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A REPORT ON THE OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ) [TESTUDINES : CHELONIIDAE] OF BAY OF BENGAL

By

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Zoological Survey of India, Calcutta

(With 4 Text-figures, 4 Plates and 5 Tables)

INTRODUCTION

No definite data and information are available on the present status of marine turtles of Indian Coast. Hirth & Carr (1970) have expressed their disappointment on the inadequacy of knowledge on the ecological geography of marine turtles of the Western Indian Ocean which is also true for the entire Sea Coast of India. Smith (1931), while mentioning the distribution and range of sea turtles in the Indian Coast, gave some general information ; Valliappan and Pushparaj (1973), Valliappan and Whitaker (1974) and Murthy and Menon (1976) gave some preliminary reports on sea turtles.

From Zoological Survey of India two turtles surveys were carried out by the author in 1975 and 1976 in the Orissa Coast and he visited some turtle breeding areas in that region. These surveys revealed that the most common and commercially important turtle occurring in the Bay of Bengal is the *Lepidochelys olivacea* (Eschscholtz) and it is the most exploited species of sea turtles in its breeding or nest laying season in the Bay of Bengal.

The work of Schulz (1975) on the ecology and biology of Olive Ridley in Surinam is very important and extensively deals with the nesting aggregation of *L. olivacea* along with some other sea turtles in the Atlantic coast of America. In this context the works of Pritchard (1969), Carr (1952) and Zwinenberg (1976) are also valuable and helpful for studying the Olive Ridleys.

So far no important earlier report on the nesting ground of Pacific Ridley in the coast of Bay of Bengal is available. In the present paper the author summarises results of his preliminary survey of such grounds and has also tried to ascertain the status of this turtle and their colonies

in some of the areas surveyed. The systematic account and general information on this species, with a key to other species of sea turtles will be helpful to the workers on the sea turtles of the Indian Coast.

Systematic Account

1843. *Lepidochelys* Fitzinger, *Syst. Rept.*, p. 30.
(Type : *Chelonea olivacea* Eschscholtz)

The family Chelonidae, which includes the Pacific Ridley or the Olive Ridley, contains four genera, namely *Chelonia* Latreille, *Lepidochelys* Fitzinger, *Careita* Rafinesque and *Eretmochelys* Fitzinger. The genus *Chelonia* can at once be separated from the rest of the genera in the family by the presence of one pair of prefrontal scales. The genera *Lepidochelys* and *Caretta*, likewise, can be distinguished from *Eretmochelys* in having five or more laterals and also in the precentrals being in contact with the laterals. The remaining two genera, however, continued to be confused with each other for a long time even after the publication by Deraniyagala (1933). This was caused by the broad similarity in characters, and the apparent similarity leading to the resultant taxonomic confusion and for a long time the two were identified as *Caretta*, commonly known as Loggerhead.

Generic characters : Laterals from five to nine ; four enlarged inframarginals, some of which perforated by a pore near the hind margin ; precentral and lateral laminae usually in contact ; pterygoid bones markedly broadened anteriorly, with strong ectopterygoid processes ; in the lower jaw a strong median elevation at the posterior edge of the bony alveolar surface ; nural bones eleven to fifteen in number.

A key to all the genera, species and subspecies of the family Cheloniidae is given below with the help of which *Lepidochelys* could be easily identified even to the subspecies level.

Key to the genera, species and subspecies of the family Chelonidae

1 (4) One pair of prefrontal scales. Lateral laminae 4. ... Genus *Chelonia* Latreille

2 (3) Colouration above predominantly brownish ; shell margin not markedly indented above hind limb ; shell less chunky and deep, especially from the middle of the laterals towards periphery ... *Chelonia mydas mydas* (Linné)

(Atlantic and Caribbean)

3 (2) Colouration above predominantly greenish or olive brown ; shell often markedly indented above hind limb ; chunky and often with the laterals completely straight from the margin of centrals ... *Chelonia mydas agassizii* Bolourt.

(Pacific Coast of America, throughout Indian and Indo-chinese water including Andaman and Nicobar groups of Islands).

4 (1) Two pairs of prefrontals. Laterals 4-9.

5 (6) Laterals in 4 pairs ; precentral not in contact with the lateral ; laminae of the carapace usually conspicuously imbricated ... Genus *Eretmochelys* Fitzinger

Eretmochelys imbricata (Linné)

(In all the tropical waters widely seattered along the Atlantic Ocean, Indian and Indochinese waters).

6 (5) Laterals in 5 or more pairs ; precentral in contact with 1st lateral ; snout relatively short and broad.

7 (10) Inframarginal bridge with 4 enlarged scales ; colour gray or olive green. ... Genus *Lepidochelys* Fitzinger

8 (9) Colour dorsally olive ; laterals usually in more than five pairs ; each inframarginal with a pore ; limbs with one or two claws. ... *Lepidochelys olivacea olivacea* (Eschscholtz)

(Indian and Pacific Oceans ; West coast of Africa, West coast of America, Pacific coast or Mexico and Costa Rica).

9 (8) Colour dorsally dark grey ; laterals usually in five pairs ; inframarginal poreless ; limbs three clawed. ... *Lepidochelys olivacea kempii* (Garman)

(Waters of Massachusetts, England, Ireland and Azores).

10 (9) Colour brown or reddish brown ; bridge with three enlarged inframarginals. Genus *Caretta* Rafinesque

11 (10) Marginal laminae averaging 12 on each side; limbs two or one clawed ... *Caretta caretta caretta* (Linné)

(Atlantic and Mediterranean).

12 (11) Marginal laminae averaging 13 on each side ; limbs two clawed ... *Caretta caretta gigas* Deraniyagala

(Indian and Pacific Oceans).

Lepidochelys olivacea olivacea (Eschscholtz)

1829. *Chelonia olivacea* Eschscholtz, *Zool. Atlas* pt. 1, p. 2, pl. 11.
(Type locality : Manila Bay, Philippine Islands)
1931. *Caretta caretta olivacea*, Smith, *Fauna Bri. Ind.*, **1** : 71 & 72.
1933. *Lepidochelys olivacea*, Deraniyagala, *Ceylon J. Sci.* (B) **XVII** : 62-72.
1951. *Lepidochelys olivacea olivacea* Carr, *Hand Book of Turtle*, pp. 341-410.
1976. *Lepidochelys olivacea*, Zwinenberg, *Bull. Maryland Herpt. Soc.* **12** (3) : 75-95.

Description : The carapace in adult is more depressed than in other chelonians and slightly longer than broad. In dorsal view it looks almost circular or rather broadly heart-shaped which is expansively coradate in both the sexes without any trace of carina. The carapace is fairly high, highest point being anterior to the middle but it is flattened or even dished in along the centrals. The margin is more or less serrated posteriorly, formed of 27, rarely 25 shields. The variation of marginals are from 12 to 14 in each side. The nucal or precentral is generally in contact with the first costal. The vertebrals or centrals range from five to nine and also the costal or the laterals display a corresponding number of pairs of asymmetrical arrangement. The costals vary in number 6 to 8, occasionally 5 to 9. The numerical arrangement of centrals and costals are variable but the plastral scutes are more or less constant. The plastron distinguishes this turtle from all the other chelonians in possessing a distinct pore on the posterior edge of each of the four enlarged inframarginal scutes or laminae. A similar pore may also occur on the axial lamina.

The head is large and broad, with convex sides to the wide beaks. Due to the characteristic parrot like beak of these turtles they are popularly known as Parrot Beaked Turtles. Each beak possesses edges and these in the adult form an anterior point which blurts with edge. The margin of each beak is nearly V-shaped and the horny upper beak extends to the choanae. The alveolar surfaces of the upper jaw bone smooth and symphysis of lower jaw is very long. There is one enlarged scale on the middle of outer surface of lower jaw. The cephalic scales comprise of two pairs of frontals, the posterior one of which is larger than anterior, a hexagonal frontal usually forming an emargination in the fronto-parietal which is narrower anteriorly and posteriorly, two or three pairs of parietals, interparietal usually wanting, supraocular one to three on each side, the lst in contact with fronto-parietal, preocular 3 or 4, supraocular ten.

In young specimens the carapace is strongly tricarinate and plastron bicarinate. Usually each flipper is furnished with two claws but many adults possess only one upon the anterior limb. The scales are juxtaposed and margins are subimbricate in adolescent.

The tail of the mature male is much longer than that of the female, extending at least as far as the tips of the posterior stretched flippers and not exceeding the hind rim of carapace in the latter. In the male the single claw on each anterior limb is much stronger and more curved. The middle part of plastron in the male is more concave and the lateral profile slopes more gradually from the highest point of back and down to the hind shell margin.

Colour : The carapace colour is uniform olive without mottling or veriegation found in other species. Due to its colouration it is popularly known as Olive Ridley. The plastron is light greenish yellow or greenish white. The legs and neck are olive above, lighter below.

The young are of more or less uniform black with a faint white margin to the limbs and carapace. The adolescent is dark grey dorsally, pale yellow ventrally and cheeks and beaks pale green.

Remarks : The Olive Ridley, *Lepidochelys olivacea olivacea* of the Indian Coast is often confused with the Atlantic Ridley, *L. olivacea kempii* or even with the Atlantic Loggerhead, *Caretta caretta caretta* (Linnè) and Pacific Loggerhead, *C. caretta gigas* Deraniyagala. Many considered this species conspecific with the Atlantic *C. c. caretta* which they considered to be more variable in the Indo-Pacific region than the Atlantic. It was not until 1933 that the skeletal anatomy, vomer separating the maxillaries and by the lateral processes on the pterygoids, of the two genera were shown to be very different from one another although externally they appear very similar.

Distinction between *L. olivacea kempii* and *L. olivacea olivacea* is also very narrow. In the adult *L. o. kempi* the carapace colour is greyish and the enlarged inframarginal scutes are at times three on one or both the sides (Carr. 1952). In the typical subspecies the carapace is greenish olive, there are almost invariably four pairs of enlarged inframarginals and presence of a single inframandibular scale. Otherwise the two subspecies agree in other respects including bony alveolar ridge upon the palate, skeleton, subcircular outline of carapace, the bluish green dorsal pigmentation of head and limbs and the pale greenish yellow plastron. The pigmentation of the young of these two forms are almost black and differs feebly from one another. According to Deraniyagala (1961) the colouration of the first recorded young by Lourence (1951) and of four hatchlings from Vera Cruz kept in the Kansas University Museum of Zoology were as dark as the young ones of the forma *typica* but differed from them in lacking the white margin to the carapace.

The geographic continuity of ranges of these two subspecies has not been demonstrated within the Atlantic and Indo-Pacific forms though there may be potentiality of breeding contact around South America but certainly not around Cape Horn. According of Schmidt and Inger (1957) this potentiality does not seem to be realised with present zonation of sea in temperate turtles as the Atlantic forms are clearly distinguishable even by their minor characters.

Distribution : This species is distributed widely in the warmer parts of tropical and subtropical East and West Atlantic, Indian and Pacific Oceans. The northern limit of it in the Western Pacific is southern Japan and in the Eastern Pacific (W coast of America) it is from Baja California to Chile. According to Carr (1961) the Ridleys occur regularly in the 650 miles long coast from Kino to San Blas including much of the eastern shore of Gulf of California and to the coast south of the mouth of the gulf. Deraniyagala (1939) mentioned its distribution from the East Atlantic and west coast of Africa. This species not only nests on the west coast of Africa from Senegal to Congo but Schulz (1975) has reported it in the northern and north eastern coast of S. America, in the coast of Guyana, Surinam and French Guiana. This species shows a remarkable distribution in the Atlantic being virtually absent in the Caribbean region. According to Smith (1931) it is generally distributed in the Indian waters and abundant in the vicinity of Andaman Islands and near the coast of Sri Lanka but rare in the Gulf of Siam. In the East Indies the species appears to be more abundant than the Loggerhead and it seems this species reach remote islands of the midway chains in the Pacific. In short Pacific Ridley ranges from the west coast of Africa, Ceylon and the East Indies to the Pacific coast of America.

Range and status : In this section I have tried to mention the nesting localities of the species and its present status if it was available with special interest in the Indian and Pacific Oceans regions from the available literature in my hand. Pritchard's (1969) work in this respect will further improve our knowledge but due to its absence I have mostly depended on the work of Frazier (1975). Detailed information from China, South Japan, East Indies and Australia is not available to me for its detail study of distribution and present status.

East-Atlantic and west coast of Africa—Banana (East Atlantic) ; Ivory coast, Gabon and Congo one specimen from each of the place was examined by Babcock (1930).

Western Indian Ocean Region : Frazier (1975) has grouped this region in two territories, the islands and the mainland : *Ethiopia*—recorded in

the last century. *United Republic of Tanzania*—may not be uncommon, at least nest on Maziwi. *Mozambique*—a substantial population, notably in the north where they nest. *Kenya*—may nest and there may be a fair sized breeding population in Ungwana Bay.

Republic of South Africa—nest very rarely. *Sultanate of Oman*—nest on Masirah. *Iran*—common specially in the Persian Gulf and nest on Lavan Island. *Pakistan*—Ridleys continue to use their traditional nesting sites around Karachi beaches and from all available evidence the egg laying females are more numerous than available beach areas so that some earlier egg clutches often being partly excavated or disturbed by subsequent nesting females which in turn encourages predatory dogs (Roberts, 1977). *Malagasy Republic*—there is substantial population in the south west, but they do not nest. The estimated recent catch is 2,400. *Sri Lanka*—The most common species and several thousand may nest yearly. Deraniyagala (1939) has mentioned several nesting grounds.

Indian Coast : In the Zoological Survey of India record only of two specimens have been mentioned which were collected from the Kerala beach by Furguson in 1891 and about another collection of Asiatic Society of Bengal, the collection locality generally mentioned as Bay of Bengal. In the Western Coast, Greaves (1933) recorded this species nesting in the Malad-Merve beach of Maharashtra. It also nests in the Konkan and Trivandum beach, Kerala Coast. Ridleys have been reported from some small Islands of Gulf of Mannar. The east coast of India (Bay of Bengal) is a very important nesting ground for this species. There are mass nesting places in the Madras beach, West Bengal and Orissa Coast [Satbhya, Gahirmatha, Konarak (Chandrabhaga)]. According to Bhaskar (1978) waters off India's coast, Lakshadeep islands, situated 120-200 miles off Kerala's Coast (in five islands of Amindivi) this species is predominantly common. According to him (Bhaskar 1979) some islands in the Gulf of Kutch in Western India are nesting ground of Olive Ridley.

Pacific Coast of North and South America : Mass nesting sites are there in this coast from Baja California to Chile, particularly in the coast of Mexico and Costa Rica (Pritchard, 1969). Hondurus nesting occurs but in Colombia there may be possibility. *West Malaysia* : All the fiive genera of sea turtles occur along the coast of west Malaysia but *L. olivacea* nests in number. Its eggs are in good demand which sells 8.10 cents each (Moll, 1976).

Western Atlantic, northern and eastern South America : In Surinam mass nesting occurs at Eilanti, Galibi and Bigisanti beach. Another

nesting place is east of Marowijne river of French Guiana (Schulz, 1975). It was recorded earlier from Caracas, Venezuela.

Philippines : The type specimen was collected from Manila Bay. *New Britain* : Some broods of eggs had been collected many years ago.

Nesting grounds of Olive Ridley in the Bay of Bengal

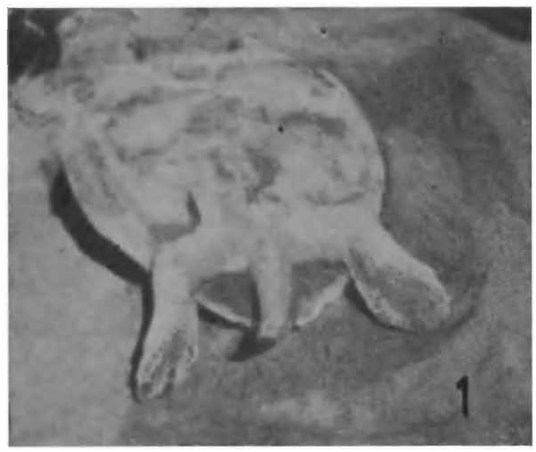
Tamilnadu—(1) Valiappan and Pushparaj (1973) made a preliminary survey in the Tuticorin area of Tamilnadu which is an area important for the turtle industry in South India. The stretch of beach between Tiruchendur and Idinthakaral is an important nesting area of Ridley and some years ago great numbers of nests could be seen along beaches near Manappod. (2) *Madras to Kalpakkam area*—Valliappan and Whitekar (1974) undertook a survey of Olive Ridleys in the 50 kms coastline of the above mentioned area. In the Madras coast the fishermen consider the turtle a god or "Sami". The turtles are mostly released into the sea when cauget in a fishing net. But the "Kattukarans" such as Harijans, Villis, Irulas, Kurvikars and some villagers living along the coast collect eggs for personal consumption and sale. The Ridleys are known as "Kadalaamai" in this area. Though the present status of the species in the Madras coast is not known, it is certain that Ridleys are the most common nesting turtles.

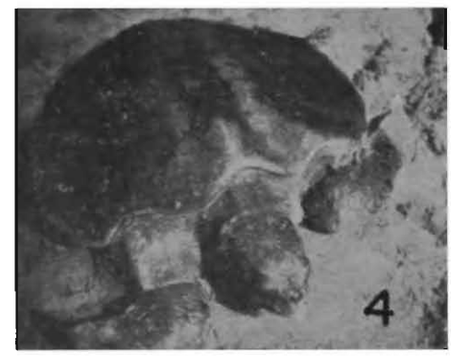
It is also reported that Ridleys also nest in the coasts of Porto Novo, South Arcot Dist. and Point Calimere, Thanjavur Dist.

It is estimated that during 1975-76 (December-March) nesting season roughly 4,500 eggs were collected from 42 nests of Madras Coast.

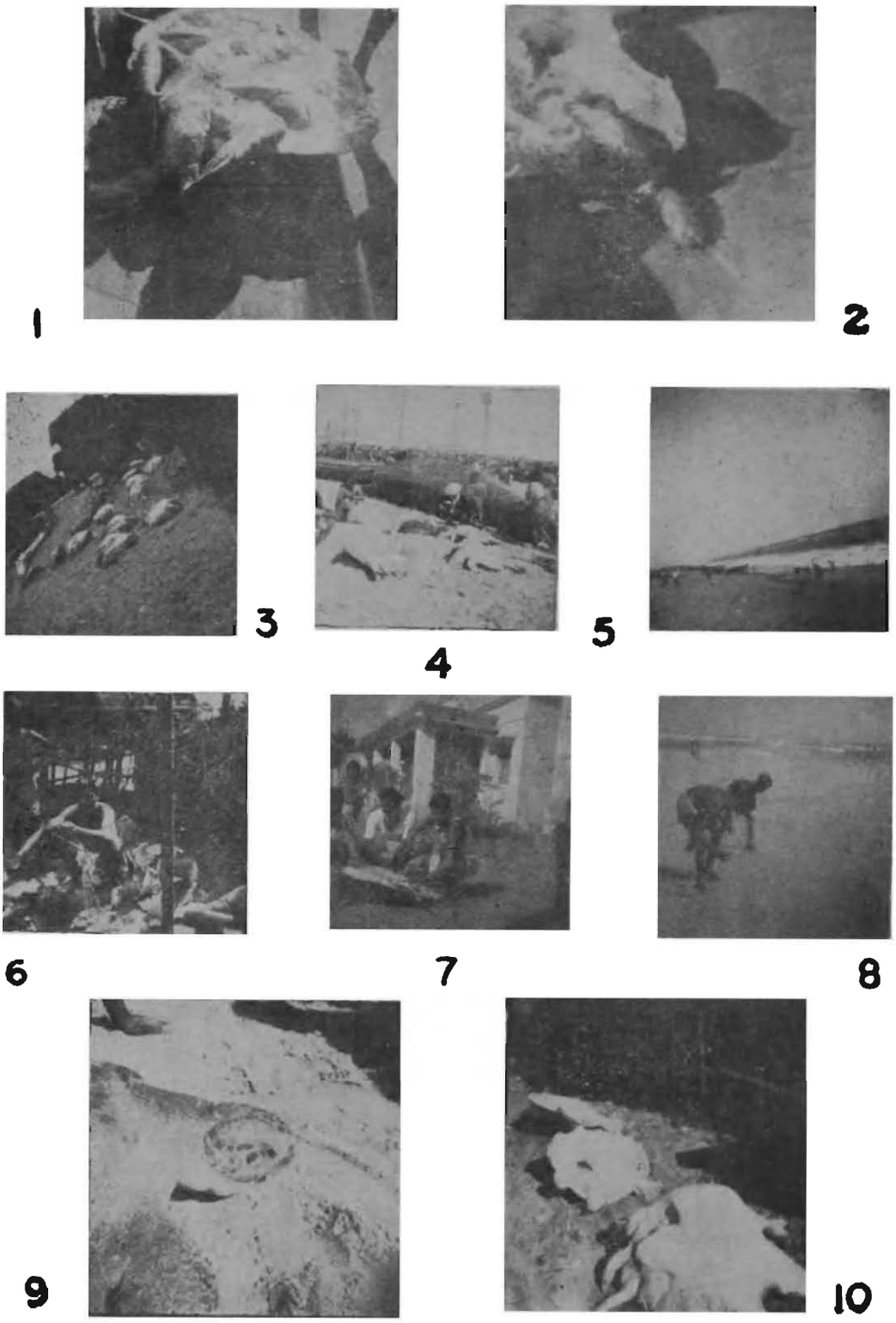
Orissa Coast : Surveys conducted by the Zoological Survey of India in the Orissa Coast have revealed four areas as the major nesting ground of Ridleys, in the Orissa Coast, such as sea side deltoid area of Brahamani and Baitarani rivers, Puri-Balukhand, Konarak-Chandrabhaga and Chandipur-Burablang estuary (Text-fig. 1).

(1) *Sea side Delta of Brahamani-Baitarani*—Two sea side places within the Cuttack Dist. of this area known as *Gahirmatha* and *Satbhyia* are very good nesting grounds of Ridleys. *Gahirmatha*—This place is nearly 35 km. east of Chandbali, Balasore Dist. at the mouth of Dhamara river where it meets the sea. There are also some islets at the mouth of the river which are also good nesting grounds. During the nesting season in 1975 it is reported that 33,000 Olive Ridleys were marked in three nights on 8 km. stretch of the sea coast near Wheelers Islands in this area (Kar 1980). Experiment on a clutch of eggs of this species has been carried out at this place (Biswas *et al.* 1977). The tagging





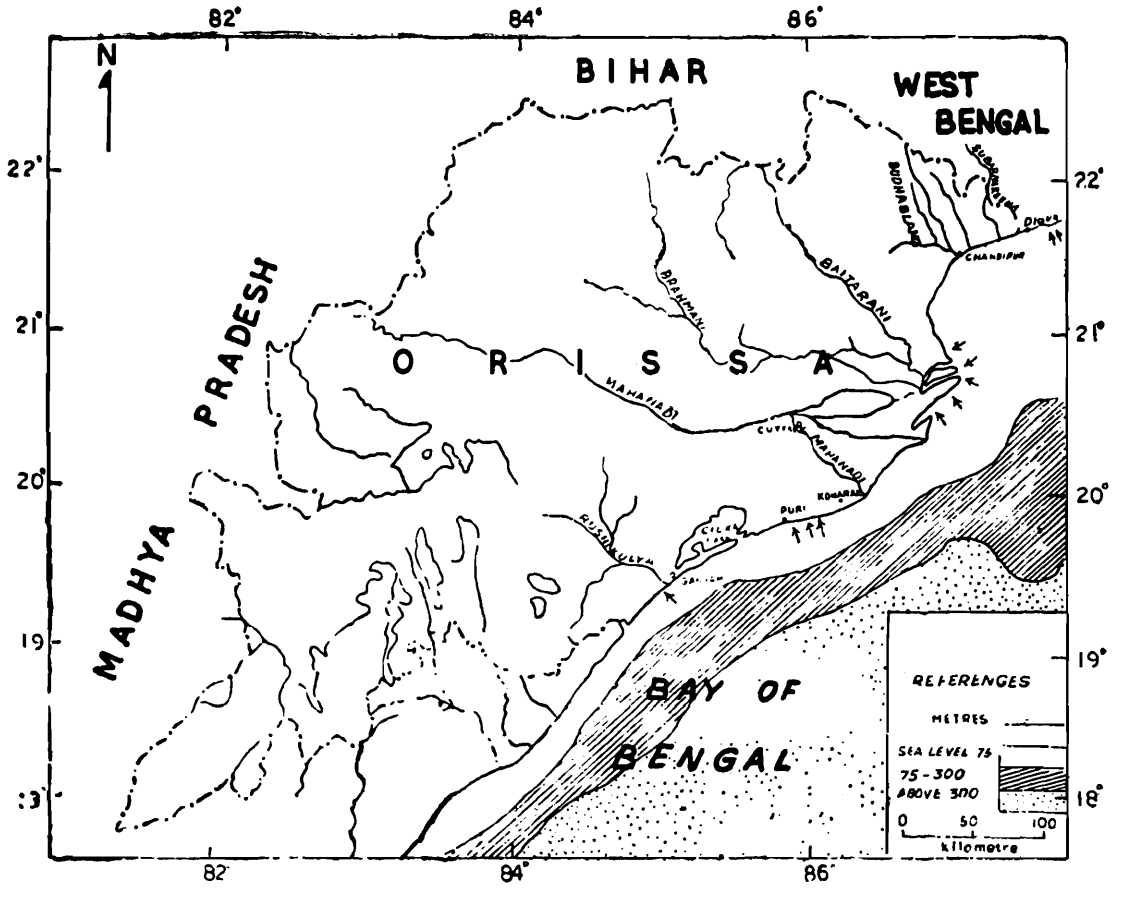
Lepidochelys olivacea (Eschscholtz). Fig. 1. ♂, Ventral view. Fig. 2. ♀ Ventral view (Note Comparative tail length). Fig. 3. A stacking of turtles at Puri where turtles are stacked before despatching to the Railway Station. Fig. 4. Dorsal view of a freshly caught turtle. Fig. 5. Author and an Assistant taking measurement of a ♂ and a ♀ turtle. Fig. 6. Author and the local Veterinary Surgeon examining and consulting over a turtle.



Lepidochelys olivacea (Eschscholtz). Figs. 1 and 2. Two stages of extended penis of two ♂♂ ; (1) fully extended, (2) partially extended with wart like tubercles at the end portion. Fig. 3. Entire view of a stacking yard. Fig. 4. Author is examining freshly landed turtles at Puri beach. Fisherwomen are waiting to carry them to the stacking yard. Fig. 5. A part of the typical beach where the species lay its eggs. Fig. 6. A fish seller at Chandbali fish-market selling turtle meat. (Chandbali inland port on the Baitarani river). Fig. 7. Assistants are busy dissecting one specimen. Fig. 8. A part of the beach at Astrang. The beach is less sloping comparatively from the Puri beach. Fig. 9. Head shield of a specimen. Fig. 10. Plastron depression of ♂.

and marking operation is now being carried out here by the Forest Dept. of the State Government.

(2) *Satbhyia*—This sea coast place of Cuttack Dist. is nearly 35 km. south east of Chandbali and it is only approachable from here upto Dangmal (Vitorkonika) by boat or launch and from there after crossing



Text-fig. 1. Map showing the coast line of Orissa and part of West Bengal. Arrow marks indicate the nesting ground of the species.

the branch of Brahamani river one has to walk down the sea coast. Due to the difficulty of communication the Satbhyia coast is most undisturbed nesting ground of Ridley in the Orissa Coast.

In the nesting season the egg laying density may be so intensive in this place that even it may reach one nest per square meter.

(3) *Puri-Balukhand*—This area is the most important turtle fishing center of the Orissa Coast. The southern part of Puri after Chakrathistha is known as Balukhand and the sea side Casurina Reserve Forest of this area is reported as a nesting ground of Ridleys.

(4) *Konarak-Chandrabhaga*—Chandrabhaga, 22 miles east of Puri is nesting ground and some clutches of eggs were collected at this place in 1975 (Biswas *et al.* 1977) where a small stream known as Kushabhadra meets the sea. Ridleys are nesting all along the coast from Chandrabhaga to Astharang, one fishing centre between Konarak and Puri,

Practically the entire Puri to Konarak sea coast is nesting ground of this species excepting some short distances to this area due to fishing and human disturbances.

After Puri, Konarak is next important turtle catching center of the Orissa Coast.

(5) *Chandipur*—This sea side fishing centre of Balasore Dist. situated on the mouth of Burhabalang river is another important turtle fishing center of the Orissa Coast. The sea is very shallow here and during low tide nearly 2 to 3 km. beach becomes exposed and may be for this reason turtles are not able to utilize this beach as a nesting ground though good turtle fishing is carried out in the near about sea of Chandipur. I once came across a dead Ridley upside down in a pit of a beach which may be the result of an unsuccessful attempt of nesting.

West Bengal :

(1) Digha—This is the sea coast place of Midnapore Dist., West Bengal which is well known for turtle fishing (Text-fig. 1).

(2) Sunderban—The seaface islands of Sunderban estuary such as Lothian and Sagar islands are nesting ground of this species. Hatchlings and eggs have been collected from these islands.

Remarks on the weather and physiography of the nesting beaches in the Bay of Bengal

The study of weather and physiography of nesting beaches and the adjacent sea of the Bay of Bengal is very important and essential to understand and explain the seasonal migration, nesting, incubation etc. of the Olive Ridley coming for nesting in the coast of Bay of Bengal.

The present investigation shows that *Lipidochelys olivacea* is the only dominant extensively occurring sea turtle of the Indian subcontinent. Therefore, it is presumed that weather condition and physiography of Indian coast is suitable for the purpose of their nesting. In this chapter I have tried to compile some data on weather condition and physiography of the region keeping in view that it will be useful to the workers if investigations are carried on in relation to these data. Though I was not able to work in detail the species in relation to the data presented but it has been suggested in the preceeding chapters that there is a relation of starting the breeding season with the on set of the north east monsoon from the last week of November and continuing the same till last week of January. Incubation period of eggs ends with the on set of south west monsoon in the middle or 3rd week of

June. Further, prevailing temperature of the beach directly dependent on the atmospheric temperature is one main factor of controlling the duration of incubation period of eggs.

The beach condition is another important factor to induce the Olive Ridley for selecting their nesting ground in the Bay. During my surveys I have found the surface condition of the Chandipur beach in the Orissa coast and Digha beach in the West Bengal are most unsuitable for their nesting though these two places are good turtle fishing centres. The sea is very shallow in these two places and long distances in the sea bed from the coast become exposed during the low tide. The beach becomes harder after the exposure due to muddy soil mixed with sand. Sandy beach is most suitable for digging out their nest holes.

Table 1. Annual Rainfall in Orissa coast according to Ray and Ray (1974)
1964-1971

Month	1964	1965	1966	1967	1968	1969	1970	1971
				YEARS				
				(In Millimetres)				
January	—	0.5	63.6	—	2.77	—	8.32	15
February	—	63.8	27.1	27.43	53.84	5.70	45.61	15
March	—	22.6	1.8	34.35	5.21	13.71	75.43	3
April	—	30.5	64.5	16.55	24.54	51.36	7.82	376
May	38.2	25.5	26.7	8.88	23.66	99.13	131.66	459
June	592.7	25.9	249.4	67.42	202.00	138.37	478.25	575
July	437.0	417.0	201.2	140.10	253.00	296.16	238.20	812
August	425.5	206.8	144.1	130.35	247.00	380.83	175.65	650
September	219.6	210.7	138.5	273.10	177.45	245.90	325.23	991
October	135.6	79.4	112.6	88.42	172.41	35.86	85.46	656
November	25.8	—	104.6	7.70	59.07	62.38	30.70	501
December	—	—	0.3	—	—	—	—	—
Total	1874.7	1082.7	1134.4	794.30	1368.80	1329.40	1600.33	5362

Table 2. Average monthly air temperature (C°)
at Chandipur Base

Month	*Average Range C°*	
	Minimum	*Maximum*
September	23.8	35.5
October	21	33
November	21	31
December	17	29
January	15	27
February	17	30
March	21	33
April	22	35
May	25.5	35.5

Ocean currents originating from the Indian Ocean flow along this coast principally in two directions ; from north to south during December to May and from south to north from June to November, but according to Sewell (1929) the flow of the surface current during March to May is from south to north and according to Wyrtkis (1961) the flow of surface current in February is from south to north which agrees with the observation of Sewell. The general circulation of surface water in August is from north to south along this coast. During the December-January period, there is a shift in current direction along the coast of the Bay upto December, there is northerly flow of warm water, which originates from the Indian Ocean. From December there is a northerly flow reversal of the current, with the direction shifting from north to south. Consequently, there is gradual overlapping by the cold current from the north of the warm, but strong current from the south. Perhaps, due to this reason the upper strata of water remains cold and the lower one is warm during December-January period.

Salinity : The general salinity of water recorded (Chandipur Base) from December 1971 showed a slow increase from 22.8°/00 in December 1971 to 34.6°/00 in May, 1972.

Table 3. Salinity Fluctuation in Coastal Waters

Month	*Average Salinity* (°/00)
December	22.8
January	25.0
February	26.9
March	30.6
April	31.5
May	33.6

Some Notes on the Natural History, Ecology and Biology of the Ridley

Common name : The generic name *Lepidochelys* means "scale turtle". Unlike the other sea turtles the Olive Ridley or the Pacific Ridley has more than five costal scales or shields along the sides of the carapace which may go up to a dozen, arranged irregularly.

In the East African coast the Olive Ridley is called "Kigemge" by the Bajun people. According to Carr (1961) the Pacific form which ranges from Sri Lanka and the East Indian to the Pacific coast of America is known in southern Mexico and central America generally by the word "Couama" but actually the term is an old carribean name used for

Loggerhead. In Mexico the light coloured variety of Ridley is known as "Mestiza" but actually "Golfina" is the name applied for the *L. olivacea*. In the Madras coast of India it is known as "Kadalaamai" (sea turtle).

Catching method of the turtle in Bay of Bengal

The main catching method of this turtle mentioned by Valliappan and Pushparaj (1973) in its feeding ground is by means of nets. In the Tuticorin coast the fishermen place their heavy large hole nets of a bottom set type across the channels between islands and reefs or parallel to the reefs. The turtles use high tide to go over the reefs to feed and while coming back during the receding tide turtles are caught in the net but it is not clear from their description what species of turtles are being caught in this method. In the Orissa coast no doubt accidentally turtles are being caught in fishing nets but fishermen usually try to avoid nets for catching turtles because nets are damaged by turtles. I have seen such damaged nets being repaired by fishermen. During the mating season of this species the males remain floating hooked above the female in copulation so indifferently in the sea that the pairs allow the fishermen in boats to approach very near them. The fishermen upturn the pair suddenly and drag up the pair on the boat and in this operation a piece of wood and a small strong net is also used or even if a plank is placed in front of the couple the paired turtle may crawl out of water into the boat for better copulation facilities. No doubt sometimes nesting females may be also being caught but this catch is negligible. The method of catching the Ridley floating in copulation is indicated further by the maximum number of catch in Orissa coast during their mating season and of 50% male and female ratio in the total number of catch per day.

The food and feeding ground : No adequate information of its feeding ground is available but it is presumed that coral reef areas near the Andaman and Nicobar islands are the feeding grounds of the nesting population that come to nest in the Orissa and West Bengal coast. One report by Biswas and Sanyal (1977) of one juvenile green turtle being collected from the sea near the Nicobar coast indicated that a population of sea turtles spends a period of its life near about Andaman and Nicobar Islands.

According to Valliappan and Pushparaj (1973) the 160 km. distance between Tuticorin to Rameswaram where there is a chain of 20 islands of atolls, is the feeding ground of turtles. Here the average depth of water between shore and island is 2 fathoms and the channel between

islands is 3 fathoms. The island reef of this area is known as "Paarai" to the fishermen where they place their nets to catch the turtles that come to feed here.

In the opinion of Dernaniyagala (1939) this species is probably more of a bottom dweller and less of the habit of floating the sea surface excepting during its breeding season. This point is substantiated when some nesting turtles are found with settlements of *Balanus* on their carapace. It inhabits shallow water between the reef and shore and by no means uncommon in larger bays and lagoons.

This species is mainly herbivorous, at least in its adult stage. I have found gut full of algae in the dissected adult Ridley specimens but Daraniyanagala (*loc. cit.*) has mentioned that it also takes sea urchin, *Clypeaster humilis*, as well as young pearl oysters.

There is possibility of change of food habit from carnivorous tendencies in the young stage to mainly herbivorous feeding habit in the adult stage like that of *Chelonia mydas*. In cases of some Ridley population great distance separates their feeding and nesting grounds unlike green turtles. But in respect of Bay of Bengal population possibility of a great distance separating between feeding and nesting grounds is unlikely having feeding grounds in the Bay itself. Carr and Caldwell (1956) were getting regularly in Florida in the same net green turtles as well as *Lepidochelys olivacea kempii* (Garman) which are supposed with different feeding habits. Green turtles are available in pastures of grass flats (Turtle grass, *Thalassea* and Manatee grass, *Cymodocea*) but for the presence of Atlantic Ridley it was surmised that they were on the flats with the green turtles to feed there on crabs and invertebrates. But in the case of Pacific Ridley as it also turns to vegetarian diet in its adult stage it can be also expected to be available in association with the green turtles in the Bay of Bengal wherever the turtle pasture will be available. This possibility of change of feeding habits is further strengthened by the report of Zwinenberg (1976) on the food and feeding habits of Olive Ridley.

Range in size and weight : The Ridley is the smallest sea turtle and seldom weighs more than 40 kgs. According to Schulz (*loc. cit.*) it seldom weighs more than 50 kgs. Pritchard (1969) gave the average weight of 14 turtles as 35.7 kgs. The average weight of turtle from the Orissa coast is 30 kgs. which may vary between 30 to 35 kgs. but it will seldom exceed 35 kg.

The Ridley is the smallest of the sea turtle reaching maturity at a length of shell about two feet (61-68 cm.). The measurements given (Table 4) below of 10 specimens each of male and female are more

than the measurements quoted above. The average carapace length and breadth of 500 females of Surinam Ridleys given by Schulz (1975) is 68.5×60.4 cm. but in the ten samples of adult females of Puri Coast it is 57.8×50.2 cm. The difference of the two averages may be due to less number of measurements in the Puri population and the range of variation in the length into breadth is 63 to 75×53 to 66 cm. in the Surinam specimens and 64 to 72×55 to 63 in the same number of females of the Puri Coast.

The plastron breadth is slightly more than its length.

Table 4. *Measurements of mating males and females of Puri Coast*
(Measurements in cm.)

Female				Male			
Carapace		Plastron		Carapace		Plastron	
Length	Breadth	Breadth	Length	Length	Breadth	Breadth	Length
70	60	55	52	68	61	51	49
69	61	50	49	70	57	49	48
67	55	50	49	67	59	50	48
72	59	53	52	64	56	48	47
69	62	53	52	68	65	52	48
67	65	53	51	78	60	50	49
67	63	54	54	70	59	51	49
66	57	51	50	79	64	53	51
67	61	51	50	73	60	51	50
64	59	53	52	70	61	50	48

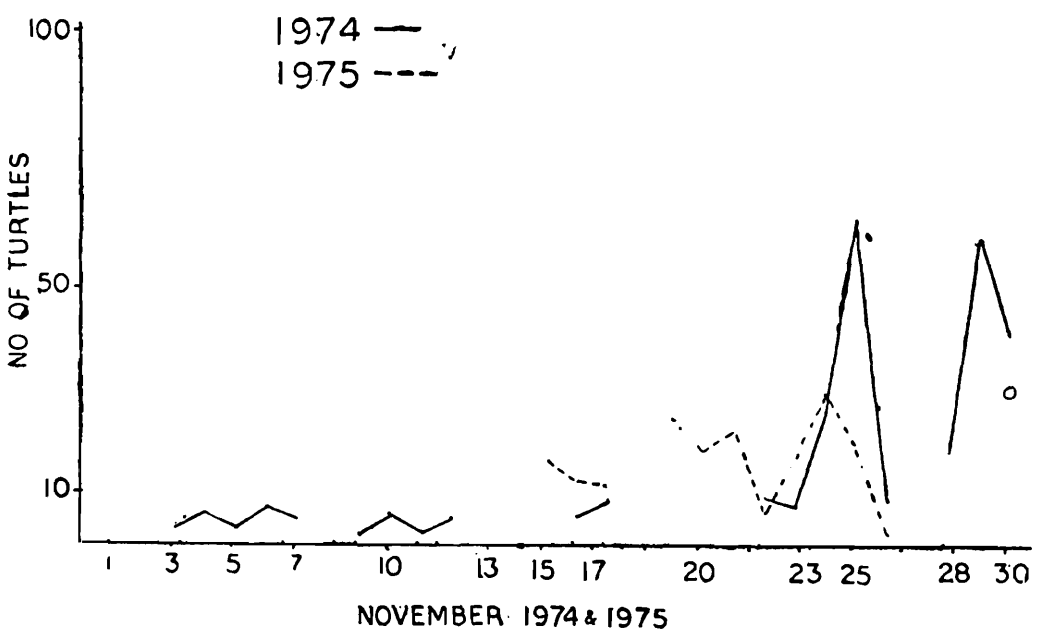
Breeding season of the Ridley in the Bay of Bengal

Mating season : For the Ridley the season generally starts in the Bay of Bengal from the 3rd week of November and ends in the end of January. The actual peak of the mating season may be taken as the period of the breeding season which is from the middle of December to the middle of January. The mating season almost coincides with the north-east monsoon or the trade wind that sets in usually in the last week of November and lasts till the last week of January. This is the most suitable period of the year when the sea condition for the copulating pairs can remain in undisturbed condition in a calm, quite and cool sea. During the December-January period due to the shift in current direction along the coast of Bay, the northward flow of warm water originating from the Indian Ocean is very helpful to the breeding pairs. The concentration of turtle population occurs during this period just before the nesting season in the Bay of Bengal and this congregation is particularly observable off the mouth of rivers

of Orissa approximately 6 km. coast line starting from the mouth of Chilka to Chandrabhaga (Konarak Coast) to the mouth of Mahanadi Baitarani estuary (Sea faces of Bhitorkonika estuary) and Budhabalang river mouth of Balasore district and also in the coast of West Bengal at the sea faces of Digha to Sunderban estuary. During this time the combined pairs of turtles are found floating scattered in these areas and become the victims of easy catch to the fisherman.

An approximate idea of a part of the mating turtle population and its peak periods can be gathered from a catch of an area of sea adjacent to Puri coast by the number of turtles booked from the Puri Railway Station for the consumption of Calcutta market where it is sold profitably. The local consumption of turtle meat is very negligible due to religious taboo and also nonprofitable market price. Therefore the number of turtles booked per day may be taken as the approximate average per day catch of this area.

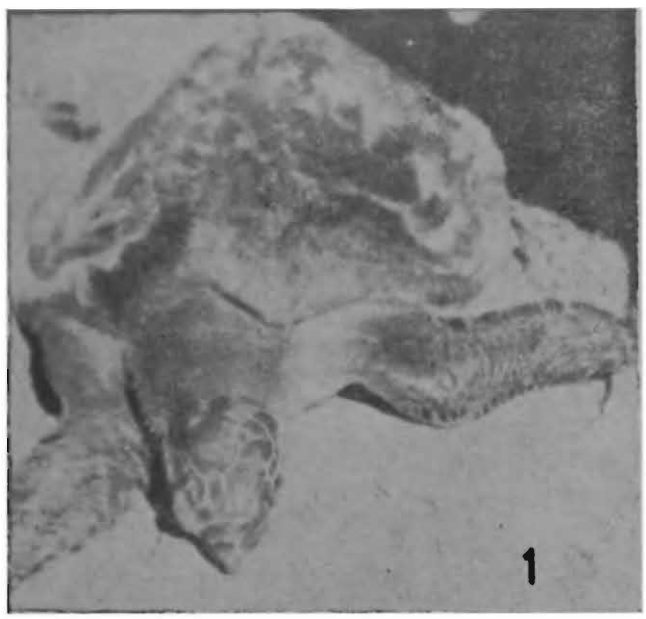
Like the nesting periodicities of Ridleys and Green turtles they have also the mating or pairing periodicities which can be seen from the daily catches of these turtles from the sea of Puri coast during their mating season. The comparative study of turtle catch in the month



Text-fig. 2. Graph showing the turtle catch of November 1974 & 1975.

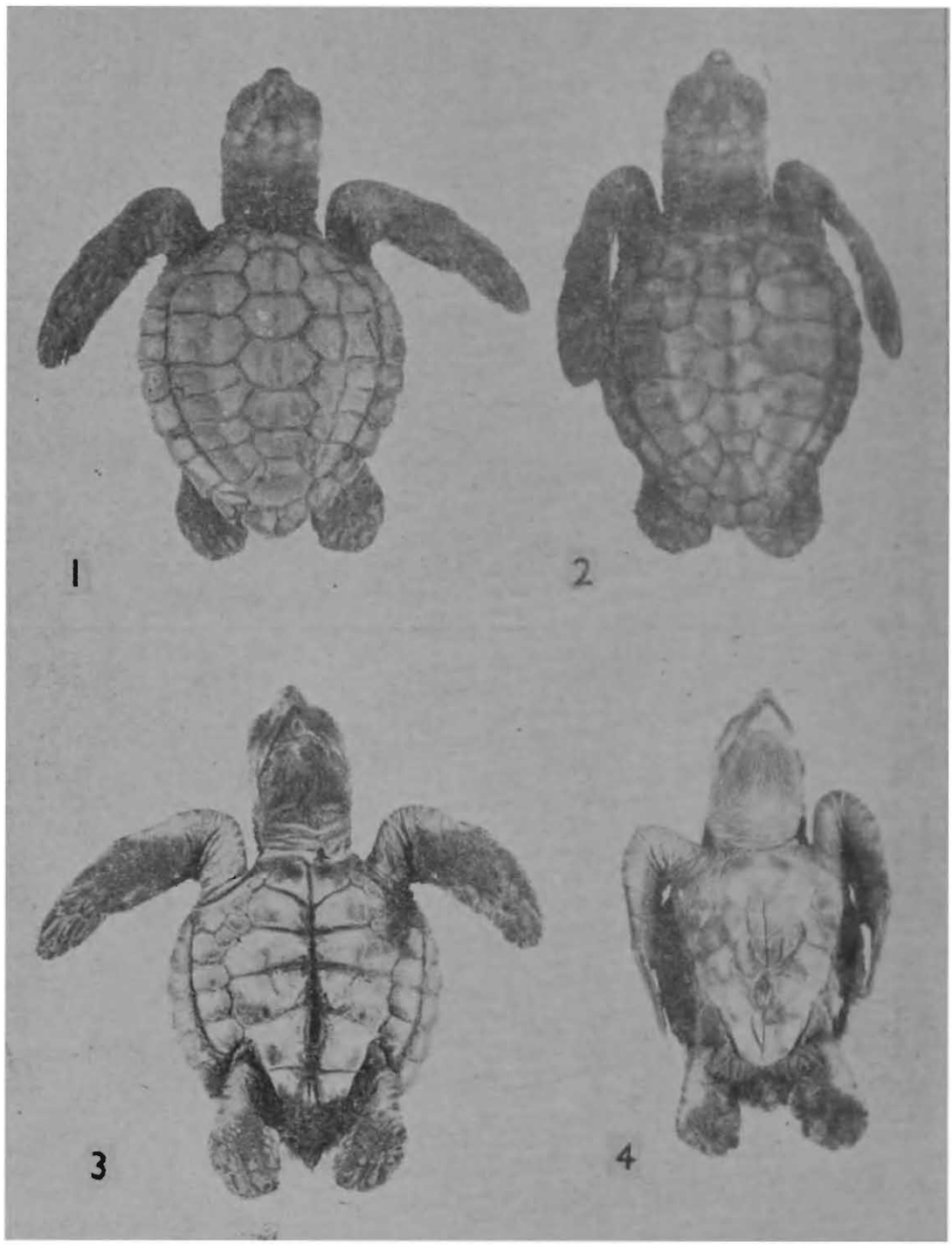
of November, the beginning of the turtle fishing season and in December, the peak period of the season of two consecutive years 1974 and 1975 will give an approximate idea of this periodicity or rhythm. The first picking up of the catch in the season is on 24th and 25th November of the years 1974 and 1975 respectively (Text-fig. 2). In both these two years the peak collection period was from 1st to 10th

BISWAS PLATE IX



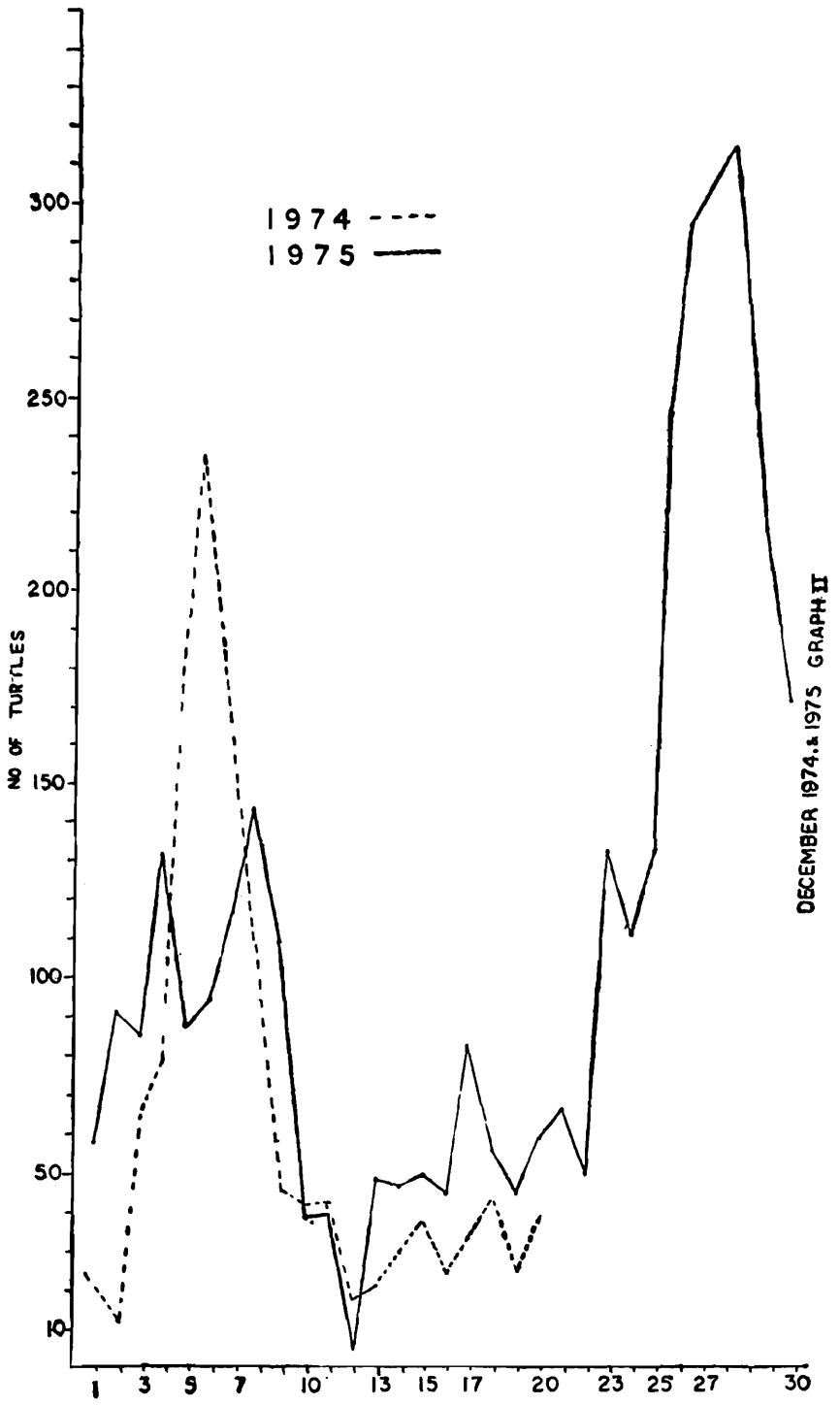
Lepidochelys olivacea (Eschscholtz), Fig. 1. Head shield and the expansion of the front flipper. Fig. 2. Side view of head from the ventral side. Fig. 3. Wavy marking on the carapace of a freshly caught specimen. Fig. 4. Fishermen children playing with a turtle lying the flipper. Fig. 5. The beach condition of Chandipur.

BISWAS PLATE X



Lepidochelys olivacea (Eschscholtz). Figs. (1 & 2) dorsal and (3 & 4) ventral views of four hatchlings. Fig. 4. Specimen is underdeveloped, hatched in an artificial condition.

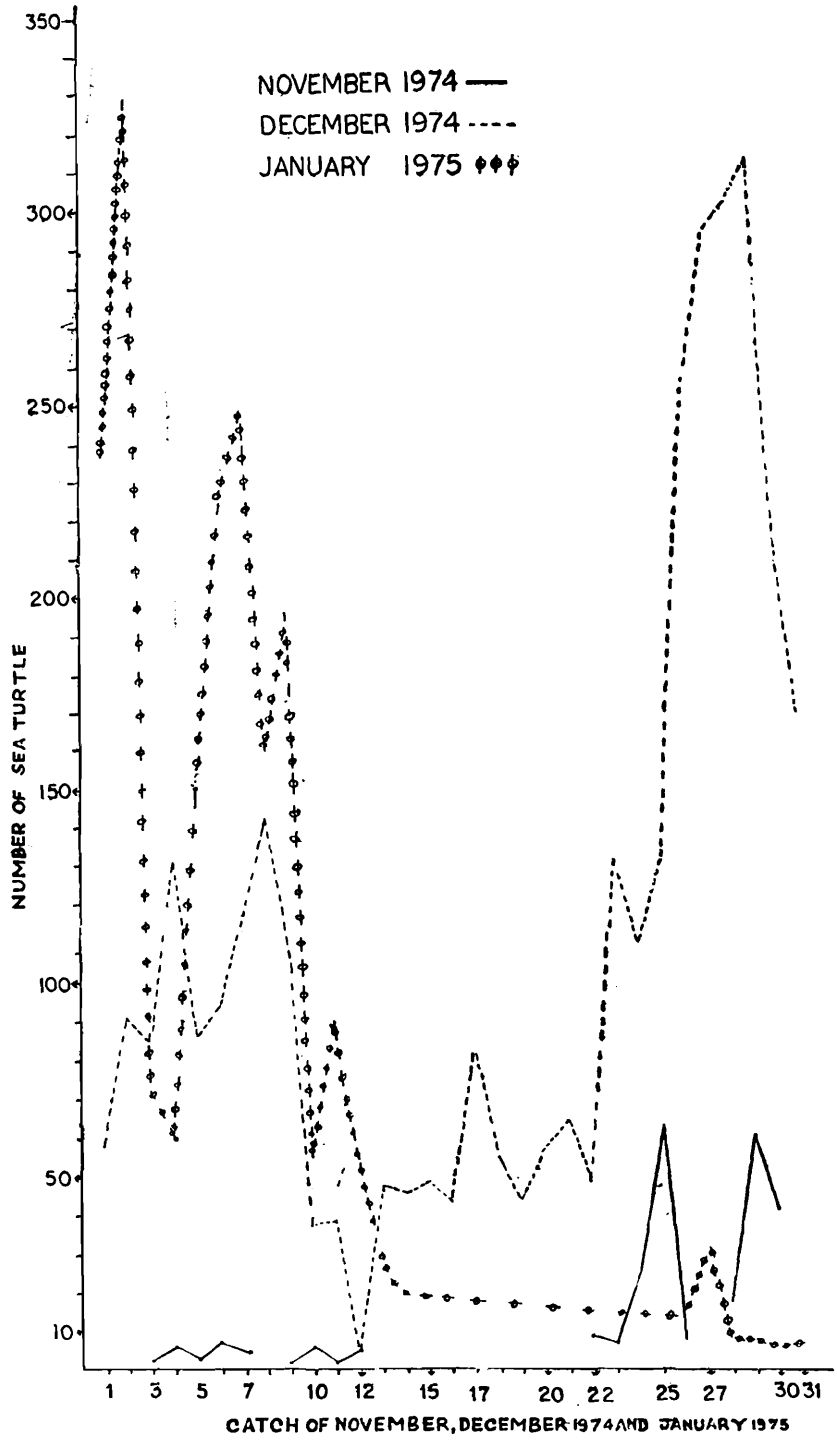
December which fell down abruptly on 12th but continued in a higher lavel (Text-figs. 3 & 4).



Text-fig. 3. Graph showing the turtle catch of December 1974 & 1975.

Comparative study of daily turtle catches from the sea of Puri coast in the three months of the turtle season 1974-'75 (Text-fig. 4) shows that from 22nd November the catch started to rise and reached to two peaks on 25th and 29th and the trend continued and the catches increased further in December reaching peaks on 2nd, 4th, 8th, 11th, 17th, 21st, 23rd, 26th and 29th. In January the trend continued and reached peaks on 2nd, 7th, 9th, 11th after which the catch went

down abruptly but remained steady from 15th to 25th. The catch again rose on 27th and ended in February. 29th December and 2nd January were the two days of highest catch of the season. One peculiarity is observed in this detailed study of daily catch that it is not continuous



Text-fig. 4. Graph showing the turtle catch of November, December 1974 & January 1975.

rise or fall of catches but always with 2 to 5 days of intervening low catches between peak collections.

In the chapter on the commercial importance of the species it has been noted on the basis of information of two collecting agents of Digha

coast, West Bengal that the actual turtle fishing season started in West Bengal coast in 1978-'79 from middle of October. The collection increased throughout November, reached maximum in December and ended in middle of January. When compared with the breeding season of turtles of Puri coast we find that in West Bengal it bad started and ended earlier in 1978-'79 which may be due to early start of the trade wind.

Nesting season : Since mating brings about fertilization of eggs that will be laid two or three years later and has nothing to do with the eggs of the season, it seems likely that copulation could take place equally well before or after nesting and that it may also occur at both times. Observation along the Coast of Sinaloa, Mexico (Carr 1961) seems to indicate that the same is ture of *Lepidochelys olivacea*.

The mating as well as nesting period of this species overlaps. The nesting time starts near about middle of December which is also the peak mating time and continues upto the middle of February and consequently hatching period lasts near about upto the end of May. The laying of eggs and hatching duration has been adjusted in such a timely requlority in the Ridley population of Bay of Bengal that the hatching will be completed in the end of May or just before onset of rainy season which usually starts in the coast of Bay of Bengal in the middle of June. We may have an idea of the period from the date of egg collections (Table 5) and its hatching out dates.

During this period turtles begin to come up in number for laying eggs along practically entire coast of Bay of Bengal wherever they get suitable beach condition. The author has come across during his survey of Orissa coast such suitable nesting grounds at Satbhya, Gahirmatha, Chandrabhaga, Balukhanda etc. out of which Satbhya was found most suitable for their nesting where the density of eggs laying reaches even one clutch in a square meter.

A phenomenon is seen in *L. O. olivacea* coming for nesting in a mass as if in waves having a clear periodicity which is comparable with similar mass nesting of *L. o. kempii* known as 'arribada'. This 'arribada' also takes place in the Ridleys of Orissa coast in the peak time of its nesting season but the author missed to observe the incident when he was at Talichua on 17. 1. 76 a place in the Bhitorkonika. It has been reported by the local fishermen that usually it takes place at Gahirmatha and Satbhya in the month of January in the period after spring tide with decreasing high water, *i. e.*, between newmoon and first quarter, and between fullmoon and last quarter. [Just after

Purnima (full moon) Kotal (Spring tide) or Amabasya (new moon) Kotal]. Following are the nesting seasons in different coasts of Bay of Bengal and East Pacific :

Regions		Months	
East Pacific Ocean	—	August to November	—4
Sri Lanka	—	September to January	—5
Burma	—	March to April	—2
India	—	January to April	—4

Table 5. Data of collections of eggs and hatching period of 13 clutches from Madras and Orissa coast.

Nos.	Date of collection	Date of hatching	Total nos. of eggs	Days to hatch	Locality
1.	22. 12. 73	21. 2. 74	135	60	Madras coast
2.	25. 12. 73	26. 2. 74	43	63	,,
3.	28. 12. 73	26. 2. 74	143	60	,,
4.	5. 1. 74	2. 3. 74	139	57	,,
5.	9. 1. 74	5. 3. 74	128	55	,,
6.	9. 1. 74	7. 3. 74	120	57	,,
7.	20. 1. 74	28. 3. 74	105	66	Orissa coast
8.	25. 1. 74	17. 3. 74	105	50	Madras coast
9.	25. 1. 74	19. 3. 74	85	52	,,
10.	29. 1. 74	21. 3. 74	127	51	,,
11.	29. 1. 74	21. 3. 74	116	51	,,
12.	29. 1. 74	21. 3. 74	140	51	,,
13.	12. 2. 75	10. 4. 74	119	54	Orissa coast

So far collected clutch size of this area are found to vary from 43 to 145 number of eggs and days of hatching 51 to 66 days.

Some notes on nesting behaviour, incubation and hatchlings

Nesting behaviour : Carr (1948) has observed in detail the nesting behaviour of a number of Pacific Ridleys on the beach of Isler de Ratones in Hunduras in the Gulf of Forseca (Pacific Ocean) and Werler (1951) recorded an egg laying incident of this species at Padre Island off the Texas coast. In Bay of Bengal nesting behaviour and incidences have been observed by Biswas *et al.* (1977), Valliappan and Whitaker (1974) and Greaves (1933).

Incubation : In natural condition the incubation success of eggs varies from clutch to clutch from 50% to 80% of the laid eggs due to presence of a good number of nonfertile eggs and also due to obstruc-

tion or overcrowding of fully formed hatchlings not being able to get out of their nests. In an experiment conducted at Gahirmatha beach, Orissa Biswas *et al.* (*loc. cit.*) got 66.66% incubation success.

The above mentioned paper also suggests that the incubation period depends on the average air temperature during that period. Usually 60 days are recognised for incubation of eggs in natural condition at the beginning of the season when air temperature remains comparatively low but in the end of the season when temperature rises it takes less time for incubation.

Size and weight of eggs and hatchlings : Following are measurements of two samples of eggs and hatchling from two nesting areas of Orissa coast according to Biswas *et al.* (1977).

Gahirmatha	*Konarak*
5 eggs on 1. 4. 75	*20 eggs*
Diameter—34 to 38 mm.	Diameter—35 to 37 mm.
Weight —33 to 33 gms.	Weight —25.5 to 27.2 gms.
10 hatchlings	*10 hatchlings*
Length of carapace 35 to 40 mm.	Length of carapace 34 to 42 mm.
Weight — 12.2 to 15.5 gms.	Weight — 13.5 to 16 gms.

ECONOMIC IMPORTANCE OF THE SPECIES IN THE COASTAL AREAS OF BAY OF BENGAL

This species has a commercial importance in the economy of eastern and southern coastal areas of India. One of the main occupations of many fishermen in the coastal belt of Bay of Bengal and Orissa for three months of a year is the turtle fishing and *Lepidochelys olivacea* is the only main catch of this season.

A major portion of the turtle catch from the Orissa coast comes from Puri coast which also includes the catch of the Konarak coast. This catch is mainly exported out of the state from Puri Railway Station. The majority of the fishermen community engaged in turtle catching operation in this area are the Christian community of coastal Andhra temporarily settled in the sea side bustees (hutments) known as Luniasahi in the Puri coast of Balukhand area. Most of them come by their sailing boats from the Andhra coast in the beginning of September and leave this place in March and April after the closure of the important fishing season of this area. At present some of them have permanently settled in the Balukhand area of Puri. Usually the Hindu Andhra fishermen or local fishermen are not engaged in the turtle catching operation due to the religious taboo.

Calcutta is the main market of consumption of this species. From the Puri Rly. Station most turtles are booked to the Howrah Rly. Station. Recently developed anothar minor center of consumption is Raipur, Madhya Pradesh. Konarak is another centre for turtle catch in the Orissa coast. The turtles caught from the sea are carried from the Chandrabhaga seashore to the stocking centre of Konarak near the northern side of the Sun-Temple. The turtles are loaded on the bus top at this place for transporting them either to Bhubaneswar or Puri Rly. Station. At Puri fishermen sell turtle to the middleman at the price of Rs. 20 to 25 each and it is sold to the wholeseller of Howrah Chandni market, a market of fish wholesale at Rs. 57 to 60 per turtle. The retailers or fish-sellers purchase in the Chandni wholesale market to sell the turtle meat at Rs. 5/- or 6/- per kg. The fishermen of Chandrabhaga get less price per turtle than the fishermen of Puri may be due to the more transporting cost of this place than Puri. The turtles are despatched by train upside down, both pairs of fore and hind limb tied up together with an identification mark and a number inked on the plastron. The Puri municipality charges 25 paise on each turtle as octroi duty.

Following is the month-wise despatch of turtle from the Puri Rly. Station in the year 1974-75 which can be taken as the approximate month-wise turtle catch of this area in that season.

Despatch from Puri Rly. Station :	November, 1974	—	282
,, ,, ,,	December, ,,	—	3448
,, ,, ,,	January, 1975	—	2460
Despatch from Malatipatpur Rly. Stn., the Rly. Stn. after Puri from 3.11.74 to 23. 11. 74.			149
	Total		6339

The turtles that used to be caught at Gahrrmatha, at the mouth of the Dhamara river and the seaface places of Vitorkonika estuary used to be brought to Chandbali by boat and from here it again used to be carried on bus stop or by truck to the Bhadrak Rly. Station, finally for despatching to Howrah Rly. Station. This area was wellknown for the collection of turtle eggs. It was reported by the Range Officer Konika, Forest Dept., Govt. of Orissa that seven boat loads of turtle eggs were collected in 1974 from this area and despatched to the Calcutta market. But turtle catching and collection of its eggs in the nesting season of this area has been stopped since 1975 with the declaration of the area of Vitorkonika as the turtle and crocodile sanc-

tuary. The eggs are usually sent to the Calcutta market. Though turtle meat is not popular it is also used by the local low caste people. I have seen turtle meat being sold in the Chandbali market of Orissa and Namkhana (Sundarban), West Bengal.

November is also the month when the season of turtle catch starts from Chandipur, an important fishing center in mouth of Burdhabalaug river. On an average 4 quintals of sea turtles numbering nearly 30 specimens are usually caught at this place daily during the peak period of the turtle season and despatched to the Calcutta market.

From the Digha and Sunderban coast of West Bengal this species is also being caught and marketed in the Calcutta market. Though I have also data of annual catch of this area but which can be presumed to be no less than twenty thousand in the season.

Information about the Madras coast will be available from the reports of Pusparaj, Whitaker and Valliappan (*loc. cit.*).

An account of turtle catch at Digha coast of West Bengal in 1978-'79 has been gathered from two agents, one stationed at Digha proper and another at Junput. Turtles are collected at Digha from 6 seaside depots. and at Junput from 2 and sent by truck to the Kharagpur Railway Station for the Calcutta market.

Turtle catch at Digha coast of West Bengal in 1978-79.

15th October, 1978 to 30th October, 78	858	161
1st November, 78 to 15th November, 78	1661	284
16th November, 78 to 30th November, 78	3880	889
1st December, 78 to 15th December, 78	4644	1080
16th December, 78 to 31st December, 78	5081	1412
1st January, 79 to 15th January, 79	1201	210
	17,325	4,036
	4,036	
Total catch	21,361	

PROTECTION AND CONSERVATION

It is regretable that very little attention has been paid to the sea turtles that are nesting in the coast of India. To find out a rational plan of protection for the turtles of Indian coast and sea, the nesting areas or grounds of the species concerned are to be first searched out. The key to the future of turtle resources lies in the preservation of these nesting grounds of beaches. The next important step is ascertaining the number of nests that are being laid in these different nesting grounds in every year. In this respect the steps taken in Surinam for

the conservation of Olive Ridley will be very relevant to state here (Schulz, 1975) :

In 1963 for the protecting of nesting turtles Bigisanti nesting beach Wia-Wia Nature Reserve had been set up. In 1966 the boundaries of the Nature Reserve was further expanded. In April 1964 poachers started poaching turtles. The Forest Deptt. took firm action against it. The Nature Reserve authority is gathering quantitative data about laying in approximately 10 km. long beach which is being patrolled daily from April to August and all nests laid during the previous night are being counted. In this Reserve tagging, weighing and taking measurements of turtles are also regularly carried on and more data were collected about incubation periods and hatching percentage for eggs including of those replanted in nests. The World Wild Life Fund is also financing in this work of the Nature Reserve which paid in 1964 for buying up and rebuying of 30,000 eggs and in 1968 most of the Ridley nests of Eilanti were bought with the financial aid from the W. W. F. In this respect it can be mentioned that the W. W. F. is also helping the Madras Snake Park for its plan of rebuying turtle eggs of Madras coast.

Lastly for the conservation of the Ridleys of the Indian coast, information on population dynamics, such as sex ratio, annual recruitment and mortality, age distribution are important for the proper management of a conservation programme in the Indian coast.

The following proposals are therefore proposed to the Government and to the people concerned for the protection and conservation of the Olive Ridley of Bay of Bengal which are also equally applicable for other sea turtles.

1. Annual quotas of turtle catch and collection of its eggs should be fixed for each demarcated area only. The total ban for exploitation of this species at present is not necessary as the species is predominantly the most numerous marine turtle today in the Bay of Bengal. This fact has been well experienced by the author in his present survey as well as by the reports of Zwinenberg (1977), Valliappan and Whitaker (*loc. cit.*).

2. Fishery and Forest Depts of the concerning States should be entrusted to supervise that the exploitation beyond the fixed quota does not exceed.

There is a Government ban for turtle catching which is not strictly enforced in India.

3. Selected areas and beaches where mass nesting is now taking place are to be declared turtle sanctuaries where total ban should be enforced and the immediate off shore areas should be closed for trawling.

The Bhitorkonika estuary of Brahamani and Mahanadi rivers has been declared such a sanctuary by the Orissa Government and the Forest Dept. at present is engaged there for marking turtles.

4. Buying and rebuying scheme of turtles eggs in the entire coast should be started under the Fishery and Forest Depts. If the financial help from the Govt. is limited for such a scheme, the help of W. W. Fund and other societies interested in the conservation should be sought for. The eggs thus procured should be buried for iucubation.

The Madras Snake Park has already been receiving financial help in this scheme from the W. W. Fund.

5. Nesting areas should be protected by the Coastal, Forest and Lighthouse guards and it should be incorporated in their duties to protect the nesting beaches from the poachers and predators by regularly patrolling these areas.

6. To increase conservation awareness in the coastal people and fishermen a programme of conservation education should be carried out.

7. Lastly a pilot project of a Turtle Ranch as is in operation at the Field Station of the Surinam Forest Service to raise newly hatched Green sea turtle in captivity should be started at a suitable place in the coast of Bay of Bengal (*Marine Turtle Newsletter No. 7. April 1975*). The specific goals of the Surinam project should be also the objectives for our project. There is a scope in India for establishing such a project in Waltair coast at the Waltair Zoogarden.

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Rec. zool. Surv. India, **79** : 303-310,

DISTRIBUTION PATTERN OF *MARTESIA STRIATA* (LINNAEUS) IN ESTUARINE SYSTEMS OF THE EAST AND SOUTH WEST COASTS OF INDIA

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(With 1 Text-figure and 1 Plate)

INTRODUCTION

Molluscs of the families Teredinidae and Pholadidae, which bore into wood and cause extensive damage to submerged structures in the sea have been studied in detail, in recent years in India. The teredinids are generally known to bore into wood whereas pholadids besides boring into wood have been reported from other structures like granite rock, lead, brickwork, sandstone, corals, concrete cement and compact clay. The genus *Martesia* Blainville, 1824 is represented by two species viz. *striata* (Linnaeus, 1758) and *fragilis* Verrill and Bush, 1890 in Indian Waters (Daniel and Srinivasan, 1956). The latter species has been reported from catamarans, fishing boats and floating wood, from the open sea and has not been commonly met with inside protected harbour areas and estuarine regions where *M. striata* abounds.

The distribution pattern of *M. striata* in the marine environment is well known and specimens from infested timber samples have been collected from all the Indian harbours, and on the east and west coasts of India (*vide* Daniel and Srinivasan, 1956 ; Nagabhushanam, 1958, 1962 ; Srinivasan, 1959 ; Nair, 1965 b ; Balasubrahamanyan, 1968 ; Purushotham and Satyanarayana Rao, 1971). In the estuarine environment, the occurrence and distribution of this species in Cochin backwaters, on the south-west coast of India, have been dealt with by Beeson (1936), Balasubrahmanyan and Menon (1963), Nair (1965 a) and Santhakumari and Nair (1975). However, on the east coast excepting for a few brief references or records of *M. striata* at Calcutta Port (Annandale,

1923), and in the estuaries of Mahanadi (Subba Rao, 1968), Godavary (Ganapathi & Lakshmana Rao, 1959), Krishna (Pampapathi Rao et al, 1957) and Adyar (Daniel, 1958 b) no information is available about the distribution and the extent to which it has penetrated into the estuarine systems. The objective of the present study was to investigate the distribution of this species in the various estuaries of the east and south west coasts of India, and the adaptations, if any, as a result of interaction of several factors prevalent in an estuarine environment.

A detailed study of the distribution of *M. striata* in various estuaries in India has therefore been made, based on surveys and collections made by the authors, collections available in the Zoological Survey of India, and all published records. This study has revealed the occurrence of *M. striata* in all the major estuaries, though the range of penetration appears to vary and its ability to bore into other types of substrate as well, in the estuarine region is well marked while in the marine environment it is typically a wood borer.

Observations

Hooghly-Matla Estuary : Annandale (1923) recorded the occurrence of this species in brickwork in Calcutta Port. We have examined young and adult forms (6 mm to 32.5 mm) from timber structures and wood from Sagar Island, Kakdwip, Diamond Harbour and Calcutta Port along the course of the main river Hooghly and at Port canning on the river Matla (Text-fig. 1). Specimens boring into brickwork in Calcutta Port have also been examined. According to Calcutta Port authorities, damage caused by this species, to submerged timber in service in this port is about 70 percent greater than the extent of destruction by teredinids. While specimens from Kakdwip-Sagar Island zone nearer the marine environment are usually, normally elongated, those encountered further inside are sometimes twisted at the siphonal ends. A comparison of the forms occurring in wood and in brickwork revealed that in the specimens from brickwork, the surface is mostly irregular and sculpture eroded. The shells are generally stronger and thicker than those found on wood. Some specimens from Calcutta Port area are stunted and distorted, although sexually nature. Stray specimens have been noticed by us in waters of very low salinity, 1 m below the lowest water mark near the Howrah Bridge.

Observations based on short term test-panel and test-pole studies at Kakdwip (nearer the marine environment) and Kidderpore docks (Calcutta Port) in the interior (Text-fig. 1) revealed that successful

settlement and boring occurred for the major part of the year escepting for the months from July to September, at both the stations, although the intensity of attack appeared to be greater during the period February-May, when the salinity records were high.

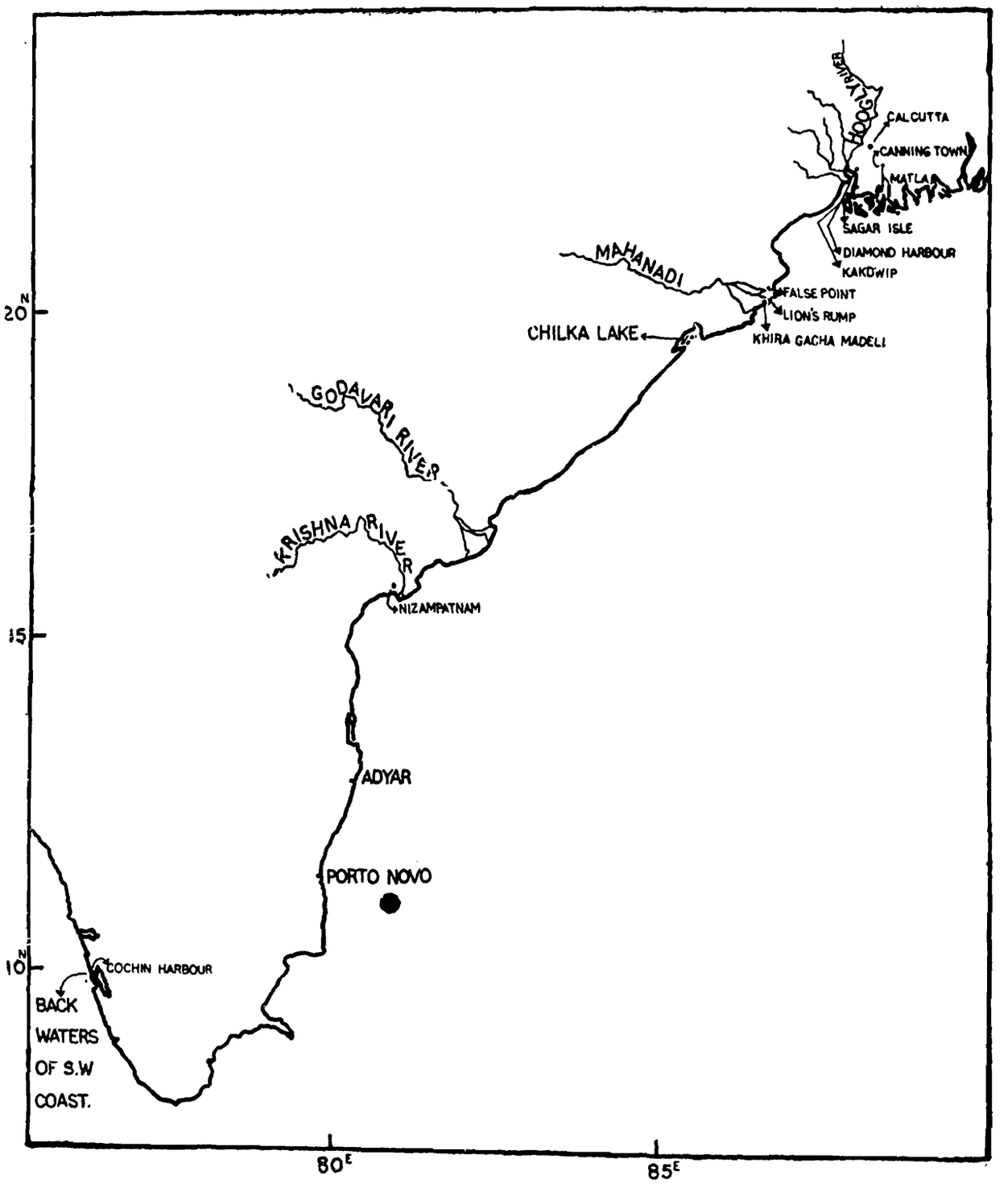
The ability of the species to bore into brickwork in Calcutta Port is noteworthy and is probably an adaptation in estuarine waters under considerable silting and turbid conditions. Further work is, however, required to elucidate this problem and to prove conclusively whether they breed successfully in the inner zones of this estuary or whether the recruitment of the larvae takes place successively from the populations inhabiting tbe estuarine zones nearer the marine environment.

