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A NYMPHAL POPULATION DYNAMIC STUDY
OF *DARTHULA HARDWICKII* GRAY (HEMIPTERA
MEMBRACIDAE) ON *ACACIA DEALBATA* LINDL.

By

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INTRODUCTION

Darthula hardwickii Gray is a membracid, hemipterous insect that feeds on the sap of trees and herbaceous plants. In Shillong and its vicinity, this common tree-hopper is seen to profusely infest *Acacia dealbata* Lindl., which is an economically important plant, and in particular, its nymphs are known to be the cause of extensive damages. Earlier, Mandal and Biswas (1965) observed the biology of this insect from this area. It is known that with general reference to phytophagous insects and in particular forest trees inhabiting ones mostly do not reach infestation levels. Their number usually fluctuates well below the carrying capacity. It is only at certain season and some year that a pest status is reached. Cyclic changes associated with seasonal populations probably constitute the most important and the all-encompassing set of environmental variables that organisms encounter.

The present investigation was therefore, to evaluate the population dynamics of the nymphs, firstly, to observe the rise and fall of their numbers, and secondly to arrive at some relationship between their densities and other possible operative factors.

THE STUDY AREA

The study area was the Mayurbhanj Campus of the North-Eastern Hill University, Shillong ($25^{\circ}34'N$; $91^{\circ}56'E$). The area is about 1500m in altitude and predominated by *Pinus kesiya* Royle ex Gordon. A patch of the area at the School of Life Sciences is colonised by *Acacia dealbata* Lindl.

The climate of Shillong and its adjoining areas are controlled by the two seasonal winds, viz. the South-West monsoons and the North-East winter wind. Hence, the area may be divided into spring season (March to mid-April), dry summer season (late April to May), rainy season (June to mid-October), autumn season (late October to November) and winter season (December to February).

The average summer temperature of Shillong is $24-26^{\circ}C$ and during the cold winter months the mercury drops as low as $1^{\circ}-2^{\circ}C$. Frost is common, particularly in the mornings, during the winter period. Shillong and its adjoining areas enjoy an annual rainfall of 2500-3000mm.

MATERIALS AND METHODS

Although the area was dominated by *Pinus kesiya* Royle ex Gordon, the insect, *Darthula hardwickii* Gray (Plate I) was found to colonise the *Acacia dealbata* Lindl. only. Therefore, three *Acacia* trees of unequal heights were chosen (Tree No. 1 = 1.5 m ; Tree No. 2 = 3.0m ; Tree No. 3 = 6.0m). Each tree was divided into three equal zones, viz. Zone A (bottom portion), Zone B (middle portion), Zone C (top portion). Thus, the height of each zone of the first tree was 0.5 m, that of the second tree 1.0m each and the third tree 2.0 m each. All the three trees were situated within the distance of one meter from each other.

The study period extended between 18th March, 1983 (when the population was in the early 1st nymphal stage) to 30th May, 1983 (when the adult emergence was completed). Sampling was done twice a day at 06.00 hrs. and 18.00 hrs. From each zone of the trees, the insects were counted from

a quadrat, measuring 25 cm² in surface area. Counting of the insects were made from 10 such quadrats. Therefore, daily counts of insects were made from 20 quadrats for each zone of the trees. A total of 20 × 74 or 1480 quadrats of insect samplings were made from each zone of the trees and 1480 × 3 or 4440 quadrats for all the zones of each tree, during the whole investigation period. All the counts are represented in results as daily average per tree.

In addition to the population sampling of *Darthula*, single abiotic factor that has been considered in the present study was the atmospheric temperature. Thus, on every sampling occasion, the temperature was measured with an ordinary thermometer near the zone of sampling.

RESULTS

The three different zones in the three different trees undertaken was primarily to understand the aggregational behaviour and movement from zone to zone within the trees and also between the trees.

The movement between trees is seen from the graph (Fig. 1) where the maximum was seen at the beginning of the study period with 50 individuals in Tree No. 2, while it was only around 34 in Tree No. 3, and 20 in Tree No. 1.

In Tree No. 1, the population fluctuated around 20 ± 2 till the 10th of April when it reached nearly 27 and continued to be so for two days. Thereafter, it fell to half the level till the 30th of April and with a similar phenomenon as the initial stage, continued till 12th of May. This was seen to dwindle till all the nymphs emerged around 27th of May.

In tree No. 2, a more or less similar phenomenon was seen as in Tree No. 1, except in the magnitude of numbers which oscillated around 40 ± 2 till the 9th April. Thereafter, a reduction to nearly half was observed, which continued to be so till the 9th of May. The numbers in Tree No. 2, suddenly shot up to nearly 28 on the 10th May and continued to fluctuate around that till 16th May when a fall in the population was recorded till the 30th.

In case of Tree No. 3, the population rose and fell till a peak was seen on 29th March which was more or less maintained till 3rd April. Immediately following this, the number was more or less constant, around 30 ± 3 till 30th April, when a decline in the population was seen till a minimum was reached at the end of the study period.

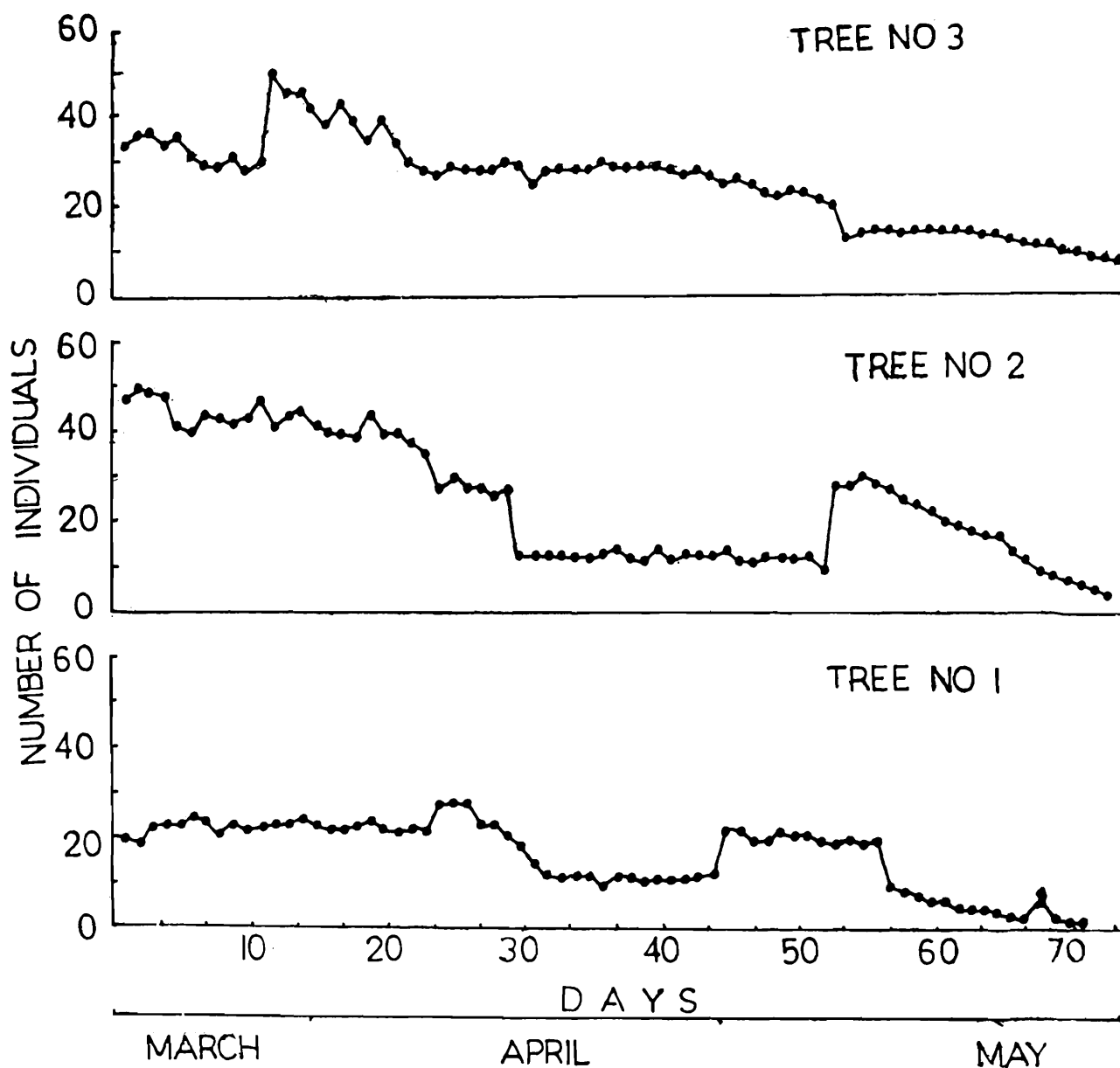


FIG-1

Fig. 1 : Showing the average numbers of *Darthula hardwickii* Gray per day in the three experimental trees.

The population dynamics of the insects between the zones of each trees were also observed. Thus, in Tree No. 1, the nymphs increased gradually from 18th March till the 21st,

when a peak of 35 individuals was seen, and thereafter it declined gradually to a level of 20 individuals, till the 12th April in the zone A. However, no insects were observed at this zone after 12th April, and reappeared from the 1st May.

