimens.

Neumann (1908) described *A. zeylanicum* on the basis of 2 females received from Sri Lanka from an unstated host, and Warburton (1925) reported a single collection of *A. clypeolatum* (number unstated) from *Geochelone elegans* in the Colombo Museum, Sri Lanka. Robinson (1926) and Sharif (1928) also cited collections of *A. clypeolatum* from *Geochelone elegans* in India and Sri Lanka, and Seneviratna (1965) collected adult *A. clypeolatum* on *G. elegans* in the Zoological Gardens, Dehiwela, Sri Lanka.

Amblyomma clypeolatum is not well represented in collections. The U.S. National Museum Collection contains 1 female from a specimen of *Geochelone elegans* 'from Calcutta, India' (RML 48932). Calcutta is well outside the known geographic range of *Geochelone elegans*, which is found from southeastern Pakistan, throughout much of western and southern India, to Sri Lanka (Frazier in prep.).

In Sri Lanka, Deraniyagala (1939:275) reported that *G. elegans* hosted large concentrations of the tick *Aponomma gervaisi* (Lucas). However, *A. gervaisi* is known to parasitize only snakes and varanid lizards (Kaufman 1972); therefore, this record from a chelonian is questionable.

It is remarkable that during a study in western India (Rajasthan and Gujarat) only 2 out of 90 specimens (2%) of *G. elegans* were parasitized by ticks (species identified in 1 case); in both cases there was only one tick attached to the host. In contrast, the *G. elegans* population in south India (Andhra Pradesh) appears to be much more heavily parasitized; 5 out of 9 (56%) were infested: each one with a single tick. Sites of attachment include: forearm; hind leg near base; base of tail; midplastral

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TABLE 1
TICKS COLLECTED ON CHELONIANS

Tick host species	Numbers	RML No.	Species	JGF No	Date	Locality
Amblyomma clypeolatum	1 IM	119771	*Geochelone elegans*	5042	24 Aug. '86	Moti Mager Snake Park, Udaipur, Rajasthan, India.
Amblyomma clypeolatum	1 M	118982	*Geochelone elegans*	5467	16 July '87	Batundody Cross, Chitoor District, Andhra Pradesh,India.
Amblyomma clypeolatum	1 F	118983	*Geochelone elegans*	5468	16 July '87	Batundody Cross, Chitoor District, Andhra Pradesh, India.
Amblyomma clypeolatum	1 F	118984	*Geochelone elegans*	5469	16 July '87	Batundody Cross, Chitoor District, Andhra Pradesh, India.
Amblyomma geoemydae	2 F	118985	*Melanochely s trijuga*	5506	23 July '87	Chibidre &Charmady South Kendra, Karnataka, India.
Aponomma varanensis	6 M	118986	*Manouria emys*	5532	3 Sept. '87	Rangoon Zoological Park, Rangoon, Burma

suture; and carapace suture. In no instance did a tortoise hosting a tick appear to be in bad condition.

Amblyomma clypeolatum appears to be a specific ectoparasite of *G. elegans* in both India and Sri Lanka. There are no known records of ticks on the sister species, *Geochelone platynota* (Blyth), found only in Burma.

Amblyomma geoemydae (Cantor)
Ixodes geoemydae Cantor 1847
Amblyomma geoemydae Neumann 1906
Amblyomma malayanum Nuttall and Warburton 1908
Amblyomma caelaturum Cooper & Robinson 1908
Amblyomma caelaturum perfectum Schulze 1932

Amblyomma geoemydae was originally described by Cantor (1847) from the batagurine terrapin *Heosemys* (formerly *Geoemyda*, see Moll *et al.* 1987) *spinosa* (Gray) caught in the Pinang Hills, Sumatra. This tick parasitizes a variety of reptiles (especially chelonians, but occasionally lizards) in Thailand, Malaysia, Indonesia, Philippines, Taiwan, Ryuku Islands, and Japan (Yamaguti *et al.* 1971). Recently this tick was found on a Travancore tortoise *Indotestudo travancorica* (Boulenger) from Kerala (Vijaya 1983), some 3,000 km outside its known range.

Out of 22 specimens of *Melanochelys trijuga* (Schweigger) examined in Dakshin Kannad District (South Kanara), Karnataka, only 1 (5%) was parasitized by *A. geoemydae*. Not one of 21 specimens of this species of terrapin examined in Corbett National Park, Nainital District, Uttar Pradesh (north India), was infested with ticks. (According to contemporary taxonomy the terrapins from Karnataka would be *Melanochelys trijuga coronata* (Anderson) and those from Uttar Pradesh, *M. t. indopeninsularis* [Annandale].)

The occurrence of *A. geoemydae* on *Melanochelys trijuga* in India represents a new host record and confirms a range extension of approximately 3,000 km for the tick. *Amblyomma geoemydae* is likely to occur on a variety of chelonians, and some lizards, in southern India, northeastern India and Burma. The Western Ghats may be the western-most limit of the geographic range of this tick.

Aponomma varanensis (Supino)
Ixodes varanensis Supino 1897
Aponomma quadratum Cooper & Robinson 1908
Aponomma gervaisi var. *lucasi* Warburton 1910
Aponomma lucasi Schulze 1933
Aponomma barbouri Anastos 1950
Aponomma varanensis Santos Dias 1958

Aponomma varanensis was first described from *Varanus salvator* collected at Monti Catcin, Burma (Supino 1897). This tick is most often reported from snakes and varanid lizards, and is known from a wide geographic range, including India, Sri Lanka, Bangladesh, Burma, Thailand, Cambodia, Vietnam, Malaysia, Singapore, Indonesia, and the Philippines (Kaufman 1972).

Chelonians on which *A. varanensis* has been reported are few and include the Asian box turtle *Cuora amboinensis* (Daudin), (Kaufman 1972). The occurrence of *Aponomma varanensis* on *Manouria emys* (Schlegel and Muller) represents a new host record.

Nothing is known of rates of tick infestation on *Manouria emys*. The presence of 6 male ticks on the appendages of a single male tortoise is not as remarkable as it may seem because this is a giant tortoise; the individual infested was 40.7 cm in straight carapace length.

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STATUS OF THE SWAMP DEER *CERVUS DUVAUCELI DUVAUCELI* IN THE DUDWA NATIONAL PARK, UTTAR PRADESH[1]

RAVI SANKARAN[2]

(With three text-figures)

Despite protection to the Dudwa National Park since 1968, the swamp deer population has continued to decline. Satiana, which had about 1200 swamp deer in the early 1970s currently has only 300. In other areas, the population has remained static or has increased as in Kakraha. The reason for this decline at Satiana is the seasonal movement of the deer into two marshes that lie outside the Park in agricultural areas. Protection in these areas is non-existent and poaching presumably takes a heavy toll. It is suggested that a fence be erected along the Park boundary at Satiana to prevent the seasonal movement of swamp deer into agricultural areas.

INTRODUCTION

Most threatened species of deer occur in isolated rural areas of developing countries where wildlife poaching and pressures on wildlife habitats, to graze stock, cut grass or collect fuel is frequently intense (Holloway 1975). The rapid decline of the swamp deer *Cervus duvauceli duvauceli* in the terai of Uttar Pradesh (U.P.) over recent years is a case in point. This despite the establishment of two sanctuaries, Kishanpur and Katerniaghat, and the Dudwa National Park with the objective to conserve this species. Out of eleven areas where swamp deer were reported in the mid 1960s (Schaller 1967) only three held any 'reasonable' numbers by the early 1970s (Holloway1973). The situation has deteriorated in some areas (Table 1).

Preferred habitat of the swamp deer are marshes and grasslands. Due to the repatriation of settlers throughout the terai of U.P. most of the grassland have been converted into agriculture in the past, the predominant crops being sugarcane *Saccharum officinarum*, wheat *Triticum aestivum* and paddy *Oryza sativa*. Forestry policies have often considered grasslands as 'wastelands'. The resulting planting of exotics and indigenous tree species in grasslands has converted several good grassland habitats into woodlands (Rahmani *et al.* 1988). In addition, relentless hunting has decimated the large herds that were seen in the terai belt (Singh 1973). Today, North Lakhimpur, South Lakhimpur and Pilibhit are the only three forest divisions where swamp deer exist in U.P. Excepting Dudwa National Park which holds the largest population, the current status of the swamp deer in other areas of U.P. is unknown.

Despite protection of the Dudwa National Park since 1968, the swamp deer numbers have continued to decline there. The main grasslands of the Park are present along the Suheli river, hence most of the swamp deer are seen along the river which forms the southern boundary of the Park (Fig. 1). The grasslands of Satiana had the maximum numbers of swamp deer. Certain areas that are traditionally used for rutting by the herds at Satiana have not been included in the National Park. This has resulted in the movement of the swamp deer into unprotected agricultural areas for over half the year. Due to the high incidence of poaching outside the Park, the deer numbers continue to decline there. In areas where such movement is not seen populations have remained static or have shown an increase.

STUDY AREA

In 1968, 212 sq. km, of the North Kheri forest division was declared as Dudwa Wildlife Sanctuary primarily to conserve the swamp deer. On 1 February 1977 the Dudwa Sanctuary was upgraded to a National Park, and covered an area of 614 sq. km, with a core area of 490 sq. km (Fig 1). In 1987 Dudwa National Park was brought under Project Tiger. Along with the Kishanpur Wildlife Sanctuary (158 sq. km core area and 43 sq. km buffer) the Project Tiger area covers 815 sq. km. However, the two forest areas are not contiguous.

The Dudwa National Park is situated between 28°24' and 28°27'N and 80°31' and 80°52'E in the northern extremity of Lakhimpur Kheri district of Uttar Pradesh (Fig. 1). Elevation above sea level

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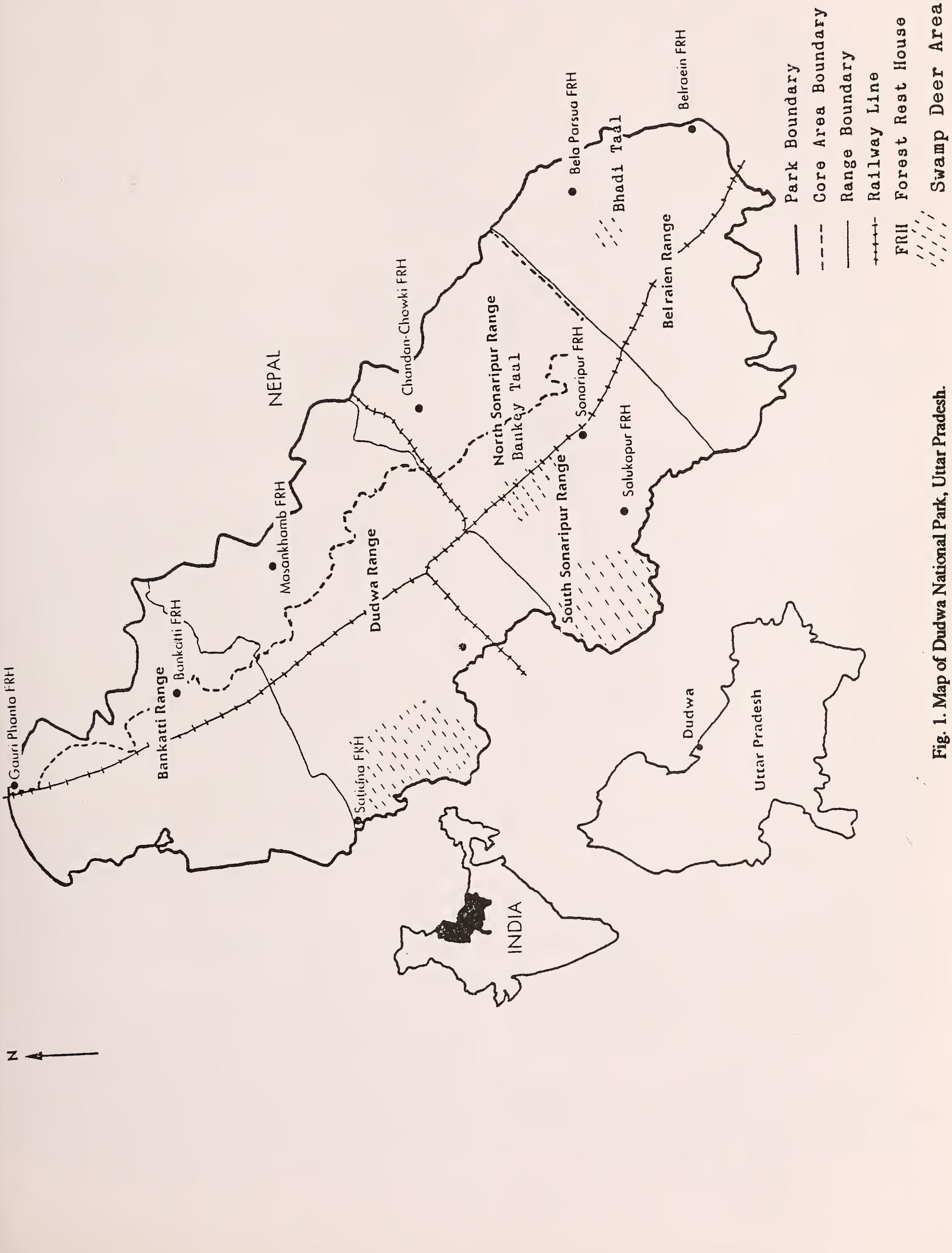

Fig. 1. Map of Dudwa National Park, Uttar Pradesh.

TABLE 1
POPULATION OF SWAMP DEER IN DUDWA NATIONAL PARK AS REPORTED BY HOLLOWAY (1972), SCHAAF & SINGH (1977), V.P. SINGH (1984) AND THIS STUDY (1988 & 89)

Area	1972		1977		1981		1988		1989	
	Actual count	Estimate	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.
1. Satiana	627	1200	950	–	932	–	262	400	287	300
2. Kakraha	12a	20	276	–	221	–	150	250	302 *	325
3. Bankey taal	40a	50	18	–	173	–	64	100	71	100
4. Nagra taal	c.	20	b.	–	40	–	b.	–	4a.	–
5. Bhadi taal	12a.	30	b.	–	35	–	10	35	18	40
	691	1320	1244		1401		486	800	682	765

a. reported (not personally seen by author); b. not counted; c. 'present'
* Q. Qureshi, pers. comm.

ranges from 150 m in the southeast to 182 m in the north. The Mohana and Suheli rivers form natural boundaries to the north and south respectively. The Park's water system drains into these two rivers which are tributaries of the Sharda, which in turn is a part of the Ganges river system.

The vegetation is chiefly moist deciduous forest, dominated by sal *Shorea robusta*. Typical of the *terai*, these forests are interspersed with tracts of low lying grasslands which tend to get flooded during the monsoons. In the 1950s, under plantations schemes, tracts of the grasslands were planted with sheeshum *Dalbergia sissoo*, simul *Bombax ceiba* and eucalyptus. These plantations have mostly been unsuccessful, leaving behind scattered clusters of trees in varying densities.

Grasslands occupy about 120 sq. km of the Park and can be broadly classified into two types. Wet low lying areas are dominated by tall grass species such as *Schlerostachya fusca*, *Phragmites karka*, *Arundo donax* and *Saccharum spontaneum* while drier high ground is dominated by grasses like *Imperata cylindrica*, *Desmostachya bipinnata*, *Erianthus munja*, *Cymbopogon martini* (Jain and Sastry 1983, Hajra and Shukla 1983, pers. obs.).

The climate can be divided into three seasons. Winter (October to early March); summer (mid March to mid June); and monsoon (mid June to October). The annual precipitation is about 1600 mm with July and August being the wettest months. The temperatures can reach 47°C in May/June, and may drop to a minimum of 0°C in December/January.

METHODS

The study period extended from 22 January 1988 to 22 June 1988, 1 to 13 November 1988 and from 15 February 1989 to 10 July 1989.

All data pertaining to herd size and composition were collected from an area of about 25 sq. km around the Satiana Forest Rest House. Other areas occupied by swamp deer were visited frequently to assess the populations there.

Between 1 and 13 November 1988 the entire Satiana region, including the marshes at Ghola and Ghajrola (agricultural areas into which the swamp deer move, Fig. 2) was surveyed extensively on elephant back.

Swamp deer were counted mostly from a vehicle, and less frequently from a machan, on foot or from an elephant's back. The grasslands around Satiana were divided into three zones namely Kowhaghatti and Chapra, Navalkhad and Madraiya, the roads being fixed transects (Fig. 2). The former two were visited at least once a day and Madraiya was visited approximately thrice a week. In addition to this, in 1989 all grasslands holding swamp deer in the Satiana region were extensively surveyed on elephant back. Every sighting of swamp deer was recorded and time and visibility permitting, the deer were also aged and sexed. They were classified into three groups. Stags and hinds were identified irrespective of age. Fawns were all animals estimated to be born in the preceding fawning season. The ratios for stags, hinds and fawns are calculated for the period between 24 January and 29 April 1988. During this time the visibility was best because the grasses were short.

Estimate of population for 1988 at Satiana is based on the percentage of grasslands covered. As in 1988, counts were made from the roads and only about 65% of the grassland area was visible from the vehicle. Therefore while estimating (Table 1), I have correspondingly calculated for Satiana. In 1989 Satiana was surveyed extensively using elephants.

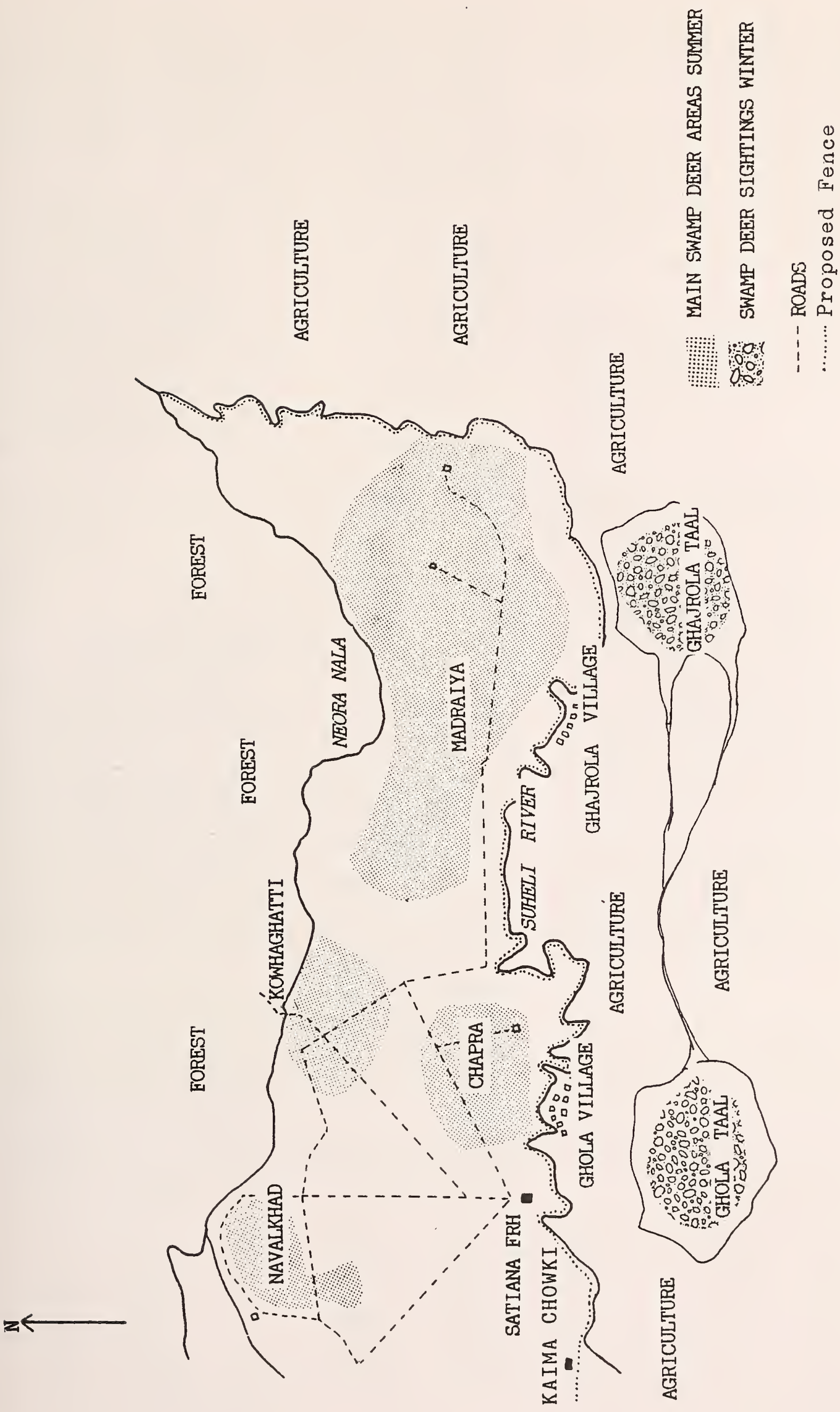

Fig. 2 Satiana (Dudwa Range) showing ranges of swamp deer during end winter/summer and monsoon/early winter.

By this method areas not visible from roads and machans are covered and very few swamp deer are missed. Both estimates for Bhadi taal are based on population structure as seen at Satiana.

In 1988 Kakraha was surveyed in May when swamp deer herds are fragmented and the vegetation is tall. Therefore in spite of using elephants the actual counts were poor and estimating population was difficult. Estimate of 1988 population is based on total 1989 population minus fawns under one year old.

In this paper I compare the total population present in the various areas in 1989 with the 1988 census. Other details pertaining to population are from 1988.

Results

Census: A comparative account of the swamp deer population between 1972 and 1989 is given in Table 1.

In 1988, 800 swamp deer were estimated in 4 disjunct grasslands of Dudwa National Park. Of these four grasslands Satiana had 50%, Kakraha 31%, Bankey taal 13% and Bhadi taal 5% respectively of the 800 swamp deer estimated in the Park. The remaining two areas reported to have swamp deer (Singh 1984), i.e. Nagra taal and Churela taal were visited only twice and swamp deer were not seen there.

In 1989 about 765 swamp deer were estimated, with Satiana having 39%, Kakraha having 42%, Bankey taal 13%, and Bhadi taal 5% of the population. Four and seven deer were seen respectively at Nagra and Churela taals in 1989 (V. B. Sawarkar pers. comm.)

At Bankey taal 173 swamp deer were counted in 1981 (Singh 1984). During this study, a maximum of 64 swamp deer was counted once in 1988 and 71 deer were seen in 1989. Up to 90 animals have been reported. Generally in the summer months, deer numbers varied between 20 and 40. The swamp deer are believed to move, seasonally, between Kakraha block and Bankey taal (Singh 1984, Q. Qureshi pers. comm., pers. obs.) and so an accurate estimate will be difficult to arrive at.

In Kakraha block, which is now part of the rhino enclosure where seven rhinos *Rhinoceros unicornis* have been re-introduced, the second largest congregation of swamp deer is seen. 276 were seen in 1977, 221 in 1981 and 150 deer by me in 1988 (see also materials and methods) and in 1989, 302 animals were counted within the enclosure (Q. Qureshi, pers. comm.). There has undoubtedly been an increase in the swamp deer population in this area.

At Bhadi taal all 10 swamp deer seen in 1988 seemed to be stags. In 1989 out of 18 deer seen here 12 were stags. If the stag to hind to fawn ratio is assumed to be the same as in Satiana, then the population has remained stable between 1981 (35 deer), 1988 (*c.* 35 deer) and 1989 (*c.* 40 deer).

Periodic data on the numbers of swamp deer present in the Satiana region are available, between 1972 and 1989. There has been a drop by 75% of the population during the last 17 years. Losses have been comparatively less between 1972 and 1981 (22.3%), and severe between 1981 and 1988 (57.1%) and between 1988 and 1989 (25%). In 1981 an actual count tallied 932 swamp deer (Singh 1984), but during this study the maximum seen in one day was 287, both studies having used elephants to do the census.

Population structure: A comparative account of the average monthly herd sizes seen at Satiana in 1980 and 1988 is given in Table 2. Average herd size of all herds seen was 29.35 in 1980 and 18.41 in

Table 2
COMPARATIVE DATA ON HERD SIZE 1980 & 1988

Months	Herd size 1980		Herd size 1988			Difference
	Average	(n)	Average	(n)	(s.d.)	in %
1. Jan.	39.0	(23)	10.33	(6)	4.23	73.51
2. Feb.	38.7	(19)	19.78	(51)	15.69	48.89
2. Mar.	32.6	(12)	28.52	(94)	29.47	12.52
3. April	29.6	(26)	22.16	(75)	21.56	25.14
4. May	19.3	(27)	17.48	(96)	16.52	9.43
5. June	16.9	(9)	12.21	(38)	11.47	27.75

(n) = Number of herds; 1980 Singh (1984); 1988 this study.

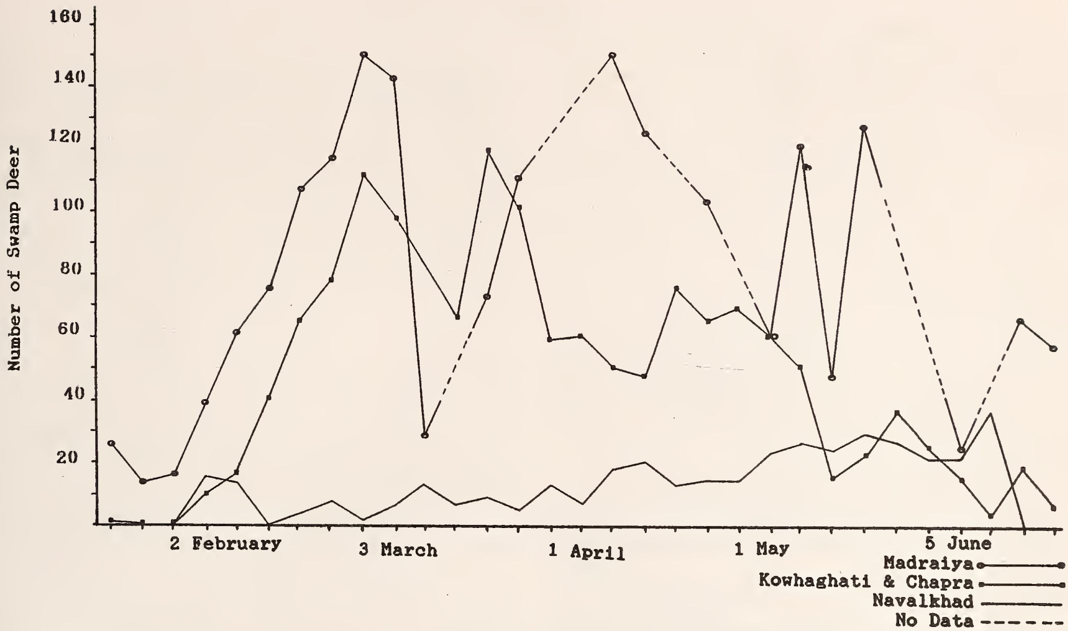

Fig. 3. Highest number of swamp deer seen on any given day during 5-day periods between 23 January and 22 June 1988 in the grassland around Satiana Forest Rest House.

1988, showing a distinct drop in the herd sizes between the two studies. This is more marked when the deer return to the Park and less so once they begin to disperse in the grassland (see also Fig.3). In 1988 the largest herd seen was of about 150 swamp deer, a drop of 37% from the herd of 237 animals seen in 1981 (Singh 1984). The largest herd seen in 1989 had 130 deer. Herd size averages have been calculated from groups of two or more individuals, and hence are the same in both studies.

During this study, the ratio between hind and stags was 100:45.5. In 1964-65 it was 100:50 (Schaller 1967) and in 1979-80 it was 100:40 (Singh 1984) (Table 3). In the hard ground Barasingha *Cervus duvauceli branderi* in Kanha the ratio had remained more or less the same between 1964-65 and 1971-73 at 100 hinds to 75.2 stags (Schaller 1967, Martin 1977). Martin (op. cit.) also found in Kanha that the sex ratio between yearlings is 1:1 while in adults it is biased towards the hinds. In this study, ageing was not done while noting down the sex ratios. It is likely that the bias will be even greater towards the hinds.

In 1988 37.14% and in 1989 *c.* 30% of the hinds had fawns. As counts were carried out more than 6 months after the fawning period, these figures would represent those fawns that survived early fawn mortality. In 1979-80, 27.58% of the hinds had fawns (Singh 1984) and for 1964-65 Schaller (1967) found that between 26.85 and 35.19% of the hinds had fawns. In the Sukla Phanta reserve in Nepal Schaaf (1978) found that between 33.9% and 42.6% of the swamp deer hinds had fawns over three successive years. In the barasingha at Kanha, 26.7%,

TABLE 3
COMPARATIVE DATA ON HERD COMPOSITION 1980 - 1988

Year	% of Total			Number of fawns
	Stag	Hind	Fawn	per 100 hinds
1980	25.4	58.5	16.12	27.58
1988	25.02	54.65	20.03	37.14

1980 Singh (1984), 1988 this study

TABLE 4
NUMBER OF SWAMP DEER SIGHTINGS IN DUDWA N.P. BETWEEN 3 TO 13 NOVEMBER 1988

Area	Total	Stag	Hind	Rutting call	Hoof prints
Bankey taal	43	15	22	3	–
Kakraha	0	0	0	0	(present but not seen, Sinha pers. comm.)
Satiana					
Chapra	0	0	0	0	none
Navalkhad	0	0	0	0	none
Kowhaghatti	0	0	0	0	none
Madraiya	3	1	1	0 *	few near Muthna taal
Agriculture					
Ghola taal	18	9	3	8	numerous
Ghajrola	10	5	4	0 *	numerous

*Seen in the afternoon, a time of day the swamp deer do not bugle

41.2% and 36.1% of the hinds had fawns during the years 1971 to 1973 (Martin 1977).

MOVEMENT OF SWAMP DEER AT SATIANA

The swamp deer at Satiana have two distinct ranges. The late winter and summer range is within the Park, during which time they are seen in the grasslands of Madraiya and around the Satiana Forest Rest House. During the monsoons and early winter the deer move outside the Park and are present in predominantly agricultural areas (Fig. 2). As both ranges are adjacent to each other, distance travelled by the deer is about two kilometres at most.

With the onset of the monsoons the swamp deer at Satiana emigrate into the adjacent agricultural areas (Singh 1984, Schaaf and Singh 1977, this study). For the next seven months the deer live in the jheels (and in the sugar cane) of Ghola and Ghajrola. It is in this marshy habitat that the annual rut commences at the end of August and ends in the last week of January (Singh 1984).

About mid January, when the grasses have dried up, the annual grass burning begins and is completed by the end of February. The swamp deer begin returning to the Park in the end of January following the grass burn. At first they arrive in small herds, and then gather in larger groups before dispersing within the grasslands. The swamp deer are seen at Madraiya first and then at Chapra and Kowhaghatti and lastly at Navalkhad (Fig. 3). By the end of June the swamp deer begin moving out of the Park into the adjacent agricultural areas of Ghola and Ghajrola.

Monsoon and early winter range: The monsoon/early winter and the late winter/summer ranges are given in Fig. 2.

In 1965 Schaller saw a herd of about 500 swamp deer in and around the Ghola taal. At this time the land (about 1200 ha) belonged to a few large landholdings and much of the marshland and grassland remained intact. After the Land Ceiling Act, the land was cut into smaller portions ranging from 1.2 ha upwards and distributed among landless immigrants from eastern U.P. and the Punjab. The grasslands and marshes swifly gave way to sugarcane and to a lesser extent paddy.

All that remains of the marsh at Ghola is one fairly large jheel called Ghola taal that covers about 100 ha less than 1 km. west of the Satiana Forest Rest house. From this a narrow channel, about 50 m at its widest, runs roughly parallel to the Suheli river and widens into another jheel adjacent to Ghajrola village, and in parts contiguous with the forest that flanks the Suheli river. This jheel is south of the Madraiya grasslands (Fig. 2). Thick stands of grass predominantly *Sachharum spontaneum* (local name kans) are present in and around the jheels.

At Ghola (in the 1st week of November 1988) I counted about 18 swamp deer of which 9 were stags. Of these at least 5 stags were bugling. At Ghajrola the jheel was surveyed only in the afternoon and so rutting was not heard. Ten swamp deer were seen of which 5 were male. Inquiries among the locals indicated that at least 7-8 rutting stags were present. It was also understood from the agriculturists that several swamp deer spent the day inside the sugarcane. It is probable that the swamp deer of Madraiya move into Ghajrola while the deer around the

Satiana forest rest house move into Ghola (Figs. 2 and 3).

In contrast inside the Park no swamp deer were seen in Chapra Phanta, Navalkhad, Kowhaghatti and most of Madraiya. Furthermore there were no signs of swamp deer using these areas. Only 3 swamp deer were seen inside the Park, 1 stag and 1 hind near Muthna taal and 1 hind near the electric fence adjacent to Ghajrola taal. Bugling was not heard from any place within the Park.

Discussion

Till 1988 Satiana region had the maximum numbers of swamp deer found in the Park. With a further loss of about a hundred animals the population is now slightly less than that of Kakraha. The decline in numbers in Satiana is reflected as a general reduction in the total population.

It is widely assumed that the loss of habitat is one of the major causes for the decline of many species of animals. The decline of swamp deer at Satiana can be attributed only indirectly to a loss of habitat because the area has been protected since 1967, first as a Wildlife Sanctuary and then as a National Park.

Singh (1984) postulated that one reason for the decline of the swamp deer population was a high fawn mortality rate caused by the flooding of the grasslands during the monsoons. Data available to me contradicts this. Fawning success rates of 27.58% in 1980, 37.14% in 1988 and *c.* 30% in 1989 indicate normal fawning successes as compared to other mono-tocous deer (Martin 1977, Schaaf 1978). Furthermore, fawning takes place between end May and early July (Singh 1984), just with the onset of the monsoons at the end of June. Thus the fawns would escape all but unusually early floods. Fawn mortality is therefore not a likely explanation for the decline.

The major cause for the decline in deer populations all over the world has been over exploitation by hunting (Cowan and Holloway 1973). In India two other Cervidae, the hangul *Cervus elaphus hanglu* and the Manipur brow antlered deer *Cervus eldi eldi* have been seriously affected by hunting (Kurt 1978, Ranjitsinh 1978). Holloway (1973) and Singh (1984) recognized poaching as the cause for the decline of the swamp deer at Satiana. While hunting may not occur within the Park it is fairly widespread outside the Park. The swamp deer are therefore vulnerable when they leave the Park and move into their monsoon and early winter ranges. Evidence of poaching was present at both the marshes at Ghola and Ghajrola. The marshes are entered in buffalo drawn carts and swamp deer are shot with the aid of a spotlight. Alternatively, hunters drive around the crop areas and shoot deer from jeeps. Conversations amongst local agriculturists indicated frequent poaching incidents, especially by the wealthier farmers. Furthermore gunshots were heard almost daily throughout the study periods from the Satiana Rest House.

Movement of the Swamp Deer

Similar to the barasingha at Kanha (Martin 1977), the swamp deer at Satiana have distinct seasonal ranges. As a little over half the year is spent outside the Park in what are presently agriculture areas this has had a direct negative influence on the population. Before a conservation strategy can be prepared it is imperative to understand the causes behind this seasonal movement. While only an in-depth study will reveal in detail these factors, I attempt here to postulate certain relevant ideas. Seasonal migration or movement has been well documented in deer. This movement between seasonal ranges is an adaptation to specific climatic or food conditions in the different ranges during the year. In the elk *Cervus canadensis* and in the moose *Alces alces* such movements are largely due to non-availability of food due to snow (Phillips *et al.* 1973). Similar movements due to snow are seen in the hangul (Kurt 1978). In the hard ground barasingha at Kanha this movement is due to seasonal non-availability of water in different parts of its range (Martin 1977). Furthermore, deer are known to be traditional and have a strong tendency to return to their seasonal ranges over the years (Martin 1977, Schaaf 1978, Cederlund *et al.* 1987). In fact this tendency to return to rutting grounds appears to be so strong that in old fallow deer areas the rutting grounds were used for over 50 years (Ueckermann 1968).

In the barasingha at Kanha in central India, lack of surface water is the main factor behind the deer's movement (Martin 1977). At Dudwa this is not the case, for due to a high water level, surface water is available in almost the entire area throughout the year.

It has been suggested that the deer migrate outside the Park at Satiana due to flooding of the grasslands (Singh 1984, Schaaf and Singh 1977). This is unlikely due to three reasons: a) Ghola and Ghajrola are also prone to flooding during the monsoons, b) Flood waters are not a permanent feature and subside within a few hours or days, depending on the intensity of the rains, c) The swamp deer had already begun leaving the Park at the end of June 1988, much before the monsoons had set in.

In 1989 I surveyed the entire grassland areas of Satiana using elephants between 2 and 6 July. No swamp deer were seen at Kowhaghatti, Navalkhad or Chapra. In the adjacent Ghola taal at least 13 animals were present. Similarly, at Madraiya less than 10 deer were located. The outward migration had already taken place well before flooding of any sort had occurred.

The reasons possibly lie in a need for a specific habitat during the monsoons and for the rutting season. This habitat is the marsh or jheel (shallow lake that dries up in part or completely in summer). All swamp deer seen during the November 1988 survey were found in and around the jheels, the only exceptions being the 3 deer seen at Madraiya, and even these were close to a waterbody. At Bankey taal, in three visits in November 1988, all the swamp deer seen were within the water grazing on aquatic vegetation. Singh (1984) says that aquatic vegetation forms an important part of the swamp deer's diet. Therefore the marsh would be an important source of food to the swamp deer when grasses elsewhere have flowered and dried up.

The marsh also appears to be important for rutting. An integral aspect of the rutting season is wallowing (Schaller 1967, Martin 1977, Schaaf 1978, Singh 1984, pers. obs.). At all the marshes visited, several wallowing holes were present at the periphery of the jheels. Martin (1977) and Schaaf (1978) state that stags appear to show site fidelity to their wallows.

Furthermore, as the swamp deer have presumably been using the Ghola and Ghajrola taals for several years as their rutting grounds, they would traditionally return to these taals to rut in. Martin's (1977) observation that at least one wallow remained the same between 1964-65 and 1972-73 would also indicate a strong traditional bond to the rutting grounds among swamp deer.

At Satiana, though there are several ponds and taals they are all quite deep. Marshland habitat (or jheels) do not exist inside the Park in this region. Hence the swamp deer would be compelled to leave the Park to fulfill specific habitat requirements for the monsoon and early winter period.

The swamp deer would be induced to return to the Park primarily due to the new grasses emerging after the annual grass burn in January. Undoubtedly the human related disturbances would hasten their return, in spite of the conditions appearing to be favourable outside.

Conclusions

Satiana was the only area with a significant loss in swamp deer numbers. At Kakraha there has been an increase in deer numbers probably as a result of the deer being localised within the rhino reintroduction area. At Bhadi taal and Bankey taal the population seems to have remained stable but more data is necessary for these two regions.

The decline of the Satiana population is due to traditional movements into preferred habitat that lie in areas which are not protected from poaching. In areas of the Dudwa National Park where such movements into agricultural areas are not found, the swamp deer populations have remained stable or increased over the years.

Intensive patrolling of the Ghola and Ghajrola agricultural areas during the monsoon and winter is the immediate action that needs to be taken to ensure the survival of the swamp deer at Satiana.

Ideally the agricultural areas of Ghola and Ghajrola should have been acquired to prevent further loss of habitat and to prevent poaching in the vital rutting grounds. However, these areas are quite densely populated now and land acquisition will be difficult to achieve. Instead, I propose that the entire length of the Suheli upto its confluence with the Neora nala be permanently fenced so that the deer are forcibly retained within the Park throughout the year. If the outward seasonal movement of the swamp deer is not stopped it is likely that the swamp deer will vanish from the grasslands of Satiana in a few years.

One basic requirement for the survival of any species is safe breeding grounds. At Satiana, where the largest herds of swamp deer were present, traditional movement patterns between breeding and non-breeding grounds were not taken into consideration when the Dudwa National Park was created. This has resulted in an annual exposure of the swamp deer to heavy poaching pressures and the continuing conversion of swamp deer rutting grounds into agriculture.

Acknowledgements

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NEW DESCRIPTIONS

JULOSTYLIS POLYANDRA (MALVACEAE) – A NEW SPECIES FROM INDIA[1]

N. Ravi and N. Anilkumar[2]

(With a text–figure)

Julostylis polyandra, a new species from the forests of Kerala, is described and illustrated.

Introduction

Until the discovery of the species described here, *Julostylis* Thw. has been a monotypic genus represented by *J. angustifolia* (Arn.) Thw. from Sri Lanka (Thwaites 1858) and Kerala (Ramamoorthi and Rajan 1985). The specimens of the new species have been collected from the forests of Ponmudi Hills, Trivandrum District and Kakki, Pathanamthitta District, Kerala at different periods. The new species, especially in herbarium specimens, has superficial resemblance to *Kydia calycina* Roxb. and hence is often mislabelled in local herbaria.

Julostylis polyandra sp. nov.

Affinis *J. angustifolia* (Arn.) Thw. ab hac tamen differt in eo quod habet suborbicularia ad ovata folia cum elongatis glandibus ad inferiorem basem, largi flores cum 4-6 triangulares-ovatae epicalyx segmento, cordatae ad basem, sparse stellatae cum pilis exterioribus, stamina 17-20 et aciculares staminales dentes.

Holotypus Ravi 2475 A (MH), *Isotypus* 2475 B (CAL), 2475 C (Sree Narayana College Herbarium) (SNCH), Quilon et 2475 D (KFRI),15 August 1988, Ponmudi Hills, Trivandrum Dt., Kerala, *Paratypus* Ravi 2647 (SNCH), 19 December 1988, Ponmudi Hills, Anilkumar 70 (SNCH), 11 September 1987, Kakki, Pathanamthitta Dt., Kerala et Anilkumar 364 (SNCH), 12 January 1988, Kakki.

Julostylis polyandra sp. nov. is allied to *J. angustifolia* (Arn.) Thw. but differs from the latter in having suborbicular to ovate blade with elongate glands at the base below, large flowers with 4-6 triangular-ovate epicalyx segments, cordate at base, sparsely stellate hairy outside, 17-20 stamens and acicular staminal teeth.

Holotype Ravi 2475 A (MH), *Isotypes* 2475 B (CAL), 2475 C (Sree Narayana College Herbarium) (SNCH), Quilon and 2475 D (KFRI), 15 August 1988, Ponmudi Hills, Trivandrum Dist., Kerala, *Paratypes* Ravi 2647 (SNCH), 19 December 1988, Ponmudi Hills, Anilkumar 70 (SNCH), 11 September 1987, Kakki, Pathanamthitta Dist., Kerala and 364 (SNCH), 12 January 1988, Kakki.

Small trees, 8-15 m high; branches terete, rusty stellate tomentose when young. Leaves reddish when young, simple, alternate, stipulate; stipules linear-oblong, stellate tomentose outside, caducous; petiole 1-8 cm long, terete, stellate tomentose; blade suborbicular to ovate, 4-21 by 2-18 cm progressively small upwards, often palmately 3-angled or – lobed in the upper half, palmately 5-ribbed at base, sparsely stellate tomentose on both sides, prominently so on ribs and veinlets below and usually with an elongate gland with a median slit at the base and lower surface of mid-rib, sometimes also on one or both inner lateral ribs, base rounded or cuneate, margin subentire. Inflorescence erect more or less congested pyramidal panicle, branches 2 to many flowered, progressively shorter upwards. Flowers yellow, bisexual; pedicel up to 1.5 cm long; bract elliptic- oblong, 3 by 1 mm, rusty stellate tomentose outside; bracteoles obovate, a little shorter than bract, stellate tomentose outside. Epicalyx accrescent, segments 4-6, slightly connate at base, triangular-ovate, up to 15 by 8 mm, stellate pubescent, subcordate at base, acute to subacute, erect, ultimately spreading. Calyx persistent, connate to the middle, 8-10 by 5-6 mm, stellate tomentose outside, prominently so on the tube; lobes triangular, subacute, 3-nerved. Corolla yellow with a purple centre; petals 5, free, narrowly obovate, 1.5-2 by 1 cm, stellate pubescent on outer surface and simple hairy on inner surface. Stamens 20 (rarely

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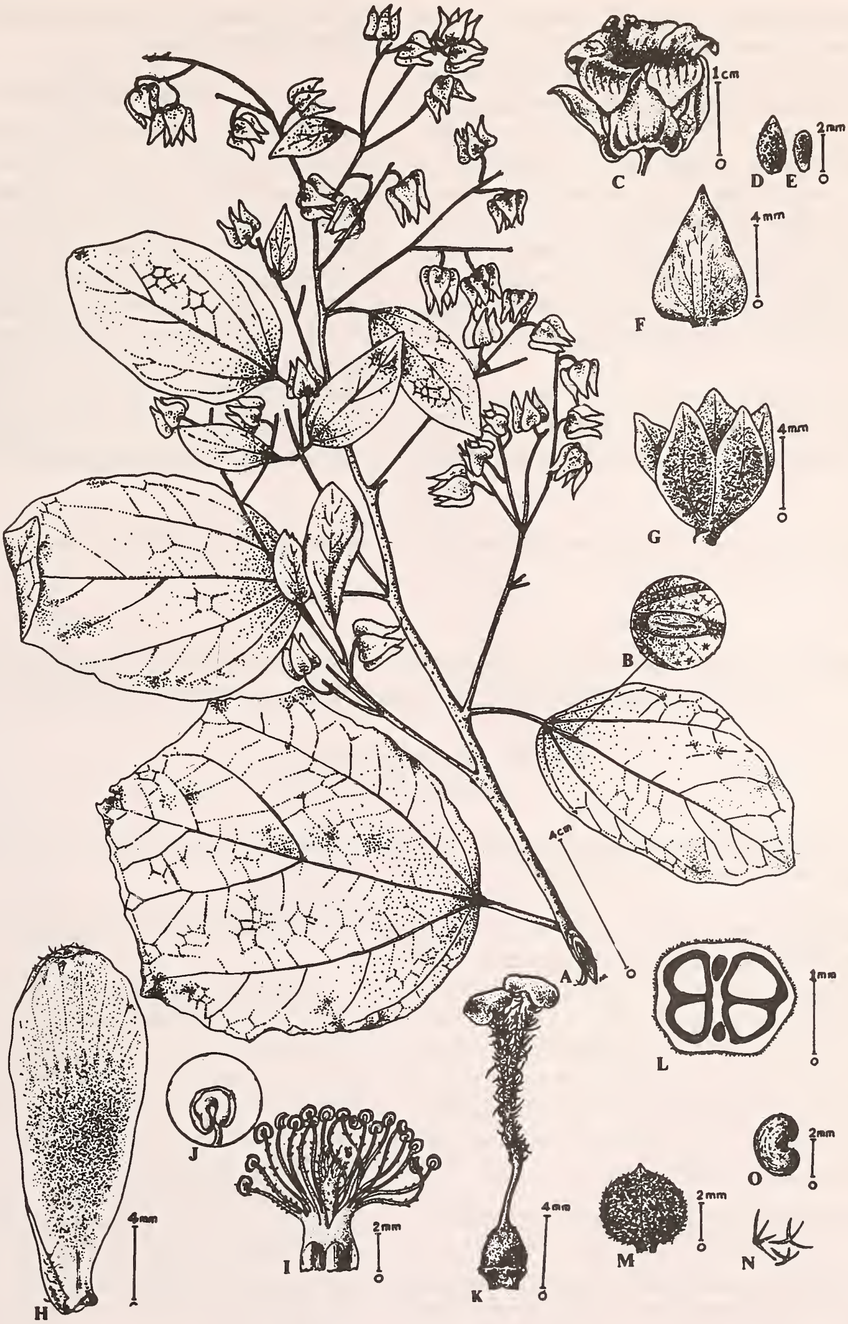

Fig. 1. *Julostylis polyandra* sp. nov.
A. Infrutescent twig; B. Gland (Anilkumar 364); C. Flower; D. Bract; E. Bracteole; F. Epicalyx segment; G. Calyx; H. Petal; I. Androecium; J. Anther; K. Gynoecium; L. C.S. of ovary (Ravi 2475); N. Stellate hairs on fruit; O. Seed (Ravi 2647).

17-19), monadelphous, sparsely glandular hairy; column short 5-7 mm long; apical teeth 5, acicular; filaments slender, purplish *c.* 6 mm long; anthers yellow, 1-celled, reniform. Ovary *c.* 2 mm long, densely hairy, bilocular; ovules 2 per loculus, basal-axile; style exserted, up to 1.5 cm long with 2 (rarely 1) branches, thickened and stellate hairy above the middle, stigma peltate-thickened. Fruit indehiscent *c.* 5 by 6 mm, shortly beaked, densely covered with stellate and simple hairs. Seeds reniform, *c.* 4 mm long, dark brown, closely longitudinally striate with sparse to more or less dense fugaceous stellate hairs.

There is much variability in the extent of lobing of the blade, number of glands on the ribs, nature of inflorescence and hairiness of the seed in different plants. The glands are often absent in the smaller upper leaves.

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A NEW SPECIES OF GALL– FORMING *CROTONOTHRIPS (INERMOTHRIPS)* (THYSANOPTERA: PHLAEOTHRIPIDAE) FROM MANIPUR[1]

L. NILAMANI AND B. PRASAD[2]

(With a text–figure)

Crotonothrips (*Inermothrips*) *maoensis* sp. nov. which inhabited horn gall on *Schefflera wallichii* from Mao, Manipur State, is described and illustrated.

Ananthakrishnan (1967) erected a new genus *Crotonothrips* with *C. gallarum* as type-species and Muraleedharan & Sen (1978) described a new subgenus *Inermothrips* under the genus *Crotonothrips* Ananthakrishnan with *Crotonothrips* (*Inermothrips*) *cacharensis* as type-species. In this paper a new species *C. (Inermothrips) maoensis* producing horn-like galls on *Schefflera wallichii* from Mao, Manipur State is described.

KEY TO INDIAN SPECIES OF SUBGENUS *Inermothrips* OF GENUS *Crotonothrips*

Fore femora yellow, antennal segment 1 brown, yellow at extreme base, 2 yellow, brown at base and margin, 3-4 yellow, rest brown. Forewings with 6-7 double fringes .... *cacharensis* Muraleedharan & Sen

Antennal segments 1–2 brown, 3–8 yellow. All the femora brown, forewings clear with 12-15 double fringes .... *maoensis* sp. nov.

Crotonothrips maoensis sp. nov.

FEMALE (Macropterous): General body colour brown; head, abdominal segments V-VIII and tube dark. Antennal segments 1-2 brown, 3-8 yellow. All femora brown, fore tibiae yellow, mid and hind tibiae brown with yellow at apices. Wings clear with brown stripe at the middle parallel to the wings. All setae brown and blunt.

Head a little broader or as long as wide, 194-200[3] long, 186-190 wide across the eyes, 198-202 wide across the cheeks, 182-186 wide across the base. Eyes 56-60 long, 44-48 wide. Lateral ocelli 20-24 wide, median ocellus overhanging between the

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[3]All measurements in microns unless otherwise mentioned.

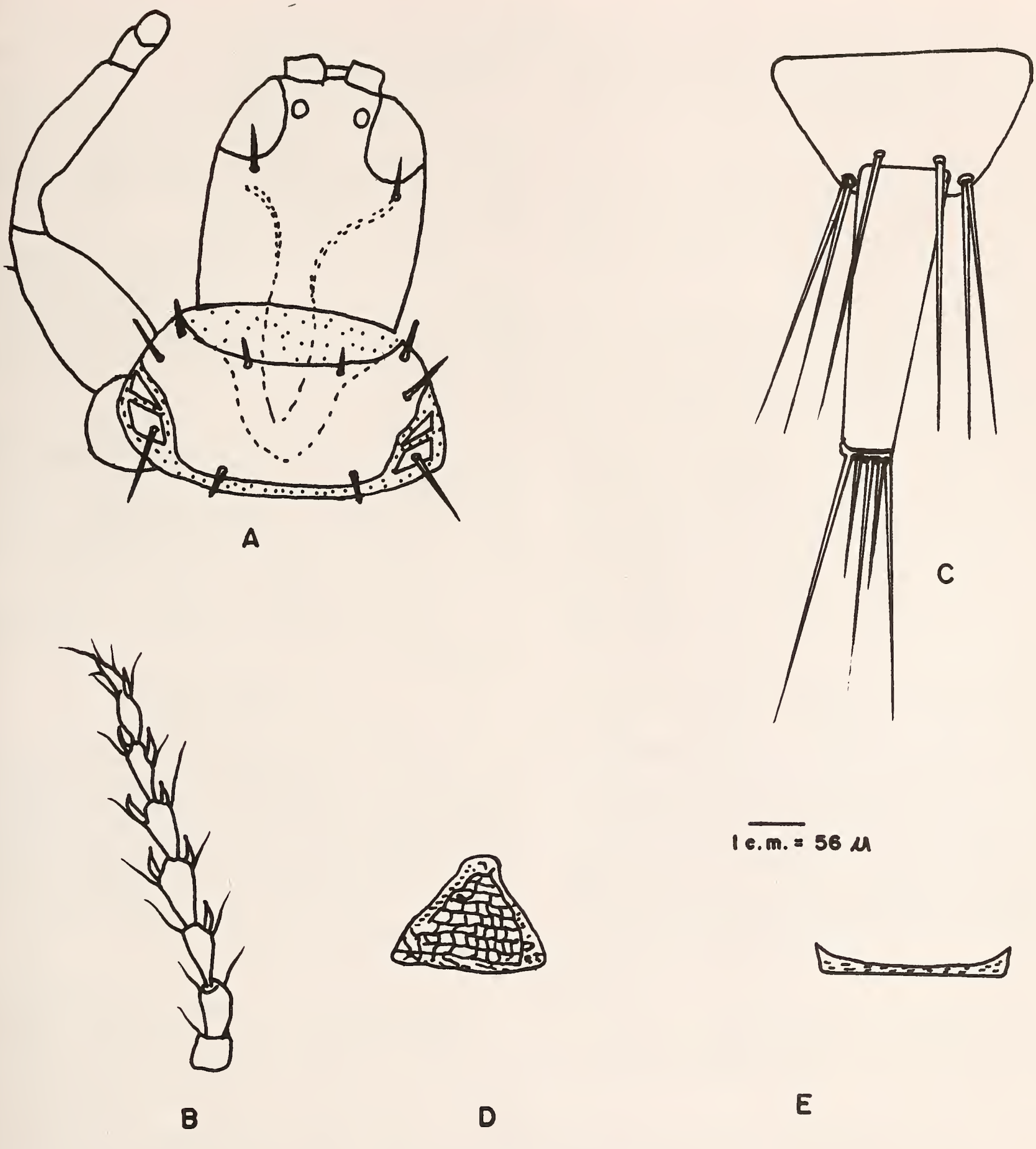

Fig. 1. *Crotonothrips maoensis* sp. nov.
A. Head and Prothorax; B. Antennae; C. Abdominal segment IX with tube; D. Pelta; E. Mesopraesternum.

antennae. Postoculars shorter than eyes, 36-40 long. Antennal segments 1-8 length (width) 1:24-28(44); 2:44-48(34); 3:50-54(32); 4:52-54(36); 5:50-54(36); 6:50-54(28); 7:42-46(18); 8:20-24(8). Sense cones 20-24 long, mouth cone 120-126 long, 166-170 wide at base, 40-44 wide at apex. Maxillary stylets oculad, retracted from the base of the postoculars and closed at the middle.

Prothorax 122-126 long at median line, 190–194 wide at anterior margin, 318-322 wide at posterior margin including coxae. Anteroangulars a little longer than anteromarginals, 26-30 and 18-22 long respectively. Mid laterals 42-46 long, epimerals 82-86 long, postangulars 26-30 long. Pterothorax 364-370 wide at meso — and 348-354 wide at metathorax. Forewings 782-788 long, 80-84 wide with 1215 double fringes. Specially, it has 4 basal wing bristles 42-46, 50-54, 52-56, 44-48 long respectively. Mesopraesternum complete, narrow at middle.

Abdomen 334-338 wide at base, 336-340 wide at middle, 250-254 wide at segment VIII, 160-164 wide at segment IX. B_1-B_3 of segment IX 208-212, 206-210, 220-224 long respectively. Tube 264–268 long, anal setae 212-216 long.

Total body length without tube 1.9- 2.1 mm.

MALE (Macropterous): Body colour same as female. Head 202-206 long, 180-184 wide across the eyes, 192-196 wide across the cheeks, 172-176 wide across the base. Eyes 80-84 long, 48-52 wide, lateral ocelli 20-24 wide, median ocellus overhanging. Postoculars 28-32 long. Antennal segment 1–8 length (width) 1:36-40(40); 2: 48-52(28); 3:64-68(32); 4:68-72(36); 5:64-68(28); 6:60-64(28); 7:56-60(20); 8:28-32(12). Sense cones 20-24 long. Mouth cone 152-156 long, 156-156 wide at base, 40–44 wide at apex. Maxillary stylets oculad, closed at middle.

Prothorax 148-152 long at median line, 196-200 wide at anterior margin, 352-356 wide at posterior margin including coxae. Anteroangulars 28-32 long, anteromarginals 24-28 long. Mid laterals 40-44 long, epimerals 92-96 long, postangulars 36-40 long. Pterothorax 384-388 wide at meso—and 376-380 wide at metathorax. Fore wings 780-786 long, 80-84 wide with 12-15 double fringes. Basal wing bristles B_1- B_5 48-52, 44-48, 60-64, 48-52, 40-44 long respectively. Mesopraesternum complete, narrow at middle.

Abdomen 352-356 wide at base, 384-388 wide at middle, 208-212 wide at segment VIII, 112-116 wide at segment IX. B_1-B_3 of segment IX 220-224, 60-64, 180-184 long respectively. Tube 232-236 long, anal setae 160-164 long.

Total body length without tube — 1.1-1.3 mm.

Material examined: Holotype female, allotype male, paratype 6 females, 4 males, INDIA: Manipur, Molnum (Pallel, 1000 m), 8 December 1984 and Mao (3000 m), 2 November 1986. Ex-Leaf horn gall on *Schefflera wallichii.*

This new species resembles *Crotonothrips* (*Inermothrips*) *cacharensis* Muraleedharan and Sen in general characters, but differs in colour of femora and antennae, number of double fringes, shape of pelta; and specially it is differentiated from other species in having 4-5 basal wing bristles.

The new species *Crotonothrips maoensis* sp. nov. is named after the Mao area which is the collection site.

ACKNOWLEDGEMENTS

We are indebted to Prof. (Dr.) T.N. Ananthakrishnan, Director, Entomological Research Institute, Madras for the confirmation of the species. We also thank Dr Samir Sen, Assistant Zoologist, Thysanoptera Section, Zoological Survey of India, Calcutta for his invaluable help in the identification and providing us many relevant literature.

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TWO NEW VARIETIES OF *CHRISTELLA DENTATA* (FORSSK.) BROWNSEY ET JERMY[1]

N. PUNETHA AND B.S. KHOLIA[2]

(*With a text–figure*)

Among thelypteroid ferns, *Christella dentata* (Forssk.) Brownsey et Jermy is fairly widespread in the western Himalaya. It grows in varied habitats and is spreading in the areas where the forests have been felled. It is an extremely polymorphic species. During fern-collection from Pithoragarh district of Kumaon region (northwest Himalaya) certain vari-

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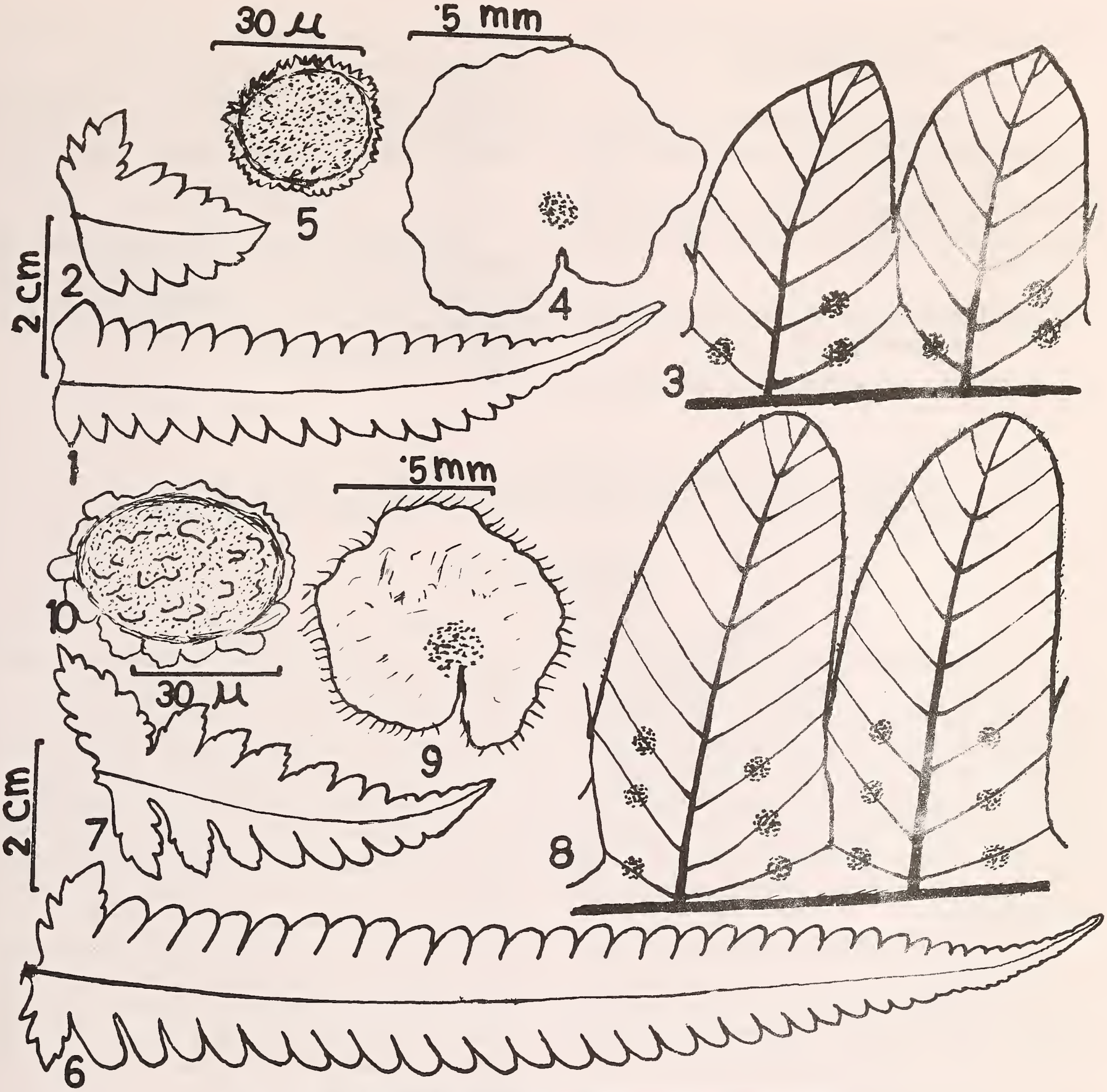

Fig. 1. New varieties of *Christella dentata* (Forssk.) Brownsey et Jermy
1-5. *Christella dentata* var. *glabra* var. nov.: 1. Lateral pinna; 2. Reduced basal pinna; 3. Venation; 4. Indusium; 5. Spore.
6-10. *Christella dentata* var. *himalayensis* var. nov.: 6. Lateral pinna, 7. Reduced basal pinna, 8. Venation, 9. Indusium, 10. Spore.

able populations of this fern from the typical *Christella dentata* (which are cytologically, however, invariably sexual tetraploid) were observed and specimens collected. Subsequently these, along with our comments were sent to Prof R.E. Holttum (at Kew), who confirmed their identity as new varieties of *C. dentata*. A key is provided to distinguish between the two varieties.

KEY FOR TWO VARIETIES OF *Christella dentata*

Rhizome erect; plants glabrous; pinnae broadly lobed; veins 6-7 pairs; perispore spinulose .... *C. dentata* var. *glabra*
Rhizome long creeping, plants pubescent; pinnae narrowly lobed; veins + 7 pairs; perispore verrucose .... *C. dentata* var. *himalayensis*

Christella dentata (Forssk.) Brownsey et Jermy var. **glabra** var. nov.

A varietate typica speciei differt: caudice erecto. Stipite apicem versus glabro, pinnis late-lobatis, veins 6-7-jugatis (Fig. 1:1-5).
Specimens examined: Holotype, K; Isotype, Bot. Pithoragarh 88130, 88131. Locality: Thal (800 m), April 1988.

Christella dentata (Forssk.) Brownsey et Jermy var. **himalayensis** var. nov.

A varietate typica speciei differt: pinnis inferioribus 3-5- jugatis sensim redactis, infimis 5.5 cm longis; veins +7-jugatis (Fig. 1: 6-10).
Specimens examined: Holotype, K; Isotype Bot. Pithoragarh, 88120, 88121, 88122. Locality: Village Hachila (Didihat -1200 m), February 1988.

ACKNOWLEDGEMENTS

We thank Prof. R.E. Holttum (Kew) for the identity of the ferns, for the Latin diagnosis of the new varieties and for encouragement. Thanks are also due to the University Grants Commission, New Delhi, for financial support.

A NEW SPECIES OF GENUS *MEGACHILE* LATREILLE (HYMENOPTERA: APOIDEA: MEGACHILIDAE), FROM INDIA[1]

VIRENDRA KUMAR[2]

(*With a text–figure*)

The genus *Megachile* Latreille is represented by 8 subgenera: *Eutricharaea* Thomson, *Paramegachile* Friese, *Xanthosarus* Robertson, *Cyphopyga* Robertson, *Delomegachile* Viereck, *Litomegachile* Mitchell, *Macromegachile* Noskiewicz, *Addendella* Mitchell from Western Hemisphere (Mitchell 1980); 2 subgenera: *Callochile* Michener as well as *Eutricharaea* Thomson from Eastern Hemisphere. *Megachile* s. str. occurs in both the Hemispheres.

Megachile s. str. from the Indian region was so far represented by only one species, namely: *Megachile buddhae* Dall. Torr. (Bingham 1897). In this paper a new species, *Megachile* (*Megachile*) *bharatpurensis* is described from Bharatpur (India).

Megachile (Megachile) bharatpurensis sp. nov.

MALE: Integument black, shining; tegulae brown; punctures are fine and closely placed; pubescence golden-red, on cheeks and sternums white.

Head wider than the median length; inner eye margin convergent below and slightly incurved at median area; clypeal surface is flat, apical margin laterally outcurved and medially broadly invaginated; parocular area with a prominent carina; occipital margin without parallel fold; genae distinctly narrowed above; hypostomal area with dense, elongated white hairs; mandible four dentate, lower margin almost straight from base to apex.

Scutum convex, with coarse and sparsely distributed punctures; median line distinct, parapsidal lines very fine and obscure; scutellar surface medio–longitudinally shallowly grooved; anterior and posterior margins of metanotum carinate; wing colour dark fuscous with basal hyaline area, veins black to piceous; coaxae and trochanter are normal; ventral margin of femora is carinate; inner face slightly concave; anterior and posterior surfaces of tibiae are broadly smooth; tarsi ventrally with milky-white fringe.

Basal tergum concavity margin semicarinate; tergite 2-5-with completely eclipsed pregradualar area; 6th tergum with more angulate carina at median area; 6th sternum projects beyond the apical margin of post gradualar area; apical lobe of 8th sternum with flattened and medially slightly invaginated apex, posterior lobe projects acutely.

Gonocoxite protuberant basally and constricted subapically at outer margin; gonostylus is slightly dilated and with an inward diversion subapically, with elongated setae.

[1]Accepted November 1989.
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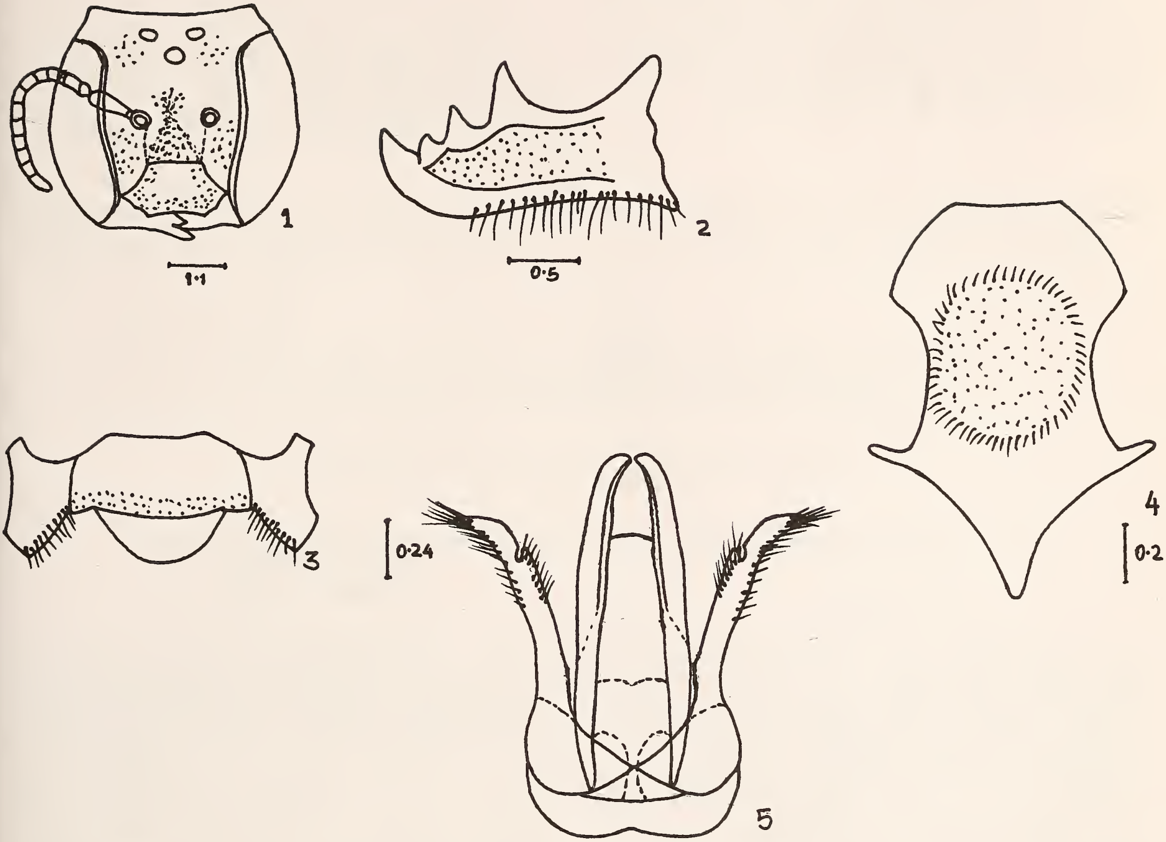

Fig. 1. *Megachile (Megachile) bharatpurensis* sp. nov.: male
1. Head, front view (dots indicate pubescence); 2. Mandible; 3. Sternum 6th; 4. Sternum 8th; 5. Genitalia.

Measurements: (in mm). Total length 7.5; eyes: length 2.25, lateral width 1.0; clypeus: median length 0.9, basal width 1.12, apical width 1.75; antennae: length of scape 0.57, pedicel 0.2, flagellar segments I-0.5, II-0.32, XI-0.4, labrum: median length 1.0, basal width 1.0, apical width 0.9; mandible: length of dentate and lower margin 0.8 and 0.65; scutum: median length 1.5, maximum width 2.5; fore wing: total length 6.25; tergites I-VII, relative median width 0.9, 0.7, 1.2, 1.0, 1.3, 1.4, 0.3.

FEMALE: Not known.

Material examined: Holotype: male, Bharatpur, 15 June 1986 (V.K.); paratypes: two males with same data, all specimens in the collection of the Deptt. of Entomology, Agra College, Agra.

The new species is close to *M. buddhae* Dall. Torr. However, *M. bharatpurensis* sp. nov. can be distinctly separated from *M. buddhae* by: "thorax above with golden red pubescence; clypeal surface is flat; lower margin of mandible is almost straight from base to apex; apex of gonostylus of genitalia is pointed, with long and dense setae; apex of penis valve is narrow; pregradualar area of 6th sternum projecting on both laterals; apex of 8th sternum is flattened, medially slightly invaginated."

This specimen has been named after the collection locality, Bharatpur.

ACKNOWLEDGEMENTS

I thank Dr V.K. Tewari, Department of Zoology, Agra College, Agra, for providing necessary laboratory facilities and Dr Prem Kishor, Entomology division, I.A.R.I. New Delhi, for suggestions.

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NEW SPECIES OF *ACONURELLA* AND *PARAMESODES* (HOMOPTERA: CICADELLIDAE) FROM INDIA[1]

V. RAMA SUBBA RAO[2] AND USHA RAMAKRISHNAN[3]

(With two text-figures)

Two new species, *Aconurella neosolana* and *Paramesodes wilsoni* from India are described and illustrated.

INTRODUCTION

Aconurella Ribaut, when erected, was a monotypic genus with its type-species *Thamnotettix prolixus* Lethierry. Vilbaste (1965) synonymized *Doratulina* Matsumura with *Aconurella* and published a consolidated list of 10 species. Anufriev (1972) described two new species. Ghauri (1974) described a new species, *A. solana* and proposed a new combination *A. erebus* (Distant) from *Deltocephalus*. Thus there are 14 species recorded so far from all over the world, out of which five are reported from India. One new species is described here.

Wilson (1983) redescribed and revised *Paramesodes* Ishihara with 11 species, of which three species are recorded from India. One new species is described here.

[1]Part of Ph.D. thesis submitted by the first author to the Indian Agricultural Research Institute, New Delhi .

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MATERIAL AND METHODS

The methods used in the handling and preparation of specimens for study including dissection of male genitalia advocated by Knight (1965) were followed. The terminology given by Blocker and Triplehorn (1985) was used in descriptions. For studying external morphological characters and genitalia dissections a Nikon SMZ 10 stereozoom binocular microscope was used. Dissected male genital structures were further studied in detail with a Leitz Ortholux II Phase contrast, interference, compound microscope and illustrations were also made with the same microscope, using drawing apparatus. The scales of magnifications are indicated on the right side of the illustrations and in all cases the line is equal to 0.1 mm.

Abbreviations: NPC: National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi. BMNH: British Museum (Natural History), London.

Aconurella neosolana sp. nov. (Fig. 1)

Colour: Stramineous to greenish yellow.

External morphology: Vertex subacute, slightly shorter than the width between eyes, excavated and

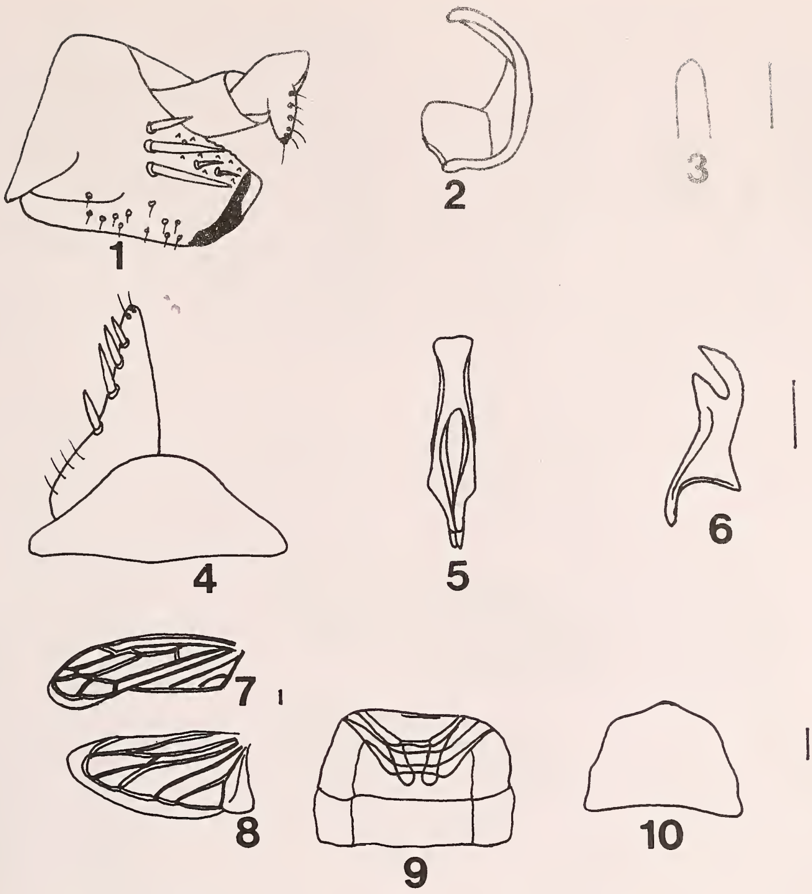

Fig. 1. *Aconurella neosolana* sp. nov.
1. Pygofer, lateral view; 2. Aedeagus, lateral view; 3. Aedeagus apex, ventral view; 4. Valve and subgenital plate; 5. Connective; 6. Style; 7. Forewing; 8. Hind wing; 9. Abdominal apodemes; 10. Female sternum VII.

sulcate at the base. Ocelli marginal, away from the eye at a distance equal to its own diameter. Clypeus black with median yellow stripe. Clypellus long, extending up to the lower margin of genae. Pronotum with black maculations and obscure fine transverse striae anteriorly. Forewings extending beyond the abdomen, with four apical and two anteapical cells. Posterior femoral setal pattern 2-2-1. Abdominal sternal apodemes well developed.

Male genitalia: Pygoferal lobe angulate at postero–mesal margin; serrated comb-like structure on postero-ventral margin, posteriormost tooth well developed compared to other teeth; macro and micro setae on dorsolateral surface. Valve is as shown in Fig. 1. Subgenital plates triangular, shorter than pygofer, with marginal setae. Connective Y-shaped with arms close together. Style with narrow body, claw-like apophysis well developed, inner process longer than outer process, both wide apart. Aedeagus as shown in the figure; gonopore apical.

Female sternum VII as shown in Fig. 1

Measurements (mm) of male (female): Head, width 0.7 (0.85); vertex, width 0.3 (0.35), length 0.25 (0.3); pronotum, width 0.6 (0.75), length 0.25 (0.3); scutellum, width 0.35 (0.5), length 0.2 (0.25); total length including forewings 2.15 (2.85).

Types: Holotype Male, Raghavendranagar, Visakhapatnam Dt., Andhra Pradesh, grasses, 13 May

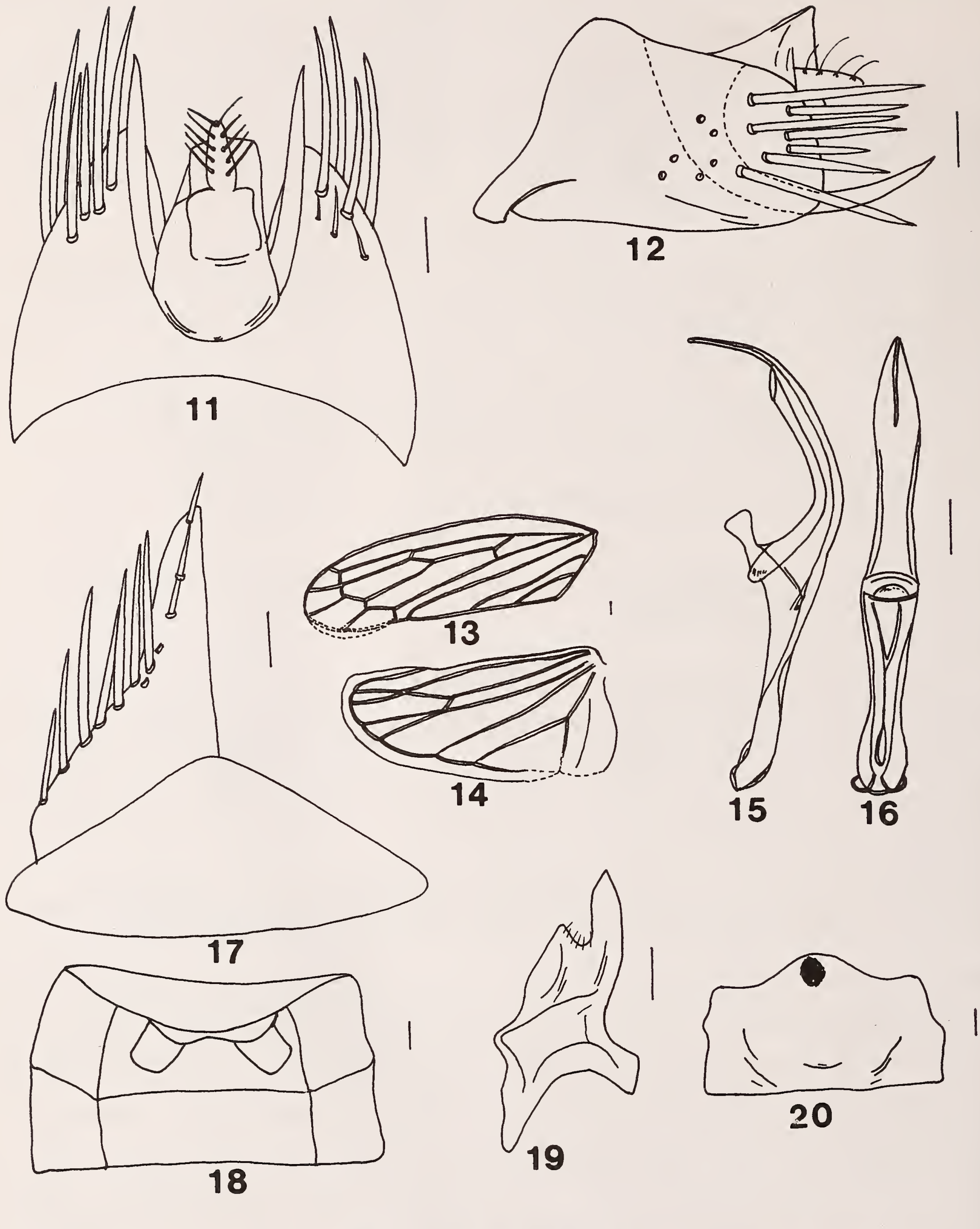

Fig. 2. *Paramesodes wilsoni* sp. nov.
11. Pygofer, dorsal view; 12. Pygofer, lateral view; 13. Forewing; 14. Hind wing; 15. Aedeagus and connective, lateral view; 16. Aedeagus and connective, ventral view; 17. Valve and subgenital plate; 18. Abdominal apodemes; 19. Style; 20. Female sternum VII.

1987, V.R.S. Rao, deposited in NPC.

Paratypes: 1 male, 8 females, same data as holotype, deposited in NPC. 1 male, 2 females, same data as holotype deposited in BMNH.

This species resembles *A. solana* Ghauri in having pygofer with postero-ventral marginal serrated comb-like structure, but differs from *solana* in the shape of pygofer, style, female sternum VII and also in the arrangement of macro and micro setae which are not covered along the entire length of comb-like structure of pygofer. It also differs from *solana* in the absence of markings on the head and thorax.

Paramesodes wilsoni sp. nov. (Fig. 2)

Colour: Pale yellowish brown. A submarginal transverse pale black band on the vertex between eyes and two sunken spots at the base of the latter. *External morphology:* Head broader than pronotum. Vertex with anterior margin rounded, slightly longer medially than next to eyes. Forewings with four apical and three anteapical cells, the inner anteapical cell open basally. Posterior femoral setal pattern 2-2-1. Abdominal sternal apodemes well developed. *Male genitalia:* Pygofer lobes with long, prominent setae; pygofer processes projecting considerably beyond pygofer lobes, directed posteroventrally up to posterior margin of pygofer lobes, afterwards curving dorsally, in lateral view. Subgenital plates triangulate, approximately same length as pygofer with ventrolateral submarginal row of spines. Styles well developed as shown in the figure. Connective fused to aedeagus, arms closely apposed. Aedeagal shaft tubular, narrowed apically with its ventral wall, extending beyond gonopore, bifurcated, appearing like closely apposed processes; gonopore subapical.

Female sternum VII as shown in the Fig. 2 *Measurements* (mm) of male (female): Head, width 1.50 (1.7); vertex, width 0.75 (0.85), length 0.35 (0.4); pronotum, width 1.35 (1.5), length 0.50 (0.65); scutellum, width 0.85 (0.95), length 0.5 (0.65); total length including forewings 4.75 (5.40). *Types:* Holotype Male, Delhi (IARI), grasses, 5 November 1965, R. Menon, deposited in NPC.

Paratypes: 3 females (2 abdomen lost), same data as holotype, deposited in NPC; 2 females, same data as holotype deposited in BMNH.

The new species is close to *P. lucaniae* (Dlabola) in the key given by Wilson (1983) in having long, slender pygofer processes, with recurved apices directed dorsally, in lateral view. This species differs in the aedeagus, the apex of its shaft bifid, appearing like closely apposed processes extending beyond gonopore, whereas in *lucaniae*, the apex of the aedeagus is not bifurcated. This aedeagal character is unusual and is unlike any other species of *Paramesodes*. The species is named in honour of Dr M. R. Wilson who has contributed a lot to the study of this genus.

ACKNOWLEDGEMENTS

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ON A NEW SPECIES OF *SALMOSTOMA* SWAINSON (CYPRINIDAE : CULTRINAE) FROM DHOM RESERVOIR, SATARA DISTRICT, MAHARASHTRA[1]

R.T. SRITHAR AND K.C. JAYARAM[2]

(With two text-figures)

A new species of *Salmostoma* (Cyprinidae: Cultrinae) from river Krishna at Dhom reservoir, Satara District, Maharashtra, is described. Statistical comparison with *S. novacula* indicates its divergence in having a longer caudal peduncle, shorter body and head and smaller eyes, besides a greater number of lateral line scales.

During the course of a bioresources survey of the Krishna river system, peninsular India, we found that the population of *Salmostoma* species inhabiting the Dhom reservoir comprises of a hitherto undescribed species. The species is akin to *S. novacula* (Valenciennes) but differs from it in many characters.

The genus *Salmostoma* was established by Swainson (1839) with *Cyprinus bacaila* Hamilton as the designated type. Later Banarescu (1968), in an excellent revision of this genus, clarified the generic status of *Salmostoma* vis-a-vis *Chela* Hamilton and *Securicula* Gunther. Jayaram (1981), following Banarescu, listed 10 species found in Indian waters. Of these, five are known in the western ghats river systems, and three of these — *S. boopsis* (Day), *S. clupeoides* (Bloch) and *S. novacula* (Val.) — occur in the Krishna river.

We have examined 29 specimens of the new species and made a statistical comparison with the samples of *S. novacula* from Madras, Poona, Deolali and Deccan. The material was sent to Prof. Banarescu who also confirmed its separate identity. Data on 17 meristic and 17 non-meristic characters were recorded, and 29 examples, comprising of both sexes and of all size ranges, were selected. This was compared with data published in Banarescu (1968, p. 6) and the results are presented in Table 1. The intergradations and divergences can be seen from Fig. 1.

Meristic characters such as lateral line scale counts and lateral line/pelvic fin counts could not be compared, as frequency and other details of *S.*

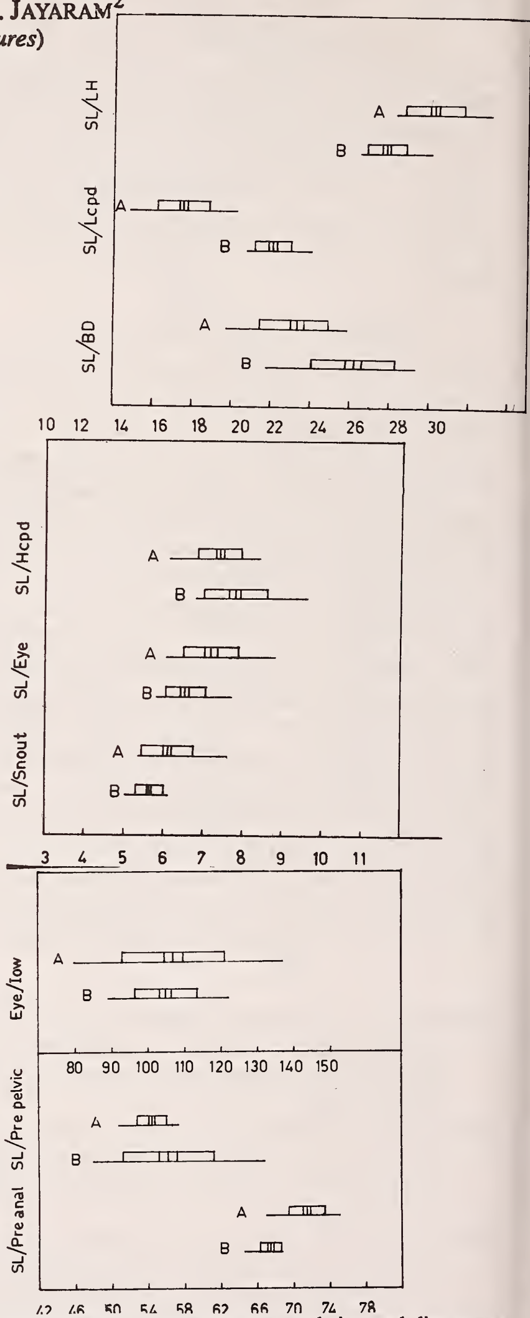

Fig. 1. Bar diagrams comparing intergradation and divergence between *S. longicauda* and *S. novacula*.

[1]Accepted August 1989.

[2]Krishna River Project, C/o Zoological Survey of India, Madras, Tamil Nadu 600 028.

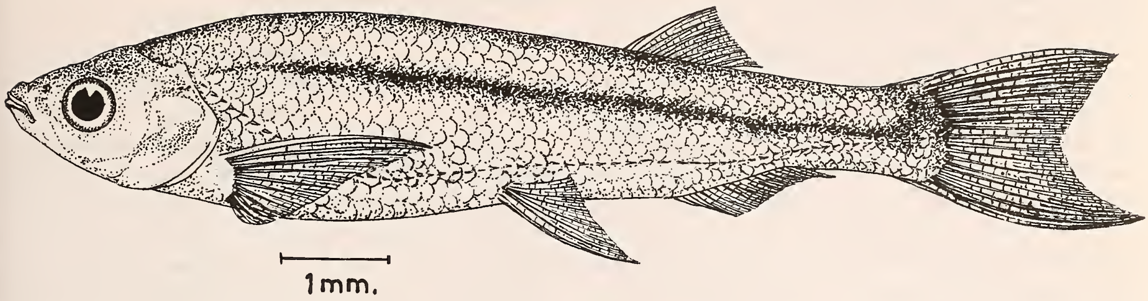

Fig.2. Lateral view of *S. longicauda*, holotype.

novacula are not available in the published work. Although lateral line scales in the new species of Dhom reservoir range from 51 to 70 and in the rest 79 to 95, which itself clearly differentiate the species; the other characters also support its identity.

The new species can be easily separated from *S. novacula* by its longer caudal peduncle, shorter body depth, shorter head and smaller eyes, besides greater number of lateral line scales (Table 1).

Salmostoma longicauda sp. nov.

D ii or iii, 7 or 8; P. i, 10 or 11; V. i-ii, 7 or 8; A ii-iv, 13-16; C. 10 + 9; LL 51-70.

Material examined: Holotype 84 mm. SL; Paratypes 10 exs, 62 to 83.5 mm. SL; Others 18 exs, 62 to 85 mm. SL. from rivers Krishna and Vaitali at Dhom reservoir at Asari village, 8 km west of Wai, Satara District, Maharashtra, 3 January 1988, K.C. Jayaram *et al.* All specimens are in the Zoological Survey of India, Madras.

Diagnosis: A *Salmostoma* species with gill raker counts 58-76, length of caudal peduncle 13.52 % (10.76-16.21) of standard length and with lateral line scales 51 to 70.

Description: Dorsal profile nearly straight with a gentle rise up to occiput. Body compressed and elongated, head short, mouth upturned, lips thin, snout plain, eyes placed superiorly in the anterior part of head, visible from below ventral surface of head, no barbels.

TABLE 1
BIOMETRIC COMPARISON OF TWO POPULATIONS OF *Salmostoma* SPECIES

		N	Range	Mean	SD	SE	t
SL/BD	A	29	15.67-21.79	19.25	1.564	0.290	5.9822
	B	25	17.70-25.30	22.23	2.089	0.418	
SL/Lcpd	A	29	10.76-16.21	13.52	1.341	0.249	14.2606
	B	25	16.70-0.00	18.05	0.915	0.183	
SL/Hcpd	A	29	6.08-8.39	7.38	0.539	0.100	2.2764
	B	25	6.80-9.60	7.80	0.807	0.161	
SL/Pre-anal	A	29	67.11-75.19	71.40	1.970	0.366	8.3786
	B	25	64.50-68.50	67.49	1.344	0.269	
SL/Pre-pelvic	A	29	50.51-57.14	54.38	1.675	0.311	1.8145
	B	25	48.00-66.80	56.18	5.035	1.007	
SL/LH	A	29	24.21-29.07	26.15	1.286	0.239	7.5781
	B	25	22.40-26.00	23.74	0.994	0.199	
SL/Snout	A	29	5.39-7.58	6.09	0.637	0.118	3.0386
	B	25	5.00-6.12	5.67	0.289	0.058	
SL/Eye	A	29	6.06-8.79	7.22	0.703	0.131	3.8672
	B	25	5.80-7.70	6.56	0.522	0.104	
Eye/IOW	A	29	80.00-136.99	106.68	13.790	2.560	0.6052
	B	25	89.00-122.00	104.75	8.601	1.720	

A – Dhom reservoir.
B – *S. novacula* from Madras, Poona, Deolali and Deccan.

Measurements: Head length 26.15 (24.21-29.07), body depth 19.25 (15.67-21.79), pre–dorsal distance 70.56 (67.57-72.46), pre–pelvic 54.38 (50.51-57.14), pre–anal 71.40 (67.11-75.19), length of caudal peduncle 13.52 (10.76-16.21), height of caudal peduncle 7.38 (6.08-8.39) in percent of standard length. Eye diameter 27.73 (23.26 -34.25), snout 24.44 (20.92-31.25), width of mouth 17.47 (11.63-24.21), width of head 35.03 (31.55-44.44), height at occiput 61.80 (56.50-73.53) in percent of head length. Eye diameter 106.68 (80.00-136.99) percent of interorbital width, 111.08 (80.00-129.89) in percent of snout.

Gill rakers very long, 58-76 in the first gill arch. Dorsal fin inserted above anal origin. Pectoral fins laterally inserted, not reaching pelvic fin, outer rays prolonged. Pelvic fins not reaching anal fin. Anal fin moderately long, not reaching caudal fin when depressed. Least depth of caudal peduncle 55.11 (41.67-71.43) in percent of its length. Lateral line curved, reaching base of caudal fin. Caudal fin forked with unequal lobes.

Colour: In fresh specimens, metallic green over sides of body, fins and abdomen pale white. In preserved specimens, light grey above lateral line, a streak of grey running along centre of body and over dorsal ridge, pale white below lateral line.

Distribution: Krishna river at Dhom reservoir, Satara District, Maharashtra.

Scale counts: LL/Dorsal 9 1/2
LL/Pelvic 1 1/2 or 2 1/2
LL/Anal 2 1/2 or 3 1/2
Circumpeduncular 16 or 17.

Dhom reservoir is a man–made impoundment across the Krishna and Vaitali rivers. Fishermen operate a purse–seine type net with a mesh size of 1 cm and invariably the catch comprises of *Salmostoma novacula* and *S. longicauda*, the latter to a larger extent. It appears that the changed habitat and isolation has resulted in the fish having a longer caudal peduncle, shorter body and head, smaller eyes, and greater number of lateral line scales.

Acknowledgements

This study was supported by a financial grant to the second author by the Department of Environment, Government of India, for which he is grateful. Our sincere thanks are due to the Director of Fisheries, Maharashtra; Regional Deputy Director of Fisheries, Poona and to Mr. Jagdale in particular. Thanks are also due to the Officer in Charge, Marine Biological Station, Zoological Survey of India, Madras, for facilities, and to Prof. Petru Banarescu, Department of Biology, Bucharest, Rumania, for confirming the material and for his critical comments.

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NEW PLANT TAXA FROM THE SIND VALLEY, KASHMIR[1]

G.H. Dar[2] and A.R. Naqshi[3]

(With three text–figures)

The following new taxa from the Sind valley, Kashmir (India) are described: *Ermania kashmiriana*, *E. kachrooi*, *Lepidium virginicum* var. *kashmiricum* (Brassicaceae), *Dolomiaea baltalensis* (Asteraceae) and *Veronica biloba* var. *densa* (Scrophulariaceae). The three new species are also illustrated.

Ermania kashmiriana sp. nov.

Herbae perennis, 3-10 (-15) cm alta, multiramosa ad basim, dense foliosa, pilosa sine siliquae. Folia basalina dense rosulata, subcarinosa,

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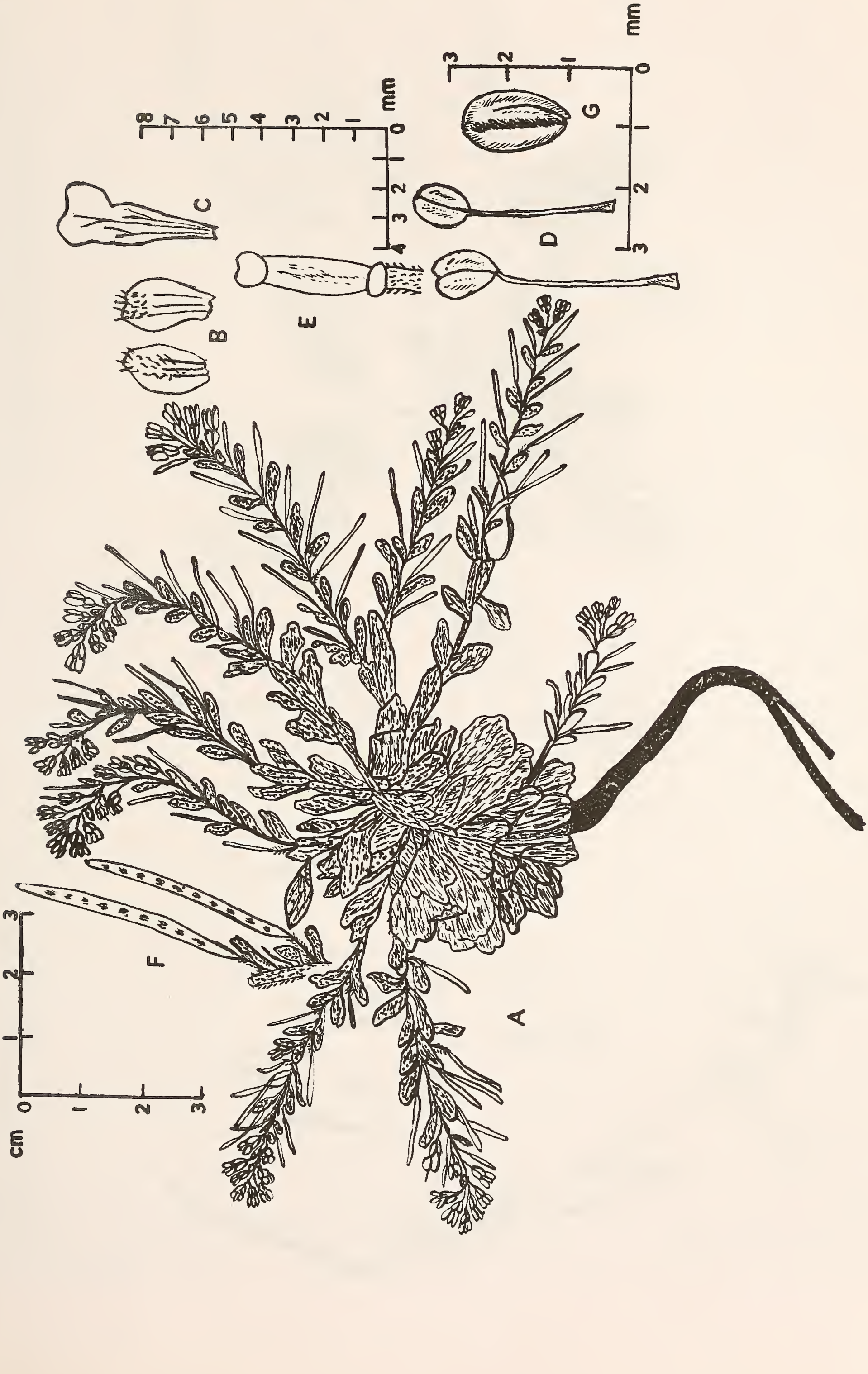

Fig. 1. *Armania kashmiriana* sp. nov.
A. Habit; B. Sepals; C. Petal; D. Stamens; E. Ovary; F. Siliquae; G. Seed.

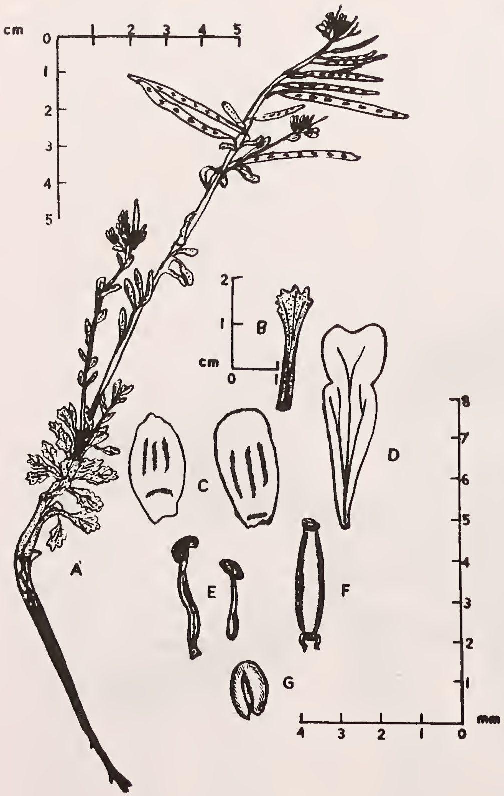

Fig. 2. *Ermania kachrooi* sp. nov.
A. Habit; B. Lower cauline leaf; C. Sepals; D. Petal; E. Stamens; F. Ovary; G. Seed.

Fig. 3. *Dolomiaea baltalensis* sp. nov.
A. Habit; B. Achene with pappus; C. Achene with pappus removed.

spathulata-obovata, 3-5-dentata et subintegra. Folia caulina lineari- oblanceolata. Racemus multiflorus, densus, in fructo 10 cm longus. Flores 4-6 mm diam.; pedicelli 7 mm longi in fructis, ascendentes. Sepala subaequalia, oblonga-elliptica et obovata-elliptica. Petala spathulata, purpurea, subemarginata et ± integra. Stamina 3:4 mm longa. Ovarium subcylindricum-oblongum, multiovulatum; stigma depresso-capitatum, sessilia. Siliquae lineari–oblongae, subcylindricae, 42 x 2 mm; valvae glabrae, uninervatae. Semina uniseriata, obovoidea-elliptica, 1.5-1.7 x 1 mm, brunea, non-mucilaginosa; septum membranaceum, enervatum. Typus: India, Kashmir, Sind valley, *G.H. Dar* 7786 (holotypus KASH).

Perennial, 3-10 (-15) cm tall, decumbent to suberect herbs, much branched from the base, leafy throughout, pilose with white hairs except the siliquae. Radical leaves subfleshy, thickish, densely rosulate, spathulate-obovate, 1-2 cm long, 3-10 mm broad, 3-5 toothed towards the apex or ± entire, pilose. Cauline leaves oblanceolate to linear, entire, smaller, usually functioning as bracts, pilose. Racemes dense, many-flowered, bracteate, up to 10 cm long in fruit. Flowers 4-6 mm in dia. Pedicels up to 7 mm long in fruit, ascending, turning to one side at maturity, pilose. Sepals subequal, 2-3 mm long, oblong-elliptic or obovate-elliptic, pilose, the lateral two often purplish, saccate at base. Petals purple, sometimes turning white when dry, 5-7 x 1.5-2.5 (-3) mm, spathulate, subemarginate to ± entire. Stamens tetradynamous, 3:4 mm long. Ovary subcylindrical–oblong, many ovuled; stigma sessile, capitate, usually depressed and subretuse. Siliquae subcylindric when young, linear-oblong when mature, compressed, up to 42 mm long, 2 mm broad; valves glabrous, midvein usually less distinct; septum complete, veinless. Seeds many, uniseriate, obovoid–elliptic, 1.5-1.7 x 1 mm, brown, non-mucilaginous when wet; radicle accumbent (Fig. 1).

INDIA: Kashmir, Shalimar, Sonamarg (Sind valley), 3900 m, rocky slopes along the alpine meadow, 20 Aug. 1983, *G.H. Dar* 7786 (holotype KASH); Pranshur, Sonamarg (Sind valley), 4000 m, rocky slopes along mountain top, with fruits lying flat on sand, 26 Aug. 1983, *G.H. Dar* 8296 (paratype KASH); Nilnai, Sonamarg (Sind valley), 4100 m, on sandy slopes at mountain top, 26 Aug. 1983, *G.H. Dar* 8301 (paratype KASH).

Ermania kashmiriana resembles *E. stewartii* (T. Anderson) O. Schulz and *E. himalayensis* (Cambess.) O. Schulz in habit but differs from the former by its dense, many flowered racemes up to 10 cm long in fruit, longer (3-4 mm) stamens and narrower (2 mm wide) siliquae. It can be distinguished from the latter by its radical leaves ranging from 3-10 mm in width and 10-20 mm in length, shorter fruiting pedicels (up to 7 mm), longer stamens (up to 4 mm), longer siliquae (up to 42 mm) which are glabrous and do not exceed 2 mm in width and usually lack a prominent midvein on their valves. From the glabrous forms of *E. himalayensis* it can be easily distinguished by its pilose surface in almost all the parts except siliquae.

Ermania kachrooi sp. nov.

Herbae perennis, 8-15 cm alta, ascendens et suberecta, glabra, multiramosa. Folia basalina non-rosulata. Folia caulina inferiore spathulata, subcarinosa, (3-4-) 5-multidentata. Folia superiora lineari-oblanceolata, integra. Racemus 10-18-florus, 5-6 cm longus in fructis, ascendentes et unilaterales. Sepala subaequalia, elliptica et obovato-oblonga. Petala clare rosea, spathulata, subemarginata-integra. Ovarium subcylindrico-oblongum, multiovulatum; stigma depresso-capitata, sessilis. Siliquae (immaturae) subcylindricae, maturae lineari-oblonga, 36 x 1.5-2 mm; valvae glabrae. Semina uniseriata, obovoidea–elliptica, 1-1.5 x 1 mm, brunea, nonmucilaginosa; septum enervatum. *Typus:* INDIA, Kashmir, Baltal, Sind valley, *G.H. Dar* 3934 (holotypus KASH; isotypus KASH).

Perennial, 8-15 cm tall, ascending–suberect, totally glabrous herbs, branched from above the base. Basal rosette of radical leaves absent. Lower cauline leaves subfleshy, spathulate, 8-16 mm long, 3-8 mm broad, narrowed below into stalk-like lower half sheathing at base, (3–4-) 5- many toothed in the apical half; upper cauline leaves oblanceolate to linear, small, entire. Racemes 10-18-flowered, bracteate below, 5-6 cm long in fruit. Flowers 4-5 mm wide. Pedicels 4-5 mm long, ascending, unilateral. Sepals subequal, 2.5-3 mm long, elliptic or obovate-oblong, the lateral pair often puplish, saccate at base. Petals light pink, 4-5 x 1.5-2 mm, spathulate, submarginate or somewhat entire. Stamens 2:3 mm long. Ovary subcylindric-oblong, many-ovuled;

stigma sessile, capitate, usually depressed or subretuse. Siliquae subcylindric when young, linear-oblong when mature, compressed, up to 36 mm long, 1.5-2 mm broad; valves glabrous, midvein often obscure; septum complete, veinless. Seeds many, uniseriate, obovoid-elliptic, 1-1.5 x 1 mm, brown, nonmucilaginous when wet; radicle accumbent (Fig. 2).