Mahanadi Estuary : Subba Rao (1968) has recorded the occurrence of *M striata* in large numbers along with other shipworms in Mahanadi Estuary. At Khira Gachha Madeli, (Text-fig. 1) the waters are somewhat turbid and silting occurs to some extent. Adult specimens occurring in the vicinity of the sea (Lion's Rump) ranged in size from 13 mm to 19.5 mm. whereas those from creek near khira Gachha Madeli measured 22 mm. specimens from False point (30 km. from the sea) measured 5 mm. to 11 mm. A comparative study of the size ranges reveals that bigger sized forms occur abundantly at Khira Gachha Madeli—about 10 km. from sea, whereas at regions near the sea and also those well within the estuary are smaller and not in abundance. Their abundant occurrence at Khira Gachha Madeli zone shows that this species has found favourable conditions for survival and rapid growth in this area and has established itself.

Chilka lake : The specimens from the outer channel of Chilka lake (Text-fig. 1) are all stunted and distorted forms which are twisted at the siphonal ends and dull in colour. It is probable that stray larvae from the marine zone are carried into the outer channel and find it possible to settle down and grow to some length without being able to survive for more than a few months. Annandale & Kemp (1916) while recording this species from "Chilka Lake" however commented on P. 356 that "the specimens probably came from a log that had drifted into the mouth of lake".

Godavary Estuary : (Text-fig. 1.) *M. striata* appears to be scarcely represented in this area and only very few specimens were collected from dead stumps. Ganapathi and Lakshmana Rao (1959) also encountered only 3 specimens of this species amongst the borers which were represented mainly by teredinids. Dead stumps and live mangrove trees were found to be honeycombed with the terednid borers and few specimens of *Martesia* were collected from dead stumps only. Probably,

M. striata can successfully settle and bore into dead stumps only, but not into living trees in this estuary. The few dead stumps on which they settle and bore probably become uprooted during strong gales and are carried away with the current resulting in very few living forms being found and collected during casual visits.



Text-fig. 1. Records of *Martesia striata* in the estuarine systems of the east and South-West coasts of India.

Krishna Estuary : During the surveys of areas in the Nizampatnam backwaters in the Krishna Estuary, (Text-fig. 1), specimens ranging in size

from 6 mm to 22 mm were collected from dead stumps. Since animals of varying sizes were collected, it appears to us, that in this environment, the occurrence of *M. striata* is regular and perhaps permanent, as had been suggested by Pampapathi Rao *et al.* (1957) in the main part of the river Krishna. It is of interest to note that while in the main part of the river this species has been recorded in soft compact clay on either side of the river mouth (*vide* pampapathi Rao *et al*, 1957). our collections from the tributary are only from dead stumps, with the species penetrating to a greater extent in this part of the estuary. It is noteworthy, that its record in a substratum other than wood (*i. e.*, in soft compact clay) is remarkably again in an estuarine environment.

Adayar Estuary : In the Adyar river (Text-fig. 1) *M. striata* has been recorded at its mouth (Daniel, 1958 b). Test panel studies conducted intermittently during the years 1955-58 and 1971-79 have revealed that successful settlement and boring of *M. striata* occurred right through the year, though marked by seasonal intensity (Plate XI, Figs. 1 & 2—for young and old forms). It is probable, that during high tide, larvae are brought in from the sea and successfully settle there. Hence, in this region, *M. striata* may be considered as a tolerant or hardy marine species. It is noteworthy that when heavy fouling of barnacles occurred in the test panels, the infestation of *M. striata* was found to be very less at the places fouled by the barnacles, whereas in the "unfouled" regions there was heavy attack by *Martesia striata* (L.) (Plate XI, Fig. 3).

Porto Novo : Although this species has been recorded from Porto Novo (Srinivasan, 1959 ; Nair, 1965b) the exact locality records are not known and we are therefore unable to comment on its occurrence, in the estuarine habitat in this region.

Backwaters of South West Coast : Beeson (1936) observed the settlement of *M. striata* in the mouth of Beypore river from November to June. Erlanson (1936) while reporting this species from Cochin concluded that the activity of molluscan borers in Cochin harbour and vicinity is less than elsewhere, although Nair (1965b) comments that "Erlanson's tests were confined chiefly to the monsoon and post-monsoon periods (May to November).....when the breeding period of *Martesia*...was almost nearing completion." Balasubrahmanyan and Menon (1963) noted greater density of borer attack due to *Martesia* during the months extending from December to April. Nair (1965b) found at Cochin harbour that the premonsoon and postmonsoon periods were characterised by severe attack by *Martesia* which declined in numbers during the monsoon period, there being practically no attack

during the major part of the monsoon and during part of the post-monsoon period. This, he attributes as being due to the great lowering of the salinity during these periods. Santhakumari & Nair, (1975) confirm the results of the earlier work of Nair (1965b).

Remarks

An analysis of the distribution pattern of *M. striata* in the major estuarine systems studied shows that this species has become fairly well established in the Hooghly, Mahanadi and Krishna estuaries on the east coast, and also in the Cochin backwaters on the south west coast of India. In the Godavary estuary it appears to have not successfully established itself, while in Chilka Lake and Adyar estuary this may be considered as a tolerant marine species.

The observations made on the south west coast of India compare well with the settlement of this species in Hooghly estuary where also there appears to be an interruption in successful settling during the monsoon period, *i.e.*, July to September. However, it should be borne in mind that the speed of water currents, coupled with lowering of salinity, may be some of the major factors responsible for preventing the successful settlement of the borer (Daniel, 1958a ; Nagabhushanam, 1961).

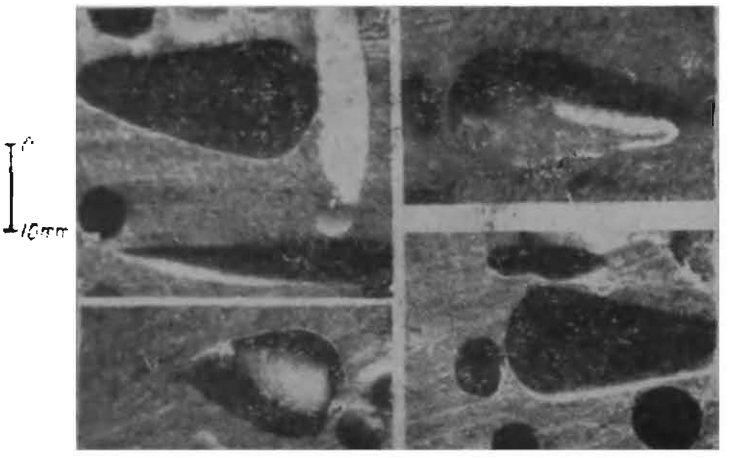
The intensity and distribution of *M. striata* must depend upon many factors prevailing in an estuary, of which, salinity, temperature, water movement and availability of wood, or other suitable structures may have to be considered as important. The occurrence of this species in dead stumps or wood in Mahanadi, Godavary and Krishna estuaries and the absence of records from living trees in these areas are of some significance in determining the distribution pattern of this species in these estuaries.

Further it is seen that authentic records of *M. striata* from brickwork in Calcutta, soft compact clay in the mouth of river Krishna, in the Indian region ; and in argellaceous sand stone in the Irawady delta, Burma (Blanford, 1867) are from estuarine habitats. Similarly, records of attack on lead sheathing of power cables reported from Ortegan river, Jacksonville, and Lake worth in Florida waters are also from estuarine waters under turbid conditions ; and in Boeca Ciega Bay, St. Peterbourg, in turbid waters with considerable silting in the causeway area, wherein the salinity is usually moderately high, although much lower during the rainy season. (Springer and Beeman, 1960).

From these records it is sufficiently clear that the trend to bore into brickwork, soft compact clay, argellaceous sandstone, lead etc. is always

DANIEL & SUBBA RAO PLATE XI

1



2

3

Martesia striata (Linnaeus).

1. Juveriles 2. Adults 3. Area heavily colonised.

associated with the estuarine habitat. This offers a fascinating field for environmental adaptation studies and underlines the need for further investigation.

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Rec. zool. Surv. India, **79** : 311-318,

TERMITES FROM MADHYA PRADESH, INDIA, WITH NEW DISTRIBUTIONAL RECORDS (INSECTA : ISOPTERA)

By

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INTRODUCTION

This report is based on the study of 74 vials of termites (Insecta : Isoptera) received from Central Regional Station, Zoological Survey of India, Jabalpur, collected by parties of Zoological Survey of India, from Madhya Pradesh, during the period 1968 to 1975. We are reporting here 18 species of termites of two families, Rhinotermitidae and Termitidae. The following 6 species of termites namely *Coptotermes kishori* Roonwal & Chhotani ; *Speculitermes goesswaldi* Roonwal & Chhotani ; *Microcerotermes sakesarensis* Ahmad ; *Odontotermes boveni* Thakur ; *Odontotermes wallonensis* (Wasmann) and *Trinervitermes nigrirostris* Mathur & Sen Sarma are recorded first time from Madhya Pradesh.

Measurements are given for those species which were not earlier reported from Madhya Pradesh.

The following are the abbreviations used in this paper : Dist., District ; Im., Imago ; S., Soldier ; Sev., Several ; Syn., Synonym ; Type-loc., Type-locality ; W., Worker.

SYSTEMATIC ACCOUNT

Family RHINOTERMITIDAE

Subfamily COPTOTERMITINAE

1. **Coptotermes kishori** Roonwal & Chhotani

1962. *Coptotermes kishori* Roonwal & Chhotani, *Indian Counc. Agric. Res. Ent. Monogr. No.* **2**, : 57-61. S. & W. *Type-loc.* INDIA : West Bengal : Berhampur.

Material : A vial with 10 S. & 2W. Jabalpur, Devtal on Nagpur Road (Jabalpur Dist.) ; *L. P. Dubey* coll, ; 7. 12. 1973.

Measurements (in mm. of 1 S. from Jabalpur) : Total body length with mandibles 4.46 ; Head length with mandibles 2.02 ; Head length without mandibles 1.25 ; Max. width of head 1.03 ; Max. length of

mandibles 0.78 ; Min. (median) length of postmentum 0.67 ; Max. width of postmentum 0.39 ; Pronotum length 0.44, width 0.75 ; Antennal segments 14.

Distributions : (i) *Previous records* : INDIA : West Bengal ; Asssm Tripura ; Rajasthan. (ii) *Present record* : Madhya Pradesh : Jabalpur (Devtal on Nagpur Road).

Family TERMITIDAE

Subfamily AMITERMITINAE

2. **Speculitermes chadaensis** Mathur & Thapa

1964. *Speculitermes chadaensis* Mathur & Thapa, *Indian Forester,* Dehra Dun, **90** (8) : 514-516. W. *Type-loc.* : INDIA : Madhya Pradesh : Chada, Karanjia Forest Range.

Material : (i) Two vials with 20 W. ; 4 & 8 Km. E. from S. S. S. Club Shivpuri (Shivpuri Dist.) ; *R. K. Singh* coll. ; 13, 21. 9. 75.

Distributions : (i) *Previous record* : INDIA : Madhya Pradesh : Chada. (ii) *Present record* : Madhya Pradesh : Shivpuri as above.

3. **Speculitermes cyclops cyclops** Wasmann

1902. *Speculitermes cyclops cyclops* Wasmann, *Zool. Jb.* (*Syst.*) Jena, **17** (1) : 160-162. Im., W. *Type-loc.* : Khandala near Bombay.

Material : (i) A vial with 5W., Budhaghat tank, Jabalpur ; *V. V. Rao* coll. ; 17. 9. 69. (ii) A vial with 6W. ; Ghat area on Nagpur Road, Jabalpur ; *H. S. Sharma* coll, 23. 6. 1970. (iii) A vial with 3 W. ; Jabalpur (Z. S. I. Office campus) ; *H. Khajuria* coll. ; 18. 8. 70. (iv) 3 vials with 13 W. ; Shivpuri (Shivpuri Dist.) ; *R. K. Singh* coll ; 13, 20. 9. 75.

Distributions : (i) *Previous records* : INDIA : Maharashtra ; Madhya Pradesh ; Uttar Pradesh ; Rajasthan ; Jammu and Kashmir ; Coorg. (ii) *Present records* : *Madhya Pradesh* : Jabalpur and vicinity (Jabalpur Dist.) and Shivpuri (Shivpuri Dist.).

4. **Speculitermes goesswaldi** Roonwal & Chhotani

1964. *Speculitermes goesswaldi* Roonwal & Chhotani, *Indian J. agric. Sci.* Delhi, **34** (2), pp. 126-130. W. *Type-loc.* : INDIA : Karnataka state : Dharwar.

Materials : (i) Two vials with 10 W. ; Jabablpur, on Nagpur Road near Bargi ; *N. K. Sinha* coll. ; 3, 11. 5. 1973. (ii) A vial with 5 W. ; Budhaghat, Jabalpur ; *D. K. Ghosal* coll. ; 20. 7. 1973.

Measurements (in mm. of 2W. from Jabalpur) : Total body length with mandibles 6.12-6.31 ; Head length with mandibles 1.75-1.83 ; without mandibles 1.08-1.16 ; Max. width of head 1.36 ; Pronotum length 0.42, width 0.86 ; Max. diameter of mid-dorsal spot 0.08 ; Antennal segments 14.

Distributions : (i) *Previous records* : INDIA : Karnataka state : Dharwar. (ii) *Present record* : Madhya Pradesh : Jabalpur and vicinity.

5. **Microcerotermes sakesarensis** Ahmad

1955. *Microcerotermes sakesarensis* Ahmad, *Biologia*, Lahore, **1** (2). : 247-248. S. & W. *Type-loc.* : PAKISTAN : Sakesar (Sargodha Dist.).

Material : A vial with 1S. & 5W. ; 3 Km. from Mainpat FRH (Sarguja Dist.) ; *R. K. Singh* coll, ; 24. 1. 1975.

Measurements (in mm. of 1S. from Mainpat, Madhya Pradesh) : Total body length with manidbles 4.3 ; Head length with mandibles 2.4 ; without mandibles 1.53 ; Max. width of head 0.86 ; length of mandibles 0.89 ; Min. (median) length of postmentum 0.89 ; Max. width of postmentum 0.31 ; Pronotum length 0.28, Width 0.58 ; Antennal segments 13.

Distributions : (i) *Previous records* : INDIA : Rajasthan. PAKISTAN : Punjab ; N. W. F. P. (ii) *Present record* : INDIA : Madhya Pradesh : Mainpat (Sarguja Dist.).

Subfamily TERMITINAE

6. **Dicuspiditermes obtusus** (Silvestri)

1923. *Capritermes obtusus* Silvestri, *Rec. Indian Mus.*, Calcutta, **25** (2) : 229-231. *Type-loc.* : INDIA : Orissa : Barkuda Island, Chilkalake.

Material : A vial with 5S. and 12W. ; 3 Km. from Mainpat FRH (Sarguja Dist.) ; *R. K. Singh* coll. ; 24.1.1975.

Distributions : (i) *Previous records* : INDIA : Orissa : Barkuda Island, Chilkalake. *Madhya Pradesh* : Kanha National Park. (ii) *Present record* : Madhya Pradesh : 3Km. from Mainpat FRH (Sarguja Dist.).

Subfamily MACROTERMITINAE

7. **Odontotermes assmuthi** Holmgren

1913. *Odontotermes* (*Odontotermes*) *assmuthi* Holmgren, *J. Bombay nat. His. Soc.*, Bombay, 22 (1) : 112-113. S. & W. ; *Type-loc.* : INDIA : Bombay (Borivilli Jungles).

Materials : Two vials with 2S. & 5W. ; Jabalpur (Madan Mahal & Z. S. I. Office campus) : *H. Khajuria* coll. ; 18.7.69 and 11.6.70.

Distributions : *Previous records* : INDIA : Jammu & Kashmir ; Himachal Pradesh : Punjab ; Maharastra ; Bihar : Uttar Pradesh ; Madhya Pradesh ; Tamil Nadu, Karnataka ; West Bengal. PAKISTAN : Hanges (Kohat Dist.) ; BANGLADESH : Dinajpur & Rajshahi (ii) *Present record* : Madhya Pradesh : Jabalpur.

8. **Odontotermes boveni** Thakur

In press. *Odontotermes boveni* Thakur, *Indian Forest Rec.*, Dehra Dun.

Material : A vial with sev. S. & W. ; 4 Km. W. from Konta Motor stand (Bastar Dist.) ; *R. K. Singh* coll. ; 19.1.1974.

Measurements (in mm. of 1S. from Konta, Bastar District) : Total body length with mandibles 4.32 ; Head length with mandibles 1.92, without mandibles 1.22 ; Max. width of head 1.16 ; Max. length of mandibles 0.72 , Tooth distance from tip 0.22 ; Min. (median) length of postmentum 0.53 ; Max. width of postmentum 0.75 ; Pronotum length 0.53, width 0.83 ; Antennal segments 16.

Distributions : (i) *Previous records* : INDIA : Uttar Pradesh : Garhwal : Gwaldam ; Jakhkandar, Syumpaitham, Kumaon Hills : Kandadhar Forest, Askot. (ii) *Present record* : Madhya Pradesh : 4 Km. W. from Konta motor stand (Bastar Dist.).

9. **Odontotermes feae** (Wasmann)

1896. *Termes feae* Wasmann, *Annali. Mus. civ. Stor. nat.* Giacomo Doria, (2) **16** (36) : 625-626. S. & W. *Type-loc.* BURMA : Carin Cheba.

Material : (i) A vial with 3S. & 5W. ; Sihora Rd., Garjtal (Jabalpur Dist.) ; *H. Khajuria* coll ; 4.5.73. (ii) 2 vials with 4S. & Sev. W. ; Barhai nallah (4 Km. S. from Mainpat FRH) and Haratickeri village (8 Km. from Ambikapur (Sarguja Dist.) ; *H. Khajuria* coll. ; 3, 4.1.75.

Distributions : Widespread in INDIA ; BANGLA DESH ; NEPAL : BURMA and THAILAND. *Present record* : Madhya Pradesh : Garjtal (Jabalpur Dist.), Mainpat and Ambikapur (Sarguja Dist.).

10. **Odontotermes guptai** Roonwal & Bose

(*Synonym* : *O. lokanandii* Chatterjee & Thakur)

1962. *Odontotermes bellahunisensis guptai* Roonwal & Bose, *J. Bombay nat. Hist. Soc.* Bombay, **58** (3) : 588-593. S. & W. *Type-loc.* : INDIA : Rajasthan : Near Gudha village (Nagaur Dist.).

Material : (i) 3 vials with 4S. & 20W. ; Jabalpur (King garden, Paritnala, Tilwaraghat) ; *V. S. Durve & V. V. Rao* coll. ; 17. 12. 68, 25. 7. 69. & 6. 8. 69. (ii) A vial with 10S. & 5W. ; Khudera village

(Bastar Dist.) ; *R. K. Singh* coll. ; 20. 1. 74. (ii) 2 vials with 7S. & 10 W. ; Ambikapur & Bhanghgacha village (Sarguja Dist.). *H. Khajuria* coll. ; 6, 7. 1. 75.

Distributions : (i) *Previous records* : INDIA ; Jammu & Kashmir ; Himachal Pradesh ; Uttar Pradesh ; Rajasthan ; Maharashtra ; Madhya Pradesh ; Orissa. BANGLADESH and PAKISTAN. (ii) *Present records* : Madhya Pradesh : Jabalpur & vicinity ; Khudera village (Bastar Dist.) ; Ambikapur and Banghgacha village (Sarguja District).

11. **Odontotermes gurdaspurensis** Holmgren & Holmgren

1917. *Odontotermes* (*Cyclotermes*) *obesus f. gurdaspurensis* Holmgren & Holmgren, *Mem. Dept. Agric. India* (*Ent.*) Calcutta, 5 (3) : 149-150. Im., S. & W. *Type-loc* : INDIA : Punjab : Gurdaspur.

Material : (i) A vial with 2S. & 10 W ; Kantangi village, *D. K. Ghosal* coll. ; 8. 8. 1969. (ii) Two vials with sev. S. & W. ; Konta Motor stand (Bastar Dist.) ; *R. K. Singh* coll. ; 20, 21. 1. 1974.

Distributions : (i) *Previous records* : INDIA : Jammu & Kashmir ; Himachal Pradesh ; Punjab ; Uttar Pradesh ; Madhya Pradesh ; Rajasthan. PAKISTAN : Punjab ; N. W. F. P. ; Baluchistan ; Lahore ; Jhelum ; Rawalpindi ; Islamabad ; Campbellpur ; Peshwar ; Kohat and Lovali. (ii) *Present records* : INDIA : Madhya Pradesh : Konta (Bastar Dist.) and Katongi village.

12. **Odontotermes microdentatus** Roonwal & Sen-Sarma

1960. *Odontotermes microdentatus* Roonwal & Sen Sarma, *Indian Counc. Agric. Res.* (*Ent. Monogr, No. 1*) New Delhi, pp. 33-39. Im., S. & W. *Type-loc* : INDIA : Uttar Pradesh : Dehra Dun.

Material : A vial with 5S. & Sev. W. ; 1 Km. N. from Mainpat FRH (Sarguja Dist.) ; *R. K. Singh* coll. ; 30. 1. 1975.

Distributions : (i) *Previous records* : INDIA : Uttar Pradesh ; Himachal Pradesh ; Punjab ; Madhya Pradesh ; Bihar ; Karnataka and Andhra Pradesh. (ii) *Present record* : INDIA : Madhya Pradesh : Mainpat (Sarguja Dist.).

13. **Odontotermes obesus** (Rambur)

1842. *Termes obesus* Rambur, *Hist. Natur. Insectes Ne'uropte'res.* Paris, p. 304, Im. *Type-loc.* : INDIA : Bombay.

Material : (i) A vial with sev. S. & W. ; Jabalpur (Pali Pather on Gwarighat Rd.) ; *H. Khajuria* coll. ; 23. 4. 66. (ii) Two vials with 2S. & 10 W. ; Jabalpur (Sita Pahad & Rani Durgavati Samadhi) ; *V. S. Durve*

coll. ; 2. 12. 68 & 20. 1. 69. (iii) A vial with 3S. & 10 W. ; Amkhas ; *V. V. Rao* coll. ; 4. 7. 69. (iv) A vial with 5S. and 10 W. ; Jabalpur (Nagpur Road) ; *N. K. Sinha* coll. ; 11. 5. 73 (v) 3 vials with sev. S. & W. ; Konta Motor Stand (Bastar Dist.) ; *R. K. Singh* coll. ; 16, 18. 1. 74. (vi) A vial with 2S & 15 W. ; 48 Km. E. Kantu Galapalli (Bastar Dist.) ; *H. Khajuria* coll. ; 25. 1. 74. (vii) A vial with sev. S &. W. ; Jabalpur (Bheraghat) ; *H. Khajuria* coll. ; 9. 8. 74. (vii) A vial with 2S. & 5W. ; Jabalpur (Madan Mahal) ; *D. K. Harshey* coll. ; 4. 9. 74.

Distributions : This species is common all over INDIA, PAKISTAN and BANGLA DESH. *Present records* : Madhya Pradesh : Jabalpur and vicinity ; Amkhas ; Konta Motor stand and vicinity and Kantu Galapalli (Bastar District).

14. **Odontotermes redemanni** (Wasmann)

1893. *Termes redemanni* Wasmann, *Wien. ent. Ztg.*, **12** (7) : 239. Im., Q., S., & W. *Type-loc.* SRI LANKA : Commobo.

Material : (i) A vial with 1S. & 5W ; Jabalpur (Saopatal) ; *L. P. Dubey* coll. ; 9. 10. 73. (ii) A vial with 1S. & 5W. ; Jabalpur (Madan Mahal) ; *H. Khajuria* coll. ; 18. 7. 69.

Distributions : (i) *Previous records* : INDIA : Himachal Pradesh ; Andhra Pradesh ; Uttar Pradesh ; Rajasthan ; Madhya Pradesh ; Maharashtra ; Karnataka ; Tamil Nadu ; Kerala ; Orissa ; West Bengal and Bihar. SRI LANKA : Whole of the Sri Lanka. (ii) *Present record* : INDIA : Madhya Pradesh : Jabalpur.

15. **Odonotermes wallonensis** (Wasmann)

1902. *Termes obesus* subsp. *wallonensis* Wasmann, *Zool. Jahrb. Abt. Syst.*, Jena, **17** (i), p. 106. *Type-loc*, ; INDIA : Wallon (Ahmadnagar Dist.).

Material : A vial with 5 Im ; Jabalpur (Madan Mahal) ; *B. S. Gurm* coll. ; 21. 6. 75.

Measurements (in mm. of 2 Im. from Jabalpur). Total body length without wings 11.5.-12.0 ; Head length to base of mandibles 1.80-1.83 : Max. width of head with eyes 2.22-2.24 ; Labrum length 0.53 ; width 0.78 ; Max. diameter of eyes 0.64 ; Min. diameter 0.53 ; Max. diameter of ocellus 0.28 ; Min. diameter 0.23 ; Min. eye ocellus distance 0.83 ; Antennal segments 19.

Distributions : (i) *Previous records* : INDIA : Andhra Pradesh ; Bihar ; Gujarat ; Maharashtra ; Uttar Pradesh ; Rajasthan ; Orissa and Tamil Nadu. (ii) *Present record* ; INDIA : Madhya Pradesh : Jabalpur.

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We are thankful to Dr. T. N. Ananthakrishnan, Director, Zoological Survey of India, Calcutta, for encouragement in termite work, to Dr. B. S. Lamba, Deputy Director, Zoological Survey of India, Dehra Dun, for facilities and procuring this material for our study. We are also grateful to Dr. M. L. Roonwal, Emeritus Scientist, Zoological Survey of India, Jodhpur and Dr. O. B. Chhotani, Superintending Zoologist, Zoological Survey of India, Calcutta, for useful suggestions. Finally we are thankful to Dr. H. Khajuria, Deputy Director (now at Solan), Zoological Survey of India, Jabalpur, for placing this material for our study.

SUMMARY

Eighteen species of termites (Insecta : Isoptera) are reported from Madhya Pradesh. The six species of termites, i. e., *Coptotermes kishori* Roonwal & Chhotani, *Speculitermes goesswaldi* Roonwal & Chhotani ; *Microcerotermes sakesarensis* Ahmad ; *Odontotermes boveni* Thakur ; *Odontotermes wallonensis* (Wasmann) ; and *Trinervitermes nigrirostris* Mathur & Sen Sarma, are reported first time from Madhya Pradesh.

Rec. zool. Surv. India, 79 : 319-342,

ON SOME SCELIONIDAE (PROCTOTRUPOIDEA : HYMENOPTERA) FROM INDIA*

By

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(With 12 Text-figures)

INTRODUCTION

This paper deals with thirteen species of Scelionidae from India, collected by Dr. M. S. Mani and party, in the course of Field Surveys with PL-480 financial grant by the U. S. Department of Agriculture. Of the thirteen species dealtwith here, nine are described as new, one known species has been redescribed and additional distributional data for other three species are also included. The type specimens are for the present retained in the School of Entomology, pending final disposal.

My thanks are extended to Dr. Lubomir Masner, Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario, Canada, for help in interpretation of the species of *Gryon*. I also express my cordial thanks to Prof. M. S. Mani, for guidance and encouragement.

1. **Anteromorpha glabra** sp. nov.

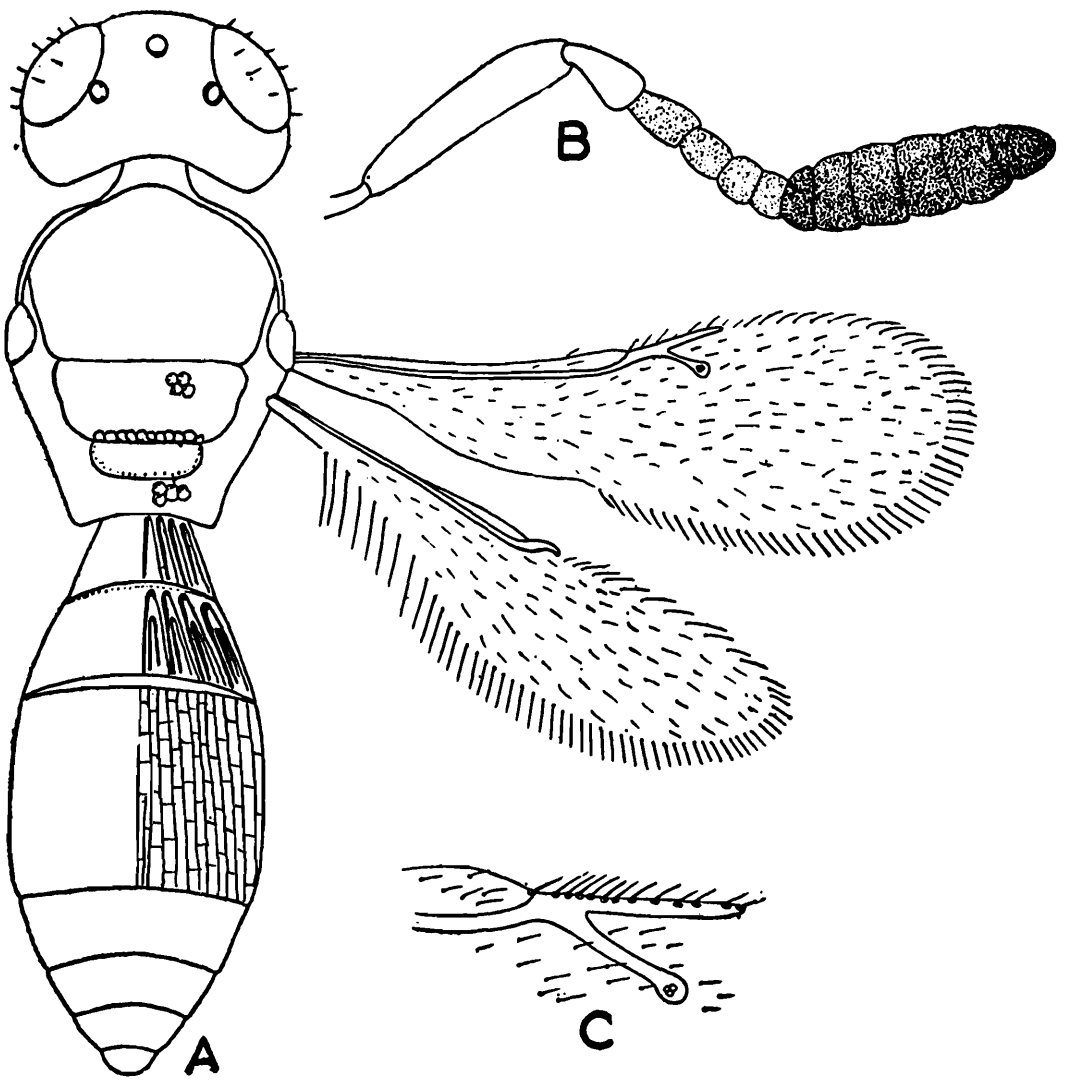
(Text-fig. 1)

Female : Body length of holotype 2.00 mm (range 2.00-2.10 mm) ; fore wing 1.36 mm, reaching to sixth tergite ; hind wing 1.22 mm ; abdomen 1.12 mm. Head black ; eyes black with brown tinge ; scape and pedicel brown, funicular segments brownish-black, club black ; scutellum and metanotum very dark brown, rest of thorax ferruginous brown ; legs yellowish-brown ; wings faintly brown ; abdomen brownish-black, somewhat darkened at the tip.

Head as wide as thorax ; frons without impression ; viewed from above (Text-fig. 1 A) length to width 26 : 15 ; seen laterally higher than long ; vertex reticulately punctate : frons reticulately striate and with punctae, with silvery-white hairs ; occiput strongly sinuate, margined ; mandibles long, bidentate ; lateral ocelli contiguous with the eyes, front ocellar space about 3.00 times the ocellar diameter, interocellar space about 4.00 times the ocellar diameter ; eyes with short, conspicuous

*Contribution No. 265 from the School of Entomology, St. John's College, Agra-282002.

hairs, eye to head length 12 : 15. *Antenna* (Text-fig. 1 B) to body length 43 : 100 ; segments 12, 1.1.4.6 ; scape 4.00 times as long as thick, equal to the following four segments combined ; pedicel somewhat less than twice as long as thick, 0.33 of the scape ; first funicular segment slightly shorter than pedicel, 1.70 times as long as thick ; second segment 1.25 times as long as thick, 0.70 of the first ; third globose, somewhat shorter than second ; fourth subglobose, very slightly shorter



Text-fig. 1. *Anteromorpha glabra* sp. nov. Female A. body dorsal view, B. antenna, C. veins enlarged.

than third ; club segments transverse except the terminal segment being oval ; first segment half of its width, nearly equal to preceding segment ; segment second somewhat longer than first, nearly half of its width ; segments third to fifth subequal, 0.62 of their width, slightly longer than second ; terminal segment as long as wide, 1.40 times the preceding segment.

Thorax (Text-fig. 1 A) length to width 33 : 16 ; with white pubescence ; notauli absent ; mesonotum to scutellum 17 : 9 ; mesonotum

minutely punctate ; scutellum semi-circular, unarmed, punctate ; metanotum medially expanded to form a plate that is slightly wider in the middle than at sides, with hexagonal reticulations ; propodeum reticulately striate in middle, matt laterally. *Fore wing* (Text-fig. 1 A & C) length to width 68 : 21 ; venation *sm* : *m* : *pm* : *st* 33 : 3 : 5 : 5 ; basalis absent ; marginal fringe well developed. *Hind wing* (Text-fig. 1 A) to fore wing 61 : 68 ; length to width 61 : 13.

Abdomen (Text-fig. 1 A) to body 56 : 100 ; segments 7 ; length to width 56 : 21 ; fusiform ; first, second and third tergites 7 : 8 : 22 ; first tergite without tubercle ; first and second tergites longitudinally striate ; third tergite finely, reticulately, longitudinally striate ; other tergites smooth, matt, with scattered white pubescence and setigerous punctures.

Holotype : Female mounted on card, 20.11. Maldare Teak Forest : Karnataka Survey, Coll. *M. S. Mani, S. K. Sharma & G. G. Saraswat*, 25.v.-1,6.vi. 1978. *Paratypes* : 1 female on card, with same data as for holotype ; 2 females on cards, 20.13 Hudukeri, other data as for holotype.

This species differs from *A. deccanensis* Sharma[1], in general body colour ; frons being reticulately striate ; metanotum not like a subtriangular plate but with a simple plate ; sculpture of third and other tergites also differ.

2. **Calliscelio coorgensis** sp. nov.

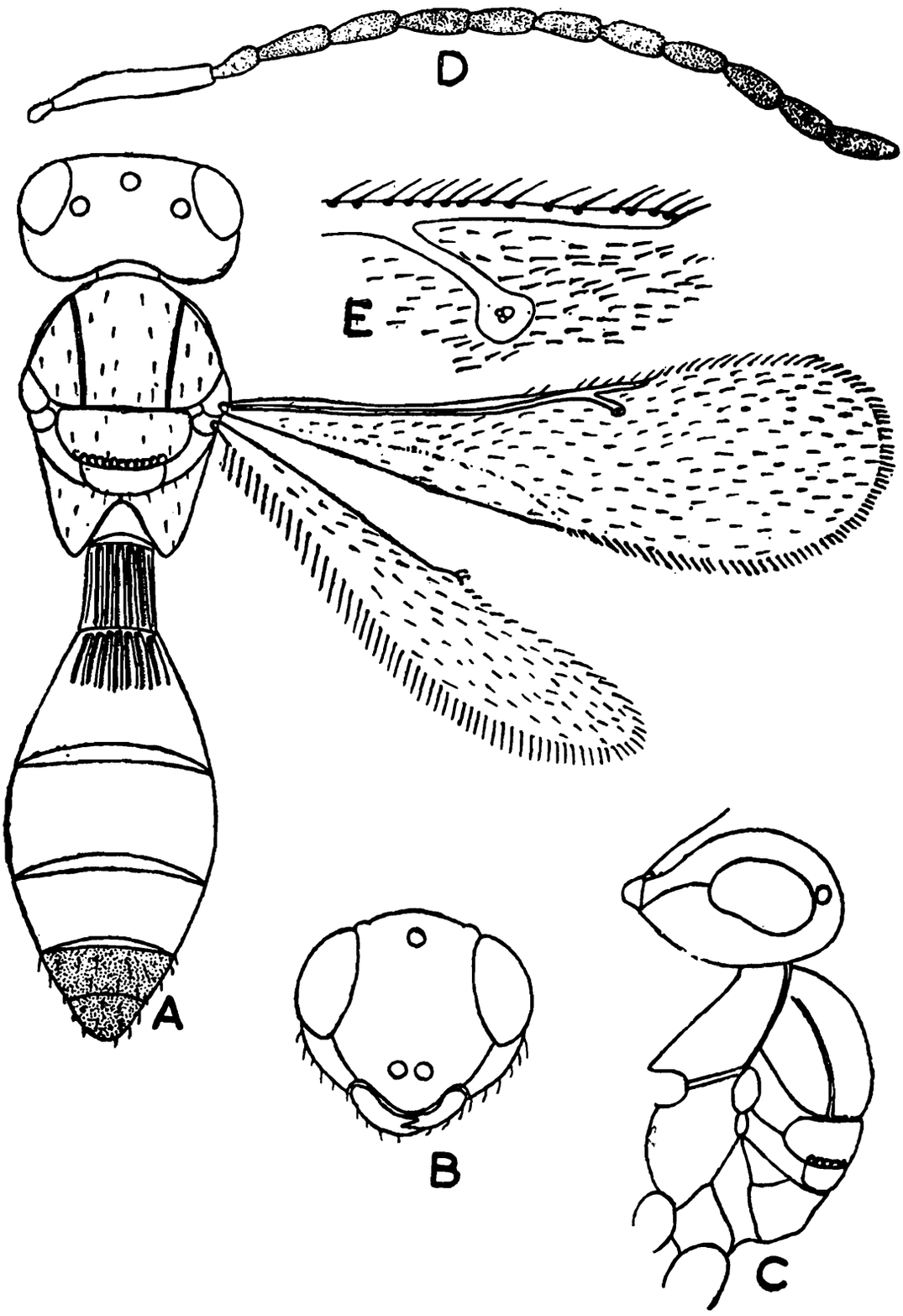
(Text-fig. 2)

Male : Body length 3.20 mm ; fore wing surpassing the abdomen, 2.20 mm ; hind wing 1.90 mm ; abdomen 1.80 mm. General colour of body yellowish-brown except last two black tergites ; eyes black ; ocelli blackish ; scape yellowish-brown, pedicel brownish-black, rest of antennal segments black ; wings hyaline, veins brown ; legs yellowish-brown.

Head somewhat wider than thorax ; sub-quadrate ; frons without fovea, with minute shallow well separated punctae ; vertex matt, with leathery sculpture and fine pubescence ; gena smooth, shiny, with distinct carina and fine pubescence ; mandibles tridentate ; viewed from above (Text-fig. 2 A) length to width 40 : 20 ; seen from front (Text-fig. 2 B) length to width 36 : 40 ; seen laterally (Text-fig. 2 C) somewhat higher than long ; ocellocular space nearly half the ocellar diameter, front ocellar space somewhat more than twice the ocellar diameter, interocellar space 5.00 times the ocellar diameter ; eyes bare,

1 Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 20.

oval, eye to head length (Text-fig. 2 A) 15 : 20. *Antenna* (Text-fig. 2 D) to body 100 : 160 ; antennal hairs much shorter than the thickness of segments ; segments 12, 1.1.9.1 ; scape cylindrical, somewhat more than



Text-fig. 2. *Calliscelio coorgensis* sp. nov. Male. A. body dorsal view, B. head front view, C. head and thorax in profile, D. antenna, E. veins enlarged.

5.00 times as long as thick, subequal to 2.75 of the following segments combined ; pedicel twice as long as thick, 0.30 of the scape ; first funicular segment longer than the following segments except the terminal,

2.57 times as long as thick, 1.50 times the pedicel ; segments 2-9 subequal, gradually becoming slightly shorter, 2.60 times as long as thick, 0.90 of the first ; terminal segment 3.00 times as long as thick, 1.12 times the preceding segment.

Thorax viewed dorsally (Text-fig. 2, A) length to width 45 : 35 ; with close, minute, shallow punctae ; notauli distinct, complete, widely separated behind and slightly diverging in front ; mesoscutum to scutellum 25 : 10, with scattered setigerous punctures ; scutellum unarmed, rounded behind, with a row of sulci ; mesopleura obscurely transversely rugulose ; metanotum lamellate, lamella medially wider than at the sides, with white pubescence ; propodeum with a 'Λ'-shaped carina, forked behind and with dense, white, short pubescence. *Fore wing* (Text-fig. 2 A & E) length to width 110 : 34 ; venation *sm* : *m* : *pm* : *st* 55 : 4 : 9 : 6 ; basalis absent ; discal ciliation well developed ; marginal fringe short. *Hind wing* (Text-fig. 2 A) to fore wing 86 : 100 ; length to width 100 : 18.

Abdomen (Text-fig. 2 A) to body 100 : 177 ; fusiform ; first tergite cylindrical, slender, somewhat longer than wide, longitudinally striate, with white pubescence ; first, second and third tergites 15 : 23 : 18 ; second tergite basally longitudinally striate, otherwise smooth and shiny ; other tergites smooth and shiny, with scattered setigerous punctures ; conspicuous silvery-white hairs on the last two tergites.

Holotype : Male mounted on card, *paratype* 1 male on card, 20.6. Walayar Forest : Kerala (South India), Coll. *M. S. Mani & S. K. Sharma*, 9-11. v. 1976.

Differs from *C. orientalis* Sharma[1], in body colour ; vertex not aciculately punctate but matt ; gena without punctae ; mesoscutum and scutellum not smooth but with shallow punctae ; *pm* being shorter ; second tergite not completely longitudinally striate. This species also differs from *C. coromandelensis* Sharma[2], in body colour not being black ; vertex and gena not punctate ; frons above antennal sockets without fine transverse striations.

3. **Calliscelio orientalis** Sharma

1978. *Calliscelio orientalis* Sharma, In : Saraswat & Sharma. *Mem. Sch. Ent.*, **5** : 34, figs. 17-18.

This species was originally described from material mounted on slides. I have since then before me additional material mounted on cards.

1. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 36.
2. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 32.

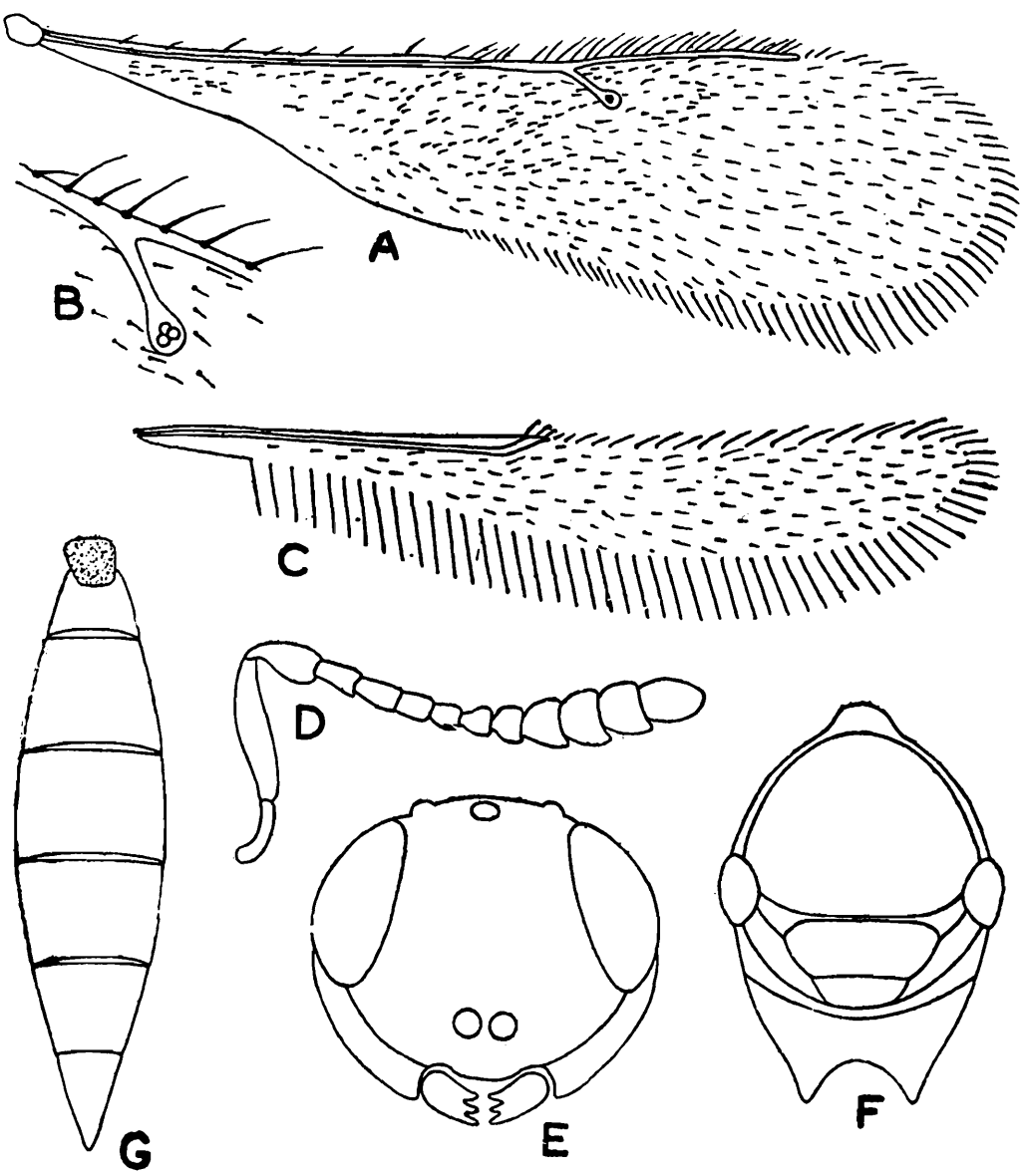
The original description may be amended to read that the metanotum is expended in a lamina medially wider than at sides.

Material studied : 3 females and 4 males on cards, 20. 9. Attur Reserve Forest ; 2 females and 8 males on cards, 20.11. Maldare Teak Forest ; 1 male on card, 20.12. Dubare Forest, Karnataka Survey, Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 20. v.-10. vi. 1978.

4. **Calotelea immaculata** sp. nov.

(Text-figs. 3 & 4)

Female : Body length 1.82 mm ; fore wing 1.18 mm ; hind wing 1.04 mm ; abdomen 1.20 mm. General colour of body yellowish-brown



Text-fig. 3. *Calotelea immaculata* sp. nov. Female. A. fore wing, B. veins enlarged, C. hind wing, D. antenna, E. head front view, F. thorax, G. abdomen.

except the head being black ; eyes blackish-brown ; antennae light brown except for the dark brown pedicel and club ; wings hyaline ; legs

yellowish ; tubercle, sixth and seventh tergites blackish-brown, fifth brown, other tergites yellowish-brown.

Head as wide as thorax ; vertex smooth and shiny ; frons without impression, minutely and closely punctate ; gena longitudinally striate ; mandibles tridentate with small middle tooth ; viewed from front (Text-fig. 3 E) length to width 30 : 25 ; lateral ocelli contiguous to the eyes, front ocellar space 1.50 times the ocellar diameter, interocellar space more than 4.00 times the ocellar diameter ; eyes naked, eye to head length 10 : 15. *Antenna* (Text-fig. 3 D) to body 38 : 100 ; segments 12, 1.1.5.5 ; scape cylindrical, 4.65 times as long as thick, subequal to following two segments combined ; pedicel 2.66 times as long as thick, 0.57 of the scape ; funicular segments first and second subequal, longer, twice as long as thick, 0.60 of the pedicel ; third segment less than twice as long as thick, somewhat shorter than preceding segment ; club transverse except the terminal ; first segment slightly wider than long, subequal to preceding segment ; second segment as long as wide, 1.33 times the first ; segments third and fourth subequal, slightly wider than long, somewhat longer than second ; terminal segment oval, 1.30 times as long as thick, somewhat longer than preceding segment.

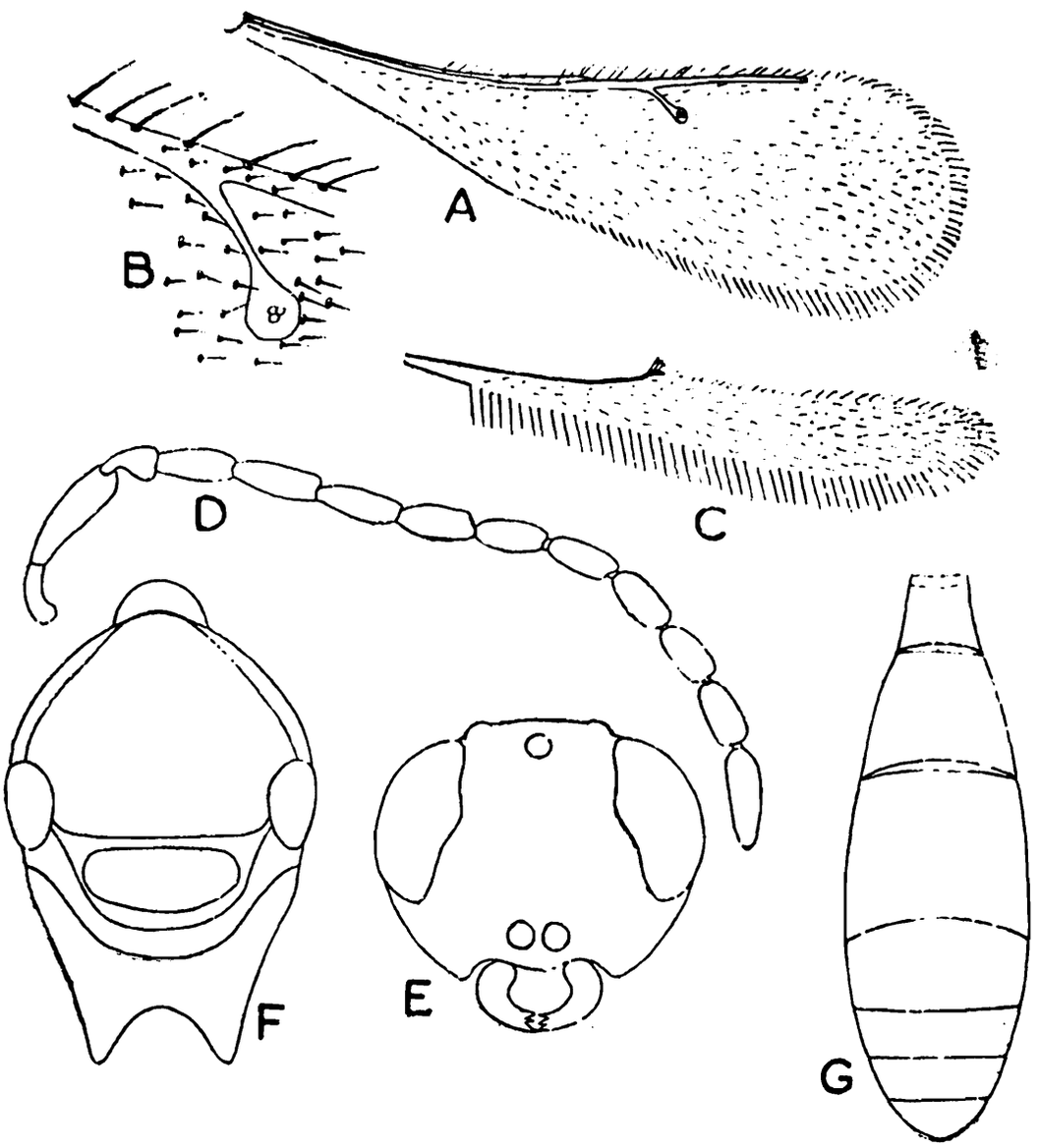
Thorax (Text-fig. 3 F) length to width 22 : 17 ; smooth and shiny ; notauli absent ; mesonotum to scutellum 12 : 4 ; metanotum and propodeum unarmed. *Fore wing* (Text-fig. 3 A & B) narrow, elongate and unspotted ; length to width 100 : 26 ; venation *sm* : *m* : *pm* : *st* 28 : 5 : 15 : 3. 5 ; basalis absent. *Hind wing* (Text-fig. 3 C) to fore wing 88 : 100 ; length to width 100 : 15.

Abdomen (Text-fig. 3 G) to body about 50 : 100 ; first tergite with a short, broad tubercle and with fine longitudinal striations ; rest of abdomen smooth and shiny ; first, second, third and fourth tergites 9 : 11 : 11 : 10.

Male : Body length 1.76 mm ; fore wing 1.24 mm ; hind wing 1.10 mm ; abdomen 0.96 mm. General colour of body yellowish-brown ; head yellow ; eyes blackish-brown ; scape yellowish-brown, rest of antennae blackish-brown ; thorax brown ; legs yellowish-brown ; wings faintly yellow ; first, second and third tergites yellow, with black patches at sides in second and third, rest of abdomen black.

Head as wide as thorax ; viewed from front (Text-fig. 4 E) length to width 15 : 19 ; frons finely punctate ; vertex smooth and shiny ; gena finely longitudinally striate ; lateral ocelli close to the eyes, front ocellar space nearly equal to the ocellar diameter, interocellar space about 3.00 times the ocellar diameter ; mandibles tridentate ; eyes bare, eye to head length 9.5 : 15. *Antenna* (Text-fig. 4 D) to body 65 : 100 ;

segments 12, 1.1.9. 1 ; scape cylindrical, somewhat thicker apically, 3.50 times as long as thick, subequal to following two segments combined ; pedicel 1.50 times as long as thick, 0.43 of the scape ; first funicular segment twice as long as thick, 1.33 times the pedicel ; second segment 2.50 times as long as thick, 1.25 times the first ; third segment somewhat more than twice as long as thick, slightly shorter than second ;



Text-fig. 4. *Calotelea immaculata* sp. nov. Male. A. fore wing, B. Veins enlarged, C. hind wing, D. antenna, E. head front view, F. thorax, G. abdomen.

segments 4-9 subequal, about 2.00 times as long as thick, slightly shorter than preceding segment ; terminal segment 3.00 times as long as thick, 1.50 times the preceding segment.

Thorax (Text-fig. 4 F) length to width 27 : 15 ; notauli absent ; mesonotum to scutellum 13 : 5, smooth and shiny ; scutellum unarmed ; metanotum and propodeum unarmed. *Fore wing* (Text-fig. 4A & B) length to width 100 : 29 ; narrow, elongate ; venation *sm* : *m* : *pm* ; *st* 29 : 6 ;

11 : 4 ; basalis indicated by brown discolouration. *Hind wing* (Text-fig. 4 C) to fore wing 88 : 100.

Abdomen (Text-fig. 4 G) to rest of body 50 : 40 ; 7 segmented ; first tergite without tubercle, longitudinally striate ; second tergite smooth and shiny except the impressed area in front with short striae ; other tergites smooth and shiny ; first, second and third tergites 6 : 9 : 13.

Holotype : Female mounted on slide, 17.6. Kollimalai Hills : Eastern Ghats Survey, Coll. *M. S. Mani & S. K Sharma*, 20. i-3. ii. 1977. *Allotype* : Male mounted on slide, with same data as for holotype.

This species differs from *C. auriventria* Sharma[1], in *m* being longer than *st* ; fore wing without brown transverse band.

5. **Gryon fulviventris** (Crawford)

1912. *Hadronotus fulviventris* Crawford, *Proc. U. S. nat. Mus.*, **42** : 2.

I have before me 1 female labelled as "17.8. Hogenakal ; Karnataka, Coll. *S. K. Sharma & G. G. Saraswat*, 1. ii. 1976" ; 4 females labelled as "9.15. Thanjavur, 9.9. Achankovil, 9. 1. Mallapuram, Cardomom Hills, Coll. *M. S. Mani & party*, 1-15. iv. 1973" ; 1 female labelled as "20.12. Dubare : Karnataka Survey, Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 26-v. 4-7.-vi. 1978".

This species was originally described from Bangalore as parasitic on the eggs of *Clavigralla gibbosa*. The identification of this species was confirmed by Dr. Masner.

6. **Gryon gonikopalensis**. sp. nov.

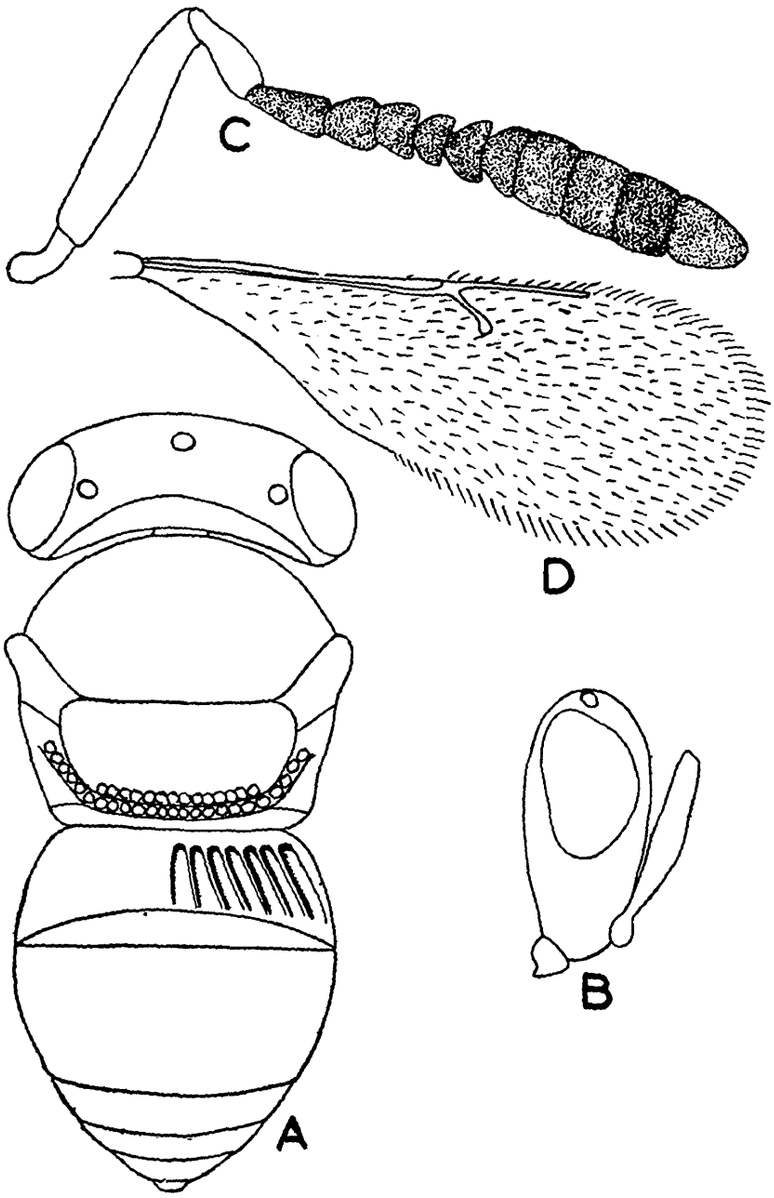
(Text-fig. 5)

Female : Body length 1.68 mm ; fore wing 1.36 mm ; abdomen 0.80 mm. General colour of body black ; eyes brownish-black ; scape and pedicel brown, rest of antennae black ; wings hyaline, veins brown ; legs brown except the black coxae.

Head transverse, as wide as thorax ; vertex and frons very finely, minutely and closely reticulate ; gena with very fine, longitudinal striations and with scattered pubescence ; scrobe shallow, obscurely defared with a fine median longitudinal carina, on the sides of carina reticulately transverse striations ; viewed from above (Text-fig. 5 A) length to width 33 : 100 ; seen laterally (Text-fig. 5 B) length to height 16 : 30 ; viewed from front somewhat wider than long ; lateral ocelli close to eyes,

1. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 40.

interocellar space about 7.00 times the ocellar diameter, front ocellar space about 4.00 times the ocellar diameter ; eyes perfectly bare, oval. *Antenna* (Text-fig. 5 C) to body 60 : 100 ; segments 12, 1.1,4.6 ; scape cylindrical, 5.50 times as long as thick, equal to following six segments combined ; pedicel somewhat more than twice as long as thick, 0.30 of



Text-fig. 5. *Gryon gonikopalensis* sp. nov. Female. A. body dorsal view, B. head in profile, C. antenna, D. fore wing.

the scape ; first funicular segment 1.50 times as long as thick, 0.60 of the pedicel ; second segment slightly shorter than first, somewhat longer than wide ; third transverse, somewhat wider than long, 0.80 of the second ; fourth segment transverse, 1.50 times as wide as long, 0.80 of the preceding segment ; club segments transverse except the terminal ; first and second segments subequal, 1.50 times as wide as long, equal to preceding segment ; segments third to fifth subequal,

1.33 times as wide as long, 1.50 times the preceding segment ; terminal segment oval, 1.28 times as long as thick, 1.66 times the preceding segment.

Thorax with short white pubescence ; seen from above (Text-fig. 5 A) depressed, length to width 32 : 36 ; seen laterally somewhat wider than high ; notauli absent ; mesonotum to scutellum 18 : 13, finely reticulate ; scutellum semi-circular, elevated ; mesopleura with double row of well separated minute punctae ; metanotum very narrow, strip-like, with a row of sulci. *Fore wing* (Text-fig. 5 D) length to width 100 : 48 ; venation *sm* : *m* : *pm* : *st* 64 : 4 : 24 : 11 ; *sm* reaching nearly half the front margin of wing ; *m* punctiform ; other veins absent ; marginal fringe short ; discal ciliation well developed.

Abdomen (Text-fig. 5 A) to rest of body 40 : 44 ; length to width 40 : 35 ; seen laterally height to width 20 : 40 ; first tergite very finely longitudinally striate ; second tergite largest, anteriorly with fine longitudinal striations, posteriorly minutely, closely punctate ; third tergite anteriorly with close minute punctae ; other tergites narrow.

Holotype : Female mounted on card, 14. 4. Gonikopal : Western Ghats Survey, Coll. *M. S. Mani & party*, 12. iii. 1975.

7. **Gryon hogenakalensis** sp. nov.

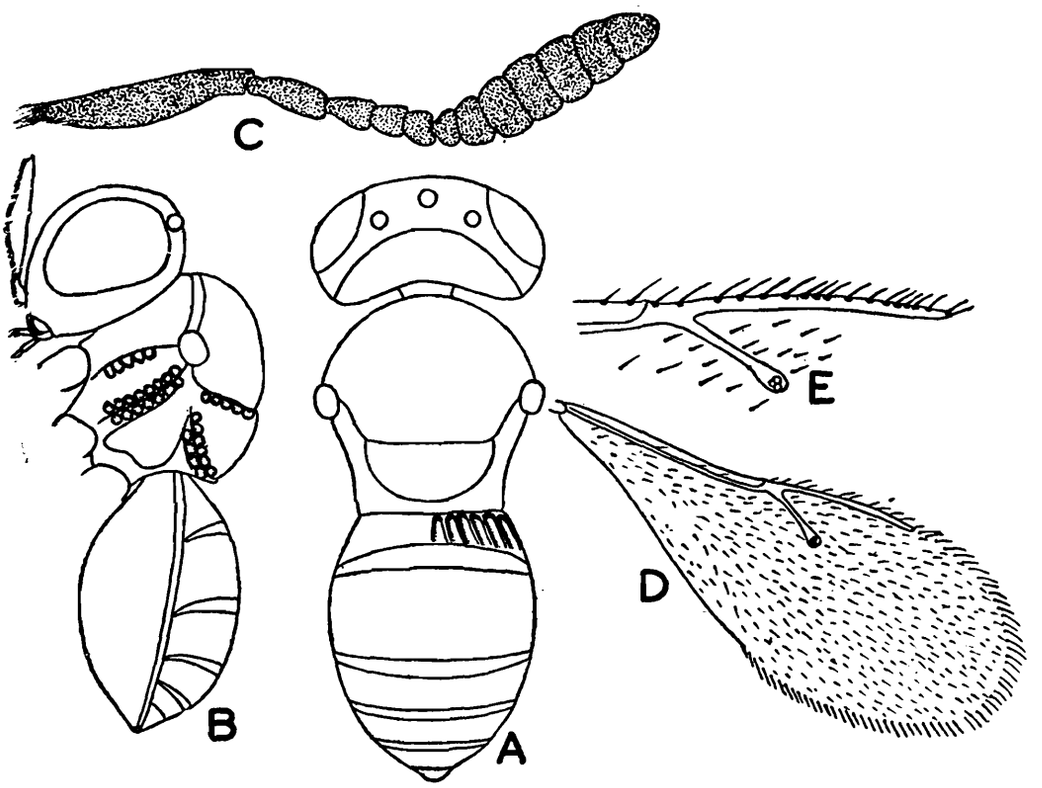
(Text-fig. 6)

Female : Body length 1.36 mm ; forewing 1.20 mm ; hind wing 0.80 mm ; abdomen 0.64 mm. General colour of body black ; eyes brownish-black ; antennae black, scape at the base brown ; coxae and femora black, tibia and tarsus brown ; wings hyaline.

Head slightly wider than thorax ; viewed dorsally (Text-fig. 6 A) length to width 12 : 26 ; seen laterally (Text-fig. 6 B) length to height 16 : 23 ; frons without fovea ; vertex strongly margined behind ; head finely, closely, minutely reticulate ; gena finely reticulate ; ocellocular space slightly less than the ocellar diameter, front ocellar space 2.50 times the ocellar diameter, interocellar space about 5.00 times the ocellar diameter ; eyes oval, perfectly bare. *Antenna* (Text-fig. 6 C) to body 60 : 100 ; segments 12, 1.1.4. 6 ; scape long, slightly thickens in middle, cylindrical, about 5.00 times as long as thick, slightly more than following five segments combined ; pedicel 2.25 times as long as thick, 0.32 of the scape ; first funicular segment 1.50 times as long as thick, 0.66 of the pedicel ; second segment as long as thick, 0.66 of the first ; third and fourth segments subequal, subglobose, somewhat thicker than long, slightly shorter than second ; club segments transverse except the last, equal

to scape ; first segment 0.80 of its width, 1.33 times the preceding segment ; segments second to fifth subequal, 1.40 times as wide as long, slightly longer than preceding segment ; terminal segment oval, slightly longer than preceding segment.

Thorax seen dorsally (Text-fig. 6 A) length to width 26 : 25 ; seen laterally (Text-fig. 6 B) slightly higher than wide ; notauli absent ;



Text-fig. 6. *Gryon hogenakalensis* sp. nov. Female A. body dorsal view, B. body in profile. C. antnena, D. fore wing, E. veins enlarged.

mesonotum to scutellum 18 : 10, with fine reticulate sculpture ; mesopleura with scattered punctae ; metanotum very narrow. *Fore wing* (Text-fig. 6 D & E) length to width 60 : 23 ; venation *sm* : *m* : *pm* : *st* 25 : 3 : 15 : 7.5 ; other veins absent ; marginal fringe short ; fore wing to hind wing 60 : 40.

Abdomen (Text-fig. 6 A & B) to rest of body 32 : 36 ; length to width 32 : 25 ; abdomen dorsoventrally bulging ; first tergite longitudinally striate ; second and third tergites closely, minutely, reticulate ; other tergites with very fine sculpture and with scattered setigerous punctures ; second tergite largest.

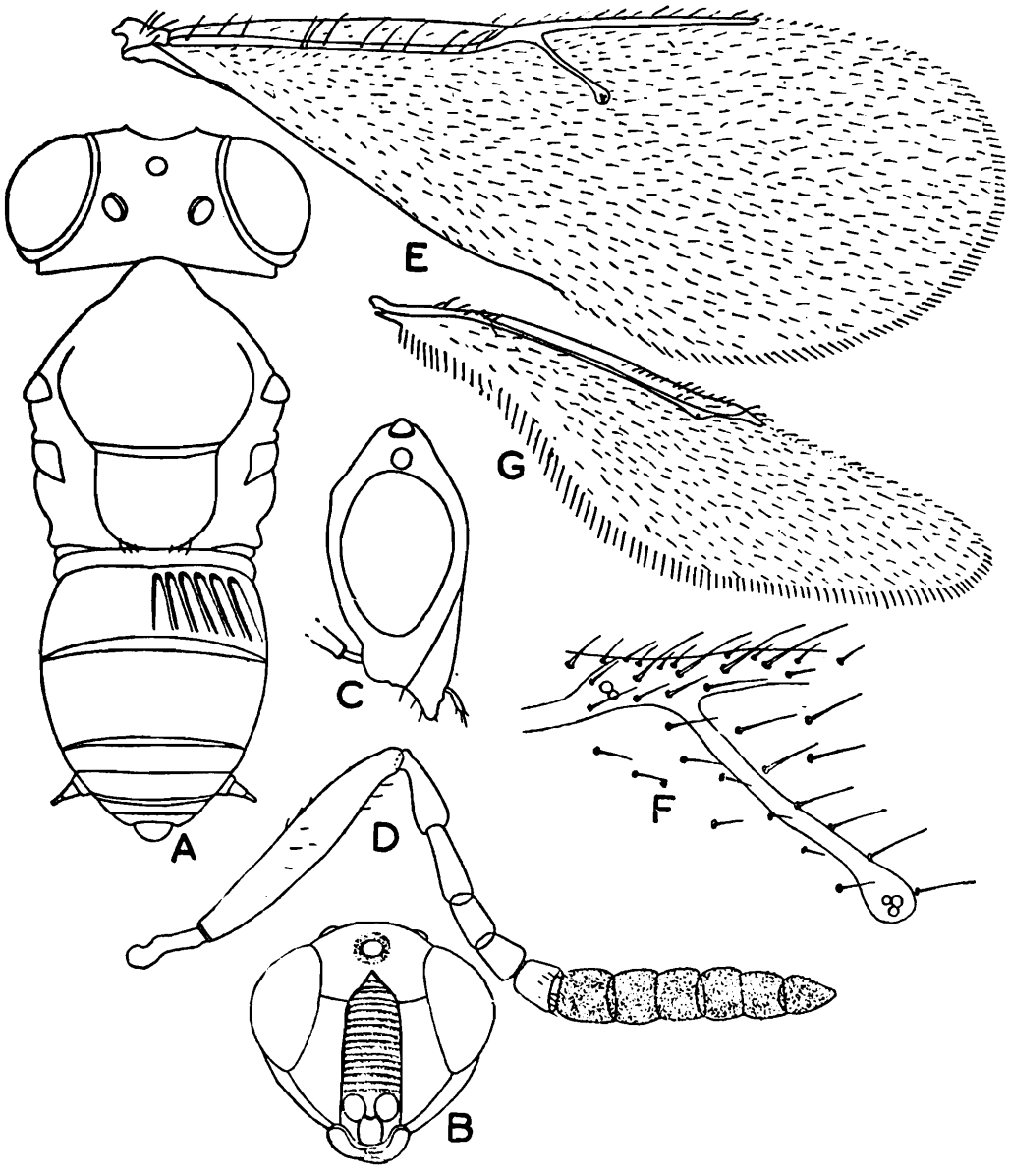
Holotype : Female mounted on card, 17.8. Hogenakal : Karnataka (Eastern Ghats Survey), Coll. *S. K. Sharma & G. G. Saraswat*, 1. ii. 1977. *Other material examined* : 2 females on cards, labelled as "9. 1. Mallapuram and 9.9. Achankovil, Cardamom Hills, Coll. *M. S. Mani* & *party*, 1-5. iv. 1973."

8. **Gryon homoeoceri** (Nixon)

(Text-fig. 7)

1934. *Hadronotus homoeoceri* Nixon, *Stylops* (B) **3** : 4.

I have before me 2 females (wings and antenna of 1 female on slide, the rest on card strips) labelled as "12.4. Ponmudi : Kerala Survey, Coll. *M. S. Mani & party*, 23. viii. 1974", which apparently belong to this species (this view is shared by Dr. Masner in a letter). The species was originally described from Java as parasitic in the eggs of



Text-fig. 7. *Gryon homoeoceri* (Nixon). Female A. body dorsal view, B. head front view, C. head in profile, D. antenna, E. fore wing, F. veins larged, G. hind wing.

Homoeocerus marginellus. This is the first record of the species from India. The original description by Nixon is not complete and the following additional notes may be useful.

Female : Body length 2.24 mm ; fore wing 2.00 mm ; hind wing 1.60 mm ; abdomen 1.00 mm. General colour of body black ; eyes blackish-brown ; scape brown, antennal segments second to sixth brown with blackish tinge, rest of antennal segments black : wings hyaline, veins yellowish-brown ; coxae black, rest of legs brown.

Head transverse, with scattered moderate silvery-white pubescence ; wider than thorax (51 : 47) ; scrobe deep, coarsely, transversely striate and strongly carinately margined, connected by a transverse carina above with the eye ; vertex coarsely reticulate, with the carinae ring round the front ocellus ; frons on either side of scrobe transversely rugose ; sculpture of gena like that of frons ; viewed from above (Text-fig. 7 A) length to width 23 : 51 ; seen from front (Text-fig. 7 B) globose; seen laterally (Text-fig. 7C) higher than long; ocelli very conspicuous, ocellocular space somewhat less than half the ocellar diameter, front ocellar space slightly less than twice the ocellar diameter, interocellar space 3.30 times the ocellar diameter ; eyes oval, naked. *Antenna* (Text-fig. 7 D) to body 74 : 100 ; segments 12, 1.1.4.6 ; scape cylindrical, slightly thickened in the middle, 6.00 times as long as thick, equal to 4.50 of the following segments combined ; pedicel 2.70 times as long as thick, 0.31 of the scape ; first funicular segment 3.00 times as long as thick, somewhat shorter than pedicel ; second segment 2.00 times as long as thick, 0.67 of the first ; third segment 0.80 of the second, 1.33 times as long as thick ; fourth segment quadrate, equal to third ; club segments transverse except the first and terminal segments ; first segment somewhat longer than wide, 1.20 times the preceding segment ; segments second and third subequal, slightly wider than long, 0.80 of the first ; fourth very slightly wider than long, nearly equal to the preceding segment ; fifth quadrate, equal to fourth ; terminal segment oval, 1.60 times as long as thick, very slightly longer than preceding segment.

Thorax (Text-fig. 7 A) with moderate silvery-white pubescence ; seen laterally somewhat higher than wide ; notauli absent ; mesonotum to scutellum 25 : 18, reticulately rugose ; scutellum strongly convex, rounded behind, unarmed, overlapping the metanotum, elevated ; mesopleura reticulately rugose ; metanotum narrow, strip like. *Fore wing* (Text-fig. 7 E & F) length to width 100 : 41 ; venation *sm* : *m* : *pm* : *st* 45 : 5 : 25 : 12 ; other veins absent ; marginal fringe short ; discal ciliation moderate. *Hind wing* (Text-fig. 7 G) to fore wing 80 : 100 ; length to width 100 : 26.

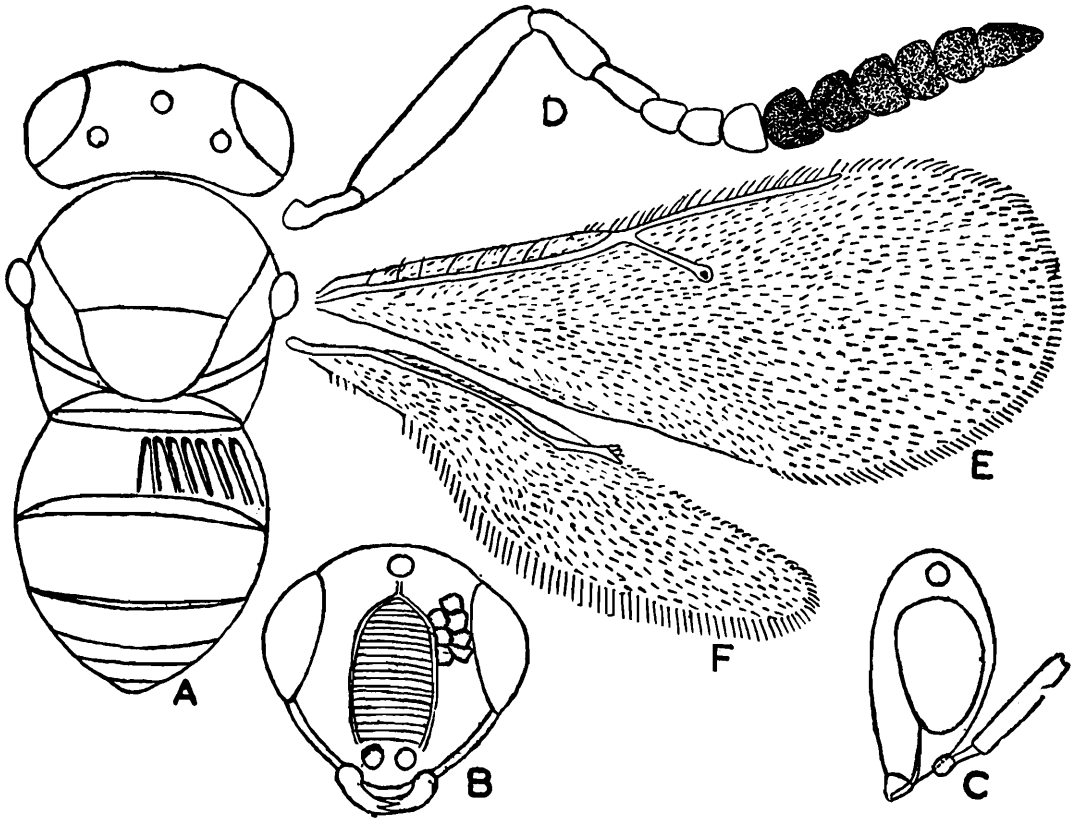
Abdomen (Text-fig. 7 A) to body 50 : 12 ; length to width 100 : 84 ; first tergite coarsely longitudinally striate, posterior margin smooth and shiny ; second tergite reticulately striate ; other tergites matt ; first, second and third tergites 14 : 18 : 16.

9. **Gryon krishnagiriensis** sp. nov.

(Text-fig. 8)

Female : Body length of holotype 1.80 mm, range 1.80-2.00 mm ; fore wing 1.70 mm ; hind wing 1.34 mm ; abdomen 0.76 mm. General colour of body black ; eyes brownish-black ; club black, rest of antennal segments brown ; legs brown , coxae dark brown ; wings hyaline.

Head very slightly wider than thorax ; frons and vertex with striations and reticulately rugose ; frontal scrobe finely transversely striate and margined laterally with keels ; with a conspicuous transverse carina between the lateral ocelli ; gena rugose ; viewed in front (Text-fig. 8 B) length to width 87 : 100 ; seen from above (Text-fig. 8 A) length to



Text-fig. 8. *Gryon krishnagiriensis* sp. nov. Female A. body dorsal view. B. head front view, C. head in profile, D. antenna, F. fore wing, F. hind wing.

width 45 : 100; seen laterally (Text-fig. 8 C) higher than long ; ocellocular space equal to the ocellar diameter, front ocellar space twice the ocellar diameter, interocellar space about 5.00 times the ocellar diameter ; eyes oval, with very few scattered hairs. *Antenna* (Text-fig. 8 D) to body 100 : 150 ; segments 12, 1.1.4. 6 ; scape cylindrical, 5.50 times as long as thick, almost equal to following five segments combined ; pedicel about 2.40 times as long as thick, 0.30 of the scape ; first funicular segment longest, twice as long as thick, 0.66 of the pedicel ; second segment somewhat longer than thick, 0.75 of the first ; third segment

subequal to second, subequal in length and thickness ; fourth segment transverse, 0.83 of its thickness, subequal to third ; club segments transverse except the terminal ; segments 1-4 subequal, first being somewhat larger, 0.75 of their width, 1.20 times the preceding segment ; fifth segment 0.80 of its width, subequal to fourth ; terminal segment 1.66 times as long as thick, 1.66 times the preceding segment.