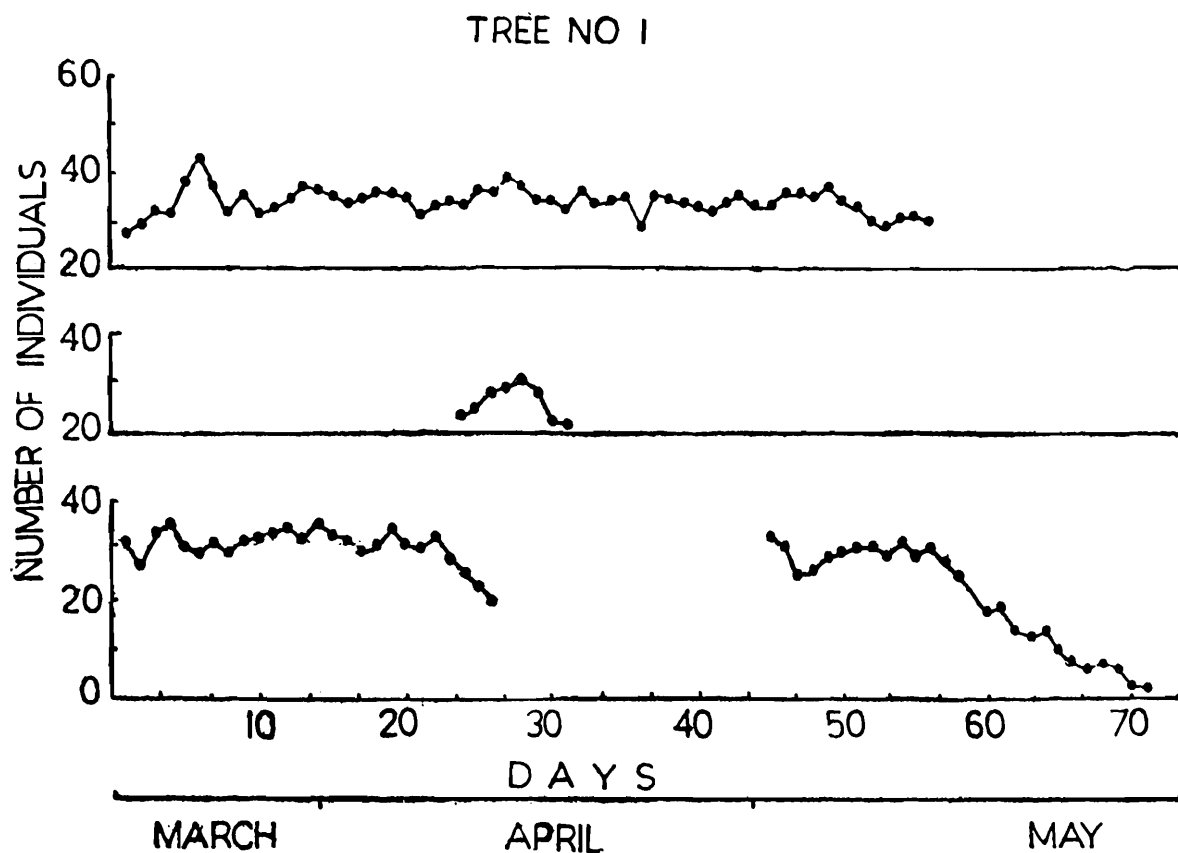


FIG - 2

Fig. 2 : Showing the average numbers of *Darthula hardwickii* Gray per day in three zones (A, B & C) of Tree No. 1.

In zone B of the same tree, nymphs were observed only from the 10th April till the 17th April. Between these days, the population fluctuated from 30 maxima to 20 ± 1 minima. In zone C, the nymphs were observed to oscillate between 44 to 26 individuals (Fig. 2).

Zone A of Tree No. 2 has a gradual increase in the nymphal populations from 18th March till the 24th when a peak of 48 individuals were counted. Thereafter, a gradual decline was seen till the 11th April when all the individuals were seen to disappear from that zone. The nymphs reappeared from the 10th May till the end of the study period, and the number during this period varied between 32 to 3 per day. Zone B of the same tree showed a peak population

of 67 individuals on 20th March, and there after showed a decline till the 16th April. The insects reappeared from the 10th May till the end of the investigation. In zone C, the nymphs fluctuated between 42 individuals on 19th March to 4 individuals on 30th May (Fig. 3).

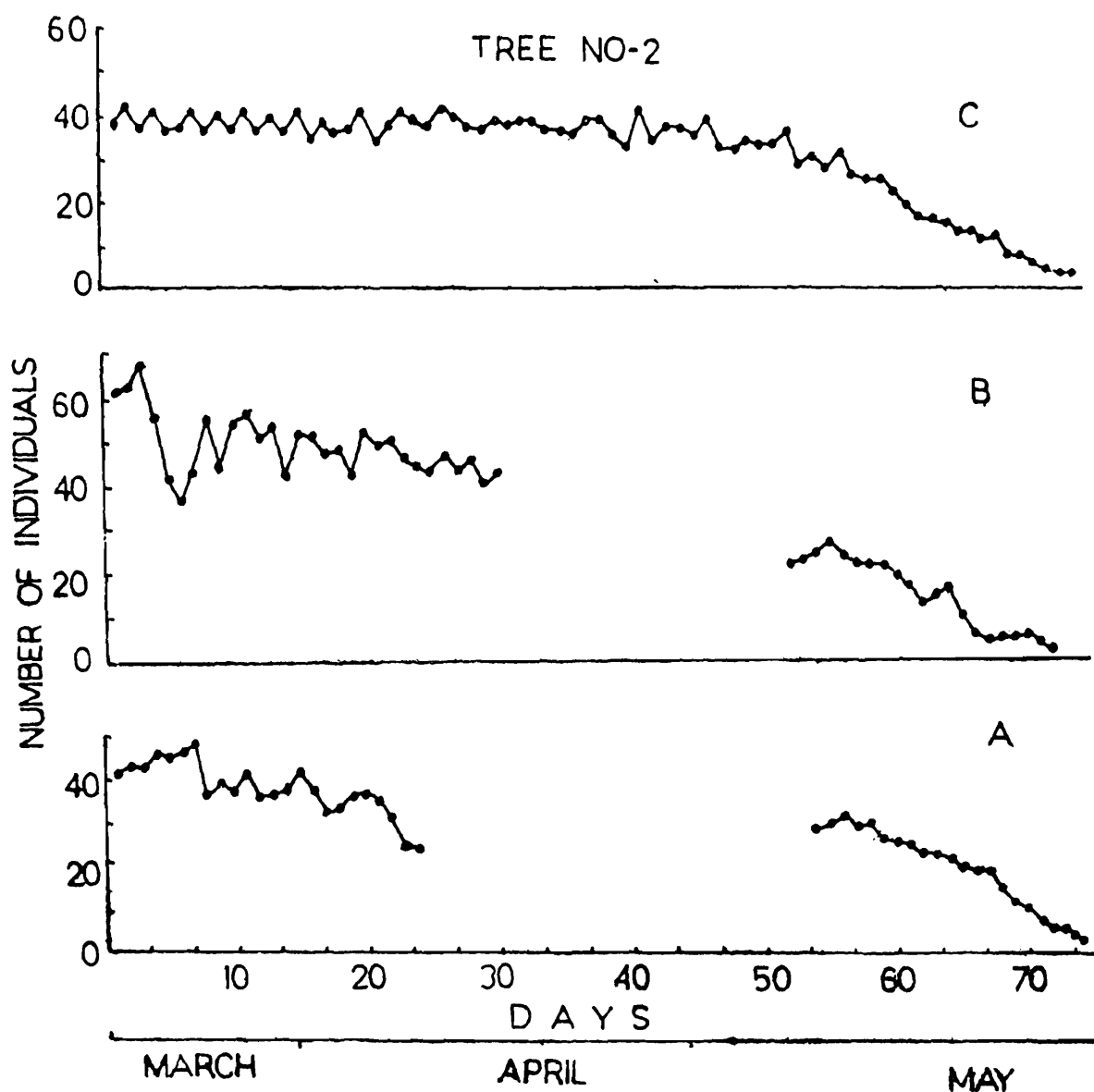


FIG - 3

Fig. 3 : Showing the average numbers of *Darthula hardwickii* Gray per day in three zones (A, B & C) of Tree No. 2.

In Tree No. 3, zone A recorded nymphal population fluctuations from 60 individuals on 29th March to 23 individuals on 7th April. Thereafter, no insects were recorded at this zone. The zone B recorded a maximum population 64 individuals on the 20th March and a minimum of 23 individuals

on the 9th May. Zone C showed a gradual decline from 53 individuals on the 18th March to 22 individuals on the 30th May (Fig. 4).

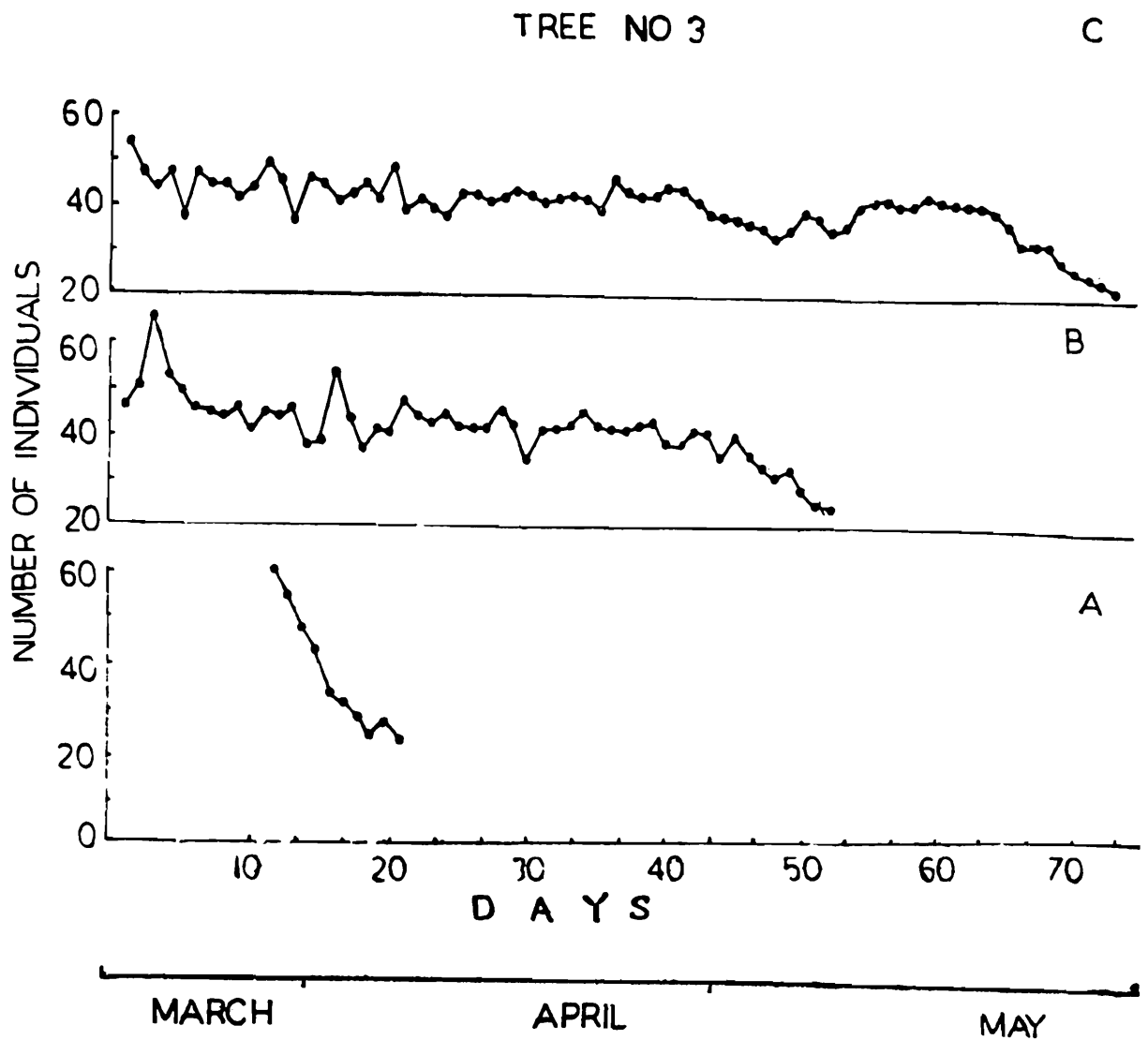


FIG - 4

Fig. 4: Showing the average numbers of *Darthula hardwickii* Gray per day in three zones (A, B & C) of Tree No. 3.