INDIA: Kashmir, Baltal, Sonamarg (Sind valley), 3200 m, rocky slopes, 2 Sept. 1982, *G.H. Dar* 3934 (holotype KASH; isotype KASH).

Ermania kachrooi differs from *E. stewartii*, *E. kashmiriana* and *E. himalayensis* by the absence of basal rosette of radical leaves and presence of lower cauline leaves which are narrowed into stalk-like lower half, and (3-4-)5-many toothed in the apical half. It can readily be separated from *E. stewartii* and *E. kashmiriana* by its totally glabrous surface. However, it resembles glabrous forms of *E. himalayensis* but can be differentiated by the presence of usually 5-many toothed, non-rosulate lower cauline leaves, shorter fruiting racemes, pedicels, and stamens, and mostly obscure midvein on the valves.

Dolomiaea baltalensis sp. nov.

Herbae perennis, acaulis. Folia basalina rosulata, patens, ± procumbens, elliptica-ovata, haud lobata-dentata, pubecentia conferta et densa albo-tomentosa. Capitula corymbosa, discoidea, oblonga, pedunculata. Phyllaria multiseriata, externa ovata-lanceolata, lanosa ad basim; interia lanceolata et oblonga–lanceolata. Flores bisexualia. Petala purpurea. Stamina 5; antheris sagittatis, ciliatus et laciniatus ad basim. Cypsela cuneato–obovoidea, sub 4-costata, cinerea et lutea. Pappus densus, brunneus, barbellatus (scabridus), 2-3 et multiseriatus. *Typus:* INDIA: Kashmir, Baltal, Sind valley, *G.H. Dar* 3899 (holotypus KASH; isotypus KASH, K & E).

Perennial, acaulescent herbs. Leaves radical, petiolate. Petioles 3-10 cm long, flattened, ± sheathing at the base, channelled, woolly. Lamina ovate to elliptic–ovate, slightly cordate, cuneate or somewhat rounded at base, 5-10 x 3-7 cm, entire or very shallowly and irregularly lobed, spinulosely dentate, densely woolly above, densely white–tomentose beneath. Capitula homogamous, discoid, 7-24 in number, corymbose, oblong, expanded above after anthesis, up to 4 cm long, peduncled. Peduncles stout, 0.5-4.5 cm long, channelled, woolly. Involucral bracts multiseriate, imbricate, serrulate; outer ovate-lanceolate, often woolly at least at base, appressedly hairy towards apices; inner lanceolate to oblong-lanceolate, long-acuminate, scarious, longer than outer ones, appressedly pubescent, more so in apical half. Florets actinomorphic, hermaphrodite. Corolla purple, tubular, tube slender, ± 1 cm long; limb inflated, about as long as tube, 5-partite. Stamens 5; filaments slender, *c.* 4 mm long, glabrous; anthers syngenesious, 6-7 mm long, bases sagittate with ciliate-lacerate, ± 2 mm long tails. Style slender, ± 2 cm long, glabrous, bifid at apex; stigmatic lobes 2 mm long. Cypsela cuneate–obovoid, 5-7 mm long, indistinctly 4-angled, ± compressed, often slightly curved, glabrous, ashy grey with irregular transverse black streaks or yellowish, nearly smooth, shining; apex prominently rimmed, umbonate. Pappus many, 2-3 or multiseriate, brown, deciduous; hairs unequal, barbellate, cohering at the base into a ring. (Fig. 3).

INDIA. Kashmir, Baltal, Sonamarg (Sind valley), 3000 m, rocky slopes, 2 Sept. 1982, *G.H. Dar* 3899 (holotype, KASH; isotypes KASH, K & E); Pranshur, Sonamarg (Sind valley), 3500 m, rocky slopes above the meadowland, 27 Aug. 1983, *G.H. Dar* 8325 (paratypes KASH, K & E).

The genus *Dolomiaea* was first recognised by A.P. de Candolle (in Guill., Arch. Bot. 2: 330. 1833) on the basis of the Himalayan *D. macrocephala* (Wallich) DC., but was not considered as different from *Jurinea* Cass. by Bentham and Hooker f. (Gen. Pl. 2:474.1873), a treatment since then followed by most botanists. However, *Dolomiaea* is now regarded as distinct from *Jurinea* (see Ling in *Acta Phytotax. Sin.* 10:85-90.1965). In fact the former shows close affinity with *Saussurea* DC. rather than with *Jurinea*. *Dolomiaea baltalensis* resembles *D. macrocephala* (Wallich) DC. in habit but differs in having ovate to elliptic-ovate, entire or very shallowly and irregularly lobed, densely woolly leaves, longer peduncles and darker capitula.

Lepidium virginicum L., sp. Pl. 645. 1753. Type described from Virginia, Jamaica. var. **kashmiricum** var. nov.

Differs from the type variety by its glabrous stems and leaves, fruiting pedicels with longer, spreading hairs and smaller (1.5-2 x 1-2 mm), pubescent, wingless siliculae.

Typus: INDIA: Kashmir, Chattergul (Sind valley), 1850 m, moist road sides, 3 July 1983, *G.H. Dar* 6304 (holotype KASH).

Veronica biloba L., Mant. Plant. 172.1771 var. **densa** Dar & Kachroo var. nov.

Differs from the type variety by its very small (1-1.5 cm tall), diffuse, densely tufted racemes arising from the base and by shorter pedicels (less than half the length of subtending leaves or bracts).

Typus: INDIA: Kashmir, Sonamarg (Sind valley), 2700 m meadowland, flowers blue, 5 July 1983, *G.H. Dar* 6529 (holotype KASH; isotypes KASH).

ACKNOWLEDGEMENTS

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A NEW SPECIES OF *EUAGORAS* (HETEROPTERA :REDUVIIDAE : HARPACTORINAE) FROM WESTERN GHATS, INDIA [1]

DAVID LIVINGSTONE AND G. RAVICHANDRAN[2]

(*With a text-figure*)

A new species of the genus *Euagoras* Burm., *E. erythrocephala* sp. nov. from the Western Ghats has been described and illustrated.

INTRODUCTION

The genus *Euagoras* Burm. is endemic to the tropical rain forest and is characterised by the presence of very long, slender, often curved spines at the lateral angles of the posterior lobe of pronotum and also by having a short tubercle at the base of each antenna. Distant (1904) recorded only two species from the Orient, one from East Garo Hills, Assam, and another from Kandy, Sri Lanka. The present paper describes one more species from the Oriental region.

Euagoras erythrocephala sp. nov.

FEMALE: Length 15 mm, width across the abdomen 4 mm; elongate, slender; fusco-ferrugineous; eyes, the median dorsal area of the posterior lobe of pronotum, tibiae and longitudinal fascia on the under surface of the abdomen piceous; head elongate, cylindrical, ante-ocular area a little shorter than postocular area; ocelli reddish brown, set wide apart, ocellar prominence moderately elevated; antennae far removed from the eyes; head declivent in front of the antennal base; scape a little longer than the head and thorax combined; pedicel almost one third as long as scape; first segment of the rostrum not exceeding the eyes, second segment longest, a little longer than postocular area, third segment minute, luteous; head with a few white hairs dorsally; anterior lobe of the pronotum almost half as long as the posterior lobe, with a robust inwardly curved spine at its anterolateral angles; the median longitudinal fissure widening beyond the middle and shallowing out at the posterior lobe; epimeron of the thoracic segments fuscous; posterior lobe of pronotum bicolourous, medially piceous, laterally fusco-ferrugineous; lateral spines elongate, piceous, slightly curved anteriorly; scutellum rufescent, triangular, unarmed; median dorsal foveation shallow and continues as a median dorsal longitudinal carination; clavus and membrane piceous; corium fusco-ferrugineous; coxae rufescent; abdomen with a median carination stramineous, laterally with a submarginal black fascia; connexivum rufescent; hind tibiae much longer than the femora; fore and mid tibiae slender, sub-equal.

This species resembles *Euagoras plagiatus* Burm. in the pattern of pronotal coloration, pronotal spines, hemelytra, and submarginal ventral fas-

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cia of the abdomen. But it differs from it by its larger size, rufescent femora, coxae, head and anterior lobe of the pronotum, vary prominent spines of the anterolateral angles of the pronotum and by the bicolourous nature of the thoracic sternites.

TYPE INFORMATION: *Holotype:* Monotypic, female; serial No. 88; pinned specimen deposited for the present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, South India.

Etymology: The name *erythrocephala* refers to the sanguineous head and the anterior lobe of the pronotum.

Collection information:

Specimen collected from Tropical Rain Forest, near five falls, Courtrallam, Tamil Nadu, on 10 October 1983 at 325 MSL, temperature 27°C and humidity 80%.

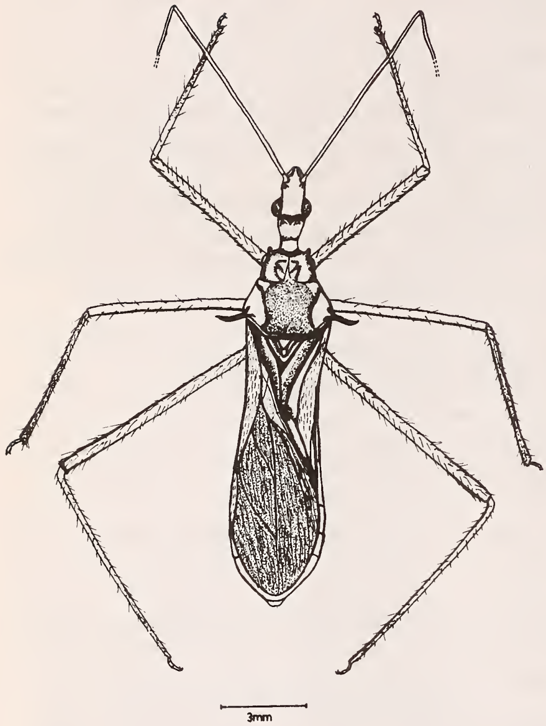

Fig. 1. *Euagoras erythrocephala* sp. nov. (Female)

ACKNOWLEDGEMENTS

We are grateful to the authorities of the Bharathiar University, Coimbatore for providing facilities and to the Department of Science and Technology, New Delhi, for financial assistance during the course of investigation. Our sincere thanks to Dr. S.K. Tandon, Zoological Survey of India, Calcutta for his assistance in comparing this specimen with the National Collection of Reduviidae.

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LECANTHUS PEDUNCULARIS (ROYLE) WEDD. VAR. *GARHWALENSIS*: A NEW VARIETY FROM GARHWAL HIMALAYA[1]

R.A. SILAS AND R.D. GAUR[2]

(*With a text-figure*)

During a recent floristic collection (1982-86), from a remote Dudhatoli Region of District Pauri-Garhwal, Uttar Pradesh, we collected some interesting specimens allied to *Lecanthus peduncularis* (Royle) Wedd. (Urticaceae). The perusal of literature and critical study of the specimens, at the Plant Systematic Laboratory GUH, Srinagar; BSD and DD Herbaria, Dehra Dun, has warranted separating them as a distinct variety, which is described and illustrated.

[1]Accepted March 1990.

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Lecanthus peduncularis (Royle) Wedd. var. garhwalensis var. nov.

Varietati *pedunculari* (Royle) Wedd. affinis, sed differet caulibus brevioribus delicatis, foliis par-

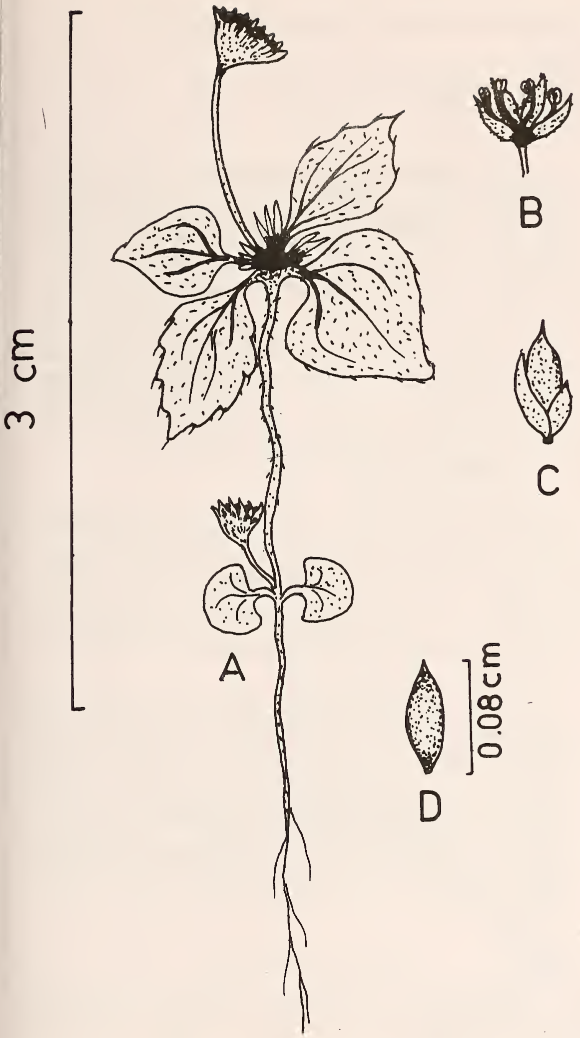

Fig.1. *Lecanthus peduncularis* (Royle) Wedd. var. *garhwalensis* var. nov. A. Habit; B. Male flower; C. Female flower; D. Achene.

vioribus, glabrescentibus, receptaculis 0.3-0.8 cm longis, floribus minutis, 0.15-0.25 cm diam., acheniis apiculatis, 0.08 cm longis, rubro-brunneis, sine caespite pilorum.

Annual dark green herbs. Stem delicate, erect, 1-3 cm long, nearly glabrescent. Leaves opposite, membranous, sub-sessile, crowded towards the tip

empty space (frame)

of the stem, elliptic-ovate, 0.3-0.6 x 0.2-0.5 cm, base cuneate or subcordate, apex acute or obtuse, margins nearly entire, sparsely ciliated, 3 to penninerved. Stipules linear, 0.1-0.2 cm long, bifid, hyaline. Flower minute, pale green, 1-2 sexual, crowded on 0.3-0.8 cm long receptacles, 0.1-0.25 cm across. Male flowers: perianth 3-4 partite, lobes equal, 0.08-0.15 cm long, ovate, apiculate, style short, glabrous, stamens 4-5, smaller than the perianth lobes. Female flowers: perianth 3-partite, lobes unequal, ovate, apiculate, style short. Achenes red-brown, up to 0.08 cm long, oblong, apiculate, smooth, exceeding the lobes, without a tuft of hairs (Fig. 1).

L. peduncularis (Royle) Wedd. var. *garhwalensis* is allied to *Lecanthus peduncularis* (Royle) Wedd., differing by its comparatively short, delicate stem and smaller leaves with glabresent surfaces; receptacles 0.3-0.8 cm long; flowers minute, 0.15-0.25 cm across; achenes apiculate, 0.08 cm long, red-brown, without a tuft of hairs.

Flowers: August-September.

Fruits: September-October.

Holotype: GUH 6868-A, *R.A. Silas*, 8 September 1985, Dudhatoli, District Pauri Garhwal, Uttar Pradesh, 3000 m.

Isotypes: GUH 6868-B,C,D, *R.A. Silas*, 8 September 1985, Dudhatoli, District Pauri Garhwal, Uttar Pradesh, 3000 m.

Distribution and Ecology: Rare annual herbs of shaded, moist localities. Found growing on moist old walls and crevices with mosses and other small herbs. Presently, this variety has been collected from temperate Garhwal Himalaya (Binsar-Dudhatoli trek) in the Dist. Pauri Garhwal, at an elevation of 3000 m.

The varietal epithet is based on the name of the Garhwal region.

ACKNOWLEDGEMENTS

We are thankful to the Herbarium authorities of BSD and DD Herbaria, Dehra Dun, for providing herbarium facilities and to Dr. N.C. Majumdar, Indian Botanic Garden, Howrah, for rendering the Latin diagnosis.

A NEW *EURYA* THUNB. (THEACEAE) FROM ARUNACHAL PRADESH[1]

G.S. Giri, G.D. Pal[2] and T.K. Pal[3]

(With a text-figure)

Eurya arunachalensis sp. nov.

Eurya nitidae Korth. affinis, sed differt ramulis hirsutis, foliis supra cum venis depressis, disco florali piloso, staminibus 5 et ovario cum stylis duobus.

Typus: India: Arunachal Pradesh, Subansiri F.D., Saling vicinity about 32 km S.E. of Hapoli, 18 April 1965, *A.R.K. Sastry* 42065 (Holotypus: CAL).

Shrubs, 3-4 m high; young stems and branches striate, hirsute with ferrugineous hairs, become glabrescent at maturity. Leaves alternate, elliptic or oblong-lanceolate, 2.5-4.5 x 1.0-2.0 cm; apex acute or shortly acuminate; base acute; margin serrate towards the apex, lower half subentire to entire, slightly revolute at maturity; coriaceous, both surfaces glabrous, shiny, become dull green to yellowish brown on drying; veins 7-10 on either side of midvein, arcuate, midvein and lateral veins prominently depressed above, raised underneath, midvein with a few simple ferrugineous hairs towards the base; petioles strong, canaliculate, 1-2 mm long with a few simple ferrugineous hairs.

Flowers axillary, solitary or two together, sometimes from the axils of fallen leaves, dioecious, fragrant; pedicels 1.0-1.5 mm long, glabrous; bracts broadly triangular or suborbicular with obtuse to rounded apex, 1.0-1.5 x 1.0 mm, glabrous; bracteoles 2, adpressed at the base of sepals, broadly triangular to ovate-acute, 1.0-1.5 x 1.0 mm, glabrous, persistent. Floral disc pilose. Sepals 5, free, oblong-orbicular, 2.0 x 1.5 mm, apex obtuse, rounded or rarely mucronate, fleshy, deeply concave, margin membranous, finely ciliate or fringed, glabrous without, golden-brown adpressed hairy within. Corolla 5- lobed, connate below the middle, fleshy, glabrous, white; tube *c.* 0.75 mm long; lobes broadly ovate, 2.0-3.0 x 1.75- 2.0 mm, apex obtuse, margin entire. Stamens 5, free; filaments ribbon-like, 1.5-1.75 mm long, glabrous; anthers oblong, 0.75-1.0 mm long, dorsifixed, longitudinally dehiscent. Ovary subglobose, *c.* 1 mm long, bilobed, bilocular; styles 2, connate below the middle, upper free part slightly reflexed, glabrous; stigma simple.

Flowers: March-May.

Fruits: not seen.

Specimens examined: INDIA: Arunachal Pradesh, Saling vicinity about 32 km S.E. of Hapoli, Subansiri F.D., 18 April 1965, *A.R.K. Sastry* 42065 (Holotype, CAL); Pariea, Kameng F.D. 9150 ft. (2781 m), 2 April 1957, *G. Panigrahi* 6375 (CAL, 3 specimens).

Eurya arunachalensis sp. nov. is allied to *Eurya nitida* Korth. but differs in having hirsute branchlets, leaves with depressed veins above, floral disc hairy, stamens 5 and ovary with 2 styles; whereas the latter species has branchlets glabrous, veins on the upper surface of leaves not depressed, floral disc glabrous, stamens 15 and ovary with 3 styles.

Acknowledgements

We thank the Director, Botanical Survey of India, Calcutta and Scientist–in–charge, Arunachal Field Station, Itanagar, for all facilities. Thanks are also due to Dr. N.C. Majumder, Scientist SD, Botanical Survey of India, Calcutta, for the Latin diagnosis of the new taxon.

[1]Accepted March 1990.

[2]Botanical Surveys of India, Arunachal Field Station, Itanagar 791 111.

[3]Botanical Survey of India, Calcutta 700 001.

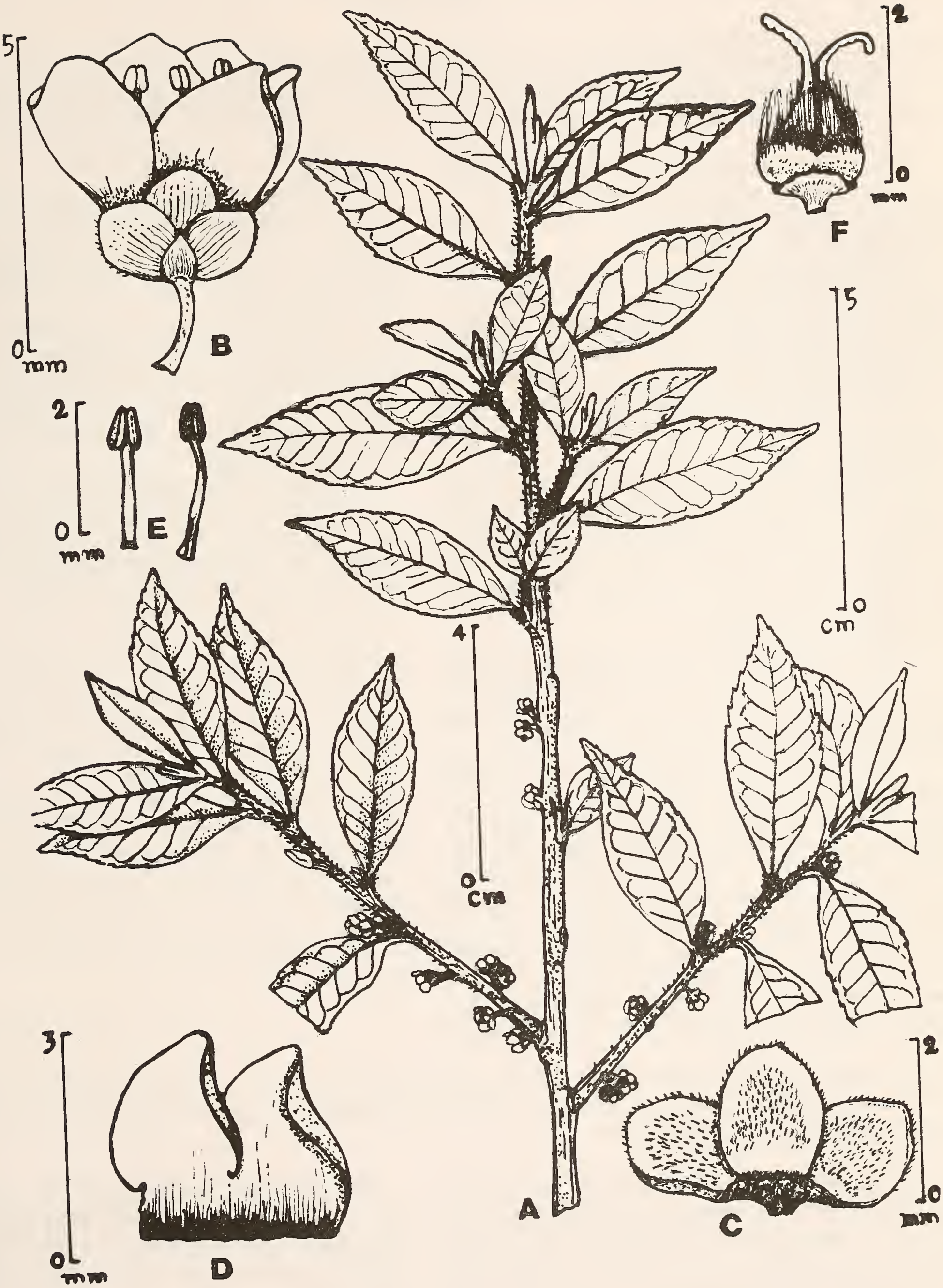

Fig. 1. *Eurya arunachalensis* sp. nov.
A. Habit; B. Flower; C; Sepals; D. Petals; E. Stamens; F. Gynoecium.

REVIEWS

PLANTS OF DHOFAR (THE SOUTHERN REGION OF OMAN) by Anthony G. Miller and Miranda Morris, illustrated by Susanna Stuart-Smith. pp. xv + 150 (23 x 16 cm). Published by the office of the Adviser for Conservation of the Environment, Divan of Royal Court, Sultanate of Oman, 1988. Price not indicated.

This book gives traditional economic and medicinal uses of plants of a special phytogeographical region. The area is part of the Sultanate of Oman, most of which consists of sparsely vegetated steppe.

The preface has been written by Dr Richard Evans Schultes, Emerites Jeffrey, Professor of Biology and Director of the Botanical Museum of Harvard University. According to him, 'The historical connection between Oman and Eastern Africa on the one hand and India on the other has resulted in an interchange of knowledge of plant usage and possibly in the introduction from these areas of various plants'.

The authors do not give a definite figure for the number of species represented in this book, but physical verification shows that 144 plates in the book illustrate 180 species of flowering plants. This, together with distinguishing characters between allied species found in the region (as detailed in the text), may put the total figure somewhere around 200 species.

The book mentions common Indian species found in the area as follows: *Paracaryum coelestinum*, *Lobelia heyneana*, *Ipomoea turbinata*, *Canscora concanensis*, *Stictocardia macalusi* and *Gossypium stocksii*.

However, the following plants could also be added to the list: *Justicia diffusa* Willd., *Remusatia vivipara* Schott., *Calotropis procera* (Ait.) Ait., *Impatiens balsamina* L., *Suaeda fruticosa* Forsk. ex Gmel., *Ipomoea pes-caprae* (L.) R. Br., *I. nil* L., Roth., *Citrilus colocynthis* (L.) Schradr., *Cucumis sativus* L. *Schoenoplectus littoralis* (Schrader) Palla, *Acalypha indica* L. *Fluggea virosa* (Roxb. ex Willd.) Wight, *Plectranthus barbatus* Anders, *Delonix elata* (L.) Gamble, *Salvadora persica* L., *Psoralea corylifolia* L., *Chlorophytum laxum* R. Br., *Plumbago zeylanica* L., *Solanum nigrum* L. and *Portulaca oleracea* L.

In addition, the following plants are also found in India as cultivated species: *Abelmoschus esculentus* (L.) Moench., *A. manihot* (Linn.) Medic., *Lawsonia inermis* L., *Ricinus communis* L., *Cissus quadrangularis* L., *Tamarindus indica* L.

Although there has been every effort to collect information, as is evident from the enormous amount of data presented, the authors say modestly that "This book lays no claim to being a comprehensive study of all the plants in Dhofar which were of traditional economic and medicinal importance."

Families are arranged in alphabetical order irrespective of whether they are monocotyledons or dicotyledons; and within the families, genera and species are described at random without any particular order. The book gives information under the following headings: 1. Botanical names with complete references, 2. Local names wherever available, 3. Complete description, 4. Ecological notes, 5. Phytogeography of the species and related taxa and 6. Colour illustration of the species, on the facing page. Both description and ethnobotanical data are meticulously collected and presented. The colour plates by Susan Stuart-Smith are really praiseworthy.

From the point of view of Indian floristic studies, critical study of the following taxa may be of some significance: *Bentia fruticosa* Rolfe, *Blepharia linearifolia* Pers., *Pentatropis nivalis* (J.F. Gmel.) Gield and Wood, *Cordia perottettii* Wt., *Commicarpus boissieri* (Heimerl.) Cufod.

This book should serve as a model for ethnobotanical field studies.

M.R. ALMEIDA

FURTHER ILLUSTRATIONS ON THE FLORA OF THE TAMIL NADU CARNATIC, Vol. 4 by K.M. Mathew. pp. xxxvi + 916 (24 x 16 cm.). The Rapinat Herbarium, St. Joseph's College, Tiruchirapalli 620 002, 1988. Price: Rs. 180; US $ 60.

This is the fourth volume of the series entitled 'The Flora of the Tamil Nadu Carnatic' by the author. The first volume gives miscellaneous information about the flora including the inventory of old as well as freshly made botanical collections. The second gives the representative genera of the flora of Tamil Nadu Carnatic, and the third (initially in two parts and later divided into three) gives a taxonomic account of the flora.

The fourth volume consists of 834 plates covering 820 species and 74 genera of flowering plants not included in the second volume represent cultivated and exotic garden plants. As in the previous volume, sketches in this volume also are contributed by various artists, and have been very carefully and methodically prepared. However, most of the plates are not complete in a sense that all the parts of the plants are not shown in the diagrams. Most of the figures lack in representation of fruit in the plate. Plate no. 324 is lacking in basal rossete of leaves.

There are almost no typographical errors.

Randia spinosa (Thunb.) Bl., *R. dumetorum* (Retz.) Poir and *Randia brandisii* Gamble are treated in recent taxonomic work as synonymous. In the present work the latter two are illustrated as different distinct species with the help of line drawings of morphological features.

This volume has three appendices, of which the first (6 pages) gives of additions, corrections and emendations to names of taxa published in earlier volumes.

Nomenclature has been the weak point of the Flora of Tamil Nadu Carnatic from the beginning. The author follows the nomenclature after earlier authors and more particularly overseas authors. In earlier reviews of this series I have already pointed out that the total leaning on opinions of foreign authors has resulted in a number of nomenclatural errors in the work.

Nomenclature of the following species names may require a fresh look: *Portulaca gradiflora* Hook. (Plate 23), *Dopatrium lobelioides* Benth. (Plate 418), *Paspalum compactum* Roth. (Plate 811).

One of the plate remains unidentified (Plate 428) identity of following plates must be rechecked: *Glycosmis pentaphylla* (Retz.) DC. (Plate 78), *Crotalaria retusa* L. (Plate 142), *Crotalaria nana* Burm. f. (Plate 135), *Tephrosia pulcherrima* (Baker) Gamble (Plate 203), *Memecylon umbellatum* Burm. f. (Plate 267), *Asystasia crispata* Benth. (Plate 439), *Asystasia dalzelliana* Sant. (Plate 440), *Premna serratifolia* L. (Plate 475), *Brachiaria distachya* (L.) Stapf (Plate 724), *Sacciolepis curvata* (L.) Chase (Plate 817).

Repetition of epithet of typical sub-species, variety and forma is simply waste of space. Use of such repetitions is only relevant when both typical intraspecific taxa as well as allied taxa of the same rank are simultaneously exisiting in the area and repeated epithets are used to distinguish between them. Repetitions of epithets in the following cases are unnecessary: *Rhynchosia viscosa* (Roth.) DC. ssp. *viscosa* var. *viscosa*, *Dimocarpus longan* Lour. ssp. *longan* var. *longan*, *Teramnus labialis* (L.f.) Spreng ssp. *labialis* var. *labialis*

No doubt it is a valuable addition to Indian floristic contributions and the price being suitable to all pockets, it is recommended to all research institutes and college libraries as well as for personal collections.

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. ON THE LONGEVITY OF TWO SPECIES OF INDIAN WILD CATS IN CAPTIVITY

Not much information is available on the longevity of different species of Indian cats. In this note we record some data on the longevity of the golden cat *Felis temmincki* and leopard *Panthera pardus* observed at the Nandankanan Biological Park, Orissa.

Golden cat: One female golden cat born in the park on 2 March 1972 died on 13 January 1987 at the age of 14 years, 10 months and 11 days. It was housed along with its parents in an enclosure with a cemented floor space of approximately 16.5 sq. m and height 2.80 m. 750 g of goat meat and 250 g of beef with bones were fed six days a week with only 375 g of goat meat once a week. It was also given one live chicken instead of beef and goat meat once a month.

None of this species survived at the New York Zoological Park for more than 2 years but one, however, lived for 17 years, 8 months and 25 days at St. Louis Zoological Park (Crandall 1965). A golden cat has lived for a maximum period of 5 years at Alipore Zoological Garden, Calcutta (Sanyal 1892). Acharjyo and Mishra (1981) have recorded the death of a male at an estimated age of 15 years.

Leopard: A 15 day old female leopard received in the Park on 20 June 1964 died on 1 July 1987 after remaining for 23 years and 11 days in captivity. During her lifetime she gave birth to 19 cubs in 10 litters.

Another approximately one month old female leopard was received in the park on 14 August 1966. She died on 14 April 1986 after 19 years and 8 months. She also gave birth to 19 cubs in 10 litters during her lifetime.

The leopards of the Park are housed in spacious covered enclosures with suitable vegetation and sandy floors. Each enclosure has a set of cells with cemented floor for protection from extreme weather conditions and for feeding. On an average each animal is fed about 3 kg of fresh raw beef with bones six days a week. They are kept in pairs or in small groups.

A leopard has lived for a maximum period of 14 years at the Alipore Zoological Garden, Calcutta (Sanyal 1892). The best longevity for this species recorded at the New York Zoological Park was 17 years, 1 month and 18 days but another specimen had exceeded that span by October 1963 (Crandall 1965).

L.N. ACHARJYO
S.K. PATNAIK

August 30, 1989

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2. RELATIVE TOXICITY OF THREE ACUTE RODENTICIDES AGAINST *RATTUS RATTUS RUFESCENS*

Numerous chemical control methods have been adopted world-wide as the most practical way to solve rat problems. Single dose acute rodenticides like red squill, barium carbonate, zinc phosphide and arsenous trioxide, thallium sulphate, alpha naphthylthiourea (ANTU) etc. are the oldest toxicants, out of which zinc phosphide is the only one still being used extensively (but with limited success).

The present study was conducted to evaluate the comparative efficacy of three acute rodenticides, Silmurin, *Abrus precatorius* and zinc phosphide against *Rattus rattus*.

No-choice feeding tests were conducted on the *R. rattus* caught from the local area. Trials were conducted on acclimatized healthy adult animals. The animals were sexed, weighed and after 24 hours of starvation were exposed to poison bait. All the three rodenticides were exposed in two concentrations and for each concentration 10 animals were used. The poison bait was prepared by mixing the desired amount of rodenticide with wheat flour, 1% groundnut oil and 1% molasses. Fresh bait and water was supplied *ad libitum*. The amount of consumed bait was recorded daily up to three days. After three days of poison baiting the rats were maintained on normal feed until death.

Results reveal that the consumption of zinc phosphide bait decreases after the first day of feeding. This indicates poison aversion of rats towards this rodenticide. In

TABLE 1
RELATIVE TOXICITY OF THE THREE ACUTE RODENTICIDES IN LABORATORY AGAINST *R. rattus rufescens*

Rodenticides	Concentration of poison bait (%)	Mean body wt. (g)	Mean consumption of poison bait (g/kg) 1 day	2 days	3 days	Total active ingredient intake (g/kg)	Time to death	Mortality
Silmurin	0.1	112.42	64.75	58.17	57.10	0.18	18-24 hrs	10/10
	0.2	110.28	60.02	60.57	56.40	0.357	10-14 hrs	10/10
Abrus precatorius	7.5	110.68	56.37	50.41	49.51	11.72	3-4 days	10/10
	10	108.76	55.35	40.27	40.27	13.58	2-3 days	10/10
Zinc phosphide	1.0	100.22	42.50	32.12	28.73	1.03	3-7 days	10/10
	2.0	104.42	37.15	23.55	19.34	1.59	3-5 days	10/10

the case of *Abrus precatorius* and Silmurin the acceptance of poison bait was fairly good and consumption of poison bait continued for all three days. Comparative efficacy revealed that Silmurin resulted in 100% mortality in less time as compared to *Abrus precatorius* and zinc phosphide (Table 1).

High efficacy of Silmurin against *R. rattus* L. (Pahwa and Doharey 1980, Rai *et al.* 1982), *Bandicota bengalensis* and *Tatera indica* (Srivastava *et al.* 1980) has already been reported. *Abrus precatorius* followed Silmurin in efficacy during no-choice feeding test with respect to acceptancy of bait and lethal dose required to get 100% mortality. The efficacy of powdered seeds of *A. precatorius* against the black rat has been reported by Doharey *et al.* (1980).

The present study indicates the sign of poison shyness with zinc phosphide, which is in accordance with the findings of Barnett *et al.* (1975) and Htun and Brooks (1979) against *B. bengalensis.*

Analysis of the study reveals that the three acute rodenticides differ significantly from each other with respect to time taken for causing death at various concentrations.

From the above reports and present findings it may be concluded that Silmurin can be effectively used to control rat populations.

August 17, 1989 Y. SAXENA

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3. REACTION OF A GROUP OF GAUR *BOS GAURUS* TO THE PRESENCE OF AN UNIDENTIFIED PREDATOR IN BANDHAVGARH NATIONAL PARK, MADHYA PRADESH

On 1 February 1989, while driving through the Bandhavgarh National Park, Madhya Pradesh, early in the morning, I came across a herd of gaur *Bos gaurus* feeding on either side of the road. 11 individuals were present of which I identified 9 : 1 adult bull, 4 adult cows, 2 juveniles and 2 very young calves. The jungle here is fairly dense mixed forest with patches of undergrowth, interspersed with extensive clumps of bamboo *Dendrocalamus strictus.*

About 40 m away, clearly visible, was one of the adult females who was the mother of one, or both, of the calves. She seemed to be the sentinel of the herd because, while the others were feeding in a relaxed manner, she was staring alertly into the forest with ears pricked up. Occasionally she would lift her head to scent the wind. Once she lifted her muzzle and I could see that her lips were pursed, forming an 'O' with her mouth with only the tip of her tongue showing. She was straining her neck outwards and upwards but making no sound that I could hear.

20 minutes later during which time the look-out female had not relaxed her vigil, a groups of langurs *Presbytis entellus* about 50-60 m away, started making the

alarm call followed immediately by some chital *Cervus axis*. These alarm calls were from the same area that the sentinel female had been looking towards. One of the langurs that I could see was looking directly below its own perch while calling.

On hearing the alarm calls, all the gaur stopped moving and feeding and looked intently towards the source of the calls. The sentinel then began snorting and blowing spray through her nostrils and emitting short, hoarse, loud bellows which were echoed by some of the other gaur. The "pff-hong" alarm call described by Brander (1923) was not heard. As the sentinel's agitation increased she started making short rushes in the direction of the predator, began to paw the ground and leap violently around, kicking her legs high into the air. Because of the poor visibility, I could not make out whether the gaur deeper in the forest were also indulging in these gyrations, but they were certainly extremely noisy. This went on for about 10 minutes. Meanwhile another cow, possibly the mother of the second young calf, was far more restrained, only emitting a few snorts. She remained close to the two young calves who appeared a little nervous but not frightened.

Suddenly the sentinel charged towards the unseen predator, upon which two of the other females also charged. I quickly lost sight of them because of the thick growth but could hear them about 100 m away. After a few minutes the frequency of the alarm calls tapered off indicating that the predator had moved away. Since the bull remained hidden I could not see his reaction. Unfortunately the identity of the predator remained unknown, although I had earlier seen the fresh tracks of a tigress heading in this direction. It is therefore quite likely that she was the predator in question.

There are two points of interest here: 1) The very different reactions of the 'sentinel' and the second cow — one alert, agitated and aggressive, the other more restrained, staying with the young during the crisis.

2) The extreme reaction of the gaur was probably induced by the presence of the two young calves. This perhaps was compounded by the dense nature of the forest which effectively concealed the predator. This provides an interesting contrast to the reaction of an alarmed bull gaur in Bhadra Wildlife Sanctuary, which rushed out of a teak forest into a clearing around a waterhole and then allowed a tigress to approach to within 20 m, perhaps because he could see her and gauge her unaggressive intention (Karanth 1984).

August 9, 1989 HASHIM N. TYABJI

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4. RECTO-VAGINAL PROLAPSE IN A WILD CHITAL *CERVUS AXIS*

On the evening of 19 February 1988 in Sariska Tiger Reserve, Rajasthan, a chital *Cervus axis* doe was seen resting near a wallow with some portions of intestine, including rectum hanging outside. Soon it got up and walked for a short distance and laydown near a *Capparis* bush. Meanwhile a jackal went to the place where the doe was previously resting, sniffed, took up the trail, tracked and started chasing the doe. After 200 m of chase the doe was cornered and killed by the jackal. However, the jackal had to soon abandon the kill because of the disturbance caused by tourists in a vehicle.

Based on the presence of milk in the engorged udder and the tucked up abdomen, I concluded that the animal had given birth recently. As happens in domestic ungulates, the retention of placenta or weakening of peritonial muscle or dystokia might lead to either prolapse of vaginal mass alone or vaginal and rectal mass together (vaginal prolapse or recto-vaginal prolapse). This has been reported in wild ungulates in captivity (Fowler 1978). Animals in the wild with this post-partum condition may have little chance of survival and they fall easy prey to predators, as it happened in this case.

November 26, 1988 K. SANKAR

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5. GREAT CRESTED GREBE *PODICEPS CRISTATUS CRISTATUS* NEAR BHILWARA, RAJASTHAN

I reached Rampura Agucha Mines near Bhilwara, Rajasthan on 23 December 1982 to conduct a faunal survey. The following day, while scanning the shallow lake at Agucha village for aquatic birds I sighted two pairs of birds on the opposite shore of the lake. The birds were very active and occasionally diving like cormorants. Since the distance was too great to identify them even with field glasses of 10 x 50, I reduced the distance till I was able to see the details of the birds. They had long necks and pointed bills and two black eartufts pointing backwards. Due to elongated black feathers below the head the throat appeared puffed up. The upper parts were dark brown. HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (compact edition) by Salim Ali and S. Dillon Ripley. The characteristics of the birds were similar to great crested grebe. Strangely enough the lake has almost no reeds or other aquatic vegetation.

According to the HANDBOOK, apart from Bharatpur this is the first sighting of these birds in Rajasthan.

January 15, 1988 RAZA TEHSIN

6. BLACK BITTERN *IXOBRYCHUS FLAVICOLLIS* (LATHAM), AN ADDITION TO THE AVIFAUNA OF MAHARASHTRA

On 23 February 1987 we were birdwatching at the water's edge of Vihar Lake in the Sanjay Gandhi National Park, Borivli, Bombay, when, around 0800 hrs, our attention was drawn to a dark-coloured bird which flew out of the reedbed, disturbed by an approaching fisherman. It flew towards us, appeared as if to land, then circled thrice low overhead at eye level and dropped into another reedpatch. As there was perfect visibility we had a good look at the bird in flight and identified it as a black bittern *Ixobrychus flavicollis*.

This bittern has an unmistakable plumage distinguishing it from other bitterns. It is about the size of a pond heron *Ardeola grayii*, black above with a white cheek patch and prominent chestnut and black markings on the underparts. The bird was an adult male. This species is crepuscular in nature and had it not been for the fisherman we would have certainly missed it. Despite our regular weekend visits to Vihar lake we have not seen this species before in this area. We later confirmed its identity by checking specimens in the BNHS collection.

The black bittern is not recorded from Maharashtra (Abdulali 1981). Its distribution is given as 'Resident, shifting locally with water condition. Thinly and patchily distributed throughout the better watered parts of the subcontinent' (Ali and Ripley 1978). It is generally found in reedy inland swamps, and lakes bordered by forests.

It is quite possible that the prevailing drought conditions in many areas of the peninsula this season have caused this species to shift residence locally to areas where water is more abundant. It is also possible that this species may have been missed in the state due to its crepuscular and secretive nature and to a paucity of people looking out for birds in general.

NITIN JAMDAR
April 12, 1988 KIRAN SRIVASTAVA

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7. OCCURRENCE OF SPOONBILL *PLATALEA LEUCORODIA* LINN. IN KERALA

To our knowledge, the spoonbill does not appear to have been recorded in Kerala at any time and is not mentioned in Salim Ali's BIRDS OF KERALA (1969). The Vernay Survey report (*JBNHS 39:* 450) says the spoonbill appears to have been recorded only from the eastern side of Madras presidency.

On 25 January 1988 we were at Manakkody Kole lands 10 km southwest of Trichur town. Here paddy is cultivated in the marshy fields (Kole fields) after pumping out the monsoon water which submerges the fields for nearly half of the year. This vast marshland is a haven for birds like egrets, waders, gulls, terns, teals and many other species.

While watching the egrets through binoculars we noticed that some of the birds exhibited a peculiar feeding behaviour—sweeping semi-circular movements from side to side, with bill immersed in the mud. This struck us and there was no difficulty in identifying them as spoonbills when the birds came into closer view. We went to the spot again on 1st and 2nd of February and were lucky enough to see 3 and 5 spoonbills respectively. One of us, (A.P.J.) photographed these birds using a 300 mm telephoto lens. On our first visit (25 February 1988) we observed the birds (7) from1700 to 1800 hrs and all of them were feeding actively. On our subsequent visits (1st and 2nd of February) we observed the birds from 1600 to 1800 hrs but the birds were resting and preening and not feeding. The birds were quite at home among little and large egrets which were present in hundreds.

March 15, 1988 A.P. JAIRAJ
V.K. SANJEEV KUMAR

8. BRAHMINY DUCK *TADORNA FERRUGINEA* (PALLAS) BREEDING IN SIKKIM

On 12 August 1987 while returning from Kupup (*c.* 3700 m) in East Sikkim, I kept a sharp look-out for the 'golden ducks' which people in the army said were 'always' around the few high altitude lakes there. Besides, on our earlier visit on 7 May 1987 they took us to a lake at Kupup called Batang Chu where at 1005 hrs I could clearly hear the ducks calling nearby, but could not sight them due to a thick fog which reduced visibility to a few feet. (Recently, during the Asian Waterfowl Census conducted here on 11 January 1988 two adult brahminy ducks *Tadorna ferruginea* were finally sighted at a 60% frozen Batang Chu.)

This day, the fog cleared up by afternoon and sure enough at 1555 hrs on the bank of Sherathang lake (3650 m) which was just below the road we saw a group of seven brahminy ducks clearly visible due to the stunted vegetation. A closer look confirmed that there were two adult birds and five large chicks a shade darker than the adults. They were quite tame and not at all disturbed by our presence 100 m above them. We watched them moving around placidly and aimlessly, not feeding, for a few minutes and then moved on.

Earlier on 19 May 1982, a pair of 1 year old chicks were handed over to the Forest Department by a police constable, Bir Bahadur Rai. He had collected them as chicks and hand-reared them for a year at Muguthang (*c.* 5000 m), west of Thangu, in north Sikkim. These chicks were released into the aviary at the Deer Park in Gangtok and have over five years grown into healthy, vociferous adults.

Members of the Botanical Survey of India, Sikkim Circle, after a tour of north Sikkim in August 1987 reported sighting about a dozen free brahminy ducks and two birds caged by the army personnel stationed at Chho Lhamo (*c.* 5300 m) where there are warm water lakes.

Salim Ali, in his BIRDS OF SIKKIM (1962) lists the brahminy duck in the Appendix amongst "Birds recorded as occurring, or having occurred, in 'Sikkim' including the terai, foothills, mountains and the Tibetan plateau facies, of which either the status is indeterminate or no recent or sufficient data are available."

Hence these records from Batang Chu (3700 m) Sherathang (3650 m), Muguthang (*c.* 5000 m) and Chho Lhamo (*c.* 5300 m) provide sufficient evidence to include the brahminy duck in the bird list of Sikkim.

March 24, 1988 USHA GANGULI-LACHUNGPA

9. SPOTBILL DUCK *ANAS POECILORHYNCHA* J.R. FORSTER IN KERALA

In the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Compact Edition, 1983), Salim Ali and Dillon Ripley say that the spotbill duck *Anas poecilorhyncha* is found only up to Mysore in the south. Also it is not mentioned in Salim Ali's BIRDS OF KERALA (1969).

On 11 March 1983, I saw four spotbill ducks in the Mangalam reservoir in Palghat district of Kerala. Due to the failure of both the monsoons in 1982, there was an unprecedented drought in Kerala during the first half of 1983. The reservoir was almost completely dried up and there was very little water near the dam. In this water four spotbill ducks were swimming.

On 15 February 1987 I and L. Namasivayam of the Kerala Natural History Society saw three spotbill ducks in the Kadalundy estuary, 20 km south of Kozhikode. It was high tide and the birds were resting among reeds in one of the exposed reedbeds, near a group of openbill storks, also a rare sight in Kerala now. Again we two saw four spotbill ducks in the estuary of the Bharatapuzha, near Ponnani in Malappuram district. There were over 2000 garganey teals and pintail ducks in the estuary. But the spotbill ducks kept away from all other birds there. Namasivayam saw two spotbill ducks in Kadalundy on 9 September, 1985 (pers. comm.). Thus, the spotbill duck has begun to appear in north Kerala regularly, even though in small numbers.

Its occurrence in Kadalundy and Ponnani is interesting in another respect also. Hugh Whistler says: "Fresh water is essential to them (spotbill ducks), even brackish water like the Sunderbunds not being to their taste." (POPULAR HANDBOOK OF INDIAN BIRDS. Natraj Publishers, 1986). But in Kadalundy and Ponnani the birds are seen in brackish water.

A flock of spotbill ducks is not a rare sight in Tirunelvelli district in the southern part of Tamil Nadu. I have seen them several times in the irrigation tanks in Nanguneri Taluk and flocks of 25-50 birds flying to farther south. It is clear that the distribution of the spotbill duck extends far south of Mysore.

April 12, 1988 P.K. UTHAMAN

10. RED KITE *MILVUS MILVUS* IN LADAKH

On 20 July 1987 a raptor flying over Leh (Ladakh) attracted our attention. We identified it as a red kite *Milvus milvus*, a species which we are familiar with, it being common in France. The main field marks seen were the overall reddish coloration, the forked, red tail, the large white patches on the underwing and the light coloured head. A few black kites *M. migrans* flying around provided additional references for comparison. On 21 July, 2 red kites were seen again, flying low over the town. One of them could be identified as an adult, and one was carrying some prey. On returning to Leh on 2 August, none of them could be seen again.

Ali and Ripley (1983) mention 4 previous observations in the Indian subcontinent, in Kutch, Gujarat and Orissa; a fifth one was made recently in Bharatpur (V. Prakash, pers. comm.). Ours seems to be the first record of the red kite occurring in India within its known breeding season in Europe; the record of 2 birds (a pair?) is noteworthy, though breeding was not even suspected.

M. FILY
May 21, 1988 C. PERENNOU

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11. OSPREY *PANDION HALIAETUS* IN SIKKIM

In the second week of November 1986, an adult osprey *Pandion haliaetus* was trapped by the trout keeper of the Fisheries Department with the help of a glue-trap called 'lisso', while catching trout from the trout farm at Yoksum in west Sikkim (alt. 1515 m). The bird which was skinned and displayed in their office, was noticed by the local wildlife warden who brought it to me for identification. It is now in the museum of the Forest Department at Gangtok.

Salim Ali, in his BIRDS OF SIKKIM (1962) mentions the osprey as one of the "Birds recorded as occurring, or having occurred, in 'Sikkim' including the terai, foothills, mountains and the Tibetan Plateau facies of which either the status is indeterminate or no recent or sufficient data are available." HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (1983) by Ali and Ripley mentions that it "breeds in small numbers ... along the Himalayas between 2000 m to 3300 m altitude (Ladakh, Kashmir, Garhwal, Kumaon) and in Assam (Cachar). Observed throughout the year in Nepal valley. Mainly winter visitor, September through March, throughout the subcontinent." The book also mentions that it is locally called 'pantiong' by the Lepchas.

The osprey is placed in Schedule I of the Indian Wildlife Protection Act (1972).

March 24, 1988 USHA GANGULI-LACHUNGPA

12. SUCCESSFUL NESTING OF SHAHEEN FALCON *FALCO PEREGRINUS PEREGRINATOR* IN TAMIL NADU

The Indian peregrine, or shaheen falcon *Falco peregrinus peregrinator*, is a rare breeding bird found in scattered populations throughout the entire Indian Union (Baker 1917, Ali and Ripley 1968). Despite its widespread geographic occurrence, no information has been published on its present-day reproductive success rate. North temperate peregrine falcons *Falco peregrinus* have experienced drastic population declines resulting from the use of certain pesticides such as DDT (Peakall 1976). Such pesticides are presently used in many parts of India (Kalra and Chawla 1981). It is noteworthy, therefore, to report on a recent, successful nesting of the shaheen falcon in the Eastern Ghats of Tamil Nadu. I hope that this account will promote intensive shaheen falcon censusing to assess present population trends in this raptor (see also Naoroji 1986a, b).

On 29 and 30 May 1982, Preston and Anne Ahimaz and myself visited Gingee Fort in northeastern Tamil Nadu. The site is administered and protected by the Archaeology Survey of India. The terrain is typical for that of the southern Eastern Ghats and consists of rocky, isolated hills and low mountains surrounded by large expanses of sparsely wooded, low agricultural land (elevation less than 100 m). Climatically, the area is categorized as tropical dry deciduous (Ali and Ripley 1968).

The shaheen falcons resided on the high butte (elevation 307 m) supporting the ruins of Gingee Fort in the Muttakadu Reserved Forest. The falcons used several of the overhung, horizontal ledges on the sheer, south-facing cliff for resting and feeding. Accumulated guano ('white wash') on these ledges marked the location of several possible nest sites. The cliff varied in height from 50 to 70 m, and was approximately 180 m in length.

The falcons were observed on the evening of 29 May for a total of 2 hours and on 30 May for nearly the entire day. During this period they were active frequently. At several times clear views were had of both adult falcons and their two fully-fledged young. The young birds were already accomplished fliers, capable of following the adults about the butte and engaging in diving food-exchange manoeuvres.

One prey item being carried by an adult was identified as a roseringed parakeet *Psittacula krameri*. Falcon vocalizations heard included: begging screams of the young, mate recognition *e-chuck* calls of the adults, and defensive screaming of the adults when they chased off black kites *Milvus migrans* who strayed too close to the home cliff. The presence of human visitors passing the cliff on their way to the archaeological site did not appear to disturb the falcons. Indeed, I was able to observe one of the immature shaheens while it sat in a tree not more than 20 m away.

I judged the young falcons to be 7 weeks old, based on their advanced fledgling stage (see Cade 1960). This implies that they hatched during the first week of April, in turn suggesting that the eggs were laid in the first week of March. Ali and Ripley (1968) report laying dates of shaheen falcons in southern India from March to April. In contrast, Baker (1928) described their laying period as January to February for the same region. Heller and Heller (1984) observed nesting behaviour in shaheen falcons which indicated the presence of advanced young at a Sri Lankan eyrie site on 10 August, implying a possible egg laying date in May.

As many as six separate complexes of mountains and buttes lie within a 40 km radius of Gingee Fort. Despite heavy agricultural use, the area may be excellent habitat for shaheen falcons. Impaired peregrine falcon reproduction suggests that persistent pesticides are present in the environment (Peakall 1976). Consequently, a survey of nesting shaheen falcon populations in this area would provide valuable information, allowing one to assess potential environmental threats to their survival.

ACKNOWLEDGEMENTS

I wish to express my gratitude to Preston and Anne Ahimaz for showing me the falcons at Gingee, to the Archaeological Survey of India for permission to visit their site, and Julie Smith for her helpful comments on the manuscript. I thank Prof. Rudolf Altevogt of the Zoology Institute, Munster University (F.R.G.), for introducing me to India, and Mr. Romulus Whitaker, Madras Snake Park Trust, for his hospitality.

January 16, 1988 DOUGLAS A. BELL

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13. REAPPEARANCE OF COMMON PEAFOWL *PAVO CRISTATUS* LINN. IN PARAMBIKULAM WILDLIFE SANCTUARY, KERALA

The first Working Plan for Nemmara Forest Division (1976) mentions 'very rare' occurrence of common peafowl *Pavo cristatus* around Sungam in Parambikulam Wildlife Sanctuary (10° 25'N, 76° 43'E). The species does not appear in the bird list of the area by Vijayan (*J. Bombay nat. Hist. Soc. 75(3):* 888-900). I have also not seen the bird during the last seven years of my work in the area. A pair (a male and a female) is now commonly sighted near Sungam watch tower area. This pair must have moved from the adjacent area of Anamalai Wildlife Sanctuary of Tamil Nadu where it is normally seen in some parts. The reasons for its disappearance and reappearance after about eleven years remain obscure.

March 22, 1988 P.S. EASA

14. ON THE VOICE OF THE KORA OR WATERCOCK *GALLICREX CINEREA*

Since Salim Ali and Ripley in the HANDBOOK (1983) and Dillon Ripley (1977) in his comprehensive monograph on the Rallidae have based their description of the kora's voice on a note contributed by me to this Journal in 1958 (*JBNHS* 55: 560-61), I deem it my duty to bring that note up to date in the light of more recent observations.

Although the 1958 note was based on a single experience, subsequent observations stretching over two years (1986 and 1987) and involving more than 70 encounters with the bird at Kavassery (Palghat Dt., Kerala) have validated it. But something has to be added to the description given therein.

At Kavassery the kora *Gallicrex cinerea* is a monsoon visitor and is heard only from the middle of June to late September. As no male seen here develops red legs during this period, I suspect that all males are birds that have not started breeding. The total absence of violence when males meet seems to support this suspicion.

On 18 August 1986 I was able to get very close to a male calling in a field of tall paddy. This enabled me, for the first time, to hear a brief, low *drrr*, which the bird uttered at the beginning of each of a number of runs. This sound resembled nothing so much as that of a distant scooter starting. Once I became aware of this brief and subdued practice, I was able to hear it even when the bird was at a greater distance.

Thereafter I found that whenever a kora began a run with a set of *utumb*'s, he prefixed the low 'drumming' (as I named it), but not if the run began with either of the other notes. A single exception was noted on 5 August 1987 when a bird drummed and then uttered a series of *kok*'s. The drumming, like the *utumb* 's, was always uttered with the neck arched and the head held very low.

The *kok* 's were uttered almost at the same rate as the *utumb*'s. The sharp *kkow* 's were produced at a lower rate and were also fewer. Generally, a male would begin a run with the drumming, follow it with a variable number of *utumb* 's and, without a pause, raise its head and emit a series of *kok* 's and wind up the run with a small number of *kkow's*. Sometimes it would straightaway lower its head and, omitting the drumming, begin uttering another set of *utumb* 's, *kok* 's and *kkow* 's.

On some evenings a bird would go on calling like this with occasional brief intervals of silence for two hours or more. On 4 August 1987 between 1750 and 1815 hours I timed six runs at random with a stopwatch. The 1st and 5th runs lasted 19 seconds each; the 2nd 5 seconds; the 3rd 7 seconds; the 4th 10 seconds; and the 6th only 3 seconds (average 10.5 seconds). But on 6 August 1987 a male uttered extraordinarily long runs, one of which lasted nearly 120 seconds.

Regardless of the nature of the note emitted, the kora keeps its bill open while uttering it, snapping the bill shut at the end of each note. Generally, each *kok* is accompanied by a downward jerk of the head while the *kkow* 's were not.

During 1986-87 various birdwatchers including Suresh Elamon, Dr K.V. Sreenivasan, P.K. Uthaman and R. Venugopalan who visited Kavassery were able to listen to the calls of the kora including the drumming. P.S. Sivaprasad recorded the drumming and the other sounds using a parabolic reflector.

May I take this opportunity to point out that an error has crept into the account of the kora's call given in Ripley's book? The opening words of the sentence 'With its back in the original position ...' should read 'With the head back in the original position ...' I was able to go through Ripley's text only because of his kindness in sending me photostats of ten pages of the expensive volume. I am deeply obliged to him for his generosity.

May 10, 1988 K.K. NEELAKANTAN

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15. RECENT BREEDING RECORDS OF THE LESSER FLORICAN *SYPHEOTIDES INDICA* (MILLER) FROM ANDHRA PRADESH

(With a text-figure)

While the breeding range and biology of the lesser florican *Sypheotides indica* has been well documented (Jerdon 1864, Baker 1921, Dharmakumarsinhji 1950), the non-breeding range and movements are as yet obscure (Ali and Ripley 1969, Ali *et al.* 1985, Sankaran and Rahmani 1986). The birds appear to winter in peninsular and southern India (Jerdon 1864, Dharmakumarsinhji 1950). Jerdon (1864) also wrote that a few birds breed in all parts of southern India, from July to November, and in an instance a hen was seen incubating as late as January. In Maharashtra, it was reported to be common and bred around Solapur (Davidson and Wenden 1878, Butler 1880). However, between 1981 and 1984, while R.M. was studying the great Indian bustard *Ardeotis nigriceps* at Solapur the lesser florican was seen only on two occasions. Breeding was not recorded from that area.

The lesser florican is a monsoon breeder, utilizing the grasslands of northwestern India as the breeding habitat (Magrath *et al.* 1985). Males arrive into the grasslands with the southwest monsoons. Fluctuations are seen in the population of floricans in a given area depending on the vagaries of rains. For instance, at Sailana near Ratlam, Madhya Pradesh, (where R.S. has been studying the lesser florican since 1985) the number of floricans that entered the grasslands and settled to breed varied widely depending on the time of commencement of the rains and the amount of rainfall received (Sankaran and Rahmani 1986). By early October males stop displaying and disappear from the grasslands.

Andhra Pradesh is the only region from where the lesser florican has been sighted regularly during the post breeding periods (Ali *et al.* 1985, Sankaran and Rahmani 1986). At Rollapadu near Kurnool, Andhra Pradesh (where R.M. studied the great Indian bustard between 1985 and 1987) the lesser florican has been seen occasionally every winter. Trappers of the 'Neel shikari' community from the Kurnool, Guntakal, Bellary and Raichur areas know the florican (they call it 'Dhabhor'), and noted that it was now infrequently seen. They have seen its display and nest and claimed that the display was usually seen from Dussera onwards, i.e. October/November but none for the last 8 to 10 years.

Results

Between June 1986 and January 1989, lesser floricans were seen on 29 occasions at Rollapadu (Table 1). As locating displaying males is much easier compared to chance flushing of a non-displaying male, the three or four males seen displaying regularly in January 1988 have been taken into account as four sightings. Nesting females have not been taken into consideration. Though the data (Table 1) shows a trend of more florican sightings in the winter, the total number of sightings (29 in two and a half years) is too small to draw a conclusion.

Table 1
LESSER FLORICAN SIGHTINGS AT ROLLAPADU

	J	F	M	A	M	J	J	A	S	O	N	D
1986							1			2		
1987						1		1		5		1
1988	6	1		1				1				7
1989	2											
Total	8	1		1		1	1	2		7		8

Table 2
DISPLAYING MALE LESSER FLORICANS SEEN AT ROLLAPADU

Dates of Display	No. of males	Habitat
11 Oct. 1987	1	Grassland
19 Oct. 1987	1	-do-
29 Oct. 1987	1	-do-
30 Oct. 1987	1	-do-
30 Oct. 1987	1	-do-
End Oct.–early Nov. 1987	1	Crop field
End Oct.–early Nov. 1987	1	-do-
3rd week of Nov. 1987	1	Grassland
7 Jan. to 21 Jan. 1988	3 to 4	-do-
22 Jan. 1988	1	-do-
25 Jan. 1988	1	-do-

In the winter of 1987/1988, displaying lesser floricans were recorded for about 30 days (Table 2). Between 7 January and 21 January at least 3 to 4 males were displaying regularly in the grassland. Nest and/or chicks were located 7 times (Table 3). Breeding of the lesser florican was thus recorded from Andhra Pradesh after a gap of at least 8 to 10 years.

Neither in the winter of 1986/87 or 1988/89 was

TABLE 3
NESTING RECORDS FROM ROLLAPADU

Date of finding	Date of hatching	Habitat	Remarks
27 Dec. 1987	Abandoned	Crop field	
2 Jan. 1988	8 Jan. 1988	Grassland	
12 Jan. 1988	17 Jan. 1988	Crop field	
	19 Jan. 1988	Crop field	2-week old chicks found
26 Jan. 1988	26 Jan. 1988	Fallow land	
	6 Feb. 1988	Grassland	Hatched shells found
Early Feb. 1988			2-3 week old chick found

breeding recorded in spite of the presence of both males and females within the grassland at Rollapadu (Table 1). Only one nest was reported from Banganpalle near Kurnool in January 1989.

DISCUSSION

In 1987 northwestern India (the main florican breeding range) was under severe drought. At Sailana very few floricans came, and displaying males were seen irregularly. In Saurashtra —the main breeding area of the lesser florican —the condition was very much worse and almost no floricans were seen. This was in sharp contrast to 1986, when due to copious rainfall at least 50 territorial males were present at Sailana. In 1988 northwestern India had very high rainfall during the monsoons and the floricans were recorded as breeding from several places in Gujarat and western Madhya Pradesh.

The breeding of the lesser florican in Andhra Pradesh appears to be distinctly linked with the amount of rainfall in northwestern India. Floricans were not seen displaying/nesting at Rollapadu during years when rainfall was excellent (1988), normal (1986) or sub normal (1985) in northwestern India. They however bred in the Rollapadu area in a year when northwestern India was under severe drought and where very few floricans were successful in having territories or finding adequate nesting habitat.

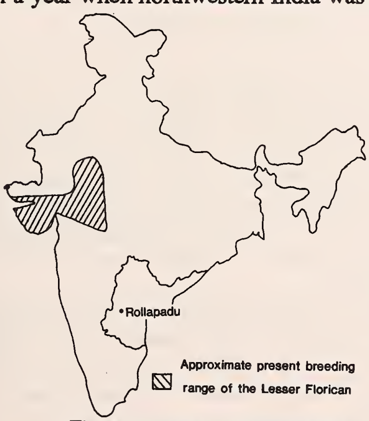

Fig. 1 Location of Rollapadu and normal breeding range of lesser florican.

The first male lesser florican to be seen displaying at Rollapadu was on 11 October. This is about 10 to 15 days after display stops at, and the birds disappear from, areas like Sailana and Dahod in northwestern India. In 1985, 1986 and 1988 displays were last seen at Sailana between 28 September and 3 October.

During years of normal rainfall male lesser floricans begin immigrating into grasslands of northwestern India by the end of June. At this time males can be seen moulting into their complete breeding plumage. While doing this males begin establishing territories and start displaying (Sankaran and Rahmani 1986). The complete breeding plumage is maintained up to the end of the season, i.e. early October when display tapers to a finish. Reversal to a non-breeding plumage was never seen while males were displaying during the regular breeding season.

In contrast, males at Rollapadu were seen displaying while moulting out of their breeding plumage. Unlike at Sailana where territorial males are seen displaying for between 75 and 100 days, at Rollapadu they were not a consistent feature at the grassland. Between mid October and end January, barring a two week period when three to four males displayed every day, display was recorded only sporadically (Table 2).

CONCLUSIONS

From the evidence available, it seems that the lesser floricans breed in suitable habitat in southern India when unfavourable conditions like droughts severely affect the regular breeding season in northwestern India. However, as the birds show a tendency to prolong the breeding season under unfavourable conditions, individual birds which have been unsuccessful in holding territories or in nesting may breed in the wintering range.

ACKNOWLEDGEMENTS

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January 5, 1988
Updated Feb. 10, 1989

RAVI SANKARAN
RANJIT MANAKADAN

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16. BLACKTAILED GODWIT *LIMOSA LIMOSA* AND LARGE INDIAN PRATINCOLE *GLAREOLA PRATINCOLA* – TWO NEW RECORDS FROM KERALA.

On 27 February 1986, I was observing birds on the extensive mud-flats at the estuary of the Baliapattam river, about 9 km north of Cannanore. Two large waders feeding at the water's edge caught my attention immediately. One of them was identified unmistakably as the oystercatcher, which is a rare winter visitor to the Kerala coast. The other bird had longer legs, long rufous-tinged neck and breast and a slightly upcurved long bill. In flight, a black band across the tip of white tail similar to that of the oystercatcher and white wingbars confirmed the identity of the bird as a blacktailed godwit *Limosa limosa*. This bird has not been reported earlier from Kerala.

While observing birds in a wetland about 10 km northeast off Cannanore on 28 April 1984, I came across a group of 8 birds flying over fallow fields, with tern-like flight on narrow pointed wings. After flying zig-zag hawking insects obviously for some time, the birds alighted in a ploughed paddy field and could be observed for more than 20 minutes as they picked food on the ground, running in short spurts and resting at intervals. The birds were identified as the large Indian pratincole *Glareola pratincola,* another new record from Kerala.

April 6, 1988

SASI KUMAR

17. MARSH SANDPIPER *TRINGA STAGNATILIS* EATING A FROG

On 31 December 1987, in Dihaila jheel in the Karera Bustard Sanctuary, Shivpuri district, Madhya Pradesh, we saw a reeve *Philomachus pugnax* with a small frog. The frog was alive and the bird was trying to kill it. Several times, it put the frog in the shallow water, then caught it again and shook it vigorously. Soon a marsh sandpiper *Tringa stagnatilis* appeared and started following the reeve, but the latter did not let go the frog. The marsh sandpiper kept following the reeve and the prospective meal.

A couple of minutes later it was joined by a second marsh sandpiper. Seeing two sandpipers, the reeve dropped the frog. The first sandpiper immediately dived for the frog and after a few seconds of struggle swallowed it head first while the reeve continued to watch.

As the frog was perhaps too big a food item for the bird, for about 40 seconds, a bulge was seen in the neck of the sandpiper and the bird appeared to be visibly uncomfortable. To facilitate swallowing the frog, the sandpiper walked slowly and drank water twice. When the frog was gulped down fully, the sandpiper stood for a few minutes and then resumed foraging. Meanwhile the second sandpiper made no attempt to grab the food from the first sandpiper.

Frog as a food item has not been reported for *Philomachus pugnax* or *Tringa stagnatilis*. According to Ali and Ripley (1969), the food of *Philomachus pugnax* is molluscs, crustaceans, insects, worms and large quantities sometimes exclusively of vegetable matter, while that of the marsh sandpiper is "small molluscs, crustaceans, insects and worms".

The reeve could not eat the frog but the way it was struggling to dismember the prey, suggests that if the frog had not been taken away by the marsh sandpiper, it would have eaten it. Though frogs may not be a regular food item for these small waders, they should be included as an occasional prey, especially for the marsh sandpiper.

ASAD R. RAHMANI
K.K. MOHAPATRA
April 9, 1988 CARL D'SILVA

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18. FOOD OF THE SPOTTED SANDPIPER *TRINGA GLAREOLA* LINN.

On one of my regular trips to Kaliveli tank near Pondicherry on 5 January 1988, I happened to observe a spotted sandpiper *Tringa glareola* Linn. The bird was hopping about and pecking at a food item which had mingled with the grass and debris. When it finally lifted it up, I found it was a frog, a subadult of *Rana* sp. The frog was larger than the bird's beak, and was struggling in vain to escape from its captor. The frog was soon overpowered, and minced in the end, whereupon the bird started gulping it down. After gulping the bird started regurgitating, and the process recurred two or three times, before the frog was finally consumed. The HANDBOOK OF BIRDS (Ali and Ripley, comp. ed. 1983) gives the diet of this bird as tiny molluscs, crustaceans, insects, worms and small fishes. But its feeding on a frog is being reported for the first time. A similar observation of a marsh sandpiper *Tringa stagnatilis* was made by Asad R. Rahmani (pers. comm.).

June 15, 1988 K. SAMPATH

19. SKUAS *STERCORARIUS* SP. ON THE WEST COAST

Skuas are among the seabirds rarely reported from the Indian west coast. My experience from Gokarn in North Kanara district indicates that these birds are not difficult to see provided a telescope is at hand.

On 6 September 1987 at 0800 hrs the first was observed from Gokarn beach as it attacked a tern. Its underparts were almost white with no breastband visible. Wings and upperparts were uniformly dark brown apart from white wing patches. It was more elegant than a pomatorhine skua *Stercorarius pomarinus*, but not as sleek as the longtailed skua *Stercorarius longicaudus*. The tail streamers were not visible on this or any of the skuas subsequently observed. The observation corresponds well with Peter Harrison's description of an Arctic skua *Stercorarius parasiticus* of the light morph variety in its breeding plumage (Harrison 1985). Another Arctic skua was seen on 22 November from a beach near Gokarn. It was probably a subadult bird. None of the other skuas observed were positively identified but, a few birds apart, all appeared to be Arctic skuas.

The total number of skuas observed was 50. Some of these may have been repeaters moving around in the area. In fact, 22 birds did not move in any specific direction.

As is the case with the gulls and terns along this coast, skuas were seen moving both northwards (12) and southwards (16).

Only one bird was seen in September during 4 hours of observation. 13 were recorded in October (11th: 3, 12th: 5, 13th: 2, 17th: 3) during 4 hours and 30 minutes of observation, i.e. about 3 skuas were seen per hour of observation.

In November 32 were recorded (5th: 6 of which one was doubtful, 15th: 22, 22nd: 4. 4 skuas were seen per hour. In December skuas went unnoticed on the 9th while I was aboard a purse-seiner, and on the 25th. Three were recorded on 12 December. In December there was less than half a skua per hour of observation.

On 17 January 1988, Ranjit Daniels, who has spent five years studying the birds in this district, and I visited the rocky shore near Gokarn for about one hour and 30 minutes. We saw one skua though the number of gulls and, even more so, terns had dropped sharply.

Skuas were not reported by Davidson from the district (*J. Bombay nat. Hist. Soc. 11:* 652-679 and *12:* 43-72). According to S.A. Hussain (pers. comm.) the last report from the west coast was by J.C. Sinclair in 1974.

February 4, 1988 STIG TOFT MADSEN

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20. INDIAN RIVER TERN *STERNA AURANTIA*, A COASTAL SPECIES OR A CASE OF MISTAKEN IDENTITY?

Lal Mohan (1986) in a note on the recovery of a ringed sandwich tern *Sterna sandvicensis* in the Pillaimadam lagoon, a coastal area of Mandapam in Tamil Nadu, makes reference to the common species of terns seen there. These include the Caspian tern *Hydroprogne caspia*, gullbilled tern *Gelochelidon nilotica*, and Indian river tern *Sterna aurantia*. The last of this list deserves some attention.

The Indian river tern as the name suggests, is a denizen of rivers, reservoirs, and other freshwater courses, and is rarely seen on the coast (Ali and Ripley 1983). A marine tern that on casual observation may be mistaken for the Indian river tern is the Indian lesser crested tern *Sterna bengalensis*. The latter species is regarded as common along both seaboards of India (Ali and Ripley, loc. cit.). Sugathan (1983) lists both species from Point Calimere, further north along the same coast in Tamil Nadu, but does not mention the habitat of his sightings. However, Lal Mohan (in press), lists the gullbilled tern, Indian lesser crested tern, large crested tern *Sterna bergii*, Caspian tern, and sandwich tern, in decreasing order of capture by nomadic tribals on the coast in Mandapam during the same period of time. The author makes no reference to the presence of the Indian river tern. Balachandran (pers. comm.), who has been trapping coastal birds for ringing in the same area, confirms that the Indian lesser crested tern is very common along that coast, and that there have been no sightings of the Indian river tern on the coast or at a freshwater lagoon about 7 km inland.

Both species are of a similar size and overall general coloration. However, the bill of the Indian river tern is smaller and is yellow in colour, while that of the other species is larger in size and is yellow to orange yellow in colour. The colour of the legs can be used to differentiate the two, red in the former and black in the latter species. The former has a black crown in summer, while in the latter the crown and nuchal crest are black.

From my experience in the Gulf of Kutch in particular, and Gujarat in general, the Indian lesser crested tern is a common species along the coast throughout the year, and is often seen foraging in tidal creeks and lagoons. The Indian river tern on the other hand, is ubiquitous on fresh water and even nests at some reservoirs during early summer. On no occasion have I seen these species in each other's normal habitat. I have personally known birdwatchers to confuse these two species in marine waters in Gujarat.

In the light of the above, it would be of interest that the Indian river tern, if the identification is valid, is in fact a common species along the coast in the Mandapam area of Tamil Nadu.

March 5, 1988 TAEJ MUNDKUR

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21. ON THE STATUS OF THE SANDWICH TERN *STERNA SANDVICENSIS* ON INDIA'S WEST COAST

(With a text-figure)

Considerable uncertainty seems to shroud the status of the sandwich tern *Sterna sandvicensis* in India. Alexander (1929) includes both the Arabian Sea and the Bay of Bengal in the wintering range of this maritime tern, while Ripley (1982) restricts its occurrence in the Indian subcontinent to the coast of Pakistan and Gujarat. In the light of recent records from the southern peninsula (Ambedkar 1985 and Lal Mohan 1980) my own observations from Goa might be of interest.

Since March 1982 I have been visiting a sandspit on Morjim Beach at the mouth of the river Chapora in North Goa district (*c.* 15° 32'N, 73° 53'E) that seems to be the only regular resting place of maritime terns on Goa's 160 km long coastline. The main constituents of this congregation through the year are the large crested tern *Sterna bergii* with up to 150 individuals in August and the Indian

TABLE 1
MONTHLY MAXIMUM NUMBERS OF SANDWICH TERNS IN THE YEARS 1982–86

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1982	n.d.	n.d.	45	400	200	150	100	40	1	0	n.d.	5
1983	6	50	150	200	50	40	2	n.d.	n.d.	5	6	100
1984	250	200	500	n.d.	200	10	25	20	300	50	20	20
1985	200	100	60	250	400	50	30	20	25	0	n.d.	1
1986	250	500	400	180	200	300	15	15	250	150	150	250

n.d. = no data

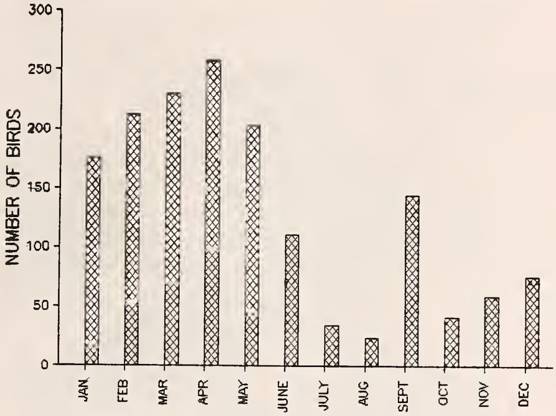

Fig. 1. Monthly maximum numbers of sandwich terns, averaged for the period 1982–86

lesser crested tern *Sterna bengalensis* with up to 800 individuals in March. Gullbilled tern *Gelochelidon nilotica*, Caspian tern *Hydroprogne caspia*, common tern *Sterna hirundo*, brownwinged *tern Sterna anaethetus* and little tern *Sterna albifrons* are also regular or occasional visitors.

The most regular visitor and the one arriving in the greatest number I found to be the sandwich tern. From March 1982 to December 1986 I undertook a quantitative survey of this species at Morjim Beach. Counts and estimates of birds at rest were generally done at about ten day intervals and usually at midday, when the fewest terns are likely to be off-shore on foraging trips, and preferably at low tide, when exposed tidal sandbanks offer additional and undisturbed resting places. Estimates during the winter months November to April are very much on the low side since the relatively small flock of terns is then dwarfed and partly obscured by a huge number of wintering gulls. The optical equipment used comprised Zeiss 10/40 binoculars and a Zeiss 30/60 telescope. The results of this survey are shown in Table 1. All the sandwich terns seen between April and August were in sub-adult plumage

A detailed discussion of these results would be premature in view of the relatively short period of observation and the consequent lack of statistical significance. However, in the light of these observations on Morjim Beach, the sandwich tern can be categorized as a regular winter visitor in substantial numbers, with a sizeable summering population of non-breeding birds. Singles and groups of up to 10 individuals can be seen along Goa's coastline at all seasons, so it would seem that this species is largely overlooked, as Ambedkar (1985) suggests.

Or could it be that the mouth of the river Chapora is an isolated resting place of the sandwich tern that has escaped the attention of ornithologists? But in that case, how could these mainly non-pelagic and easily identifiable terns reach this site without being noticed during their migration?

February 4, 1988 HEINZ LAINER

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22. INCUBATION PERIOD OF INDIAN LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS* (LINN.)

The incubation period of one of the commonest birds, the Indian little brown dove *Streptopelia senegalensis* is not known, although its breeding season is recorded as from January to October (Ali and Ripley 1983). Fortunately we got an opportunity to record the incubation period of this bird.

In the first week of February 1987, we saw its nest with two eggs on a dicotomous branch of a guava *Psidium* *guajava* tree in the small backyard of our house. Unfortunately the eggs were preyed upon by some predator. After a week, it laid two more eggs, the first egg on 21 February and the second, the following day. The eggs hatched on 8 March, taking 14 days for incubation.

According to Ali and Ripley (1983), both male and female share incubation. However, during our observation it was difficult to differentiate between the male and female. The incubation shift was not immediate, leaving the nest unprotected for a long time in the day, which may be the reason for the predation.

C.R. AJITH KUMAR
January 9, 1988 N.K. RAMACHANDRAN

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23. INDIAN GREAT HORNED OWL *BUBO BUBO* (LINN.) AND PEAFOWL *PAVO CRISTATUS* LINN.

Chandesra, a village *c.* 20 km from Udaipur (Rajasthan) and its surroundings abound in peafowl, because the inhabitants of the village religiously protect these birds. On the evening of 22 April 1988 we were standing near a big mango tree at the base of a hill on the outskirts of the village. Many birds had already settled on the tree for the night. The sun had already set and hence the light was dim. A full grown peafowl *Pavo cristatus* with a long train flew down the hill and perched on top of the tree. A great horned owl *Bubo bubo* suddenly came and struck the bird, which dropped to the ground with a thud. The owl took a long turn and came back to its prey. Meanwhile three pie-dogs which were already under the tree dashed towards the crippled or probably dead bird and started tearing it to pieces. The owl, on seeing its prey in the possession of the dogs, turned and flew away.

RAZA TEHSIN
June 14, 1988 FATEMA TEHSIN

24. UNUSUALLY LARGE CONGREGATION AND BEHAVIOUR OF INDIAN ROLLERS *CORACIAS BENGHALENSIS*

Normally, Indian rollers *Coracias benghalensis*, a common species, are to be seen sitting singly on electric/telephone wires, pouncing on prey like frogs, lizards, insects etc. on the ground and returning with the prey either to the same perch or to another nearby. Black drongos *Dicrurus adsimilis*, in contrast, hunt flying insects from a perch singly or in small parties and return to the perch with prey.

In the evening of 17 September 1987 about 40 Indian rollers and 20 black drongos were noticed gathered on one span (70 m) of an electric line, passing over a piece of ploughed land with scanty patches of grass and several pools of accumulated rain water. The mixed hunting party was busy hawking winged insects in the air, in the manner of bee-eaters, and returning to the same stretch of electric wires.

What was unusual was the abnormally large congregation of rollers and the manner of hunting the winged insects, which do not form part of their regular diet. Instead of pouncing upon the insects on the ground, they were catching their food in mid-air.

The abundance of insects on the wing in that particular locality could be the reason for the unusually large congregation and the changed hunting technique.

April 6, 1988 A.M.K. BHAROS

25. COMMON GREY HORNBILL *TOCKUS BIROSTRIS* (SCOPOLI) DUST BATHING

During the course of a field outing to the Mamundur Reserve Forest (East Chittor district, Andhra Pradesh), I came across several grey hornbills *Tockus birostris* in the open scrub jungles with a few trees, close to the Mamundur Forest bungalow. There were at least 15–20 birds in the locality, which were often seen flying about from tree to tree. They were quite vocal and their commonest call was somewhat reminiscent of the calls of the pariah kite *Milvus migrans*.

On the morning of 3 January 1988, around 0840 hrs, I saw a grey hornbill on the ground along a dry, dusty forest path. The bird was seen hopping on the ground very briefly before flying off. After some time, I noticed another individual fly down to the ground. As I was watching, the bird pressed its belly on to the ground with its wings held loose, and proceeded to dust-bathe. Soon another bird joined it and followed suit. The birds appeared to be very wary and were seen at the bath only for about a minute or two, after which they flew off to a nearby tree.

The grey hornbill has been recorded descending to the ground for feeding on fallen fruit (Ali and Ripley, HANDBOOK Vol. 4). But there is no mention of this species dust-bathing. However, the Indian pied hornbill *Anthracoceros malabaricus* is said to be 'very fond of dust-bathing'. (Primrose, *J. Bombay nat. Hist. Soc. 27:* 950).

February 26, 1988 V. SANTHARAM

26. INDIAN BLACK DRONGO *DICRURUS ADSIMILIS* EATING A BIRD

(With a text-figure)

Fig. 1. Indian black drongo *Dicrurus adsimilis* eating a martin (*Riparia* sp.)

On 10 January 1988 in Berkhera Taal in the Karera Bustard Sanctuary, Madhya Pradesh, our attention was drawn towards stands of *Ipomoea carnea* by a redvented bulbul *Pycnonotus cafer* calling agitatedly. Upon closer observation we discovered about a metre from the bulbul, a drongo devouring a sparrow-sized bird about six to eight metres away from where we were standing. We edged closer, and photographed the bird. The drongo at first was disturbed and flew down into the base of the *Ipomoea* clump, but a few minutes later it came up in full view. The bird was so busy devouring its food that we managed to get to within one metre of it. The drongo must have started eating much earlier as only the tail and a part of one wing remained in its talons. From the shape, length and colour of the remains we think that the prey was a martin.

According to Ali and Ripley (1972) small birds (*Prinia, Aegithina* and *Zozterops*) are recorded to be taken by drongos, but ours is possibly the first photographic evidence of a drongo eating a bird.

CARL D'SILVA
RAVI SANKARAN
K.K. MOHAPATRA
February 17, 1988 JAGDISH CHANDRA

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27. INDIAN HOUSE CROW *CORVUS SPLENDENS* PREYING UPON PIED GROUND THRUSH *ZOOTHERA WARDII* AT POINT CALIMERE, TAMIL NADU

On 13 October 1987 at 1220 hrs I heard the distress call of a thrush (later identifed as an adult male of the pied ground thrush *Zoothera wardii*) near the fence of our office campus at Point Calimere, Tamil Nadu. Simultaneously I noticed a house crow carrying the thrush in its bill and flying towards an *Ixora parviflora* tree. The house crow perched on the tree, transferred the thrush to its feet and started pecking and tearing at it. The thrush was still calling, and was surrounded by two more house crows.

Around 1225 hrs the thrush stopped calling. By the time I went near the tree to rescue it, the thrush was dead and partly eaten. I collected the dead specimen and cut open the stomach, which held two species of beetles, a fly and a centipede.

Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN. Compact edition. pp. 386, 1983) mention that house crows are omnivorous and eat grain, fruits, flower, nectar, lizards, small rodents, fish, insects, crabs, and young or sickly birds. It is interesting to note that the house crow caught an adult bird but probably exhausted after its migratory flight.

The HANDBOOK (op. cit.) mentions that the pied ground thrush's food includes insects and berries. The stomach contents reveal that in addition to insects they also feed on other invertebrates such as centipedes.

January 15, 1988 P. BALASUBRAMANIAN

28. YELLOW-EYED BABBLER *CHRYSOMMA SINENSIS* IN KERALA

Although Whistler and Kinnear in the Vernay Survey Report (*J. Bombay nat. Hist. Soc. 35:* 745) say that Jerdon found the yellow-eyed babbler at 'Wulliar' (Presumably Walayar on the Palghat-Coimbatore border), Salim Ali did not include the species in his BIRDS OF KERALA (1969). Ripley' SYNOPSIS (revised edition, 1982) too, has not specifically mentioned Kerala in its range.

I first saw the yellow-eyed babbler in Kerala on 29 October 1950, and again on 10 December 1950 (12-15 together, their tails appearing as if they were split into two, probably owing to the moulting of the middle tail feathers) and on 13 March 1955, all at Malampuzha (*c.* 15 km NNE Palghat town).

At 1000 hrs on 19 May 1988 when birding at Anakkappara (Alatur Taluk, Palghat Dt., 10°84'E, 76°36'N) with Jamal, Mohanan and Shaji, I saw a single yellow-eyed babbler on a bush in a large patch of scrubland at the foot of a line of small hills. We watched the bird through 10x Trinovid and Swift Audubon binoculars from a distance of 8 m with the sun behind us. The bird sang and chirped, but no other individual of the same species was seen by us.

The yellow-eyed babbler is resident at least in the Palghat Gap and has to be included in the list of birds occurring in Kerala.

May 26, 1988 K.K. NEELAKANTAN

29. SIMLA BLACK TIT *PARUS RUFONUCHALIS* AND RUFOUSBELLIED CRESTED TIT *PARUS RUBIDIVENTRIS* BREEDING SYMPATRICALLY IN KASHMIR

TABLE 1

MEASUREMENTS OF 2 *P. rubidiventris* AND 2 *P. rufonuchalis* CAUGHT ON CONSECUTIVE DAYS (26 AND 27 MAY 1987) IN OVERA WILDLIFE SANCTUARY

	Weight (g)	Wing (mm)	Tarsus length (mm)	Beak length (mm)[1]	Beak depth (mm)[1]	Beak width (mm)[2]
P. rubidiventris	14.1	70	18.2	7.8	3.8	5.0
P. rubidiventris	12.0	71	17.6	7.9	4.1	5.0
P. rufonuchalis	13.5	73	18.2	7.3	4.1	5.6
P. rufonuchalis	11.9	70	–	–	–	–

[1]Measured from the front of nares. [2] Measured at the base of the gonys.

Martens (1971) produced evidence that two forms of black tit, *Parus rubidiventris rubidiventris* and *P. rubidiventris rufonuchalis* occur sympatrically in central Nepal, but do not interbreed, and therefore should be given specific status. Vaurie (1950) had classified both forms as subspecies, and Ali and Ripley (1983) accepted Vaurie's classification. During our studies in Kashmir, we have found evidence similar to Martens'. *Parus rubidiventris* and *P. rufonuchalis* appear to be good sympatric species over a broad area of the Himalayas.

In May 1987 we noted a species of black tit that had a rufous underbelly in our study area (the Overa Wildlife Sanctuary near Pahalgam, Kashmir). We subsequently captured a pair together in a mist net. Both individuals had extensive rufous on their undersides and fit the description for *rubidiventris* given by Ali and Ripley (1983). In June and July we observed pairs of *P. rubidiventris* on several occasions, but only between *c.* 3,300 m and the tree line (3,700 m). Although we did not locate a nest we saw individuals carrying food, and the species clearly breeds in the area[3]. This is a first record for the species in Kashmir, although it is found in Uttar Pradesh (Green 1986).

P. rufonuchalis, which does not have the rufous underbelly, breeds commonly over much of the elevational range of Overa Sanctuary —from at least 2,200 m to *c.* 3,400 m. This is the form recorded as *Lophophanes rufonuchalis rufonuchalis* by Bates and Lowther (1952),

[3]On 1 June 1989 a nest of *P. rubidiventris* was observed in a crack in a silver birch tree *Betula* sp. 6 m from the ground. The site was at approx. 4000 m in mixed birch, rhododendron, and juniper forest. Contents of the nest could not be closely examined as it would have damaged the nest. The bird was apparently incubating eggs.

and *P. rubidiventris rufonuchalis* by Ali and Ripley, and known to occur commonly in Kashmir. In total we captured 4 *P. rubidiventris* and 8 *P. rufonuchalis*. We have never observed a mixed *rufonuchalis–rubidiventris* pair or captured an individual with hybrid appearance. In Table 1 measurements of a pair of *P. rubidiventris* captured together on May 1987 are compared with measurements of a pair of *P. rufonuchalis* captured together two days later in a net less than 50 m away. A third species of black tit, the crested black tit *P. melanolophus,* also breeds commonly in the Sanctuary, and is abundant close to the tree line (Price and Jamdar 1990)

We thank K. Forney for translating Martens' paper.

NITIN JAMDAR
TREVOR PRICE

January 16, 1988

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30. NEST TRANSPLANTS AND BEHAVIOUR OF BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS*

(With two plates and seven text-figures)

Introduction

Many experiments were conducted by Salim Ali to determine the level of intelligence of male baya weaver birds *Ploceus philippinus* (Ali and Ambedkar 1957). This note describes certain transplant experiments done on the nests of *P. benghalensis* at the Forest Mixed Plantation Area Tatarpur 'B' in Alwar district, Rajasthan, during the 1983 breeding season.

To determine the response of male and female birds, many removal, addition and exchange experiments were done with entrance tubes of completed nests occupied by females. Alterations were done with scissors, needle and fine thread of khaki colour for camouflage.

Transplanting was of two types: (i)*Inter-nest transplants:* When the entrance tube of any nest was transplanted on the same nest at a different position or transplanted on other nests of the same cock or nests of other cocks of the same species.

(ii) *Intra-nest transplants:* When the entrance tube was transplanted on to the nests of another species of baya.

Experiment 1: To study the behaviour of *Ploceus benghalensis* for exogeneous nest transplant, I cut the entrance tube of a completed nest from PB 1 colony and stitched it on the entrance tube of another completed nest of PB 6 colony. The additional entrance tube was transplanted on a circular opening of 5 cm diameter made near the egg chamber. This arrangement was made three days after hatching of the first egg. I manipulated the nest so that the original entrance tube faced a different direction while the addition gained the position of original tube.

This arrangement was done at 1200 hrs in the absence of the female. At about 1217 hrs the female came back to her nest with food for the nestlings. She realized the disturbance at once and seemed very suspicious. She hovered restlessly around the nest twice without alighting. Finally, at 1222 hrs she alighted on the nest at the junction point of the two entrance tubes. After a suspicious examination, she entered the nest at 1225 hrs through the original entrance tube after much hesitation.

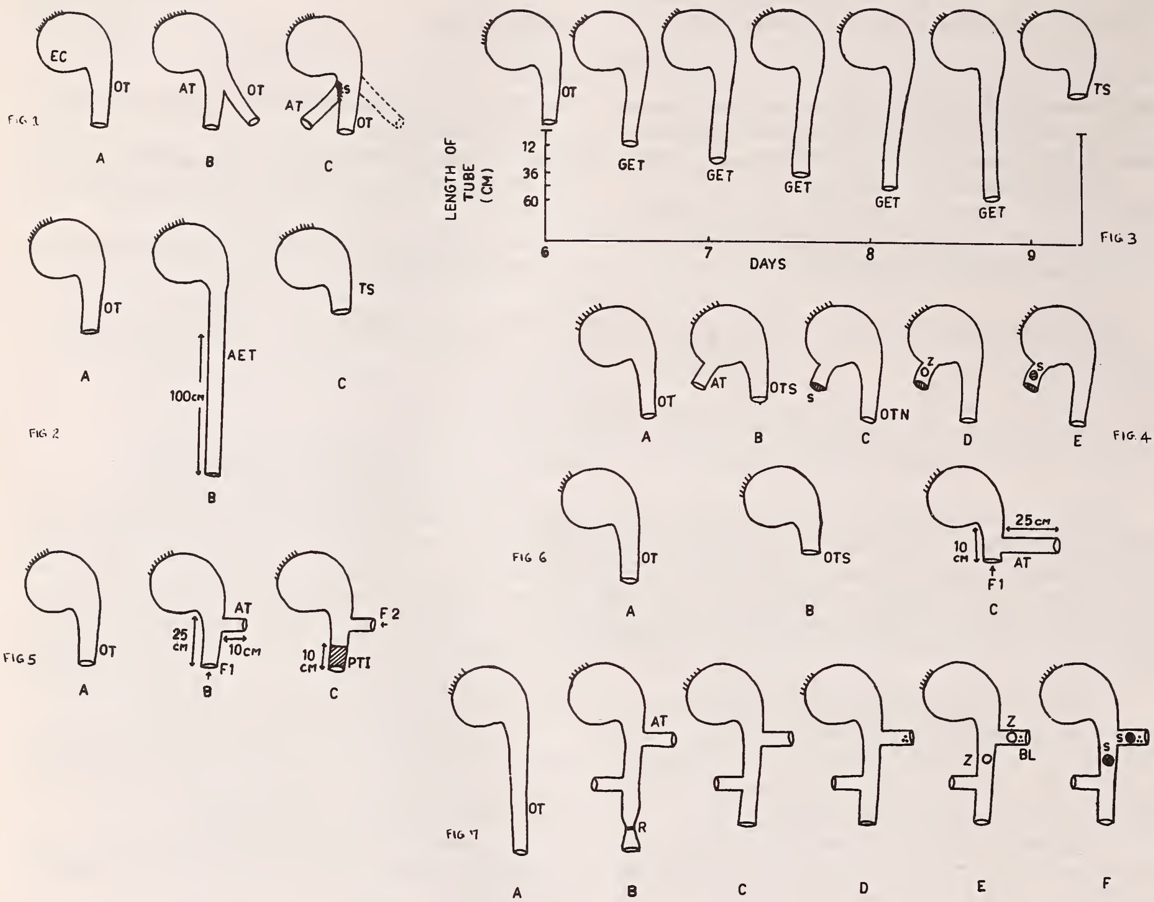
The response of the cock to an additional tube was very interesting. He tried his best to pull out the thread, used for stitching the additional tube, but finding the thread unbreakable, left it after a few attempts.

I examined the same nest the next day at 1130 hrs and found the additional tube sealed off at its base near the the egg (Fig. 1).

Experiment 2: A completed nest of *Ploceus benghalensis* with a three day old first chick in PB 9 colony was selected. I took four pieces of entrance tubes, each of 25 cm from four completed nests of *P. philippinus* and stitched them together to form a 100 cm long hollow tube, which was then stitched to the mouth of the entrance tube of the selected nest in PB 9 colony (Plate 1).

This arrangement was completed at about 0900 hrs. The female came to the nest once when the process was still going on but due to my presence she remained away, showing her agitation. She kept herself away from the nest as long as I stayed near it.

At about 0909 hrs she alighted on her nest. Unable



Figs. 1 – 7. Nest transplanting and behaviour of *Ploceus benghalensis*
1. Importance of orientation of original tube in completed nest ; 2. Abrupt rejection of entrance tube created by abrupt lengthening; 3. Gradual extension of entrance tube and behaviour of *P. benghalensis*; 4. Response to additional entrance tube grafted towards egg–chamber; 5. Relative length of original and additional side tube and preference of female for first entrance; 6. Relative length of original and additional side tube and preference of female for first entrance; 7. Response to two additional side entrance tubes.
EC = Egg Chamber; OT = Original entrance tube; AT = Grafted additional tube; S = Opening sealed;
AET = Abruptly extended entrance tube; TS = Tube stump; GET = Gradually extended entrance tube; OTS = Original entrance tube shortened; OTN = Original entrance tube normalized; Z = Circular additional opening;
F1 = First entrance of female through original tube.; F2 = First entrance of female through additional tube;
PTI = Paper tube inserted; R = Rubber ring; BL = Blobs of dung.

Above left: Entrance tube of nest lengthened abruptly by transplanting pieces of tubes from other nests: *Right:* Transplantation of two side tubes; two additional circular openings are made, one on the upper side tube and another on the original tube.
Below: Both circular openings have been darned neatly by the cock.

to comprehend the situation, she frequently hovered around the clump of *Saccharum munja* which was the base. She alighted five times on the nest till 0939 hrs but failed to notice the new opening of the nest which was approximately 125 cm away from the egg chamber. After exhaustive scrutiny, she climbed down along the tube in slow short jerks. Ultimately at about 0951 hrs, she entered the nest, but did not stay there more than 35 seconds before flying off. I re-examined the nest the next morning and found many pieces of tube below the nest. The remaining part of the tube was hardly 5 cm long (Fig. 2).

Experiment 3: When the first chick was six days old, the same nest in PB 9 colony was used for a further experiment. This time the tube stump was lengthened bit by bit (rather than all at once) by adding small pieces of tubes taken from completed nests of *P. philippinus*. This process continued for three successive days and the entrance tube attained a length of 60 cm. But, when more attempts were made for further extension, on fourth day, the cock rejected a big portion of the transplanted tubes (Fig. 3).

Experiment 4: A completed nest of PB 17 colony having a one day old chick had its original entrance tube removed, leaving behind a small stump of tube. The removed tube piece was transplanted on the same nest on a circular hole of 5 cm diameter made at the bottom of the egg chamber.

A new tube was prepared on the stump of the original tube within two days by the cock and the transplanted tube was sealed off at its free end. Two days later I made a circular hole on the transplanted tube. Again it was darned the very same day by the cock (Fig. 4).

Experiment 5: To study the importance of the original entrance tube, an experiment was conducted on a nest in PB 16 colony, containing a one day old first chick. A 10 cm long entrance tube of the selected nest near its base opposite the egg chamber. Thus, the first entrance of the female was through the original tube (Fig. 5, Plate 1).

A khaki coloured paper tube of 10 cm length and 5 cm diameter was then inserted in the main tube. In this situation the first entrance of the female was through the side tube and the exit through the main tube. After removal of the paper tube, the first entrance of the female was again through the main tube, but she came out through the side tube (Fig. 5).

The latter half of the experiment was repeated on another nest of PB 27 colony on the first day of hatching. The original entrance tube of the nest was removed, leaving behind a stump 10 cm in length. A 25 cm long entrance tube taken from A/PB 4 colony, was transplanted on the stump tube on a hole of 5 cm diameter made near the egg chamber as done in PB 16 colony. The first entrance of the female was through the stump of the original tube (Fig. 6). These experiments prove that the female prefers the original tube for its parental duties.

Experiment 6: An elaborate transplanting experiment was conducted on a nest in PB 16 colony (the same nest that had been used in experiment 5) with a six day old first chick. I transplanted one more side tube on a circular hole of 5 cm diameter made towards the lower half of the main tube. The top side tube was also replaced using a new piece of tube. The opening of the original tube was sealed off using two closely spaced rubber bands.

The nest was again examined the next evening. The main tube had been reopened by the cock and the rubber bands, along with a small piece of tube, were found below the nest. It was worth noting that both the side tubes were untouched. During the next two days nothing new happened. On the morning of the third day I was astonished to note that the cock was busy darning the junction points of the tubes; the work was completed on the joints by noon the same day. Both the side tubes were still open and no alteration was noticed except deposition of a few blobs of dung in the upper side tube, near its mouth.

At noon on the third day, I made two circular openings, one on the upper side tube and another on the main tube, between the two side tubes (Plate 2) to study the tolerance power of the cock and the hen. I re-examined the nest in the evening, by which time the cock had neatly darned both openings. (Plate 2, Fig. 7).

Conclusions: On the basis of these experiments, the following inferences can be drawn.

(i) The original position and orientation of the main tube is important.

(ii) Abrupt changes are not generally accepted. Slow and gradual changes may be accepted up to a certain extent.

(iii) Generally, just after hatching (1st to 10th day), transplanting is hardly accepted. As the hatchling grows, the bird becomes indifferent to transplantation and alteration in the nest.

(iv) After each transplant, both male and female take their own time to adapt themselves to the new situation.

(v) Intra-nest transplanting is possible in *P. benghalensis*.

September 26, 1987 SATISH KUMAR SHARMA

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31. STATUS OF SOME BIRDS IN SOUTHEASTERN INDIA

The status of various species of birds in southeastern India appears to be poorly known (Ali and Ripley 1983). In some cases this is due to the difficulty in field identification, and these authors rightly predict that many species may in fact prove to be less uncommon than suspected. Regular observations have already contributed to defining the status of a few species previously regarded as uncommon or absent from southern India. Actually, they proved to be wintering down to *c.* 12°N (Perennou 1989); they include the white stork, greater spotted eagle, brahminy duck, common and tufted pochards and blacktailed godwit. Their presence in winter appears to be a regular feature, as seen from a second wintering season. This note presents recent information on the status of several other species in southeastern India.

Black stork *Ciconia nigra:* First record. This stork occurs south to *c.* 18°N, and had not been previously recorded from southern India (Ali and Ripley 1983), although a couple had been seen in Sri Lanka decades ago (Henry 1971).

On 30 January 1988, a single bird was seen feeding in Kaliveli tank (*c.* 12° N). A close approach facilitated its identification as a juvenile, the characters of which are not fully described by Ali and Ripley (1983). The upperparts, neck and head were dark brown instead of black; the bill horny brown and the legs a dull orange, instead of bright red. This stork was again observed in Kaliveli on 5 February (G. Dolia, pers. comm.). This seems to be the first record for southern India.

Glossy ibis *Plegadis falcinellus:* Regular. This ibis used to be resident in southern India (Baker and Inglis 1930) and in Sri Lanka where breeding occurred one century ago (Henry 1971). It later vanished from the island, where a few birds have been again seen regularly in recent years (Hoffmann 1987). The glossy ibis also became apparently rarer in southern India: Ali and Ripley (1983) mention its presence only south to the Deccan. However, occasional winter observations were made in various wetlands along the Coromandel coast, mainly in the Vedanthangal Bird Sanctuary (pers. obs.; Kannan 1984; Stromaney 1984; Van der Ven 1987).

It was not until 1986-87 and 87-88 that regular wintering could be proved. Flocks of 30 to 60 (max. 80) birds wintered in Kaliveli and Ousteri tanks near Pondicherry, between 10 October and 14 April; occasional sightings were made as early as 14 August.

Barheaded goose *Anser indicus*: Regular. This goose has recently been found regularly wintering in the extreme south of Tamil Nadu (Krishnan 1987). It was also observed in winter in Pulicat lagoon (pers. obs.) and Point Calimere (Van der Ven 1987, A. Perennou, pers. comm.). Kaliveli tank is a regular stop-over for the birds migrating further south, which are seen from late November to mid December, and unidentified geese, most likely barheaded, have been seen in Madras. This goose is therefore more widespread in the south than previously supposed, although in small numbers.

White-eyed pochard *Aythya nyroca*: Rare. Occasionally seen around Madras in winter (pers. obs.; W.G. Harvey, pers. comm.), it had not been recorded from the eastern side of the peninsula further south (Ali and Ripley 1983). Two drakes were observed in Ousteri tank, close to Pondicherry, on 4 February 1988.

Cinereous vulture *Aegypius monachus*: First record. An uncommon bird even in north India, it occurs down to *c.* 21° N (Ali and Ripley 1983). On 11 January 1988, close to Nelapattu pelicanry (Andhra Pradesh, *c.* 13°45' N), a bird was seen among a flock of *c.* 50 whitebacked vultures taking off from a low, degraded scrub. Its size was enormous (wingspan 30% larger than whitebacked); its completely black plumage, both above and below, contrasted with the light-coloured feet even at a distance, and its head showed a clear contrast between dark and light parts. Its wings were held flat or slightly drooping when soaring. All these characters readily identified it as a cinereous vulture. This seems to be the first record for southern India.

Bronzewinged jacana *Metopidius indicus*: Rare. Although it is described by Ali and Ripley (1983) as common and widespread throughout peninsular India, it is actually a rare bird along the southern Coromandel coast, between Pulicat lagoon and Pichavaram mangroves (*c.* 11° to 14°N). Only one recent record from Madras exists.

Avocet *Recurvirostra avosetta*: Regular/common. In Tamil Nadu, it is mentioned by Ali and Ripley (1983) as merely 'recorded from Rameshwaram and Point Calimere'. It is actually regular in early and late winter around Pondicherry and in Madras (Adyar estuary), where overwintering has been observed. The 845 birds seen in Pulicat lake in January 1988 probably represents the largest congregation ever recorded in the south.

Eastern knot *Calidris tenuirostris*: Regular? Its status is not precisely known in southern India; Ali and Ripley (1983) only state: 'recorded from Madras'.

In recent years, this species has been identified from various coastal places in Tamil Nadu: Kaliveli tank (7 + birds on 6 Nov. 1987; 2 on 20 Feb. 1988); Adyar estuary (1 between 1 Feb. and 16 Feb. 1986; 1 on 18 Oct. 1987); Pichavaram mangroves (10 on 20 Jan. 1988, A. Perennou, pers. comm.); Ramnad district (10 on 11 Jan. 1987, in Van der Ven 1987).

Therefore, the eastern knot is likely to be a regular visitor in small numbers to southeastern India, often overlooked among other waders.

Longtoed stint *Calidris subminuta*: Regular. Although Henry (1971) records it as an abundant winter visitor in Sri Lanka, Ali and Ripley (1983) curiously do not mention its presence in southern India, where it is regarded as uncommon in Point Calimere (Sugathan 1982) and Adyar Estuary (pers. obs.). Recent observations show that it is actually a regular and sometimes even common species in Pondicherry marshes, from at least early October throughout winter till April. A migratory passage seems to occur in March-April, when up to 30 (and probably 50) birds can be seen among little stints.

Whitewinged black tern *Chlidonias leucopterus*: Common. This tern is regarded as a rare visitor to northeastern India and Sri Lanka (Ali and Ripley 1983). However, Kannan (1986) mentions a few recent sightings in Madras, Sugathan (1982) records it as common in Point Calimere and Henry (1971) as a regular winter visitor to Sri Lanka.