Thorax (Text-fig. 8 A) as long as wide ; clothed with short silvery-white pubescence ; notauli absent ; mesonotum to scutellum 17 : 12, coarsely reticulately sculptured ; scutellum semi-circular, extremely projecting behind over the metanotum and propodeum ; mesopleura transversely rugose ; metanotum narrow ; propodeum unarmed. *Fore wing* (Text-fig. 8 E) surpassing the abdomen ; length to width 100 : 40 ; *m* punctiform ; *pm* : *st* 100 :46; discal ciliation well developed ; marginal fringe short. *Hind wing* (Text-fig. 8 F) to fore wing 100 : 127 ; length to width 100 : 24.

Abdomen (Text-fig. 8 A) to body 42 : 100 ; length to width 37 : 35 ; first tergite longitudinally striate ; second tergite irregularly rugulose ; third tergite finely, closely, minutely reticulate ; rest of abdomen finely, closely reticulate ; first, second and third tergites 11 : 14 : 7.

Holotype : Female mounted on card, 5.24. Thana Hill : Krishnagiri-Bombay, Coll. *M. S. Mani & party*, 17-21. iv.1972. *Paratypes* : 13 females (7 specimens mounted on cards and 6 on slides), with same data as for holotype. *Other material examined* : 2 females, 5.11. Parikatti Hill : South India Survey, Coll. *M. S. Mani & party*, 26. iii. 1972 ; 2 females (one on slide), 14.9. Mudugeri : Western Ghats (Mysore-Coorg) Survey, Coll. *M. S. Mani & party*, 9-21. iii. 1975.

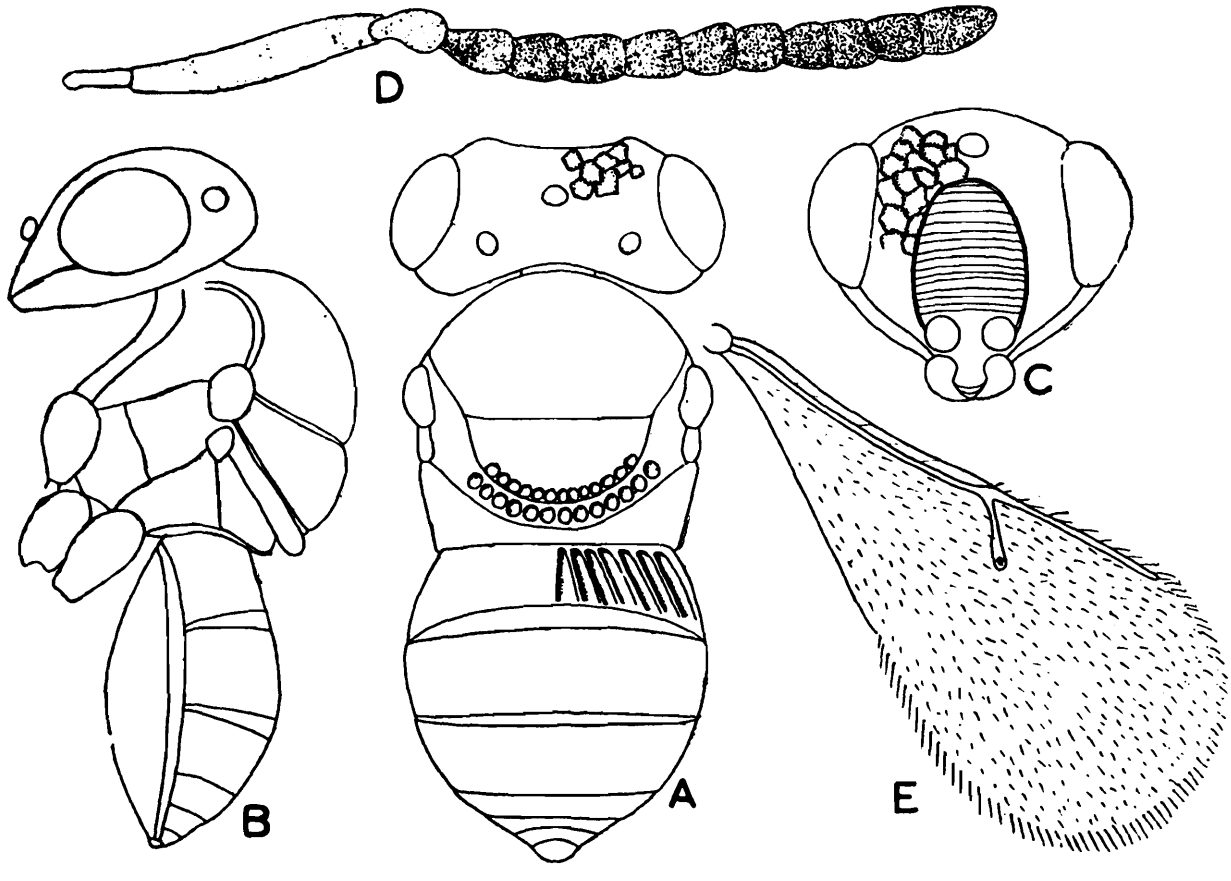
10. **Gryon mudugeriensis** sp. nov.

(Text-fig. 9)

Male : Body length 1.80 mm ; fore wing 1.60 mm ; hind wing 1.20 ; abdomen 0.74 mm. General colour of body black ; eyes black ; scape and pedicel brownish-black, rest of antennae black ; coxae and femora black, tibia and tarsus brown ; wings hyaline.

Head in front with a margined shallow scrobe, scrobe being transversely striate with a short median carina ; vertex and frons reticulately rugose, with scattered short silvery-white hairs ; gena rugosely punctate ; viewed from above (Text-fig. 9 A) length to width 15 : 38 ; viewed laterally (Text-fig. 9 B) length to height 22 : 32 ; viewed from front (Text-fig. 9 C) length to width 31 : 38 ; ocellocular space about 1.25 times the ocellar diameter, front ocellar space 2.50 times the ocellar diameter, interocellar

space 4.00 times the ocellar diameter ; eyes perfectly bare. *Antenna* (Text-fig. 9 D) to body 60 : 100 ; segments 12, 1.1.9.1 ; scape cylindrical, times as 5.00 long as thick, subequal to the following four segments combined ; pedicel 1.60 times as long as thick, 0.25 of the scape ; first funicular segment longest, 1.66 times longer than thick, 1.25 times the



Text-fig. 9. *Gryon mudugeriensis* sp. nov. Male A. body dorsal view, B. body in profile, C. head front view, D. antenna, E. fore wing.

pedicel ; funicular segments 2-9 almost subequal, nearly as long as thick, of the first ; terminal segment 2.00 times as long as thick, 1.66 times 0.65 the preceding segment.

Thorax nearly as wide as head ; seen dorsally (Text-fig. 9 A) length to width 35 : 40 ; seen laterally (Text-fig. 9 B) as high as long ; notauli absent ; mesonotum to scutellum 18 : 11, closely reticulately rugulose and with setigerous punctures ; scutellum unarmed, with a row of sulci along the posterior margin; mesopleura longitudinally rugose; metanotum narrow, strip like, with a row of sulci ; propodeum sculptured like the rest of thorax. *Fore wing* (Text-fig. 9 E) length to width 80 : 36 ; venation *sm* : *m* : *pm* ; *st* 35 : 3 : 20 : 10 ; *m* punctiform ; marginal fringe moderate ; fore wing to hind wing 100 : 75.

Abdomen (Text-fig. 9 A & B) 0.41 of the body ; length to width 38 : 34 ; abdomen dorso ventrally flattened ; tergites 7 ; firstt ergite with wide

longitudinal striations ; second and third tergites with close, irregular, longitudinal striations ; other tergites matt ; first, second and third tergites 9 : 13 : 10.

Holotype : Male mounted on card, 14.9. Mudugeri : Karnataka (Western Ghats Survey), Coll. *M. S. Mani & party*, 21. iii. 1975. *Paratype* : 1 male on card, with same data as for holotype. *Other material examined* : 2 males on cards, 9. 15. Thanjavur : Coramondal Coast, Coll. *M. S. Mani & party*, 5. v. 1973.

KEY TO SPECIES

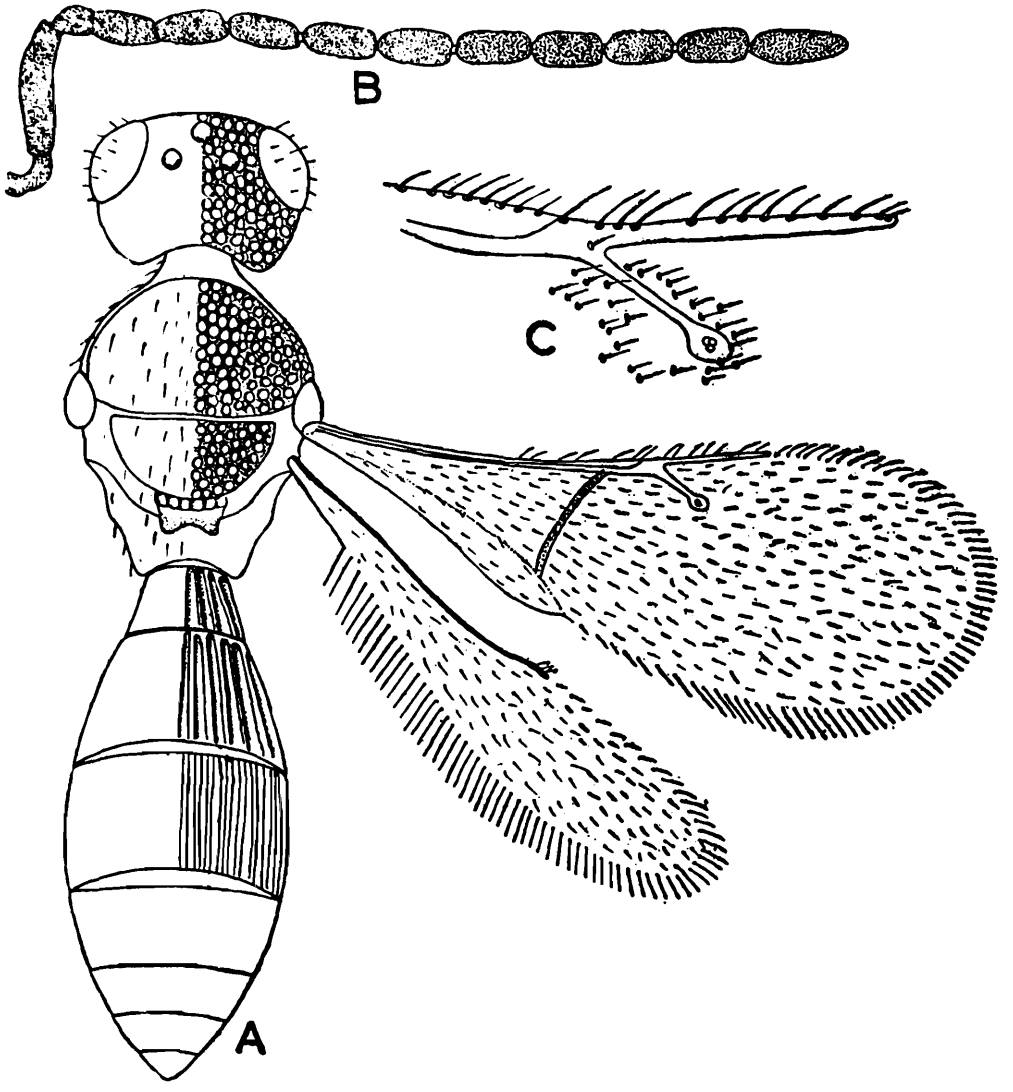
1.	General colour of body black ...	... 3
—	General colour of body not wholly black ...	... 2
2.	Reddish-brown ; antenna with 7 segments ...	*G. dunensis* Mani
—	Head and thorax black ; abdomen ferruginous ; antennae with 12 segments. ...	*G. fulviventris* (Crawford)
3.	Frons without conspicuous fovea ; mesopleura with scattered punctae ...	*G. hogenakalensis* sp. nov.
—	Frons with fovea ...	... 4
4.	Lateral ocelli with conspicuous carina ...	... 5
—	Lateral ocelli without carina ...	... 6
5.	Front ocellus with a carinate ring ; mesopleura reticulately rugose ...	*G. homoeoceri* (Nixon)
—	Front ocellus without carinate ring ; mesopleura transversely rugose ...	*G. krishnagiriensis* sp. nov.
6.	Mesopleura with a double row of well separated punctae ; second tergite anteriorly with fine longitudinal striations, posteriorly minutely, closely punctate ; third tergite anteriorly with close minute punctae ...	*G. gonikopalensis* sp. nov.
—	Mesopleura longitudinally rugose ; second and third tergites with close irregular longitudinal striations ...	*G. mudugeriensis* sp. nov.

11. **Paridris dubeyi** sp. nov.

(Text-fig. 10)

Male : Body length of holotype 2.32 mm, range 1.95-2.32 mm ; fore wing 1.44-1-70 mm, surpassing the abdomen ; abdomen 1.00-1.26 mm. General colour of body yellowish-brown to honey brown ; eyes and ocellar area blackish ; wings hyaline ; antennae brownish-black to black ; legs brown ; first, second and third tergites yellowish-brown, fourth tergite blackish-brown, other tergites brownish-black.

Head somewhat narrower than thorax ; cuboid, with moderate white pubescence ; frons without fovea, smooth and shiny, with one or two scattered punctae ; vertex aciculately punctate ; gena aciculately punctate , occiput sinuately margined ; mandibles bidentate, conspicuous and long ; head viewed from above (Text-fig. 10 A) length to width 17 : 28 ; seen from front length to width 25 : 28 ; ocellocular space subequal to ocellar diameter, front ocellar space 1.25 times the ocellar diameter, interocellar space twice the ocellar diameter ; eyes oval, with scattered fine pubescence, eye to head length 10 : 17. *Antenna* (Text-fig. 10 B) to



Text-fig. 10. *Paridris dubeyi* sp. nov. Male. A. body dorsal view, B. antenna, C. veins enlarged.

body 73 : 100 ; segments 12, 1.1.9.1 ; white antennal hairs dense, shorter than the thickness of the segments ; scape cylindrical, 2.33 times as long as thick, equal to 2.50 of the following segments combined ; pedicel 1.35 times as long as thick, 0.30 of the scape ; funicular segments 1-9 cylindrical, slender, subequal, 2.30 times as long as thick, 1.75 times the pedicel ; terminal segment 3.00 times as long as thick, 1.30 times the preceding segment.

Thorax (Text-fig. 10 A) length to width 37 : 30 ; seen laterally length to height 37 : 26 ; notauli absent ; mesonotum to scutellum 18 : 9, finely, minutely, aciculately punctate and with moderate white pubescence ; scutellum unarmed, rounded behind ; mesopleura punctate like the rest of thorax ; metanotum with a bilobed plate behind ; propodeum unarmed. *Fore wing* (Text-figs. 10 A & C) length to width 100 : 33 ; venation *sm* : *m* : *pm* : *st* 40 : 3.5 : 12 : 7 ; basalis present ; medialis very faintly indicated ; discal ciliation moderate ; marginal fringe well developed. *Hind wing* (Text-fig. 10 A) to fore wing 80 : 100 ; length to width 100 : 20.

Abdomen (Text-fig. 10 A) to body 54 : 100 ; 7 segmented, fusiform ; first and second tergites longitudinally striate ; third tergite finely longitudinally striate ; other tergites smooth, matt, with scattered setigerous punctures and pubescence ; first, second, third and fourth tergites 8 : 14 : 16 : 12 ; fifth tergite half of the fourth.

Holotype : Male mounted on card, 20.11. Maldare Teak Forest : Karnataka Survey, Coll. *M. S. Mani, S. K. Sharma & G. G. Saraswat*, 20.v.-6.vi. 1978. *Paratypes* : 3 males on cards, same data as for holotype ; 1 male 20.9. Attur Reserve Forest, other data same as for holotype.

This species differs from *P. coorgensis* Sharma[1], in the absence of notauli ; *pm* much longer than *st* ; basalis absent. This species also differs from *P. mahadeonsis* Sharma[2], in head being punctate ; *pm* much longer than *st* ; third tergite not smooth but longitudinally striate ; ocellocular space not twice the ocellar diameter but subequal.

This species is named after Dr. O. P. Dubey, Parasitologist, Cardamom Regional Station of the Central Plantation Crops Research Institute, Marcara, who helped in collecting many Proctotrupids.

12. **Paridris karnatakensis** sp. nov.

(Text-figs. 11 & 12)

Female : Body length 2.84 mm ; fore wing 1.82 mm, not reaching beyond fifth tergite ; hind wing 1.38 mm ; abdomen 1.84 mm. General colour of body black ; head black, thorax and abdomen with slight brown tinge ; eyes black ; scape and fifth antennal segment dark brown, segments 2-4 brown, sixth segment brownish-black, club black ; legs yellowish-brown ; wings hyaline, veins brown.

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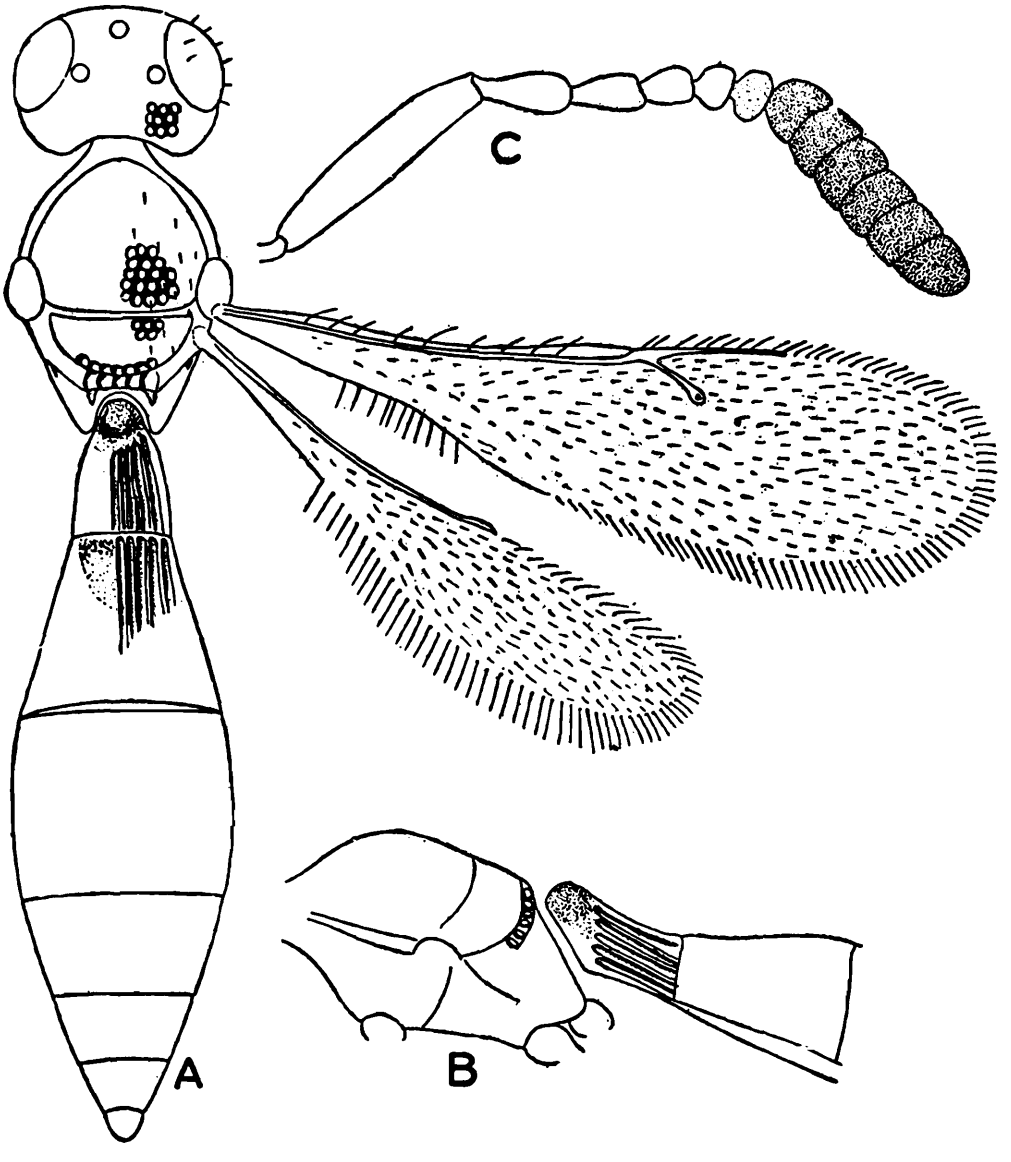
1. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 26.
2. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 28.

Head nearly as wide as thorax ; with silvery-white pubescence ; frons without fovea ; vertex and frons closely aciculately punctate ; vertex weakly margined behind ; occiput sculptured like vertex, gena aciculately punctate ; viewed from above (Text-fig. 11A) cuboid, length to width 16 : 25; seen from front globose; lateral ocelli contiguous with the eyes, front ocellar space about 2.50 times the ocellar diameter, interocellar space about 4.00 times the ocellar diameter ; eyes oval, with sparse pubescence, eye to head length 13 : 16. *Antenna* (Text-fig. 11 C) to body 36 : 100 ;



Text-fig. 11. *Paridris karnatakensis* sp. nov. Female. A. body dorsal view, B. thorax in profile, C. antenna.

segments 12, 1.1.4.6 ; scape cylindrical, 5.00 times as long as thick, 3.30 of the following segments combined ; pedicel 3.00 times as long as thick, 0.40 of the scape ; first funicular segment longest, about 2.00 times as long as thick, 0.75 of the pedicel ; second segment 1.50 times as long as thick, 0.60 of the first ; third segment subglobose, somewhat thicker than long, 0.66 of the second ; fourth subglobose, 1.50 times as wide as

long, subequal to third ; club segments transverse, except the terminal ; first segment 0.75 of its width, 1.50 times the preceding segment ; segments 2-5 subequal, about 0.60 of their width, slightly longer than first ; terminal segment oval, as long as thick, 1.60 times the preceding.

Thorax (Text-fig. 11 A & B) length to width 32 : 26 ; notauli absent ; metanotum to scutellum 20 : 8, closely, aciculately punctate, with white pubescence ; scutellum unarmed, rounded behind ; mesopleura closely, aciculately, punctate ; metanotum with bidentate plate medially and with a minute tooth-like projection at the sides ; propodeum unarmed, irregularly rugose. *Fore wing* (Text-fig. 11 A) length to width 100 : 28 ; venation *sm* : *m* : *pm* : *st* 48 : 3 : 12 : 8 ; basalis absent or very indistinct ; discal ciliation and marginal fringe well developed. *Hind wing* (Text-fig. 11 A) to fore wing 76 : 100 ; length to width 100 : 22.

Abdomen (Text-fig. 11 A) to body 65 : 100 ; length to width 100 : 27 ; fusiform ; first tergite with a conspicuous tubercle, 1.55 times as long as thick, longitudinally striate as in figure ; second tergite anteriorly longitudinally striate, otherwise smooth ; rest of abdomen smooth and shiny, with scattered silvery-white pubescence ; first, second, third and fourth tergites 17 : 21 : 23.5 : 12 ; ovipositor very long, exserted but lost in the specimen.

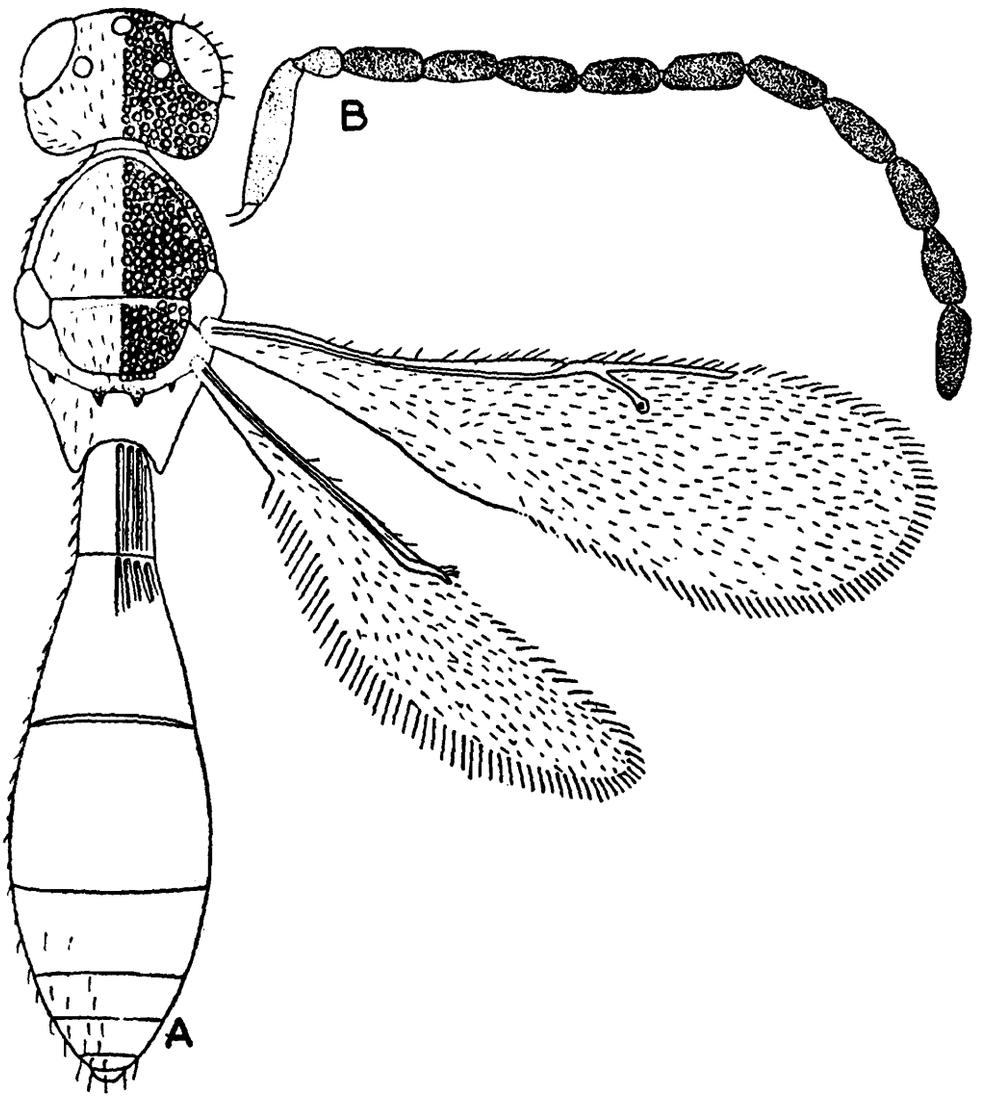
Male : Body length 2.66 mm ; fore wing 1.86 mm, reaching to the tip of abdomen ; hind wing 1.52 mm ; abdomen 1.60 mm. General colour of body brownish-black to black ; head black ; eyes blackish ; scape and pedicel brownish-black, rest of antennae black ; thorax honey brown to brownish-black ; legs brown ; wings hyaline ; first and second tergites blackish-brown, third tergite brown, other tergites black.

Head as wide as thorax ; frons without fovea ; aciculately punctate as in female; viewed from above (Text-fig. 12 A) length to width 16 : 26 ; lateral ocelli contiguous with the eyes, front ocellar space less than twice the ocellar diameter, interocellar space more than thrice the ocellar diameter ; mandibles tridentate, the middle tooth smaller ; eyes sparsely pubescent. *Antenna* (Text-fig. 12 B) to body 100 : 133 ; cylindrical, slender, segments 12, 1.1.9.1 ; antennal hairs shorter than the thickness of the segments ; scape somewhat less than 4.50 times as long as thick, slightly longer than the following two segments combined ; pedicel 1.61 times as long as thick, 0.36 of the scape ; funicular segments 1-9 subequal, 2.67 times as long as thick, 1.60 times the pedicel ; terminal segment 3.00 times as long as thick, 1.10 times the preceding segment.

Thorax (Text-fig. 12 A) viewed dorsally length to width 37 : 26 ; notauli absent ; mesonotum to scutellum 18 : 10, aciculately punctate as

in female ; metanotum with a conspicuous bidentate plate medially and with a very minute tooth at the sides ; propodeum unarmed, irregularly rugose. *Fore wing* (Text-fig. 12 A) length to width 100 : 30 ; venation *sm* : *m* : *pm* : *st* 46 : 5 : 15 : 8 ; basalis indistinct. *Hind wing* (Text-fig. 12 A) to fore wing 82 : 100 ; length to width 100 : 18.

Abdomen (Text-fig. 12 A) to body 60 : 100 ; length to width 80 : 25 ; fusiform ; first tergite without tubercle, longitudinally striate ; second tergite anteriorly longitudinally striate, other wise smooth and shiny ; rest of abdomen as in female ; first, second, third and fourth tergites 15 : 20 : 22 : 10.



Text-fig. 12. *Paridris karnatakensis* sp. nov. Male. A. body dorsal view, B. antenna.

Holotype : Female mounted on card, 20.9. Attur Reserve Forest : Karnataka Survey, Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 20-31. v.-8-10.vi. 1978. *Allotype* : Male mounted on card, with same data as for holotype. *Paratypes* : 8 males mounted on cards, with same data as for holotype ; 1 male on card, 20. 13. Hudukeri and 1

female on card, 20. 11. Maldare Teak Forest, other data same as for holotype.

This species differs from *P. coorgensis* Sharma[1], in notauli being absent ; *pm* much longer than *st* ; third tergite not longitudinally striate ; lateral ocelli close to eyes. Differs from *P. mahadeonsis* Sharma[2], in larger body size ; in body colour ; head not smooth ; metanotum with distinct bidentate plate. This also differs from *P. dubeyi* Sharma, in the frons not smooth ; third tergite not fiinely striate ; lateral ocelli very close to eyes ; absence of basalis.

13. **Probaryconus cauverycus** Saraswat

1978. *Probaryconus cauverycus*, Saraswat, In : Saraswat & Sharma. *Mem. Sch. Ent.*, **5** : 22, fig. 11.

I have before me 1 female on card labelled as "20.11. Maldare Teak Forest : Karnataka Survey, Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 25. v.-1-6. vi. 1978".

This species was originally described from a single specimen. The specimen before me is slightly larger than the holotype. Ovipositor is not exserted.

1. Sharma, S. K. 1978. *Mem Sch. Ent.*, **5** : 26.
2. Sharma, S. K. 1978. *Mem. Sch. Ent.*, **5** : 28.

Rec. zool. Surv. India, 79 : 343-358,

SOME INDIAN PROCTOTRUPOIDEA (HYMENOPTERA : SCELIONIDAE)*

By

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(With 6 Text-figures)

INTRODUCTION

The material was collected by Dr. M. S. Mani and party in the course of Field Surveys under support from PL-480 funds by the U. S. Department of Agriculture. The types of the new species are being retained for the time being in the School of Entomology, pending final disposal. I express my cordial thanks to Prof. M. S. Mani for placing this interesting material at my disposal, for valuable advice, and encouragement.

KEY TO SPECIES OF *MACROTELEIA*

1.	Body yellowish-brown to ferrugenous-brown ...	...	2
—	Body dark honey brown to black ...	...	3
2.	In female abdominal tergites 1, 5, 6 and 2 and 4 equal, 3rd largest ; in male 1, 5 equal and 3, 4 equal and longest ; *pm* more than 1.50 times *m* ...	*M. indica* Sharma	
3.	Body very long, 5.06 to 6.00 mm ; frons matt, punctate, slightly emarginately impressed and strongly, longitudinally keeled in the middle ; sublongitudinal striations near the antennal sockets ...	...	4
—	Body short, less than 5.00 mm ; frons perfectly smooth, moderately deeply and emarginately impressed ...	...	5
4.	In female abdominal tergites 1 and 5 equal, 2, 3, 6 equal and longest ; in male 1 and 5 equal, 2, 3, 4 equal and longest ; *pm* 2.00 or more than 2.00 times *m*. ...	*M. lamba* Saraswat	

* Contribution No. 266 from the School of Entomology, St. John's College, Agra-282002.

5. Body 4.66 mm ; eyes naked ; propodeum densely clothed with long setae ; in male abdominal tergites 1, 5 and 2, 4 equal, 3rd longest ; *pm* slightly more than 2.00 times *m*. ... *M. boriviliensis* sp nov.

— Body 4.24 mm ; eyes very sparsely and very minutely pubescent ; propodeum finely, longitudinally striate ; in female abdominal tergites 2, 4, 6 subequal, 3rd longest ; *pm* slightly less than 2.00 times *m* ; forns transversely striate only near the keel ... *M. livingstoni* sp. nov.

1. **Macroteleia boriviliensis** sp. nov.

(Text-fig. 1)

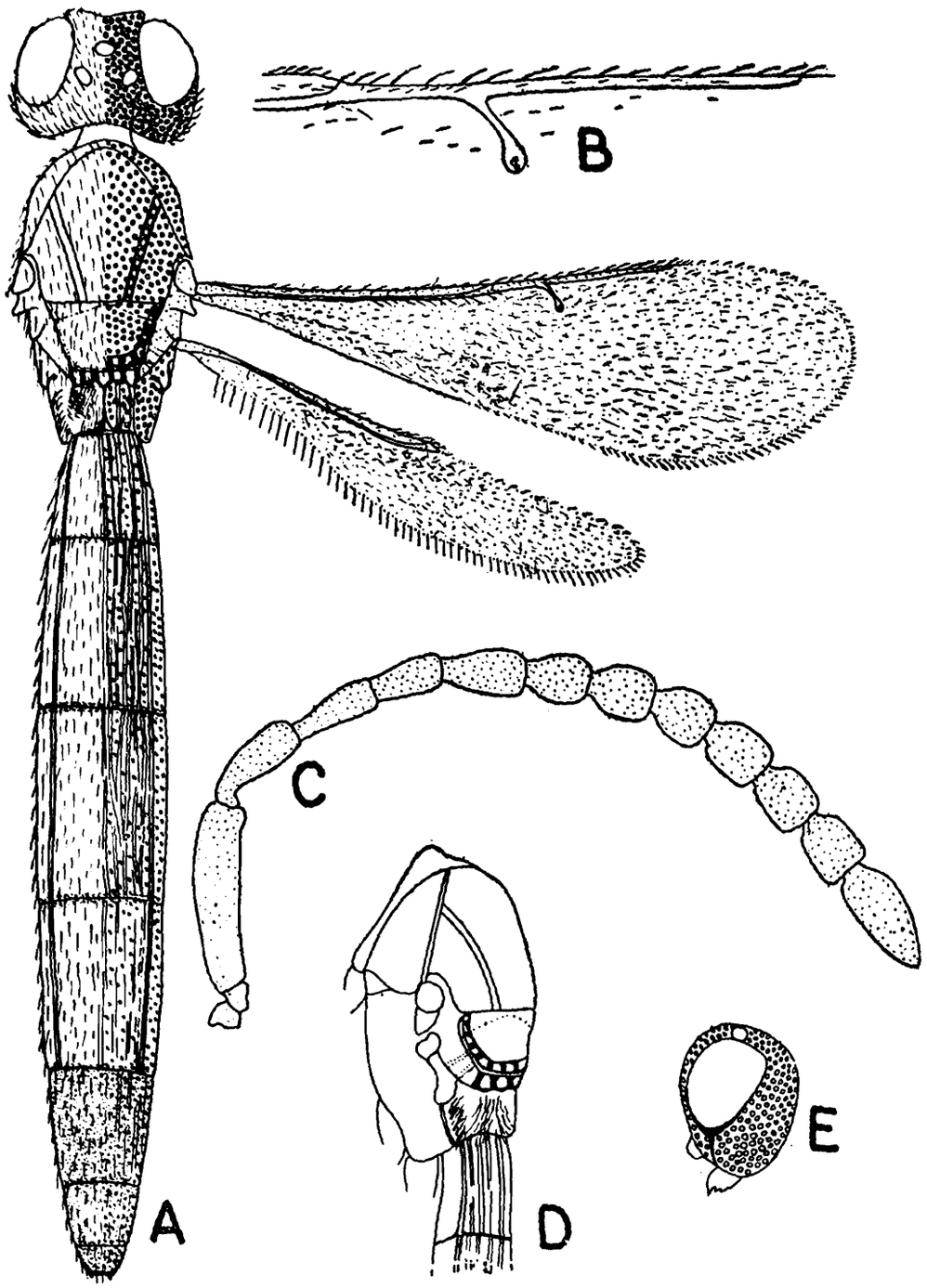
Male : Length of body 4.66 mm ; fore wing 2.72 mm ; hind wing 2.06 mm ; abdomen 3.14 mm. Body black, eyes and ocelli very dark brown, antennae dark brown, legs brown, wings subhyaline ; abdomen honey brown, last three tergites somewhat darker.

Head as wide as thorax ; viewed from above (Text-fig. 1 A) width to length 100 : 60, with large, deep and very close, setigerous punctae, the punctae separated by 0.50 to 1.00 of their own diameters ; ocellocular space less than 0.50 of the ocellar diameter, front ocellar space 2.50 times the ocellar diameter, interocellar space 4 times the ocellar diameter ; eyes smooth with only few, very minute setae, eye length to head length 80 : 100 ; frons moderately deeply and emarginately impressed in the middle, smooth, without punctae ; mandibles tridentate ; genal carina (Text-fig. 1 E) present. *Antenna* (Text-fig. 1 C) 1.66 mm, segments 12, 1.1.0.9.1 ; scape 5.33 times longer than thick, slightly more than the following 2 segments combined ; pedicel 2.66 times longer than thick, 0.50 the scape ; first funicular segment subequal to pedicel and third segment ; second 1.66 times longer than thick, 0.70 the first ; segments 4-9 equal, 1.25 times longer than thick, 0.76 the third ; club not stouter than funicle, 2.25 times longer than thick, about 1.75 times the preceding segments combined.

Thorax (Text-fig. 1 A, D) : Mesonotum and scutellum punctate like the head, but the punctae not so close ; notauli complete, deep, with a row of large and shallow, non-setigerous, somewhat round depressions ; scutellum straight posteriorly, rounded at corners, posterior margin with a row of large, deep, rectangular depressions ; metanotum narrow with the posterior margin having medially a row of 5 strongly carinated, rectangular depressions ; propodeum densely clothed with silvery-white, long setae, concealing the longitudinal carinae. Hind metatarsus 0.78 the following tarsal segments combined. *Fore wing* (Text-fig. 1 A, B)

length to width 100 : 30, venation *sm* : *m* : *pm* : *st* 500 : 100 : 208 : 50 ; fore wing to hind wing (Text-fig. 1 A) length 100 : 75.

Abdomen (Text-fig. 1 A) : Seven segmented ; all tergites longitudinally striate with fine, sparsely scattered, setigerous punctae ; first tergite 1.10



Text-fig. 1. *Macroteleia boriviliensis* sp. nov. ♂ A. Body dorsal view, B. veins enlarged, C. antenna, D. thorax in profile, E. head in profile.

times longer than wide, equal to the fifth : second 1.34 times longer than wide, about 1.50 times longer than the first ; third longest, 1.50 times longer than wide, 1.16 times longer than the second ; fourth equal to the second, 0.88 the third : fifth 0.65 the fourth ; sixth

nearly as long as thick, 0.57 the fifth ; seventh 1.50 times thicker than long, 0.50 the sixth.

Holotype : Male on card, wings and one antenna of one side on slide, 4.13. Borivili : Bombay (Maharashtra). Coll. *M. S. Mani & party*, 25. ix. 1971.

2. **Macroteleia indica** Sharma

(Text-fig. 2)

1978. *Macroteleia indica* Sharma, In : Saraswat & Sharma, *Mem. Sch. Ent.*, **5** : 11, fig. 6.

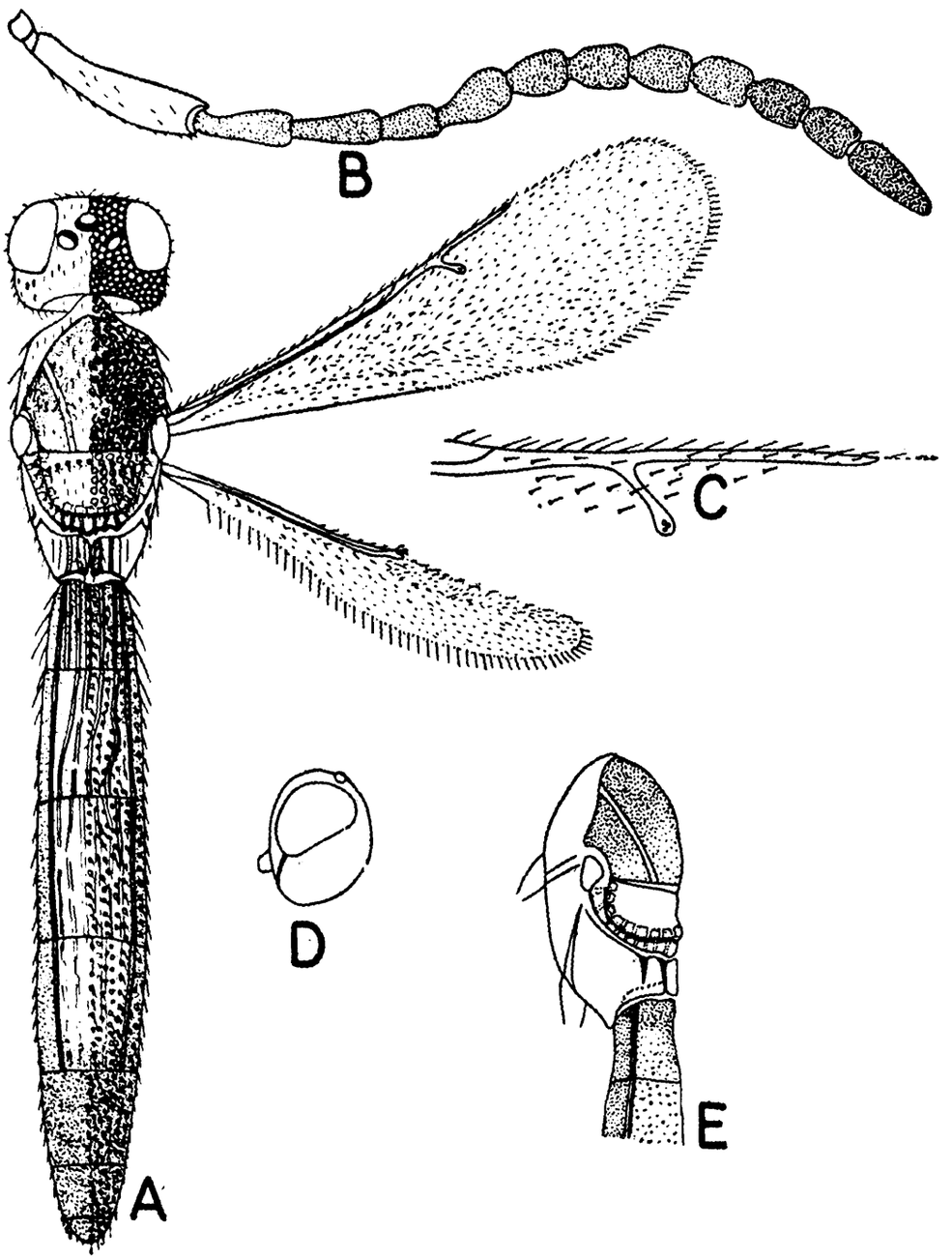
This species was originally described from females only. I have since come across a series of males which I am describing here.

Male : Body length 3.40-3.74 mm ; fore wing 2.22-2.34 mm, mean 2.29 mm ; hind wing 1.60-1.78 mm, mean 1.70 mm ; abdomen 2.08-2.42 mm, mean 2.29 mm. General colour of body ferrugenous-brown ; eyes and ocelli black ; scape yellowish-brown, flagellum dark brown. Mesonotum black, wings hyaline. Abdominal tergites 5-7 and sometimes also the posterior region of the 4th tergite black, first and second tergites less black, other tergites laterally darker black.

Head as wide as thorax ; viewed fron above (Text-fig. 2 A) width to length 100 : 67, with deep, close, setigerous punctae ; ocellocular space 0.50 the ocellar diameter, front ocellar space 2.50 times the ocellar diameter, interocellar space 3.50 times the ocellar diameter ; eyes naked, very sparsely indistinctly pubescent, eye length to head length 75 : 100 ; frons slightly impressed ; genal carina (Text-fig. 2 D) present. *Antenna* (Text-fig. 2 B) 1.48 mm, segments 12, 1.1.0.9. 1 ; scape 4.33 times longer than thick, slightly smaller than the following two segments combined ; pedicel 3 times longer than thick, 0.57 the scape. First funicular segment longest and nearly equal to the third, 2.60 times loger than thick and 0.86 the pedicel ; second segment twice longer than thick, 0.76 the first ; third twice longer than thick, very slightly shorter than the first ; segments 4-9 equal, 1.66 times longer than thick, 0.83 the third. Club 2.66 times longer than thick, slightly shorter than the preceding two segments combined.

Thorax (Text-fig. 2 A, E) : Mesonotum with deep, large, close, setigerous punctae, the punctae more distinctly separated than on the head ; notauli complete, deep, with a row of large and shallow, non-setigerous depressions ; scutellum rounded behind, its anterior margin with a transverse row of fine punctae, posterior margin raised upwards with a row of very large, shallow, rectangular depressions ; metanotum

not as narrow as in other Indian species, smooth, with a single, large, tooth in the middle and a row of 3 strongly carinated rectangular depressions on either side of the median tooth ; propodeum smooth, flat, plate-like, without bilobed structures in the middle, two strongly



Text-fig. 2. *Macroteleia indica* Sharma. ♂ A. body dorsal view, B. antenna, C. veins enlarged, D. head in profile, E. thorax in profile.

developed carinae on each side. Hind metatarsus 0.74 the following tarsal segments combined. Fore wing (Text-fig. 2 A, C) length to width 100 : 29, venation *sm* : *m* : *pm* : *st* 482 : 100 : 182 : 54 ; fore wing to hind wing (Text-fig. 2 A) length 100 : 76.

Abdomen (Text-fig. 2 A) : Seven segmented ; all tergites longitudinally

striate, with fine setigerous punctae, striations are very prominent particularly on the first two tergites ; first tergite as long as wide ; second 1.27 times longer than wide, 1.50 times longer than the first ; third longest, 1.37 times longer than wide, 1.13 times longer than the second ; fourth 1.31 times longer than wide, 0.96 the third ; fifth subequal to the first ; sixth 1.30 times thicker than long, 0.60 the fifth ; seventh 1.60 times thicker than long, 0.50 the sixth.

Material studied : 1 male on card, wings and antenna of one side mounted on slide, 20.11. Maldare Forest (Siddapur) : Karnataka ; 5 males on cards, 20.6. and 20.12. Walayar Forest (Coimbatore) : Kerala and Dubare Forest (Siddapur) : Karnataka. Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 25.v.-1, 6.vi. 1978, 9-11.v. 1978 and 26.v.-4,7.vi. 1978.

This species differs very much from *M. boriviliensis* Saraswat in much smaller body, general colour and sculpture ; in proportions of antennal segments, hind metatarsus and abdominal segments ; posterior margin of scutellum broadly rounded.

3. **Macroteleia livingstoni** sp. nov.

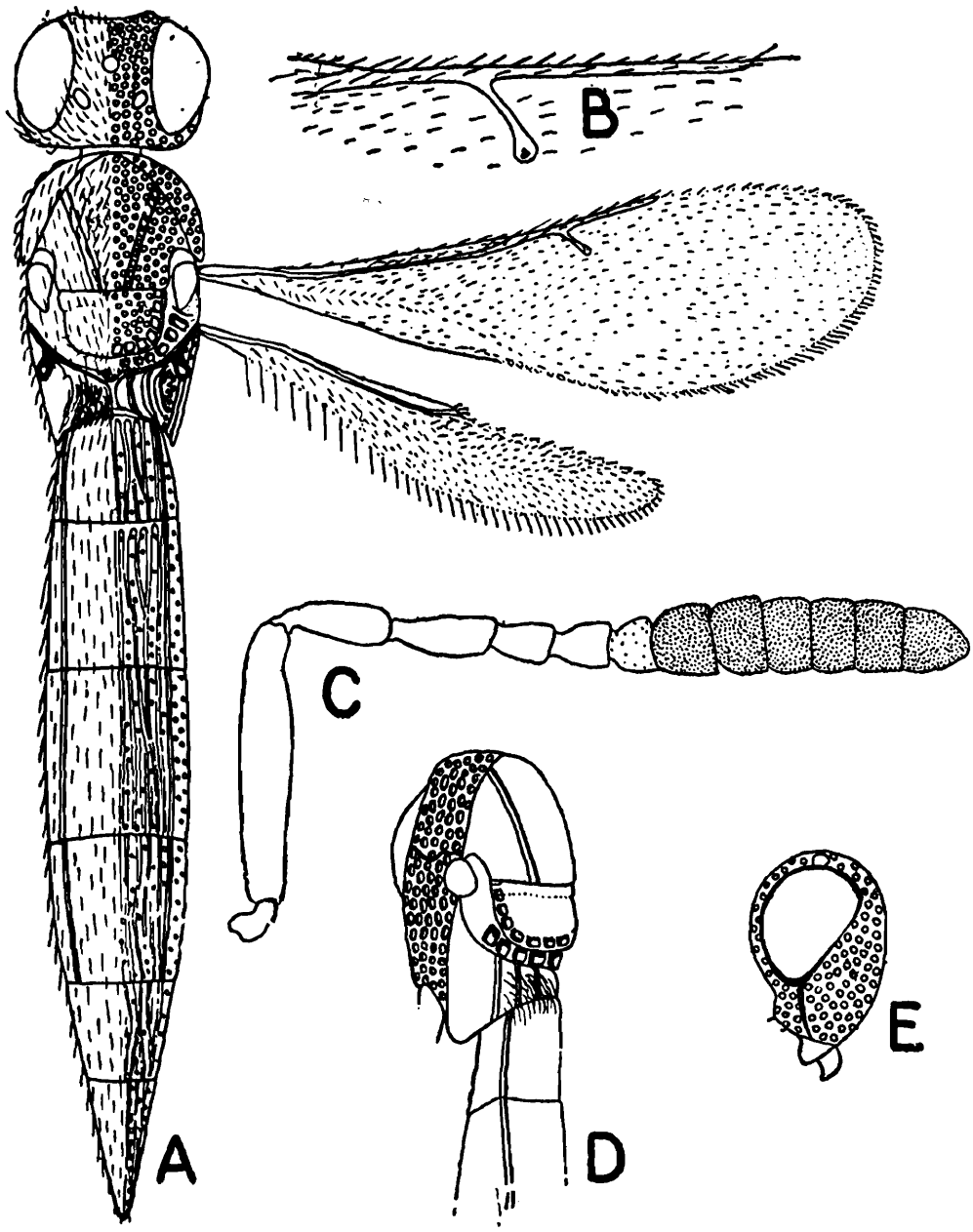
(Text-fig. 3)

Female : Length of body 4.24 mm ; fore wing 2.48 mm ; hind wing 1.80 mm ; abdomen 2.78 mm. Body black, eyes brown, antennae brown, club black, wings hyaline, legs brown.

Head : almost as wide thorax ; viewed from above (Text-fig. 3 A) width to length 100 : 72, with large, deep, close, setigerous punctae ; lateral ocelli almost contiguous with the eye border, front ocellar space 2.75 times the ocellar diameter, interocellar space 3.50 times the ocellar diameter ; eyes very sparsely and very minutely pubescent, eye length to head length 87 : 100 ; frons moderately deeply impressed, smooth, without punctae in the middle, emarginate, transversely striate only in the area just above the antennal sockets, median carina short in between the antennal sockets ; mandibles tridentate, middle tooth small ; genal carina (Text-fig. 3 E) present. *Antenna* (Text-fig. 3 C) 1.44 mm, segments 12, 1.1.0.4.6 ; scape 5.70 times longer than thick, subequal to following 3 segments combined ; pedicel 3.60 times longer than thick, 0.45 the scape. First funicular segment subequal to pedicel; second 1.66 times longer than thick, 0.62 the first ; third equal to the second ; fourth 1.16 times thicker than long, 0.75 the third. Club stouter than funicle, first 5 segments transverse, sixth rounded at tip, club 4.40 times longer than thick, equal to the preceding 4.50 segments combined ;

first segment 1.25 times thicker than long, 1.33 times longer than the preceding segment ; second only very slightly shorter than the first ; segments 3 to 5 equal ; sixth as long as thick and 1.50 times longer than the fifth segment.

Thorax (Text-fig. 3 A, D) : Mesonotum and scutellum punctate as on vertex ; notauli complete, deep, with a row of large and shallow, non-setigerous depressions ; scutellum rounded at corners, posterior margin



Text-fig. 3. *Macroteleia livingstoni* sp. nov. ♀ A. body dorsal view, B. veins enlarged, C. antenna, D. thorax in profile, E. head in profile.

with a row of large, deep, rectangular depressions ; metanotum narrow with a single, large, median tooth, rectangular depressions as on scutellum ; propodeum finely, longitudinally striate, medially with bilobed areola very well developed, with fine setae, punctae invisible. Hind metatarsus equal to the following tarsal segments combined. *Fore wing*

(Text-fig. 3 A, B) length to width 100 : 29, venation *sm* : *m* : *pm* : *st* 540 : 100 : 180 : 60 ; for wing to hind wing (Text-fig. 3 A) length 100 : 72.

Abdomen (Text-fig. 3 A) : All tergites longitudinally striate, with fine setigerous punctae ; punctae smaller, shallower than on thorax, sparsely scattered, separated from each other by 1 to 2 times the distance of their own diameter ; abdomen with 6 visible tergites, last tergite wedge-shaped, pointed ; first tergite as long as wide ; second only very slightly longer than wide, 1.20 times longer than the first ; third longest, 1.26 times longer than wide, 1.20 times longer than the second ; fourth 1.18 times longer than wide, 0.90 the third ; fifth nearly as long as wide, smaller than the first, 0.65 the fourth ; sixth equal to the second, 2.66 times longer than thick, 1.41 times longer than the fifth.

Holotype : Female on card, wings and antenna on slide, 20.6. Walayar Forest (Coimbatore) ; Kerala. Coll. *M. S. Mani, S. K. Sharma & G. G. Saraswat*, 9-11.v.1978.

This species differs from *M. indica* Sharma in much larger body ; general colour black and sculpture on head ; in different proportions of antennal segments ; in shorter scutellum and in *sm* : *m* : *pm* : *st* ratio.

I have great pleasure in naming this species after my friend Dr. David Livingstone, Reader in Zoology, Madras University, who accompanied me in the field for collecting Proctotrupoidea.

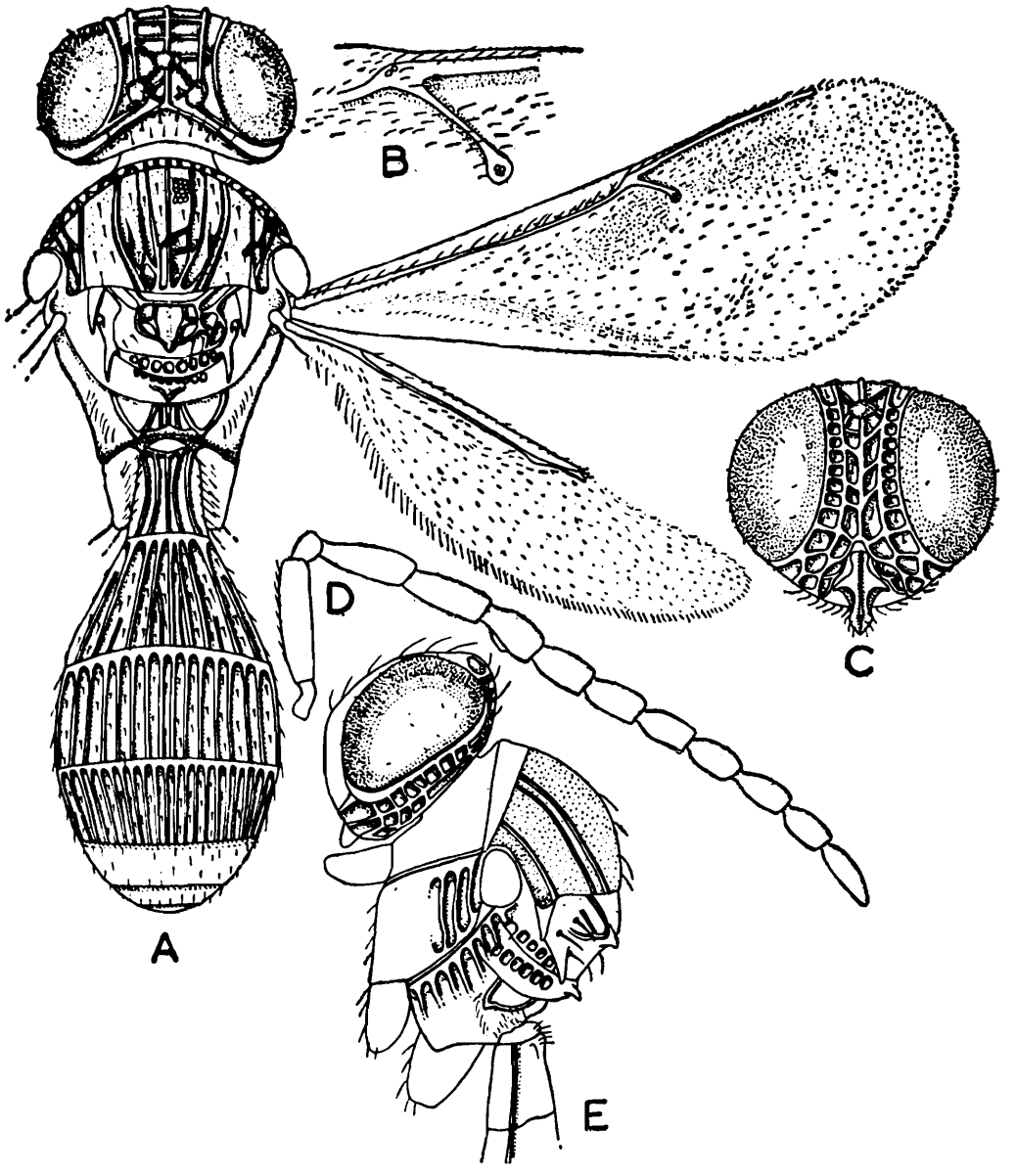
4. **Dichoteleas indicus** sp. nov.

(Text-fig. 4)

Male : Length of body 3.86 mm ; fore wing 3.00 mm ; hind wing 2.36 mm ; abdomen 2.06 mm. Body black, eyes very dark brown to black, ocelli brown, antennae dark brown, scape and pedicel yellowish-brown, wings infumated brown ; anterior part of mesonotum honey brown, otherwise thorax black.

Head almost as wide as thorax ; viewed from above (Text-fig. 4 A) width to length 100 : 54, posterior margin strongly carinated, 3 strong carinae start from the ocelli and extend in front the entire length of the head ; the middle carina extending further and united with the carina of posterior margin of vertex, sculpture as shown in figure ; ocellocular space 0.25 of ocellar diameter, front ocellar space equal to the length of lateral ocellus, interocellar space 2.00 times the ocellar diameter ; eyes very large, very sparsely, with few scattered fine hairs, eye length to

head length 90 : 100 ; viewed from front (Text-fig. 4 C) frons unimpressed, with very large, setigerous, rectangular areolate sculpture between 5 longitudinal rows of strong carinae ; genal carina (Text-fig. 4 E) present. *Antenna* (Text-fig. 4 D) 2.94 mm, segments 12, 1.1.0.9.1 ; scape 3.50 times longer than thick, subequal to following 2 segments combined ; pedicel 1.33 times longer than thick, about 0.30 the scape.



Text-fig. 4. *Dichoteleas indicus* sp. nov. ♂ A. bodydorsal view, B. veins enlarged, C. head in front view, D. antenna, E. thorax in profile.

First funicular segment longest, 3.20 times longer than thick, 2.66 times longer than pedicel ; second 2.54 times longer than thick, 0.87 the first ; third twice longer than thick, 0.85 the second ; segments 4-9 subequal, 2 times longer than thick, 0.83 the third ; club thinner than funicle, 3.25 times longer than thick, slightly shorter than the preceding 1.50 segments combined.

Thorax (Text-fig. 4 A, E) clothed with fine hairs ; mesonotum with fine, leathery sculpture ; notauli complete, deep, with carinate margins,

median longitudinal carina and other carinae between notauli strongly developed ; scutellum with a pair of long, anterior and posterior spines and one blunt, short, tooth in the middle, sculptures as shown in the figure ; metanotum narrow with a pointed, short, tooth in the middle ; propodeum with dense pubescence laterally, sculpture as in figure. Hind metatarsus 0.83 the remaining tarsal segments combined. Fore wing (Text-fig. 4 A, B) length to width 100 : 36, venation *sm* : *m* : *pm* : *st* 77 : 3.50 : 42 : 11 ; fore wing to hind wing (Text-fig. 4 A) length 100 : 78.

Abdomen (Text-fig. 4 A) : Six segmented ; spatulate ; first 4 tergites longitudinally striate ; with fine setigerous punctae ; first tergite 1.23 times longer than thick ; second longest, 1.52 times wider than long, about 1.20 times longer than the first ; third twice wider than long, 0.92 the second ; fourth 2.44 times wider than long, about 0.80 the third ; fifth 4.37 times wider than long, 0.44 the fourth ; sixth narrow.

Holotype : Male on card, wings and one antenna on slide, 9.10. Moozhiar (Kerala State) : Cardamom Hills. Coll. *M. S. Mani & G. G. Saraswat*, 17-20. iv. 1973.

This species resembles *D. rugosus* Kieffer* in the body being black, matt ; nature of striations on head and thorax ; frontal impression absent ; two proximal antennal segments differently coloured ; scape subequal to following two segments combined ; pronotum invisible in dorsal view ; scutellum broadly rounded behind ; metanotum medially with a pointed, short, tooth ; wings infumated brown ; abdomen spatulate, slightly longer than rest of the body, but differs very much in the following respects : body shorter ; eyes not completely naked, ocellocular space not equal to ocellar diameter ; eleventh antennal segment not about 3 times as long as thick, but only 2 ; notauli complete, deep with carinated margins ; scutellum with 4 spines and 1 short tooth in the middle ; *pm* not 2, but about 4 times as long as *st* ; hind metatarsus shorter than the rest of tarsal segments combined ; first 4 abdominal tergites differently sculptured ; T 1 longer than thick, T 2 less than 1.30 of T 1, T 4 shorter than T 1.

5. **Leptoteleia bengalensis** sp. nov.

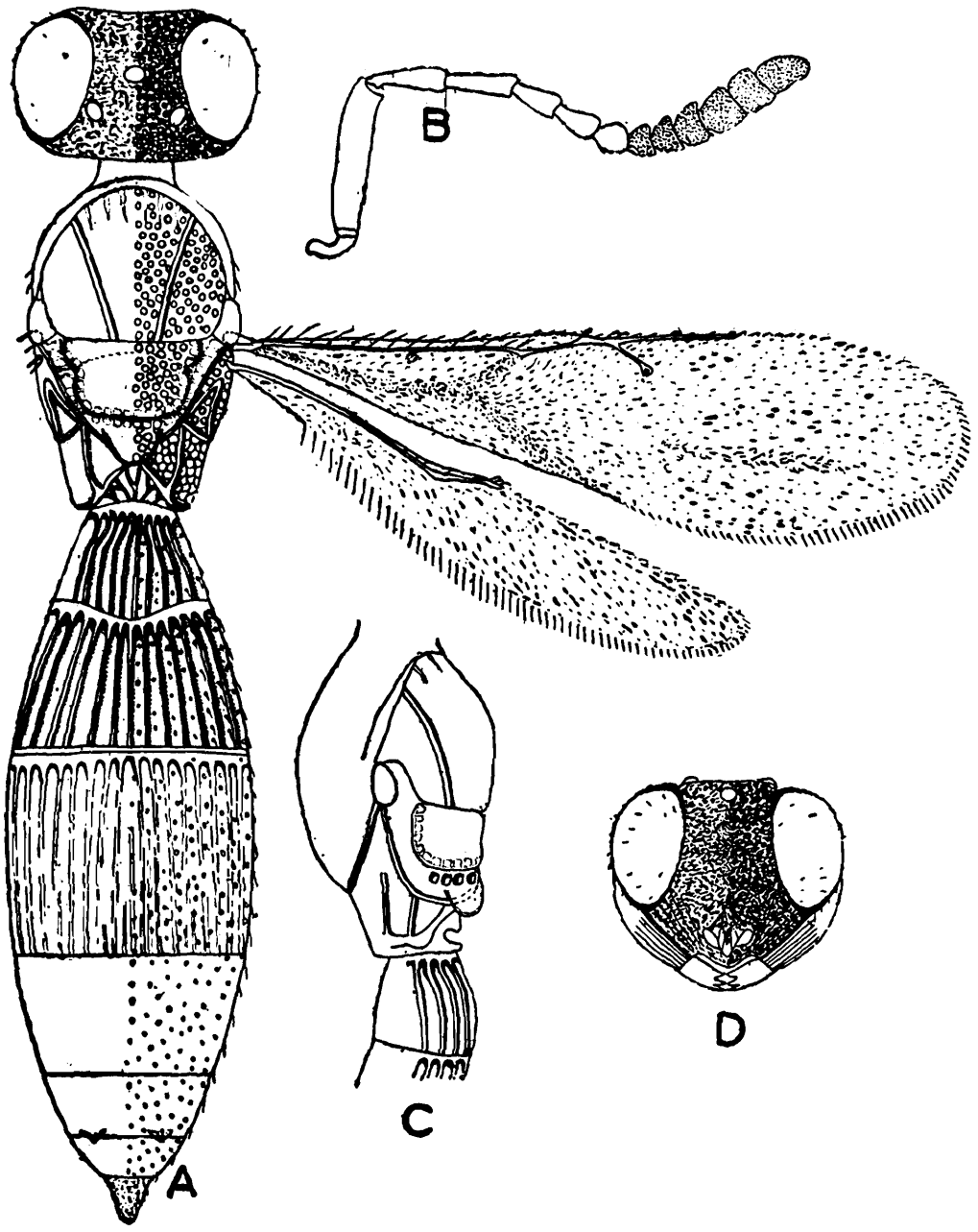
(Text-fig. 5)

Female : Length of body 3.52 mm ; fore wing 2.28 mm ; hind wing 1.88 mm ; abdomen 2.10 mm. General colour of body ferrugenous-brown ; head black, eyes blackish-brown, except black club antenna

*Kieffer, J. J. 1907. *Berl. Ent. Z.*, **51** : 297.
Kieffer, J. J. 1926. *Das Tierreich*, **48** : 885.

brown ; when compared to thorax abdomen dull ferrugenous-brown, ovipositor sheath black ; wing hyaline.

Head wider than thorax (100 : 88) ; viewed from above (Text-fig. 5 A) width to length 100 : 61 ; vertex matt ; with fine, close, non-setigerous punctae ; occipital carina complete ; lateral ocelli contiguous with the eye borders, front ocellar space 2.00 times the ocellar diameter, interocellar space 3.66 times the ocellar diameter ; eyes very sparsely, finely



Text-fig. 5. *Leptoteleia bengalensis* sp. nov. ♀ A. body dorsal view, B. antenna, C. thorax in profile, D. head in front view.

pubescent, eye length to head length 90 : 100 ; viewed from front (Text-fig. 5 D) only slightly emarginately impressed in the middle, leathery sculpture as on vertex but without punctae, genal carina very well developed, genae very finely, longitudinally striate ; mandibles

tridentate. *Antenna* (Text-fig. 5 B) 1.40 mm, segments 12, 1.1.0.4.6 ; scape 5. 14 times longer than thick, equal to following 2.50 segments combined ; pedicel 3.20 times longer than thick, 0.44 the scape. First funicular segment longest, only very slightly shorter than pedicel ; second twice longer than thick, 0.70 the first ; third equal to the second ; fourth subglobose, 0.60 the third. Club stouter than funicle, 4.66 times longer than thick, equal to preceding 4 funicular segments combined.

Thorax (Text-fig. 5 A, C) : Mesonotum with fine, shallow, large, setigerous punctae, separated from each other by about their own diameters, punctae on mesoscutum contiguous ; notauli complete ; scutellum matt, punctae as on mesoscutum ; metanotum very narrow, metanotal lamina rounded, horizontal and projected over the propodeum, with large and shallow punctae ; propodeum with 6 'Y'-shaped carinae in the middle and laterally with a strongly developed 'V'-shaped carina, very large, deep reticulations at the sides. Fore wing (Text-fig. 5 A) length to width 100 : 28, venation *sm* : *m* : *pm*. *st* 770 : 100 : 270 : 85 ; fore wing to hind wing (Text-fig. 5 A) length 100 : 82.

Abdomen (Text-fig. 5 A) : Seven segmented ; matt ; first 3 tergites longitudinally striate, tergites 4 and 5 distinctly punctate ; first tergite with a moderate hump, 1.30 times wider than long ; second 1.60 times wider than long, 1.25 times longer than the first ; third longest, 1.10 times wider than long, 1.50 times longer than the second ; fourth about twice wider than long, about half the third ; fifth 2.30 times wider than long, 0.62 the fourth ; sixth twice wider than long, 0.70 the fifth tergite ; seventh tergite distinctly visible ; ovipositor sheath extruded and sclerotized.

Holotype : Female on card, wings and one antenna on slide, 16.1. Alipur Duar : Hasimara (North Bengal Survey). Coll. *M. S. Mani, G. G. Saraswat & S. K. Sharma*, 1-19.iv.1976.

This species comes close to *Leptoteleia bicolor* (Harrington)[1] in having almost the same general colour of body ; head black ; tip of abdomen black, abdomen matt, longer than the rest of the body, third tergite quadrate but differs very much in the following respects : much longer body ; different proportions of antennal segments, only the club black, wings hyaline not weakly yellow, reach up to the hind margin of fourth abdominal tergite ; third tergite not smooth and shiny, but longitudinally striate, half of the third tergite and following tergites not black. This species runs to couplet 15 in Masner's[2] key and shares

1. (Harrington), 1899. *Canad. Ent.*, **31** : 79 (*Baryconus*).
   Kieffer, J. J. 1926. *Das Tierreich*, **48** : 477.
2. Masner, L. 1978. *Canad. Ent.*, **110** : 353-380.

some characters with *L. verae* Masner and *L. marcelae* Masner and can be placed in between the two. It is close to *L. verae* Masner in having antennal clave 6-segmented ; metanotal lamina semi-oval, almost horizontal, rounded posteriorly ; notauli fine and quite distinct but differs in slightly smaller size of the body ; metanotal lamina not notched medially ; notauli not abbreviated anteriorly and head black in contrast to ferrugenous-brown body. It resembles *L. marcelae* Masner in general appearance ; sculpture ; head black in contrast to ferrugenous-brown body ; presence of central keel running up from antennal insertion ; metanotal lamina horizontal ; but differs in much larger size of the body ; metanotal lamina not subtriangular, not bisected into two halves ; notauli present ; antennal clava not pentamerous. This species comes under the *oecanthi*-group and the xanthic *marcelae* subgroup.

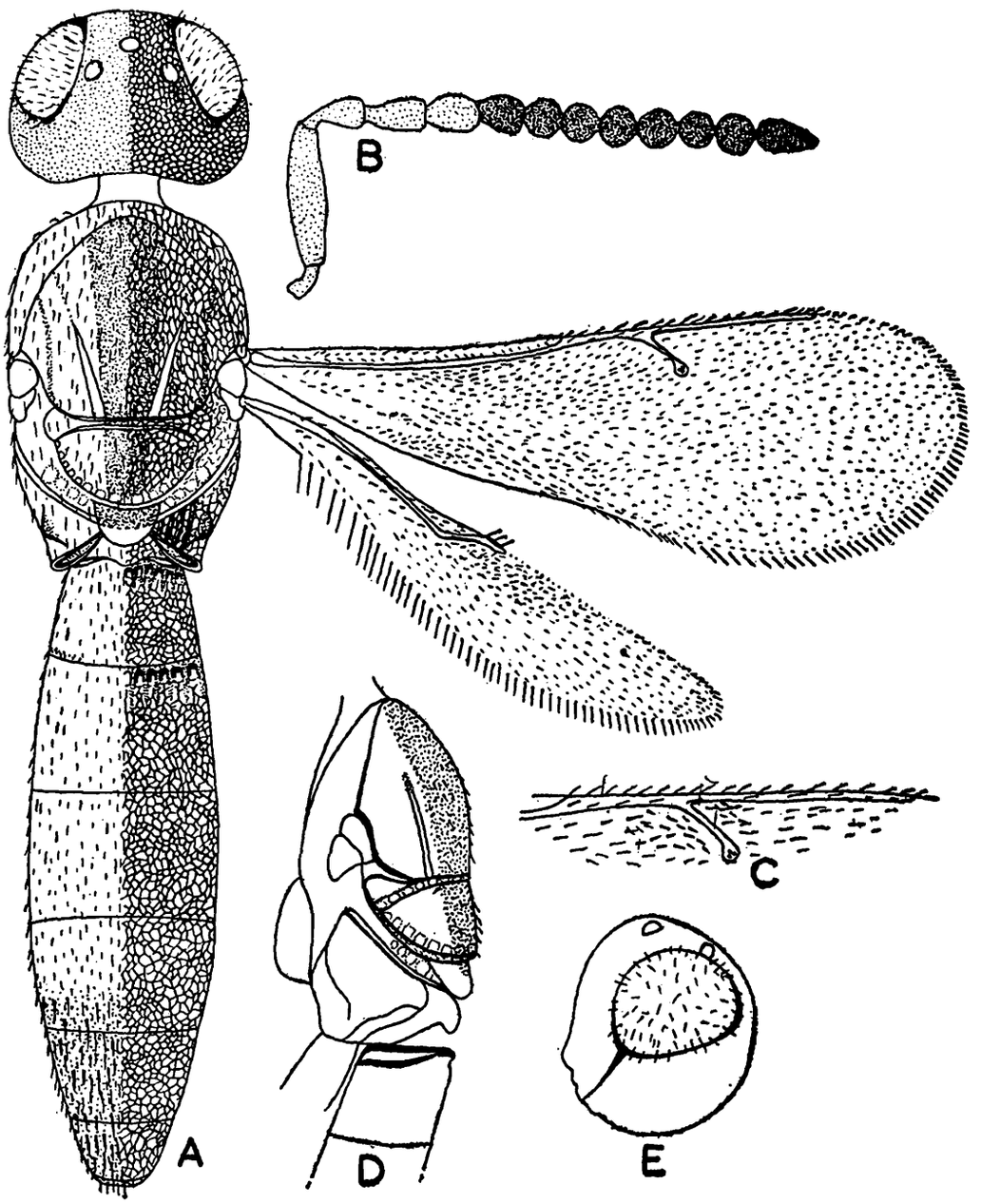
6. **Leptoteleia peninsularis** sp. nov.

(Text-fig. 6)

Male : Length of holotype 2.62 mm, length of other material examined 2.80 mm, mean 2.71 mm ; fore wing 1.66-1.70 mm ; hind wing 1.32-1.36 mm ; head 0.36 mm ; thorax 0.86-0.96 mm ; abdomen 1.40-1.48 mm. Body dark brown to black ; head black, eyes brown ; scape, pedicel and first 2 funicular segments yellowish-brown, rest of antenna brown ; thorax honey brown, mesoscutum and middle of scutellum black, scapula, sides of scutellum, metanotal lamina and propodeum, honey brown, legs yellowish-brown to brown, wings hyaline ; abdomen largely black.

Head almost cubical ; viewed from above (Text-fig. 6 A) width to length 100 : 72 ; vertex with fine, reticulate, leathery sculpture ; occipital carina complete ; ocellocular space 0.50 the ocellar diameter, front ocellar space 2.50 times the ocellar width, interocellar space 3.50 times the ocellar width ; eyes very densely pubescent, eye length to head length 72 : 100 ; frons with a small, shallow, emarginate depression ; head viewed from side (Text-fig. 6 E) genal carina very well developed. *Antenna* (Text-fig. 6 B) including radicle 1.24 mm, segments 12, 1.1.9.1, all antennal segments uniformly thick ; scape 4.33 times longer than thick, including radicle only slightly less than the following 3 segments combined ; pedicel 2 times longer than thick, 0.38 the scape. First 3 funicular segments long, 4-9 moniliform ; first funicular segment longest, 1.83 times longer than thick, only slightly longer than pedicel ; second and third equal, 1.33 times longer than thick, 0.72 the first ; 4-9 equal, as long as thick, 0.75 the third. Club subconic, 2 times longer than thick, equal to preceding 2 funicular segments combined.

Thorax (Text-fig. 6 A, D) : Mesonotum and scutellum with larger, rugosoleathery sculpture than head. Thorax with fine pubescence, without punctae ; notauli incomplete, broader posteriorly and abbreviate anteriorly with a faintly indicated line, without parapsidal carinae ; scutellum semicircular behind with carinate margin ; metanotum narrow, produced into a large, horizontal lamina in the middle, lamina originates from



Text-fig. 6. *Leptoteleia peninsularis* sp. nov. ♂ A. body dorsal view, B. antenna, C. veins enlarged, D. thorax in profile, E. head in profile.

the anterior margin of metanotum and projects over the propodeum, its tip is transluscent ; propodeum unarmed, posterior margin strongly carinate and elevate for fitting the first abdominal segment, a blunt tooth is present laterally on propodeum. Fore wing (Text-fig. 6 A, C) length to width 100 : 33, venation *sm* : *m* : *pm* : *st* 327 : 100 : 172 : 54 ; fore wing to hind wing 100 : 80.

Abdomen (Text-fig. 6 A) : Seven segmented, elongate, broadly connected with the thorax ; first and second tergites largely longitudinally striate on anterior margins only, otherwise the entire abdomen with fine, rugoso-leathery sculpture ; abdomen 1.16 times longer than rest of the body. First tergite without hump, but lifted anteriorly into a blunt, tooth-like process ; first tergite 1.45 times wider than long ; second 1.35 times wider than long ; third equal to the second, only slightly wider ; fourth 1.54 times wider than long, slightly shorter than the third ; fifth 1.60 times wider than long, 0.77 the fourth ; sixth 1.66 times wider than long, 0.60 the fifth ; seventh rudimentary, strip-like.

Holotype : Male on card, wings and antenna on slide, 5.11. Parikatti Hill (Walayar Forest) : South India. Coll. *M. S. Mani & G. G. Saraswat*, 26. iii. 1972. *Other material examined* : One male on card, wings and antenna on slide, 9.2. Nilambur (Malabar) : South India. Coll. *M. S. Mani & G. G. Saraswat*, 3-4.iv.1973.