As mentioned earlier in the results, the population appears to be univoltine, and that all the nymphs possibly hatched out from the same set of eggs laid at one time, is clear from the moulting of these nymphal stages and also from the emergence of adults. Irrespective of the zones or the trees, the first moulting occurred on the 30th March and the second moulting on 13th May. The former showed significant increase in the size of nymphs while the latter revealed the adult emergence.

Even though three trees were taken into consideration, the adults emerged were primarily from Tree Nos. 1 & 2 (Fig. 5). After the 13th of May in Tree No. 1, the adults

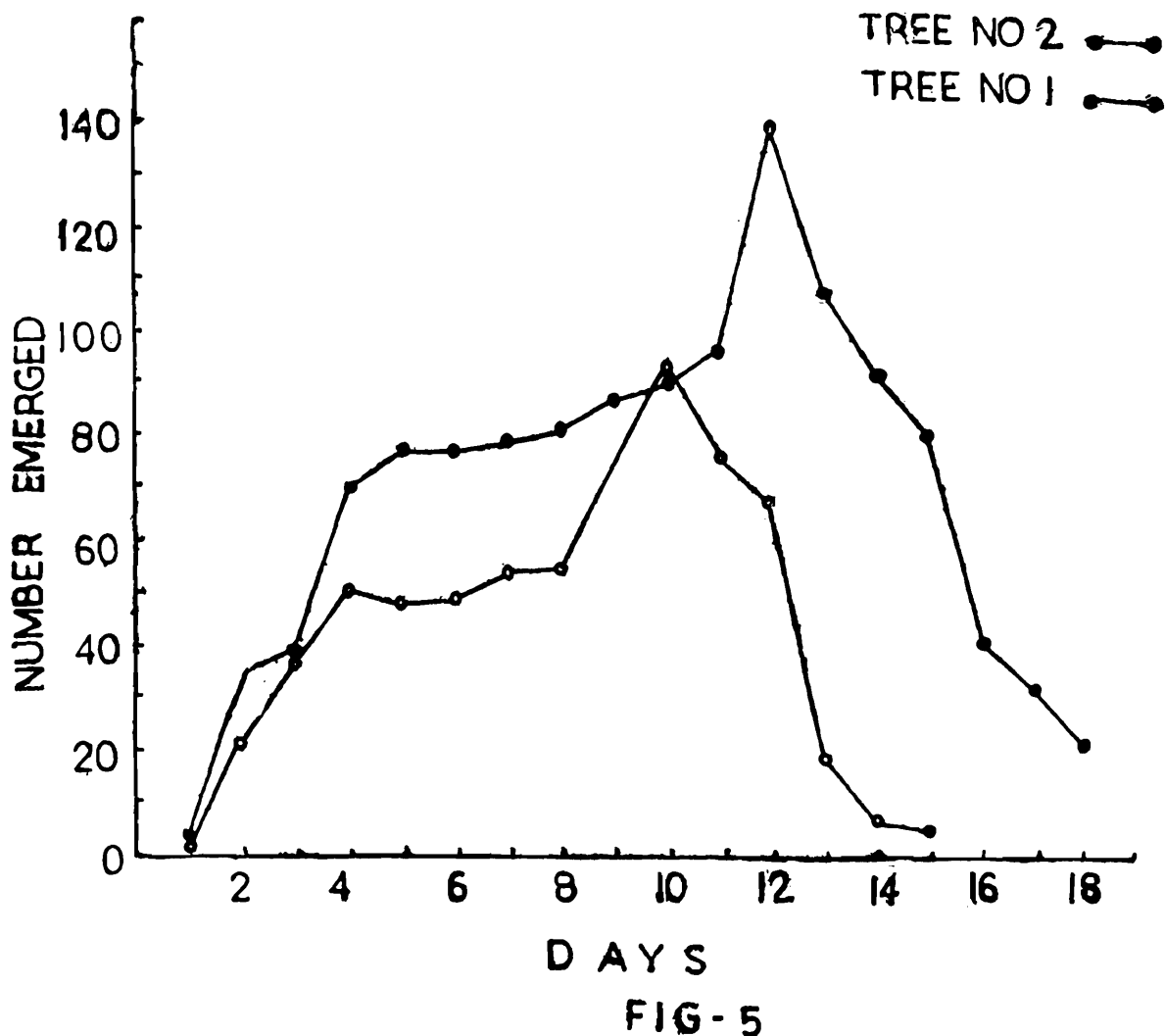
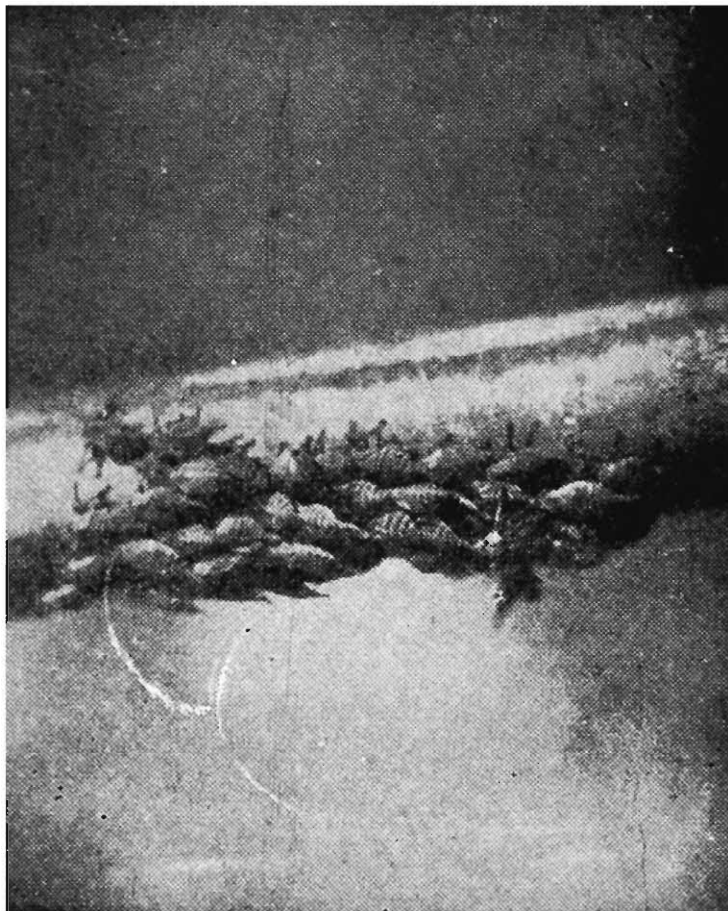


Fig. 5 : Showing the total numbers of adults emerged per day in Tree No. 1 (13th-27th May) and Tree No. 2 (13th-30th May).

slowly emerged in larger numbers and continued till the 20th May, oscillating around 50 and the next day reaching a peak of nearly 95. Subsequently it fell, though not drastically but slowly, when all emerged by the 27th May. A more or less similar phenomena was seen in Tree No. 2 in case of adult emergence except that the numbers emerged were more daily in comparison to Tree No. 1. In this Tree No. 2, the adults started emerging again steadily in larger numbers till a peak was reached on 24th May which subsequently declined till the study period when all the nymphs had totally emerged.



Showing a colony of *Darthula hardwickii* Gray (nymphs)
on *Acacia* branch.

The temperature fluctuations during the study period is shown in Fig. 6. The temperature appeared to fluctuate from 11.8°C in the beginning of the study period to 20°C at the end of the investigation.

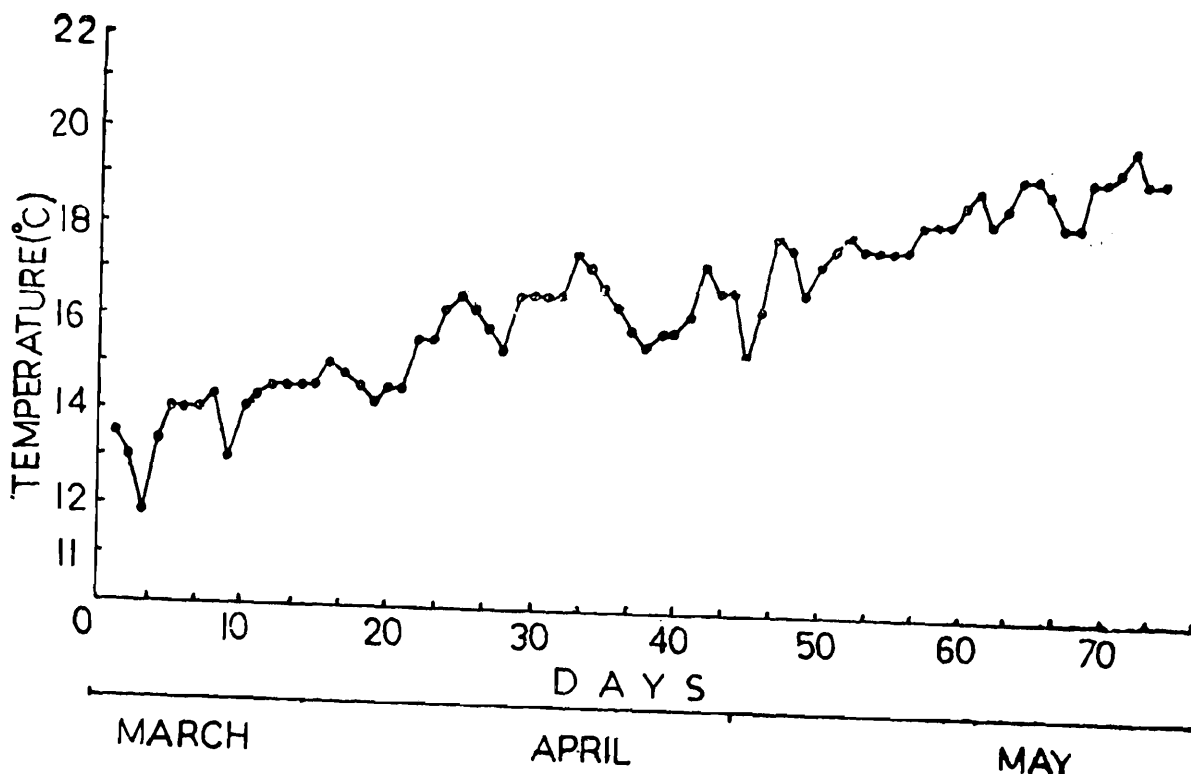


FIG-6

Fig. 6: Showing the average temperature per day of the study site.

DISCUSSION

From the results obtained, it is seen that when the total trees were taken into consideration the maximum aggregation of the population occurred in the middle of the growth stage of these insects in Tree No. 1, while it was in the beginning in the other two trees. Further, it was seen that the numbers in Tree No. 1 was nearly half of that of the other two even at its peak. This could possibly be explained by the fact that Tree No. 1 was smallest in relation to others and possibly nesting grounds and feeding places could have been subsequently reduced.

However, an interesting phenomenon is seen when the different zones of the different trees are considered. Here one observes from the results that irrespective of the trees,

zonewise maximum aggregation of populations were shown during the earlier part of the study. This further confirms the above contention that a single species population had possibly laid eggs in the different zones of the trees irrespective of the carrying capacity of that tree or zone. On emergence and when active feeding started these nymphs moved from tree to tree till they occupied the right ecological niches.