Between 1982 and 1988, it proved to be common in spring along the Coromandel coast: Pondicherry marshes, Ousteri tank, Kaliveli, Madras (Adyar estuary) and Covelong (35 km south of Madras). Flocks of 20 to 100 birds were often seen and all the observations (over 40) but one were made between 5 March and 26 May, when some birds at least had started to acquire their breeding plumage. On 25 March 1988, a large roost of *c.* 50,000 migrant terns in Kaliveli held over 2,000 whitewinged black terns: the bulk of the northwards migration may occur by late March. The species was noticed only once during autumn migration (25 Sept. 1983 in Adyar estuary).

Due to the problems in identifying the species in non-breeding plumage, we cannot assess whether it regularly winters in south-eastern India or not. However, ringing results in Point Calimere suggest that it does (Krishna Raju and Shekar 1971) since many birds were caught in December.

The whitewinged black tern is therefore at least a regular and common passage migrant along the Coromandel coast.

Collared sand martin *Riparia riparia*: First records; regular? Ali and Ripley (1983) only mention its presence in northern India. From 1980 to 1988, eight observations (up to 30 birds together) were made in Adyar estuary, Pondicherry marshes and Kaliveli tank between 28 September and 11 April. This suggests the regular winter occurrence in southeastern India of a bird probably overlooked among the much more common swallows.

ACKNOWLEDGEMENTS

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C. PERENNOU
V. SANTHARAM

May 21, 1988

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32. MARSH CROCODILE *CROCODYLUS PALUSTRIS* (LESSON) AT POINT CALIMERE, TAMIL NADU

On 17 December 1989 the villagers of Kodikkadu near Point Calimere Sanctuary (10°18'N; 79°51'E) informed the Forest Department of the presence of a crocodile in a pond called Thazhankulam. The Forest Department officials captured the crocodile with a fishing net and we identified it as a mugger or marsh crocodile

Crocodylus palustris based on the four distinct post–occipitals behind the head. The measurements of the crocodile are as follows:

Total length of the animal	102 cm
Breadth at abdomen	15 cm
Head length up to post–occipitals	14 cm
Head width	7.5 cm
Snout length up to the tip of eye	8 cm
Tail length	52 cm
Length from cloaca to the tip of tail	50 cm
Length up to two series of flattened vertical scales merging point	29 cm
Weight	3.1 kg

The marsh crocodile inhabits rivers, lakes and other large bodies of water in the plains and upto 600 m in the hills, throughout the Indian subcontinent, from Baluchistan in the west to Assam in the east, and from Nepal in the north to Tamil Nadu in the south (Daniel 1983).

All Indian river systems and their connected streams, lakes, sizeable ponds and jheels once had their quota of mugger (Daniel 1983). Till now, there was no record of mugger at Point Calimere Sanctuary. Point Calimere forms the seaward apex of the Cauvery river delta and its major tributaries the Manakundan, Valavanar and Uppanar mix with the Great Vedaranyam Swamp. This crocodile might have reached Point Calimere during the monsoon flooding when these tributaries mix with the waters of the Sanctuary.

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January 9, 1990

V. NATARAJAN
S. BALACHANDRAN

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33. A BATH BY A COMMON GARDEN LIZARD *CALOTES VERSICOLOR*

On 25 June 1989, in the Herbal Garden of World Forestry Arboretum, Jaipur at about 0945 hrs I saw a common garden lizard *Calotes versicolor* which was bathing in the water under the shade of a *Parkinsonia aculiata* bush at the fringe of Herbal Garden. Due to leakage in the irrigation pipe the water was dripping down and formed a tiny pond of hardly 30 cm in diameter and less than 2 cm deep. I observed the animal coming down several times and wallowing in the muddy water again and again at short intervals. It continued this activity for approximately 3 minutes.

Though many birds are known to bathe, terrestrial reptiles are hardly ever seen bathing. In the present case, the lizard was perhaps bathing to keep cool.

September 14, 1989

SATISH KUMAR SHARMA

34. FOOD OF THE DHAMAN *PTYAS MUCOSUS*

On 22 December 1989 afternoon while watching birds along the Nyari Dam, Rajkot, I saw a snake inside a well about 4 m deep and about 50 m from the dam, with its head above water. The snake was dark dorsally and mustard yellow ventrally with its lips margined with black lines distinct and large conspicuous eyes. I later identified the snake as a dhaman or common rat snake *Ptyas mucosus*.

The well is full of small fish and frogs. Half an hour later when at the site again, I saw the rat snake holding a fish in its mouth, which it swallowed. The snake then went into a small hole on the well wall.

According to Daniel (1983) the rat snake feeds on geckos, toads, frogs, young pond turtles, nestling birds, skinks, agamids lizards and snakes.

On three successive visits to the site the snake was seen in the well. Abundant food supply in a limited area can be the reason that the dhaman was staying in the well although the area around had abundant Indian gerbil *Tatera indica*, Jerdon's snake-eye *Opisops jerdoni*, fanthroated lizard *Sitana ponticeriana* etc.

No other snake was sighted in the area. It is interesting to note that the snake was active in winter, where the ambient temperature falls to 10° C in the coldest hours of the day. One would have expected the snake to be in a winter torpor at this time.

February 17, 1990

JUGAL KISHOR TIWARI

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35. GOLDEN TREE SNAKE *CHRYSOPELEA ORNATA* SHAW

I received a snake from C.B. Jhala for species confirmation. It had been collected in October 1987 by a local Dangi boy at the school of Saputara Hills, Dangs district, Gujarat. It was a golden tree snake *Chrysopelea ornata*. *Measurements:* Total body length 77.5 cm; tail 21.0 cm; supralabial 10, 4, 5, 6th touching the eye; loreal present; 1 pre-ocular; 2 post-ocular, temporal 2 + 2; body scale 17 rows (15:17:14); ventrals 220, last two are divided; caudal 128; anal plate 2; 74 cross bars on the body with dorsal rosette spots.

Recently a golden tree snake was reported by Basu (1989) from Katernia Ghat, Bahraich district, Uttar Pradesh. That snake had dorsal scale rows 18:16. According to Smith (1943) golden tree snakes have 17:17:15 scale rows. From the taxonomic view point, the Katernia Ghat specimen is significant.

September 22, 1989 RAJU VYAS

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36. KING COBRA *OPHIOPHAGUS HANNAH* IN GRASSLAND: AN UNUSUAL HABITAT

The king cobra or hamadryad *Ophiophagus hannah* is the largest venomous snake in the world, second in size only to the pythons. Rare in India, it occurs in the dense forests of Western Ghats, Nilgiris, Palnis, up to 2000 m on the Himalayas and its foot hills, and Andamans. It is also found in the forests of the hills, plains and estuaries of Orissa, Bihar, Bengal and Assam. The king cobra's habitat is usually described as rain forests or evergreen forests with high rainfall and dense undergrowth (Whitaker 1978, Daniel 1983).

It is not a common snake of Manas Wildlife Sanctuary (90°45' to 91°25'E and 26°40' to 26°50'N) and is seen occasionally in its dense riverine forests. During our nine month stay there between February 1987 and September 1988 we encountered king cobra in the open extensive treeless grasslands on three occasions.

The first time the snake was seen in an open grassland (altitude *c.* 60 m) near the forest department mahout camp at Basbari on 25 May 1987. While searching for a florican nest, we were startled by a huge snake which was in the process of rendering a yellow monitor lizard *Varanus flavescens* immobile. The prey escaped the clutch of the snake in the resultant commotion created by four of us. However, the snake pursued its prey and this is when we identified it as the king cobra. As we tried to take a closer look at the snake it slithered away into dense growth of grass leaving its prey. The yellow monitor was limping away and when we approached it for taking photographs it hissed but could not run away. After a few minutes its movements became sluggish and it succumbed to the poison in less than half an hour.

The grasslands around Basbari comprise mainly of thatch grass, *Imperata cylindrica*, *Saccharum narenga* and small shrubs. In the month of May the grass height is between 50 and 100 cm and it reaches a maximum height of 200–250 cm after the monsoon. The nearest dense tree forest is about 2 km away across the seasonal rivers Mora Manas and Naryanguri. The nearest patch of forest where the king cobra was seen (S.K. Sarma, pers. comm.) is about 10 km away.

On another occasion in May 1988, while working in the adjacent similar grasslands of Kasimdaha we witnessed one of our assistants coming face to face with a king cobra which emerged from the short grass and raised its head to about 150 cm above ground. The assistant was startled but the snake was equally surprised and it disappeared quickly after crashing loudly to the ground. The third encounter was in the Kuribeel grasslands about 3 km away under similar circumstances in the same month.

In Manas it starts raining intermittently from March and the grasslands are wet and green after that. The annual rainfall is 300-400 cm. Like the Mahout Camp fields the last two areas are more or less treeless and far from dense forests.

The presence of the king cobra in the open grasslands is unrecorded. Its foraging activity indicates that it might visit the grasslands in search of prey like the monitor lizard and snakes. R. Whitaker (pers. comm.) notes that these sightings are unusual and adds that so far the king cobra has been recorded in India from 'Sal forest in Uttar Pradesh, mangrove swamps in Orissa, West Bengal and Andamans, in addition to 'more typical' habitat near tea estates in south India and Assam.' In an area south of Port Blair (Garachama) which is now primary forests converted to grasslands, king cobras are also frequently seen."

August 30, 1989 GOUTAM NARAYAN
LIMA ROSALIND

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37. *RANA BHAGMANDLENSIS* : A JUNIOR SYNONYM OF *RANA AURANTIACA* BOULENGER (ANURA: RANIDAE)

Rana aurantiaca, previously known only from southern India, was reported by Grandison and Senanayake (1966) from Sri Lanka. Their description was based on six adult females collected on a herpetological trip made in December 1965 by Senanayake and V. Atukoralei in the Kanneliya Forest, south Sri Lanka.

Rana aurantiaca was considered by Rao (1922) as very closely related to his new species, *Rana bhagmandlensis*, in his original description of the species. The latter was still accepted as a valid taxon in the most recent taxonomic survey of *Rana* (Frost 1985).

I have compared the holotype of *bhagmandlensis*, which is one of the two available specimens (the other one is at the Indian Museum, Calcutta), and have compared it with the holotype and a series of other specimens of *aurantiaca* from India and Sri Lanka. Rao (1922) pointed out that the holotype of *bhagmandlensis* was examined by Miss Procter of the British Museum, London, and she wrote to Rao that the holotype agrees well with Boulenger's (1920) description of *aurantiaca*. Rao (1922) also compared the types with *aurantiaca* and commented that their characters and coloration are alike except for the smaller size of *bhagmandlensis*.

My examination of all available pertinent material revealed that Rao's (1922) *bhagmandlensis* agrees with the characters of *aurantiaca*, and accordingly I here consider *bhagmandlensis* as a junior synonym of *aurantiaca*.

Rana aurantiaca Boulenger, 1904

Rana aurantiaca , 1904, J. Bombay nat. Hist. Soc. 15(3): 430-431; Rec. Indian Mus., Calcutta 20:157-158 (1920); Rao, 1937, Proc. Indian Acad. Sci. 6(6): 424-425; Grandison and Senanayake, 1966, Ann. Mag. Nat. Hist. 13(9): 419-421; Frost, 1985, Amphibian Species of the World.
Specimens examined: BM1947.2.2.92 (holotype of *Rana aurantiaca:* Trivandrum, Travancore, Kerala); BM 1967. 533-535, 537-538 (Kanneliya Forest, Sri Lanka); AMNH 80086 (Southern Province, Kanneliya, Sinharaja, Sri Lanka); AMNH 78924 (Southern Province, Kanneliya, Sri Lanka); CAS 101609 (South Kanara, Kadnjar Khana, Mysore, India); BM1947.2.2.12 (holotype of *Rana bhagmandlensis*): forests of Bhagamandla, Coorg, Mysore.
Distribution: Trivandrum, Kerala; Coorg and Kadnjar Khana, Karnataka (India); Kanneliya Forest, Udugama (Sri Lanka).

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June 15, 1989 SUSHIL K. DUTTA

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38. AMPHIBIANS FROM INDIA - SOME FURTHER SPECIES

The most recent review of the diversity and zoogeography of the amphibian fauna of India by Inger and Dutta (1986) listed 181 species, distributed in 9 families. Chanda and Ghosh (1988) added 13 more species, which were omitted in the earlier review, but included *Bufo sulphureus* Grandison and Daniel (1964) which had been synonymised under *Bufo koynayensis* Soman (1963) by Frost (1985). A literature search revealed that 12 more valid species of Indian amphibians, belonging to 4 families, were still not incorporated, being overlooked or described subsequent to the aforementioned compilations. These, along with their sources, have been listed below. Sources of information on type localities and nomenclature, if uncited, is Frost (op. cit.).

Anura: Microhylidae

1. *Kaloula baleata ghoshi* Cherchi, 1954.
Type locality: Andaman Islands, India (Cherchi 1954, see also Whitaker 1978). Known only from type locality.
2. *Microhyla heymonsi* Vogt, 1911.
Type locality: Kosempo, Taiwan, China.
Indian record: Great Nicobar (Mehta and Rao 1987)

Ranidae

3. *Pterorana khare* Kiyasetuo and Khare, 1986.
Type locality: Sonuoru and Rukhroma rivers, Kohima district, Nagaland (Kiyasetuo and Khare 1986). Known from type localities only.
4. *Rana barmoachensis* Khan and Tasnim, 1989.
Type locality: Barmoach, Goi Medan, Kotli district, Kashmir (Khan and Tasnim 1989). Known from type locality only.
5. *Rana ghoshi* Chanda, 1990
Type locality: Khuigairk Reserve Forest, Manipur (Chanda 1990a). Known from type locality only.
6. *Rana mawlyndipi* Chanda, 1990
Type locality: Mawlyndip, Khasi Hills, Meghalaya (Chanda 1990b). Known from type locality only.
7. *Rana tuberculata* Tilak and Roy, 1985.
Type locality: Kheel Gad, west of Purari, Dehra Dun (Uttar Pradesh). Known from type locality only.

Rhacophoridae

8. *Chirixalus vittatus* (Boulenger, 1887).
Type locality: Bhamo, Burma.
Indian record: Near Kohima, Nagaland (Romer 1948).
9. *Philautus namdaphaensis* Sarkar and Sanyal, 1985.
Type locality: Farmbase Camp, Changlang district, Arunachal Pradesh (Sarkar and Sanyal 1985). Known from type locality only.
10. *Philautus shamrupus* Chanda and Ghosh, 1989.
Type locality: Hornbill, Namdapha Tiger Reserve, Changlang district, Arunachal Pradesh (Chanda and Ghosh 1989). Known from type locality only.
11. *Rhacophorus namdaphaensis* Sarkar and Sanyal, 1985.
Type locality: Near Miao, Changlang district, Arunachal Pradesh (Sarkar and Sanyal 1985). known from type locality only.

Gymnophiona: Ichthyophidae

12. *Ichthyophis longicephalus* Pillai, 1986.
Type locality: Silent Valley, Kerala (Pillai 1986). Known from type locality only.

A few comments on the reports of the occurrence of salamanders in India may be pertinent here. Commenting on the Palaearctic elements in the fauna of Kashmir, Das (1976) reported two species of salamanders, *Hynobius chinensis*, otherwise known from western China, and *Tylototriton verrucosus*, reported from the Himalayan foothills, including Nepal and northeastern India, extending into Thailand and China. These two taxa have not been since reported from Kashmir, and collections from the said area are apparently unrepresented in any major museum collection, and thus the report has not been verified.

I thank Dr Alain Dubois, Laboratoire des Reptiles et Amphibiens, Museum National d'Histoire Naturelle, Paris, for commenting on an earlier draft of the manuscript.

August 21, 1990 INDRANEIL DAS

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39. NOTES ON MORPHOMETRY, ECOLOGY, BEHAVIOUR AND FOOD OF TADPOLES OF *RANA CURTIPES* JERDON, 1853

(With two text-figures)

At the end of March 1989 I collected some tadpoles of the bicoloured frog *Rana curtipes* from two localities in Karnataka: (1) a small stream 3 km north of Londa (30 km NW of Dandeli) on 31 March 1989, and (2) Beadthye river between Nalur and Agumbe on 8 April 1989. From both localities totally 110 tadpoles of different stages were collected (prehindlimb stage 25, hind limb bud stage – 39, hind limb stage 46). The morphometry, ecology, behaviour and food items of tadpoles are described in this note.

Morphometry: The body of the tadpoles is oval, stout and wider than high, flattened dorso-ventrally. The average body length in 20 tadpoles is 33.6 mm (± 1.5) (Table 1) and the average tail length is 53.7 mm (± 4.1). The tail is about one and a half times as long as the body. The tail muscle is fairly strong, and tapers to a point. The tip of the tail is moderately rounded; dorsal fin is slightly deeper than the ventral fin.

Head depressed, with a rounded snout; nostril dorsal, nearer to the eye than the tip of snout. The eyes are dorso-lateral; pupils round. There is a groove-like line from nostrils to eyes. Interocular space is greater than internasal space. A pair of very prominent parotoid glands (Fig. 1) in size averaging 7.6 mm (± 1.2) . Spiraculam sinistral, directed upward and backward. Vent in median line in front of the ventral fin. Edge of dorsal and ventral fins with glandular warts, in a row, which are more in front of the tail than near the end.

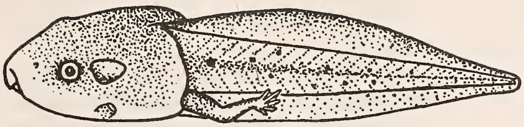
Mouth antero-ventral with 3 or 4 rows of papillae on the sides of the upper and lower lip and a single row of papillae on the edge of the lower lip. The front edge of the upper lip is without papillae. Teeth rows have the formula 2:5 + 5/1 + 1:4-7 (Fig. 2) or 3:4 + 4/1 + 1:4-7. In the upper labium the number of rows (7) seem to be constant. The first two rows are unbroken, the third may be broken or unbroken and the remaining rows are broken. In the lower labium the innermost row is broken and the other rows numbering 4 to 7 are unbroken.

The body is blackish brown with a few black dots on dorsal region and grey with slight metallic blue on ventral region. Tail muscle is copper coloured near the

TABLE 1
MEASUREMENTS OF 20 TADPOLES IN HINDLIMB STAGE OF *Rana curtipes*

Measurements	Range	Mean	S.D. ±	Ratio of measurements to body length (%)
Body length	32.0-38.0	33.6	1.5	–
Body height	16.0-20.0	18.3	1.1	54.5
Body width	18.0-24.0	20.6	1.8	61.3
Head height	12.0-15.0	13.3	0.7	39.6
Head width	16.0-21.0	18.3	1.2	54.5
Internasal space	4.5-5.5	5.0	0.2	14.9
Interocular width	13.0-15.0	14.1	0.6	41.9
Mouth width	7.0-10.0	8.5	0.8	25.3
Snout to spiraculam	19.0-23.0	20.6	1.1	61.3
Tail length	44.5-61.0	53.7	4.1	159.8
Tail height	15.0-21.0	18.3	2.0	54.5
Diameter of tail muscle	8.0-10.0	9.3	0.6	27.7
Length of hind limb	10.0-37.0	22.6	8.3	67.3
Length of parotoid gland	5.0-10.0	7.6	1.2	22.6

All measurements are in millimetres.



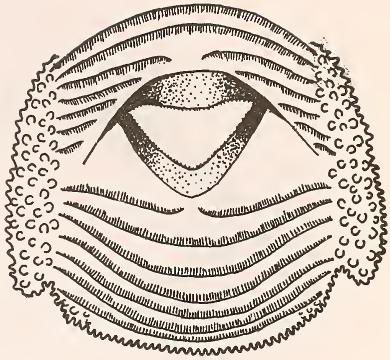


Fig. 1. Tadpole of *Rana curtipes:* lateral view. Fig. 2. Mouth of tadpole of *Rana curtipes.*

body and black at the end with dots. Tail fins are black. Parotoid glands are also copper in colour.

Ecology and behaviour: The tadpoles were collected from stagnant pools of water in the stream as well as in the river at depths of 30-80 cm. They were swimming on the surface in shoals. Four shoals were observed in the stream. They came to the shore to feed on the algae growing on the decaying leaves and twigs. When the shoals were disturbed tadpoles dispersed, and some of them hid under leaves and stones in the water, while others mixed with the other shoals. The shoals moved very slowly and could be caught easily. The stream was shaded by trees but the river had no trees nearby. Live tadpoles put in formalin excreted a white creamy substance from the parotoid glands and the warts on the fins of the tail.

Food: Gut analysis revealed the various species of algae such as diatoms, *Cosmarium*, *Closterium*, *Scenedesmus*, *Oedogonium*, along with fine sand.

The description of the tadpoles of *Rana curtipes* by Rao (1914) almost fits with these tadpoles, except the parotoid glands, which were mentioned as not conspicuous. But in the present collection the parotoid glands are very prominent. Also, the maximum total length recorded by Rao was 68 mm; but this collection has tadpoles 94 mm in total length.

January 6, 1990

A.G. SEKAR

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40. OCCURRENCE OF A TRIGGER FISH (PISCES: BALISTIDAE) IN BOMBAY SEAS

(With a text-figure)

On 23 June 1989 a fisherman brought a live specimen of trigger fish from Colaba (Bombay). The fish, after requisite quarantine, was kept in a display tank at the Taraporevala Aquarium. Contrary to the usual trend of newly captive fishes to refuse food for several weeks, this fish started feeding the very next day.

Except for a slight fungal infection on the edge of the caudal fin, the fish was healthy, but it suddenly died on 2 September 1989. Due to lack of facilities for preservation, such as formaldehyde or refrigeration, the specimen was thrown away. This was unfortunate because the species could not be identified.

Day (1878-88) described 13 species of trigger fish from the then undivided Indian seas [now comprising Pakistan, India, Bangladesh, Myanmar (Burma), Sri Lanka (Ceylon) and the Maldive Islands]. All the species were, at that time, placed under the genus *Balistes*. Munro (1955) recorded 11 species from Sri Lanka, but by this time, the genus *Balistes* had been split up into many genera. Thus Munro's species fall under several genera. The fishes are: *Abalistes stellatus*, (= *Balistes stellatus* of Day), *Balistapus undulatus* (= *Balistes lineatus* and *B. undulatus* of Day), *Balistoides viridescens*, *Canthidermis rotundatus*, *Hemibalistes chrysopterus* (= *Balistes niger* of Day), *Melichthys ringens*, *Odonus niger* (= *Balistes erythrodon* of Day), *Pseudobalistes fuscus*, *Rhinecanthus aculeatus*

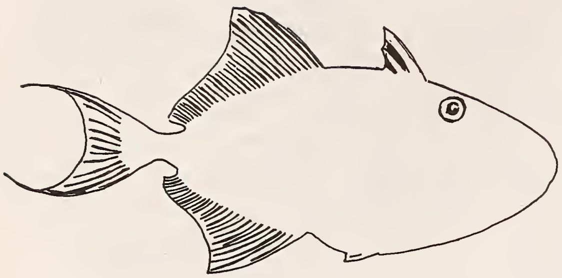

Fig. 1. Profile of a typical trigger fish.

and *Sufflamen capistratus* (= *Balistes mitis* of Day).

Although, as stated earlier, identification could not be carried out, from the authors' previous experience and from colour descriptions, the following species can be ruled out: *Abalistes stellaris, Balistapus undulatus, Balistes vetula, Balistoides conspicillum, Canthidermis rotundatus, Melichthys ringens, Pseudobalistes fuscus, Rhinecanthus aculeatus, R. rectangulus* and *Sufflamen capistratus*. Most probably it is *Odonus niger* (Ruppell).

In our experience of over 40 years, we had never come across any live trigger fish at Bombay. Enquiries with old fishermen also confirmed this, as they too had never seen one. Hence this is the first record of a trigger fish from Bombay.

This is not the first occasion that occurrence of fish, which had never been found at Bombay, has been noticed. Chhapgar and Deshmukh (1964), while commenting on rare occurrence of spiny lobster *Panulirus ornatus* in 1962, surmised that their presence could be attributed to temperature fluctuations and the veering of currents which also brought in two coral reef fishes, viz. Moorish idol *Zanclus cornutus* and squirrel fish *Holocentrum rubrum* – a first record from Bombay. Subsequently, Chhapgar and Jatar (1968) had observed the occurrence of four species of butterfly fish (*Chaetodon*) from Bombay in 1966, which was also a first record of these fishes from this region.

B.F. CHHAPGAR
A.M. RINGANGAONKAR
January 27, 1990

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41. *HYPOCALA VIOLACEA* BUTLER — A CASE OF STRONG MORPHOVARIATION

(With three text-figures)

On the basis of maculation alone, Butler (1892) and Hampson (1894) recorded a type of morphovariation in the species *Hypocala violacea* Butler. While conducting intensive surveys for the collection of Ophiderines, 60 individuals of this species were collected. The male and female genitalia of this polymorphic species have not been studied so far. The study of genital organs of polymorphic species in particular and other species in general is necessary for determining their limits/identification. In view of this, these structures have been studied to establish the identity of this species complex.

Hypocala violacea Butler

Butler, 1879, Tr. Ent. Soc. Lond.: 6 (*Hypocala*).

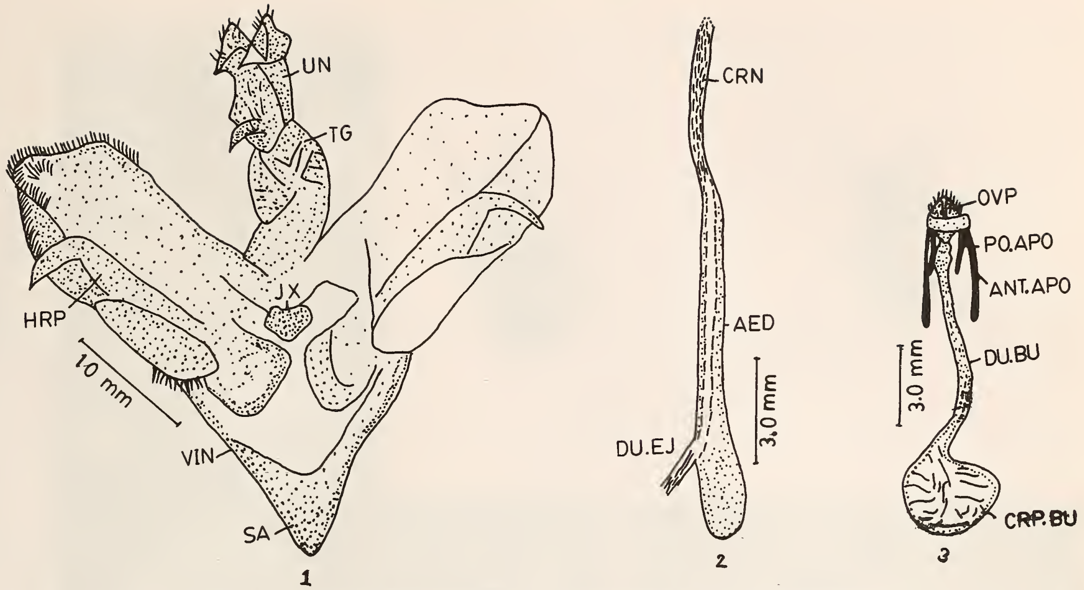
Genitalia (male, Figs. 1,2). Uncus unique (of rare occurrence), bowl shaped, strongly sclerotised, produced distally into two identical processes directed ventrally, distal half 'U' like in dorsal view, with a mid–dorsal short pointed spine; socii wanting; tuba analis long, well marked; tegumen well developed, saccus conical; reduced; valva symatrical, uniformly sclerotised, coastal region well marked; sacculus prominent; harpe conspicuous; juxta well sclerotised; aedeagus moderately long, with differentiation into base and apex, vesica armed with series of spine like cornuti.

Female (Fig. 3): Ovipositor lobes well developed, finely setosed; an anterior apophyses longer than posterior apophyses; ostium bursae sclerotised; ductus bursae of moderate length, lightly sclerotised; ostium bursae thin, membranous, globular in shape, signum wanting.

Wing expanse (half): Male 24 mm, female 23 mm.

Material examined : Assam: North Cachar Hills, Jatinga 46 males, 14 females, 13-20 September 1985.

Old distribution: Sri Lanka (Ceylon), Cachar (India),



Figs. 1-3. *Hypocala violacea* Butler: 1, 2. Male genitalia; 3. Female genitalia.
Abbreviations: AED, Aedeagus; ANT. APO, Anterior apophyses; CRP. BU, Corpus bursae; DU. BW, Ductus bursae; DU. EJ, Ductus ejaculatorius; HRP, Harpe; JX, Juxta; PO. APO, Posterior apophyses; SA, Saccus; TG, Tegumen; UN, Uncus; VIN, Vinculum.

Burma.

The heterogeneous sample consisting of 60 individuals appeared as if the individuals represented a species complex. However, sorting them followed by dissections of the male and female individuals indicated that all these individuals are conspecific and thus pertain to only one species.

I wish to thank the CSIR, New Delhi for providing financial assistance .

March 17, 1989 A. SRIVASTAVA

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42. STUDIES ON THE BIOLOGY OF *APOTOMORRHINUS CRIBRATUS* SCH. (COLEOPTERA : CURCULIONIDAE)

(With ten text-figures)

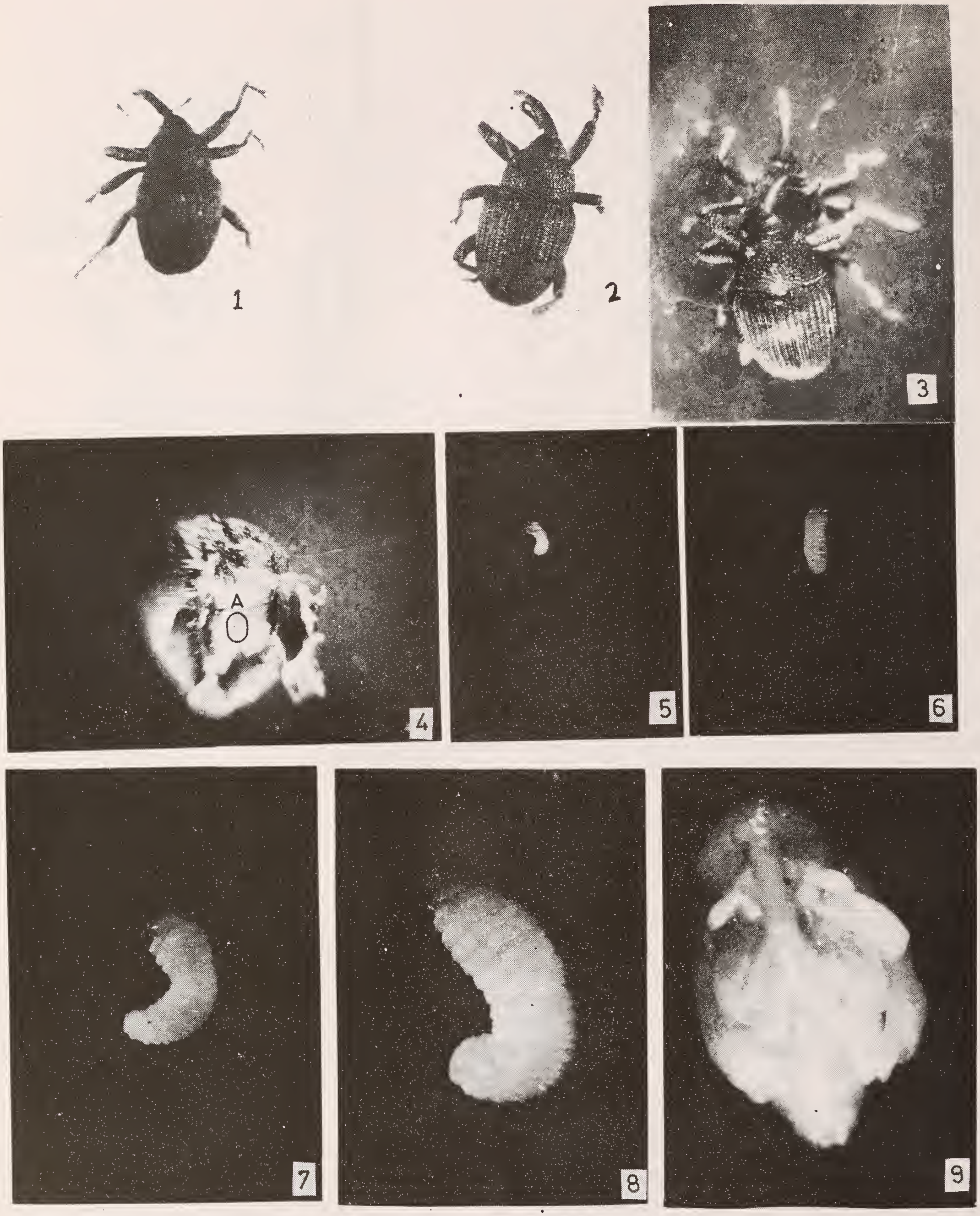
Introduction

Apotomorrhinus cribratus Sch., a member of the subfamily Baridinae, attacks the fruits of *Eugenia cuspidata* and *Eugenia jambolana* (Family Myrtaceae). There is no information on the biology of genus *Apotomorrhinus*, but some observations on the host association and development of a few other members of the subfamily have been recorded both in India and abroad.

Kushwaha (1962) recorded the association of *Barioscapus cordiae* (Mshl.) with the fruits of *Cordia myxa*. The present communication records some general observations on the biology of *A. cribratus* Sch.

Observations

The adults of *A. cribratus* Sch. are medium sized, dark brown and ovoid (Figs. 1, 2). They appear on the host tree in the middle of June when the tree is in bloom. The weevils feed and oviposit on the young fruits. The larva tunnels through the fleshy layers of fruit to reach the kernel within which it completes its development. The newly formed adults come out of the dry fallen fruits and remain



Figs. 1-9. *Apotomorrhinus cribratus* Sch.
1. Male; 2. Female; 3. Copulation; 4. Section of fruit showing eggs embedded in mesocarp (A);
5. 1st instar larva; 6. 2nd instar larva; 7. 3rd instar larva; 8. 4th instar larva; 9. Pupa;

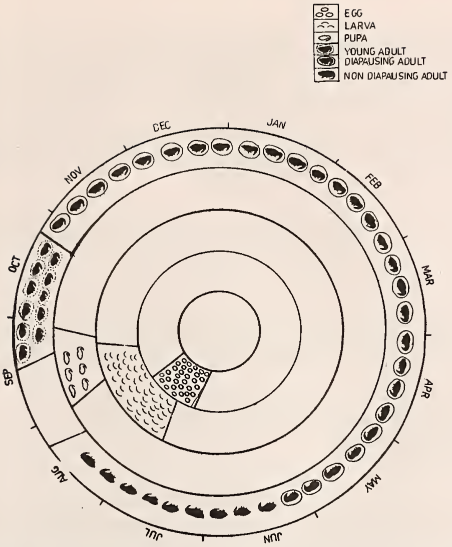


Fig. 10. Seasonal life cycle of *Apotomorrhinus cribratus* Sch. on *Eugenia jambolana* during 1986 and 1987.

in a state of diapause till the next fruiting season.

The adults are poor fliers. They generally hide themselves in between the closely appressed fruits of a bunch. The beetles feign death on being disturbed and drop to the ground where they lie motionless for 3-4 minutes before taking to their wings. The fresh adults feed on the nectar contained in the nectaries inside the calyx cup. Later on, they also feed on young and ripe fruits by inserting their snouts into the fruit.

Copulation: The adults attain sexual maturity towards the end of June after feeding on the flowers and fruits for a period of 16 to 23 days. Pairing occurs mostly in the afternoons. As the male approaches a female, she moves forward but the male continues to chase her till she becomes stationary. The male mounts the body of the female either from left side or right side and holds the female with its legs (Fig. 3). When not receptive, the female jerks off the attempting male by rapidly moving her body right and left and quickly disappears among the fruits. A couple mates for a period varying from 27-35 minutes. Both the male and the female have been found to copulate several times after the first copulation.

Oviposition: Egg laying begins 1-3 days after the first copulation, in the first week of July. The usual site of oviposition is the area around the middle of the young fruit. The female drills an ovipositional tunnel with its snout which extends up to the inner layer of mesocarp. The egg is deposited in a spacious chamber at the end of the tunnel (Fig. 4). After oviposition, the female displaces the egg a little away from the entrance with the help of its snout. The ovipositional hole later on gets blocked by the growth of the surrounding tissue. The female sometimes gives out a secretion from its anal aperture and applies it around the ovipositional hole with its snout.

Usually, 2 to 3 eggs are deposited in one fruit but their number rises to 8 in crowded conditions. The total number of eggs laid by a female varies from 9-88 with an average of 51 eggs. The oviposition period among different females extends for 9-37 days when 1-8 eggs are laid daily. Nearly 50% eggs are laid during the first half of the oviposition period.

Life cycle: (Fig. 10): Freshly laid eggs are cream coloured, oval and measure on an average 0.50 mm in length and 0.38 mm in breadth. The eggs extracted from the fruits and kept on moist cotton hatch within 5-6 days.

The newly hatched whitish legless larva (Fig. 5) tunnels through the endocarp in an irregular fashion, filling the space behind with its faecal matter and thus imparting the tunnel a brown colour. It ultimately settles in the kernel, feeds actively and moults three times before attaining full growth (Figs. 6, 7). The mature fourth instar larva is stout, strongly curved and possesses a dark brown head capsule with sharp mandibles (Fig. 8).

Usually, 3-6 larvae in various stages of development are encountered in one fruit but only one larva reaches maturity, the others dying sooner or later. By the time the ripe fruits begin to drop, most of the larvae are in advanced stages of development. The outer layers of the fruits, i.e. the thin epicarp and juicy mesocarp shrivel after 2-3 days but the cotyledons remain green for 8-13 days and serve as a source of nourishment to the growing grubs.

The grubs start transforming into pupae in the first week of September. Pupation takes place inside a wide chamber prepared in the dried cotyledons by the full grown larva. The larva stops feeding and stretches out its body to attain the prepupal stage in preparation for the pupation.

The pupal stage lasts for 8-12 days (Fig. 9). Adults start emerging in the middle of September and continue to emerge till the first week of October. The freshly formed adult remains inside the fruit for 3 to 4 days, during which the sclerotization and pigmentation of the body is completed. It then cuts its way out and flies away.

Diapause: The adults of *A. cribratus* Sch. are not seen anywhere till the next flowering season of the host plants. They presumably hide and enter a phase of imaginal diapause. When released in a jar containing soil, the beetles fail to burrow into it. The hiding place for the adults thus does not appear to be underground.

Longevity: The adults of *A. cribratus* Sch. appear in the middle of June and remain on their host tree up to third week of August. Out of 32 adults kept in the laboratory, 56% survived for 40-48 days, 32% for 33-38 days, 9% for 12-15 days, 3% for 58-61 days and 2% died in 3-6 days.

Nature and extent of damage: The injury is caused to the fruits both by the adults and the grubs. The weevils feed on both young and ripe fruits. The feeding holes are externally marked with whitish fungal material. The serious damage is, however, caused by the grubs which bore through the fleshy mesocarp into the kernel. As a result, irregular galleries are formed, which are dumped with excreta as the larva feeds. Thus the entire seed is rendered useless.

We are grateful to the Indian Council of Agricultural Research and the U.S. Department of Agriculture for financing a five year project on Indian Curculionidae. We are also thankful to the Chairman, Department of Zoology, Punjab University, Chandigarh, for providing necessary research facilities.

H.R. PAJNI
December 15, 1988 NEELIMA NANDA

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43. INTRASEXUAL COMBAT IN *ONTHOPHAGUS PYGMAEUS* (SCHALLER) (COLEOPTERA : SCARABAEIDAE)

Having extensively surveyed the literature, Halffter and Matthews (1966) reported that of all the tribes in the subfamily Scarabaeinae, individual combat is exclusive to the tribe Scarabaeini. Observations made on *Onthophagus pygmaeus* (Tribe: Onthophagini) however, contradict the above statement.

Results and Discussion

Intraspecific male combat was observed on five occasions in *O. pygmaeus* at Bangalore in 1985.

In the first instance an intruding male displaced a male from beneath a sheep pellet by butting it away from the female with which it was present. Then, with antennae waving feverishly, it remained *in copula* with the female for two minutes. The displaced male kept roving around the mating pair for some time and then hid beneath a blade of grass. Once the pair had completed mating, it emerged from concealment and approached the female. The intruder-male tossed him off with his clypeus and persistently stayed behind the female. All attempts by the displaced male to possess the female were thwarted by the new male.

Finally, the displaced male withdrew to a distance of 10 cm from the pair. It kept waiting there till the male-female pair commenced digging. When the displaced male was placed (by the author) in their vicinity, it feigned death for four minutes, by which time the pair had dug into the soil.

In two other instances three males, and in one instance four males, were involved in combat to gain access to the respective females beneath sheep pellets. In all cases, a male was originally represent with a female beneath a sheep pellet. At the end of the butting and tossing it was always one of the larger males that succeeded in mating with the female. The female never took part in any of these combats but remained passive as in females of *Gymnopleurus* spp. (pers. obs.)

It is thus evident that greater size confers some advantage to males in winning battles with other males. It may therefore be said that large size increases fitness in males. But then, the fact that in one instance, a displaced male kept waiting for an opportunity to mate with a female that had already mated with another male suggests the possibility of sperm precedence in this species (Parker 1970, Klemperer 1983). This is further strengthened by the fact that the successful male keeps guarding the female for a period after having mated with her. Only further observations supported by experiments can establish the truth of these surmises. However, the observations amply demonstrate that this Onthophagine species does engage in intrasexual male combat, proving that such behaviour is not restricted to members of the tribe Scarabaeini.

We are grateful to Dr R. Madge, British Museum (Natural History) for identifying the specimens.

K. VEENAKUMARI
December 16, 1988 G.K. VEERESH

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44. UTILIZATION OF DRY DUNG AND INTRASPECIFIC COMPETITION IN *ONTHOPHAGUS TRITINCTUS* BOUCOMONT (COLEOPTERA: SCARABAEIDAE)

(With a text-figure)

Introduction

Different species of scarabaeines are attracted to excrement of varying consistency. While liquid excrement attracts members of some species that feed *in situ*, excrement of a more pasty consistency is required by those species which indulge in ball making for overland transportation of food. However, the extreme case in which very dry dung is consistently utilized has so far been noticed only in the neotropical scarabaeine sub-tribe Eucraniina, which includes all species belonging to the genera *Eucranium, Clyphoderus* and *Anomioproides*. In these species the beetles carry dung by grasping dry pieces between the forelegs and head, and then by elevating the forebody with the food, they run rapidly forwards on their mid and hind pairs of legs. This is thought to be an adaptation to semi-desert conditions (Halffter and Matthews 1966). For the first time *Onthophagus tritinctus* (Tribe: Onthophagini) has now been observed to transport pieces of dry dung for food.

The following observations were made in Bangalore, south India, during the months May to July in the years 1983 to 1985.

Transportation of Dung by Butting

Adults of *O. tritinctus* were found to be attracted to dry dung. They were seen to be pushing flat dry pieces of either cow dung (Fig. 1) or dog exrement. Getting partially beneath the dung piece they kept shovelling it by means of their clypeus and forelegs.

Lifting one end of the dung piece they tossed it over, such that they could have the opposite end in proximity to themselves, to which they then applied their clypeus and forelegs. In this manner they transported the dung pieces over a mean distance of *c.* 68 cm (Table 1). At times a strong gust of wind would blow them over. However, they would right themselves and resume their original position to continue butting the dung piece.

Halffter and Matthews (1966) state that the butting technique appears to enable the beetles to transport 'very large pieces of food'. In line with this argument it can be seen from Table 1 that as compared to both the *Gymnopleurus* spp. which are rollers of spherical dung masses, *O. tritinctus* does succeed in transporting (by butting) a greater mass of dung. This is so despite the fact that *O. tritinctus* is much smaller than *Gymnopleurus* and that it transports dry dung fragments unlike the *Gymnopleurus* spp. Current observations also reveal that relative to its mass *O. tritinctus* transports food over much greater distances than the *Gymnopleurus* spp. Its speed is however, much less than the two species of *Gymnopleurus* (Table 1).

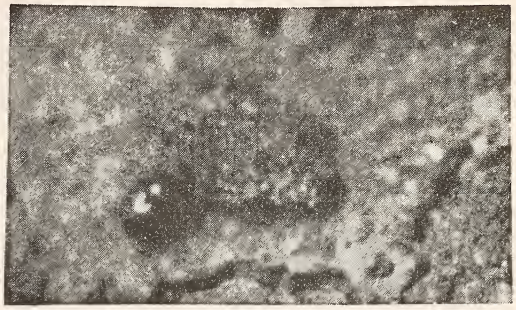

Fig. 1. *Onthophagus tritinctus* transporting a flat piece of dry dung.

O. tritinctus has thus evolved a unique combination of traits for obtaining food. It combines the capacity of the eucraniines to utilize dry dung, with the 'butting' technique of *Dichotomius nisus* (Oliver) (Luederwall 1914, as in Halffter and Matthews 1966), *Oxysternon conspicillatum* Weber (Daniel 1940, as in Halffter and Matthews 1966) and several species of *Phanaeus* (Halffter and Matthews 1966).

Even though it had to transport flat, relatively large fragments of dung, *O. tritinctus* did succeed in pushing the fragments over obstacles encountered during transportation. But then, it adopted a variable strategy when encountering obstacles, perhaps dependent on the quantum of energy it had to expend in the effort to push the fragment over, as is evident from the following observations. When a fallen stem was first encountered as an obstacle, an individual *O. tritinctus* succeeded in butting the piece of dung over it. However, when it encountered a second stem in its path it was unable to surmount it. The beetle then took the other alternative of digging at the base of the obstacle. It got beneath the dung piece and started digging with its clypeus and forelegs. As the digging continued the fragment gradually disappeared into the soil. Digging up the spot after two days revealed partially eaten dung and faecal pellets of the beetle at a depth of 2.5 cm.

Intraspecific Competition

Intraspecific competition for the fragment of excrement was observed in *O. tritinctus*. As observed in

TABLE 1
COMPARATIVE EFFICIENCIES OF 2 MODES OF FOOD TRANSPORTATION IN 3 SPECIES OF DUNG BEETLES

Species	Mode of transportation	Wt. of beetle (g)			Wt. of dung carried (g)			Total distance transported (cm)			Rate of travel (cm/min)			Wt. of ball /wt. of beetle	Distance travelled/ wt. of beetle
		N	$\bar{X}$	CV	N	$\bar{X}$	CV	N	$\bar{X}$	CV	N	$\bar{X}$	CV		
O. tritinctus	Butting	4	0.001	0	4	0.048	53.2	3	68	63.08	4	6.5	–	48.0	680.0
G. gemmatus	Rolling	7	0.051	26.9	6	0.340	33.18	2	245	14.0	9	105.1	15.0	6.7	48.0
G. miliaris	Rolling	10	0.097	43.6	6	0.360	25.0	8	1138	45.0	16	119.53	35.3	3.7	117.3

Sisyphus schaefferi (L.) and *Gymnopleurus geoffroyi* Fuessly by Prasse (1958), fights were always between two beetles only; although in the sequence of events described below, situations did arise when more than two beetles were present in the vicinity of the dung fragment and so could have been involved in multiple combat.

One beetle that was butting along a piece of dung was seen to be followed by a conspecific. This beetle did not try to wrest the dung piece from its owner but instead appeared to be following it for some distance and then buried itself in the soil. A few minutes later a third beetle of the same species arrived and attempted snatching away the piece of dung, but the owner did not yield. It continued pushing along its piece of dung. Nevertheless, owing to the rugged nature of the terrain, the owner stumbled and fell away from the dung fragment. This opportunity was utilized by the beetle that had arrived last. It took possession of the piece of dung and began butting it along. At this juncture yet another beetle alighted about 15 cm away from the beetle engaged in transporting the dung. It however, did nothing but remained still for a while and then flew away.

Meanwhile, the beetle that had fallen and lost the dung piece fought and regained possession of it from the beetle that was transporting it. It butted it along for some distance and finally buried it. In spite of potential rivals and actual loss of the dung fragment for a while, the original beetle succeeded in finally regaining control over its piece of dung. Thus, *O. tritinctus* engaged in sequential combat, where one beetle may fight with more than one beetle but only one at a time, during the course of food transportation.

O. tritinctus appears to save energy by generally avoiding direct combat with conspecifics for the possession of dung fragments. On the other hand, it appears to wait for a chance to sneak up to a faltering individual and then snatch away the fragment. Thus, while it saves energy by avoiding physical combat, it expends considerable time in following a conspecific engaged in food transportation and waiting for it to falter before gaining possession of the dry fragment. This may be a male strategy for reproductive success as the cost of finding a free female may be greater than the benefit that accrues from waiting for an opportune moment to take possession of a female from its attendant male. As Halffter and Matthews (1966) state, gaining possession of the fragment of food is only apparently the objective of intraspecific combat, but, in fact is a form of sexual behaviour.

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February 14, 1989

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45. ODONATA OF VEDANTHANGAL WATERBIRD SANCTUARY, TAMIL NADU, WITH NOTES ON THEIR FIELD ECOLOGY

INTRODUCTION

The Odonata fauna of south India is generally not so well known. Our knowledge of the dragonflies of the peninsula is confined to the works of Fraser (1924, 1932, 1933, 1934 and 1936). Recently Rao and Lahiri (1982) listed the dragonflies of Silent Valley and Kumar and Khatri (1985, 1986) recorded the dragonflies of Eastern Ghats in Tamil Nadu, to add to our knowledge of dragonflies of south India.

I have been engaged in a detailed study on the hydrobiology of Vedanthangal Tank Sanctuary during the years 1986 and 1987. In course of these investigations collections were simultaneously made of the dragonfly larvae (which form a part of the zooplankton) and imagos from and around the tank. Field observations were taken on their flight period, oviposition and emergence period and the larval habitats. It is the first such record of dragonflies from this Sanctuary. A number of the species are common with those of Silent Valley in Kerala and of Javadi, Koli and Shevroy hills of Eastern Ghats in Tamil Nadu.

Vedanthangal Sanctuary (120 m above MSL) is about 82 km south of Madras city and 48 km inland from the Bay of Bengal. It is one of the oldest known bird sanctuaries in south India. The average rainfall is 1150 mm per annum, during the months of November to January, under the influence of the retreating NE monsoon. The sanctuary includes the *c*. 30 hectare Vedanthangal tank. For detailed topography of the sanctuary and the list of waterbirds visiting the Sanctuary, see Spillett (1968).

SYSTEMATIC ACCOUNT

Suborder Zygoptera, Family Platycnemididae

1. **Copera marginipes** (Rambur)

Platycnemis marginipes Rambur, 1842, *Ins. Neurop.*: 240.

Field ecology: Flight period – April to January; oviposition – November; emergence – November to February; larval habitat – among weeds at the bank.

Distribution: India: common. Rao and Lahiri (1982) recorded it from Silent Valley, Kumar and Khatri (1986) from Eastern Ghats.

Family: Coenagriidae

2. **Pseudagrion rubriceps** Selys

Pseudagrion rubriceps Selys, 1876, *Bull. Acad. Belg.* (2) 42:510.

Field ecology: Flight period—February to November; oviposition —November to January; emergence — January to February; larval habitat—among the weeds in shallow water.

Distribution: India: common.

3. **Ceriagrion coromandelianum** (Fabricius)

Agrion coromandelianum Fabricius, 1798, *Ent. Syst. suppl.*: 287.

Field ecology: Flight period—uncommon but occurs on wings almost round the year; oviposition—November to April; emergence-occurring almost round the year; larval habitat —perching on submerged roots.

4. **Ischnura aurora aurora** (Brauer)

Agrion delicatum Hagen, 1858, *Verh. Zool.-Bot. Ges. Wien.* 8: 479.

Field ecology: Flight period —common round the year; oviposition —November to April; emergence —continues round the year; larval habitat — occurs among the roots of floating plants.

5. **Agriocnemis pygmaea** (Rambur)

Agrion pygmaea Rambur, 1842, *Ins. Neurop.*: 278.

Field ecology: Flight period — October to April; oviposition —November to April; emergence — January to April; larval habitat — among weeds in turbid water near the bank.

Distribution: India: common.

Family : Lestidae

6. **Lestes alata** Hagen

Lestes alata Hagen, 1858, *Verh. Zool. – Bot. Ges. Wien. 8: 478.*

Field ecology: Flight period—common on wings from November to January; emergence — October to January; larval habitat — in marshy areas of the lake.

Distribution: India: peninsula. Kumar and Khatri (1985) recorded it from Javadi hills in Eastern Ghats.

Suborder: Anisoptera Family : Gomphidae

7. **Ictinigomphus rapax** (Rambur)

Diastatoma rapax Rambur, 1842, *Ins. Neurop*: 169

Field ecology: Flight period—April to January; oviposition—November to January; emergence —October to November; larval habitat —amidst bottom debris in shallow turbid water near the bank.

Distribution: India: common.

Family : Aeshnidae

8. **Anax guttatus** (Burmeister)

Aeshna guttatus Burmeister, 1839, *Handb. Ent.* 2: 840.

Field ecology: Flight period—October to January; oviposition—November; emergence—January; larval habitat — at bottom and among weeds a little away from the bank.

Distribution: India: common.

9. **Anax immaculifrons** Rambur

Anax immaculifrons Rambur, 1842, *Ins. Neurop.*: 189.

Field ecology: Flight period — September to May, rarely seen; oviposition — March to April; emergence — October to November; larval habitat — in small rivulet near the lake.

Distribution: India: common in NW India. Kumar and Khatri (1986) recorded it from Javadi hills in Eastern Ghats.

Family : Libellulidae

10. **Potamarcha obscura** (Rambur)

Libellula obscura Rambur, 1842, *Ins. Neurop.*: 64.

Field ecology: Flight period —October to April; ovipostion —November to December; emergence —April to

May; larval habitat on muddy bottom near the bank.
Distribution: India: Common.

11. **Orthetrum sabina sabina** (Drury)
Libellula sabina Drury, 1770, *Ill. Exot. Ins.*, 1: 114.
Field ecology: Flight period —common on wings throughout the year; oviposition —almost round the year; emergence —same period; larval habitat — occurs in marshy side pools on sandy substratum.
Distribution: India: common. Rao and Lahiri (1982) recorded it from New Amarambalam R.F., Kerala; Kumar and Khatri (1985) from Javadi hills in Eastern Ghats.

12. **Orthetrum pruinosum neglectum** (Rambur)
Libellula neglecta Rambur, 1842, *Ins. Neurop.*: 86.
Field ecology: Flight period —occurs on wings throughout the year; oviposition—almost round the year; emergence — more common from January to April; larval habitat —at bottom amidst sand and mud.
Distribution: India: common. Rao and Lahiri (1982) recorded it from Silent Valley; Kumar and Khatri (1985, 1986) from Koli, Javadi and Shevroy hills in Eastern Ghats.

13. **Orthetrum triangulare triangulare** (Selys)
Libellula triangularis Selys, 1878, *Mitth. Mus. Dresden*, : 314.
Field ecology: Flight period —October to February; oviposition —April to May; emergence —January to March; larval habitat — occurs in muddy substratum.
Distribution: India: common.

14. **Palpopleura sexmaculata sexmaculata** (Fabricius)
Libellula sexmaculata Fabricius, 1787, *Mant. Ins., 1:* 338.
Field ecology: Flight period —October to April; oviposition —January to February; emergence —April; larval habitat —among weeds near the bank.
Distribution: India: Common.

15. **Acisoma panarpoides panarpoides** Rambur
Acisoma panarpoides Rambur, 1842, *Ins. Neurop.:28.*
Field ecology: Flight period – on wings almost round the year; oviposition – continuous round the year; emergence – commonly in September to October and January to February; larval habitat – among aquatic vegetation.
Distribution: India: common.

16. **Brachythemis contaminata** (Fabricius)
Libellula contaminata Fabricius, 1793, *Ent. Syst.*, 2: 382.
Field ecology: Flight period — common on wings round the year; emergence —February to March; oviposition — November to December; larval habitat —in muddy substratum.
Distribution: India: common. Kumar and Khatri (1986) recorded it from Shevroy hills in Eastern Ghats.

17. **Diplacodes trivialis** (Rambur)
Libellula trivialis Rambur, 1842, *Ins. Neurop.*: 115.
Field ecology: Flight period—common from September to April; oviposition—almost continuously; emergence — occurs at irregular intervals; larval habitat in weeds at muddy bank.
Distribution: India: common. Rao and Lahiri (1982) record it from Silent Valley, Kumar and Khatri (1985, 1986) from Javadi and Koli hills in Eastern Ghats.

18. **Neurothemis tullia tullia** (Drury)
Libellula tullia Drury, 1773, *Ill. Exot. Ins*, 2:85.
Field ecology: Flight period—November to February; emergence —October to November; larval habitat — among weeds in swampy part of the lake. Imagos occur in isolated colonies, Fraser (1936) recorded its colonies from swamps or weedy tanks along the Western Ghats and peninsula.
Distribution: India: common in peninsula. Rao and Lahiri (1982) recorded it from New Amarambalam R.F. in Kerala.

19. **Trithemis festiva** (Rambur)
Libellula festiva Rambur, 1842, *Ins. Neurop.:* 92.
Field ecology: Flight period —common on wings almost round the year; oviposition —January to March; emergence —July to November; Larval habitat —in weeds, cinging to roots, etc.
Distribution: India: common. Kumar and Khatri (1985) recorded it from Javadi hills in Eastern Ghats.

20. **Pantala flavescens** (Fabricius)
Libellula flavescens Fabricius, 1798, *Ent. Syst. suppl.* 1285.
Field ecology: Flight period – November to February; oviposition – November to December; emergence – December to January; larval habitat – among weeds. Imagos are known migrants and their presence at the Sanctuary corresponds with that of NE monsoon.
Distribution: India: common. Kumar and Khatri (1985, 1986) recorded it from Javadi, Koli and Shevroy hills in Eastern Ghats. Kumar (1989) studied its biology and seasonal distribution in Madras (Tamil Nadu).

21. **Tramea virginia** (Rambur)
Libellula virginia Rambur, 1842, *Ins. Neurop.*, 33
Field ecology: Flight period—November to April; oviposition —October to November; larval habitat — in submerged weeds and roots in deep water. A rare species.
Distribution: India: common in north India. Kumar and Khatri (1985) recorded it from Javadi hills in Eastern Ghats.

Discussion

Shape, size and nature of a water body are very important in habitat selection of dragonflies. If a comparison is made between the dragonflies of Vedanthangal

Sanctuary and those of the Renuka Wildlife Sanctuary in western Himalaya (Kumar 1978), it is observed that a number of dragonflies, which occur along the stream in Renuka, are absent at Vedanthangal. On the other hand, species which occur around the lake are mainly common species. This is significant in view of the geographical location of the two sanctuaries.

I am grateful to the Director, Zoological Survey of India, and the Officer-in-Charge, Environmental Monitoring Wing, Zoological Survey of India, Madras, for permission to undertake the present study and field and laboratory facilities.

April 20, 1989 ANIL KUMAR

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46. SEASONAL CHANGES IN THE POPULATION OF EARTHWORMS (OLIGOCHAETA) IN AN ORCHARD

(With two text-figures)

Introduction

Ecological studies on earthworms are of special interest since they play an important role in enhancing soil fertility (Edwards and Lofty 1977). But such studies on the oriental earthworms have remained more or less neglected. There are, however, a few informative publications on the seasonality and population dynamics of Indian earthworms (Roy 1957, Gates 1961, Dash and Patra 1977, Reddy and Alfred 1978, Senapati *et al.* 1979, Chauhan 1980, Senapati and Dash 1981, 1984, Julka and Mukherjee 1984, Krishnamoorthy and Ramachandra 1988, Mishra and Ramakrishnan 1988). This paper deals with seasonal fluctuations in the population of earthworms in a plum orchard during the course of a year (September 1984 to September 1985).

Study Area

An area of approximately 75 sq. m was selected for this study in a 15 year old plum orchard on a hill terrace at Kailar village (alt. 1450 m; 30°55' N; 70°10' E) about 5 km from Solan on Sabathu road in Himachal Pradesh. The undergrowth in the orchard consisted of grasses and weeds which were cut periodically. They remained green during March-October, and became dry and pale in November-February. In January 1985, a mixture of superphosphate and potash fertilizers was added to the soil which was subsequently ploughed. The climate of the area can be divided into four distinct seasons: spring (late February to April), summer (May to August), autumn (September to middle of November) and winter (middle of November to middle of February).

Material and Methods

Worms were extracted at monthly intervals by application of 0.55% formalin solution (Raw 1959) over ten randomly selected quadrats (25 x 25 cm each). Soil temperature, soil moisture and soil organic matter were determined for surface soil at 10 cm depth with a soil thermometer, oven–drying method at 100° C for 24 hours and Walkley Black's rapid titration method respectively. Rainfall data were procured from Y.S. Parmar, University of Horticulture and Forestry at Solan.

Observations

The soil was brown clayey loam with an alkaline pH range of 7.9 to 8.3. Seasonal changes in soil temperature, soil moisture, soil organic matter and rainfall are depicted in Fig. 1.

Five different species of earthworms, viz. *Octolasion tyrtaeum* (Savigny), *Bimastos parvus* (Eisen), *Drawida japonica* Michaelsen, *Lennogaster pusillus* (Stephenson) and *Plutellus* sp. were recorded in the orchard during the period under study. Data on the relative

TABLE 1
RELATIVE DENSITY AND RELATIVE FREQUENCY OF EARTH-WORMS IN A PLUM ORCHARD IN HIMACHAL PRADESH

Species	Relative density (%)	Relative frequency (%)
O. tyrtaeum	79.15	92.31
D. japonica	19.18	38.46
B. parvus	1.37	15.38
L. pusillus	0.15	7.69
Plutellus sp.	0.15	7.69

density and relative frequency (Table 1) showed that *O. tyrtaeum* was the most dominant and common species, followed by *D. japonica*, *B. parvus*, *L. pusillus* and *Plutellus* sp.

Monthly fluctuations in the population density of earthworms are shown in Fig. 2A. Two major peaks – one in April and another in July-September, were observed. The population was at a low level in October to March and May to June. The maximum biomass (wet weight) for the total earthworm population was recorded in July-September (Table 2). The average monthly biomass was 9.02 g wet weight/sq.m.

Seasonal changes in the population of *Octolasion tyrtaeum* represented by different age groupings are illustrated in Fig. 2B. The juvenile population structure had two distinct peaks, one in April and another in September. Between these two peaks there were phases when they were absent, as during January-March, May and November. Except in November, clitellate adults were encountered throughout the year. Their population was at a higher level during July-October.

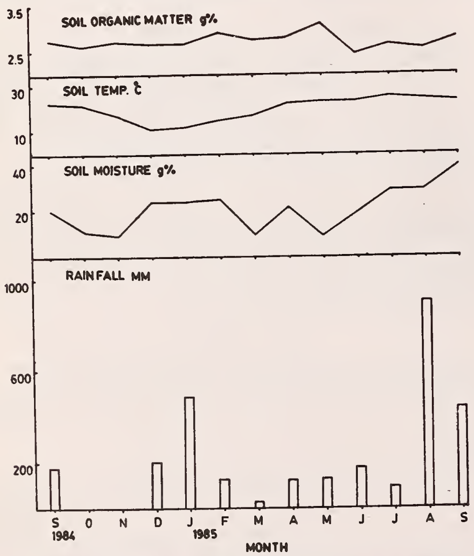

Fig. 1. Seasonal changes in rainfall and soil parameters.

Beginning in July, the juvenile population of *Drawida japonica* (Fig. 2C) increased to a maximum in July, followed by a gradual decline to zero in October. The population of clitellate adults rose from August to reach the maximum in September. A few specimens were also found in February. This species was not encountered during October-January, March and May-June. Only 1-3 specimens of *Bimastos parvus*, *Lennogaster pusillus* and *Plutellus* sp. each were recorded during August-September and their seasonality could be ascertained.

DISCUSSION

Soil temperature and soil moisture are considered to affect seasonal fluctuations in the population density of earthworms (Reynolds and Jordan 1975, Edwards and Lofty 1977). During the present studies, the correlation between worm density and soil moisture (r = 0.476) and soil temperature (r = 0.529) were analysed, and were found to be non-significant statistically. But the combined influence of these two parameters on the seasonality of the worms showed a significant positive correlation (r = 0.672; p <0.02). The correlations between total biomass (wet weight) and soil moisture (r = 0.572; p <0.05), soil temperature (r = 0.557; p <0.05), and combined soil moisture and temperature (r=0.754; p <0.01) were positively significant. The impact of changes in the rainfall and soil organic matter on the worm density was non-significant (rainfall/worm density (r) = 0.3222; soil organic matter/worm density (r) = 0.065). Kale and Krishnamoorthy (1978) also support the view that the worm population density is not related to organic matter.

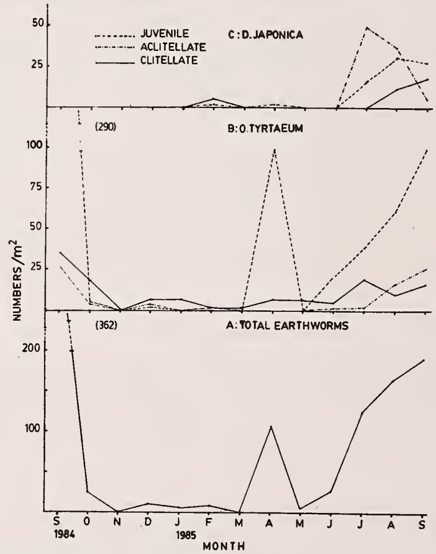

Fig. 2. Monthly fluctuations in population density of earthworms.

TABLE 2
BIOMASS (WET WEIGHT) IN G% OF EARTHWORMS IN A PLUM ORCHARD IN HIMACHAL PRADESH

Month	*O.tyrtaeum*	*D. japonica*	*B. parvus*	*L. pusillus*	*Plutellus* sp.	Total Earthworms
Sep. 1984	33.36	–	0.06	–	–	33.42
Oct.	4.33	–	–	–	–	4.33
Nov.	–	–	–	–	–	–
Dec.	1.68	–	–	–	–	1.68
Jan. 1985	2.22	–	–	–	–	2.22
Feb.	0.84	2.75	–	–	–	3.59
Mar.	0.21	–	–	–	–	0.21
Apr.	3.22	0.23	–	–	–	3.45
May	2.03	–	–	–	–	2.03
June	2.24	–	–	–	–	2.24
July	10.03	12.52	–	–	–	22.55
Aug.	8.24	11.23	0.04	–	0.06	19.57
Sep.	13.73	8.18	–	0.04	–	21.95

The average monthly biomass of total earthworms (9.02 g wet weight/sq. m in the orchard under study was much lower as compared to pastures /grasslands of Orissa, viz. 30.25 g/sq. m in a grassland (Dash and Patra 1977); 56 g/sq. m and 41 g/sq. m in ungrazed and grazed pastures repsectively (Senapati and Dash 1981). Highly leached thin mountain soil may be one of the reasons for lower production of worm biomass.

Emergence pattern of juveniles of *O. tyrtaeum* (Fig. 2B) shows one peak in April and prolonged emergence from June to a second peak in September. This corresponds to the soil temperature varying between 20-25° C and soil moisture between 20-40%. A sharp decline to nil population of juveniles in May can be due to low level of soil moisture (<10%). According to Dash and Senapati (1980), worms undergo diapause when the soil moisture level reaches around or below 10%. The population structure of *D. japonica* indicates a unimodel emergence of juveniles from July to September with a single peak in August. During this period the soil temperature is around 25°C and soil moisture between 30-40%.

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47. TAXONOMICAL AND DISTRIBUTIONAL NOTES ON *POLYGALA TELEPHIOIDES* KLEIN EX WILLD. IN INDIA

(With a text-figure)

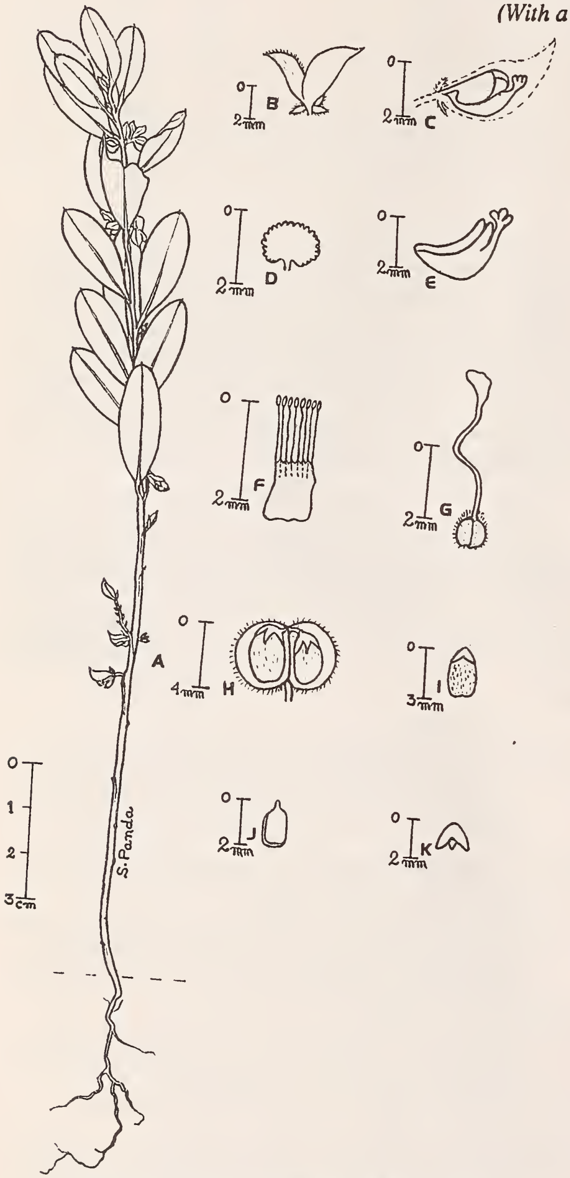

Fig. 1. *Polygala telephioides* Klein ex Willd.
A. Plant; B. Calyx; C. Flower; D. Middle lobe of corolla; E. Keel petal with crest; F. Androecium; G. pistil; H.V.S. of fruit; I. Seed; J. Embryo; K. Strophiolar appendage.

While working on the family Polygalaceae, Bennett (in Hook. f., Fl. Brit. India 1: 205.1872) recorded the name '*Polygala telephioides* Willd. sp. pl. 3(2): 876. 1802' and erroneously accepted the description of *P. buxiformis* Hussk. [in Miq., Mus. Bot. 1:161. 1863-64] considering the latter species along with *P. serpyllifolia* Poir. as synonyms of *P. telephioides* Candolle (Prodr. 1: 332. 1824) diagnosed *P. telephioides* referring Willdenow's work which matched exactly with Klein's material [Klein 936, 1795, India, Willdenow Cat. No. 12952 (Type at B), Photo at CAL]. Gamble [in Fl. Madras 1: 59 (42). 1915] and Mathew [in Fl. Tamil.Karnatic 1:74, f. 1983] have diagnosed *P. telephioides* following Bennett's (loc.cit.) description.

However, on critical examination it appears that *P. serpyllifolia* and *P. buxiformis* are conspecific while *P. telephioides* is a distinct species and is easily distinguishable by ".......... *caule simplici erecto* ....". The incomplete characters of *P. telephioides* noted on the specimen (at B) attributed by Klein and endorsed by Willdenow is insufficient for identification. So, a detailed description with illustration (Fig. 1) is provided herewith for the easy recognisation of this neglected taxon.

Polygala telephioides Klein *ex* Willd., Sp. Pl. 3(2): 876. 1802; DC., Prodr. 1: 332. 1824; Roxb., Fl. Ind. 3: 218. 1832; Wt. *et* Arn. Prodr. 36. 1834.

Erect annual, ± 21 cm tall, unbranched or rarely with 1–2 branches from the base. Stem terete, faintly ridged, scabrid-pubescent; internodes 5-6 mm. Leaves simple, alternate, exstipulate; petiole ± 1 mm, hairy; lamina obovate-elliptic to oblong-lanceolate, 22-24 x 8-10 mm, margin recurved, apex rounded with a minute mucro, glabrous, dorsally glauscesent; midvein slightly depressed above and elevated below, lateral veins obscure. Flowers 4.5-5.5 x 3.7-3.9 mm, fascicled on minute (± 1 mm) axillary and/or extra-axillary peduncles; bracts 1 mm long, scaly, narrowly lanceolate. Sepals 5, unequal, persistent; outer 3 small, 1.3-1.7 x 0.9-1.2 mm, acute, pubescent; largest sepal 4.5-5.5 x 3.5-3.8 mm, oblique, acuminate, glabrous, enclosing other parts of the flower. Petals united at the base, 3–lobed, middle lobe clawed, reniform, undulated, irregularly dentate, 1.2-1.4 mm long; keel petal 3.5-4.5 mm long, crested; crest 1-1.2 mm long. stamens 8, lower half united into a 1-1.3 mm long transparent sheath; filaments 1-1.3 mm long; anthers elliptic. Ovary superior, globose, hairy, 0.5 mm in diam., 2-loculed; one pendulous ovule in each locule on axile placenta; style undulating, 2.8-3.2 mm long; stigma elongated, flat, 0.9-1.1 mm long. Capsules loculicidal, 4.3-4.7 x 3.6-4.0 mm, 2-seeded, margins hairy, apex deeply noticed. Seeds oblong, silky, 2.8-3.3 mm, albuminous; strophiolar appendage 3-lobed, unequal, 1-1.4 mm long. Embryo straight, 1.8-2.3 mm long; cotyledons thick.

Specimen examined: Brook's Hill, Sambalpur (Orissa), 10 July 1987, *Das et Panda* 694 (Fls. & frts.).

Ecology: Less common in open places among grasses and other small herbaceous plants on red lateritic soil.

Distribution: Indian Archipelago, China and Philippines. In India it was known to grow in Karnataka, Travancore, Tamil Nadu and Kerala. The present record of occurrence of the species in Orissa also is the first report of this plant from eastern India.

ACKNOWLEDGEMENTS

We thank the Director, Botanical Survey of India, for permitting us to use its herbarium and library and also for awarding a Senior Research Fellowship to one of us (S.P.). We are also thankful to the Principal, Presidency College, Calcutta, for providing various research facilities.

SAURIS PANDA
R.N. BANERJEE
A. P. DAS

September 21, 1989

48. DISTRIBUTION OF SOME RARE AND LESS KNOWN SPECIES FROM DUDHATOLI REGION (GARHWAL HIMALAYA)

(With two text-figures)

The present communication highlights the recent occurrence and distribution of some less known, threatened angiospermic species of the Himalayan region. During a detailed floristic exploration (1982-86), of Dudhatoli hills (29°55'N to 30°10 N and 78°40'E to 79°14'E) in the Pauri Garhwal district, the authors could collect *Berberis petiolaris* Wall. ex G. Don (Berberidaceae); *Brassaiopsis aculeata* (Buch.-Ham. ex D. Don) Seem. (Araliaceae) and *Gerbera maxima* (D. Don) Beauv. (Asteraceae).

These curious taxa are poorly represented in the National Herbaria of BSD and DD, Dehra Dun. Previously, Hooker (1872, 1879, 1881); Duthie (1906, on the basis of the collections of Strachey and Winterbottom in the years 1846-1849) and Osmaston (1927) have recorded these species and marked them as very rare or scarce. These taxa have no other record of their occurrence from the Western Himalaya (Gurucharan and Kachroo 1976, Dhar and Kachroo 1979 and Naithani 1984).

Hence, the present collection and distributional notes of these taxa would be of interest in the conservation of the rare germplasm *in situ* as well as *ex situ*. Moreover, these species have several folk uses in this region. Consequently, they are facing the problems of over exploitation and destruction of their natural habitats. This note gives a brief description, illustrations of some parts, population status and the ecology of the species.

Berberis petiolaris Wall. ex G. Don, Gen. Syst. 1:116, 1831; Osmaston, For. Fl. Kum. 18, 1927. *B. pachyacantha* Kohne. Deutsch. Dendr. 170, 1893; Andrendt, J. Linn. Soc. 57, 191, 1961. *B. vulgaris* Linn. var. *vulgaris* Hook. f. FBI. 1: 109, 1878; Duthie, Cat. Pl. Kum. and Garh. 8, 1906.

Local name: Chottar.

Large sub-deciduous, spiny shrubs reaching up to 4 m high. Leaves clustered on the nodes, 1.2-6 x 2-3.5 cm. Inflorescence in lax 4-8 cm long drooping racemes. Sepals petaloid, 6 in 2 whorls, yellow. Style extremely short (Fig. 1 A and B).

Flowering: April-May;

Fruiting: August-September.

Distribution and ecology: Western Himalaya (temperate to alpine zones). The species grows at an elevation of 300 m in Dudhatoli region, forming gregarious patches in association with species of *Berberis*, *Cotoneaster*, *Viburnum*, *Rosa* etc.

Local uses: The species has high medicinal value locally. The yellow dye in the form of decoction, obtained from roots and stem bark, is used in eye complaints and fever. Besides, the ripened fruits are largely collected for eating.

Specimen examined: GUH. 6152, R.A. Silas, Sept. 1984, Dudhatoli (Kodiabagarh area), 3000 m Pauri Garhwal, Uttar Pradesh; BSD, 37387, B.D. Naithani, 1967, Tehri Garhwal, 3246 m.

Brassaiopsis aculeata (Buch.-Ham. ex D. Don) Seem. J. Bot. 2: 293, 1864: Hook. f. FBI. 2; 738, 1879; Duthie, Cat. Pl. Kum. and Garh. 76, 1906; Osmaston, For. Fl. Kum. 263, 1927.

Moderate evergreen trees, reaching up to 5.5 m high and 30-75 cm in dia. Young twigs and inflorescence unarmed, rusty tomentose. leaves 30-60 cm long, alternate, digitately compound. Inflorescence lax umbellate, many flowered, 30-60 cm long panicle (Fig. 2 A-E).

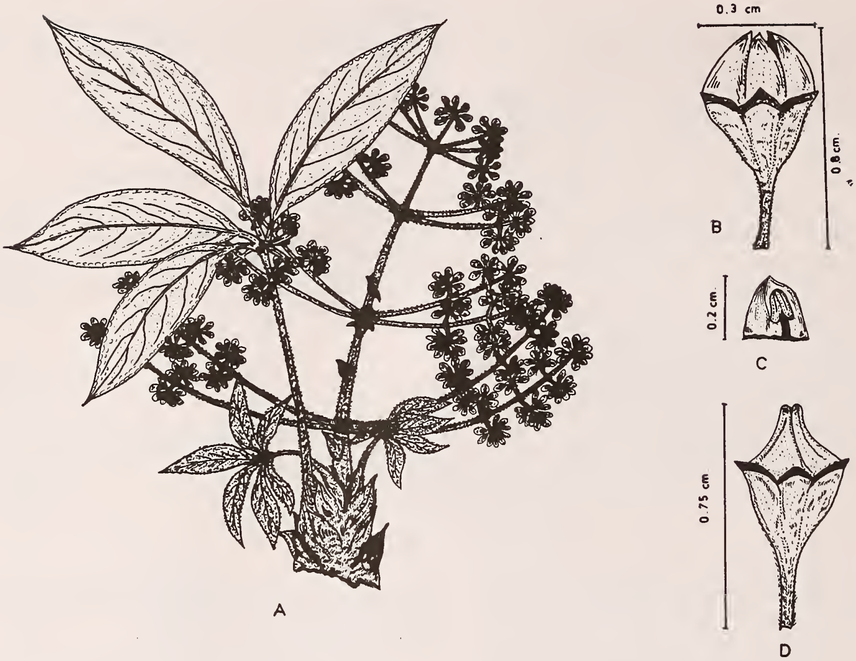

Fig. 1 *Brassaiopsis aculeata* (Buch.-Ham. ex D. Don) Seem.
A. Flowering twig; B. Single flower; C. Petal and stamen; D. Ovary with short style.

Fig. 2. *Gerbera maxima* (D. Don) Beauv.
A. Habit; B. Involucral bracts; C. Involucral bracts (inner); D. Tubular florets; E. Tubular florets dissected.

Flowering: September-October;
Fruiting: January-June.
Distribution and ecology: Temperate Himalaya (1700-2200 m). A solitary specimen of this species was observed in the investigated area, growing near a fresh water ravine, at an elevation of 2200 m, associated with species of *Skimmea, Viburnum, Prinsepia* etc. near village Daira of Dudhatoli, Pauri Garhwal, Uttar Pradesh.
Local uses: The foliage of the tree is lopped for cattle as green fodder in the area.

Gerbera maxima (D. Don) Beauvered in Bull. Soc. Bot. Geneve' Ser. 2, 2:44, 1910; Kitamura, FEH. 391, 1966. *Chaptalia maxima* D. Don Prodr. 166, 1825. *Gerbera macrophylla* Benth. ex Hook. Gen. Pl. 2: 497, 1873; Hook. f. FBI.3: 391, 1881; Duthie, Cat. Pl. Kum. and Garh. 98, 1906.
Local name: Kabasee.

Perennial, woolly-tomentose and rhizomatous herbs. Leaves up to 30 cm long, 8-12 x 4-8 cm, base sagittate, dark green and coriaceous above, woolly white-tomentose beneath. Heads radiating, terminal solitary, divergent, 2-5 cm across, purplish-white. Involucral bracts 3-4 seriate (Fig. 3 A & E).

Flowering: May-July;
Fruiting: August-September.
Distribution and ecology: Temperate Himalaya (Garhwal to Arunachal Pradesh), 1800-2000 m. The species has been collected after the collection of Strachey and Winterbottom (1846-1849), from the Dudhatoli region, at an elevation of 2000 m growing as an undergrowth of dense oak (*Quercus leucotrichophora*) forests.
Local uses: The white cottony layers of leaves, found on lower surface, is commonly used to ignite the tobacco packed in local pipes made of oak leaves by the inhabitants.
Specimen Examined: GUH, 6240, R.A. Silas, 8 July 1985, enroute Binsar-Dudhatoli trek, Pauri Garhwal, Uttar Pradesh.

ACKNOWLEDGEMENTS

We are thankful to the Herbarium authorities of BSD and DD Herbaria, Dehra Dun, for providing the Herbarium facilities and the literature.

R.A. SILAS
February 15, 1990 R.D. GAUR

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49. *XANTHIUM SPINOSUM* L.– A NEW RECORD FOR THE INDIAN SUBCONTINENT

(With a text-figure)

Xanthium spinosum L. has not so far been reported from the Indian subcontinent. During the course of plant exploration in Kashmir Himalaya, we came across specimens of *Xanthium spinosum* L. (Asteraceae), growing on wasteland, roadsides and sheep dung at some places in the Kashmir valley. This is thus a new report for Indian subcontinent. The voucher specimens are housed in the Herbarium of Kashmir University (KASH). The following description is based on these specimens.

Xathium spinosum L., Sp. Pl. 987. 1753.

Erect, annual, usually densely branched, coarse herbs. Stem tomentose, with strong, yellowish, trifid (-4-fid) spines on 2-4 mm long stalk, upto 3 cm long. Leaves with 2 mm-1 cm long, tomentose petioles; blade narrowly lanceolate, up to 8 cm long, 2.5 cm broad below the middle, lobed or not, base cuneate, apex gradually narrowed into an acute-acuminate tip, upper surface canescent, more so on veins, lower densely canescent, silvery. Flowers unisexual, monoecious, in axillary and terminal heads, male above and female below. Male heads spherical, *c.* 6 mm across, comprising numerous, crowded florets, each with tubular, 5-toothed, green corolla; anthers 5, free, oblong, *c.* 1 x 0.36 mm, basifixed, tips mucronate, inflexed; filaments monadelphous, 1.2 mm long. Female heads ovoid, *c.* 6 mm long, each comprising 2 florets within a prickly envelope formed by involucral bracts and terminating in two short beaks; styles thread-like, dark

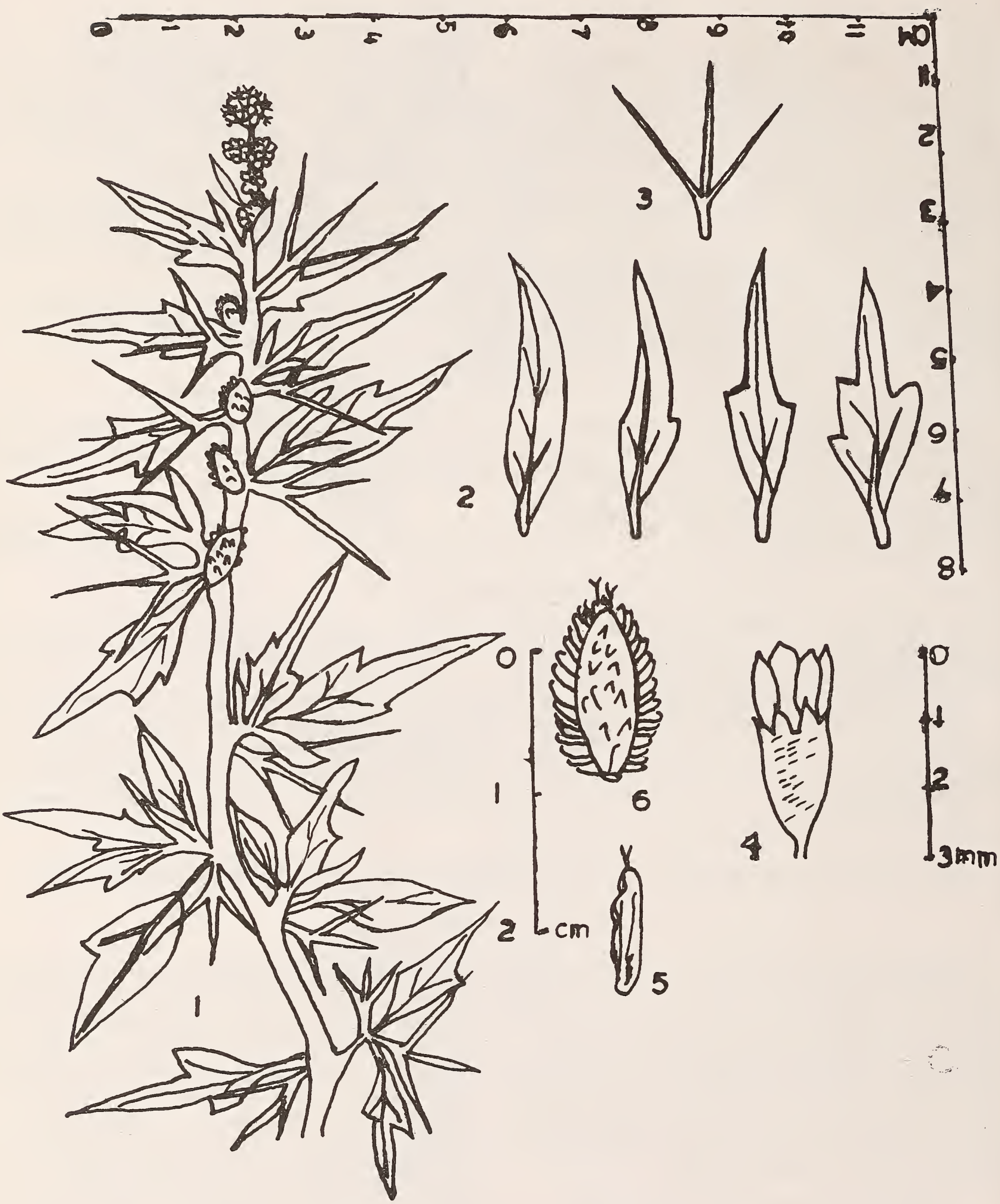

Fig. 1. *Xanthium spinosum* L.
1. A portion of plant; 2. Leaf variation; 3. A trifid spine; 4. Male floret; 5. Female floret; 6. Fruit.

brown, protruding through the beaks. Fruit elliptic, 12 x 4-5 mm, densely covered with hooked bristles. Seeds 4-6 mm long, oblong, glabrous.

Specimens examined: Ganderbal (Rangil), 1,750 m, in Soil Conservation Farm, above water treatment plant, 14 June 1981, *G.H. Dar* 2056 (KASH); Sind valley (Pranshur), 3,350 m (an alpine meadow at one days journey on foot from Sonamarg), on heaps of sheep dung, 22 August 1983, *G.H. Dar* 7934-35 (KASH); Srinagar (Hazratbal), 10 km north of Srinagar), 1,625 m, near electric substation, on waste places, in association with *X. strumarium* L. and *Cannabis sativa* L., 1 September 1983, *A.R. Naqshi* 8148-8149 (KASH); Srinagar (Chatterhama), 18 km north of Srinagar, 1,700 m, along the lower bank of Bijili Canal, 2 September 1983, *G.H. Dar* 8357, 8358 and 8359 (KASH); Srinagar around the graveyards, very common) July 1988, *A.R. Naqshi* s.n. (KASH).

Flowering and fruiting: Mid August-October.

Xanthium spinosum L., a recent introduction to India, differs from *X. strumarium* L. which is also an exotic, in the essential characters as shown in the key.

It is probable that the species, due to the presence of 'Bur', has come to India through the improved sheep breed brought from different European countries. This is strengthened by our collection of its specimens on the heaps of sheep dung in an alpine meadow of Sind valley.

KEY FOR SEPARATING TWO SPECIES OF *Xanthium*

Leaves attenuate to both ends, usually with trifid (4–fid) spines at base; fruiting bur blunt or with 2 inconspicuous beaks .... *X. spinosum*

Leaves cordate, rounded or sub–deltoid, unarmed in the axils; fruiting bur with usually 2 strong, porrect beaks .... *X. strumarium*

The specimens of the taxon observed during the present exploration showed vigorous growth and seemed to have adapted fully to the environmental conditions of their localities. This, coupled with the spiny nature of the plant (which affords protection against grazing, lopping and trampling), is indicative of its becoming a troublesome weed in the near future.

Financial assistance of the CSIR, New Delhi, is acknowledged.

G.H. DAR
A.R. NAQSHI
SHOWKAT ARA

June 15, 1989

50. *RICHARDIA SCABRA* LINN.– AN ADDITION TO THE FLORA OF ORISSA

Phulbani district in central Orissa covers an area of 11070 sq. km of which 7336 sq. km is under forest cover. The main vegetational types occurring in this district are tropical dry deciduous, tropical moist deciduous, riverine forest, mixed forest, sal forest and teak forests. However, major parts of this district are yet under-explored from the botanical point of view except for a few sporadic reports by Haines (1921-25), Mooney (1950) and others. In recent times, while collecting plants from different parts of the district in connection with an ethno-botanical investigation, we have collected a herbaceous specimen belonging to the family Rubiaceae which is apparently similar to the species of *Borreria* G.F. Mayer. On critical examination, the taxon is identified as *Richardia scabra* Linn. The generic difference between *Richardia* Linn. and *Borreria* F. Mayer is as follows:

Calyx and corolla 6 partite, stamens 6 (rarely 8), capsule 3–celled .... *Richardia*

Calyx and corolla 4 partite, stamens 4, capsule 2–celled .... *Borreria*

The available distributional data of the taxon shows that *Richardia scabra* was reported from Andhra Pradesh, Uttar Pradesh and Tamil Nadu. The occurrence of this species in Orissa extends the distributional range and forms a new record for this state. The specimen has been housed in the Herbarium, P.G. Department of Botany, Utkal University, Bhubaneswar. The nomenclature, phenology, ecological notes etc. have been provided below.

Richardia scabra Linn. Sp. Pl. 330. 1753; Mathew and Rani in Mathew, Fl. Tam. Carn. 3(2):740. 1983; Babu, Herb. Fl. Dehradun 230. 1977; Balakrishnan, Bull. Bot. Surv. Ind. 6(1): 85. 1964.

A procumbent hispidly pubescent herb, growing in hilly tracts.

Flowers and fruits: October–December.

Specimen examined: Kallinga Hills, 1100 m, Phulbani district – H.N. Subudhi.

Distribution: Native of South America, now introduced to many parts of the tropical old world.

Illustration: Mathew, Illustration Fl. Tamil Nadu Carnatic 2: f. 346. 1983.

H.N. SUBUDHI
B.P. CHOUDHURY
P.C. PANDA

December 12, 1989

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51. CHANGES IN THE STATUS OF TWO SPECIES IN THE GENUS *ARGOSTEMMA* (RUBIACEAE)

1. Hook. f. (1880) on describing *Argostemma tavoyanum* Wall. observed 'This may prove to be a variety of *A. courtallense* but the leaves are more acute, the calyx lobes more obtuse and the corolla smaller with shorter lobes'.

Working after more than a century of Hooker's study we got the opportunity of examining not only the earlier collections but also those collected since then and extant in different herbaria in India and abroad. Study of all these specimens throws light on the variability of taxa concerned, which were not observed by Hook. f.

A comparison of the descriptions of *A. courtallense* and *A. tavoyanum* in consideration of the specimens available now, shows that obtuse lobes of calyx, smaller corolla with shorter lobes and acute leaf apex are present in both the species. On the other hand, there is no other significant character on the basis of which they may be kept distinct to any extent. Thus *A. courtallense* and *A. tavoyanum* are conspecific although originally described from distant localities.

2. *A. anupama* Sivarajan (1984) was described on the basis of a single gathering *Sivarajan* 28706 from Kerala, near Calicut University campus. It was initially determined as *A. courtallense* (Sivarajan loc. cit.) but subsequently on closer examination described as a new species, being distinct from it 'in having more than 4 prominently petiolate leaves, and much smaller flowers about half the size of the latter'. This distinction may be noted when compared with its original description. But subsequent gatherings mentioned above lead to modification or enlargement of the description and the distinction does not hold good. More than 4 petiolate leaves and smaller flowers are evident in some specimens. Moreover, the anthers are free and curved, not connivent in a cone around the stigma as depicted by the author in the illustration —a characteristic evident in many species in young flowers before anthesis.

Thus *A. anupama* Sivarajan does not stand as a distinct species, and is conspecific with *A. courtallense*. The synonymy is presented below.

Argostemma courtallense Arn. in Ann. Nat. Hist. 3:22.1839 (Type: Peninsular India, Courtallum, 1835, *Wight s.n.* K); Hook. f. Fl. Brit. Ind. 3:42. 1880.

A. tavoyanum Wall. in Benn. Pl. Jav. Rar. 95.1839 (Type: Burma, Tennaserim, Tavoy, *Wall. Cat.* 8393 K-W microfiche); Hook.f. Fl. Brit. Ind. 3:43.1880, *synon. nov.*

A. anupama Sivarajan in Journ. Ind. Bot. Soc. 63:462. 1984 (Type: Kerala, near Calicut University campus, *Sivarajan* 28706 holo. CAL), *Synon. nov.*

Distribution: Peninsular India, Andaman Islands; Burma.

Note: Exsiccata studied will be cited in a forthcoming report.

Acknowledgements

Thanks are due to the Scientist SE-in-Charge of the Central National Herbarium, Indian Botanic Garden, Howrah, for facilities provided.

D.B. DEB
S.K. BASU

September 6, 1989

52. ON THE GENUS *NEANOTIS* LEWIS (RUBIACEAE) IN INDIA

In the course of taxonomic study of the genus *Neanotis* Lewis (Rubiaceae) in India, we observed some incongruity in taxonomic status and nomenclature of some taxa, which are presented here with necessary corrections.

1. *Neanotis monosperma* (Wt. & Arn.) Lewis var. *tirunelvelica* Henry and Chandrabose in Bull. Bot. Surv. India 17:188. 1975, was described on the basis of *A.N. Henry* 17454 (holo. CAL; iso. MH) collected from Tirunelveli dist., Tamil Nadu. The authors stated, inter alia, in the protologue 'there are 2-3 ovules in each locule on placenta arising from near the base of the partition wall'. But on examination of the holotype it is evident that the ovary is two loculed having one ovule attached at the middle of each locule, and that the fruit bears in each locule one seed provided with a broad ventral groove.

Further, the inflorescence is an axillary few-flowered cyme and calyx lobes are without intervening sinus. All these characteristics evidently indicate that the taxon represents the genus *Spermacoce* and not *Neanotis*. Moreover, the elliptic-lanceolate calyx lobes, filiform hyaline bracteoles, shape and size of the capsule, form of the seed etc. are characteristic of *S. latifolia* Aubl.

It is worthwhile to point out in this connection that *Borreria eradii* Ravi recently described from Kerala has been reduced by Deb and Dutta in Bull. Bot. Surv. India 18:216. 1976 to a synonymy of *Spermacoce latifolia*.

Thus the synonymy is as follows:

Spermacoce latifolia Aubl. Hist. Pl. Guiane Fr. 55.t. 1911. 1775 (Type: French Guiana, Cayenna, *Aubl. s.n.* P); Deb and Dutta in Journ. Econ. Tax. Bot. 5(5): 1037.1984. *Borreria latifolia* (Aubl. K. Schum. in Mart. Fl. Bras. 6(6): 61. 1888. *B. eradii* Ravi in J. Bombay Nat. Hist. Soc. 66(3):

539.t.1. f.1-10.1969 (Type: Kerala, Punalur, 20 June 1968; *N. Ravi* 2372 (B-D) iso. CAL). *Neanotis monosperma* (Wt. & Arn.) Lewis var. *tirunelvelica* Henry and Chandrabose in Bull. Bot. Surv India 17:188.1975 (Type: Tamil Nadu, Tirunelveli dist., Singampatti R.F., Manjanamparai, 4 September 1963, *Henry* 17454 A *holo.* CAL), *Syn. nov.*

Distribution: INDIA: Assam, Meghalaya, West Bengal, Sikkim, Kerala, Tamil Nadu; Nepal; Bhutan; Malaya Peninsula; Java, Sri Lanka.

2. *N. longiflora* (Hutch.) Lewis in Ann. Miss. Bot. Gard. 53:39. 1966 is based on *Anotis longiflora* Hutch. (1916), a later homonym of *A. longiflora* Benth. (1839). Hence the name *N. longiflora* (Hutch.) Lewis is illegitimate as per Art. 64 ICBN (1988) and as such it cannot stand. This species is given a new name as follows:

Neanotis hutchinsonii Deb et Dutta, nom. nov.

N. longiflora (Hutch.) Lewis in Ann. Miss. Bot. Gard. 53:39. 1966, nom. illegit; being based on *Anotis longiflora* Hutch. in Kew Bull. 1966: 35. 1916 (Type: Pulney Hills edge of evergreen forest, 2100 m, 6 September 1911, *C.E.C. Fischar* 2914 CAL), non Benth. (1839); Gamble, Fl. Pres. Madras 604. 1921; Fyson, Fl. S. Indian Hill St. 1:276. t. 222. 1932.

Distribution: INDIA: Kerala and Tamil Nadu.

3. *Hedyotis latifolia* Dalz. in Journ. Bot. 2:133. 1850. (Type: Malwan, *Dalzell s.n.* K.); Dalz. in Dalz. and Gibs. Bombay Fl. 116. 1861, was reduced to a synonym of *Anotis rheedei* Wt. and Arn. by Hook. f. Fl. Brit. India 3: 73, 1880 erroneously as this is distinguishable from *A. rheedei* Wt. and Arn.in (1) the flowers long pedicelled, solitary or in di trichotomously branched peduncle in the panicle, (2) hypanthium glabrous, (3) corolla broadly tubular, lobes glabrous, not puberulous or pubescent outside, (4) stamens adnate at the sinus of the corolla lobe and not at the throat of the corolla tube, anthers oblong and not linear, (5) capsules glabrous, rarely puberulous in the protruded portion, (6) seeds 2-4 in each locule, boat shaped, rounded to the back, longitudinally keeled on the hollow groove etc. Hence this is recognized as a distinct species as follows:

Neanotis latifolia (Dalz.) Deb et Dutta, comb. nov.

Hedyotis latifolia Dalz. in Journ. Bot. 2:133.1850 and in Dalz. and Gibs. Bomb. Fl. 116. 1861 (Type: Malwan, *Dalzell s.n.* K.); Hook. f. Fl. Brit. India 3:73.1880. in syn., non *Anotis rheedei* Wt. and Arn. (1834). *A. rheedei* sensu Cooke, Fl. Pres. Bomb. 2:21. 1903; Gamble, Fl. Pres. Madras 605. 1921, pro parte.

Distribution: INDIA: Maharashtra, Karnataka, Kerala, and Tripura.

D.B. DEB
RATNA DUTTA

September 6, 1989

53. REDISCOVERY OF SOME RARE FERNS OF KUMAUN HIMALAYA (WESTERN HIMALAYA)

During the year 1988, several collection trips were conducted by us especially to inaccessible areas of Kumaun Himalaya, which resulted in the collection of 6 species of ferns belonging 6 genera and 4 families. A perusal of earlier published records indicated that these ferns were not collected after the original collection, and subsequent workers included them on the authority of previous reports only (Dhir 1980, Pangtey and Punetha 1987). Therefore, these species were considered presumably extinct or on the verge of extinction in Kumaun Himalaya. As no published record is available other than the first reports, this note provides information about the rediscovery of 6 rare species of ferns of Kumaun Himalaya with other relevant information.

Voucher specimens are housed in the Herbarium, Department of Botany, D.S.B. College, Kumaun University, Naini Tal.

Family: Grammitaceae

Ctenopteris subfalcata (Bl.) Kunze, Bot. Zeit. 120. 1848; Dixit, Census Indian Pterid. 31. 1984. *Polypodium subfalcatum* Bl., Enum. Pl. Jav. 2: 130. 1828; Clerks, Trans. Linn. Soc. Lond. 2. Bot. 1: 549. 1880; Bedd., Handb. Ferns Brit. India 314. 1883; Duthie, Cat. Pl. Kumaun 230. 1906.

This extremely rare species was collected by Strachey and Winterbottom (1848) from Kalamundi around 2750 m. Later, Duthie (1884) collected it from Gini between 1800-2000 m and from Sosa between 2700-3300 m. This species has not been collected again from Kumaun Himalaya. This rare species is being collected after over one hundred years.

Status: Rather scarce and grows on moist, shaded, moss covered rocks between 1800-2400 m.

Specimens examined: Kumaun : Almora district, between Loharkhet and Dhakuri (SSS 1390); Wachham near Khati (SSS 1989); below Jatoli en route Sundardhunga Glacier (SSS 1255).

Family : Sinopteridaceae

Notholaena marantae (Linn.) Desv., J. de Bot. Appl. 1: 92. 1813; Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1: 567. 1880; Bedd., Handb. Ferns Brit. India 393. t. 213. 1883; Duthie, Cat. Pl. Kumaun 230. 1906; Dhir, Biblioth. Pterid. 1 : 42. 1980; Dixit, Census Indian Pterid. 62. 1984. *Acros-*

tichum marantae Linn., Sp. Pl. 2: 1071. 1753.

In Kumaun Himalaya, this extremely rare fern was collected by Strachey and Winterbottom (1848) from Kali Valley between 2800-3300 m. Later, Duthie (1884) and Reid (1891) collected it from Pindari Gorge around 2700 m. However, this species has not been collected from Kumaun since then. It has been collected again after nearly a century.

Status: Rather scarce and prefers to grow on dry rock surfaces, crevices and large boulders between 3500-3700 m.

Specimen examined: Kumaun : Almora District, Sundardhunga Glacier (SSS 1205).

Family : Woodsiaceae

Woodsia andersonii (Bedd.) Christ, Mem. Soc. Bot. France 1 : 45. 1905; Dixit, Census Indian Pterid. 124. 1984. *Gymnogramme andersonii* Bedd., Ferns Brit. India t. 190. 1867; Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1 : 569. 1880; Bedd., Handb. Ferns Brit. India Suppl. 100. 1892 (*pro parte*); Duthie, Cat. Pl. Kumaun 230. 1906.

This species has been collected from several localities in Kumaun Himalaya in the past by a number of workers, viz. Strachey and Winterbottom (1848) from Pindari around 3300 m; Anderson from Sundardhunga Valley around 3400 m; Duthie (1884) from above Garbyang between 3000-3300 m; Byans above Chalek between 3000-3400 m and Palang Gadh around 3200 m. This species has not been included in recent checklists of ferns of northwestern Himalaya and Kumaun Himalaya by Dhir (1980) and Pangtey and Punetha (1987) respectively. It is being collected well after a century from Kumaun Himalaya.

Status: Extremely rare. Grows preferentially on dry rocks and rock crevices between 3300-3700 m.

Specimens examined: Kumaun : Almora District, Sundardhunga Glacier (SSS 1210), Pindari Glacier (SSS 1285).

Family : Athyriaceae

Cystopteris montana (Lam.) Berh. ex Desv., Mem. Soc. Linn. Paris 6: 264. 1827; Bedd., Handb. Ferns Brit. India Suppl. 15. 1892; Dhir, Biblioth. Pterid. 1 : 81. 1980; Dixit, Census Indian Pterid. 131. 1984. *Polypodium montanum* Lam., Fl. France 1 : 23. 1778.

Duthie (1884) collected this rare fern from near Ralam Glacier between 3200-3800 m, Dhauli Valley between 3200-3600 m and Kutti Valley between 3200-3600 m. Not collected since then. The present collection is well after a century.

Status: Rare fern. Usually grows on humus-rich soils especially under rhododendron bushes between 3400-3700 m.

Specimens examined: Kumaun : Almora District, Pindari Glacier (SSS 1282).

Diplazium squamigerum (Mett.) Christ, Bull. Soc. Fr. 52. Mem. 1: 51. 1905; Dixit, Census Indian Pterid. 134. 1984. *Asplenium squamigerum* Mett., Ann. Lugd. Bot. 2 : 239. 1866; Hope, J. Bombay nat. Hist. Soc. 14: 245. 1902; Duthie, Cat. Pl. Kumaun 226. 1906.

This rare species was collected by Strachey and Winterbottom (1848) from near Khati (Almora district) around 2200 m and Pindari Gorge near Khati around 2200 m by Trotter (1891). However, this species was not collected by later workers from Khati so far. Recently, a specimen of this species has been collected by us from Khati after nearly a century.

Status: Rather rare species of fern and usually grows on humus-rich, dark shaded forest floors and forest margins around 2200 m.

Specimen examined: Kumaun: Almora District, Khati (SSS 1388).

Gymnocarpium dryopteris (Linn.) Newman, Phytol. 4: 371. 1851; Dhir, Biblioth. Pterid. 1 ; 106. 1980; Dixit, Census Indian Pterid. 135. 1984. *Polypodium dryopteris* Linn., Sp. Pl. 2: 1093. 1753; Duthie, Cat. Pl. Kumaun 228. 1906. *Polystichum dryopteris* (Linn.) Roth, Tent. Fl. Germ. 3 : 80. 1799; Pichi Sermolli, Index Fil. Suppl. 4 : 253. 1964. *Phegopteris dryopteris* Fee, Gen. Fil. 243. 1850–1852; Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1 : 545. 1880; Bedd., Handb. Ferns Brit. India 293. 1883; *Dryopteris linnaeana* C. Chr., Index Fil. 275. 1905.

Duthie (1884), Trotter (1888) and McLeod (1894) reported this species from Kumaun Himalaya without giving any definite locality. Dhir (1980) recorded it from *en route* Amarnath (Kashmir) but not from Kumaun. Further, no subsequent workers collected it from Kumaun since then. The present collection of this fern is after nearly a century.

Status: Extremely rare fern that grows in rock crevices and under the shade of large boulders between 3000-3200 m.

Specimen examined: Kumaun : Almora District *en route* Sundardhunga Glacier (SSS 1211).

We are thankful to Head, Department of Botany, D.S.B. College, Kumaun University, Naini Tal,for facilities and encouragement.