This species differs very much from *L. bengalensis* Saraswat in having smaller size of the body ; general colour ; body sculpture ; incomplete, abbreviate notauli ; different shapes of scutellum, metanotal lamina, propodeum and abdomen. This comes close to *L. martae* Masner* in general appearance ; general colour of the body ; colour of antennae ; sculpture ; emarginate, shallow frontal depression ; eyes with dense and long pilosity and fifth tergite being distinctly transverse, 1.60 times wider than long ; but differs in having larger size of the body; notauli abbreviate anteriorly ; metanotal lamina much shorter ; dorsal propodeal carinae not parallel in their upper part ; fore wings reaching a little beyond the upper margin of the fifth abdominal tergite ; first tergite without hump. This species also comes under the *oecanthi*-group and the melanic *oecanthi*-subgroup.

7. **Opisthacantha bengalensis** Sharma

1978. *Opisthacantha bengalensis* Sharma, In Saraswat & Sharma, *Mem. Sch. Ent.*, **5** : 42-44, fig. 21.

I have before me two specimens of *O. bengalensis* Sharma from the same lot as originally described. Because the holotype and one paratype were mounted on slides it was not possible to sketch the body very accurately and to describe various structures. Since these two specimens are on cards, I add some points as supplement to the original description.

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* Masner, L. 1978. *Canad. Ent.*, **110** : 353-380.

Male : Two males on cards, 16.1. Alipur Duar : Hasimara (North-Bengal Survey). Coll. *M. S. Mani & S. K. Sharma*, 1-19. iv. 1976. Length of body 2.06-2.32 mm ; fore wing 1.64-1.82 mm ; hind wing 1.40-1.50 mm ; abdomen 1.04-1.30 mm. General colour of body honey-brown ; eyes and bases of ocelli black ; wings subhyaline ; abdominal tergites 4-7 black.

Head as wide as thorax ; viewed from above width to length in the middle 100 : 50, vertex matt with few setae ; interocellar space 3.20 to about 4.00 times the ocellar diameter ; eyes finely pubescent ; frons with a small, shallow, emarginate depression in the middle, strongly keeled in the middle, sculpture as on vertex, genae longitudinally striate ; mandibles strong, large, curved, tridentate, middle tooth smaller. *Antenna* 1.88 mm, flagellum long, uniformly thick ; funicular segments 3-7 equal, 4 times longer than thick ; segments 8 and 9 equal, 3.50 times longer than thick.

Thorax viewed dorsally, metanotum broadly, medially expanded to form a semihorizontal, smooth, flat, subtriangular plate ; lateral margins of the plate straight with rounded corners ; middle tooth strongly developed, pointed and ridged in the middle ; viewed laterally, metanotal tooth projects out beyond the general surface of thorax ; postero-lateral margin of propodum with 'Y'-shaped carina ; fore wing length to width 100 : 36, venation *sm* : *m* : *pm* : *st* 1025 : 100 : 375 : 150.

Abdomen with 7 tergites, flattened, elongate spatulate, finely reticulate, reticulations very prominent on 4-7 tergites, clothed with fine setae ; tergites 4-7 slightly ridged in the middle ; tergites 1-6 in the ratio of 9 : 14 : 15 : 9 : 5 : 2.

Summary

This paper contains descriptions of two new and one already known species of *Macroteleia*, one new species of *Dichoteleas* and two new species of *Leptoteleia*. Supplementary notes are added to *Opisthacantha bengalensis* Sharma. The two genera *Dichoteleas* and *Leptoteleia* are being recorded for the first time from India.

Rec. zool. Surv. India, 79 : 359-362,

ON A NEW GENUS *SPORONCHULOIDES* WITH NOTES ON *SPORONCHULUS* (COBB, 1917) PENNAK, 1953 (MONONCHIDA : NEMATODA)*

By

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(With 1 Text-figure)

A new genus *Sporonchuloides* allied to the genera *Actus* Baqri and Jairajpuri, 1973 and *Prionchulus* (Cobb, 1916) Wu & Hoeppli, 1929 is proposed to accommodate *Sporonchulus ibitensis* (Carvalho, 1951) Andrássy, 1958 and *S. coronatus* (Carvalho, 1956) Andrássy, 1958. The generic diagnosis of *Sporonchulus* (Cobb, 1917) Pennak, 1953 is emended.

A survey undertaken to bring to light various predatory nematodes inhabiting the soils of Kerala yielded among others *Sporonchulus ibitensis* (Carvalho, 1951) Andrássy, 1958. Study of the material revealed that this species differed significantly from other species of the genus *Sporonchulus* (Cobb, 1917) Pennak, 1953. Jairajpuri (1971) pointed out this difference and removed *S. ibitensis* and *S. coronatus* from the genus and remarked that these two species should be grouped under a separate genus. A new genus *Sporonchuloides* is proposed to accommodate *S. ibitensis* and *S. coronatus*, where two rows of denticles on subventral wall of stoma are arranged in longitudinal ribs, based on the studies of *S. ibitensis* from Kerala (Mohandas, 1972). The identity of the species has been confirmed by R. H. Mulvey (Personal communication) after examination of specimens from Sri Lanka from where *S. ibitensis* had been originally described. Baqri and Jairajpuri (1973) proposed a new genus *Actus* to accommodate those species of *Sporonchulus* in which denticles are arranged longitudinally on subventral wall of stoma, but without ribs. Due to these changes the genus *Sporonchulus* (*Sens. str.*)

*Part of the Ph. D. thesis of the senior author approved by the University of Kerala.

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is at present represented only by the type species *S. dentatus* and two others. Hence the generic diagnosis of the genus has been emended.

Sporonchulus (*Sens. str.*)

Emended diagnosis

Dorsal tooth midway or anterior in buccal cavity opposed by numerous denticles which are irregularly arranged. Caudal glands and terminal opening present or absent. Tail conoid, ventrally arcuate. Male unknown.

Type species : *Sporonchulus dentatus* (Cobb, 1917) Andrássy, 1958

Other species : *S. recessus* (Cobb, 1917) Mulvey, 1963

S. vagabundus Jairajpuri, 1971

Sporonchuloides Gen. Nov.

Diagnosis : Dorsal tooth in anterior half of buccal cavity, opposed by numerous denticles arranged in longitudinal rows among which at least two are arranged in longitudinal ribs. Caudal glands and terminal opening present or absent. Tail conoid, ventrally arcuate. Male known only for the type species.

Differential diagnosis : This genus comes close to the genera *Prionchulus* in the presence of denticulate ribs and *Actus* in the presence of longitudinally arranged rows of denticles on sub ventral walls of stoma. From the former it could be distinguished by the additional row of longitudinally arranged denticles on the subventral wall and from the latter by the presence of longitudinal denticulate ribs.

Systematic position : As this genus resembles more to *Prionchulus* than to any other genera, it is being removed from the subfamily Sporonchulinae and family Mylonchulidae and placed under the family Mononchidae, close to the genus *Prionchulus*.

Type species : *Sporonchuloides ibitensis* (Carvalho, 1951) n. comb.

Syn. *Sporonchulus ibitensis* Carvalho, 1951

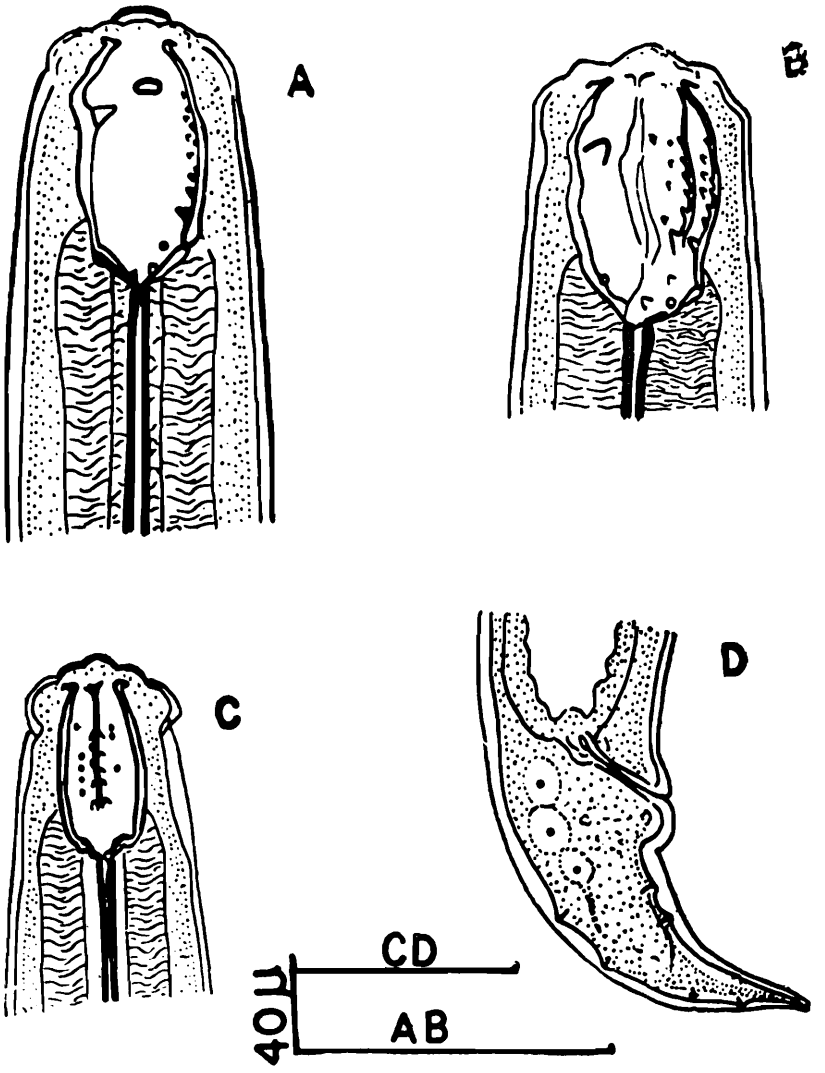
Other species : *Sporonchuloides coronatus* (Carvalho, 1956) n. comb.

Syn. *Sporonchulus coronatus* (Carvalho, 1956) Andrássy, 1958.

Sporonchuloides Ibitensis (Carvalho, 1951) N. Comb.

(Text-fig. 1, A-D)

Measurements : 21 ♀ ♀ : L=1.24–1.43 mm ; a=20–28 ; b=3.9–4.4 ; c=23–28 ; c'=1.7–2.1 ; tail length 47–60 μm, 3.6–4.3% of body length : V=60–63 ; buccal cavity=14–18×28–30 μm.



Text-fig. 1. *Sporonchuloides ibitensis* (Carvalho, 1951) N. Comb. A=Anterior end ; B—Dorsolateral view showing denticulate ribs ; C—Dorsoventral view ; D—Posterior end.

4 ♂♂ : L=1.18–1.28 mm ; a=27–30 ; b=3.8–4.0 ; c=23–24 ; c'=1.6–1.7 ; tail length=52–54 μm, 4.2–4.4% of body length ; Spicules 30—35 μm ; buccal cavity=15–16×30–31 μm.

Description : Buccal cavity about twice as long as wide, dorsal tooth anterior, 20–21 μm from base of stoma, opposed by four longitudinal rows of denticles of which the middle two rows are arranged each on a longitudinal rib. Oesophago-intestinal junction non-tuberculate. Female reproductive system didelphic, amphidelphic. Testes opposed and outstretched. Spicules slender, supplements 11-12, poorly developed. Tail short, elongate conoid and ventrally arcuate.

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Rec. zool. Surv. India, 79 : 363-365, 1982

NOTES ON *RANA DOBSONII* BOULENGER

By

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Rana dobsonii (Subgenus *Tomopterna*, Family Ranidae) was erected by Boulenger in 1882 on the basis of two female specimens collected at Mangalore, now preserved in the British Museum, London. There has not been any subsequent record of this species. The present record, therefore, is of considerable interest, more so because it is from the east coast of India while the types were from the West coast (S. Canara). Nothing is known about the ecology of this species.

Three lots of a total of 28 examples have been collected from scrub jungles at Vandalur and Kambakkam. Vandalur is about 50 km south of Madras in the Chingleput District of Tamilnadu. Kambakkam is about 100 km north in the Chittoor district of Andhra Pradesh. All of them were taken from rainwater puddles during the N. E. Monsoon months of October to December, 1977. They were mostly juveniles, the largest being a female measuring 32.5 mm from the tip of snout to vent.

Reference may be made to Boulenger (1920) for a good description. Additional notes are given below.

Profile microhylid like. Tympanum smaller being only about half the diameter of eye. First finger much longer than second and a trifle shorter than third. Tibia stouter and shorter being at best $2\frac{1}{2}$ times as long as broad. Webbing rudimentary, $3\frac{1}{2}$ to 4 digits of fourth toe free. Inner metatarsal tubercle large, crescentic and $1\frac{1}{2}$ to $1\frac{3}{4}$ times as long as first toe (measured from the distal extremity of the tubercle). Skin finely granulate or with small inconspicuous tubercles. Some have elongated warts disposed symmetrically along the back which tend to vanish in distended specimens. A strong glandular fold from eye to shoulder. Two whitish glandules behind angle of jaws. Belly and lower parts of thighs granulate in the larger examples ; smooth and translucent in the smaller ones. Grey or light brown above with slightly darker, oval or irregular patches on dorsum encircling the tubercles. Supratympanic fold deeply coloured on its lower aspect. Two dark bars from the two upper eyelids running a little backwards without meeting each other. A broad verte-

bral patch from snout to vent which is sometimes divided by a thread-like dark middle line. Limbs cross-barred. Ventral side immaculate, throat faintly spotted in some. Some examples show a tiny whitish tubercle placed on the inner aspect of the tibio-tarsal articulation in a line with the inner metatarsal tubercle as reported in *Rana breviceps* (Bhaduri and Kripalani, 1954).

The only features available in literature to distinguish *R. dobsonii* from *R. breviceps* is its snout being equal to eye in length and the rudimentary web on toes (Daniel, 1975). Study of the present examples has brought out more differences between these two confusing species as summarised below. *Rana breviceps* has also been collected from the same locality.

Rana dobsonii	*Rana breviceps*
1. Snout equal to diameter of eye.	1. Snout less than eye.
2. Occiput not swollen.	2. Occiput swollen.
3. When apposed, second finger much shorter than first.	3. Second a little shorter than first finger.
4. Heels meeting when limbs are folded at right angles to body.	4. Heels not meeting.
5. Tibio-tarsal tubercle when present small and inconspicuous.	5. Larger and more pronounced.
6. Webbing rudimentary.	6. Atleast one-third webbed.
7. Subarticular tubercles fairly conspicuous.	7. Subarticular tubercles not conspicuous.

One example of a male of *Rana dobsonii* which was hitherto unknown has been discovered from the present lot by examination of the gonad. External sex differences are wanting presumably because the specimen is immature.

The close similarity in terrain and vegetation between the scrub jungles of Vandalur and Kambakkam from where the present material was collected is undoubtedly a pointer to the type of habitat that is preferred by this species. The soil is hard and dry during the greater part of the year and vegetation consists only of thorny shrubs. Their food, as evidenced from stomach content examination, consisted of millipedes, centipedes, caterpillar, beetles, hymenopterans, gryllid, winged termite and earthworm.

Three species from India and one from Pakistan have been recognised under the subgenus Tomopterna by Boulenger (1920). Rao (1937) has described two more species from South India making a total of six. A key which identifies these species is given in the next page.

Genus *Rana*

Subgenus *Tomopterna*

1.	First finger nearly equal to the second ...	...	2
—	First finger longer than second ...	...	3
2.	Inner metatarsal tubercle spurshaped, outer tubercle conspicuous ...		*R. strachani*
—	Inner metatarsal tubercle not spur-shaped, outer not conspicuous ...		*R. parambikulamana*
3.	A small outer metatarsal tubercle present ...	...	4
—	Outer metatarsal tubercle absent ...	...	5
4.	Tarsal fold present on inner side, no fold from eye to shoulder, dorsum smooth. ...		*R. leucorhynchus*
—	No tarsal fold, strong fold from eye to shoulder, dorsum warty. ...		*R. rufescens*
5.	Snout shorter than eye, toes $\frac{1}{4}$ to $\frac{1}{2}$ webbed ...		*R. breviceps*
—	Snout as long as eye, web on toes rudimentary ...		*R. dobsonii*

ACKNOWLEDGEMENT

I am grateful to the Director, Zoological Survey of India for all facilities.

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Rec. zool. Surv. India, **79** : 367-371, 1982

ON A COLLECTION OF PHYTOSEIIDAE (ACARINA : MESOSTIGMATA) FROM MADHYA PRADESH AND UTTAR PRADESH WITH DESCRIPTION OF A NEW SPECIES OF *PHYTOSEIUS* RIBAGA

By

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(With 1 Text-figure)

So far no information is available on the phytoseiid fauna of Madhya Pradesh and only one species is known till date from Uttar Pradesh. In connection with study on Indian Phytoseiidae the author had an opportunity to survey some parts of Madhya Pradesh and could make some collection from there. Besides, a small collection from Uttar Pradesh was available through the courtesy of one of his colleagues. The present paper is based on material of these two states. Altogether, eleven species belonging to four genera are treated in this paper, of these, one species of the genus *Phytoseius* Ribaga, is described here as new to science. Chant *et al.* (1974) was followed for setal nomenclature and Chant (1965) was followed as to the concept of the genera. All the measurements are in microns.

Types are deposited in the National Collection of the Zoological Survey of India, Calcutta.

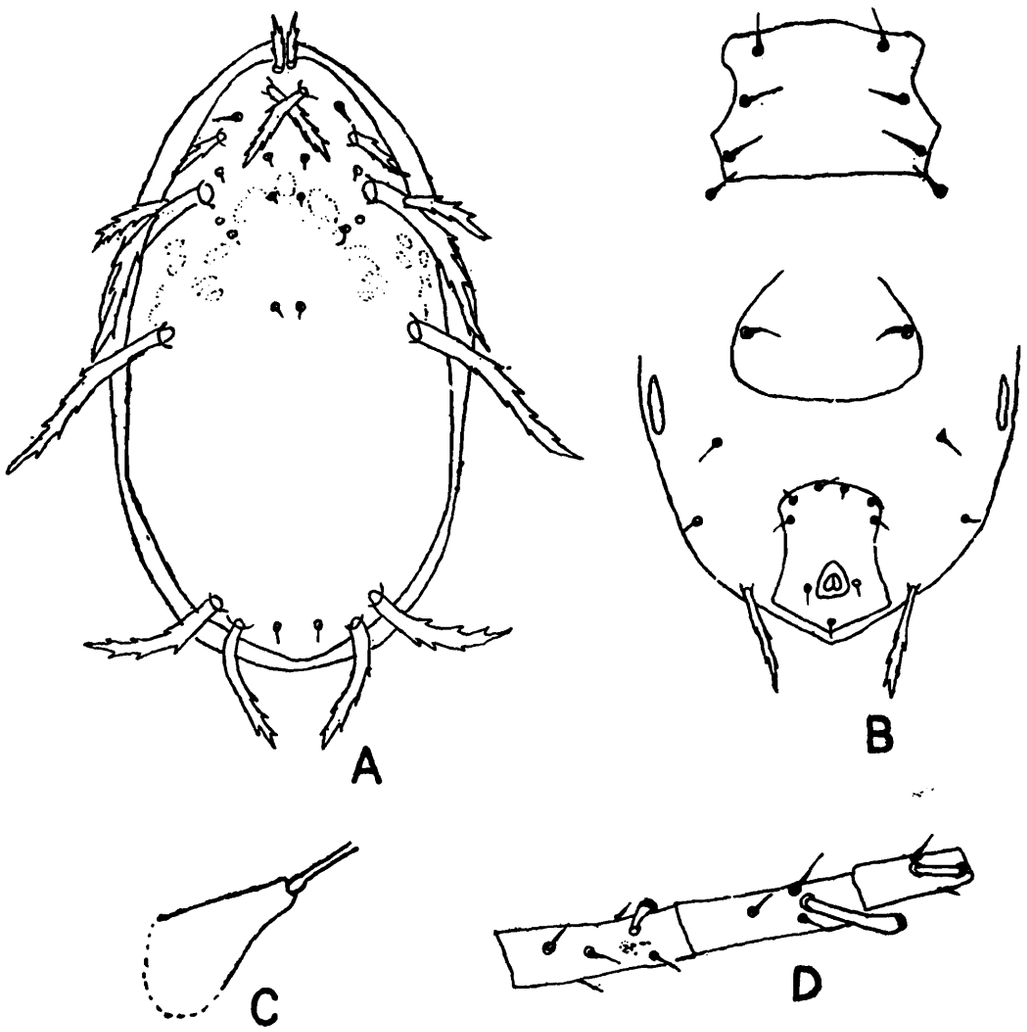
Phytoseius (Phytoseius) jaunpurensis sp. nov.

(Text-fig. 1)

Female : Dorsal shield 275 long, 150 wide with 14 pairs of setae of which j_1, j_3, s_4, s_6, Z_5 and Z_4 long and serrate, other setae being minute. Measurements of setae j1-25, j4-j6-6 each, j3-50, z2-12, z3-36, s3-12, s4-100, s6-100 Z5-66, z5-6, Z4-70, r3-44. Sternal shield with 3 pairs of sternal setae, 4th. pair of setae lie on interscutal membrane, metasternal plate absent. Genital shield normal with a pair of genital setae. Ventrianal shield 72 long, 48 wide, lateral margins deeply concave with three pairs of small preanal setae, 3 pairs of setae present around ventrianal shield, 1 pair of metapodal plates present. Spermatheca as in figure. Leg chaetotaxy : genu II 7 setae (4 dorsal, 3 lateral), genu III 6 setae (4 dorsal, 2 lateral), genu IV 7 setae (4 dorsal, 2 lateral,

1 ventral), tibia II 7 setae (3 dorsal, 2 lateral, 2 ventral) ; macrosetae on leg IV : genu-16, tibia-36, basitarsus-22.

Male : Unknown.



Text-fig. 1. *Phytoseius* (*Phytoseius*) *jaunpurensis* sp. nov.

Holotype : ♀, INDIA : U. P., Jaunpur, on *Zizyphus jujuba* Lamk., 22. x. 1974 (Coll. *Y. N. Gupta*). 1 Paratype ♀, data same holotype (ZSI Reg. Nos. 3435/17) and 3436/17.

Remarks : This new species is very close to *Phytoseius* (*Dubininellus*) *coheni* Swirski and Shechter (1961), but differs from it in having s4, s6, Z5 and Z4 longer and in spermatheca differing in shape. It further differs from another related species, *P.* (*P.*) *huangi* Ehara (1970) in having s4, s6, Z5 and Z4 being longer and in the absence of the platelets around ventrianal shield.

Phytoseius (Phytoseius) roseus Gupta

Phytoseius (*Dubininellus roseus* Gupta, 1969 *Israel J. Agric. Res.* **19** : 119-120.

Material : 1 ♀, 1♂, U. P., Izzatnagar, on guava, 6. i. 1977 (Coll. *Y. N. Gupta*) ; 4 ♀ ♀, Izzatnagar, on beans, 6. i. 1977 (Coll. *Y. N. Gupta*).

Distribution : INDIA : West Bengal, U. P. (new record).

Phytoseius (pennaseius) kapuri Gupta

Phytoseius (*Phytoseius*) *kapuri* Gupta, 1969 *Israel J. Agric. Res.* **19** : 115-117.

Material : 7 ♀ ♀, 1 ♂, M. P., Mandasor Agril. farm, on brinjal, 8. v. 1975 (Coll. *S. K. Gupta*).

Distribution : India : West Bengal, M. P. (new record).

Indoseius ricini Ghai and Menon

Indoseius ricini Ghai and Menon, 1969 *Oriental Ins.* **3** : 348.

Material : 2 ♀ ♀, U. P., Jaunpur, on *Ricinus communis*, 17. x. 1974 (Coll. *Y. N. Gupta*).

Distributian : INDIA : Tamil Nadu, U. P. (new record).

Typhlodromus rickeri Chant

Typhlodromus rickeri Chant, 1960 *Canadian Entomol.* **92** : 62-64.

Material : 3 ♀ ♀, M. P., Panchmarhi, on an unidentified host, 30. iv. 1975 (Coll. *S. K. Gupta*).

Distribution : INDIA : Meghalaya, Karnataka, M. P. (new record).

Typhlodromus homalii Gupta

Typhlodromus homalii Gupta, 1970 *Oriental Ins.* **4** : 188-189.

Material : 1 ♀, U. P., Jaunpur, on *Zizyphus jujuba* Lamk., 22. x. 1973. (Coll. *Y. N. Gupta*).

Distribution : INDIA : West Bangal, U. P. (new record).

Amblyseius alstoniae Gupta

Amblyseius alstoniae Gupta, 1975 *Intl. J. Acar.* **1** : 31-32.

Material : 12 ♀ ♀, 1 ♂, U. P., Jaunpur, on grass, 17. x. 1974 (Coll. *Y. N. Gupta*) ; 4 ♀ ♀, Jaunpur, on rose, 17. x. 1974. (Coll. *Y N. Gupta*) ; 7 ♀ ♀, 2 ♂ ♂, Jaunpur, on *Nyctanthes arbortristis*, 17. x. 1974 (Coll. *Y. N. Gupta*) ; 1 ♀, M. P., Raipur, Lavandi Agril. farm, on guava, 21. iv. 1975 (Coll. *S. K. Gupta*) ; 6 ♀ ♀, Chhindwara,on *Ficus*, 25. iv. 1975 (Coll. *S. K. Gupta*) ; 2 ♀ ♀, Chhindwara, on guava, 26. iv. 1975 (Coll, *S. K. Gupta*) ; 1 ♀, Mandasor, on *Citrus*, 3. v. 1975 (Coll. *S. K. Gupta*) ; 2 ♀ ♀, Dhar, on an ornamental plant, 4. v. 1975 (Coll. *S. K. Gupta* ; 4 ♀ ♀, 1 ♂, Rupmati, on an ornamental plant, 5. v. 1975 (Coll. *S. K. Gupta*) ; 7 ♀ ♀, Mandasor Agril. farm, on grape vines, 8. v. 1975

(Coll. *S. K. Gupta*) ; 4 ♀ ♀, Mandasor Agril. farm, on guava and citrus, 8. v. 1975 (Coll. *S. K. Gupta*) ; 5 ♀ ♀, Mandasor, on rose, 8. v. 1975 (Coll. *S. K. Gupta*) ; 2 ♀ ♀, Mandasor Agril. farm, on beans, 8. v. 1975 (Coll. *S. K. Gupta*) ; 9 ♀ ♀, Dhodhar, on mulbery, 9. v. 1975 (Coll. *S. K. Gupta*) ; 1 ♀, Nimach, on sunflower, 10. v. 1975 (Coll. *S. K. Gupta*) ; 7 ♀ ♀, 3 ♂ ♂, Shivpuri, Govt. garden, on an ornamental plant, 13. v. 1975 (Coll. *S. K. Gupta*) ; 5 ♀ ♀, Shivpuri, Govt. garden, on guava, 13. v. 1975 (Coll. *S. K. Gupta*) ; 4 ♀ ♀ Shivpuri National Park, 15. v. 1975 (Coll. *S. K. Gupta*) ; 4 ♀ ♀, 1 ♂, Shivpuri Govt. garden, on pomegranate, 15. v. 1975. (Coll. *S. K. Gupta*).

Distribution : India : West Bengal, U. P. (new record), M. P. (new record).

Amblyseius coccineae Gupta

Amblyseius coccineae Gupta, 1975 *Intl. J. Acar.*, **1** : 33.

Material : 5 ♀ ♀, M. P., Chhindwara, on *Ficus*. 25. iv. 1975 (Coll. *S. K. Gupta*) ; 5 ♀ ♀, 1 ♂, Chhindwara, on *Polianthes tuberosa*, 26. iv. 1975 (Coll. *S. K. Gupta*) ; 6 ♀ ♀, 1 ♂, Panchmarhi, on an unidentified host, 28. iv. 1975 (Coll. *S. K. Gupta*) ; 4 ♀ ♀, Panchmarhi, on *Shorea robusta*, 28. iv. 1975 (Coll. *S. K. Gupta*) ; 1 ♀, Panchmarhi, on *Eucalyptus*, 28. iv. 1975 (Coll. *S. K. Gupta*) ; 1 ♀, Piparia, on mango, 29. iv. 1975 (Coll. *S. K. Gupta*) ; 1 ♀, Mandu, on fig. 2. v. 1975 (Coll. *S. K. Gupta*).

Distribution : INDIA : West Bengal, M. P. (new record).

Amblyseius bhadrakaliensis Gupta

Amblyseius bhadrakalinsis Gupta 1969 *Bull. Ent.*, **10** : 127-128.

Material : 1 ♀, U. P., Jaunpur, on an unidentified plant, 17. x. 1974 (Coll. *S. K. Gupta*) ; 10 ♀ ♀, Jaunpur, on brinjal. 24. x. 1974 (Coll. *S. K. Gupta*).

Distribution : INDIA : West Bengal, U. P. (new record).

Amblyseius kalimpongensis Gupta

Amblyseius kalimpongensis Gupta, 1969 *Bull. Ent.* **10** : 126-129.

Material : 4 ♀ ♀, M. P., Chhindwara, on *Lantana*, 26. iv. 1975 (Coll. *S. K. Gupta*) ; 8 ♀ ♀, Panchmarhi, on *Shorea robusta*, 28. iv. 1975 (Coll. *S. K. Gupta*) ; 20 ♀ ♀, Panchmarhi, on an unidentified host, 28. iv. 1975 (Coll. *S. K.* Gupta) ; 1 ♀, Piparia, on peach, 29. iv. 1975 (Coll. *S. K. Gupta*) ; 16 ♀ ♀, Panchmarhi, on cashew-nut, 30. iv. 1975

(Coll. *S. K. Gupta*) ; 3 ♀ ♀, Mandu, on Chrysanthemum, 3. v. 1975 (Coll. *S. K. Gupta*).

Distribution : INDIA : West Bengal, U. P. (new record), M. P. (new record).

Amblyseius tetranychivorus (Gupta)

Material : 2 ♀ ♀, U. P., Izzatnagar, on *Citrus*, 6. i. 1977 (Coll. *Y. N. Gupta*).

Remarks : The same specimens were collected from Tamil Nadu, Kerala and Karnataka.

SUMMARY

Eleven species of Phytoseiidae belonging to four genera from Madhya Pradesh and Uttar Pradesh are treated in this paper. This included a new species of *Phytoseius*. All the species treated in this paper were hitherto unknown from these regions.

ACKNOWLEDGEMENTS

The author expresses grateful thanks to Dr. T. N. Ananthakrishnan, Director, Zoological Survey of India and to Dr. P. D. Gupta, Officer-in-Charge, Gangetic Plains Regional Station, Patna for the working facilities. Sincere thanks are also due to Mr. Y. N. Gupta, Acarology Section, Calcutta for placing his personal collection at the disposal of the author for study.

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CHANT, D. A., HANSELL, R. I. C. and YOSHIDA, E. 1974. The genus *Typhlodromus* Scheuten (Acarina : Phytoseiidae) in Canada and Alaska. *Canadian J. Zool.*, **52** : 1265-1291.

EHARA, S. 1970. Phytoseiid mites from Taiwan (Acarina : Mesostigmata). *Mushi*, **43** : 55-63.

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Rec. zool. Surv. India, **79** : 373-384, 1982

STUDIES ON THYSANOPTERA OF N. E. INDIA-4 TUBULIFERA FROM MANIPUR

By

N. MURALEEDHARAN

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(With 4 Text-figures)

The Cecidicolous and mycophagous Tubulifera of N. E. states of Assam, Meghalaya & Tripura were reported by Sen & Muraleedharan (1977) and Muraleedharan & Sen (1978,79) and an attempt has been made in this paper to present an account of Tubulifera of Manipur based on the material collected during a recent faunistic survey of this state.

Manipur is situated in the Eastern part of India between latitudes 23°7'-25°4' N and longitudes 93°6'-94°48' E. The state is completely land locked, bounded by the states of Nagaland, Mizoram, Assam, and Burma. The hilly terrain of Manipur is 900-3000 M high above sea level and out of an area of 22356 sq. Km. forests occupy a high percentage and nearly 92% of the total land area is hilly.

During this survey, collections were made from Moreh (Central Dist.) Ukhrul (East Dist.) and Churachandpur (South Dist.). All the specimens are deposited in the National Collections of the Zoological Survey of India.

SYSTEMATIC ACCOUNT

Order : THYSANOPTERA

Suborder : TUBULIFERA

Family : PHLAEOTHRIPIDAE

1. **Androthrips flavitibia** Moulton

1932. *Androthrips flavitibia* Moulton, *Indian For. Rec.* **XIX**(1) : 1-2.

Material : 1 ♀, (Z. S. I. Reg. No. 632/H17) MANIPUR, Moreh, 11. iii. 1979 (Coll. *N. Muraleedharan*).

2. **Apelaunothrips madrasensis** (Ananthakrishnan)

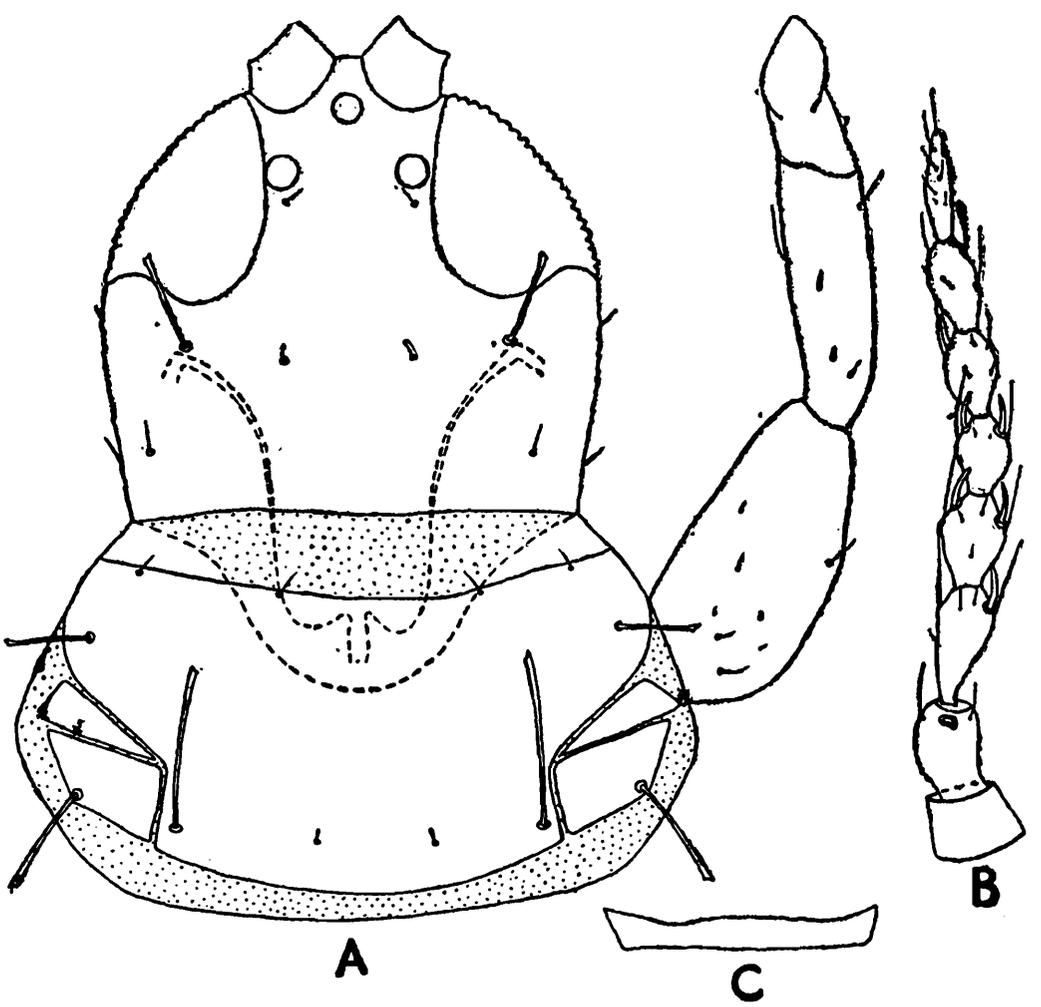
1964. *Malacothrips madrasensis* Ananthakrishnan, *Entomol Ts. Arg.* **86** (1-2) : 56-57.

Material : 1 ♂, (Z. S. I. Reg. No. 633/H17) MANIPUR, Churachandpur, 2. iii. 1979 (Coll. *N. Muraleedharan*).

3. **Araeothrips vamana** sp. nov.

Female (*Macropterons*) : Fig. 1 General body colour brown, tube darker ; antennal segments 1 and 2 brown, 3-7 uniformly pale yellow ; all femora brown, foretibiae pale yellow, proximal half of mid tibiae and $\frac{2}{3}$ of hind tibiae brown, rest pale yellow. Wings clear ; all setae hyaline and blunt.

Head distinctly broader than long *156-160 long, 176 wide across eyes, 180-184 across cheeks, 160-164 across base ; cheeks crenulate with 2-3 short prominent setae. Surface weakly reticulate. Eyes large, 72 long and 52-60 wide ; median ocellus 12 wide, placed on elevation, lateral ocelli 16 wide and located above middle of eyes. Postocular



Text-fig. 1. *Araeothrips vamana* sp. n., A. Head and pronotum, B. Antenna, C. Mesopraesternum.

setate 36 long, placed 16 below eyes. Antennal segments comparatively narrow, 7 and 8 much narrower than rest, segment 8 longest and extremely narrow. Segments 1-8 length (width) 1 : 24-28 (32) ; 2 : 36-40 (24) ; 3 : 44-48 (24) ; 4 : 36-40 (24-28) ; 5 : 40 (20) ; 6 : 36-40 (20) ; 7 : 40 (16) ; 8 : 48 (10-12). Antennal segment 3 and 6 with one sense cone

* All units in microns unless otherwise mentioned.

each and 4 and 5 with two sense cones each ; length of sense cones 12-16. Maxillary stylets thin, wide apart, retracted to the level of postocular setae. Mouthcone short, broadly rounded, 72-76 long, 164-168 wide at base and 72-80 wide at apex.

Prothorax shorter than head, 116-124 long, 192-200 wide at anterior margin 238-264 across posterior margin. Anterior pronotal setae vestigial, anteroangulars 4 long, anteromarginals net visible, mid laterals 36-44 long, epimerals 40-44 long, postangulars 60-64 long. Epimeral suture complete. Forefemora 120-128 long, 56-60 wide. Pterothorax 288-300 long, 280 wide across meso- and 276-280 across metathorax. Forewings 510-612 long, 44-48 wide, without double fringes. Basal wing bristles B_1-B_3 4, 16-28, 16-20 respectively. Mesopraesternum complete, slightly thickened at middle.

Pelta hat shaped. Abdomen 260-264 wide at base, 248-252 across middle, 200-212 across VIII, 116-132 across IX. B_1-B_3 of segment IX well developed, 92-120, 80-100, 116-148 long respectively. Tube 148-160 long and tube setae 112-140 long.

Total body length 1.47-1.59 mm.

Male (*Macropterous*) : Colour as in female. Head 140 long, 156 wide across eyes, 164 across cheeks and 152 across base. Eyes 60 long and 44 wide. Median ocellus 12 wide paired ones 16 wide. Postoculars 44 long, placed a little below eyes. Antennal segments 1-8 length (width) 1 : 24 (32), 2 : 36 (24), 2 : 44 (24), 4 : 32 (24), 5 : 32 (20), 6 : 36 (20), 7 : 32 (16), 8 : 42 (10). Sense cones 12 long. Mouthcone 68 long, 152 wide at base and 60 wide at apex.

Prothorax 104 long in median line, 176 wide at anterior margin, 220 wide at posterior margin. Anteroangulars 4 long, anteromarginal vestigal, midlaterals 28 long, postangulars 56 long and epimerals 36 long. Forefemora 104 long and 48 wide. Pterothorax 272 long, 240 wide across meso- and 232 across metathorax. Forewings 510 long, 48 wide and no double fringes present. B_1 of forewing vestigial, B_2 & B_3 16 and 20 long respectively.

Abdomen 224 wide at base, 220 wide across middle, 152 across segment VIII, 104 across segment IX. B_1-B_3 of segment IX well developed, 120, 40, 60 long respectively. Tube 132 long and anal setae 100 long.

Total body length 1.34 mm.

Material : *Holotype* ♀, (Z. S. I. Reg. No. 634/H17), *allotype* ♂ (Z. S. I. Reg. No. 635/H17), *paratypes* 2 ♀♀ (Z. S. I. Reg. No. 636-637/H17), MANIPUR, Moreh, 11. 3. 79, Ex. Wild plant. (Coll. *N. Muraleedharan*).

The genus *Araeothrips* Ananthakrishnan, is characterised by the head wider than long, short and broad mouthcone, long and narrowed terminal antennal segments with segment 8 longest and narrowest, poorly developed anterior prothoracic setae and well developed post-ocular setae. The new species is closely allied to *Araeothrips longisetis* Ananthakrishnan, the only other known species of the genus. *Araeothrips vamana* differs from *A. longisetis*, by the shorter setae, colouration of tibiae, arrangement of sense cones, absence of double fringes and the well developed B_2 of segment IX in both sexes. The discovery of this species from Manipur extends the range of distribution of *Araeothrips* Anan. (1976) from Central to N. E. India.

4. **Azaleothrips amabilis** Ananthakrishnan

1964 *Azaleothrips amabilis* Ananthakrishnan, *Entomol. Ts. Arg.* A. **3-4** : 221-222.

Material : 1 ♂, (Z. S. I. Reg. No. 638/H17) : MANIPUR, Churachandpur, 2. iii. 1979 (Coll. *N. Muraleedharan*).

5. **Bactrothrips idolomorphus** Karny

1910 *Bactrothrips idolomorphus* Karny, *Zeit. Wiss. Ins. Biol.* : 108, 116.

Material : 1 ♀, 2 ♂♂, (Z. S. I. Reg. No. 639-641/H17) ; MANIPUR, Ukhrul, 17. iii. 1976 (Coll. *N. Muraleedharan*).

*6. **Baenothrips asper** (Bournier)

1963. *Transithrips asper* Bournier *Publ. Cult. Co. Diain.* Angola **63** : 81.

Material : 1 ♀, (Z. S. I. Reg. No. 642/H17) MANIPUR, Churachandpur, 24. iii. 1979 (Coll. *N. Muraleedharan*).

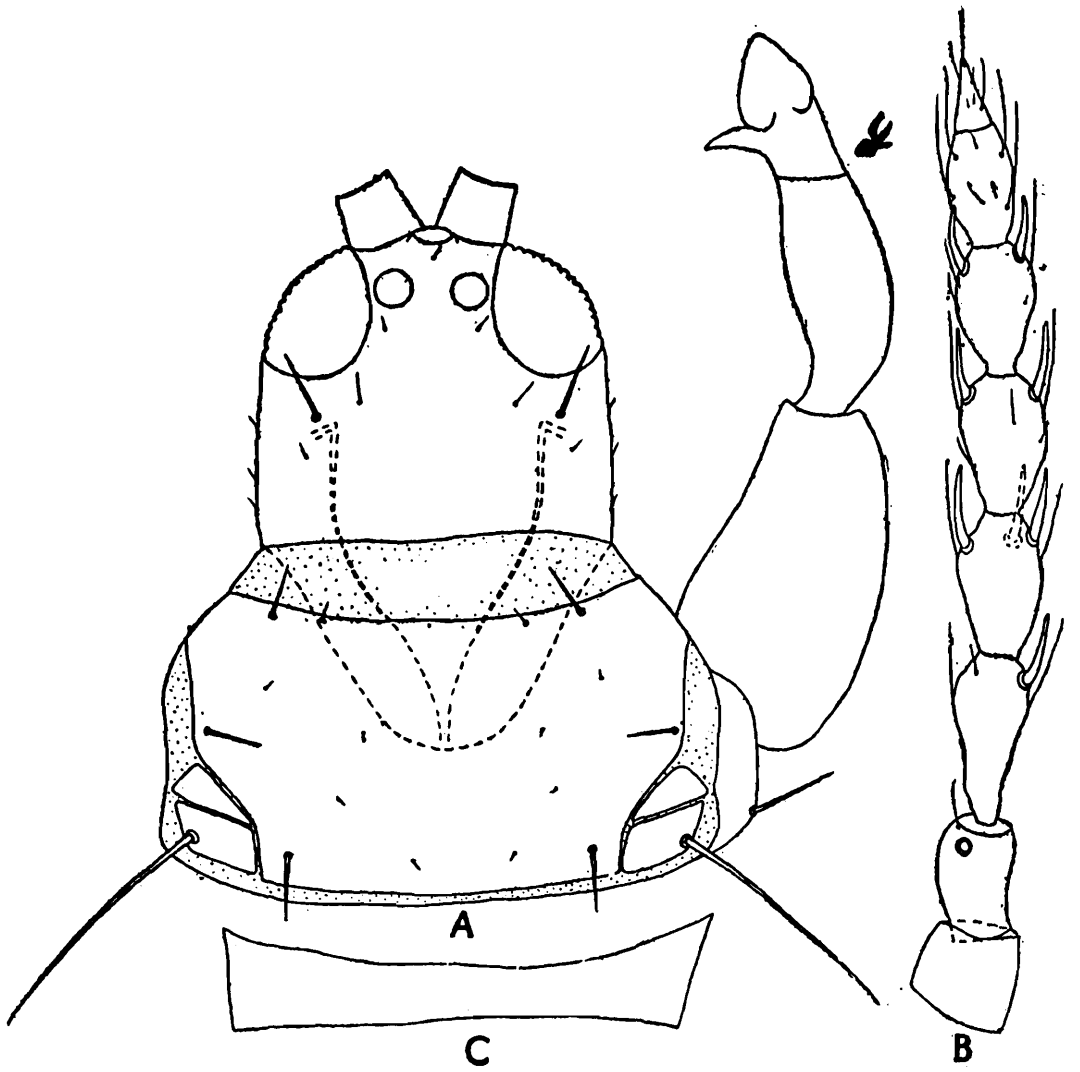
7. **Crotonothrips nagaensis** sp. nov.

Female (*Macropterous*) : (Text-fig. 2. A-C.) General body colour brown, posterior abdominal segments and tube darker, antennal segments 1 and 2 brown, 3-8 golden yellow ; all femora brown, foretibiae golden yellow, mid and hind tibiae brown, all tarsi yellow ; forewings infumate. All setae hyaline and pointed.

Head broader than long, 184-196 long, 192-200 wide across eyes, 216-220 wide across cheeks, 212-220 wide across base ; cheeks smooth, without prominent cheek setae, surface strongly reticulate. Eyes medium sized, 80-88 long, 56 wide. Median ocellus overhanging between

* See Mound (1972) for Synonymy

antennae, 20-24 wide and paired ones 24-26 wide. Postoculars 32-36 long, placed a little below eyes and much shorter than eyes. Antennal segments 3-7 pedicellate, 7 and 8 forming a unit ; segments 1-8 length (width), 1 : 40 (40-44), 2 : 52 (36), 3 : 64-68 (36), 4 : 60-64 (40), 5 : 60 (36), 6 : 60 (34), 7 : 56 (24-28), 8 : 28-30 (14-16). Mouthcone broad, 212-220



Text-fig. 2. *Crotonothrips nagaensis* sp. n., A. Head and pronotum, B. Antenna, C. Mesopraesternum.

wide at base and 100-120 wide at apex. Maxillary stylets wide apart, retracted below the level of postoculars.

Prothorax weakly sculptured, 180 long in madian line, 244-260 wide at anterior margin, 360-368 wide across posterior margin. Anteroangulars 24-32 long, anteromarginals 6 long, mid laterals 20-24 long, postangulars 20-32 long, epimerals 148-152 long ; epimeral suture complete. Pterothorax 442-459 long, 510 wide across meso- and 510-527 across metathorax. Forewings broad, 935 long, 104 wide with 17-20 double fringes. Basal wing bristles B_1-B_3, 24-40, 40-60, 52-60 long respectively. Mesopraesternum complete, narrow at middle.

Pelta roughly triangular. Abdomen weakly sculptured, 510 wide at base, 510 wild across middle, 368-372 wide across segment VIII, 200-208 across IX. B_1-B_3 of segment IX, 172-200, 96-120, 204-240 long respectively. Tube 288-296 long and tube setae 100 long.

Total body length 2.44-2.55 mm.

Material: *Holotype* ♀ (Z.S.I. Reg. No. 643/H17), *paratypes* 3 ♀ ♀ Z.S.I. Reg. Nos. 644-646/H17), MANIPUR, Moreh, 13. iii. 1979. Ex. leaf gall. (Coll. *N. Muraleedharan*).

The present species very closely resembles *Crotonothrips longirostris* Muraleedharan & Sen in general colouration but differs from the latter by the short and broad mouthcone, shorter body setae and maxillary stylets wide apart. In the shape of mouthcone and prothoracic chaetotaxy this species shows some affinity to *Crotonathrips parvus* Anan. but in the present species the epimeral setae and B_2 of IX are much longer than that of *Crotonothrips parvus* Ananthakrishnan.

8. *Ecacanthothrips tibialis (Ashmead)

1905. *Idolothrips tibialis* Ashmead *Ent. News.* **16** : 20.

Material: 1 ♀, (Z. S. I. Reg. No. 647/H17), MANIPUR, Moreh, 12. iii. 1979 Ex. dry twigs. (Coll. *N. Muraleedharan*).

*9. Elaphrothrips procer (Schmutz)

1913. *Dicaiothrips procer* Schmutz *Sber. Akad. Wiss. Wien* **122** : 73.

Material: 2 ♀ ♀ (Z. S. I. Reg. No. 648-649/H17), MANIPUR, Ukhrul, 17. iii. 1979 (Coll. *N. Muraleedharan*).

10. Hoplandrothrips flavipes Bagnall

1923. *Hoplandrothrips flavipes* Bagnall *Ann. Mag. nat. Hist.* **9** (12) : 624-631.

Material: 1 ♂, (Z. S. I. Reg. No. 650/H17), MANIPUR, Churachandpur, 23. iii. 1979 (Coll. *N. Muraleedharan*).

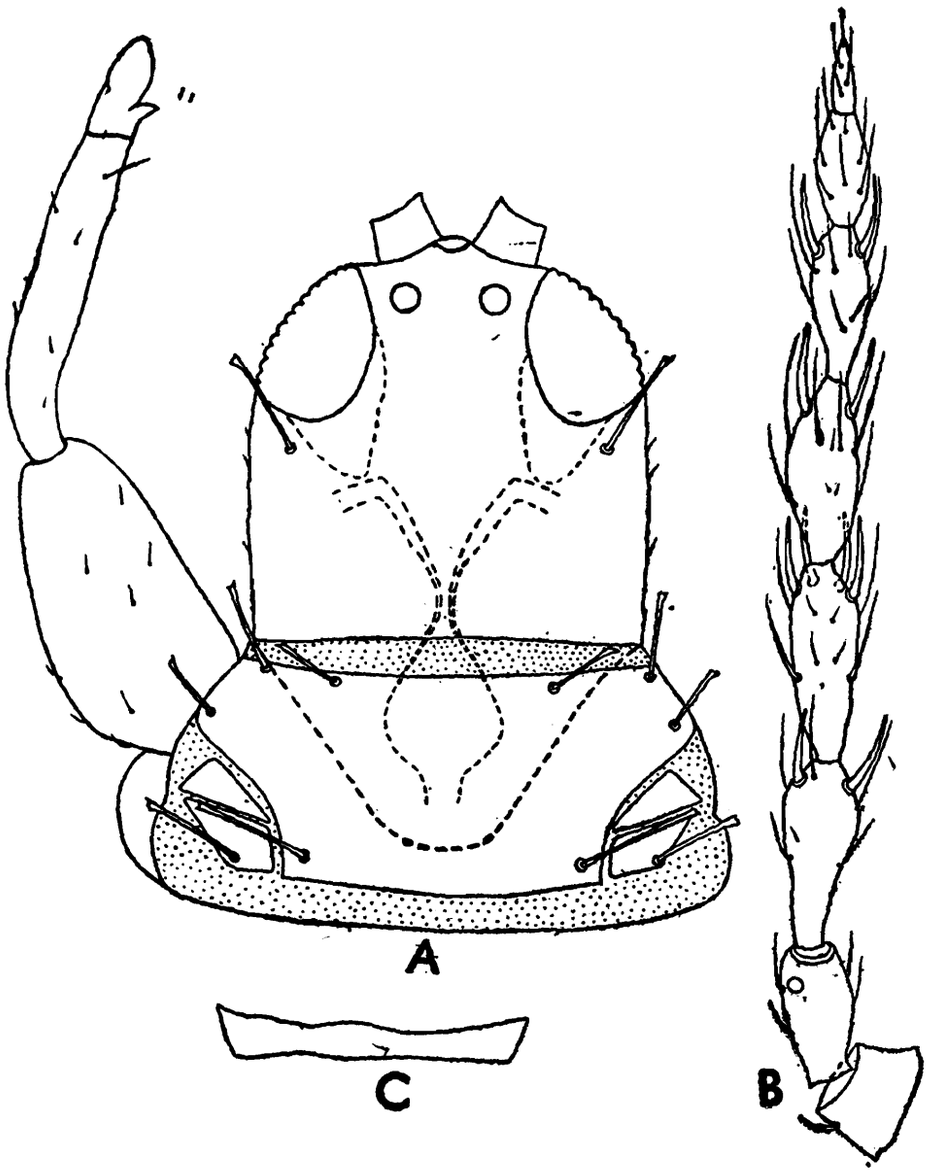
11. Hoplandrothrips kudoi sp. nov.

Female (*Macropterous*) : (Text-fig. 3) Body brown, tube a little darker ; antennal segments 1, 2, 7 and 8 brown, base and apex of segment 3 pale brown, middle yellow, distal $\frac{2}{3}$ of segments 4, 5 and 6 pale brown, proximal portions pale yellow. All femora yellow, foretibiae pale brown,

*See Palmer & Mound (1978) for Synonymy

mid and hind tibiae brown, all tarsi pale yellow. Forewings clear, with a pale brown patch in the middle ; setae hyaline, expanded at apex.

Head 200-208 long, 176-200 wide across eyes, 188-200 wide across cheeks, 180-200 wide across base. Cheeks serrate with 2-3 small cheek setae. Eyes moderately large, ventrally extended, 80 long, 56-68 wide. Median ocellus overhanging between antennae, 16-20 wide, lateral ocelli 16-20 wide, placed above middle of eyes. Antennal segments 1-8 length



Text-fig. 3. *Hoplandrothrips kudoi* sp. n., A. Head and pronotum, B. Antenna, C. Mesopraesternum.

(width) : 1 : 32-36 (36), 2 : 48-52 (28), 3 : 68-72 (28-32), 4 : 72 (28), 5 : 64-68 (24), 6 : 52 (20-22), 7 : 44-48 (16-20), 8 : 24-28 (8). Sense cones 20-22 long. Postocular setae, 64-72 long, placed a little below eyes. Mouthcone, short, broadly rounded, 112-116 long, 176-200 wide at base and 60 wide at apex. Maxillary stylets close at middle, retracted upto the level of eyes.

Prothorax 120-124 long, in the middle, 196-220 wide at anterior margin and 276-296 across posterior margin. Anteroangulars 40-44 long, anteromarginals 28-40 long, midlaterals 44 long, postangulars 40-60 long, epimerals 64 long. Epimeral suture complete. Forefemora 180 long and 88 wide. Pterothorax 306-323 long, 323-357 wide across meso- and 357 across metathorax. Forewings 714 long, 52 wide with 9-11 double fringes ; basal wings bristles B_1-B_2 expanded at tip, B_3 longer and pointed, B_1-B_3 40, 48-50, 88-92 long respectively. Mesopraesternum complete, with a median crest.

Abdomen 374-391 wide at base, 357-374 across middle, 200-240 across segment VIII, 112-140 across segment IX. B_1-B_3 of segment IX 104-108, 80-100, 108-112 long respectively. Tube 140-152 long and tube setae 112-120 long.

Total body length 1.81-1.90 mm.

Male (*Macropterous*) : Colour as in female. Head 180 long, 164 wide across eyes, 172 across cheeks, 160 across base. Eyes 72 long, 48 wide. Median ocellus 12 wide, and lateral ocelli 16 wide. Postoculars 60 long. Antennal segments 1-8 length (width), 1 : 32 (28), 2 : 40 (24), 3 : 68 (28), 4 : 68 (28), 5 : 60 (24), 6 : 48 (20), 7 : 40 (16), 8 : 24 (8). Mouthcone 96 long, 152 wide at base, 48 wide at apex.

Prothorax 104 long, 172 wide at anterior margin and 224 wide at posterior margin. Anteroangular 28 long, anteromarginals 4 long, mid laterals 24 long, postangulars 44 long, epimerals 60 long. Forefemora 156 long and 76 wide. Pterothorax 300 long, 276 wide across meso- and 276 wide across metathorax. Forewings 578 long, 44 wide ; basal wing bristles broken.

Abdomen 288 wide at base, 240 wide at middle, 144 across segment VIII, 81 wide across segments IX. B_1-B_3 of IX 72, 32, 62 long respectively. Tube 132 long and tube setae 68 long.

Total body length 1.51 mm.

Material : *Holotype* ♀ (Z. S. I. Reg. No. 651/H17), *allotype* ♂ (Z. S. I. Reg. No. 652/H17), *paratypes* 4 ♀ ♀ (Z. S. I. Reg. Nos. 653-656/H17), MANIPUR, Churachandpur, Saikot, 23. iii. 1979 (Coll. *N. Muraleedharan*).

Hoplandrothrips kudoi is related to *H. flavipes* Bagnall in general appearance but differs from the latter in the colouration of legs and antennae, B_3 of wing very long and pointed, much shorter body setae and nature of mesopraesternum.

*12. **Mecynothrips simplex** Bagnall

1912. *Mecynothrips simplex* Bagnall, *Ann. Mag. nat. Hist.* (8) **9** : 216.

Material : 1 ♀, 4 ♂♂, (Z. S. I. Reg. Nos. 657/H17-661/H17), MANIPUR, Churachandpur, Saikot. 23. iii. 1979 (Coll. *N. Muraleedharan*).

13. **Meiothrips nepalensis** Kudo & Ananthakrishnan

1974. *Meiothrips* (*Telothrips*) *nepalensis* Kudo & Ananthakrishnan *Kontya* **43** : 385-387.

Material : 1 ♀, 2 ♂♂ (Z. S. I. Reg. Nos. 662/H17-664/H17), MANIPUR, Ukhrul, 17. ii. 1979 (Coll. *N. Muraleedharan*).

14. **Stephanothrips occidentalis** Hood & Williams

1925. *Stephanothrips occidentalis* Hood & Williams, *Psyche* **32** : 69.

Material : 2 ♀♀ (Z. S. I. Reg. Nos. 665-666/H17), MANIPUR, Churachandpur, Saikot, 23. iii. 1979. (Coll. *N. Muraleedharan*).

15. **Stigmothrips okajimai** Muraleedharan & Sen

1980. *Stigmothrips okajimai Rec. Zool. Surv. India* (In Press).

Material : 3 ♀♀, 1♂ (Z. S. I. Reg. No. 667-670/H17). MANIPUR, Churachandpur, 23. iii. 1979 (Coll. *N. Muraleedharan*).

16. **Thlibothrips manipurensis** sp. nov.

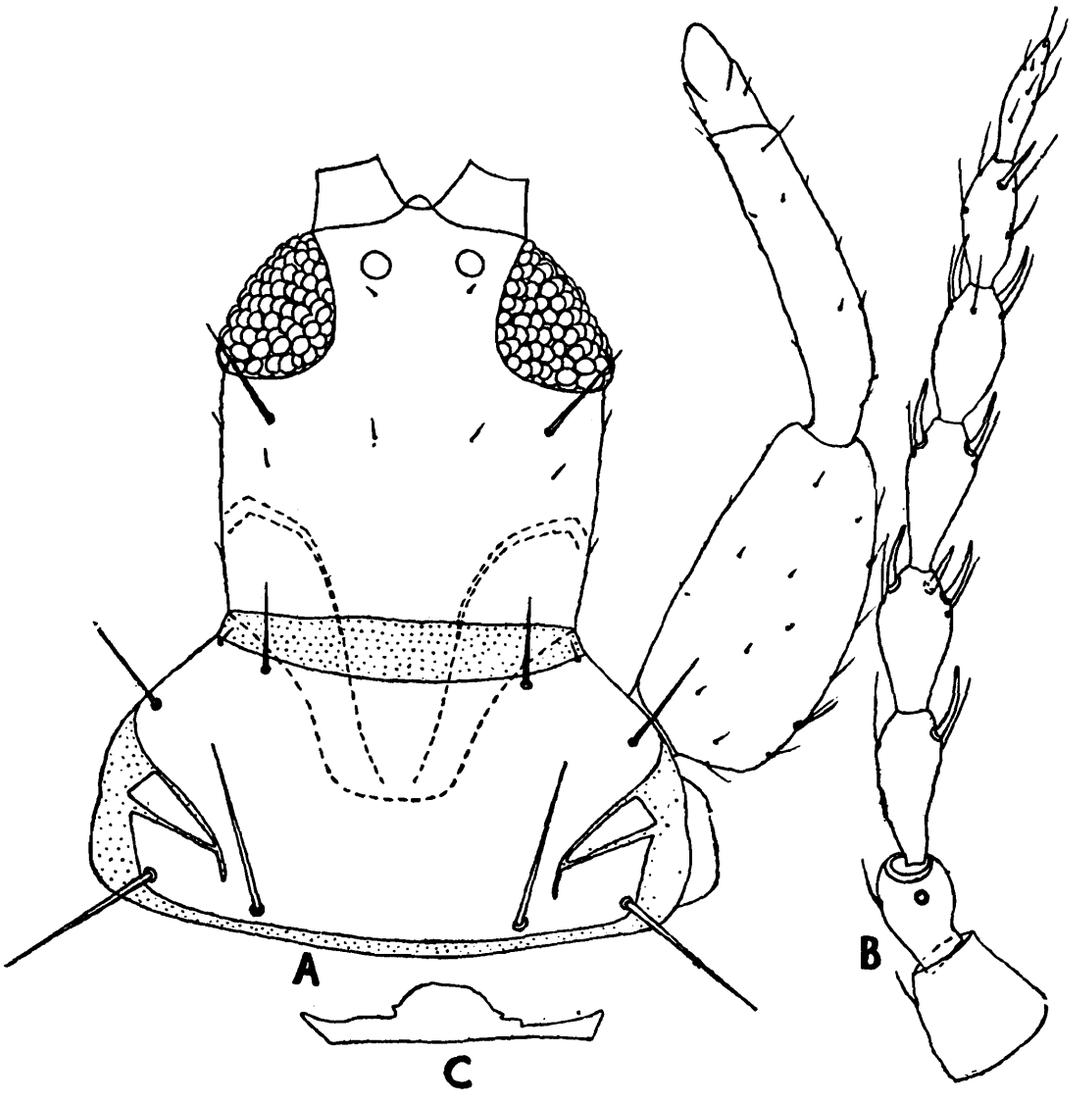
Female (*Macropterous*) : (Text-fig. 4) General body colour brown ; antennal segments 1, 2, 7, 8 and apical half of 6 dark brown, apex of 5th with brown tinge, 3 and 4 pale yellow ; all femora dark brown, mid and hind tibiae dark ; foretibiae yellow with margins dark brown and in some cases almost completely dark brown, reducing the yellow portion to a long median streak ; foretarsi yellow, mid and hind tarsi pale brown. Wings clear ; all setae pale brown and pointed.

Head 220-240 long, 196-220 wide across eyes ; 196-220 across cheeks, 168-204 across base. Cheeks crenulate with 2-3 minute cheek setae ; surface strongly reticulate. Eyes moderately large, angular behind, 88 long, 60-68 wide ; all ocelli 24-28 wide, median one overhanging between antennae, and paired ocelli placed above middle of eyes. Postoculars 64 long, pointed, placed a little below eyes. Antennal segments elongate, segment 8 long and fusiform, very little shorter than segment 7 ; segments 1-8 length (width), 1 : 44-56 (40-48), 2 : 44-48 (36), 3 : 72

*See Palmer & Mound (1978) for synonymy

(32), 4 : 68-72 (36), 5 : 64-68 (28), 6 : 60 (24-28), 7 : 52-60 (20-24), 8 : 52-56 (12-16). Sense cones 20-24 long. Mouthcone broad, 116-120 long, 168-200 wide at base and 72-92 wide at apex. Maxillary stylets retracted to $\frac{1}{8}$ of head, not meeting at middle.

Prothorax sculptured, 148-164 long, 180-220 wide at anterior margin, 296-356 across posterior margin. Anteroangulars vestigial, anteroma-



Text-fig. 4. *Thlibothrips manipurensis* sp. n., A. Head and pronotum, B. Antenna, C. Mesopraesternum.

rginals 40-48 long, midlaterals 60-68 long, postangulars 120 long, epimerals 92-96 long; epimeral suture incomplete. Pterothorax 391-442 long, 368-442 wide across meso- and 364-442 across metathorax. Wings 800-816 long, 80 broad, with 15-17 double fringes. Basal wing bristles B_1-B_8 44, 56-60, 60 long respectively. Mesopraesternum complete with a median crest.

Pelta roughly triangular. Abdomen weakly sculptured, 408-425 wide at base, 408 wide at middle, 289-323 across segment VIII, 170 across IX. B_1-B_8 of segment IX 184-216, 196-212, 164-168 long respectively. Tube 240-252 long and tube setae 96-140 long.

Total body length 2.15-2.52 mm.

Male (*Macropterous*) : Colour as in female. Head 204 long 192 wide across eyes, 168-184 across cheeks and 164-168 across base. Eyes 76-88 long, 60 wide. Postoculars 52-60 long. Antennal segments 1-8 length (width), 1 : 48 (36-40), 2 : 40 (32-36), 3 : 64 (28-32), 4 : 60-68 (32), 5 : 52-60 (24-28), 6 : 52-56 (24), 7 : 48 (20), 8 : 44-48 (12). Sense cones 16-20 long. Mouthcone 100-104 long, 164-172 wide at base and 80 at apex.

Prothorax 152 long, 176-200 wide along anterior margin and 288-300 across posterior margin. Anteroangulars vestigial, anteromarginal 40 long, mid laterals 60 long, postangulars 80-88 long, epimerals 80 long. Forefemora 168-184 long, 84-88 wide. Pterothorax 374 long, 357 wide across meso- and 357 wide across metathorax. Forewings 663-680 long, 80-84 wide, with 14 double fringes. Basal wing bristles B_1-B_3 36-44, 44-56, 44-60 long respectively.

Abdomen 352 wide at base, 320-328 across middle, 216-220 across segment VIII and 148 across IX. B_1-B_3 of segment IX, 180-192, 48-68, 180 long respectively. Tube 212-216 long and tube setae 100-120 long.

Total body length 2.09-2.10 mm.

Material : *Holotype* ♀ (Z. S. I. Reg. No. 671/H17), *allotype* ♂, (Z. S. I. Reg. No. 672/H17), *paratypes* 8 ♀ ♀, 2 ♂ ♂ (Z. S. I. Reg. Nos. 673-682/H17), MANIPUR, Moreh, 11. iii. 1979. Ex. leaf. gall. (Coll. *N. Muraleedharan*).

The genus *Thlibothrips* Priesner characterised by the fusiform terminal antennal segment, broad mouthcone and eyes angular behind is represented in India by a single species *T. inquilinus* Ananthakrishnan & Varadarasan (1978). The present species shows some similarity to *T. inquilinus* in colour pattern but differs by the well developed anteromarginals, vestigial anteroangulars and broad mouthcone.

SUMMARY

Sixteen species of Phlaeothripidae belonging to 15 genera are dealt with in this paper. Of these four species belonging to the genera *Araeothrips* Ananthakrishnan, *Crotonothrips* Ananthakrishnan, *Hoplandrothrips* Hood and *Thlibothrips* Priesner are new to science.

ACKNOWLEDGEMEMTS

I am indebted to the Director, Zoological Survey of India, for going through the manuscript, offering valuable suggestions, confirming the identity of new taxa and providing necessary facilities to carry out

this work. I also wish to record my sincere gratitude to Shri Samir Sen, Asstt. Zoologist for his manifold help.

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VERTICAL DISTRIBUTION OF MACROZOOPLANKTON BIOMASS AND ITS MAJOR CONSTITUENTS IN THE NORTHERN ARABIAN SEA DURING JANUARY TO MAY, 1974.

By

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(With 6 Text-figures)

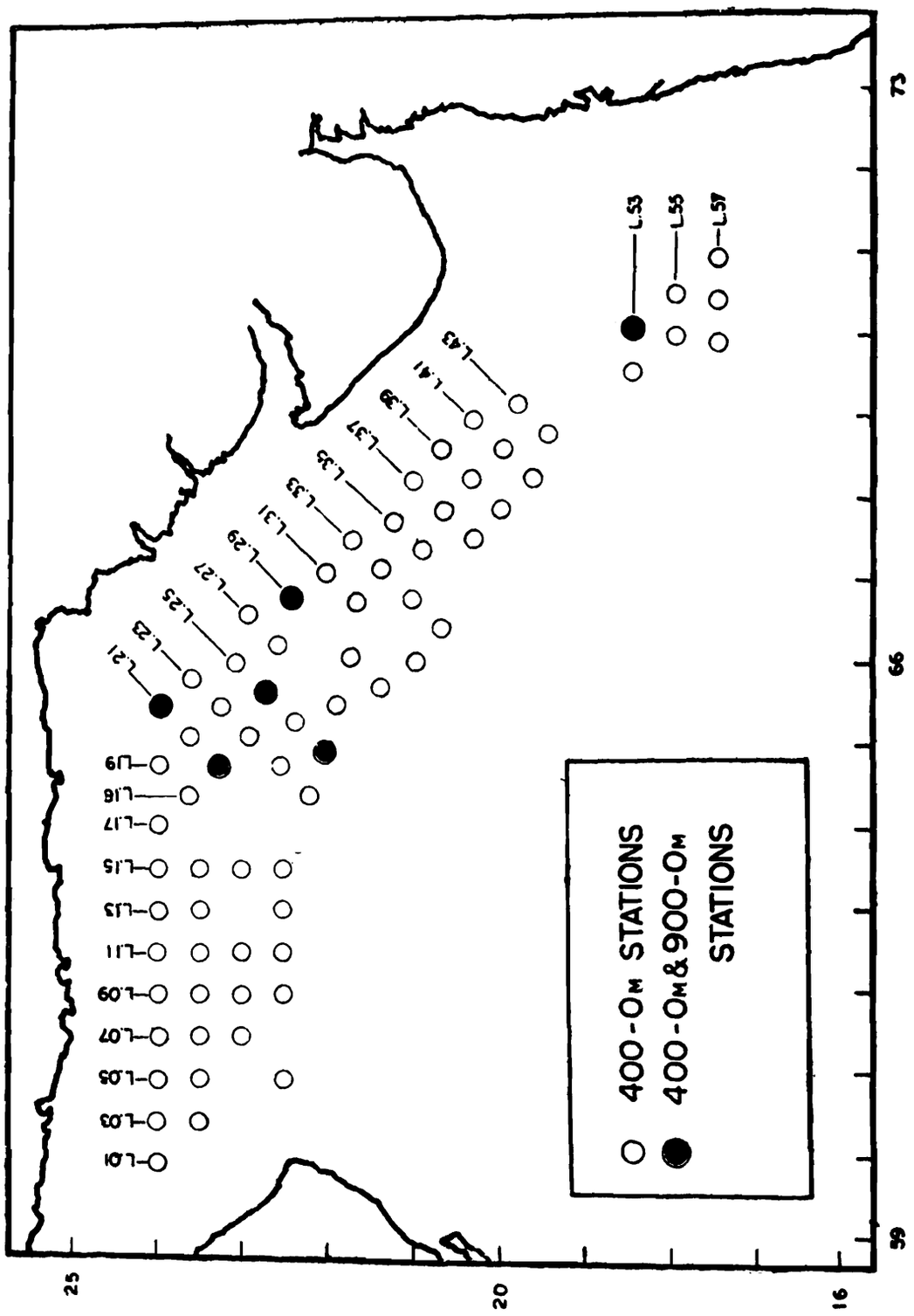
INTRODUCTION

In the tropical region of the Indian Ocean the distribution of the zooplankton in the euphotic zone of the upper 200 metres is known in great detail from the results of Oceanographic Expeditions. The zooplankton biomass distribution from depths below 200 metres and its zoo-constituents are known from (i) the results of the John Murray expedition (Sewell, 1948), (ii) observations at seven stations by R. R. S. 'Discovery' (Foxton, 1957) and (iii) the eastern sector of the Indian Ocean during the R. V. Vityaz Cruise in 1962 (Daniel and Prem Kumar, 1965). Therefore, studies were undertaken on zooplankton samples collected from 400-0 m at 72 stations and from 900-0 m at 6 stations, during the Oceanographic Expedition on I. N. S. DARSHAK in the northern Arabian sea from January to May 1974. In this paper, the biomass and the constituents of macrozooplankton measuring more than 1.32 mm based on these data are presented.

MATERIAL AND METHODS

Macrozooplankton samples were collected with Nansen pattern net of 80 cm mouth diameter, 225 cm total net length and terelene netting bolting cloth 7.5 meshes per linear cm. The net was hauled vertically at a speed of 1 m per second, over a davit from 400 m to the surface at 72 stations and from 900 m to surface at 6 stations (Text-fig. 1). The total displacement volumes in ml were obtained following the techniques of Foxton (1957), Daniel and Premkumar (1965), and Daniel and Jothinayagam (1977). Following Prasad, (1969, P. 400) the displacement volumes have been considered equivalent to total biomass of the sam-

ples. The numbers of each zoo constituent occurring in the entire plankton samples from 400-0 m and from 900-0 m were analysed for estimating the numbers of organisms in a haul. Since, the net used for

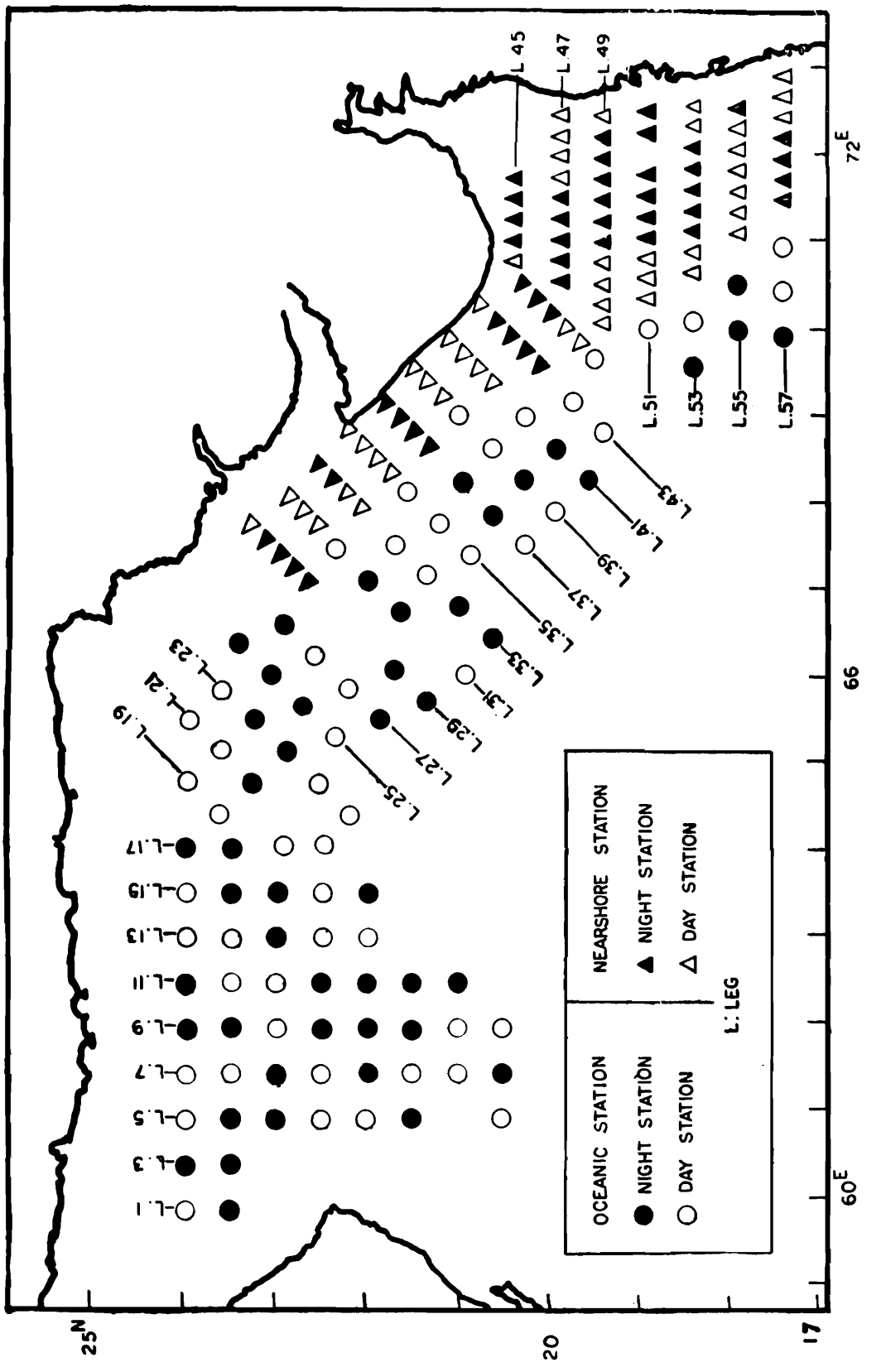


Text-fig. 1. Zooplankton stations from 400-0 m (72 Stns) and from 900-0m (6 Stns) established during expedition.

smpling was of a wider mesh, *vide* supra, only macrozooplankton measuring more than 1.32 mm were collected and the numbers of taxa like copepods were low.