In addition, while counting, it was observed that such movements could also be enhanced by other insects and in particular by ants which try to prick the abdomens of these nymphs and feed on the exudates that come out. A near to similar phenomena of analogy is an aphid colony tended by ants, where aphid aggregation is controlled by ants (Dixon, 1977). The movements of individuals within a population or community may be influenced by the presence of the other individuals of the same species or by other species. This relationship among individuals obviously affects the patterns of movements and the areas traversed. One of our many unsolved problems concerned is the absence of information on the expected frequencies of distance between two individual fauna which share the same area (Siniff & Jesson, 1969). In a closely knit fauna, on the same host plant, it seems surprising to find no evidence of intraspecific competition, but it seems to be more usual than is generally supposed although its effects are difficult to prove conclusively. Many species are known, as seen in the present case to have a preference for young bushes or for the current year's green shoot. But on the whole, any succession that occurs in this life system is mainly in the densities of population in young and old bushes rather than their complete absence (Waloff, 1968).

These things have been suggested by Aynne-Edwards (1962) that such mechanisms have evolved by natural selections of social adaptations, with the result that the disadvantageous effects of over-exploitation of the environmental resources are avoided. Living at such stage is advantageous

to the population but not so much of the individuals composing the population (Klomp, 1966). Wynne-Edwards (1962), therefore, introduces the concept of group selection, a type of selection concerned with the viability and survival of the population as a whole.

The growth of these nymphal stages do not seem to be directly controlled by the atmospheric temperature. This is obvious since both the first and second moulting were not controlled by the temperature phenomena. However, during the later period of May, the temperature shot up and there is every indication to believe that there is a synchronisation of the temperature and emergence of adults.

The conspicuous absence of select insect groups at certain times of the year suggests that many tropical insects, like their temperate zone relatives, have developed strategies for escape during particular seasons. Restricted periods of abundance may be directed by periodic food supply as well as advantages in predator avoidance and enhancement of mating success. Migration into more suitable environment (Kainy, 1951 ; Brown & Swaine, 1966 ; Janzen & Schoener 1968) offers a viable strategy for maintaining a continuously active population, but seasonal occurrence of a species in a particular area also could be achieved by coordinating periods of dormancy and development with appropriate environmental signals.

SUMMARY

A preliminary study of the nymphal population dynamics of *Darthula hardwickii* Gray was conducted. Although temperature appeared to influence the time of emergence and moulting of the nymphal stages, their population fluctuations seemed to be regulated by the emigration-migration, triggered by certain biotic factors. The concept of aggregation and group phenomena in such univoltine single species population has also been discussed.

ACKNOWLEDGEMENT

The authors are grateful to Prof. K. Chatterjee, Head of the Department of Zoology, North-Eastern Hill University, Shillong and Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing laboratory facilities. Thanks are also due to Mr. C. Radhakrishnan, Scientist 'B' ERS, ZSI, Shillong and Dr. Y. Kumar, NEHU, Shillong for identifying the insect and plant species, respectively.

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BUTTERFLIES OF MAHARASHTRA AND
KARNATAKA, INDIA

By

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INTRODUCTION

The butterflies from the states of Maharashtra and Karnataka have already been rather well surveyed during the intermittent period from the 19th till before the mid-20th century. Earlier accounts were furnished from Maharashtra including Bombay and the adjoining areas of Western Ghats and from Karnataka including Mysore and Bangalore in the plains and northern Kanara and Coorg also in the Western Ghats by several workers, as cross-referred to by Varshney (1977). As many as 191 species were listed by Peile (1937) from both the states, that represent a little over 60% of the entire Indian peninsular fauna. With the present surveys in some of the areas covering about 60 localities, the tally of the species rises to 212, of which 60 occur exotically each at Maharashtra and Karnataka, while the rest overlap at both the states. Thus, the distribution of the bulk of species under study is confirmed on the basis of past records from these states. The fauna is principally tropical oriental in origin, of which no member is ever known as endemic in any of the states concerned. It may, however, be mentioned in a broader sense that amidst the present collections, at least six representatives, viz., *Ixias pyrene sesia* (Fabr.), *Idea malabarica malabarica* (M.), *Ypthima inica* Hew., *Ergolis ariadne indica* M., *E. merione merione* (Cr.) and *Zizeeria maha ossa* (Swin.), are restricted within the Indian peninsular belts. Several others are known to extend to the eastern Palaearctic region, as cited in places under the Systematic Account. Only one species, i. e., *Cynthia cardui* (L.), is nearly universal in distribution.

MATERIAL AND METHODS

The taxonomical study is based on the material comprising over 340 specimens explored during dry- and wet-seasons of 1971-83 by different scientists including the first two authors from Zoological Survey of India. Amongst a total of 59 species and subspecies, 5 from Maharashtra (*) of Western Peninsula, 11 from Karnataka (†) of southern Peninsula and other 5 from both these states in common (*†) constitute new locality records. Of these, *Appias lalage lalage* (Db.), *Symbrenthia hippocclus* de N., *Arletta vardhana* (M.) and *Hypolycaena erylus himavantus* Fr. remained hitherto unknown from the whole of peninsular India. Besides, certain specimens of the species (§) have been found to have reduced wing measurement as compared to the size mentioned by Talbot (1939, 1947) and Wynter-Blyth (1957); a few specimens of *Eurema brigitta rubella* (Wall.) and all of *Sarangesa purendra pandra* Ev., however, have more or less larger fore wing length. The status of majority of the species in question was earlier considered to range from locally to very common. Also, certain butterflies like *Melanitis leda ismene* (Cr.) are known to be of nocturnal over and above their diurnal habits, though presently only a couple of individuals of *Lampides boeticus* (L.) could be trapped by light. Taxonomically, the system is adopted on the familiar basis rather than on the archaic one revived by certain schools of thought including Hancock (1983) and Ackery & Vane-Wright (1984).

SYSTEMATIC ACCOUNT

Family I. PAPILIONIDAE

1. *Graphium agamemnon agamemnon* (L.)

1758. *Papilio agamemnon* Linnaeus, *Syst. Nat.*, ed 10 : 462.

1939. *Graphium agamemnon agamemnon* : Talbot, *Fauna Brit. India*, Butts., 1 : 230, fig. 64.

Material examined : KARNATAKA, Bangalore, Malle-swaram, Forest Research Laboratory campus, 1 ex. 10.i.1982, S. K. Ghosh & party leg.

Fore wing length : 44 mm.

Distribution : India (Uttar Pradesh, Kumaon ; western and southern Peninsula). Upto Burma.

2. *Atrophaneura hector* (L.)

1758. *Papilio hector* Linnaeus, *Syst. Nat.*, ed. 10 : 459.

1983. *Atrophaneura hector* : Hancock, *Smithersia*, 2 : 47.

Material examined : KARNATAKA, Karwar, Kodibag, 2exs. 2.i.1972, K. S. Pradhan & party leg. ; Dharwar, Etingood village, c 500m, 1ex., 16.i.1982, S.K. Ghosh & party leg.

Fore wing length : 50 mm.

Distribution : India (western and southern Peninsula ; Andaman Is.). Sri Lanka.

3. *Atrophaneura aristolochiae aristolochiae* (Fabr.)

1775. *Papilio aristolochiae* Fabricius, *Ent. Syst.*, p. 443.

1983. *Atrophaneura aristolochiae aristolochiae* : Hancock, *Smithersia*, 2 : 47.

Material examined : MAHARASHTRA, Kolhapur, 2exs., Kagol, 1ex., Pantala, 1ex. 20-23.xii.1971, Satara, Kumroshri village, 1ex., 18.i.'72, K. S. Pradhan & party leg. ; Solapur canal, nr. Bus stand, 1ex., 7.iv.'83, A. R. Lahiri & party leg. KARNATAKA, Belgaum, 1ex., Maruti Hills, 1ex., 26-27.xii.'71, Karwar, Kochbag, 1ex., Municipal Public Garden, 1ex., Kadradi, 1ex., Kagor, 1ex., 2-3, 8.i. '72, K. S. Pradhan & party leg. ; Dharwar, Botanical Garden, 900 m. 3exs., southern Kiri, 1ex., 15, 18.i.'82, S. K. Ghosh & Party leg.

Fore wing length : 35-50 mm.

Distribution : India (throughout the mainland).

(§)4. *Papilio polytes romulus*, ♀ f. *romulus* (Cr.)

1775. *Papilio romulus* Cramer, *Pap. Exot.*, 1 : 67, pl. 43, fig. A.

1939. *Papilio polytes romulus*, ♀ f. *romulus* : Talbot, *Fauna Brit. India*, Butts., 1 : 178, fig. 46.

Material examined : MAHARASHTRA, Ratnagiri, 1ex., 7.vii.1981, *P. Parui & party leg.* KARNATAKA, Bangalore palace campus, 1ex., 12.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 42 mm.

Distribution : India (throughout the mainland). Burma, Sri Lanka, Vietnam and Malayan Peninsula.

(*)5. **Papilio demoleus demoleus L.**

1758. *Papilio demolens* Linnaeus, *Syst. Nat.*, ed. 10 : 464.

1939. *Papilio demoleus demoleus* : Talbot, *Fauna Brit. India*, Butts., 1 : 189, fig. 50.

Material examined : MAHARASHTRA, Raigadh, Poladpur, 1ex., 3.vii.1981, *P. Parui & party leg.* KARNATAKA, Maruti Hills, 3exs., Jamboti, 1ex. 26, 30.xii.'71, *K. S. Pradhan & party leg.* ; Bangalore, F. R. I. campus, 1ex., 10.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 38-42 mm.

Distribution : India (almost throughout the mainland). Up to North Burma. Sri Lanka and also extending to Iran and Arabia.

Family II. PIERIDAE

6. **Delias eucharis (Dr.)**

1773. *Papilio eucharis* Drury, *Ill. Exot. Ent.*, 2 : 16, pl. 10, figs. 5, 6.

1939. *Delias eucharis* : Talbot, *Fauna Brit. India*, Butts., 1 : 352, fig. 133a, b ; pl. 3.

Material examined : MAHARASHTRA, Kagol, 2exs., Jog, Shimoga, 1 ex., 8-9.i.1972, *K. S. Pradhan & party leg.* ; Pune, Empress Garden, 1 ex., 26.vi.'81, *P. Parui & party leg.* KARNATAKA, Thalathmore, Mercara, c. 1080m, 1 ex., 2. iii.'77, *P. T. Cherian & party leg.* ; Bangalore, F. R. L. campus, 1 ex., 10.i., in and around F. R. H., 1 ex., 13.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 33-40 mm.

Distribution : India (lower slopes of Himalaya ; peninsular belts). Sri Lanka.

7. *Cepora nerissa phryne* (Fabr.)

1775. *Papilio phryne* Fabricius, *Syst. Ent.*, p. 473.