S. S. SAMANT
Y. P. S. PANGTEY

April 4, 1989

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INSECT SPECIES DIVERSITY IN THE TROPICS : SAMPLING METHODS AND A CASE STUDY[1]

RAGHAVENDRA GADAGKAR, K. CHANDRASHEKARA AND PADMINI NAIR[2]

(With ten text-figures)

The tropical regions of the world generally have a richer store of biological diversity than other regions of the globe. But most tropical habitats face a significant threat of destruction. Yet, little is known about tropical biotic communities. Suspecting that at least part of the reason for the poor documentation of tropical insect communities is the lack of appropriate research methodology, we have endeavoured to standardize a package of methods for quantitative sampling of insects, suitable for tropical ecologists with modest research budgets. This methodology includes the use of a small light trap as well as net sweeps, pitfall traps and scented traps. The methods have been used to sample insect species diversity patterns in three replicate one hectare plots each in twelve selected sites in the Uttara Kannada district of Karnataka, India. During this case study, we have encountered 16,852 adult individuals belonging to 1,789 species, 219 families and 19 orders of insects. Here, we provide evidence that this methodology is adequate for sampling insects and differentiating habitats on the basis of the distribution of insect species. Some interesting biological problems that tropical ecologists can study with the data generated from the application of these methods are also briefly illustrated.

INTRODUCTION

One of the few relatively undisputed generalizations in community ecology is a latitudinal gradient of increase in biological species richness and diversity from the temperate regions to the tropics (see Krebs 1985, Colinvaux 1986). Apart from being something of a rule in community ecology this means that those of us who live in the tropics enjoy a biologically rich environment. Recent work suggests that the richness of the tropical insect fauna is beyond all earlier expectations (Erwin and Scott 1980, Erwin 1983 and Stork 1988). It is equally undisputed, however, that most tropical organisms are poorly studied and the little that we do know about any group of organisms comes largely from studies of temperate species. This is expressed most dramatically in the statement that the number of biologists is negatively correlated with the number of biological species in different regions of the globe (Robinson 1978). The poor state of our understanding of tropical biology may be partly attributed to the relative economic backwardness of tropical countries, the lack of facilities for research and sometimes to the lack of the tradition of modern scientific work.

We suggest, however, that at least sometimes this is due to the lack of appropriate research methodology suitable for tropical conditions. Studies on insect species diversity and the long term monitoring of insect species and populations in different habitats are good examples. Almost all the major long term insect monitoring programmes are based on light trap catches, a method that requires uninterrupted supply of electricity, often in the mid-

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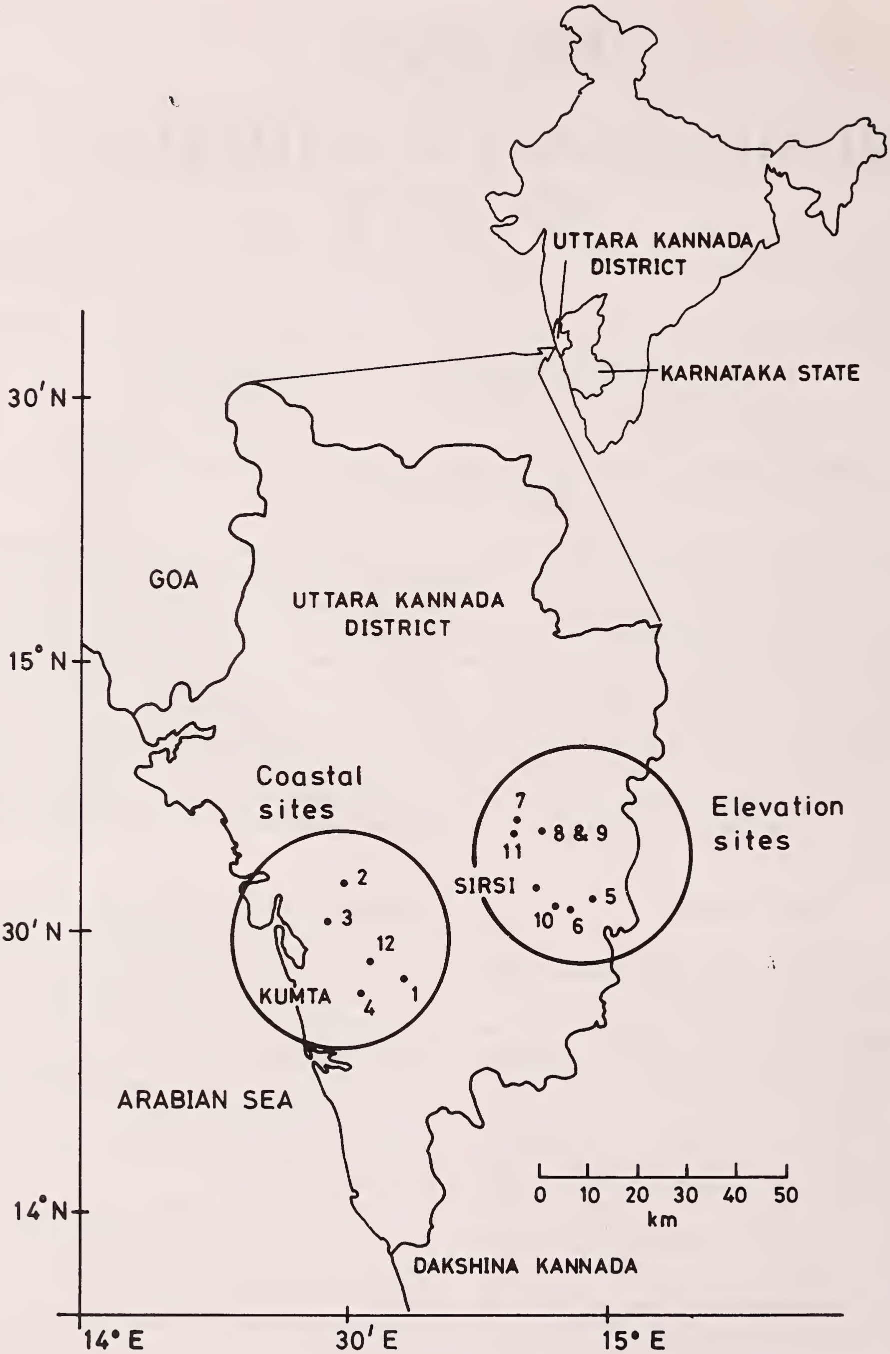


Fig. 1. Map of Uttara Kannada district showing the 12 sites used in the study.
1. Santagal R.F., 2. Nagur R.F., 3. Mirjan M.F., 4. Chandavar M.F., 5. Bengle M.F., 6. Bidaralli R.F., 7. Sonda R.F., 8. Bhairumbe M.F., 9. Betta land, 10. *Eucalyptus* plantation, 11. Teak plantation, 12. *Areca* plantation.

dle of a forest (Holloway 1983, 1987; Taylor 1978, Taylor *et al.* 1976, Wolda 1983a, b; Wolda and Roubik 1986). Sometimes the light traps are operated for years together without interruption. In most tropical situations, uninterrupted supply of electricity is nearly impossible even in cities and towns, let alone in the middle of a forest. The establishment and long term maintenance of electricity generating devices is prohibitively expensive for most ecologists working in tropical countries.

Suspecting that this has prevented many tropical ecologists from undertaking insect species diversity studies (see Wolda 1981a), we have attempted to standardize a package of methods for quantitative sampling of insects, suitable for tropical ecologists with modest research budgets. Our methodology is based on the use of a small light trap using routinely available dry batteries but substantially supplemented by other methods such as net sweeps, pitfall traps and scented traps. We show here that such a methodoloy is adequate for sampling insects and differentiating habitats on the basis of insect species distribution. We also briefly illustrate some interesting biological questions that ecologists in tropical countries can begin to ask with the data generated from such methodology.

Materials and Methods

Study sites: All our study sites were located in the Uttara Kannada district of the state of Karnataka, India (Fig. 1). The forested study sites fall broadly into two categories reflecting different levels of disturbance, namely, the Reserve Forests (R.F.) (relatively less disturbed) and the Minor Forests (M.F.) (relatively more disturbed). Sites representing both these categories were chosen in the coastal plains as well as at higher elevations (approximate altitude 600 m).

Selection of study sites in this manner ensured that these sites represent habitats under different environmental conditions and levels of disturbance. In addition to these forested habitats, three monoculture plantations (Pl.) and a leaf manure forest (Betta land) were also chosen for the study. At each of these sites, sampling was carried out in three one hectare plots. Thus a total of 36 one hectare plots from 12 habitat types were sampled (Table 1). A brief description of each study site is given in Table 2. All sampling was carried out during December, January, February and March which is part of the dry season in these localities.

Sampling methods: To develop a package of methods for quantitative sampling of insect species, collections were made using four different methods which were standardized after extensive field trials.

1. **Light trap:** A portable light trap which can be easily assembled and dismantled was fabricated using locally available inexpensive material. The light trap uses a fluorescent light source (Eveready Fluorolite 7.5 inch; 6 watts) powered by routinely available battery cells. The main framework of the trap consists of four iron legs, an aluminium roof and two aluminium baffles, between which the light source is placed. Insects attracted to the light were collected through a funnel in a cyanide jar, below the light. One light trap was placed in the centre of the plot. The light was switched on at dusk and allowed to burn itself out as the batteries drained after about seven hours. The insects trapped in the jar were collected the next morning and preserved in 70% alcohol.

2. **Net sweeps:** Net sweeps were carried out to collect insects off the vegetation. The nets used in systematic sweeping of the ground level vegetation were made of thick cotton cloth with a diameter of 30 cm at the mouth and a bag length of 60 cm.

For carrying out net sweeps the plot was divided into 100 quadrats, measuring 10 m x 10 m each. Six such quadrats were chosen at random and the entire ground level vegetation in the chosen quadrat was covered during the sweeping. Net sweeps were always done between 1000 h - 1200 hrs. The insects collected from each quadrat were transferred into polythene bags containing a cotton wad dipped in chloroform. Insects were later separated from the litter and preserved in vials containing 70% alcohol.

3. **Pitfall traps:** The pitfall traps consisted of a 2.5 litre plastic jar with an opening of 9 cm in diameter, buried at ground level and protected from rain by a tripod stand carrying a plastic plate of about 30 cm diameter at a distance of about 15 cm above the ground. One pitfall trap was placed in each of five randomly chosen 10 m x 10 m quadrats. Each jar carried 25 ml of 0.05% methyl parathion. The traps were set up between 1500 and 1700 hrs and were collected the next morning. Insects trapped in the jars were preserved in 70% alcohol.

TABLE 1
STUDY SITES, PLOTS AND SAMPLING PERIOD

	Reserve forest	Minor forest	Plantations	Leaf manure forest
Coastal sites	Santagal R.F. (Plot Nos. 1-3) March 1984	Chandavar M.F. (Plot Nos. 10-12) January 1984	*Areca* Pl. (Plot Nos. 34-36) January 1985	
	Nagur R.F. (Plot Nos. 4-6) February 1984	Mirjan M.F. (Plot Nos. 7-9) December 1984		
Elevation sites	Bidaralli R.F. (Plot Nos. 16-18) December 1983	Bengle M.F. (Plot Nos. 13-15) December 1983	Teak Pl. (Plot Nos. 31-33) December 1984	Betta Land (Plot Nos. 25-27) January 1985
	Sonda R.F. (Plot Nos. 19-21) December 1983	Bhairumbe M.F. (Plot Nos. 22-24) January 1984	*Eucalyptus* Pl. (Plot Nos. 28-30) December 1984	

TABLE 2
BRIEF DESCRIPTION OF STUDY SITES

Sites	Vegetation type	Dominant tree genera	Remarks
Santagal R.F.	Evergreen	*Cinnamomum*, *Bischofia* and *Diospyros*	Thick tree canopy, understorey of cane breaks.
Nagur R.F.	Evergreen	*Holigarna* and *Hopea*	Thick tree canopy, understorey of saplings.
Mirjan M.F.	Scrub	*Ixora*, *Buchanania* and *Terminalia*	Highly degraded semi-evergreen.
Chandavar M.F.	Semi-evergreen	*Ixora*, *Aporosa* and *Hopea*	Degraded, understorey of frequently lopped saplings.
Bengle M.F.	Moist deciduous	*Terminalia*.	*Degraded, thick undergrowth of* grass and annual herbs.
Bidaralli R.F	Moist deciduous	*Terminalia*, *Xylia* and *Lagerstroemia*	Undergrowth of herbs and shrubs, *mainly Clerodendrum*.
Sonda R.F	Moist deciduous	*Terminalia*, *Xylia* and *Aporosa*	Understorey mainly of *Psychotria* spp.
Bhairumbe M.F	Moist deciduous	*Careya*, *Ziziphus* and *Randia*	Degraded, undergrowth of *Chromelina*.
Betta land	Moist deciduous	*Terminalia* and *Lagerstroemia*	Cleared of all undergrowth, maintained for leaf manure.
Eucalyptus Pl.	Monoculture	*Eucalyptus*	Thick undergrowth of grass and herbs, surrounded by extensive moist deciduous forest.
Teak Pl.	Monoculture	*Tectona grandis*	Little or no undergrowth except *Lantana* and *Chromelina*.
Areca Pl.	Monoculture	*Areca catechu*	Plantations in valleys, surrounded by evergreen forest on hills.

4. **Scented traps:** A plastic jar of 2.5 litre capacity was used to fabricate a scented trap. The mouth of the jar was shielded from rain water using a plastic plate allowing a gap of 6 cm between the mouth of the jar and the plastic plate so that insects could freely move into the jar. The trap was baited with 200 ml of saturated jaggery (unrefined cane sugar) solution with two tablets of baker's yeast, 0.05% (final concentration) methyl parathion and 0.5 ml of pineapple essence. The traps were hung at about 1 m from the ground on a wooden peg. Five such traps were used, one each in the centre of a randomly chosen 10 m x 10 m quadrat. The scented traps were also set between 1500 -1700 hrs and collected the following morning. Insects trapped in the jaggery solution were filtered, washed and preserved in 70% alcohol.

Thus one light trap placed in the middle of a one hectare plot working for about 7 hours (1900 to 0200 hrs), net sweeps in 6 randomly chosen 10 m x 10 m quadrats, 5 randomly placed pitfall traps and 5 randomly placed scented traps, both working for about 18 hrs each constituted one sampling unit. Each of the 36 plots were subjected to one such sampling unit.

Preservation of Specimens and Data Recording

All insects (except large moths) were stored in alcohol for future sorting. The insects were identified up to the family level and within each family, recognizable taxonomic units (RTU) were separated based on morphological differences. For convenience, the RTUs will be referred to as species throughout this paper. Each such specimen was given a serial number within that family. For each plot, site and quadrat, information on the order, family, serial number, number of nymphs or larvae and the number of adults were recorded. Only data on the adult insects are presented here.

Canopy cover index: It was obvious from our preliminary results that a subjective classification of habitats into more disturbed and less disturbed categories is insufficient to discern any relationship between patterns of diversity and levels of disturbance. An attempt was therefore made to develop an index to quantify levels of disturbance. One of the major causes of disturbance in tropical forests is a tree fall, either man made or natural, which leads to large scale changes in the understorey vegetation. The extent of canopy cover could thus be one good measure of disturbance.

A relative estimate of the extent of canopy cover was obtained by the presence or absence of canopy at randomly chosen points in the study plots. 50 such points at the corners of 10 m x 10 m quadrats were chosen to make observations on the canopy cover. At each of these points the observer counted the number of trees whose canopy intersected his line of sight immediately above his head. Shrubs, tree branches and leaves obstructing the line of sight at less than about 3 m from the ground were not counted. The number of trees which formed a canopy over these 50 points was used to obtain a mean value for the plot, which we call the Canopy Cover Index.

Data analysis:

1. **α Diversity:** Several indices of alpha (within site) diversity such as the Shannon Weiner index (Margalef 1958), Simpson's index (Simpson 1949), Hill's diversity indices N_1 and N_2 (Hill 1973, see also Gadagkar 1989), S_m (Hurlbert 1971, Wolda 1983a and α of the log series Fisher *et al.* 1943) were computed. For the sake of brevity only results using α of the log series are given in this paper. α of the log series was computed by an iterative procedure using the equation,

$$S = \alpha \log_e (1 + N/\alpha)$$

where S is the number of species in the sample, N is the number of individuals in the sample, and α is the index of diversity. The standard deviation of α was estimated as α /-log (1-X) where X = N/(N +α) (Anscombe 1950). Using this standard deviation, significant differences in diversity between habitats were judged by a z test.

2. **β Diversity:** β (between site or between method) diversity was estimated as coefficients of similarity given by the Morisita-Horn Index (after Wolda 1981b),

$$C_\lambda = \frac{2\,\Sigma\,(n_{1i}.n_{2i})}{(\lambda_1 + \lambda_2).\,N_1\,N_2}$$

where,

$$\lambda_j = \frac{\Sigma\, n^2_{ji}}{N_j^2}$$

where n_{ji} is the number of individuals of

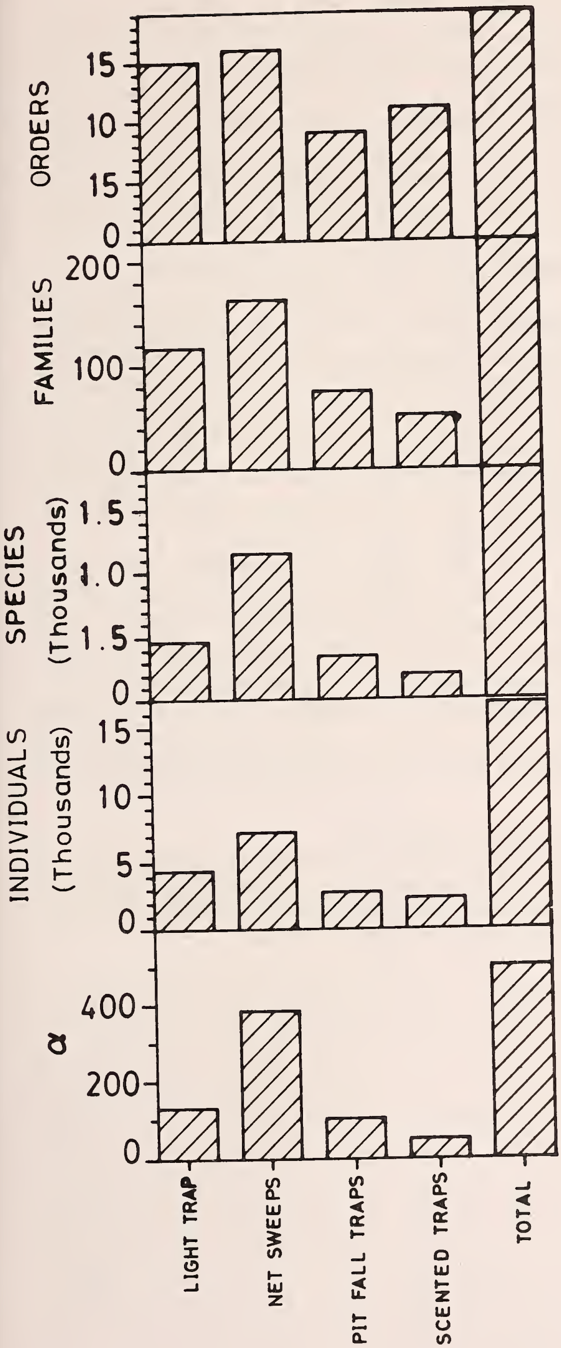
TABLE 3
SUMMARY OF CATCH DATA

Site	Plot number	No. of orders	No. of families	No. of species	No. of individuals	Alpha of log series
Santagal R.F.	1	7	36	77	144	67.31
Santagal R.F.	2	8	33	73	231	36.77
Santagal R.F.	3	9	36	88	199	60.36
Nagur R.F.	4	10	33	59	247	24.55
Nagur R.F.	5	5	28	64	265	26.81
Nagur R.F.	6	8	30	65	213	31.88
Mirjan M.F.	7	8	40	87	950	23.31
Mirjan M.F.	8	9	48	102	874	29.93
Mirjan M.F.	9	10	44	88	1085	22.61
Chandavar M.F.	10	9	52	99	529	35.93
Chandavar M.F.	11	8	37	79	757	22.20
Chandavar M.F.	12	10	45	103	407	44.42
Bengle M.F.	13	12	77	164	496	85.58
Bengle M.F.	14	5	46	110	445	46.74
Bengle M.F.	15	10	68	171	590	80.79
Bidaralli R.F.	16	10	71	144	322	100.02
Bidaralli R.F.	17	12	67	157	539	74.44
Bidaralli R.F.	18	12	53	111	445	47.44
Sonda R.F.	19	8	35	78	204	46.15
Sonda R.F.	20	6	30	73	173	47.61
Sonda R.F.	21	4	35	67	256	29.53
Bhairumbe M.F.	22	10	30	67	175	39.69
Bhairumbe M.F.	23	9	29	58	177	30.05
Bhairumbe M.F.	24	7	43	77	301	33.44
Betta land	25	7	46	122	539	49.15
Betta land	26	10	40	100	304	51.97
Betta land	27	7	33	87	262	45.56
Eucalyptus Pl.	28	12	66	204	659	101.14
Eucalyptus Pl.	29	12	68	239	1331	84.95
Eucalyptus Pl.	30	8	52	176	1191	57.04
Teak Pl.	31	7	29	55	145	32.30
Teak Pl.	32	9	24	43	128	22.73
Teak Pl.	33	7	29	46	86	40.22
Areca Pl.	34	7	45	99	862	28.87
Areca Pl.	35	7	36	102	721	32.42
Areca Pl.	36	7	42	106	600	37.37
Total		19	219	1789	16852	506.06

species i in sample j and n_j is the number of individuals in sample j. The index was computed with data logarithmically transformed as ln $(n_{ji}+1)$. Cluster analysis was performed using a single-linkage algorithm.

RESULTS

Summary of catch data: A summary of the insect catch data in the form of the number of orders, families, species and individuals and α of the log series as an index of diversity for each of the 36 plots are shown in Table 3. In any given plot we encountered from 4-12 orders, 24-77 families, 43-239 species and 86-1331 individuals. In all the 36 plots put together we encountered 19 orders, 219 families, 1789 species and 16,852 individuals. Some patterns in this data are immediately apparent. The highest number of individuals, species and the highest diversity were seen in one or more of the *Eucalyptus* plantation plots, while the lowest number of individuals, species and the lowest diversity were seen in one or more of the teak plantation plots. Natural forest plots, including relatively less as well as the relatively more disturbed ones, were between these two extremes shown by the monoculture plantations.



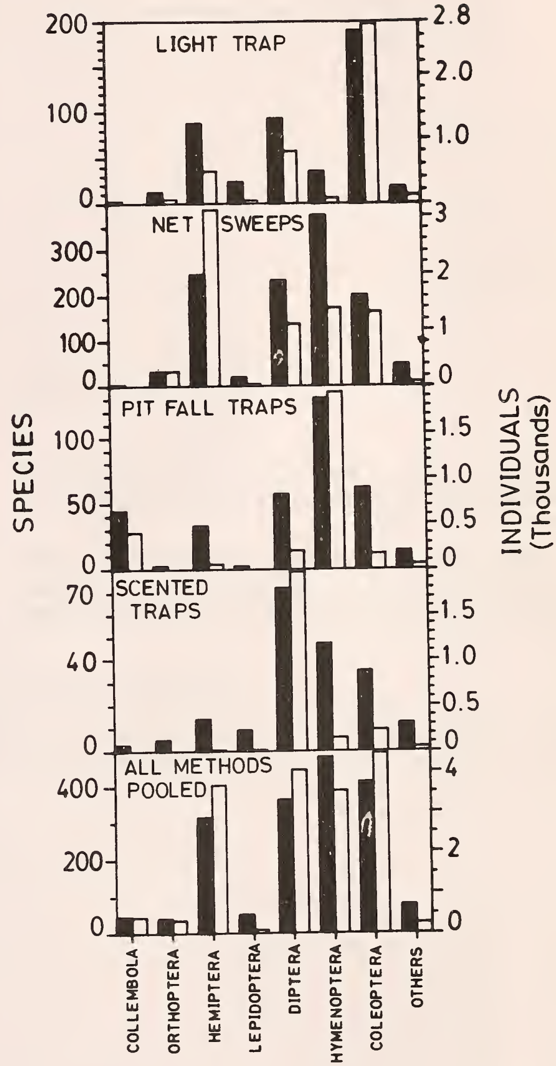


Fig.2. Numbers of orders, families, species, individuals and diversity of insects trapped by different methods.

Fig.3. Taxonomic break up of insects trapped by different methods. Closed bars = species , open bars = individuals.

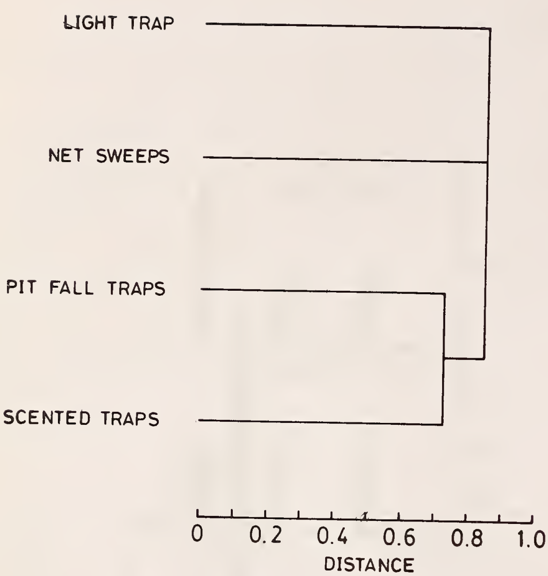


Fig.4. Dendrogram comparing insects caught by different methods (Distance = 1 – Morisita-Horn Index of Similarity). Data pooled from 36 plots.

Comparison of methods of collection: Net sweeps yielded not only the maximum numbers of orders, families, species and individuals but also the highest diversity of insects. But the remaining three methods, namely, the light trap, pitfall traps and scented traps together accounted for at least 50% of the catch (Fig. 2). The light trap yielded more Coleopterans than any other method. Most of the Hemipterans caught were in the net sweeps although net sweeps yielded an equally rich collection of Hymenopterans and Dipterans. Pitfall traps yielded more Hymenopterans than any other order while scented traps caught more Dipterans (Fig. 3).

Comparison of different species and their abundance among catches by different methods using the Morisita-Horn Diversity Index shows that each method yielded quite a different sample of insects. The similarity coefficient between any two methods ranges between 0.13 and 0.28. The consequent large distance (defined as 1 – coefficient of similarity) between insect samples obtained by different methods are shown in Fig. 4.

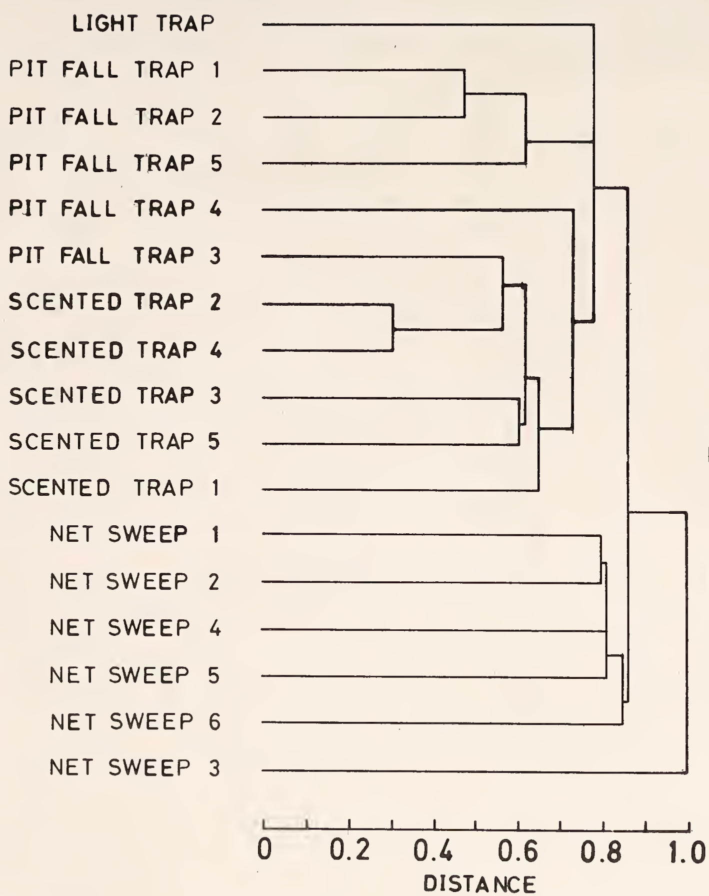
Since one light trap, 6 net sweeps, 5 pitfall traps and 5 scented traps were employed in each plot, we can compare the catches between different replicates of the same method. Employing the Morisita-Horn Similarity Index, we find that catches from different replicates of the same methods were by and large more similar than catches by different methods. It is important to note, however, that there

Table 4

COMPARISON OF DIVERSITY IN DIFFERENT CAPTURE SITES

Pairs of sites that are significantly different from each other in their levels of insect diversity as measured by α of the log series. A '+' in any cell indicates that the site mentioned in the row is significantly more diverse than the site mentioned in the column ($p < 0.05$). Numerals (1) to (12) in row and column headings refer to different sites. The mean and standard deviation of α for each site are given in the row titles. Names of sites in row titles and column titles are ordered according to diversity.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Bidaralli R.F. 142.89 ± 7.851				+	+	+	+	+	+	+	+	+
(2)	*Eucalyptus* Pl. 140.32 ± 6.66				+	+	+	+	+	+	+	+	+
(3)	Bengle M.F. 136.10 ± 7.37				+	+	+	+	+	+	+	+	+
(4)	Santagal R.F. 106.97 ± 7.60							+	+	+	+	+	+
(5)	Betta Land 97.53 ± 6.23							+	+	+	+	+	+
(6)	Sonda R.F. 87.93 ± 6.46									+	+	+	+
(7)	Bhairumbe M.F. 76.12 ± 5.80											+	+
(8)	Chandavar M.F. 74.09 ± 4.83											+	+
(9)	*Areca* Pl. 69.60 ± 4.47												+
(10)	Teak Pl. 60.36 ± 5.58												
(11)	Nagur R.F. 58.03 ± 4.72												
(12)	Mirjan M.F. 53.91 ± 3.67												



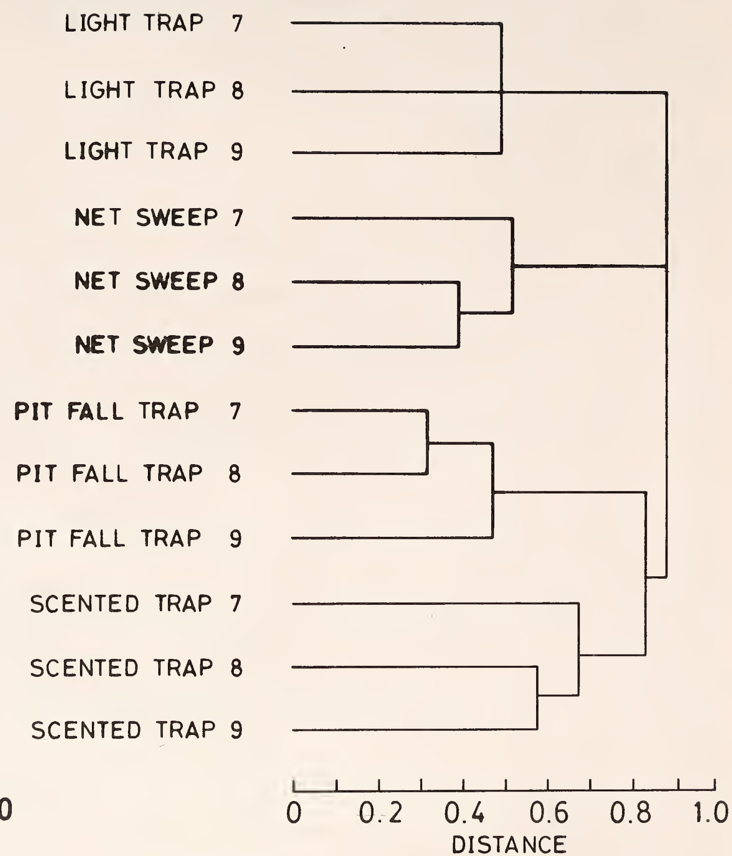
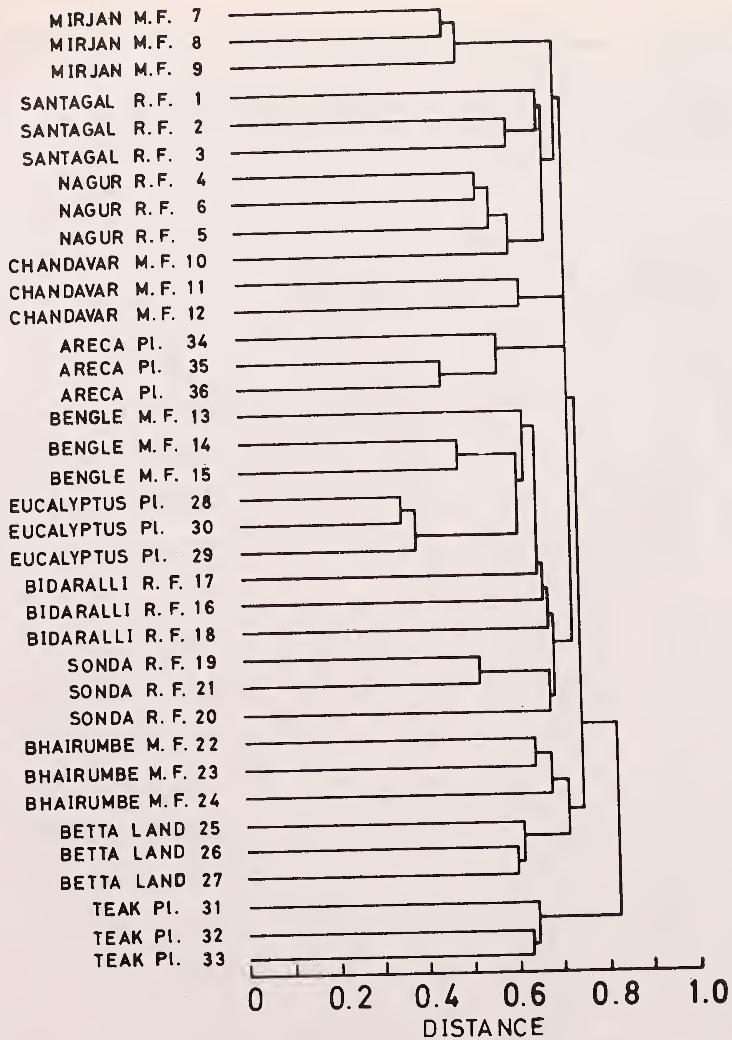


Fig.5. Dendrogram comparing insects caught by traps within a plot.
In general insects caught by the same method had greater similarity among themselves than insects caught by different methods. But insects caught in pitfall trap no. 3 were similar to those caught in the scented traps rather than those caught in other pitfall traps. Insects caught in nets weeps 3 were very different from all other insects caught in this plot. Data from plot 1.

Fig. 6. Dendrogram comparing insects caught by different methods in different replicate plots of the same site. Insects fall into four neat clusters depending on the method of trapping. Data from plots 7, 8 and 9 in Mirjan M.F.



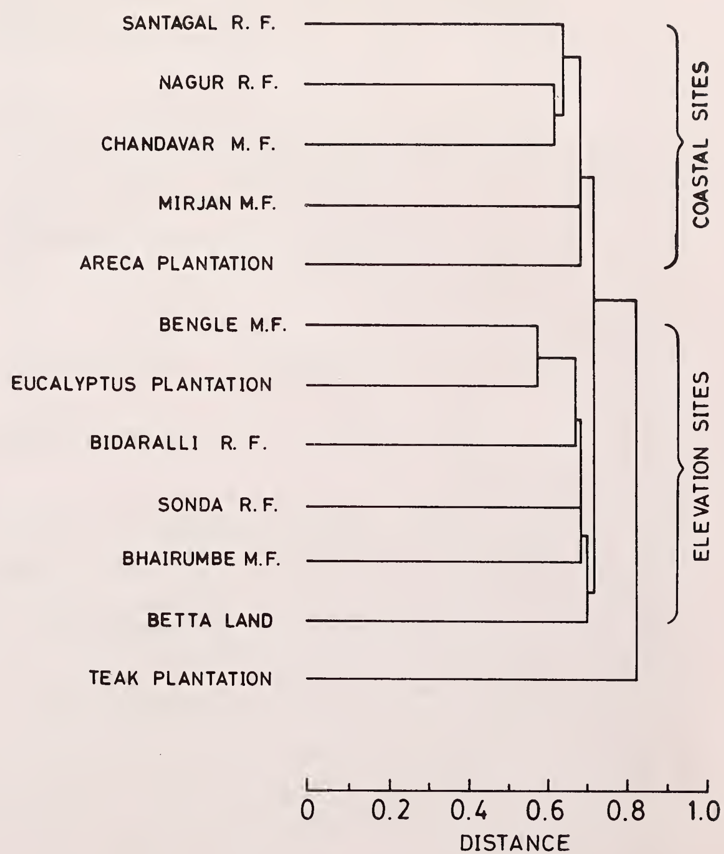


Fig. 7. Dendrogram showing similarity of insects caught in each of the 36 plots.
With the exception of Chandavar, Bengle and Bidaralli similarity between replicate plots of a site is greater than that between plots of different sites.

Fig. 8. Dendrogram showing similarity between different sites.
With the exception of the teak plantation all the down-ghat sites form one cluster and the up-ghat sites a different cluster.
Data pooled from three replicate plots for each site.

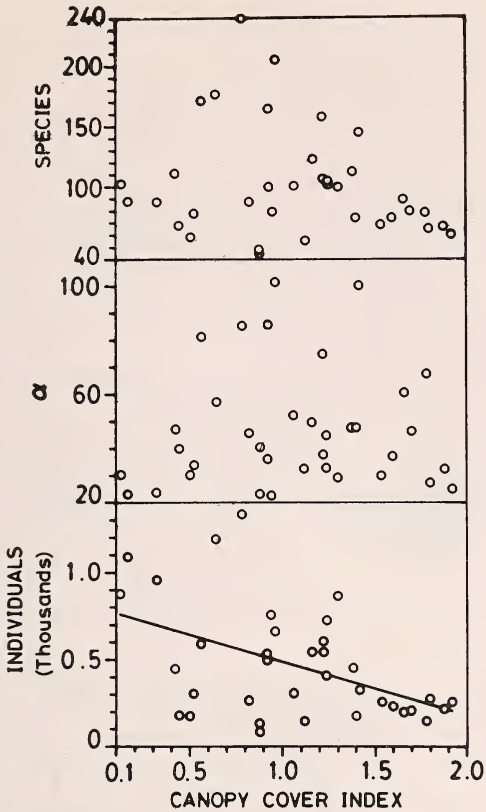


Fig. 9. Relationship between canopy cover index and number of species, α diversity index and number of individuals. There is a significant negative correlation between canopy cover index and number of individuals (Bottom panel). (Kendalls Rank Correlation Coefficient $\tau = -0.2711$; $P < 0.05$; the straight line is given by $Y = -311.68\ x + 800.74$; $P < 0.01$). Each point represents one of the 36 plots.

are occasional exceptions. This is illustrated in an example of comparison of the 17 traps employed in plot number 1 (Fig. 5). The catches from pitfall traps 1 and 3 have a greater similarity to catches from scented traps than to catches from the remaining pitfall traps. Similarly the catch from netsweep 3 stands out as being different from everything else. These anomalies may be on account of random fluctuations in the small samples of insects caught in each individual trap.

Pooling the insects from each replicate of the same method (except of course in the case of the light traps where only one was employed in each plot) leads to fewer anomalies. This is illustrated by comparing data from each method across the three replicate plots within a study site. For most sites the pattern is as distinct as in the example shown in Fig. 6 for plots 7,8 and 9 in Mirjan M.F. It is thus clear that relatively similar insects are caught by repeating the same method in different replicate plots while relatively different insects are caught by different methods. This is by and large the pattern we find in all sites although there are some minor exceptions in some plots.

Comparison of plots and sites: Pooling catch data from all 17 traps in each plot, the 36 plots may be compared using the Morisita-Horn Similarity Index. Generally, the 3 replicate plots in each site are similar to each other and form a cluster before they "join" other clusters. This pattern was seen in 9 out of 12 sites, namely, Santagal R.F., Nagur R.F., Mirjan M.F., *Areca* Plantation, *Eucalyptus* Plantation, Sonda R.F., Bhairumbe M.F., Betta land and Teak Plantation. But there are some exceptions such as Chandavar M.F. and Bidaralli R.F. where at least one plot had greater similarity to plots from some other site than to other plots from the same site (Fig. 7).

Insect catches pooled from all methods and from the three replicate plots constitute a combined sample for a site. Such combined samples permit comparison between the habitats represented by different sites. Because the variances of α can easily be computed, it is possible to conclude that the insects caught in Bidaralli R.F. are significantly more diverse than those caught in Santagal R.F. and all other sites of lower diversity (Table 4, $P<0.05$). Similarly, insects caught in Santagal R.F. are significantly more diverse than those caught in Bhairumbe M.F. and all other sites of lower diversity (Table 4, $P<0.05$). The 12 sites are ordered according to diversity and all pairs of sites that are significantly different from each other in diversity are shown in Table 4. Pooled catch data for each site can also be used to compare the sites using the Morisita-Horn Index. This leads to the remarkable result that with the exception of teak plantation, all coastal sites form one cluster and all elevation sites form a separate cluster, although it is not clear whether this result is statistically significant (Fig. 8).

Effect of canopy cover: Reserve forests, minor forests and plantations were initially chosen because they were expected to represent different levels of disturbance. To obtain a more objective and continuous index of disturbance, however, we have measured the extent of canopy cover in each plot. This was achieved through the canopy cover index, which is the mean number of trees whose canopies overlap with each other at any given point in the plot (see methods). Clearly, canopy cover is only one of the many factors that must affect the distribution and abundance of insects on the floor of the forests. This is reflected by the considerable scatter in points when we plot the number of species, and diversity or number of individuals as a function of the canopy cover index (Fig. 9). Nevertheless there is a statistically significant inverse correlation between the canopy cover index and the number of individuals ($P< 0.02$).There is also a suggestion that both the number of species and diversity are more variable and can reach very high levels at intermediate levels of canopy cover while relatively fewer species and lower diversity are obtained at very high or very low value of canopy cover index.

Sampling strategy: Our sampling strategy, aimed at making the methods quantitative and unbiased, involved three steps. First, we employed 5-6 replicates of each method within each plot (except in the case of light trap). Second, we employed four methods (light trap, net sweeps, pitfall traps and scented traps) within each plot. Finally, we sampled from three replicate one hectare plots within each site or habitat type (Twelve sites drawn from two elevations were sampled but this was meant to apply the underlying methodology).

In an attempt to evaluate each of these steps in our strategy, we have performed a nested ANOVA and partitioned the variance in the number of individuals of each species into the following compartments: (1) between replicates of the same method within a plot, (2) between methods within a plot, (3) between replicate plots of the same habitat type, (4) between different habitat types and (5) between elevations. Repeating this analysis separately for each of the 1,789 species, we present the minimum, maximum, mean and standard deviation of the percentage variance at each level in Table 5. On an average, 73.6% of the variance is seen between replicates of the same method within a plot, 23.7% between different methods within a plot, 1.7% between replicate plots of the same site or habitat type and a negligible amount of variance is seen between habitat types and between elevations. We conclude from this that the two most important steps in our sampling strategy required to ensure the collection of a wide variety of insects from each locality are to use replicate traps of each method within a plot and to use different methods to trap insects within each plot. Sampling from replicate plots of each site, on the average, adds only a minor component of the variance but we nevertheless recommend at least some replication of plots because in specific cases such replicate plots may be useful. For instance, in Chandavar M.F., Bengle M.F. and Bidaralli R.F. one of the three replicates was quite different from the other two (Fig. 7.)

Habitat *"Specializations:"* Comparing the relative contributions of different insect orders both in terms of number of species and in terms of number of individuals, we find that in some sites a very large proportion of the spelcies or individuals belong to one insect order and the dominant order varies from site to site. While some sites are so "specialized" others appear to be more "generalized" with a fairly even distribution of species and individuals across 4 or more orders.

A few of the relatively clear examples of this phenomenon are shown in Fig.10. 75% of all insects caught in Mirjan M.F. belonged to Coleoptera. 58% of all insects caught in Chandavar M.F. belonged to Diptera whereas in Bhairumbe M.F. 28% of the insects belonged to Hemiptera, 25% to Coleoptera, 22% to Hymenoptera and 17% to Diptera. Similarly 40% of all species caught from Mirjan M.F. belonged to Coleoptera, 38% of all species caught in the *Eucalyptus* plantations belonged to Hymenoptera but in Bengle M.F., 25% of the species belonged to Hymenoptera, 25% to Diptera, 22% to Hemiptera and 19% to Coleoptera.

Trophic structure of insect communities: Since all specimens are identified up to the family level, it is possible to determine the approximate trophic structure of the insect communities encountered in this study. Most insect families can be assigned to any one trophic level such as phytophages, predators, parasites and scavengers. The greatest difficulty in doing this was encountered in the family Formicidae. The ants have therefore been set aside as a separate category. The relative contributions of different trophic levels vary enormously. As in the case of the distribution of orders, we find that in some sites a very large proportion of the species or individuals belong to a particular trophic level and that

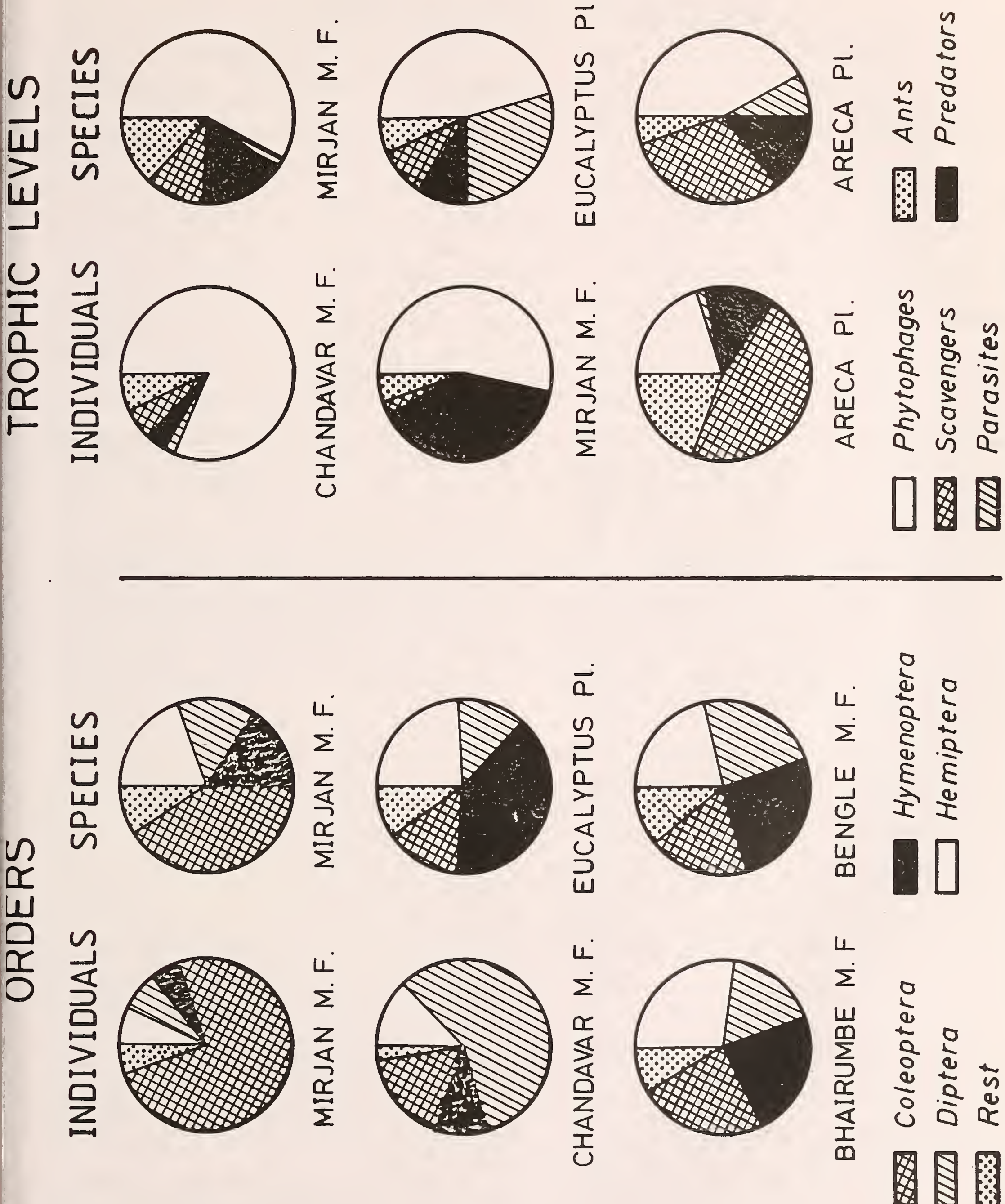


Fig. 10. Pie-charts showing the proportion of individuals and proportion of species belonging to different orders and different trophic levels in some selected sites.

2

TABLE 5
NESTED ANALYSIS OF VARIANCE TO PARTITION VARIANCE BETWEEN DIFFERENT COMPONENTS OF THE SAMPLING STRATEGY.

	Distribution of variance (%)			
	Minimum	Maximum	Mean	Standard deviation
Between replicates of the same method in a plot	0	99.7	73.6	37.7
Between different methods within a plot	0	100	23.7	38.4
Between replicate plots of the same habitat type	0	18.6	1.7	1.7
Between different habitat types	0	33.8	0.9	2.6
Between elevations	0	10.1	0.1	0.4

the dominant trophic level varies from site to site. A few clear examples of this are shown in Fig. 10. Nearly 82% of all insects caught in Chandavar M.F. were phytophages, nearly 54% of insects caught in Mirjan M.F. were phytophages whereas in *Areca* plantation only 20% were phytophages. Instead, scavengers account for 47% of the individuals caught in the *Areca* plantation. Ants constituted only 7% and 5% respectively of the individuals caught in Chandavar M.F. and Mirjan M.F. but constituted as much as 19% of the insects caught in *Areca* plantation.

Similar patterns can be illustrated with reference to the number of species rather than the number of individuals. Less than 2% of the species caught in Mirjan M.F. were parasites whereas nearly 29% of the species caught in the *Eucalyptus* plantation were parasites. Just as in the case of individuals, scavengers constituted a very large proportion of the species (31%) in the *Areca* plantation.

DISCUSSION

We have outlined here a strategy for quantitative sampling of insects in forested habitats and plantations that is likely to be useful to tropical ecologists with modest research budgets and minimal facilities. We argue that methods requiring the operation of a light trap continuously for months or years and especially in forested sites are inaccessible to most ecologists living and working in the tropical countries of the world. On the other hand it is studies of tropical communities that are most urgently needed and most likely to provide adequate field data required for understanding the principles of community ecology. We have therefore standardized a package of methods involving a small, portable, dry battery operated light trap and supplemented with other methods such as net sweeps, pitfall traps and scented traps. In an effort to make the methods reproducible, we have, by careful standardization, attempted to hold the sampling intensity or effort constant. One sampling unit thus corresponds to one light trap operated for a fixed number of hours in the middle of a one hectare plot, 6 net sweeps performed by a standardized method in 6 randomly chosen 10 m x 10 m quadrats, 5 pitfall traps and 5 scented traps placed at randomly chosen positions for 18 hours in a one hectare plot. Such a sampling exercise can be completed in 24 hours and therefore may be repeated every day by the same people and the same equipment. We have shown that such a sampling method yields a collection of insects which may be said to broadly represent that site. The method could thus be used to compare insect communities in different habitats or across different seasons and can also be used for long term monitoring of changes in tropical habitats (See Hammond 1990 and Stork and Brendell 1990 for similar efforts).

Traditional methods based exclusively on operating powerful light traps every night represent a very intense level of sampling compared to our methods. The result is that it is impossible to use all the insects caught in these light traps. Most investigators are forced to discard the bulk of the catches and concentrate their attention on one or a small group of insect species. The methods we describe sample insects at a much lower intensity making it necessary and possible to use all the insects collected. Clearly, this is a more efficient procedure and leads to minimal destruction of natural populations of insects. Undoubtedly, the traditional powerful light trap method is more convenient – little or no work is required on the part of the investigators and sorting and identifying insects belonging only to a small, selected, familiar group is relatively easy. Our method requires more work on the part of the investigators both in terms of preparation and laying out the traps and more significantly in sorting all the insects belonging to different and often unfamiliar groups. Tropical ecologists will inevitably have to pay some price for not always being able to set up well organized research stations and obtain large budgets. We believe that the price in terms of man-power required by the methods we describe is small and a requirement of man-power is one price that tropical countries can pay relatively easily. Besides, the methods we have used will also help detect community level changes in the insect fauna. This is not usually achieved when only a selected group of species is monitored.

Because of the low intensity of sampling and the consequent need to include all insects collected in any analysis, we thought it best to use a variety of different trapping methods so as to attract different kinds of insects. Our finding that the catches for each of the 4 methods are quite different from each other justifies this. Because of the low intensity of sampling and the consequent small numbers of insects caught in each trap leading to random fluctuations, we thought it necessary to include several traps of the same kind in each plot and to use at least 3 replicate plots in each habitat site. Although the insects caught by the same method have greater similarity to each other rather than to insects caught by other methods in the plot, there are a few exceptions. Similarly, although the insects caught in different replicate plots of a site have a greater similarity to each other rather than to insects caught in some other site, again there are a few exceptions These exceptions justify the inclusion of replicate traps and replicate plots, but the relative rarity of these exceptions suggest that the extent of replication is fairly adequate.

In the process of standardizing these methods, we applied them to 12 carefully selected sites representing diverse habitat types so that, if the methods were successful, we might have something to say about the habitat types. We believe that the methods are successful and we therefore rank the chosen sites in their order of diversity values. The range of diversity values obtained is sufficient to permit us to make these comparisons with statistical significance.

Another interesting result we have is that with the exception of the teak plantation, the coastal and the elevation sites form 2 different clusters, suggesting that geographical separation and altitudinal variation override even extreme differences in levels of disturbance. We obtained this result in spite of including relatively undisturbed reserve forests, relatively disturbed minor forests as well as monoculture plantations both among the coastal as well as elevation sites. This is not to say that there was no difference among the various sites in one region. Several statistically significant differences in levels of diversity between sites in the same geographical region and altitude were obtained. And yet similarity between sites within one geographical and altitudinal region was greater than similarity across geographical or altitudinal regions. In addition to providing a method of understanding and comparing tropical habitats we believe that such a method, if applied on a large scale, will permit tropical ecologists to generate substantial field data relevant to current ecological theory.

For example, we have made an attempt to understand the factors affecting the distribution of diversity and abundance of insects. Using the canopy cover index as an objective and continuous measure of levels of disturbance, we have shown that the number of individuals is inversely correlated with the canopy cover index. As the canopy is opened up, we find many more insects in the forest understorey. This result is further evidence that the insects we trap are at least loosely associated and therefore characteristic of a given region. Canopy cover is clearly only one of the many factors that must affect distribution of insects. Despite the resultant scatter in the data, we have an indication that insect diversity can reach high levels at intermediate levels of canopy cover. When the canopy is closed there is little understorey vegetation and hence, little insect activity. When the canopy is completely opened up, it results in nearly dry and barren land. It is at intermediate levels of canopy cover that a rich mosaic of habitat types can form in the forest understorey and lead to high levels of insect diversity.

The sites we have studied are different from each other in many ways. One of the more interesting differences lies in the proportional representation of species or individuals belonging to different insect orders. While some sites are "generalized" in that they have a fairly uniform distribution across 4 or more orders, others are more "specialized". For instance, Mirjan M.F. is a Coleoptera "specialist", Chandavar M.F. is a Diptera "specialist". Similarly, some sites are dominated by phytophages while others are either dominated by other trophic levels or have a relatively even representation of different trophic levels. Some sites have few ants or parasites while others have a large number of these. Why is there such a pattern in the distribution of insects ? Data of this kind will help formulate specific studies intended to understand the factors governing insect distribution. We believe that these methods will be equally useful for monitoring seasonal and long term changes in tropical habitats. Work is in progress to apply these methods in that direction.

It is now widely recognised that tropical habitats face a much greater threat of destruction than other regions of the globe. This makes the study of tropical insect communities both urgent and challenging. It is also true that the economic conditions of most tropical countries make a certain amount of developmental activity inevitable. For this reason, ecologists are being increasingly called upon to make assessments of the impact of such developmental projects on tropical biotic communities. We hope that the methods described here will contribute towards meeting these challenges.

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AN ORNITHOLOGICAL SURVEY OF SOME WETLANDS IN SOUTH-EAST INDIA[1]

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(With three text-figures)

This paper presents the results of an extensive survey of waterbirds along the southern Coromandel coast in January 1988. Special emphasis is laid on estimating the populations of ducks and egrets over a large area, identifying the most important wetlands and assessing the importance of artificial habitats, irrigation tanks and paddy fields.

The coastal plains of Tamil Nadu and southern Andhra Pradesh occupy some 65,000 km^2 subjected to roughly the same climatic regime and cultivation system. They are dotted with many natural and artificial wetlands which attract large numbers of waterbirds in winter, namely after the "north-east monsoon" rains. However, the information on these bird populations is remarkably poor, mainly qualitative and confined to a few well-known sanctuaries (Spillett 1968, Nagulu and Ramana Rao 1983, Raju and Shekar 1971, Abraham 1973, Krishnan 1978, Ali and Hussain 1982, Sugathan 1982); quantitative data are seldom provided and if so, only for individual wetlands (Anonymous 1984, Pieter 1987).

The first attempt to assess the size of waterbird populations in this large region took place within the frame of the first Asian Waterfowl Count in January 1987. Van der Ven (1987) underlined how limited the results for India were; "the data do not adequately reflect the richness and variety of species". For example, in south-eastern India a single area of *c.* 6,300 km^2 was adequately covered, by the Wildlife Association of Ramnad District, Tamil Nadu (Hussain 1987). However it included only minor wetlands, seldom holding more than 1,000 waterbirds.

The objectives of the present survey were therefore (1) to assess the waterbird population in a large region having many sizeable wetlands, in order to get a basic idea about the importance of south-eastern India for migrant and local species, (2) to identify wetlands of major importance, i.e. holding large populations of waterbirds, in order to provide data for future conservation plans; the need for such data, which was so far lacking, has been emphasized by Vijayan (1986), (3) to assess the relative importance of artificial wetlands (tanks, paddy fields), supposed to be adequate substitutes for the vanishing, natural ones.

STUDY SITE AND METHODS

The survey, held between 3 and 27 January 1988 encompasses *c.* 12,600 km^2 spread over the Coromandel coastal plains, between *c.* 11°10' and 14°10'N (Fig.1). This region contains some of the largest wetlands in south-eastern India such as Pulicat lagoon, Kaliveli and large irrigation tanks. Most of them were surveyed. Many minor wetlands depending on their accessibility were also visited, although systematic counts were impossible: Palanisami (1982) states that Tamil Nadu alone has *c.* 39,000 irrigation tanks, many of them small.

Waterbirds were counted with the help of a 20-45 x spotting scope from vantage points, and a boat was used in the huge Pulicat lagoon. We deliberately focussed on the larger species: in the Palaearctic, ducks and coots are regarded as good indicators of the ornithological importance of wetlands (Atkinson-Willes 1976); in tropical countries, large species such as pelicans, storks, flamingos and ibises are more widespread in winter than in temperate regions and can also be regarded as reliable indicators. Various species were obviously overlooked, due to their small size (waders), nocturnal habits (night heron *Nycticorax nycticorax*), or partiality for reedbeds (rails, ibises, purple heron *Ardea purpurea*).

Species such as egrets, paddybirds (*Ardeola grayii*) and waders were widespread in cultivated areas and therefore difficult to count accurately. Since the roads travelled on during daytime (525 km) can be regarded as a transect representative of the land utilization in the coastal plains, we counted the waterbirds in 100 m -wide strips along either side of the roads in order to assess their density in the cul-

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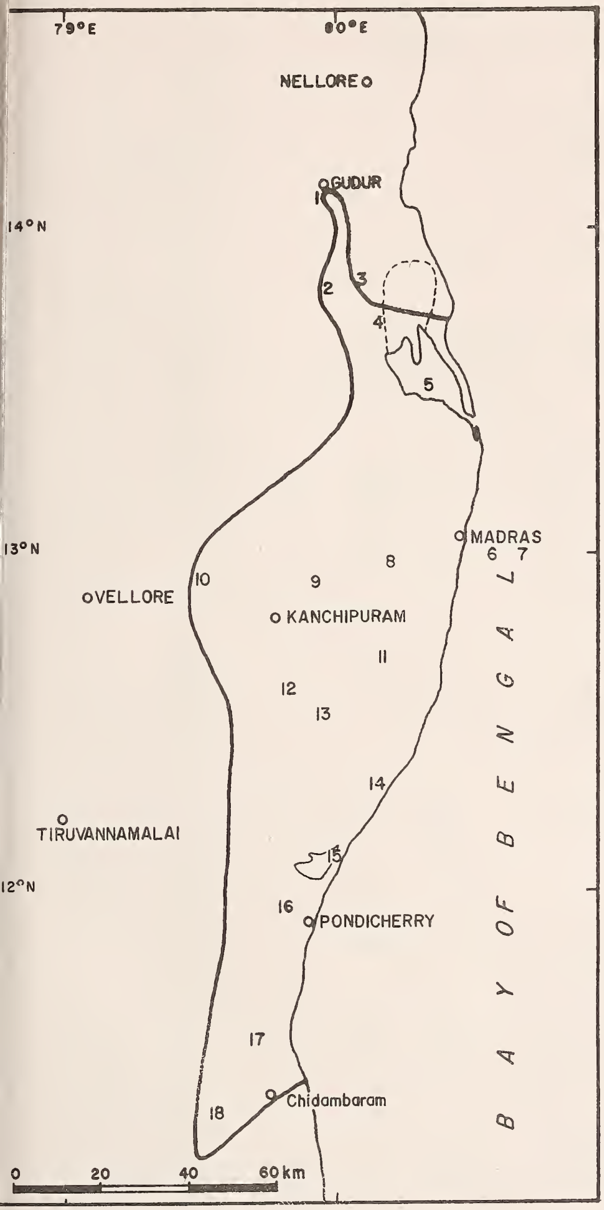

Fig. 1.Area and main wetlands surveyed
1. Gudur tank, 2. Ethirpattu, 3. Nelapattu, 4. Suluru marshes, 5. Pulicat lagoon, 6. Adyar estuary, 7. Simpson Estate, 8. Chembarambakkam tank, 9. Madras to Kaveripakkam (4 minor tanks), 10. Kaveripakkam tank, 11. Chinglepet tank, 12. Uthiramerur tank, 13. Madurantakkam tank + Vedanthangal, 14. Cheyyur lagoon, 15. Kaliveli, 16. Ousteri tank, 17. Perumal Eri, 18. Viranam Eri.
Boundary of area surveyed (*c*. 12,600 sq. km) shown by solid line.

tivated plains. White birds (egrets) were obviously recorded more accurately than paddybirds, and waders were neglected due to their small size.

Results

Sixty wetlands were surveyed and over 2,37,000 waterbirds belonging to 76 species counted, the bulk of them (75%) being ducks. The extensive results are due to appear in the International Waterfowl Research Bureau / Bombay Natural History Society reports on the second Asian Waterfowl Count.

Wetlands: The wetlands visited comprise mainly of irrigation tanks (49) of varying sizes; a few natural areas were found, all of them brackish lakes, estuaries or lagoons located along the coast such as, Pulicat, Kaliveli and Cheyyur.

The distribution of the main waterbirds in each type of wetland is shown in Table 1.

Brackish waterbodies: Pulicat and Kaliveli are the largest brackish wetlands in the surveyed area. The southern part of Pulicat is an open, permanent lagoon (Fig. 2). Its northern part, from where the water had recently receded, consisted of extensive stretches of shallow water and mudflats (over 20 km^2). The open waterbody only attracted a few of the birds (ducks, waders, egrets, flamingos), the majority of them being concentrated on the northern mudflats, along the Suluru-Sriharikota Island road.

Kaliveli, of which only 20-30% was under water, is a large temporary expanse of shallow water, dotted with many sedge beds (*Fimbristylis* sp.). The hydrology is complex, the lake ranging from almost freshwater after the rains to highly saline before drying-up in early summer. The waterbody acts as a refuge for large concentrations of wintering ducks, whereas the reed-beds attract herons, storks, ibises and egrets. Fish-eating birds congregate in even larger numbers at the end of winter, when the lake starts drying up (Perennou 1987).

The other brackish estuaries or lagoons, much smaller (Adyar estuary, Pondicherry marshes) or heavily disturbed (Cheyyur), held reduced populations of waterbirds, mainly waders.

Irrigation tanks: Their condition has to be viewed against the rains in the previous "north-east monsoon", which were locally either deficient or close to the average, as calculated from 'The Hindu' Weather Reports.

TABLE 1
RELATIVE IMPORTANCE IN % OF EACH TYPE OF WETLANDS FOR THE MAIN GROUPS OF WATERBIRDS.

	Number of wetlands	Total area covered (km^2)	Pelicans	Cormorants	Herons/ egrets	Storks	Ibises/ spoonbills	Flamingos	Ducks/ geese	Waders	Gulls/ terns	Total waterbirds
Natural, brackish wetlands	6	c. 170	6	< 1	26	63	49	100	46	89	75	53
Irrigation tanks:												
– Large (>1.5 km^2)	16	144	–	5	19	17	13	–	54	7	16	42
– Small (<1.5 km^2)	33	< 30	–	1	< 1	< 1	–	–	< 1	< 1	7	< 1
Breeding colonies	5	–	89	94	44	9.5	20	–	< 1	–	–	3
Total numbers	59	–	431	2843	6737	1848	439	5300	176762	37701	3619	237047

Note: The birds not accounted for in this table were seen in paddyfields and a wetland of dubious nature, Saluru (marshes?).

TABLE 2
NUMBERS OF NESTS AND INDIVIDUALS IN BREEDING COLONIES AND BREEDING STAGES.

	Nelapattu (11.1.89)	Ethirpattu (9.1.88)	Tada (10.1.88)	Simpson Est. (16.1.88)	Visiting Colony	Pair formation	Nest building	Incubation	Young chicks	Large chicks	Fledged juveniles	Not breeding
Spotbilled pelican	382 (+)*	1			E		N	N	N			
Cormorant	2											N
Indian shag	1200 (+)			20 (2)					N			SE?
Little cormorant		368 (92 +)	380 (100)	700 (15+)				SE	SE	E, T		
Grey heron	1	40 (13 +)	100 (35)				T	T, E?	E, T	E, T		N
Large egret	1			20 (4)			SE	SE				N
Smaller egret				40								SE?
Little egret	2	72 (20+)		400 (30)		SE	SE	SE	E	E		N
Night heron	210			2000 (200)				SE	SE		N	
Openbill stork	160								N			
Painted stork	1	14 (0)			E, N	E						
White ibis	56 (+)							N	N			
Spoonbill	28							?				
Number of trees involved	65	6 +	1	+								

20 (4): 20 birds seen, 4 nests.. 20 (+): nest.s observed, not counted.. *Two copulations noted.. E,N, SE, T: Ethirpattu, Nelapattu, Simpson Estate, Tada.

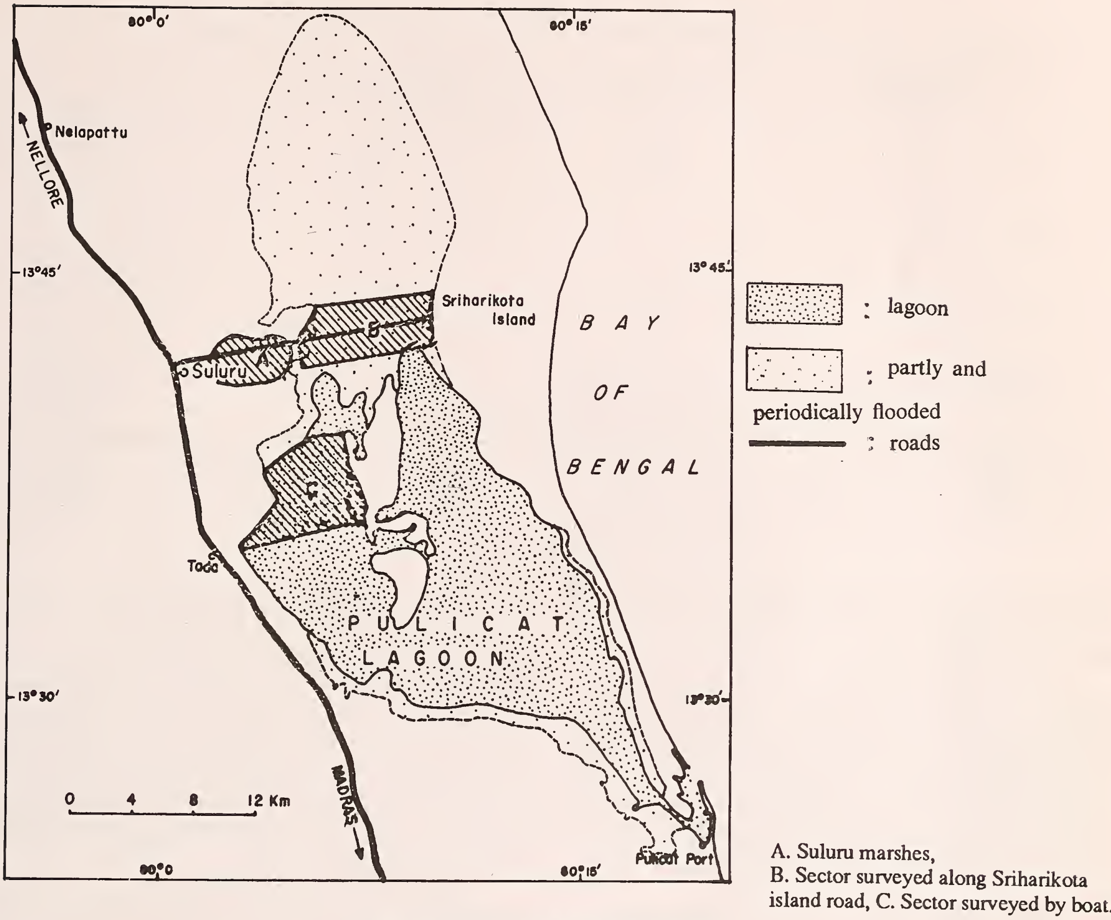

Fig. 2. Pulicat lagoon and neighbourhood

Most large tanks had over 50% of their total areas under water; a few were almost dry (Kaveripakkam, Mamandur; Madurantakkam to a lesser extent) or partly invaded by aquatic vegetation (Chembarambakkam, Perumal and Viranam Eri). Whatever be their physiognomy, they attracted large numbers of waterbirds, mainly ducks; only 2 out of the 6 largest tanks (over 1.5 sq km) attracted less than 1,500 ducks, and many of them had huge populations of 10,000 or more: Uthiramerur, Viranam Eri, Perumal Eri, Madurantakkam, Kaveripakkam, Chembarambakkam.

On the other hand, most of the smaller tanks showed a low water level, especially in Tamil Nadu. The absence of sizeable bird populations (Table 1) was striking: none of them held more than 200 ducks and most of them had none.

Breeding colonies: Five mixed colonies of waterbirds were surveyed (Table 2): Ethirpattu, Nelapattu and Tada in Andhra Pradesh, Simpson Estate and Vedanthangal Bird Sanctuary in Tamil Nadu. Ethirpattu and Tada colonies are located in villages, the former between a small tank and a river and the latter beside Pulicat lagoon. Simpson Estate lies within Madras city (Anonymous 1984), and the other two colonies are well-known (Spillett 1968, Nagulu and Ramana Rao 1983). For the second consecutive winter, Vedanthangal had neither water nor breeding birds.

In order to avoid disturbance or due to their high density, the nests in Nelapattu and Simpson Estate could not be counted accurately and only the

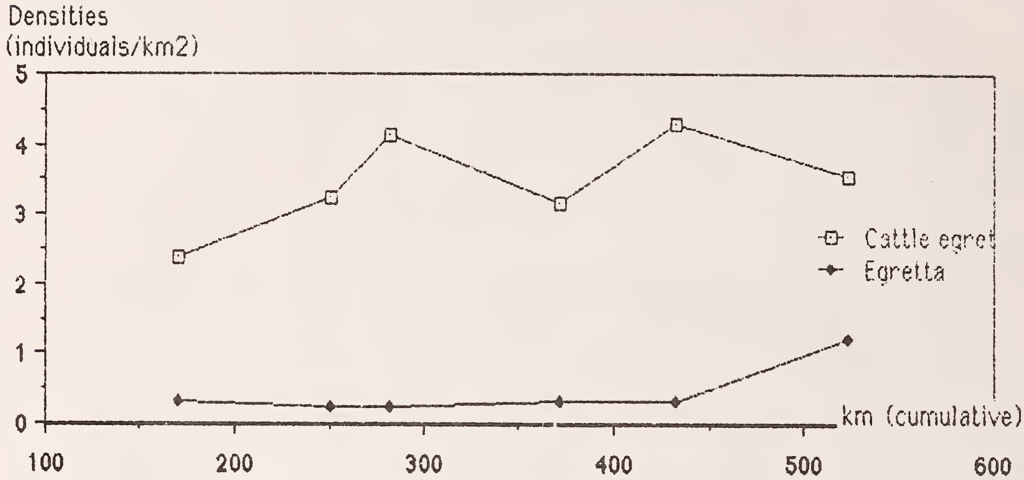

Fig. 3. Egret densities along the transect

number of birds are reliable. The colonies altogether held a large percentage of the pelicans, cormorants and herons (Table 1).

The different species were not evenly distributed over the mixed colonies, as shown by Ethirpattu (Table 3). Differences in the breeding stage were also observed both between species and between colonies (Table 2). While some juvenile night herons had already fledged in Nelapattu, painted storks *Mycteria leucocephala* had just begun breeding.

Although the birds breeding in Simpson Estate were in a less advanced stage than in other colonies, the variations remain within the known breeding dates in southern India (Ali and Ripley 1983).

The colonies also provided suitable roosts for non-breeding birds. In Nelapattu, they came from Pulicat lagoon (Forest Department watchman, pers. comm.) and probably from the adjacent Suluru marshes. Vedanthangal, although deserted as a breeding colony, still provided a roost for several hundred birds (night and grey herons *Ardea cinerea*, egrets, ibises,) from the nearby Madurantakkam tank and paddyfields (A. Perennou, pers. comm.)

Table 3
DISTRIBUTION OF NESTS WITHIN ETHIRPATTU COLONY

Tree number	1	2	3	4
Grey heron	2	1	9	1
Little egret	3	5	5	7
Little cormorant	60	16	1	15

Cultivated areas: Most paddyfields were covered with well-grown, dense paddy. Flooded fields, recently ploughed or planted, were estimated to account for less than 5% of the cultivated area. However, they held the bulk of the paddybirds and egrets counted along our transect, the only exception being a few small groups of cattle egrets *Bubulcus ibis* in dry, fallow land.

Densities in cultivated areas were obtained from the counts along the 200 m wide transect: 3.6 cattle egrets/sq km, 1.2 *Egretta* egrets/sq km and 1.1 pond herons/sq km. The latter figure is an underestimate due to the colour of the bird. Local densities in areas subjected to the same cultivation system showed much variation: for example, between 0 and 11 cattle egret/sq km were seen along various sectors at least 30 km in length. The transect, although 525 km long, does not incorporate all these variations (Fig. 3), probably due to the distribution at random of the flooded fields. Whereas the density of cattle egrets, widespread in small groups (20-40) fluctuates by ± 20% around the 3.6 ind./sq km average, the density of *Egretta* spp. has not stabilized after 525 km, since a large group (98) occurred only once, in the last sector. Due to this bias, densities should be regarded as mere estimates.

The only comparative figures result from a sur-

TABLE 4
RELATIVE IMPORTANCE OF COASTAL, BRACKISH WATERS FOR WINTERING DUCKS

	SE India, Jan. 1988	India, Jan. 1987	Sri Lanka, 1984, 86, 87
Cotton teal	0	35	
Tufted pochard	0	47	
Common pochard	0, 3	74	
Garganey	2	23	6 to 99
Spotbilled duck	16	3	
Shoveller	19	85	
Pintail	26	68	70 to 99
Common teal	40	18	
Wigeon	73	59	66 to 100
Red-crested pochard	93	17	
Reference	Present survey	Van der Ven 1987	Hoffmann 1985, 1987 a & b

vey in 1987 by the Wildlife Association of Ramnad Dt. (W.A.R.D.), Tamil Nadu. For the same species, densities were respectively 0.24/ sq km, 0.24/ sq km and 0.045/sq km (calculated from Van der Ven 1987). But the W.A.R.D. figures are *absolute minima*, obtained by dividing the populations counted along the census roads by the total area visited (*c.* 6,300 sq km), only a small part of which could actually be covered: the true densities were undoubtedly much higher.

Stability of waterbird distribution in winter: Kaliveli and Ousteri were visited twice, in early and late January. Whereas the populations in Kaliveli remained fairly stable, the numbers in Ousteri changed drastically for most species: garganeys *Anas querquedula* dwindled from 3000 + to 1500, pintails *Anas acuta* almost disappeared (3500 to 200) whereas pochards (250 to 770), storks (0 to 15) and egrets (9 to 50) increased.

Waterfowl: The bulk of the duck population belonged to 7 migrant species, the garganey, pintail and wigeon *Anas penelope* being the most abundant ones. Common teal *Anas crecca* and common *Aythya ferina*, tufted *Aythya fuligula* and red-crested pochards *Netta rufina* were also found in large numbers, whereas local ducks (cotton teal *Nettapus coromandelianus* and spotbill duck *Anas poecilorhyncha*) accounted for less than 1% of the duck population. The absence of significant numbers of coots *Fulica atra* and the observation of 11 barheaded geese *Anser indicus* on Pulicat are noteworthy.

The garganey was the only duck species in which the males did not display their breeding plumage; the first ones started showing it by the end of January. The various species were not evenly distributed (Table 4), several of them being partial either to brackish or to freshwater. The results for Sri Lanka and all-India are shown for comparison (calculated from Van der Ven 1987).

DISCUSSION

SIZE AND COMPOSITION OF SOME WATERBIRD POPULATIONS

The stability of waterbird distribution in January is not complete, as shown in Ousteri, and a count carried out over several weeks will therefore bear some flaws when the numbers are added. However, this first ever large-scale survey of the wetlands of south-eastern India provided a first basic idea about the populations of certain species.

Waterfowl and other migrants: 1,77,000 ducks were counted over one fifth of the southern Coromandel coastal plains, but our results cannot be extrapolated since the survey included most of the largest wetlands in this region. A few of these, likely to hold large populations of ducks, could not be covered: Red Hills Reservoir (Madras), Willington tank in South Arcot Dt. and Point Calimere (22,000 ducks in 1987; Van der Ven 1987). Southern Tamil Nadu (*c.* 20,000 sq km) also holds some duck populations in tanks that are on the whole smaller; 6,500 were counted in January 1987 over 6,300 sq km (in Van der Ven 1987), and good numbers were again found in 1988 (Wildlife Association of Ramnad Dt., pers. comm.)

Therefore, a minimum of 2,00,000 ducks may have wintered in south-eastern India in 1987-88, a figure likely to increase with further surveys. This can be compared with the 2 to 3,00,000 ducks estimated to winter in Sri Lanka (Hoffmann 1985, 1987a). The composition of the waterfowl was similar to this island, where the 3 most common species are also the garganey, pintail and wigeon (Hoffmann 1985, 1987a, 1987b). The main difference was the significant presence in south-eastern India of 3 species of pochards which do not reach Sri Lanka. The absence of sizeable populations of coots from both regions identifies the southern subcontinent as a minor wintering ground; the main populations winter in Pakistan and northern India (in Van der Ven 1987).

The under-representation of the local duck species seems to be the rule in tropical countries. It was also observed in 1987 in Sri Lanka and all over India (1.2% and 5.6% respectively, calculated from Van der Ven 1987), and it had been noted earlier in Western Africa (15%; Roux and Jarry 1984). It is only partly due to habitat preferences: resident ducks are widespread in small tanks rich in vegetation, and therefore more easily overlooked than the migrant species which gather in large, open water-bodies. However, the small populations of local ducks mainly reflect the lack of equilibrium between the populations which can be supported in winter and in summer by the mostly seasonal, tropical wetlands.

The preferences for either brackish or fresh-water evinced by several species of ducks have to be viewed against the prevailing climatic conditions in 1987-88 winter. Most of the large inland tanks had enough water to provide a suitable daytime refuge, and they attracted almost all the garganeys, common and tufted pochards, and local ducks. Their utilization by pintails and wigeons may be overestimated, since 65% of the unidentified ducks were seen in brackish wetlands and probably comprised of these two species, by far the most common ones in coastal waters. These results suggest local trends, sometimes very different from those observed in Sri Lanka or in the whole of India (Table 4): for example, all the garganeys present in the island may be found either in brackish or in freshwaters. The only general trend is maybe the partiality evinced by wigeons to brackish waters. On the whole, the distribution of ducks may actually reflect the availability of each type of wetland rather than any marked preferences.

We confirmed the fact that several species have obviously become common since the first edition of the HANDBOOK (Ali and Ripley 1968). The common and tufted pochards, and the blacktailed godwit *Limosa limosa* among waders, were widespread in 1988, with flocks going up to 7000, 700 and 300 respectively; this confirms Perennou's initial findings (1989). It seems difficult to attribute the increase of such noticeable game birds to that of observers, and it is likely to have taken place several years ago (pers. obs.). A similar trend has been noted in the case of the tufted pochard in Pakistan (Van der Ven 1987).

For a few other species, reputed to be irregular or rare in southern India, comparisons with the previous winter are possible. The red-crested pochard, already known as "fairly plentiful in some years" in Tamil Nadu (Ali and Ripley 1968), turned up in large numbers mainly in Kaliveli (3500 against 90 in 1987). On the other hand, both the white stork *Ciconia ciconia* and the brahminy duck *Tadorna ferruginea* (39 and 2 respectively, against 2-300 and 30) were less numerous in this lake. All these trends were confirmed by regular observations throughout winter, including in other wetlands.

Such variations in the size of the populations wintering so far south are possibly due to the conditions prevailing in the usual, northern main wintering grounds of these species, with southern India acting as a refuge when these conditions become too severe (drought, disturbances). Similar shifts, oriented southwards, occur in temperate countries during cold spells (see for example, Blondel and Isenmann 1981); in West Africa, they are oriented east-west (Roux and Jarry 1984) or southwards (Roux *et al.* 1976-77) during droughts. Several more years of mid-winter counts in the Indian subcontinent will be necessary before we start understanding such yearly fluctuations. As a first step, the main wintering grounds for each species have to be precisely identified and populations of waterbirds wintering out of their usual range carefully recorded.

Colonial waterbirds: Although the largest known colonies in this region were visited (Vedanthangal, Nelapattu, Simpson Estate), our results probably do not reflect accurately enough the breeding distribution of colonial waterbirds, since other remote colonies such as Ethirpattu possibly exist without

Table 5
DENSITY AND ESTIMATED POPULATIONS OF SOME WATERBIRDS IN CULTIVATED AREAS

	Cattle egret	*Egretta garzetta + E. intermedia*	Pond heron
Present survey:			
Density (ind/sq km	3.6	1.2	1.1
Estimated population in:			
Surveyed area (12, 600 sq km)	45000	15000	13000
Coastal plains (65,000 sq km)	234000	78000	71000
Survey by WARD:			
Min. density (ind/sq km)	0.24	0.24	0.045
Min. population in coastal plains	15600	15600	3000

being known. The colonies census (Table 2) is therefore primarily meant for future and local comparisons.

A tentative estimate of the size of the populations is possible, only for the species widespread in cultivated areas (Table 5): 200-250,000 cattle egrets, 50-100,000 *Egretta* egrets and undoubtedly the same number of pond herons may be present along the southern Coromandel coast in winter. Bearing in mind the imperfections of the method and the risks of an extrapolation to non-visited areas, these figures at least suggest a range for populations otherwise impossible to estimate accurately. They tally with the important migration passage of cattle egrets observed in Pondicherry in October and early November and with the minimum densities recorded in southern Tamil Nadu in 1987 by the W.A.R.D.

In mixed colonies, a spatial segregation of breeding species as in Ethirpattu was earlier noted in Vedanthangal (Spillett 1968), in Ranganathittu (Neginhall 1982) and in Camargue (southern France), where Hafner (1977) has shown that it is due to the differences in breeding dates: the first species to arrive select the best nesting sites, and the next species have to colonize the less suitable trees.

It may seem amazing that large numbers of colonical waterbirds (storks, ibises, spoonbills, herons, egrets) regularly occur in winter away from any colony such as in Kaliveli and Point Calimere, when the same species are breeding elsewhere along the Coromandel coast. Several interpretations can be put forward. Some of these non-breeding birds may consist of immatures and of adults which do not breed due to inadequate conditions in their usual colonies. Some birds may also come from regions with different breeding dates. This is suggested by the observation of juvenile painted and openbill storks *Anastomus oscitans*; showing a large amount of brown in their plumage, in early January in Pulicat lagoon and even earlier (October) in Ousteri tank. The breeding season in south-eastern India (November to March; Ali and Ripley 1968) is unlikely to account for such early observations, and a local migration from other parts of the subcontinent may be suspected.

Relative Importance of Different Habitats

The relative importance of the various types of wetlands cannot be assessed through mere counts, since more than one type may be used by a given bird within the span of a day: egrets or ibises will feed in a tank or a marsh and roost in a nearby colony, whether active (Nelapattu) or not (Vedanthangal). However, a comparison between the main habitats can be attempted for a few species.

The two largest natural wetlands, Pulicat lagoon and Kaliveli, proved to be the most important wintering sites for waterbirds, although many could not be specifically identified and Pulicat was only partly surveyed. These lakes held altogether 45% of the total duck populations including most of the wigeons and red-crested pochards, all the flamingos, large congregations of waders, storks and egrets. The number of ducks (46,000 and 33,000 respectively) provide a clue to the international importance of these wetlands, which in the case of Kaliveli is confirmed by the counts made in the previous winter (22,000).

Although none attains the level of Pulicat or Kaliveli individually, large irrigation tanks also proved to be very important for waterbirds. Altogether, they held over 50% of the duck populations, and several species were confined to this freshwater habitat (Table 4). Large tanks also attracted congregations of egrets, herons, storks, ibises (Maduranthakkam) or waders (Kaveripakkam) when drying up. The large size of their waterbody warrants that at least part of it would always remain free of human disturbance and therefore suitable for birds.

Small man-made tanks, having a low water level and usually subjected to human activity all along the banks, did not provide a large enough refuge free of disturbance. They were poorly used by waterbirds and accounted for less than 1% of the total. This result confirms that the population of many species, especially that of the migrant ducks, can be accurately estimated by a survey focussed on the largest tanks.

Finally, paddyfields were a major, and probably the main foraging habitat for egrets (cattle, little and smaller) and paddybirds. Their populations in cultivated tracts (Table 5) are worthy of comparison with the much lower figures, a few hundreds at most, counted in tanks and natural wetlands.

Conservation: Two out of the three major wetlands of south-eastern India, Pulicat and Point Calimere, are already protected as bird sanctuaries; a similar, much awaited status for Kaliveli is under consideration by the Forest Department of Tamil Nadu. It should help prevent poaching, which has been regularly practised up to now: it should also be instrumental in doing away with the plans to drain the lake for cultivation, which have come up periodically.

The dispersal of many waterbirds over numerous irrigation tanks implies that the bulk of them cannot be protected through a few sanctuaries. However, the number of such tanks warrants that in case one becomes unsuitable, alternative habitats are readily available. Since water conservation is a regional priority, irrespective of wildlife conservation, the future of the tanks does not appear bleak.

Finally, the most appropriate conservation plans for species widespread in cultivated areas probably consist in having the main breeding colonies protected. This seems to be on the whole effective, be it thanks to the spontaneous protection by villagers (Nelapattu, Ethirpattu), official sanctuaries (Nelapattu, Vedanthangal), or to private, motivated ownership (Simpson Estate).

Conclusions

This survey gave a first impression about the numerical importance of south-eastern India for wintering waterbirds. Even if we lack references for comparisons with other regions, the southern Coromandel coast definitely proved to be an important wintering area both for Palaearctic migrants (ducks, waders) and local waterbirds. The results have to be viewed against the water availability in the 1987-88 winter, locally scarce enough to reduce the bird populations in some wetlands such as Vedanthangal.

For a few groups of species (ducks, egrets), a first estimate of the size of wintering populations could be attempted, which needs validation through further years of observations.

The importance of Pulicat lagoon and Kaliveli tank was numerically assessed: together with Point Calimere, they are likely to be the 3 most important wetlands in south- eastern India for trans-Himalayan migrants, in addition to holding large populations of local waterbirds. We also proved the importance of irrigation tanks and cultivated land for many species.

Finally, the regular winter presence and in some cases (pochards) the abundance of species still described as rare in southern India was assessed.

Many more results can be expected from the Asian Waterfowl Censuses to come, and other analyses at a local level will prove very useful for an all-India synthesis.

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HABITAT, NESTING AND REPRODUCTIVE ADAPTATIONS IN NARROW-HEADED SOFT-SHELL TURTLE *CHITRA INDICA* (GRAY), (REPTILIA: CHELONIA)[1]

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INTRODUCTION

The narrow-headed soft-shell turtle, *Chitra indica* (Gray) ranges from the Indus river system in the north-west of the Indian subcontinent to Thailand in south-east Asia (Smith 1931, Pritchard 1979, Daniel 1983). It has recently been reported from the Godavari river system in peninsular India (Moll and Vijaya 1986). This trionychid turtle attains a length of 90 cm (Pritchard 1979) or even more (Daniel 1983). In spite of the wide distribution very little is known about the species' natural history or reproduction, Pritchard's account of its habits being probably based on that of Smith. This paper presents observations on the nesting, eggs and their incubation in *Chitra indica* and discusses the reproductive adaptations of this species

HABITAT

According to Smith, *Chitra* has been recorded from both the upper reaches of rivers with clear water and sandy bottoms, as well as from downriver and deltas. In the latter type of habitat, conditions are likely to be quite different, with muddy bottoms and turbid, brackish water, although Pritchard has emphasised the preference for the former type of habitat. In his general comments on the habitat of Trionychidae, Smith has included bodies of stagnant water such as lakes and ponds. But he has omitted to make an important distinction in the case of *Chitra,* which is restricted exclusively to flowing rivers (authors' upublished observations).

REPRODUCTION

Pritchard has stated that the reproductive habits of the species are unknown. However, Daniel, citing Chaudhuri (1912), mentions that its hatchlings are extraordinarily small, with carapace size of even *c.* 2.9 x 3.3 cm. During collection of eggs of soft-shell turtles from the Chambal river in north India, as part of the Fresh Water Turtle Rehabilitation Project under the auspices of the Ganga Action Plan, several nests of *Chitra* were located and their eggs collected for controlled incubation and rearing of the hatchlings for the 'grow and release' programme.

Nesting: Nests of *Chitra* were located between 2 and 17 September 1988. The nesting, therefore, as determined from the age of spoor found at the nest sites, occurred between 23 August and 17 September 1988. Details of individual nests are given in Table 1.

Nests were flask-shaped holes dug in substrates of sand or sandy loam. The eggs were tightly compacted in the sub-soil after laying. The dimensions of the egg chamber at mid-depth of one nest were 15 x 23 cm. The depths at the top and bottom layer of eggs in the same nest were 15 cm and 33 cm respectively. These measurements are representative of the nest configurations of *Chitra*. The distance from the water of 7 nests of 1988, ranged from 8 m to 135 m and their mean distance was 44.9 m. The nests were located at safe heights above the river level. Only one nest site (No. 2, 1988) was flooded by the rise of the river level by 5.11 m on 8 October 1988 over the lowest river level on 16 June 1988.

The temperature of the soil in the nests was measured at the time of collection, by pushing the bulb of a Hg thermometer (accurate within 0.5° C) into the soil. Mean temperature of 6 nests of 1988, measured between 0900 and 1700 hrs, was 36.25° C. The temperature of one nest (No. 7, 1988) was low in comparison (29.5° C).

Clutch size and description of eggs: The eggs of *Chitra* are spherical, brittle-shelled, unpigmented and translucent whitish in appearance when laid. The mean weight and diameter of eggs (n = 80) were 10.4 g (10.0-18.0) and 26.8 mm (25.4-28.2)

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Table 1
DETAILS OF INDIVIDUAL NESTS OF *Chitra*

Year of collection	Nest no.	Clutch size	Date of location	Probable laying date, determined from age of spoor	Date of hatching	Possible range of incubation period in days
1987	1	130	9 Sep.	–	–	–
	2	101	24 Sep.	–	–	–
	3	65	22 Sep.	–	–	–
1988	1	122	4 Sep.	2 Sept.	11 to 29 Oct.	40 to 70 days
	2	178	5 Sep.	29 Aug.		
	3	111	5 Sep.	23 Aug.		
	4	122	6 Sep.	1 Sep.		
	5	120	10 Sep.	2 Sep.		
	6	140	10 Sep.	26 Aug.		
	7	89	17 Sep.	17 Sep.		

respectively. Mean clutch size of the 3 nests located in 1987, 7 nests located in 1988 and pooled data for both years were respectively 99, 126 and 118 eggs. The largest and smallest clutches located contained 178 and 65 eggs respectively.

Incubation: Soon after location of the nests, the eggs were collected in wooden boxes filled with soil from the nest site. They were subsequently transported by road to the turtle rearing facility at Kukrail near Lucknow, approximately 275 km away on the 14 September 1988, or roughly 12 to 22 days after the eggs were laid. Clutch no. 7 (1988) was collected later for transportation to the Turtle Rehabilitation Centre at Varanasi.

At the Kukrail turtle facility, incubation was completed in the collection boxes which were kept in a heated room. The temperature of the incubation medium ranged between 25.5° C and 36.0° C and the approximate mean temperature was 31.2° C. Hatchlings emerged between 11 October and 29 October 1988, which approximates the time of emergence of the hatchlings in nature, where emergence has been observed in November (R.J. Rao pers. comm.). The incubation period of *Chitra* is computed to range between 40 and 70 days with a median incubation period of 55 days.

Table 2
WEIGHTS AND MEASUREMENTS OF *Chitra* HATCHLINGS

	Mean	Range
Disc length (mm)	33.8	30.1-36.4
Carapace width (mm)	26.1	24.0-28.9
Plastron length (mm)	26.5	24.0-27.9
Hatchling weight (g)	7.5	6.5-8.8

The weights and measurements of the hatchlings (n=6) are given in Table 2. The hatchling sizes are in agreement with those given by Chaudhuri (1912).

Discussion

The reproductive parameters of chelonians have been reviewed by Ewert (1979, 1985) and Moll (1979). The reproductive adaptations of *Chitra* are discussed below in the light of these reviews and the studies of Rao and Singh (1984, 1987a, 1987b) on sympatric emydid species. *Chitra indica* conforms to the tendency of large turtle species to lay large clutches. Among the fresh water turtles only the Pelomedasid *Podocnemis expansa* (1 m in length, reported mean clutch size of 82) is comparable in both clutch size and body size to *Chitra*. The size of *Chitra* eggs is correlated inversely with clutch size as is typical for chelonians, and lies at the lower end of the scale similar to other trionychids (minimum diameter of chelonian eggs, 20 mm *Trionyx sinensis*).

Although the size of the females is not known, it is logical to expect that the egg weight/body weight ratios for *Chitra* would be very low as well (<0.002). This parameter following a weak trend is directly proportional to the species' incubation period. *Chitra*, with an incubation period of approximately 55 days, conforms to this trend (known incubation periods of chelonians range from 42 days to over 200 days). It is not known if *Chitra* is capable of laying multiple clutches annually. Even without multiple clutches it possesses a moderately high reproductive potential on account of its large clutch size. However, some species of chelonians are known to possess large clutch sizes as well as lay multiple clutches per season (*Chelonia mydas*, 10 x 100). But these species are also known to have 2 to 4 year sexual cycles, which is rare among fresh water species.

According to Moll, *Chitra* would be a primitive species which has retained a large body size and lays a large clutch of small eggs, whereas small body size, clutch size and large egg size represent advanced characters and specialization in chelonians and favour their survival. Moll has also quoted several authors according to whom the timing of the reproductive cycles of most species is determined by the environmental conditions prevailing at the time of emergence of the hatchlings. He has also stated that the nesting season of most temperate species allows the most vulnerable period of turtle development to take place during the most favourable season of growth. What then are the factors which have prompted *Chitra* to transgress the above generalizations and influence the choice of its nesting season whereby emergence of hatchlings just precedes winter, the most unfavourable season for growth?

The most appropriate interpretations emerge if the reproductive adaptations of *Chitra* are evaluated in the context of the adaptations of sympatric fresh water turtles which live in the Chambal river along with *Chitra*. Rao and Singh (1984) enumerated 3 trionychid and 4 emydid turtle species in the Chambal. Subsequently Pai and Basu (1988) identified another trionychid and these make up the known complement of fresh water turtle species inhabiting this river. These are, among the Trionychidae, *Chitra indica, Trionyx gangeticus, T. hurum, Lissemys punctata* and among the Emydidae, *Kachuga kachuga, K. dhongoka, K. tentoria, and Hardella thurgii.*

The significant characteristics of nesting in Emydidae that have been pointed out by Rao and Singh are: (1) *Kachuga* nest after the monsoons after final recession of the river level or in the post winter dry season, thereby precluding chances of nest flooding. (2) There is inter-specific temporal and spatial separation of nests of the 3 *Kachuga* species. (3) There is heavy predation of *Kachuga* nests ranging from 38.5% to 95.4% for the 3 species, with the highest incidence of predation in *K. tentoria* (whose eggs have the longest incubation period).

Thus, apart from the energetics of egg production and the developmental requirements of the embryos, the major factors determining nesting parameters of fresh water turtles are partitioning of nesting habitat, preclusion of nest flooding and predator avoidance at specific, generic and family levels.

Nesting in the Trionychidae begins earlier than in the Emydidae and occurs mainly in the period August through October (authors' unpublished observations), thus achieving temporal separation of nesting from the Emydidae. Spatial separation of nesting at the family level is also achieved by the Trionychidae utilising steep river banks of clay and loam and by the Emydidae utilising flat or gently sloped sand banks.

Inter-specifically within the Trionychidae, there is greater temporal and to a lesser extent, spatial overlap of nesting. Even so a marked spatial separation exists between nests of *Trionyx* and *Chitra*. Nesting of both *Trionyx* and *Chitra* roughly coincides with the monsoons but different strategies are adopted by them to preclude flooding of nests as a result of rise of the river level. (Details of nesting in *Trionyx* will be presented elsewhere).

Separation of nesting habitat of *Chitra* from that of *Trionyx* may have been influenced by a number of different overlapping factors, but seems primarily to be an adaptation for survival of eggs from predation, as is elucidated below.

(1) *Chitra*, with a large reproductive potential, even through a single clutch, has adapted for the rapid incubation of eggs. The obvious survival advantage of such a nesting strategy is a shorter exposure of the delicate egg stage to environmental hazards. It has to therefore seek nesting media which are significantly warmer than that of *Trionyx* and at the same time friable to facilitate emergence of the hatchlings without having to wait for the monsoons to loosen the nest plug. *Trionyx*, on the other hand, to attain an adequate reproductive potential, produce multiple clutches (Rao 1986). They achieve synchrony in the emergence of the hatchlings with the most favourable period of growth following the

onset of the monsoons, by genetic programming for embryonic diapause and/or aestivation, (authors' unpublished observations).

(2) Moll and Legler (1971) have ascribed the differences in the reproductive patterns of 3 sympatric species of turtles in the Panama, primarily to adaptation for predator avoidance of eggs and hatchlings. They have emphasised the pervasive influence that predation of eggs and hatchlings can have on the success of chelonian populations in favourable habitats.

The high rates of predation of Emydid nests in the Chambal pointed out by Rao and Singh, attests to the high priority that predator avoidance of nests could receive in the evolution of *Chitra's* reproductive adaptations. Assuming that the energetics of reproduction necessitates the concurrence of its nesting season with that of *Trionyx, Chitra* would be at a distinct advantage if it could utilise a different nesting habitat. Carr (1967) mentions how egg predators of community nesting turtles actually converge on nesting areas, causing intense depredations of their reproductive potential. *Chitra* nests, by spatial separation from *Trionyx* nests, would escape detection by predators if the major predatory efforts were directed at *Trionyx* nests. Preliminary indications in the field suggest exactly this, that *Chitra* nests suffer from significantly lower incidence of predation than *Trionyx* nests (authors' unpublished observations).

(3) Hatchlings of most other species emerge just prior to arrival of the monsoons, i.e. from mid-May to mid-June. (Rao and Singh 1987, authors' unpublished observations). Emergence of the hatchlings of *Chitra* around November would enhance hatchling survival against predators, which would become increasingly active with the concurrent emergence of the hatchlings of all other species at a different time of the year.

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DUGONG *DUGONG DUGON* MULLER IN THE GULF OF KUTCH, GUJARAT[1]

J. G. Frazier[2] and Taej Mundkur[3]

(With two text-figures)

A review of records of dugongs *Dugong dugon* from the Gulf of Kutch, Gujarat, is presented. Details of an immature male found dead near Bet Dwarka Island are also given, with morphometrics (including rarely measured internal organs), stomach contents and parasites. Stomach contents indicate that the small marine angiosperm *Halophila ovalis* is an important food item. Three intestinal flatworms were found: *Haerator caperatus, Rhabdiopoeus taylori*, and *Indosolenorchis hirudinaceus;* the first two are new records for Indian dugongs. It is concluded that, although formerly discounted as consisting of strays, the dugong population in the Gulf of Kutch is significant; there is evidently a resident, breeding population. This population needs to be investigated and protected.

Introduction

One species of Sirenia, Steller's sea cow *Rhytina stelleri* (Zimmermann), has been exterminated during historic times, and all four of the living species of this order are regarded as vulnerable (Anon.1988:17). Of these, the dugong *Dugong dugon* Muller has the largest geographic distribution, having been recorded from as far west and south as Mozambique (Hughes and Oxley-Oxland 1971), from along the east coast of Africa, in the Red Sea (Gohar 1957), Persian Gulf (Gallagher 1976, 1978), at offshore and oceanic islands of the Indian Ocean (Jones 1976, 1980), and as far east as Australia, Papua New Guinea, Palau, and New Caledonia and nearby islands of southeast Micronesia (Prater 1928, 1980, Nair *et al.* 1975, Husar 1978, Nishiwaki and Marsh 1985).

Of the populations around the Indian subcontinent, those in the Gulf of Mannar and Palk Bay are best known (Annandale 1906, Prater 1928, Jones 1959, 1967, 1976, 1980, 1981, Jonklass 1961, Thomas 1966, James 1974, Nair *et al.* 1975, Mohan 1976, Bhaskar 1986, Anon. 1987a, Silas and Fernando 1988). Hence, both southern India and Sri Lanka are well known for dugongs. There seem to be no records from farther north along the east coast of India or from the Sunderbans (Nishiwaki and Marsh 1985), although there are records from the Chittagong coast of Bangladesh (O'Malley 1908) and Burmese waters (Tun Yin 1971, Jones 1981:44, 45). The species has been recorded from the Andaman Islands (Anon. 1909:238, Jones 1980:236; James 1988), where it has been claimed that few remain (Husar 1978:2). However, little attention has been paid to this population.

Evidently, the animal once occurred along the west coast of India, for Jerdon (1894:311-312) stated that they were reported (as seals) from salt water inlets off the south Malabar and Concan (Konkan) coasts as far north as Canara (which corresponds to southern Maharashtra, Goa, Karnataka and Kerala today). The occurrence of dugongs along the Malabar coast was also mentioned in the Imperial Gazetteer (Anon. 1909:238). However, Prater (1928:85) later stated "I have not been able to obtain any information regarding the present occurrence of the dugong on the west coast of India." Jones (1967:216, 1980:236) also commented on the lack of contemporary records from the west coast.

At the beginning of the century this animal was regarded as "approaching extermination in Indian seas" (Anon 1909:239), and 60 years ago Prater (1928:86) concluded that the dugong was becoming increasingly rare in Indian waters. The status of this species in the Gulf of Mannar and Palk Bay has worsened over the years (Jonklass 1961, Jones 1967:216, 1980, Anon. 1987a, Silas and Fernando 1988). Claims to the contrary (e.g. Thomas 1966) are unsubstantiated and, as Jones (1980:236; 1981:46) suggested, possibly the result of confusion with porpoises and/or dolphins.

The Gulf of Kutch (spelled also 'Cutch', or 'Kachchh', or 'Katchch') is often omitted or underplayed in discussions of the dugong. Jones

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TABLE 1
RECORDS OF DUGONGS IN THE GULF OF KUTCH, GUJARAT (SEE FIG. 1 FOR LOCATIONS)

Record number	Date	Locality	Specimen	Sex*	Source
1	1877	Sachana	1 carcass	?	Moses (1942)
2	April (1893)	Mandvi	1 skull	?	Phipson (1895)
3	17 July 1959	Bedi Bunder, Jamnagar	1 carcass	M	Mani (1960)
4	30 July 1959	Bedi Bunder, Jamnagar	1 carcass	F	Mani (1960)
5	Oct. 1961	Pirotan island	2 carcasses	?	Mohan (1963)
6	6 March 1962	Salaya	1 carcass	F	Mohan (1963)
7	15 June 1978	Bhaidar island	1 carcass	M	Bhaskar (1978)
8	3 Sept. 1983	Bet Dwarka	2 beached	1 M 1 F	Ved (1983)
9	5-6 Jan. 1987	Bet Dwarka	1 lower mandible 1 upper mandible 1 premaxilla	? ? M	This study -do- -do-
10	7 Jan. 1987	Poshitra Point	1 carcass	M	This study

*M = male; F = female; ? = sex unknown

(1959:198) stated that there are probably "very stray numbers in the Gulf of Cutch", and Nair *et al.* (1975:8) commented that 'stray numbers' are caught in the Gulf. The suggestion that the individuals which occur in the Gulf of Kutch are vagrants has been repeated recently (Jones 1981:46). The present paper reviews the information available on dugongs in the Gulf of Kutch; it also describes the opportunistic discovery of bones and details from the examination of an intact specimen from the Gulf of Kutch. The carcass was examined for morphological features, and the resulting data and published observations relevant to them are discussed.

Review of records from the Gulf of Kutch: Moses (1942:75) reported "The dugong is said to have been caught in a *bush vada* (fence net) near Sachana (northeast of Jamnagar) in 1877; he could list no other record of dugong in his summary of the Gujarat coast. A skull from Mandvi was presented to the Bombay Natural History Society (BNHS) in April 1893 by C.M. Sykes (Phipson 1895, see also Prater 1928:85). This is apparently the same skull which Phipson (1893) referred to under the name of Dr. Ardeshir Dadabhai, under contributions to the collections for the month of May 1893.

Two dugongs were landed at Bedi Bunder, north of Jamnagar; the first was found floating dead on 17 July 1959; the second, a female landed on 30 July, was reported to be 4.06 m (13' 4") long (Mani 1960). The editors of this article (Ali *et al.* 1960:217) added that these specimens extended the recorded distribution of the species northward in India, evidently unaware of the earlier records (two of which had been published in the same journal). The skull of one of the animals from Bedi Bunder was later reported to be of a male, so presumably this was the specimen of 17 July, for the other specimen was a female (Santapau and Abdulali 1961:264).

Silas (1961) commented on Mani's report, raising several points germane to the present paper. He argued that marine mammals generally sink when dead. Silas also pointed out that the length given for the female was extraordinarily large, far greater than either the average, or the maximum for Indian specimens, which he stated are 2.5 m and 3.5 m respectively. He also posed the question of whether or not dugongs are seasonal visitors to the Gulf of Kutch.