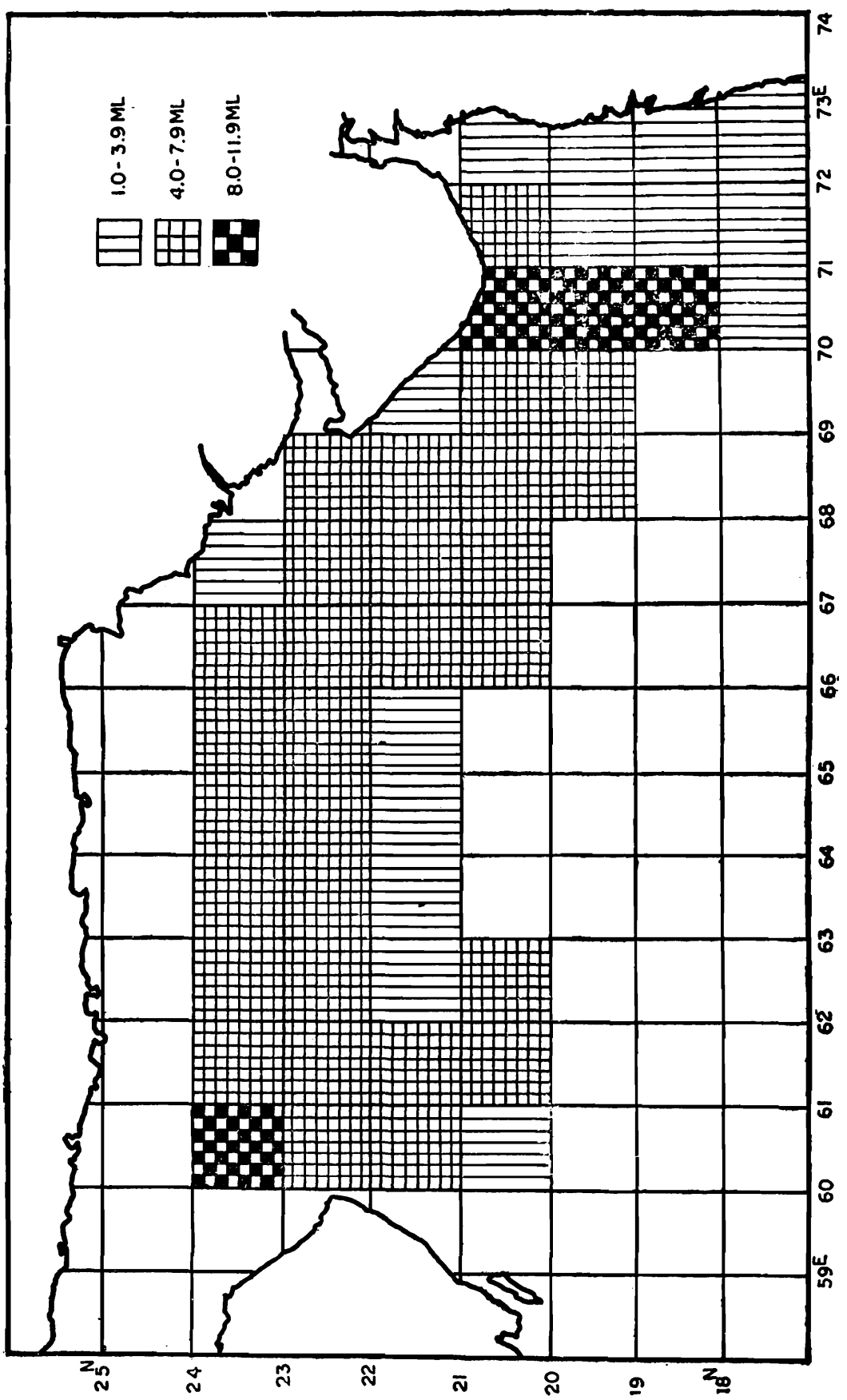
OBSERVATIONS AND CONCLUSION

The biomass of macro-zooplankton measuring more than 1.32 mm and the macrozooplanktonic organisms (*i. e.*, Medusae, Siphonophores, Polychaetes, Ostracods, Copepods, Mysids, Amphipods, Euphausids,



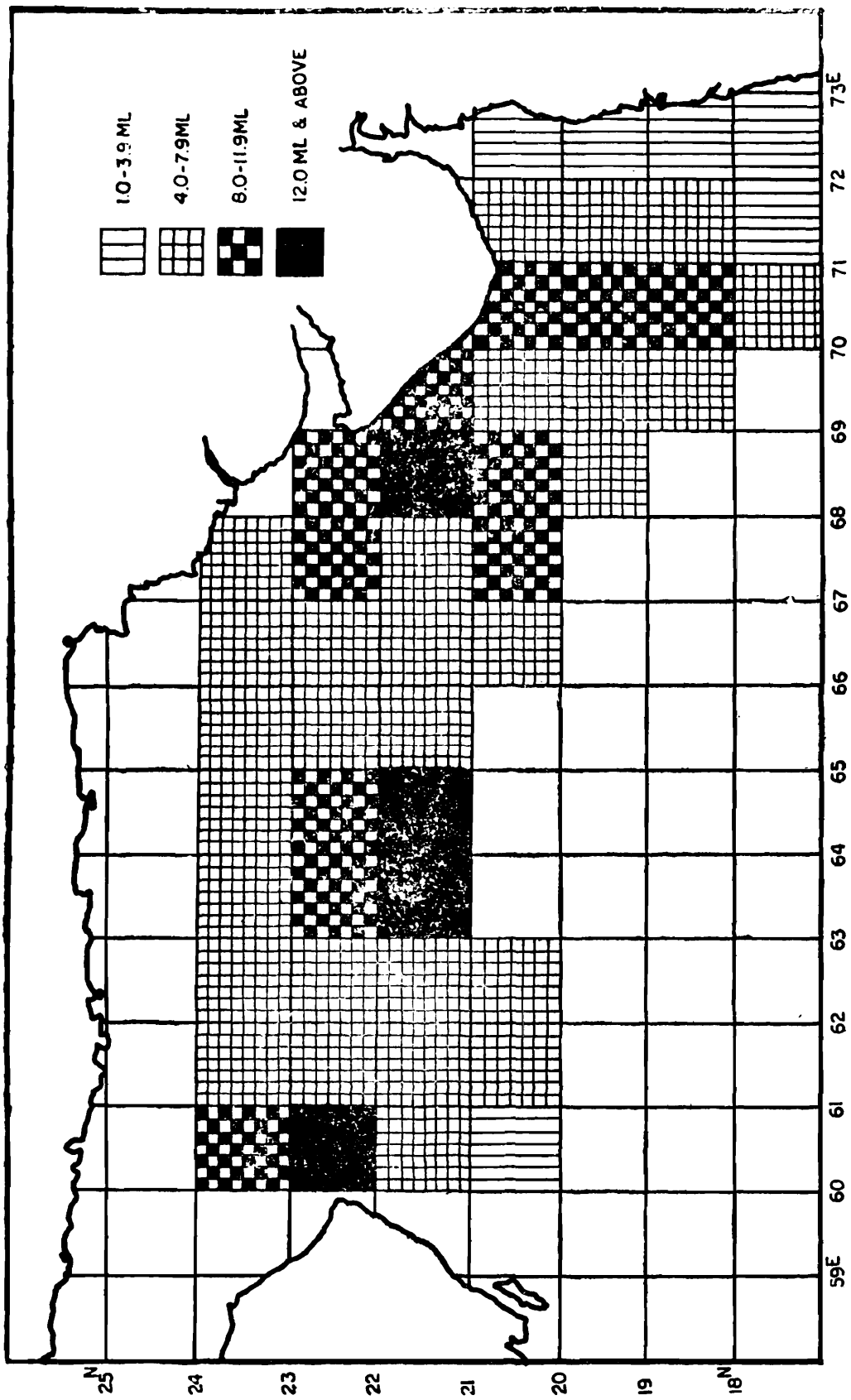
Text-fig. 2. Zooplankton stations from 100-0m in the Oceanic region (100 Stns) and from near seabed to surface from shallow near shore stations (94 Stns).

Shrimp early stages, Mollusca, Chaetognata, Salpa, Fish larvae and others which include heteropods, pteropods and decapod larvae) in the samples are presented in Text-figures 2-6.



Text-fig. 3. Distribution of Zooplankton biomass from 100-0 m (100 Stns) and from near seabed to surface (94 Stns) Day.

The macrozooplankton biomass of the 400-0 m depth samples was very high at 6 stations, namely, 2509, 2907, 3509, 3710, 3906 and 5311



Text-fig. 4. Distribution of Zooplankton biomass from 100-0 m (100 Stns) and from near seabed to surface (94 Stns). Night.

with the displacement values being 20 ml, 21 ml, 25 ml, 23 ml, 29.5 ml and 36 ml respectively (Text-fig. 2-5.). The macrozooplankton biomass

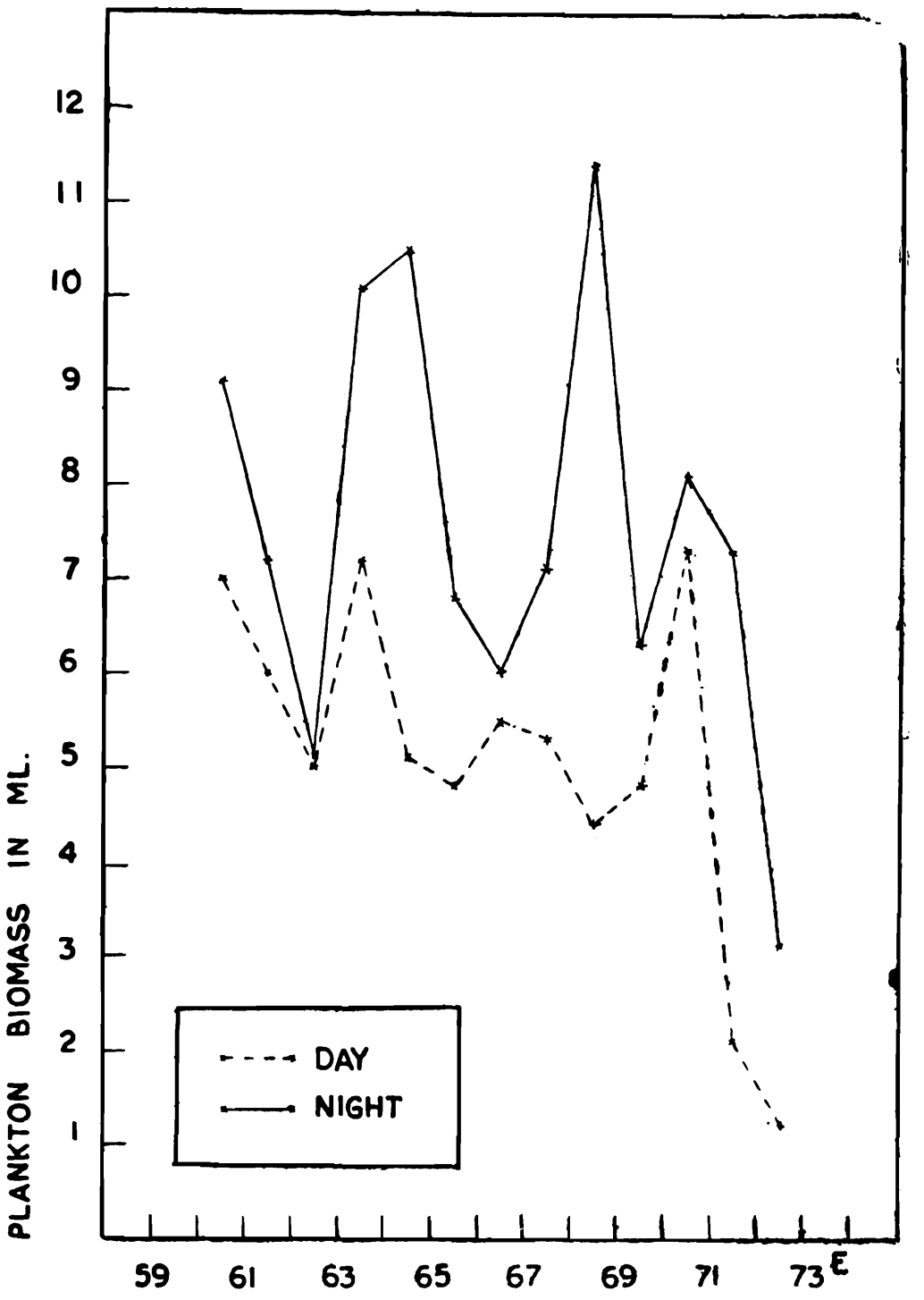
of the 900-0 m depth samples was correspondingly higher at 3 stations (2509, 2907 and 5311) where the displacement values were 28 ml, 32 ml and 60 ml respectively (Text-fig. 6).

From Text-figs. 2.5, it appears that the increase in the total biomass in these samples were contributed by the abundance of siphonophores, scypho and hydromedusae, chaetognaths, shrimps (early stages), euphausiids, ostracods, copepods, amphipods and salps.

At station 2509, swarms of siphonophores [*Diphyes dispar* Chamisso & Eysenhardt, *Bassia bassensis* (Quoy & Gaimard), *Chelophyes contorta* (Lens & Van Riemsdijk)] Scyphomedusae (*Pelagia noctiluca* Peron & Lesuer) Mydromedusae (*Liriope* sp.) chaetognaths (*Sagitta lyra* Krohn, *S. robusta* Doncaster) and shrimps (early stages of *Acetes* sp., *Lucifer* sp.) in both samples contributed to the increase in biomass. At this station, four specimens of *Dimophyes arctica* (Chun) were encountered. Swarms of siphonophores (*Diphyes dispar*, *D. bojani* (Eschscholtz) *Bassia bassensis*, *Hippopodius hippopus* (Forskal) and chaetognaths (*Sagitta lyra*) occurred at the samples of station 2907. Similarly, siphonophores (*Diphyes dispar*, *Sulculeolaria quadrivalvis* Blainville, *Bassia bassensis*), shrimps—early stages, euphausiids (*Euphausia* sp.), salps [*Metacalfina hexagona* (Quoy & Gaimard), *Iasis zonaria* (Pallas)] and ostracods (*Cypridina dentata* Muller) at Station 3509 ; siphonophores (*D. dispar*, *S. quadrivalvis*, *D. bojani*) shrimp—early stages (*Acetes sp.*) and euphausiids (*Euphausia* sp.) at station 3710 ; siphonophores (*D. dispar*, *D. bojani*, *B. bassensis*), polychaetes—(young stages), Scyphomedusae (Pelagia noctiluca), Hydromedusae (*Liriope* sp.) and Salpa (*Metacalfina hexagona*) at station 3906 ; and copepods (*Eucalanus* sp.) amphipods (*Hyperia* sp.), salps (*Metacalfina hexagonae* and *Iasis zonaria*) shrimps—early stages (*Lucifer* sp.) at both samples of station 5311 contributed mainly to the high displacement values.

The biomass is rich ranging from 9.0 ml to 17.0 ml at 23 stations (*vide* Text fig. 2-5) *i.e.*, 0301, 0303, 0501, 0503, 0507, 0901, 1907, 1505, 2105, 2503, 2505, 2703, 2911, 3107, 3109, 4106, 4108, 4110, 4307, 5313, 5512, 5711 and 5713. At stations, 2105 and 2505 the biomass from 900-0 m depth were only slightly higher than the displacement values from the 400-0 m depth samples (Text-fig. 6). Abundant occurrence of siphonophores (*Agalma okeni* Eschscholtz, *D. dispar*, *D. bojani*, *Sulculeolaria chuni* Lens & Van Riemsdijk, *Lensia hotspur* Totton, *Eudoxoides mitra* (Huxley), *Chelophyes contorta*, *B. bassensis*, *Abylopsis tetragona* (Otto) and *A. eschscholtzi* (Huxley), shrimps—early stages (*Acetes* sp. and *Lucifer* sp.) and Scyphomedusae (*Pelagia noctiluca*—young forms), at all stations and ostracods (*Cypridina dentata*) chaetognaths, (*Sagitta lyra*, *Sagitta robusta*,

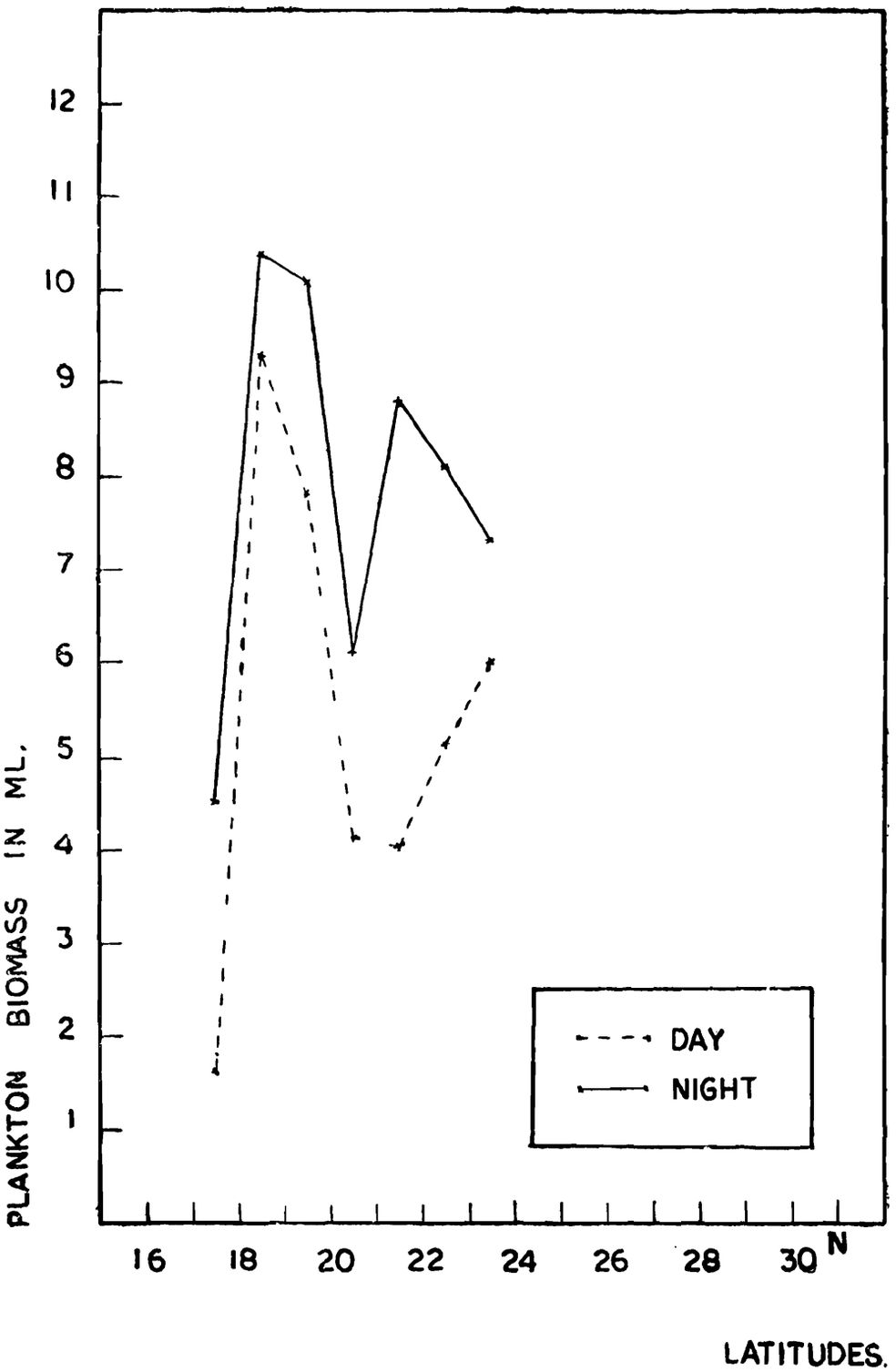
Sagitta hexaptera d'Orbigny, polychaetes—(young forms) and mysids at some of the stations had increased the biomass values (Text-figs. 2-5). The displacement values of the total biomass of macrozooplankton were low, ranging from 3.5 ml to 8.0 ml or less in most of the other stations



Text-fig. 5. Longitudinal variations in the plankton biomass during Day/Night periods for 1° intervals.

i.e., 0101, 0703, 0705, 0903, 0905, 1103, 1105, 1107, 1307, 1507, 2305, 2307, 2309, 2507, 2705, 2913, 3306, 3308, 3310, 3312, 3507, 3706, 3708, 3908 and 4309 for the 0-400 metre depth and stations 2101 for the 0-900 m depth. At 18 stations (*i.e.*, 0701, 1101, 1301, 1303, 1501, 1503,

1701, 1901, 1903. 2101, 2103, 2303, 2311, 2709, 3113, 3910, 5510 and 5709) the total biomass is extremely low, the displacement values ranging from 0.75 ml to 3.0 ml. From Text-figs. 2-6 it is seen that at these 43 stations where the biomass ranged from 0.75-8.0 ml, the numbers of



Text-fig. 6. Latitudinal variations in the plankton biomass during Day/Night periods for 1° intervals.

different zoological constituents were low, probably due to these areas being biologically poor.

Although, a comparison of the data on biomass and zooconstituents

of plankton hauls from the surface (188 stations) (Daniel and Jothinayagam, 1977) 100 m depth (100 stations) (Daniel and Krishnamoorthy, 1977) 200 m depth (165 stations). (Paulinose and Aravindaksham, 1977) 400 m depth (72 stations) and 900 m depth (6 stations) would yield interesting results, since there is much diversity in the gear used for collecting the samples from the different stratified depths (*i.e.*, diameter of the mouth of the sampler, mesh size and the length of the net and speed of haul were different) it is not possible to compare these results. However, it appears from the present study and the papers published earlier, based on samples made from the same area and collected during the same cruises from the surface, 100 m depth, and 200 m depth (Daniel & Jothinayagam, 1977 ; Daniel & Krishnamoorthy (in press) and Paulinose & Aravindaksham, 1977) that (i) zooplankton biomass is comparatively very high at the surface extending upto 100 m in the oceanic regions and upto the thermocline in the shallower inshore regions (Daniel and Jothinayagam, 1977, Daniel and Krishnamoorthy, (in press) (ii) the macrozooplankton below the euphotic zone is not very rich and (iii) swarming of certain meso pelagic macro-zooplankters contributed to the high biomass values in the deeper waters in some stations (see Text-figs. 2-6).

It is of interest to note the occurrence of *Dimophyes arctica* (Chun) in both the 400 m and 900 m samples at station 2509, located at Latitude 22°09' N and Longitude 64°53' E. The occurrence of this species at this station suggests the upwelling of deep water masses in this region, during March, 1974. Further, this is the first record of this species north of 12° latitude in the Arabian Sea, the previous record being off Cochin at the lower boundary of the thermocline, in November (Daniel, 1977). This underlines the need for further investigations on deepwater macroplankton.

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Summary

In the cruises of the INS DARSHAK during January to May 1974 in the northern Arabian Sea studies were made on the macrozooplankton biomass, abundance and distribution of its major constituents at 72 stations of the vertical zone of 0-400 m and at 6 stations of the vertical zone of 0-900 m. It was found that the biomass was very high at certain stations, rich at some, low in few others and very low in the rest, indicating the variations in the fertility of the area. The richness at some stations were attributed to swarms of siphonophores, medusae, chaetognaths, shrimp early stages, euphausiids and ostrocods. It is concluded that zooplankton is very high at the surface extending upto 100 m in the oceanic regions and upto the thermocline in the inshore regions. The occurrence of *Dimophyes arctica* at station 2509 (22°09' N, 64°53' E) is attributed to the upwelling of deepwater in this region.

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STUDIES ON FRESHWATER ROTIFERS FROM VISAKHAPATNAM, INDIA.

By

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(With 1 Text-figure)

INTRODUCTION

The present paper is based on the material collected from different bodies of water comprising of lakes, tanks, ponds and monsoon fed streams located in and around Visakhapatnam during July 1973 to July 1975. In the present paper seven species of the genus *Lecane* Nitzsch and four of the genus *Monostyla* Ehrenberg are described.

Studies on Indian species of these two genera include those of Edmondson and Hutchinson (1934), Hauer (1936), Pasha (1961), Arora (1965), Wulfert (1966), Vasisht & Gupta (1967), Nayar (1968), Vasisht & Battish (1971), Dhanapathi (1976), and Sharma (1978).

Edmondson (1935) proposed to combine these two genera. His suggestion was based on the observations of Hauer (1929) who had recorded certain species having the characters of both *Monostyla* and *Lecane*. In these species the toes are fused to some extent although they are distinctly two in number.

Voigt (1957) recognised Edmondson's argument and includes the species of the genus *Monostyla* in the genus *Lecane* but for the sake of convenience divided the species of the genus Lecane into three groups : A, B and C. In group A forms are having free toes which are far apart, group B includes forms with toes fused to varying extent while in group C forms are with a single toe (*Monostyla*). Bartos (1959) proposed a genus *Hemimonostyla* to include species of *Lecane* included by Voigt under his group B. Sudzuki (1964) accepted Voigt's reasoning but commented that his arguments were based on characters of females only. However he considered the structure of toes as generically important and treated the genera *Lecane* and *Monostyla* seperately. Sharma (1978) considered the character of toes not sufficient to warrant

* This paper has been presented in the Third All India Congress of Zoology held at Waltair in 1976.

establishment in different genera. However he accepted the structure of toes as sub-generic character which has been done by Chengalath & Fernando (1973), Chengalath, Fernando & Koste (1974) and Chengalath & Mulamoottil (1974).

Out of the 11 species described here six fall into group A, four into group C and one into group B. As the information in inter-grading forms between the genera *Lecane* and *Monostyla is* inadequate, they are treated here seperately. Out of these eleven species seven species are being reported for the first time from Andhra Pradesh.

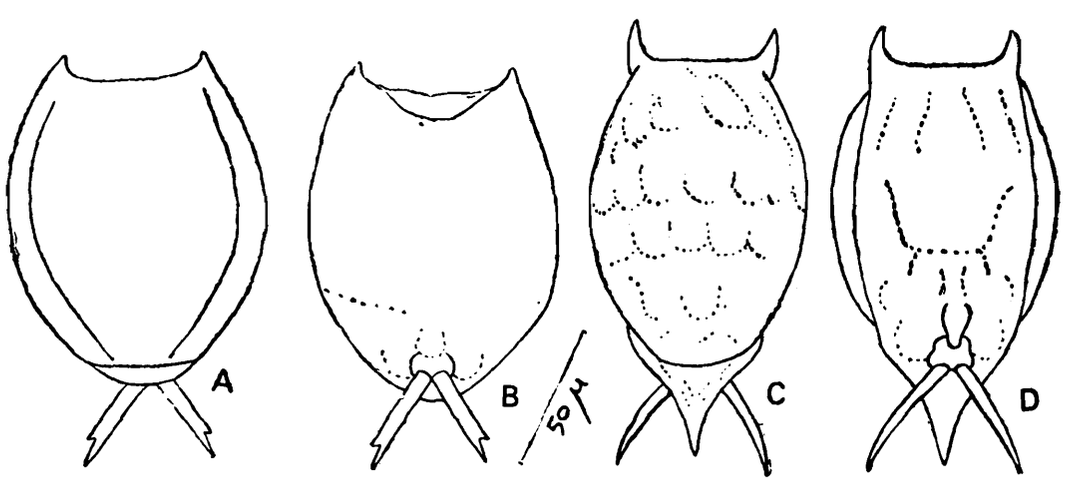
Material and Methods

Water in the vicinity of aquatic plants was stirred and was passed through a sieve to arrest the dead decaying leaves and other floating matter. Water then was passed through a plankton net of bolting silk (mesh size 70 μm). 10 percent formalin was added to the concentrate so as the soft parts shrink considerably leaving a clear outline of the lorica. Forms with soft lorica were narcotized with 5 percent procaine hydrochloride and then fixed in Schaudinn's fluid.

Lecane ludwigii (Eckstein) 1883, Harring 1913

(Text-fig. 1C, D)

The outline of the lorica is oval, the anterior margines coincident and slightly concave. There are two fairly long anterior spines at the external angles. The dorsal plate is oval and truncate posteriorly and



Text-fig. 1. (A & B) *Lecane acronycha* Harring & Myers ; (C & D) *Lecane ludwigi* (Eckstein).

marked with four transverse rows of prominent coarse tesselations. The ventral plate is slightly pyriform in outline, narrower than the dorsal and marked with few longitudinal ridges. The lateral sulci are deep. The posterior segment is semicircular and is produced as a long

triangular pointed spine. The coxal plates are large and rounded posteriorly. The first foot joint is narrow and overlaps the trapezoidal second joint as a lobate projection. The toes are long ending in acute conical points without claw.

Total length 155 μm, length of dorsal plate 104 μm, of ventral plate 152 μm, width of dorsal plate 76 μm, of ventral plate 62 μm, width of anterior margin 48 μm and length of toes 46 μm.

The present specimen differs from the description given by Harring & Myers (1926) in having the toes which are slightly incurved. Recorded earlier by Dhanapathi (1976) from Andhra Pradesh and by Sharma (1978) from West Bengal.

Lecane acronycha Harring & Myers 1926

(Text-fig. 1 A, B)

The outline of the lorica is moderately elongate oval, the anterior dorsal margin almost straight projecting slightly infront of the ventral margin. The dorsal plate is narrower than the ventral and its edges do not reach anterior margin. There is a transverse ridge infront of the foot joint on the ventral plate. The posterior segment is small. The coxal plates are small and obtusely pointed. The first foot joint is indistinct and the second moderately large and trapezoidal in form. The toes are short and fairly robust ending in a short claw.

Total length 138 μ m, length of dorsal plate 100 μ m, of ventral plate 118 μ m, width of dorsal plate 72 μ m, of ventral plate 90 μ m, of anterior ventral margin 52 μ m, length of toes without claw 28 μ m, claw 8 μ m.

The specimens in our collection are relatively smaller than those recorded by Harring & Myers (1926).

Lecane tryphema Harring & Myers 1926

Very few specimens of this species were obtained in the collections from the Municipal Tank at Mudasarlova. Nayar (1968) reported this species from Rajasthan.

Total length 90 μ m, length of dorsal plate 60 μ m, of ventral plate —70 μ m, width of dorsal plate 60 μ m, of ventral plate 56 μ m, of anterior dorsal margin 44 μ m, length of toes 26 μ m.

Lecane curvicornis var. **padespares** Arora 1965

Few specimens of this species were obtained from a pond near Bhimili. This species has earlier been reported from Nagpur by Arora

(1965). The forms in our collection agree with the form described by Arora except that they are having longer anterior spines.

Total length 186 μ m, length of dorsal plate 112 μ m, of ventral plate 126 μ m, width of dorsal plate 82 μ m, of ventral plate 92 μ m, length of toes without claw 56 μ m, claw 6 μ m.

Lecane crepida Harring 1914

This species obtained from the collections of Municipal Tank at Mudasarlova. Pasha (1961) reported this species from Madras and Sharma (1978) from West Bengal.

Total length 138 μ m, length of dorsal plate 88 μ m, of ventral plate 100 μ m, width of dorsal plate 64 μ m, of ventral plate 72 μ m, of anterior spines 70 μ m, length of toes without claw 22 μ m, claw 12 μ m. The animal differs from the description given by Harring & Myers (1926) in having shorter anterior spines.

Lecane papuana (Murray) 1913

This species is common in the collections and agrees with the description given by Harring & Myers (1926). Edmondson & Hutchinson (1934) reported this species from Kashmir, Pasha (1961) from Madras, Nayar (1968) from Rajasthan, Dhanapathi (1976) from Andhra Pradesh and Sharma (1978) from West Bengal.

Total length 160 μ m, length of dorsal plate 106 μ m, of ventral plate 112 μ m, width of dorsal plate 92 μ m, length of toes 44 μ m, claw 9 μ m.

Lecane (Hemimonostyla) sp.

A single specimen of the genus *Lecane* was obtained from the sample collected from a stream near Dairy Farm. In this species the toes are partly fused at their base. The form does not agree to any one of the known species of the genus *Lecane*. Possibly a new species but more specimens of this form will have to be studied before assigning to it the status of a new species.

Monostyla bulla (Gosse) 1851

This species is common in our collections. Reported earlier by Anderson (1889) from Calcutta, Edmondson & Hutchinson (1934) from Kashmir and Punjab, Pasha (1961) from Madras, Arora (1965) from Nagpur, Vasisht & Gupta (1967) from Chandigarah, Nayar (1968), from

Rajasthan, Vasisht & Battish (1971) from N. W. India, Dhanapathi (1976) from Andhra Pradesh and Sharma (1978) from West Bengal.

Total length 160 μ m, length of dorsal plate 94 μ m, of ventral plate 106 μ m, width of lorica 70 μ m, toe 56 μ m, claw 16 μ m.

Monostyla closterocerca Schmarda 1859

Few specimens of this species were collected from Bhimili pond. Nayar (1968) reported this species from Rajasthan, Vasisht & Battish (1971) from N. W. India and Sharma (1978) from West Bengal.

Total length 130 μ m, length of dorsal plate 98 μ m, of ventral plate 106 μ m, width of dorsal plate 100 μ m, of ventral plate 90 μ m, of anterior margin 52 μ m, toe 14 μ m.

Monostyla lunaris (Ehrenberg) 1838

This is a common species in the collections from Dairy Farm stream. Edmondson & Hutchinson (1934) reported this species from Kashmir and Ladakh and Sharma (1978) from West Bengal.

Total length 144 μ m, length of dorsal plate 80 μ m, of ventral plate 99 μ m, width of dorsal plate 70 μ m, of ventral plate 56 μ m, toe 48 μ m, claw 6 μ m.

Monostyla unguitata (Fadeew) 1925

This has been collected from a small garden pond in Andhra University Campus. Wulfert (1966) reported this species from Baroda and Sharma (1978) from West Bengal.

Total length 132 μ m, length of dorsal plate 94 μ m, of ventral plate 106 μ m, width of dorsal plate 88 μ m, of ventral plate 92 μ m, toe 32 μ m.

SUMMARY

Eleven species of rotifers belonging to two genera Lecane and *Monostyla* were described. Out of these seven species are being reported for the first time from Andhra Pradesh.

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Rec. zool. Surv. India 79 : 405-409, 1982

ON A NEW SPECIES OF THE GENUS *BRACHYLIA* FELDER FROM INDIA (COSSIDAE : LEPIDOPTERA)

By

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(With 1 Text-figure and 1 Plate)

Introduction

Moore (1879) described an Indian species *acronyctoides* under the genus *Brachylia* Felder from Bombay for the first time, but the species was transferred to the genus *Zeuzera* Latreille (*vide* Cotes & Swinhoe, 1887), and ultimately to the genus *Cossus* Fabr. (*vide* Hampson, 1892) under which genus the species was treated till as recently as 1976 (*vide* Arora, 1976). The genus *Brachylia* remained mostly as a synonym of the *Cossus* till Clench (1959) revived and redefined the genus and included in it a new species, *B. eutelia* from African region. A new species, *Brachylia clenchi** is described from Himachal Pradesh, extending the distribution of the genus to India, this being the first species since the earlier one has been already assigned to *Cossus*.

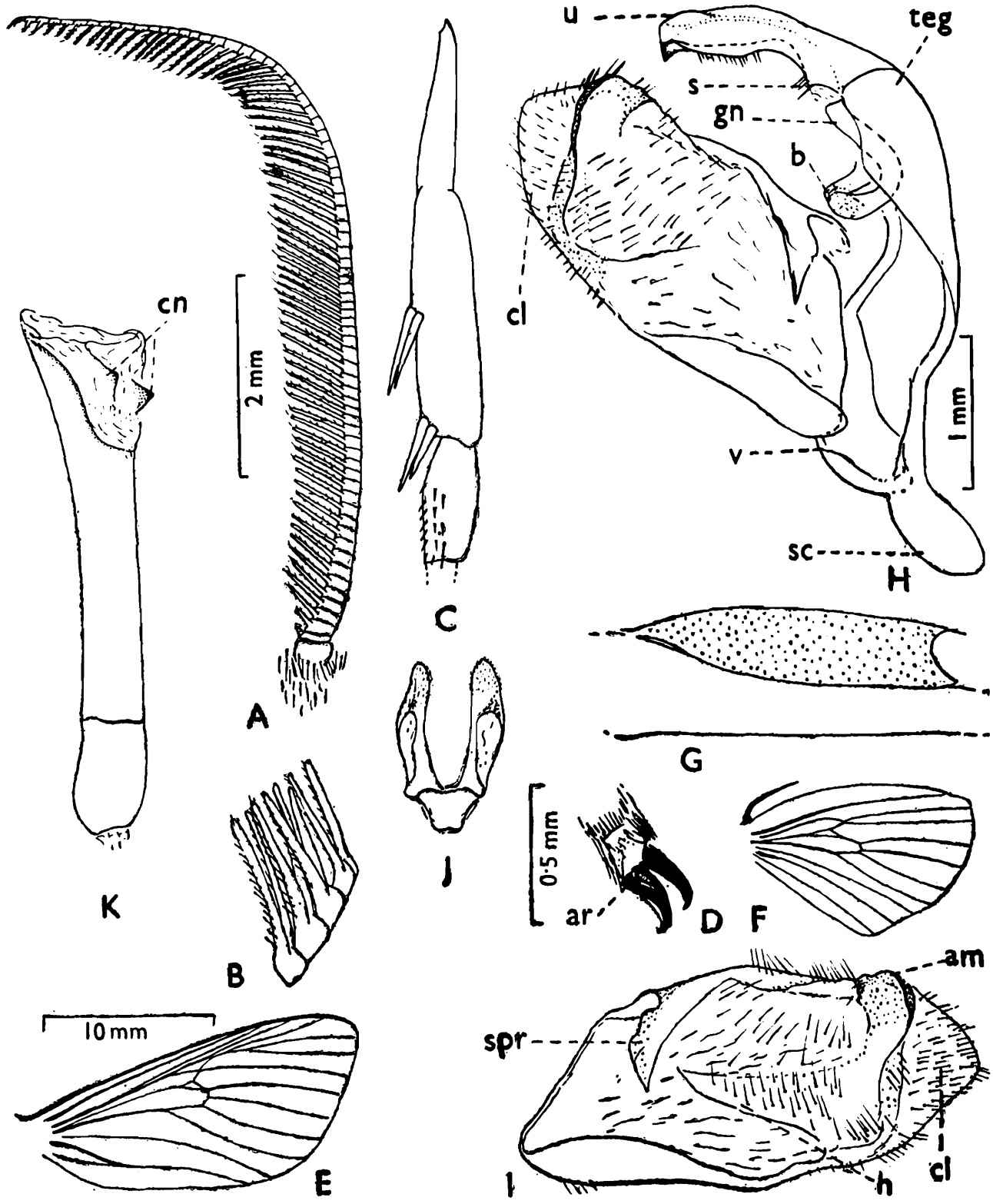
Description

Brachylia clenchi, sp. nov.

(Text-fig. 1A-K ; Plate XII)

Head with the labial palpi brown ; antennae blackish brown ; eyes dark. Thorax greyish-brown to brownish. Fore wings blackish-brown nearly up to the basal half, with the costa darker ; the distal half lighter in colour, being greyish-brown, marked by faint transverse striae inbetween veins throughout, a few striations prominent, especially the postmedial line which is excurved from subcosta to vein M_3, then incurved up to Cu_2 below which it runs straight up to 2A ; another prominent line in the submarginal area runs from below the apex to tornal angle and almost single throughout except at the area between M_3—Cu_{1b} where it is paired. Hind wings pale greyish-brown, marked with very faint transverse striae on cost and from beyond cell angle to apex distally and up to vein Cu_2 in inner area. Underside both wings of slightly paler in colour especially in basal half of fore wing.

* Named after late Mr. Harry K. Clench, Carnegie Museum, Pittsburg (U. S. A.), who had revived the genus.



Text-fig. 1. *Brachylia clenchi*, sp. nov. : (A) Male antenna, showing pectination on one side. (B) A few basal segments of the antenna showing bipectination. (C) A part of the hind-leg showing dilated tibia, with spurs, and the Ist tarsal segment with spines. (D) Tarsal claws, with an arolium. (E) and (F) Fore- and hind wing venation, respectively. (G) Retinaculum. (H) Male genitalia in a latero-ventral view, without one clasper. (I) An inner view of the clasper. (J) Juxta with lobes. (K) Aedeagus. (Mag. of C same as of A ; B and G as of D ; F as of E ; and I-K as of H).

Abdomen blackish brown. Legs blackish brown, marked with white bands on all the tarsal segments.

Head with the frons smooth ; labial palpi long, well developed, closely appressed to face but upturned and reaching about the bases of antennae. Antennae strongly bipectinate except at the tip (Text-figs. 1, A-B), the shaft about 73-74 segmented, the last segment simple and elongate, the rami short towards base as well as apex, the longest ramus as long as about seven segments. Legs with a pair of spurs on mid-tibiae and two pairs on hind-tibiae, the latter (Text-fig. 1, C) and the first tarsal segment dilated ; spines present on all the tarsal segments ; arolium present, though small (Text-fig. 1, D).

Venation.—Fore wing (Text-fig. 1, E) : All the veins present. Vein R_1 free, arising from the cell before the origin of areole which is in line with the origin of median cell ; areole very short ; R_2 from end of the areole, R_3 stalked with R_4-R_5, arising almost halfway between tip of the areole and the origin of Radial veins 4-5 ; M_1 from upper angle or slightly above it ; median cell short, with its upper branch ending at the middle of discocellulars and the lower at M_2 ; M_2 from above the lower angle of cell and as far from M_3 as the latter from Cu_{1a} which is from angle of the cell ; Cu_{1b} from before the lower angle ; Cu_2 present ; 2A forming a fork with 1A. Hind wing with 8 veins ; Sc free ; Rs and M_1 connate and arising from the upper angle of cell ; median cell short, with both the branches ending at discocellulars ; M_2-M_3 and Cu_{1a}-Cu_{1b} as in fore wing ; three Anal veins present ; frenulum present, well developed but not held by the retinaculum which is short and broad but functionless (Text-fig. 1, G).

Male genitalia (Text-figs. 1, H-K).—Uncus about twice as long as its width at middle, broader at base than at the apex which is truncated, with its end produced into a downwardly directed point. Gnathos arms slender directed inwards, then bent outwardly and meeting each other through a slightly chitinised membrane, the bulla. Tegumen broad, narrowing gradually and continued with 'U' shaped short vinculum ; saccus very short. Claspers broader at middle, about two and a half times as long as the width at the middle ; the cucullus slightly membranous and setose ; ampulla highly sclerotised and with ridges ; costa produced into a short prolongation ; juxta formed of two lobes, the latter with their tips blunt and beset with minute spines and produced on the underside into short but blunt projections. Aedeagus well developed, sclerotised, with the distal end narrowed ; the vesica with two conical cornutal projections on the underside.

Holotype.—One male as follows : India : Himachal Pradesh, Chamba, 20. v. 1927 (*S. L. Hora* coll.) (Regd. No. 3192/H10 at Z. S. I.).

Expanse.—42 mm.

Remarks.—*Brachylia clenchi*, sp. nov. is close to *Cossus acronyctoides* (Moore) in the structural plan of the genitalia, particularly in the poor development of costal process, in the shape of juxta and in well developed aedeagus. The two species, however, differ from each other in antennal pectinations which are bipectinate in *clenchi*, sp. nov. *vs* unipectinate in *acronyctoides*, juxtal lobes being rounded and blunt in *clenchi*, sp. nov. *vs* narrow and pointed lobes in *acronyctoides*, and the aedeagus with two cornutal spines in *clenchi*, sp. nov. on the underside *vs*four in *acronyctoides*.

Phylogenetically, the genus assumes an important position among the Indian Cossidae, particularly between the genus *Catopta* Staudinger and *Cossus* Fabricius of the subfamily Cossinae. The genus *Catopta* is characterised by the bipectinate antennae with well developed rami, presence of ocelli (*vide* Arora, 1976) and in the poorly developed costal process, passing through the transitional stage of the genus *Brachylia* which is having bipectinate antennae with well developed rami and a poorly developed costal process, as in *Catopta*, but is without ocelli and with a functionless retinaculum as in the genus *Cossus* where the antennae are, however, unipectinate.

Brachylia clenchi, sp. nov. is thus an interesting species as far as the systematics of Indian Cossidae are concerned.

Acknowledgement

The author is indebted to the Director, Zoological Survey of India, Calcutta, for various facilities provided in the laboratory.

The author records his grateful thanks to Late Mr. Harry K. Clench, Carneige Museum, Pittsburg, for having sent the relevant literature on the group, particularly on the genus *Brachylia*, so as to help identify the species as a new one under this genus.

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ARORA

PLATE XII

A male holotype : Himachal Pradesh, Chamba 20. v. 1927 (*S. L. Hora* coll.)

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DIURNAL VARIATIONS IN PHYSICO-CHEMICAL FACTORS AND PLANKTON IN SURFACE LAYERS OF THREE TROPICAL FRESHWATER FISH TANKS OF NAGPUR*

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(With 3 Text-figures and 9 Tables)

INTRODUCTION

Extensive work on the diurnal variation of fresh water bodies has been carried out in the temperate region. Such investigations from tropical waters are few and scattered. Cushing (1951) has reviewed the earlier investigation on the vertical migration of planktonic crustaceans. Vaas and Sachlan (1953) observed the diurnal fluctuations in shallow ponds of Indonesia. Chacko and Krishnamoorthi (1954) noted the diurnal variation of phytoplankton and zooplankton of fish ponds from Madras. Ganapati (1955) observed the diurnal variations of some physico-chemical factors from a stream bed at Mettur dam. Talling (1957), Hussainy and Abdulappa (1963), noted that superficial stratification in the lake takes place during the day. George (1961) opined that the diurnal migration pattern of the plankton in the tropics was not similar to that found in temperate waters. Krishnamoorthi and Visweswara (1965) stated that the principal factor involved in the diurnal movement was light. Khan and Siddiqi (1970) studied the diurnal variations in a pond at Aligarh and Saha *et al.* (1971) contributed to our knowledge about the diurnal variations in a perennial fish pond. However, a detail study on diurnal variation of the water bodies of the Nagpur area is not available. In order to enhance our knowledge in this field, the present investigation have been carried out. The present observation is an outcome of the study of diurnal changes in water chemistry and plankton populations during March 1974 in three water bodies of Nagpur.

*Part of the thesis approved for the Ph. D. Degree of the University of Nagpur.

Morphometry and Topography of the tanks

All three tanks are located within a radius of 5 km and are used for rearing fish (Text-fig. 1).

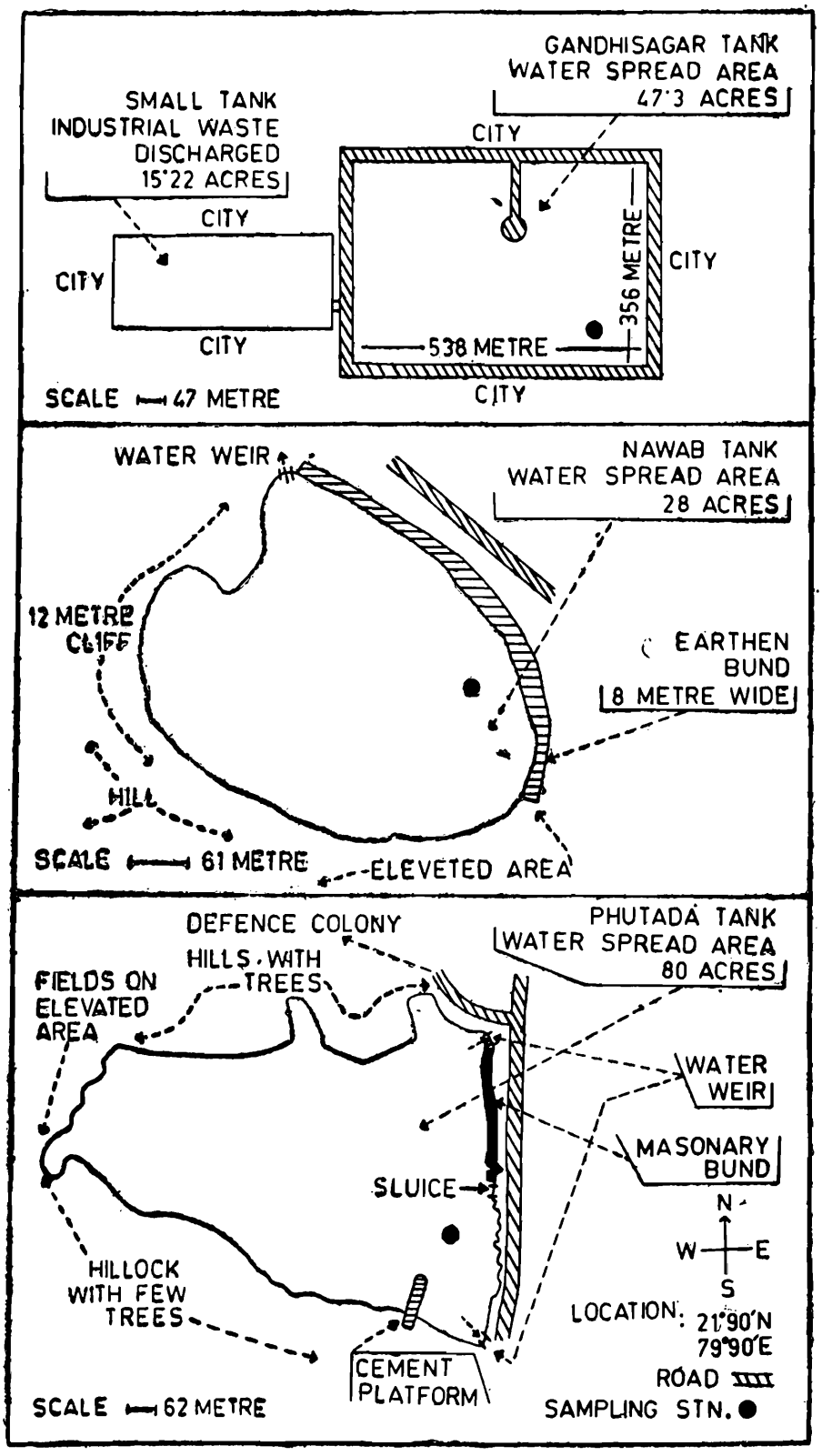


FIG. 1

Text-fig. 1. Map of Gandhisagar tank, Nawab tank and Phutada tank.

1. *Gandhisagar tank* : This is a rectangular tank situated in the heart of the city. The area is 47.3 acres, and on the three sides of the tank there are cement roads and on the fourth side the tank is

seperated from another small tank with an area of 15.22 acres. The depth of the tank is almost uniform and varies from 6 to 10 m. Three sides of the tank have stone embankment with stone steps running into the water level. The tank is partly polluted by domestic sewage and due to seepage from the adjoining small tank receiving textile mill effluent. Clothes are washed here on the stone steps.

2. *Nawab tank* : This is a small tank and the area being 28 acres. The depth of the tank varies from 2 to 10 m. This tank receives a continuous supply of water due to seepage from Ambazari, a large water reservoir, which is located close by. Hence, the water level is not reduced much in summer.

3. *Phutada tank* : This tank is used by State Fisheries department for rearing fish. The depth of the tank varies from 3 to 12 m. and the area being 80 acres. It receives land run-off and is subjected to recreational activities, like boating, angling etc. The tank is also used for bathing and washing purposes. The shore line is wavy and on one side there is a stony embankment. There are few trees on Western and Southern banks of the tank.

The day air temperature, especially in March, was generally high and ranged between 19.42°C to 38.70°C recorded from Meteorological data. Investigations were carried out for twenty four hours from 8.30 a.m. onwards on 13th March 1974, in Gandhisagar and from 10 a.m. onwards on 16th March 1974 in Nawab tank. Phutada tank was also investigated for twenty four hours from 9 a.m. onwards on the same day, *i.e.*, on 16th March 1974, as the latter two tanks are located near each other. On 13th and 16th March 1974 the sky was clear with bright sunshine.

METHODS OF INVESTIGATION

Water samples from the surface layers were taken with the help of a bottle from the same collecting stations every two hours and the chemical analysis was carried out immediately in the field. Special samples were taken for estimating dissolved oxygen (D.O.) and free carbon dioxide (Co_2). The water samples were always collected by gently allowing the water to flow into the bottles without causing entry of air bubles. For the plankton samples, water from the surface layers was taken into a plastic bucket of 20 liters capacity and filtered through the plankton net. Facilities for collecting the samples from deeper layers were not available, hence only surface samples were taken. The temperature was recorded with the help of an ordinary thermometer and pH by a pH meter. Turbidity was determined by a

turbidometer. Chemical factors such as dissolved oxygen, free carbon dioxide, bicarbonate and carbonate alkalinity, chloride, free ammonia, phosphate and total hardness due to calcium and magnesium were estimated as per methods given in the "Standard methods for the examination of water and waste water" (American Public Health Association, 13th Edition 1971).

Plankton samples were collected every two hours along with the water samples collected for chemical analysis. The samples were immediately preserved in 5% formalin. The phytoplankton counts were made by the "drop method" and the zooplankton was estimated with the help of a "Sedgwick Rafter cell".

Observations

Diurnal variations in the water chemistry of the tanks are given in Tables 1 to 3.

Temperature : Temperature fluctuations were between 20° to 23.5°C in Gandhisagar, 20° to 23° C in Nawab tank and 20.5° to 23.5°C in Phutada tank. The range of variations in the temperature was 3 to 3.5° C. The maximum temperature was recorded in all the tank between 2 p. m. to 3 p. m. and the lowest at 6 a. m. in Nawab tank between 1 to 5 a. m. in Phutada and from 4.30 to 6.30 a. m. in Gandhisagar. Thus marked variations in the day and night temperatures were not noticed as the difference being only 3° to 3.5°C.

Turbidity : Fluctuations in turbidity were ranged between 132 to 177 mg/litre in Gandhisagar. The minimum value was recorded from 12.30 a. m. to 8.30 a. m. and the maximum was at 12.30 p. m. The same was continued upto 6.30 p. m. After this there was decrease in value till 12.30 a. m. In Nawab tank maximum value observed was 177 mg/litre at 6. p. m. and 8 p. m., while the minimum of 144 mg/litre was seen at 10 a. m. In Phutada the turbidity values were low and ranged between 36 to 51 mg/litre. The minimum turbidity value was noted at 9. a. m. to 11 a.m. and after that there was a slight increase upto 42 mg/litre, which continnued from 1 p. m. to 11 p.m. The maximum was reached at 1 a. m. and contiued upto 7 a. m. of the second day.

pH : In all the tanks the pH was above 8. In Gandhisagar the range was between 8.85 and 9.30. The maximum was noticed at 4.30 p. m. and the minimum from 12.30 a. m. to 2.30 a. m. In Nawab tank, the fluctuation was between 8.1 to 8. 9. The minimum was noticed at 6 a. m. and the maximum was from 2 p. m. to 4 p.m. In Phutada

TABLE 1. Diurnal variations in the Physico-chemical factors in Gandhisagar tank on 13th/14th March 1974.

Time	Temperature (C)°	Turbidity mg/litre	pH	Free carbon-dioxide/ mg/litre	Carbonate as per $CaCo_3$ mg/litre	Bicarbonate as $CaCo_3$ mg/litre	Total Hardness as $CaCo_3$ mg/litre	Chloride as Cl mg/litre	Dissolved Oxygen mg/litre	Phosphate mg/litre	Free Ammonia mg/litre
1	2	3	4	5	6	7	8	9	10	11	12
8.30 a. m.	20.5	165	9.0	Nil	72	519	230	160	3.6	4.8	Nil
10.30 a. m.	20.5	165	9.0	Nil	80	534	195	165	5.2	4.8	Nil
12.30 p. m.	21.0	177	9.2	Nil	80	541	200	177	10.1	4.8	Nil
2.30 p. m.	23.5	177	9.25	Nil	88	546	185	177	14.5	4.8	Nil
4.30 p. m.	23.0	177	9.3	Nil	126	558	195	177	15.1	4.8	Nil
6.30 p. m.	22.5	177	9.15	Nil	120	560	190	177	12.9	5.2	Nil
8.30 p. m.	22.0	144	9.1	Nil	95	536	175	144	9.2	5.2	0.04
10.30 p. m.	21.0	144	9.0	Nil	94	523	180	144	8.4	5.6	Nil
12.30 a. m.	21.0	132	8.85	Nil	90	520	185	132	7.0	5.6	Nil
2.30 a. m.	21.0	132	8.85	Nil	80	520	175	132	5.8	5.6	Nil
4.30 a. m.	20.0	132	8.9	Nil	78	518	185	132	3.0	5.6	Nil
6.30 a. m.	20.0	132	8.9	Nil	78	514	190	132	2.8	5.6	Nil
8.30 a. m.	20.0	132	8.9	Nil	81	596	185	132	3.1	5.6	Nil

TABLE 2. Diurnal variations in the Physico-chemical factors in Nawab tank on 16/17 March 1974.

Time	Temperature (C)°	Turbidity mg/litre	pH	Free carbon-dioxide mg/litre	Carbonate as per $CaCo_3$ mg/litre	Bicarbonate as $CaCo_3$ mg/litre	Total Hardness as $CaCo_3$ mg/litre	Chloride as Cl. mg/litre	Dissolved Oxygen mg/litre	Phosphate mg/litre	Free Ammonia mg/litre
1	2	3	4	5	6	7	8	9	10	11	12
10.00 a. m.	22.0	144	8.6	Nil	10	92	115	50.0	7.8	0.4	Nil
12 Noon.	22.5	165	8.5	Nil	12	95	105	50.5	8.9	0.4	0.08
2.00 p. m.	23.0	165	8.9	Nil	18	98	100	46.0	9.4	1.0	Nil
4.00 p. m.	22.5	165	8.9	Nil	20	96	100	52.0	9.8	0.2	Nil
6.00 p. m.	22.0	177	8.7	Nil	22	92	100	53.0	9.6	0.2	2.0
8.00 p. m.	22.0	177	8.55	Nil	14	88	125	46.0	9.0	1.6	1.0
10.00 p. m.	21.0	165	8.5	Nil	12	85	100	56.0	8.2	1.0	1.0
12.00 a. m.	20.5	165	8.6	Nil	12	82	115	48.0	6.0	0.4	Nil
2.00 a. m.	20.5	165	8.4	Nil	11	81	105	47.0	6.1	1.6	1.0
4.00 a. m.	20.5	165	8.4	Nil	8	80	100	47.0	5.8	1.0	0.2
6.00 a. m.	20.0	165	8.1	0.1	Nil	86	100	48.0	2.8	0.8	1.0
8.00 a. m.	20.5	165	8.3	0.1	Nil	87	100	48.5	3.0	0.8	Nil
10.00 a. m.	21.0	165	8.5	Nil	9	90	115	49.5	6.2	0.8	Nil

TABLE 3. Diurnal variations in the Physico-chemical factors in Phutada tank on 16/17 March, 1974.

Time	Temperature (C)°	Turbidity mg/litre	pH	Free carbon-dioxide mg/litre	Carbonate as per $CaCo^3$ mg/litre	Bicarbonate as $CaCo^3$ mg/litre	Total Hardness as Cl. mg/litre	Dissolved Oxygen mg/litre	Chloride as Cl. mg/litre	Phosphate mg/litre	Free Ammonia mg/litre
1	2	3	4	5	6	7	8	9	10	11	12
9.00 a. m.	21.0	36	8.1	Nil	1.0	152	168	7.8	19.0	0.2	Nil
11.00 a. m.	21.5	36	8.25	Nil	6.0	156	184	9.0	18.0	0.2	Nil
1.00 p. m.	22.5	42	8.4	Nil	10.0	154	180	9.4	20.0	0.2	0.2
3.00 p. m.	23.5	42	8.4	Nil	12.0	174	175	9.6	21.0	Nil	0.2
5.00 p. m.	22.0	42	8.3	Nil	8.0	162	175	9.9	19.0	Nil	0.2
7.00 p. m.	22.0	42	8.2	Nil	2.0	152	175	9.2	18.5	Nil	0.04
9.00 p. m.	21.0	42	8.2	Nil	2.0	152	180	8.2	18.0	Nil	0.04
11.00 p. m.	21.0	42	8.15	Nil	1.0	154	160	6.0	19.0	Nil	0.02
1.00 a. m.	20.5	51	8.1	Nil	1.0	151	175	6.1	18.0	0.4	Nil
3.00 a. m.	20.5	51	8.0	Nil	1.0	150	160	5.8	17.5	Nil	0.04
5.00 a. m.	20.5	51	8.0	0.2	Nil	152	160	2.8	18.0	Nil	0.2
7.00 a. m.	21.0	51	8.1	0.3	Nil	142	165	3.0	18.0	Nil	0.2
9.00 a. m.	21.0	51	8.15	0.2	Nil	146	165	6.2	17.0	Nil	0.2

tank, the pH value was between 8 and 8.4 and the maximum noticed was from 1 p. m. to 3 p. m. and the minimum from 3 a. m. to 5 a. m.

Free carbon dioxide : Free carbon dioxide was not detected in Gandhisagar whereas it was present in Phutada tank from 5 a. m. to 7 a. m. and in Nawab tank from 6 a. m. to 8 a. m.

Carbonate : In Gandhisagar the carbonate content of water was slightly higher than in the other two tanks. The maximum value was 120 mg/litre at 6.30 p. m. and the minimum was 7.20 mg/litre at 8.30 a. m. of the first day. In Nawab tank, the maximum value of 22 mg/litre was noticed at 6 p. m. but no carbonate was detected at 6. a. m. and 8 a. m. In Phutada the maximum value of 12 mg/litre was noticed at 3 p.m. and the absence of carbonate was recorded at 5 a. m.

Bicarbonate : In Gandhisagar the bicarbonate fluctuations were between 514 to 560 mg/litre, the maximum at 6. 30 p. m. and the minimum at 6. 30 a. m. There was a gradual fluctuation in bicarbonate content in Nawab tank and the maximum value of 98 mg/litre was found at 3 p. m. and the minimum of 80 mg/litre at 4 p. m. In Phutada, the range was between 142 and 174 mg/litre, the maximum value was noticed at 3 p. m. and the minimum at 7 a. m. In all the tanks maximum bicarbonate content was noticed between 2 to 6 p. m. and the minimum from 4 a. m. to 7 a. m.

Total hardness ; Total hardness fluctuated from 175 to 230 mg/litre in Gandhisagar, 100 to 125 mg/litre in Nawab tanks and 160 to 184 mg/litre in Phutada. The maximum value was found at 8.30 a. m. in Gandhisagar at 8 p. m. in Nawab tank and at 11 a. m. in Phutada. The minimum values were recorded either in the evening or early morning hours.

Chloride : The chloride content of the Gandhisagar tank varied between 132 to 177 mg/litre. There was a gradual increase in the chloride content from 8.30 a. m. to 12.30 p. m. It stabilised there upto 6.30 p. m. and afterwards there was a gradual decrease. In Nawab tank, the chloride content did not show much variation. The fluctuations were between 46 to 56 mg/litre. In Phutada the range was still more limited and the fluctuations were between 17.5 to 21 mg/litre.

Dissolved oxygen : In Gandhisagar dissolved oxygen showed a fluctuation from 2.8 to 15.1 mg/litre. The amount of dissolved oxygen was maximum at 4.30 p.m. and minimum at 6.30 a.m. In Nawab tank, the highest value of 9.8 mg/litre was at 4 p. m. and the minimum of 2.8 mg/litre was at 6 a.m. Dissolved oxygen varied from 2.8 to 9.9 mg/litre in Phutada tank and the highest value was noticed at 5 p.m. and the

lowest at 5 a.m. Gandhisagar showed a rich phytoplankton population, and had a steep rise in dissolved oxygen value from 12.30 p.m. to 4.30 p.m. but the minimum value was the same as in the other tanks.

Phosphate : In Gandhisagar, the phosphate content ranged between 4.8 to 5.6 mg/litre. From 8.30 a.m. upto 4.30 p.m. the values were minimum and 6.30 p.m. onwards a slight increase was observed and the maximum value was reached at 10.30 p.m. This value remained constant till 6.30 a.m. next day. In Nawab tank, the minimum value observed was 0.2 mg/litre and the maximum was 1.6 mg/litre. The phosphate content, showed the least value in Phutada tank and during certain hours of the day, *i.e*, from 3 p.m. to 11 p.m. and from 3 a. m. to 7 a.m. It was totally absent. The range was between 0.2 to 0.4 mg/litre.

Free ammonia : In Gandhisagar, free ammonia of 0.04 mg/litre was noticed at 8.30 p.m. In Nawab tank, the maximum value of free ammonia content recorded was 2 mg/litre at 6 p.m. Free ammonia was not noticed between 2 p.m. to 4 p.m. and at 8 a.m. In Phutada tank free ammonia was noticed from 1 p.m. to 11 p.m. and again from 3 a. m. to 7 a.m. The maximum value recorded was 0.2 mg/litre.

ZOOPLANKTON

Diurnal variations in the zooplanktonic forms of the three tanks is given in Tables 4 to 6. The zooplankton of the three tanks (Text-fig. 2) showed three peaks during the 24 hours. In Gandhisagar the maximum number of planktons was 7186 units/litre at 12.30 a.m. and the minimum of 103 units/litre at 12.30 p.m. The highest number of the zooplankters was observed at 5 a.m. in Phutada and at 8 a.m. in Nawab tank. The maximum number of plankters were 679 units/litre in Nawab tank and 538 units/litre in Phutada.

The Zooplankton mainly consists of Rotifers, cladocerans, copepods and nauplius larvae. In all the three tanks Rotifera was the dominant group followed by nauplius larvae, copepods and cladocerans. The maximum Rotifer population was noticed in Gandhisagar. In Nawab tank the cladocerans were not found excepting a few forms at 10 p.m. (9 units per litre). The copepod population in Nawab tank and Phutada tank was roughly the same but in Gandhisagar it was muchmore. In Phutada the number of nauplius larvae was comparatively small.

ROTIFERA

In Gandhisagar the maximum Rotifer population was noticed at 12.30 a.m. and the minimum at 12.30. p.m. At 6.30 p.m. as many as

TABLE 4. Showing the diurnal variations of Zooplankton in Gandhisagar tank on 13/14th March, 1974 (Units/Litre).

Name of the Genera & species.	8.30 a. m.	10.30 a. m.	12.30 p. m.	2.30 p. m.	4.30 p. m.	6.30 p. m.	8.30 p. m.	10.30 p. m.	12.30 a. m.	2.30 a. m.	4.30 a. m.	6.30 a. m.	8.30 a. m.
ROTIFERA													
Rotaria sp.	10	—	—	—	—	6	—	—	—	—	—	20	—
Floscularia sp.	—	—	5	—	—	6	—	—	—	—	—	—	—
Sinantherina sp.	—	—	—	5	10	—	—	—	—	—	—	—	—
Filinia longiseta Ehrenberg	5	8	—	—	—	6	—	—	—	—	12	—	—
Keratella cochlearis (Gosse)	480	301	50	170	770	362	432	1001	2386	156	563	1268	887
Keratella tropica (Apstein)	265	250	—	280	1070	678	528	252	1298	451	358	998	755
Asplanchna intermedia Hudson	—	—	—	—	—	—	—	—	58	12	—	—	—
Brachionus angularis (Gosse)	685	121	—	25	740	356	128	121	512	178	179	374	524
Brachionus urceolaris O. F. Muller	—	—	—	—	10	—	—	—	—	—	—	—	—
Total :	1445	680	55	480	2600	1414	1088	1374	4249	797	1112	2660	2166
CLADOCERA													
Diaphanosoma sarsi Richard	—	—	—	—	—	—	32	—	140	42	38	41	64
Moina micrura	30	33	—	5	10	6	72	44	194	97	356	187	—
Ceriodaphnia rigaudi Richard	—	8	—	—	—	—	—	—	—	—	—	—	—
Total :	30	41	—	5	10	6	104	44	334	139	394	228	64
COPEPODA													
Cyclops sp.	110	223	16	80	120	30	1560	1012	620	132	397	395	230
Mesocyclops hyalinus (Rehberg)	—	43	—	—	—	—	40	76	53	4	12	41	12
Total :	110	266	16	80	120	30	1600	1088	673	136	409	436	242
Nauplius larvae	1120	86	32	695	1350	1410	168	594	1930	165	908	747	816
Total Zooplankton	2705	1073	103	1260	4080	2860	2960	3100	7186	1237	2723	4071	3258

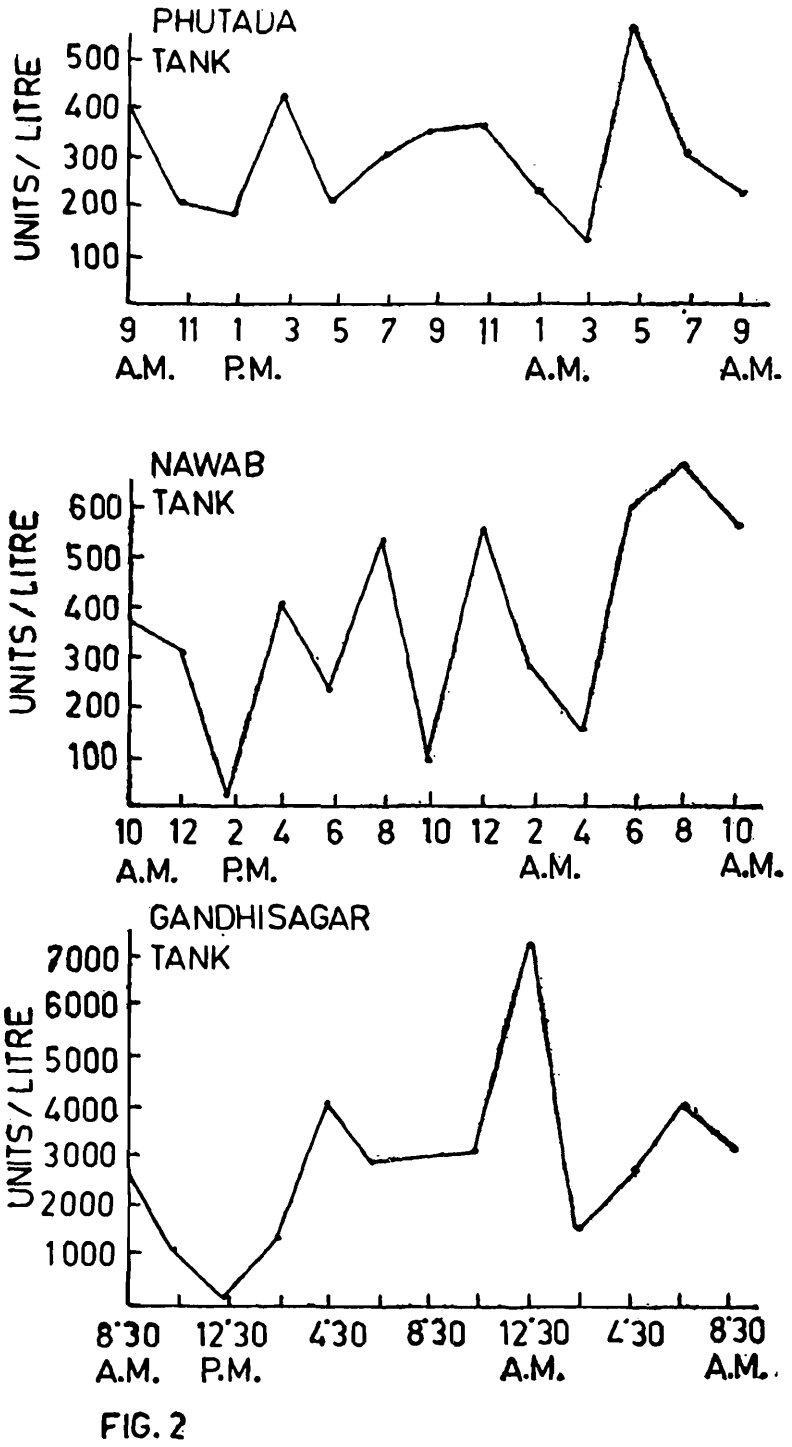
TABLE 5. Showing the diurnal variations of Zooplankton in Nawab tank on 16/17th March, 1974 (Units/Litre).

Name of Genera and species	10.00 a. m.	12.00 noon	2.00 p. m.	4.00 p. m.	6.00 p. m.	8.00 p. m.	10.00 p. m.	12.00 mid-night.	2.00 a. m.	4.00 a. m.	6.00 a. m.	8.00 a. m.	10.00 a. m.
ROTIFERA													
Filinia longiseta Ehrenberg	—	—	—	—	—	—	—	—	—	—	18	—	33
Polyarthra vulgaris Carlin	58	120	—	120	27	—	8	140	20	—	18	63	50
Keratella cochlearis (Gosse)	185	30	4	100	18	162	17	80	80	108	90	252	151
Keratella tropica (Apstein)	12	10	8	40	—	—	—	—	—	—	54	—	—
Asplanchna intermedia Hudson	6	22	8	26	12	129	9	—	—	—	18	38	101
Trichocerca cylindrica Imhof	6	25	—	60	3	—	17	40	20	—	18	63	50
Brachionus quadridentata Hermann	—	—	—	—	—	—	—	40	—	—	—	—	16
Epiphanes sp.	—	17	—	—	9	16	9	—	—	—	—	25	16
Lecane sp.	—	6	—	—	—	—	—	—	—	—	—	—	—
Monostyla sp.	—	—	—	—	—	—	—	—	20	—	162	88	16
Total :	267	230	20	346	69	307	60	300	140	108	378	529	423
CLADOCERA													
Moina dubia de Guerne et Richard.	—	—	—	—	—	—	9	—	—	—	—	—	—
COPEPODA													
Cyclops sp.	—	—	4	20	—	48	17	—	20	—	—	—	—
Mesocyclops leuckarti Claus	42	58	4	20	151	97	9	140	40	48	54	37	51
Total :	42	58	8	40	151	145	26	140	60	48	54	37	51
Nauplius larvae.	58	22	—	26	18	92	17	140	80	12	162	113	84
Total Zooplankton	367	310	28	412	238	549	112	580	280	168	594	679	568

TABLE 6. Showing the diurnal variations of Zooplankton in Phutada tank on 16/17th March 1974 (Units/Litre).

Name of Genera and species.	9.00 a. m.	11.00 a. m.	1.00 p. m.	3.00 p. m.	5.00 p. m.	7.00 p. m.	9.00 p. m.	11.00 p. m.	1.00 a. m.	3.00 a. m.	5.00 a. m.	7.00 a. m.	9.00 a. m.
ROTIFERA													
Conochilus sp.	—	—	—	—	—	5	5	25	8	—	15	5	15
Keratella cochlearis (Gosse)	27	10	—	—	—	5	10	5	77	—	25	10	30
Keratella tropica (Apstein)	165	64	27	85	18	61	82	76	77	25	173	65	70
Asplanchna intermedia Hudson	11	—	5	5	—	—	—	—	—	—	5	5	10
Trichocerca cylindrica Imhof	—	—	—	10	—	—	5	—	—	—	—	—	—
Brachionus angularis (Gosse)	5	5	10	—	—	—	2	—	—	—	—	—	—
Brachionus quadridentata Hermann	93	43	59	205	80	120	172	34	34	20	100	85	45
Brachionus urceolaris O. F. Muller	—	5	5	5	5	5	—	4	4	—	15	—	—
Brachionus caudatus Barrois & Daday	—	—	—	5	—	10	—	—	—	—	—	5	—
Epiphanes sp.	—	—	5	—	5	15	—	4	4	—	—	—	—
Total :	301	127	111	315	108	221	174	162	144	45	333	175	170
CLADOCERA													
Simocephalus vetulus Schodler	—	—	—	—	—	—	—	—	—	5	—	—	20
Moina brachiata (Jurine)	—	10	5	—	—	10	48	52	25	15	35	20	5
Macrothrix sp.	—	—	—	—	—	—	—	10	—	10	—	—	—
Total :	—	10	5	—	—	10	48	62	25	30	35	20	25
COPEPODA													
Cyclops sp.	60	16	16	40	23	50	81	76	25	25	120	35	—
Diaptomus sp.	—	—	—	—	—	—	5	25	8	5	15	—	5
Total :	60	16	16	40	23	50	86	101	33	30	135	35	5
Nauplius larvae.	49	59	48	65	75	15	40	35	25	10	35	70	30
Total Zooplankton	410	212	180	420	206	296	348	360	227	115	538	300	230

six different species of rotifers were noticed. The populations were dominated by *Keratella cochlearis*, *Keratella tropica* and *Brachionus angularis*. In Nawab tank fluctuations were observed in the rotifer population and the maximum number were noticed from 6 a.m. to



Text-fig. 2. Diurnal variations in the total Zooplankton population in the three tanks.

10 a.m. and the minimum at 2 p.m. The rotifers mainly consisted of *Keratella cochlearis* and *Polyarthra vulgaris*, *Asplanchna intermedia* and *Trichocerca cylindrica* was also present in good numbers. *Asplanchna* showed a peak at 8 p.m. and was not recorded from 12 a.m. to 4 a.m. In

Phutada tank three major peaks of rotifer population were observed at 9 a.m., 3 p.m. and 5 a.m. The population being dominated by *Keratella tropica* and *Brachionus quadridentata*.

Keratella cochlearis

In Gandhisagar a major peak of 2386 units per/litre of *Keratella cochlearis* was recorded at 12.30 a.m. and a minor peak of 1269 units/ litre at 6.30 a.m. The minimum number of only 50 units per litre was noticed at 12.30 p.m. In Nawab tank this rotifer was not found in large numbers, the maximum number was 252 units/litre at 8 a.m, and the minimum was 4 units/litre at 2 p.m. In Phutada the maximum number was 27 units/litre at 9 a.m. and in the samples collected from 1 to 5 p.m. it was not present.

Keratella tropica

In Gandhisagar *Keratella tropica* was found in abundant numbers and showed two major peaks at 12.30 a.m. and 4.30 p.m. One minor peak was recorded at 6.30 a. m. This rotifer was totally absent from the sample taken at 12.30 p. m. In Nawab tank the rotifer was recorded from 10 a. m. to 4 p. m. and again at 6 a. m. It was not observed from 6 p. m. to 4 a.m. The maximum number recorded was 54 units/litre In Phutada, the rotifer was present in the samples throughout the period of collection but its number varied from 18 to 173 units/litre. The maximum number was noticed at 5 a. m. and the minimum at 5 p. m.

Brachionus angularis

This form was present in good numbers in Gandhisagar. It was totally absent in the samples collected from Nawab tank and only a few forms were noticed in the samples from Phutada from 9 a. m. to 1 p. m. In Gandhisagar tank, *Brachionus angularis* showed three peaks, at 8. 30 a. m., 4.30 p. m. and 12.30 a. m. At 12.30 p. m. (noon) they were totally absent.

Brachionus quadridentata

Brachionus quadridentata was absent in all the samples from Gandhisagar. In Nawab tank it was recorded in small numbers only in two samples. *Brachionus quadridentata* along with *Keratella tropica* formed the major bulk of the rotifers in the samples of Phutada. It was present in moderate numbers throughout the period of collection. The maximum number of 105 units/litre was observed at 3 p. m.

Asplanchna intermedia

In Gandhisagar tank it was found only in two samples collected at 12.30 and 2.30 a. m. In Nawab tank the maximum number was recorded in the samples collected from 12 a. m. to 4 a. m. In Phutada this rotifer was recorded in the samples collected at 5 a. m., 9 a. m., 1 p. m. and 3 p. m. Their number never exceeded 10 units/ litre.

Polyarthra vulgaris

This rotifer was present in the samples of Nawab tank and the highest number of 140 units/litre was found at midnight. It was not recorded at 2 p. m., 8 p. m. and 4 a. m.

Trichocerca cylindrica

Trichocerca cylindrica was present in Nawab tank and showed maximum number of 63 units/litre at 8 a.m. This rotifer was absent in the samples collected from Gandhisagar and Phutada.

CLADOCERA

The cladocera population was comparatively poor. In Gandhisagar only three forms were noticed and *Moina micrura* was the dominant form. The maximum number of 256 units/litre was recorded at 4.30 a.m. *Diaphanosoma sarsi* was observed during the night time and early morning hours, and the maximum number was 140 units/litre at 12.30 a.m. In Nawab tank the cladocerans were absent from all the samples excepting on one occasion, when only 9 units/litre of *Moina micrura* were recorded at 10 p.m. In Phutada, *Moina brachiata*, *Simocephalus vetulus* and *Macrothrix* sp. were present in small numbers. The maximum number of *Moina brachiata* was 52 units/litre at 11 p.m.