1939. *Cepora nerissa phryne* : Talbot, *Fauna Brit. India*, Butts., 1 : 362, pl. 2, fig. 7.

Material examined : MAHARASHTRA, Satara, Wai, 1ex., 17.i.1981, P. Parui & party leg. KARNATAKA, Bangalore, F. R. L. campus, 3exs., St. Peter's Seminary campus, 1ex., 10-11.i.'82, S. K. Ghosh & party leg.

Fore wing length : 20-26 mm.

Distribution : India (western Himalaya ; throughout the Peninsula). Pakistan, Nepal and Sri Lanka.

(*)8. *Appias lalage* (Db.)

1842. *Pieris lalage* Doubleday, in Gray, *Zool. Misc.*, p. 76.

1939. *Appias lalage lalage* : Talbot, *Fauna Brit. India*, Butts., 1 : 387, fig. 143a.

Material examined : MAHARASHTRA, Pratapgadh, 1ex., Mahabaleswar, Wilson Pt., 4 exs., 18-19.i.1972, K. S. Pradhan & party leg.

Fore wing length : 25 mm.

Distribution : India (Uttar Pradesh ; Maharashtra). Upto Burma.

(§)9. *Ixias marianne* (Cr.)

1779. *Papilio marianne* Cramer, *Pap. Exot.*, 3 : 41, pl. 217, fig. C, D.

1939. *Ixias marianne* : Talbot, *Fauna Brit. India*, Butts., 1 : 440, fig. 155 ; pl. II, fig. 13.

Material examined : KARNATAKA, Bangalore, Malle-swaram, Arthur's pt., 1ex., 16.i.1972, K. S. Pradhan & party leg.

Fore wing length : 20 mm.

Distribution : India (Western Himalaya ; throughout the Peninsula). Sri Lanka.

10. *Ixias pyrene sesia* (Fabr.)

1777. *Papilio sesia* Fabricius, *Gen. Ins.*, p. 257.

1939. *Ixias pyrene sesia* : Talbot, *Fauna Brit. India*, Butts., 1 : 445.

Material examined : MAHARASHTRA, Ambanali, 1 ex., 17.iv.1983, A. R. Lahiri & party leg. KARNATAKA, Bangalore, St. Peters Seminary campus, 1 ex., 11.i.'82, S. K. Ghosh & party leg.

Fore wing length : 26 mm.

Distribution : India (western, eastern and southern Peninsula).

11. *Catopsilia crocale crocale* (Cr.)

1775. *Papilio crocale* Cramer, *Pap. Exot.*, 1 : 87, pl. IV. figs. C, D.

1980. *Catopsilia crocale crocale* : Varshney, *J. Bombay nat. Hist. Soc.*, 76 (1) : 39.

Material examined : MAHARASHTRA, Pune, Aund, 2 exs., 28.vi.1981, P. Parui & party leg. KARNATAKA, Bangalore, St. Peter's Seminary campus, 1 ex., 11.i.'82, S. K. Ghosh & party leg.

Fore wing length : 35 mm.

Distribution : India (throughout the mainland ; Andaman Is.). Burma, Sri Lanka, South China, Sundaland and Philippines.

12. *Catopsilia pyranthe pyranthe* (L.)

1758. *Papilio pyranthe* Linnaeus, *Syst. Nat.*, ed. 10 : 469.

1939. *Catopsilia pyranthe pyranthe* : Talbot, *Fauna Brit. India*, Butts., 1 : 497, fig. 168 b ; pl. II, fig. 15.

Material examined : MAHARASHTRA, Kolhapur, Shivaji Univ. campus, 2 exs., 21.xii.1971, Jog Falls, 1 ex., Kagol, 1 ex., 7-8.i.'72, K. S. Pradhan & party leg. Jog Falls, Shimoga, c. 50m, 1 ex., 2.vi.'81, B. C. Saha & party leg. ; Pune, Aund, 1 ex., 28.vi., Ratnagiri, 2 exs., 7.vii.'81, P. Parui & party leg. KARNATAKA, Belgaum, Maruti Hills,

2 exs., 27.xii.'71, Karwar, 2 exs., Kodibagh, 1 ex., 1-2.i.'72, K. S. Pradhan & party leg. ; Bangalore, F. R. L. campus, 2 exs., 18.i., Belgaum, outskirts of the city, 5 kms. south of F. R. H., 1 ex., 23.i.'82, S. K. Ghosh & party leg.

Fore wing length : 25-30 mm.

Distribution : India (throughout the mainland ; Andaman Is.). Burma, Sri Lanka, extending to Hainan, Taiwan, South China and also Sundaland, Sulawesi and Philippines.

(†)13. **Catopsilia florella gnoma** (Fabr.)

1776. *Papilio gnoma* Fabricius, *Ent. Syst.*, Append., p. 828

1939. *Catopsilia florella gnoma* : Talbot, *Fauna Brit. India*, Butts., 1 : 500, fig. 168a.

Material examined : MAHARASHTRA, Kolhapur, Kagol. 1 ex., 23.xii. ; KARNATAKA, Belgaum, Maruti Hills, 4 exs., 27-28.xii. 1971, Karwar, Kodibagh, 3exs., 2.i.'72, K. S. Pradhan & party leg. ; Univ. campus, 1ex., Dharwar, Botanical Gardens. 1ex., Etingood village, 1ex., 15-16.i. '82, S. K. Ghosh & party leg.

Fore wing length : 25-32 mm.

Distribution : India (almost throughout the mainland ; Andaman Is.). Burma and Sri Lanka.

(*†)14. **Eurema brigitta rubella** (Wall.)

1867. *Terias rubella* Wallace, *Trans. ent. Soc. Lond.*, (3) 4 (3) : 323.

1939. *Eurema brigitta rubella* : Talbot, *Fauna Brit. India*, Butts., 1 : 515, fig. 171.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 1ex., Shivaji Univ. campus, 1ex., 20-21.xii. 1971, Jog, 2exs., 8.i., Satara, Purli, 2exs., Kshetra, Mahuli, 1ex., 12-13.i., Lingmala, 2exs., 17.i., Mahabaleswar, Wilson Pt., 2exs., 17,19.i. '72 ; KARNATAKA, Belgaum Maruri Hills. 8exs. 26.xii., Jamboti, 2exs., 30.xii.71, Karwar, Kadradi, 1ex., 3.i.'72. K. S. Pradhan & party leg. ; Karnataka Univ. campus, 1ex., Dharwar, Botanical Gardens, 1ex., 15.i., Belgaum, 1km. north of F. R. H., 1ex., 24.i.'82. S. K. Ghosh & party leg.

Fore wing length : 14-22 mm.

Distribution : India (almost throughout the mainland ; Nicobar Is.). Burma and Sri Lanka, extending to South China.

15. *Eurema leata laeta* (Bd.)

1836. *Terias laeta* Boisduval, *Spec. Gen. Lep.*, 1 : 674.

1939. *Eurema laeta laeta* : Talbot, *Fauna Brit. India*, Butts., 1 : 517, fig. 172 a-b.

Material examined : MAHARASHTRA, Kolhapur, Shivaji Univ. campus, 3exs., Pantala, 1ex., Sangam, 2exs., 21-22, 24.xii.1971, Purli, 2exs., Chinchani, 2exs., 12,14.i.'72, K. S. Pradhan & party leg. ; Satara, 2exs., 30.vi.'81, P. Parui & party leg. KARNATAKA, Belgaum, Maruti Hills, 1 ex., Jamboti, 1ex., 26,30.xii.'71, K. S. Pradhan & party leg. ; Kangari village, 5exs., 21.i.'82, S. K. Ghosh & party leg.

Fore wing length : 18 mm.

Distribution : India (Western Himalaya ; throughout the Peninsula). Sri Lanka.

16. *Eurema hecabe contubernalis* (M.)

1886. *Terias contubernalis* Moore, *J. Linn. Soc. Lond. Zool.*, 21 : 46.

1939. *Eurema hecabe contubernalis* : Talbot, *Fauna Brit. India*, Butts., 1 : 527, fig. 177 a-e.

Material examined : MAHARASHTRA, Satara, Circuit House, 2exs., Purli, 1ex., Medha, 3exs., Mahabaleswar, Elphinston's pt., Pratapgardh Garden, 1ex., 11-12, 14, 16, 18.i.1972, K. S. Pradhan & party leg. Raigadh, Poladpur, 2exs., 3.vii.'81, P. parui & party leg. KARNATAKA, Belgaum, Maruti Hills, 2exs., 27.xii.'71, Karwar, 5 exs., Kodibagh, 5exs., 1-2.i.'72, K. S. Pradhan & party leg. ; Bangalore, St. Peter's Seminary campus, 3exs., 11.i., in and around F. R. H., 1ex., 13.i., outskirts of Belgaum city, 2exs., 23.i.'82, S. K. Ghosh & party leg.

Fore wing length : 17-24 mm.

Distribution : India (Western Garhwal ; Sikkim ; West Bengal ; Maharashtra ; Karnataka). Burma and Malay Peninsula.

Family III. DANAIDAE

(*)17. **Idea malabarica malabarica** (M.)

1877. *Hestia malabarica* Moore, *Ann. Mag. Nat. Hist.*, (4) 20 : 46.

1947. *Idea malabarica malabarica* : *Fauna Brit. India*, Butts., 2 : 10, figs. 3-5.

Material examined : MAHARASHTRA, Raigadh, Poladpur, 1ex., 3. vii. 1981, P. Parui & party leg.

Fore wing length : 62 mm.

Distribution : India (western and southern Peninsula).

(§)18. **Danaus chrysippus chrysippus** (L.)

1758. *Papilio chrysippus* Linnaeus, *Syst. Nat.*, ed. 10 : 471.

1947. *Danaus chrysippus chrysippus* : Talbot, *Fauna Brit. India*, Butts., 2 : 20.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 4exs., 23.xii.1971, Jog, 1ex., Shimoga, 1ex., 1ex., 8-9.i., Mahabaleswar, Wilson Pt., 2exs., 19.i.'72, K. S. Pradhan & party leg. ; Pune, dry river-bed, 2exs., 23.vi., Ratnagiri, Babnati village, 2exs., 8.vii.81, P. Parui & party leg. KARNATAKA Belgaum, Maruti Hills, 1ex., 27.xii., Jamboti, 4exs., 30.xii.'71, Karwar, Kodibag, 2exs., 2.i.'72, K. S. Pradhan & party leg.

Fore wing length : 28-36 mm.

Distribution : India (throughout the mainland). Extending to the Malayan subregion, China and Japan in the east and Asia Minor in the west.

19. **Danaus genutia genutia** (Cr.)

1779. *Papilio genutia* Cramer, *Pap. Exot.*, 3 : 23, pl. 206, figs. C, D.

1886. *Danans genutia genutia* : Doherty, *J. Asiat. Soc. Beng.*, 55 (2) : 114.

Material examined : MAHARASHTRA, Satara, Kayana River bank, Kumroshri village, 3exs., 18.i. ; KARNATAKA, Karwar, Maltapur, 1ex., 4.i.1972, *K. S. Pradhan & party leg.* ; Bangalore, St. Peter's Seminary campus, 1ex., 11.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 36-43 mm.