Mohan (1963:152) reported two dead animals from Pirotan island in October 1961 and a dead female from Salaya on 6 March 1962. On 15 June 1978, Bhaskar (1978:10) found the decomposed carcass of a male on Bhaidar island; as large pieces

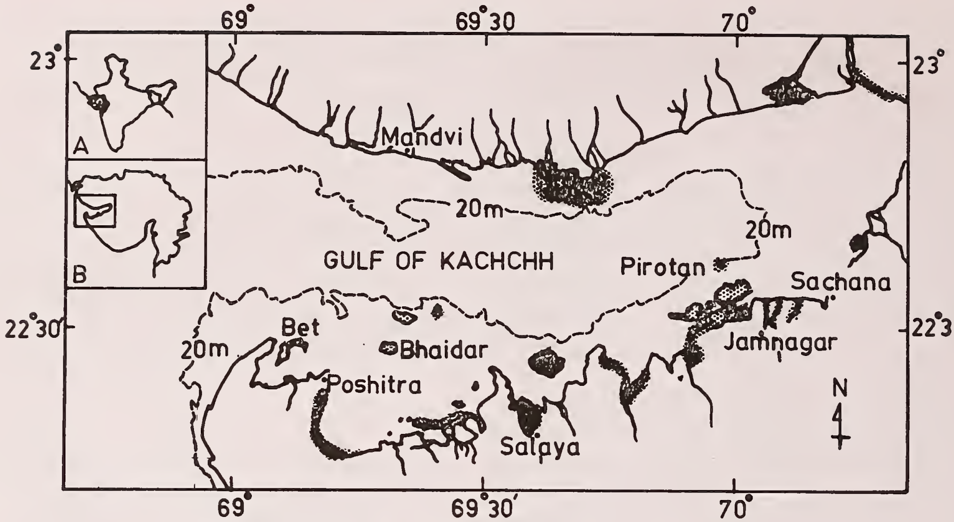

Fig. 1. Locality map of dugong records for the Gulf of Kutch.
A. Outline map of the Indian subcontinent with Gujarat shaded. B. Outline map of Gujarat with the Gulf of Kutch indicated within the rectangle. C. Gulf of Kutch, showing localities of dugong records. Shading represents areas of present day mangrove vegetation. The continuous line is the shore and the dotted line, the 20 m isobath. Map adapted from The Gulf of Kutch, Chart No. 203; published by the Naval Hydrographic Office 1978, Dehra Dun .

of it were missing, he assumed that it had been attacked by a shark (but this could easily have occurred after death). Ved (1983) wrote about a beached male and a beached female found at Bet Dwarka on 3 September 1983. At least two popular articles have been published on the carcass described below (Anon. 1987b, c). These records are summarized in Table 1 and Fig. 1.

Material and Methods

From 4 to 10 January 1987 we visited the Hingolgadh Nature Conservation Education Programme camp at Bet Dwarka Island (also called 'Bet Shankhodhar' or simply 'Bet'), at the southwestern extreme of the Gulf of Kutch (Fig. 1). Casual walks along about 1.5 km of beach on the eastern shore of the island were made on 5 and 6 January, and signs of dugong (stranded specimens) were recorded opportunistically. On 7 January a dead but intact specimen (JGF 5137) was found floating offshore of Poshitra Point, evidently having been driven across the Gulf by a strong north-northeasterly wind. This specimen was taken to the Nature Camp to show the school children and dissected on 8 January; it was estimated to have been dead since at least 6 January.

Linear measurements (see Spain and Heinsohn 1975) were made with a flexible tape. Weights of greater than 1 kg were measured with a 'Champion' spring balance, with a capacity of 11 kg; weights of less than 1 kg were measured with a 'Pesola' 155 spring balance. Although the specimen had to be weighed in pieces, there was little apparent loss of body fluids. The organs and parts of the alimentary tract were prepared for weighing by squeezing out the contents, rinsing the tract, and draining it completely.

Hair densities were measured in one of two ways. Over most of the body the jaws of a vernier caliper were set 2 cm apart and a distance of 2 cm was marked off along on each jaw, to produce a 2 x 2 cm square. This square was laid on the skin, after it had been removed from the specimen, and hair follicles were counted in the 4 sq cm area. Squares were positioned randomly in mid-dorsal and mid-ventral positions of the thoracic, abdominal and caudal sections, as well as on dorsal and ventral surfaces of the flippers and flukes and on the dorsal surface of the head. Because of the relatively small area, but high density of stiff hairs on the face, the square used for counting here was reduced in size. The jaws of the caliper were set 1 cm apart and a distance of 1 cm was marked off along both jaws; the 1 cm squares were positioned randomly for counting hair follicles.

Fishermen and boatmen of the area were asked informally about dugongs, common names, when they saw them, etc. These interviews were facilitated by the presence of the intact specimen for demonstration.

RESULTS

Common names and information: The local name of the dugong used by Hindu fishermen in the Gulf of Kutch is 'Bai Manas', meaning 'woman human', and they claim that they release these animals if they are caught in their nets. Muslim fishermen in the Gulf have two names: 'Suwar Machi' (meaning 'pig fish'), or 'Lulli' (meaning 'female cripple'). Because they believe the animal is related to the pig, they claim that they will not eat it but release it when accidentally caught. It is relevant that the common names reported by Jones (1959:198) (presumably from south India where dugong are actively fished and eaten by Muslims) are 'avolia' and 'kadalpanni', names which mean 'sea pig'.

However, the oil of dugong is valued as a preserver and conditioner of wooden boats in the Gulf, and it is likely that both Muslim and Hindu fishermen will use it when available. Because the species is protected by wildlife protection laws of both the state and central governments, but more importantly because there is no commercial fishery for dugong, there are no data available on accidental catches, much less on the number of animals utilized (illegally) per year.

Local knowledge of the dugong varies tremendously from person to person. One local businessman reported that a dugong had been caught about 3 years before and photographed; it was the first one he had seen during his life, having lived some 40 years on Bet Dwarka. However, fishermen of both religions knew the animals well, and one man reported having captured a dugong in a net near Bet Dwarka about a month before our visit.

Fishermen along the north coast of the Gulf, as far east as Mandvi, have occasionally caught dugongs accidentally in nets, and later released them. Until three years ago they could see groups of up to 10 or 15 individuals (Pravez pers. comm.).

Stranded remains: On about 1 km of the eastern shore of Bet Dwarka Island various bones of dugongs were found. These include cranial and postcranial material which came from at least 3 individuals: a badly weathered premaxillary of a mature animal (male ?- having enormous sockets for tusks); a relatively fresh lower mandible (having 6 tooth sockets on each side) and parts of the zygomatic arch of an adult-sized individual of unknown sex; and a weathered maxillary (having 4 distinct tooth sockets) and parts of the zygomatic arch of an immature-sized individual. However, it is likely that more than 3 individuals had been washed up on this short length of beach during the past few years. A few other bones were seen but not examined during the brief visit to this site. Furthermore, 1 or 2 km of the eastern shore of Bet Dwarka represents a tiny part of the total shoreline of the Gulf of Kutch, so one could assume that the number of stranded specimens in the entire Gulf might be considerable.

TABLE 2.
EXTERNAL BODY MEASUREMENTS OF DUGONG JGF 5137

Measurement	Value (cm)
Length:	
Total length (tip of snout to median posterior of fluke)	172
Posterior insertion of lower lip to navel	59
Navel to anterior of genital slit	17
Genital slit	3
Posterior of genital slit to mid-anus	28
Mid-anus to median posterior of fluke	61
Flipper: axilla to tip	22
Fluke width	60
Girth* at: axilla	114
navel	132
genital slit	120
anus	83
caudal peduncle	39

*The specimen was bloated, so some girth values are slightly larger than they would normally have been.

SPECIMEN JGF 5137

External features: This carcass was very positively buoyant, and had evidently been floating for at least 12 hours when it was found (c.f. Silas 1961). It had been driven across a large expanse of open water by a strong wind. Its colour was light grey dorsally and cream white ventrally; the dorsal surfaces of the flukes were darker grey. Although there were small scratches on the body, especially near the ventral surfaces, there were no major scars, as has been reported on animals, particularly males, from other localities (see Prater 1928:93, Marsh *et al.*

1984a:780), including the Gulf of Mannar (Annandale 1906:243, Jones 1967:219). There was also no sign of epizoic algae on the skin, as has been reported from captive dugongs in southern India (Jones 1959:199, Jonklass 1961:3). See Frazier (1989) for colour photos of JGF 5137.

Cause of death: A distinct impression of a line ran around the animal's neck, indicating that its head had been caught and tightly held in a (gill) net. There were less than 15 g of fluid in each lung, but a massive haemorrhage was conspicuous at the base of the throat. This indicates death by asphyxiation – not by drowning (inhaling water).

Sex size and age class: The specimen was a male with a total length of 172 cm (see Table 2 for other external body measurements). This is considerably smaller than the average from south India of 250 cm given by Silas (1961) and is at the smaller end of the range of body sizes reported by Mohan (1976), also from south India. Of the three recognized size / age classes for dugongs, the smallest – calf – includes animals up to 180 cm long (Heinsohn 1972, Husar 1978:4).

Unfortunately, although the penis was found, its testes were not. Harrison (1969:337) stated that there is doubt about the exact position of the testis and that they are probably between layers of abdominal muscles, but Marsh *et al.* (1984b:725) clearly described them as lying caudal and slightly lateral to the corresponding kidney.

There were no signs of tusks in the upper jaw. Marsh *et al.* (1984b:729) reported that in no immature dugong had the tusks begun to erupt. Furthermore, erupted tusks are not unique to males, but may also occur in mature females (Marsh *et al.* 1978:162).

The light body colour (see Jones 1959:199), relatively small body size (well within the calf size class), and absence of conspicuous testis and tusks all indicate that the animal was an immature.

The total weight of the specimen was nearly 120 kg (Table 3). The relationship between length and weight (172 cm and 120 kg) is consistent with the predictive lines presented by Nair *et al.* (1975:Fig. 5) for the Gulf of Mannar, India, and by Spain and Heinsohn (1975: Fig. 6) for Australia.

Skin and body wall: Skin (with attached adipose tissue) accounted for more than 20% of the total weight, and body wall muscles, etc. was nearly 30% (Table 3). The skin was thick, most of which consisted of adipose tissue with a remarkably dense concentration of connective tissue. Dorsally it was 25 mm thick, and ventrally, 10 to 13 mm (Table 4). In comparison, the skin of a 288 cm long female from the Red Sea was 35 mm thick dorsally and 25 mm ventrally (Gohar 1957:11). Spain and Heinsohn (1975:167) found that dorsal and ventral skin thickness increase isometrically with body length. In the Kutch specimen there was no thick layer of fatty tissue, or 'blubber', that was low in connective tissue and high in fat; this is consistent with what other authors have reported (Marsh *et al.* 1978:165).

Hair: Thick hair follicles were conspicuous over almost the entire body. Although the hairs are sometimes said to be devoid of pigment (Annandale 1906:239; Gohar 1957:15; Husar 1978:3), the follicles of JGF 5137 appeared to be brown in colour. Prater (1980:94) described the hairs as 'fine', but on our specimen they were nearly 0.5 mm thick. The only surfaces where hairs were absent were the ventral flippers and flukes (cf. Gohar 1957:13). On the trunk, the ventral thorax ('chest') had the lowest concentration and the dorsal abdomen, or sacral region, had the highest; hairs were more than three times denser dorsally than ventrally (Table 5). Similarly, the dorsal surfaces of the flippers and

TABLE 3
WEIGHTS OF VARIOUS BODY PARTS OF DUGONG JGF 5137

Body part	Weight(kg)	% of total
Head	9.60	8.1
Flipper (including scapula): left	1.30	2.2
right	1.30	
Flukes	4.40	3.7
Skin (minus head, flippers & flukes)	25.55	21.6
Body wall muscles, fascia, fat etc.	33.895	28.6
Dorsal muscles	13.675	11.5
Vertebrae & ribs	11.730	9.9
Internal organs (from Table 6)	9.185	7.7
Contents of gastro-intestinal tract (from Table 7)	7.870	6.6
Total	118.555	99.9

TABLE 4
THICKNESS OF ADIPOSE TISSUE OF DUGONG JGF 5137

Position	Thickness (mm)
45 cm posterior of axilla: mid-dorsal	25
mid-ventral	13
Anus: mid-dorsal	25
mid-ventral	10

TABLE 5
DENSITY OF HAIR FOLLICLES IN DUGONG JGF 5137

Body position	Hair follicles/ cm^2					
	Dorsal			Ventral		
	$\overline{X}$	sd. (±)	n	$\overline{X}$	sd. (±)	n
Lower lip	–	–	–	4.06	1.34	16
Chin	–	–	–	0.02	0.45	5
Upper lip phalanges	11.00	2.94	4	–	–	–
Upper lip edge	6.19	1.87	16	–	–	–
Vibrissael disk —centre	6.70	1.63	20	–	–	–
Vibrissael disk—dorsal	4.77	1.24	13	–	–	–
Between vibrissael and nares	2.13	1.25	8	–	–	–
Around nares	1.40	0.52	10	–	–	–
Behind eyes	5.60	1.35	20	–	–	–
Thoracic	4.69	0.69	8	0.28	0.09	8
Flipper	0.35	0.55	31	0.00	0.00	10
Abdominal	4.91	0.69	8	1.19	0.26	8
Caudal	3.75	0.41	4	1.44	0.24	4
Flukes	0.29	0.46	31	0.00	0.00	6

flukes had hairs, while the ventral surfaces did not. By far the densest concentration, and longest hairs, were on the face. As hairs are thought to be more numerous and longer in younger animals (Jonklass 1961), the data in Table 5 can be considered typical of only calves.

Flipper callosities: The specimen had 2 keratinous areas along the edge of each flipper near the tip (Fig. 2). The distal callosity, which was at the tip of the fourth digit, was 14 mm long and 4 mm wide on the right and 21 mm long and 4 mm wide on the left. The longer, proximal callosity, which extends from the tip of the second to the tip of the third digit, was 56 mm long and 18 mm wide on the right and 54 mm long by 18 mm wide on the left.

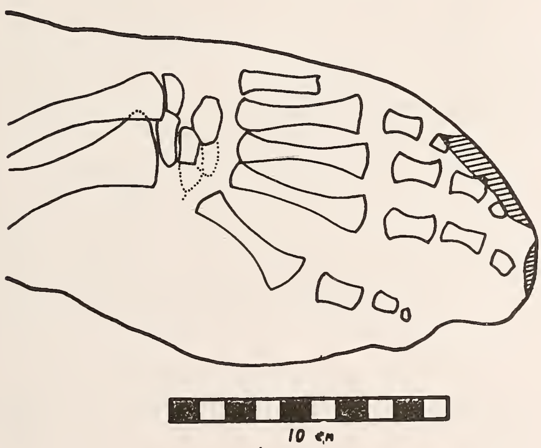

Fig. 2. Ventral view of left flipper of *Dugong dugon* JGF 5137, based on a tracing from a radiogram, showing position of callosities (cross-hatched areas) in relation to digits 2, 3 and 4, and also the number of phalanges in each digit.

It is commonly stated that, unlike the manatees (*Trichechius* spp.), the dugong has no nails on its forelimbs (Prater 1928:95, Husar 1978:1). However, many descriptions of dugongs refer to 'callosities' on the anterior ventral surfaces of the flippers (e.g. Gohar 1957:9, Jones 1959:201). In Australia these processes are reported to occur on all specimens observed, and they are attributed to abrasions caused during feeding activities (Marsh *et al.* 1978:159). It is notable that Marsh and colleagues in Australia have worked on the largest sample of dugongs ever studied, which includes foetuses, neonatal individuals, and numerous calves, as well as other age classes from juveniles and adults to apparently senile adults (Marsh *et al.* 1984a).

Although neonates have been found with food remains in the mouth and gastrointestinal tract (Marsh *et al.* 1982:64), it is unclear how these young animals would have experienced enough abrasion to develop flipper callosities. It is also remarkable that these processes occur precisely at the tips of digits; and in the case of JGF 5137, at least, there is a symmetric arrangement of two callosities each on both flippers. These features raise questions as to whether these are only dermal thickenings produced by local abrasions or in fact vestigial nails.

Skeletal features: A radiogram of the left hand (Fig. 2) shows the following number of metacarpals

TABLE 6
ORGAN WEIGHTS OF DUGONG JGF 5137

Organ		Weight (g)
Heart		270
Liver		1,750
Lung:	left	535
	right	570
Kidney:	left	260
	right	260
Spleen		45
Stomach & duodenum*		950
Small intestine*		2,500
Caecum*		195
Large intestine*		1,850
Total		9,185

*without contents of digestive tract.

+ phalanges in each digit: I = 1; II = 3; III = 4; IV = 4; V = 4. This condition is different from all three examples illustrated by Annandale (1907) and also different from the description given by James (1974:178). Annandale's (1907) claim that there is considerable variability in the skeletal elements of the dugong manus is supported by these observations.

The vestigial pelvic girdle of JGF 5137 consists of two elongate bones, forming an elongate structure on both left and right sides, comparable to the description in James (1974:178). Although earlier anatomists had described only two bones on each side of the pelvic girdle, Annandale (1907), working with specimens from 'Madras' and Australia, reported a third, small bone at the 'distal extremity of the lower of the two [bones] already recognized.' What this third bone might be was not stated, and since the mammalian pelvic girdle consists of three bones (ilium, ischium and pubis) which all articulate with each other, and there is no linear three-piece articulation found on each side, it is unclear what Annandale's third bone is.

Internal organs: Weights of various internal organs are given in Table 6. There were no gross signs of putrefaction or decomposition, although some post-mortem changes in histology are likely to have occurred. Data on dugong organ weights are rarely given.

Gastrointestinal tract and contents: The gastrointestinal tract was more than 22 m long, of which more than half was large intestine (Table 7). Spain and Heinsohn (1975:166) reported that there is an allometric increase in the length of the large intestine in relation to body length; in contrast, they found that lengths of both the small intestine and caecum increase isometrically.

The total weight of the contents of the Kutch specimen's alimentary tract was nearly 8 kg, of which more than half was contained in the large intestine. It is relevant that the main chamber of the stomach held only about 20% of the total weight of contents.

Reporting on a full grown dugong from the Gulf of Mannar, Thivy (in Jones 1959:200) stated that the stomach contents were about 6.4 kg (14 lbs) wet and 1.1 kg (2.5 lbs) dry; this is nearly the weight of the entire contents of the alimentary tract of JGF 5137. However, there is a paucity of information on gross weight of stomach contents or daily feeding intake (see Marsh *et al.* 1982). As Marsh *et al.* (1977: 291, 1978:162) explained, this species appears to specialize in hind-gut digestion, which is supported by the relatively great length, and weight of contents, of the large intestines.

Unlike the observations reported by some authors (Annandale 1906, and others cited by Prater 1928:92), no intact plant material was seen anywhere in the stomach of the Kutch specimen, or farther along its intestine. The contents, even in the stomach, were greatly broken down and macerated, as has been described in detailed studies with Australian dugongs (Marsh *et al.* 1982:56).

Although no intact material was found, only plant matter was present, and it was all consistent with leaves and stipules of the angiosperm *Halophila* sp. Dr. A.G. Untawale, National Institute of Oceanography, Goa, identified remains of *H. ovalis* (R. Br.) Hook. (*in litt.* 22 Feb. 1988). In contrast to the Australian stomach contents, which all contained rhizomes (Marsh *et al.* 1982:59), there was no evidence of rhizomes in the stomach of JGF 5137. These plant parts may have been obscured or overlooked because of the highly macerated nature of the material.

Although most indications are that the dugong in Indian waters eats phanerogams (e.g. Jones 1959:199, Jonklass 1961:3, Nair *et al.* 1975:19, Silas and Fernando1988), there are reports of the remains of algae in the stomach (Annandale 1906:242, Mani 1960:217). Both algae and marine angiosperms cover large areas of intertidal and sub-tidal habitats in the Gulf of Kutch (Murthy *et al.* 1978, Naik *et al.* 1987, Murthy pers. comm.; pers. obs.).

Detailed, long term studies in Australian waters (Marsh *et al.* 1982) indicate that although dugongs selectively feed on marine angiosperms, non-epiphytic algae can occur in more than half the stomachs. As the amounts of algae were normally small and the fragments undigested, it appeared that the ingestion had been incidental to feeding on angiosperms. In the few cases where algae made up major portions of the stomach contents, there was evidence that there had been catastrophic reductions in the standing crop of sea grasses. Although there does seem to be avoidance of algae and the coarser species of angiosperms, the dugong's diet is thought to be based mainly on availability and not on selection of specific species (Marsh *et al.* 1982:62).

There was no evidence anywhere in the alimentary tract of JGF 5137 of sand or other substrate matter. Given the low stature of *Halophila* spp. and the sparseness with which this angiosperm usually grows, it is remarkable that over 7 kg of plant matter could be eaten without ingesting large amounts of substrate, especially as this animal feeds by ploughing deep troughs in the substrate (Heinsohn and Marsh 1982:1004, Fig. 8). While it is unlikely that the animal uproots and stacks sea grasses to allow the substrate to settle out (cf. Gohar 1957:42), it is clear that the dugong has a very efficient means of separating plant material from substrate.

Parasites: Flat worms were conspicuous in both the small and large intestines of JGF 5137. These have been identified as *Indosolenorchis hirudinaceus* Cruz, *Rhabdiopoeus taylori* Johnston, and *Haerator caperatus* Blair (Blair *in litt.* 14 Aug. 1987). The respective collection numbers are: USNM 79991, 79993, and 79992 (Lichtenfels *in litt.* 29 Oct. 1987). *I. hirudinaceus* has been recorded from dugongs in the Gulf of Mannar (Nair *et al.* 1975:27), Sri Lanka, and from East Africa to Papua New Guinea (Blair 1980:512). *R. taylori* has previously been recorded from the Red Sea (Gohar 1957:45) and Australia (Blair 1981:36); and *H. caperatus* has been reported from Australia (Blair 1981:44). All three species are specific to dugongs.

There were no signs of roundworms, such as described by Linstow (1906) from a dugong in the Gulf of Mannar. Marsh *et al.* (1977:286) found that 97% of the specimens from Australia had *Paradujardinia halichoris* (Owen) in the stomach and / or cardiac gland, and Gohar (1957:43) reported that 53% of the Red Sea dugongs that he examined were infected with this worm.

Edibility: It has been commented elsewhere (Annandale 1906, Prater 1928: 87, Thivy in Jones 1959:200) that dugong flesh is good eating and that it remains edible at least three days after death. This is consistent with the information at our disposal.

Conclusions

Reviews of the dugong in Indian waters have consistently treated the Gulf of Kutch as an area of little significance, with frequent implications that the animals which occur there are strays or vagrants (e.g. Jones 1959:198, 1981:46, Nair *et al.* 1975:8). While the records are not abundant, there have been

Table 7
LENGTHS OF PARTS OF THE GASTRO-INTESTINAL TRACT AND WEIGHTS OF THEIR RESPECTIVE CONTENTS OF DUGONG JGF 5137

Portion	Portion length (cm)	% of total length	Weight of contents (g)	% of total weight
Stomach (main sac)	24[a]	1.1	1,595	20.3
Duodenal diverticula:				
ventral	42[b]	1.9	190	2.4
dorsal	21[b]	0.9	0	0.0
Proximal duodenum	33	1.5	380	4.8
Small intestine	955	42.4	1,500	19.1
Caecum	21[c]	0.9	55	0.7
Large intestine	1,155	51.3	4,150	52.7
Total	2,251	100.0	7,870	100.0

a = diameter, b = curved length, following the curvature of the chamber, c = total length; length of the blind pouch is 13 cm.

recurrent reports of dugongs from the Gulf of Kutch for over a century (Table 1; Fig. 1). The paucity of records must be considered in the light of the fact that little scientific work has been done in this area.

In addition, the presence of immature-sized individuals and herds of up to 15 individuals (reported herein) indicates that there are resident animals that breed in the Gulf. Although no detailed data are available, dugongs appear to be a regular part of the fauna of the Gulf of Kutch, where there may be a sizable population.

The status of this population is unknown, but with the rapid increases in human populations, levels of pollution, ship traffic and fisheries technology (e.g. boat motors and synthetic fibres for nets) that have occurred during the last few decades, it is expected that the dugongs and their habitats have come under ever increasing pressures. This is the case throughout the range of this species, from wherever data are available. An active, well organized – but highly illegal – fishery in the Gulf of Mannar and Palk Bay has been described by Silas and Fernando (1988; see also Anon. 1987a).

The question of seasonal movements into and out of the Gulf of Kutch, raised by Silas (1961), still remains unanswered and uninvestigated. Dugongs have been caught round the year in the Gulf (Table 1). In addition, conversations with fishermen from the south coast of Saurashtra and the Gulf of Khambhat (Cambay) indicate that they have no knowledge of this animal. This suggests that dugongs do not migrate south along the Saurashtra coast and that the Gulf of Khambhat is outside the normal distribution – at least this seems to be the case during the past decade or two.

Long distance migrations are unknown in other, better studied populations (Husar 1978:5). However, there may be localities in Australia where extensive seasonal movements occur, and there may even be resident and migratory populations in the same areas (Heinsohn and Marsh 1982:1005; see also Jones 1967:216).

If the Kutch dugongs do migrate, the nearest known population would be northwest in the Persian Gulf, some 1,500 km away. The next nearest population is in the Gulf of Mannar, about 1,700 km to the south. It is remarkable that dugongs do not feature in a thorough treatise of the mammalian fauna of Pakistan (Roberts 1977), and there is no evidence of their occurrence along this coast (Jones 1981:44). Nowadays dugongs are unknown along the west coast of peninsular India. Hence, dugongs are not known to occur between the Gulf of Kutch and either the Persian Gulf or the Gulf of Mannar. Given the great distances involved and the lack of any evidence to suggest movements to or from the Gulf of Kutch, it seems unlikely that there are regular, long distance migrations into and out of this area.

If Neumayer's (1983:41, 146) interpretations of rock paintings at Gandhi Sagar, Rajasthan, are correct, dugongs were depicted by Mesolithic people at a site which is now more than 200 km from the Gulf of Kutch. However, at the time when the paintings were made, perhaps more than 10,000 years ago, the site was probably much closer to the sea coast. It is argued that the Kathiawar Peninsula become attached to mainland Gujarat during recent times (Flam 1986:67, 68) and that in 'subrecent times' parts of the Indus and Luni valleys were still marine, after a large sea which covered western Rajasthan began to recede to its present configuration (Gupta and Prakash 1975a,b). It is remarkable, however, that dugongs have not been reported from any of the faunal analyses of archaeological work done in this region.

The possibility that the Kutch animals are of gigantic size, discussed by Silas (1961) in his comments on data presented by Mani (1960), remains unconfirmed. Mani's (1960) length of 4.6 m and weight of 908 kg are, respectively, about 50% and 100% greater than the maximum values from other well studied populations. Although Silas (1961), Spain and Heinsohn (1975:165) and Nishiwaki and Marsh (1985:6) presented good reasons for questioning Mani's data, these extreme values have unfortunately been repeated in recent reviews on the species (Jones 1967:218, Husar 1978:1,4). The ease with which exaggerated figures get into print is shown by a recent news release (Anon. 1987b) concerning JGF 5137, claiming that 'A dugong grows to more than 23.2 metres in length'.

Morphological data from the Kutch specimen are consistent with those from specimens of other populations, although some measurements are not easily compared for a lack of comparable data – such as organ weights. The importance of the hind gut is clear from the relative length and weight of intestinal contents. The variability of phalangeal elements of the manus is also seen.

Dugongs, in contrast to the manatees, are said to lack nails. However, the presence of symetrically placed flipper callosities on the Kutch specimen, and published evidence that these features occur in very young individuals, suggest that dugongs have vestigial nails.

Although it has been claimed that dugongs in Indian waters may specialize on algae (Annandale 1906:242, Prater 1928:86), the stomach of the Kutch specimen had macerated remains of only the marine angiosperm, *Halophila ovalis*. This is consistent with what is known of the feeding habits of these animals elsewhere.

Two species of flatworms found in the Kutch specimen are new records for India: *Rhabdiopoeus taylori* Johnston and *Haerator caperatus* Blair. Roundworms were not found.

Recommendations

A detailed, long term study of the Kutch dugongs is urgently needed, as is a sensitive and realistic program of environmental education and extension. Although there are both state and central government laws protecting the species, the possibilities of stiff fines for catching and killing dugongs should be carefully considered in the social context of the inhabitants of the Gulf.

The marine park gazetted in the Gulf of Kutch is an important start toward establishing protected habitats, but a great deal yet needs to be done. The park must be given true protection if it is to function. In terms of dugongs, critical habitats such as feeding pastures, sleeping areas, and calving grounds need the strictest of protection; no nets or motorized vessels can be allowed in these areas.

Jonklass (1961:8) raised the possibility of a dugong farm, but given the great difficulty in keeping these animals in captivity (Nishiwaki and Marsh 1985:21), this seems an impractical proposition. Claims by Thomas (1966) that dugongs are hardy and kept in captivity without much care are inconsistent with what is reported from more detailed studies. Furthermore, it would require long term commitments of technical and professional support, major facilities and reliable and substantial funds.

Unfortunately, failure to implement the detailed recommendations to protect the south Indian population, made by Dr. S. Jones (1980:257; 1981), former Director of CMFRI, three decades ago, may result in the extinction of this population (Silas and Fernando 1988).

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RANGE EXTENSION AND NOTES ON *RANA ERYTHRAEA* (SCHLEGEL, 1837) (ANURA: RANIDAE) FROM DUDHWA NATIONAL PARK, UTTAR PRADESH [1]

RAJ TILAK AND PRANJALENDU RAY [2]

(*With five text-figures*)

Rana erythraea (Schlegel, 1837) has so far been known from Assam, Meghalaya, Mizoram, West Bengal and Orissa. The collection of this species from Dudhwa National Park, District Lakhimpur Kheri, Uttar Pradesh Terai, extends the range of distribution north-westward. The morphology has been discussed in detail and the taxonomic status of the species clarified . The sexual dimorphism based on different meristic and morphometric characters have been discussed and compared with earlier studies. The habitat is also discussed.

INTRODUCTION

Rana erythreae (Schlegel, 1837) has so far been recorded from Assam, Meghalaya, Mizoram, and Lower Bengal (Boulenger 1920, Sarkar 1984, Chanda 1986) and from Orissa (Mohanty-Hejmadi 1974). During July 1987, We located a sizeable population of the little known leaping frog in marshy places near Kakraha Taal, Ranwass Taal and along the bushy banks of the Joraha Nala within Dudhwa National Park, District Lakhimpur Kheri, Uttar Pradesh Terai. This species has never been recorded from the northern part of India, specially from Terai region of Uttar Pradesh. The present collection extends the range of distribution of this species from the north-eastern parts of India north-westward as far as the Uttar Pradesh Terai.

TAXONOMIC STATUS OF *Rana e rythraea* (SCHLEGEL, 1837)

Since the description of this species as *Hyla erythraea* Schlegel (1837) from Java (Type in Rijks Museum, Leyden), the taxonomic status has been unclear. Recent literature cast doubts on distribution of this species in India. Boulenger (1882) considered this species under the genus *Rana* Linnaeus, including *Hylorana subcaerulea* Cope. Later he (Boulenger 1920) synonymised *Limnodytes erythraeus* Dumeril and Bibron, *Hylorana tytleri* Theobald, *Rana tytleri* of Annandale (in part) and *Rana taipehensis* Van Denburgh under *Rana erythraea* (Schlegel), quoting the notes of Annandale on its habitat. Van Kampen (1923) recorded *Rana erythraea* (Schlegel) from Assam and Bengal in India but does not mention *Rana taipehensis* Van Denburgh or *Rana tytleri* Theobald. Subsequently, Gorham (1974) considered *Rana erythraea* (Schlegel) and *Rana taipehensis* Van Denburgh, as two distinct species and broadly mentioned the distribution as Asia and south-east Asia respectively.

Inger and Dutta (1987) also recognised *Rana taipehensis* Van Denburgh as a valid species from India, without making a mention of *Rana erythraea* (Schlegel) in their list. They included all materials of *Rana erythraea* (Schlegel) by different authors (Boulenger 1920, Mohanty-Hejmadi 1974, Sarkar 1984, Chanda 1986) from Assam, West Bengal and Orissa as *Rana taipehensis* Van Denburgh, which is characterised by the presence of web between the third and fifth toes, not extending up to the disc, and three phalanges of the fourth toe free from web, small outer metatarsal tubercle, thighs and back with black and white streaks. It has been observed in the present material that webbing and the subarticular tubercles, including the discs of toes and fingers, are clearly visible in life and also in the material preserved in formalin (4-5% formaldehyde solution), whereas the same features are not clearly seen if the living material is preserved in alcohol (95%). In alcohol the body fluids particularly of the soft parts, i.e. skin of web, sub- articular tubercles and the disc of toes and fingers, get dehydrated and shrink. Earlier workers probably described new taxa based on alcohol-preserved material.

The descriptions of *Rana tytleri* and *Rana taipehensis*, therefore, appear to be examples of the description of new taxa based on artifact of preservations. In the light of the discussions of the different characteristics in which *tytleri* and *taipehensis* differ from each other and those of *erythraea*, it

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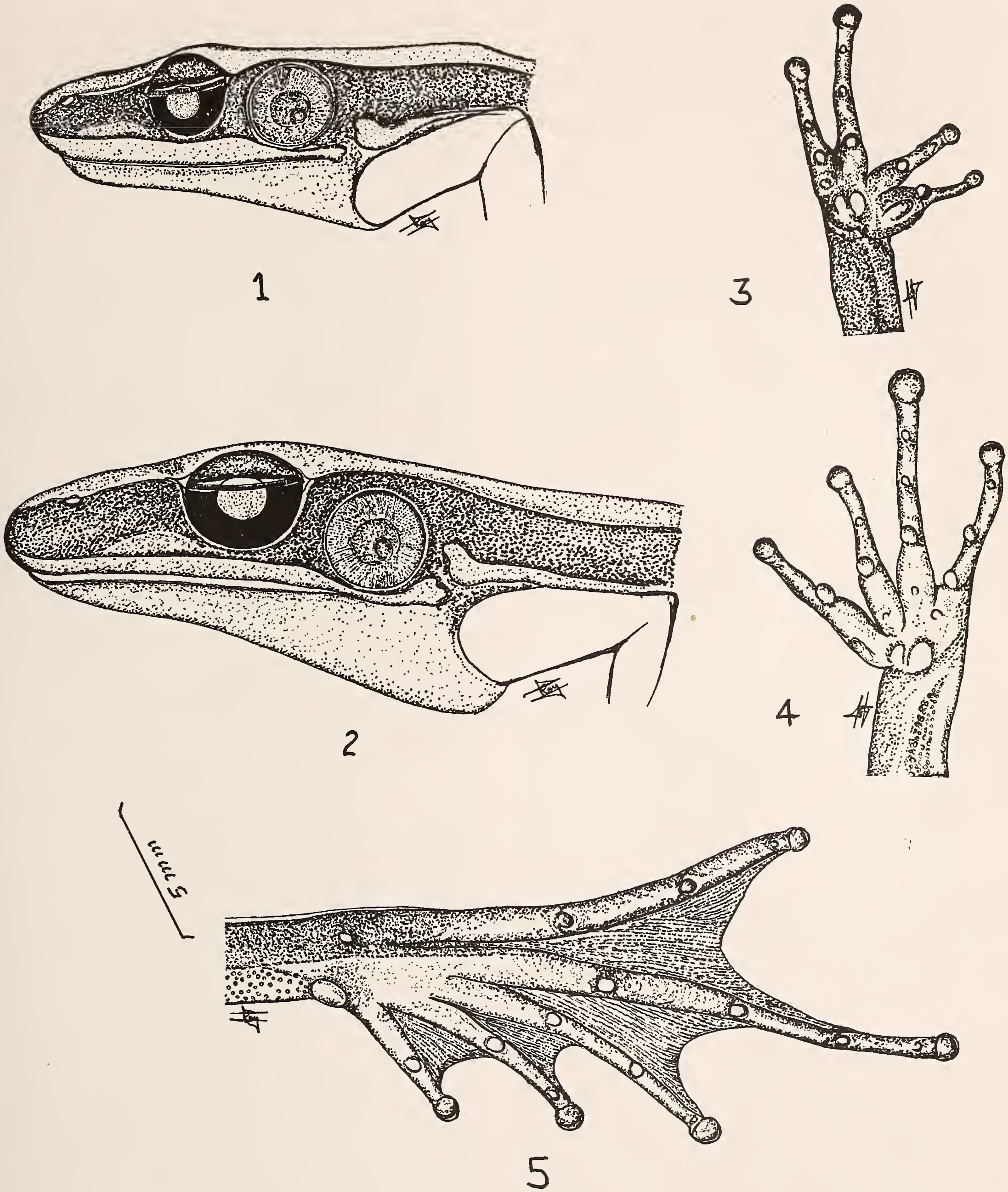

Figs. 1-5. *Rana erythraea* (Schlegel, 1837)
1. Lateral aspect of head and thoracic region of male. 2. Lateral aspect of head and thoracic region of female. 3. Ventral aspect of foreleg (palm) of male. 4. Ventral aspect of foreleg (palm) of female. 5. Ventral aspect of foot.

is evident that these are synonyms of *Rana erythraea* (Schlegel, 1837) and have been correctly treated by Boulenger (1920). In the same population from the same locality some examples show some variation in the pattern of webbing, which could be misleading if a large number of examples are not studied. The present material comprising 45 examples of *Rana erythraea* of different sizes. (27.00 to 47.5 mm SVL) and sexes has been thoroughly studied in life and also in properly preserved condition under stereomicroscope in laboratory. Besides, the collection of this species from Assam and West Bengal (courtesy Zoological Survey of India, Calcutta) have also been studied and compared. A controversy exists regarding the relative length of the first and second fingers, and ratio of maximum diameter of eye to the maximum diameter of tympanum. In respect of the length of the fingers, Boulenger (1882) mentioned "first not extending beyond second", but in Fig. 'a' (p. 66) shows the first finger longer than the second. Subsequently he (Boulenger 1920) mentioned "first finger as long as or a little longer than second." Van Kampen (1923) observed in *Rana erythraea* (Schlegel) "the first finger is not or slightly extending beyond the second". The present study reveals that the relative length of the first and second fingers and the ratio of tympanum to eye diameter differ not only by the size but also remarkably in different sexes. Apart from these the descriptions of *Rana erythraea* (Schlegel) by Boulenger (1882, 1920), Van Kampen (1923) are too meagre for study of inter-relationship. In order to record the differences in the morphology of the species studied here and to elaborate the description further, the present material from different localities of Dudhwa National Park is described here in detail.

Description of Adult

Head and Body: Narrow, elongated, streamlined. Head dorsoventrally flattened, longer than wide. Width of head 1.17-1.29 in head length. Tip of snout obtusely pointed and projects well beyond the anterior extremity of lower jaw. Canthus rostralis strong, slightly concave. Loreal region bordered by elevated upper jaw. Nostrils nearer to the tip of snout than eye. Maximum diameter of orbit 1.40-1.83 times in snout length. Interorbital distance equal to internarial distance as well as width of upper eyelid. Maximum diameter of orbit 1.15 to 0.75 times in maximum diameter of tympanum. Denticulated oval patch of vomerine teeth obliquely placed in between the choanae; these are nearer to choanae than each other. Tongue elongated, free and deeply notched behind. Maxillary teeth sharp. Skin smooth except the anal and surrounding areas below the thigh, where it is glandular. Two dorsolateral glandular folds start from the posterior corner of eye lid and continues parallel to each other up to illiosacral joint and then converge towards the tip of the urostyle above anus. Ventral surface smooth with scattered yellow glands embedded in skin. Another ventrolateral glandular fold stretches from the upper jaw, continues up to the ventral margin of tympanum and after a break there is a glandule behind the angle of jaws. The fold continues as a broken line on ventral aspect up to the angle of thigh.

Fore leg: Forearm slender. Fingers with discs at the tip. Discs longer than wide with circum-marginal groove. Disc of first finger less developed. Proximal sub-articular tubercles on the ventral aspect of each finger well developed. Small additional tubercle on the ventral aspect below the proximal sub-articular tubercle on the metacarpal present. First finger either equal to or smaller than the second. First and second metacarpals free a little distance above the base. The second and third metacarpals free only at their distal halves. The third and fourth metacarpals not free. Third finger the longest, 1.20-1.40 times the length of fourth finger. Two closely set palmer tubercles present.

Hind leg: Hind limb long and slender, contained 1.53-1.74 times in the tip of snout to vent length. Tibial length 3.23- 3.68 times in tip of snout to vent length. The diameter of tibia contained 3.80-5.33 in tibial length. Diameter of femur 2.12-2.54 in the length of femur. Length of tibia 1.03-1.17 times in length of foot. Two metatarsal tubercles distinct, outer is circular and small, inner elongate, 2.25-3.00 times in the length of first toe. Outer metatarsal separated up to the base. Subarticular tubercles prominent. First toe with single subarticular tubercles at the joint of first metacarpal and first phalange. Second similar to the first. Third toe with two subarticular tubercles, the proximal one placed at the joint of third metacarpal and first phalange, the distal one at the joint of first and second phalange. Fourth toe with three subarticular tubercles, the proximal one placed at the joint of first phalange and fourth metatarsal, middle one placed at the joint of first phalange and second phalange, distal one on the joint of second phalange. Fifth toe with two subarticular tubercles, proximal one placed at the joint of fifth metatarsal and first phalange, the distal one placed at the joint of first and second phalange. The web stretches from the base of the disc of first toe, incurves downwards and then upwards, meeting just at the level of first subarticular tubercle of second toe; thereby the side facing the first toe is free of web from subarticular tubercle to the disc. The side of second toe, facing the third toe, bears web originating from the base of the disc, and stretching up to the level in between the first and second subarticular tubercles of the third, leaving the rest of toe free of web up to disc facing second toe. In between third and fourth toe, the web originates from the base of the disc of the third toe and stretches up to the level just above the middle subarticular tubercle, leaving three phalanges free of the web except for a fringe on the side facing the third toe. In between the fourth and fifth toe, the web starts from a level just away from the distal subarticular tubercle of fourth toe, incurves, and then stretches up to the base of the disc of fifth toe. The webbing is therefore absent on two phalanges of the second and third toes, three phalanges on the inner side and two phalanges on the outer side of fourth toe.

Coloration: In life, cryptic, matching coloration of the surrounding vegetation. Ground colour of dorsal side leafy green with two longitudinal dorsolateral golden bands starting from the posterior corner of eye lid to almost the sides of the sacral region. Similar golden yellowish band runs on the edges of the upper jaw up to the axil with a break below the tympanic area and continues up to the groin as a broken band on the ventrolateral side of the body. In between dorsolateral glandular fold and ventrolateral band, there is a black lateral stripe starting from tip of snout, covering canthus-rostralis and eye, continuing up to the groin. Limbs speckled with green, black and yellow longitudinal stripes on dorsal aspect. Ventrally immaculate in female, and with a brown network on the lower jaw, forelimbs and hind limbs in male. In both sexes yellow glands present in the skin, on ventral side.

Sexual Dimorphism

Male: The breeding males (27-32 mm SVL) show granulated nuptial pad on the inner dorsolateral aspect of the first metacarpal. The relative length of first and second finger is almost equal to or slightly greater than second finger. The gap in between the base of the first and the second metacarpals is comparatively less in males than females. The diameter of tympanum is always greater (1.03 to 1.15 times) than the maximum diameter of eye. The specimens with ventral brown network, relatively light colour and small size constitute the male population. Internally cream coloured testis is large, pear shaped, tapering on the lower side and placed on the ventral aspect of the kidney. Length of the testis 2.00-2.12 times in the length of the kidney and 9.50-10.00 times in tip of the snout to vent length. Diameter of femur 2.40-2.54 in the length of femur. The inner metatarsal tubercle 2.00-2.66 times in length of first toe. The interorbital distance 1.00 -1.25 times in the distance in between dorsolateral fold at sacral region.

Female: The breeding females (41 to 47.50 mm SVL) are longer than the males. The second finger is always longer than first finger. Length of first finger 0.83-0.92 times in the length of second finger. The greatest diameter of tympanum is 0.75-0.89 times in the greatest diameter of eye. The diameter of femur contained 2.12 - 2.28 in the length of the same. The inner metatarsal tubercle 3.00-3.11 times in the length of first toe. The interorbital distance is 0.75-0.87 times in the length of the inner distance of dorsolateral fold at the sacral region. The distance in between the dorsolateral fold near the posterior corner of eye is 1.60-1.75 times in the distance of the same at the sacral region. Internally the eggs are 0.80 mm to 0.90 mm in diameter.

Habitat: We have collected these frogs from marshy places. The frogs conceal themselves under leaf litter and also in moist tree holes near a perennial water source. When disturbed, they come out, leaping into the thick vegetation near waterbodies. Sometimes, they jump into water and remain submerged for a long time. They have been located on wooden logs and dead tree trunks, partly submerged under water in lakes. They are nocturnal, concealing themselves in holes during the day. At night, they are very active, feeding and breeding. The stomach contents comprises insects mainly Orthoptera, Coleoptera, Diptera and Hemiptera and some of the just metamorphosed larval forms.

Material examined: 1) 3 exs. (all females) from Kakraha Taal, nearly 8 km. from Camp Sonaripur F.R.H. on 17 June 1987, by Raj Tilak and P. Roy. 2) 7 exs. (5 females and 2 males) from Joraha Nala, on Sonaripur to Belraien forest road, on 18 June 1987, by Raj Tilak and P. Roy. 3) 30 exs. (21 females and 9 males) from Ranwas Taal, nearly 2.5 km north of Belraien, on 22 June 1987, by Raj Tilak and P. Roy. 4) 5 exs. (three males and two females) from Jorha Nala, nearly 3 km north of Masankhamb F.R.H. on 27 June 1987, by Raj Tilak and P. Roy.

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VARIATION ANALYSIS OF COALESCENCE OF SPOTS IN THE MELANICS OF *COCCINELLA SEPTEMPUNCTATA* L. (COCCINELLIDAE: COLEOPTERA)[1]

M. RHAMHALINGHAN[2]

(*With twenty text-figures*)

The melanics of *Coccinella septempunctata* show confluence of elytral spots. The combination type 'complete' and the coalescent pattern 1-3-4-2 occur abundantly (41.18% and 37. 19% respectively). The scutellar and discal spots coalesce more frequently than others (32.07%). The coalescent behaviour of individual spots reveals that the discal spot coalesces more frequently with others (35.84%). It appears that evanescence of spots is very rare.

INTRODUCTION

The intraspecific variations in colour patterns in Coccinellidae give them polymorphic status (Hodek 1973). The mechanism governing the appearance of these anomalies is still unknown and it may be either genetic or epigenetic (Katakura 1974). Ford (1975) is also of the opinion that though the colour patterns are based on a series of multiple alleles, it is partly, but not entirely, controlled by them.

Studies on polymorphic coccinellids show that there are two types of anomalies, the evanescence (disappearance) and coalescence (fusion) of spots on the elytra (Hodek 1973, Katakura 1974). The elytral colour patterns in *Coccinella septempunctata* L. in the Indian subcontinent have been observed by Varma (1954), Kapur (1959), Sudha Rao (1962) Singh and Mann (1977) and Rhamhalinghan and Manavalaramanujam (1983). But the frequency of different coalescent patterns of this species has not been worked out. It is desirable that such studies are undertaken, which may provide useful information for further studies on the bioecology of the polymorphic aphidophagous coccinellids.

MATERIAL AND METHODS

The collection of melanics of *C. septempunctata* and their grouping methods have been described in detail elsewhere (Rhamhalinghan 1988). Each elytral spot was numbered and named following the systems of Varma (1954) and Kapur (1959) (Fig. 1). The spot-1, which is situated mid-suturally below the pronotum, is called the scutellar spot. Spot-2, that lies on the linea externa, is termed the anterior marginal spot. Spot-3, which is placed near the mid-sutural line but below the scutellar spot, is designated as the discal spot. The posterior marginal spot (spot- 4) is found below the anterior marginal spot, on the linea externa.

The coalescence of various spots is shown by the combination of these numerals and their relative frequencies are worked out (Katakura 1974).

Tentatively, two combination types have been described as 'island' and 'complete' patterns. The island pattern has been observed by Varma (1954) in Kanpur, in which the 2nd, 3rd and 4th spots coalesce to produce a non-melanic central region. In the accompanying tables it is represented as $\begin{array}{c} 3 - 2 \\ \searrow 4 \swarrow \end{array}$.

When the island form is connected to the spot-1, it is termed the 'complete' pattern which is represented (Figs. 18-20) by the combination of numerals

$$1 - 3 \begin{smallmatrix} \nearrow 2 \\ \searrow 4 \end{smallmatrix}$$

RESULTS AND DISCUSSION

The basic type in *C. septempunctata* is the spot pattern. The spots occupy exact places on the elytra (Hodek 1973). The variations may involve a number of spots, a number of fusions and the pattern of fusions of spots (Katakura 1974). Thus in a given pattern, the number of fusions may increase or decrease and different spots coalesce to present variable patterns.

C. septempunctata is a polymorphous species in India (Kapur 1959) and in different regions of the Indian subcontinent the spot size may vary (Kapur 1959, Singh and Mann 1977, Rhamhalinghan 1988). In the Himalayan region and many parts of India, this species occurs with confluent spots. The melanic form *C. septempunctata* var. *confusa* Wiedemann, occurs in North Bengal, Assam, Sikkim, Nepal, Uttar Pradesh, Punjab, Rajasthan, Bihar

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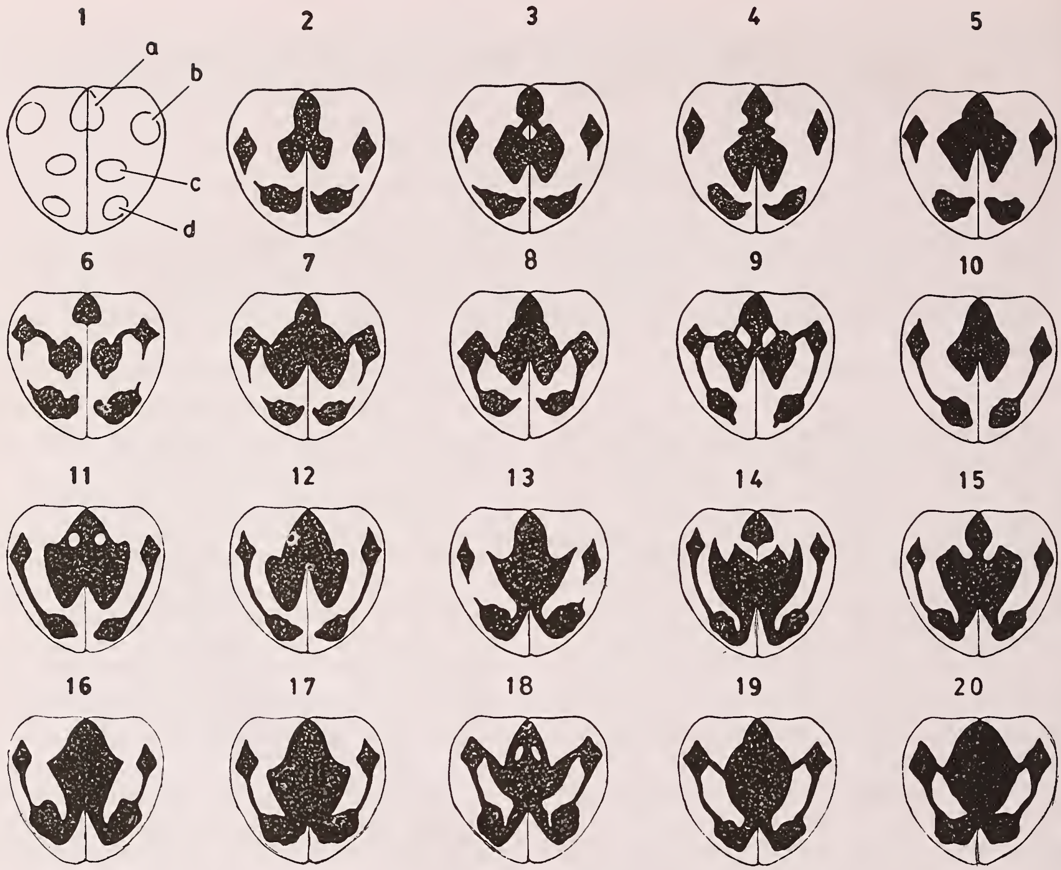

Figs. 1-20. Variations in the elytral patterns of melanics in *Coccinella septempunctata*.
1. Right elytra. a = scutellar spot; b = anterior marginal spot; c = discal spot; d = posterior marginal spot.
2-20. Different elyt ral patterns.

and Nilgiri Hills (Table 6). The seasonal occurrence of these melanics in the Nilgiris has been investigated and correlated with low temperature, high humidity and low sunshine level (Rhamhalinghan 1986). Though 19 elytral colour patterns have been noticed, no such variations with regard to the pronotal patterns have been found.

The frequency in general population: The number and frequencies of melanics of *C. septempunctata* collected from various regions of the Nilgiri district during 1979 to 1985 are presented in Table 1. The overall percentage of melanics for the study period was 6.14%. The variation in the elytral patterns was found to be exhibited mainly by the coalescence of different spots that occur frequently during winter. But evanescence of spots has not been observed.The present study shows that neither do all the 19 patterns of melanics occur during a particular sampling period (i.e. a period of one year) nor in a specific locality (Table 1).

Different coalescent patterns: The type 'complete' and the coalescent pattern 1-3-4-2 occur abundantly during the peak seasons (41.18% and 37.19% respectively). The relative frequencies of the patterns 1-3 and 1-3 and 2-4 are 11.01% and 7.66% respectively. The fifth place is occupied by the pattern 1-3-2-4 and other types are comparatively rare (Table 2). Figure Types 15 to 20 are abundant in those regions, where the winter temperature ranges from 4 to 13°C. Other patterns (Figs. 2 to 14) are abundant in regions where the minimum and maximum winter temperatures are about 3 to 4°C greater than that of the coldest area.

The pattern occurring in a particular period

TABLE 1
RELATIVE FREQUENCIES OF DIFFERENT ELYTRAL PATTERNS OF *Coccinella septempunctata* MELANICS FROM NILGIRIS COLLECTED DURING 1979-85

Melanic Type figures	1979	1980	1981	1982	1983	1984	1985	Total	%
2.	1	4	12	12	13	8	17	67	5.35
3.	–	1	1	–	–	1	1	4	0.32
4.	4	2	5	6	6	7	4	34	2.71
5.	–	2	9	6	3	9	4	33	2.63
6.	–	1	2	–	–	1	1	5	0.40
7.	–	–	2	–	–	1	–	3	0.24
8.	–	–	–	3	–	3	1	7	0.56
9.	–	–	–	3	–	4	1	8	0.64
10.	1	7	22	16	9	7	13	75	5.98
11.	–	–	–	3	–	–	–	3	0.24
12.	3	1	5	2	4	1	2	18	1.44
13.	2	1	4	–	–	1	1	9	0.72
14.	–	2	1	–	–	–	2	5	0.40
15.	2	7	6	18	4	3	3	43	3.43
16.	40	21	42	34	16	22	28	203	16.20
17.	39	36	34	41	18	26	26	220	17.56
18.	–	–	–	–	3	2	2	7	0.56
19.	36	40	39	64	20	25	58	282	22.50
20.	40	37	44	36	18	21	31	227	18.12
Total	168	162	228	244	114	142	195	1253	
Typicals	2337	2449	3543	3568	1343	2349	3572	19161	
Melanics %	6.71	6.20	6.05	6.40	7.82	5.70	5.18	6.14	

may disappear in another period (Table 1). Further, the melanics form 5.18 to 7.82% of the general population, the average being 6.14% during the study period. The percentage of melanics varies from year to year (Table 1).

The different types of confluences of spots and their relative frequencies are presented in Table 2.

TABLE 3
PREDOMINANT PATTERNS OF COALESCENCE OF ELYTRAL SPOTS AND THEIR FREQUENCIES IN *Coccinella septempunctata* MELANICS

Pattern of coalescence spots	Number of specimens showing the combination	% frequency
1-3	234	17.35
2-3	5	0.37
2-4	96	7.12
1-3-2	3	0.22
1-3-4	9	0.67
2-4-3	5	0.37
1-3-2-4	15	1.11
1-3-4-2	466	34.54
1-3 $<^{2}_{4}$	516	38.25
Total	1349	

Since more than one combination can be observed in the same specimen (Figs. 10, 11, 12), these combinations were considered separately counting each coalescence as one unit, following the method of Katakura (1974). Hence the total frequency of coalescence is higher (1349) than the actual number of specimens examined (1253) (Tables 3, 4). The frequency of the 'complete' form (Figs. 18, 19 and 20) was greater than other patterns (38.25%). The coalescent pattern 1-3- 4-2 (Figs. 15, 16, 17) attains the second place (34.54%). The simple coalescence of spots 1-3 (Figs. 2, 3, 4 and 5) and 2–4 (Figs. 10, 11 and 12) score 17.35% and 7.12% respectively. Frequencies of other patterns are comparatively lower (Table 3).

TABLE 4
PERCENTAGE RATIO OF FREQUENTLY LINKED ELYTRAL SPOTS IN THE MELANICS OF *Coccinella septempunctata*

Linkage of spots	No. of specimens showing the linkage	% frequency
1-3	1243	32.07
2-3	539	13.91
2-4	1098	28.33
3-4	996	25.69

TABLE 2

TYPES OF COMBINATION OF ELYTRAL SPOTS AND THEIR FREQUENCY IN *Coccinella septempunctata* MELANICS

Confluence of spot nos.	Type figure	No. of specimens showing confluence							% frequency of confluence							Total specimens	Overall % frequency
		Years							Years								
		1979	1980	1981	1982	1983	1984	1985	1979	1980	1981	1982	1983	1984	1958		
1-3	2,3,4,5	5	9	27	24	22	25	26	2.98	5.55	11.84	9.84	19.30	17.61	13.33	138	11.01
2-3	6	–	1	2	–	–	1	1	–	0.62	0.88	–	–	0.70	0.51	5	0,40
1-3-2	7	–	–	2	–	–	1	–	–	–	0.88	–	–	0.70	–	3	0.24
1-3-4	13	2	1	4	–	–	1	1	1.19	0.62	1.76	–	–	0.70	0.51	9	0.72
2-4-3	14	–	2	1	–	–	–	2	–	1.23	0.44	–	–	–	1.03	5	0.40
1-3 & 2-4	10,11,12	4	8	27	21	13	8	15	2.38	4.94	11.84	8.61	11.40	5.64	7.69	96	7.66
1-3-2-4	8,9	–	–	–	6	–	7	2	–	–	–	2.46	–	4.93	1.03	15	1.20
1-3-4-2	15,16,17	81	64	82	93	38	51	57	48.21	39.51	35.96	38.11	33.33	35.92	29.23	466	37.19
1-3 (2, 4)	18,19,20	76	77	83	100	41	48	91	45.24	47.53	36.40	40.98	35.97	33.80	46.67	516	41.18
Total		168	162	228	244	114	142	195								1253	

Linkage of spots: The percentage ratio of frequently linked elytral spots shows that the scutellar and discal spots (Spots 1 and 3) coalesce more frequently than other pairs (32.07%). It appears that these two spots are strongly linked. Similarly, the anterior and posterior marginal spots (Spots 2 and 4) are joined more often. Thus the order of occurrence of the frequently connected spots is 1-3 (32.07%) > 2-4 (28.33%) > 3-4 (25.69%) > 2-3 (13.91%) (Table 4). This may presumably be due to the closely linked genes in the multiple allelic systems that govern the elytral colour patterns.

On the contrary, Singh and Mann (1977) observed that the coalescence was much less in the distantly placed two lateral spots in comparison to the medially placed discal spot with others. Further the authors remarked that the scutellar spot also coalesces rarely, with the discal spot. Kapur (1959) opined that these variations might be due to the differences in the geographical and ecological traits.

Total number of fusions: Comparison of total number of fusions of individual elytral spots with others throws light on the active involvement of the spots in the formation of colour patterns. Thus the order of occurrence of the frequency of coalescence with other spots is, 3rd spot 35.84% > 4th spot 27.01% > 2nd spot 21.12% >1st spot 16.03% (Table 5).

Table 5
COMPARISON OF OVERALL FREQUENCIES OF COALESCENCE OF INDIVIDUAL ELYTRAL SPOTS IN THE MELANICS OF *Coccinella septempunctata*

Spot no.	Total no. of fusions with other spots	% frequency
1.	1243	16.03
2.	1637	21.12
3.	2778	35.84
4.	2094	27.01

Geographical variations: Comparison of various patterns of coalescence in *C. septempunctata* from different regions of the Indian subcontinent sheds light on the behaviour of the spots in relation to the abiotic conditions (Table 6).

It could be observed from this data that some of the coalescent types common in the Nilgiri Hills are either rare or not represented in other areas and vice versa. This observation strengthens Kapur's (1959) remark that the frequencies of patterns in a given species often differ in different areas and oc-

Table 6
COMPARISON OF THE TYPES OF COALESCENCE AND EVANESCENCE IN *Coccinella septempunctata* REPORTED FROM DIFFERENT PARTS OF INDIA

Patterns of confluence of spots	Kanpur (Varma 1954)	Eastern Himalaya, north-west Himalaya, Bangalore (Sudha Rao 1962)	Eastern Himalaya, western Himalaya, plains of North India (Kapur 1959)	Semi-desert area of Punjab (Singh &Mann 1976)	Nilgiris (Present author 1979-85)
1-3	–	+	+	–	+
2-3	+	+	+	–	+
2-4	+	+	+	+	+
3-4	+	+	+	+	–
1-3-2	–	–	+	–	+
1-3-4	–	–	+	–	+
3-2 4	+	+	–	–	–
2-4-3	+	+	–	–	–
3-2-4	–	+	+	–	–
1-3-2-4	+	–	+	–	+
1-3-4-2	–	+	+	–	+
$1\text{-}3\genfrac{}{}{0pt}{}{2}{4}$	–	–	+	–	–
$1\text{-}3\genfrac{}{}{0pt}{}{2}{4}$	+	+	+	+	+
Evanescence	–	–	–	Evanescence of third spot	–

+ = Present, — = Absent

casionally a pattern common in an area may be rare or absent in another area, within the geographical range of the same species. The data gathered from previous literature presented in Table 6, also prove the veracity of this statement. However, the 'complete' pattern and the coalescence of spots 2 and 4 appear to be common and occur in all the regions (Table 6).

Though the evanescence of the discal spot has been reported by Singh and Mann (1977) in the specimens from the semi-desert area of Bhatinda, Abohar and Fazilka of Punjab, it appears that evanescence of spots is very rare in *C. septempunctata*. The report of Singh and Mann may, perhaps, be the only report on the evanescence of elytral spots (Table 6) from India, though the disappearance of spots has been reported in the specimens from Persia and Turkestan previously (Dobzhansky 1933).

Variations of spots: The available literature and the specimens collected, further throw light on the variations of the spots. The pigmented area of the spots increases almost on all sides, though there are exceptions. The spreading power or the active increase of the pigmented area of the spot is determined by the total number of fusions of individual spots with others on the elytra. Varma (1954) observed that the coalescing of the spot is by the gradual spreading of the black pigmented area along certain well-defined lines. The successive stages in the spreading of pigments are well illustrated by the individual patterns themselves given in Figs. 2 to 20. Further, the gradual accumulation of black pigments around the spots could be observed in the laboratory, in the freshly emerged adults. The seven spots appear first on the elytra and the connecting bridges follow them a little later.

The scutellar spot is more or less inactive and never spreads along the basal region of the elytra, touching the base of pronotum. On the contrary, it always extends downwards to join the discal spot. The total number of fusions of this spot is the lowest when compared to others (Table 5). Further, it never spreads sideways to coalesce with the anterior marginal spot.

As for the anterior marginal spot, its spreading is also limited. It enlarges towards the posterior side to meet the posterior marginal spot by a thin black line. Further, the lateral extension of the same, to join the discal spot is very much restricted. When compared to the spreading power of the discal and posterior marginal spots, the anterior marginal spot shows passive expansion or restricted increase. In no specimens does it touch the linea externa.

It appears that the most active spot on the elytra is the discal spot. It extends towards the linea interna and increases also laterally, towards linea externa. Anteriorly and posteriorly also it meets the scutellar and posterior marginal spots respectively. Further it enlarges at an angle of about 45° to join the anterior marginal spot. Its active involvement in the formation of different colour patterns is shown by its highest number of fusions (35.84%, Table 5).

The posterior marginal spot is also active and its frequent increase on all sides has been witnessed in a number of specimens. Its overall frequency of fusions lies next to the discal spot (Table 5).

Conclusions

When multiple alleles are involved in colour patterns, each pattern represents a stage in the multiple interacting systems, that shows the involvement of a certain number of alleles, influenced by environmental factors. Either the absence of the alleles or the lack of conducive external factors, leads to the appearance of the typical spotted pattern and their presence by the enlargement of spots and the degree of confluence of different spots. The full complement, perhaps, is represented by Fig. 20. Many isoalleles and modifier genes may also be involved (Houston and Hales 1980). This is evidenced by the different patterns, and warrants further investigation.

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SPATIAL AND TEMPORAL FLUCTUATIONS IN THE POPULATION OF COMMON MYNA *ACRIDOTHERES TRISTIS* (LINNAEUS) IN AND AROUND AN INDIAN CITY[1]

ANIL MAHABAL[2], D.B. BASTAWADE[3] AND V.G. VAIDYA[4]

(With three text-figures)

The common (Indian) myna *Acridotheres tristis* (Linnaeus) is a familiar bird in urban areas distributed over the entire Indian subcontinent. The monthly collection of data on its population ecology was carried out at Pune (Maharashtra) from June 1973 to August 1976. Three well marked seasons were observed in its annual cycle – the pre-breeding, the breeding and the post-breeding seasons. Monthly and seasonal changes were noticed in its population size. The dispersal of its population among different communal roosts also showed regular seasonal and yearly fluctuations. The population density of mynas during daytime changed according to seasons and habitats.

INTRODUCTION

The common myna (also called Indian myna) *Acridotheres tristis* (Linnaeus) is a familiar bird in urban areas distributed over the entire Indian subcontinent. It occurs in plains and in wooded and cultivated areas. It is omnivorous. In all the seasons, it roosts communally at night. Though the common myna has been associated with man for many centuries, there is very little information on various aspects of its population structure. A few observations on number, flock size and roosting behaviour of the mynas have been reported by Coleman (1945), Hindwood (1948), Wilson (1973), Counsilman (1974), Feare (1976) and Sengupta (1982).

The present paper deals with observations on the seasonal fluctuations in population, dispersal of population among roosts and population density of common myna at Pune (Maharashtra).

MATERIAL AND METHODS

The studies on common myna were carried out at Pune (18°30'N and 73°53'E) and surrounding areas. Altogether 27 communal roosts of mynas within a radius of 24 km were located (Fig. 1) and censused. Of these, 19 communal roost (R-I to R-XIX in Fig. 1) were centrally located within a radius of 8 km. The remaining 8 roosts were situated in the surrounding areas.

Population counts: The 19 centrally located roosts were censused intensively once in each month from June 1973 to August 1976 and later in the representative months, August 1978 and February 1979. At these roosts, observations were recorded between 1645 and 1930 hrs on the number of birds (accompanied by their young ones, if any) arriving at every 5 minute interval. In addition to this, morning counts were made between 0500 and 0730 hrs fortnightly at two roosts R-III and R-IV for a fixed period from August 1975 to September 1976. The remaining 8 roosts were censused twice a year during 1974-1977 only for their population counts. Besides this, the arriving mynas were censused for ten days consecutively in the evenings at three roosts R-III, R-IV and R-I during October, November and December 1975 respectively.

During the census of mynas carried out in the evening, the number of young ones fledged during the season, was recorded separately at eight roosts R-I to R-VIII from June to December in 1974 and 1975. The young ones differ from the adults in their smaller size and in their faltering flight. Therefore, they can be identified in the flocks, though with some difficulty, until December. After December, the young ones cannot be distinguished in the population because of the increase in their body size.

Population density: The feeding areas of various roosts (Fig. 1) were marked by following the mynas in the morning and evening and also by observing their directional routes. Population density of mynas during day time was studied once a month at three different localities – Model Colony, Poona University Campus and Paud Road – from April 1974 to September 1975 (Fig. 1). The census was carried out by line transect method four times a day at each

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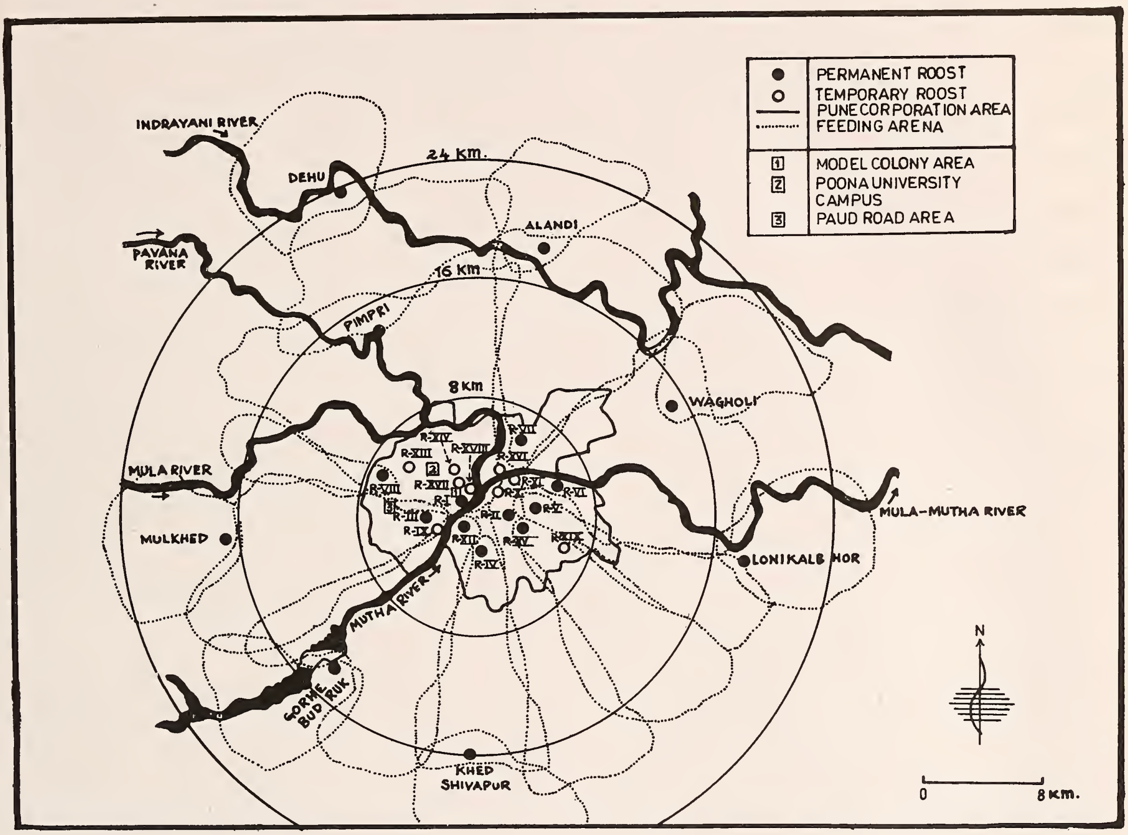

Fig. 1. Locations of communal roosts of common myna in and around Pune with their respective feeding areas.
R-I: Police Ground, R-II: St. Vincent, R-III: Film Institute, R-IV: Peshave Park, R-V: Race Course, R-VI: Koregaon Park, R-VII: Yerawada, R-VIII: Pashan, R-IX: Diwagi Metal Works, R-X: Pune Railway Station, R-XI : Bund Garden, R-XII: Valkunth, R-XIII: N.C.L., R-XIV: Agricultural College, R-XV: Cantonment Hospital, R-XVI: Deccan College, R-XVII: Sancheti Hospital, R-XVIII: Engineering College, R-XIX: Wanowori.

locality covering an area of approximately 1 sq km. Details of the localities are as follows: (1) Model Colony Area: The housing colony has number of bunglows with gardens around them. The whole area has substantial amount of greenery. (2) Poona University Campus: This area has residential quarters, buildings, garden, number of trees, *Acacia* shrubs, barren land and short grass patches. (3) Paud Road Area: The area consists of open land with short grass patches and some *Acacia* shrubs near residential quarters. Hardly any trees can be seen.

Observations and Results

After a period of rest, mynas slowly become active in the early morning by vocalizing and vacate the roost around the time of sunrise. They spend the daytime in the feeding area in various activities. They start their return journey towards the communal roost in the evening, arrive at the roost around the time of sunset and vocalize loudly till they finally rest for the night. The birds were counted while they departed from the roost in the morning and while they arrived at the roost in the evening.

Fluctuations in total population: The total population of mynas in the city (considering all the 19 communal roosts) was observed to fluctuate monthly, seasonally and yearly.

Fig. 2 shows that there were two peaks, each followed by a trough in the number of mynas arriving at the roosts during every 12 month period from August to July. The highest peak in August and the lowest trough in June seem to be characteristic fea-

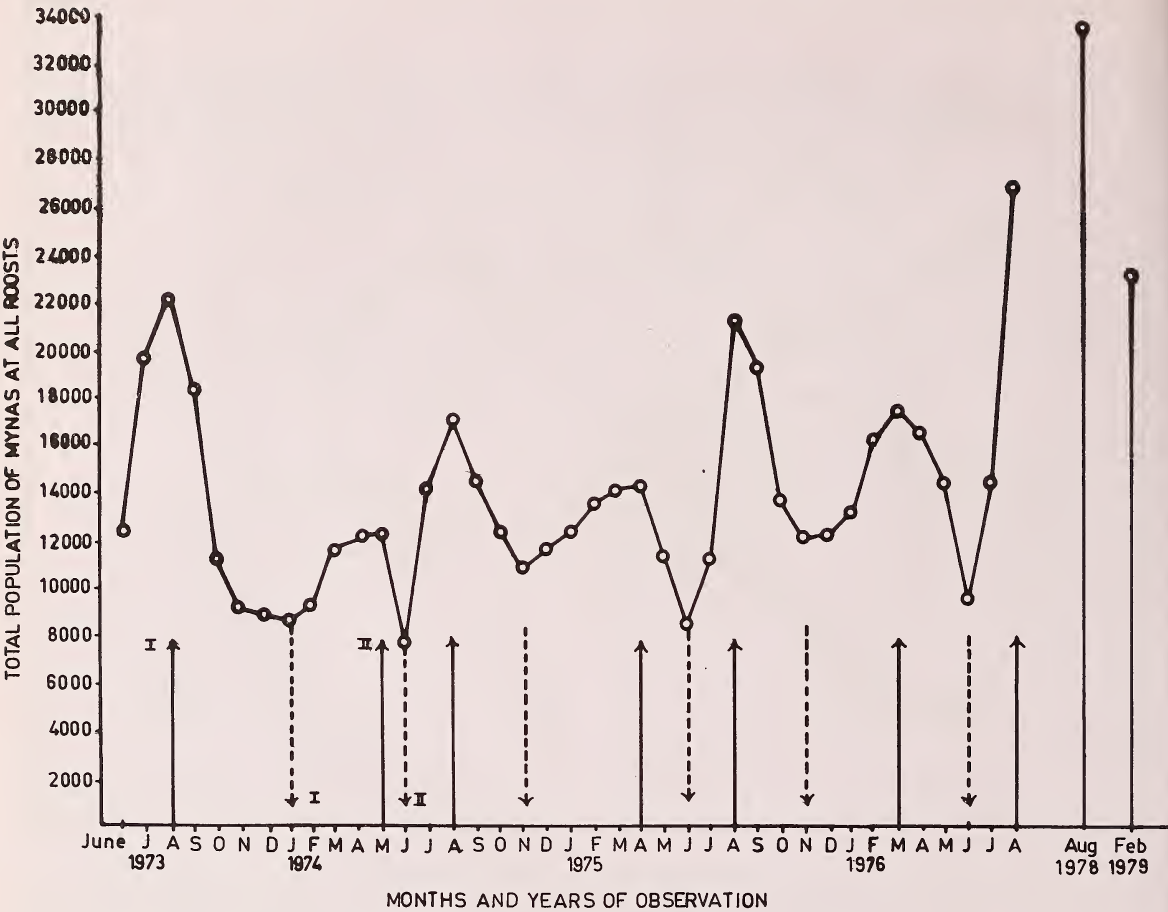

Fig.2. Monthly fluctuations in total number of common mynas arriving at 19 communal roosts.

tures for the number of birds at communal roosts. The timings of second peak and following trough, however, were variable. Another study undertaken for a period of 14 months in the mornings, when the number of birds leaving the roosts R-III and R-IV only were counted, revealed that the monthly fluctuations in the roosting population estimated by the above two methods gave comparable results.

TABLE 1
SEASONAL CHANGES IN THE AVERAGE NUMBER OF COMMON MYNAS IN PUNE DURING 3 OBSERVATIONAL YEARS

	Average number of birds		
Season	1973-74	1974-75	1975-76
Post-breeding (Aug.-Oct.)	17296.7	14591.7	17977.7
Pre-breeding (Nov.-Mar.)	9625.2	12509.2	14189.6
Breeding (Apr.-July)	11637.0	11311.0	13679.5

The following three phases were observed in the annual cycle of common myna – the pre-breeding season (November to March), the breeding season (April to July) and the post-breeding season (August to October). Changes in the average number of mynas during these three seasons showed that the post-breeding season had the highest population as compared to the remaining two seasons during all the years of observations (Table 1).

When population fluctuations were considered on yearly basis from August to July 1973-74, 1974-75 and 1975-76, it was observed that the mean population for these years was 12221.6 ,12630.4 and 14966.6 respectively. This shows that there was an

TABLE 2
ROOSTWISE DISPERSAL OF MYNA POPULATION IN DIFFERENT SEASONS

	Average percentage of mynas at different roosts *										
Seasson & Year	R-VI	R-VII	R-I	R-VIII	R-III	R-XII	R-IV	R-II	R-XV	R-V	R-IX to R-XI R-XIII R-XIV R-XVI to R-XIX
1973-74											
Post-breeding	2.8	4.5	45.5	4.1	10.7	3.0	2.5	22.2	0.0	2.7	2.0
Pre-breeding	3.6	7.0	45.4	4.8	9.4	3.5	3.2	16.7	0.0	3.6	2.8
Breeding	4.1	7.6	43.2	2.5	9.9	2.0	2.7	18.9	1.1	4.3	3.7
1974-75											
Post-breeding	5.3	8.2	30.5	3.0	18.1	1.8	4.7	16.6	1.4	6.3	4.1
Pre-breeding	9.6	7.8	39.4	2.8	9.5	2.0	5.1	13.0	1.5	6.0	3.3
Breeding	6.8	8.8	40.2	0.8	12.2	2.7	3.3	16.3	3.1	1.7	4.1
1975-76											
Post-breeding	6.8	7.5	32.3	0.03	15.6	4.9	5.4	18.0	4.3	1.6	3.57
Pre-breeding	8.9	8.8	37.9	3.1	7.2	6.5	5.0	12.5	5.7	2.1	2.3
Breeding	7.7	8.5	40.4	2.5	7.6	5.7	5.3	12.4	5.3	1.7	2.9

* Roosts R-I to R-XIX have been arranged according to locations of feeding areas.

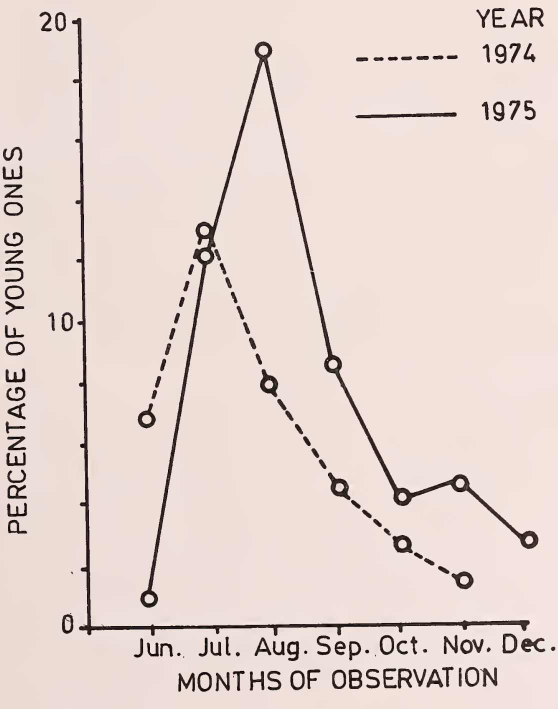

Fig. 3. Monthly mean percentage of young ones in the common myna population.

increase of 3.3% from 1973-74 to 1974-75 and a further increase of 15.6% from 1974-75 to 1975-76. Isolated observations during August 1978 and February 1979 indicated the possibility that there was a further increase in population of mynas during the intervening years 1976-77 and 1977-78 (Fig. 2).

The populaion counts of mynas at eight communal roosts of outer rings (Fig. 1) during 1974 to 1977 were as follows: Alandi 500-800, Wagholi 500-600, Loni-Kalbhor 500-600, Khed-Shivapur 500-700, Gorhe-Budruk 500-560, Mulkhed 300-400, Pimpri 600-800 and Dehu 500-700.

Population of young ones: The monthly mean percentage of young ones in the population was calculated and presented in Fig. 3. During the month of June, the number of young ones was found to be relatively less in the population. After this month, the number of young mynas increased in the population; during 1974, percentage of young ones was maximum in the month of July, whereas in 1975 it was maximum in the month of August. Thereafter, the number of young ones decreased and reached its lowest level in the months of November-December. After December, the young mynas could not be distinguished from adults in the population.

Fluctuations in dispersal of population among different roosts: The total population of the common mynas in the city area (inner ring of 8 km radius) is dispersed among 19 communal roosts. Of these, only 10 roosts were found to be permanent and the remaining 9 roosts were temporary (Fig. 1). The permanent roosts were present throughout the period of study and had an average population over 300. Temporary roosts were abandoned frequently or totally at some time during the study period. As the populations at the temporary roosts were relatively small, they were considered together as a single unit in Table 2. The table indicates that the dispersal of population among various roosts was not uniform. There were one major roost (R-I) where more than 30% of the Pune birds roosted, two medium-sized roosts (R-II and R-III) where 10 to 30% roosted and a number of small-sized roosts (R-IV to R- XIX) where less than 10% roosted (Table 3). At these roosts, the populations seemed to undergo regular changes during different seasons and years (Table 2).

(1) The major roost R-I had a large feeding area and it overlapped those of the medium-sized (R-III) and small-sized (R- VII and R-VIII) roosts (Fig. 1). The relative percentage of population roosting at R-I decreased from breeding to post-breeding season and increased towards pre-breeding season during the year 1974-75 and 1975-76. Exactly reverse conditions were noticed at roost R-III more or less in the same ratio. As against these complementary changes, there was a small but parallel increase in population at roost R-I as well as R-III from pre-breeding to breeding season.

(2) Although rather small, some complementary changes in relative percentage of population were noticed at the medium-sized roost R-III and the small-sized roost R-XII during most of the seasons (Table 2). The feeding areas of these two roosts again overlapped each other.

(3) The feeding area of the medium-sized roost R-II overlapped those of small-sized roosts R-IV, R-XV and to certain extent the area of the roost R-V (Fig. 1). The decrease or increase in the population at roost R-II had complementary effects mainly on the roost R-IV and to some extent on the roosts R-XV and R-V during all the seasons.

(4) In general, Table 3 indicates that the roost R-III showed an increase in population from 1973-74 to 1974-75 and then a decrease of about 3% towards 1975-76. On the other hand, at the roost R-XII showed a decrease in population from 1973-74 to 1974-75 and then an increase of about 3% towards 1975-76. The feeding areas of these above two roosts overlapped each other. Secondly, a steady increase in population was noticed at roosts R-XV and R- IV and a decrease at roosts R-VIII and R-II during all the three years of observation.

The feeding areas of communal roosts of the inner ring and those of the outer ring showed overlapping (Fig. 1). This indicates that exchange of myna population may also be taking place between the roosts of inner and outer rings during favourable or lean seasons.

Day-to-day variations in population at three roosts: The arriving mynas were censused for ten days consecutively in the evenings at three roosts R-III, R-IV and R-I during October, November and December 1975 respectively. The purpose of this study was to determine the day-to-day changes in the population of mynas at the above roosts.

TABLE 3
YEARLY TRENDS IN THE ROOSTWISE DISPERSAL OF COMMON MYNA POPULATION

Year	Average percentage of mynas at different roosts*										
	R-VI	R-VII	R-I	R-VIII	R-III	R-XII	R-IV	R-II	R-XV	R-V	R-IX to R-XI R-XIII R-XIV R-XVI to R-XIX
1973-74	3.5	6.4	44.7	3.8	10.0	2.8	2.8	19.3	0.4	3.5	2.8
1974-75	7.2	8.3	36.7	2.2	13.3	2.2	4.4	15.2	2.0	4.7	3.8
1975-76	7.8	8.3	36.9	1.9	10.1	5.7	5.2	14.3	5.1	1.8	2.9

*Roosts R-I to R-XIX have been arranged according to locations of feeding arenas.

TABLE 4
SEASONAL DIFFERENCES IN THE POPULATION DENSITY OF COMMON MYNAS DURING DAYTIME AT THREE DIFFERENT LOCALITIES DURING 1974-75

Season	Number of mynas per sq. km Model colony area	Poona University campus	Paud Road area
Breeding	26.4	33.9	26.4
Post-breeding	15.6	27.3	17.5
Pre-breeding	15.0	19.2	13.8
Mean	19.0	26.8	19.2

It was observed that there were day-to-day variations in the arriving population at each roost. The range of these changes on any two consecutive days was found to be between – 9.6% and + 6.9% at R-I (major roost), – 6.3% and + 17.1% at R-III (medium-sized roost) and – 25.3% and + 18.2% at R-IV (small-sized roost). These observations suggest that there was a local shift of mynas from roost to roost. Further, they also suggest that the magnitude of dispersal varied according to the size of the roost; the day-to-day variations in the population of mynas at a major roost R-I were the least, at a medium-sized roost R-III slightly more and at a small-sized roost R-IV still more.

Population density: Mynas from different communal roosts disperse into their feeding areas in the morning. They cover a roughly circular area of 1018 sq km with a radius of 18 km (Fig. 1). The mean population of mynas in Pune city, obtained from data collected over three years was about 13273 (see above). Therefore, the population density of mynas in the city area during daytime works out to about 13 birds per sq km irrespective of habitat and season.

In the evening, most of the mynas concentrate at the communal roosts located in the city area covering only about 138 sq km. This corresponds to a population density of 96.2 birds per sq km, which is 7.4 times the population density of feeding mynas during the daytime. Further, about 61% of the total population was restricted to roosts R-I, R-II, R-X, R-XII and R-XIV, which lie within a circular area of 2.3 km radius. This central area had thus the highest population density of 491.1 birds per sq km, which is 37.8 times the population density of the feeding mynas during daytime. This showed a very highly clumped distribution of mynas in the city area during night time.

A study was undertaken to assess the population density of mynas in the feeding area during daytime at three different localities in different seasons. The average number of mynas were calculated at each locality during each season (Table 4). The table indicates that at each locality, the population density of mynas was highest in the breeding season followed by that in the post-breeding season. It was lowest in the pre-breeding season. The annual mean population density of mynas was higher at the Poona University campus than at the other two localities selected for this study.

DISCUSSION

Monthly changes in the population of mynas have shown similar trends during the three consecutive years of observation. A considerable increase was seen in the number of individuals in July-August, which seemed to be mainly due to the addition of juveniles to the population. A part of the increase may be due to the breeding females or one partner of the mated pairs who now returned to the roost after nesting. The decrease in number of mynas from August to September/October could be because of deaths of young ones due to disease or predators (young coming down on ground for feeding were sometimes attacked by domestic cats). Further fall in population from September/October to December could be explained as local migration outside the study area (emigration).

Towards the middle of the pre-breeding season (January onwards), there was a slow increase in the population till the beginning of the breeding season (April). This may be because of returning of mynas, which had emigrated outside the study area, to secure safer nesting sites before the commencement of the breeding season. The sudden drop in the roost populations from early to middle of the breeding season (April/May to June) could be related to the females or one partner of the mated pairs remaining at the nest for various nesting activities. Often, one partner of the mated pair was observed to be staying at the nest at night. Counsilman (1974) has also made similar observations with Indian mynas at Auckland, New Zealand.

The yearly mean population of mynas in the study area was found to be increasing slowly during the period of observation. This was probably linked with the following ecological factors: the nesting, roosting and feeding habits of mynas. Mynas are camp followers of man. They roost communally in large numbers. The roost provides a relatively safe shelter at night. It is a fact that every year the human population in Pune city is increasing with a consequent expansion of residential quarters associated with trees and gardens. This in turn provides additional nesting sites and feeding areas for mynas and leads to an increase in their population.

Some fluctuations in the dispersal of myna population among different roosts have been observed every year. These could be due to seasonal changes in the quality and quantity of food in the feeding areas attached to the different roosts. The data reveal that, in spite of the above mentioned fluctuations, a definite minimum level of population was normally maintained at each roost and that a major roost has relatively more stability of population size as compared to the medium and small-sized roosts.

The daytime population density of mynas at the three selected areas was higher during the breeding season, when the nesting activities were in full swing. In this season, the mynas lingered in the city area for selecting safer nest holes, for collecting suitable nesting material and searching for food for themselves and for their young. In the post-breeding and the pre-breeding seasons, there were no nesting activities. The search for better feeding localities may result in their moving outside the city area, thus decreasing the daytime population density in these seasons.

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BLOTCH STRUCTURE IN INDIVIDUAL IDENTIFICATION OF THE INDIAN PYTHON *PYTHON MOLURUS MOLURUS* LINN. AND ITS POSSIBLE USAGE IN POPULATION ESTIMATION[1]

S. BHUPATHY[2]

(With two plates and three text-figures)

Identification of individuals of Indian python *Python molurus molurus* in Keoladeo National Park, Bharatpur, was made using the structure of the blotch pattern. A total of 35 individuals could be identified in the intensive study area and the blotch structure seems to be unique for each individual.. The advantages of using this method in the estimation of python population is discussed.

INTRODUCTION

Studies on the populations of the reptilian fauna in India are rare. However, information on general status, distribution and habits of Indian reptiles are available (Smith 1933, 1944; Whitaker 1978, Daniel 1983). The Indian python *Python molurus molurus* is classified as endangered in the IUCN Red Data Book, and listed under Schedule I of the Indian Wildlife (Protection) Act 1972. In the present study an attempt has been made to identify individual pythons using blotch structure and to examine the possibility of using this method in estimating populations. The paper also deals with the size classes of python in the study area.

STUDY AREA AND METHODOLOGY

The Keoladeo National Park, Bharatpur (27° 7.6' to 27°12.2'N and 77° 29.5' to 77°33.9'E) is situated 50 km west of Agra and 180 km south of New Delhi. The total area of the park is 29 sq km of which 8.5 sq km is wetland. The park has about 46 sites where pythons are frequently seen (Bhupathy and Vijayan 1989). The present study was conducted in an area of about 27 ha having 6 sites which the pythons frequent. These sites are termed hereafter as python points and referred to as P1, P2, P3, P4, P5 and P6 (Fig.1). The nature of the soil is saline with least or no ground cover and the vegetation is of *Salvadora-Prosopis* community. A detailed account of the abiotic and biotic features is available elsewhere (Ali and Vijayan 1986 ,Vijayan 1987).

In an earlier study (Bhupathy and Vijayan 1989), the population of python was estimated by checking the probable sites and counting them at each site. The maximum number of snakes seen at each site was accounted for the total population. One of the serious limitations of this method is that at a given time one cannot expect to see all the snakes of a particular point because of partial hibernation and foraging movement. Hence population might be underestimated. Inter-point movement may lead to overlap in counting. Therefore, in the present study an attempt has been made to identify each snake individually and a new method to identify individual snake using the variation in blotch structure was developed.

Regular surveys were made on foot between 0900 and 1500 hrs from November 1988 to March 1989. All the six points in the intensive study area were covered at a stretch in each survey. At each sighting of a python, dorsal blotches were closely observed and shape of a few anterior ones was drawn. In most cases photographs were taken using Pentax K1000 camera. The number of snakes seen at each point and approximate length of each individual were also noted.

The probability of repetition of two similar blotch pattern among pythons was calculated by comparing a few anterior dorsal blotches individually and collectively.

RESULTS AND DISCUSSION

General description of blotches: All the markings which are pigmented darker than the body colour of the snake are referred to as "blotches". Some information of the colour, size and shapes of the blotches of python is available (Smith 1943, Whitaker 1978, Daniel 1983).

The prominent blotches in the body colour pattern of the Indian python considered in the present

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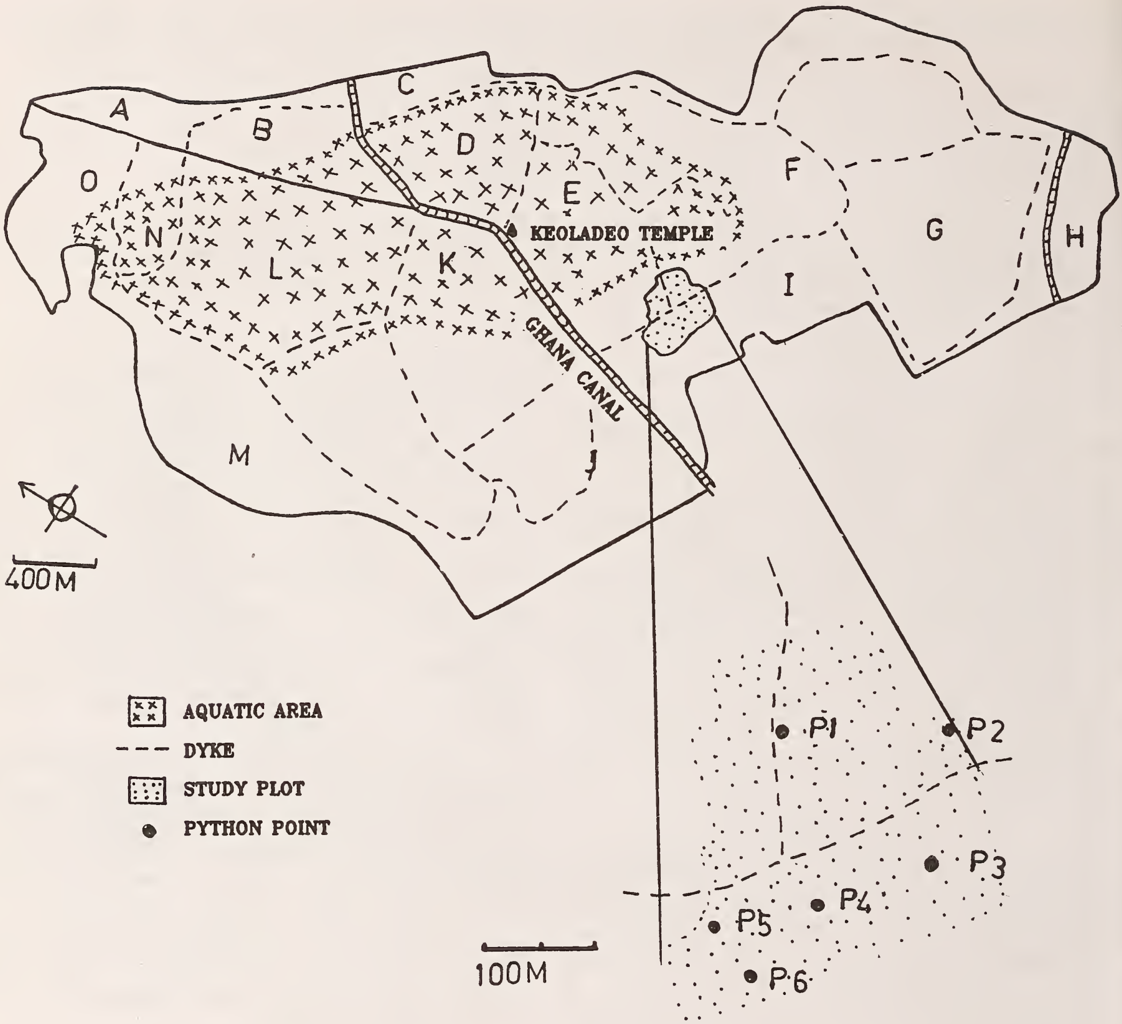
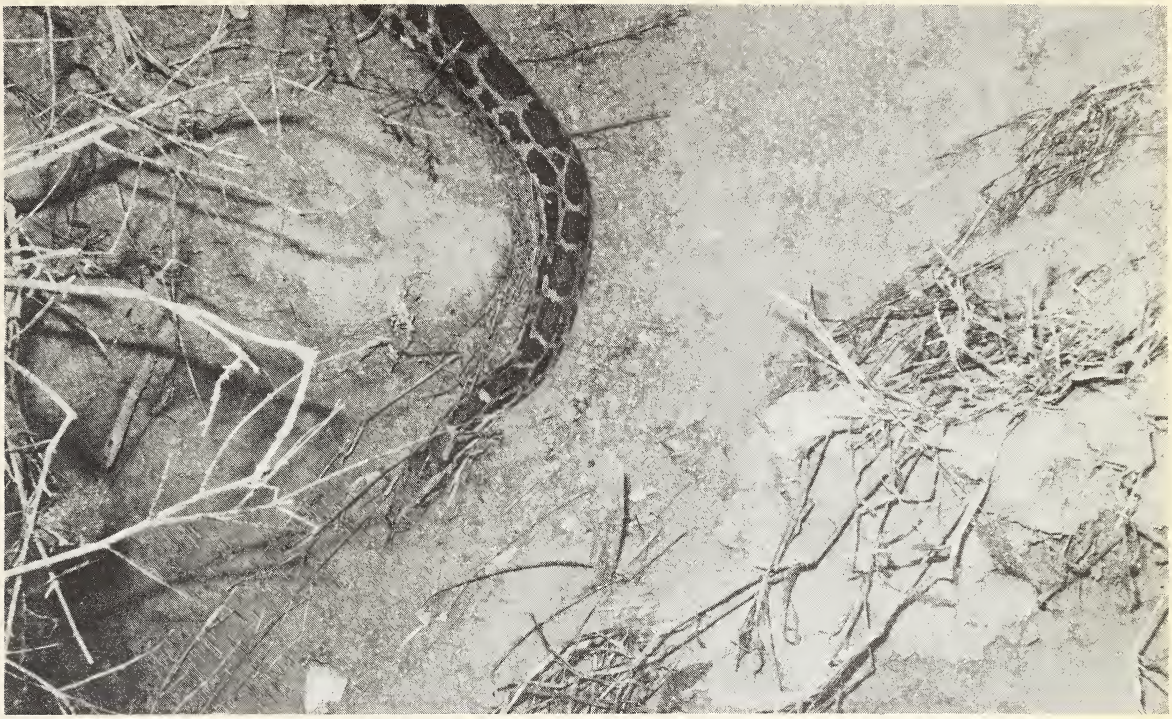


Fig.1. Map of Keoladeo National Park, Bharatpur, showing intensive study area.

study are:

1) head blotch – single, lance shaped and fading anteriorly, 2) eye marking – an oblique streak behind the eyes, 3) dorsal (vertebral) blotches in series, starting immediately after head and extending up to tail tip; varied in size and shape, 4) dorso-lateral blotches in series, parallel to dorsals on either side; smaller in size up to the tail, 5) lateral blotches in series, next to dorso-laterals; smaller in size, contrary to the blotches of other series, most of them have a pigmentless portion in the centre which is partially visible from the side (Fig.2).

Identification of individual python using dorsal blotches: The size and shape of the blotches of dorsals or vertebrals varied considerably. In this study a few dorsals of the anterior end were considered for individual indentification. Some of the most commonly occurring blotches and their shapes are given in Table 1, and a few are shown in Plates 1 and 2. These blotches appeared in different size and group combinations. The anterior blotches are better for comparison as they are larger than the posterior ones. In some cases, dorso-laterals and the size of the python were used to substantiate the identity of



Above: Dorsal blotches (3,4,5,6) connected with the dorso-laterals. Note the connection of first dorso-lateral with the head blotch.
Below: First few dorsal blotches completely fused with the head blotch. Note the spots on either side of the 5th dorsal blotch.

Above: First dorsal blotch is beaded by the partial fusion of a few blotches. Note the centrally pigmentless lateral blotches.
Below: First dorsal blotch is bridged with the second.

TABLE 1
SOME COMMON SHAPES OF ANTERIOR DORSAL (VERTEBRAL) BLOTCHES OF INDIAN PYTHON

Blotch shape	Description
Rectangular	Size varied, horizontal or vertical, sometimes very lengthy by the fusion of two or more blotches.
Dumbell-shaped	Two blotches merged with a depression in the centre on either side.
Bridged	Two blotches connected by a narrow canal.
Beaded	Three or more blotches connected.
Irregular	No specific shape.
Blotch with vacuoule-like structure	Pigmentless air bubble like spot inside a blotch.

two snakes having apparently similar dorsal blotch pattern (Plate 1).

24 surveys were conducted and a total of 132 individuals were sighted during the study period. Altogether 35 snakes were identified by their blotch pattern (Fig.3). Identification marks, approximate length and the name of the points are given in Appendix I.

Population: Altogether, 35 pythons were identified using the blotch structure, whereas only 24 could be recorded using the earlier method (Bhupathy and Vijayan 1989) of repeated survey and taking the highest number seen at each point as the population. It is clear that individual identification was the best method as the figure obtained by the other method was a 30% underestimation. Again, at one point (P_1) as many as 10 pythons could be recognised by blotch structure, whereas only 3 were seen by the other method. It is to be mentioned that in all the points similar phenomenon was recorded (Table 2).

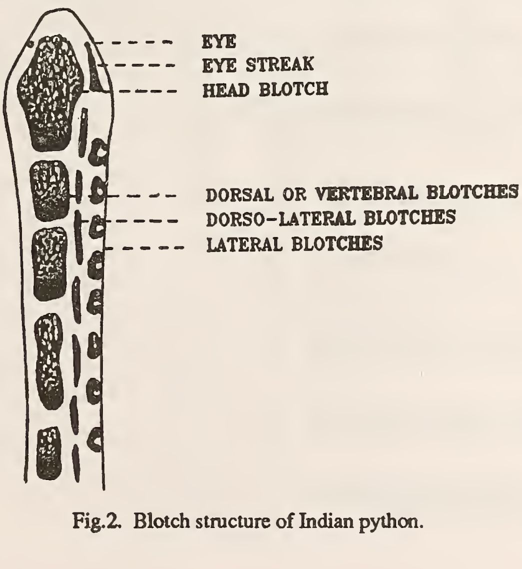


Fig.2. Blotch structure of Indian python.

Of the 132 pythons encountered only 4 were seen 25-100 m away from python points, and might have been foraging. Four out of the 35 individually distinguished snakes (11.6%) were seen in points other than from where they were first recorded.

These possibilities will not affect the estimation of the population if individual identities are known.

Size class: The intensive study area had pythons of different size classes. The most represented size class was 2.1-2.7 m (51.4%) followed by 2.7-3.3 m (25.7%) and 1.5-2.1 m (17.1%) (Table 3). There

TABLE 2
COMPARISON OF NUMBER OF SNAKES RECORDED BY DIFFERENT METHODS BETWEEN NOV. 1988 & MARCH 1989

Point	Method	
	Maximum no. of snakes recorded	Individual identification
P_1	3	10
P_2	5	7
P_3	7	8
P_4	3	4
P_5	3	6
P_6	0	0
Total	21+3 *	35

* Dead python seen

TABLE 3
SIZE STRUCTURE OF A SAMPLE POPULATION OF THE INDIAN PYTHON IN KEOLADEO NATIONAL PARK

Size class (Metre)	No. of snakes	Percentage
<1.5	0	0
1.5–2.1	6	17.1
2.1–2.7	18	51.4
2.7–3.3	9	25.7
<3.6	2	5.7

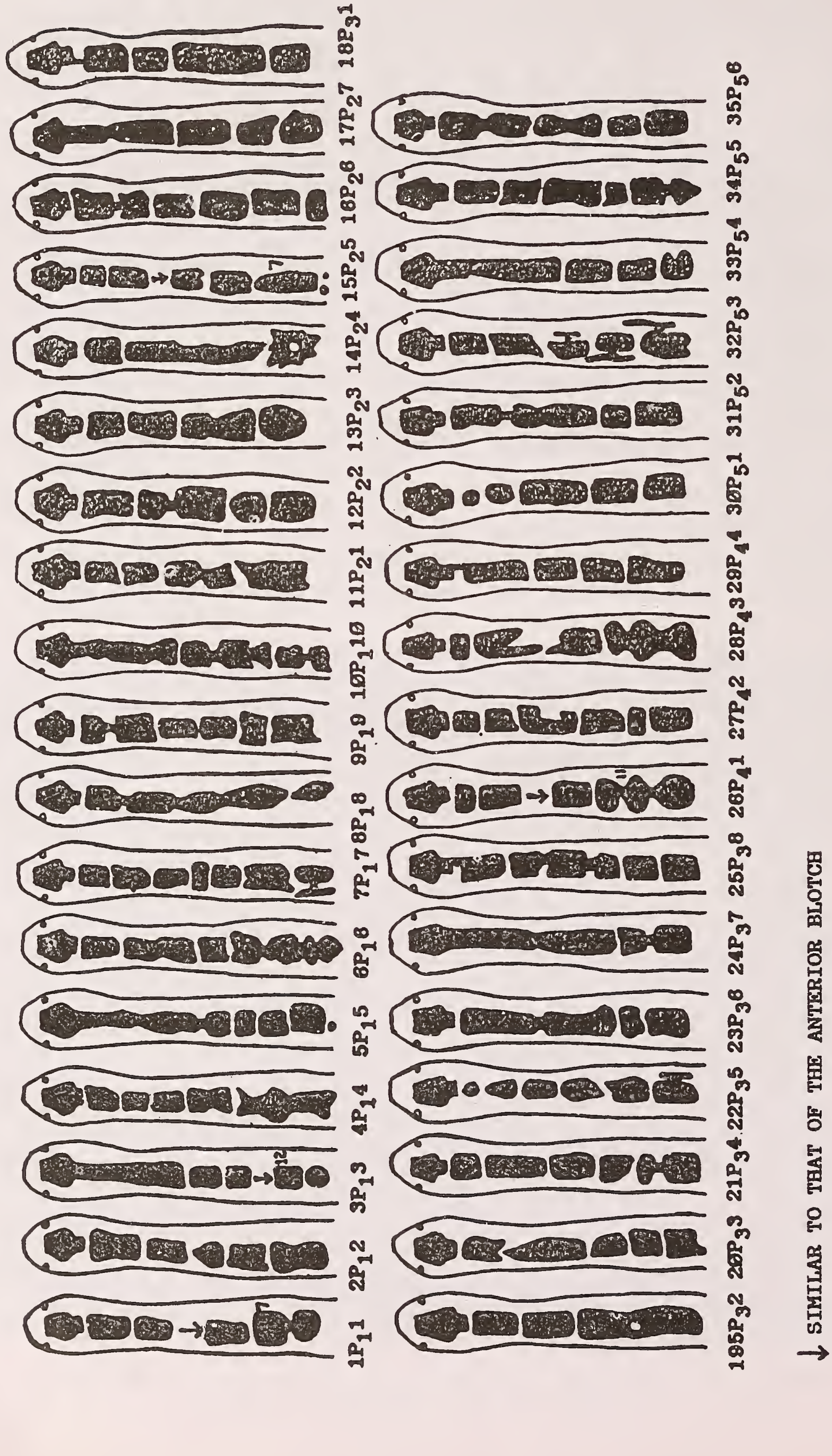


Fig.3. Dorsal blotch pattern of pythons identified in the intensive study area.

was no blotch pattern characteristic of any of the size class.