COPEPODA

The copepoda population was abundant in Gandhisagar and was found throughout the 24 hours period. The dominant form was *Cyclops* sp. The maximum number of *Cyclops* sp. (1560 units/litre) was found at 8.30 p.m. and they were found in good numbers during night hours, *i.e.*, from 8.30, p.m. to 6.30 a.m. *Mesocyclops hyalinus* was mainly present during the night hours and the maximum numbers recorded was 76 units/litre at 10.30 p.m. This form was absent from the samples collected from Nawab tank and Phutada tank. Nawab tank showed

maximum number of *Mesocyclops leuckarti* at 6 p.m. and the maximum was 151 units/litre. In Phutada tank the copepod population mainly consisted of *Cyclops* sp. and *Diaptomus* sp. The copepods showed two peaks of 101 units/litre and 135 units/litre at 11 p.m. and 5 a.m. respectively. The maximum number of *Cyclops* sp. (120 units/litre) was recorded at 5 a.m. *Diaptomus* sp. was observed during night hours and the maximum number was 25 units/litre at 11 p.m.

NAUPLIUS LARVAE

Nauplius larvae were present in almost all the samples of the three tanks. In Gandhisagar they were found in large numbers and showed one major peak at 12.30 a.m. and two smaller peaks at 6.30 p.m. and 8.30 a.m. of the first day.

In Nawab tank the maximum number recorded was 162 units/litre at 6 a. m. and 140 units/litre at 12 a. m. At 2 p. m. they were not noticed in the sample. In Phutada they were present in small numbers throughout the 24 hours period.

PHYTOPLANKTON

In all the samples phytoplankton was composed of (Table 7 to 9, Text-fig.3) Myxophyceae which was the dominant group. In Gandhisagar the phytoplankton was very rich and it showed two pulses, one at 12.30 p. m. and the other at 8.30 p. m. (148604 units/litre). In Nawab tank two pulses were noticed, one at 12 p. m. and the other at 8 to 10 p. m. (55213 units per litre). In Phutada also two pulses were noticed one at 1 p.m. and the other at 7 p. m. (35636 units/litre).

MYXOPHYCEAE

This group was represented by four genera namely *Microcystis*, *Oscillatoria*, *Spirulina* and *Nostoc* in Gandhisagar. *Nostoc* was present during the period, 12.30 p. m. to 4.30 p. m. and was represented in small numbers (200 to 615 units/litre). The other three genera were very well represented and showed two distinct peaks, one at 12.30 p. m. and other at 8.30 p.m. The minimum number was observed between 2.30 to 6.30 a. m. In Nawab tank *Nostoc* was not observed and the other three genera were well represented and showed two peaks, one at 12 p. m. and the other at 8 p. m. The minimum numbers were recorded late in the night or in early hours of the morning In Phutada only two genera namely, *Microcystis Oscillatoria* were observed. These algae showed a gradual rise in numbers from 9 a. m. to 7 p. m. and the minimum number was noticed from 1 a. m. to 7 a. m.

TABLE 7. Showing the diurnal variations of Phytoplankton in Gandhisagar on 13th March, 1974 (Units/Litre).

Name of Genera	8.30 a. m.	10.30 a. m.	12.30 p. m.	2.30 p. m.	4.30 p. m.	6.30 p. m.	8.30 p. m.	10.30 p. m.	12.30 a. m.	2.30 a. m.	4.30 a. m.	6.30 a. m.	8.30 a. m.
MYXOPHYCEAE													
Microcystis	13100	12000	88400	69780	60009	38955	96000	81312	24000	17877	13000	9650	11570
Spirulina	6560	11870	16800	14590	19672	24860	25000	16000	4400	8912	2500	4990	4886
Oscillatoria	16840	22384	24800	19900	12300	14663	24623	19912	3496	3190	10096	11213	14007
Nostoc.	—	—	625	200	300	—	—	—	—	—	—	—	—
Total :	36500	46254	130625	104470	92311	78478	145623	117224	31896	29979	25596	25853	30463
CHLOROPHYCEAE													
Scenedesmus	500	621	1850	892	509	603	2250	2104	400	476	396	342	421
Clostorium	150	151	240	168	190	121	291	300	258	130	102	100	136
Total :	650	772	2090	1090	699	724	2541	2404	658	606	498	442	557
EUGLENOPHYCEAE													
Euglena	102	216	480	491	522	448	340	302	366	470	309	218	89
Phacus	—	—	240	137	80	86	100	—	—	—	—	—	—
Total :	102	216	720	628	602	534	440	302	366	470	309	218	89
BACILLARIOPHYCEAE													
Pinnularia	48	79	240	196	—	48	—	—	52	68	—	—	—
Navicula	—	75	160	32	—	—	—	—	—	—	—	—	—
Total :	48	155	400	228	—	48	—	—	52	68	—	—	—
Total Phytoplankton.	37300	47397	133825	706386	93612	79784	148604	119930	32972	31123	26403	26513	31109

TABLE 8. Showing the diurnal variations of Phytoplankton in Nawab tank on 16/17th March, 1974 (Units/Litre).

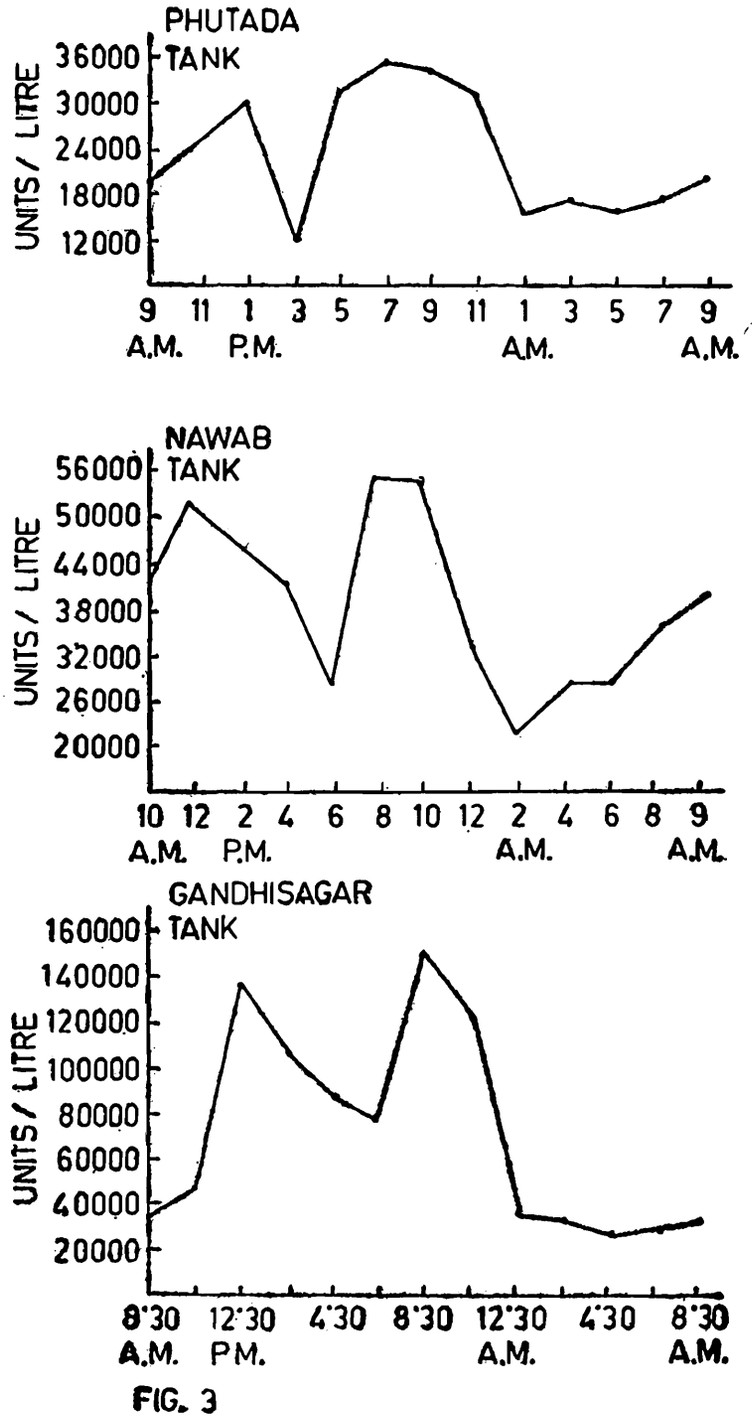
Name of Genera	10.00 a. m.	12.00 noon.	2.00 p. m.	4.00 p. m.	6.00 p. m.	8.00 p. m.	10.00 p. m.	12.00 midnight	2.00 a. m.	4.00 a. m	6.00 a. m.	8.00 a. m.	10.00 a. m.
MYXOPHYCEAE													
Microcystis	2600	25317	22950	18196	12980	28481	28612	14880	7289	15915	15110	24862	26106
Oscillatoria	5920	12180	10812	8902	5098	12930	11600	10707	8690	6961	7215	5000	5970
Spirulina	6420	10701	9868	10160	6412	11437	12016	7415	3915	3765	4081	3970	5186
Total :	38340	48198	43630	37258	24490	52848	52228	33002	19894	26636	26411	33832	37262
CHLOROPHYCEAE													
Eudorina	131	174	206	366	50	—	—	—	—	—	—	46	120
Pediastrum	200	288	174	280	160	203	385	155	190	175	88	170	176
Total :	331	462	380	646	210	203	385	155	190	175	88	216	296
EUGLENOPHYCEAE													
Euglena	677	1392	1012	1248	1300	896	808	509	200	415	341	251	576
Phacus	—	50	41	—	—	—	—	—	—	—	—	—	—
Total :	677	1442	1053	1284	1300	896	808	509	200	415	341	251	576
BACILLARIOPHYCEAE													
Navicula	1820	2160	1200	1981	2006	1266	890	312	765	571	571	965	1260
Total Phytoplankton	41168	52262	46263	41169	28006	55213	54311	33978	21049	27744	27411	35264	39394

TABLE 9. Showing diurnal variations of Phytoplankton in Phutada tank on 16/17th March, 1974 (Units/Litre).

Name of Genera	9.00 a. m.	11.00 a. m.	1.00 p. m.	3.00 p. m.	5.00 p. m.	7.00 p. m.	9.00 p. m.	11.00 p. m.	1.00 a. m.	3.00 a. m.	5.00 a. m.	7.00 a. m.	9.00 a. m.
MYXOPHYCEAE													
Microcystis	5416	9630	10038	10038	11161	12318	15980	16160	8463	8106	5960	6896	6000
Oscillatoria	15230	15133	19635	1835	20264	22898	18200	15033	7019	9813	10312	10930	13884
Total :	20646	24763	29673	11873	31425	35216	34180	31193	15482	17687	16272	17826	19884
CHLOROPHYCEAE													
Scenedesmus	206	330	284	150	230	300	364	218	250	180	126	159	189
BACILLARIOPHYCEAE													
Navicula	51	160	88	78	102	110	200	85	50	52	71	60	46
Total Phytoplankton	20719	25253	30045	12101	31757	35626	34744	31496	15782	17919	16469	18045	20119

CHLOROPHYCEAE

In Gandhisagar only two genera, namely, *Scenedesmus* and *Closterium* were found in the samples and the peaks were observed at 12.30 p. m. and 8.30 p. m. Their population was very much less than Myxophyceae. In Nawab tank, *Eudorina* and *Pediastrum* were present in small numbers.



Text-fig. 3. Diurnal variations in the total phytoplankton population in the three tanks.

Eudorina was not recorded from 8 p. m. to 6 a. m. and their maximum number (366 units/litre) was at 4 p. m. and the minimum at 6 a. m. In Phutada only one genus, namely *Scenedesmus* was observed in the

samples, and two minor peaks were noticed one at 11 a. m. and the other at 9 p. m.

EUGLENOPHYCEAE

This group was represented by two genera only *Euglena* and *Phacus* in Gandhisagar and Nawab tank. This group was not present in the samples from Phutada. In Gandhisagar *Phaeus* was noticed from 12.30 p. m. to 8.30 p. m. and the maximum number of 240 units/litre was recorded at 12.30 p. m. *Euglena* was present in all the samples and was recorded in good numbers (480 to 522 units/litre) from 12.30 p. m. to 4.30 p. m. In Nawab tank, *Phacus* was present in small numbers and was recorded between 12 p. m. to 2 p. m. *Euglena* was present throughout the 24 hours period and the maximum number of 1392 units/litre was recorded at 12 p. m. Their number was less during night.

BACILLARIOPHYCEAE

This group represented by *Pinnularia* and *Navicula*. *Pinnularia* was found only in Gandhisagar during certain hours of the day and the maximum number of 240 units/litre was recorded at 12.30 p. m. *Navicula* was recorded from 10.30 a. m. to 2. 30 p. m. in Gandhisagar and in the other two tanks it was noticed throughout the 24-hour period. In Nawab tank the maximum number was noticed at noon and in Phutada at 9 p. m.

DISCUSSION

In the study on the diurnal variations of the three water bodies it was observed that the temperature fluctuations ranged between 20°C to 23.5°C. The highest temperature reached at 2 p. m. in Nawab tank, at 2.30 p. m. in Gandhisagar and at 3 p. m. in Phutada. This is in conformity with the size of the tanks, Nawab tank being the smallest and Phutada the largest. Besides, Nawab tank is surrounded by a small practically barren hills and consequently is heated up early and takes longer time to cool and the lowest temperature was observed at 6 a. m. Phutada tank is located on the outskirts of the city and is exposed to wind, hence it cools earlier, the lowest temperature was observed between 1 to 5 a. m. In Gandhisagar the lowest temperature was reached at 4.30 a. m. The highest D. O. value was observed between 4 p. m. to 5 p. m. and the lowest from 5 a. m. to 6.30 a. m. Free carbon dioxide (0.1 to 0.3 mg/litre) was noticed in Phutada and Nawab tank between 5 a.m. to 7 a.m or 8 a.m. In Gandhisagar, free

carbon dioxide was not detected at all. This might have been due to the high carbonate values. In all the tanks the PH value was above 8. The highest pH was reached between 1 p. m. to 4 p. m. and the lowest from 12.30 a. m. to 6 a. m. These results are in agreement with the findings of Michael (1966). The Phosphate values were quite high in Gandhisagar (4.8 to 5.6 mg/litre) comparatively lower in Nawab tank (0.2 to 1.6 mg/litre) and very low in Phutada (0.2 to 0.4 mg/litre). The chloride value was quite high in Gandhisagar. The high chloride content indicates pollution of water (Sarkar and Rai, 1964 ; Mills, 1972).

Jolly (1965) found that some copepods and cladocera rise to the surface water in their greatest concentration exactly after two hours of sunset. Krishnamurthi and Visweswara (1965) stated that cladocera and copepods were most abundant at surface at night than during day indicating vertical diurnal movement. The present study confirms this view. It has been found that the phytoplankton showed bimodal peak one at noon and other between 7 p.m. to 10.30 p.m. Shetty *et al.* (1962) pointed out that phytoplankton peaks, should be followed by zooplankton peaks. Since the former serves food for latter. Gilyarow (1965) also observed a definite correlation between the distribution of zooplankton and phytoplankton while discussing vertical distribution of plankton. Considering Phytoplankton as food for cladocera and copepods the latter peak of phytoplankton between 7 p.m. to 10.30 p.m. might have brought the cladocerans and copepods to the surface layer for grazing purposes. This view is also confirmed by the grazing theory of Harvey *et al.* (1935). Welch (1952) also stated that the diurnal movement on the basis of food relations, are largely based upon the fact that phytoplankton is abundant near the surface, thus making such a region rich for the migrating forms. The absence of these organism (Crustacea) in the surface water during day time could be explained on the basis of the hypothesis of Davis (1955) who pointed out that though zooplankters are driven by hunger, yet stay away from surface layer due to day light. The diurnal variations in the zooplanktonic forms in all the three tanks showed three peaks during the 24-hours period. In Gandhisagar the highest number was found at 12.30 a.m. and the maximum number of zooplankton was noticed at 5 a.m. to 8 a.m. in Phutada and Nawab tank respectively. Zooplankton mainly consists of Rotifer, cladocera, copepoda and nauplii. Among the rotifers *Keratella*, *Brachionus*, *Asplanchna* and *Polyarthra* were the main genera to show their diurnal movement. *Keratella cochlearis* does not reveal any diurnal migration as its peaks were found at different times during the twenty four hours in all the three tanks.

Keratella tropica showed their maximum number during mid night at 12.30 a.m. and 4.30 p.m. in Gandhisagar. In Nawab tank it is recorded from 10.00 a.m. to 4 p.m. whereas in Phutada the maximum number was found at 5 a.m.

Brachionus angularis was present in Gandhisagar in good numbers and showed three peaks at 8.30 a.m., 4.30 p.m. and 12.30 a.m. In Phutada tank *Brachionus quadridentata* was present in moderate numbers throughout the period of collection, the maximum was observed at 3 p.m. *Polyarthra vulgaris* showed its highest number at midnight. *Trichocerca cylindrica* was present only in Nawab tank and the maximum number was found at 8 a.m. The above rotifers did not exhibit any prominent pattern of their migration and they show various peaks at different times in all the tanks. Probably their migration is different from tank to tank as stated by Welch (1952) that even the member of any one species may not exhibit a same pattern of diurnal movement in the different water bodies. As such rotifers do not manifest any diurnal migration which is in conformity with the view of Welch (1952) who stated that apparently the rotifer group as a whole is very little concerned to show diurnal migration. Nauplii showed their peak at midnight or early in the morning in all these water bodies.

In all the samples Phytoplankton was composed of Myxophyceae, Chlorophyceae, Euglenophyceae and Bacillario-phyceae. The main genera involved were *Mcrocystis*, *oscillatoria* and *Spirulina*, which showed two peaks one at noon and the other at 8 to 8.30 p.m. in Gandhisagar and Nawab tank. In Phutada only two genera *Microcystis* and *oscillatoria* were present and showed gradual rise from 9 a.m. to 7 p.m. The total phytoplankton showed bimodal peak one at noon and the other between 7 to 10 p.m. Out of these four groups, Myxophyceae was dominant which exhibited diurnal movement.

Thus the diurnal variation studies showed the abundance of the phytoplankton, in the early part of night. The cladoceran and copepods peaks were also observed at this time. The pH values were high in afternoon and comparatively low in the latter part of the night. The maximum D. O. values were recorded in the afternoon and the lowest between 5 a.m. to 6.30 a.m. The rotifer population was generally low at noon. The nauplius larvae showed a peak at midnight or early in the morning.

Maloney and Tressler (1942) noticed that the nauplii of copepods showed no diurnal movement in Carogo lake at New York. Pennak (1944) did not notice any vertical movement of nauplii in late summer in five northern Colorado mountain lake. Pew and Pennak (1949)

observed a diurnal movement of nauplii throughout the year in a lake in Indiana U.S.A. The present investigations carried out in March 1974 in three tropical water bodies reveal that the nauplii exhibit a diurnal movement showing peak at midnight or early in the morning. Probable reasons for the migration of planktonic forms have been discussed but in order to study the diurnal movement in detail, a much more extensive study is needed. Efforts should be made to find out some features about which our present knowledge is scanty. As such diurnal movement of plankton is rather a complicated phenomenon which requires further investigation.

Summary

Diurnal variations in the physico-chemical factors and plankton in surface layers of three tanks have been studied. The diurnal variation studies showed the abundance of phytoplankton in the early part of night. The Cladoceran and Copepod peaks were also observed in the early part of night. The pH values were high in afternoon and comparatively low in the latter part of night. The minimum dissolved oxygen values were reached in the afternoon and lowest between 5 a. m. to 6.30 a. m. The rotifer population was generally low at noon. The nauplius larvae showed a peak at midnight or early in the morning.

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THE OSTEOLOGY OF A CAVE-DWELLING BAT, *RHINOPOMA MICROPHYLLUM KINNEARI* WROUGHTON (CHIROPTERA : RHINOPOMATIDAE) FROM RAJASTHAN.

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(With 9 Text-figures)

INTRODUCTION

Bats being flying mammal, their skeleton has attracted the attention of anatomists mainly to study the extent to which demands of flight have changed their skeletal features (e. g., the radius, metacarpals and phalanges are greatly elongated ; the sternum has a keel for the attachment of the large pectoral muscles ; the cartilaginous rod (calcar) is sometimes attached to the inner side of the ankle for supporting the interfemoral membrane in the fast fliers, the ulna is vestigial to reduce the body weight ; and the scapula is large and broad).

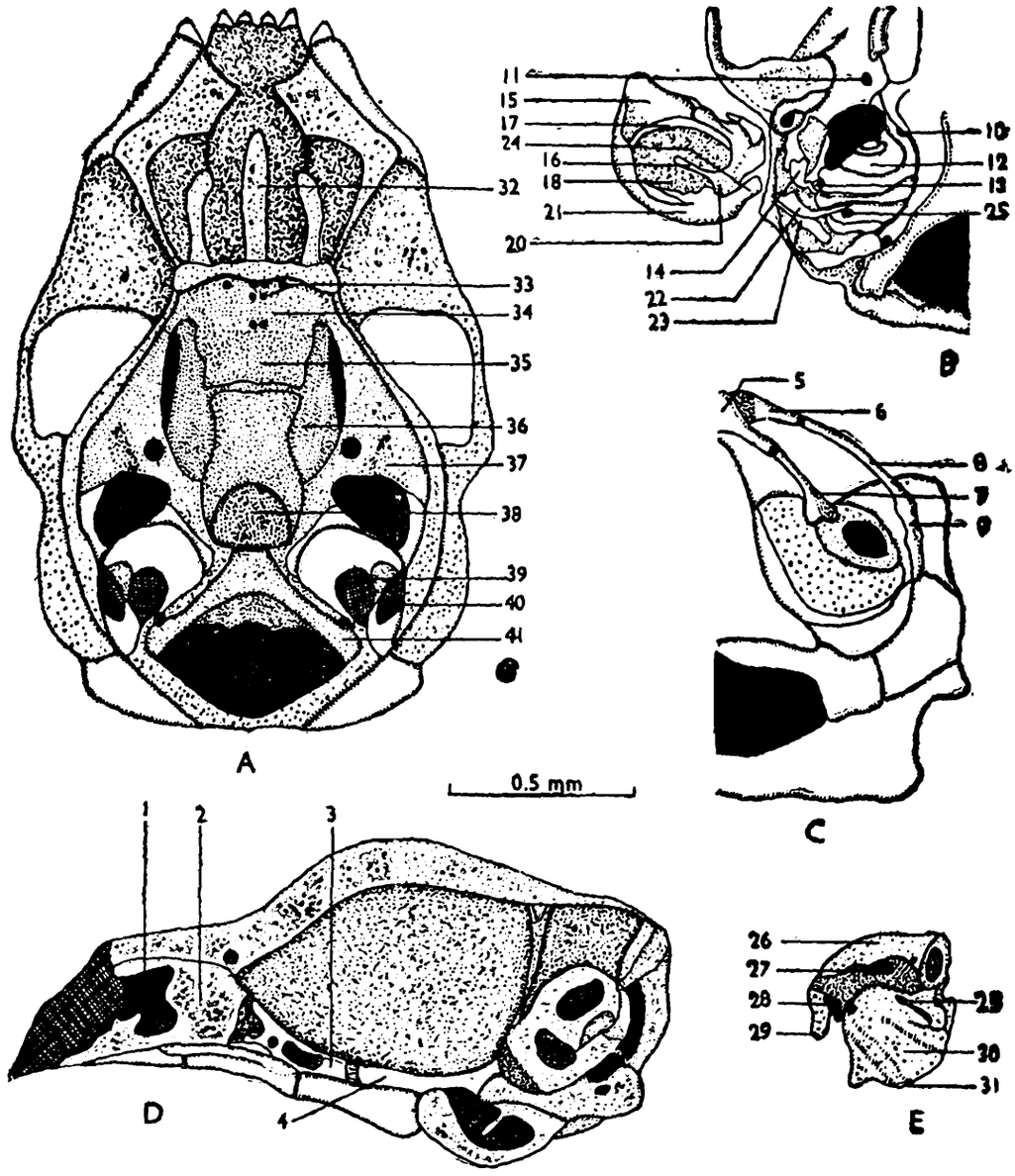
Miller (1907), Andersen (1912), Winge (1941), Tate (1942, 1943), Dobson (1876, 1878), Thomas (1915 *a*, *b*), and Madkour (1976) studied variations in a few skeletal parts such as skull, shoulder girdle and sternum which have taxonomic value. Supplementary works on the Indian region are those of Khajuria (1952), Prakash (1963), Agrawal (1967), Sinha (1969 *a*, *b* ; 1970, 1973, 1975) ; Sinha and Chakraborty (1971), Das and Sinha (1971) and Hill (1977). But the only detailed study is that of Vaughan (1970) who has described the skeletal system of the widespread genus *Myotis*, and also made comparative studies in the axial skeleton of the chiroptera. Wassif and Madkour (1963) studied the Osteology of the genus *Rhinopoma* found in Egypt. However, no Indian species has so far been studied in detail.

In the desert and other areas of Rajasthan, *Rhinopoma microphyllum kinneari* is the most common species and lives in caves, tunnels, and dark discarded rooms in old buildings. It is of the "hanging type." It was chosen for detailed study with a view to compare it with a species living in crevices, e. g., *Tadarida aegyptiaca thomasi*.

The skull

(Text-fig. 1)

The general plan of the skull of *Rhinopoma microphyllum kinneari* resembles that of any other terrestrial mammal and the complete description need not to be repeated. Therefore, here only important



Text-fig. 1. *Rhinopoma microphyllum kinneari* Wroughton. A, Skull (calvarium removed) ; B, ventral part of skull (tympanic bone and malleus reflected laterally) ; C, hyoid apparatus ; D, sagittal section of skull ; E, osseous labyrinth.

characters of the skull are described with special stress to its adaptation for aerial mode of life and different hanging pattern.

The skull of *R. m. kinneari* is medium-sized (total length 19.0-22.5 mm. ; zygomatic width 12-13 mm.) and oval in shape. In adult specimens the sagittal crest is very high in the middle, taking a bow-shape, fused posteriorly with the well-marked overhanging supraoccipital crest.

Basisphenoid not excavated as in *Taphozous* mentioned by Dobson (1876). Zygomatic arch arises from the lower part of the squamosal and fuses anteriorly with the maxillary bone in the region of third molar (in some cases as in *Taphozous* it fuses in the region of 2nd molar). Maxilla carries reduced number of teeth (c^{1-1}, pm^{1-1}, m^{3-3}) as in *Eptesicus*, *Hesperoptenus*, *Tylonycteris*, *Vespertilio*, *Otonycteris*, *Nycticeius*, *Scotomanus* and *Asellia*, (Miller, 1907) among Indian bats. Premaxillaries bony, separate, not fusing with surrounding parts and support slender incisors (1-1). Frontal concave just behind the nasal as in *Taphozous* and triangular in shape (more or less rhomboidal in *Taphozous*). Lachrymal regions have prominent ridge. Unlike *Taphozous*, postorbital process absent.

The space between the exoccipital and the squamosal filled with the bones of the auditory capsule. The latter consists of an inner cochlea and an outer mastoid process. Cochlea (Text-fig. 1 B, E.) internally encloses a series of canals which open outside by two openings—a fenestra cochleae and a fenestra vestibuli. Cochleae large, having three ducts ; firmly attached with the basisphenoid and the basioccipital, making a suture at the junction, and loosely attached to the squamosal. There is a hollow between the mastoid and the inner cochlea, with an opening in the cranial cavity. On the outer surface of the tympanic bulla lies the tympanic membrane. Tympanic bulla encloses the middle ear and supports it which is horseshoe shaped. A chain of three ear ossicles (mallaeus, incus and stapes) lies suspended within the tympanic bulla ; each ossicle is small, delicate and firmly attached at one point.

Internal feature of skull

(Text-fig. 1A & D)

Extending from the frontal to the presphenoid and vomer is the more or less expanded vertical bony plate, the mesethmoid, the latter joins posteriorly crebriform plate of the ethmoid and is perforated by numerous small foramina for the passage of the olfactory nerves ; it separates the olfactory chamber and the brain case. Fused with the crebriform plate are two lateral, thin and twisted bones, the ethmoturbinales.

The brain case may be divided into three distinct parts the anterior, middle and posterior cranial fossae. The anterior fossa is separated from the middle one by a distinct shelf formed by the posterior rim of the orbitosphenoid ; the middle fossa is separated from the posterior one by the elevated petrous bones that lie inside the external auditory meatus.

Lower jaw :—Unlike *Pteropus*, (Flower, 1885) and *Rousettus*, (Madkour, 1976), the mandible of *Rhinopoma microphyllum kinneari* has more longer and thinner coronoid, condylar and angular processes. The curvatures between these processes are relatively much prominent. On the outer lateral margin of the posterior end of the mandible (before these processes start) there is a prominent depression, such depression is not present in either *Pteropus* or *Rousettus*. The mandible bears a row of teeth (i_2, c_1, pm_3, m_3) on each side.

The hyoid apparatus (Text-fig. 1 c) :—Hyoid apparatus consists of an inverted 'V' shaped bone, the basihyal or body of hyoid, from which articulate the anterior and posterior cornu. The anterior cornu lies on each side of the pharynx and consists of a ceratohyal and a long and curved stylohyal which is fused anteriorly with the epihyal. The posterior cornu consists of a thyrohyal to which the thyroid cartilage of the larynx is attached.

The vertebral column

(Text-fig. 2)

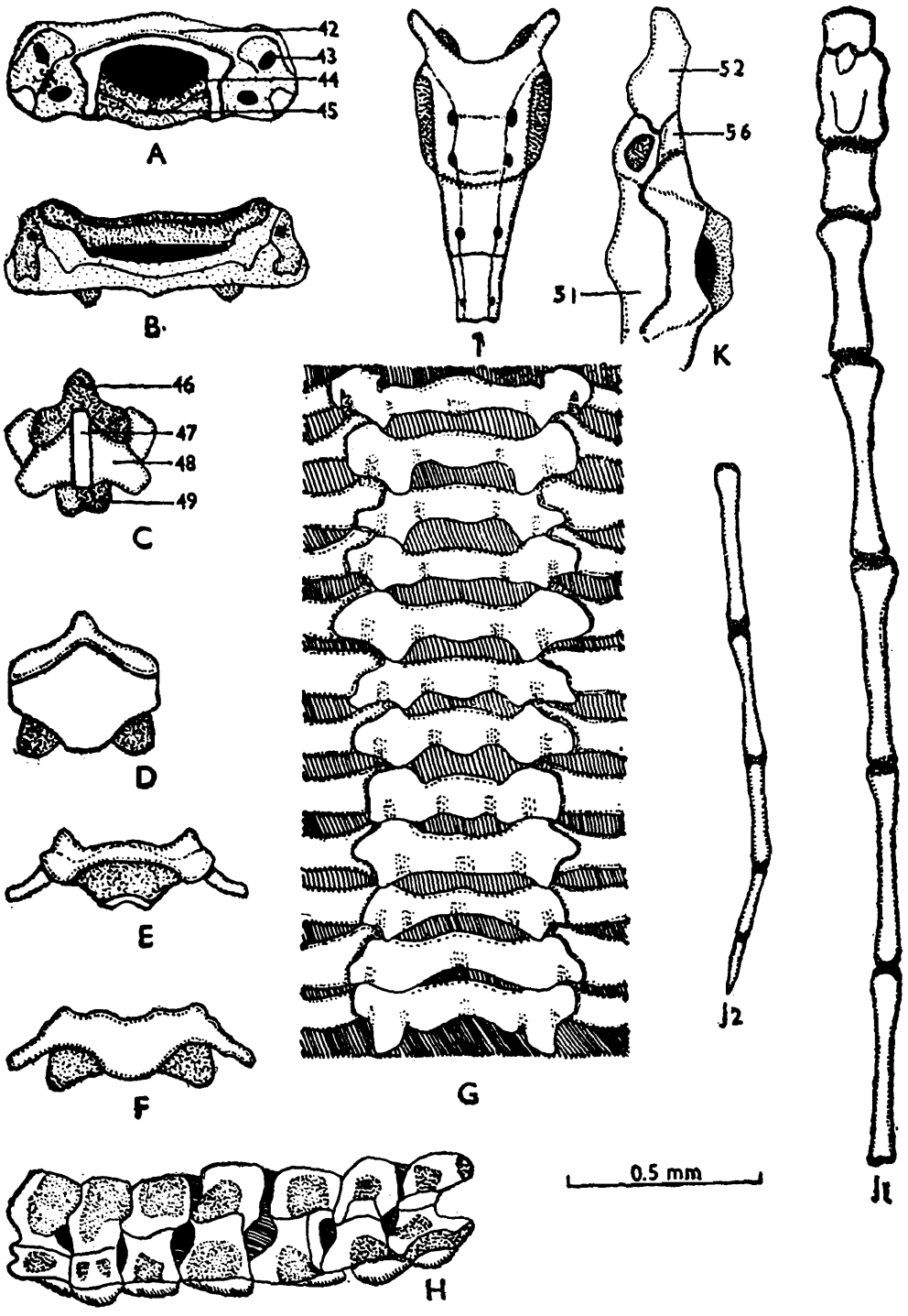
Cervical vertebrae.—Like some other bats as mentioned by Flower (1885), there are seven cervical vertebrae in *Rhinopoma m. kinneari*.

Atlas, the first cervical vertebra, is broader than the others (length 2.5 mm, width 8.0 mm.) and ring-like ; neural canal large ; centrum not discernible ; neural spine absent ; transverse process broad. Axis, the 2nd cervical vertebra is longer but narrower than the atlas (length 3.7 mm, width 3.5 mm.) ; its centrum anteriorly bears a prominent peg-like odontoid process ; prezygopophysis absent but postgygopophysis present ; the neural spine well developed and transverse processes small. The third to seventh cervical vertebrae are almost alike (length 1.5 to 2.0 mm, width 5.5 to 6 mm.) ; centrum procoelous ; anterior odontoid process not visible ; prezygopophysis, postzygopophysis and neural spine absent ; transverse process well developed.

Thoracic vertebrae.—In general feature the thoracic vertebrae of *R. m. kinneari* resemble that of *Myotis*, (Vaughan, 1970). Their number is twelve (eleven in *Myotis*) ; length 2.5-3.0 and width 4.5-5.0 mm. Centrum similar to that of *Myotis* ; last three vertebrae weakly procoelous as against *Myotis* in which the last two are weakly procoelous. A ridge like neural spine present only in the first thoracic vertebrae (in *Myotis* it is present in the last three thoracic vertebrae).

Lumbar vertebrae.—Lumbar vertebrae number-seven in *R. m. kinneari* while five in *Myotis* (Vaughan, 1970). Neural arch is very similar to Mytois. A ridge-like large transverse process is present in all lumbar

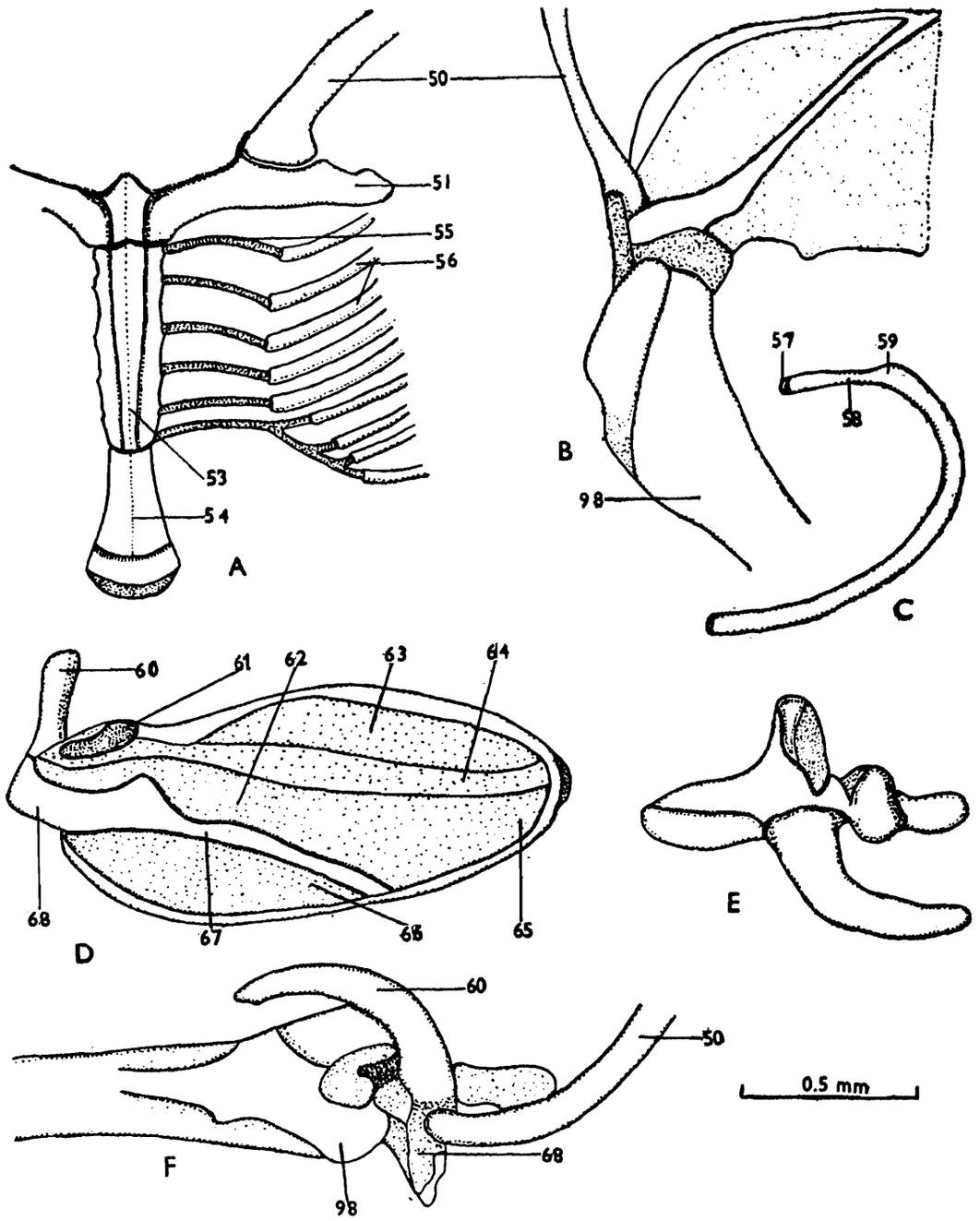
vertebrae of this bat while in *Myotis* it is smaller and only present in the last two vertebrae. Prezygopophysis and the postzygopophysis present, but Vaughan (1970) is silent about these structures while describing lumbar vertebrae of *Myotis*.



Text-fig. 2. *Rhinopoma microphyllum kinneari* Wroughton. A-F, cervical vertebrae ; G, thoracic vertebrae with ribs ; H, lumber vertebrae ; I, sacrum ; J1-J2, tail vertebrae.

Sacral and Caudal vertebrae.—The sacral vertebrae of *Rhinopoma microphyllum kinneari* when compared with those of *Myotis*, (Vaughan, 1970), it is found that both have four numbers of vertebrae which are fused to form the sacrum. In *Rhinopoma m. kinneari* the transverse

processes of only first two vertebrae are fused to form a pad-like surface for the articulations of the pelvic girdle while in *Myotis* (mentioned by Vaughan, 1970) all the transverse processes are fused, forming a continuous lateral mass that is thickest in the first two sacrals. In *Rhinopoma*



Text-fig. 3. *Rhinopoma microphyllum kinneari* Wroughton. A, ventral view of sternum, costal cartilages, distal end of ribs and proximal end of scapula ; B, Humerus, clavicle and scapula Joint ; C, a complete rib ; D, dorsal view of right scapula ; E, anterior view of left scapula ; F, posterior view of proximal end of humerus, scapula and distal end of clavicle joint.

m. kinneari all the neural spines are completely fused to form a neural crest but sutures present, while in *Myotis*, (Vaughan, 1970) the spines

are partly fused and higher. The number of caudal vertebrae is more in *R. m. kinneari* (13-16 Nos.) than the *Myotis* (10 Nos. ; Vaughan, 1970) and all are without neural foramina.

The sternum, ribs and pectoral girdle

(Text-fig. 3)

Sternum and Rib.—Sternum is very much similar to that of *Myotis* (Vaughan, 1970). It consists of a distal shield like manubrium (length 3.5 ; width 12.5 mm), a middle body of sternum (length 7.5, width 1.4 mm) and a distal fin-shaped xiphoid process.

The number of ribs is higher (12 Nos.) than *Myotis* (11 Nos. ; Vaughan, 1970). The first seven are sternal, the next three are vertebrocostal, and the last two are attached only to vertebrae. The structure of ribs is more or less as described by Vaughan (1970) for *Myotis*.

Pectoral girdle.—The pectoral girdle consists of a scapula with a coracoid process and a clavicle or collar bone.

The scapula (length 15.5-17 mm ; width 6.5-7 mm.) is narrow and more alike to *Pteropus* (Vaughan, 1970). Acromium process 3 mm. high and curved downward ; coracoid process long (length 5.5 mm.) and curved ; supraspinous and infraspinous fossa deeply concave ; the former about half the size of the latter ; glenoid fossa much deepen.

Clavicle long (length 14 mm.) and bowed distally ; its proximal end expanded and connected with the distal end of the lateral arm of the manubrium.

The forelimb skeleton

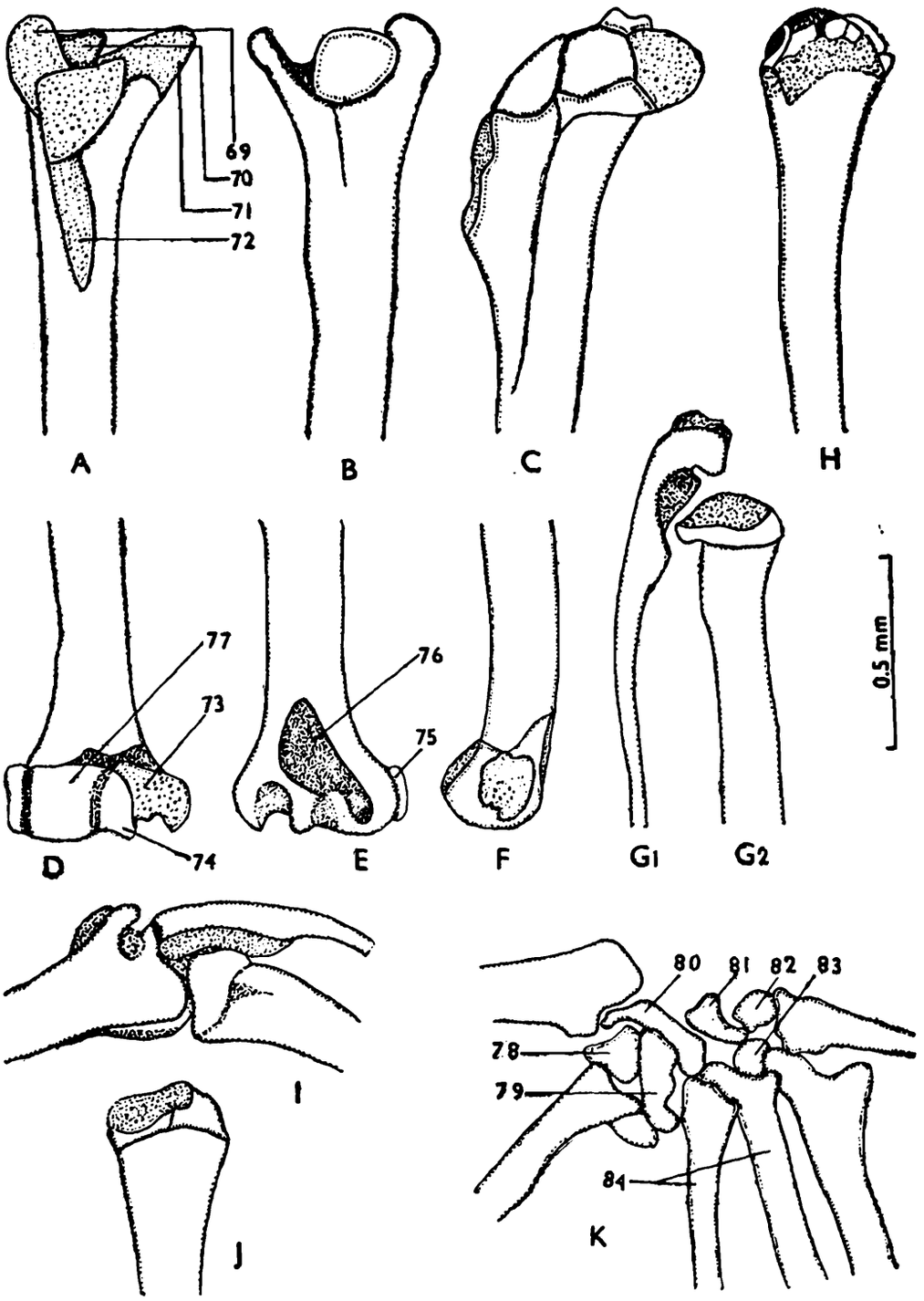
(Text-fig. 4)

The forelimb consists of the humerus, radius, ulna and manus.

The humerus is long (length 36 mm.) and rod-like. Its greater and lesser tuberosities less developed as in other primitive bats and slightly proximal to the head. In this respect it differs from the advanced bats of the family Molossidae and Vespertilionidae in which the greater tuberosity is large and extended well beyond the head (Vaughan, 1970).

The radius is very long (over 170% of the humerus) and bowed slightly forward ; its proximal articular surface is marked by a large and deep central groove and a small shallow lateral groove. The distal articular surface is deeply concave,

The ulna is small (about 60% of the radius) gradually narrowing from proximal end to distal end, latter fused to the radius in the same manner as in *Myotis*, (Vaughan, 1970).



Text-fig. 4. *Rhinopoma microphyllum kinneari.* A-C, anterior, posterior and medial views of distal end of humerus ; C_1—C_2, anterior view of proximal end of radio-ulna ; H, anterior view of distal end ofradius ; I, distal end of humerus and proximal end of radio-ulna ; J, posterior view of distal end of radius ; K, medial view of right carpus.

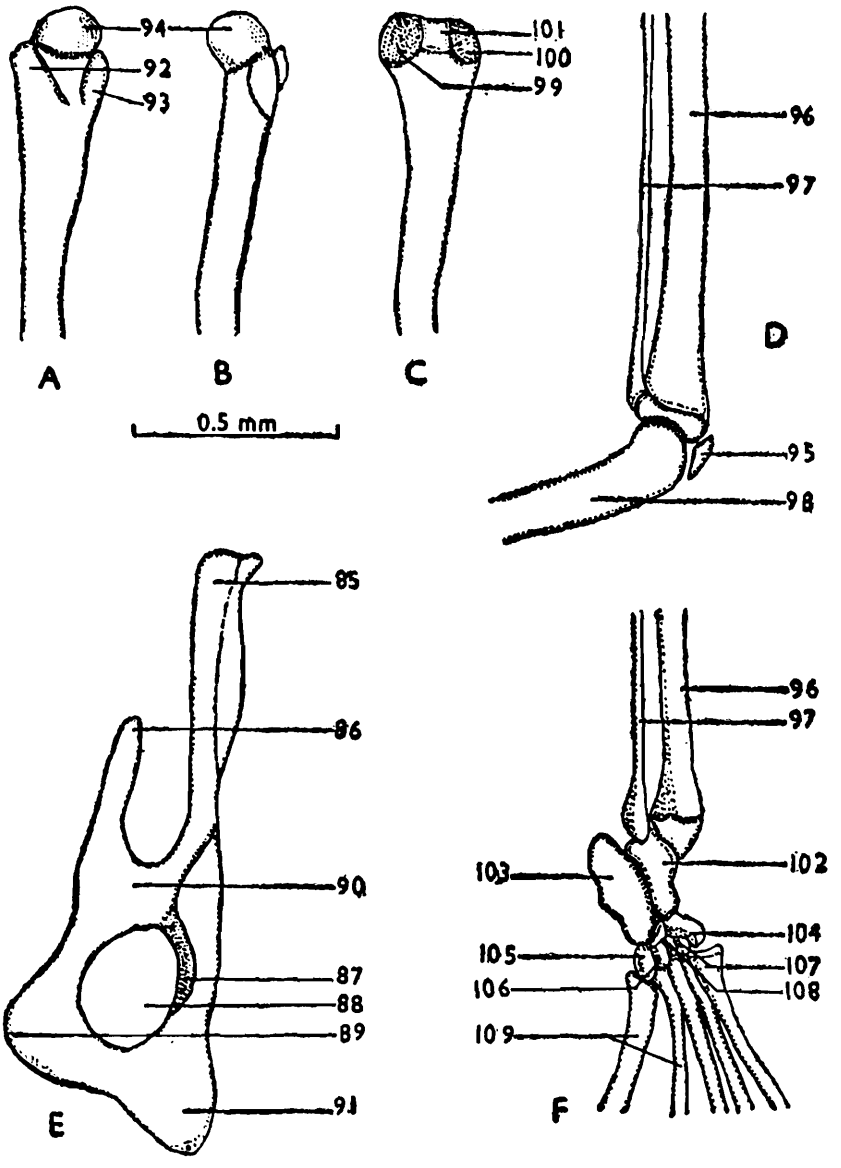
Like other bats, the manus consists of the carpal elements, the metacarpals and the phalanges. The proximal surfaces of two carpal elements, the lunar and the cuneiform, articulate with the radius ;

and the rest with the proximal end of the metacarpals. Unlike vespertilionid bats all the digits except thumb have two phalanges each. In *Myotis*, as described by Vaughan (1970), the 2nd digit has one phalanx and the rest digits have three phalanges each, the terminal ones being cartilaginous.

The pelvic girdle and the hind limbs

(Text-fig. 5)

Like other bats, the pelvic girdle resembles that of terrestrial mammals in general structure. It comprises two long curved bones



Text-fig. 5. *Rhinopoma microphyllum kinneari*. A, anterior view and B, medial view of proximal end of femur ; C, anterior view of distal end of femur ; D, tibia, fibula, femur and patela joint ; E, lateral view of pelvis ; F, dorsal view of distal tibia fibula and tarsal bones.

(length 14.0-15.5 mm.), the innominates which unite with the two sacral vertebrae dorsally and with each other ventrally, forming a pubic

symphysis. The acetabulum is small and faces dorsolateral and slightly posterior as in *Myotis* (Vaughan, 1970). The pubic spine is long (about one third the length of the pelvis) and projects anteriorly and somewhat dorsally. The ilium is long (about 64% of the pelvis) and projects dorso-anteriorly.

The femur is slightly longer (24 mm.) than the tibia (22 mm.) and differs from *Myotis* (Vaughan, 1970) in which it is roughly the same length as the tibia. The tibia is thin and as long as the femur.

The calcaneum (length 2.8 mm.) is longer than the astragalus (length 1.9 mm.) and is without a calcar bone. The foot is long (37% of the hind limb). The phalangeal formula is 1-2-2-2-2 ; and all the five digits are subequal in length.

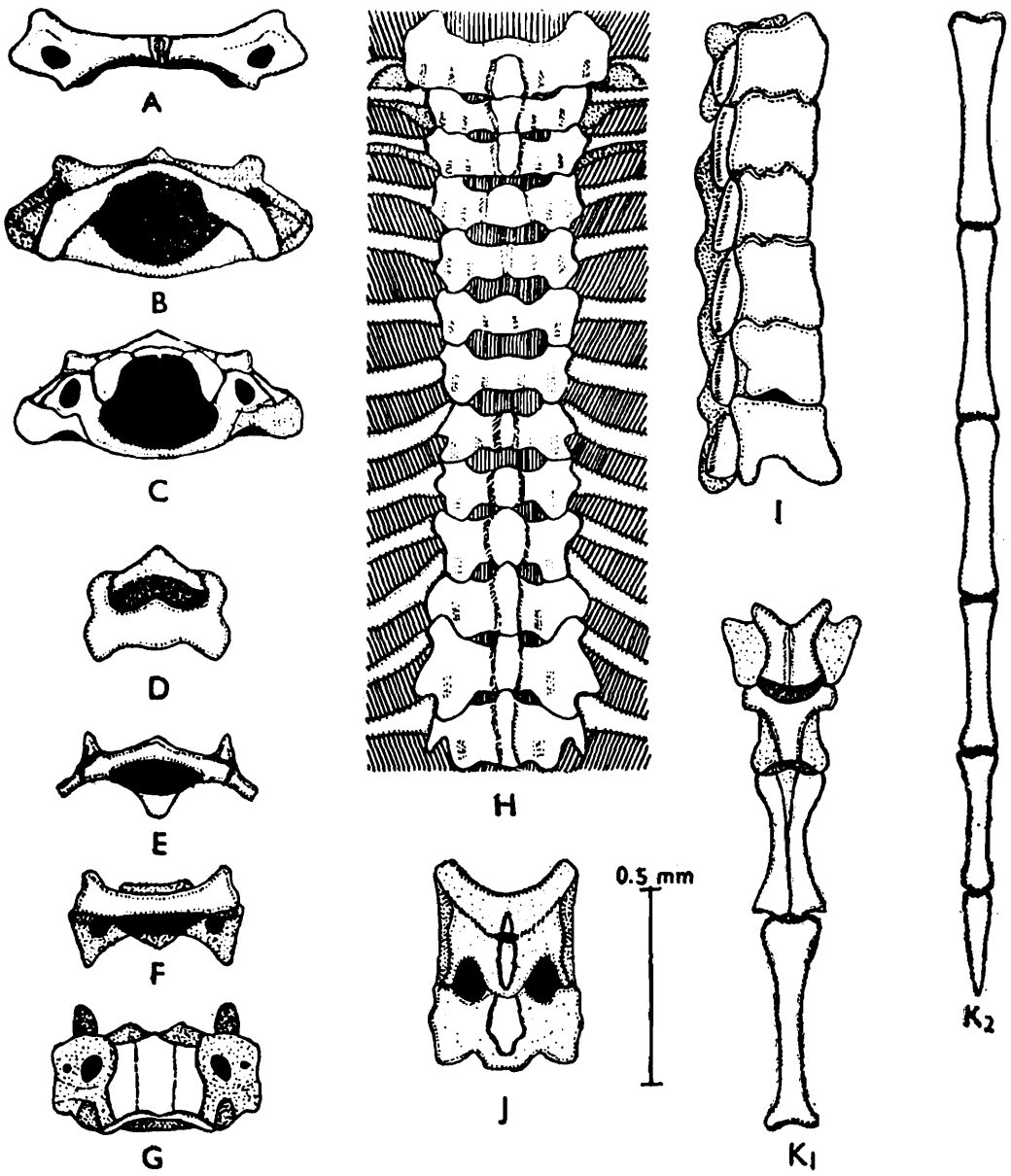
Skeletal variations in Rajasthan bats

Post cranial skeleton.—Many variations occur in the postcranial skeleton of bats, but the functional basis for these differences are not clear. Vaughan (1970) explained some possible causes of these variations. Here is given only a comparative account of postcranial skeleton, with a possible functional basis in the cave dwelling bat, *Rhinopoma microphyllum kinneari* a slow (flier) and crevices dwelling bat, *Tadarida aegyptiaca thomasi* (a fast flier).

Vertebrae.—Unlike *R. microphyllum kinneari*, in *Tadarida aegyptiaca thomasi* (Text-fig. 6) the total number of vertebrae is smaller (38 *vs.* 43-46). There are 6 free cervical vertebrae and the seventh is fused with the first thoracic ; in *R. microphyllum kinneari* are 7 and the seventh is not fused with the first thoracic. The atlas of *T. a. thomasi* (length 3.2 mm., width 7 mm.) is longer in proportion to width than in *R. microphyllum kinneari* (length 2.5 mm., width 8.0 mm.). The neural canal is wider (diameter 3 mm. *vs.* 2 mm.) in *R. microphyllum kinneari.* The axis is slightly shorter (length 3.4 mm, width 3.2 mm. *vs* 3.7 mm. and 3.5 mm.) ; the neural spine is poorly developed (height 1 mm.) in *T. a. thomasi* and well developed (height 1.8 mm.) in *R. microphyllum kinneari.* Other cervical vertebrae are similar but slightly higher than in *R. microphyllum kinneari* (height 2.5-2.6 mm. *vs.* 2.3-2.4 mm.) ; the neural canal is wider (width 4 mm, height 2 mm, *vs.* 2.2 and 1.5 mm.).

There are 13 thoracic vertebrae in *T. a. thomasi* ; in *R. microphyllum kinneari* 12. The lumbar vertebrae are 6 in number, all nearly alike ; in *R. microphyllum kinneari* they are 7. The neural arch above bears a neural ridge, but is not as developed as in *R. microphyllum kinneari.*

Sacral vertebrae are three in number and completely fused ; in *R. microphyllum kinneari* there are 4. The dorsal and anterior surface of the first sacral vertebrae is deeply concave and crescent shaped anteriorly, the lateral surface of the first sacral vertebra with the lateral surface of the second making a pad-like surface for the articulation of



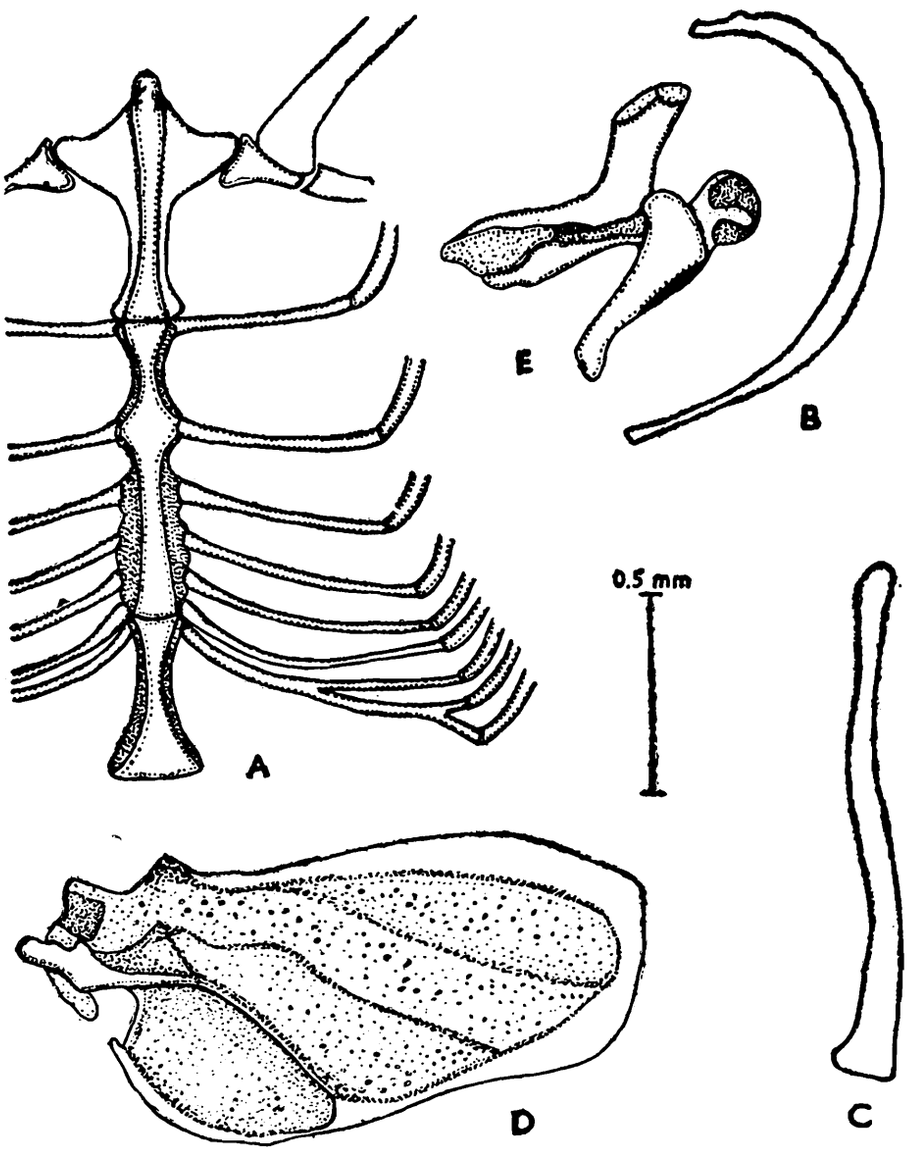
Text-fig. 6. *Tadarida aegyptiaca thomasi*. A-F, cervical vertebrae ; G, 1st thoracic vertebrae ; H, thoracic vertebrae with ribs ; I, lumbar vertebrae ; J, sacrum ; K_1—K_2, tail vertebrae.

the pelvic girdle ; ventrally there is a keel-like projection which slopes posteriorly. The neural spines are prominent in the 2nd and 3rd sacral vertebrae ; the neural foramina wider than in *R. microphyllum kinneari*.

There are 9 caudal vertebrae (13-16 in *R.. microphyllum kinneari*) ; the first is much broader than the rest.

Reduction in number of vertebrae and fusion help *T. a thomasi* in fast flying by lessening the body weight.

The sternum, ribs etc. (Text-fig. 6).—The sternum of *Tadarida aegyptiaca thomasi* is composed of three parts. The anterior part (the manubrium), unlike *R. microphyllum kinneari*, is longer than broad (length 5.8 mm ; width 4.2 mm.) *vs.* broader than long (length 3.5 mm., width 12.5 mm.) and is fused with the costal bone as in the latter.

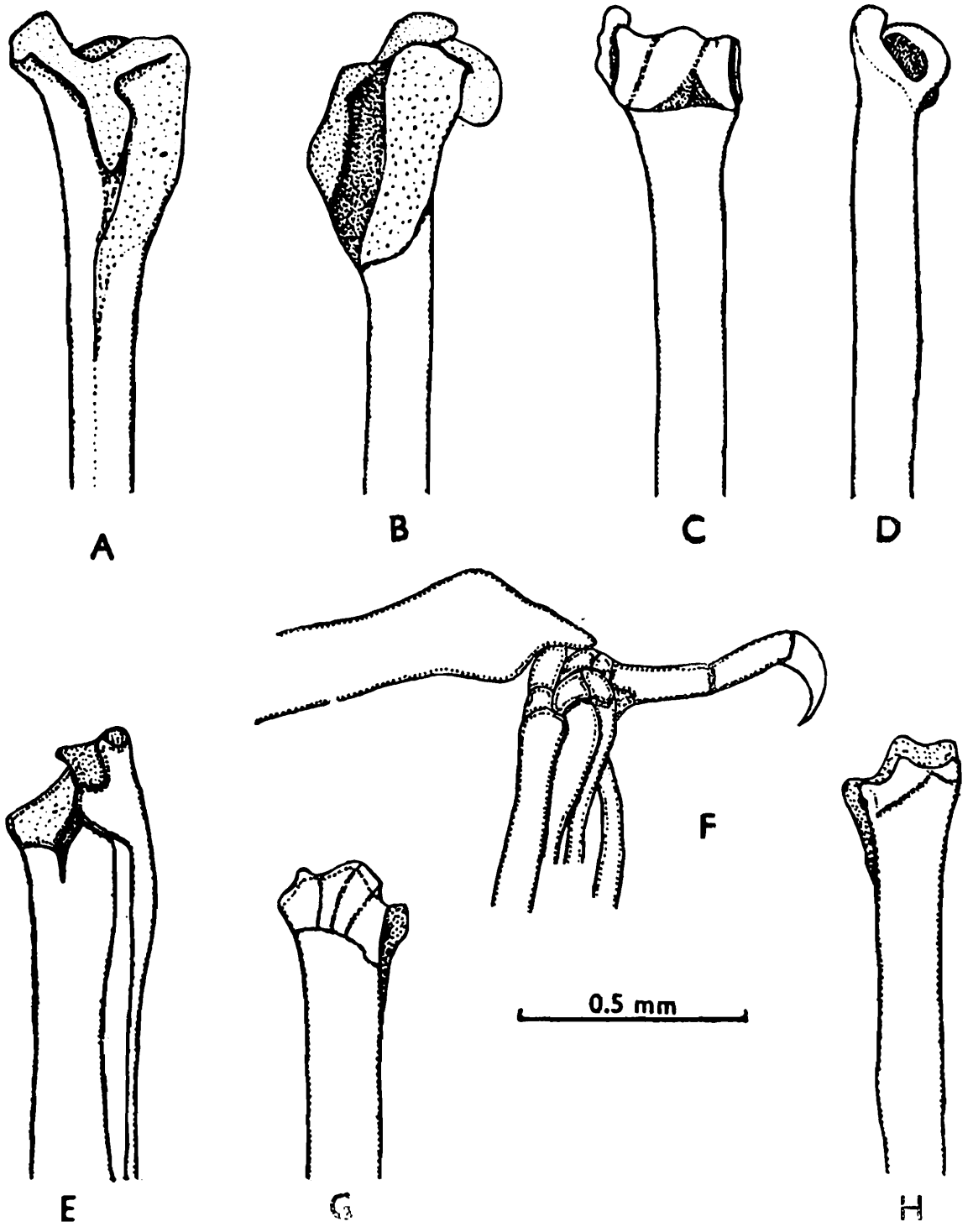


Text-fig. 7. *Tadarida aegyptiaca thomasi.* A, ventral view of sternum, costal cartilages, distal end of ribs, and proximal end of scapula ; B, a complete rib ; C, complete clavicle ; D, dorsal view of right scapula ; E, anterior view of left scapula.

The keel of the sternum is more developed than in *R. microphyllum kinneari* and this is related to its fast flying habit. The middle portion of the sternum is larger in proportion to body size than in *R. microphyllum kinneari* (length 7.7 mm. ; width 1.6 mm. *vs.* 7.5 mm. and 1.4 mm.). The xiphoid process is as in *R. microphyllum kinneari.*

There are 13 ribs (12 in *R. microphyllum kinneari*), the first nine are sternal, the next two vertebrocostal and the last two are only attached with the vertebrae.

Pectoral girdle and the forelimb (Text-figs. 7 and 8).—The scapula is broader than in *R. microphyllum kinneari* (length 50.2% of the humerus and width 26.3% *vs.* 47.2% and 19.4% respectively). The supraspinous

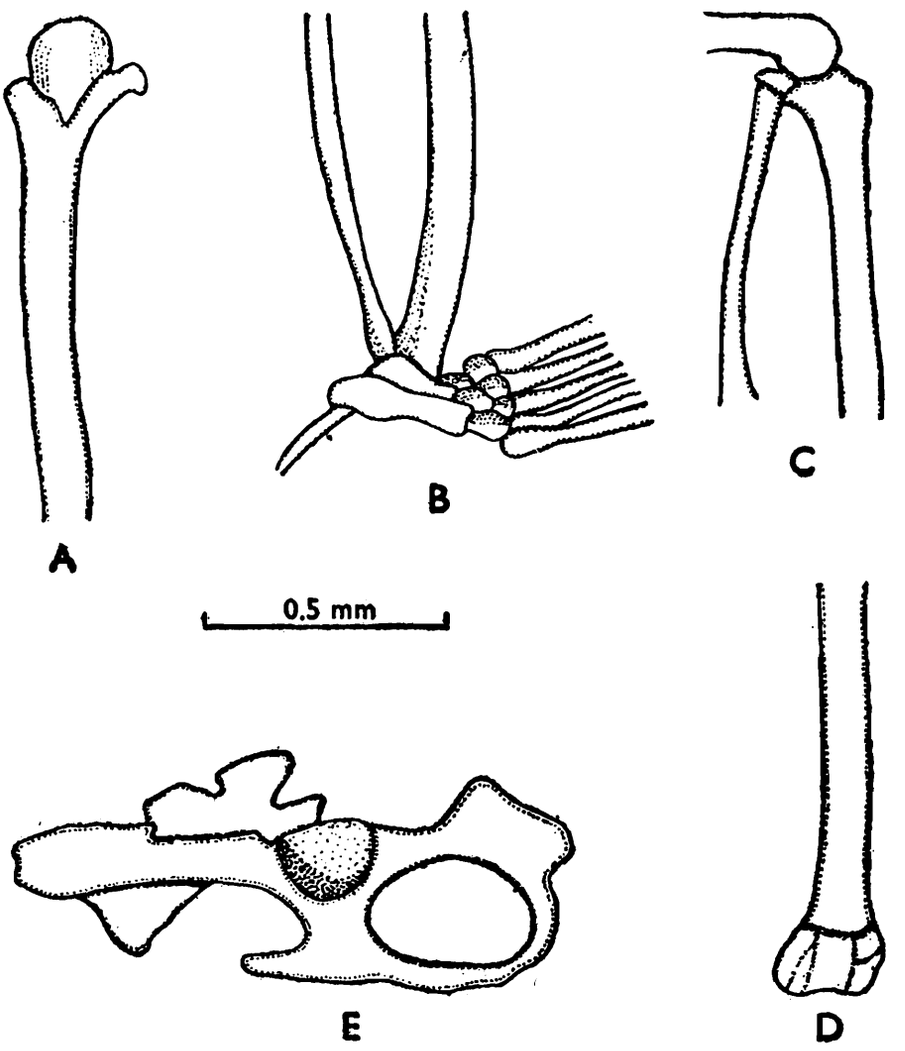


Text-fig. 8. *Tadarida aegyptiaca thomasi.* A-B, anterior and medial views of proximal end of humerus ; C-D, anterior and medial views of distal end of humerus ; E, anterior view of distal end of radio-ulna ; F, lateral view of the right carpus ; G-H, anterior and posterior views of distal end of radius.

fossa is less than half of the area of the infraspinous fossa (*vs.* about half in *R. microphyllum kinneari*). The anterior flange of the scapula is more developed than in *R. microphyllum kinneari.* The coracoid

process is projected medial, but is lateral in *R. microphyllum kinneari*. The anterior emargination of the scapula between the anterior flange and the base of the coracoid process is very deep (*vs.* shallow in *R. microphyllum kinneari*). The acromion process is less flat than in *R. microphyllum kinneari*, its distal end is more apart from the proximal base of the coracoid process and exceeds the lateral border of the scapula. The glenoid fossa is deeper.

The humerus (length 28.2 mm.) is more modified than in *R. microphyllum kinneari*. The greater tuberosity (length 1.5 mm ; 0.5 in *R.*



Taxt-fig. 9. *Tadarida aegyptiaca thomasi*. A, medial view of proximal end of femur ; B, dorsal view of distal end of tibia, fibula and tarsal bone ; C, medial view of proximal end of tibia and fibula, distal end of femur and patela joint ; D, medial view of distal end of femur ; E, lateral view of pelvis.

microphyllum kinneari) is longer and extends beyond the head. On the top of the head there is a pit (1.5 mm. deep) ; no such pit is found in *R. microphyllum kinneari*. The medial ridge of the humerus is higher than in *R. microphyllum kinneari* (7% of humerus *vs.* 5.5%)

and the medial epicondyle bears a spinous process (there is no such process in *R. microphyllum kinneari.*

The radius is smaller than in *R. microphyllum kinneari* (below 170% of the humerus *vs.* above 170%) ; the ulna is much reduced (46.2% of radius *vs.* 60% in *R. microphyllum kinneari*), thinner and fused within the proximal half of the radius. The metacarpals are longer than in *R. microphyllum kinneari* (86-101% of radius *vs.* 60-75% in R. *microphyllum kinneari*).

The great reduction of the ulna and the considerable lengthening of the metacarpals is related to its fast-flying habit.

Pelvic girdle and hind limbs (Text-fig. 9).—There is considerable variation in the posture and proportion of the hind-limbs and the structure of the pelvis in *Tadarida a. thomasi* and *R. microphyllum kinneari.* Such variation is related to their roosting habit and mode of locomotion.

T. a. thomasi roosts in narrow crevices and can crawl well and the posture of the hind limbs is "reptilian". The hind limbs and feet are short and strongly built. The femur (17.5 mm.) longer than the fibula (12.2 mm.), but both are much shorter than in the cave dwelling bat *Rhinopoma microphyllum kinneari* (femur 28% and fibula 20% of head and body length *vs.* 33.3% and 30% in *R. microphyllum kinneari*). The pelvis is broad (compressed in *R. microphyllum kinneari*). The depth of the pelvis, from the pubic symphysis to the ischial tuberosity, is about 38% of the total length of the pelvis (about 40% in *R. microphyllum kinneari*). The pubic spine is shorter (19% of the length of the pelvis, *vs.* 36% in R. *microphyllum kinneari*) and the acetabulum is larger.

SUMMARY

The Cranial and post-cranial osteology (including the hyoid apparatus) of a cave-dwelling bat (*Rhinopoma microphyllum kinneari* Wroughton) was studied. Post cranial osteology of this species was compared with a crevice-dwelling bat (*Tadarida aegyptiaca thomasi* Wroughton). It is concluded that in comparison with the cave dwelling and slow flying *Rhinopoma m. kinneari*, the crevice-dwelling and fast flying *T. a thomasi* has a more developed sternal keel, broader scapula, fusion and numerical reduction of vertebrae, smaller radius, a reduced ulna, longer metacarpals and the hindlimb bones shorter.

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ABBREVIATIONS USED IN FIGURES

1, maxilloturbinal
2, mesethmoid
3, vomer
4, presphenoid
5, basihyal
6, ceratohyal
7, thyrohyal or posterior cornu
8, epihyal
9, stylohyal
10, foramen lacerum
11, foramen ovale
12, cochlea or osseous labyrinth
13, fenestra vestibuli (oval window)
14, incus
15, styliform process with semicanal for auditory tube and tensor tympani muscle.
16, manubrium mallei
17, sulcus tympanicus
18, umbo membranae tympani
19, membranae tympani (paretensa)
20, tuber mallei
21, tympanic bone (anulus, tympanicus, ectotympanic)
22, stapes
23, stylomastoid
24, posterior limb of tympanic bone
25, fenestra cochleae (round window)
26, crista transversa
27, semicanal for facial
28, canalis facialis
29, processus petrosus posterior
30, basis cochleae
31, cupula cochleae
32, mesethmoid
33, olfactory foramina
34, cribriform plate
35, anterior cranial fossa
36, alisphenoid
37, middle cranial fossa
38, sella turcica (turk saddle)
39, canalis centralis modiolis
40, lateral semicircular canal
41, posterior cranial fossae
42, neural arch
43, transverse foramen
44, neural canal
45, facet for odontoid process
46, odontoid process
47, neural spine
48, postzygopophysis
49, centrum
50, clavicle
51, manubrium
52, lateral arm of manubrium
53, body of sternum
54, xiphoid process
55, costal cartilage
56, rib
57, capitulum
58, neck of rib
59, tuberculum
60, coracoid process
61, glenoid fossa
62, infra spinous fossa
63, posterolateral process
64, intermediate facet
65, spine of scapula
66, supraspinous fossa
67, spine of scapula
68, acromium process
69, greater tuberosity
70, head of humerus
71, lesser tuberosity
72, medial ridge
73, medial epicondyle
74, trochlea
75, lateral epicondyle
76, olecranon fossa
77, capitulum
78, cuneiform
79, unciform
80, lunar
81, magnum
82, trapezium
83, trapezoid
84, metacarpal
85, crest of ilium
86, pubic spine
87, acetabulum
88, obturator foramen
89, ischium

90, pubic
91, pubic symphysis
92, greater trochanter
93, lesser trochanter
94, head of femu
95, patela
96, tibia
97, fibula
98, humerus
99, aductor tubercle (medial tubercle)
100, lateral tubercle
101, patellar fossa
102, astragulus
103, calcaneus
104, navicular
105, cuboid
106, external cuneiform
107, middle cuneiform
108, internal cuneiform
109, metatarsal

Rec. zool. Surv. India, 79 : 457-461, 1982

SARCOPHAGID FLIES (DIPTERA : SARCOPHAGIDAE) FROM SIKKIM, INDIA.

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INTRODUCTION

This paper presents the result of the study of the Sarcophagid flies from Sikkim collected by the authors in 1977. Ten species under five genera are reported here. Out of these nine species are being recorded for the first time from Sikkim.

SYSTEMATIC ACCOUNT

1. **Bercaea haemorrhoidalis** (Fallén)

1816. *Musca haemorrhoidalis* Fallén, *Sevensk vet. Akad. Handle*, p. 236.

1975. *Bercaea haemorrhoidalis* : Rohdendorf, *Steenstrupia*, 3 : 202.

Material : 7 ♂♂, Sikkim : Mangan, 1, 189 m., 23. x. 1977 ; 11 ♂♂, Swistik Camp, 1,650 m., 21. x. 1977 ; 14 ♂♂, Dentam, 1,372 m., 2. xi. 1977 ; 3 ♂♂, Gangtok Hospital Campus, 1,677 m., 27. xi. 1977 ; 9 ♂♂, Phensang, 1,484 m., 19. x. 1977 ; 4 ♂♂, Gezing, 1,586 m., 6.xi. 1977 ; 3 ♂♂, Kabi, 1,644 m., 19. x. 1977 ; 4 ♂♂, Gangtok Palace Campus, 1,688 m., 17. x. 1977 ; 3 ♂♂, Chungthang, 1,647 m., 25. x. 1977 ; 1 ♂, Jorethang, 305 m., 20. x. 1977 ; 4 ♂♂, Kabi Chulung, 1,644 m., 20. x. 1977 ; 2 ♂♂, Lachung, 2,896 m., 26. x. 1977.

Distribution : West Bengal, Himachal Pradesh, Uttar Pradesh. This species is being recorded for the first time from Sikkim.

Bionomics : This species is mainly attracted to human excrement and is responsible for causing myiasis in man and animals. Larvae of this species can be reared in human faeces and animal carcasses.

2. **Boettcherisca** (*s. str.*) **peregrina** (Bobineau—Desvoidy)

1830. *Myophora peregrena* Robineau— Desvoidy, *Essai Myodaires*, 1 : 356.

1937. *Boettcherisca* (*s. str.*) *peregrena* : Rohdendorf, *Fauna de l' U R S S.*, 19 (1) : 271.

Material : 1 ♂, Sikkim : Mangan, 1,189 m., 23. x. 1977 ; 1 ♂, Gezing, 1,586 m., 6. xi 1977 ; 1 ♂, Dentam, 1,372 m., 2. xi. 1977,

Distribution : West Bengal, Maharashtra, Tamil Nadu, Bihar, Andaman Islands. This is the first record of this species from Sikkim.

Bionomics : This species is attracted to animal carcasses, animal dung and human faeces and is responsible for causing human tissue myiasis. The larvae of this species mainly breed in dead animals, garbages and other decomposing animal matter.

3. **Boettcherisca (Coeisca) khasiensis** (Senoir—White)

1924. *Sarcophaga khasiensis* Senior—White, *Rec. Indian Mus.*, **26** : 246.

1966. *Boettcherisca (Coeisca) khasiensis* : Rohdendorf, *Bull. Brit. Mus. (nat. Hist.) Ent.*, **17** (10) : 469.

Material : 2♂ ♂, Sikkim : Gangtok Palace Campus, 1,688 m., 17. xi, 1977 ; 1♂, Gangtok Hospital Campus, 1,677 m., 27. x. 1977 ; 1♂, Kabi Chulung, 1,644 m., 20. x. 1977 ; 1♂, Swistik Camp, 1,650 m., 24. x. 1977.

Distribution : Meghalaya. This species is recorded for the first time from Sikkim.

Bionomics : Nothing is known about the bionomics of this species. The present specimens have been collected from bush-sweeping.

4. **Parasarcophaga** (*s. str.*) **orchidea** (Böettcher)

1913. *Sarcophaga orchidea* Böettcher, *Ann. Hist. Mus. Nat. Hung.*, **11** : 375.

1967. *Parasarcophaga* (*s. str.*) *orchidea* : Lopes, *Ent. Meddl*, **35** : 170.

Material . 2♂ ♂, Sikkim : Gezing, 1,586 m., 30. x. 1977.