Distribution : INDIA (throughout the mainland ; Ardaman & Nicobar Is.). Also Afghanistan, Pakistan, Burma, Sri Lanka, Thailand, China, Vietnam and Riu-Kiu Is.

(§) 20. ***Danaus limniace leopardus* (Butl.)**

1866. *Danaus limniace* var. *leopardus* Butler, *Proc. zool. Soc. Lond.*, p. 52.

1947. *Danaus limniace leopardus* : Talbot, *Fauna Brit. India*, Butts., 2 : 31, fig. 10.

Material examined : MAHARASHTRA, Kagol, 1 ex., 23.xii.1971, Jog Falls, 1 ex., Shimoga, 1 ex., 7.9.i. ; KARNATAKA, Karwar, Maltapur, 1 ex., 4.i.'72, *K. S. Pradhan & party leg.*

Fore wing length : 32-44 mm.

Distribution : India (western and eastern Himalaya ; western, eastern and southern Peninsula ; Nicobar Is.). Pakistan, Burma, Sri Lanka, also Chinese and Malayan subregions.

21. ***Euploea core core* (Cr.)**

1780. *Papilio core* Cramer, *Pap. Exot.*, 3 : 133, pl. 267, figs. E, F.

1947. *Euploea core core* : Talbot, *Fauna Brit. India*, Butts., 2 : 67, fig. 25.

Material examined : MAHARASHTRA, Jog, Falls, 1 ex., Shimoga, 3 exs., 7.9.i.1972, *K. S. Pradhan & party leg.* Raigadh, Poladpur, 2exs., 3.vii.81, *P. Parui & party leg.* KARNATAKA, Mangala Devi Nagar, Mascar, c 1300 m, 1 ex., 3.iii.'77, *P. T. Cherian & party leg.* ; Dharwar, Gandhinagar Farm, 1 ex., 22.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 40-45 mm.

Distribution : India (throughout the mainland).

Family IV. SATYRIDAE

(†) 22. *Mycalesis perseus blasius* (Fabr.)

1798. *Papilio blasius* Fabricius, *Ent. Syst. Suppl.*, p. 426.

1947. *Mycalesis perseus blasius* : Talbot, *Fauna Brit. India*, Butts., 2 : 132.

Material examined : MAHARASHTRA, Shimoga, 1 ex., 9.i.1972 ; KARNATAKA, Belgaum, Maruti Hills, 1 ex., 26.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 20 mm.

Distribution : India (Himachal Pradesh ; Maharashtra ; Karnataka). Upto Burma.

(*†) 23. *Lethe rohira neelgheriensis* (Guer.)

1843. *Satyrus neelgheriensis* Guerin, in Delessert, *Souv. Voy. Ind.*, 2 : 74, pl. 21, figs. 1, 1a.

1947. *Lethe rohira neelgheriensis* : Talbot, *Fauna Brit. India*, Butts., 2 : 201.

Material examined : MAHARASHTRA, Mahabaleswar, Elphinston Pt., 1 ex., 16.i.1972 ; KARNATAKA, Belgaum, Maruti Hills, 1 ex., 27.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 28 mm.

Distribution : India (Madhya Pradesh ; Up to Nilgiris of southern Peninsula). Sri Lanka.

(*†§)24. *Ypthima inica* Hew.

1865. *Ypthima inica* Hewitson, *Trans. ent. Soc. Lond.*, (3) 2 : 284, pl. 17, fig. 5.

Material examined : MAHARASHTRA, Jog Falls, 1 ex., Shimoga, 2 exs., 7,9.i.1972 ; KARNATAKA, Belgaum, Jambotti, 1 ex., Khasbag, 1 ex., 29-30.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 10-14 mm.

Distribution : India (almost throughout the Peninsula).

(§) 25. *Ypthima ceylonica hübneri* Kir.

1871. *Ypthima hübneri* Kirby, *Syn. Cat. Diurn. Lep.*, p. 95.

1947. *Ypihima ceylonica hübneri* : Talbot, *Fauna Brit. India*, Butts., 2 : 329.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 4 exs., 20,23.xii.1971, Satara, Chinchani, 1 ex., 14.i., Mahabaleswar, Lingmala, 1 ex., 18.i.'72 ; KARNATAKA, Belgaum, Maruti Hills, 3 exs., 26.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 13 mm.

Distribution : India (Assam ; throughout the Peninsula). Burma and Malaya.

(*) 26. *Orsotrioena medus mandata* (M.)

1857. *Mycalesis mandata* Moore, *Cat. Lep. Ins. E.I.C.*, 1 : 234.

1947. *Orsotrioena medus mandata* : Talbot, *Fauna Brit. India*, Butts., 2 : 350.

Material examined : MAHARASHTRA, Shimoga, 1 ex., 9.i.1972, K. S. Pradhan & party leg.

Fore wing length : 21 mm.

Distribution : India (western and southern Peninsula). Sri Lanka.

27. *Melanitis leda ismene* (Cr.)

1775. *Papilio ismene* Cramer, *Pap. Exot.*, 1 : 40, pl. 26, figs. A, B.

1947. *Melanitis leda ismene* : Talbot, *Fauna Brit. India*, Butts., 2 : 366. figs. 96-97.

Material examined : KARNATAKA, Bangalore, F. R. L. campus, 2 exs., 10.i., St. Peter's Seminary campus, 2 exs., 12.i.1982, S. K. Ghosh & party leg.

Fore wing length : 32-40 mm.

Distribution : India (throughout the mainland ; Andaman and Nicobar Is.). Burma and Sri Lanka, extending to the Malayan subregion, Taiwan and Japan.

Family V ACRAEIDAE

28. *Acraea violae* (Fabr.)

1775. *Papilio violae* Fabricius, *Ent. Syst.*, p. 460.

1973. *Acraea violae* : Varshney, *Curr. Sci.*, 42 (3) : 107.

Material examined : MAHARASHTRA, Ratnagiri, 1 ex., 8.vii.1981, P. Parui & party leg.

Fore wing length : 27 mm.

Distribution : India (gangetic plains and the Peninsula).
Sri Lanka.

Family VI. NYMPHALIDAE

(§) 29. *Ergolis ariadne indica* M.

1884. *Ergolis indica* Moore, *J. Asiat. Soc. Beng.*, p. 20.

1932. *Ergolis ariadne indica* : Evans, *Ident. Ind. Butts.*, ed. 2 : 191.

Material examined : KARNATAKA, Bangalore, St. Peter's Seminary campus, 1ex., 11.i.1982, S. K. Ghosh & party leg.

Fore wing length : 22 mm.

Distribution : India (western, eastern and southern Peninsula).

(†§)30. *Ergolis merione merione* (Cr.)

1777. *Papilio merione* Cramer, *Pap. Exot.*, 2 : 76, pl. 144, figs. G, H.

1932. *Ergolis merione merione* : Evans, *Ident. Ind. Butts.*, ed. 2 : 191.

Material examined : MAHARASHTRA, purli, nr. Satara, 1ex., 12.i.1972, K. S. Pradhan & party leg. ; Barivali National Park, 1 ex., 21.vi.1981, P. Parui & party leg. KARNATAKA, Belgaum, Maruti Hills, 4 exs., Khasbag, 1 ex., Tilakwadi Park, 1 ex., 27-29.xii.'71, K. S. Pradhan & party leg.; Devara Forest, 1 ex., 5.iii.'77, P. T. Cherian & party leg.

Fore wing length : 20-25 mm.

Distribution : India (western and southern Peninsula).

31. **Byblia ilithyia** (Dr.)

1773. *Papilio ilithyia* Drury, *Ill. Exot. Ent.*, 2 : 29, pl. 17, figs. 1, 2.

1932. *Byblia ilithyia* : Evans, *Ident. Ind. Butts.*, ed. 2 : 190.

Material examined : KARNATAKA, Dharwar, Mrityunjoynagar & vicinity, 1 ex., 17.i.1982, S. K. Ghosh & party leg.

Fore wing length : 25 mm.

Distribution : India (northern and southern Peninsula). Sri Lanka.

32. **Phalanta phalantha phalantha** (Dr.)

1770. *Papilio phalantha* Drury, *Ill. Exot. Ent.*, 1 : 41, pl 21, figs. 1, 2.

1967. *Phalanta phalantha phalantha* : Donahue, *J. Bombay nat. Hist. Soc.*, 64 : 38.

Material examined : MAHARASHTRA, Purli, nr. Satara, 1ex., 12.i., Lingmala, 1ex., 17.i.1972, K. S. Pradhan & party leg. KARNATAKA, Bangalore Palace campus, 1ex., 12.i., outskirts of the Belgaum city, 5 Kms. south of F. R. H., 3exs., 23.i.'82, S. K. Ghosh & party leg,

Fore wing length : 26 mm.

Distribution : India (throughout the mainland). Pakistan, Burma and Sri Lanka.

33. **Precis iphita pluviatilis** Fr.

1900. *Precis pluviatilis* Fruhstorfer, *Berl. Ent. Zschr.*, 45 : 22.

1932. *Precis iphita pluviatilis* : Evans, *Ident. Ind. Butts.*, ed. 2 : 177.

Material examined : MAHARASHTRA, Lingmala, 1ex., 17.i.1972, K. S. Pradhan & party leg.

Fore wing length : 27 mm.

Distribution : India (western, northern and southern Peninsula). Sri Lanka and Maldives.

 (§)34. **Precis almana almana** (L.)

1758. *Papilio almana* Linnaeus, *Syst. Nat* , ed. 10 : 472.

1932. *Precis almana almana* : Evans, *Ident. Ind. Butts.*, ed. 2 : 176.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 2exs., 23.xii.1971, Lingmala, 1ex., 17.i.'72, K. S. Pradhan & party leg. ; Raigadh, Poladpur, 1ex., 3.vii.'81, P. Parui & party leg. KARNATAKA, Belgaum, Maruti Hills, 1ex., 26.xii., Jamboti, 1ex., 30.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 27 mm.

Distribution : India (throughout the mainland ; Andaman Is.). Burma and Sri Lanka.

(†)35. *Precis lemonias persicaria* Fr.

1927. *Precis lemonias* f. *persicaria* Fruhstorfer, in Seitz, *Macrolep. World*, 9 : 520.

1932. *Precis lemonius persicaria* : Evans, *Ident. Ind. Butts.*, ed. 2 : 176.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 1ex., 23.xii.1971, Lingmala, Pratap Singh Park, 3exs., 17.i., Satara, Kumroshri village, 2exs., 18.i.'72, K. S. Pradhan & party leg. ; Raigadh, Poladpur, 2exs., 3.vii., Ratnagiri, Babnati village, 2exs., 8.vii.'81, P. Parui & party leg. ; around Kagol border, 1ex., 4.iv.'83, A.R. Lahiri & party leg. KARNATAKA, Belgaum, 1ex., Khasbag, 1ex., Jamboti, 1ex., 28-30.xii.'71, Kaiga, nr. Malhapur Down stream, 1ex., 4.i., Maleswaram, Elphinston's Pt., 1ex., 16.i.'72, K. S. Pradhan & party leg. ; Bangalore, St. Peters seminary campus, 2exs., 11.i., cropfield nr. Shivaji Park, 1ex., 20.i., outskirts of Belgaum city, 5 Kms. south of F. R. H., 1ex., 23.i.'82, S. K. Ghosh & party leg.