Pythons of more than 3.6 m were absent in the intensive study area, and infrequent elsewhere in the park. Smith (1943) also records the rarity of such large pythons. Dattatri (1990) reported that in captivity python hatchlings measure on an average 70 cm and double in length (1.4 m) by the end of the first year. The absence of individuals smaller than 1.5 m in the present population might be due to absence of breeding as a result of drought in the area in 1987 and 1988.

Validity of the method: When the characteristics of the first blotch of all the 35 snakes were compared, similarity was found only in 7-8%, i.e. in 92-93% of pythons the first blotch showed a distinct individual pattern. In the case of the second blotch also, similar blotches were seen only in 7-8%. When the characteristics of first and second are considered as a unit, the overlap was <2%. The characteristics of the first four blotches when considered together, then each snake had a separate pattern. In other words no two snakes exhibited an identical pattern in the characteristics of the first four blotches.

Therefore it is assumed that the pattern of blotch structure is unique for individual snakes. However, changes of blotch structure, if any, with age is to be investigated. Even if there is any variation with age it would not cause any problem in a short term assessment of population, at least within one season.

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APPENDIX I
INDIVIDUAL IDENTITY OF THE PYTHONS OF THE PYTHON POINT AREA IN KEOLADEO NATIONAL PARK

Code	Length of snake (m)	Sl. no(s) of the dorsal blotch having distinct features	Description of blotch (blotch no. in parenthesis)
1P_1 1	2.4	7	Dumbell shaped blotch.
2P_1 2	3.6	3	Round, with pointed anterior end.
3P_1 3	3.0	1	Head and first few blotches fused completely.
4P_1 4	2.7	5	Beaded (three blotches involved).
5P_1 5	2.4	1, 5	Head and first few blotches fused (1) A simple spot (5)
6P_1 6	2.4	4	Beaded.
7P_1 7	2.7	4, 7	Small rectangular (4) Connected with lateral blotch (7)
8P_1 8	1.8	1	Beaded.
9P_1 9	3.0	1	Bridged with the second.
10P_1 10	1.8	1, 2	Very long, united with head blotch (1), Beaded (2)
11P_2 1	2.55	3	Inverted bottle shaped.
12P_2 2	2.25	2	Bottle shaped.
13P_2 2	2.55	4	Oval
14P_2 4	3.0	2, 3	Partly beaded (2), Irregular with vacuole (3)
15P_2 5	2.4	7, 8	Elongated spots. (7), Two small round spots (8)
16P_2 6	3.15	1	First and second blotch bridged.
17P_2 7	2.85	1, 2	Fused with the head blotch (1), Large rectangular (2)
18P_3 1	2.85	1, 3	Bridged with the head blotch (1), Very long (3)
19P_3 2	2.4	3	Dumbell shaped with vacuole.
20P_3 3	7.5	2	Elongated with pointed anterior end.
21P_3 4	2.55	5	Dumbell shaped.
22P_3 5	3.6	1, 6	Round (1), Connected with the laterals (6)
23P_3 6	2.55	1	Very long having depression in the middle
24P_3 7	3.3	1, 2	Fused with the head blotch (1), Dumbell shaped (2)
25P_3 8	1.8	1, 2	Bridged with head blotch (1), Beaded (2)
26P_4 1	2.7	1, 11	Horizontal , rectangular (1), Beaded (11)
27P_4 2	1.8	3	Telephone receiver shaped
28P_4 3	1.8	2, 4	Irregular (2), Beaded (4)
29P_4 4	1.8	1	Bridged with head blotch
30P_5 1	2.7	1, 2	Round (1), Small rectangular (2)
31P_5 2	2.4	1	Elongated
32P_5 3	2.7	3, 4, 5	All connected with dorso-laterals
33P_5 4	3.3	1, 4	Very elongated, fused with head blotch (1), Incomplete round (4)
34P_5 5	3.3	3, 5	Unequal equal dumbell.
35P_5 6	2.4	1, 2	Elongated (1), Dumbel (2)

A STUDY OF THE MIGRATION OF COMMON TEAL *ANAS CRECCA CRECCA* LINNAEUS BASED ON RING RECOVERIES IN INDIA AND U.S.S.R.[1]

V.C. AMBEDKAR AND J.C. DANIEL[2]

(With five text-figures)

INTRODUCTION

The common teal *Anas crecca* L. is a regular winter visitor (August/September to March/April) to the Indian subcontinent (Ali and Ripley 1978). However, there is very little quantitative and qualitative data published on its migratory movements in India. Except for a few earlier stray and sporadic attempts[3], bird ringing has not been undertaken on a large scale.

In 1959 Dr Salim Ali, on behalf of the Bombay Natural History Society (BNHS), attended a meeting of ornithologists and virologists at Geneva sponsored by World Health Organisation (WHO) to consider research on birds as possible disseminators of arthropod-borne viruses, and the possible connection between bird migration ana the outbreak of encephalitis (K.F.D.) in Kayasanur Forest area in Karnataka (13° 55' N, 75° 34' E) India, similar to a disease occurring in the Omsk Region (*c.* 55° N; 73° 22'E) of U.S.S.R. (Ali, S. 1963b; 1972; Netsky *et. al.* 1978).

A pilot scheme from the BNHS to study bird migration in India was approved and financial assistance was received from the WHO. Ringing stations in various parts of India were established with Dr Salim Ali as Chief Investigator (Ali 1962 b,c, 1963a, 1964). The Bharatpur bird ringing station was established in 1961 and started ringing first passerines and later ducks and waders. The first teal was ringed on 3 October 1965 at Bharatpur.

This paper analyses the data obtained on the migratory movements of common teal ringed at Bharatpur and recovered in the U.S.S.R. and in the Indian subcontinent, between the years 1965 and 1974.

STUDY AREA

Bharatpur Bird Sanctuary, presently the Keoladeo National Park (27°15'N, 77°30'E), is situated 178 km south of New Delhi at a height of 174 m.a.s.l. The area of the National Park is approx. 29 sq.km, of which 8.5 sq. km is wetland. It is among the best winter wildfowl refuges in the country (for details see Ali 1953, 1985, Ali and Vijayan 1983, Bates 1925. Breeden, S. and B. 1982, Ewans 1989, Mathew 1971, McClure 1974, Sauey, 1985, Scott 1966).

Professional bird trappers from Bihar, namely Mirshikars and Sahanis, were used for trapping wildfowl (for methodology see George 1964, Akhtar 1987). The ring used was 'C' size split-ring, manufactured by I.O. Mekaniska HB, Sweden, with the following specifications: diameter 6.5 mm, height 9.0 mm, thickness 1.0 mm and weight *c.* 0.6g. The ring was made of aluminium and brass alloy (BA 21) and bore the following inscription on its outer surface: C-00 (i.e. numbers) INFORM BOMBAY NAT. HIST. SOCIETY.

The key word in the inscription was and is still 'Bombay,' the return address. Between 1965 and 1974 the BNHS ringed 10,958 common teals at Bharatpur.

METHODS OF ANALYSIS

Recoveries were grouped into two classes.

1. Recoveries from the U.S.S.R. These were reported by the U.S.S.R. Academy of Sciences, The Centre of Ringing and Marking of Birds and Terrestrial Mammals, Moscow (485 recoveries). Only one ring recovery was reported directly to us by a school teacher from Chimkent, Kazakh, S.S.R.
2. Recoveries in the Indian subcontinent including Pakistan and Bangladesh (85 recoveries). These were reported by individual hunters and sportsmen

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[1]Accepted August 1990.

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[3]The very first ring recovery outside the Indian subcontinent was reported as follows:
Maharani at Dhar Series, Ring No. 116, male
Ringing details: 23-2-1929, Dhar State 22°35"N, 75°20"E
Recovery details: 6-10-1931, Near Vasugana River, Tomsk, Siberia. *c.* 58°N, 77°E
Manner of recovery? (*JBNHS 35:* 901 , *47*:690)

TABLE 1

MONTHLY FLUCTUATIONS IN NUMBERS OF THE COMMON TEAL (*Anas crecca*) RINGED IN BHARATPUR

Sex	January No.	January %	February No.	February %	March No	March %	April No	April %	May to August	September No.	September %	October No.	October %	November No.	November %	December No.	December %	Total No.	Total %
M	415	32.4	666	31.4	369	17.0	8	4.5	No Ringing in	2	40.0	635	54.7	926	48.4	852	39.8	3873	35.3
F	861	67.3	1447	68.2	1788	82.4	169	95.4	Bharatpur	1	20.0	256	22.0	913	47.7	1247	58.3	6682	60.9
U	02	0.1	08	0.3	11	0.5	0	0.0		2	40.0	268	23.1	74	3.8	38	1.7	403	3.6
Total	1278		2121		2168		177			5		1159		1913		2137		10958	

Figures from 1965 to 1974 are combined. M = Male, F = Female, U = Unsexed. Sex ratio: 35.33 males: 60.9 females (1:1.7)

TABLE 5

MONTHLY LATITUDINAL RECOVERIES IN INDIA AND U.S.S.R. DURING FIRST YEAR OF RINGING

Latitude Deg North	January M	January F	February M	February F	March M	March F	April M	April F	May M	May F	June M	June F	July M	July F	August M	August F	September M	September F	October M	October F	November M	November F	December M	December F	Total M	Total F
65-70	–	–	–	–	–	–	–	–	2	–	3	1	–	–	–	1	–	1	–	–	–	–	–	–	5	3
60-65	–	–	–	–	–	–	–	–	5	3	1	1	–	–	–	–	1	–	–	–	–	–	–	–	7	4
55-60	–	–	–	–	–	–	1	–	24	8	–	–	–	–	1	10	11	13	2	5	–	–	–	–	39	36
50-55	–	–	–	–	–	–	5	1	3	2	–	–	–	–	6	7	7	27	1	8	–	1	–	–	22	46
45-50	–	–	–	–	1	–	3	–	–	–	–	–	–	–	2	3	4	15	–	2	–	–	–	–	10	20
40-45	1	–	–	–	11	2	2	1	–	–	–	–	–	–	3	–	6	9	2	10	1	–	–	–	26	22
35-40	1	–	–	–	4	3	–	–	1	–	–	–	–	–	–	–	–	2	1	1	–	–	–	–	7	6
Total	2	–	–	–	16	5	11	2	35	13	4	2	–		12	21	29	67	6	26	1	1	–	–	116	137
													INDIA													
30-35	1	–	3	3	3	2	2	3	–	2	–	–	–	–	–	–	1	1	–	2	–	–	1	2	11	15
25-30	2	1	3	4	–	1	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	2	4	10	10
20-25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	1	1
Total	3	1	6	7	3	3	2	3	–	2	–	–	–	–	1	–	2	1	1	2	1	–	3	7	22	26

TABLE 6

TIME LAPSE BETWEEN RINGING IN BHARATPUR AND RECOVERY OF RINGS IN THE U.S.S.R. 1965-1974

Sex	No. of recoveries	Recovered in the years 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13
M	190	116	34	21	9	5	1	3	0	1	0	0	0	0
F	258	137	65	29	17	7	1	1	0	1	0	0	0	0
U	25	12	7	5	1	0	0	0	0	0	0	0	0	0
Total	473	265	106	55	27	12	2	4	0	2	0	0	0	0
%		56.0	22.5	11.6	5.7	2.5	0.4	0.8	–	0.4	0	0	0	0
		TIME LAPSE BETWEEN RINGING IN BHRATPUR AND RECOVERY OF RINGS IN THE INDIAN SUBCONTINENT 1965-1974												
M	40	22	15	1	1	0	0	0	0	1	0	0	0	0
F	43	26	9	5	0	0	1	0	0	0	0	1	0	1
U	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Total	85	49	25	6	1	0	1	0	0	1	0	1	0	1
%		57.6	29.4	7.0	1.1	0	1.1	0	0	1.1	0	1.1	0	1.1

TABLE 2
NUMBER OF COMMON TEAL RINGED AND RECOVERED IN THE PERIOD 1965-74

Year	M	No. recovered	F	No. recovered	U.	No. recovered	Total	Total no. recovered	Percentage
1965	48	3	8	1	15	0	71	4	5.6
1966	320	36	71	6	173	14	564	56	9.9
1967	656	59	560	39	70	4	1286	102	7.9
1968	140	8	193	13	2	0	335	21	6.2
1969	410	31	619	29	56	5	1085	65	5.9
1970	356	22	791	37	7	1	1154	60	5.1
1971	764	32	1003	48	49	0	1816	80	4.4
1972	196	3	756	29	1	0	953	32	3.3
1973	856	38	2376	88	30	4	3262	130	3.9
1974	127	5	305	15	0	0	432	20	4.6
Total	3873	237	6682	305	403	28	10958	570	5.2

% of recovery male 6.1%, female 4.5%, unsexed 6.9%, total recoveries 5.2%
M = male, F = female, U = unsexed.

TABLE 3
MANNER OF RECOVERIES OF THE COMMON TEAL *Anas crecca* IN INDIA AND U.S.S.R.

Recovery details	Symbol[1]	India M	India F	India U	U.S.S.R. M	U.S.S.R. F	U.S.S.R. U	Total	% with the Total
1. Shot by man	+	35	36	–	182	228	25	506	88.7
2. Killed by predatory bird	+AC	–	–	–	1	–	–	1	0.1
3. Found dead	x	1	–	–	2	3	1	7	1.2
4. Found wounded	(x)	–	–	–	1	1	–	2	0.3
5. Caught, its further fate unknown	C?	–	3	1	–	1	–	5	0.8
6. Manner of recovery unknown[2]	?	4	4	1	11	29	–	49	8.5
Total		40	43	2	197	262	26	570	
Grant Total			85			485		570	

[1]The Moscow Bird Banding Bureau symbols are followed in this paper. [2]Unknown means the reporter has failed to inform the centres on how he obtained the ring. Sex ratio of birds shot in both the countries, 45.1 males: 54.8 females (1:1.2)
M = male, F = female, U = unsexed.

to the Bombay address.

All these recoveries were written on separate cards for classification.

In addition, we received eight recoveries from Iran and Afghanistan, and three MOSKWA rings were recovered in India. Details of these recoveries are shown in Appendix 2.

RESULTS

Computer analysis: Analysis was carried out on a main-frame computer DEC System-10 at National Centre for Software Technology, Tata Institute of Fundamental Research, Bombay, using the SPSS package. From the complete bird-banding data base holding data for about 200,000 birds, data relating to *Anas crecca* were extracted and analysed. Cross TABS procedure in SPSS was used to analyse monthwise banding history. A FORTRAN programme was written to produce a simple graphic display of banding schedules.

Bias in the results: There were striking differences between the number of rings recovered in the U.S.S.R. and the Indian subcontinent (Table 3). The chance of a ringed teal being recovered in the two countries depends upon many factors. Probably the first and crucial factor is that Russian duck hunters are well informed about ringing operations and are aware of the importance of rings being recovered.

They also know where to send details of ring recoveries. The Centre of Ringing and Marking of Birds in Moscow is responsible for collecting and disseminating information to duck hunters (Pokravsky 1963, Priklonsky and Sapetina 1981).

In India, on the contrary, the people are largely illiterate and unaware of the importance of recovered rings, probably keeping rings as mementos of their duck shooting days. Obtaining such rings from local hunters is a very difficult task, as in many instances the shooting may have been without a licence and therefore illegal. Other factors, such as religious taboos in certain communities, political and cultural constraints and delay in postal services, are all responsible for low recoveries. The Wildlife Protection Act (1972) no doubt, plays an important role in the non-recovery of the rings.

Although all these factors cannot be rectified immediately, we feel that a documentary film and other audiovisuals on ringing operations will no doubt enlighten people.

We selected this particular period, 1965 to 1974, not because we had continuous data for 10 years (Tables 1, 2), but on the assumption that the teals ringed during the period are now dead and no more rings would be recovered. The last ring recovered and reported from this period was in 1978 (Ambedkar 1980). We stopped our ringing activities at Bharatpur under this scheme in 1974.

The Society again started ringing at Bharatpur from 1980, under the project 'Studies on the Movement and Population Structure of Indian Avifauna', sponsored by the Ministry of Environment and Forests, Government of India and the US Fish and Wildlife Service. Unfortunately permission was denied to us to continue ringing by the Rajasthan Forest Department in 1982 as the area had been declared a National Park and this type of research where birds are handled was felt by the authorities to be harmful to the birds! We have not been able to convince them so far that millions of birds are handled and ringed all over the world without any deleterious effects.

Discarded data: In the analyses, the following recoveries have been excluded.

1. Those with incomplete ring numbers and omission of the key alphabet letter as reported by hunters
2. Eroded rings, where the alphabet and/or, ring number could not be deciphered correctly.
3. When year, month and day are wrongly reported (6 recoveries). In one case the recovery date was supplied as 29 February 1967.
4. When the same recoveries were reported again and again after a lapse of time (11 recoveries). Here only the first report was accepted unless a correction was made.
5. The ringing and recovery data of other field stations like Kabar Tal, Begusarai dist. (Bihar), Chilka Lake (Orissa), Calcutta (West Bengal) have not been incorporated here in order to keep the data homogenous for critical analysis.

Distribution and Present Status of Common Teal

The typical race *crecca* breeds throughout the Palearctic Region between April and June (Cramp and Simmons 1977, Dementiev *et al.* 1952). As regards the Indian subcontinent, Hume and Marshall (1881) wrote, "No record exists of the common teal breeding within our limits, but it breeds generally in suitably secluded spots in Europe and Asia throughout the temperate zone, north of the 40th degree N. latitude, and I should not be at all surprised if it bred with us in Kashmir just as the mallard[4] does. Not only there, but in a small lake not far from Hanle, I have known teal killed in June and July".

Ornithologists who surveyed the northernmost part of the subcontinent, Kashmir and Ladakh, during the past 80 years or so, did not obtain any breeding records of the teal. (Ward 1906, Ludlow 1920, spring and summer, Osmaston 1931, April to August, Bates and Lowther 1952, Holmes 1986).

Recent field work undertaken by the BNHS, in search of nests of the blacknecked crane *Grus nigricollis* also did not report any nesting activities of the teal in and around Hanle and Chushul (Hussain 1985).

Migration

General: Common and garganey teals *Anas querquedula* are the earliest migratory ducks, visiting the Indian subcontinent in early autumn (Ali and Ripley 1978). An examination of the literature suggests that the common teal is widely distributed from such far-flung areas as Manipur (eastern India) and Kutch (western India) (Appendix 1), and their

[4]Due to destruction of habitat, egg collection and shooting the mallard no longer breeds in the Kashmir Valley (Shah, G.M., Qadri, M.Y. *JBNHS* *85* (2): 325-331.

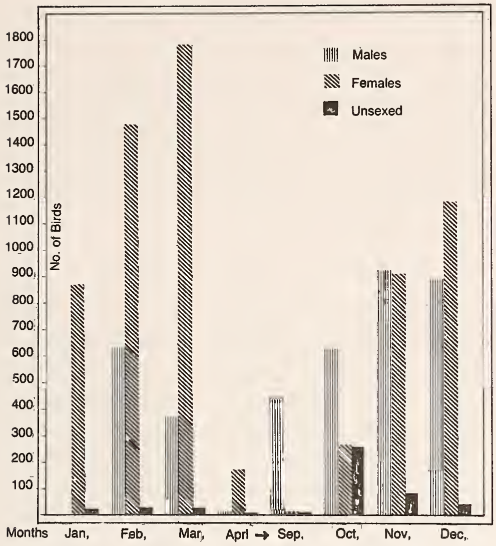

Fig. 1 Number of common teal ringed in Bharatpur, 1965-1974.

influx continues till November, with the birds spreading out widely in the country. They start arriving in Bharatpur in small flocks, reaching a maximum in October or early November when the first heavy flights have been noted (Fig. 1).

An interesting but complicated problem, as Baker (1908) rightly points is: "It is possible, indeed probable, that our eastern birds are those which come from China; and as they breed there as far south at least as the 40th degree latitude, they have not nearly so far to come as those which travel from the west, few of whom really come from further south than about the 50th degree." This suggests that we have birds from the northwest as well as the northeast intermingling in the subcontinent in winter. How far the teals from the northeast population penetrate into the territory and in what proportion they get mixed up in the subcontinent with the northwest population is difficult to answer at this stage.

During their stay in natural habitat like jheels, marshes and open water in the subcontinent, the common teal associates freely with pintail *Anas acuta*, shoveller *Anas clypeata* etc.

Shooting records (Cunningham 1927, Wright and Dewar 1925) suggest that the mallard *Anas platyrhynchos* was the commonest duck in India, the common teal stood second; while Ali and Vijayan (1983) state that "Among the migratory species, which came to Bharatpur, *Anas acuta* (19.0%) had the maximum number, followed by *Anas crecca* (13.3%)". The latter statement was also confirmed by the Asian Waterfowl Count.

Moult migration: The phenomenon of moult migration was apparently unknown to Indian ornithologists till the Bikaner Darbar's Secretary (1940) reported a flightless teal which was shot in Bikaner on 4 October 1940. He wrote, "The only feasible explanation is that it migrated and arrived at the end of August or early in September in the lake, and for some unnatural and extraordinary reason, moulted after arriving here. A lot of feathers on both wings are in a growing state and still bluish in colour and soft".

Commenting on this incident, Salim Ali (loc. cit., p. 445) wrote: "Till I caught several such flightless teals and shovellers for ringing on the Ghana jheel in Bharatpur last October (1939), I did not know that some of our migrant ducks underwent the complete post-nuptial or autumn moult after flying thousands of miles to their winter quarters on their old remiges (wing quills)". Some individuals among the ducks, however, seem to be in such a hurry to get back to their winter quarters (they often arrive as early as August or September) that they forsake their breeding grounds before the autumn moult has begun and go through this process at this end. Such birds, presumably, are yearlings that will not breed till the second season". Abdulali (1943) did not come across moulting ducks in Nasik district (Maharashtra) except one record of a moulting wigeon. It appears that the Bharatpur National Park is a moulting ground where the migratory teals get maximum protection from predation, sufficient food and water during this critical time of the life cycle.

We do not have any other special moulting places for ducks on record, but Prof. Stresemann, as quoted by Salomonsen (1968), observed a similar phenomenon from a secluded lake, at an altitude of about 4,500 m on the Tibet-Sikkim border, where dabbling ducks moulted their flight feathers after a migration of nearly 2,000 km. He further suggested that these ducks came from northern Siberia.

Ringing

Between 1965 and 1974 we ringed 10,958 teals: 3873 males, (35.3%), 6682 females (60.9%) and 403 unsexed (3.6%) (Table 2). We gathered data on the arrival and departure, general trend of migration, sex ratio, seasonal patterns (Fig. 1) and the recovery rate (Table 2). The preponderance of females over males was an interesting feature of the ringing operation. Biometric analysis of wings and weights will be dealt with elsewhere.

General pattern of arrival and departure: Grouping the ringing data monthwise in the season (Table 1), it suggests that by September the teals had started to arrive. However, the published records suggest that the teals start to visit the Indian subcontinent one week earlier, by the end of August, in far-flung areas like Manipur (eastern India) and Kutch (western India) (Appendix 1). In September we ringed 5 birds, 2 males, 1 female and 2 unsexed. The first heavy flight occurred in October when we ringed 1,159 teals. Out of these 635 (54.7%) were males. The female and unsexed or yearling birds were almost in equal number, 256 (22.0%) and 268 (23.1%) respectively. This suggests that males arrived in the Bharatpur area early in large numbers before females and unsexed teals arrive. October was probably the period where the teals after the migration, gathered in Bharatpur for moulting.

In November we ringed almost an equal number of males and females, 926 (48.4%) and 913 (47.7%) respectively, but fewer unsexed birds, 74 (3.8%) only. From December onwards the sex- ratio shifted toward the females; our catch was 852 (39.8%) males, 1,247 (58.3%) females, and only 38 (1.7%) unsexed birds. This suggests that two conditions were probably operating: (a) from mid December onwards, and after spending quite a number of days in Bharatpur, the males start migrating and spread out, even moving northwards[5] into Russian territory and (b) probably a large number of visiting females remain in the Park area for a longer period than the males.

This condition was seen clearly in January and February. January—415 males (32.4%) to 861 females (67.3%) and only 2 unsexed birds (0.1%). February—666 males (31.4%) against 1,447 females (68.2%) and 8 unsexed birds (0.3%).

From March onwards the return or outward migration started on a large scale and males left the area before the females, as in the inward migration. Our catch in March was 369 males (17.0%) to 1,788 females (82.4%) respectively. By April most of the males had left the area and in all only 8 males were ringed (4.5%) as against 169 females (95.4%). From May to August we did not observe or ring any teal in Bharatpur, as there were no ringing operations during this period.

[5]C–19008, M, 12-12-1971 Bharatpur
14-1-1972 Turkmen SSR near Serakhs
36°28'N, 61°12'E
+ Shot NW to Bharatpur

Number of Teals Recovered

Table 2 shows the number of teals ringed in each year, together with the number of recoveries and the percentage rate of recovery. From among the 10,958 teals we ringed we received recovery information on 570 birds, both from the Indian subcontinent and the U.S.S.R. The average recovery rate was 5.2%, with a maximum and minimum of 9.9% and 3.3% for the years 1966 and 1972 respectively.

The recovery rate of males was higher (6.1%) than of females (4.5%). Unsexed birds were recovered at the rate of 6.9% which is slightly higher than the recovery rate of males. There was no correlation between the number of birds ringed and the increase of ring recoveries in later years.

In 1966 we ringed 564 teals, with a recovery rate of 9.9% . In 1972, when 953 teals were ringed, the recovery rate was 3.3%.

The gradual fall of recovery rate from 9.9% in 1966 to 3.3% in 1972, in 7 years period is interesting. But again in 1973 the rate of recovery started to increase. It was 3.9%, and in 1974 it rose to 4.6%, when we stopped ringing. The trend of recoveries is incomprehensible at this stage and further research and continuous ringing is necessary to determine if there is any significance in these fluctuations.

Manner of Recoveries

The majority of letters received from people in India, Pakistan and Bangladesh, indicated that the ducks were shot. In some instances the recoveries were also made from birds found dead on the shore or caught in fishing nets. However, we did not receive information on the manner of recovery in all instances (Table 3).

The Bird Banding Bureau at Moscow clearly reported the manner of recovery using specific symbols for each category. Each recovery was reported on a separate printed sheet giving all the necessary

Table 4
MONTHLY DISTRIBUTION OF RECOVERIES OF COMMON TEAL *Anas crecca* IN U.S.S.R. 1965-1974

Month	Males No. of recoveries	%	Females No. of recoveries	%	Unsexed No. of recoveries	%	Total	%
January	2	1.0	1	0.3	–	–	3	0.6
February	4	2.1	–	–	–	–	4	0.8
March	18	9.4	6	2.3	5	20.0	29	6.1
April	14	7.3	3	1.1	–	–	17	3.5
May	58	30.5	24	9.3	2	8.0	84	17.7
June	6	3.1	4	1.5	–	–	10	2.1
July	–	–	3	1.1	–	–	3	0.6
August	19	10.0	35	13.5	3	12.0	57	12.0
September	46	24.2	125	48.4	11	44.0	182	38.4
October	19	10.0	52	20.1	4	16.0	75	15.8
November	2	1.0	4	1.5	–	–	6	1.2
December	2	1.0	1	0.3	–	–	3	0.6
Total	190		258		25		473	
*Spring	2		1		–		3	–
*Summer	–		–		–		–	–
*Autumn	4		3		1		8	–
*Winter	–		–		–		–	–
**No month	1		–		–		1	–
Grand Total	197		262		26		485	–

*These recoveries were reported with seasons, but without date and month. They are not included in further Tables 5 and 6.
**Reported as 0-0-1972
M = male, F = female, U = unsexed.

details of the recovery and this facilitated analysis.

The analysis of the 570 recoveries suggests that nearly 89% recoveries were made by duck hunters in both countries. 'Manner of recovery unknown' constituted the next largest group; nearly 8.5% belonged to this class. This means that the duck hunter had failed to inform the ringing centre of the manner in which he procured the ring. The statement 'Found dead' also belongs to this group, as suggested by Boyd (1957).

Analysis of Recoveries in U.S.S.R.

Monthly distribution of recoveries: During the period between 1965 and 1974, 485 ring recoveries were reported from the Russian territories (Table 4). All these were made east of 60° E longitude, suggesting that the teals had crossed the Himalayas during their migratory journey (Table 5, Fig. 2). Table 4 shows the monthly distribution of the recoveries in the Russian territory. We received precise information on the date, month and year of 473 recoveries. 11 recoveries were reported without date and month, though the seasons. e.g. spring, autumn etc., were mentioned. Only one recovery was reported as 0.0.1972.

The most interesting aspect of the monthly distribution is that the Russian duck hunters collected teals, with BNHS ring, each and every month of the year, suggesting that all the teals did not leave the Russian territory even in the harsh winter.

The maximum number of recoveries, 182 or 38.2% of the total, were reported in the month of September, and the minimum of 3 (0.6%) in December, January and July.

The sex-wise analysis of the recoveries suggests that the maximum number of males, 58 or 30.0% of the total number of male recoveries, was made in the month of May and the maximum number of females (125 or 48.4%) was reported in the month of September.

These two peaks, in May and September, suggest that the teals were on migration and were therefore available over a large area of the territory. Curiously the males seem to be more susceptible to being shot during the spring migration to the breeding area and the females during the autumn migra-

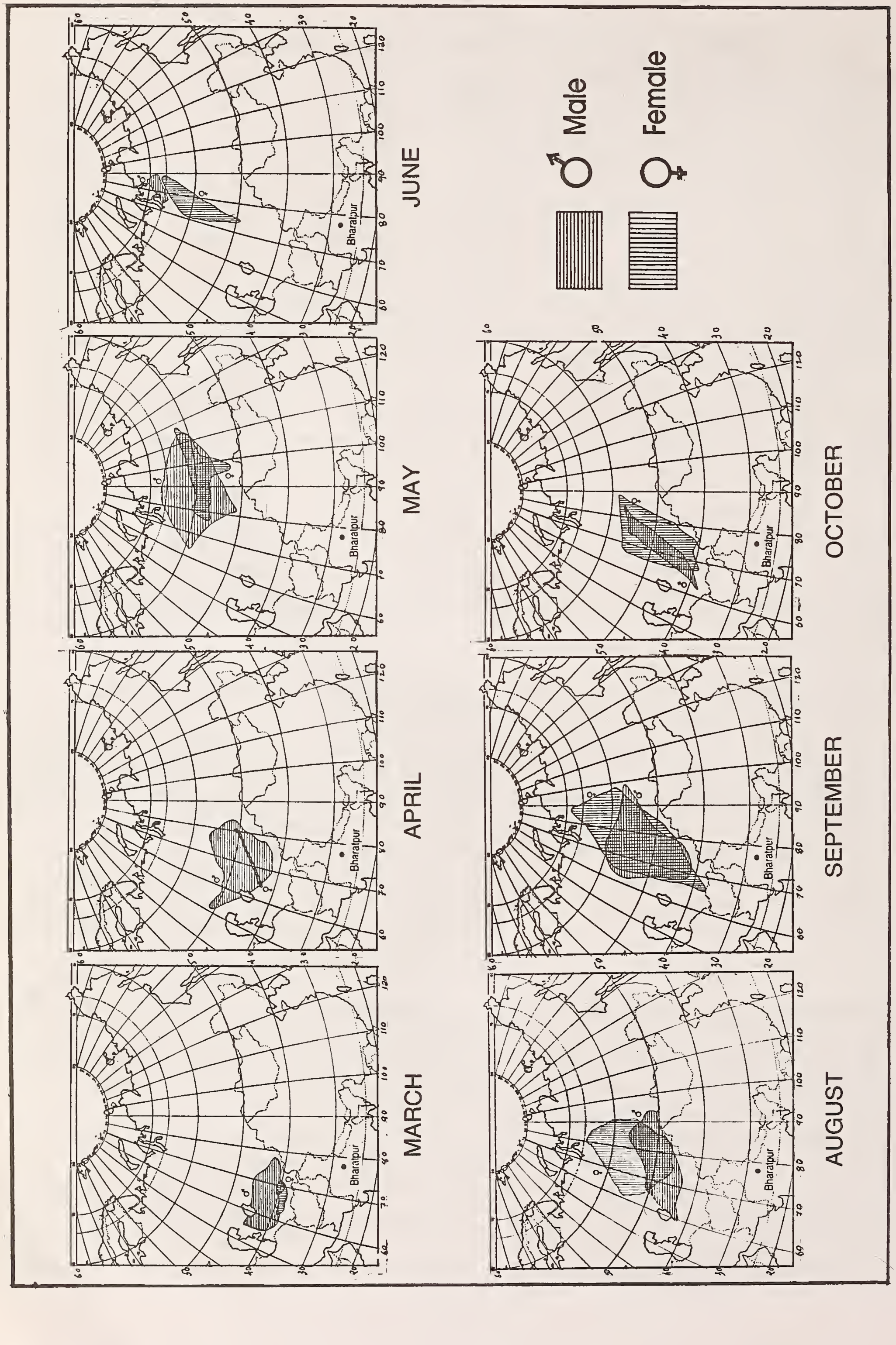

Fig. 3. Monthly recoveries of male and female common teal from the U.S.S.R., March-October.

tion to India. The reasons for this are not evident to us.

Migratory Movement in First Year of Ringing

All the recoveries except two, were reported between 36° 28' to 69° 20' N and 61° 22' to 148° 08'E (Fig. 2). This suggests that east of 60° E longitude or east of the Aral Sea, a salt lake, was the major area of ring recoveries of the common teal in the U.S.S.R.

Two unusual recoveries were reported from Kyzyl-Orda region near Ianykurgan (43° 55'N, 47° 05'E) and Uralsk region, near Uralsk (51° 17'N, 51° 23'E), west of the Aral Sea (Fig. 2).

Out of 473 recoveries (Table 6)reported by the Moscow Bird Banding Bureau we received 265 (56.0%) recoveries within the first year of ringing. These included 116 males, 137 females and 12 unsexed birds. Table 5 shows variation of monthly recoveries with latitude to determine the high latitude to which the teals travelled in a year, after ringing.

The data revealed interesting aspects of the migration and movement of the teals in U.S.S.R. One male (C-19008, see p. 410) was ringed on 12 December 1971 and shot on 14 January 1972 in Turkman SSR near Sarakha, 36°38'N. It appears that the bird travelled approximately 1700 km northwest of Bharatpur in 33 days, at an average speed of 55 km/day. The noteworthy feature of this recovery was that the bird, after crossing the NW Himalayan snow-covered ranges, migrated 12° N higher than the Bharatpur latitude. This was unexpected and contrary to the normal trend in the winter migration of species. Another example of the same kind is[6]

This male was also shot at a slightly higher latitude than C-19008 and was recovered after 66 days in the month of January in the Tashkent region.

These two examples indicate that the males were moving in the Russian territory in the month of January, in winter where the atmospheric temperature was below 0°C. As Cramp *et al.* (1977) do not include these two areas in the breeding range of the species, we believe that these two were examples of anomalous migration.

No female was recovered in January in Russia. Likewise, no ring recovery was reported in February in the first year of ringing. Apparently the females had not yet started their northward migration.

Except July, from March to November (Fig. 3) more recoveries were made at mid and high latitudes. In March (21 recoveries) recoveries of males outnumbered those of females, 16 to 5 (76.1:23.8). Only one male was reported between 45-50° latitude, while the females were lagging behind, as far as latitudinal migration was concerned. In April, the same situation prevailed. One male was shot further north between 55-60°, but no female had been shot yet. Only in June, for the first time, one female was shot between 65-70° latitudes. In this group also more males were shot than females namely 3 males against 1 female. One male was shot at the highest latitude and had travelled *c.* 4000 km from Bharatpur. This is the northernmost record in our data. The details of this recovery are as below:

C-3672, M, 5-11-1967 Bharatpur
14-6-1968 Krasnoyarsk region near Norilsk
69°20'N, 88°14'E.
(Time lapse 222 days, distance: (+ shot, *c.* 4000 km north of Bharatpur)

It is interesting that the females were shot at high latitude, beyond the Arctic Circle, in August and September, but no male was collected at these latitudes during these months. Presumably, the males had left this area before the females.

Table 5 suggests some interesting aspects of the progressive latitudinal migration amongst the sexes. The available data suggests that, as the season advanced and as the day length increased, the males were probably taking advantage of the longer day length during the northward migration. Being the vanguard, the males were recovered at higher latitude earlier than the females, as the summer solstice advanced in the northern hemisphere, i.e. March to June/July. Between 65-70° latitudes, 5 males against 3 females (62.5:37.5) were recovered, while at mid latitude the sex ratio varied in favour of females, in all 22 males against 46 females were recovered (32.3:67.6). The females were more common at mid latitude; they probably left the Indian subcontinent much later than the males to breed.

Apart from different sex ratios at various latitudes there might be another possible factor in-

[6]C–3643, M. 5-11-1967, Bharatpur
10-1-1968 Taskhent region, Chirchik River
40° 42'N, 69 °19'E + shot NNW to Bharatpur.

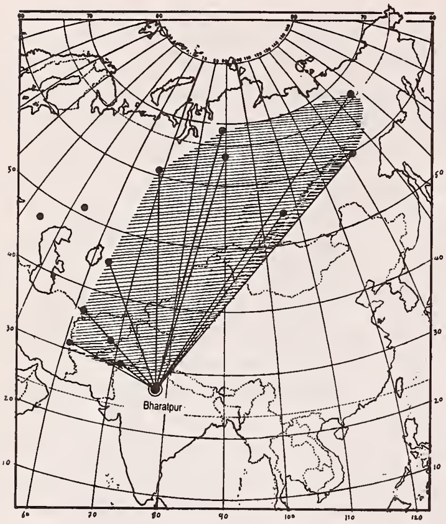

Fig. 2. General distributional areas of ringed common teal with their possible flyways.
Dots show locations of single recoveries

volved - that the Russian duck hunters' activities were enhanced due to warm and congenial weather for shooting. This may be a crucial factor in the recovery of rings.

This also suggests that the magnitude of the teals' migration and duck hunters' activities went on concurrently in nature, at various latitudes and at various times of the year.

Latitudinal distribution of the teals in India will be discussed later.

Flock Migration as Revealed by Recoveries

Do the members of a flock ringed at Bharatpur migrate together over the Russian territory? This was a question before us while analysing the ringing and recovery data, and the following three recoveries were interesting and suggestive from this point of view.

On 19 October 1966 we ringed 92 teals, including 58 males and 34 females and received the following three recoveries in March, the fourth month after the ringing.

1. C-2621, M. Ringed on 19-10-1966 Bharatpur; Recovered on 8-3-1967, Uzbek SSR near Samarkand 39°47'N, 66° 56'E. Time lapse 4 months 20 days + shot, NW of Bharatpur.

2. C-2661, M. 19-10-1966 Bharatpur; 9-3-1967, Tadjik SSR, Leninobad dist. near Proletarrsk 40°11'N, 69° 29'E; Time lapse 4 months 21 days + shot NW of Bharatpur

3. C-2652, M. 19-10-1966 Bharatpur; 10-3-1967, Fergana region near Kirovo; 40° 27'N, 70° 36'E; Time lapse 4 months 22 days + shot NW of Bharatpur

All 3 males were shot at an interval of one day only, and these recoveries allow us to make the following comments.

It appears that the males, in winter, gathered together in unisexual flocks spending all the time in feeding, resting and moving together. As summer commenced and the migration urge developed, the vanguard of males started to move together and crossed the Himalayas through NW Frontier area of the subcontinent (Figs. 4, 5). The present study did not show any female group or family group formations, as far as our ring recoveries are concerned.

Time Lapse Between Ringing and Recovery

The data on recoveries makes it possible to study the distribution of recoveries, particularly of those rings recovered between 0-1 year. It is possible to identify the flyways of migration between the Indian subcontinent and U.S.S.R. The minimum time taken to fly to the nearest location from Bharatpur, general distribution in Central Asia and the Siberian plain, and the longevity record.

We reckon the days and year from the date of ringing to the date of recovery of the ring at a particular spot. By tabulating many facts emerge. All the recoveries are set out in Table 6.

Of the 473 recoveries, 265 (56%) were reported within the first year of ringing, and there were drastic falls in numbers in the successive years.

Flyways of the migration: As mentioned earlier the Ring C-19008 was recovered in Turkmen SSR and the Ring C-3643 was reported from Tashkent region, in January. These two recoveries suggest the possible early entry route of the first migrants into U.S.S.R. These two places are situated NW and NNW of Bharatpur. However, the nearest recovery point was noted in March.

C-1580, M, 12-10-1966 Bharatpur
19-3-1967, Tadjik SSR, near Dushanbe
38° 35'N, 68° 47'E
(Time lapse 5 months 8 days, + shot)

Dushanbe is approximately 1200 km NNW of Bharatpur

TABLE 7
MONTHLY DISTRIBUTION OF RECOVERIES IN INDIA 1965-1974

Monthly distribution	Males No. of recoveries	%	Females No. of recoveries	%	Unsexed No. of recoveries	Total	%
January	6	15.3	6	13.9	0	12	14.2
February	8	20.5	10	23.2	0	18	21.4
March	8	20.5	6	13.9	1	15	17.8
April	5	12.8	4	9.3	0	9	10.7
May	0	0	2	4.6	0	2	2.3
June	0	0	0	0	0	0	0.0
July	0	0	1	2.3	0	1	1.1
August	1	2.5	0	0	0	1	1.1
September	3	7.6	2	4.6	0	5	5.9
October	1	2.5	3	6.9	0	4	4.7
November	3	7.6	1	2.3	0	4	4.7
December	4	10.2	8	18.6	1	13	15.4
	39		43		2	84	
without date	1		0		0	1	
Total	40		43		2	85	

The northern most recovery was of C-3672 (p.413). The bird was shot in June near Norilsk 69° 20' N, 88°14'E, approximately 4000 km north of Bharatpur. However, most of the other recoveries were reported from Central Asia and the Siberian plains (Fig. 2).

The easternmost recovery was reported from Yakut SSR from the basin of Indagirka River, approximately 6000 km NNE of Bharatpur.

C-16263, M, 2-2-1971 Bharatpur
23-5-1974, Yakutian SSR
Momskii dist., near Khonyy
66° 28' N, 148° 08'E
(Time lapse 3 years 3 months 21 days, + shot)
NNE of Bharatpur

Longevity record: Maximum longevity record (Table 6) of the teal from U.S.S.R. was as follows:

C-8297, M, 31-10-1969 Bharatpur
21-2-1978 Tijumen, mouth of Nadym River, 66°10' N, 72° 00'E.
NW of Bharatpur
(Time lapse 8 years 9 months 26 days, +shot)

RECOVERIES IN THE INDIAN SUBCONTINENT

All the recoveries, in the Indian subcontinent are tabulated in Tables 5,6,7. As the available data is comparatively limited we give an overview.

85 recoveries were reported, 40 males, 43 females and 2 unsexed birds. One recovery of a male was reported without date and month in 1974.

MOVEMENT IN THE FIRST YEAR OF RINGING

Table 5 shows the distribution of 48 recoveries of both sexes within the first year of ringing. These recoveries are arranged by 5° squares of latitude against each month to determine the latitudinal movements of the teals within the Indian subcontinent.

We received an interesting recovery of a ring in December, which showed northward movement of a male in winter, as similarly recorded previously (p. 410, 413). Details are as follows:

C-1558, M, 11-10-1966 Bharatpur
2-12-1966 Sialkot, Pakistan
32° 31' N, 74° 36'E
(Time lapse 52 days, distance 630 km NW of Bharatpur, + shot)

The male ringed in October moving north in December, i.e. north by west is an unusual movement. This confirms the earlier two records (p. 410, 413). But the movement shown by a female was quite different even though both were ringed in the same month and the year. For example

C-2685, F, 20-10-1966 Bharatpur
5-12-1966, Kushtia, Bangladesh
23°55'N, 89°10'E

(Time lapse 46 days, distance 1250 km ESE of Bharatpur, + shot)

The female travelled approximately 27 km/day, probably along the river Ganges, up to Bangladesh (Fig. 5). Interestingly, the female was moving east, the latitude being 23°55'N.

These two examples suggest that both sexes had different types of migratory movements in the subcontinent in winter.

Monthly distribution: It was significant that, as in the U.S.S.R., the teals were collected in every month of the year, except June (Table 7). It was possible that duck hunters did not observe the teals which were fewer in numbers, and hence were not collected in June. It appears that the teals were available throughout the year in the subcontinent even in the breeding season. This is an excellent opportunity for the field biologist to look out for the nests in the northern part of the country, like Kashmir and Ladakh as suggested by Hume and Marshall (1881).

The maximum number of recoveries were reported during winter, December to March, when the teals were moving in India. February was the most productive month, where the yield was as high as 21.1% of the total recoveries. The majority of the reports received by us were from NW areas of Pakistan, namely Peshawar, Chitral, Kurram Valley and Swat Valley[7]. As compared with the Moscow data, our yield was extremely low, and this was probably due to lack of knowledge of the importance of ring recoveries, and possibly reflects the communication failure of the ringing programme.

Longevity record: Ambedkar (1980) reported (Table 6) the longest survival record of the female teal as 12 years, one month and 13 days. This female was shot near Lahore, Pakistan.

Nepal and Sikkim

Though Nepal (Inskipp 1985) and Sikkim (Ali 1962) have been thoroughly worked out from the ornithological point of view, yet we have not received a single ring recovery of *A. crecca* or any other migratory species from these parts of the subcontinent. This is a clear lacuna in our knowledge which must be rectified by field ornithologists (Figs. 4,5).

Discussion

The discussion is based on ringing recovery data and as such there are limitations in the interpretation. Moreover, the results of our study raise more problems which are, at this stage of our knowledge, unanswerable.

Trans-Himalayan Migration: Whether the lofty Himalayas hinder the migratory to and fro movements of birds between Central Asia and the Indian subcontinent and whether they fly over the Himalayan ranges are questions that have been discussed by various ornithologists (Ali 1981, Donald 1917, 1923, 1952, Swan 1961, Inskipp 1985). Hunza[8] and Gilgit (Karakoram range, Pakistan) have the highest concentration of mountains in the world with 82 peaks over 7000 m. While migrating through such high altitude areas, birds have to face many formidable difficulties such as poor visibility, low temperature, decreased oxygen pressure, blizzards, sudden weather changes and change in direction of airflow at various heights. In India at Dehra Dun, the birds were observed at an altitude of 8830 m through a telescope while observing the solar eclipse (Harrisson 1931), and from west Africa, Laybourne (1974) reported an incident where a vulture (*Gyps rueppellii*) collided with an aircraft at 11,277 m.

However, the migratory journey between Central Asia and India is quite hazardous to birds, as evidenced by the finding of dead common teal at an altitude of 3352 m in Solang Valley, Manali, in Himachal Pradesh in the middle of May (Khacher, 1978). Ring recoveries in the NWFP of Pakistan and particularly in Hunza and Gilgit area and Hindu Kush range (Afghanistan) during the outward migration of the common teal suggest that most teals pass through valleys like Kaghan, Kurram etc. before entering the USSR. We received supporting evidence, while analysing the data, where early recoveries were reported from Dushanbe (38°50'N, 69°20'E) and Serakhs (36°28'N, 61°12'E) in USSR (Figs 2,3). These mountainous areas possibly are bottlenecks where the migrant flyways are narrow, resulting in dense flock formation. This is probably one reason why we were getting more ring recoveries from this area. Since there is no ring

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[7] C-4975, F, 1-1-1968, Bharatpur
14-3-1968, Swat State, Pakistan
35° N, 72°06' E
(Time lapse 2 months, 13 days, + shot.

[8] The name Hunza is derived from the Snskrit 'Hansa marg', meaning 'path of the geese' (*JBNHS 50*:435

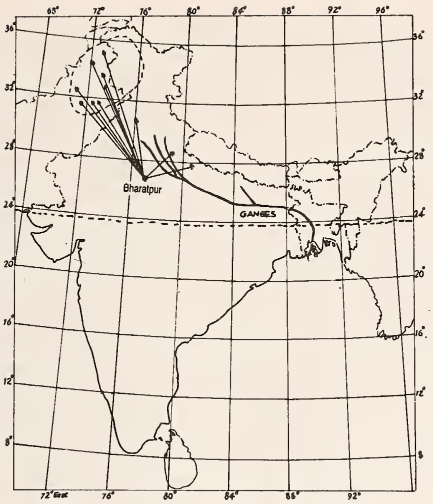

Fig.4. First winter movement of male common teal in the Indian subcontinent

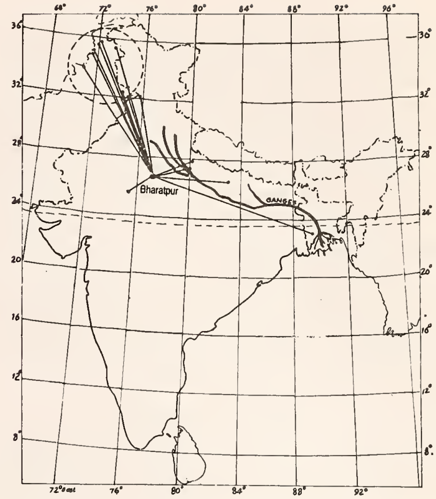

Fig. 5. First winter movement of female common teal in the Indian subcontinent

recovery from Nepal and Sikkim, it appears that the NWFP of Pakistan is probably the nearest fly way for the entry to the Russian territory before spreading out in the Ob, Yenisey and Lena River basins in the Siberian part of USSR.

Moult Migration

Keoladeo Ghana National Park was established by the Maharajas of Bharatpur in 1890. Ever since it has had a reputation of being among the best duck wintering grounds in the Indian subcontinent, though many other wetlands are available, in the Indo-Gangetic plain. Why migratory birds, including the common teal concentrate at Bharatpur in such large numbers in winter will possibly be known when the report of the present ecological research is completed. It is possible that the National Park is a winter moulting ground for the common teal, as suggested by our ringing programme.

Our catch of unsexed and moulting teals in the month of October was 23.1% of the total (Table 1). This suggests that nearly one-forth of the October catch moulted as soon as they arrived from the Central Asian and Siberian parts of the USSR. The advantage of protection, sufficient food and water was perhaps the reason for completing the process within the shortest possible time.

It appears that the strategy for selection of the moulting ground is probably of recent origin. We have to look for similar places in the Indo- Gangetic plain as well as at higher Himalayan lakes as suggested by Salomonsen (1968). It is noteworthy that no moulting ground is reported or located in the southern part of India (Abdulali 1943).

Sex Ratio

The data gathered between 1965 and 1974 have given us an opportunity to study the problem of sex ratios in the common teal. There are two principal sources of information in the present study.

Ringing records: The very comprehensive ringing records kept by the BNHS between 1965 and 1974 are summarized in Table 1. During this period we caught and ringed 3873 males and 6682 females (1:1.7), an unbalanced sex ratio. The question arises as to whether the method of trapping employed by the local bird trappers was selective for a particular sex or not. Since the trapping operation was performed randomly at night there was no possibility of catching more females than males.

Diversity in Sex Migration: Table 1 summarizes the results of monthly catch of the common teal which shows the differential sex migration. The early influx of males into the subcontinent is clearly reflected in the monthly catch: 54.7% and 48.6% males in October and November respectively. The females visited the National Park much later in large numbers. However, we need to know whether or not there is any geographic variation in the sex ratio. Considering that all the teals do not leave the Russian territory even in winter (Table 4) we lack exact knowledge of migration and movements of sexes.

Hunters' reports: Table 3 summarizes the results of the manner of recoveries and suggests that shooting was the main sources of recoveries of the rings in both countries. Nearly 89% of the rings were recovered by shooting.

A comparison between the two methods, catching and shooting, shows that both methods gave similar sex ratios, 1:1.7 and 1:1.2 respectively in favour of females (Tables 1,3)

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APPENDIX 1

EARLY ARRIVAL DATES OF COMMON TEAL IN THE SUBCONTINENT PUBLISHED IN *JBNHS*, VOLS. 1-82 (1886-1985)

Dates	Locality	References
21-8-1932	Manipur, East India	Higgins, J.C. Vol. 36: 594
22-8-1898	Northern India and Assam	Baker, E.C. Stuart, Vol. 12:251
22-8-1924	Manipur	Higgins, J.C. Vol. 36: 593
27-8-1915	Manipur	–do–
27-8-1927	Manipur	–do–
28-8-1943	Kutch, Gujarat	Ali, Salim, Vol. 52: 390
31-8-19 (?)	Makran coast (Pakistan)	Ticehurst, C.B. Vol. 32:94
9-9-1906	Kohat and the Kurram Valley (Pakistan)	Whitehead, C.H.T. Vol. 20:978
19-9-19(?)	Mhow, Madhya Pradesh	Briggs, F.S. Vol. 35: 404
8-10-19(?)	Madura, dist., Tamil Nadu	Nichols, E.G. Vol. 45: 131

LATE DEPARTURE DATES OF COMMON TEAL FROM THE SUBCONTINENT

Dates	Locality	References
24-3-1916	Ambala dist., Haryana	Whistler, H. Vol. 26:191
21-4-1929	Manipur	Higgins, J.C. Vol. 36:594
2-5-1917	Agar, Malwa, Madhya Pradesh	Colvin, E.J.D. Vol. 25: 301
9-5-19 (?)	British Baluchistan (Pakistan)	Ticehurst, C.B. Vol. 22: 94
14-5-1975	Solang Valley, Manali (3352-metre) 11,000 ft. (Himachal Pradesh)	Khacher, L. Vol. 73:391
15-5-19(?)	Tinnevelly dist., Tamil Nadu	Nichols, E.G. Vol. 45:131
9-7-19(?)	Pubjab Salt Range (Pakistan)	Waite, H.W. Vol. 48: 116

APPENDIX 2

Ring No.	Details of ringing	Details of recovery	Reported by
		MOSKWA RINGS	
E-555512	M 29-7-1959, Kurgaldzhin lake Tzelinograd region,Kazakh SSR, 50°30'N; 69°35'E	+ 0-11-1963, 20 miles S. of Lahore, Pakistan 31°37' N; 74°26'E	C.D.W. Savage JBNHS Vol. 62: 307
E-556085	M 17-7-1959, Kurgaldzhin lake 150 km Sw from Akmolinsk Kazakh SSR *c*. 50°30'N; 69°35'E	+ 30-12-1959, Bandha lake 38 miles west of Pratapgarh, Uttar Pradesh 25°34'N; 81°59'E	S.I. Moosa Qasim *JBNHS* Vol. 57: 223
E-706740	F 30-7-1967, Chany Lake Baraba dist. Novosibirsk USSR 55°06'N; 78°00'E	? 0-11-1967, Near Shekhupura, Pakistan 31°30'N, 74°00'E	C.D.W. Savage Unpublished *
		BOMBAY RINGS	
C-4051	M 11-11-1967, Bharatpur 27°15'N; 77°30'E	+ 0.12.1970, 5 km from the town of Zabul, Iran 31°00'N; 61°32'E	Abdul Hassan Fetemi Unpublished *
C-5005	F 7-1-1968, Bharatpur	+ 16-3-1970, Kabul, Afghanistan 34°30'N; 69°13'E	Fracesoii Naurille *JBNHS*, Vol. 68:254
C-9469	F 12-12-1969, Bharatpur	+ 17-3-1970, 5 miles east of Kabul 34°53'N; 69°2'E	Dr K.M. Price *JBNHS* Vol. 68:256
C-18082	M 11-11-1971, Bharatpur	+ 25-12-1976, Changdraz, Zabul, Iran 30°30'N; 62°10'E	Dept. of Environment Tehran, Iran Unpublished *
C-18615	M 28-11-1971, Bharatpur	+ 18-9-1972, Rouback, Near Zabul, Seistan, Iran 31°00'N; 61°30'E	Dr. D.A. Scott Unpublished *
C-22193	M 2-3-1973, Bharatpur	+ 0-6-1973, Nawgahar Province, S.E. Afghanistan	Mohd. Mujadedi Unpublished *
C-26005	F 28-11-1973, Bharatpur	? 5-12-1974, Gomishan Mazandaran, Iran 37°05'N; 54°06'E.	Mohammed Khorzani Unpublished *
C-29754	F 24-1-1974, Bharatpur	? 1-2-1975, Bandah Shah Gorgan, Iran 36° 56'N; 54° 06'E	Dept. of Environment Tehran, Iran Unpublished *

* Unpublished data extracted from BNHS recovery files.

ECOLOGICAL AND MORPHOLOGICAL NOTES ON *PIPER* SPP. FROM THE SILENT VALLEY FORESTS, KERALA[1]

P.N. RAVINDRAN, R. ASOKAN NAIR, K. NIRMAL BABU, K. CHANDRAN AND M.K. NAIR[2]

(With a text-figure)

The *Piper* spp. occurring in the tropical evergreen forests of the Silent Valley have been studied. Seven species of *Piper* were found distributed in this forest. Two new taxa of Piper (*P. silentvalleyensis* Ravindran, Nair, and Asokan Nair; and *P. nigrum* var. *hirtellosum* Asokan and Ravindran) were also recorded during the study. Ecological and morphological notes on the species are given.

The Silent Valley forests located in the Palghat district of Kerala comprise an area of 8900 ha of mostly undisturbed ever-green tropical rainforests which contain unique flora and fauna. This paper represents the results of the survey and study on the *Piper* spp. of the Silent Valley.

The genus *Piper* is the largest in the family Piperaceae consisting of over 3000 reported binomials (INDEX KEWENSIS (1895-1970), the members of which are largely tropical and pantropical in distribution. The most important species is *P. nigrum* L., the black pepper of commerce. Other important species are *P. betle*, the betel leaf, *P. longum*, the long pepper, *P. cubeba*, the tailed pepper and *P. methysticum*, which is used in indigenous medicine. Two independent centres of distribution are recognised for the genus *Piper* in the Indian subcontinent – the trans-Gangetic region and the South Deccan region (Hooker 1886). Of more than 100 species reported from the Indian subcontinent, nearly 26 are from the Western Ghats of south India which is also believed to be the centre of origin of *Piper nigrum*.

DISTRIBUTION

Piper spp. are found distributed extensively in the evergreen, semi-evergreen and moist-deciduous forests of Kerala, Tamil Nadu and Karnataka, and in the northeastern regions of India. *Piper* grows from almost sea level to an altitude of about 2000 m. Some species like *P. schemidtii*, *P. mullesua* etc. occur only at high elevations, while others like *P. longum* prefer valleys and plains. *Piper* spp. thrive best in sholas where the soil is loose, moist and rich in humus. They grow as undergrowth and spread on the ground or climb up on shrubs and trees, some species reaching to a height of 20-25 m. In the Silent Valley forests the distribution of *Piper* spp. is denser along the footpaths, animal tracks, rivulets etc., where there is better light penetration. In the disturbed forest areas they are found to grow even in the interior of the forests in relatively high numbers because of the increased light penetration. Though *Piper* vines were not observed on trees which shed bark, no particular tree preferences were noted. They were also often found growing over rocks, tree stumps and also as runners on the ground.

The elevation of the Silent Valley forests range from 1000-2400 m. Within the forest, the distribution of *Piper* spp. varied in terms of their frequency of occurrence. *Piper nigrum* is the most widely distributed, occurring throughout the forest. This is followed by *P. attenuatum*, *P. hymenophyllum*, *P. argyrophyllum* and *P. trichostachyon*. *P. mullesua* occurs in certain isolated pockets. *P. silentvalleyensis* (Ravindran *et al.* 1987) is the rarest, and was collected only from a single spot in the forest. *P. longum*, which is very common in the plains and at lower elevations, and the related species *P. hapnium* do not occur in Silent Valley. So also *P. schemidtii* and *P. wightii*, common in the sholas of higher elevations (over 2000 m), are absent in the Silent Valley.

POPULATION STRUCTURE

The population structure of any species is determined mainly by the breeding system of the species, the mechanism of pollen, fruit and seed dispersal and presence or absence of isolation mechanisms. In the genus *Piper* male, female and hermaphrodite vines exist. The cultivated types of *P. nigrum* are hermaphrodite (monoecious); while the wild species including wild *P. nigrum* are dioecious. Human selection might have played a major role in the directional evolution of hermaphroditism

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Fig. 1. Schematic representation of *Piper* population along a footpath in the forest.
A. One bisexual vine giving rise to clonal progenies (open circles), seedling progenies (closed circles), back cross and sib-cross progenies (crossed circles). B. Two parent vines of same or related taxa growing side by side (or climbing up the same tree). The population developing around consists of clonal progenies of both parents; their seedling progenies; hybrid (F_1) from chance crossings between the two parents, their clonal progenies, seedling progenies and chance back cross and sib-cross progenies. C. A clonal population developing from a male vine. D. A population developing from a female vine consisting of clonally developed vines and seedling progenies consisting of male and female vines. This population can in due course gives rise to sib- cross progenies.

in the present day cultivated types. They are naturally self pollinated which is aided by rain or dew drops and also by the gravitational descending of pollen grains (geitenogamy). The flowers are protogynous, but in the absence of any active pollen transfer mechanism protogyny becomes ineffective in enhancing crossing.

Active and efficient pollen and seed dispersal mechanisms ensure gene flow within and between populational segments leading to the establishment of intergrading populations. The absence of any such mechanism in *Piper* thereby establishes effective isolation barriers between individuals and between population units. Within such units variations then could depend upon segregation in the seedling progenies, accumulation of mutations and chance crossing followed by segregation. Any such variation arising in the population would get immediately fixed as a result of the prevailing vegetative mode of propagation, and such a unit may get gradually diverged from other similar units. In *P. nigrum* it was noted that dioecy occasionally breaks down leading to the production of hermaphrodite flowers. Such a hermaphrodite vine climbing on a tree gradually spreads out by means of runners which climb on nearby trees which become separated from the mother vines in due course (apparently because the runners get covered up by humus and soil, gradually leading to their degeneration). Simultaneously the seeds germinate around the mother vine which also grow and climb up the surrounding trees. Thus gradually from a single vine a small population develops, consisting of the mother vine, its clonally developed vines, sexual progenies, the second generation progenies of the above vines, and their clonally developed vines etc. (Fig. 1).

When more than one vine (of different types, species etc.) climbs up a single tree chances of out crossing increase, resulting in hybrid seedlings. They grow, later climbing up the same or nearby trees and chance out crossing with the parental vine or its clonal or other seedling progenies resulting in further back cross and hybrid progenies, thus leading to considerable variability within the population. These forces acting together might have contributed to the evolution of many cultivars in due course.

When only male or female vines alone are present initially, the population developing out of it can be either a population of the vines of the same sex (clonal population of male vines) or a population of both sexes if the vine is female. This population consists of the mother vine, its clonally propagated female vines, its seedling progenies consisting of both male and female vines, and their intercrossed progenies etc. (Fig.1).

Thus in the absence of free gene flow such populational segments will remain discrete and isolated from similar populational segments in the neighbourhood. Variations in such populational segments occur mainly by: (i) recombination and segregation, (ii) chance crossing followed by segregation, (iii) variations due to chance mutations which will remain fixed as a result of the vegetative reproduction and (iv) isolation of discrete populational segments and the subsequent divergence of such units.

Quite often good seed setting was noted in many isolated vines of *P. attenuatum*, *P. argyrophyllum*, *P. hymenophyllum* etc. The absence of any pollen parent in the vicinity of such vines makes one to think of apomixis as the cause of such high seed setting. This needs further investigation.

Morphological Notes

The species of *Piper* are profusely branching shrubs, which in most cases climb up with the roots produced at the nodes. A few like *Piper longum* L. are scandent with diffused branches, while certain other species are erect shrubs.

The shoot system in *Piper* consists of the orthotropic vegetative climbing shoot and the plagiotropic fruiting branches which are developed from the axillary buds. Both the shoots bear alternate leaves but orthotropic shoots alone produce roots at nodes normally. After the growth of a single node length, the terminal bud of the fruiting branch develops into a spike. Then the axillary bud takes over further growth and occupy terminal position, pushing aside the spike so as to become leaf opposed. This pattern of growth continues. The mode of branching does not generally vary among the species. Pepper plants have an adventitious root system with extensive mass of surface feeding roots.

During our surveys of the Silent Valley Forests we came across six already reported species of *Piper* namely *Piper argyrophyllum* Miq., *P. attenuatum* Buch.-Ham. ex Miq., *P. hymenophyllum* Miq., *P. mullesua* Buch.-Ham. ex D. Don (*P. brachystachyum* Wall. ex Hook. f.), *P. nigrum* L. and *P. trichostachyon* DC., *P. silentvalleyensis* (Ravindran, Nair and Asokan Nair) and *P. nigrum* var. *hirtellosum* Asokan and Ravindran are the new taxa identified during the present study. All the species except *P. silentvalleyensis* were dioecious.

Apart from the overall similarity in the mode of branching, *Piper* species show extensive variation in their leaves, flowering habit and fruiting spikes (Tables 1-3).

Leaves vary much from species to species in length, breadth, nature and texture. They are ovate-elliptic in *P. argyrophyllum*, *P. attenuatum*, *P. hymenophyllum* and *P. nigrum* and are more or less elliptic-lanceolate in *P. mullesua*, *P. trichostachyon* and *P. silentvalleyensis*. Leaf base and leaf tip are also quite variable. Of all the species collected, *P. nigrum* has the largest leaves and *P. silentvalleyensis* and *P. mullesua* have the smallest. *P. hymenophyllum* has hairy leaves, petioles and branchlets. Except for *P. argyrophyllum* having sparse hairiness beneath the leaves, all others have glabrous leaves and petioles. In *P. mullesua* the or-

TABLE 1
VEGETATIVE CHARACTERISTICS OF THE SPECIES OF *Piper*

Name of the species	Habit	Leaf						
		Length (cm)	Breadth (cm)	Shape	Base	Tip	Texture	Nature
P. argyrophyllum	Shrubby climber	8.2-17	3.5-8.2	elliptic-ovate	rounded or cordate	acuminate	glabrous or sparsely hairy	membranous or slightly chartaceous
P. attenuatum	-do-	7.9-17.3	3.1-7.2	elliptic to ovate	acute/rounded or slightly cordate	acuminate	quite glabrous	membranous
P. hymenophyllum	-do-	7.0-10.5	3.1-5.3	elliptic or ovate	acute or rounded	acuminate	puberulous or hirsute	membranous or slightly chartaceous
P. mullesua	-do-	6.6-11.1	2.2-6.1	elliptic lanceolate	acute or oblique	caudate – acuminate	glabrous	slightly coriaceous
P. nigrum	stout woody climber	8.0-21.3	2.8-11.0	ovate-elliptic to cordate	round or acute	acuminate	glabrous	coriaceous
P. trichostachyon	-do-	12.5-20	7.0-10.5	elliptic-lanceolate	obtuse or acute	acuminate	glabrous	coriaceous and margin recurved
P. silentvalleyensis	shrubby climber	5.0-8.5	2.0-3.5	-do-	acute	caudate – acuminate	glabrous	slightly coriaceous

TABLE 2
SPIKE (FEMALE) CHARACTERISTICS OF THE SPECIES OF *Piper*

Name of the species	Length (cm)	Nature	Shape/ form	Texture	Nature of bracts	Shape of developing ovary	Diameter of ripe drupe (cm)	Taste	Colour change in ripe fruit
P. argyrophyllum	5.5-16.0	pendulous	filiform	glabrous or slightly puberulous	sessile and adnate to the rachis	ovate	0.45	bitter	green to black
P. attenuatum	7.1-15.2	Pendulous	-do-	glabrous	-do-	oblong	0.4	-do-	-do-
P. hymenophyllum	5.2-12.8	pendulous	-do-	-do-	-do-	-do-	0.4	-do-	-do-
P. mullesua	1.0-1.5	erect	oblong and stout	-do-	pillate-stalked and orbicular	ellipsoidal and orbicular	0.2	pungent	-do-
P. nigrum	6.3-11.5	pendulous	filiform	-do-	cupular with decurrent base	spherical	0.7	-do-	green to orange then to red
P. trichostachyon	4.6-8.2	-do-	-do-	hirtellous	transformed to a fleshy cup decurrent	obovate	1.0	-do-	green to deep yellow
P. silentvalleyensis (bisexual)	2.5-5.5	erect	short filiform	glabrous	peltate, stalked and orbicular	obovate with striations	0.1	-do-	green to black

TABLE 3
SPIKE (MALE) CHARACTERISTICS OF THE SPECIES OF *Piper*

Species	Length	Nature	Shape/form	Texture	No. of stamens	Nature of bracts
P. argyrophyllum	8.0-14.8	Pendulous	slender and filiform	glabrous or slightly puberulous	3 or rarely 4	sessile and adnate to the rachis
P. attenuatum	8.2-17.5	pendulous	filiform	glabrous	3	-do-
P. hymenophyllum	7.5-16.5	-do-	-do-	hirsute	3	-do-
P. mullesua	3.0-4.6	ascending	very slender and filiform	glabrous	2	peltate orbicular and stalked
P. nigrum	7.1-15.2	pendulous	filiform	glabrous	2	decurrent, with the upper portion flat
P. trichostachyon	4.8-9.5	pendulous	-do-	hirtellous	2	decurrent, transformed into a fleshy cup
P. silentvalleyensis sp. nov.	(bisexual form)	–	–	–	2	–

thotropic shoot, especially the juvenile ones are hirsute. The leaves are membranous in *P. attenuatum* or slightly chartaceous in *P. argyrophyllum* and *P. hymenophyllum* somewhat coriaceous in *P. mullesua* and *P. silentvalleyensis* and coriaceous and thick in *P. nigrum* and *P. trichostachyon.*

The inflorescence is characteristically a spike with unisexual flowers except in *P. silentvalleyensis* which has bisexual flowers. The flowers are very small achlamydeous, represented by either stamens or carpels only, and are subtended by bracts of varying nature. The shape, nature, texture and orientation of spikes, number of stamens and nature of bracts etc. are important in taxonomic discretion. Among our collections *P. mullesua* has the shortest spike (female spike measures about 1.0-1.5 cm in length) whereas *P. attenuatum* has the longest spike (male spike measures up to 17.5 cm). Bracts are sessile and adnate to the rachis with free membranous margins in *P. argyrophyllum*, *P. attenuatum* and *P. hymenophyllum*, the upper portion cupular with decurrent tail in *P. nigrum*, much swollen forming a cup-like receptacle in *P. mullesua.* The outer surface of the bracts is glabrous in all except in *P. trichostachyon* where it is hirtellous. Spikes are pendent in all the species except in *P. mullesua* and *P. silentvalleyensis.*

The number and size of stamens in each flower also vary among the species. In *P. argyrophyllum*, *P. attenuatum* and *P. hymenophyllum* there are three stamens, sometimes four, whereas in others there are only two. The stamen has dithecous anthers in all the species.

The female flower is represented by a single unilocular ovary. Stigma 3-5 lobed and minutely papillate. Style absent. The developing ovary is ovate-oblong in *P. argyrophyllum*, *P. attenuatum* and *P. hymenophyllum*; spherical in *P. nigrum*, obovate in *P. trichostachyon* and ellipsoidal in *P. mullesua* and *P. silentvalleyensis.*

The fruit is a drupe, but often referred to as berry in literature. Mature drupe is ovate-elliptic in *P. argyrophyllum*, *P. attenuatum*, *P. hymenophyllum*, *P. silentvalleyensis* and *P. mullesua* and globoid in *P. nigrum* and *P. trichostachyon.* Ripe fruit is as small as 0.2 cm in diameter in *P. mullesua* and as large as 1.0 cm in *P. trichostachyon.* The colour change in ripe fruit follows two courses. In one, the green mature fruit turn directly black as in *P. argyrophyllum*, *P. attenuatum*, *P. hymenophyllum*, *P. silentvalleyensis* and *P. mullesua.* In the other it turns to yellow as in *P. trichostachyon* and then turns to red as in *P. nigrum.*

Of all the species *P. nigrum* was found to be most variable and widely distributed and *P. silentvalleyensis* was the rarest. Tables 1-3 summarise the various morphological characters of the various species.

The genus *Piper* was established by Linnaeus in 1753 describing 17 species, of which five were assigned to peninsular India. Miquel in his SYSTEMA PIPERACEARUM (1843) described more than 600 species including seven from India. Of the 640 species described by C. de Candolle (1869), 52 were from the Indian peninsula. Hooker (1886) in the FLORA OF BRITISH INDIA described 45 species of which 29 were from peninsular India. Gamble (1925) reported 14 species of *Piper* from the old

Presidency of Madras including part of Kerala and Karnataka.

The taxonomy of the genus is difficult owing to the greater ranges of variability and minute nature of the flowers, which may lose their morphological characteristics while under herbarium preparation. Realizing these difficulties Hooker (1886) advised the local botanists in the various centres of distribution of these species to examine the plants in their natural habitat "with a view to matching the sexes, and flowering with fruiting specimens and to observing the transition from young to old foliage and the effects of locality and climate on the characters of each species". In this regard Howard (1973) comments: "the difficulty of establishing a valid species concept within the family, and the existing over description of taxa is recognized". No monographer is available, and one might ask if a single life time would be enough to straighten out one of the worst messes in plant taxonomy.

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Ravindran, P.N., Nair, M.K. & Asokan Nair, R. (1987): New Taxa of *Piper* (Piperaceae) from Silent Valley Forest, Kerala. *J. Econ. Tax. Bot. 10 (1):* 167-169.

NEW DESCRIPTIONS

ON THE GENUS *CHRYSOSARUS* MITCHELL (HYMENOPTERA: APOIDEA: MEGACHILIDAE), WITH DESCRIPTION OF A NEW SPECIES FROM SOUTH INDIA[1]

RAJIV K. GUPTA[2]

(With six text-figures)

Chrysosarus (Zonomegachile) tamiliensis. a new species collected from Madras, India has been described. It possesses a distinction male genitalia with the apices of its gonocoxites prominently trilobed. The new species is closely related to *Meghachile ceylonica* Bingham which has now been assigned to *Chrysosarus* (*Chrysosarus*) *ceylonica* (Bingham) comb. nov.

Chrysosarus Mitchell (1943) was a small subgenus of the genus *Megachile* Latreille, with *Megachile guaranitica* Schrottky as type species. Mitchell (1980) upgraded it to generic status with the subgenera *Dactylomegachile* Mitchell, 1943 (type-species: *Megachile parsonsiae* Schrottky); *Steloides* Moure, 1953 (type-species: *Megachile euzona* Perez); *Zonomegachile* Mitchell, 1980 (type-species: *Megachile mariannae* Dalla Torre) and *Chrysosarus* s. str. The following combination of characters can distinguish the genus *Chrysosarus* from neighbouring megachiline genera: 'form broad and rather short; metasoma more cordate or ovoid in females; sternum 6 in females either well clothed with scopal hairs or without a bare apical lip; in females mandible 4 or 5 dentate, usually without cutting edges; in males: inferior margin of mandible usually lacking any process; front coxae with well developed spines; terga more flattened transversely and sternum 4 always exposed'.

Mitchell described the genus as a native of the neotropic. However, many species from India have also been grouped under this new genus, which were formerly under *Megachile* Latr. The new species described below falls under the subgenus *Zonomegachile* Mitchell, on the basis of the margin of the hypostome being angulately or carinately produced beneath the base of the mandible; the metasoma with discal pubescence other than black and legs in both sexes never bright ochraceous.

[1]Accepted May 1989.

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[3]After Tamil Nadu, from where the species was collected.

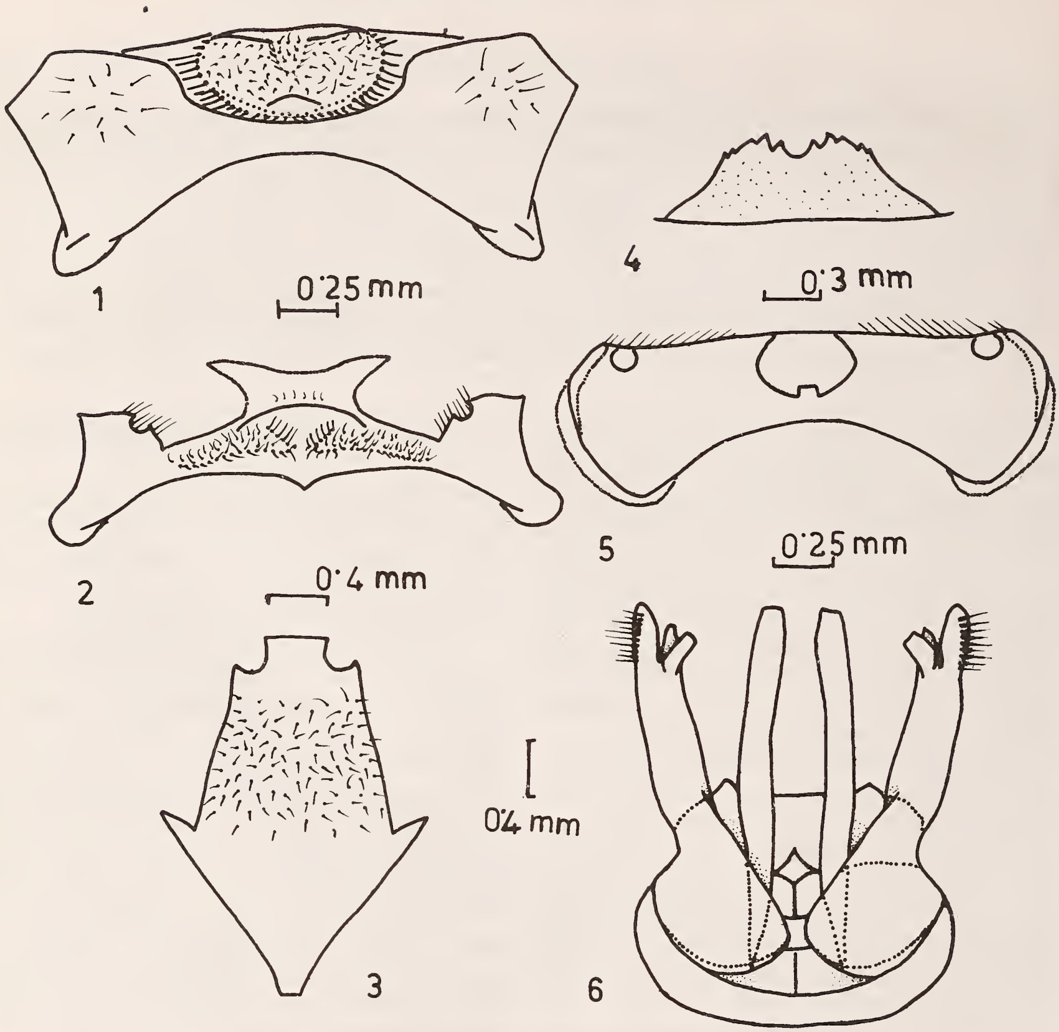
Chrysosarus (Zonomegachile) tamiliensis[3] sp. nov.

MALE: Integument in general black, tegulae brown, legs with redness and front femora and tarsi pale-yellow; punctures fine and closely placed; pubescence shining pale-yellow including fasceae but on legs mixed with black, tarsal fringe pale.

Head wider than median length; inner eye margin almost straight, convergent below; clypeal surface almost flat, apical margin laterally angulate and finely serrated medially; maximum width of paraocular area about half of the clypeal basal width, eye carina strongly protuberant and separated from eye by a wide groove; subocellar area flat but in between eye and midocellus deeply concave, midfacial groove absent; occipital margin incarinate and nearby vertex broadly incurved; genal maximum width exceeding that of eye in lateral view, narrower below and hypostome with remarkably broad truncated projection beneath the mandible, fulvously pubescent; mandible tridentate, interspace in between 2nd & 3rd tooth wide, broadly attached to base; labial palpi very short hidden beneath the labrum.

Scutum broadly convex; produced anterior ridge of pronotum incarinate; scutellar surface doubly punctured; metanotal extensions at the base of hind wings are strongly depressed but not covered by scutellar crest; first recurrent vein little far from base than the second one which is quite close to apex of second cuboital cell in fore wing, wing colour pale-hyaline and veins brown piceous; tegulae finely punctured & fulvously pubescent.

Fore leg: Coxal spine base with a patch of silky hairs, surface finely striated; basitarsi – apex much produced (projection from ventral surface also in-



Figs. 1-6. *Chrysosarus (Zonomegachile) tamiliensis* sp. nov. male
1. Sternum V; 2. Sternum VI; 3. Sternum VIII; 4. Tergum VI carina; 5. Sternum VII; 6. Genitalia.

corporate) as a thick rounded lobe anteriorly, surface yellow with white pubescence, ventrally fringe mixed with black bristles, in 2nd, 3rd & 4th tarsi ventral surface does not contribute in apical excavations and black bristles lacking; tarsus 5: normal unmodified but broadly robust; mid and hind legs normal.

Basal tergal concavity margin incarinate; in terga 2-5 gradular line with a parallel groove, apical rims distinct, discal pubescence much denser laterally, all completely fasciate; tergum 6th carina medially invaginated, laterally very finely serrated, apical margin below with a rudimentary tooth at lateral extremities, so as in tergum 7th on either sides of median invagination at apical margin; four sternites exposed, all densely pubescent; apical margins: outcurved in first, becoming broadly invaginated up to 4th; 5th sternite uniformly bristled on post-gradular area as well on lateral lobes of pregradular area; 6th sternum apically evaginated, bristled along gradulus; 7th broad and deeply incurved basally; apical lobe of 8th sternite notched at angles, finely setose.

Gonobase of genitalia very narrow; gonocoxites narrowly constricted at middle and apices distinctly cleft to form three lobes, lateral one

with exterior fringe; penial valve quite low.
Measurements (in mm.): Total length 14.5; eyes: length 3.02, lateral width 1.4, distances of upper, median and lower interspaces 3.02, 2.7 and 2.5: clypeus: median length 1.3, basal and apical widths 1.25 and 2.4; antennal sockets: distance to eye 0.51, to clypeus 0.8, to median ocellus and to each other 0.9 and 0.9; antennae: length of scape 1.0, pedicel 0.25, flagellar segments Ist 0.3, IInd 0.35, VIth 0.4, XIth 0.6 and breadth of VIth 0.3 and XIth 0.4; lateral ocelli: distance to eye 0.55, to occipital margin 1.0 and to each other 0.7; labrum: median length 1.5, basal and apical width 1.7 and 1.1; scutum: median length and maximum width 3.15 and 4.5; scutellum: median length of dorsal surface 1.1; fore wing: total length 9.0 and length of radial cell 2.25; relative median widths of terga Ist to VIth: 2.7, 4.5, 4.55, 4.5, 3.7 and 3.0.
FEMALE: Not known.
Material examined: Holotype: male, Gandhi Memorial Park, Madras (Tamil Nadu), 8 July 1981, Coll. Rajiv K. Gupta (N.P.C., Division of Entomology, I.A.R.I., New Delhi); no paratype.
Flower record: *Callistomum* sp.

The new species described above is closely related to *Megachile ceylonica* Bingham, 1897 (reported from Ceylon and Tenasserim, I have also trapped it at Madurai, Tamil Nadu). *M. ceylonica* also falls under subgenus *Chrysosarus* s. str. of genus *Chrysosarus* (diagnosis: wings pale-yellow with testaceous veins, tegulae testaceous, margin of hypostome not at all produced below the mandibles). Hence a new combination is suggested. Besides the subgeneric characters, *ceylonica* further differs from *tamiliensis* in its tetradentate mandible, VIth tergal carina margin without serration on either sides of median incurve; apices of gono-coxites not trilobed and overall body pubescence golden-yellow.

ACKNOWLEDGEMENTS

I thank Drs. S.I. Farooqi and S.L. Gupta, both senior scientists at the Entomology Division, I.A.R.I., New Delhi, for facilities and guidance in the preparation of this manuscript.

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A NEW SPECIES OF *DASINEURA* (DIPTERA: CECIDOMYIIDAE) INJURIOUS TO BUDS OF *BRASSICA* SPP. (CRUCIFERAE) IN HARYANA[1]

R.M. SHARMA[2] AND HARVIR SINGH[3]

(*With thirteen text-figures*)

A new species of cecidomyiid fly, *Dasineura hisarensis* which breeds in the buds of *Brassica campestris* L. var. *toria*, *B. rapa* L. var. *glauca* and *B. juncea* (Linn.) Czern and Coss sub. sp. *juncea* Linn. at Hisar, Haryana state, has been described and illustrated. The available biological information on this species is also included.

INTRODUCTION

In the year 1988, a large number of cecidomyiid flies were bred by one of us (HS) from the buds of *Brassica campestris* L. var. *toria*, *B. rapa* L. var. *glauca* and *B. juncea* (L.) sub. sp. *juncea* Linn. at Haryana Agricultural University, Hisar. On closer examination all these flies were determined as assignable to a new species under the genus *Dasineura* Rondani. Until 1981, *Dasineura* Rondani, a genus of Phytophagous cecidomyiids was represented in India by six species (Grover 1981). Sharma (1987) added one more to the list and the present species is the eighth.

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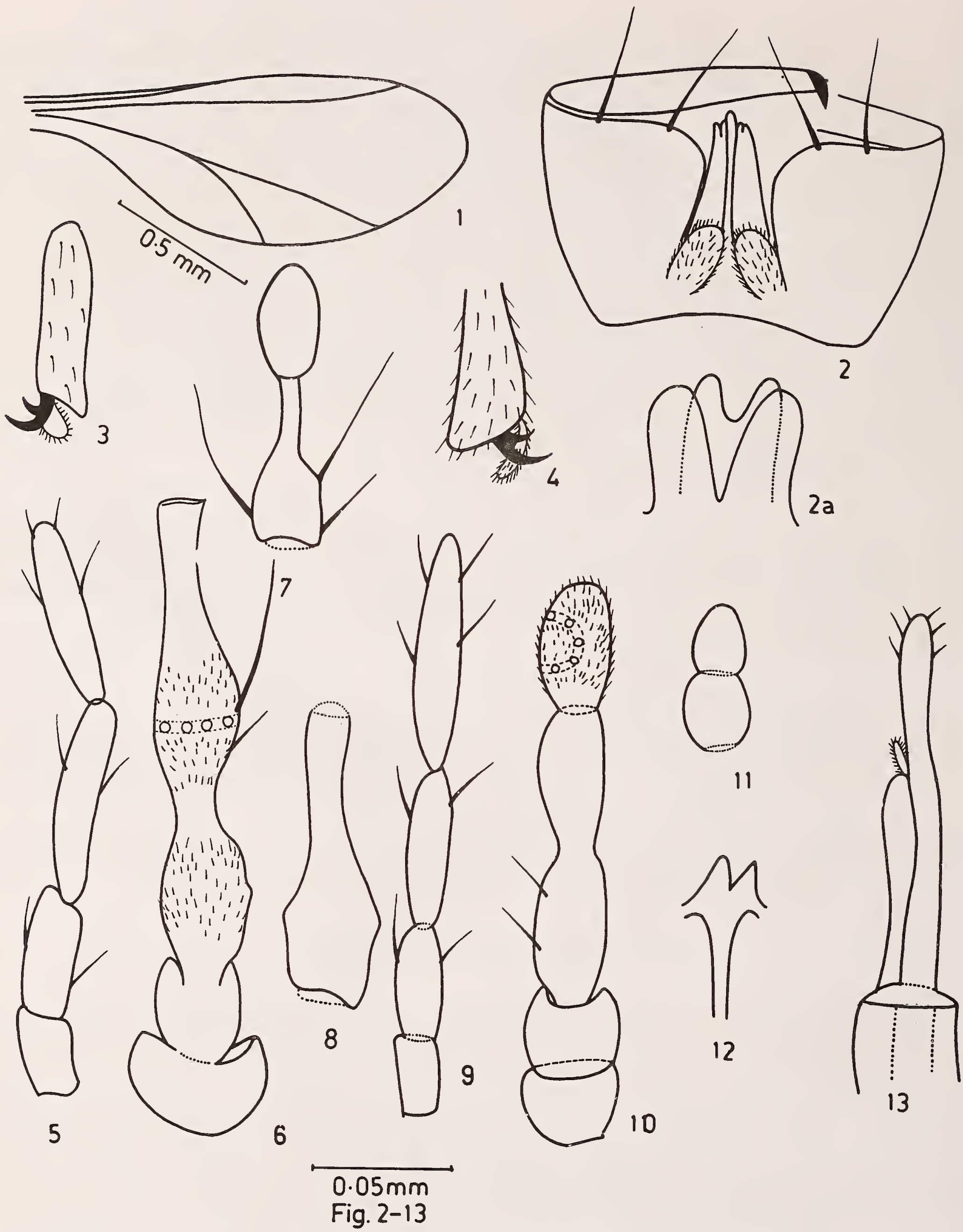

Figs. 1-13. *Dasineura hisarensis* sp. nov.
1. Wing (male); 2. Genitalia (dorsal view); 2a. Dorsal and subdorsal plates. 3. Claw (male); 4. Claw (female); 5. Palpus (male); 6. Scape, pedicel, third and fourth antennal segments (male); 7. Terminal two antennal segments (male); 8. Fifth antennal segment (male); 9. Palpus (female); 10. Scape, pedicel, third, fourth and fifth antennal segment (female); 11. Terminal two antennal segments (female); 12. Sternal spatula; 13. Ovipositor.

Dasineura hisarensis sp. nov. (Figs. 1-13)

MALE: Body 2.20 mm. long, light yellowish-brown. Eyes confluent above. Trophi normal. Palpus 4- segmented, pale brown, sparsely setose, moderately long, first segment (10 : 7)[4] cylindrical, length 1.42 x its maximum thickness; second sgment (20 : 10) cylindrical, length 2.00 x its maximum thickness; third segment (32 : 8) cylindrical, longer and thinner than second, length 4.00 x its maximum thickness; fourth segment (32 : 8) cylindrical as long as third and 4.00 x its maximum thickness.

Antenna: Shorter than body with 2 + 13 to 2 + 14 segments (2 + 14 in holotype), segments with cylindrical enlargements and long apical stems: enlargements with two whorls of setae, basal ones much shorter than apical; circumfila ring-like; scape (16 : 24) cup-shaped wider than long; pedicel (15 :16) subglobose: third segment (33) confluent with and shorter than fourth, enlargement (20 : 15) 0.60 the length of the segment and 1.33 its maximum thickness, stem (10 :6) 0.50 the length of the enlargement and 1.66 x its maximum thickness; fourth segment (47) with enlargement (24 :11) a little more than half the length of the segment and 2.18 x its maximum thickness, stem (23 : 6) a little less than the length of the enlargement and slgihtly less than 4.00 x its maximum thickness; fifth segment (47) as long as fourth, enlargement (23 : 14) 0.48 the length of the segment and 1.64 x its maximum thickness, stem (24 : 6) a little more than the length of the enlargement and 4.00 x its maximum thickness, distal flagellar segments gradually becoming shorter and thinner; penultimate segment (26) with an enlargement (15 : 10) 0.57 the length of the segment and 1.50 x its maximum thickness, stem (11 : 3) 0.73 the length of the enlargement and 3.66 x its maximum thickness; terminal segment (18 : 9) conical, shortest of all, length twice its maximum thickness.

Wing: (51: 22) hyaline, 2.36 x as long as broad, costa sparsely hairy, vein R_1 joining costa beyond 0.25 the length of the wing, vein R_5 reaching costa well before the wing apex, uninterrupted at its union with the latter, vein *Cu* forked.

Legs: Long, moderately hairy, metatarsus (6) shorter than terminal tarsal segment, second segment (63) longest of all, longer than the following segments combined together (53); claw (7) dentate on all legs, evenly curved; empodium broad or elongated, longer than claw (11).

Genitalia: Light brown, sparsely setose, basal clasp segment (41 : 27) enlarged apically, narrowed basally with a heavily setose elongated basal lobe, length 1.51 x its maximum apical width, shorter than terminal clasp segment; later (48 : 6) slender, evenly narrowed, ending in a dark pointed tooth, length 8.00 x its maximum thickness; dorsal plate (25 : 25) as long as broad, deeply and broadly bifid, lobes broad, rounded apically, sparsely setose; subdorsal plate (20 : 11) shorter and narrower than dorsal plate, slightly less than twice its maximum width, broadly and deeply incised, lobes elongated, tips rounded, setose apically; parameres cylindrical, beset with fine setae laterally, bilobed apically, slightly shorter than aedeagus; later (25 : 2) rounded apically, as long as dorsal plate, length a little more than 12.00 x its maximum thickness.

FEMALE: Body 2.28 mm long (including ovipositor). Eyes and trophi as in male. *Palpus*: 4 segmented, first segment (9 : 7) squarish, 1.28 x as long as thick; second segment (18 : 9) cylindrical, twice as long as thick; third segment (25 : 7) cylindrical, wide apically, 1.38 x longer than second and 3.57 x as long as its maximum apical width; fourth segment (34 : 6) cylindrical, longest and thinnest of all, 1.36 x longer than third and 5.66 x as long as thick.

Antenna: 0.33 the length of the body, with 2 + 13 to 2 + 14, cylindrical, sessile segments (2 + 13 in allotype), segments with two whorls of long setae, circumfila low; scape (11 : 15) cup-shaped, pedicel (14 : 13) subglobose; third segment (25) confluent with and slightly longer than fourth, enlargement (22 : 11) 2.00 x its maximum thickness; fourth segment (22 :10) slightly shorter than third, enlargement 2.20 x its maximum thickness; distal flagellar segments gradually becoming shorter, penultimate segment (11 : 9) 1.22 x as long as thick; terminal segment (11 : 9) conical, as long as penultimate, length 1.22 x its maximum basal width. Wing, legs and claw as in male.

Ovipositor: exerted, protractile, typical dasineurine, 0.33 the length of the body and shorter than abdomen, terminal lobe (25 : 6) elongate, length 4.16 x its maximum thickness, with a few

[4]Numbers in parentheses indicate length: breadth ratios, measured with an oculometer.

lateral long setae; ventral lobe very small, setulose.

Larva: whitish when young, turns pink as grow old. Sternal spatula present, distally incised by a V-shaped emargination forming two lobes: shaft weakly sclerotized.

Host Plants: Brassica campestris L. var. *toria, B. rapa* L. var. *glauca* and *B. juncea* (L.) Czern and Coss, subsp. *juncea* L. (Cruciferae).

Holotype male, allotype female and paratypes 5 males, 8 females dissected and mounted on slides, 4 larvae on slides, *Ex.* buds of *Brassica campestris* L. var. *toria* HAU, Hisar (Haryana), India 15 Nov. 1988. Harvir Singh Coll. All types are deposited in Z.S.I. Pune for the time being and will be deposited in National Zoological Collections, Z.S.I. Calcutta (Regd. Nos. WRS/ZSI/Ent 10/79 to Ent 10/97).

Distribution: INDIA: Haryana state (Hisar and other districts).

Etymology: The specific epithet *hisarensis* refers to the type locality, Hisar in Haryana state, India.

Dasineura brassicae (Winnertz) commonly called the Brassica Pod Midge is known as one of the most serious pests of rape, *Brassica napus* L., *B. rapa* L. and *B. campestris* L. in Europe (Ahman 1985). But the incidence of *Dasineura* on *Brassica* spp. from India constitutes the first report for major rapeseed growing Asian countries (*Nepal, Pakistan, Bangladesh and China).*

The females of *D. hisarensis* sp. nov. resemble the Palaearctic species *D. brassicae* (Winn.) but males differ in the genitalia (as communicated in the identification report of C.I.E. London). This new species comes close to *D. amaramanjarae* Grover (1965) and *D. psoraleae* Sharma (1987) among Indian species affecting inflorescence of *Mangifera indica* Linn. and *Psoralea corylifolia* Linn. respectively; but differs considerably from both the species in having different number, length and breadth proportions of antennal segments; proportions of empodium and claw; shape of basal lobe of basal clasp segment; structure of dorsal and subdorsal plates and proportions of dorsal lamella of ovipositor.

The scant biological information available on the species is summarised. The female lay eggs in flower buds by inserting its ovipositor. At the site of oviposition, an eye-shaped spot is developed which gradually widens. This gall-midge does not form any complex gall. The infested buds inflate in size. Each bud may harbour 2-15 larvae inside. Such inflated buds fail to form pods, retain their normal colour till the larvae drop out for pupation in the soil. Later the infested buds die, turn black but remain attached to the plant till harvest. This species is multivoltine. Females outnumber the males (male 42 : 58 female). Drastic decline in field population occurs after the first week of March.

At present, we are uncertain of its economic status, largely because infestation of this species on *Brassica* plants was encountered only recently. However, based on the preliminary field observations by one of us (HS), pest incidence varied from 2-5% depending on the different agroclimatic zones of Haryana. The larvae of this species are parasitized by an unidentified chalcid. The extent of parasitization varies from 8.70 to18.75% during December to March.

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We thank Prof. M.S. Jairajpuri, Director, Zoological Survey of India, Calcutta; Dr R.S. Pillai, Jt. Director, SRS, Madras and Dr G.M. Yazdani, Scientist-SE and Officer-in-Charge, WRS, Pune, for facilities and encouragement. One of us (HS) is grateful to Dr. Hari Singh, Senior Scientist (Oilseeds), HAU, Hisar, for providing facilities to carry out the survey for this insect pest in Haryana State. We also thank the Director, C.I.E. London for kindly confirming the identity of the species.

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OPHIORRHIZA TALEVALLIENSIS (RUBIACEAE) A NEW SPECIES FROM ARUNACHAL PRADESH[1]

G.D. PAL AND G.S GIRI[2]

(With a text-figure)

Ophiorrhiza talevalliensis sp. nov. (Fig 1, A-D.)

Ophiorrhiza bracteatae Korth. affinis, sed differt herbis glabris, floribus albis, corollae tubis 1.75-2.0 cm longis, fauce intus dense piloso; stylis minoribus, 1.0-1.25 cm longis.

Holotypus lectus a *G.D. Pal* and locum Arunachal, Inferior Subansiri District, Pange-Tale valley Road, Tale Valley, die 16.4.1980, 2900 m, sub numere 77660 et positus in CAL. Isotypus *G.D. Pal* 77660 A positus in ARUN.

Erect or suberect herbs, 20-45 cm high, rarely decumbent, rooting from the lower nodes, unbranched or branching at ground level. Stems terete, fleshy or the lower part woody or subwoody, somewhat compressed, glabrous or dirty brownish verrucose; internodes 3-6 cm long, nodes slightly swollen. Leaves opposite decussate, ovate-elliptic, elliptic or elliptic-lanceolate, (1.5–) 5.0-8.0 (–11.0) x (1.0–) 2.0-2.5 (–3.5) cm, base usually acute to cuneate, rarely subrounded; apex acute to acuminate; margin entire; membranous; 6-9 (–12) nerves arise from either side of the midrib, oblique, reticulations not prominent; both surfaces glabrous or slightly verrucose on the nerves beneath; upper surfaces dark brown and lower surfaces remain brownish-green or turn light brown on drying; petioles slender, (0.5–) 0.8-1.8 (–3.0) cm long, glabrous or brownish verrucose.

Inflorescence terminal cymose panicle, usually unbranched or rarely dichotomously branched, upto 3 cm across, 4-8 flowered. Flowers usually in pairs and rarely unpaired, milky white; peduncles 1.5-5.0 cm long, verrucose; lower bracts leafy, lanceolate, 18-23 x 2.5-4.0 mm, base cuneate, apex acute, uninerved, glabrous; upper bracts smaller, linear, up to 10 mm long; outer flowers bracteolate, inner flowers bracteolate or ebracteolate, bracteoles linear, 5-8 mm long, uninerved; pedicels up to 2 mm long for paired flowers and 3-5 mm long for unpaired flowers, glabrous or verrucose. Calyx-tube globose or trapezoid, *c.* 2 mm across, prominently costate, costa often decurrent to the pedicels, glabrous or verrucose; lobes 5, usually equal, rarely unequal, narrowly oblong with acute or acuminate apex, 1.0-1.75 mm long, uninerved, glabrous.

Corolla narrowly campanulate, up to 2.5 cm long; tubes 1.75-2.0 cm long, 6-8 mm across towards the throat, glabrous without, plumose hairy in the form of a ring from the throat downward about a length of 4-5 mm, hairs bright yellow; lobes 5, ovate, acute, 4-5 x 3.5-4.5 mm, slightly dilated or reflexed, prominently keeled, glabrous.

Stamens 5, inserted near the throat of the corolla-tube; filaments *c.* 1 mm long, glabrous; anthers embedded within the plumose ring of hairs, oblong, *c.* 2.5 mm long, dorsifixed, distinctly bilobed, lobes narrow at base, longitudinally dehiscent. Disc *c.* 0.5 mm high. Ovary inferior, globose, glabrous; styles 1.0-1.25 cm long, glabrous, included within the corolla-tube and remain below the level of plumose hairs; stigma flat, bilobed. Fruits not seen.

Flowers : April– May.

Type: INDIA: Arunachal Pradesh, Lower Subansiri District: Pange-Tale valley road, Tale valley, 2900 m, 16.4.1980, *G.D. Pal* 77660 (Holotype - CAL, Isotype – ARUN); Pange, *c.* 2240 m, 19.4.1980, *G.D. Pal* 77735 (Paratype– ARUN).

Ophiorrhiza talevalliensis is an elegant species that grows along the road side under shade or on the moist forest floor over thick humus. This new taxon is closely allied to *O. bracteata* Korth., but can be differentiated by its glabrous habit, ovate-elliptic to elliptic-lanceolate leaves with acute to cuneate base, larger flowers (up to 2.5. cm long) with corolla-tube 1.8-2.0 cm long, tubes densely pilose near the throat within and styles remain below the level of plumose hairs; whereas in the latter species, the stem is pilose and leaves oblanceolate with gradually tapering base; pedicels rufopuberulous, flowers smaller (up to 1.8 m long) with corolla-tube 1.0-1.25 cm long, tubes two-third hairy

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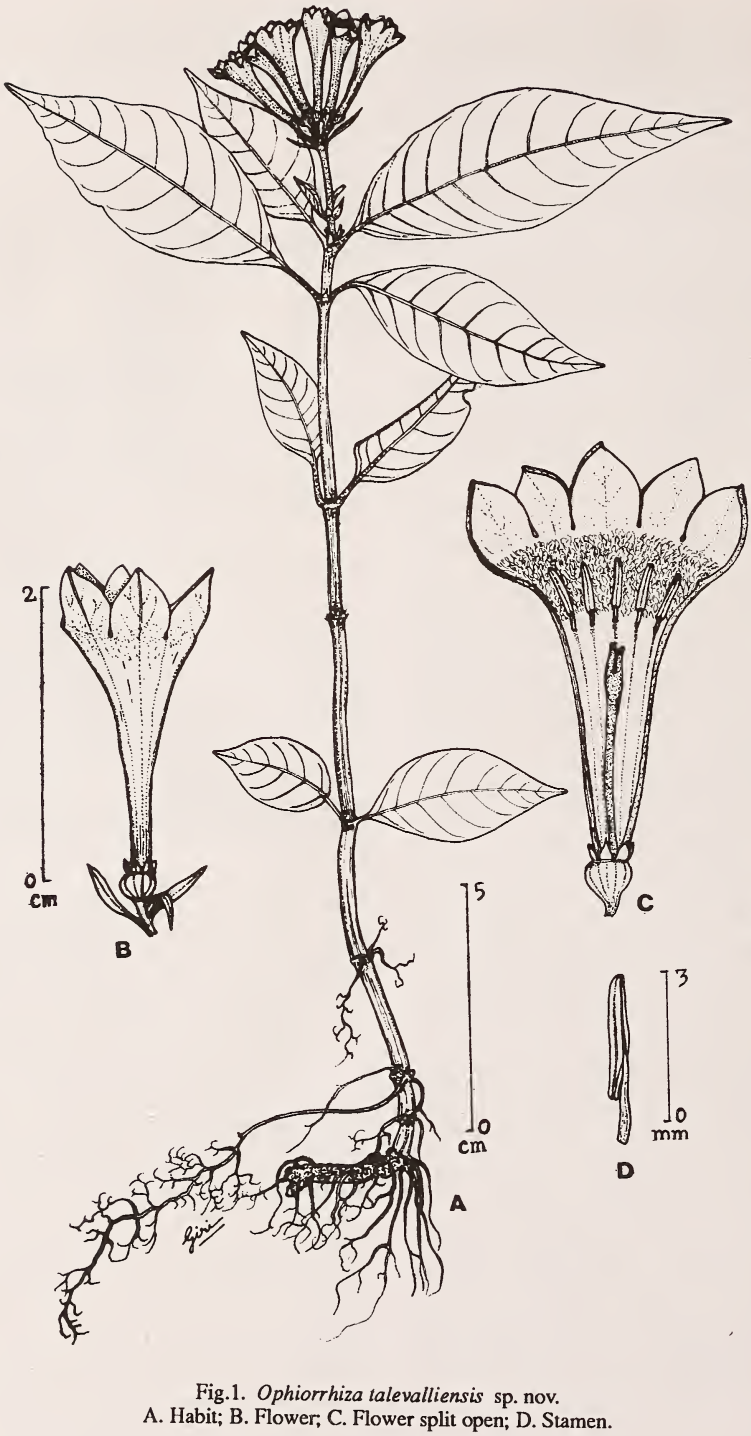

Fig.1. *Ophiorrhiza talevalliensis* sp. nov.
A. Habit; B. Flower; C. Flower split open; D. Stamen.

from the base upward and styles exceeding the level of plumose hairs.

The new taxon also comes closer to *O. wattii* Fischer, but *O. wattii* is characterised by more or less puberulous habit, larger leaves with caudate apex, smaller flowers (up to 1.3 cm long) with tube pubescent at the middle third within, stamens inserted at the middle of corolla-tube with longer filaments (3.5-5.0 mm long).

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A NEW SPECIES OF *MAESA* FORSK. (MYRSINACEAE) FROM ARUNACHAL PRADESH[1]

G.S. GIRI AND G.D. PAL[2]

(With a text-figure)

Maesa ziroensis sp. nov. (Fig.1, A-G).

Maesa perlario (Lour.) Merr. Proxime affinis, sed facile distinguenda ramis dense ferrugineo-pilosis, foliis ellipticis ad elliptico-lanceolatis, chartaceis, supra pubescentis, in sicco denigricantibus, inflorescentiis paniculatis axillaribus perramosis, sepalis dorsaliter glabris, petalis infra medium connatis, lobis manifeste glandulari-lineatis.

Holotypus lectus a *G.D. Pal* ad locum Arunachal, Inferior Subansiri District Ziro-begi road, 6 km E Ziro, 1700 m, die 9 April 1980 subnumere 77433A positus in CAL. Isotypii: *G.D. Pal* 77433 B positus in CAL; *G.D. Pal* 77433 C positus in ARUN.

Shrubs, 2.0-2.5 m tall, erect, branches woody, terete, striate, lenticellate, densely rusty pilose.

Leaves: alternate, elliptic to elliptic-lanceolate, (7.0–) 8.0-11.5 (–13.0) x (2.2–) 2.5-3.0 (-3.5) cm, base acute to subrounded, apex acuminate, margin denticulate, 8-10 nerves on either side of midrib, lateral nerves bifurcate near the margin, one end from marginal loop and the other terminate to a gland at each dentation; upper surfaces sparsely rusty pubescent, lower surfaces densely pubescent, hairs more dense on the nerves and nervules; petioles strong, 0.6-1.0 cm long, densely rusty pubescent.

Inflorescence: axillary panicles, usually double the length of petioles, densely rusty pubescent; bracts narrowly triangular or subulate, 0.5-1.0 mm long, sparsely hairy without, margin ciliate.

Flowers: 5-merous, 2.5 mm across, pedicellate, pedicels 1.0-1.5 mm long, densely rusty pubescent; 2-bracteolate, bracteoles like those of bracts. Sepals broadly ovate, 0.5-0.75 x 0.5 mm, imbricate, dorsally glabrous, ciliolate at margin. Petals joined below the middle, lobes nearly triangular or ovate, 1.0 x 0.5-1.0 mm, apex obtuse, prominently glandular lined, the glandular lines arise from the attachment of filaments to the petals, yellow.

Stamens : opposite and attached at the base of petal, included within the tube, filaments small, 0.25-0.5 mm long, glabrous; anthers triangular, 0.25-0.5 mm, distinctly notched at apex, divergent at base, dorsifixed, longitudinally splitted. *Ovary* semi inferior, subglobose, glabrous, *c.* 1 mm diam. *Style* short, *c.* 1mm long, slightly flattened towards apex, glabrous. *Stigma* capitate or indistinctly lobed.