Distribution : West Bengal, Maharashtra, Bihar, Assam, Andaman Islands. This is the first record of this species from Sikkim.

Bionomics : Occasionally this species causes intestinal myiasis in man. The larvae of this species can be reared in human faeces and dead animals.

5. **Parasarcophaga** (*s. str.*) **knabi** (Parker)

1917. *Sarcophaga knabi* Parker, *Proc. U. S. natn. Mus.*, **54** : 96.

1967 *Parasarcophaga* (*s. str.*) *knabi* : Lopes, *Ent. Meddl.*, **35** : 170.

Material : 4♂ ♂, Sikkim : Gezing, 1,586 m., 30. x. 1977 ; 2 ♂ ♂, Dentam, Bongtong Busty, 1,385 m., 5. xi. 1977.

Distribution : West Bengal, Uttar Pradesh, Haryana, Gujarat, Maharashtra, Tamil Nadu, Orissa, Assam, Andaman Islands. This species is recorded for the first time from Sikkim.

Bionomics : This species is attracted to human faeces and dead animals. This can be reared in meat in the laboratory.

6. **Parasarcophaga** (*s. str.*) **albiceps** (Meigen)

1825. *Sarcophaga albiceps* Meigen, *System. Beschr*, **5** : 22.

1967. *Parasarcophaga* (*s. str.*) albiceps : Lopes, *Ent. Meddl.* **35** : 169.

Material : 4♂♂, Sikkim : Mangan, 1,189 m., 21-24. x. 1977 ; 2♂♂, Naya Bazar, 310 m., 29. x. 1977 ; 2♂♂, Dentam, Bongtong Busty, 1,385 m., 5. xi. 1977 ; 3♂♂, Gangtok Hospital Campus, 1,677 m., 27. x. 1977 ; 8♂♂, Gangtok Palace Campus, 1,688 m., 17. x. 1977 ; 4♂♂, Jorethang, 305 m., 29. x. 1977 ; 4♂♂, Kabi, 1,644 m., 10. x. 1977 ; 1♂, Swistik Camp, 1,650 m., 21. x. 1977 ; 2♂♂, Phensang, 1,484 m., 19. x. 1977 ; 34♂♂, Dentam, 1,372 m., 1. xi. 1977 ; 31♂♂, Gezing, 1,586 m., 6. xi. 1977 ; 3♂♂, Kabi Chulung, 1,644 m., 20. x. 1977.

Distribution : West Bengal, Haryana, Gujarat, Maharashtra, Tamil Nadu, Bihar, Assam, Meghalaya, Sikkim.

Bionomics : This species causes myiasis in bull and the larvae can be reared in human excrement, dead animals and other decomposing animal matter.

7. **Parasarcophaga** (*s. str.*) **macroauriculata** (Ho)

1932. *Sarcophaga macroauriculata* Ho, *Bull. Fam. Mem. Inst. Biol.*, 3 : 347.

1966. *Parasarcophaga* (*s. str.*) *macroauriculata* : Rohdendorf, *Bull, Brit. Mus.* (*nat. Hist.*) *Ent.*, **17** (10) : 458.

Material : 3♂♂, Sikkim : Swistik Camp, 1,650 m., 21. x. 1977 ; 2♂♂, Phensang, 1,484 m., 19. x. 1977 ; 4♂♂, Kabi Chulung, 1,644 m., 20. x. 1977 ; 2♂♂, Dentam, 1,372 m., 2. xi. 1977 ; 1♂, Gangtok Palace Campus, 1,688 m., 2. xi. 1977.

Distribution : West Bengal. This is the first record of this species from Sikkim.

Bionomics : This species causes intestinal myiasis in man and other domestic animals and can be reared in meat. This species was collected from bush-sweeping near human excrement.

8. **Parasarcophaga (Curranea) kalimpongensis** Nandi

1978. *Parasarcophaga* (*Curranea*) *kalimpongensis* Nandi, *Rev. Brasil Biol.*, [39 (2) 457].

Material : 1♂, Sikkim : Mangan, 1,189 m., 24. x. 1977.

Distribution : West Bengal. This is the first record of this species from Sikkim.

Bionomics : Nothing is known about the bionomics of this species. The present specimen was collected from bush-sweeping.

9. **Robineauella (Jantiella) coei** Rohdendorf

1966. *Robineauella* (*Jantiella*) *coei* Rohdendorf, *Bull. Brit. Mus.* (*nat. Hist.*) *Ent.*, **17** (10) : 458.

Material : 3♂♂, Sikkim : Gangtok Palace Campus, 1,688 m., 17. x. 1977 ; 1♂, Kabi Chulung, 1,644 m., 20. x. 1977.

Distribution : This species is being recorded for the first from Sikkim.

Bionomics : Nothing is known about the bionomics of this species. This species has been collected near human excreta.

10. **Seniorwhitea krameri** (Böettcher)

1912. *Sarcophaga krameri* Böettcher, *Ent. Mitt.* **1** : 166.

1964. *Seniorwhitea krameri* : Lopes, *Mem. Inst. Oswaldo Cruz.*, **62** : 162.

Material : 2♂♂, Sikkim : Gezing, 1,586 m., 30. x. 1977 ; 1♂, Dentam, Bongtong Busty, 1,385 m., 5. xi. 1977.

Distribution : West Bengal, Uttar Pradesh, Maharashtra, Tamil Nadu, Bihar, Assam, Orissa. This is the first record of this species from Sikkim.

Bionomics : This species is parasitic on other insects and have records of breeding from different insects.

Summary

This paper deals with a systematic account of the Sarcophagid flies collected from different parts of Sikkim. Ten species are dealt with under five genera. Nine species are being recorded for the first time from Sikkim. Distributional records of the species from India along with notes on bionomics are also included.

Acknowledgements

The authors are grateful to Dr. B. Dasgupta, Principal, Darjeeling Govt. College, Darjeeling for constant encouragement throughout the course of the study. The financial help to the senior author by the University Grants Commission, New Delhi is also duly acknowledged.

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Rec. zool. Surv. India, 79 : 463-468, 1982

ON SOME DERMAPTERA FROM NORTH WEST PROVINCE AND SALT RANGES, PAKISTAN

By

G. K. SRIVASTAVA

Zoological Survey of India, Catcutta

(With 2 Text-figures)

The present paper is based on small collecion of Dermaptera from various localities in Chitral Dist. of N.W.F. Province collected by Dr. B.N. Chopra during the years 1929-30. Besides, some material from Salt Ranges, Punjab Dist. brought by Drs. S.L. Hora and H.S. Pruthi in the year 1930 are also dealt with. Altogether eight species are recorded, out of which five and one species are reported exclusively from Chitral and Salt Ranges, respectively and the remaining species are common to both these areas. Some intraspecific variations have been noted in *Oreasiobia fedtschenkoi* (Saussure) and *Anechura zubovskii* (Semenov).

Since very little is known about the Dermaptera fauna of this area of Pakistan, it is hoped that the present report will be useful and of interest.

CARCINOPHORIDAE

CARCINOPHORINAE

Euborellia annulipes (Lucas)

Forficesila annulipes Lucas, 1847, *Annls. Soc. ent. Fr.*, **15** : 84.

Euborellia annulipes : Burr, 1915, *Jl. R. microsc. Soc.*, **1915** : 545.

Material examined : NWF PROV. : Chitral, Drosh, 2 ♂♂, 4 ♀♀ 4 nymphs,—. ix. 1929 ; Ram ram Gol, near its junction with Chitral river, below Arandu, 1 ♂, 2 ♀♀, 15-16.x. 1929 (Coll. *B.N. Chopra*).

Remarks.—A cosmopolitan species.

Euborellia compressa Borelli

Anisolabis compressa Borelli, 1907, *Boll. Musei Zool. Anat. comp. R. Univ. Torino*, **22** (558) : 3 (♂ ♀ : Uganda).

Euborellia compressa : Burr, 1915, *Jl. R. microsc. Soc.*, **1915** : 545.

Material examined : NWF PROV. : Chitral : Ram-ram Gol, near its junction with Chitral River, below Arandu, 1 ♂, 15-16.x.1929 (Coll. *B.N. Chopra*).

Remarks.—It has close resemblance with *E. annulipes*, but it can be easily separated in having the parameres somewnat rectangular.

Originally described from Africa it has been subsiquently reported from South India (Ramamurthi, 1963) and the present record from Chitral is of interest.

ISOLABOIDINAE Brindle, 1978

Isolaboides burri (Borelli)

Pseudoisolabis burri Borelli, 1909, *Boll. Musei. Zool. Anat. Comp, R. Univ. Torino*, **24** (603) : 1 (♂, ♀, N. E. Kashmir).

Isolaboides burri : Hincks, 1958, *Eos, Madr.*, **34** : 132.

Material examined : NWF PROV. : Chitral : Madaglasbt, 1 ♀, 1 nymph, 9. ix. 1929 ; Karakal, Bumboret Valley, 1 ♀, 22-25. vii. 1929 (Coll. *B. N. Chopra*).

Remarks.—The presence of this species from Chitral suggests its further westernward distribution. Hitherto, it was known to occur in Himalayas from various localities in Kashmir, Himachal Pradesh and Kumaon.

LABIDURIDAE

LABIDURINAE

Forcipula trispinosa (Dohrn)

Labidura trispinosa Dohrn, 1863, *Stettin. ent. Ztg.*, **24** : 310 (♂, India orientali).

Forcipula trispinosa : Bormans, 1900, *Das Tierreich*, II, Forficulidae ; 80.

Material examined : NWF PROV. : Chitral, Ram-ram Gol, near its junction with Chitral River, Choa, 10 miles from Khusra, 1 ♀, 15-21.x. 1930 (Coll. *S.L. Hora and H.S. Pruthi*).

Remarks.—This species is quite common all along the Himalayas from East to West. It has been reported from various localities in Afghanistan (Bey-Bienko, 1963, 1967 and Brindle, 1967). It is reported from the area for the first time and is not unexpected.

Labidura riparia (Pallas)

Forficula riparia Pallas, 1773, *Reise Russ. Reichs*, 2 : 727.

Labidura riparia : Burr, 1911, *Gen. Insect.*, **122** : 37.

Material examined : NWF PROV. : Chitral : Izah, Lutkoh Valley, 8 ♂♂, 5 ♀♀,—. viii. 1929 ; Ram-ram Gol near its junction with Chitral

river below Arandu, 1 ♀, 2 nymphs, 15-16. ix. 1929 (Coll. *B. N. Chopra*); PUNJAB : Salt Ranges, Khewra, 1 ex. (hind portion of body missing), 24. ix-x. 1930; 4 ♂♂, 3 ♀♀, 3 nymphs, 24. ix-x. 1930, Kallar Kahar (from Lake) 4 ♂♂, 12 ♀♀, 1 ex. (abdomen missing), 5 nymphs, 20-23. x. 1930, under stones (Coll. *S. L. Hora and H.S. Pruthi*).

Remarks.—A very variable and widely distributed species occurring throughout the world.

Nala lividipes (Dufour)

Forficula pallipes Dufour, 1920, *Ann. Gener. Sci. Phy. Bruxelles*, **4** : 316.

Forficula lividipes : Dufour, 1828, *Annls Sci. nat.*, **13** : 340 (new synonymy).

Nala lividipes : Zacher, 1910, *Ent. Rdsch.*, **27** : 29.

Material examined : PUNJAB : Salt Range, 10 miles from Khewra, 4 ♀♀, 15-20. x. 1930, under stones ; Kallar Kahar, 1 ♀, 20-23. x. 1930, under stones (Coll. *S.L. Hora and H.S. Pruthi*).

Remarks.—Almost cosmopolitan in distribution.

FORFICULIDAE

ANECHURINAE

Oreasiobia fedtschenkoi (Saussure)

(Text-fig. 1, A-C)

Forficula fedtschenkoi Saussure, 1874, *Turkestan Orth.* : 6, pl. 1, fig. 1.

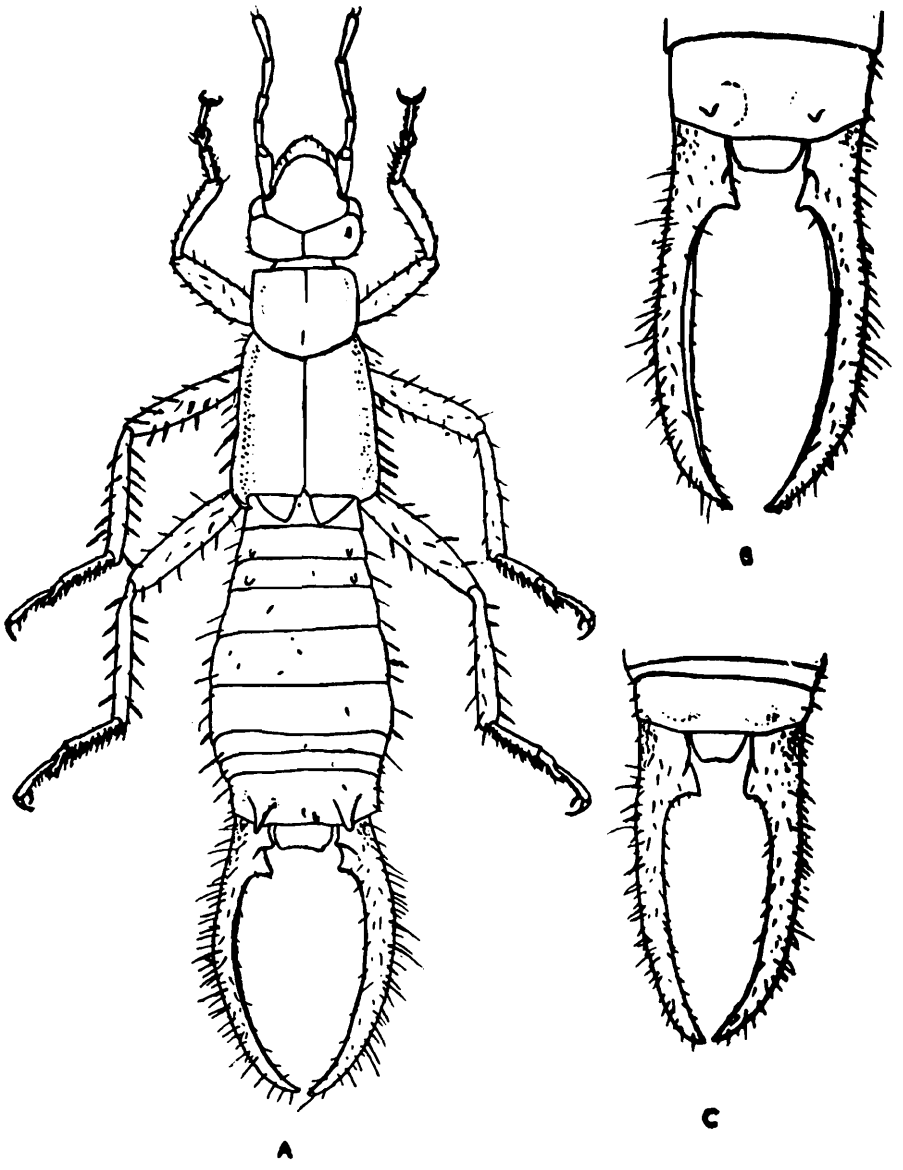
Anechura fedtschenkoi : Bormans, 1900, *Das Tierreich*, **11** : 103 ; —Semenov, 1902, *Horae. Soc. Ent. Ross.* **35** : 191 ;—Kirby, 1904, *Syn. Cat. Orth.* : 41 ; —Semenov, 1908, *Russk. ent. Obozr.*, **2** : 190 ; —Burr, 1911, *Gen. Insect.*, **122** : 73 ; —Burr, 1912, *Ann. Naturh Hofmus. Wein*, **26** : 95.

Oreasiobia fedtschenkoi : Bey-Bienko, 1936, *Faune De L'URSS. Dermapteres* : 161, figs. 49 & 50 ; —Bey-Bienko, 1967, *Acta ent. Bohem*, **64** (6) : 435.

Material examined : NWF PROV. : Chitral : Chimiksan stream, a little below Kunisht, Rambhur Valley, 5♂♂, 3♀♀, 4. vii. 1929 ; Utsui Gol, Rambhur Valley, 1♀, 8. vii. 1929, Kunisht, Rambhur Valley, 1♂, 6♀♀, 1-13. vii. 1929 (Coll. *B. N. Chopra*).

Remarks.—The present material shows variation in the colouration of elytra and in the degree of development of mammiform tubercles of ultimate tergite, pygidium and the upper basal tooth of forceps. In the majority of specimens the elytra are provided with a yellow spot in the middle which is often poorly marked whereas in 1♂ and 1♀ it is completely absent. Normally the ultimate tergite is provided with two

posteriorly directed pointed tubercles above the bases of forceps and forceps are armed near base above with a triangular tooth at the level of hind margin of pygidium and another similar but slightly larger tooth below, placed a little posteriorly. It is noted in the present material



Text-fig. 1. *Oreasibia feltschenkoi* (Saussure) ♂, A. Dorsal view, B and C. Ultimate tergite and forceps.

that mammiform tubercles as well as upper basal tooth of forceps are either well developed or totally lacking with various intermediate stages.

Bey-Bienko (1935) considered *Anechura calciatii* Borelli, as subspecies of this species but Srivastava (in press) has treated it as distinct owing to the presence of orange head, unicolorous elytra, strongly transverse pronotum and distinctive parameres which are enlarged at base and apex.

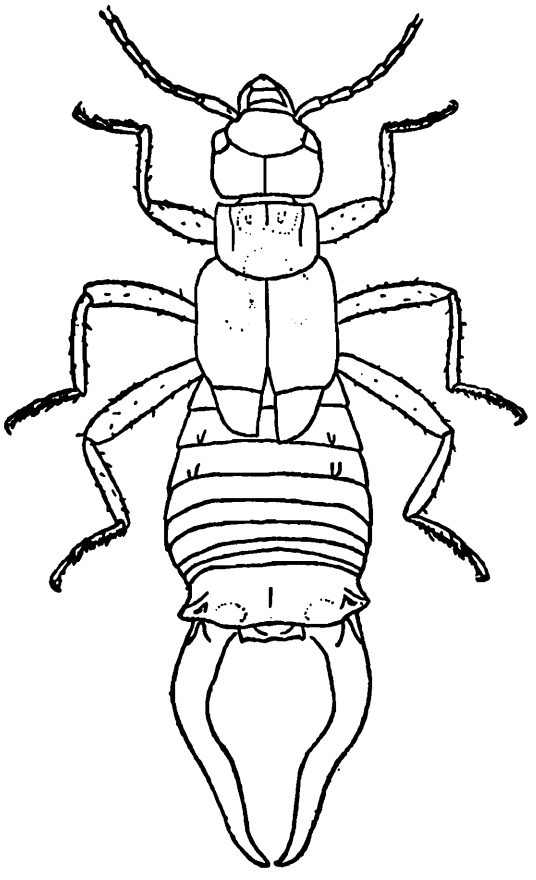
Anechura zubovskii Semenov

(Text-fig. 2)

Anechura bipunctata zubovskii Semenov, 1901, *Trud. Russ. Ent. Obr.*, 35 : 188.

Anechura zubovskii : Steinmann, 1975. *Fol. Ent. Hung.*, 28 ; 162, Fig. 32.

Material examined : NWF PROV. : Chitral, Rambhur Valley, 7♂♂, 3♀♀, 15-16. vii. 1929 ; Chimiksan Stream, a little below Kunisht, Rambhur Valley, 2♂♂, 2♀♀, 4. vii. 1929 ; Ustui Gol, Rambhur Valley, 1♂,



Text-fig. 2. *Anechura zubovskii* Semenov ♂, Dorsal view.

3♀♀, 8. vii. 1929 ; Karakal, Bumborit Valley, 2♀♀, 22-25. vii. 1929 (Coll. *B. N. Chopra*) ; PUNJAB : Kareri Lake (hill sides), 3040 m, 2♂♂, 1♀, 1. vi. 1926 (Coll. *S. L. Hora*).

Remarks.—It is widely distributed in Western Himalayas and recently reported by Bey-Beinko (1967) from Nuristan (E. Afghanistan). Therefore its occurrence in Chitral, though not unexpected, provides a possible clue to the interchange of western Himalayan forms through Afghanistan to central Asiatic mountains and vice-versa.

This species is characterised by having a yellow spot on elytra. Forceps are stout, remote at base ; in basal half branches raised up with a vertical tooth above near base, thence bent down and undulate, in

apical half inner margin below thickened in middle, reminiscent of an obsolete tooth, apices gently hooked.

In some specimens forceps are less stout and weakly undulate.

General Observations

From Salt Range (Punjab) only three species are represented of which two, viz., *Nala lividipes* (Dufour) and *Labidura riparia* (Pallas) are widely distributed and the third *Anechura zubovskii* Semenov, though more common in Western Himalayas occurs in N. E. Afghanistan also. The Chitral Dist. (NWF Prov.) being located on N.E. part of Hindukush Ranges appears to have in its fauna derivatives of both Western Himalayan and Central Asiatic mountains *via* Afghanistan. The former are represented by *Isolaboides burri* (Borelli), *Forcipula trispinosa* (Dohrn) and *Anechura zubovskii* Semenov, and the latter by *Oreasiobia fedtschenkoi* (Saussure). Besides two species, viz., *Labidura riparia* (Pallas) and *Euborellia annulipes* (Lucas) are cosmopolitan in distribution. The occurrence of *Euborellia compressa* Borelli, is of interest as it was originally described from Africa and subsequently recorded from South India. The present record of the species from Chitral fills a large distributional gap.

Thus it becomes evident that Chitral area serves as zone of transgression and intermingling for North Asiatic forms *via* Afghanistan on one hand and Western Himalayan element on the other.

Acknowledgement

My thanks are due to the Director, Zoological Survey of India, Calcutta fot providing necessary facilities.

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Rec. zool. Surv. India, 79 : 469-473, 1982

INOPEPLIDAE (COLEOPTERA) FROM ANDAMAN ISLANDS, INDIA

By

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(With 2 Text-figures)

INTRODUCTION

The Inopeplidae is a sharply defined small family of the section Heteromera under the superfamily Cucujoidea. Hetschko (1930) listed 3 of 52 species under the genus *Inopeplus* Smith from India, thence treated under the family Cucujidae (Cucujinae : Inopeplini). Crowson (1955) erected the family Inopeplidae to include the genera *Inopeplus* Smith, *Diagrypnodes* Waterhouse and *Aciphus* Oliff. Sengupta, Pal and Mukhopadhyay (1977) discussed its systematic position and described three more species from India. All these species were recorded from the Indian main land. The family is represented for the first time from the Andaman islands with the description of a new species and record of *Inopeplus albonotatus* (Motschulsky). The type specimen is deposited in the National Zoological collection of the Zoological Survey of India, Calcutta.

Inopeplus andamanicus sp. n.

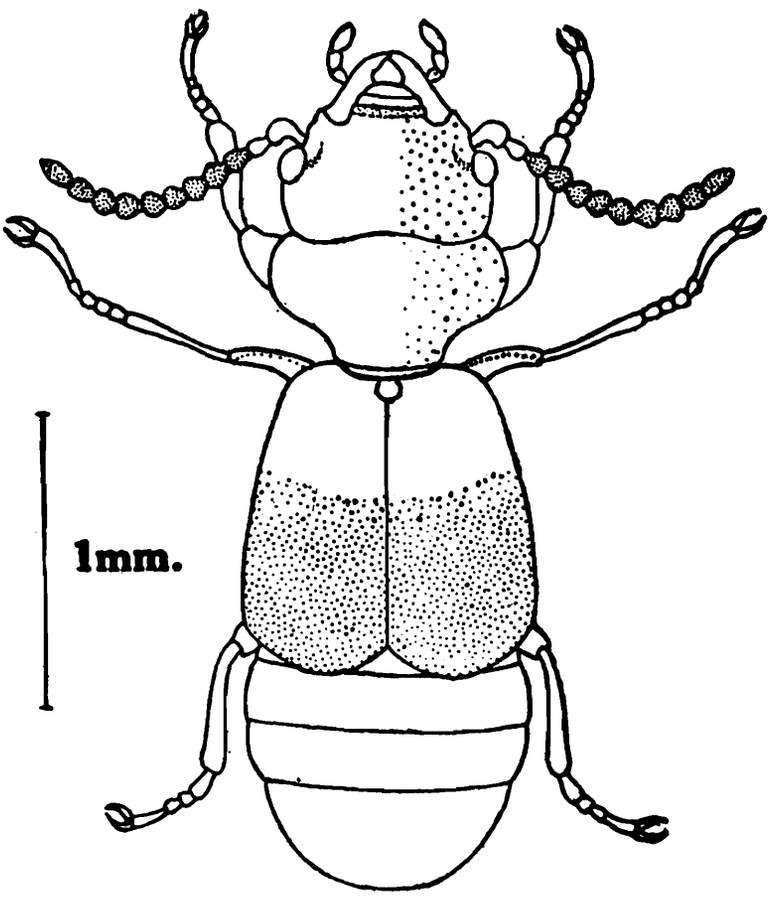
(Text-fig. 1)

General appearance (Text-fig. 1) elongated, flattened, shiny, head and prothorax reddish brown and elytra partially blackish, last three segments of abdomen exposed.

Head.—Broader than long, apical margin of head truncate, fronto-clypeal suture distinct and nearly straight, apical margin of frons with a transverse depression ; puncturation on vertex fine and sparse ; eyes moderately large and finely faceted, a semicircular depression surrounding inner margin of eye less distinct, a short transverse depression arise from semicircular depression. Antenna moderately long and slender, scape moderately large and curved, pedicel shorter and narrower than scape, joint 3 slightly wider and longer than pedicel, joints 4-10 subequal and about as broad as long, joint 11 elongated

and acuminate at apex, scape and pedicel reddish brown and joints 3-11 blackish.

Prothorax.—Transverse, flattened, widest beyond middle and markedly narrowed towards base ; lateral margin curved, smooth and without any denticles, indistinctly bordered ; puncturation on pronotum slightly more finer than on vertex and sparsely arranged.



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Text-fig. 1. *Inopeplus andamanicus* n. sp., dorsal view.

Scutellum.—Transverse, rounded at apex and impunctate.

Elytra.—Broader than long, widest near apex, puncturation fine and almost similar as on pronotum, anterior half pale brown and posterior half blackish, three segments of abdomen completely exposed.

Remarks.—This species is closely related to *Inopeplus nigricorpus* Sengupta, Pal and Mukhopadhyay but can be differentiated by its pale brown anterior half of elytra, distinctly finer and sparser puncturation on head and prothorax, and exposed last abdominal segments. This species also shows some resemblances with another Indian species, *Inopeplus nitidus* Sengupta, Pal and Mukhopadhyay but can be readily distinguished by the entirely blackish elytra, four distinct denticles on lateral side of prothorax and distinctly bordered pronotum in *nitidus*.

Measurements.—Total length 2.91 mm., width of head across eyes 0.73 mm., length of antenna 0.86 mm., length and width of prothorax 0.44 mm. and 0.76 mm., length and width of elytra 1.02 mm. and 1.05 mm.

Holotype.—INDIA : ANDAMAN Is., Quari, Hut bay, 22. xi. 1978, *B. N. Nandi and party*, under bark of Tomping log. (ZSI Reg. No. 9187/H4A)

Inopeplus albonotatus (Motschulsky)

(Text-fig. 2)

1859. *Euryplatus albonotatus* Motschulsky, *Etud. Ent.*, **8** : 98 (Indian subcontinent).

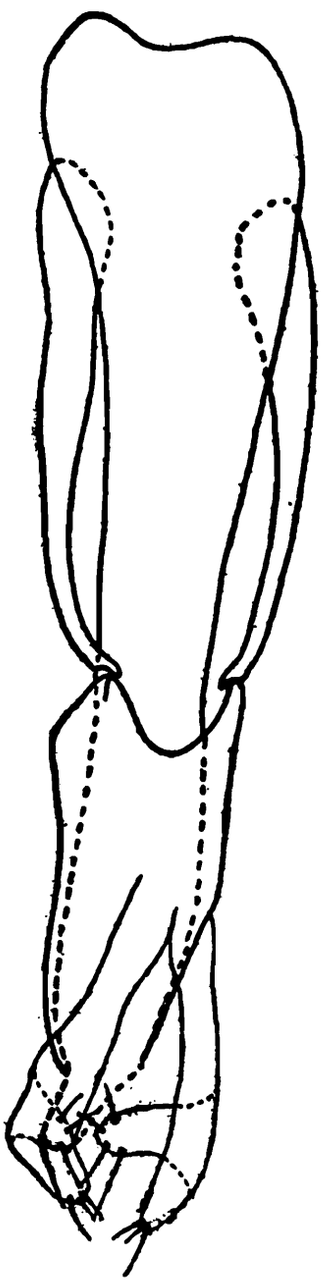
1908. *Inopeplus albonotatus* (Motschulsky) ; Grouvelle, *Annls Soc. ent. Fr.*, **77** : 462 ; Sengupta, Pal & Mukhopadhyay, 1977. *Oriental Ins.*, **11** (3) : 403.

This species can easily be recognised by its two posterior denticles on lateral margin of prothorax, a whitish spot near apex of each elytron, exposed last three abdominal segments and colour dark brown. Aedeagus (Text-fig. 2) with abruptly narrowed and broadly pointed apex of median lobe ; broad, bilobed and with a few setae at apex of each paramere.

Length—3.08-3.17 mm.

Material.—INDIA : ANDAMAN Is., S. Andaman, Kamorta, 11 ex., 11-13. xi. 1978, B. Nandi & party ; under bark of pipal log ; Campbell bay, Premarine area, 2 ex., 3 xii. 1978, B. Nandi & party, under bark of white Dhup log.

Distribution.—INDIA : WEST BENGAL, ANDAMAN IS.



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Text-fig. 2. Aedeagus of *Inopeplus albonotatus* (Motschulsky)

Key to the Indian Species of **Inopeplus**

1.	Head and prothorax reddish. ...	...	2
	Head and prothorax dark brown to deep black. ...	...	4
2.	Lateral margin of prothorax smooth. ...		*andamanicus sp. n.*
	Lateral margin of prothorax distinctly denticulate. ...	...	3

3.	Elytra blackish with a whitish rounded spot on each elytron, abdominal segments 4 and 5 exposed. ...	*biocellatus* (Motschulsky)	
	Elytra entirely black and without any spot, abdominal segment 2 partly and segments 3 to 5 completely exposed. ...	*nitidus* Sengupta, Pal and Mukhopadhyay	
4.	Lateral margin of prothorax smooth. ...	...	5
	Lateral margin of prothorax with two or three denticles. ...	...	6
5.	Head across eyes distinctly wider than prothorax, pedicel and joint 3 of antenna distinctly shorter and narrower than other joints, lateral margin of prothorax distinctly bordered, last four abdominal segments exposed. ...	*distinctus* Sengupta, Pal and Mukhopadhyay	
	Head across eyes slightly narrower than prothorax, pedicel and joint 3 of antenna together about as long as joints 4-10 together but slightly narrower, lateral margin of prothorax finely bordered, last two abdominal segments exposed. ...	*nigricorpus* Sengupta, Pal and Mukhopadhyay	
6.	Lateral margin of prothorax with two posterior denticles, a whitish testaceous spot near apex of each elytron. ...	*albonotalus* (Motschulsky)	
	Lateral margin of prothorax with one anterior and two posterior denticles, a whitish longitudinal spot near middle to apex of each elytron. ...	*decisus* (Walker)	

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India for providing laboratory facilities, to C. S. I. R., New Delhi for providing a Sr. Research Fellowship to one of them (Pal). They are also thankful to Dr. T. Sengupta for reading the manuscript.

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Rec. zool. Surv. India, 79 : 475-481, 1982

ON A NEW SPECIES OF THE GENUS *CHAETOSPANIA* KARSCH (DERMAPTERA : LABIIDAE) WITH A KEY TO SPECIES FROM THE INDIAN SUB REGION

By

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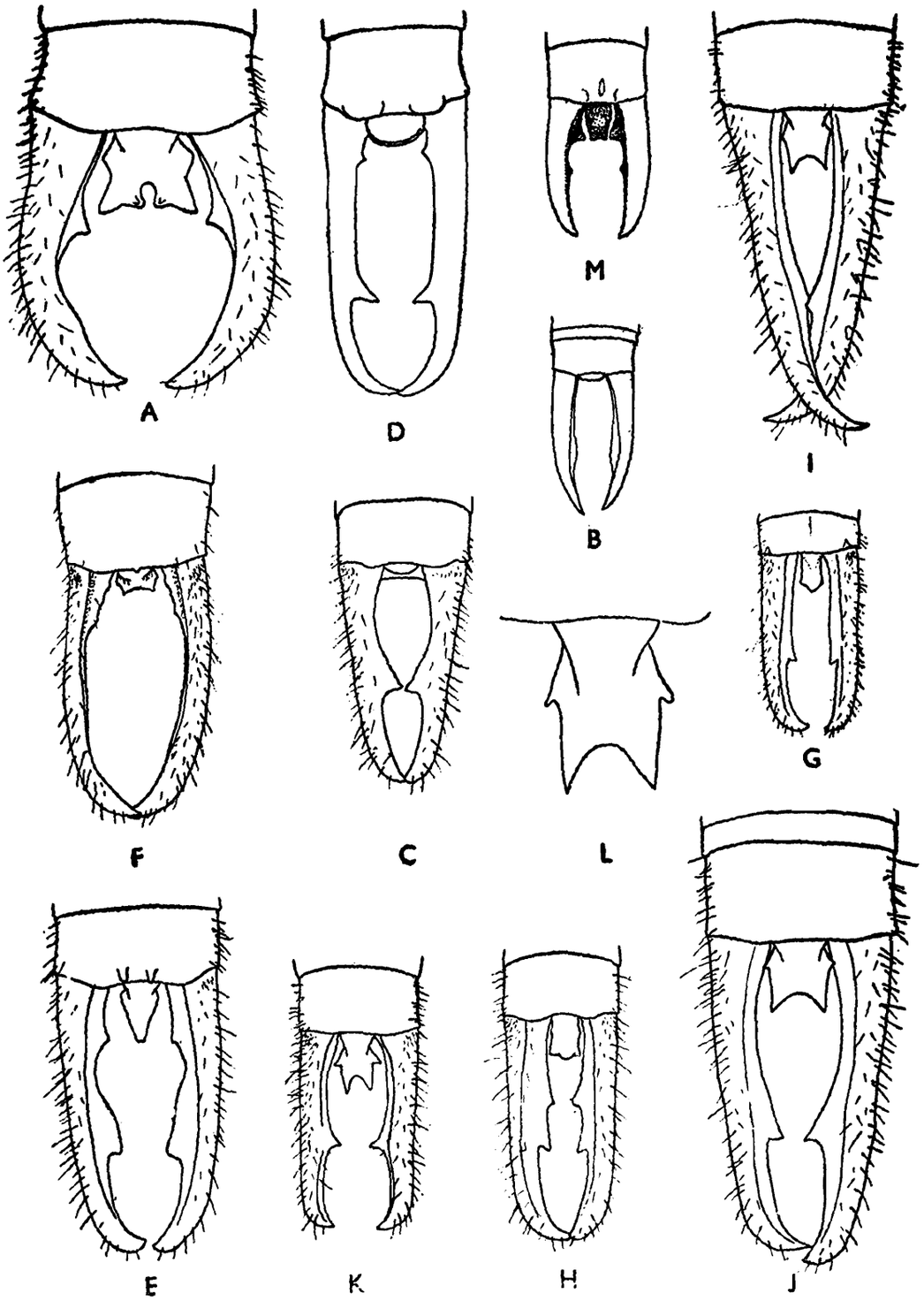
(With 2 Text-figures)

The genus *Chaetospania* Karsch, is represented by 14 species from India, Nepal, Bhutan, Burma and Sri Lanka, of which the generic assignment of three, *i.e.*, *C. cingalensis* (Dohrn) from Ceylon and *C. jeolikotensis* (Baijal and Singh) and *C. lakhamandiensis* Kapoor, Bharadwaj and Banerjee, both from India, is uncertain. The first one was originally described by Dohrn (1865) under *Forficula* L. Zacher (1910) examined the type ♀ as well another ♂ of the species and placed it provisionally under *Erotesis* Burr. This genus was synonymized by Burr (1911) under *Proreus* Burr, and in the same publication he transferred *F. cingalensis* to *Chaetospania* Karsch, but owing to the presence of a carina along the costal margin of elytra as stated by Zacher (*l.c.*) its inclusion in *Chaetospania* does not seem to be justified. Perhaps a new genus might be required for its reception. The figure of forceps and ♂ genitalia (vide Zacher, *l.c.*) are reminiscent of *Labia lutea* (Bormans). However, in order to ascertain its correct generic position, an examination of the type will be desirable. The types of other two species have been examined and neither belong to this genus. Their taxonomic status will be discussed elsewhere.

During the course of the present study some variation in the shape of pygidium and inner armature of forceps have been noted in some species which does not seem to have been recorded earlier. In *C. feae* Bormans, pygidium is narrow and sub-vertical at base, afterwards deplanate with sides straight and converging apically. But in a large series from Sikkim it has been seen that on sides it is often provided with a posteriorly directed tooth in middle, of variable size. Even the position of inner tooth of forces has also been found to vary. It may be either small and directed posteriorly or well developed and placed at right angles. In *C. nigriceps* (Kirby) it has been observed that the inner ventral margin of forceps forms a flange which may be provided with one or two teeth. Burr (1910) although treated this species as

distinct remarked ".....the case is not yet quite proven in favour of its inclusion as a varietal form of *P. thoracica*". Brindle (1972) has treated both these spècies as distinct on the basis of the shape of



Text-fig. 1. Ultimate tergite and forceps ♂, A. *Chaetospania anamalaiensis* Srivastava, B. *C. andersoni* Brindle (redrawn from Brindle, 1971), C. *C. kurseongae* Hebard, D, *C. malaisei* Hincks (redrawn from Hincks, 1947), E. *C. stiletta* Burr, F. *C. foliata* (Burr), G. *C. thoracica* (Dohrn), H. *C. nigriceps* (Kirby), I J. and K. *C. feae* Bormans ; Pygidium enlarged, L. *C. feae* Bormans, M. *C. mandex* Borelli (redrawn from Borelli, 1932)

pygidium and forceps. It has been observed by the author that the ♂ parameres of both are also different.

Platylabia fallax described by Bormans (1894) from Burma was synonymised subsequently by him (1900) under *C. nigriceps* (Kirby). Hebard (1927) and Bey-Bienko (1959) has treated the former as valid species. And on the basis of this, Srivastava (1976) treated it as distinct. Hewever, after a careful comparison of the description of *P. fallax* with *C. nigriceps* it becomes evident that Bormans was right in placing the former as synonym of the latter.

Genus **Chaetospania** Karsch

Chaetospania Karsch, 1886, *Berl. ent. Z.*, **30** : 87 ; Burr, 1911, *Dt. ent. natn-Biblthk*, : 60 ; Burr, 1911, *J. Asiat. Soc. Beng.*, **7** : 785 ; Burr, 1911, *Genera Insect.*, **122** : 53 ; Kapoor, 1968, *Agra Univ. J. Res.* (Sci.), **16** (1) : 14 ; Srivastava, 1976, *Rec. zool. Surv. India. Occ. pap.*, 2 : 35.

Platylabia (part) Dohrn, 1867, *Stettin. ent Ztg.*, **28** : 347.

Labidophora (part) Scudder, 1876, *Proc. Boston Soc. nat. Hist.*, **18** : 297.

Sparattina Verhoeff, 1902, *Zool. Anz.*, **25** : 198 (Type-*Sparattina flavicollis* Verhoeff, 1902)

Diagnostic characters.—Body strongly depressed and pubescent. Head as long as broad or slightly longer, sutures weak or obsolete, emarginate posteorirly, eyes shorter than genae in length ; antennal segments long and cylindrical, 4th and 5th as long as 3rd or longer. Pronotum convex anteriorly. Legs short, hind metatarsus equal to 2nd and 3rd segment together. Elytra and wings well developed, thickely pubescent. Abdomen somewhat depressed with long pubescence laterally ; pygidium distinct, various ; forceps long, depressed, with long pubescence.

Type-species.—*Chaetospania inornata* Karsch, 1886

Distribution.—Oriental Ethiopian and Australian Regions.

All the known species from the Indian subregion can be separated by the following key based on males only. The three species, *i.e.*, *C. cingalensis*, *C. Jeolikotensis* and *C. lakhanmandiensis* have not been included owing to their uncertain taxonomic status.

1 (2). Ultimate tergite in middle posteriorly depressed and provided with two pair of compressed tubercles. ... *C. decipiens* (Kirby)

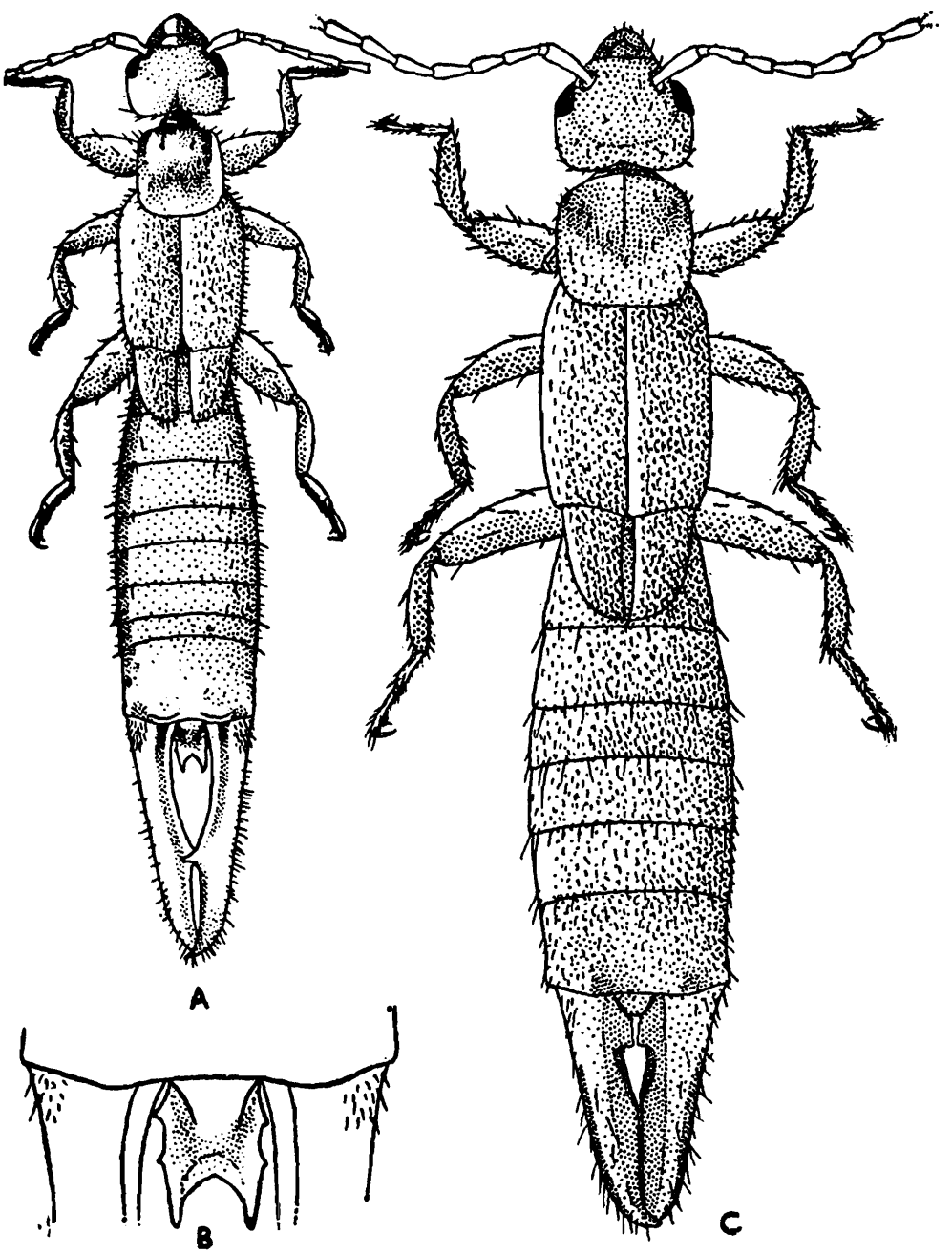
2 (1). Ultimate tergite without any compressed tubercles in middle posteriorly (excepting in *C. stiletta* Burr where there is a pair of compressed tubercles extending beyond the posterior margin)

3 (4).	Pygidium divided into two halves by a deep median cleft extending from apex up to middle (Text-fig. 1A) ...	*C. anamalaiensis* Srivastava
4 (3).	Pygidium devoid of any cleft in apical half	
5 (10).	Pygidium short and transverse	
6 (7).	Size smaller (up to 6.5 mm) ; forceps remote, slender and lacking any sharp tooth internally (Text-fig. 1 B) ...	*C. andersoni* Brindle
7 (6).	Size larger (9.9 to 18.5 mm) forceps depressed, armed internally with one or two teeth	
8 (9).	Size smaller (9.9 to 10.2 mm), pygidium with hind margin truncate (Text-fig. 1C) ...	*C. kurseongae* Hebard
9 (8).	Size larger (15 to 18.5 mm), pygidium with hind margin semicircular (Text-fig. 1D) ...	*C. malaisei* Hincks
10 (5).	Pygidium projecting, about as long as broad or longer	
11 (12).	Ultimate tergite with a pair of compressed tubercles in middle posteriorly, pygidium triangular with apex acute (Text-fig. 1E) ...	*C. stiletta* Burr
12 (11).	Ultimate tergite without any compressed tubercles in middle posteriorly ; pygidium various but not as above	
13 (14).	Pygidium about as long as broad (Text-fig. 1F) ...	*C. foliata* (Burr)
14 (13).	Pygidium longer than broad	
15 (18).	Pygidium almost of uniform width throughout	
16 (17).	Pygidium with hind margin triangular with a tubercle in middle (Text-fig. 1G) ...	*C. thoracica* (Dohrn)
17 (16).	Pygidium with hind margin straight with three small tubercles, one in middle and one each on angle (Text-fig. 1 H) ...	*C. nigriceps* (Kirby)
18 (15).	Pygidium either broader at base or narrowed in middle, in apical half generally sides convex or angular and sometimes provided with one or two fine teeth	
19 (22).	Pygidium emarginate posteriorly with angles produced into sharp point	
20 (21).	Pygidium on sides straight and converging apically and often provided with a minute teeth (Text-fig. 1 I-L) in middle ...	*C. feae* Bormans
21 (20).	Pygidium with sides broadly convex and provided with a pair of teeth, placed a little apart (Text-fig. 2A, B) ...	*C. shillongensis* sp. n.
22 (19).	Pygidium with hind margin truncate (Text-fig. 1 M) ...	*C. mandex* Borelli

Chaetospania shillongensis sp. nov.

(Text-fig. 2 A-C)

Head pronotum, elytra and wings black, antennae dark brownish black with a few preapical segments somewhat lighter or whitish ; legs clear yellow. Abdomen reddish brown with a few basal segments blackish on sides ; pygidium and forceps dark reddish brown. Form depressed, pubescent.



Text-fig. 2. *Chaetospania shillongensis* sp. n. ♂. A. Holotype B. Pygidium enlarged and C. Paratype ♀.

Male.—Head cordiform, about as long a broad, smooth, depressed, median suture well marked but transverse suture obliterated, hind margin emarginate in middle. Eyes small, much shorter than genae

in length. Antennae with (partly damaged) 13 segments remaining, 1st stout, narrowed at base, about as long as the distance between the antennal bases ; 2nd small ; 3rd long and slender and almost equal to 5th in length which is slightly stouter, gently expanded ; 5th onwards segments gradually increasing in length and becoming more slender apically. Pronotum about as long as broad, sides parallel, hind margin subtruncate, median sulcus faintly marked in anterior half only ; prozona moderately convex and metazona flat. Elytra and wings well developed. Legs typical of the genus. Abdomen depressed, gently dilated in middle, faintly punctulate. Penultimate sternite broadly rounded posteriorly with slight emargination in middle. Ultimate tergite weakly transverse, disc depressed and with stripes of punctate and smooth areas alternating, faintly raised above the root of forceps and intervening space slightly depressed, hind margin faintly emarginate in middle. Pygidium narrow and subvertical at base, afterwards deplanate, sides convex with a pair of minute points of which the posterior one is larger, hind margin deeply emarginate with angles produced into sharp point. Forceps with branches depressed, stout, at base separated by the pygidium, almost straight, tapering, gently curved near apex with tip pointed, internally in basal third dorsal and ventral margin sharp, afterwards forming a flange with a sharp pointed tooth in middle.

Female.—Agrees with ♂ in most characters except that pygidium short, subvertical and convex, gently narrowed posteriorly ; forceps with branches contiguous at base, almost straight with apices gently hooked and pointed, internally with a rectangular lamellate area, afterwards margin below forming a flange and faintly serrated.

Measurements (In mm) :

	Holotype ♂	Paratype ♀
Length of body	7.0	6.4
Length of forceps	2.45	1.5
Length of pygidium	0.55	

Material examined.—INDIA : MEGHALAYA : Shillong, nr. Police Bazar, 28. xi. 1974, Holotype ♂, Paratype 1 ♀, under the bark of log (Coll. *T. Sengupta*) ; in the Zoological Survey of India, Calcutta.

Remarks.—The described species comes very close to *C. feae* but differs in having a pair of minute teeth, situated a little apart on the sides of pygidium.

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Rec. zool. Surv. India, 79 : 483-487, 1982

OXYURICHTHYS DASI, A NEW GOBIOID (PISCES : GOBIIDAE) FROM THE ANDAMAN ISLANDS

By

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Zoological Survey of India, Calcutta

(With 1 Text-figure)

INTRODUCTION

Eight species of the genus *Oxyurichthys* Bleeker have generally been recognized (Menon & Govindan, 1977) from the thirty-one nominal species known only from the tropical Indo-Pacific : *O. tentacularis* (Valenciennes, 1837), *O. papuensis* (Valenciennes, 1837), *O. microlepis* (Bleeker, 1849), *O. auchenolepis* Bleeker, 1876, *O. longimanus* (Weber, 1909), *O. jaarmani* Weber, 1913, *O. lemayi* Smith, 1947, and *O. nijsseni* Menon & Govindan, 1977. Recently two specimens of an undescribed species were collected in the Andaman Sea by the junior author (MKD).

This paper describes the new species of *Oxyurichthys* and presents some remarks on the taxonomic status of *O. nijsseni* Menon & Govindan. The new species is named after Dr. A. K. Das.

Oxyurichthys dasi sp. nov.

(Text-fig. 1 a, b)

Material.—Holotype : 50 mm in standard length, Sippighat, South Andaman Is. ; 26 July, 1978 ; Coll. *M. K. Dev Roy* ; Zoological Survey of India. Regd. No. F 7610/2.

Paratype : 44 mm in standard length ; Kada Kachang, South Andaman Is. ; 29 July 1978 ; Coll. *M. K. Dev Roy* ; ZSI Regd. No. F 7611/2.

Meristic counts and measurements.—Meristic counts and morphometric measurements (in mm) of the paratype are given in parentheses.

D_1 VI, D_2 I, 10 (VI ; I, 10) ; A I, 10 (I, 10) ; P 16 (16) ; segmented caudal fin rays 16 (15) ; L e scales 39 (40) ; L tr. scales 12 (11) ; predorsal scales 17 (17).

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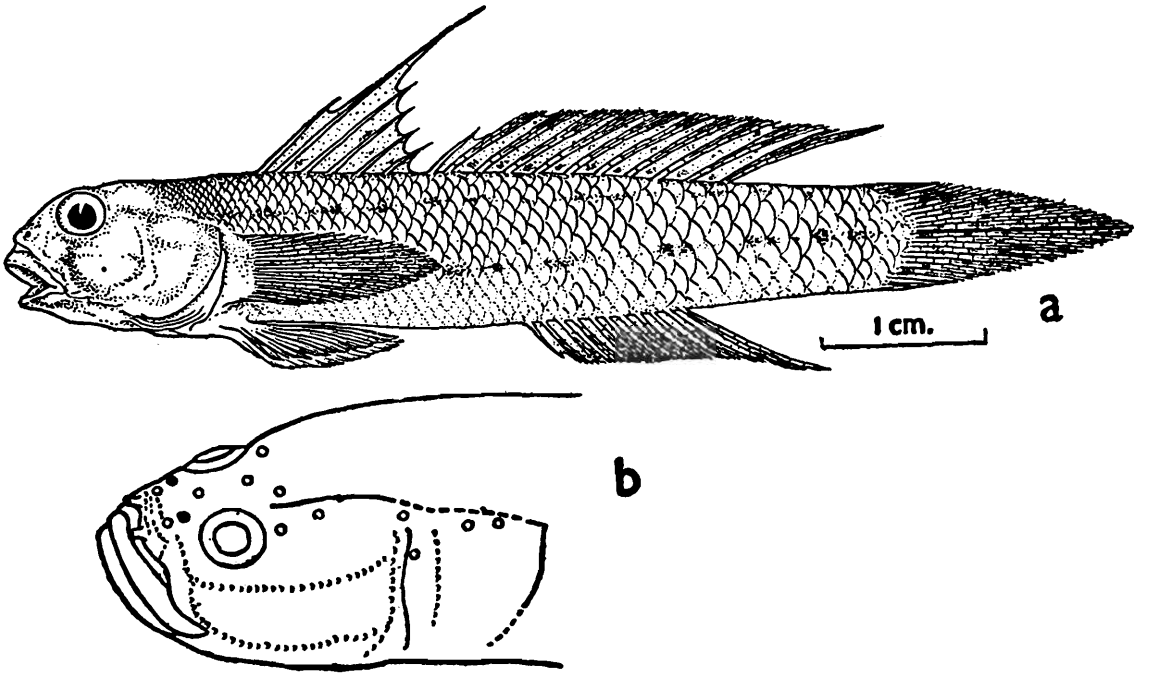
Length of head 13.0 (11.5) ; body depth at dorsal fin origin ± 9.0 (9.0), at anal fin origin 9.0 (8.5). Eye-diameter 3.25 (3.0), interorbital width 1.5 (1.5), snout length 3.25 (3.0), length of maxillary 4.0 (3.5). Length of longest (2nd) dorsal fin spine 16.0 (15.0), length of pelvic fin 10.0 (10.0), of pectoral fin 12.0 (11.0), of caudal fin 18.5 (*c.* 14.0, broken at tip) ; least depth of caudal peduncle 6.5 (5.5).

Description.—Based on holotype and paratype.

Body elongate, somewhat compressed. Head compressed ; gape of mouth moderate, oblique, posterior tip of maxillary below anterior third of eye. Snout obtuse, its length equals eye-diameter. Interorbital narrow, about half eye-diameter. Anterior nostril in a short tube, posterior nostril non-tubular. Tongue weakly emarginate. Cephalic



Text-fig. 1. a. Lateral view of *Oxyurichthys dasi* sp. nov., holotype (ZSI F 7610/2) ; b. diagrammatic dorsolateral view of head showing cephalic sensory pores and canals.

sensory pores and canals as shown in Text-fig. 1 b. Gill openings moderate, extending ventrally slightly beyond lower base of pectoral fin. No ocular tentacles.

Teeth : in upper jaw, in one row of caninoid teeth ; about 25 one each side of jaw, followed by 2 rows of minute teeth (visible only under high magnification) ; lower jaw teeth in 4 rows.

Scales : cycloid on anterior part of body, posteriorly ctenoid. Head naked ; nape, breast and belly scaled.

Dorsal fins prominent, 2nd spine of 1st dorsal fin prolonged and filamentous. Pelvic fins united, basal membrane well developed.

TABLE I– Comparison of Indo-Pacific species of *Oxyurichthys* Bleeker

Character	*O. tentacularis*	*O. papuenis*	*O. microlepis*	*O. auchenolepis*	*O. longimanus*	*O. jaarmani*	*O. lemayi*	*O. nijsseni* (=*O. jormosanus*)	*O. dasi*
Tentacle at upper margin of eye	(+)	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(–)
Scale rows in lateral series	52-65	75-80	50-55	± 80	35	30	100-110	26-28	39-40
Scales on nape	Mid-line naked	Mid-line naked	Mid-line naked	Scaled in the median line	Naked posteriorly	?Naked	Mid-line naked	Naked	Scaled
Vertical black band below eye	(–)	(–)	(–)	(–)	(–)	(–)	(–)	(+)	(+)

Pectoral fin pointed, as long as head. Caudal fin pointed, much longer than head.

Colour : in alcohol, light brown ; lateral sides of the trunk with violet spots arranged in two distinct longitudinal rows ; head with many violet spots and streaks and a conspicuous dark vertical band below eye. Dorsal fins with minute spots, intermixed with some bigger ones ; 2nd dorsal fin, additionally, with about ten bigger spots in a longitudinal row near its base. Pectoral fin base with irregular markings. Pelvic and anal fin with blackish margins. Caudal fin with several violet spots arranged in about four vertical rows.

Remarks

The salient diagnostic characters of the eight valid species of the genus *Oxyurichthys* of the Indo-west-Pacific are given in Table I to facilitate their comparison with the new species. The new species differs from all the species of *Oxyurichthys* but *O. formosanus* Nichols in having a most striking dark vertical band below eye. It closely resembles *O. formosanus* but may be distinguished readily by the greater number of scales (39-40 *vs* 26-28) in the lateral series. Further, the pectoral fin is as long as the head length (*vs* considerably longer) in the new species.

Koumans (1941) reported two species of *Oxyurichthys* from Indian waters namely, *O. microlepis* (Bleeker) and *O. tentacularis* (Valenciennes). To this was added *O. jaarmani* Weber by Talwar (1969) and *O. papuensis* (Valenciennes) by Natarajan & Subrahmanyam (1975), both recorded from the east coast of India. Menon & Govindan (1977) presented a key to the Indo-Pacific species of *Oxyurichthys* and described a new species *O. nijsseni* also from the east coast of India, relegating Talwar's (*nec* Weber) *O. jaarmani* to its synonymy.

Oxurichthys nijsseni which has a diagnostic dark vertical black band below eye, is clearly conspecific with *O. formosanus* Nichols from Taiwan (Nichols, 1959), a species inadvertently overlooked by Menon & Govindan (1977). The holotype and paratypes of *O. nijsseni* were examined by one of us (PKT).

Summary

A new species of the Indo-Pacific genus *Oxyurichthys* Bleeker is described, *O. dasi* from South Andaman Island. The systematic status of *O. nijsseni* Menon & Govindan is discussed.

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Rec. zool. Surv. India, 79 : 489-503, 1982

A NOTE ON GEOGRAPHIC VARIATION IN THE INDIAN BLACKBUCK (*ANTILOPE CERVICAPRA* LINNAEUS, 1758)

By

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(With 2 Text-figures and 2 Tables)

The Blackbuck is one of the species which is restricted to the Indian subcontinent. It is not the only Bovid to be so restricted : the Nilgai (*Boselaphus tragocamelus*) and Four-horned Antelope (*Tetracerus quadricornis*) are also confined to the subcontinent ; but the very fact that each of these three species occupies a genus by itself, and has never been found, even as a fossil, outside the Indian region; indicates that here we have the Bovid component of "India vera", the product of the Peninsular amphitheatre of faunal and floral differentiation (Mani, 1974, ch. XXIV).

As a fine study of the biology of the Blackbuck—including the general morphology, age and seasonal changes and sexual differences—has recently appeared (Mungall, 1976), these aspects need not be dealt with here.

The first author to study geographic variation of Blackbuck was Zukowsky (1927*a*, *b* ; 1928*a*, *b* ; 1929) ; prior to his study it had been assumed that variation within the species' range was non-existent or negligible, on the grounds one supposes that a plains-inhabitant within India would not have much restriction on its movement, hence not much opportunity to develop geographic forms in a situation of restricted gene-flow between populations.

The systematics of Zukowsky have been much criticised as those of an extreme "splitter". A historical background may be helpful here. Zukowsky was a pupil of Paul Matschie, who believed that a genus was represented by a different species in each river system encompassed by its range ; each of these species was a product of Special Creation—Matschie had no truck with evolutionary ideas. If he had before him samples from two different river systems, therefore, it was not a question of comparing them to see whether they differed taxonomically—but to see what the differences were, for difference there must be, in

his philosophy. It is interesting that in this theory can be seen the germs of a systematic theory based on populations: in this sense, Matschie was well ahead of his time, although he would have been the first to remonstrate against placing any such interpretation on his views.

Where two species met—as they were bound to, occasionally—they would, Matschie supposed, form hybrids. Concerned with the genetic advances of his day as little as with the advances in evolutionary theory, Matschie had his own ideas as to what these hybrids would look like: they would have the characters of one of the parent species on one side of the body, those of the other on the other side! The testing of this hypothesis came in 1910, with a paper by Zukowsky on some wild-shot buffaloes and hartebeest from Africa, which showed horn asymmetry; these specimens were, naturally enough, the long-sought "half-sided hybrids". The fact that in some cases the parent forms were undescribed was no deterrent: Zukowsky went right ahead and described *Bubalus caffer cunenensis* and *cubangensis* from a single specimen, the former being represented by the right horn, the latter by the left horn, of the same specimen. As he did give ranges of variation for the horn characters of his two new forms (and the other buffaloes and hartebeests described at the same time, two per specimen), one must suppose that specimens representing the parent forms were in fact to hand: but if so they have never been described, nor are they at present in any museum visited by me or by anyone known to me.

The ridicule heaped on Zubowsky for this paper is easy to imagine. In retrospect, it does seem most unfair for Matschie to have off-loaded the task of demonstrating his impossible theory onto his fresh young student: especially as it appears to have been Zukowsky's first publication. Yet, Zukowsky did hold to this theory for at least 20 years following, and as we shall see he thought he had an example of a half-sided hybrid in his Blackbuck collection.

Matschie went on to become more and more mystical, and eventually came to speak of species as inhabiting river valleys but quadrants of the earth's surface. At some point, Zukowsky seems to have parted company with him philosophically, although he seems always to have retained an enormous respect for his memory after his death in 1924, quoting him on every possible occasion. He himself however went on to fit fairly well—though always a little on the "splitter" side of the spectrum—into taxonomic thought of the 1930s to 1950s; by the time he died in 1965 he had even been known to mention the theory of evolution once or twice in his writings.

Matschie and Zukowsky were not, in general, known for describing new taxa from large samples ; it must be admitted, however, that they did tend to allot more specimens per taxon than some of their contemporaries—such taxonomists as Rothschild and Lydekker, and even Pocock, were distressingly fond of creating new species or subspecies on the basis of single specimens. But it is quite unexpected to read in his first paper on *Antilope* (1927*a*) that Zukowsky had examined "about 85" living specimens—and divided them into only three taxa ! It was unfortunately not stated how many individuals represented each taxon ; nor were any type specimens mentioned ; and there is no record that any of these specimens (imported by Carl Hagenbeck for his zoo at Stellingen, Hamburg) ended up in a museum.

Although he had previously pre-empted his teacher, Matschie, in adopting the subspecies concept, in this case Zukowsky described his three blackbuck taxa as full species. They were as follows :

1. *Antilope cervicapra* Linnaeus ; type locality fixed as "Inland of Trivandrum", in the modern Kerala. Very small ; horns about 40-45 cm. long, little divergent, with only $2\frac{1}{2}$-3 (occasionally $3\frac{1}{2}$-4) spiral turns. Old males black-brown to black in the breeding season ; both sexes very short-haired. Limbs very faintly marked, almost white below knees. The southernmost species.

2. *Antilope hagenbecki* spec. nov. : type locality, hinterland of Calcutta. About a hand's breadth higher at withers ; horns wide-spiralled, over 10 cm. longer than in previous form, more divergent, with at most 3-4 spiral turns. Old males coloured as previous species ; but with more clearly maked leg pattern—a sharply marked brown stripe reaching almost to hoofs on outer side of legs. From the northeast part of "Vorderindien".

3. *Antilope rajputanae* spec. nov. ; type locality, Bahawalpur, Rajputana (now in Punjab, Pakistan). Large like the previous form ; horns 70 cm. long, even more divergent, with 6 clear, narrow turns. A clear grey sheen on back, flanks and outer side of legs ; pattern in between the first two on limbs, with only a whitish-yellow "shadow-stripe" below knee. Hair in both sexes much longer than in previous two species. The species from Rajputana and Punjab. Although the diagnosis is as above, Zukowsky also mentions, in the same paper, a specimen referred to this species with horns only 50 cm. long, with $4\frac{1}{2}$-5 spiral turns, and less divergent.

Apart from the uncertainty about the precise number of specimens seen, most of the diagnostic characters refer only to adult males : and presumeably the imports would have contained at least 50% of females.

Still, the division into three species is obviously much more securely based than many of the taxonomic apportionments of the day. Although he does not say so in so many words, his species *hagenbecki* and *rajputanae* are based on the Ganges and Indus rivers respectively ; only *cervicapra* has no strict river-valley allocation.

In the same paper, Zukowsky goes on to say that the range of *hagenbecki* does indeed go west along the Ganges system, as far as Agra according to records from the literature, and perhaps even to Gwalior, unless there is a special Central Indian form ; the male from Gwalior in Plate XLVII of Sclater and Thomas's *Book of Antelopes* has a grey sheen like *rajputanae*, and long horns, but the horn twists are very wide, and only 3-4 in number, while again the pattern on the legs is not so sharply marked.

In a second paper in the same year, Zukowsky (1927*b*) describes the leg patterns of his three species, stressing that *hagenbecki* is more different from the other two, in its clearly marked leg-stripe, than they are from each other.

The following year Zukowsky (1928*a*) mentioned seeing a further 28 specimens ; most of these were from the northeastern part of India and could be identified without difficulty as *hagenbecki*, but the other 6, from Agra, resembled the plate in Sclater and Thomas, and so a new species was required : duly described as *Antilope centralis*. Like *rajputanae* and *hagenbecki*, this is a big form with strong horns up to 70 cm. long, with a very long flat spiral of only 3 turns ; the axes of the horns stand at 20° to the nasofrontal plane, not in the same plane as in the other races. Like *rajputanae* it has a grey sheen ; the leg mark reaches the fetlock although not as strongly marked as in *hagenbecki*.

In fact, Zukowsky said, Agra is at the very eastern edge of the range of *centralis*, for one of the specimens from this locality is—yes, a half-sided hybrid : it has the right horn of *hagenbecki*, the left horn of *centralis* ! And to be sure, the photograph he gives of the animal shows a very odd-looking assymmetry.

A short description was also given in this paper of seasonal changes in colour in male blackbuck. A buck of *A. hagenbecki* in November and December 1927 was a shining black-brown colour ; in mid-May of the following year it began to lighten, and by the beginning of July had a yellow-brown coat with a gazelline lateral flank-stripe : only the head, neck and limbs remaining darker, just slightly lightened from their winter hue.

A second publication in 1928 described four males of *cervicapra* obtained by Hagenbeck from the southern part of India ; they substantiate his earlier description of this species as being small and short-haired, and deep brown to black in winter ; in summer they too became much lighter in tone.

A final publication by Zukowsky in 1929 describes skulls of two of his species : *A. rajputanae* was said to have broader frontals than *A. centralis*, a shorter molar row, smaller lacrimal, broad intermaxillae, and small supraorbital foramina. The significance of these differences is diminished by the size and quality of the samples studied : a single adult male *rajputanae*, and two young males of *centralis* : one of them castrated ! The greater skull breadth and shorter molar row of the former species are adequately explained by the age difference.

Ellerman and Morrison-Scott (1951), obviously impressed by the large samples ("over a hundred living specimens", as they go out of their way to point out), accept Zukowsky's classification with the qualification that his species are actually only subspecies. They make also one nomenclatorial change : Zukowsky's name *hagenbecki* is superseded by *Antilope rupicapra* Müller, 1776, which as they point out is not preoccupied by *Capra rupicapra* Linnaeus (the earliest name for the Chamois of Europe).

Thus far the literature. But the theory and practice of taxonomy has in the meantime changed, and the question that immediately occurs to an enquirer in 1977 is whether these four subspecies are real, or whether they are merely the ends of cross-cutting clines. That such a question is appropriate has been recognised by Corbet (1970), who perhaps represents the modern consensus viewpoint when he says,

> The only solution, to make subspecific names meaningful, seems to be to reject all names based on average differences or that have been shown to represent points on a cline ; to treat as "provisional subspecies" groups that can be discretely diagnosed on the basis of presently available data but cannot yet be confidently considered to represent discrete groups in nature ; and as "definitive subspecies" groups whose presence as discrete entities in nature has been shown by adequate sampling.

So, with the problem in mind—do the "subspecies", assuming the differences between them are them are real, represent discrete entities in nature ?—we turn to the data. I have studied specimens in the following collections : British Museum (Natural History) ; Rijksmuseum voor Natuurlijk Historie (Leiden) ; Powell-Cotton Museum (Birchington, Kent, England) ; Zoologisches Museum A. Humboldt (Berlin) ; the

Indian Museum and the Zoological Survey of India (Calcutta) ; Bombay Natural History Scoiety ; Delhi Natural History Museum ; Indian Forestry College (Dehra Dun) ; Van Ingen and Van Ingen, Taxidermists (Mysore) ; The Palace, Wankaner ; The Palace, Kolhapur ; The Palace, Vadodara ; Gass Forest Museum (Coimbatore). From collation of measurements on these specimens we arrive at the results listed in Table 1. (Breadth measurements, also taken on each specimen where available, followed the length measurements exactly, for adult male skulls.)

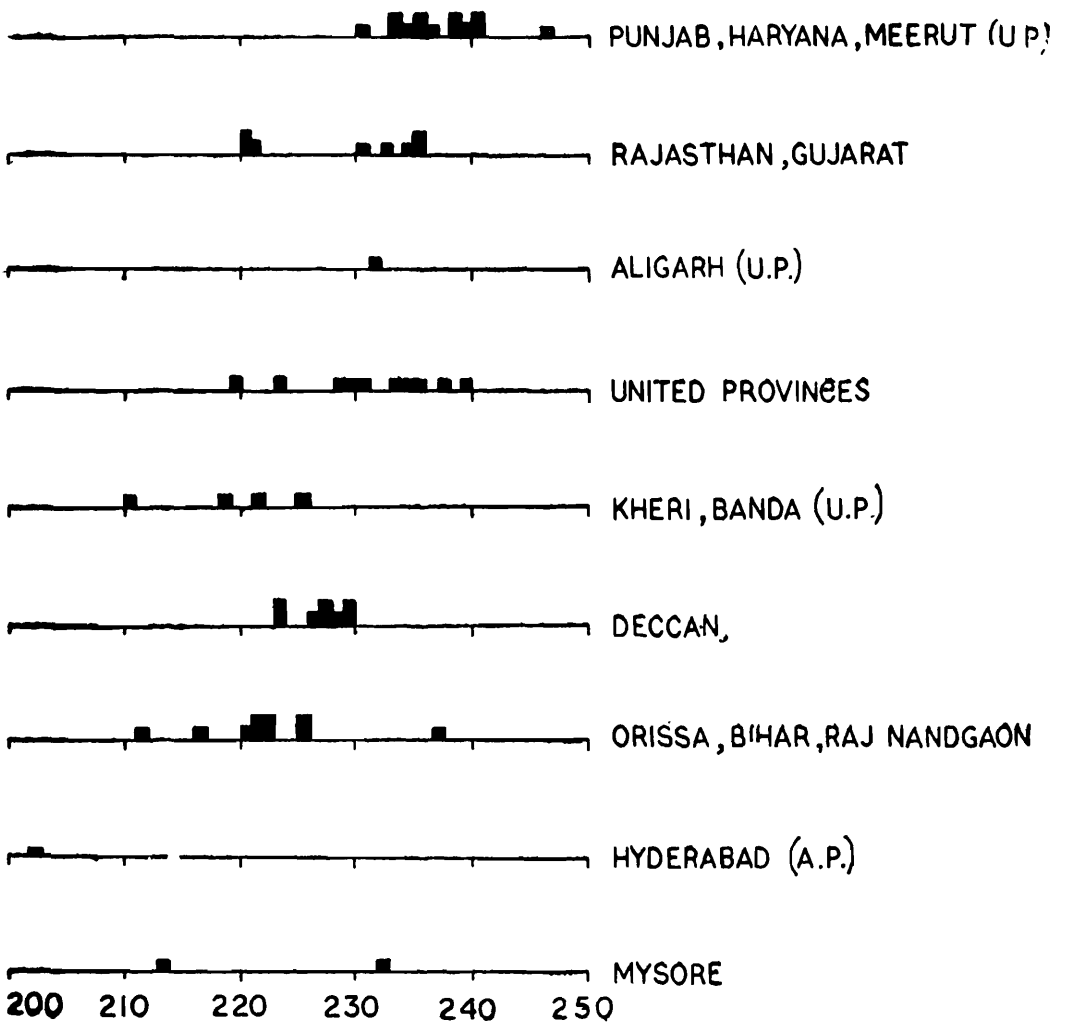
We see in Table 1 that skull length falls into two groups : those from the northwestern part of the range (Saurashtra, Baroda, Faridkot/Karnal/Amritsar/Hissar/Meerut, Bikaner, Gurgaon/Gwalior/Agra/Aligarh, and various groupings not specified beyond State ("Punjab") or even vague area ("N. W. India") being larger than those

TABLE 1. Skull and Horn Measurements of Geographical groups of Blackbuck (Males)

	Horn Length			Tip-to-tip			Skull length		
	Mean	S. d.	n	Mean	S. d.	n	Mean	S. d.	n
"N. W. India"	505.0	39.05	3	311.7	25.66	3	238.5	—	2
"Kashmir"	420.0	—	1	305.0	—	1	—	—	—
"Himalayas"	521.7	7.64	3	313.3	11.55	3	—	—	—
"Punjab"	550.4	58.40	5	469.8	87.92	5	237.5	—	2
"Rajputana"	545.0	18.03	3	315.0	118.22	3	235.0	—	2
Amritsar	631.0	—	1	327.0	—	1	227.0	—	1
Saurashtra	548.0	37.73	13	397.8	56.89	13	227.0	6.56	3
Faridkot/Meerut	639.1	36.48	10	441.9	95.94	9	236.3	5.04	8
Baroda	508.3	10.41	3	372.0	16.29	3	220.0	—	1
Bikaner	605.0	—	2	442.5	—	2	231.0	—	2
Gurgaon	545.0	—	1	249.0	—	1	238.0	—	1
Gwalior/Agra	526.0	59.23	3	371.7	34.03	3	231.0	—	1
"United Provs."	455.0	29.31	12	338.8	52.36	12	231.8	6.21	12
Kheri/Banda	498.6	61.31	6	379.8	47.07	6	218.5	6.35	4
"Central Provs."	540.0	—	2	482.5	—	2	—	—	—
Bhopal	540.0	—	1	380 0	—	1	—	—	—
Rajnandgaon, M. P.	452.0	—	1	262.0	—	1	222.0	—	1
Deccan	519.4	34.69	8	364.2	55.54	6	226.5	2.39	8
Dharwar	467.0	—	1	222.0	—	1	—	—	—
Hyderabad	530.0	—	—	—	—	—	202.0	—	1
Mysore	414.0	15.68	4	366.8	82.50	4	222.5	—	2
Bangalore	430.0	—	2	345.0	—	2	—	—	—
Puri	455.0	37.53	7	311.4	64.53	7	219.4	4.58	7
Bihar/Bengal	383.0	16.61	4	302.0	37.72	4	225.0	—	1

from southern ("Central Provinces", Bhopal, Deccan (Khandesh and Haturna (?=Eturna, Andhra Pradesh near the Maharashtra border), Hyderabad, Mysore) and eastern (Rajnadgaon, Kheri/Banda, Puri,

Ranchi, and Palamau/Bokaro/Champonan) parts ; skulls labelled only "United Provinces" (*i.e.*, Uttar Pradesh) stretch across both these groups. From Text-fig. 1, it can be seen that this distinction is fairly clear-cut : most skulls more than 230 mm. belong in the northwestern group, most of those less than 230, in the southern and eastern group. Moreover, these two groups approach each other closely in Uttar Pradesh : the skull from Aligarh is 231 mm. long, within the range of the Faridkot/ Meerut sample, while the largest skull from Kheri or Banda is 225 mm. It would therefore be most enlightening to know whether the "United Provinces" skulls—of which all but one (of the complete, measureable



Text-fig. 1. Skull length in different geographical groupings of Blackbuck.

ones) are in series, in the British Museum—are from a single locality, presumeably somewhere between Aligarh and Banda or Kheri, or from a number of widely scattered localities. As can be seen from Text-fig. 1, they range in length from 219 to 239 mm., not quite covering the combined ranges of the whole of the other samples.

The single skull from Hyderabad deserves further comment. It falls right outside the range for the southern series as a whole, and so

is "small" as Zukowsky said *cervicapra* should be ; but does it represent a discrete, small form, or the tail end of a normal curve ? There is no evidence either way as yet ; but specimens from Mysore, further south, are larger, so the second possibility seems more likely.

Horn length varies rather differently : there is a general tendency for southern and eastern samples to have smaller horns than northern and western, but there are many exceptions ; and the standard deviations are—as one would expect—extremely large. The largest horns are those of the Faridkot/Meerut sample ; the smallest, from Bihar and Bengal. No marked asymmetry was noted, not even in the potentially intermediate "United Provinces" series ; the only noticeable asymmetry, and that not very marked, was in a British Museum specimen (no. 98.6.3.1) from Kathiawar, in which the right horn is 530 mm, long, the left horn only 490.

The tip-to-tip distance is a measure of horn divergence ; obviously it must be taken in conjunction with horn length (tip-to-tip distance will be as great in a specimen with very long, not very divergent horns as in one with short, widely divergent ones!), but even when this is done we have a picture like that of horn length : a general tendency, not very marked, for northwestern animals to have more divergent horns, but standard deviations so large as to render any search for an absolute distinction hopeless.

In Table 2 are listed the numbers of spiral twists per horn, in each of the samples. A weak correlation appears between this measure and horn length ; specimens from the Faridkot/Meerut series have very long horns, with many turns (up to the maximum observed, $5\frac{1}{2}$), while easternmost samples have rather short horns, with few turns (maximum $3\frac{1}{2}$; more usually only 3 or even the minimum observed, $2\frac{1}{2}$).

As far as traditional subspecific differentiation goes (the Coefficient of Difference—the difference between the means divided by the sum of the standard deviations), the Faridkot/Meerut sample differs in skull length from the Banda/Kheri sample at C. D. = 1.56 ; from Puri at C. D. = 1.76 ; and from Deccan at 1.32. All of these figures are above the level (C. D. = 1.27) of conventional subspecific difference, at 90% joint non-overlap or 75% vs. 100%. Compared to the general "United Provinces" sample, no other reaches this level.