Fore wing length : 20-25 mm.

Distribution : India (Kashmir ; Maharashtra ; Karnataka). Sri Lanka, Thailand and South Annam.

36. *Precis hierta hierta* (Fabr.)

1798. *Papilio hierta* Fabricius, *Ent. Syst. Suppl.*, p. 424.

1932. *Precis hierta hierta* : Evans, *Ident. Ind. Butts.*, ed. 2 : 176.

Material examined : MAHARASHTRA, Kagol, 1ex., 8.i.1972, K. S. Pradhan & party leg. KARNATAKA, Bangalore, F. R. L. campus, 2exs., 10.i., Palace campus, 2exs., 12.i., Dharwar, Mrityunjy nagar & vicinity, 2exs.,

17.i., Belgaum crop field nr. Shivaji Fort, 2exs., 20.i., Malleswaram, 8 Kms. north-east of Bangalore F. R. H., 2exs., 27.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 26 mm.

Distribution : India (throughout the mainland). Pakistan and Sri Lanka.

37. *Precis orithyia swinhoei* Butl.

1885. *Precis swinhoei* Butler, *Ann. Mag. nat. Hist.*, p. 309.

1932. *Precis orithyia swinhoei* : Evans, *Ident. Ind. Butts.*, ed. 2 : 176.

Material examined : MAHARASHTRA, Kolhapur, Kagol, 1ex., Shivaji Univ. campus, 1ex., 20-21.xii.1971, Satara, Chinchani, 3exs., 14.i.'72, KARNATAKA, Belgaum, Maruti Hills, 5exs., 26.xii.'71, *K. S. Pradhan & party leg.* ; Dhawar, Botanical Gardens, 1ex., 15.i., Belgaum, Kangari village, 1ex., 21.i., Gandhinagar Farm, 1ex., 22.i., Malleswaram, 8 Kms. north of Bangalore F. R. H., 1ex., 27.i.'82, *S. K. Ghosh & party leg.*

Fore wing length : 20-25 mm.

Distribution : India (western Himalaya ; western and southern Peninsula). Ranging northwards to Pakistan.

(§) 38. *Precis atlites* (L.)

1763. *Papilio atlites* Linnaeus, *Centur. Ins.*, p. 24.

1932. *Precis atlites* : Evans, *Ident. Ind. Butts.*, ed. 2 : 176.

Material examined : MAHARASHTRA, Kagol, 1 ex., 8. i.1972, *K. S. Pradhan & party leg.* ; Raigadh, Poladpur, 1ex., 3.vii.'81, *P. Parui & party leg.*, KARNATAKA, Belgaum, 1 ex., 28.xii.'71, Karwar, 2 exs., 1.i.'72, *K. S. Pradhan & party leg.*, 1 km. north of F. R. H., 1 ex., 24.i.'82, *S. K. Ghosh & party leg.*

Fore wing length ; 22-30 mm.

Distribution : India (throughout the mainland ; Andaman and Car Nicobar Is.). Burma and Sri Lanka.

39. *Neptis hylas varmona* M.

1872. *Neptis varmona* Moore, *Proc. zool. Soc. Lond.*, p. 561.

1932. *Neptis hylas varmona* : Evans, *Ident. Ind. Butts.*, ed. 2 : 166.

Material examined : MAHARASHTRA, Purli, 2 exs., 12.i.1972 ; KARNATAKA, Belgaum, Maruti Hills, 3 exs., 27.xii., Jamboti, 3 exs., 30.xii.'71, K. S. Paadhan & party leg. ; Gandhinagar Farm, 1 ex., 22.i.'82, S. K. Ghosh & party leg.

Fore wing length : 23 mm.

Distribution : India (western and eastern Himalaya ; western and southern Peninsula). Sri Lanka.

(*) 40. *Pantoporia perius* (L.)

1758. *Papilio perius* Linnaeus, *Syst Nat.*, ed. 10 : 471.

1932. *Pantoporia perius* : Evans, *Ident. Ind. Butts.*, ed. 2 : 164.

Material examined : MAHARASHTRA, Pratapgadh Park, 3 exs., 18.i.1972, K. S. Pradhan & party leg.

Fore wing length : 29 mm.

Distribution : India (Himachal Pradesh to the peninsular belts). Burma.

41. *Hypolimnias bolina* (L.)

1758. *Papilio bolina* Linnaeus, *Syst. Nat.*, ed. 10 : 479.

1932. *Hypolimnias bolina* : Evans, *Ident. Ind. Butts.*, ed. 2 : 174.

Material examined : MAHARASHTRA, Ratnagiri coast, 2 exs., 7.vii.1981, P. Parui & party leg.

Fore wing length : 35-40 mm.

Distribution : India (throughout the mainland ; Andaman and Car Nicobar Is.). Pakistan, Burma and Sri Lanka.

(§) 42. *Hypolimnias misippus* (L.)

1764. *Papilio misippus* Linnaeus, *Mus. Ulr.*, p. 264.

1932. *Hypolimnasmisippus* : Evans, *Ident. Ind. Butts.* ed. 2 : 173.

Material examined : KARNATAKA, Belgaum, Tilakwadi Park, 1 ex., 29.xii.1971, Karwar Municipal Garden, 2 exs., 3.i.'72, K. S. Pradhan & party leg.

Fore wing length : 30-42 mm.

Distribution : India (throughout the mainland ; Andaman and Car Nicobar Is.). Pakistan, Burma and Sri Lanka.

43. *Euthalia nais* (Forst.)

1771. *Papilio nais* Forster, *Nov. Spec. Ins. Cent.*, 1 : 73.

1932. *Euthalia nais* : Evans, *Ident. Ind. Butts.*, ed. 2 : 157.

Material examined : KARNATAKA, Belgaum, Khasbag, 2 exs., 29.xii.1971, K. S. Pradhan & party leg. ; Bangalore, St. Peter's seminary campus, 1ex., 11.i.'82, S. K. Ghosh & party leg.

Fore wing length : 29—32 mm.

Distribution : India (western and eastern Himalaya ; throughout the Peninsula). Sri Lanka.

44. *Cynthia cardui* (L.)

1758. *Papilio cardui* Linnaeus, *Syst. Nat.*, ed. 10 : 475.

1977. *Cynthia cardui* : Varshney, *Newsl. Zool. Surv. India*, 3 (1) : 13.

Material examined : MAHARASHTRA, Mahabaleswar, Elphinston Pt., 1ex., Lingmala, 2exs., 16-17.i.1972, K. S. Pradhan & Party leg. KARNATAKA, Belgaum, Gandhinagar Farm, 1ex., 22.i.'82, S. K. Ghosh & party leg.

Fore wing length : 27—30 mm.

Distribution : Universal except South America.

(†) 45. *Symbrenthia hippoclus* de N.

1886. *Symbrenthia hippoclus* de Nicéville, *Butt. India*, 2 : 240.

Material axamined : KARNATAKA, Bangalore, Malle-swaram, 1ex. 27.i.1982, S. K. Ghosh & party leg.

Fore wing length ; 24 mm.

Distribution : India (Himachal Pradesh to Sikkim and Assam ; Karnataka). Burma, extending to Malayan subregion.

Family VII. LYCAENIDAE

46. *Tarucus nara* (Koll.)

1848. *Lycaena nara* Kollar, in Hügel, *Kasch. Reich. Seik. Ins.*, 4 : 241.

1962. *Tarucus nara* : Cantlie, *Lycaen. Port. Evans' "Ident. Ind. Butts. 1932"*, p. 33.

Material examined : MAHARASHTRA, Satara, Wai, 1ex., 1.vii.1981, P. Parui & party leg.

Fore wing length : 15 mm.

Distribution : India (western and eastern Himalaya ; throughout the Peninsula).

(†) 47. *Arletta vardhana* (M.)

1874. *Polyommatus vardhana* Moore, *Proc. zool. Soc. Lond.*, p. 572, pl. 66, fig. 5.

1962. *Arletta vardhana* : Cantlie, *Lycaen. Prot. Evans' "Ident. Ind. Butts. 1932"*, p. 41.

Material examined : KARNATAKA, Maruti Hills, Belgaum, 1ex., 27.xii.1971, K. S. Pradhan & party leg.

Fore wing length : 13 mm.

Distribution : India (Kashmir to Kumaon ; Karnataka). Nepal.

48. *Freyeria trochilus putli* (Koll.)

1848. *Lycaena putli* Kollar, in Hügel, *Caseh. Reich. Seik. Ins.*, 4 : 422.

1962. *Freyeria trochilus putli* : Cantlie, *Lycaen. Port. Evans' "Ident. Ind. Butts. 1932"*, p. 62.

Material examined ; KARNATAKA, Maruti Hills, Belgaum, 3 exs., 26.xii.1971, K. S. Pradhan & party leg.

Fore wing length : 5 mm.

Distribution : India (western and eastern Himalaya ; throughout the Peninsula). Burma.

(*†) 49. *Zizeeria otis indica* (Murr.)

1874. *Lycaena iudica* Murray, *Trans. ent. Soc. Lond.*, p. 525, pl. 10, figs. 2, 3.

1962. *Zizeeria otis indica* : Cantlie, *Lycaen. Port. Evans* "Ident. Ind. Butts. 1932", p. 63.

Material examined : MAHARASHTRA, Wilson Pt., 2 exs., 19.i.1972 ; KARNATAKA, Belgaum, Jamboti, 2 exs., 30.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 7 mm.

Distribution : India (western and eastern Himalaya ; almost throughout the Peninsula). Pakistan and Nepal.

(†§) 50. *Zizeeria maha ossa* (Swin.)

1885. *Zizera ossa* Swinhoe, *Proc. zool. Soc. Lond.*, p. 132, pl. 9, figs. 11, 12.

1962. *Zizeeria maha ossa* : Cantlie, *Lycaen. Port. Evans* "Ident. Ind. Butts. 1932", p. 64.

Material examined : KARNATAKA, Belgaum, Maruti Hills, 3exs., 26.xii.1971, K. S. Pradhan & party leg.

Fore wing length : 10 mm.

Distribution : India (northern to southern Peninsula).

51. *Zizula hylax* (Fabr.)

1775. *Pithecopis hylax* Fabricius, *Ent. Syst.*, p. 526.

1962. *Zizula hylax* : Cantlie, *Lycaen. Port. Evans* "Ident. Ind. Butts. 1932", p. 65.

Material examined : MAHARASHTRA, Wilson Pt., 1ex., 19.i.1972, K. S. Pradhan & party leg.

Fore wing length : 8 mm.