Local name : 'Abanchini' (Apatani).

Type: INDIA : Arunachal Pradesh, Lower Subansiri District, Old Ziro-Begi road, 6 km from Old Ziro, 1700 m, 9.4.1980, *G.D. Pal* 77433A (Holotype-CAL), Isotype; ibid.: *G.D. Pal* 77433B (CAL); ibid.: *G.D. Pal* 77433C (ARUN).

Fls. & Fruits. : September– December.

Ecology: Grows in moist primary forests along the hilly foot track.

The new species is closely allied to *Maesa per-*

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Fig.1. *Maesa ziroensis* sp. nov.
A. Habit; B. Inflorescence; C. Flower with bract and bracteoles; D. Petals with stamens; E. Stamen (dorsal view); F. Stamen (ventral view); G. Gynoecium.

larius (Lour.) Merr., but can be easily distinguished by its densely rusty pilose branches; leaves elliptic to elliptic-lanceolate, chartaceous, upper surfaces pubescent, turn black on drying; inflorescence branched axillary panicles; sepals dorsally glabrous; petals joined below the middle and lobes prominently glandular lined.

ACKNOWLEDGEMENTS

We thank the Director, Botanical Survey of India, Calcutta and Scientist B in-charge, Arunachal Field Station, Itanagar, for all facilities, and Dr. N.C. Majumder, Scientist SD for the Latin diagnosis of the new taxon.

DESCRIPTION OF A NEW SPECIES OF GENUS *COELIOXYS* LATREILLE (HYMENOPTERA: APOIDEA: MEGACHILIDAE)[1]

RAJIV K. GUPTA[2]

(With four text-figures)

A new species of genus *Coelioxys* Latreille has been described from Pathankot (Himachal Pradesh). *Coelioxys (Coelioxys) indicus* sp.nov. described in this paper has close affinities with *Coelioxys (C.) farinosa* Smith.

'Bees of the genus *Coelioxys* are so distinct that ever since Latreille (1809) erected the genus, not a single bee now considered to be in *Coelioxys* has been described in another genus...' (Baker 1975). The distinctive characters which clearly separate *Coelioxys* from the rest of the Megachiline bees are: arolium absent between the claws; axillae produced behind to points; abdomen conical, in females acute or spatulate and in males with a few to numerous spines, at apex; pollen collecting scopa absent; cleptoparasites, mostly in the nests of *Megachile* Latr., *Chalicodoma* Lepeletier and some *Xylocopa* Latr.

Approximately 20 species of *Coelioxys* have been so far described from the Indian region. The new species described here, falls under subgenus *Coelioxys s. str.*, on the basis of the following characters (Mitchell 1973 and Baker 1975); 'Ocellar area moderately to closely punctured, pre-occipital carina incomplete medially; inner surface of mandible simple; prothoracic tubercles with carina distinct but not expanded into thin plate-like structure; scutellum usually rounded posteriorly; gradular grooves complete on metasomal terga two and three; in females VI th sternum with margin entire or constricted subapically, never notched; in males hypostomal area of gena with distinct excavation, foveal area of second tergum closely punctured, Vth tergum with inconspicuous lateral spines, VIth tergum with dorsal spines long or short and VIIth sternum represented by two small sclerites.'

The known Indian species of genus *Coelioxys* which have been grouped under *Coelioxys s.str.* are: *farinosa* Smith and *decipiens a* Spinola (=*apicata* Smith). Among them *apicata* was designated the type of subgenus *Liothyrapis* Cockerell (genus *Liothyrapis* nov. stat. Pasteels 1977), later became a synonym of the subgenus *Coelioxys s. str.* (Krombein *et al*. 1979).

Coelioxys (Coelioxys) indicus sp. nov.[3]

MALE: Integument black, eyes, mandibles, antennae, tegulae, legs, tergal margins and sternites with redness; in general coarsely and closely punctured, dorsally on metasomal tergites sparse; pubescence snowy-white all over the body; face, hypostome, thorax below and propodeum with erect and incomplete tergal fasceae, complete sternal fasceae and on tergal discs ferruginous; tarsal fringe white.

Head much wider than median length; eyes bare, inner margin broadly incurved above and semicarinate; clypeus flat, totally covered with pubescence, apical margin slightly outcurved with 4 fine dents at middle; supraclypeal surface resemble clypeus, midfacial line fine; paraocular areas sloping towards antennal sockets, densely hairy; subocellar area coarsely punctured; vertex slightly convex, sparsely hairy, occipital margin broadly incurved; genae narrowed down, maximum width lesser than eye width in lateral view, hypos-

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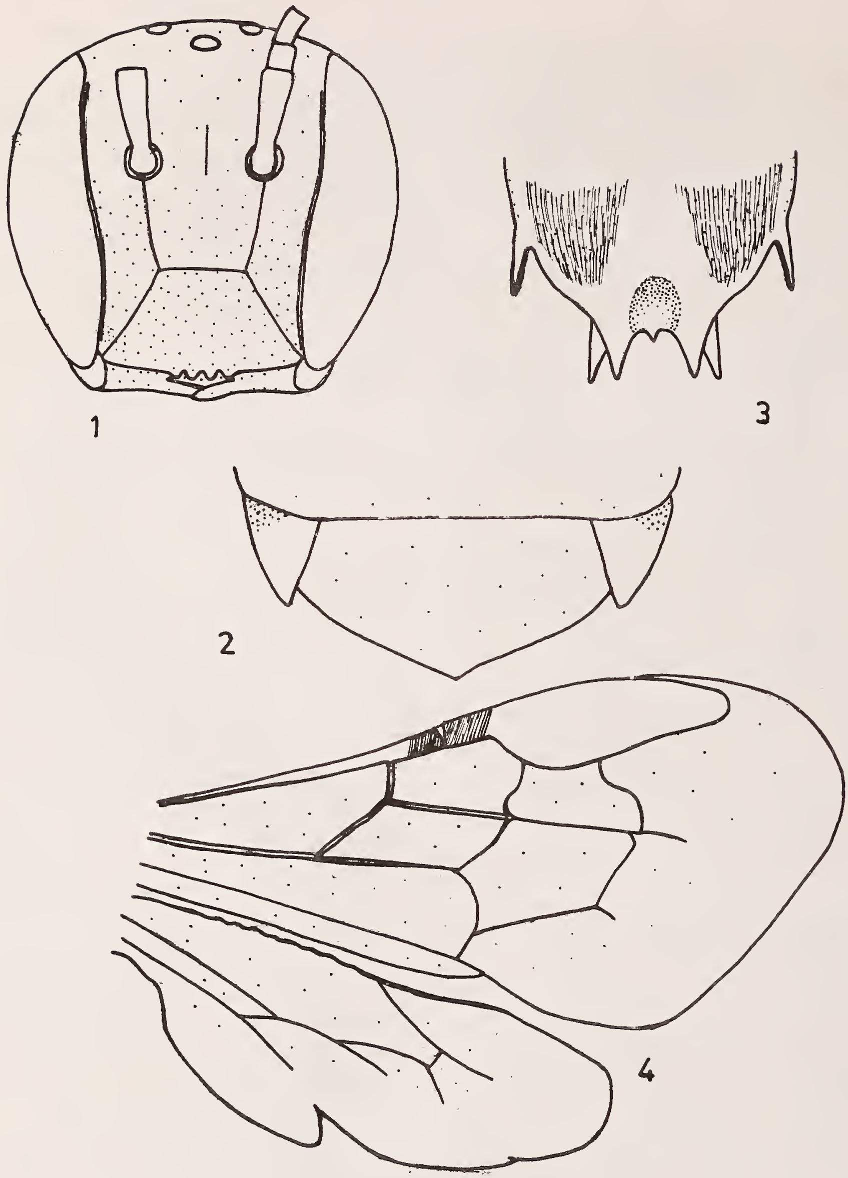

Figs. 1-4. *Coelioxys (Coelioxys) indicus* sp. nov. (male)
1. Head, front view; 2. Axillae and scutellum, dorsal view; 3. Tergum VIth, dorsal view 4. Wings
Dots on Figs. 1,2,4 indicate pubescence.

tome much excavated and fulvously pubescent.

Scutum anteriorly convex, punctures close, anteriorly with ferruginous and rest with fine setae, all sparse; axillar spine short; scutellum resemblig scutum and axillae in surface, broadly emarginate posteriorly; mese- and metepisternites with long bristles equal to the length of coxal spine; legs normal, unmodified; wings pale-hyaline, veins brown-piceous, first recurrent vein at the base and second slightly far from the apex of second cuboital cell of forewing.

Apical fasceae on terga 1-5 as well as discal pubescence confined to lateral sides, apical rims smooth with red lustre; VIth tergum with 4 prominently produced spines at apex and two at extreme lateral sides; at centre of apical spines a fine projection follows the subapical concavity on the dorsal surface; only 4 sternites exposed; apical margin of first sternum broadly outcurved; postgradular area of sternum 2 medio-laterally with a short transverse smooth tubercle on either side; sternum 4th bidentate at apex; all sterna completely fasciate, fasceae becomes much prominent posteriorly up to 4th and discal pubescence, and also increases in density upto fourth sternum.

Measurements: (in mm): Total length 7.0; maximum width and median length of face 2.25 and 1.5; eyes: length and median width 1.5 and 0.8, distance between upper, median and lower interspace 1.52, 1.5 and 1.3; clypeus: median length 0.51, basal and apical widths 0.5 and 1.2; antennal sockets: distance to eye 0.35, to mid-ocellus 0.51, to clypeus 0.35 and to each other 0.4: antennae: length of scape 0.5, pedicel 0.15, flagellar segments Ist-0.12, IInd-0-15, XIth-0.25, widths of Ist 0.15 and XIth 0.152; lateral ocelli: distance to eye 0.4, to occipital margin 0.52 and to each other 0.4; mandible: length of outer margin 0.85; length of segment Ist and IInd of labial palpi 0.5 and 0.4; scutum: median length and maximum width 1.0 and 1.52; length of scutellar surface in dorsal view 0.5; total wing length 5.5 and median widths of terga Ist to VIth 1.5, 2.0, 1.54, 1.52, 1.35 & 1.0.

FEMALE: not known.

Material examined: Holotype: male, Simla Hill, Pathankot (H.P.), 3.V.1982 (on wing), Coll. Rajiv K. Gupta (NPC, Division of Entomology, I.A.R.I., N. Delhi); Paratype male (same data as for holotype (with author himself).

The new species is close to *C. (C.) farinosa* Smith in its subgeneric characters. However, *farinosa* distinctly differs from *indicus* sp. nov.in: clypeal margin without median dents, simply outcurved; scutum with 2 patches of ferruginous hairs at anterio-lateral angles; axillar spine more prominently produced; coxal spine merely markable and with dense pubescence near its base; first recurrent vein slightly far from the apex of second cuboital cell in forewing; legs dorsally with dense white ferruginous hairs; medio-lateral tubercles on sternum 2nd absent; lateral spines and dorsal spines at apex of 6th tergum comparatively short and obtuse; body size large (12 mm.)

ACKNOWLEDGEMENTS

I am grateful to Dr. S.K. Bhatia, Head, for providing the necessary facilities and to Dr. S.I. Farooqi, Senior Scientist, for his cooperation and guidance during this study while both were stationed at Division of Entomology, I.A.R.I., New Delhi.

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NOMENCLATURE OF INDIAN SPECIES OF *OXYTENANTHERA* MUNRO[1]

H.B. NAITHANI[2]

The genus *Oxytenanthera* was described by Munro in 1868. Holttum (1956) pointed out that this genus is in fact monotypic with *Oxytenanthera abyssinica* (A. Rich.) Munro, a native African type species while the rest of the Asiatic species placed under this genus belong either to *Gigantochloa* or *Dendrocalamus*. This view has been supported by Clayton and Renvoize (1986) and Widjaja (1987) also. However while working on the bamboos of Sri Lanka, Soderstrom and Ellis (1988) discovered that Sri Lankan species of *Oxytenanthera* actually

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belonged to a new taxon which they described as a new genus *Pseudoxytenanthera* and transfered *Oxytenanthera monodelpha* Thw. under a new generic name. According to them the capitate clusters of spikelets, pubescent style, 6 stamens and lack of lodicules in *Pseudoxytenanthera* allies it to *Dendrocalamus*, but it differs in the branching pattern and vine-like nature of the culms; the large central bud remains dormant with simultaneous production of numerous basal branches, the whole breaking through the hard sheath or pushing it off during its development. When developed the large central bud becomes an elongated and whip-like branch, producing clusters of branches at each of its nodes. Due to its hairy anther tips it is allied to *Gigantochloa*, but differs by the characters of the fruit with a thin pericarp below, which is separable from the seed. From *Bambusa* it differs by its capitate inflorescence and non-disarticulating spikelets with short rhachilla segments. It also resembles *Oxytenanthera* to some degree, but Holttum (1956) and Clayton and Renvoize (1986) restrict that genus to the single African species, *O. abyssinica*, which has large spikelets arranged in tufts and with a hollow style.

Majumdar (1989) also independently came to the conclusion that Indian species of *Oxytenanthera* also differ from the actual original generic concept and in brief he described a genus *Pseudotenanthera* by giving the characters "subscandent to scandent; branches in tufts; no resting central bud; style thin, solid, pericarp thin, separable from seed". Incidentally the characters on which the genus *Pseudotenanthera* Majumdar is based are similar to *Pseudoxytenanthera* Soderstrom and Ellis.

Therefore the *Pseudotenanthera* Majumdar is a superfluous name and may be treated as a synonym of *Pseudoxytenanthera* Soderstrom and Ellis. Accordingly the following new combinations have become necessary.

Pseudoxytenanthera bourdillonii
(Gamble) Naithani comb. nov.

Oxytenanthera bourdillonii Gamble in Ann. Roy. Bot. Gard. Cal. 7:76, pl. 67. 1896.

Pseudotenanthera bourdillonii (Gamble) R. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocot. 281. 1989.

Distribution : Kerala.

Pseudoxytenanthera ritcheyi
(Munro) Naithani comb. nov.

Bambusa ritcheyi Munro in Trans. Linn. Soc. Lond. 26:113. 1868.

Oxytenanthera ritcheyi (Munro) Blatt. and McCann in J. Bombay nat. Hist. Soc. 33:773 (Oct.) 1929; Blatt. in Ind. For. 55:592. (Nov.) 1929.

Pseudotenanthera ritcheyi (Munro) R. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum,. Monocot. 281. 1989.

Oxytenanthera monostigma Bedd., Fl. Sylv. 333. 1873 et Ic. Pl. Or. 1:56. t. 234. 1873; Gamble in Ann. Roy. Bot Gard. Cal. 7:74, pl. 65. 1896.

Distribution: Maharashtra, Karnataka, Kerala and Tamil Nadu.

Pseudoxytenanthera stocksii
(Munro) Naithani comb. nov.

Oxytenanthera stocksii Munro in Trans. Linn. Soc. Lond. 26:130. 1868; Gamble in Ann. Roy. Bot. Gard. Cal. 7:75, pl. 66. 1896.

Pseudotenanthera stocksii (Munro) R. Majumdar in Karthikeyan *et al.*, Fl. Ind. Enum. Monocot. 281. 1989.

Distribution: Maharashtra, Kerala and Goa.

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A NEW *UTRICULARIA* L. (LENTIBULARIACEAE) FROM PENINSULAR INDIA[1]

M.K. JANARTHANAM AND A.N. HENRY[2]

(With a text-figure)

Utricularia subramanii sp. nov.

U. bifida L. Affinis sed pedicellis in fructiferum erectis; calicibus lobis ad apicem acutis, acuminatis vel dentatis; labio infero corollam ligulis fimbriatis et testa cellulis intra non striatis differt.

Herbs; rhizoids up to 8 mm long, thick at base, tapering towards apex, glandular; stolons filiform. Racemes up to 15 cm long, erect, glabrous, 2-5 flowered; scales *c.* 1.2. x 0.8 mm, basifixed, ovate, 3-nerved, acute to acuminate at apex; bracts *c.* 1.5 x 1.2 mm, basifixed, ovate, 3-nerved, acue to acuminate at apex; bracteoles *c.* 1 mm long, subulate to linear; flowers up to 7 mm long; pedicels up to 2.5 mm long, shorter than calyx-lobes, erect, winged. Calyx-lobes subequal, ovate, denticulate; upper lobe *c.* 3 x 2.8 mm (*c.* 4 x 4 mm in fruit), acute to acuminate at apex; lower lobe *c.* 2.4 x 2 mm (*c.* 4 x 3 mm in fruit), 2-4 dentate at apex. Corolla yellow; upper lip 3 mm long, cucullate, crested at middle on ventral side, hairy along lower margin, obtuse at apex; lower lip c. 3 x 2 mm, more or less obovate, hairy along the margin of throat, gibbous at base, rounded at apex, ligulate: ligule fimbriate along margin; spur conical, acute. Stamens *c.* 1 mm long; filaments linear; anther thecae distinct. Pistil *c.* 1 mm long; ovary ovoid; style thick; stigma 2-lipped. Capsules *c.* 2.5 x 1.8 mm, ovoid, uniformly membranous; placenta *c.* 1.5 x 1.4 mm, ovoid, compressed. Seeds *c.* 0.3 mm long, oblongoid; hilum terminal; testa reticulate, scrobiculate.

Holotype: *C.N. Mohanan* 58342 (CAL) and Isotype *C.N. Mohanan* 58342 (MH Acc. no. 134033) were collected on 30 July 1978 from Pathanamthitta,Quilon District (now Pathanamthitta district), Kerala at a altitude of *c.* 325 m.

This terrestrial plant growing in marshy areas was incorrectly identified as *U. graminifolia* Vahl in MH. The presence of ligule on lower lip of corolla is unique and is useful in segregating this species from all other *Utricularia* in India. *Utricularia subramanii* can be easily differentiated from the allied *U. bifida* L. as given in Table 1.

We dedicate this species to the memory of the late Dr K. Subramanyam, ex-Director, Botanical Survey of India for his valuable contributions to the study of Indian Utricularias.

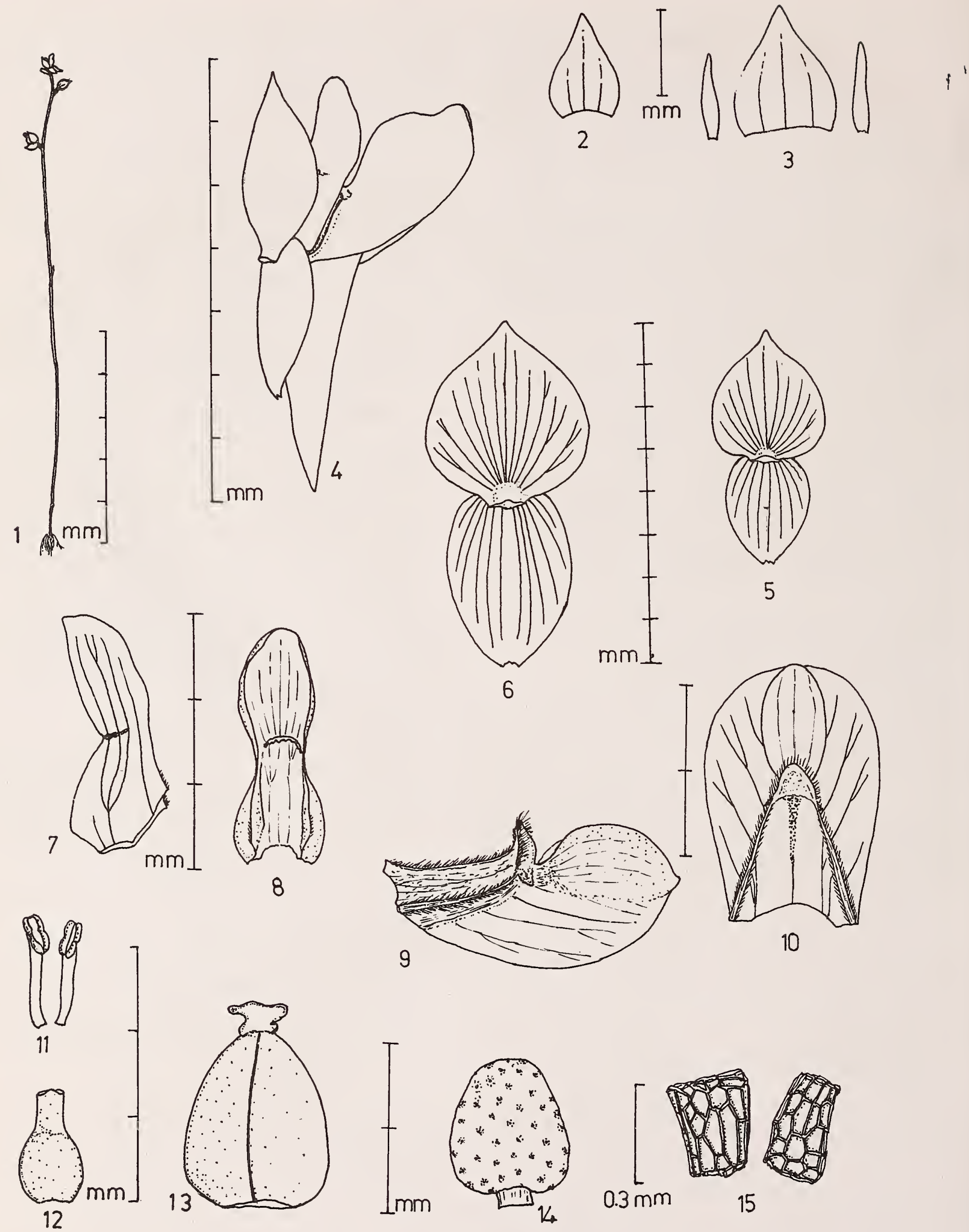
ACKNOWLEDGEMENTS

We thank Dr. N.P. Balakrishnan, Deputy Director, Botonical Survey of India for facilities and encouragement and Dr. V.J. Nair, Scientist SD for Latin translation of the diagnosis.

TABLE 1
DIFFERENCES BETWEEN *U. bifida* AND *U. subramanii* SP. NOV.

	U. bifida	*U. subramanii* sp. nov.
Calyx-lobes	Obtuse at apex	Acute to acuminate or dentate at apex
Lower lip of corolla	Not ligulate	Ligulate at middle
Fruiting pedicel	Recurved	Erect
Seeds	More or less ovoid; testa cells striated within	More or less oblongoid; testa cells not striated within.

[1]Accepted April 1990
[2]Botanical Survey of India, Coimbatore 641 003



Figs-1-15. *Utricularia subramanii* sp. nov.
1. Habit; 2. Bract; 3. Bract and bracteoles; 4. Flower; 5. Flowering calyx; 6. Fruiting calyx; 7. Corolla – upper lip (lateral view); 8. Corolla – upper lip (front view); 9. Corolla – lower lip (lateral view); 10. Corolla– lower lip (front view); 11. Stamens; 12. Pistil; 13. Capsule; 14. Placentum; 15. Seeds.

OBITUARIES

PROF. M.L. ROONWAL

Prof. Dr Major M.L. Roonwal, M Sc., Ph.D., D.Sc., F.N.A., F.E.S.I., F.Z.S.I., passed away on 22 July 1990. He was 82. A renowned zoologist, entomologist and educationist, he occupied many distinguished offices during his career, including Forest Entomologist of the Forest Research Institute, Dehra Dun; Director of the Zoological Survey of India, Calcutta; and Professor of Zoology and later Vice-Chancellor of the University of Jodhpur.

Mithan Lal Roonwal was born at Jodhpur (Rajasthan) on 18 September 1908. His early education was at Jodhpur and Lucknow, after which he took his M.Sc. (Hons.) degree from the University of Lucknow, and a Ph.D., on the embryology of the African migratory locust, under the guidance of the famous Dr A.D. Imms, from Cambridge University in 1935. In 1962 he was awarded the D.Sc. degree by Cambridge, for his published works on the systematics of termites.

His service record started with a stint at the Locust Research Laboratory, Lyallpur (now in Pakistan) in January 1931. Soon after his return from Cambridge, he took up the post of Entomologist-In-Charge of the Locust Field Research Station at Pasni on the Baluchistan coast, unraveling the migration routes of locusts while riding on camel-back day after day (the jeep had not yet been invented). For ten years from 1939, Dr Roonwal served as the Officer-In- Charge of the Bird and Mammal Section of the Zoological Survey of India, Calcutta. In between, during the Second World War, he served as a mammalogist in the Field Typhus Research Team in the 5th Punjab Regiment of the Indian army, on the Assam-Burma border. For his meritorious services he was awarded the Burma Star and the War Medal.

It was in 1946 that he started publishing a series of papers on the studies on intraspecific variations in the desert locust, which appeared for a long time in different journals and finally led to the 'Roonwal's Hypothesis on prediction of swarming'. As the Chief Research Officer and Forest Entomologist at the Forest Research Institute, Dehra Dun, during 1949-1956, he initiated and guided the preparation of an exhaustive systematic catalogue of the main identified entomological collection, and of the insect pests of forest plants in India and adjacent countries. His interest in the taxonomy of Indian termites was initiated during a visit to the U.S.A. in 1951-52 , when he brought back a large number of specimens of identified termites. He was awarded the Sir Dorabji Tata Gold Medal of the Zoological Society of India in 1956.

Dr Roonwal joined as the Director of Zoological Survey of India in July 1956. He held this chair with great distinction – as an able administrator and a first rate zoologist. He was responsible for the reorganization and expansion of the Survey, establishing Regional Stations in different parts of the country. Due to his efforts, the Government of India declared its collections as the National Zoological Collections of India in 1964. He also served as Chairman of the UNESCO Committee on Key Zoological Collections for South and South-East Asia. It was sad that he had to prematurely relinquish charge as Director, Z.S.I., said to be due to his straightforward and unbending nature. His successor, Dr M.S. Mani, then remembered him as ' not Roonwal, but a stone wall'!

He soon joined Jodhpur University as the Professor and Head of the Department of Zoology, and one year later, the University appointed him Vice-Chancellor for a three year term. On retirement from active service, he was made an Emeritus Scientist of the Council for Scientific and Industrial Research for four years.

His last years passed working at the Desert Regional Station of the Z.S.I., Jodhpur, in an honorary capacity, where the undersigned had the privilege of working with him. In this period he was actively engaged on two pet projects: tail form and carriage in the Hanuman langur and other primates, and micro-sculpturing on the wings of insects, particularly termites.

Dr Roonwal was a member of the Advisory Council of the BNHS (1954-1965), Secretary-General of the Indian Board for Wildlife (1956-1962), President of the Zoology and Entomology Section of the Indian Science Congress (1945), a Fellow of the National Institute (now Indian National Science Academy) since 1945, and the President of the First All-India Congress of Zoology (1959). A number of other societies nominated him as their Honorary Fellow. He published more than 400 research papers, several books, and more than a hundred reviews, forewords, articles etc.

Tall, soft spoken, straightforward and unemotional in deliberation, highly knowledgeable and well read, meticulous and precise in language, a prolific writer (still using the ink-pot), orthodox (somewhat British) in nature but a non-believer in rituals, a philosopher by disposition and above all a genius, that was Dr Roonwal. He was suffering from prostrate and cataract ailments in old age, when his students and well wishers celebrated his 80th birthday at Jodhpur, in December 1988, holding a National Seminar on the Advances in Economic Zoology. When the undersigned met him last, he showed the autobiography he was penning at leisure. Wish he had completed it.

R.K. VARSHNEY

PROFESSOR T.A. DAVIS

Professor T.A. Davis, who passed away on 10 November 1989 following a heart attack, was an extraordinary scientist who combined unusual interests and abilities with novel approaches to produce work of great originality and simplicity. In his passing away the Indian National Science Academy has lost a distinguished Fellow, and his friends an amiable and respected colleague.

Davis was born on 9 February 1923 in Tamil Nadu. He took his B.A. degree in botany from the St. Josephs College, Tiruchi, and a post-graduate diploma from the Agricultural Research Institute, Coimbatore, in 1947. He had a diploma in radio-tracer techniques from the Indian Agricultural Research Institute, New Delhi and a Ph.D. in biostatistics from the Indian Statistical Institute, Calcutta. He was a Fullbright Fellow (1973). Starting his career on sugarcane research at the Sugarcane Breeding Institute, Coimbatore, around 1947, he was appointed Plant Physiologist at the Central Coconut Research Station, Kayamkulam in 1952, and in 1960 he moved to the Indian Statistical Institute, Calcutta, as Professor and Head of the Crop Science Unit. In 1972 he was asked to take charge of the Biology Division of the Institute, a position he held until he retired. He was also commissioned by the United Nations as a Specialist on palms (1975).

J.B.S. Haldane, who happened to see his work, then wrote that he (Davis) had made the staggering discovery that palms whose leaves were arranged in a left-handed spiral gave a higher yield without the use of extra fertilizer or any special breeding programme. Indeed, Haldane thought that in Davis he had discovered a potentially illustrious scientist, asserting that his opinion could not but be relied on as at least twenty of his pupils had become Fellows of the Royal Society. By then Davis had accumulated data which would permit, so Haldane believed, of a start being made on the genetics of the coconut palm along the lines which have proved successful in other plants. Indeed, it was Haldane who 'discovered' him and encouraged him in his work.

His most outstanding contributions, of course, relate to symmetry and asymmetry and right-and left-handedness in plants and animals, but specially in the coconut palm. His discovery that levo and dextro-rotatory asymmetry in plants is non-genetic is particularly significant. These and other discoveries which he made came from the application of statistics and mathematics to aspects of plant and animal life. His construction of the sunflower (capitulum) and the demonstration of the existence of Divine Proportion (Golden Ratio) in man both were a result of the application of the Fibonacci concept to plants and animals. The Fibonacci theme was his favourite and he gave a remarkable exposition of this at the International Botanical Congress at Leningrad in 1975. He was never ashamed or tired of speaking on this, whether it related to the beauty of the flower or the beauty of the human form! On one occasion, I recall his saying asymmetry in plants and animals occupied fifty percent of his time ever since he became interested in the subject.

His flair for recording and analysing quantitative data on biological specimens or material contributed to precision in understanding form and function in plant and animal systems. A great deal of what we know as science today is 'molecular' science: I mean something that is narrow and ruthlessly specialised. But there is the wholeness of science, call it holistic, integrated, inter-disciplinary, what you will – the work of Davis belongs in this category.

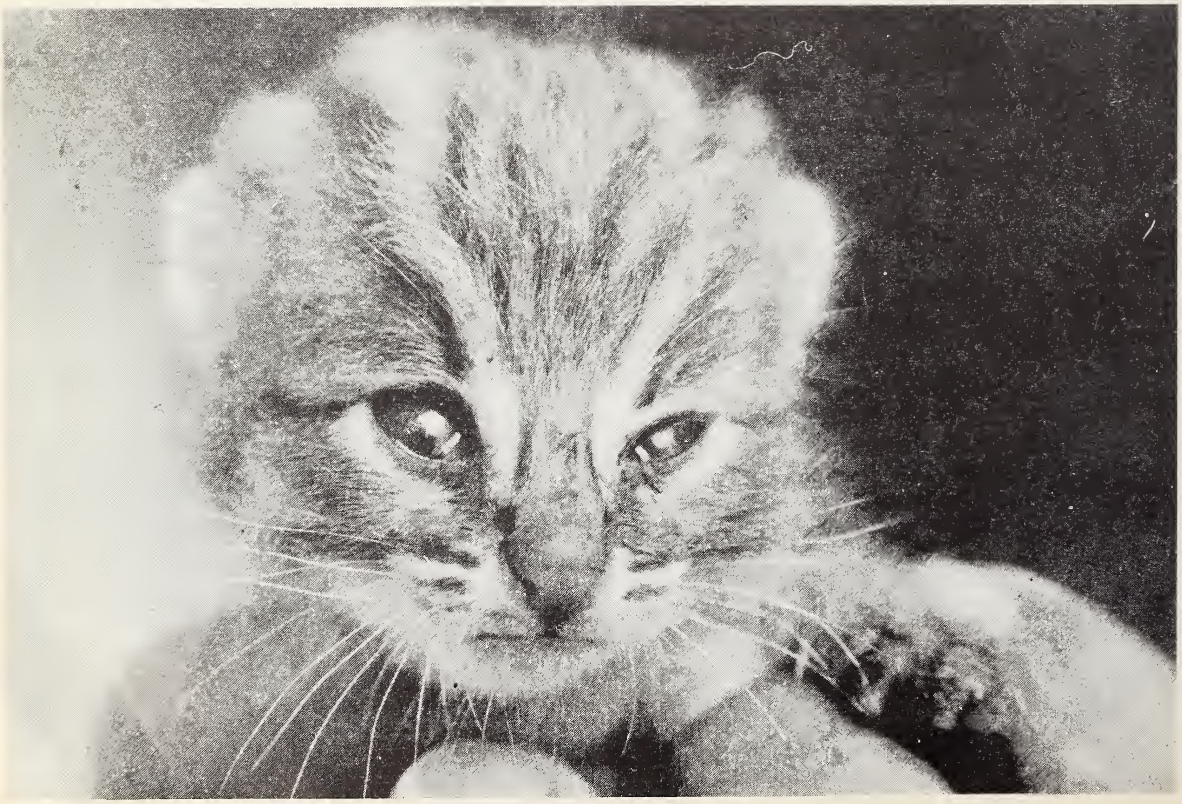
Examples of the extraordinary range of his interests may be seen in his publications: these dealt with problems such as the role of pressure in xylem transport in palms, biology and mathematics of the chambered nautilus, golden mean of the human body, selection of nesting trees and the frequency of nest visits by the Baya weaver bird. His invention of an electronic detector to detect insects within plant organs, wooden structures or storage casks, and of a vertical bicycle to climb palms and forest trees reflect his peculiar interest in doing such things. Davis was also an enthusiastic explorer of plants and animals and their behaviour. He was considered by experts to be very knowledgeable about these. Besides these, he had a passion for photography: he had built a superb collection of photographs of palms, plants, birds and other animals from many parts of the world.

Davis was a member or fellow of national and international societies and associations too many to mention here. He had travelled widely and had many friends all over the world. Following his retirement from Calcutta, he set up the J.B.S. Haldane Centre in Nagercoil for the kind of research he had been doing. There was also a great deal that was humane in him: intensely human qualities such as geniality and generosity, dignity and modesty, a flair for languages and culture, which made him the centre of attraction in any group where he was present.

His work was known and respected by many scientists in many countries. He did not get similar recognition in our own country. It is perhaps one of the disadvantages of doing the kind of work that he did (in which the main emphasis was on the application of statistics and mathematics to biology) that neither biologists nor statisticians or mathematicians feel happy with the situation. Work of this kind may get relegated to 'no man's land' – it is neither biology, nor statistics, nor mathematics. But it is science.

C.V. SUBRAMANIAN

Above: Rusty spotted cat *Felis rubiginosa* observed at Gir Wildlife Sanctuary
Below: Kitten of *Felis rubiginosa* from Gir Wildlife Sanctuary



MISCELLANEOUS NOTES

1. RUSTY SPOTTED CAT *FELIS RUBIGINOSA* GEOFFROY : A NEW RECORD FOR GIR WILDLIFE SANCTUARY AND NATIONAL PARK

(*With a plate*)

Gir Wildlife Sanctuary and National Park is located between 20°40' and 20°50' N, and 70°70' and 70°71' E. With its total spread of 1412.13 sq. km, it is the single largest contiguous forest ecosystem of the Saurashtra peninsula in western India. The climate is arid to semi arid with an average rainfall of about 800 mm. The typical monsoon climate has three distinct seasons—summer, monsoon and winter.

The vegetation is fairly homogenous and nearly 70% of the area is dominated by teak *Tectona grandis* and its several associates. Following the classifications by Champion and Seth (1968) two forest types are observed in Gir: dry deciduous forests and tropical thorn forests.

The vegetation shows a transition from comparatively more moist teak bearing forest in the west to dry *Anogeissus* bearing forest in the east.

The Gir ecosystem harbours about 32 species of mammals, 300 of birds, more than 25 reptiles, and several thousand insects, with the Asiatic lion *Panthera leo persica* as the apex predator and panther *Panthera pardus* as an important co- predator.

Apart from Asiatic lions and panthers, two more members of the family Felidae, the jungle cat *Felis chaus* and the desert cat *Felis lybica,* have been reported in Gir. *Felis chaus* is widely distributed and abundant. So far the occurrence of the rusty spotted cat *Felis rubiginosa* has not been reported in Gir. Recently this species was observed thrice in Gir at three different sites and was photographed for the first time in the wild.

The rusty spotted cat was first seen near Sasan between Bavalwala chowk and Khokhara check post, in a vegetation dominated by teak. At 0030 hrs on 13 May 1990 we saw it crossing the forest road and effortlessly climbing a straight boled teak tree. It remained perched on a small branch for more than 15 minutes, during which time we were able to take photographs.

On 19 June 1990, Navinchandra Iswarlal of Haripur observed one newly born kitten in the sanctuary area near Sandhbeda. It had not yet opened its eyes, and was in a very weak condition. He handed over the kitten, subsequently identified as the rusty spotted cat, to the sanctuary authorities on 21 June. The kitten later died.

Shyamal Tikadar (IFS), Assistant Conservator of Forests, Jamwala (Gir West Forest Division) observed an adult rusty spotted cat near Munda chowk, south of Sasan. Rohit Vyas, accompanying Tikadar, photographed the cat.

These observations confirm that the rusty spotted cat *Felis rubiginosa* is found in Gir. All three observations are from western Gir. Meanwhile Dr. A.J.T. Johnsingh of Wildlife Institute of India has reported (in litt.) his observation of a rusty spotted cat between Kankai and Chhodavadi in November 1989. So far there is no record of the cat from eastern Gir. However, the Gir being one compact forest ecosystem, its possible existence in eastern Gir cannot be ruled out.

September 7, 1990 BHARAT J. PATHAK

2. OBSERVATIONS AT A HYENA *HYAENA HYAENA* (LINN.) DEN

Among the four species of hyenas in the world (Walker 1975) only the striped hyena *Hyaena hyaena* is found in India (Prater 1980). Although it is found in several protected areas in the country (Rodgers and Panwar 1988) it is a little known animal. Not even basic natural history information is available. Johnsingh (1986), however, has discussed the conservation problems of this species. This paper presents the observations made in the wild on a family of hyena at their den from May to June 1984.

The observations were made in the Sigur forest range adjacent to Mudumalai Wildlife Sanctuary on the lower Nilgiri plateau (11°30' N, 75°44' E) in south India. The terrain is undulating to hilly and the vegetation is thorn scrub jungle to dry deciduous. Numerous villages and cattle camps dot the Sigur forest range. Elephants *Elephas maximus* were conspicuous in the area, and hampered the work, which involved walking through the forest during the crepuscular hours.

The den was under observation during the whole of May and June 1984. It was visited every day mostly in the evenings from about 1700 to 1830 hrs and also in the mornings on every third day. When there was hyena activity I stayed there till late in the evening. Observations were made from artificial or natural hides whose distance from the den varied from 15 to 50 m.

Observations

The den was located in May 1984. It lay at the head of a deep ravine on a hill slope. It was an old earth den, sloping away at angle of 45° and had a narrow entrance (70 cm wide and 30 cm high at the highest point). It looked spacious and deep. For a radius of 1.5 m around the den mouth, earth had been flattened out through constant usage. The den showed other signs of occupation as well, such as hyena tracks, fresh bones, faeces and unmistakable hyena odour.

Behaviour at the den site: The first sighting was on 6 May 1984. Three large cubs emerged at 1815 hrs. They appeared to be 10 to 12 weeks old and were probably born in February. One was a male, larger than the other two, the females. One of the females was much smaller than its siblings. The cubs seemed unaware of my presence although they distinctly heard the camera shutter and could have also made out my outline through the leaf screen. I was downwind from the den but when the wind shifted occasionally it gave them the opportunity to smell me. However, they seemed unaware of my presence.

During the entire observation period, the mother hyena was not at the den with her young. The mother was very circumspect about visiting the den. Visiting hours commenced late in the evening and ended at dawn. I made an estimate of the number of visits from the fresh tracks left on the trails leading to the den (Table 1).

Until the approximate age of 12 to 14 weeks (mid May), the cubs were mostly on mother's milk. The mother would appear in front of the den and make a low, grunting noise to attract the cubs. When they came out, it would lead them to flat ground to the north of the ravine. There it would lie down stretched out and let them suckle. From 10 May onwards, the cubs began playing with sticks and pieces of wood, but there were no signs of either bones or meat outside the den. For the first time on May 27, (14 to 16 weeks old), the mother hyena provided evidence of the cubs taking solid food. It brought a stomach lining, holding it high. It was late (0600 hrs) and I was rather careless. The top of my head was visible above the hide, and our eyes met. The hyena turned about and went off in the direction of its lair, carrying the food away. Until May 20, the excreta of the young was soft and they had no difficulty defecating. After this it was firmer and harder, the cubs having to strain to defecate. Also, small bones and pieces of meat began to appear in front of the den.

Table 1
VISITS TO THE DEN BY THE MOTHER HYENA

	May 1984 (N = 28 days) No. of visits	June 1984 (N = 28 days) No. of visits
0630-1800 hrs	0	0
1800-1900 hrs	16	12
1900-0600 hrs	81	90

It was only on one occasion that I saw a spatter of meat and bone fragments in front of the den (which could have been regurgitated by the hyena mother). The two larger cubs were observed suckling even as late as 19 June, when they were almost full-grown. All food was dragged inside and consumed, except a rib cage and an assortment of bones. The carrion brought by the mother was comparatively fresh, but on some occasions, they were decayed. The skull of a cow that was brought was bone dry. The mother hyena was able to keep its young well supplied with food, as I saw evidence of a young tiger *Panthera tigris*, two leopards *Panthera pardus* and a pack of wild dogs *Cuon alpinus* operating in the area. Additionally, carcasses of domestic cattle which may have died of natural causes, contributed to the hyena's larder.

Occasionally the cubs were observed quarrelling over food outside the den. The cubs defecated outside as soon as they came out of the den in the evening. As they grew older, they went further away from the den, down the slope of the ravine to defecate.

They scratched themselves with their hind feet after defecating. After a good scratch, the siblings groomed one another; these grooming sessions sometimes ended in scuffles. Fights were mostly jaw-wrestling matches: one of the contestants would hold is head low, twisting its neck upwards at an awkward angle and the other would grip its jaw with its own from an upright position and wrestle. They would growl while thus engaged. The smallest cub seldom took part in the fight.

An open flat area, 15 m from the den mouth, was the cubs 'play area'. They appeared to spend the night there as was evident from their spoor. At first the play area was restricted to a 5 m diameter circle. As the cubs grew, the play area also grew in size, until it occupied the entire open ground which was 40 m^2. But play was not as vigorous as in wild dog young, for instance. From the tracks left behind and also from sightings, it appeared that the mother also interacted with the young. During the whole of May, they did not venture far, except for short forays of 50 m or so (as their tracks revealed). Even during early June they did not accompany their mother on her nightly rounds. It was only towards the end of June that their tracks could be seen a kilometre beyond the den. The cubs were bolder at twilight than at dawn and as a rule, they never came out during the day.

The male cub was bolder than his sisters. He took on the role of investigator. He was the first to emerge in the evenings and the last to retire. This gave him more time with his mother and the opportunity to feed better, accounting for his larger size. I lost sight of the smaller female cub for 10 days and was beginning to wonder whether she was alive, when she surfaced again. She had to be coaxed to remain above ground even with her mother around. The other female cub, on the other hand, was quick to follow the male cub's lead and was almost his equal in every activity.

I had to wait for several days to find out the role of the father hyena. Late one evening, a large male hyena, possibly the father, approached the den entrance cautiously. It stood immobile for a few seconds, its long dorsal crest of fair hair (a hyena characteristic) swaying; then it yawned, burped and went back. The male and the large female cub, thinking it was their mother, rushed out. The moment they realised their mistake, they shot back into the den, terrified. For some days afterwards they would not come out until quite late. Thereafter they had to be quite certain it was their mother before they came out. I had no subsequent evidence of the male visiting the den.

The following tentative conclusions are possible :

1. Hyena appear to litter in winter in the lower Nilgiri plateau.
2. Males do not appear to take part in raising the litter.
3. The young appear to be dependent on the mother for procuring food till they are about four months old.

July 12, 1990 E.R.C. DAVIDAR

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3. RESPONSE TO BIRD CALL MIMICRY BY HIMALAYAN WEASEL *MUSTELA SIBIRICA* PALLAS

While birding in Naini Tal area in the 1990-91 winter we frequently mimicked the chittering alarm calls of birds to flush them, and were often surprisingly successful. In the afternoon of 5 December 1990, near the base of China Peak, a Himalayan weasel responded to our mimicry. The animal followed the chittering for several times in trying to locate the source of the alarm calls. Prater (The Book of Indian Animals, 1980) stated that it usually comes out after nightfall and trails its prey by scent. However, the present observation indicates that the animal also depends on its hearing for locating prey and responds to the prey call/song.

July 19, 1990 H.S.A. YAHYA

4. IS *RHINOPOMA* A RHINOLOPHOID BAT? AN ADDENDUM

After the publication of the paper entitled "Is Rhinopoma Rhinolophoid bat? (Gopalakrishna and Badwaik 1987) additional evidence has become available to support the contention that *Rhinopoma* may be a Rhinolophoid bat. This refers to the nature of the corpus luteum, which has been shown to be extrovert in Nycteridae (Bernard 1980) as in all the other families included in the superfamily Rhinolophoidea. This is an additional character remote from environmental influence and is shared between *Rhinopoma* and Rhinolophoidea.

A. GOPALAKRISHNA
May 12, 1990 N. BADWAIK

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5. INSECTIVORY BY THREESTRIPED PALM SQUIRREL *FUNAMBULUS PALMARUM*

Though Prater (The book of Indian animals, 1980) recorded the threestriped palm squirrel *Funambulus palmarum* as feeding on insects, there is no record of the prey species. On 21 December 1987 I had an opportunity to observe insectivory by the threestriped palm squirrel. I was mist netting forest birds at Mandapam in Tamil Nadu, and was moving around the netting sites to collect the trapped birds, when I saw a three striped palm squirrel on one of the loops of the net pocket. From a distance I thought it was a bird, but at close quarters saw it was a squirrel gnawing at something by pulling the net and holding it with its feet. As I moved slowly towards the net the squirrel became alarmed, climbed down and disappeared into the scrub. On checking the net, I found the remnants of a beetle, where the squirrel had been. The soft abdomen had been eaten completely leaving the hard elytra and the head. Later the beetle was identified as *Anomala varians* Oliv. It is noteworthy to record this incidence of insectivory in the squirrel.

March 29, 1990 S. BALACHANDRAN

6. FOOD OF THE INDIAN GERBIL *TATERA INDICA INDICA* (HARDWICKE) IN AN ARID ENVIRONMENT

The study of feeding habits of rodents provide useful clues to their role in an ecosystem. Keeping this aspect in view, a year long analysis of stomach contents of *Tatera indica* was undertaken to understand its food preference in the natural vegetation of its habitat. The prefered vegetation, if any, can possibly be used as a baiting medium. Some studies on feeding habits of Indian rodents have been undertaken by Prasad (1954), Prakash (1962, 1969), Sood and Dilber (1977) and Rana and Advani (1981).

TABLE 1
PERCENT FREQUENCY (F) OF VARIOUS PLANT PARTS (MEAN ± S.E.) IN THE STOMACH OF *Tatera indica*

Food items	Seasons		
	Summer	Monsoon	Winter
Prosopis cineraria	2.0 ±1.2	7.3 ± 1.7	20.0 ± 0.00
Zizyphus nummularia	4.0 ± 2.9	2.8 ± 0.4	11.7 ± 5.25
Cynodon dactylon	5.0 ± 2.8	15.0 ± 0.0	15.0 ± 7.6
Lasiurus sindicus	5.6 ± 2.1	11.5 ± 2.9	4.7 ± 2.9
Panicum antidotale	5.8 ± 1.9	4.0 ± 0.6	Nil
Cenchrus ciliaris	6.0 ± 2.9	10.0 ± 3.9	3.3 ± 0.9
Rhizomes and stems	29.2 ± 7.7	16.5 ± 9.6	12.7 ± 3.5
Seeds	4.4 ±1.7	10.5 ± 3.6	41.3 ± 0.6

The study was undertaken during 1988 at Central Research Farm at Jodhpur (23°18' N, 73°08' E) in the western Rajasthan desert. The stomach contents of freshly-captured *T. indica* (20 samples in each season) were macerated and microscopic studies prepared following the method described by Cavender and Hansen (1970). For identification of plant material, the epidermal structure was studied and compared with reference slides of the plant species occurring in the home range of the rodents.

The percentage frequency (F) of occurrence of a plant species was calculated according the formula given by Cavender and Hansen (1970): F = (No. of locations in which species occurs/Total no. of locations examined) x 100.

Table 1 shows the percentage frequency of various fallen tree leaves, grass leaves, rhizomes, stems and seeds found in the stomach of *T. indica* during summer, monsoon and winter. Grasses were preferred more during monsoon than in summer and winter seasons, apparently because of their abundant occurrence in the monsoon season. Leaves of trees were preferred significantly more during winter than in summer and monsoon seasons. Interestingly, rhizomes and stems of grasses were preferred during summer, followed by monsoon and winter seasons. Likewise, seeds were consumed significantly more during winter than in summer and monsoon months. Dry matter contents of the stomach (g/100 g body weight) were recorded to be higher in winter than during the rest of the year.

It may be concluded that preference of vegetation by the Indian gerbil is influenced by the frequency of occurrence of various plant parts available in nature in various seasons.

We are grateful to Dr. J. Venkateswarlu, Director, and Dr. B.D. Rana, Head of the Division of Animal Sciences and Rodent Control, Central Arid Zone Research Institute, Jodhpur, for providing necessary facilities and encouragement during the course of this study.

August 31, 1990
FARZANA PRAVEEN
NISHA KASHYAP

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7. RED-BILLED TROPIC BIRD *PHAETHON AETHEREUS* LINNAEUS FROM NEENDAKARAI, KERALA.

(*With a text-figure*)

Fig. 1. *Phaethon aethereus* specimen at Neendakarai.

An unidentified stuffed specimen of tropic bird is kept in the museum of the Department of Zoology, Sree Narayana College, Quilon, Kerala. The bird was obtained in June 1982 from the sea off Neendakarai fishing harbour by local fishermen. According to them, the bird, which was afloat in the water at night, got entangled in their fishing nets and was thus captured. Because the bird looked unfamiliar with its large size and heavy body, they carried it home. Shanmughan, an attendant at the Zoology Department, bought it from the fishermen and kept it in the departmental museum after skinning and stuffing it. He said the bird was very aggressive when handled. A fisherman was wounded by its bill.

A study of the specimen with reference to the HANBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1983) shows that it is an immature red-billed tropic bird *Phaethon aethereus*. The tail-streamers are absent. The bill is yellow and the culmen slightly arched. A black patch in front of each eye continues back as a band across the eye to the nape. On the nape, the two bands join together to form a crescent, continuous with the barred back. The primaries are tipped with black. The legs and feet are yellowish. The anterior toes and webs between them are black, as are the claws.

The measurements of the specimen are: wing 275 mm, bill 58 mm, tarsus 27 mm, and tail 58 mm.

BIRDS OF KERALA (Salim Ali 1968) and KERALATHILE PAKSHIKAL do not mention any previous record of this bird anywhere from the coastal areas of Kerala.

I wish to thank Dr. S. Ramachandran, Sri J.S. Serrao and Prof. K.K. Neelakantan for their help and encouragement, Prof. S.Krishnakumar, Head, Department of Zoology, S.N. College, Quilon, for permitting to photograph the specimen and Sri S. Shanmughan for assistance in preparing this note.

February 22, 1989 OMKAR G. KRISHNAN

8. MASKED BOOBY *SULA DACTYLATRA MELANOPS* HEUGLIN FROM KERALA

A live specimen of masked booby *Sula dactylatra melanops* Heuglin was collected by some fishermen near Chaliyam, approximately 10 km south of the coastal city of Calicut on 14 August 1988. The bird was found standing on a rocky promontory jutting into the sea. Apparently in a flightless condition, it hopped onto a boat belonging to some oyster collectors. Right from the first day of its captivity, the bird feds voraciously on fish and was not unduly wary of human presence.

The specimen measured 82 cm from the tip of the bill to the tip of tail and had a wingspan of 152 cm. The bill was 11 cm long, the tail 17 cm and tarsus 5 cm. The iris was bright yellow, the bill greenish yellow and the feet slaty blue.

Another such specimen was caught in 1988 ago near Kadalundi river mouth, one km south of the present capture site. A similar bird was reportedly caught, three years earlier, from abôut the same area.

Perhaps the masked booby is a regular visitor to the Malabar seaboard despite its rather scanty occurrence mentioned in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1983).

August 30, 1989 D. K. NARAYANA KURUP

9. AN UNRECORDED FEEDING HABIT OF THE PARIAH KITE *MILVUS MIGRANS GOVINDA* SYKES

Ali and Ripley (HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, 1983) and some of the earlier ornithologists like Hume (1869), Jerdon (1877), Murray (1888), Finn (1917), Baker (1928) and Whistler (1941) recorded that the pariah kite *Milvus migrans govinda* picks up food or prey and transfers it from the feet to the bill, tearing the morsel apart, all in flight. The kite, unlike vultures, was not observed to sit on the ground and appropriate its food.

Pariah kites were observed to sit and feed on flesh attached to bones and insect larvae flourishing in decaying meat and marrow of bones heaped near slaughter houses, bone mills and carcass utilization centres at Agra (in 1980, 1981, 1983 and 1987), Bombay (in 1982, 1983 and 1984) and Vanasthalipuram (in 1986), about 18 km from Hyderabad on Vijayawada road. They were also feeding on flesh attached to the hides of cattle carcasses and tannery wastes, sitting on the ground along with crows and vultures at Bangalore (in 1984) and Vaniyambadi, between Madras and Bangalore. They were sitting and feeding at garbage dumps and poultry dressing waste dumps along with crows in Madras (in 1986).

The evidence already collected from different places indicates that kites do sit and feed at times. They probably do so when their safety during feeding is assured and when the food is difficult to separate from the source.

March 10, 1989 S.M. SATHEESAN

10. SIGHTING OF THE LESSER FLORICAN *SYPHEOTIDES INDICA* (J.F. MILLER) IN KARUNAGAPPALLY, KERALA

A lesser florican *Sypheotides indica* was caught at Mararithottam, near Karunagappally of Quilon district, Kerala, on 14 January 1989. The previous record of lesser florican from Kerala is of a specimen shot in 1876 by H.S. Ferguson, the then curator of the Trivandrum Natural History Museum. He obtained it "in some rushes near Trivandrum" (Ali 1984).

The present find was made by a person in his shop around 0600 hrs. Some harvesters and children claim to have seen the bird in the adjacent paddy fields, earlier the same day. The children pelted stones at it and chased it away. Evidently, the bird became disturbed and took shelter in a dark corner of the shop.

Finding it to be a strange bird, the shopkeeper put it in a cage. It became a source of attraction to the people around. Very soon, it acquired considerable religious and sentimental value when somebody pointed out that it was a *Thanka mayil* - Golden peacock, the vehicle of Lord Muruga. Finding it difficult to cope with the flow of visitors, it was transferred to a nearby Muruga Temple, where it drew much attention from the public, before it escaped on 6 March.

The bird, which was about the size of a village hen, appeared to be a female as the white colour present in the wings of the male lesser florican was absent. The two parallel black stripes down the throat and foreneck were present. The pale median 'centre parting' through the crown and forehead was also present as were the characteristic blackish arrowhead marks on wings and back (Sankaran 1987). A curious feature of the florican obtained here was that the upper mandible was slightly shorter than the lower.

According to Ali and Ripley (1983), the range of the lesser florican is in western India, especially in Gujarat and parts of Madhya Pradesh and Rajasthan. They state that the floricans are "rare in the coastal strip between the Western Ghats and the sea". Karunagappally is a coastal taluk separated from the Western Ghats by more than 50 km. The bird obtained here must be an "exceptional straggler".

I wish to thank Dr. S. Ramachandran for his help and encouragement in preparing this note.

July 13, 1989 OMKAR G. KRISHNAN

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11. WOODCOCK *SCOLOPAX RUSTICOLA* LINN. IN THE JATINGA BIRD PHENOMENON

(*With a text-figure*)

Fig.1. Proposed migratory rout of some woodcocks from Jatinga to Nilgiris.

On 29 September 1986, while I was investigating the bird phenomenon in Jatinga, Assam, a male woodcock *Scolopax rusticola* dropped onto a petromax lantern placed near the observatory tower. As in other cases the bird lost its flight responses, becoming almost immobile, and refused any food or liquid. It could be easily handled for taking measurements etc.

This the first record of a woodcock or any other migratory bird around lighted areas during the occurrence of the bird phenomenon in Jatinga. Consequently, this is the first record of the capture of this long distance migratory flier in Barail hill (south Assam). It appears that the woodcock descended to that low hilly region prior to its migratory sojourn to Nilgiri hill and other south Indian hills. If it is so, then the migratory route of some woodcocks would be through Bangladesh, West Bengal (several specimens were netted in Salt Lake, Calcutta, between 1963 and 1969 by B. Biswas), Eastern Ghats, etc. with or without a stop-over en route (Fig. 1). The woodcock is regarded as the only long distance flier in India and is believed to fly non-stop from the Himalaya to Nilgiri hills, a distance of 2400 km.

An attempt should therefore be made to find out the actual migratory pathways of this crepuscular/nocturnal bird, which are still shrouded in mystery.

February 28, 1989 SUDHIN SENGUPTA

12. GREAT BLACKHEADED GULL *LARUS ICHTHYAETUS* PALLAS IN EARLY SUMMER PLUMAGE

On 8 January 1989, while counting birds at Kookas Lake near Jaipur (Rajasthan), I observed a gull as large as a duck with a black head and neck. The gull had crescentic white marks one above and one below the eyes. Its back and wings were pearl grey and the rest of the plumage was snow-white, except the primaries which were subterminally black. There were no 'mirrors' in the wings. The gull, identified as a great blackheaded gull *Larus ichthyaetus*, was swimming with a group of 34 large cormorants.

The unusual feature was the black head and neck - the summer plumage which, according to the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN (Ali and Ripley 1983), is assumed about February. I have observed such a plumage deviation from that reported in the HANDBOOK in the case of the Desert wheatear *Oenanthe deserti* (Temminck) also, at the Sambhur lake (27 December 1988) and Bharatpur (19 January 1989).

April 11, 1989 . DHIRENDRA DEVARSHI

13. ADDITIONAL NOTES ON THE OCCURRENCE OF BLACK TERN *CHLIDONIAS NIGER* (LINN.) IN INDIA

At 2200 hrs on 22 December 1988, while ringing waterbirds at Point Calimere, Tamil Nadu, we ringed two black terns *Chlidonias niger* along with 12 whiskered terns. One more black tern was ringed on 24 December. The ringing details of the three birds are as in Table 1. We could differentiate this tern from whiskered tern by the silvery grey mantle and slate-grey rump. The black tern differs from the closely related whitewinged black tern by the black of the hind head continuing as a dark patch on either side of the neck in front of the base of the wings, and the absence of a white rump (Ali and Ripley 1983).

It was sight recorded near Delhi on 11 October 1949

TABLE 1
RINGING DETAILS OF 3 BLACK TERNS RINGED AT POINT CALIMERE

Age	Wing (mm)	Bill (from feathers) (mm)	Tarsus (mm)	Tail (mm) Central	Outer	Weight (g)	Moult (Wing primaries)
Adult	210	25	19	65	74	60	1st primary old, rest were new.
Adult	–	26	20	66	76	60	-do-
Juvenile	205	23	20	64	70	50	All the primaries were old.

(Alexander 1950). Abdulali and Ambedkar (1983) confirmed their occurrence in India from a ring recovery (bird ringed at Moscow) at Point Calimere, Thanjavur district, Tamil Nadu, during 1970. There is no previous ringing record of this bird in India. Hence this ringing record further confirms its definite occurrence in India, and is an addition to the bird list of Point Calimere.

V. NATARAJAN
January 19, 1989 P. BALASUBRAMANIAN

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14. BIOMETRICS AND FOOD OF SOME DOVES OF THE GENUS *STREPTOPELIA*

Between 1982 and 1987, we obtained carcasses of spotted dove *Streptopelia chinensis*, ring dove *S. decaocto*, and little brown dove *S. senegalensis* from Bombay, Tezpur, Gwalior and Sirsa. They were killed by impact or shock at aerodromes.

Biometrics of nine doves of *Streptopelia* genus showed the following. On an average a spotted dove weighed 126.5 g, a male ring dove weighed 167.67 g and the little brown, 82.5 g. Female spotted doves were not available, whereas one female each of ring dove and little

TABLE 1
BIOMETRICS AND STOMACH CONTENTS OF SOME DOVES OF *Streptopelia* GENUS

Species	Locality	Date	Sex	Weight in (g)	Measurements-Length in (mm) Wing	Bill	Tarsus	Tail	Stomach contents
Streptopelia chinensis Spotted dove	Bombay	Sept. 1982	M	125	140	19	22	132	Nil
-do-	Tezpur	Dec. 1986	M	128	136	17	24	124	Rice and other grains
Streptopelia decaocto Ring dove	Gwalior	Dec. 1986	M	160	185	–	–	–	Nil
-do-	Sirsa	Jan. 1987	F	165	168	21	26	–	Wheat
-do-	-do-	-do-	M	173	171	20	27	–	Wheat, Black seeds
-do-	-do-	-do-	M	170	172	19	25	–	Wheat
Streptopelia senegalensis Little brown dove	Gwalior	Dec. 1986	M	85	134	–	–	–	*Cyperus* grains
-do-	-do-	-do-	F	85	129	–	–	–	Grains of *Celosia argentea* and *Dactyloctenium* sp.
-do-	-do-	-do-	M	80	122	–	–	–	Seeds of *Momordica* sp.
Average for *Streptopelia chinensis*			M	126.5 (2)	138 (2)	18 (2)	23 (2)	128 (2)	
Average for *Streptopelia decaocto*			M	167.67 (3)	176 (3)	19.5 (2)	26 (2)	– –	
Average for *Streptopelia senegalensis*			M	82.5 (2)	128 (2)	–	–	–	

brown dove were examined (Table 1).

According to Ali and Ripley (1983), the doves of *Streptopelia* genus are principally grain and seed eaters, though at times they may also feed on young shoots of certain plants like mustard and wheat in cultivated land or grassland. Baker (1913) pointed out that in captivity they feed not only on cereals and pulses but also on bread, potatoes, cabbage and almost anything except meat and fish.

During the analysis, the stomach contents of spotted dove showed rice and other grains, while those of three ring doves showed wheat and unidentifiable seeds. Four little brown doves had grains of *Cyperus* sp., *Celosia argentea* and *Dactyloctenium* sp., and seeds of *Momordica* sp.

This data was collected as part of the BNHS project 'Ecological Study of Bird Hazards at Indian Aerodromes' sponsored and funded by Aeronautics Research and Development Board, Ministry of Defence, Government of India.

S.M. SATHEESAN
PRAKASH RAO
HEMANT DATYE

December 12, 1989

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15. LARGE INDIAN PARAKEETS *PSITTACULA EUPATRIA* (LINN.) HARASSING A PARIAH KITE *MILVUS MIGRANS GOVINDA*

There are many community roosting sites of parakeets in Udaipur city, Rajasthan. In the morning parakeets fly away from the roosts towards the fields and orchards around Udaipur, returning to the city in small and big groups in the evening.

At 1750 hrs on 25 September 1988, on the outskirts of Udaipur, we spotted a pariah kite *Milvus migrans govinda* slowly gliding towards the city. A group of 21 large Indian parakeets *Psittacula eupatria* were flying a little higher than the kite. They slowed, dropped and encircled the kite and started harassing it. The kite twisted, turned and tried every possible means to evade this harassment, but failed. We followed them slowly on our scooter. The kite slowly lost altitude and after going for about 500 m in this fashion perched on a eucalyptus tree. The parakeets followed suit. After ten minutes the kite flew off the tree and remained just at tree top level, with the parakeets following. After flying about 100 m in this fashion, they went out of sight.

RAZA TEHSIN
AREFA TEHSIN

December 15, 1988

16. NEW CALL RECORD OF GREENBREASTED PITTA *PITTA SORDIDA* (P.L.S. MULLER) IN DEHRA DUN, UTTAR PRADESH

On the morning of 16 July 1988, we sighted a hooded or greenbreasted pitta *Pitta sordida* in the New Forest campus at Dehra Dun, the northern slopes of which are covered with thick natural jungle. The black throat and sides of neck, brown crown and nape and the green breast were diagnostic. We sighted the pitta again on 23 July 1988. It was calling from a low tree fork.

Ali and Ripley (1983), quoting Baker, mentioned only the possibility of a loud musical whistle call. There is no mention about the calls of the greenbreasted pitta in other available literature. However, on this occasion a distinctive call was noted - a quick double fluty whistle *quek-quek* for duration of a second. The pitta monotonously repeated the calls at 3-5 intervals, lifting the head partially while calling. The next morning two greenbreasted pittas were heard simultaneously making the double whistle call. The pitta was last heard on 30 July 1988 and since then all attempts to locate it failed.

These observations therefore constitute probably the first record of a double whistle call of the greenbreasted pitta. Also, these records are probably the first sightings of the greenbreasted pitta in Dehra Dun, as the two main checklists of the area by Joseph George (1957) and B.B. Osmaston (1935) do not mention this bird. The greenbreasted pitta occurs from central Nepal eastwards and there is one specimen in the BNHS collection from Simla (Ripley 1982).

DHANANJAI MOHAN
RAVI CHELLAM

July 13, 1989

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17. LARGE SCALE MIGRATION OF SWALLOWS TO KERALA

For the last 10 years, thousands of swallows have been ariving at the end of September at Muvattupuzha, Kerala. The birds perch on the telephone wires criss-crossing the town and extending across the nearby river. They fly over the town at sunset, roost at night on the telephone wires and fly away in search of food by early morning.

Crows prey on the swallows at their roosts. The birds were identified as *Hirundo rustica gutturalis* by Dr. V.S. Vijayan of B.N.H.S. In 1985 Dr. R. Sugathan ringed a few birds, and in March 1986 some were collected from Tamil Nadu (pers. comm.). Usually, the birds roosting at Muvattupuzha exploit the area for about four months, leaving by January-February. From Sugathan's observations, it is clear that Muvattupuzha is only a midway station during the birds' migration southwards.

The site preference of these birds for Muvattupuzha may be due to the availability of food, especially insects, as by September the paddy fields, after the harvest have plenty of insects.

January 13, 1989 SHAJU THOMAS

18. ORIENTATION OF NEST COLONIES BY BAYA WEAVER BIRDS

It is a general observation that nesting baya weaver birds *Ploceus philippinus* invariably select the eastern side of trees to build upon, since this side is protected from the south-west monsoon. However, colonies which are built late in the season, when the severest part of the monsoon is over, may face in the opposite direction (Nesting habits of the Baya *Ploceus philippinus*. Salim Ali, *J. Bombay nat. Hist. Soc. 34 (4)*: 947-964).

During the breeding season of 1987, orientations of 141 nest colonies of *Ploceus philippinus* were studied in four districts of Rajasthan, viz. Alwar, Jaipur, Chittoragarh and Udaipur. Various types of habitats like plain agricultural fields, forest areas, dams, hill slopes, old wells etc. were examined to study the orientation of nest colonies in respect of the SW monsoon in Rajasthan. The surveys were made from July to end of October. My findings are given in Table 1

It was seen that yearling and sexually mature males show three types of colony orientation in Rajasthan: peripheral orientation, central orientation and lateral orientation.

Peripheral colonies were the fewest, constituting only 2.1% of the colonies studied. In such colonies, nests are hung in all directions at the peripheral zone of the tree canopy.

Centrally oriented colonies were about 17%. In such colonies, nest are placed in deeper points of canopy of host trees, so that they get protection from all directions.

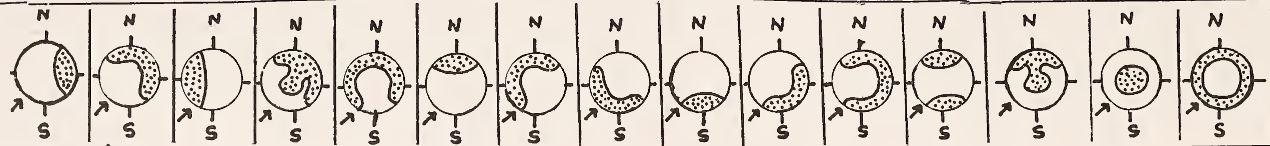
Lateral colonies were maximum in number, about 80.9% of total colonies studied. Such colonies can face one, two or even three directions. Colonies which were facing the eastern side were maximum in number about 40.4% of total colonies and 50% of lateral ones. There may be many combinations of directions among lateral colonies as shown in Table 1.

Large nest colonies may extend in more than one direction, but many 'one nest' colonies have been observed facing off-directions, i.e. other than eastern side in plain terrain even at the beginning of the monsoon. In certain types of habitat such as sloping areas, vertical banks of rivers and nallahs, and old wells, the tendency of 'eastern side colonization' is less marked.

In sloping areas like hill slopes, generally nesting is done towards the downhill side of the tree canopy irrespective of the SW monsoon. The aim of selection of downhill side for nesting is to get extra elevation as a protection against predators. Similarly, on or near the vertical banks of rivers and nallahs, that side of host trees is preferred which faces the stream bed. Again, the reason probably is the extra elevation. In wells and vertical banks of river and nallahs even small hanging trails of vegetation can be used for hanging the nest, irrespective of SW monsoon. It is very difficult for predators to climb the vertical surfaces, hence the nest colonies in such areas can be said to be well protected (Figs. 1-5).

August 30, 1988. SATISH KUMAR SHARMA

TABLE 1
ORIENTATION OF NEST COLONIES BY *Ploceus philippinus* IN RAJASTHAN



Host plants	E	N-E	W	C-N-E	N-W-E	N	N-W	S-W	S	S-E	N-E-S	S-N	C-N	No. of colonies showing central orientation	No. of colonies showing peripheral orientation	Total
	No. of colonies showing different types of lateral orientation with orientation diagrams															
Phoenix sylvestris	9	3				1			1							14
Acacia nilotica	28	2	5	1	1	4		1	1	2		2	1	10	1	59
Acacia leucophloea	11	7							1	4		1		5		29
Acacia senegal									1							1
Acacia tortilis						1								1		2
Prosopis juliflora	4															4
Prosopis cineraria	1	1	2			2	1	1	3		1			4	2	18
Butea monosperma	2	2														4
Zizyphus mauritiana	2	3	1											4		10
TOTAL	57	18	8	1	1	8	1	2	7	6	1	3	1	24	3	141

E=East, W=West, N=North, S=South, C=Central colony, P=Peripheral colony, → =Direction of SW monsoon, O=Tree canopy, ⁘ Nested part of canopy in respectof SW monsoon.

19. SOME ALITUDINAL RECORDS OF BIRDS FROM THE HIGH RANGE, KERALA

The period 25-30 April 1988 was spent birdwatching in and around the Eravikulam National Park, Kerala. Almost no information has been published on the avifauna of the park, which includes the highest Indian summit south of the Himalayas (Anaimudi 8840 ft.). A number of bird species were observed at altitudes higher than the upper limits given in BIRDS OF KERALA (Salim Ali, 1969).

Little grebe *Podiceps ruficollis:* a male in breeding plumage on the river at the High Range Club, Munnar, *c.* 1600 m.

Blackshouldered kite *Elanus caerulens*: a pair hunting over the Eravikulam plateau at 2400 m on consecutive days.

Brahminy kite *Haliastur indus*: at *c.* 1500 m at Munnar.

Crested serpent eagle *Spilornis cheela*: one perched in a dead shola tree at 2300 m on the plateau.

Banded crake *Rallina eurizonoides*: in reeds at the High Range Club at *c.* 1600 m (identification not positive)..

Whitebreasted waterhen *Amaurornis phoenicurcus*: on the river at the High Range Club, *c.* 1600 m.

Maroonbacked imperial pigeon *Ducula badia*: scattered individuals at *c.* 2300 m along the track and in small patches of shola on the plateau.

Spotted dove *Streptopelia chinensis*: as high as 1900 m in Vaguvurrai Tea Estate.

Small green barbet *Megalaima viridis*: seen at 2400 m on the very highest tree of a large patch of shola stretching up steep cliffs above Erumapatti, from where it made brief forays out over the grassy plateau.

Little scalybellied green woodpecker *Picus myrmecophoneus*: seen at *c.* 2200 m at the upper edge of the Vaguvurrai Tea Estate.

Southern greybacked shrike *Lanius schach*: up to at least 1900 m at Vaguvurrai.

Redwhiskered bulbul *Pycnonotus jocosus*: seen occasionally as high as 2300 m on the plateau.

Magpie-robin *Copsychus saularis*: seen at up to 1700 m at Vaguvurrai.

April 12, 1990 ANDREW ROBERTSON

20. BIRD RECORDS FROM MANDAPAM AND NEIGHBOURING ISLANDS, TAMIL NADU

The Mandapam peninsula (9°17' N, 79°8' E) lies on a narrow strip of land projecting from the south-east coast of India in Ramanathapuram district, Tamil Nadu, with the Gulf of Mannar to the south and the Palk Bay to the north. Rameswaram island lies at the end of the peninsula and is connected to the mainland by a railway bridge. At distances ranging from 5-8 km from the mainland the Gulf of Mannar has a chain of islands running roughly parallel to the coast.

Some of these islands, the lagoon of Rameswaram island and the Pillaimadam lagoon in the mainland adjoining Palk Bay are the major habitats available for waterbirds. The birds mainly use these islands and lagoons as resting places before migrating to Sri Lanka. However, thousands of birds may remain at these lagoons and islands for the whole winter. The BNHS bird ringing station established at Mandapam since September 1985 has proved extremely valuable in obtaining data on the movements of such migrants. Information on some of the species considered to be rare is recorded below :

Antarctic skua *Catharacta skua*: On 8 January 1988 our trappers saw a dark bird with black legs and beak, equivalent in size to the herring gull, which they identified as an Antarctic skua when shown a picture of the latter. On 10 January one of our trappers and members of the Ramnad Wildlife Association, when taking a waterfowl census in the island, observed the same bird. Perumal Raja identified it as an Antarctic skua. I went to the island on 12 January to confirm their identification. The bird was located at the intertidal area at low tide. The slight projection of central feathers identified the bird as of genus *Catharacta.*

Ringed plover *Charadrius hiaticula*: On 25 February 1988 we trapped a bird at Dhanuskodi, Rameswaram island, which appeared similar to the little ringed plover *Charadrius dubius* but differed in size, being equivalent to the lesser sandplover *Charadrius mongolus*. It had a clear wing bar, lacking in *C. dubius*. The bird was identified as the eastern ringed plover *Charadrius hiaticula tundrae* (Prater *et al.* 1977). The bird was an adult with fresh primaries, and had the following measurements:

wing 138 mm, bill 15 mm, tarsus 26 mm, tail 68 mm, weight 57 g. The wing and tail were 6 and 7 mm longer than the measurements given by Ali and Ripley (1983).

The bird is recorded as a straggler or very rare winter visitor by Ali and Ripley (1983). After two birds were trapped at the same site on 22 February 1990 by the Society's bird ringing camp at Muthupet (*c.* 10°35' N, 79°36' E), Thanjavur district in Tamil Nadu, Abdulali and Hussain opined that this species was not so rare or as much of a straggler as was suggested by Ali and Ripley (1983). Though the bird was listed in the checklist of birds of Point Calimere none of them were ringed during the last eight years of bird ringing by the Society's Avifauna Project. At

Mandapam under the same project this is the only bird caught for the last three years (1985-88), during which time around 3000 plovers were ringed. It is suggested that the bird is a rare winter visitor as noted by Ali and Ripley (1983).

Noddy tern *Anous stolidous*: On 26 November 1987 a noddy tern was seen in the Pillaimadam lagoon, situated 3 km from Mandapam adjoining Palk Bay. At Point Calimere, the noddy tern was recorded with other pelagic species like the lesser frigate bird and sooty tern, immediately after the cyclonic storm on 22 December 1983 (Balachandran *et al.* 1984). The bird was always seen floating on the water. When approached, it flew away some distance, and again settled on the water. The next day also the bird was seen at the same site, but it disappeared thereafter.

February 8, 1989 S. BALACHANDRAN

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21. FURTHER ADDITIONS TO THE AVIFAUNA OF POINT CALIMERE

Eastern steppe eagle *Aquila rapax nipalensis*: On 26 November 1988 one bird was noticed sitting on the ground opposite the old forest rest house. It is a winter visitor, common in west Pakistan, Nepal and North India, wandering south at least to the Bombay Deccan, and east to southern Orissa (Ali and Ripley 1983). The bird's sudden appearance at Point Calimere might be due to the formation of a cyclonic depression in the Bay of Bengal during the same period.

Red spurfowl *Galloperdix spadicea*: On 4 September 1984 a male was seen on the grass patches on the verge of the road near Ramarpatham area. On 29 April 1988 two hens were sighted in the same locality.

Eastern whimbrel *Numenius phaeopus variegatus*: An adult was obtained on 18 November 1988 while trapping ducks in the monsoon puddles near the casuarina belt in the forest. The bird was ringed and released. Ali and Ripley (1983) mention that this bird has been obtained as a vagrant and/or on migration in Assam in autumn or winter, and Manipur. It occurs in the Sunderbans (West Bengal and Bangladesh).

Brownwinged tern *Sterna anaethetus*: One bird was accidentally caught in fishing nets at sea on 19 December 1988. The bird was totally wet and died after a few hours. Its skin was collected. Ali and Ripley state that the post breeding dispersal of this bird occurs chiefly over the Arabian sea to the coasts of Pakistan, western India and Sri Lanka. Two records exist from the Andaman islands (Abdulali 1971).

Sandwich tern *Sterna sandvicensis*: Two birds were ringed on 22 and 29 October 1983, but were not included in the previously published bird list of Point Calimere. One more bird was ringed on 28 September 1988. Though this bird is a common winter visitor to coastal Pakistan (Ali and Ripley 1983), it was previously recorded in the east coast only at Mandapam and Rameswaram island (Lal Mohan 1986, S. Balachandran, pers. comm).

V. NATARAJAN
P. BALASUBRAMANIAN
S. ALAGAR RAJAN
January 3, 1989 RANJIT MANAKADAN

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22. SITE FIDELITY AND POWER OF RECOGNITION IN PARIAH KITE *MILVUS MIGRANS GOVINDA*

Observations were made on site fidelity on pariah kite *Milvus migrans govinda*, bayback shrike *Lanius vittatus*, redwattled lapwing *Vanellus indicus*, common myna *Acridotheres tristis*, pied myna *Sturnus contre*, little egret *Egretta garzetta*, cattle egret *Bubulcus ibis*, night heron *Nycticorax nycticorax*, pond heron *Ardeola grayii* and painted stork *Mycteria leucocephala* at the National Zoological Park, New Delhi.

The pariah kites congregate at selected sites in hundreds with the approach of winter every year. The birds had use the same site and had even used the same tree in some cases to build nests during my study in 1976-1979, and this process is continuing even to-day.

According to Ali (1977), the birds return not only to the same general locality for breeding year after year, but often to the identical nesting sites. This pattern of arrival has also been observed in egrets, herons and painted storks at the Zoological Park.

During the study of the breeding biology of pariah kite, Bacha Manjhi, Assistant Keeper, was associated with the project. Manjhi and I used to regularly climb the trees to take measurements of nests, eggs, etc. It was observed that the kites (male and female) recognized us very well. They used to spot us from a distance of 200-300 m from the nesting site, and attack us. We were forced to use helmets to protect our heads. Further, we noted that when I approached the nesting site accompanied by other persons, I was the only target of attack.

During 1977, Manjhi was replaced by Ram Sakal. He was picked as a target of attack after a few visits to the nests. Thousands of people visit the Park, but are not attacked, suggesting that pariah kites have strong recognition power for particular objects with which they frequently come into contact.

In order to judge their ability to recognise persons or objects, Manjhi was sent with a group of 6 zoo employees near the nesting site. He was the sole target of attack. On an another occasion, he was made to approach the nesting site (accompanied by other persons) wearing different coloured clothes, but again he was the target of attack, notwithstanding the change in colour of his dress.

10 chicks were hand reared to compare their growth with natural grown chicks. They were fed 3 times a day with pieces of beef and fish. As a result of association, these chicks had developed attachment and were responsive to calls. Moreover, the chicks recognised the sound of the horn of the van which supplied the food material. On hearing the van, chicks would become alert and start calling. Although a number of vehicles passed through that area, they responded solely to the sound of the particular vehicle, showing that pariah kite chicks had the innate ability to recognise objects and sound/voice.

During 1977, 22 chicks of pariah kite were ringed when they were 40 days old. Two chicks died one week after their release. A few were seen returning to the zoo area in 1978 along with adult kites

The bay-back shrike which breeds during summer also attacked us when we approached their nests, showing their ability of recognition. Similar abilities have been observed in the lapwing, common and pied myna (Desai and Malhotra 1988).

February 22, 1989

A.K. MALHOTRA

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23. AGE AT SEXUAL MATURITY OF GHARIAL *GAVIALIS GANGETICUS* (REPTILIA: CROCODILIA)

McCann (1940) advocated that with reptiles, "It is perhaps better to arrive at the size at which they breed rather than place any reliance on age". Bustard and Singh (1981) mentioned, "It is not known if there is an age or size 'over- ride' in crocodilians" as far as the attainment of first breeding is concerned. Data on sizes of some of the small breeding gharial *Gavialis gangeticus* females are available in Hornaday (1885), Parshad (1914), Srivastava (1981) and Bustard and Maharana (1982). The sizes are 2.70 m, 2.97 m, 3.12 m, and 3.0-3.17 m respectively.

The gharial referred by Bustard and Maharana (1982) were obtained by the Nandankanan Biological Park from river Mahanadi at sizes of 1.35 m (on 22 March 1963) and 0.90 m (on 10 November 1964). Singh (1978) estimated these juveniles to be respectively 17 months and 33 months old at the time of capture. Therefore, at the time

TABLE 1
EGG LAYING BY 3 CAPTIVE GHARIALS AT NANDANKANAN

Sl. No.	Egg laying		Hatching		
	Date	Nos. of eggs	Date	Nos. of hatchling	% of hatchling
1.	22 Mar. '84	33	20/22 May '84	29	87.9
2.	28 Mar. '84	29	21/23 May '84	26	89.7
3.	23 Mar. '85	30	17 May '85	26	86.7

of first breeding in 1980 (Bustard and Maharana 1982) the females were 16.5 to 19.9 years old. These figures are undoubtedly high because of the protracted captivity without a suitable breeding pen and breeding male.

We present here more direct data on the age at first breeding for three female gharials, all hatched in captivity from wild-collected eggs. The ages were 8.5 years for two females and 9.5 years for another.

During April-June 1977 a total of 26 captive-reared gharials, hatched in June 1975, were released from the Gharial Research and Conservation Unit, Tikarpada, into river Mahanadi. Nine of these were subsequently recaptured by accident (Bustard *et al.* 1982). Out of these recaught gharials three were received at the Nandankanan Biological Park. The tail scute clippings confirmed the origin and date of release of these juveniles. These three juveniles were housed in the main gharial breeding pen, where they grew up to lay their first clutches of eggs as shown in Table 1.

The size of the females was not measured at Nandankanan. The sizes of other female gharials of the same year of hatching, retained at Tikarpada, were a maximum of 3.24 m (mean 3.10 m, n=10) at 9 years old and a maximum of 3.30 m at 10 years and 3 months old (Singh 1990).

Two of the 1975-hatched female gharials laid eggs at Nandankanan in 1984 when they were 8 years and 9 months old. Since breeding activity commences from December the receptive age for breeding reduces further to 8.5 years. The sizes of these females are expected to be close to 3.0 m at first egg laying, because relatively larger (in 1977) females of the same brood retained for rearing at Tikarpada were 3.10 m at 9 years old.

The third female of the same brood laid eggs a year later in March 1985 suggesting variation in growth and age at first breeding with juveniles of the same brood.

The maiden clutch sizes of the three female gharials are 29-33. These appear large considering reports of a clutch of 10 eggs from a female in Mahanadi during 1976 (Singh 1978), 15 eggs from a 2.7 m female (Hornaday 1885) and 17 from a female in Chambal during 1985 (Rao and Singh 1990). The clutch sizes may have direct relation with food and hormonal levels, which needs further investigation.

We acknowledge with thanks the facilities provided by the Principal Chief Conservator of Forests, and Chief Conservator of Forests (Wildlife), Orrisa. Office facilities were availed by L.A.K.S. at the Similipal Tiger Reserve.

L.N. ACHARJYO
L.A.K. SINGH
S.K. PATTANAIK

July 17, 1990

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24. INDIAN FLAPSHELL TURTLE *LISSEMYS PUNCTATA* IN THE FOOD OF THE ADJUTANT STORK *LEPTOPTILOS DUBIUS*

The adjutant stork *Leptoptilos dubius*, which has been listed as an endangered species (Luthin 1987), is a summer visitor to Keoladeo National Park, Bharatpur. The arrival of these birds coincides with the drying up of marshes and the availability of dead or dying fish (they feed mainly on fishes in this area). In recent years the number of adjutant storks arriving in the park has shown a declining trend. 25 of them arrived in 1986 and fewer than five in the subsequent year.

During the regular aquatic bird counts in May 1988 a solitary stork was seen resting near a drying waterbody in the centre of the wetland. To our surprise the normally lethargic adjutant made a swift move and pecked at some object which was about 5 m away. It was an Indian flapshell turtle *Lissemys punctata*. Soon the turtle retracted into its shell, but this did not discourage the stork from swallowing it. It was a small turtle (carapace length about 10 cm) and the whole sequence of feeding took place within 3 minutes. Similar incidents were observed twice in the same season and once in the monsoon of 1989. The latter occurred outside the park.

Fishes, amphibians, snakes, lizards, ducks and bone have been recorded as food of the adjutant stork by Ali and Ripley (1983) and Rao and Muralidharan (1989). However, live turtles have not been reported in their diet so far. The Indian flapshell turtle is known for its movement on land to find suitable hiding places when the marshes dry up in summer. In the present case the stork fed on the turtle as it was moving out of a drying waterbody.

We thank Dr. V.S. Vijayan, Project Scientist, BNHS, for his comments and encouragement.

C. SIVASUBRAMANIAN
S. BHUPATHY

March 29, 1990

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25. OBSERVATIONS ON THE FOOD OF THE GANGES SOFT-SHELL TURTLE *TRIONYX GANGETICUS* IN KEOLADEO NATIONAL PARK, BHARATPUR

Although *Trionyx* spp., commonly known as soft-shell turtles, are reported to be omnivorous (Das 1985), precise information on their diet in wild condition is lacking. Observations on the food of the Ganges soft-shell *Trionyx gangeticus* were made in and around Keoladeo National Park, Bharatpur, Rajasthan, from 1985.

The Ganges soft-shell turtle took a wide range of food from vegetable to animal matter during this period. They fed on the fruits of the 'gular' tree *(Ficus racemosa)* in groups and exhibited an association with rhesus monkeys *Macaca mulatta*, similar to that between langurs *Presbytis entellus* and chital *Cervus axis*. Aggregations of more than 20 turtles were seen in a pond with overhanging boughs of 'gular' when the rhesus raided it for fruits. Turtles swallowed the dropped fruits as such. In temple ponds outside the park, these turtles accept cooked food such as 'chappatis' and peanuts.

Young (smaller sized) turtles fed on the swarms of millipedes repeatedly, but were seldom seen taking slow moving garden slugs near the water during the monsoon. In all cases the turtle extended its head and pulled the food into the water with the utmost speed. Fish were also recorded on a few occasions. Live flapshell turtles *Lissemys punctata* were fed on during summer when the water level was low. The *Trionyx* made surprise attacks on the flapshell and grabbed the head or leg, which was then pulled out with great force by kicking the prey in the opposite direction. Finally, visceral contents were eaten. Records of soft-shell turtles feeding on live flapshells in the natural condition are not available. However, Ganges soft-shell feeding on the eggs and meat of its own species is recorded in captivity (Rao 1986). The soft-shell was also seen drowning waterfowl on several occasions during winter; this has also been reported elsewhere (Das 1985). These observations confirm that *Trionyx* spp. are actively carnivorous throughout the year (Smith 1933).

Besides live food, dead fish and mammals were scavenged by soft-shells. Details of the feeding of this species on aquatic vegetation, insects, molluscs and fishes remains little known because of the practical difficulties of observation in an aquatic medium.

I thank Dr. S.V. Vijayan, Project Scientist, BNHS, for encouragement.

July 23, 1990

S. BHUPATHY

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26. INCUBATION AND HATCHING OF THE INDIAN STAR TORTOISE *GEOCHELONE ELEGANS* IN CAPTIVITY

The star tortoise *Geochelone elegans* is fairly common in India, Sri Lanka and Pakistan (Deraniyagala 1939, Smith 1931). It is crepuscular, being most active in the early hours of the morning and in the late afternoons. During the day, it hides between plants and stones.

TABLE 1
NEST AND CLUTCH SIZES IN CAPTIVE *Geochelone elegans*

Sl. no.	Nest (mm) (l x b x w)	No. of eggs laid
1.	160 x100 x115	4
2.	125 x100 x110	3
3.	120 x100 x100	3

l: length, b: breadth, w: depth of nest.

Adult tortoises are kept in captivity in the Indira Gandhi Zoological Park (17°42' N, 83°20' E) and their breeding habits have been studied in 1981. Courtship and mating are observed between the first week of August and the first week of October, with a peak period in mid September. The onset of breeding coincides with the premonsoon showers of the south-west monsoon and ends with the first north-east monsoon showers in October. The maximum rainfall at Visakhapatnam is during October.

Copulation is usually preceded by prolonged strenuous activity by the male. During courtship, the male butts and bites the female on her forelimbs. If the female is not interested, the male tries to lift the posterior part of the female by placing its head under the plastron. This is perhaps meant to force the female to draw in her head and forelegs. Once successful, the male mounts the female in a semi-upright position, curving round the cloacal region.

After achieving a firm grip the process of copulation begins, during which the penis, an enlarged brownish black structure, enters the cloacal opening. During copulation the male gives out sometimes prolonged, low grunting sounds. The female in most cases quietly chews during copulation or moves away, dragging the male along with her. Copulation lasts only two minutes. The excitation of males during their attempts to copulate can lead them to tackle almost all the available females in the group. The male was seen dipping his penis in water after retraction to remove the sticky seminal fluid.

After copulation, the female star tortoise digs a hole in loose ground, using her hind legs, softening the earth by ejecting urine from its cloaca. The sizes of the pits dug by the three different females observed Indira Gandhi Zoological Park are shown in Table 1. On an average it takes 5 hours to complete a first nest of 120x100x115 mm to complete. The other two females were less experienced; while excavating the nest, most of the time they were lifting soil fallen from earlier deposits (Table 1).

It took 3 minutes to lay the second egg and 5 minutes for the third. After laying the eggs, female pressed down the eggs, pushed the excavated earth back into the nest and smoothened the surface with her plastron.

The eggs are white and oval, with a more or less heavily calcified shell. The mean incubation period of 2 female star tortoises was 113.5 days (i.e. 112-115 days) (Table 2).

To ascertain the hatching period, six eggs constituting two clutches of three each, laid by two different females were obtained. They were incubated in a wooden tray, 45x30 cm in size, containing dry river sand at room temperature (28 ±1°C). The eggs measured 411-460x340-360 mm. Two clutches of eggs (4/3) were left *in situ* for hatching, for purposes of comparison. Unforunately, however, unprecedented rains flooded the area where the eggs were laid, resulting the death of the embryos.

All the eggs incubated in the laboratory were hatched and the incubation period was found to be 166-171 days (Table 3). The newly hatched tortoises weighed from 19.2-21.2 g. Hatchling carapace was 39.9 mm long

TABLE 2
COPULATION, EGGS AND INCUBATION PERIOD OF *Geochelone elegans* IN CAPTIVITY

Sl. No.	Date of copulation	Date of laying	No. of eggs laid	Incubation period (days)
1.	Not known	not known	4	Not known
2.	10 Aug. 1981	4 Dec. 1981	3	115
3.	9 Sep. 1981	31 Dec. 1981	3	112

TABLE 3
CLUTCH SIZE, EGG SIZE, HATCHING AND INCUBATION PERIOD OF *Geochelone elegans* IN CAPTIVITY

Sl. no.	No. of eggs per clutch	Mean egg size (mm)	Date of hatching	Incubation period	Hatching success (%)
1.	2	450 x 340	15 May 1982	Not ascertained	–
2.	2	460 x 350	15 May 1982	-do-	–
3.	4	420 x 350	19 May 1982 10.09 hrs.	166	100
4.	4	420 x 360	19 May 1982 18.00 hrs.	166	100
5.	4	430 x 350	20 May 1982 19.30 hrs.	168	100
6.	4	412 x 341	24 May 1982 06.00 hrs.	170	100
7.	4	425 x 355	–	–	–
8.	4	411 x 345	–	–	–
9.	4	430 x 346	–	–	–
10.	4	440 x 360	–	–	–
11.	3	440 x 360	–	–	–
12.	3	440 x 356	–	–	–
13.	3	430 x 349	–	–	–

and 30.0-39.16 mm wide. The size of the plastron was 37.4-38.8 mm and the shell height was 23.7 mm.

The yolk sac persisted for 48 hours after hatching, during which no feeding took place. The feeding began after complete absorption of the yolk. Young tortoises fed on chopped vegetables, bananas, carrot and cactii free of spines and were observed to prefer bananas.

We wish to thank Mr. Pushp Kumar, Principal Conservator of Forests; Mr. T. Ramakrishna, Director of Zoos, Govt. of Andhra Pradesh and Mr. B. Trinadha Rao, Curator, Indira Gandhi Zoological Park, for their encouragement. M.V.S.R. thanks the Department of Environment, Government of India, for financial support.

K. THULASI RAO
April 4, 1990 M.V. SUBBA RAO

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27. DOUBLE HEADED COMMON SAND BOA *ERYX CONICUS* (SCHNEIDER)

On 2 August 1988, a common or Russell's sand boa *Eryx conicus* with two heads was captured at Shikaripura, Shimoga district in Karnataka state. The snake is now in the possession of a snake keeper, Ravindranath Aithal.

The snake measures 18 cm from the snout to the tip of the tail. The point of axial bifurcation is 3 cm from the tip of the mouth and 15 cm from the tip of the tail. A hump on the body, about 1.5 cm behind the point where the two heads diverge, was noticeable. Both the heads were identical. The snake can take food through both the mouths.

Two headed *Eryx conicus* has also been reported from Karnataka by Desai (1984) and from Madhya Pradesh by Jahan and Ovais (1979).

June 9, 1990 A. SURYA NARAYANA RAO

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28. FIRST RECORD OF THE PIED-BELLY UROPELT *MELANOPHIDIUM PUNCTATUM* BEDDOME (SERPENTES: UROPELTIDAE) FROM MAHARASHTRA

(*With a text-figure*)

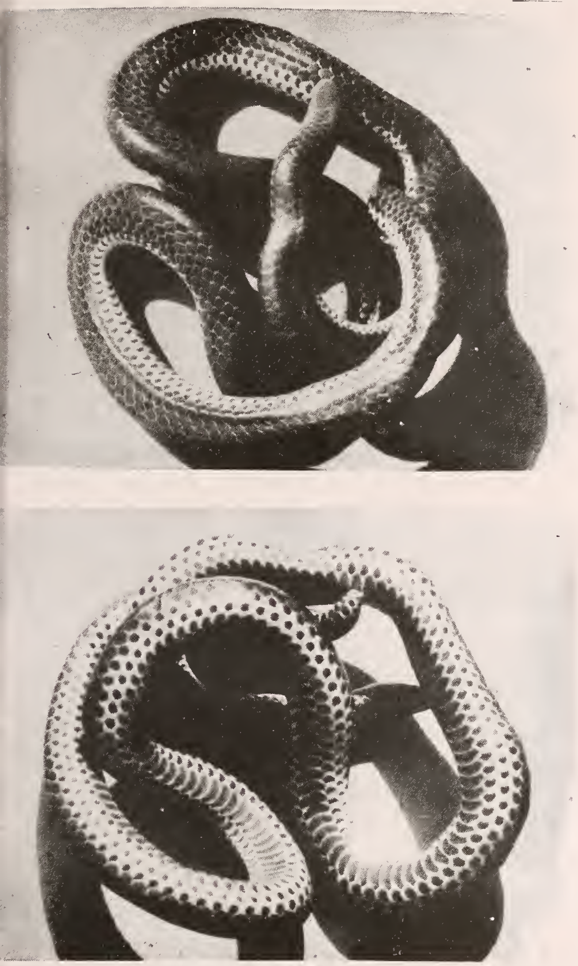

Fig. 1. *Melanophidium punctatum*.
Above– dorsal view showing typical colour pattern. Below– ventral view. Note the broad ventrals and the adjacent 3 scale rows of white scales with a black centre.

The genus *Melanophidium* of the family Uropeltidae is endemic to India and is represented by 3 species, namely *M. punctatum*, *M. bilineatum* and *M. wynaudense* (Murthy 1982, 1985). Of these, *M. punctatum*, the pied-belly uropelt, is known from Travancore hills, Talewadi and Goa frontier (Smith 1943). Other reports are from Attapadi in Tamil Nadu and Silent Valley in Kerala (Murthy 1981a, b; 1982). In his later paper Murthy (1985) states that the distribution of this species seems to be "... from Goa to hills of south Kerala.."

The genus *Melanophidium* can be distinguished from other uropelts by the presence of a mental groove (Smith 1943, Murthy 1981b). The species *M. punctatum* can be diagnosed by iridescent black coloration of the dorsum and the presence of a typical character :"... ventrals and outer 2-3 scale rows white with a black centre.." (Smith 1943) (Fig. 1).

The specimen in the collection of WRS, ZSI was picked up from a locality about 30 km west from Amboli Ghat, dist. Sindhudurg (specimen number V/785, date of collection 19 July 1987, name of the collector: Dr. D.B. Bastawade).The lepidosis and measurements of the specimen are as follows: length 480 mm; diameter about 9 mm; scales at midbody in 15 rows; ventrals 193, caudals 12.

The present record now extends the range of the species northward up to Maharashtra (district Sindhudurg). The record is also of interest because of the few available specimens of the species.

We are grateful to Dr. R.S. Pillai, Joint Director of Zoological Survey of India and Officer-in-charge of the Southern Regional Station, ZSI, Madras, for encouragement; the Director, Zoological Survey of India, Calcutta, for providing facilities; and Dr. T.S.N. Murthy, SRS, ZSI, Madras, for providing useful literature and also for going through the manuscript critically and making useful suggestions.

H.V. GHATE
G.M. YAZDANI

March 21, 1990

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29. TAXONOMIC STATUS OF THE GOBIOID FISH *OXYURICHTHYS DASI* TALWAR, CHATTERJEE AND ROY

In their revisionary studies, Pezold and Larson (1986) stated that the genus *Oxyurichthys* Bleeker has been historically recognized on the basis of a single row of teeth in the upper jaw, though this character is not limited to *Oxyurichthys* alone. *Oxyurichthys* can, however, be readily distinguished from its presumed relatives belonging to the subfamily Gobionellinae *sensu* Miller by several uniquely derived characters. All members of the group possess a membranous crest on the nape and a distinctly rounded tongue. The upper rear portion of the eye is modified in the form of a spot, a callus or a tentacle except in one species, viz. *O. stigmalophius*. The genus contains perhaps 15 species primarily distributed in the Indo-Pacific, with one species in the western Atlantic.

Oxyurichthys dasi was described from the Andaman islands by Talwar, Chatterjee and Roy (1982). From the description of teeth rows in this species as being more than one in the upper jaw, the absence of a membranous crest and a reduction in the sensory canal system on the cheek, it is evident that this species does not belong to the genus *Oxyurichthys*. On the other hand a greater affinity is noted to the genus *Oligolepis* Bleeker in the reduction in the transverse papillae and suborbital pores on the cheek and in the shape and position of the mouth.

Some other species of *Oligolepis* have been inadvertently overlooked by earlier workers and placed under the genus *Oxyurichthys*. Pezold and Larson (pers. comm.) have defined the genus *Oligolepis* as having a disjunct lateral canal, a preopercular canal with two pores, a reduction of transverse papillae on the cheek and a loss of suborbital rows, in addition to certain osteological characters.

Oxyurichthys jaarmani Weber, reported from Indian waters (Talwar 1969), is now know to be *Oligolepis jaarmani* and *Oxyurichthys nijsseni* Menon and Govindan (1976) is a synonym of *Oligolepis acutipinnis*. Both species possess more than one row of teeth in the upper jaw and have the sensory canal system characteristic of the genus *Oligolepis*. With the addition of *Oxyurichthys talwari* Ranjana Mehta, Kamala Devi and Mehta (1989), the number of species so far known from the Indo-Pacific is seven.

We thank the Director, Zoological Survey of India and the Officer-in-charge, Southern Regional Station, Madras, for facilities.

A.G.K. MENON
May 12, 1990 K. REMA DEVI

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30. *NEMATOLOSA NASUS* (BLOCH, 1795) (PISCES: CLUPEIDAE): A NEW RECORD FROM THE FRESHWATERS OF TRIPURA

(*With a text-figure*)

Whitehead (1973), while revising the fishes of the family Clupeidae, mentioned the genus *Nematolosa* Regan, represented by a single species from the Indian seas. Misra (1976) and Jayaram (1981) also mentioned the fishes of the genus *Nematolosa* as represented by a single species, viz. *N. nasus* (Bloch). Talwar and Kacker (1984) recovered two species of the genus in Indian marine waters, viz. *N. galathea* Nelson and Rothman and *N. nasus* (Bloch). *N. galatheae* is a rare species, known only from Karnataka coast of India and is now considered identical with *N. chanpole* (Hamilton-Buchanan) by Wongratana (1980). The fishes of the genus *Nematolosa* are basically marine. Jayaram (op. cit.) stated *N. nasus* enters freshwaters. This species is known to inhabit "Pulta, Calcutta, West Bengal, Puri, Chilka Lake, Orissa coast, Coromandel coast, Madras, Travancore-Cochin coast, Calicut, Malabar coast and Bombay" (Misra 1962). Day (1889) gave the distribution of the species as "Seas of India

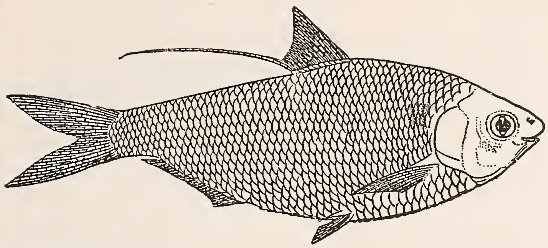

Fig.1. *Nematolosa nasus* (Bloch).

to Malaya Archipelago and Philippine islands".

During the systematic study of the freshwater fishes of Tripura, one specimen of *N. nasus* was collected from the river Gumti. The occurrence of this species in Tripura, extends their distributional range to the north-eastern states of India.

Geographic distribution: India, Pakistan, Bangladesh, Burma, Sri Lanka, Gulf of Aden, the Persian Gulf, Thailand, Vietnam, Indonesia, Japan and Philippines.

Size: It attains 203 mm in total length.

Zoogeography: *N. nasus* is generally found in the commercial catches of Bombay, Karnataka and Kerala coasts. The presence of this species in the river Gumti in Udaipur, south Tripura, is a first record for the state. It is significant in respect of its zoogeographical interest, because its occurrence there extends its distribution to the north-eastern states of India.

The occurrence of *N. nasus* in the freshwaters of Tripura may be due to its migration from the Bay of Bengal in Bangladesh through the river Gumti, which joins the river Meghna in Comilla district, Bangladesh. The Meghna ultimately flows into the Bay of Bengal off Bangladesh. The Gumti is the largest river in Tripura. It originates from the hill range of Longtarai and passes westwards through four subdivisions of the state, viz. Tirthmukh, Amarpur, Udaipur and Sonamura. The river enters Bangladesh from Sonamura subdivision of Tripura.

I thank Drs. Shamim Md. Jairajpuri, Director, and A.K. Ghosh, Joint Director in charge of Fish Division, for facilities and encouragement. I also thank Shri N.C. Ghose, Deputy Director of Fisheries of Tripura, for collection of the specimen and for necessary facilities during the study.

June 6, 1990 R.P. BARMAN

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31. OCCURRENCE OF *ODYNERUS OVALIS* SAUSS. ON FENNEL *FOENICULUM VULGARE* MILLER

Fennel *Foeniculum vulgare* Miller is an important spice crop usually grown as a mixed crop and sometimes as a single crop. It is usually free from insect attack. During December 1988 at Main Research Station, Dharwad, a large number of fennel plants showed wilting symptoms with broken branches. A close observation of the affected plants revealed many large (about 5 mm) circular holes. When the stem was split open, the hollow space was found to be filled with dead flies and jassids which could not be identified further, since they were damaged beyond recognition. White apodus grubs about 10 mm long were found feeding on them.

Several black wasps with yellow bands, measuring about 8 mm, were visiting these plants. These wasps bored the stem of fennel and stored paralyzed prey, which served as food for their young. The holes were large enough to cause the breaking of the branches because of the weight of flower heads, especially after seed set. The hollow stem of fennel served as an ideal breeding place for these wasps. On each plant 7-12 holes were seen and the damage caused was quite serious. The wasp was later identified as *Odynerus ovalis* Sauss. (Eumenidae: Hymenoptera). This wasp has been reported to be commonly occurring in the southern plains (Bingham 1897) and is considered to be pollinator of lucerne *Medicago sativa* L. (Gachchinamath 1983).

A.S. VASTRAD
S.N. HOLIHOSUR
December 15, 1989 K. BASAVANAGOUD

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32. FIRST REPORT OF *CHRYSIS FUSCIPENNIS* BRULLE IN SOUTH INDIA

The cuckoo wasp *Chrysis fuscipennis* Brulle has not been reported from south India so far (Bingham 1897). The wasps and their nests were collected in and around Coimbatore (11° N, 76°85' E) during August, September and October 1988.

The wasps lead an ectoparasitic life on the stored food of the hosts and also utilise the completely built nests of the hosts for egg-laying and for the development of the young. The hosts normally are members of the family Sphecidae (Krombein 1956). They also parasitize the spider-hunting wasps such as *Sceliphron madraspatnum* and *Sceliphron deforme* (Krombein 1956).

The cells of the nests of the host sphecid wasps are made of clay and mud. Several individual barrel-like cells are always grouped to form one nest. The nests are found in places closely associated with human habitations. The entrance openings of the cells of the nests are oval or round in shape.

The wasp *Chrysis fuscipennis* visits the nest of the host from time to time until the nest building, food-storing and egg-laying are completed by the host wasp. Soon after the closing of the cells by the host, the female *Chrysis fuscipennis* makes a small hole by means of the mandible and inserts the ovipositor for the laying of eggs. The young, on emerging, feed on the host larvae or chrysomelid larvae stored by the host, grow and metamorphose. They emerge from the cells of the nests as fully grown wasps. The adult wasp may emerge from the regular closed entrances or through the side walls.

I thank Dr. K.M. Harris, Director, CAB International Institute of Entomology, London, for identification of the wasps.

February 1, 1990 P. KADIRVELU

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33. AN INTERESTING SPECIMEN OF *NEPTIS RADHA* (MOORE)

Neptis radha is an uncommon *Neptis* found in the Himalaya from Kumaon to Burma and western China. It flies in spring and autumn at elevations of 1400-2400 m. *Neptis radha* has the usual *Neptis* markings, which are orange in this species. The exact description can be found in the Fauna of British India (Talbot).