For horn length, Faridkot/Meerut is above this level of difference compared to Banda/Kheri, Puri, Deccan, Bihar ; and Gwalior/Agra ; Bihar is above it compared to Deccan, Banda/Kheri ahd Gwalior/Agra ; no other pairwise comparisons reach the level. This means that among

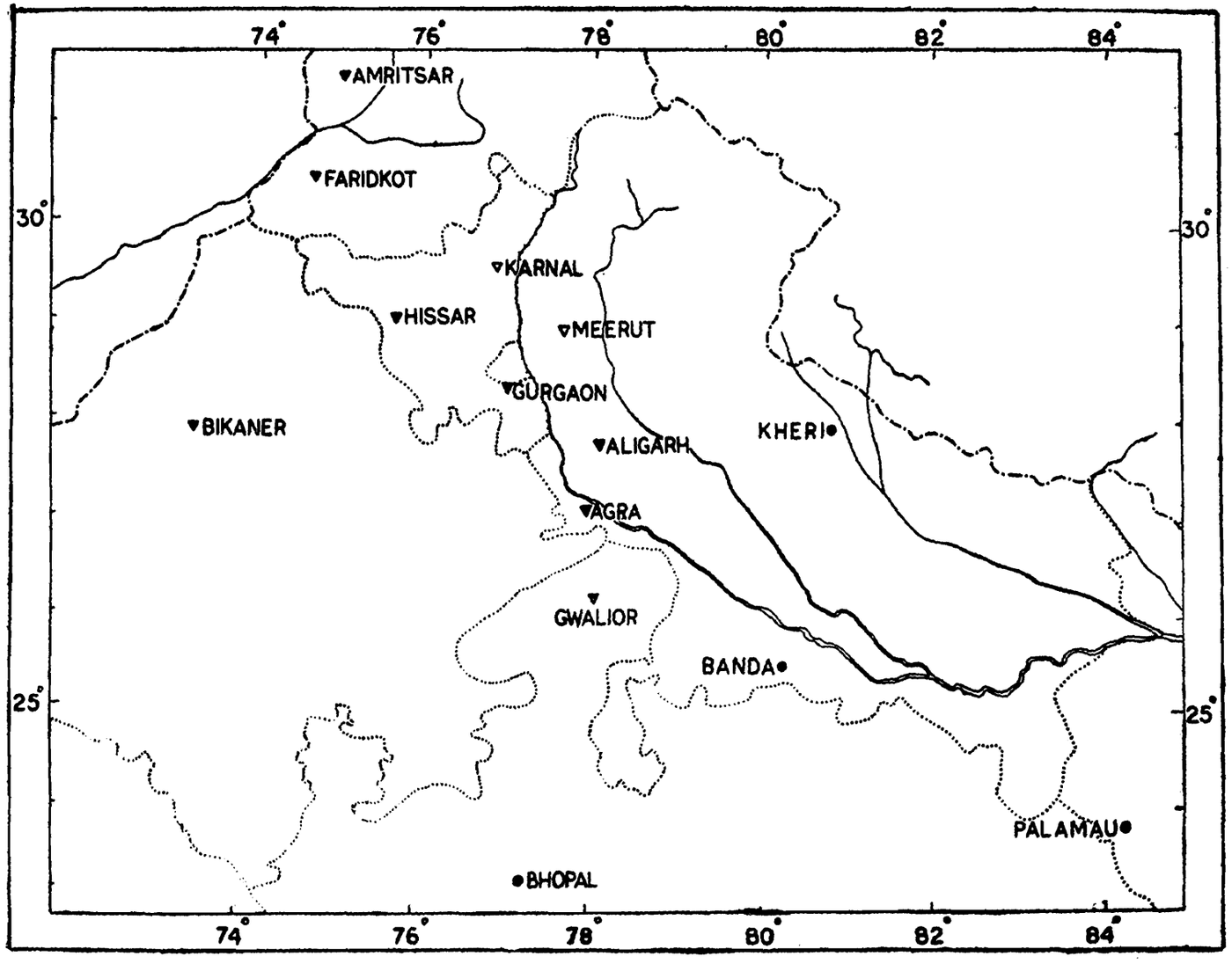
the samples of the Northwestern group, Faridkot/Meerut stand out, and Bihar/Bengal stand out among the southern and eastern samples—rather than these two groups differing from one another as a whole.

TABLE 2. Number of Horn Spirals of Geographical Groups of Blackbuck

	2½	3	3½	4	4½	5	5½
"N. W. India"		3					
"Kashmir"		1					
"Himalayas"		1	2				
"Punjab"		1	2	1	1		
"Rajputana"		1	2				
Amritsar				2			
Saurashtra			3	6	3	1	
Baroda				3			
Faridkot/Meerut			2	3	1	1	3
Bikaner				1		2	
Gurgaon				1			
Gwalior/Agra	1	2	1				
"United Provs."		3	5	3	1		
Kolhapur		1	1	2		2	
Kheri/Banda	1		2	2		1	
"Central Provs."				2			
Bhopal					1		
Rajnandgaon				1			
Deccan		1	3	3		1	
Hyderabad					1		
Mysore		2	2				
Bangalore		1	1				
Puri	2	5	1				
Bihar/Bengal	1	4					

The amount of skin material available for this study was rather limited : 12 complete skins, and 30 head-skins (one albino aside). All the skulls belonged to males ; only 3 skins were female, all the rest males. However, a large number of living animals were observed : in Guindy and Kanha National Parks, Sunderpura and Sikandra Reserves, and Ahmedabad and Hyderabad zoos (these latter of known origin).

The full skins consisted of 1 from Saurashtra, 1 from Sind, 1 from Ghazipur (U. P.), 1 from Khandesh, 4 from Bengal, 1 from Mysore, and 2 from Dharwar, together with the type of *A. centralis*, from Gwalior. The Bengal skins all show the dark colour of the body extending right down the limbs, becoming nearly black on the pasterns ; the adult male is dark black-brown, the young male and the two females are paler brown, with a gazelle-like pattern of longitudinal light and dark zones on the flanks. These four are in the Leiden Museum,



Text-fig. 2. Map of northern segment of distribution of Blackbuck in India, to show close approach of *A. c. rajputanae* (triangles) and *A. c. cervicapra* (dots) in Uttar Pradesh.

The young male from Mysore (British Museum) is a medium brown, and this colour too extends all the way down the legs—much more marked than Zukowsky said should be the case in *A. cervicapra* from southern India. Wild specimens in Guindy (Madras) and Kanha (M. P.) are exactly of this description, as are those in Hyderabad zoo from Andhra Pradesh. The two from Dharwar (in Calcutta), a male and a female, are both red-brown—the male darker than the female, but not in its black breeding coat—with a dark line down the limbs ; and the type of *A. centralis* is, exactly as described by Zukowsky and figured in Sclater and Thomas, washed with a grey sheen, and having the dark line rather poorly marked down the limbs. Living bucks in Sikandra reserve, at Akbar's tomb, near Agra, vary somewhat with either weak leg-stripe or none at all ; while those in Sunderpura, near Baroda, have a marked grey sheen and—from a distance, at least—pure white shanks.

The head-skins show no particular differences in colour ; the head is in any case darker than the body in this species—except in the full sable livery—and does not appear ever to have much of a grey tone to it. One noticeable difference does stand out between one series and another however : in all the Northwestern specimens the eye-ring is very broad, both above and below the eye, whereas in southern and eastern specimens it is broad only below it, but rather narrow above, in approximately 3 : 5 ratio. The type of *centralis* shows the broad type as do skins from Khandesh, Saurashtra and Sind, the other full skins show the superior narrow type. Northwestern head-skins are from Faridkot, Kathiawar, Hissar, Kashmir, "Punjab", "Jarpin" (not traced), and "United Provinces" ; southern and eastern ones are from Kolhapur, Bhopal, Banda and "Central Provinces". It is interesting to note that of the five "United Provinces" head-skins, the only two which are associated with skulls have a skull-length of above 230 mm. This difference can be seen in photos of wild blackbuck, or zoo specimens of known origin.

It remains firstly to compare these findings with Zukowsky's, and then to see whether the differences found between the regional forms are subspecific or not. Finally, diagnoses and synonymies will be given.

Zukowsky said that *rajputanae* and *centralis* both have an overall grey sheen, which the others do not (in sable-coated males !). As far as the data go in the present study, this difference is probably valid. The degree of expression of the leg-stripe should be : good in *hagenbecki*, fair in *centralis*, poor in *rajputanae*, little or absent in *cervicapra*. The

material seen in the present study supports Zukowsky for *centralis*, *rajputanae* and *hagenbecki*, but fails to support him in the *cervicapra* case. Either, therefore, there is individual variability in southern India, or else Zukowsky's specimens came actually from a restricted locality not represented in the present study. It is a pity that the distinctively small Hyderabad skull lacks as associated skin ; but as specimens in Hyderabad zoo stated to be from Andhra Pradesh and showing other characters of the southern/eastern type (eye-ring, short horns, etc.), had leg-stripes, this is unlikely to be the source of Zukowsky's *cervicapra*.

Again, according to Zukowsky *cervicapra* should be smaller than all the rest, which are of equal size. Leaving aside the Hyderabad skull, which may or may not be from whatever region the Hagenbeck specimens derived from, we have seen that there is in fact a very clear-cut size difference of which Zukowsky was unaware : between his *rajputanae* and *centralis*, on the one hand, and *hagenbecki* (and *cervicapra?*) on the other.

According to Zukowsky the horns are very long in *centralis* and *rajputanae*, shorter in *hagenbecki*, very short in *cervicapra*. In the present study a restricted sample, probably referable to *rajputanae* (the Faridkot/ Meerut sample), has very long horns, and the outstandingly short-horned sample is that from Bihar and Bengal, presumeably topotypical *hagenbecki*.

The horns diverge most, according to Zukowsky, in *centralis* and *rajputanae*, less in *hagenbecki*, least in *cervicapra*. Again, the picture is rather one of some samples standing out, rather than whole regions.

Finally in Zukowsky's study *rajputanae* has the most spiral turns to the horns, *hagenbecki* next, *cervicapra* and *centralis* fewest. Again we note some samples standing out within their general regions, although it is true that it is among "*rajputanae*" that the most twists can occur ($5\frac{1}{2}$, rather than 6 as Zukowsky described), but it is *hagenbecki* which commonly has the fewest (only $2\frac{1}{2}$).

How to explain these discrepancies ? The probable answer is that the Hagenbeck imports will have been from relatively restricted areas : Zukowsky speaks of the Rajputana/Punjab border, the hinterland of Calcutta, the very south (Trivandrum and Cape Comorin), Gwalior, and Agra. The first of these regions is precisely the Faridkot district, whence come the longest-horned members of the Northwestern type ; while no specimens are known to have come from the hinterland of Calcutta (merely, "Bengal") or as far south as Trivandrum.

We have found, then, that Zukowsky's descriptions are in part applicable to wide-ranging populations of blackbuck ; in part not. As far as present evidence goes, a Northwestern and a Southern and Eastern form can be distinguished : the former is larger, with a longer coat of hair, a grey sheen in the breeding male, little or no dark leg-stripe, and a broader eye-ring—this last being a character not noticed by Zukowsky. The latter is smaller, short-haired, with no grey sheen, a more clearly marked leg-stripe, and an eye-ring that is narrowed above the eye. Whether a third form can be distinguished in the south, very small in size and with almost completely white limb shanks, there is as yet no evidence to say : but a skin from Mysore and the living animals in Guindy, Madras, indicated that if such a southern form did exist it would have to be very restricted in distribution, and the very small skull from Hyderabad (well to the north of Mysore) suggests that any such form would be characterised by non-concordance of its two distinguishing features.

The fact that so few females are in collections does not allow us to say with any confidence that the size difference holds overall. One can note only that little or no difference in shoulder height is apparent in living specimens of the two sexes. The limb-extension and eye-ring characters do work in females as well as males, however, although all females (as well as males in non-breeding coats) have at least some indication of a dark shankstripe ; and the hair-length difference seems to work as well.

Now : are these two regional types subspecies, or not ? Inspection of Table 1 and Text-fig. 1 shows that the Northwestern sample that approaches the Southern and Eastern group geographically, the sample from Gwalior, Aligarh and Agra, is as large-sized as any northwesterner ; while the sample from the other group which approaches the northwesterners geographically, that from Banda and Kheri, is as small as any. There is therefore a sharp break between these two samples. The eye-ring character follows this exactly ; one cannot vouch for the leg-stripe, although the type of *centralis* does, perhaps, have a rather less obliterated one than the *rajputanae* illustrated by Zukowsky or those seen by me ; but on the contrary, the type of *centralis* has a clear grey sheen, which no southern or eastern specimen does. Accordingly, the two really do seem to be "discrete entities in nature", with just a suggestion—in the character of the leg-stripe in the *centralis* type and that and the eye-ring in Khandesh—of gene-flow between them in some characters.

The two subspecies may now be defined as follows :

1. **Antilope cervicapra rajputanae** Zukowsky, 1927. Northwestern Blackbuck

Synonym : *A. centralis* Zukowsky, 1928.

Localities : Faridkot, Gurgaon, Hissar, Meerut, Ghazipur, Aligarh, Agra, Gwalior, Kular (not traced, but in Rajasthan), Bikaner, Saurashtra (Bhal, Bhavnagar, Rajthali, Wankaner), Baroda, Jarpin State (not traced), Mehna (Punjab), Amritsar ; "Punjab", "Rajputana", "Kashmir", "Himalayas", "N. W. India".

Diagnosis : Adult male skull length usually above 230 mm. ; grey sheen in breeding season in adult male ; long rough hair ; leg-stripe poorly marked or absent on shanks ; eye-ring broad all round eye.

Comments : the longest, most divergent, and most closely spiralled horns occur in this race, but the character is not an absolute one.

The photos of Texas blackbuck in Mungall (1976) show animals very decidedly of this race, which agrees with the likelihood (p. 21) that they were originally imported from the present-day Pakistan.

2. **Antilope cervicapra cervicapra** Linnaeus, 1758. Southern and Eastern Blackbuck.

Probable synonyms : *A. rupicapra* Muller, 1776 ; *A. bilineata* Grey, 1830 ; *A. hagenbecki* Zukowsky, 1927.

Localities : Kheri, Banda, Dharwar, East Khandesh (including Bhadwad, Ghodasgaun), Haturna (?=Eturna), Hyderabad, Bangalore, Mysore, Madras, Rajnandgaon, Kanha, Puri, Jeypur (Orissa), Palamau, Ranchi, Bokaro, Champonan (not traced, but in Bihar, probably Champaran), Bhopal ; "Central Provinces", "Bengal".

Diagnosis : Adult male skull length less than 230 mm. ; no grey sheen ; short, fine hair ; leg-stripe well-marked all down legs, at least in specimens examined ; eye-ring distinctly narrowed above eye.

Comments : the shortest, least divergent, and most open-spiralled horns occur in this race, but there are wide overlaps.

Summary

Geographic variation in *Antilope cervicapra* is described. It is of a type which can be termed subspecific even under stringent criteria. Many of the characters described by Zukowsky as of taxonomic significance fail, because of the restricted geographical nature of his samples ; but others are valid, and some of the differences between the Northwestern and Southern and Eastern races (*A. c. rajputanae* and *A. c. cervicapra*) were not noticed by Zukowsky.

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ON A COLLECTION OF THYSANOPTERA (INSECTA) FROM SILENT VALLEY, KERALA, INDIA

By

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(With 2 Text-figures)

Silent Valley situated in the Western Ghats in the Palghat gap area is a part of a luxurious tropical wet evergreen forest harbouring a wealth of plant species as well as forest litters. So far no attempt has been made to study the thrips fauna of the area and the present paper is a preliminary attempt to study the faunal wealth of this group.

SYSTEMATIC ACCOUNT

Order THYSANOPTERA

Suborder TEREBRANTIA

Family THRIPIDAE

Subfamily THRIPINAE

1. **Anaphothrips sudanensis** Trybom

Anaphothrips sudanensis Trybom, 1911 *Res. Swed. Zool. Exped. Egypt* : 1.

Euthrips flavicinctus Karny, 1912 *Marcellia*, **11** : 115-117.

Anaphothrips sudanensis : Mound, 1968, *Bull. Br. Mus. nat. Hist.* (*Ent. Suppl.*), **11** : 21.

Anaphothrips sudanensis : Bhatti, 1978, *Oriental Ins.*, **12** (1) : 3-4.

Material examined : 3 ♀ ♀, KERALA : Silent Valley, *ex.* grass, 22.1.80 (*N. Muraleedharan* Coll.). [Z. S. I. Reg. Nos. 720-722/H_{17}]

Distribution : All over INDIA. *Elsewhere* : EGYPT JAVA ; INDONESIA ; SRI LANKA.

2. **Megalurothrips distalis** (Karny)

Taeniothrips distalis Karny, 1913, *Arch. Naturgesch.*, **79**A : 122.

Megalurothrips distalis : Bhatti, 1969, *Oriental Ins.*, **3** (3) : 240.

Material examined : 2 ♀ ♀ ; KERALA : Silent Valley, 1979 (*R. S. Pillay* Coll.). [Z. S. I. Reg. Nos. 723-724/H_{17}].

Distribution : All over INDIA. *Elsewhere* : JAPAN to AUSTRALIA and SOUTH ASIA.

Subfamily PANCHAETOTHRIPINAE

3. **Heliothrips haemorrhoidalis** (Bouche)

Thrips haemorrhoidalis Bouche, 1833, *Nat. Schdl. Garten Ins.* : 42.

Heliothrips haemorrhoidalis : Burmeister, 1833, *Handbuch der Ent.*, **2** (pt. 2, sec. 1) : 412.

Heliothrips haemorrhoidalis : Wilson, 1975 *Mem. Am. Ent. Inst.*, **23** : 146.

Material examined : 2 ♀ ♀, KERALA : Silent Valley, *ex.* wild plant (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 725-726/H_{17}]

Distribution : INDIA : Tamil Nadu ; Karnataka ; Andaman Is. *Elsewhere* : GERMANY ; U. K. ; NORTH AMERICA ; SURINAM ; BRAZIL ; MEXICO ; SRI LANKA.

Suborder TUBULIFERA

Family PHLAEOTHRIPIDAE

Subfamily PHLAEOTHRIPINAE

4. **Alocothrips hadrocerus** (Karny)

Trichothrips hadrocerus Karny, 1926, *Mem. Dep. Agric. India ent. Ser.*, **9** (6) ; 220.

Alocothrips hadrocerus : Priesner, 1951, *Indian J. Ent.*, **13** (2) : 195.

Alocothrips hadrocerus : Ananth. & Jagadish, 1969, *Marcellia*, **36** (1-2) : 22.

Material examined : 3 ♀ ♀, KERALA : Silent Valley, *ex.* plant gall, 22.1.80 (*N. Muraleedharan* Coll.). [Z. S. I. Reg. Nos. 727-728/H_{17} & 772/H_{17}]

Distribution : Kerala ; Tamil Nadu ; Andhra Pradesh ; Londa—Goa border.

5. **Byctothrips ayyari** Ananthakrishnan

Byctothrips ayyari Ananthakrishnan, 1973, *Oriental Ins.*, **7** (4) : 540.

Material examined : 2 ♀ ♀, KERALA : Silent Valley, *ex. Linochera malabarica* ?, 15.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 729-730/H_{17}]

Distribution : Valparai (Tamil Nadu).

6. **Crotonothrips coorgensis** Ananthakrishnan

Crotonothrips coorgensis Ananthakrishnan, 1976, *Oriental Ins.*, **10** (3) : 412-414.

Material examined : 4 ♀ ♀, 1 ♂, KERALA : Silent Valley, *ex.* plant galls, 23.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 731-735/H_{17}]

Distribution : Murnad (Karnataka).

7. **Gynaikothrips imitator** Ananthakrishnan

Gynaikothrips imitator Ananthakrishnan, 1968, *Oriental Ins.*, **2** (1) : 44-45.

Gynaikothrips imitator Ananth. & Jagadish, 1969, *Marcellia*, **36** (1-2) : 34.

Gynaikothrips imitator Ananth. & Muraleedharan, 1974, *Oriental Ins. Suppl.*, **4** : 7.

Material examined : 3 ♀ ♀, KERALA : Silent Valley, *ex.* leaf rolls of *Antidesme* sp. (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 773-775/H_{17}]

Distribution : Yercaud.

8. **Haplothrips ganglbaueri** Schmutz

Haplothrips ganglbaueri Schmutz, 1913 *Sitz. Akad. Wiss. Wien*, **122** : 1034

Haplothrips ganglbaueri : Pitkin, 1976 *Bull. Brit. Mus. nat. Hist.* (*Ent.*), **34** (4) : 249.

Material examined : 3 ♀ ♀, KERALA : Silent Valley, 1979 (*R. S. Pillay* Coll.) [Z. S. I. Reg. Nos. 736-738/H_{17}]

Distribution : All over India. *Elsewhere* : SRI LANKA ; JAVA : PHILIPPINES.

9. **Hoplandrothrips graminis** Ananthakrishnan

Hoplandrothrips graminis Ananthakrishnan, 1964, *Entomol. Ts. Arg.* **85** (1-2) : 105-106.

Hoplandrothrips priesneri Ananthakrishnan, 1956, *Proc. R. ent. Soc. Lond.*, (B) **25** : 75-76.

Hoplandrothrips indicus Ananthakrishnan, 1959, *Zool. Anz.*, **162** (9-10) : 320-322.

Hoplandrothrips graminis Ananthakrishnan, 1973, *Occl. Publ.* **2**, *Ent. Res. Unit, Loyola College*, Madras : 33.

Material examined : 3 ♀ ♀, KERALA, Silent Valley, *ex.* leaf-litter, 22.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 739-741/H_{17}]

Distribution : Tamil Nadu.

10. **Karnyothrips melaleucus** (Bagnall)

Hindsiana melaleuca Bagnall, 1911, *Entomologist's Mon. Mag.*, **47** : 61.

Karnyothrips melaleuca : Hood, 1927, *Pan-Pacif. Ent.*, **3** : 176.

Watsoniella melaleuca : Bailey, 1947 *Fla. Ent.*, **30** : 22.

arnyothrips melaleucus : Mound, 1968 *Bull. Br. Mus. nat. Hist.* (*Ent.*) *Suppl.* **11** : 128.

Karnyothrips melaleucus : Pitkin, 1976, *Bull. Br. Mus. nat. Hist.* (*Ent.*), **34** (4) : 263.

Material examined : 1 ♀, KERALA : Silent Valley, 27.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 742/H_{17}].

Distribution : INDIA : Kerala ; Tamil Nadu ; Andaman Is. *Elsewhere* : DENMARK ; VIETNAM ; CHINA ; NORTH AMERICA ; HAWAII Is. ; SOUTH AFRICA ; EGYPT.

11. **Karnyothrips mucidus** (Ananthakrishnan & Jagadish)

Xylaplothrips mucidus Ananth. & Jagadish, 1971, *Zool. Anz.*, **186** : 260-261.

Karnyothrips mucidus : Pitkin, 1976, *Bull. Br. Mus. nat. Hist.* (*Ent.*), **34** (4) : 264.

Material examined : 1 ♂, KERALA : Silent Valley, *ex.* dry twigs, 18.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 743/H_{17}]

Distribution : Wynad (Kerala).

12. **Liothrips epacrus** Ananth. & Muraleedharan

Liothrips epacrus Ananth. & Muraleedharan, 1974, *Oriental Ins. Suppl.*, **4** : 11 & 16-17.

Specimen examined : 2 ♀♀, 1 ♂, KERALA : Silent Valley, *ex.* marginal leaf gall of *Piper* sp., 16.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 744-746/H_{17}].

Distribution : Pachmarhi (M. P.).

13. **Liothrips eugeniae** Priesner

Liothrips (*Phaenothrips*) *eugeniae* : Ananth. & Jagadish, 1968, *Oriental Ins.*, **2** (2) ; 214-215.

Liothrips eugeniae : Ananth. & Muraleedharan, 1974, *Oriental Ins. Suppl.*, **4** : 10.

Material examined : 4 ♀♀, KERALA : Silent Valley, *ex.* leaf rolls, 24.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 747-750/H_{17}].

Distribution : Thenmalai (Kerala).

14. **Liothrips hradecensis** Uzel

Liothrips hradecensis Uzel, 1895, *Mon. Ord. Thys.*, **7** : 262.

Liothrips hradecensis : Ramakrishnan, 1928, *Mem. Dep. Agric. India ent. Ser.* **10** : 283-285.

Liothrips hradecensis : Ananth. & Jagadish, 1967, *Bull. Ent.*, 8 (2) : 4-5.

Liothrips hradecensis : Ananth. & Muraleedharan, 1974, *Oriental Ins. Suppl.*, **4** : 12.

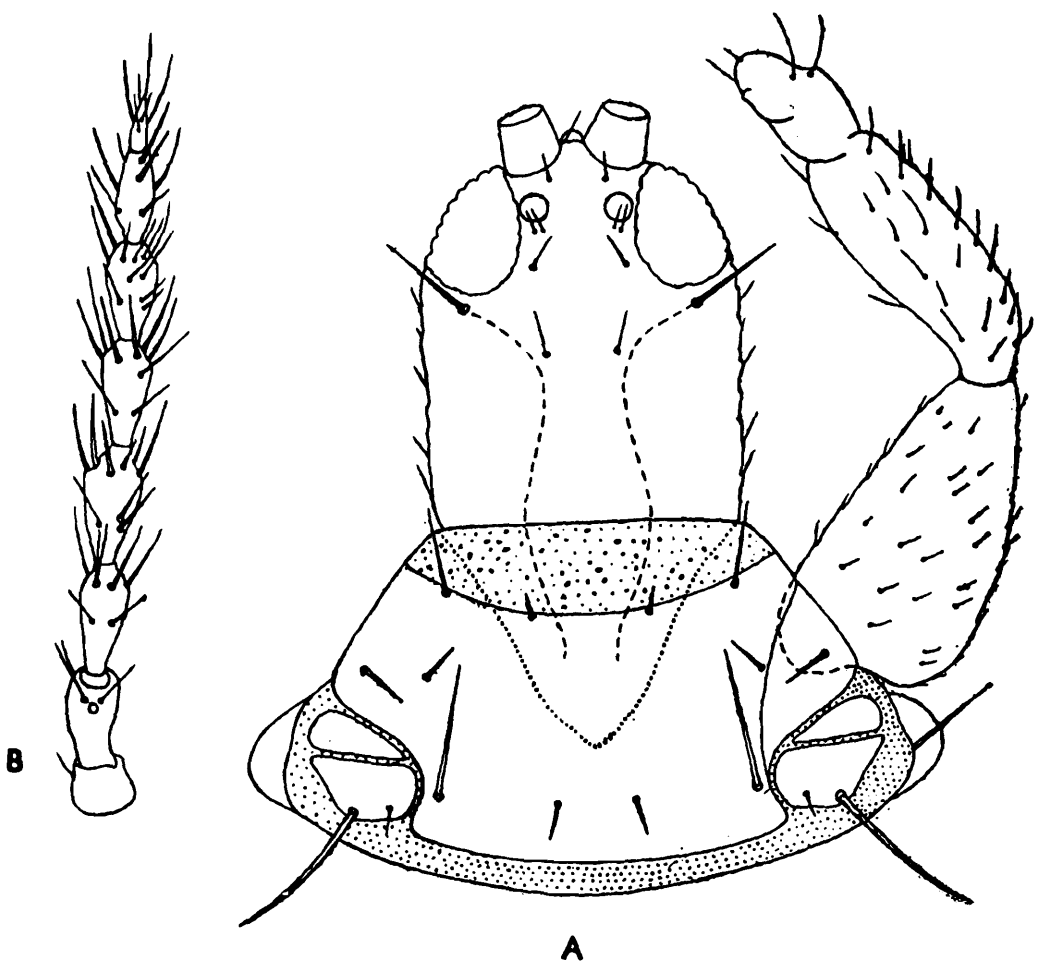
Material examined : 1 ♀, 1♂ KERALA : Silent Valley, *ex.* leaf galls, 16.1.80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 751-752/H_{17}].

Distribution : Tamil Nadu.

15. **Liothrips muralii** sp. nov.

(Text-fig. 1)

Female (*Macropterous*) : General body colour deep brown, head and tube darker ; antennal segments 1, 7 & 8 brown, 2 yellow with base and inner margin brown, 3-5 yellow, 6 yellow at base light brown distally ; all femora brown, foretibiae yellow with light brown tinge, mid and hind tibiae brown with extreme apex yellow, all tarsi yellow ; forewings light grey. All setae brown and pointed.



Text-fig. 1. *Liothrips muralii* sp. nov. A. head and prothorax, B. antenna.

Head very little longer than broad, *198-206 long, 172-184 wide across eyes, 186-194 across base ; cheeks crenulate with 2-4 short spines, surface strongly reticulate. Eyes 76 long, 58 wide, all ocelli 20-24 wide, median ocellus overhanging. Postoculars 62 long. Antennal segments 3-5 subpedicellate, 6-7 pedicellate ; segments 1-8 length (width) : I : 46-50 (36) ; II : 54-58 (32-36) ; III : 66-70 (32) ; IV : 66-70 (36) ; V : 58-62 (28-32) ; VI : 56-58 (32) ; VII : 52-56 (24-28) ; VIII : 32 (12-14) ; sense cones short, moderately thick, 32-36 long. Mouthcone broadly pointed 114-122 long, 166-172 wide at base, 38 at apex ; maxillary stylets oculad, close at middle.

* All measurements are in microns unless otherwise specified.

Prothorax 152 long, 222-240 wide at anterior margin. Prothoracic chaetotaxy—anteroangulars 38-40, anteromarginals vestigial 8, midlaterals reduced 24-32, posteroangulars 84-98, epimerals 96-104 long respectively ; epimeral suture complete. Forefemora 198-202 long, 92-98 wide. Pterothorax 358-370 long, 422-448 wide across meso- and 428-438 across metathorax. Forewings 816-850 long, 66-78 wide with 14 double fringes ; basal wing setae 40, 66 and 64-66 long respectively. Mesopraesternum very much narrowed at middle, almost thread like.

Abdomen 408-428 wide at base, 408-412 at middle, 320-324 across segment VIII, 190 across segment IX. B_1-B_3 of abdominal segment IX : 172 ; 184-188 & 180 long respectively. Pelta roughly triangular with apex flat. Tube 208-212 long, anal setae 172 long.

Total body length : 2.46-2.51 mm.

Type specimen : *Holotype* ♀ (Z. S. I. Reg. No. 753/H_{17}) and *paratypes* 2 ♀ ♀ (Z.S.I. Reg. Nos. 754-755/H_{17}) INDIA : KERALA. Silent Valley, *ex.* leaf gall, 16.1.80 (*N. Muraleedharan* Coll.).

This species is named in honour of N. Muraleedharan for making the collection and for his contributions to Indian Thysanoptera.

The new species comes close to *L. retusus* Ananthakrishnan but it is a distinct species and can easily be distinguished by vestigial anteromarginals, not subequal to anteroangulars, reduced midlaterals, antennal segments 7 & 8 brown, tube as long as head, not shorter and pointed mouthcone.

16. **Liothrips viticola** (Karny)

Gynaikothrips viticola Karny, 1913, *Bull. Jard. bot. Buitenz.* **10** : 112-113.

Gynaikothrips viticola : Ananth. & Jagadish, 1969, *Marcellia*, **36** (1-2) : 36.

Liothrips viticola : Ananth. & Muraleedharan, 1974, *Oriental Ins. Suppl.*, **4** : 14.

Material examined : 3 ♀ ♀, KERALA : Silent Valley, *ex.* plant gall, 28. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 756-758/H_{17}].

Distribution : Kerala.

17. **Mesicothrips plicans** Priesner

Mesicothrips plicans Priesner, 1951, *Indian J. Ent.*, **13** (1-2) : 191-192.

Mesicothrips plicans : Ananth. & Jagadish, 1969, *Marcellia*, **36** (1-2) : 57-58.

Material examined : 2 ♀ ♀, 1 ♂, KERALA : Silent Valley, *ex.* leaf folds, 23. 1. 80. (*Muraleedharan* Coll.) [Z. S. I. Reg. Nos. 759-761/H_{17}].

Distribution : Valparai (Tamil Nadu).

18. **Mesothrips manii** Ananthakrishnan

Mesothrips manii Ananthakrishnan, 1972, *Marcellia*, **37** (5) : 13-14.

Material examined : 1 ♂, KERALA : Silent Valley, *ex.* leaves of an unknown plant, 16. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 762/H_{17}]

Distribution : Kolli Hills (Tamil Nadu)

19. **Stigmothrips limpidus** Ananthakrishnan

Stigmothrips limpidus Ananthakrishnan, 1964, *Entomol. Ts. Arg.*, **85** (3-4) : 231-232.

Stigmothrips limpidus Ananthakrishnan, 1971, *J. zool. Soc. India*, **23** (2) : 231-232.

Stigmothrips limpidus Ananthakrishnan, 1973, *Occl. Publ.* **2**, *Ent. Res. Unit., Loyola College*, Madras : 63.

Material examined : 1 ♂, KERALA : Silent Valley, *ex.* leaf litter, 22. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 763H/$_{17}$].

Distribution : Kerala ; Tamil Nadu.

Subfamily IDOLOTHRIPINAE

20. **Meiothrips menoni** Ananthakrishnan

Meiothrips menoni Ananthakrishnan, 1964, *Opusc. ent. Suppl.*, **25** : 99-101.

Meiothrips menoni Ananthakrishnan, 1973, *Occl. Publ.* **2**, *Ent. Res. Unit, Loyola College*, Madras ; 111-112.

Material examined : 1 ♀, KERALA : Silent Valley, 19. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 764/H_{17}].

Distribution : Kerala ; Karnataka ; Andhra Pradesh.

21. **Neosmerinthothrips fructuum** Schmutz

Neosmerinthothrips fructuum Schmutz, 1913, *Sher Akad. Wiss. Wien.*, **122** : 1052.

Oedemothrips ceylonicus Karny, 1925, *Bull. ent. Res.*, **16** : 137.

Neosmerinthothrips fructuum : Mound, 1974, *Bull. Br. Mus. nat. Hist.* (*Ent.*), **31** (5) : 152.

Material examined : 1 ♀, KERALA : Silent Valley, 23. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 765/H_{17}].

Distribution : INDIA : Kerala ; Karnataka ; M. P. ; West Bengal ; Andaman Is. *Elsewhere* : SRI LANKA.

22. **Polyphemothrips cracens** Ananthakrishnan

Polyphemothrips cracens Ananthakrishnan, 1968, *Oriental Ins.*, **2** (1) : 55-56.

Polyphemothrips cracens Ananthakrishnan, 1969, *Oriental Ins.*, **3** (3) : 308-309.

Polyphemothrips cracens Ananthakrishnan, 1973, *Occl. Publ.* **2**, *Ent. Res. Unit, Loyola College*, Madras : 53.

Material examined : 1 ♂, KERALA : Silent Valley, *ex.* dry twigs, 16. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 766/H_{17}].

Distribution : Kerala ; Tamil Nadu ; Andhra Pradesh.

23. **Polyphemothrips indicus** (Ananthakrishnan)

Erythrinothrips indicus Anathakrishnan, 1955, *Indian J. Ent.*, **17** (3) : 341-342.

Symphyothrips associatus Ananthakrishnan, 1968, *Oriental Ins.*, **2** (1) : 56-57.

Polyphemothrips indicus Ananthakrishnan, 1969, *Oriental Ins.*, **3** (3), : 307-308.

Polyphemothrips indicus Ananthakrishnan, 1973, *Occl. Publ.* **2**, *Ent. Res. Unit, Loyola College*, Madras : 53-54.

Material examined : 1 ♀, 1 ♂, KERALA , Silent Valley, *ex.* dry leaves and twigs, 23. 1. 80 [Z. S. I. Reg. Nos. 767-768/H_{17}] ; 1 ♂, 27. 1. 80 (*N. Muraleedharan* Coll.) [Z. S. I. Reg. No. 771/H_{17}]

Distribution : Kerala ; Tamil Nadu ; Andhra Pradesh.

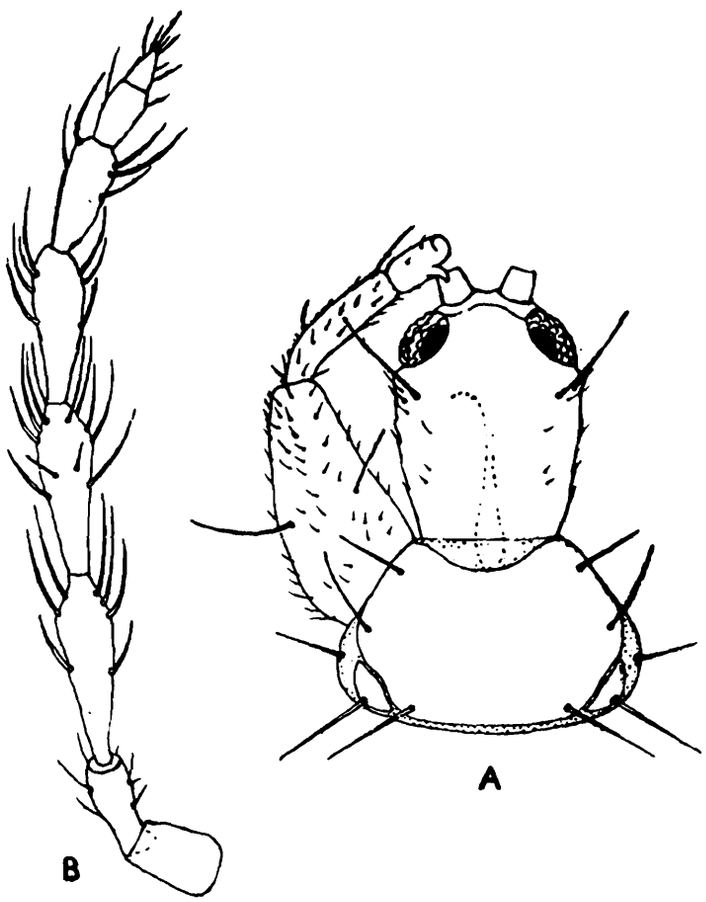
24. **Polyphemothrips kuntiae** sp. nov.

(Text-fig. 2)

Female (*Macropterous*) : General body colour yellow with profuse red pigmentation in the entire body ; tube brown except proximal one fourth yellow ; antennal segments 1 & 7 brown, 2-3 yellow, 4 yellow in proximal three fourth and brown distally, 5 & 6 brown light in base dark distally ; all femora yellow with brownish shade, mid and hind femora dark, all tibiae and all tarsi yellow with apex brown. Forewings grey with base and apex light. All setae hyaline and blunt.

Head longer than broad, 420 long, 292 wide across eyes, 304 across cheeks, 228 across base ; cheeks highly corrugated, constricted, behind eyes bulging afterwards and gradually narrowing, constricted at base, surface sculptured. Eyes 124 long, 76 wide, all ocelli 38 wide, median ocellus not overhanging. Postoculars very long 186 long, placed 58 below posterior margin of eyes. Antennal segments 1-7 length (width) : I : 80 (58) ; II : 88 (50) ; III : 156 (52-54) ; IV : 148 (50) ; V :

122 (42-44) ; VI : 104 (38) ; VII : 100 (32) ; sense cones on 3-6 long and moderately thick 60-76 long. Maxillary stylets retracted upto the limit of postoculars meeting at middle.



Text-fig. 2. *Polyphemothrips kuntiae* sp. nov. A. head and prothorax, B. antenna.

Prothorax 342 long, 248 wide at anterior margin, 456 at posterior margin. Prothoracic chaetotaxy-anteroangulars 108-116, midlaterals 156-164, posteroangulars 126, epimerals 138 long respectively. Forefemora 418 long, 190 wide, inner margin straight, foretarsal tooth 40 long. Pterothorax 456 long, 514 wide across metathorax. Forewings broad 1.63 mm. long 122 wide with 22 double fringes ; basal wing setae 90, 124 & 140 long respectively.

Abdomen 456 wide at base, 484 at middle, 368 across segment VIII, 210 across segment IX. B_1-B_8 of segment IX 274, 248 & 286 long respectively. Tube broad at base gradually narrowing at apex narrowest at apical tip 270 long, anal setae 96 long.

Total body length : 1.98 mm.

Type specimens : *Holotype* ♀ (Z. S. I. Reg. No. 769/H_{17}), *paratype* 1 ♀ (Z. S. I. Reg. No. 770/H_{17}) [damaged] INDIA : KERALA, Silent Valley, 18. 1. 80, ex. dry twigs (*N. Muraleedharan* Coll.)

This new species is named after the River Kuntipuzha flowing along Silent Valley.

The new species is an unique and distinct species differing from all known species by head constricted at base, cheeks highly corrugated and shape of the head.

Acknowledgements

I am indebted to Dr T. N. Ananthakrishnan Ex. Director for providing necessary facilities, confirming the identity of the new taxa, going through the manuscript and offering valuable suggestions. My thanks is also due to Shri P. K. Karmakar, Artist, for preparation of diagrams.

Summary

The paper deals with Thysanoptera fauna of Silent Valley. 24 species under 17 genera have been recorded including 2 species—*Liothrips muralii* & *Polyphemothrips kuntiae* new to science.

Rec. zool. Surv. India, 79 : 515-520, 1982

TWO NEW RECORD OF THE SPECIES BELONGING TO THE GENUS *VARANUS* MERREM, 1820 [REPTILIA : SAURIA : VARANIDAE] FROM ORISSA

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AND

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(With 2 Plates)

INTRODUCTION

We had the oppportunity for examining five varanus lizards from Orissa of which two juveniles are from Bhitorkonika, one from Barang of Cuttack district and the other two from Chandraka village of Puri district. Bhitorkonika is an island in the estuary of Mahanadi Baitarani river system of Athaghar forest Division. This area has now been declared crocodile sanctuary. Barang and Chandraka village is adjoining to the Chandraka Reserve Forest in the Puri Forest Division.

Regarding the earlier work on the varanus lizards of Orissa work of Annandale (1907, 1917 & 1921) is very useful but concerning the Varanidae of India Smith's (1932 & 1935) work are very important and essential. Annandale (1907) reported the occurrence of the common Indian Monitor, *Varanus bengalensis* (Dandin) and one clouded Monitor, *V. nebulosus* (Gray) from Orissa but the latter species had been collected only once by Hadgart from the Gopkuda island of Chilka lake. Now it can be definitely stated that four species of *Varanus* are occuring in Orissa.

The distribution of *V. bengalensis* (Dandin) and *V. salvator* (Laurenti) are interesting as the former species though occurs throughout India its eastern range is limited upto Henzada Dist., Burma (Lat 17°39′ N) and the latter species though widely distributed in the south east Asia it is confined only in India in the eastern region and absent in Peninsular India.

Systematic Account

Order SQUAMATA

Suborder SAURIA

Family Varanidae

Varanus flavescens (Gray)

(Pl. XIII, Figs. 1 & 2)

1827. *Monitor flavescens* Gray, *Zool. Journ.* iii, p. 226 and Ill. Ind. Zool. ii, pl. 67 [1834]

1935. *Varanus flavescens*, Smith, *Fauna of Brit. India*, Vol. II, pp. 404-405.

Material.—1 ex., Dangmal vill., Bhitorkonika, Dist., Cuttack ; 24. vii. 78, *S. Kar.* 4 exs., Serogarh, *Ca* 8 km. E of Nilgiri, Dist., Balasore, 27. x. 71 and 27. xi. 71 ; 13 exs., From jungle around Nandankanan Biological Park, Barang, Dist., Cuttack. 29. x. 71, *D. P. Sanyal.*

Measurement and count of the 1st. juvenile example.—S. V. L. 803 mm., T. 807 mm., abdominal scales in 68 transverse rows from axilla to groin.

Distribution.—The range of distribution is Northern India, from Punjab (Pakistan) to West Bengal.

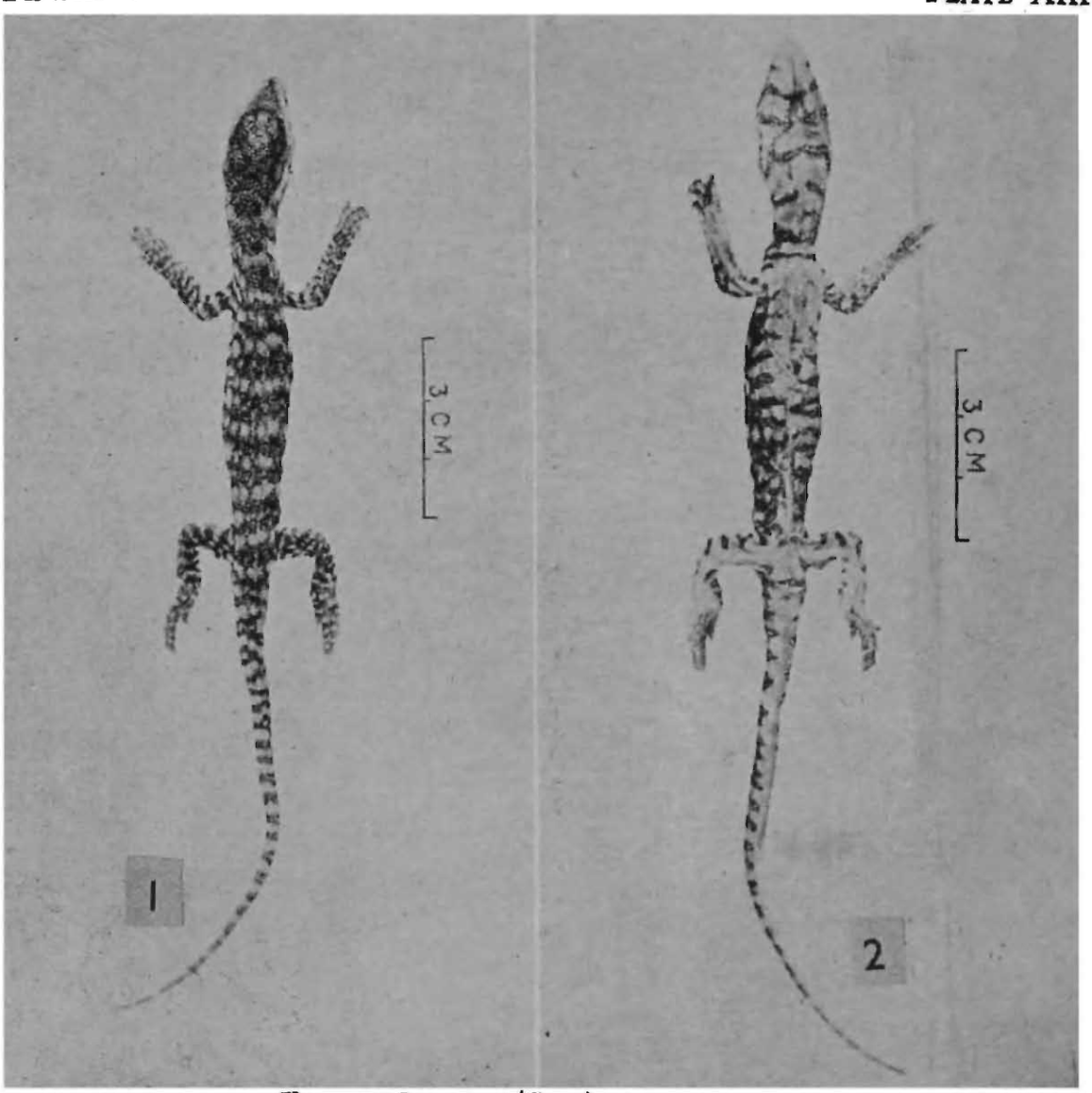
Smith (1932) recorded the species from Ambala (Punjab), Agra (U.P) Saran (Bihar), Goalbathan, Pakur and Midnapore (W. Bengal). So far there is no record of this species from Orissa but there are earlier collections from Balasore and Cuttack Dists. respectively in the collection of Zoological Survey of India. This species is common in jungles of Chandraka Reserve Forest of Cuttack Dist. and Nilgiri hills of Balasore Dist.

About the status of the species Smith (1935) mentioned that it is common in many places but according to d' Abreu (1932) it is common monitor of Bihar.

Remarks.—The colour description of young specimen described in the literature broadly conforms with that of the present specimen. The specimen is dark brown above with white spots transversely arranged but in first two rows these are confluent into bars and in other subsequent rows spots are prominent. The temporal streak is present. On the lip and throat cross bars, some incomplete, are there. On the belly the dark brown marking are like *V. salvator*, vertical and V-shaped eleven marks extend on the sides. On the tail the bars are 24 (Pl. XIII).

According to Smith (*loc. cit*) the above mentioned colours pattern changes to alternating transverse bars of reddish-brown and dirty yellow

BISWAS & KAR PLATE XIII

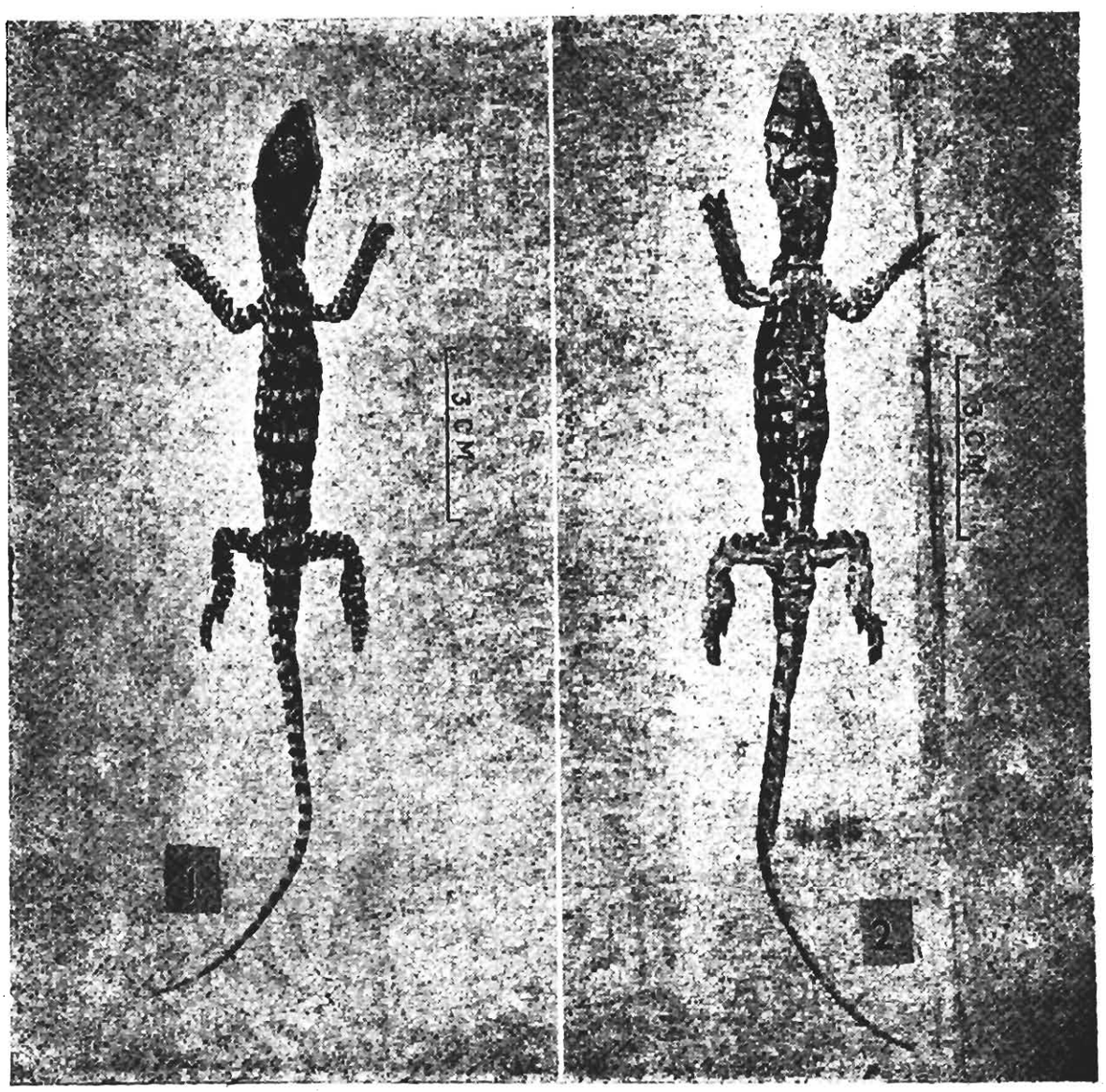


Varanus flauescens (Gray)

1. Dorsal view of a juvenile.
2. Ventral view of the same specimen.

BISWAS & KAR

PLATE XIV



Varanus salvator (Laurenti)

1. Dorsal view of a juvenile.
2. Ventral view of the same specimen.

but d' Abreu (*loc. cit.*) states that adult changes colour yellow with red cross-bars only in the rainy season which is the breeding season.

Though the species is stated by the earlier workers apparently common in many places or in a area of North India it is poorly represented even in the recent collection of Zoological Survey of India. Smith (1932) mentioned the cause of its rare distribution, "As its distribution coincides with one of the most densely populated parts of India, it may be that it is gradually exterminated". Even though the species has been declared protected by the Board of Indian Wild Life the species has no bright future in North India. But in the Bhitorkonika crocodile sanctuary it is now well protected and flourishing. The present collection is a hatchling collected by the village boys by throwing a hand net on it when several of them were found coming out of their nest after hatching. This fact indicates that the month of July is the month of hatching out time for the hatchlings of this species, (Biswas & Kar 1979).

Varanus salvator (Laurenti)

1968. *Stellio salvator* Laurenti, *Sny. Rept.* (based on Seba's Illustr. ii, pl. 88, fig. 2).

1935. *Varanus salvator* Smith, *Fauna Brit. India,* Vol. II. pp. 406 & 407. (pl. 11, Figs. 1 & 2).

Material.—1 ex., from Dangmal vill., Bhitorkonika, Dist. Cuttack, 24. viii. 78, *S. Kar.*

Measurement and scale count.—S. V. L. 150 mm., T. 220 mm., Abdominal scales in 83 transverse rows.

Distribution.—The species is widely distributed in South east Asia, *viz.* India including Andaman & Nicobar Is. (Biswas & Sanyal, 1971), Sri Lanka, Indochina, Southern China and E. Indian Archipelago.

Occurrence of this species in the eastern India is an example of extention of Indochinese species. Smith (*loc. cit.*) mentioned its distribution in the eastern India as, "extreme north-east, easten Bengal and eastern Himalayas (upto 6000 ft.), said to be common in the Sunderban".

It is common as well in the lower West Bengal and its part of Sunderban and particularly well adopted in the esturine condition as it is found at home also in the Mahanadi estuary of Orissa extending its distribution further south-eastern part of India.

Remarks.—The present record disproves the earlier opinion of Biswas and Acharjyo (1977) that the species may not likely to occur in Orissa. The specimen is a juvenile. It is 80 days old after it hatched

out. Therefore, the colour description of this preserved specimen tallies with the colour pattern of a juvenile. It is blackish above, with its small yellow spots and larger round spots or ocelli arranged in transverse series. These yellow spots are very prominent on the legs and tail and also arranged transversely on tail but distally these spots marged producing alternate bands of white and black. The ocelli are white with black spots. Ventrally there are 9 black bands on the throat and chest some of which are incomplete and two in numbers on the snout (Pl. XIV).

In Bhitorkonika Water Monitor nest in June (Biswas and Kar, 1979). They usually select termitarium on a high ground as their nest for laying eggs due to the reason may be that the esturine area is innundated by tide twice daily.

Varanus bengalensis (Daudin)

1802. *Tapinambis bengalensis* Daudin, *Nat. Rept.*, iii, p. 67.

1935. *Varanus monitor* Smith, *Fauna Brit. India*, Vol. II. p. 402-404.

Material.—2 exs., from the campus of Veterinary Dispensary, Chandraka vill., Dist. Puri ; July, 1966, *L. N. Acharjyo.* ; 1 ex., Barang, Dist., Cuttack ; 3. ii. 74.

Measurement and scale count.—Two juvenile S. V. L. 140 & 150 mm., T. 225 & 213 mm., abdominal scales in transverse rows 90. One adult S.L.V. 330 mm., T. 435 mm., abdominal scales in 94 transverse rows.

Distribution.—The range of its distribution is eastern Persia, Waziristhan, whole of India, Nepal, Sri Lanka and Burma as far south as Lat. 17° 13 N.

Remarks.—The difference of colour pattern between young or juvenile and adult specimens is very clear in the present lot consisting of two young specimens and one adult as has been mentioned by Smith (1932). In the two young specimens the characteristic ocelli, yellow spot or spots surrounded by dark brown, are transversely arranged alternating with dark spots or bars. As the specimen grows with age these ocelli start to disappear gradually from anterior part first leaving only the black spots and finally in the adult these dark spots turn into black dots.

Eggs containing fully developed embryos were collected in the end of March from the Megapod mound in Great Nicobar, Biswas & Sanyal (1977).

ACKNOWLEDGEMENT

The authors are thankful to the Director, Zoological Survey of India and the Chief Conservator of Forest, Govt. of Orissa for allowing us the facilities for working out this problem and to Dr K. K. Tiwari for his valuable suggestion to improve the paper.

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Rec. zool. Surv. India, 79 : 521-530, 1982

INTRASPECIFIC GEOGRAPHICAL VARIATIONS IN THE INDIAN BUSH RAT, *GOLUNDA ELLIOTI* J. E. GRAY [RODENTIA : MURIDAE]

By

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Zoological Survey of India, Calcutta

(With 4 Text-figures)

The Indian Bush Rat, *Golunda ellioti*, was first described by J. E. Gray (1837) and was accommodated in a new genus *Golunda*, having an unusual dentition (upper incisors broad and prominently grooved, cusps of upper molars peculiarly enlarged and raised up, and third upper molar large and lacking the outer row of cusps). Subsequently, a number of species of the Bush Rat, namely, *Mus hirsutus* Elliot, 1839, *Mus myothrix* Hodgson, 1845, *Golunda coffaeus* Kelaart, 1850, *Golunda nuwara* Kelaart, 1850, and *Pelomys watsoni* Blanford, 1876, were described from the Indian subregion. Wroughton (1920) recognized only three species under the genus *Golunda*, namely, *ellioti*, *nuwara* and *watsoni* and synonymized *coffaeus* and *myothrix* with the nominate subspecies. Thomas (1923) maintained only one species, *G. ellioti*, under this genus and treated all others as its subspecies. In addition, he (loc. cit.) erected six new subspecies, namely, *bombax*, *coraginis*, *gujerati paupera*, *coenosa* and *limitarius* from different regions of India. But both Wroughton (1920) and Thomas (1923) did not mention any thing about the status of *Mus hirsutus*. Ellerman (1941) maintained all the above eleven subspecies and treated *hirsutus* as a synonym of the nominate one. Later, he (1947) stated that "all the named forms of this species are very similar to each other, and it becomes largely a matter of personal preference whether it is worth while dividing this species into subspecies at all", and provisionally maintained seven of them, synonymizing *coffaeus*, *bombax* and *coraginis* with the nominate subspecies and *limitarius* with *watsoni*. Ellerman (1963) retained all the seven subspecies recognized earlier by him with the remark that most of the colour characters mentioned by Thomas (1923) for subspecific differentiation are nothing but individual or seasonal variations, and apart from the subspecies *nuwara*, others retained are most doubtful and might well be placed in synonymy of the nominate form. Hence, it was felt necessary to study in detail the intraspecific variations in the Indian Bush Rats from different geographical areas. For this purpose, a good

number of specimens from different parts of India, Pakistan and Sri Lanka present in the Zoological Survey of India and the Bombay Natural History Society were studied. The data provided by Ellerman (1963) were also taken into consideration. The results of our study are summarized in this paper.

All measurements are in millimetres and have been taken after Ellerman (1963). The body and cranial measurements of about 250 specimens belonging to different populations were statistically analysed. The measurement of type-specimens, wherever available, have been taken into consideration. Population range diagrams (Text-figs. 1-4) for different external and cranial measurements have been prepared according to the methods of Dice and Leraas (1936) and Hubbs and Perlmutter (1942). The length of each ordinate represents the extremes of each set of measurements and a central crossbar the mean ; a narrow shaded rectangle represents a distance equal to one standard deviation from the mean on either side of the mean, while the broad rectangle represents a distance equal to twice the standard error of the mean on either side of the mean. The colours given with initial capital letters in the text are after Ridgway (1886).

Observation

Nature of fur : Body covered with thick fur ; its texture varies with age, altitude and season. Fur long and soft in winter specimens, while short, crisp and spiny in summer ones. Similarly, fur in juvenile specimens and in those of high altitude is softer than that of adults and of those belonging to plains, irrespective of the locality. Hair covering the tail generally short and coarse.

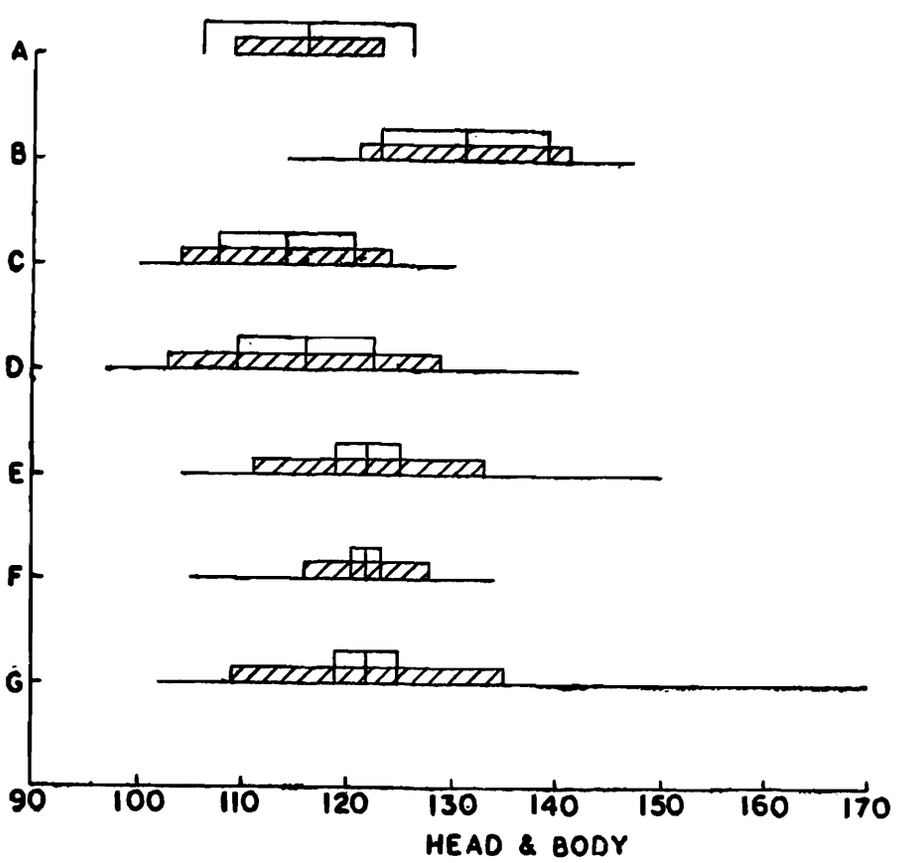
Colour : Dorsum ranging from greyish brown to black. Normally, hairs are of two types. One type of hair is slaty to Mouse Gray on the base, pale Ochraceous to pale yellow in the middle and Seal Brown at the tip. Another type of hair is slaty to Mouse Gray on the base and sandy to yellowish brown at the tip. It is the mixture of these yellow brown and Seal Brown-tipped hairs which give the dorsum a grizzled appearance and different shades of colour. In *nuwara* Seal Brown-tipped hairs dominate over sandy or yellowish brown ones, hence the mid-dorsum is blackish. In other populations, the pale yellow and Seal brown-tipped hairs are almost equally represented, hence the colour effect is light. However, there is a tendency of the dorsal colour being dark in populations of the humid north eastern India, and gradually becoming lighter in those of the relatively drier zone, *viz.* western India forming almost a cline.

Juvenile and subadult specimens are normally darker than the adults. Similarly, winter specimens are relatively darker than the summer ones. However, specimens in moulting phase appear blackish as their slaty underfur is exposed.

In many specimens, irrespective of sex, season and locality, small areas at the base of the ear, around the eyes and side of the nostrils are buff or brown in colour looking like a spot or ring. But these spots are variable and may or may not be present in all specimens of the same locality and season.

Venter : Ventral surface is white in *gujerati*. Hair may be white up to the base or the basal one-third may be gray and rest white (exceptions being two out of 42 specimens where ventral colour is greyish white). In *nuwara*, ventral colour is bluish grey. In populations other than *gujerati* and *nuwara*, hairs vary from grey to slaty for greater part of the basal region and the tip whitish, yellowish or brown, making the venter greyish in appearance, exceptions being six out of 124 specimens (two from Salt Range, one from Sind, two from Madhya Pradesh and one from Kumaon, Uttar Pradesh, all collected in summer) where the undersurface is almost white.

Colour of the hand and foot vary from dirty white to pale brown



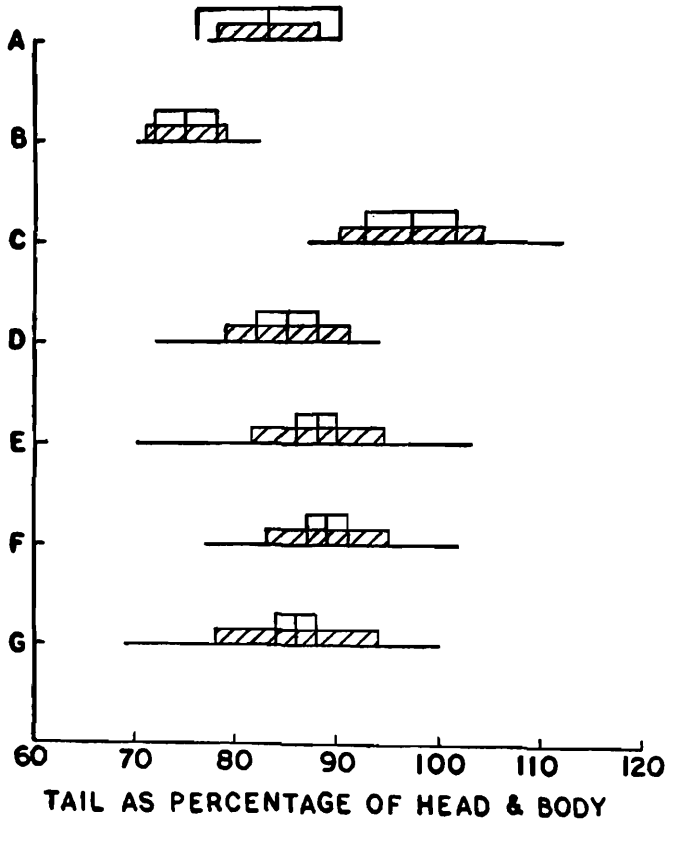
Text-fig. 1. Graphic comparison of head and body length (in mm) in seven populations of *Golunda ellioti* J. E. Gray. A, *paupera* ; B, *nuwara* ; C, *watsoni* ; D, *coenosa* ; E, *myothrix* ; F, *gujerati* ; G, *ellioti*.

or even darker, irrespective of the locality. But, in general, the hand tends to be lighter in colour than the foot.

Tail distinctly bicoloured, dark brown above and pale below.

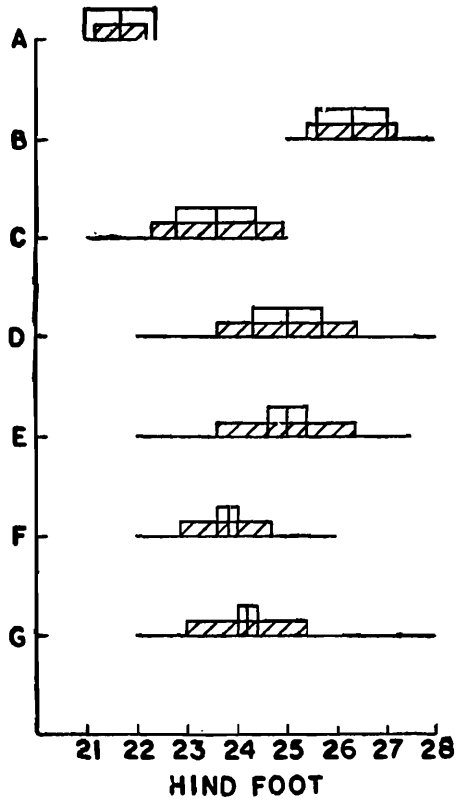
Size : Head and body length : Highly variable within the species, ranging from 97 to 170 mm. Although the population from Sind (*watsoni*) is, on an average, smaller than those of other areas, the difference is not significant (indicated by overlap of one standard deviation rectangle of comparable lines) (Text-fig. 1 & Table 1).

Tail-length : Length of tail, within the species, ranges from 84 to 131 mm and is generally smaller than the head and body. On an average, it is less than 100 mm in populations *coenosa*, *paupera* and *nuwara* and more than this in *ellioti*, *myothrix*, *watsoni* and *gujerati*. It is, on an average, greatest in *watsoni* and smallest in *nuwara*, both in absolute length as well as in relation to head and body. However, statistical analysis of the relative length of tail reveals that the populations from the range of *nuwara* are significantly smaller than those of *myothrix*, *watsoni*, *coenosa* and *gujerati*, whereas, of *watsoni* are significantly greater than those of *paupera* only (Text-fig. 2).



Text-fig. 2. Graphic comparison of length of tail as percentage of head and body length in seven populations of *Golunda ellioti* J. E. Gray.

Hindfoot : Length of hindfoot varies from 21 to 28 mm and is, on an average, greatest in specimens from the range of *nuwara* (26.3 mm) and smallest in those of *paupera* (21.7 mm). However, the former



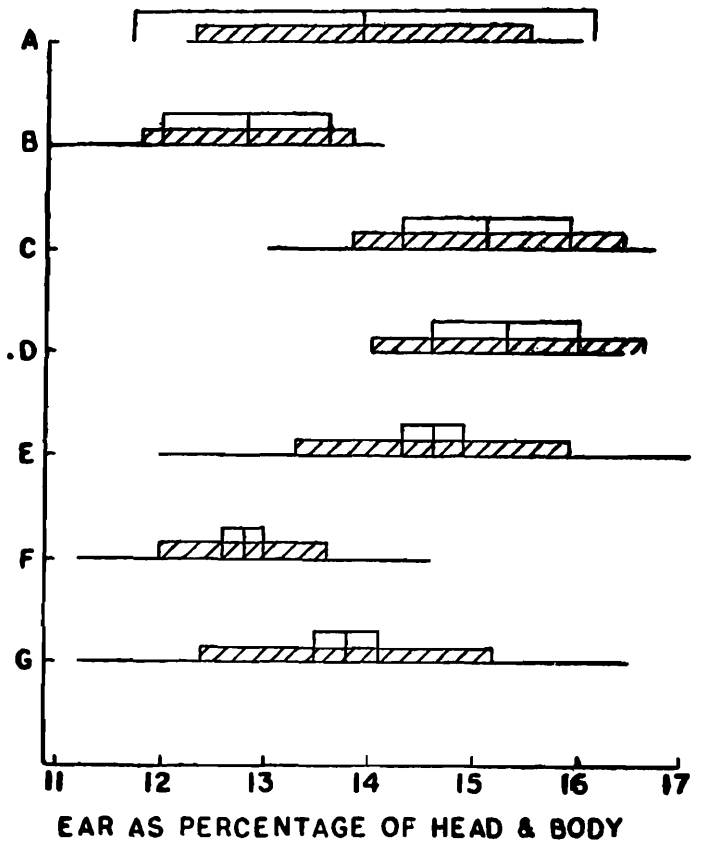
Text-fig. 3. Graphic comparision of length of hind foot (in mm) in seven populations of *Golunda ellioti* J. E. Gray.

population differs significantly from that of *ellioti*, *gujerati*, *paupera* and *watsoni*, whereas the latter differs from all except that of *watsoni*. (Text-fig 3).

Ear : Length of ear in relation to that of head and body is, on an average, greater in populations from the range of *watsoni*, *coenosa* and *myothrix* (more than 14.5% of head and body length) than those of *nuwara*, *paupera*, *ellioti* and *gujerati* (less than 14.5%). Although this difference between the two groups is of probable significance (indicated by nonoverlap of standard error rectangles of comparable lines), (Text-fig. 4) it does not hold good even at one standard deviation from the mean. Hence, it cannot be treated as a distinguishing character. However, *gujerati* may be differentiated from *watsoni* on this character.

Skull : The structure of skull has been dealt with in detail by Ellerman (1963). There is practically no variation in its structure at subspecific level except that in some specimens the zygomatic plate tends to be concave anteriorly.

Occipitonasal length varies from 28-35.2 mm. It is, on an average, longer in specimens from the ranges of *coenosa* and *watsoni* (more than



Text-fig. 4. Graphic comparison of length of ear as percentage of head and body length in seven populations of *Golunda ellioti* J. E. Gray.

32 mm) than those of others. Only one skull of *nuwara* available for examination has the upper molar toothrow 7.2 mm, which is longer than that in other populations.

Discussion

Thomas (1923) described a number of subspecies based on the body coloration and facial markings. Ellerman (1963) stated that "the various facemarkings, eyespots and noserings, and patch below ear, seem to be based on very little marked and individual characters rather than characters which have any importance for racial discrimination." Our observations support Ellerman's (1963) view.

There is no marked difference in the colour of dorsum in different populations of *Golunda ellioti* except in *nuwara* where it is definitely blackish. Ellerman (1963) differentiated the population from northern Uttar Pradesh and Himachal Pradesh (*myothrix*) from that of Bhutan Duars (*coenosa*), and the populations from Rajasthan and Gujarat (*gujerati*) from that of Western Ghats (*ellioti*) on the basis of lighter

TABLE 1. External measurements in different populations of *Golunda ellioti* J. E. Gray with Range, mean ± 2 standard error, sample size in parentheses.

Name of subspecies	Head & body	Length of tail	Tail as % of HB	Hindfoot	Hindfoot as % of HB	Ear as % of HB
G. e. ellioti	102-170	86-131	69-100	22-28	16.2-22.6	11.2-16.5
	122±2.8 (88)	104±2.5 (79)	86±2 (78)	24.2±0.25 (86)	20.1±0.35 (86)	13.8±0.3 (84)
G. e. paupera	106-123	95-98	77-90	21-22	17-20.7	12.2-16
	116±10 (3)	96±1.4 (3)	83±7 (3)	21.7±0.7 (3)	18.8±2 (3)	13.9±2.2 (3)
G. e. myothrix	104-150	86-129	70-103	22-27.5	17.2-23.8	12-17.1
	122±2.8 (62)	107±2.6 (55)	88±1.7 (55)	25±0.36 (61)	20.6±0.4 (61)	14.6±0.32 (61)
G. e. coenosa	97-142	84-112	72-94	22-28	18.3-25.8	14-16.4
	116±6.5 (16)	99±4.4 (13)	85±3.2 (13)	25±0.7 (15)	22±1.0 (15)	15.3±0.7 (15)
G. e. watsoni	100-130	92-122	87-112	21-25	19.2-23.5	13-16.7
	114±6.4 (10)	110±6.4 (10)	97±4.4 (10)	23.6±0.8 (10)	20.8±0.8 (10)	15.1±0.8 (10)
G. e. nuwara	115-147	89-119	70-82	25-28	17.7-22.6	10.9-14.1
	131±8 (7)	98±7 (7)	75±3.2 (7)	26.3±0.7 (7)	20.1±1.4 (7)	12.8±0.8 (7)
G. e. gujerati	105-134	94-126	77-102	22-26	17.5-21.9	11.2-14.6
	122±1.6 (55)	110±2.4 (45)	89±1.8 (45)	23.8±0.24 (55)	19.5±0.26 (55)	12.8±0.22 (52)

colour of the dorsum. Our study shows that although there is a tendency in the dorsal colour being lighter in specimens of the drier zone than those of the relatively humid areas, this difference is gradual and almost clinal. Hence, it cannot be treated as a differentiating character. However, the subspecies *gujerati* may be differentiated from other subspecies on the colour of its undersurface which is white as against drab grey or bluish grey.

The head and body length in different populations does not vary much. Ellerman (1963) differentiated *watsoni* from other populations (Table 1) by its relatively longer tail (more than 90% of head and body *vs.* less than 90%). But our analysis shows that this difference is not significant (indicated by overlap of one standard deviation rectangle of comparable lines), as such, it cannot be treated as a distinguishing character. However, the tail in *nuwara* is significantly smaller than in *watsoni*, *coenosa*, *myothrix* and *gujerati* (Text-fig. 2).

TABLE 2. Cranial measurements in different populations of *Golunda ellioti* J. E. Gray with Range, mean ± 2 standard error, sample size in parentheses.

	Occipitonasal length	Toothrow
G. e. ellioti	28.0-35.4 30.5±0.4 (49)	5.8-6.8 6.5±0.07 (49)
G. e. paupera	— — — —	— — — —
G. e. myothrix	28.9-34.3 31.1±0.46 (22)	6.0-6.9 6.4±0.08 (22)
G. e. coenosa	31.1-33.3 32.2±0.5 (8)	6.0-6.7 6.3±0.15 (8)
G. e. watsoni	31.8-35.2 32.9±1.1 (5)	6.3-6.7 6.5±1.4 (5)
G. e. nuwara	30 (1)	7.2 (1)
G. e. gujerati	28.5-33.5 31.0±0.36 (35)	5.8-6.7 6.3±0.01 (35)

Ellerman (1963) differentiated the subspecies *watsoni*, *myothrix* and *coenosa* from *paupera*, *nuwara*, *gujerati* and *ellioti* on the relative length of ear *viz* more than 14% of head and body as against less than 14% (Table 1). But as mentioned earlier, this difference is not significant, and, as such, cannot be treated as a distinguishing character.

Based on four specimens from Ambala (Haryana), Thomas (1923) described the subspecies *paupera*, and differentiated it from *gujerati* by

its smaller size and relatively shorter tail. Ellerman (1963) maintained it on the basis of its shorter hindfoot, ranging from 21 to 22 mm as against generally more than 22 mm in other subspecies. Our analysis shows that although there is significant difference between this population and others in absolute length of the hindfoot, there is no difference between them when its relative length is taken into consideration. Moreover, hindfoot as small as 21 or 22 mm is not an unusual feature in other populations too, and it appears to be simply a chance that all the three specimens of *paupera* examined by Ellerman (1963) have hindfoot 21 or 22 mm. Hence, it should not be taken as a distinguishing character.

Of the cranial features, the length of the upper toothrow is significantly long in *nuwara* (more than 7 mm. *vs.* less than 7 mm. in other populations) but nothing definite can be said as our observation is based on a single skull only (Table 2).

From the above discussion, it is clear that there is no difference amongst the populations *ellioti*, *myothrix*, *coenosa*, *paupera* and *watsoni*, and therefore, we would treat them as one, namely, *Golunda ellioti ellioti*, characterized by greyish brown dorsum and greyish undersurface, thus extending its range to whole of India (excepting Gujarat and southern Rajasthan), Pakistan (Sind and Punjab) and low lands of Sri Lanka (Central and parts of South and North Central Province up to an altitude of c 900 m). However, the subspecies *gujerati* and *nuwara* stand valid. The former can be separated on the basis of whitish undersurface combined with the tendency of having a longer tail and relatively shorter ear (Table 1) and the latter by its blackish dorsum, bluish gray venter and relatively shorter tail. The subspecies *gujerati* is restricted to southern Rajasthan and Gujarat and *nuwara* to the mountains of Central Province, Sri Lanka, above an altitude of c 1200m.

A key to the subspecies of *Golunda ellioti* as recognized by us is given below :—

1.	Undersurface of body white ...		*gujerati*
	Undersurface of body slaty grey or bluish grey	...	2
2.	Dorsum blackish ...		*nuwara*
	Dorsum speckled greyish brown ...		*ellioti*

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