The specimen in question was caught on 19 July 1987 (during the monsoon) at an elevation of 1800 m, at Anini in the Dibang valley in the Lohit district of Arunachal Pradesh. The Dibang valley is heavily forested, unexplored and very rich in wildlife. Though only one specimen was caught, several others were seen.

The important and indeed the only difference between this specimen and other members of its species is that its markings are white and not orange. In all other respects it is identical to *N. radha radha*. There are two other subspecies, *sinensis* from western China and *asteratilis* from Burma. These two are paler than *N. radha radha* but they are still orange, not white. It is odd that *N. radha radha* occurs both to the east and to the west of this locality. However, it must be said that the Himalaya to the east of Sikkim has been very poorly studied. The hills of Assam, namely the Khasia-Jaintia and Naga hills, have been well studied but the actual Himalaya in Bhutan and Arunachal Pradesh has been little studied. The Dibang valley in the eastern Himalaya is hemmed in by high mountains on either side, perhaps allowing a subspecies to evolve.

I feel that this specimen does represent a new subspecies. However, I am not describing it, for two reasons. Firstly, there is only one specimen, and secondly a lack of expertise on my part. The specimen is now located in the entomology department of the British Museum (Natural History) in South Kensington, London, where it and others of its species can be examined and compared.

I would like to thank Mr. C. Smith of the B.M.(N.H.) for allowing me to look at the specimens in the museum and Colonel Eliot for his comments on the specimen.

February 1, 1990 PURNENDU ROY

34. INSECTS INFESTING MESQUITE *PROSOPIS CHILENSIS* (MOLINA) S. AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

Prosopis chilensis (Molina) S. (syn. *P. juliflora* DC.) or a number of varieties of the same species appear to have been introduced into India as far back as 1877 (Raizada and Chatterji 1954). This species has established itself very well in semi-arid areas and in some cases in the moist parts of the Indian peninsula. In Point Calimere Wildlife Sanctuary, Tamil Nadu, it has spread especially in the open areas and where the forest is degraded. The main agents for the dispersal of *Prosopis* seeds at Point Calimere are cattle (Natarajan *et al.* 1984), spotted deer *Cervus axis*, wild boar *Sus scrofa* and feral ponies. I recorded a few insects infesting *Prosopis*, which are listed below.

1. Two sap sucking bugs *Oxyrhachis tarandus* Fabr., and *Otinotus oneratus* Walker (Homoptera: Membracidae) infest tender shoots and cause chlorosis of leaves.

2. The blister beetle *Mylabris pustulata* Thunb. (Coleoptera: Cantharidae) has been noticed to feed on flowers of *P. chilensis*. They were also noticed feeding on the flowers of *Rivea hypocrateriformis* and *Gmelina asiatica*.

3. The weevil *Amblyrrhinus poricollis* Boheman (Coleoptera: Curculionidae) has been noticed feeding on the leaf buds during July to September.

I thank Dr. G. Thirumalai, Scientist SD, Zoological Survey of India, Southern Regional Station, Madras, for the identification of the bug specimens and Dr. V.V. Ramamurthy, Curator, Division of Entomology, Indian Agricultural Research Institute, New Delhi, for the identification of the weevil.

August 1, 1990 V. NATARAJAN

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35. STANDARDIZATION OF SPORE GERMINATION TECHNIQUE IN *ASPLENIUM NIDUS* L.

Asplenium nidus L. is an epiphytic fern commonly known as the bird's nest fern. In India it is distributed particularly in the eastern Himalayan ranges where the mean temperature ranges between 8°C min. and 24°C max. with a mean annual rainfall of 2400 mm and relative humidity 70-80 %. Holttum (1960) reported its distribution in the tropics of the old world including Malaya. Latter Beddome (1969) and Deb (1981) reported its occurrence in Sri Lanka, Tripura (India) and Malaysia.

The fern is nest-shaped, with a rosette of glossy fronds. Each frond is 1-1.5 m long and 10-20 cm wide with brown spores. Recently, Lal and Pandey (1982) reported the interesting phenomenon of forking of frond in this fern. It is used as an indoor decorative plant for its beautiful fronds (Firminger 1869).

Ecology: The arrangement of fronds in *A. nidus* L. helps to catch the dead leaves firmly between new fronds, which ultimately decompose there, and form a suitable spongy mass along with the roots of the fern. This spongy mass holds water during rains. Holttum (1960) reported that the growth of *A. nidus* L. is poor in exposed places, but luxuriant near the periphery of the forests where ground moisture is very high.

Being epiphytic in nature, it gets less natural sunlight. Considering the above factors and for its cultivation in Calcutta conditions, it was felt necessary to provide similar conditions by providing diffuse sunlight and cool, humid atmosphere in a greenhouse.

MATERIAL AND METHODS

Propagation of this fern is generally carried out by germination of spores. It has been observed that dusting

TABLE 1
COMPARISON OF 4 MEDIA FOR SPORE GERMINATION OF *A. nidus*

Medium no.	No. of spores germinated	Remarks
Medium 1	Germination nil	This medium is not suitable for germination of spores of *A. nidus*.
Medium 2	Innumerable spores germinated	*Brownea* gall is very suitable for propagation of *A. nidus*.
Medium 3	50 spores germinated	This medium is partially suitable, but requires further improvement.
Medium 4	27 spores germinated, but soon died	It is necessary to find out the cause of death of sporophytes.

the spores of locally available terrestrial ferns on porous brickbats and keeping them in humid conditions yields good results. However, with *A. nidus* L. the results were not encouraging. A trial was therefore conducted at Indian Botanic Garden, Howrah, using 4 different experimental media to find out one suitable for the germination of *A. nidus* L. spores in Calcutta conditions.

Medium no.1 is a partial modification of the medium suggested by Bailey (1958). Medium no.4 is a modification of the media used by Rao *et al.* (1979) for cultivation of a member of the genus *Dendrobium* Sw., an epiphytic orchid. Medium nos. 2 and 3 are being tried for the first time by us.

Medium 1: A mixture of leaf mould, garden soil and sand in the proportion 2:2:1. *Medium 2: Brownea hybrida* Hort. ex Back galls of size 10 cm x 8 cm. *Medium 3:* Bark of *Mangifera indica* L., *Swietenia mahagoni* Jacq., chopped tree fern and sand in the proportion 2:2:1:1. *Medium 4:* Chopped coconut fibre, leaf mould, sand, moss, broken charcoal and broken crocks in the proportion 1:1:1:1:0.5:0.5.

Spores were collected on a clean butterpaper from matured fronds and stored in a dessicator. Three flat earthen pans of 25 cm diameter were filled with medium nos. 1,3 and 4. For medium no.2, a gall of *Brownea hybrida* was selected from a plant growing in the garden. All the pots and the *Brownea* gall were sterilized to avoid soil-borne nematodes and other spores if any. The media were cooled and drenched with clean tap water. The spores were weighed and kept in 4 separate butterpaper packets, each containing 100 mg of spores. The spores in each packet were scattered uniformly over the surface of each medium. All the 4 media containing the spores were kept over a water-filled cement tank in a greenhouse to provide humid conditions. All the mediums were watered by a mist spray at regular intervals.

Spores showed signs of germination within a week in a few media and the results are shown in Table 1.

Experimental Cultivation

The experimental observations show that fern seedlings at the age of 12-15 weeks are the most suitable ones for transplantation. Shallow earthen pots (25 cm diameter) were filled with of bark dust, charcoal bits and leaf mould in equal proportions. The pots were dipped into water up to their rims, allowing water to enter from the bottom-hole till the contents were soaked properly. The sporophytes were taken out carefully from the *Brownea* gall with a sharp knife and separated from each other. The sporophytes were dipped for a minute into a dilute (0.1%) solution of 'Blitox', an antifungal preparation available in the market. This method was adopted for the first time by us to prevent fungal attack on the plants. The ferns were transplanted in the medium, spaced 8 cm apart, and kept in the green house for 3 months. During this period each fern grew to a stage of 6-7 fronds, suitable for further transplantation and pot culture.

For pot culture shallow earthen pots of 25 cm diameter and 15 cm in height are suitable. One third of the pot was filled with over-burnt pieces of brick and the rest of the pot with leaf mould and small pieces of charcoal. The pots were moistened with water as per the method adopted earlier. The fern with 6-7 fronds was transplanted in centre of the pot, and a few medium sized pieces of brick were laid on the surface of the potting materials to keep the plant fixed properly. The plant was allowed to grow in the greenhouse, and watered regularly with a syringe during non-rainy days. The plants mature within 3-4 years and the fronds produce innumerable light brown spores every year. It was observed that the nocturnal flying insects generally damage the tiny fronds. This damage could be prevented by spraying a systemic insecticide such as 'Rogor'.

Asplenium nidus L. can thus be grown easily from spores under the climatic conditions of Calcutta. From our findings *Brownea* galls are a very suitable medium for the germination of *Asplenium nidus.*

A.K. BANERJEE
H.S. PANDEY
A.P. BHATTACHARYA

March 17, 1990

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36. RANGE EXTENSION OF THREE EXOTIC AQUATIC MACROPHYTES IN NORTH INDIA

Aquatic plants have not been surveyed in detail in and around Delhi. No additions have been made to the flora of Delhi since Maheshwari (1963). This note reports the occurrence of three exotic aquatic macrophytes which appear to have become naturalized in Delhi and its surroundings during recent years.

Salvinia molesta, a noxious aquatic weed of neotropical origin, has long been cultivated in botanical gardens. It has spread to cause serious problems in Kerala, especially in the Kakki reservoir, in the early sixties (Cook and Gut 1971). Since then it has spread further in most of the south Indian states but does not occur naturalized or in weedy proportions anywhere in the Indo-Gangetic plains. Here it was first observed during the winter of 1986 in a side channel of river Yamuna near Wazirabad in north Delhi. During the past two years it has spread downstream up to Okhla, apparently with the river flow. It has been growing throughout the year, forming a dense mat near the pumphouse at Wazirabad. It has also become overgrown by a number of other aquatic plants.

Alternanthera philoxeroides, commonly known as the alligatorweed is a noxious aquatic weed in Australia (Mitchell 1978) and U.S.A. (Weldon 1960). It was first reported in India from Bihar and West Bengal (Maheshwari 1964), and later from parts of Assam and Bangalore (Sankaran and Narayanan 1971). It was noticed growing by the sides of Agra canal near Okhla barrage during 1986. At that time its identity could not be confirmed. During a recent survey, extensive flowering stands of *A. philoxeroides* were found along the river Hindon and also along the river Yamuna from Wazirabad downstream to Okhla. There is as yet no report of its occurrence under field or cultivated conditions from anywhere in northern or western India.

Another interesting find is *Lemna trisulca*, which is morphologically distinct from all other species of *Lemna* (Landolt 1986). It was found in the shallow riverside ponds on the floodplain of river Hindon near the bridge on the Delhi-Meerut road. *L. trisulca* is distributed mainly in cooler climates. It is known to occur in India in Srinagar (Zutshi and Kaul 1963), Calcutta and Manipur (Landolt 1986). The plants are reported to grow at temperatures below 30°C (Landolt 1986). However, we found it growing at a much higher temperature (35°C) during the summer of 1989.

A common feature of the three species is their predominantly vegetative propagation. *A. philoxeroides* flowers profusely but viable seeds have not been reported from anywhere in its distribution range. Apparently, vegetative propagation causes the maintenance and spread of this weed (Mitchell 1978). *Salvinia molesta* is a hybrid producing sterile spores (Mitchell 1972). *L. trisulca* flowers occasionally (Landolt 1986), but it has not been reported from India.

This raises the interesting question about the mechanism of dispersal in these species. While it is probable that *Salvinia molesta* escaped from botanical gardens in Delhi to the river through various wastewater drains, the long range dispersal of the other two species cannot be readily explained. This calls for detailed surveys of aquatic plants in the region.

We are grateful to Dr. Brij Gopal for guidance, and to the University for necessary facilities and fellowship.

CHAMAN LAL
MALAVIKA SAH

October 27, 1989

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37. *EUPATORIUM TRIPLENERVE*: A GOOD FORAGE FOR FLOWER VISITING INSECTS

Eupatorium triplenerve (Compositae) is a native of tropical America, with slaty-blue flowers, commonly grown in gardens. The plants bloom at Visakhapatnam (17°42' N, 82°18' E) all through the year with a peak period during September-January. During the study period, 28 insect visitors were found foraging at the flowers.

The flowers are tubular, pinkish violet, arranged in heads. Heads are ($\overline{X}$) 1.3 cm in length and 0.7 cm across.

TABLE 1
PARTICULARS OF FLOWER VISITORS ON *Eupatorium triplenerve*

Insect visitor	Year 1986	Year 1987	Forage type Pollen	Forage type Nectar
Hymenoptera				
Apidae				
Apis dorsata	+	+		
Apis florea	+	+	+	+
Apis cerana indica	+	+	+	+
Trigona sp.	+	+	+	+
Anthophoridae				
Thyreus histrio	+	–	+	+
Sphecidae				
Bembix sp.	+	+	+	+
Lepidoptera				
Danaidae				
Danaus limniace	+	–	–	+
Danaus chrysippus	+	+	–	+
Euploea core	+	–	–	+
Nymphalidae				
Hypolimnas bolina	+	+	–	+
Hypolimnas misippus	+	+	–	+
Precis lemonias	+	+		+
Precis hierta	+	+	–	+
Precis orithyia	+	–	–	+
Precis almana	+	+	–	+
Phalanta phalanta	+	+	–	+
Acredidae				
Acraea violae	+	–	–	+
Lycaenidae				
Jamides celeno	+	+	–	+
Euchrysops cnejus	+	+	–	+
Rapala iarbus sorya	+	–	–	+
Papilionidae				
Atrophaneura aristolochiae	+	+	–	+
Graphium agamemnon	+	+	–	+
Pieridae				
Cepora nerissa	+	+	–	+
Eurema hecabe	+	+	–	+
Catopsilia crocale pomona	+	+	–	+
Catopsilia pyranthe	+	+	–	+
Hesperidae				
Borbo cinnara	+	+	–	+
Pelopidas mathias	+	+	–	+

The length of each flower is (X) 0.8 cm with 0.5 cm tube. Stamens 5, synandrous, stigma excerted, length (X) 1.3 cm. The essential organs are exerted just above the corolla tube. On an average, 22 flowers were recorded in every inflorescence.

The flowers anthese during 0530-0730 hrs. Immediately after anthesis, anthers dehise presenting the pollen. The pollen grains are small, ranging from 17-25 mm in diameter. Their number per flower averages 3438. The total output of pollen grains per head is 75,636.

Nectar secretion begins with anthesis. In volume the nectar measures (X) 1.66 µl per head and nectar concentration ranges from 23-28%. Paper chromatography revealed the constituent sugars: glucose, sucrose and fructose, the former predominating. Proteins and amino acids too were present as indicated by ninhydrine and bromophenol tests. Histedine scale was recorded to 6.0

During the period of study, 28 insect species were found foraging at the flowers (Table 1). Of these, 6 are Hymenoptera (Apidae 4, Anthophoridae 1 and Sphecidae 1), and the remaining are Lepidoptera (Danaidae 3, Nymphalidae 7, Acraeidae 1, Lycaenidae 3, Papilionidae 2, Pieridae 4 and Hesperidae 2).

Five of these 28 species foraged on both pollen and nectar, while the others foraged on nectar only. All the visitors were not encountered in both the years. All the flower visitors are diurnal in activity. They foraged at the flowers between 0700-1800 hrs. Some of them were more active during certain hours only. Thus *Apis dorsata* was more frequent during 0700-1200 , *Apis cerana indica* from 0700-1400, *Precis lemonias* during 0700-1600, *Danaus chrysippus* between 0700-1500, *Graphium agamemnon* from 0800-1300, *Precis almana* during 0900-1400 hrs.

On the umbellate type of inflorescences of *E. triplenerve* the insects walked over them to cover all opened flowers, while the bees collected pollen as well as nectar. *Trigona* sp. collected only pollen because the length of proboscis was smaller than the tube of the flower. The wasp *Bembix* and butterflies foraged on nectar only. When collecting the pollen or nectar the ventral side of the body, legs and head touched the essential organs. In the case of butterflies the legs and proboscis touched the essential organs.

Data regarding the number of flowers visited in a minute and the time spent on a flower by 8 of the common visitors indicated that *Graphium agamemnon* is more mobile, covering on an average 22 flowers in a minute and spending on an average 4 seconds per flower. The corresponding figure for other species are *Atrophaneura aristolochiae* 19, 5; *Bembix* sp. 15.3, 6; *Apis cerana indica* 10, 9; *Hypolimnas misippus* 13, 7; *Euploea core* 21, 5; *Danaus chrysippus* 24, 43.

The forage offered by *E. triplenerve* constitutes both pollen and nectar to the flower visitors, the latter being the more predominant and preferred. A close examination of intrafloral behaviour of the visitors revealed that the bees made substantial number of visits to the flowers and collected pollen. On an average 3438 and 75,636 pollen grains were produced per flower and head respectively. Out of this an average 90% of the pollen grains were depleted during 0700-1300 hrs, during which the foragers activity was also found to be high. Pollen depletion was mostly due to the foragers activity because they remove the pollen from the anthers and pack then into their corbiculae.

T. BYRAGI REDDY
July 23, 1990 C. ARUNA

38. ADDITIONS TO THE VERBENACEAE OF ANDHRA PRADESH

During the study of the Verbenaceae of Andhra Pradesh we came across two interesting plants, namely *Lantana wightiana* Wall. and *Sphenodesme involucrata* var. *paniculata* (Clarke) Munir which have been collected from the forests of Guntur district. From available literature and examination of specimens at different herbaria in India, it has been concluded that these two taxa are new records for Andhra Pradesh. The up-to-date nomenclatural citation and characters of three taxa are given below for easy identification. The specimens have been deposited in the Herbarium of the Department of Botany, S.K. University, Anantapur.

Lantana wightiana Wall. ex Gamble, Fl. Pres. Madras 1087. 1924. 2:761.1957 (repr. ed.). *L. indica* Roxb. var. *albiflora* Wight ex Clarke in Hook. f. Fl. Brit. India 4:562.1885.

A woody unarmed shrub up to 3 m tall; tender parts scabrous. Leaves 2-4 x 1 5-3 cm, elliptic-ovate, softly appressed-pubescent above and below, base rounded to acute, margin crenulate, apex subacute. Flowers white in elongated spikes. Berries brown-black when ripe.

Exsicc: Andhra Pradesh, Guntur District, N. Varam, dated 27 Aug. 1986, *V. Ramakrishnaiah* 3966 (SKU).

Gamble (1.c.) recorded from Carnatic and Eastern slopes of Western Ghats, in or near the hills. An examination of material in different herbaria viz., MH, CAL, BLAT, DD, HH, revealed that there are no specimens of this species from Andhra Pradesh. Hence it forms a new record for Andhra Pradesh.

Sphenodesme involucrata (Presl.) Rob. var. **paniculata** (Clarke) Munir in Gard. Bull. Singapore 21:338.1966.

S. paniculata Clarke in Hook f. Fl. Brit. India 4:600.1885; Gamble, Fl. Pres. Madras 1104.2:773.1957 (repr. ed.).

A climbing shrub. Leaves 4-6 x 2-3 cm, shortly petioled, ovate to elliptic, glabrescent, margin broadly serrate, apex acute. Flowers green in 7-flowered cymes; bracts 6, foliaceous, tomentose; calyx cuplike or companulate, teeth 5; corolla tube cylindric, short. Drupe 1- or 2-seeded, globose, included in the calyx.

Exsicc.: Andhra Pradesh, Guntur district, Vinukonda RF, dated 9 April 1989, *V. Ramakrishnaiah* 6897 (SKU).

There are no specimens of this plant from Andhra Pradesh in different herbaria namely MH, CAL, DD, BLAT, HH, etc. Even Gamble reported its occurrence only from Western Ghats, evergreen forests of Cochin and Travancore; Coorg (Rottler); Shevaroy Hill (Perrottet). It is, therefore, a first record for Andhra Pradesh.

We thank the authorities of MH, CAL, DD, BLAT, for permission to consult the herbaria and for confirming the identity of the specimens.

V. RAMAKRISHNAIAH
D. ALI MOULALI
December 21, 1989 T. PULLAIAH

39. AN INFRA-SPECIFIC NOMENCLATURAL COMBINATION IN THE GENUS *LEUCAS* L. (LAMIACEAE)

While revising the Lamiaceae of Andhra Pradesh we came across some names in taxonomic literature which needed correction. Article 25 of the International code of Botanical Nomenclature (ICBN) states "For nomenclatural purposes, a species or any taxon below the rank of species is regarded as the sum of its subordinate taxa, if any". In this paper we give the latest valid name for an infra-specific taxon of *Leucas* L. as per the ICBN.

According to Keng in Steenis Flora of Malesiana I.8:340.1978, and Bakshi (1984) in Flora of Murshidabad district the valid name for *Leucas mollissima* Wall. is *Leucas flaccida* R. Br. S.R. Srinivasan in Henry's Flora of Tamil Nadu Analysis vol. 2.176.1987 transferred the variety *scabrula* Hook. f. to *Leucas flaccida* R. Br. as per the ICBN. Therefore the typical variety should be named *Leucas flaccida* R. Br. var. *flaccida*.

Accordingly, the variety *sebastiana* that is endemic to the Eastern Ghats should be named as follows:

Leucas flaccida R. Br. **var. sebastiana** (Subba Rao et Kumari) Moulali et Pullaiah *comb. nov.*.

Basionym: *Leucas mollissima* Wall. var. *sebastiana* Subba Rao et Kumari in Bull.Bot.Surv.India 11:452.1965, plate 453 (Figs. 1-7) (see Articles 60, 61 of ICBN)

Type: Holotype Subba Rao et Kumari 29743 A (CAL) and isotypes Subba Rao et Kumari 29743 B to N (MH) were collected on 4 January 1968 at Cherukonda in Visakhapatnam district of Andhra Pradesh.

March 17, 1990 D. ALI MOULALI
T. PULLAIAH

40. SEED DISPERSAL OF *CASSYTHA FILIFORMIS* AT POINT CALIMERE, TAMIL NADU

Cassytha filiformis L. (Lauraceae) is a parasitic, leafless, yellow plant that grows on bushes. It is commonly noticed on the seashore all over the tropics, including many islands (Ridley 1930). The fruits are white and pulpy. Guppy (1906) stated that the fruits are buoyant and can be dispersed by sea currents. Ridley (1930) mentions that the seeds are mainly dispersed by sea and hence the plant has a wide distribution. However, quoting Hemsley's observation (original paper not referred to) on the presence of *Cassytha filiformis* seeds in the crop of pigeons, Ridley (1930) mentions that the seeds can be dispersed to some extent by birds. Van der Bijl (1982) records that this species is pantropical on beaches due to its floating seeds, but may occur inland due to ornithochorous fruits.

In Point Calimere *Cassytha filiformis* is commonly seen along the beach as well as inland. Here it is mostly found growing on *Dichrostachys* bushes. The fruiting season is from March to May. During three years of study on frugivory by birds and mammals, I observed the whitebrowed bulbul *Pycnonotus luteolus*, a common resident bird, eating the fruits of this plant. The bird swallows the whole fruit. Obviously, being a 'legitimate' frugivore, the seeds would be ejected uninjured along with the droppings and thus help in the dispersal of this plant. This observation records a definite avian seed disperser for this plant, and also explains their distribution inland.

I am grateful to Prof. P.V. Bole for his guidance and Mr. J.C. Daniel for encouragement and for going through the manuscript.

December 5, 1989 P. BALASUBRAMANIAN

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41. RECORDS OF TWO NEW TAXA FROM ORISSA

(*With a text-figure*)

During the analyses of the flora of Keonjhar district in Orissa, the following two taxa, observed and collected in the wild, appeared to be new records for the state. They are discussed below:

Cyathea balakrishnani Dixit et Tripathi
Bull. Bot. Surv. Ind. 26:170.1984.

Dixit and Tripathi (1984) correctly named the plant from many old and new specimens which are intermixed with *C. giganteae* (Wall. ex Hook.) Holtt., *C. glabrae* (Bl.) Copel. and *C. podophyllae* (Hook.) Copel. etc. Dixit and Tripathi (1984) also described the taxon in detail with illustrations and ecological notes.

Time of Sori formation: December - January.

Locality: Khandadhar waterfall at Keonjhar district, 31 Jan. 1988, *Mondal*, 1208.

Earlier reports of the taxon have been from Madhya Pradesh, Tamil Nadu and Kerala. The present collection in Orissa is a new record for the state and extends the distribution of the species further north.

Dracaena spicata Roxb. Fl. ind. 2:157.1824; Hook. f. in Fl. Brit. India 6:328.1892.

Evergreen tree. Stems erect, marked with leaf scars. Leaves caulescent, crowded at the end of the branches, drooping, lanceolate to elongate-lanceolate, apex acuminate, base attenuate, coriaceous, 120-200 mm long, 42-62 mm wide; petioles broad, half-stem clasping, wide at base, 40-60 mm long, 4-5 mm wide. Inflorescence spike terminal, slightly curved, bracts lanceolate, subulate-acuminate, recurved; bracteoles ovate, acute. Flowers numerous, sessile, fascicled, greenish yellow, slender, 20-23 mm long; perianth 6 lobed; tubes strongly twisted; lobes shorter than tubes, oblong, obtuse, spreading; stamens 6; filament white, inserted; stigma 3-lobed. Berry 1-3 lobed, reddish orange when ripe, 5-6 mm diam.; each lobe containing one, white horny seed.

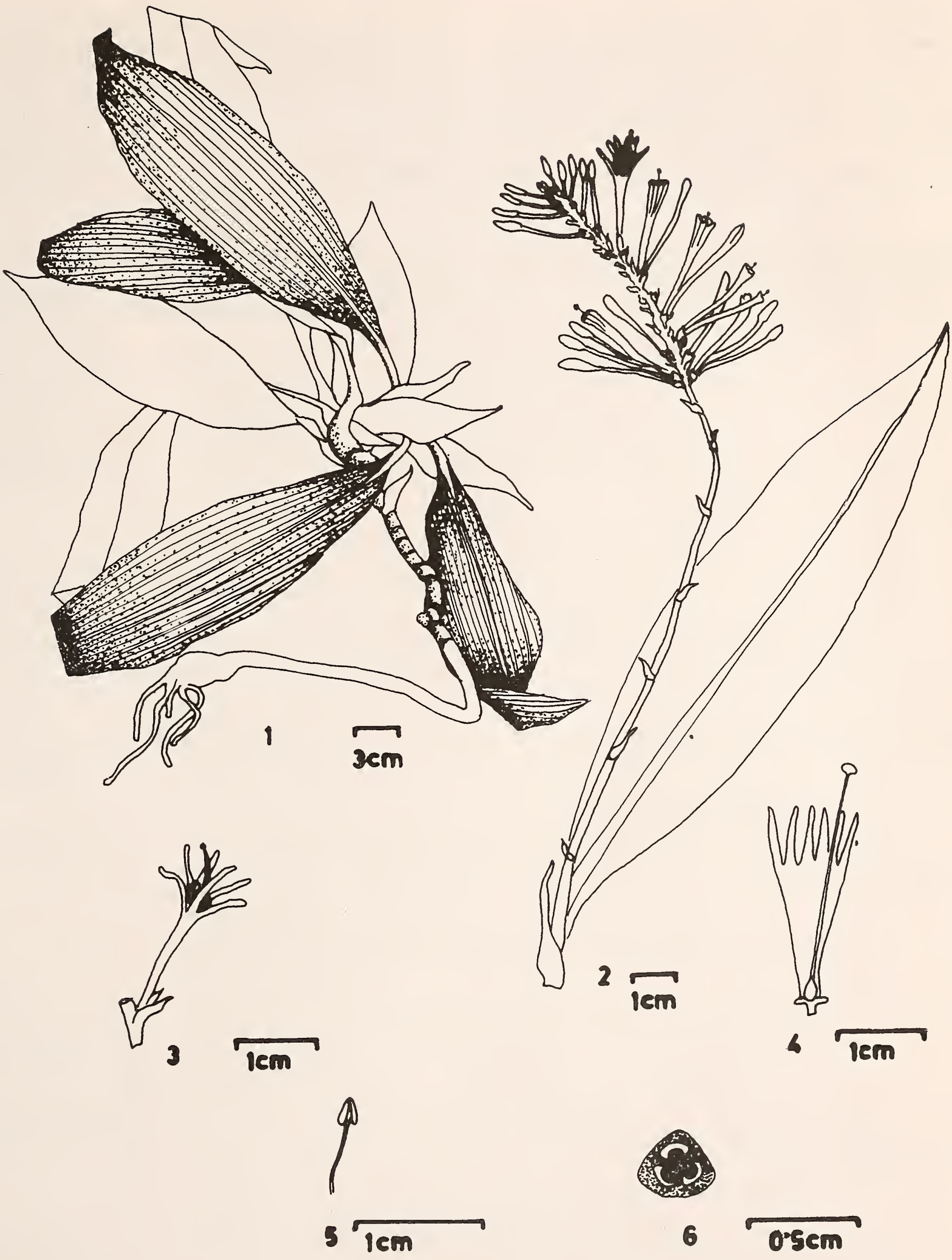

Fig.1. *Dracaena spicata* Roxb.
1. The plant body; 2. Inflorescence; 3. Flower; 4. Opened flower; 5. Stamen; 6. T.S. of ovary.

Flowering and fruiting:: April-June.

Locality: Khandadhar waterfall at Keonjhar district, 31 Jan. 1988, *Mondal*, 1204.

The plants collected from Orissa are without flowers or fruits but their identity is based on authentic specimens at Herb. CAL.

According to Kurz (1877) this species is not infrequent in South Andaman. Wallich and Roxburgh had collected the species from different parts of Bangladesh, viz. Silhet and Chittagong (Hooker 1892). The present collection forms a new record for Orissa and the Indian mainland.

PAPIA MONDAL
P. K. MUKHERJEE

December 30, 1989

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Hooker, J.D. (1892): Flora of British India 6: 328.

Kurz, S. (1877): Forest Flora of British Burma. 2: 543, 546.

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INDEX OF AUTHORS, MISCELLANEOUS NOTES

BOMBAY NATURAL HISTORY SOCIETY
Minutes of the EGM held on 12-9-1989

An Extraordinary General Meeting of the Bombay Natural History Society requisitioned by 31 members, was held on Tuesday the 12th September 1989, at 6.00 p.m. at Hornbill House. The following were present :

Prof P V Bole (In the Chair)
Mr Unmesh Brahme
Mr Humayun Abdulali
Mr Debi Goenka
Mr J C Daniel
Mr Bharat Bhushan
Mr Kisan Mehta
Mr S A Hussain
Mrs D S Variava
Mr Ulhas Rane
Mr Cyrus Guzder
Ms Sashi Rekha Iyer
Ms Thrity Badam
Mr Vilas Shigre
Mr M R Almeida
Dr A N D Nanavati
Mr S Asad Akhtar
Mr Jugal Kishor Tiwari
Mr S Chandrasekar
Mr N D Mulla
Ms Renee Borges
Mr S G Bhatkar
Mr Nitin Jamdar
Mr Amit Rathod
Ms Heta Pandit
Mr Chandrahas A Kolhatkar
Mr Hirji C Mistry
Mr Owen Joseph Fonseca
Mr R Naoroji
Mr P Lalla
Mr A Varadachary
Prof Parvish Pandya
Mr R Ashok Kumar

The following resolution was unanimously passed:

"Resolved that the Bombay Natural History Society publicly expresses serious concern about the grave environmental consequences of the Narmada Valley Project in its entirety, and particularly the Sardar Sarovar and Narmada Sagar Dams, and calls upon the Government of India, the concerned State Governments and all other agencies involved in the funding and implementation of the project to suspend further work on execution of any aspect of the project pending the completion of a comprehensive environmental, socio-economic appraisal of the project in its entirety".

Prof P.V. Bole
President

Minutes of the AGM held on 15-12-1989

The Annual General Meeting of the Bombay Natural History Society was held on Friday the 15th December 1989, at 6.00 p.m. at Hornbill House. The following were present:

Prof P V Bole (In the Chair)
Mr J C Daniel
Mr M R Almeida
Ms Sangeeta Pradhan
Mr Sorab Pandey
Ms Sashirekha Iyer
Mr Ulhas Rane
Mr N P Behramfram
Ms Ashraf Macchiwala
Mr Tareen Calkaka
Dr (Ms) Meena Haribal
Mr T M Davar
Ms Sejal Worah
Dr Pratap Saraiya
Mr Sunjoy Monga
Mr Bharat Bhushan
Mr D I Solanki
Mr Nitin Jamdar
Mr K G Sathe
Mr A Varadachary
Mr Parvish Pandya
Mr Praveen Pardeshi
Mr K P Karamchandani
Mr Kisan Mehta
Mr M K Mistry
Mr Suresh Bhtakal
Mrs D S Variava
Mr Debi Goenka
Mr Mihir Devare
Ms Heta Pandit
Mr Humayun Abdulali
Mr A V Ghangurde
Mr Sangeet Sharma
Mr Kiran Srivastav
Mr D D Khanvilkar
Mr Shashikumar Menon
Mr Hirji C Mistry
Mr P D Khambata

1. Confirmation of Minutes

The minutes of the A G M held on 22nd November 1988 were confirmed. The minutes of the Extraordinary General Meeting held on 12th September 1989 were confirmed subject to the note that the Resolution passed at that Meeting had been proposed by Mr D Goenka and seconded by Mr Kisan Mehta.

2. Report of the Committee for the 15 month period ended 31st March 1989

The President expressed regrets that the name of Mr K T Satarwalla had inadvertently been omitted in the list of Vice- Presidents given in the Report. The Report of the Committee, duly proposed by Mr Ulhas Rane and seconded by Prof Parvish Pandya, was adopted by the Meeting.

3. Statement of Accounts for the 15 month period

Dr Pratap Saraiya (Hon. Treasurer) explained the main features of the financial results of 1988/89, and invited questions from members.

Mr D Goenka sought clarifications regarding the

Research and Education Fund, Staff Gratuity Fund, investments and establishment expenses, and these were given by the Hon. Treasurer.

Mr T M Davar felt that the Statement of Accounts should be sent to all members with the Notice of the A G M. The Hon. Treasurer explained that the practice, which had been confirmed at the Extraordinary General Meeting held on 26 March 1988, was that the Accounts were sent by post only to upcountry members who asked for the same. The reason was that substantial expenditure would have to be incurred in printing and mailing copies to all members, and that only a few members were interested in receiving the Accounts. Various suggestions were proposed by members in this connection, and it was agreed that the Executive Committee would review the matter.

The Balance Sheet and Statement of Accounts were approved on their being proposed by Mr Debi Goenka and seconded by Dr (Ms) Meena Haribal, and members expressed appreciation of the financial results and also the timely completion of the audit.

4. Appointment of Auditors

M/s Habib & Co. were appointed Auditors for the year 1989-90 at a remuneration of Rs 2,000/- for the audit work.

5. Amendment of Rules

The following Resolution was passed, proposed by : Dr Pratap Saraiya and seconded by: Mr S Gandhi and Mr T M Daver

RESOLVED that the Rules and Regulations of the Society be amended as follows :

In Rule 52

i) Substitute the words "31st March" for the words "31st December".

ii) At the end of Rule 52 add the sentence "For the period commencing 1st January 1988, all accounts shall be made for the fifteen month period ending 31st March 1989, and shall be audited as hereinabove provided.

6. Election of the Executive Committee

The President stated that 20 valid nominations had been received and he read out the names of the nominees. It was, therefore, necessary to have an election by ballot and voting papers would be sent to all members eligible to vote.

The Meeting ended with a vote of thanks to the Chair.

107TH ANNUAL REPORT AND ACCOUNTS FOR THE YEAR 1ST APRIL 1989 TO 31ST MARCH 1990

EXECUTIVE COMMITTEE FOR 1988-89

President	:	Prof. P V Bole
Vice Presidents	:	Mr Humayun Abdulali
		Ms D S Variava
		Mr K T Satarawala
Hon. Secretary	:	Dr A N D Nanavati
Hon. Treasurer	:	Dr Pratap R Saraiya
Curator	:	Mr J C Daniel

MEMBERS

Mr. M R Almeida; Dr Erach K Bharucha; Dr B F Chhapgar; Mr Cyrus J Guzder; Dr (Ms) Meena Haribal; Mr K Karamchandani; Mr Kisan Mehta; Prof. Parvish Pandya; Mr Ulhas Rane; Mr D I Solanki, The Secretary, Dept. of Education & Social Welfare, Government of Maharashtra

EXECUTIVE COMMITTEE FOR 1990-91

President	:	Prof. P V Bole
Vice Presidents	:	Mr Humayun Abdulali
		Ms D S Variava
		Mr Kisan Mehta
Hon. Secretary	:	Mr Ulhas Rane
Hon. Treasurer	:	Mr Bittu Sahgal
Curator	:	Mr J C Daniel

MEMBERS

Mr M R Almeida; Vice Admiral M P Awati (Retd.); Dr Erach K Bharucha; Dr (Ms) Meena Haribal; Dr Ashok Kothari; Dr Sashikumar N Menon; Mr Sunjoy Monga; Dr A N D Nanavati; Prof. Parvish K Pandya; Maj. Gen. E D'Souza (Retd.); The Secretary, Dept. of Education & Social Welfare, Government of Maharashtra.

Auditors

M/s Habib and Company, Chartered Accountants, Bombay

BOMBAY NATURAL HISTORY SOCIETY

Registered Office: Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023.

107TH ANNUAL REPORT

REPORT OF THE COMMITTEE FOR THE YEAR ENDED 31 MARCH 1990

OBITUARIES

We are sad to inform you of the demise of two of our former Vice Presidents: Mr Ralph E. Hawkins, who passed away on 13th October 1989 and Mr. Dinshaw J. Panday, who passed away on 4th February 1990. Both were deeply involved with the Society's functioning for many decades and were devoted to the Society's wellbeing.

Mr. Panday became a member on 27th September 1947 and served on the Executive Committee of the Society from July 1952 to May 1978, when he became a Vice President of the Society. He retired as Vice President in December 1986. Mr. Dinshaw Panday was a keen amateur naturalist and often accompanied Dr. Salim Ali, members and staff on field trips.

Mr Hawkins, who was a member of the Society from 28th March 1938 until his death was, for many years, the General Manager of the Oxford University Press (OUP). After he retired from the OUP, he unstintingly contributed the considerable skills which he had acquired as a publisher, to developing the Society's publications. He was Chairman of the Society's Publications Sub-Committee for many years and personally made a landmark contribution to the Society's publication efforts by producing and editing the monumental 'Encyclopedia of Indian Natural History'. The hallmark of his contribution to the Society's publications was his uncompromising commitment to quality and accuracy. He was also Chairperson of the Salim Ali Loke Wan Tho Ornithological Research Sub-Committee for many years.

The Society also suffered a serious loss in the passing away of Shri Shivrajkumar Khachar, the former Durbar Saheb of Jasdan, on 10th May 1989. He was not only an outstanding amateur ornithologist, but a well-wisher and benefactor of the Society, and a member of its Advisory Committee for many years. Shri Shivrajkumar Khacher's fort at Hingolgadh and his warm hearted hospitality was always available to nature lovers and to numerous children who will treasure unforgettable memories of camps at Hingolgadh.

Mr Panday, Mr Hawkins and Mr Shivrajkumar Khachar embodied the finest traditions of selfless service to the Society. Their modesty, their integrity of purpose and their devotion to the Society was both an inspiration and a model for others.

MEMBERSHIP

There was a substantial fall in ordinary membership of the Bombay Natural History Society during this year, but the number of life members has shown a considerable increase. We have taken several steps to enhance the membership of the Society by increasing members' activities. However, it is not possible to achieve this goal without your cooperation.

FIELD PROGRAMMES

Membership and Programmes Sub-Committee

Chairperson	Dr (Ms) Meena Haribal
Convenor	Mr Naresh Chaturvedi
Members	Mr S.D. Bhaumik
	Ms Shashi Rekha Iyer
	Dr Ashok Kothari
	Mr C.B. Mehta
	Prof. Parvish Pandya
	Mr S.A. Hussain
	Mr P.B. Shekar
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

A video cassette player and monitor were purchased and several video films were screened. Interesting nature walks were organised on weekends for local members around Chena Creek at Borivli National Park, Tungareshwar, Palghar, Kakoba Hills, around Tulsi and Vihar lake, Jambhulwadi, Barvi Dam area and Tansa. Special outings were also organised for the study of monsoon flora of the Borivli National Park

Type of membership	1985	1986	1987	1988	1989
Ordinary Members	1764	1680	1960	2008	1521
Corporate Members	152	138	81	83	82
Life Members	639	737	986	1057	1269
Compound Corporate Members	108	115	115	115	115
Student Members	164	141	190	206	225
Honorary Members	3	3	3	3	3
Vice Patrons	4	4	4	4	4
Centenary Life Members	3	3	3	3	3

The Bird Count programme was substituted by the study of plant-animal relationships at the Borivli National Park. Regular outings were arranged at Karnala Bird Sanctuary to monitor the natural history of the area. Several popular and scientific slide/lecture shows were arranged on subjects ranging from natural history topics, like butterflies of Sikkim, common honey bees, identification of birds of prey, nature around Lakshadweep and Andaman Islands to personal experiences on nature around Mount Everest and South Africa.

Conservation issues like water pollution at Chitali in Ahmadnagar, tropical forest degradation etc. were presented. The members were taken on a tour of Canyon Country, U.S.A. and nature reserves in U.S.A. and U.K. through slide presentations. Week-end nature camps were organised at Borivli National Park, Bhimashankar, Butcher Island, Vikramgadh and Nandur Madhmeshwar. An evening course on natural history was also conducted.

Annual nature camps remained the most popular among members. This year camps were organised at Kanha National Park, Bustard Sanctuary at Nanaj in Maharashtra, Anamalai/Topslip in Tamil Nadu and Similipal National Park and Bhitarkanika Wildlife Sanctuary in Orissa.

All these activities were possible due to active participation of members and BNHS staff as volunteers and camp leaders.

PUBLICATIONS

Publications Sub-Committee

Chairperson	Mr C.J. Guzder
Convenor	Mr Ajay Varadachary
Member	Dr B.F. Chhapgar
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

The Society's publications continue to attract a wide readership, and their popularity has necessitated reprinting during the year of almost all the titles published by the Society, in appreciably larger quantities than in earlier years. However, the results will be fully reflected in the accounts only in 90-91, when sales of books reprinted in 89-90 will be completed.

Journal

384 notes and articles were received from members and others for publication in the Journal during the year. From among these and notes and articles received earlier, 214 were accepted for publication.

During the year 4 issues of the Journal, i.e. Vols. 85 (3) and 86 (1,2 &3) were published. The 720 pages of these Journals held 255 articles and notes.

A board of editors was constituted in order to streamline the process of review, modification and acceptance of papers submitted. There have been major changes in the method of production of the Journal. Offset printing is now being done, as against the earlier letterpress method. Page composing is now done in-house and the development of this expertise within the Society will be of use in its other publications as well.

As a result of these changes the Journal contains appreciably more material in the same number of pages, without a loss in readability or quality of printing. Costs of production have also been sought to be controlled, and in spite of steep increases in paper prices, the cost to the Society has increased only slightly over the earlier levels.

Hornbill

The Hornbill continues to be popular and attracts members. However, more inputs from members by way of articles are necessary. We are trying our best to bring out these regular publications (Journal and Hornbill) in time

NATURE EDUCATION SCHEME

Nature Education Sub-Committee

Chairperson	Mr Ulhas Rane
Convenor	Mrs Shailaja Grubh
Members	Mr Bibhas Amonkar
	Dr (Ms) Meena Haribal
	Dr Arun Joshi
	Dr Shshikumar Menon
	Prof Parvish Pandya
	Mr S. A. Hussain
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

The regular activities like field trips, slide shows, camps, competitions etc. involving schools and colleges in Bombay were continued during the year. 19 programmes of slide/film shows and talks were conducted for schools, colleges and nature clubs in Bombay. These included municipal schools and teachers' colleges. 41 field trips were organised for schools and colleges at Borivli National Park and Tansa Sanctuary. Additionally, 17 study visits were organised for schools to the Natural History Section of the Prince of Wales Museum, Jijamata Udyan and Taraporewala Aquarium. A quiz programme for schools and junior colleges was organised on World Forestry Day

60 teachers participated in a nature orientation camp on marine life, organised for biology teachers. An exhibition of shells and stamps was also organised on this occasion. Camp for Municipal schools was conducted for 60 students of 12 schools, at Borivli National Park during December '89.

The Nature Education Sub-Committee members carried out various educational programmes for BNHS members, college students and rural children. These included slide shows, film shows, exhibitions, nature trails, competitions, basic courses in natural history subjects, nature orientation camps for members, awareness programmes and publicity through newspapers, radio and television.

The special features of the programmes conducted in the year 1989 were: Involvement of more voluntary organisations in our rural programmes; active involvement of the BNHS staff and members in nature education activities; continuation of nature education courses for amateurs; compilation of educational literature on natural history in English and Marathi; organisation of Nisarg yatra in the flood affected areas of Raigad district in Maharashtra, during Wildlife Week; nature camps for rural children in Aurangabad, Vidarbha and Ranebennur in Karnataka; continuation of experiments at Murbad in Thane district, to orient tribal children towards nature conservation , in co-ordination with Lok Vidnyan Chalwal and Shramik Mukti Sanghatana. Visits to the BNHS, Nehru Planetarium, Museum and Borivli National Park were arranged for these tribal children.

COLLECTIONS

The BNHS presently holds a reference or study collection of 18,260 mammals, 26,763 birds, 7,450 reptiles and amphibians, over 50,000 insects, a collection of birds' eggs, a small collection of shells and a herbarium. The purpose of this collection is to assist in taxonomic studies.

Collections Sub-Committee

Chairperson	Mr M.R. Almeida
Convenor	Mr N. Chaturvedi
Members	Dr B.F. Chhapgar
	Dr (Ms) Meena Haribal
	Mr Nitin Jamdar
	Staff in charge of different collections
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

Computerisation of collection data

The work of computerisation of collection data commenced last year and work of appending data of mammals is progressing well (3300 records are completed). The work of computerisation of collection data of reptiles and amphibians commenced this year. The Research Assistants also participated in the Computer Workshop conducted by the experts from U.S. Fish &Wildlife Service held at BNHS.

Visitors

Collections were shown to the post graduate students of the Jodhpur University and Janaki College of Sivakasi. school teachers and Adivasis students were also taken around the collections. Collections were referred to by members, students and participants of various evening courses in natural history.

Mammals

Assistance was given to Dr Corbett and Dr Bates of the British Museum in the study of mammal collections, i.e. rodents and bats. Specimens received from various projects, forest dept. and members were identified. A short survey of Surat Dangs was conducted to ascertain the status of giant squirrel and rusty spotted cat. Trips were made to BNHS land at Goregaon, for regular monitoring.

Birds

Two more parts of the catalogue were completed in 1989. Part 34 covered 500 specimens of 39 species and subspecies (nos. 1731- 1768 in the Handbook and Synopsis and 5 extra limitals). Part 35 covered 865 specimens of 85 species and subspecies (nos. 1769-1851 and 11 extra limitals).

During the year 32 specimens were added to the bird collection, out of which 20 specimens were from the Bhutan survey, returned by Dr. S.D. Ripley.

80 specimens were added to the exchange collection.

Reptiles/Amphibians

35 specimens of 8 species of amphibia collected at Srivilliputtur reserve forest by Ms Anita Malhotra and party of Oxford University, and 127 specimens of 13 amphibian species collected at Goa by Mr A.G. Sekhar and Mr Vithoba were registered. Amphibian specimens, sent by Dr Kanmadi, Dharwad University, Karnataka were identified and a report was sent.

Five specimens of snake species *Lytorhynchus ridgewayi* and 20 specimens of *Echis carinatus* were sent on study loan to Dr Walter Auffenburg, Florida Museum. BNHS land was visited for phenology studies. A trip to Panchgani, Belgaum, Goa, Kundapur, Kasargod, Calicut and Ooty was made along with Dr. Harry Nelson, an entomologist from Field Museum, Chicago, for a collection of aquatic beetles. A field trip was made to Goa for the collection of amphibia.

The morphology of tadpoles of *Rana curtipes* collected in Karnataka during the west coast trip, was studied. Tadpoles of *Rhacophorus malabaricus*, the Malabar gliding frog brought from Goa were reared in captivity to study their developmental stages.

Entomology

25 specimens of butterflies collected by Mr Nitin Jamdar from Kashmir were identified and added to the collection. A small collection (8 specimens) from Narcondam island in Andaman was identified. 16 specimens of butterflies received from AVC college, Tamil Nadu were identified. Assistance was given to Dr Nelson, entomologist, Field Museum, Chicago who is working on Dryopids and the group of beetles present in the collection.

Shells and other Invertebrates

Two type specimens of sea anemones and *Edwardsi athalyei, Acontiactus gokhalae* were received.

Several specimens of shells brought by Mr Taej Mundkur, Dr Kulkarni from Institute of Science, Somani High School, and by H.K. Gidwani High School were identified.

Herbarium

Trips were made to the BNHS land at Goregaon. During these trips specimens were collected, identified & preserved. 20 quadrats were studied. Seeds of herbaceous plants were collected. Specimens received from members were identified. 1000 specimens from Blatter herbarium which were donated to them by Alchemie Research Centre and 150 specimens (Bhimashankar & Magod collection) from Dr. Renee Borges were added to the herbarium.

NATURAL HISTORY STUDIES

Natural History Studies Sub-Committee

Chairperson	Dr E. Bharucha
Convenor	Mr S.A. Hussain
Members	Mr M.R. Almeida
	Prof. P.V. Bole
	Dr B.F. Chhapgar
	Mr Rishad Naoroji
	Mr Ulhas Rane
	Mr Bharat Bhushan
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr. J.C. Daniel, Curator

During the course of the year the Sub-Committee received eight applications for funding. Of these the following were considered and funded.

Salim Ali Loke Wan Tho Scholarship

1. **Feeding and breeding biology of openbilled stork in Andhra Pradesh** — Ph.D. Programme — *Scholar:* Ms Mehrab Johnson *Guide:* Dr J.V. Ramana Rao, Dept. of Zoology, Osmania University, Hyderabad.

Vegetation and snail abundance at Koleru was studied by quadrat method. At the nesting site, six nests from the 3 species of trees used for nesting, were randomly selected and marked for observations. Information was collected on the feeding mechanism, the activity patterns, habits and habitats of the bird and the general behaviour during the feeding and breeding seasons.

2. **Ecological and behavioural Study of the Indian black ibis at Rajkot.** — Ph.D. Programme — *Scholar:* Mr Sachin Vyas, *Guide:* Dr V.C. Soni, Department of Biosciences, Saurashtra University, Rajkot. *Grant:* Rs 17,000/-.

A regular census (morning & evening) was done at the roosting sites of the ibises in the study area around Rajkot. Adult-young ratios were calculated at various roost sites.

3. **Assistance for thesis writing:** Grant: Rs 3,000/- . A three month fellowship was granted to Mr R. B. Singh, Research Scholar, BNHS, to complete his thesis.

Pirojsha Godrej Fund

1. The grant of Rs. 2,000/- each was sanctioned to Mr Bholu Khan, Keoladeo National Park, Bharatpur, and Mr Harak Singh, Corbett National Park, U.P. to meet their expenses for wildlife study training.

Education and Research Fund

1. **Floristic studies in the Sanctuaries of Orissa** — Dr B P Chowdhury — Grant: Rs 18,500/- The grant could not be utilised this year. However, a research scholar has been appointed now to carry out the study in the following year.
2. **Study of Guindy National Park: its habitat evaluation for conservation strategies.** 'Madras Naturalists Society', Madras. A grant of Rs. 5,000/- was awarded as seed money to initiate the study.
3. **Ecology and Behavior of Lampyridae around Pune**: A grant of Rs 5,000/- was awarded to Ms Varsha Kerkar, University of Pune, as seed money to start field work.

Plant Studies Fund

Expenses of the Research Assistant (Botany), for collection field trips were met from the fund.

THE SALIM ALI NATURE CONSERVATION FUND (SANCF)

SANCF Sub-Committee

Chairperson	Mrs D.S. Variava
Convenor	Mr Bharat Bhushan, Conservation Officer
Members	Dr E. Bharucha
	Mr. D. Solanki
	Mr S.A. Hussain
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

The sub-committee continued to initiate as well as support activities of conservation interest from SANCF. Major projects and initiatives undertaken during the year were

Narmada

The proposed damming of the Narmada is a matter of serious concern and SANCF provided considerable support to the movement against the project.

The 28 September Harsud Rally that brought together over 50,000 people from all over the country to protest against the Narmada dams was supported with a grant of Rs 60,000 provided to the rally organisers towards preparation of education brochures, banners and pamphlets and supporting volunteers.

Financial support was provided to Mr Arun Vinayak, the coordinator for the Western Group of the Narmada Bachao Andolan.

A short survey of the proposed Narmada Sagar submergence areas was conducted. The report later formed the basis of the BNHS resolution against the Narmada Project. Significant support was provided for awareness meetings and documentation.

Lesser Florican (*Sypheotides indica*) A grant of Rs 5,000/- was provided to support a survey by Mr Ravi Sankaran towards identification of breeding areas of the lesser florican in Gujarat and parts of Rajasthan.
Aerial Survey of Dangs Survey work was completed and a report submitted on a landmark aerial survey of habitat in the Surat Dangs forest by Dr E. Bharucha. A paper has been published in the *JBNHS*.
Dugong Dr Helene Marsh's final report on conservation of the Dugong was received. Follow-up action was initiated with the Central and State governments.

Training programmes

The upgrading of knowledge and skills of members and others was a major priority. Several training programmes were organised as follows:

a] **Vertebrate Ecology Workshop:** A month-long 'Vertebrate Ecology Workshop' for 25 persons was organised at the Mudumalai Wildlife Sanctuary, Tamil Nadu with a grant from the Ministry of Science and Technology, Government of India. The Wildlife Institute of India, Kerala Forest Research Institute, Indian Institute of Science, Tamil Nadu Forest Department and other organisations provided generous support.

b] **Environmental journalism:** A one-day workshop on 6th May 1989 and a training course in January-February 1990 was conducted in environmental journalism at Hornbill House. This was in collaboration with the Forum of Environmental Journalists of India.

c) **Workshop on Conservation Biology:** A three-day workshop was conducted for more than 50 students of the School of Environmental Sciences at the Pune University. Support faculty included BNHS members who had been earlier trained at the Vertebrate Ecology Workshop.

d] **Maharashtra Institute for Development Administration (MIDA):** On an initiative from IAS officers, Mr D.T. Joseph, and Mr Pravin Pardeshi, BNHS conducted a one-day conservation orientation programme for the MIDA faculty.

NGOs meeting at Hemalkasa

Financial support was granted to Mr Sharat Hegde as an assistant to Baba Amte for the NGOs meeting against "destructive forms of development" at Hemalkasa. The meeting later culminated in a human wall of several thousand person across the Indravati river in protest against the proposed Bodhghat Dam Project.

BSAP decennial seminar

An amount of Rs 5,000/- was granted to the Birdwatcher's Society of Andhra Pradesh's decennial seminar titled 'The Role of Birds in the Environment and their Conservation'.

Networking and documentation

a] **Government of Maharashtra:** Dr E. Bharucha and Mr Bharat Bhushan conducted an orientation programme at the Pune Commissioner's premises where the State Chief Secretary and several other senior officials were present. Definite action on conservation issues in the state were consequently initiated, including Bhigwan, Rehekuri and Nawegaon.

b] **Forum of Environmental Journalists of India:** With the help of FEJI, about 200 journalists from all over India have been identified as being interested on reporting on the environment.

c] **Documentation:** SANCF is receiving documentation on conservation perspectives from the Centre for Education and Documentation, from FEJI and some BNHS members. The entire documentation has been catalogued and compiled for easy access.

PROJECTS

Projects Sub-Committee

Chairperson	Prof P.V. Bole
Convenor	Dr R.B. Grubh, Research Coordinator
Members	Mr Humayun Abdulali
	Mr M.R. Almeida
	Dr Erach Bharucha
	Mr K. Karamchandani
	Mr S.A. Hussain
	Dr A.R. Rahmani
	Dr V.S. Vijayan
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

During the year 1989 the BNHS handled six major field ecological research projects:
Bharatpur (Keoladeo) Ecology Project (Funded by USFWS), Bird Migration Project (Funded by USFWS), Elephant Ecology Project (Funded by USFWS), Endangered Birds (Florican) (Funded by USFWS), Point Calimere Ecology Project (Funded by USFWS), Ecological Study of Bird Hazard at Indian Aerodromes (Funded by Directorate of Aeronautics, Ministry of Defence, Government of India)

Bharatpur (Keoladeo) Ecology Project

Having completed major data collection work, the scientific staff concentrated on analysis of data gathered over nine years. In order to facilitate data analysis the Bharatpur field station was provided with three computers (Two XTs and one AT-386 with Co-processor) and two printers.

In addition to routine work the project personnel were also engaged in organizing a wetland seminar with special reference to Bharatpur. This seminar was conducted in February 1990 at Bharatpur and was attended by scientists from India and abroad as well as by officers from the state Forest Department and senior officials of the Centre and state governments.

Bird Migration Project

Having worked at various sites over the years, it was decided to look for new areas. Accordingly two new sites were located, one at Sriharikota Island in Andhra Pradesh, north of Madras, and the other at Chari in Kutch, Gujarat.

Sriharikota island is bounded on its west by Pulicat lake which has waterbirds during winter. The tropical dry evergreen forest of the island offers a wide variety of arboreal and ground birds of resident and migratory species. It is hoped that Sriharikota will become a major field station for the study of the avifauna of the region. The officials of the Indian Space Research Organisation, Shar Centre, have provided all facilities and cooperation to BNHS in establishing this important field station. Chari field station at Kutch was set up with a view to work on the migratory waterbirds visiting the lake Chari near Nakatrana, and to use it as a base to work on terrestrial birds around the lake as well as on water-birds in other areas in Kutch. This important site was located with the help of a life member of the BNHS, Shri Himmatsinhji.

In addition to the above two sites, ringing was resumed at Point Calimere where extensive banding was undertaken from 1969 to 1973 and again in the early 1980s.

Other areas where limited banding operation was carried out include Chilka lake in Orissa, Khabertal in Bihar and Dachigam National Park, Hokarsar and Haigaon lakes in Kashmir. Apart from banding and collecting morphometric data from captured birds, the project also looked at the ecological requirement of the migrant as well as resident birds at the major field stations.

Elephant Ecology Project

The study of the Indian elephant was conducted from Mudumalai as the base and Denganikota (Dharmapuri Dist., Tamil Nadu) and Dalma (Bihar) as two subsidiary stations. Two US computer experts, namely Dr Micheal Stuwe and Mr John Cary conducted a computer training workshop at Mudumalai specially for the elephant project research team with a view to train them in analysis of habitat mapping data and data to be obtained from radio-telemetry on wild elephants.

While intensive field studies are on at Dalma and Denganikota, special attention is being given to analysis of data at Mudumalai. A computer (XT with co-processor) and a printer have been provided at the base station.

Ecology of Lesser and Bengal Florican

Intensive field study of the lesser florican was conducted at Sailana in Madhya Pradesh. Extensive survey of this species was conducted in different states. The Bengal florican study was primarily conducted at Manas and Dudhwa.

Field studies are now complete and analysis of data has begun. The research team has returned to Bombay for this purpose. The computer and other facilities available at Bombay are being put to use.

The final report on the great Indian bustard, which was one of the study species under the Endangered Species Project, was brought out in 1989. The research team has also published 22 research papers and many short notes since the commencement of the project.

Point Calimere Ecology Project

The original research plan was revised to give an ecosystem oriented thrust to the field studies. It was also decided to analyse the data side by side and a computer PC XT with co-processor and a printer were provided to facilitate data analysis.

Ecological study of bird hazard at Indian aerodromes

The final report of the field study conducted in 22 airports was brought out. A high level committee constituted by the Government of India for bird hazard prevention undertook to implement the recommendations given in the report. The Bombay Airport which started implementing BNHS recommendations showed drastic reduction in bird strikes within one year.

The Bird Hazard Research Cell being funded by the Government of India (ARDB) continued to identify bird strike remnants for IAF, Civil Aviation and Indian Navy aircraft.

Evaluation of field research

The quality and quantity of research being undertaken under the above projects are assessed annually by a Research Advisory Panel which includes eminent ecologists from different parts of India and abroad.

LIBRARY

The library continues to be one of the most used member facilities. In 1989, 81 books were added to the library. 8 books were received from publishers for favour of publishing reviews in the Journal and 9 as complimentary copies from authors and publishers. 12 books were received as donations to the library.

Library Sub-Committee

Chairperson	Dr B.F. Chhapgar
Convenor	Mr Isaac Kehimkar
Members	Mr M.R. Almeida
	Mr Kisan Mehta
	Mr Kiran Srivastav
Ex-officio	Dr A.N.D. Nanavati, Hon. Secretary
	Dr Pratap Saraiya, Hon. Treasurer
	Mr J.C. Daniel, Curator

The photocopier serves a useful purpose to provide reprints of various articles to members and scientists.

UNIVERSITY DEPARTMENT

Mr U. Sridharan submitted his thesis for Ph.D on ecology of the resident ducks of Keoladeo National Park. Mr Natarajan and Mr Alagar Rajan submitted synopsis of their thesis on the Ecology of the Crow Pheasant and Ecology of the Spotted Ring Dove.

The Bombay University sent an expert committee for continuation of the Society's recognisation for M.Sc. by Research and Ph.D. in Botany. The following students are registered for M.Sc. and Ph.D degrees through the BNHS.

CONSERVATION

The Society was consulted by the Govt. of India and other organisations and by members of the Society on various matters of conservation interest. The Society's representatives on various conservation committees and organisations offer the expertise available at the Society.

The proposal to construct major dams on the Narmada river and the clearance of the proposal by the Government of India for funding was a cause for acute concern. The Committee consulted other like minded organisations and persons on a possible positive approach to prevent environmental damage.

SALIM ALI CENTRE FOR ORNITHOLOGY AND NATURAL HISTORY

The work of drafting the Memorandum, formation of Governing Council etc. continued. A grant of Rs. 10 lakhs was received from the Dept. of Environment & Forests, Govt. of India, for preliminary expenses. After receipt of formal sanction from Govt. of India, the formality for registration was initiated.

PRODUCTS

Organiser Mrs D.S. Variava

The calendars and greeting cards produced by the Society continued to sell well, with an increase of nearly 50% over the previous year's levels in income generated. A six page wall calendar was introduced for the first time.

Name of Student	Subject of Study	Guide from BNHS
	M.Sc. Zoology	
Mr Gurmeet Singh	Ecology of Bank Myna	Dr R.B. Grubh
Mr Ramachandran	of Jacanas	Dr V.S. Vijayan
Mr P.D. Vivek	Birds of Delhi	Dr R.B. Grubh
	Ph.D. Zoology	
Mr. G Narayan	The Ecology of the Bengal Florical	Mr J.C. Daniel
Mr S.M. Satheesan	Birds of Pray	Mr J.C. Daniel
Mr Sunderamoorthy	The Ecology of terrestrial Birds of Keoladeo National Park, Bharatpur	Mr J.C. Daniel
Mr Bharat Bhushan	Ornithology of Eastern Ghats	Mr J.C. Daniel
Mr Ranjit Manakadan	Ecology of Flamingoes	Mr J.C. Daniel
Mr Ravi Sankaran	The Ecology of Lesser Florican	Mr J.C. Daniel
	PhD. Botany	
Mr. P. Balasubramanian	Plant-animal Interactions	Prof P.V. Bole
	M.Sc. Botany	
Ms Neelam Patil	Plant-insect Interactions	Mr M.R. Almeida

ODA-BNHS ENVIRONMENTAL EDUCATION PROJECT

The Overseas Development Administration of the United Kingdom had agreed to fund two projects – Environmental Education and Tropical Forest Bird Studies—under the Indo-British Technical Collaboration agreement. The two projects were approved by BNHS E.C. as well as Dept. of Environment, Govt. of India. The RSPB at the request of ODA sent Mr David Elcome to BNHS to discuss the Environmental Education Project and prepare a final project document which was approved by ODA. The ODA appointed British Council, Bombay, to manage the project on their behalf in India. Mr David Elcome from RSPB and Mr S.A. Hussain from BNHS were nominated as Principal Coordinators for the project. The Project seeks to:

1. Establish a team for environmental education with emphasis on rural education at BNHS. This will be a valuable cadre of staff for future EE projects in India.
2. Strengthen the educational facilities of BNHS through provision of equipment for a DTP system, a Nature Discovery Room, etc.
3. Establish local environmental education centres at 3 selected sites to assess the most effective techniques and resources for environmental education programme and to disseminate the scientific information, in a popular form to grassroot level.
4. Have, by the end of the project, a tried and tested range of educational resources for communicating with rural communities.

DONATIONS

We are grateful to the many organisations and persons for donations to the Society.

		Rs
1.	General donations received from members	19,995
2.	Maharashtra Foundation, New York, U.S.A. for rural education activities	3,373
3.	Charles McCann Vertebrate Zoology Field Work Fund Mr S. Chaudhury	600
4.	Dr Salim Ali Memorial Fund Mr John D Constable, Boston	4,080
5.	Salim Ali Nature Conservation Fund: As per the Will from the estate of late Dr Salim Ali	50,000
6.	Seth Purshotamdas Thakurdas Divaliba Charitable Trust	
	For Library	25,000
	For Hornbill newsletter	25,000
7.	Staff Welfare Fund: As per the Will of late Dr Salim Ali	50,000
8.	From Pirojsha Godrej Foundation For nature conservation activity	50,000
9.	Col. Burton Fund Mr John Toovey	8,483

ACKNOWLEDGEMENTS

The Executive Committee acknowledges with thanks the assistance given to 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, the Government of Maharashtra, and the Charity Commissioner, Bombay. It also thanks the several donors, the members and staff of the BNHS for their unstinting support in the various activities of the Society.

23 August 1990 — ULHAS RANE
Bombay — Hon. Secretary

HONORARY TREASURER'S REPORT ON THE ACCOUNTS FOR THE YEAR 1st APRIL 1989 TO 31st MARCH 1990

1. The 'Annual' Accounts for the year 1989-90 (12 months), compared to the previous 15 months period from 1-1-88 to 31-3-89, show a satisfactory trend. Income by way of dividends, sale of books, calendars, greeting cards taken into account together are encouraging.

2. During the period under review the total funds owned by the Society went up by Rs. 16.56 lakhs as follows:

The increase of Rs. 15 lakhs under item (iii) may be considered as a fair measure of improvement in the working of the Society. The corresponding figure for the previous 15 month-period was Rs. 11.22 lakhs.

3. The expenses on establishment inclusive of Journal, Hornbill Newsletter & Members' Activities have increased by 16.24%.

4. The Research Projects, funded by the U.S. Fish and Wildlife Service, and the Bird Hazard Research Cell project funded by Ministry of Defence, Govt. of India have played a vital role in building up the Society's resources by way of men, material and money. Besides, out of funds made available by the Govt. of India, Dept. of Environment, we purchased scientific equipment, worth about Rs. 7,00,000/- thus substantially adding to the value of our fixed assets. It will be seen that the administrative fees for handling the project funds make substantial contribution to our annual revenues. The accounts do not reveal the assets given on loan for these projects, such as computer systems, laboratory equipment, vehicles etc. The original cost of these assets, many of which may be eventually donated to the Society by the funding agency at the conclusion of the projects add up to Rs. 35 lakhs.

5. While the results of 1989-90 show an improvement over 1988- 89 there is no room for complacency in regard to the finances of the Society. Establishment costs and other expenses in regard to our traditional activities, continue to rise due to inflation.

6. Further as two of our current projects, are coming to an end shortly, it is necessary to undertake new projects if receipts by way of administrative fees are to be maintained at the current level.

7. In the final analysis the real challenge is to build up our own financial resources in order to progressively increase our regular income and also to meet growing requirements of working capital.

23 August 1990
Bombay

BITTU SAHGAL
Hon. Treasurer

AUDITOR'S REPORT
BOMBAY NATURAL HISTORY SOCIETY
Registration No.F-244 (Bom)

We have audited the attached Balance Sheet of the Society as at 31st March, 1990 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 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 past practice separate Receipts & Payments Account has been drawn for the Nature Education Scheme, and the same has not been incorporated in the accounts of the Society,

(b) the receipts and disbursements have been properly and correctly shown in the accounts,

(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, deeds, accounts, vouchers and/or other documents or records required by us were produced to us,

(e) the register of movable and immovable properties is properly maintained and the changes therein have been communicated to the Regional Office,

(f) 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 items were outstanding for more than one year:

(i) Due towards supplies and services. ....Rs. 10,246.15
(ii) Loan to staff (since recovered Rs. 5,000/- on 23.8.90) ....Rs. 5,600.00
(iii) Grant from ARDB for Bird Hazard Research Cell for 1988-89.. ....Rs. 8,105.99

We may add that the outstanding against supplies and services interalia include certain items, which are outstanding since 1987. We have been assured that the outstanding balances are considered good and realisable. We may nonetheless suggest that effective measures be taken to realise the outstanding. During the financial year under report a sum of Rs.530.50 representing dues considered irrecoverable has been written off,

(i) during the financial year there were no major repairs or construction carried out to the property in the occupation of the Society involving expenditure exceeding Rs. 5,000/=,

(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,

(ii) the income towards membership subscription is being accounted on realisation basis,

(iii) the subscriptions received in foreign currency, we observe, are deposited in an account maintained with Grindlays Bank Plc., London Branch. The said receipts and disbursements made therefrom have been accounted at the exchange rate prevailing at the date of the Balance Sheet.

The closing balance has been translated at the current exchange rate, at the date of the Balance Sheet and the difference in exchange amounting to Rs.9,750.13 has been credited to Income & Expenditure account,

(iv) we observed that the Society had made a payment of Rs.58,645/- against purchase of a computer. The said payment continues to be held under the head Advances and has not been appropriately adjusted pending the clarification that has been sought from the Central Government for utilisation of the grant for the purpose of the acquisation of the computer.

(v) we suggest the following items of disbursement effected, provisions made, administrative charges levied and amount written off be confirmed and ratified at the next meeting of the Executive Committee :

A. Disbursement from:

		Rs.
(i)	Interest on Col. Burtons Nature Conservation Fund	22.50
(ii)	Charles McCann Vertebrate Zoology Field Work Fund	642.51
(iii)	Interest on Salim Ali/Loke Wan Tho Ornithology Research Fund Investment	51,973.17
(iv)	Interest on Salim Ali Nature Conservation Fund Investment	1,82,764.11
(v)	Interst on Pirojsha Godrej Foundation Field Work Fund Investment	489.30
(vi)	Dorabjee Tata Trust Field Work Fund	2,915.90
(vii)	Plant Study Fund	35,339.40
(viii)	Field Study and Schlolarship Fund from Watanmal Boolchand Charitable Trust	1,741.85
(xi)	Grant from Government of Maharashtra for 1988-89 towards establishment, Building Maintenance and Educational Activity, (i.e. Journal Printing exp.)	2,15,000.00
(x)	Govt. of India A.R.D.B. Grant for Bird Hazard Research Cell	1,24,389.70
(xi)	Education and Research Fund	40,710.00
(xii)	Grant from U.S. Department of Interior, Fish & Wildlife Service for :	
	(a) Study of Lesser Bustard (Florican)	2,01,920.75
	(b) Ecology of Keoladeo National Park, Bharatpur	11,88,970.79
	(c) Ecology of Point Calimere Sanctuary	8,01,247.51
	(d) Ecology of Indian Elephants	13,53,123.70
	(e) Study of Migration Pattern of Indian Birds and Avifauna Migration Data Bank	10,17,738.76
	(f) For the project on the habitat and population dynamics of Wolves and Blackbucks	1,70,139.00
	(g) For Study on Conservation of Birds of Prey with particular emphasis upon Restoration of the Endangered Species	2,19,492.62
(xiii)	Grant Indian National Science Academy for the publication of Journal	5,000.00
(xiv)	Grant Chief Wildlife Warden, Jammu &Kashmir for the project on Survey of Blacknecked Crane	12,653.45
(xv)	Grant Govt. of India (DST) towards Dr. Salim Ali Centre for Ornithology and Natural History	8,637.80
(xvi)	Grant Govt. of India, Dept. of Culture for publishing the Centenary Seminar papers	29,657.45
(xvii)	Grant Govt. of India, D.O.E. for Airconditioning Hornbill House, Library and Collection Rooms	4,90,700.00
(xviii)	Grant Govt. of India, D.S.T. for the publication of Tree Book	23,126.90
(xix)	Grant Govt. of India, Ministry of Environment & Forests for Seminar on Wetland Ecology and Management at Bharatpur	11,590.00

(xx) Grant Govt. of India, Ministry of Science & Technology (D.S.T.) for Seminar School in Vertebrate Ecology 2,98,970.00
(xxi) Grant Govt. of Rajasthan for Lignite-Project 8,385.00
(xxii) Grant Govt. of India, Ministry of Environment and Forests on a Project "A Study of the habitat requirement of the Rusty Spotted Cat and other endangered wildlife of the Dang Forests" 2,18,179.91
(xxiii) Grant Govt. of M.P., Office of the Chief Engineer, for Indira Sarovar Hydro Electric Project 4,921.90
(xxiv) Grant Smithsonian Institution, Washington, for the revision of Handbook of the Birds of India &Pakistan 91,037.93

B. APPROPRIATIONS:

(i) Govt. Publication Fund, sale proceeds of publication 19,559.46
(ii) Building Fund for repairs & maintenance 4,00,000.00
(iii) Staff Gratuity Fund 2,00,000.00
(iv) General Reserve Fund 1,50,000.00
(v) Fixed Assets Fund towards depreciation on Fixed Assets 1,38,906.29
(vi) Amount written off 530.50
(vii) Administrative fees charged to various Grants/Funds for handling the projects etc. 6,32,965.70
(viii) Addition to fixed assets (other than those charged to various projects) 8,30,602.89

(m) so far as is ascertainable from the books of accounts and according to the information and explanation furnished to us by the accountant and the Hon. Secretary, there were no cases of irregular, illegal or improper expenditure or failure to recover the monies or other properties belonging to the Society or loss or waste of money or other property of the Society, subject to the observation made in para (h) hereinabove,

(n) provision of Sec. 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.

II. (a) the maximum and minimum number of Executive Committee members is maintained having regard to the provision contained in the rules and regulations of the Society,

(b) there is no specific provisions in the rules and regulations of the Society regarding the holding of the meetings of the Executive Committee,

(c) the minute book recording the proceedings of the meetings is maintained,

(d) no member of the Executive Committee has any interest in the investment of the Society,

(e) no member of the Executive Committee is a debtor or a creditor of the Society.

HABIB AND COMPANY
CHARTERED ACCOUNTANTS

Bombay
Dated: 3rd September, 1990

BOMBAY NATURAL HISTORY SOCIETY

REGD. NO. F-244 (BOM)

BOMBAY PUBLIC TRUST ACT 1950 SCHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET AS AT 31ST MARCH 1990

FUNDS AND LIABILITIES

	Rs.	Rs.
Life Membership Fund (Individual)		
Balance as per last Balance Sheet	10,67,123.11	
Add: Amount received during the year	1,06,639.05	11,73,762.16
Corporate Life Membership Fund		
Balance as per last Balance Sheet	2,15,742.31	
Vice Patron Fees		
Balance as per last Balance Sheet		42,769.00
CORPUS FUNDS		
As per Schedule 'A'	18,16,174.48	
OTHER FUNDS		
As per Schedule 'B'	60,30,980.83	
LIABILITIES		
Unspent Grants as per Schedule 'C'	71,25,675.06	
For Expenses	3,09,785.03	
For Library Deposits	3,000.00	
For Sundry Credit Balances	17,484.09	
For Advance for Publications	39,041.17	
For Advance Nature Camps	2,525.00	74,97,510.35
Carried over Rs.		1,67,76,939.13

IMMOVABLE PROPERTIES

	Rs.	Rs.
IMMOVABLE PROPERTIES		
Investments (at appropriate value) Government Securities (at cost) 5.5% Govt. of India Loan 2000 of the face value of Rs. 2000/- (Market value Rs. 1,211/-	2,000.00	
4,834,835 Units of the Unit Trust of India under reinvestment plan of the face value of Rs. 100/- each (Total face value Rs. 4,88,747.24 including accumulated dividend units 2,834.835	5,00,429.91	
70.150 Units of the Unit Trust of India each of the face value of Rs. 10/- (Total face value Rs. 7,01,500/-, Unit Scheme 1964 repurchase value Rs. 9,96,130/-)	9,99,637.50	
4,560 Units of the Unit Trust of India - each of the face value of Rs. 100/- (Total face value Rs. 4,56,000/-) Unit Scheme CRTS 1981	5,01,600.00	
4400 Units of the Unit Trust of India– each of the face value of Rs. 100/-. (Total face value Rs. 4,40,000/-) Unit Scheme CRTS. 1981	5,06,000.00	
Carried over		25,09,667.41

FUNDS AND LIABILITIES	Rs.	Rs.
Brought over		1,67,76,939.13
OTHER ADVANCES		
Amount received for and on behalf of the proposed Institute		
Balance as per last Balance Sheet	2,69,744.16	
Add: Interest Credited during the year	20,000.00	
	2,89,744.16	
Less: Expenditure for and on account of the Institute incurred during the year	13,856.85	
		2,75,887.31
INCOME AND EXPENDITURE ACCOUNT		
Balance as per last Balance Sheet	16,552.77	
Add: Excess of Income over expenditure account during this year	24,806.52	
		41,359.29
Carried over		1,70,94,185.73

ASSETS	Rs.	Rs.
Brought over		
INVESTMENTS (Contd.)	25,09,667.41	
4470 Units of the Unit Trust of India– each of the face value of Rs. 100/- each. (Total face value Rs. 4,47,000/- Unit Scheme CRTS. 1981	5,00,640.00	
FIXED DEPOSITS WITH		
Indian Petrochemicals Corporation Ltd. F.D. receipt No. 39493. dtd. 4-8-1989	15,00,000.00	
		45,10,307.41
MOTOR CARS, MOTOR CYCLE, AUTO CYCLE, MINIBUS		
Balance as per last Balance Sheet	63,710.11	
Less: Depreciation during the year	12,742.03	
		50,968.08
FURNITURE, FIXTURE AND EQUIPMENTS		
Balance as per last Balance Sheet	1,78,711.20	
Add: Additions during the year (including Rs. 7,81,852.53 spent from various grants/funds)	8,30,602.89	
	10,09,314.09	
Less: Depreciation during the year	1,26,164.26	
		8,83,149.83
Loans (unsecured considered good) To employees		33,554.00
Carried over Rs.		54,77,979.32

FUNDS AND LIABILITIES	Rs.	Rs.	ASSETS	Rs.	Rs.
Brought over		1,70,94,185.73	Brought over		54,77,979.32
			ADVANCES (Unsecured considered good)		
			For Expenses		
			To Hon. Secretary (For Nature Education Activity)	34,00.00	
			To employees (For Projects & other expenses)	6,26,821.53	
			To others (For various projects & other expenses)	70,541.29	
			For purchase of equipment accessories and spares	1,30,550.00	
			Amount receivable from Nature Education Scheme	58,045.62	
			US Fish & Wildlife Services (US Embassy)	1,33,536.90	
				1,91,582.52	
			To employees Advance against salary	12,100.00	
			Deposits		
			Mahanagar Telephone Nigam Ltd.	15,000.00	
			BEST Undertaking	8,140.00	
			For Project accommodation	12,396.00	
			For Gas Cylinders	4,950.00	
				40,486.00	
					11,06,081.34
Carried over		1,70,94,185.73	Carried over		65,84,060.66

FUNDS AND LIABILITIES	Rs.	Rs.
Brought over		1,70,94,185.73
Carried over		1,70,94,185.73

ASSETS	Rs.	Rs.
Brought over		65,84,060.66
STOCKS		
A) Publications under BNHS Funds as per inventory taken and certified by the Hon. Secretary at or below cost	11,33,895.15	
B) Publications under Govt.of India funds as per inventory taken and certified by the Hon. Secretary at or below cost	59,207.68	
C) Safety cartridges (as certified by the Hon. Secretary)	9,530.35	
D) Publications (Under preparation) Expenses incurred till date		
i) Book of Indian Birds, New Edition	65,610.00	
		12,68,243.18
INCOME OUTSTANDING		
Interest Accrued	38,066.72	
Supplies and Services (Bills receivable)		
i) Publications & Calendars	24,218.05	
ii) Greeting Cards	77,874.00	
Grant Govt. of India, Ministry of Defence ARDB for Bird Hazard Research Cell	1,32,495.69	
Grant Govt. of India D.O.E. for		
i) Scientific equipment	1,80,600.00	
ii) Vertebrate Ecology Workshop	23,970.50	
		4,77,224.96
Carried over		83,29,528.80

FUNDS AND LIABILITIES	Rs.	Rs.	ASSETS	Rs.	Rs.
Brought over		1,70,94,185.73	Brought over		83,29,528.80
			CASH AND BANK BALANCES		
			Cash and bank balances as per Schedule 'D' including Rs. 37,54,583.34 in fixed deposits + monthly income certificates		87,64,656.93
Total Rs.		1,70,94,185.73	Total Rs.		1,70,94,185.73

BOMBAY NATURAL HISTORY SOCIETY

AS PER OUR REPORT OF EVEN DATE

HON. SECRETARY HON. TREASURER

HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay
Dated: 3rd September 1990

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1990

SCHEDULE 'A'

Name of the Corpus Funds	Balance as per last balance sheet 1	Amount Received/ appropriated during the year 2	Total of columns 1 & 2 3	Balance as on 31-03-1990 4
	Rs.	Rs.	Rs.	Rs.
Salim Ali/Loke Wan Tho Ornithological Research Fund	4,03,136.52	–	4,03,136.52	4,03,136.52
Salim Ali Nature Conservation Fund	13,11,554.96	50,000.00	13,61,554.96	13,61,554.96
Col. Burtons Nature Conservation Fund	3,000.00	8,483.00	11,483.00	11,483.00
Pirojsha Godrej Foundation Fieldwork Fund	40,000.00	–	40,000.00	40,000.00
	17,57,691.48	58,483.00	18,16,174.48	18,16,174.48

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1990

SCHEDULE 'B'

Name of the other funds	Balance as per last balance sheet 1	Amount recd./ appropriated during the year 2	Interest credited during the year 3	Total of columns 1, 2 & 3 4	Transferred to income & expenditure account during the year 5	Expenditure on objects of the trust as shown in Income & Exp. account 6	Balance as on 31-3-90 7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs
Staff Welfare Fund	36,322.84	50,000.00	–	86,322.84	–	–	86,322.84
Col. Burtons Nature Conservation Fund Investment Revenue A/c.	960.95	–	300.00	1,260.95	22.50	22.50	1,238.45
Charles McCann Vertebrate Zoology Field Work Fund	79,668.20	600.00	7,966.82	88,235.02	642.51	642.51	87,592.51
Salim Ali/Lok Wan Tho Ornithological Research Fund Revenue A/c.	69,941.21	–	40,313.65	1,10,254.86	51,793.17	51,793.17	58,461.69
Salim Ali Nature Conservation Fund Investment Revenue A/c.	1,58,431.28	50,000.00	1,34,072.16	3,42,503.44	1,82,764.11	1,82,764.11	1,59,739.33
Fieldwork Fund under Pirojsha Godrej Foundation Fund Investment Revenue A/c.	981.25	–	4,000.00	4,981.25	489.30	489.30	4,491.95
Fieldwork Fund Sir Dorabjee Tata Trust	5,149.20	–	–	5,149.20	2,915.90	2,915.90	2,233.30
Field Study and Scholarship Fund from Watanmal Boolchand Charitable Trust	1,741.85	–	–	1,741.85	1,741.85	1,741.85	–
Carried over	3,53,196.78	1,00,600.00	1,86,652.63	6,40,449.41	2,40,369.34	2,40,369.34	4,00,080.07

SCHEDULE 'B' (Contd..)

Name of the other funds	Balance as per last balance sheet	Amount recd./ appropriated 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 the trust as shown in Income & Exp. account	Balance as on 31-3-90
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	3,53,196.78	1,00,600.00	1,86,652.63	6,40,449.41	2,40,369.34	2,40,369.34	4,00,080.07
Photography Exhibition Fund received from Shri M Y Ghorpade of Sandur	10,000.00	–	–	10,000.00	–	–	10,000.00
Plant Study Fund	82,341.20	–	–	82,341.20	35,339.40	35.339.40	47,001.80
Education & Research Fund created out of Income	1,33,698.36	–	–	1,33,698.36	40,710.00	40,710.00	92,988.36
Donation from Seth Purshottamdas Thakoredas & Divaliba Charitable Trust for Library Books/ Furniture purchase	–	25,000.00	–	25,000.00	–	–	25,000.00
Fixed Assets Fund	1,69,956.59	*7,81,852.53	–	9,51,809.12	1,38,906.29	1,38,906.29	8,12,902.83
Building Fund	1,03,227.68	4,00,000.00	–	5,03,227.68	–	–	5,03,227.68
General Reserve Fund	3,07,624.02	1,50,000.00	–	4,57,624.02	–	–	4,57,624.02
Staff Gratuity Fund	5,62,305.92	2,00,000.00	56,230.59	8,18,536.51	83,099.50	83,099.60	7,35,437.01
Chacko Fund for Education & Conservation	37,559.70	–	–	37,559.70	–	–	37,559.70
Salim Ali Memorial Fund	13,39,850.91	4,080.00	–	13,43,930.91	–	–	13,43,930.91
Carried over	30,99,761.16	16,61,532.53	2,42,883.22	50,04,176.91	5,38,424.53	5,38,424.53	44,65,752.38

* Value of additions to Fixed Assets Fund from various Funds /Grants (as per contra).

SCHEDULE 'B' (Contd.)

Name of the other funds	Balance as per last balance sheet	Amount recd./ appropriated 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 the trust as shown in Income & Exp. account	Balance as on 31-3-90
	1	2	3	4	5	6	7
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	30,99,761.16	16,61,532.53	2,42,883.22	50,04,176.91	5,38,424.53	5,38,424.53	44,65,752.38
Publication Fund BNHS	9,66,788.76	1,04,243.65	–	10,71,032.41	–	–	10,71,032.41
Publication Fund from Govt. of India, Deptt. of Science & Technology 1) Sale proceeds of Century of Natural History 6,462.31 2) Sale proceeds of Book of Indian Reptiles 13,097.15	4,74,636.58	19,559.46	–	4,94,196.04	–	–	4,94,196.04
TOTAL	45,41,186.50	17,85,335.64	2,42,883.22	65,69,405.36	5,38,424.53	5,38,424.53	60,30,980.83

A) Revenue Expenditure on other Educational objects of the Trust	
towards Studies in Natural History	37,526.15
towards depreciation on Fixed Assets	1,38,906.29
towards staff gratuity payment	83,099.50
towards other Educational Objects	2,36,346.34
	4,95,878.28
B) Capital Expenditure for purchase of equipment (towards other educational objects)	
i) Education & Research Fund	30,700.00
ii) Storewell & Index Cabinet from Plant Study Fund	9,746.25
iii) Storewell from Salim Ali Nature Conservation Fund Investment Revenue A/c.	2,100.00
	42,546.25

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1990
SCHEDULE 'C'

Name of Grants/ Advances		Balance as per last Balance sheet 1	Amount received/ receivable during the year 2	Total of columns 1 and 2 3	Transferred to Income & Expenditure account during the year 4	Expenditure on objects of the Trust as shown in Income & Exp. account 5	Balance as on 31-3-1990 6
		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Grant Govt. of India, Ministry of Defence, ARDB for Bird Hazard Research Cell		–	1,24,389.70	1,24,389.70	1,24,389.70	1,24,389.70	–
GRANTS FROM U.S.Department of Interior, Fish and Wildlife Service - National Park Services							
1) Hydrological (Ecological) Research Station, Keoladeo Ghana Sanctuary, Bharatpur		7,617.47	–	7,617.47	–	–	7,617.47
2) Study of Lesser Bustard (Florican) *Sypheotides indica* and the Bengal Florican *Eupodotis bengalensis*							
Amount recd.	3,75,224.00						
Less: Due as on 31.3.89	1,73,303.25	–	2,01,920.75	2,01,920.75	2,01,920.75	2,01,920.75	–
3) Ecology of Keoladeo Ghana National Park, Bharatpur							
Amount recd.	29,47,377.00						
Less: Due as on 31.3.89	6,10,404.76	–	23,36,972.24	23,36,972.24	11,88,970.79	11,88,970.79	11,48,001.45
4) Ecology of Indian Elephant		1,11,418.05	15,63,238.00	16,74,656.05	13,53,123.70	13,53,123.70	3,21,532.35
5) The Ecology of Pt. Calimere Sanctuary (An Endangered Ecosystem)		1,62,030.64	18,97,359.00	20,59,389.64	8,01,247.51	8,01,247.51	12,58,142.13
Brought over		2,81,066.16	61,23,879.69	64,04,945.85	36,69,652.45	36,69,652.45	27,35,293.40

SCHEDULE 'C' (Contd.)

Name of Grants/ Advances	Balance as per last Balance sheet 1	Amount received/ receivable during the year 2	Total of columns 1 and 2 3	Transferred to Income & Expenditure account during the year 4	Expenditure on objects of the Trust as shown in Income & Exp. account 5	Balance as on 31-3-1990 6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Brought over	2,81,066.16	61,23,879.69	64,04,945.85	36,69,652.45	36,69,652.45	27,35,293.40
6) Study of the Migration pattern of Indian Birds and Avifauna Migration Study Data Bank	48,961.06	19,13,783.00	19,62,744.06	10,17,738.76	10,17,738.76	9,45,005.30
7) Study on Conservation of Birds of Prey with particular emphasis upon Restoration of the Endangered Species	–	17,30,058.00	17,30,058.00	2,19,492.62	2,19,492.62	15,10,565.38
8) For the project on Wolves and Blackbucks (the Habitat and Population dynamics of Wolves & Blackbucks)	85,053.00	1,91,000.00	2,76,053.00	1,70,139.00	1,70,139.00	1,05,914.00
Grant Govt. of India D.O.E. for the expenses on secretarial assistance to Dr Salim Ali for environmental research programme for processing archieval material	21,453.38	–	21,453.38	–	–	21,453.38
Grant Govt. of India, Dept. of Culture, for publishing the Centenary Seminar papers of the Society 1984-85	29,657.45	–	29,657.45	29,657.45	29,657.45	Nil
Carried over	4,66,191.05	99,58,720.69	104,24,911.74	51,06,680.28	51,06,680.28	53,18,231.46

SCHEDULE 'C' (Contd..)

Name of Grants/ Advances	Balance as per last Balance sheet	Amount received/ receivable during the year	Total of columns 1 and 2	Transferred to Income & Expenditure account during the year	Expenditure on objects of the Trust as shown in Income & Exp. account	Balance as on 31-3-1990
	1 Rs.	2 Rs.	3 Rs.	4 Rs.	5 Rs.	6 Rs.
Brought over	4,66,191.05	99,58,720.69	104,24,911.74	51,06,680.28	51,06,680.28	53,18,231.46
Grant Govt. of India, D.O.E. for air conditioning the Hornbill House Library and Collection Rooms	8,14,150.00	–	8,14,150.00	4,90,700.00	4,90,700.00	3,23,450.00
Grant Govt. of India, D.O.E. for the purchase of scientific equipment during 1988-89, (Contd. 89-90)	5,90.000.00	–	5,90,000.00	5,77,425,90	5,77,425.90	12,574.10
Grant Govt. of India, D.O.E. for the purchase of equipment during '89-90	–	1,80,600.00	1,80,600.00	1,05,657.00	1,05,657.00	74,943.00
Grant Govt. of India, D.S.T. for the publication of Tree Book	–	75,000.00	75,000.00	23,126.90	23,126.90	51,873.10
Grant Govt. of India, Ministry of Environment &Forests for Seminar on Wetland Ecology and Management at Bharatpur	–	2,22,500.00	2,22,500.00	11,590.00	11,590.00	2,10,910.00
Grant Govt. of India, Ministry of Science &Technology (D.S.T.) for Summer School in Vertebrate Ecology	–	2,98,970.50	2,98,970.50	2,98,970.50	2,98,970.00	Nil
Carried over	18,70,341.05	107,35,791.19	126,06,132.24	66,14,150.58	66,14,150.58	59,91,981.66

SCHEDULE 'C' (Contd.)

Name of Grants/ Advances	Balance as per last Balance sheet 1	Amount received/ receivable during the year 2	Total of columns 1 and 2 3	Transferred to Income & Expenditure account during the year 4	Expenditure on objects of the Trust as shown in Income & Exp. account 5	Balance as on 31-3-1990 6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Carried over	18,70,341.05	107,35,791.19	126,06,132.24	66,14,150.58	66,14,150.58	59,91,981.66
Grant Govt. of Rajasthan for Lignite Project	–	10,000.00	10,000.00	8,385.00	8,385.00	1,615.00
Grant Govt. of India, Ministry of Environment, Forests & Wildlife towards Salim Ali Centre for Ornithology and Natural History	9,95,288.00	–	9,95,288.00	8,637.80	8,637.80	9,86,650.20
Grant from Chief Wildlife Warden, Jammu & Kashmir for the project survey of Blacknecked Crane	38,765.39	–	38,765.39	12,653.45	12,653.45	26,111.94
Grant Govt. of India, Ministry of Environment and Forests for the project on 'A Study of the habitat requirement of the Rusty Spotted Cat and other endangered Wild Life of the Dang Forests' by Dr E K Bharucha	–	2,56,600.00	2,56,600.00	2,18,179.91	2,18,179.91	38,420.09
Grant Govt. of Madhya Pradesh, Office of the Chief Engineer for Indira Sarovar Hydro-electric Project	–	25,000.00	25,000.00	4,921.90	4,921.90	20,078.10
Carried over	29,04,394.44	110,27,391.19	139,31,785.63	68,66,928.64	68,66,928.64	70,64,856.99

SCHEDULE 'C' (Contd.)

Name of Grants/ Advances	Balance as per last Balance sheet 1	Amount received/ receivable during the year 2	Total of columns 1 and 2 3	Transferred to Income & Expenditure account during the year 4	Expenditure on objects of the Trust as shown in Income & Exp. account 5	Balance as on 31-3-1990 6
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs
Brought over	29,04,394.44	110,27,391.19	139,31,785.63	68,66,928.64	68,66,928.64	70,64,856.99
Grant from Smithsonian Institution, Washington D.C., for the revision of Handbook of the Birds of India & Pakistan	–	1,36,856.00	1,36,856.00	91,037.93	91,037.93	45,818.07
Grant from World Wide Fund for publication of Newsletter	–	15,000.00	15,000.00	–	–	15,000.00
TOTAL RS	29,04,394.44	111,79,247.19	140,83,641.63	69,57,966.57	69,57,966.57	71,25,675.06
A) Revenue expenditure on other educational objects of the trust		62,18,660.29				
B) Capital expenditure for purchase of equipment (towards other educatioinal objects)		7,39,306.28				
TOTAL RS		69,57,966.57				

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 1990

SCHEDULE 'D'

		Rs.	Rs.
CASH AND BANK BALANCES			
A)	**IN CURRENT ACCOUNT WITH**		
i)	A N Z Grindlays Bank Plc, M.G Road, Bombay 400 023	7,21,806.06	
ii)	A N Z Grindlays Bank Plc, London (6,885.01 @ Rs. 26.73 per pound)	1,84,036.31	
iii)	Standard Chartered Bank, M.G Road, Bombay 400 023	1,135.75	
iv)	State Bank of India, Gateway of India Branch, Bombay 400 023	2,86,649.77	
			11,93,627.89
	IN SAVINGS ACCOUNT WITH		
v)	A N Z Grindlays Bank Plc, M.G Road, Bombay 400 023	15,05,857.60	
vi)	A N Z Grindlays Bank Plc, M.G Road, Bombay 400 023 (Salim Ali Memorial Fund A/c)	41,387.08	
vii)	Bank of India, Museum Saving Branch, M.G Road, Bombay 400 023	82,196.26	
viii)	Bank of Baroda,University Branch, M.G Road, Bombay 400 023	1,90,572.97	
ix)	Corporation Bank, Dalal Street Branch, Bombay 400 023	19,95,350.34	
x)	Corporation Bank, Dalal Street Branch, Bombay 400 023 (FERA)	1,081.45	
B)	**IN FIXED DEPOSIT WITH**		
i)	Bank of India, M.G Road, Bombay 400 023	1,19,583.34	
ii)	Standard Chartered Bank, M G Road, Bombay 400 023	1,00,000.00	
iii)	Bank of Baroda, University Branch, Bombay 400 023	1,00,000.00	
iv)	Corporation Bank, Dalal Street Branch, Bombay 400 023	31,00,000.00	
v)	A N Z Grindlays Bank Plc, M.G Road, Bombay 400 023	60,000.00	
C)	**IN MONTHLY INCOME CERTIFICATE WITH**		
	Bank of India, M.G. Road, Bombay 400 023	2,75,000.00	37,54,583.34
TOTAL RUPEES			87,64,656.93

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT 1950, SCHEDULE IX VIDE RULE 17(1)

REGD. NO. F-244 (BOM)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31st MARCH 1990

EXPENDITURE

	Rs.	Rs.
EXPENDITURE IN RESPECT OF PROPERTIES		
Rates and Taxes	4,926.00	
Insurance on Building	266.00	
OTHER CONTINGENCY EXPENSES		
Contingency Exps., Electricity Charges	36,801.00	
Building Maintenance	16,530.43	
		58,523.43
ESTABLISHMENT EXPENSES		
A) Salaries including D.A., H.R.A. etc. for Reference Collection Staff for the year 89-90	2,66,218.00	
B) Salaries including D.A., H.R.A. etc. other than above (excluding Rs. 26,923/- & Rs. 33,842/- for Plant Study Staff and Conservation Staff	9,07,595.00	
Gratuity payment to staff members	83,099.50	
Medical expenses to staff members	9,401.25	
Society's contribution to staff Provident Fund	17,776.00	
Postages	17,057.65	
Printing and stationery	41,902.00	
Advertisement	16,112.50	
Telephone rental & call charges	12,228.75	
Meeting expenses	4,880.30	
Conveyance and travelling expenses	3,145.20	
Bank charges	816.60	
	13,80,232.75	
Carried over		58,523.43

INCOME

	Rs.	Rs.
RENT		
Interest (Realised & accrued) on securities	110.00	
On fixed deposits and, Bank account (including Rs. 2,62,883.22 on earmarked funds)	5,04,612.72	
		5,04,722.72
DIVIDEND		
On Units of the Unit Trust of India		1,90,019.64
DONATIONS (In cash or kind)		
i) General donations	19,368.05	
ii) For specific donations		
a) Charles McCann Vertebrate Zoology Field Work Fund	600.00	
b) Salim Ali Nature Conservation Fund	50,000.00	
c) Staff Welfare Fund	50,000.00	
d) Donation from Pirojsha Godrej Foundation for Conservation Activity	50,000.00	
e) Donations from Seth Purushotamdas Thakurdas & Divaliba Charitable Trust - each for Hornbill, Newsletter	25,000.00	
Library Book/furniture purchase etc.	25,000.00	
f) For Col. Burton's Fund from (Mr. John Toovey)	8,483.00	
g) Salim Ali Memorial Fund	4,080.00	
h) Life membership contribution (Individuals)	1,06,639.05	
		3,39,170.10
		10,33,912.46

EXPENDTURE	Rs.	Rs.
Brought over		58,523.43
ESTABLISHMENT EXPS. (Contd.)	13,80,232.75	
Vehicle maintenance	17,301.82	
Leave trave to staff members	4,197.20	
Wages (Casual labour)	1,500.00	
		14,03,231.77
Audit Fees		2,000.00
AMOUNT WRITTEN OFF		
Bad debts (Irrecoverable dues)		530.50
MISCELLANEOUS EXPENSES		
General Contingency Expenses	6,096.75	
Insurance Premium for fire & Accident	1,483.00	
Repairs to Furniture & Equipment	3,498.00	
Garden Maintenance	825.00	
Society's Prospectus	2,992.00	
Election of Executive Committee Exps.	15,292.25	
Referendum Expenses	13,292.40	
Uniform for Class IV Employees	4,237.50	
Professional Fees	2,250.00	
University Registration Fees	10,000.00	
Management Study Consultancy Exps.	7,433.00	
		67,399.90
Carried over		15,31.685.60

ASSETS	Rs.	Rs.
Brought over		10,33,912.46
GRANTS		
i) Grant Govt. of Maharashtra for 89-90 for establishment, Building maintenance expenses (including Rs. 42,339/- for Nature Study Teaching Scheme)	2,15,000.00	
ii) Grant from Indian National Science Academy for Journal printing expenses	5,000.00	
iii) Other Grants as per Schedule 'C'	69,57,966.57	
		71,77,966.57
INCOME FROM SUBSCRIPTIONS AND ENTRANCE FEES		
Members subscription (individual)	1,26,386.16	
Student Membership Subscription	5,825.00	
Corporate Membership Subscription	16,280.00	
Subscription to Journal from Individual members	61,382.30	
Subscription to Journal from non-members	52,456.94	
Entrance Fees	25,424.60	
		2,87,755.00
Carried over		84,99,634.03

EXPENDITURE

	Rs.	Rs.
Brought over		15,31,685.60
DEPRECIATION		
On Furniture and Equipment	1,26,164.26	
On Motor Cars, Motor Cycle, Minibus, Auto Cycle (Met out of Fixed Assets Fund as per Schedule 'B')	12,742.03	1,38,906.29
AMOUNTS TRANSFERRED TO RESERVE OR SPECIFIC FUNDS		
i) Life Membership Fund Contribution during the year	1,06,639.05	
ii) Other Funds		
Specific Donation transferred to respective fund accounts	1,88,163.00	
iii) Interest on earmarked Investment/ Dontations	2,62,883.22	
iv) Sale Proceeds of Publications to Govt. Publication Fund		
a) Book of Indian Reptiles	13,097.15	
b)Century of Natural History	6,462.31	
	19,559.46	
v) Grant Govt. of Maharashtra for Nature Study Teaching Scheme for 89-90. Transferred to separate receipt and payment account of N.E. Scheme.	42,339.00	
		6,19,583.73
Carried over		22,90,175.62

INCOME

	Rs.	Rs.
Brought over		84,99,634.03
INCOME FROM PUBLICATIONS		
Journal Sales	11,433.54	
Book of Indian Birds	60,052.97	
Book of Indian Animals	28,130.60	
Some Beautiful Indian Climbers & Shrubs	15,121.65	
Identification of poisonous snake charts	90.00	
Synopsis of Birds of India & Pakistan	1,746.50	
Grasses of Western India	369.89	
Encyclopedia of Indian Natural History	41,160.46	
Pictorial Guide to the Birds of Indian sub-continent	49,890.12	
Book of Indian Reptiles (including Rs. 13,097.15) transferred to Govt. Publications Fund	56,285.31	
A Century of Natural History	6,462.31	
Other publications	3,735.63	
Nature Calendars (Desk & Wall Calendars) and Calendar Card	2,09,122.60	
Greeting Cards	3,45,676.61	
	8,29,278.19	
Less: Packing & forwarding charges	3,287.95	
		8,25,990.24
MISCELLANEOUS INCOME		
Miscellaneous receipts (general)	1,764.93	
Surplus on members Nature Camps	42,864.67	
Exchange fluctuation (Grindlays Bank, London)	9,750.13	
Fees for the use of Society's transparencies	4,000.00	
Royalty on Dr Salim Ali's Publications	2,08,487.31	
		2,66,867.04
Carried over		95,92,491.31

EXPENDITURE	Rs.	Rs.
Brought over		22,90,175.62
APPROPRIATION TO SPECIFIC FUNDS		
i)BNHS Publication Fund 50% Royalty amount on Dr Salim Ali's royalty income	1,04,243.65	
ii)Building fund transferred from income during the year	4,00,000.00	
iii) Staff gratuity fund transferred from income during the year	1,50,000.00	
		8,54,243.65
EXPENSES ON OBJECT OF THE TRUST		
i) Educational met from respective funds as per Schedule 'B'	2,78,892.59	
ii) Expenses met out of grants as per Schedule 'C"	69,57,966.57	
iii) For publishing the Society's Journal (including Rs. 5,000/- from Indian National Science Academy)	97,766.18	
Postage for the despatch of Journals to members & others	54,406.40	
Contd...	73,89,031.74	
Carried over		31,44,419.27

INCOME	Rs.	Rs.
Brought over		95,92,491.31
ADMINISTRATIVE FEES		
For handling publication sales under Govt. publication funds	1,482.99	
For handling project funds	6,03,879.15	
For handling other earmarked funds	27,603.56	
		6,32,965.70
AMOUNT DRAWN FROM SPECIFIC FUNDS AS PER SCHEDULE 'B'		
I) From Staff Gratuity Fund	83,099.50	
ii) From various specific funds towards expenses on objects as per Schedule 'B'	37,526.15	
iii) From various specific funds towards expenses on objects of the Trust as per Schedule 'B'	2,78,892.59	
iv) Amount transferred from Fixed Assets Fund towards depreciation as per Contra	1,38,906.29	
		5,38,424.53
Carried over		1,07,63,881.54

EXPENDITURE	Rs.	Rs.	INCOME	Rs.	Rs.
Brought over		31,44,419.27	Brought over		1,07,63,881.54
EXPENSES ON OBJECTS OF THE TRUST (Contd.)					
Brought over	73,89,031.74				
iv) For publishing Hornbill Newsletter including Donation of Rs. 25,000/- received from Seth Purshotamdas Thakurdas & Divaliba Charitable Trust	1,03,915.97				
v) Library account					
Subscription to other Societies	3,806.73				
Purchase of Books	13,153.40				
Library book binding	11,840.00				
Library other expenses	644.50				
vi) Maintenance of reference collection	9,407.10				
vii) Expenses on field study programme and other members activity	15,318.25				
viii) Expenditure under the studies in natural history	37,526.15				
ix) Expenses under nature education scheme	10,011.91				
		75,94,655.75			
Excess of income over expenditure transferred to Balance Sheet		24,806.52			
Total Rs.		1,07,63,881.54	Total Rs.		1,07,63,881.54

BOMBAY NATURAL HISTORY SOCIETY

Hon. Secretary   Hon. Treasurer

Bombay
Dated 3rd September 1990

AS PER OUR REPORT OF EVEN DATE

HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

BOMBAY NATURAL HISTORY SOCIETY
NATURE EDUCATION SCHEME
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31st MARCH 1990

RECEIPTS	Rs.	Rs.	PAYMENTS	Rs.	Rs.
To Balance as on 1st April 1989:			By Balance Amount due to Bombay Natural History Society		49,214.47
i) With ANZ Grindlays Bank Plc, Bombay, on current account	4,126.85		By Salaries (Nature Education Organiser)		42,069.00
ii) With Nature Education Organiser	200.00	4,326.85	By General Charges Account		3,811.56
GRANTS			By Printing & Stationery Account		679.00
Govt. of Maharashtra for the year 1989-90		42,339.00	By Postage Account		400.30
Sale of Nature Study Booklets		115.85	By Balance as at 31st March 1990		
To Balance			i) With ANZ Grindlays Bank Plc., Bombay, on current account	8,622.99	
Amount due to Bombay Natural History Society during 1989-90		58,045.62	ii) With Nature Education Organiser	30.00	8,652.99
Total		1,04,827.32	Total Rs.		1,04,827.32

BOMBAY NATURAL HISTORY SOCIETY

HON. SECRETARY HON. TREASURER
TRUSTEE

AS PER OUR REPORT OF EVEN DATE

HABIB AND COMPANY
CHARTERED ACCOUNTANTS
BOMBAY

Bombay,
Dated: 3rd September, 1990

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.* 90)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*Price to members Rs.* 90)

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