Distribution : India (throughout the mainland ; Andaman and Nicobar Is.). Pakistan. Burma and Sri Lanka.

52. *Euchrysops cnejus* (Fabr.)

1798. *Hesperia cnejus* Fabricius, *Ent. Syst., Suppl.*, p. 430.

1962. *Euchrysops cnejus* : Cantlie, *Lycaen. Port. Evans* "Ident. Ind. Butts. 1932", p. 65.

Material examined : MAHARASHTRA, Mahabaleswar, Kolhapur, Sangam, 1ex., 24.xii.1971, K. S. Pradhan & party leg.

Fore wing length : 11 mm.

Distribution : India (throughout the mainland ; Andaman, Car and South Nicobar Is.). Pakistan, Nepal, Burma and Sri Lanka.

(†) 53. **Lampides boeticus** (L.)

1767. *Papilio boeticus* Linnaeus, *Syst. Nat.*, ed. 12 : 789.

1962. *Lampides boeticus* : Cantlie, *Lycaen. Port. Evans* ' *Ident. Ind. Butts. 1932* ', p. 69.

Material examined : MAHARASHTRA, Jog, 2exs., 7.1.1972, "at light" ; KARNATAKA, Belgaum, Maruti Hills, 1ex., 26.xii., Karwar, Kodibag, 1ex., Municipal Gardens, 2exs., 2-3.i.'72, K. S. Pradhan & party leg.

Fore wing length : 15 mm.

Distribution : India (throughout the mainland ; Andaman and Nicobar Is.). Pakistan, Nepal and Sri Lanka.

(†) 54. **Hypolycaena erylus himavantus** Fr.

1900. *Hypolycaena himavantus* Fruhstorfer, *Berl. Ent. Zeit.*, 56 : 237.

1962. *Hypolycaena erylus himavantus* : Cantlie, *Lycaen. Port. Evans* ' *Ident. Ind. Butts. 1932* ', p. 142.

Material examined : KARNATAKA, Dharwar, Etingood village, 1ex., 16.i.1982, S. K. Ghosh & party leg.

Fore wing length : 18 mm.

Distribution : India (Sikkim ; Karnataka). Nepal. Upto Burma.

Family VIII. HESPERIIDAE

55. **Sarangesa purendra pandra** Ev.

1949. *Sarangesa purendra pandra* Evans, *Cat. Hesp. Eur. Asi. Austral. Brit. Mus. (Nat. Hist.)*, p. 119.

Material examined : MAHARASHTRA, Mahabaleswar, Wilson Pt., 3exs., 19.i.1972, K. S. Pradhan & party leg.

Fore wing length : 15 mm.

Distribution : India (western, northern and southern Peninsula). Sri Lanka.

56. *Spialia galba* (Fabr.)

1793. *Hesperia galba* Fabricius, *Ent. Syst.*, p. 352.

1949. *Spialia galba* : Evans, *Cat. Hesp. Eur. Asi. Austral. Brit. Mus. (Nat. Hist.)*, p. 175.

Material examined : MAHARASHTRA, Eduvani, 2exs., 6.i.1972, K. S. Pradhan & party leg.

Fore wing length : 10 mm.

Distribution : India (western and eastern Himalaya ; throughout the Peninsula). Pakistan, Burma and Sri Lanka.

(*) 57. *Potanthus pseudomaesa pseudomaesa* (M.)

1881. *Padraona pseudomaesa* Moore, *Lep. Ceylon*, 1 : 170.

1949. *Potanthus pseudomaesa pseudomaesa* : Evans, *Cat. Hesp. Eur. Asi. Austral. Brit. Mus. (Nat. Hist.)*, p. 377.

Material examined : MAHARASHTRA, Satara, Chinchani 1ex., 14.i.1972, K. S. Pradhan & party leg.

Fore wing length : 12 mm.

Distribution : India (western, northern and southern Peninsula). Sri Lanka.

(†) 58. *Telicota augias augias* (L.)

1767. *Papilio augias* Linnaeus, *Syst. Nat.*, 1 (2) : 794.

1949. *Telicota augias augias* : Evans, *Cat. Hesp. Eur. Asi. Austral. Brit. Mus. (Nat. Hist.)*, p. 394.

Material examined : MAHARASHTRA, Kolhapur, Kagol. 2exs., 23.xii.1971, K. S. Pradhan & party leg. KARNATAKA, outskirts of Belgaum city, 5 Kms. south of F.R.H., 2exs., 23.xii.'82, S. K. Ghosh & party leg.

Fore wing length : 15 mm.

Distribution : India (Nagaland ; Maharashtra ; Karnataka). South Burma, Malaya and South Vietnam.

(†)59. ***Pelopidas mathias mathias* (Fabr.)**

1798. *Hesperia mathias* Fabricius, *Ent. Syst. Suppl.*, p. 433.

1949. *Pelopidas mathias mathias* : Evans, *Cat. Hesp. Eur. Asi. Austral. Brit. Mus. (Nat. Hist.)*, p. 441.

Material examined : MAHARASHTRA, Kolhapur, Shivaji Univ., 1ex., 21.xii.1971, KARNATAKA, Belgaum, Maruti Hills, 2exs., 27-28.xii.'71, K. S. Pradhan & party leg.

Fore wing length : 14 mm.

Distribution : India (almost throughout the mainland ; Nicobar Is.). Pakistan, Burma, Sri Lanka, Sundaland, Lesser Sunda Is. extending. Upto Tenimber.

SUMMARY

An account along with distribution of 59 species and subspecies in 39 genera under 8 families of butterflies (Lepidoptera : Rhopalocera) from the Indian peninsular states of Maharashtra and Karnataka is presented. 21 species, of which 4 were hitherto unknown from the whole of the Indian Peninsula, constitute new locality records for one state or the other or both concerned.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Zoological survey of India, for kindly providing the laboratory facilities in their work. They are also thankful to Drs. S. K. Bhattacharya, Scientist 'D', B. Dutta, Scientist 'C' and Shri I. J. Gupta, Asstt. Zoologist of the same institute, for numerous courtesies.

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ON FOUR SPECIES OF ECHIURA FROM THE
VENEZUELA BASIN

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INTRODUCTION

The material which forms the basis of this report was received for the purpose of identification from Dr. Kevin B. Briggs, Head : Biology, Department of the Navy, Naval Ocean Research and Development Activity, NSTL, Mississippi, U.S.A. These animals were collected in trawls from the Venezuela Basin by the biology team of the department. Most of the specimens are very much damaged, nevertheless, identities of four species could be determined and reported here. The identified echiurans have been deposited to the Museum of the Zoological Survey of India.

List of the species

Thalassematidae

Arhynchite Sato : *A. inamoenus* Fisher, 1946.

Bonellidae

Bonellia Rolando : *B. suhmii* Selenka, 1885

Kurchatovus DattaGupta : *K. epeedentatus* DattaGupta, 1986

Amalosoma Fisher : *A. eddystonense* Stephen, 1956

***Arhynchite inamoenus* Fisher, 1946**

(Fig. 1)

Arhynchite inamoenus Fisher, 1946 : 247-249.

Arhynchite inamoenus : Stephen & Edmonds, 1972 : 418.

Material : 2 females and 1 male, NORDA 334-station 32 ; collected 27 × 81 : locality coordinates 15°04'N 69°03'W, depth 4000m ; 1 female, station 35 ; collected 25 × 81 :

locality not given, depth 3939m : 1 female, station 38 ;
collected 27 X 81 : locality 15°03'N 69°13'W, depth 3950m ;
1 female, station 40 ; collected 3 XII 81 : locality not given.

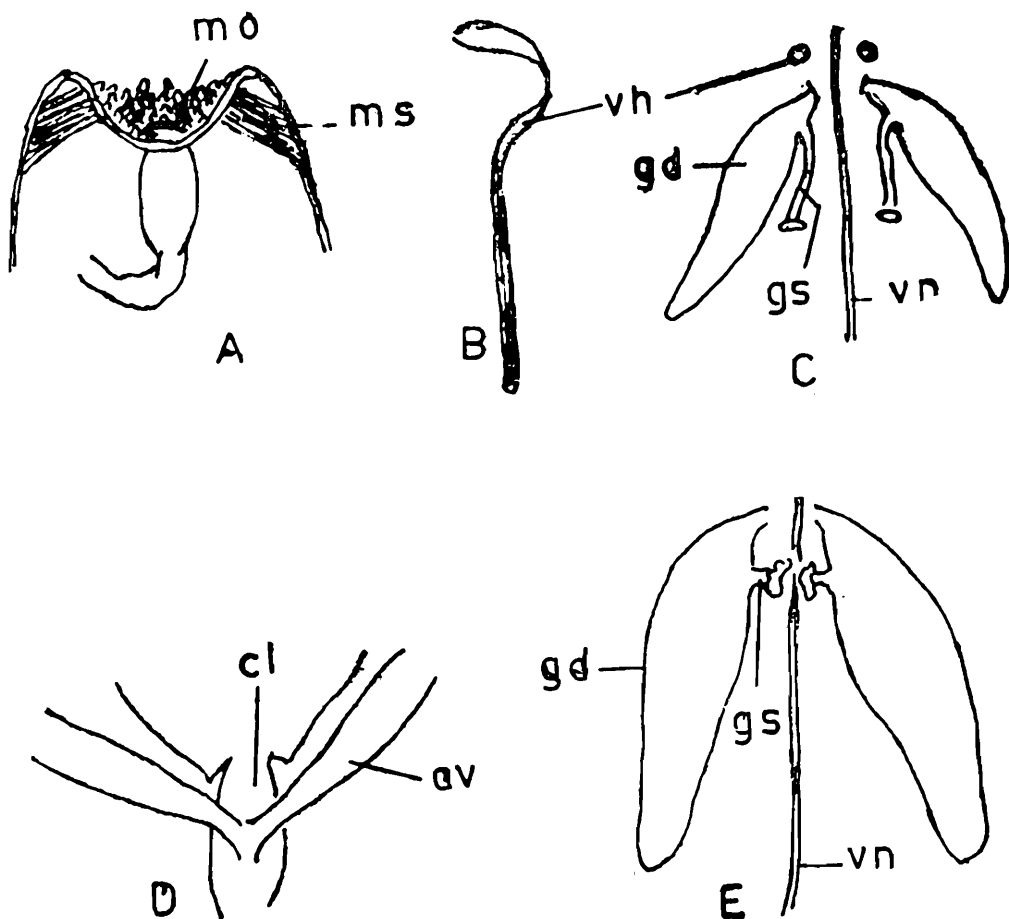


Fig. 1. A-D, *Arhynchite inamoenus*. A, anterior tip of the trunk, B, ventral hook, C, gonoducts, D, anal vesicles. E, gonoducts, *Amalosoma eddystonense*.

av—anal vesicle, cl—cloacal chamber, gd—gonoduct, gs—gonostome, mo—mouth, ms—muscles acting as retractors, vh—ventral hook, vn—ventral nerve cord.

Description : The preserved specimens are greyish pink in colour, cylindrical in shape, without a proboscis and measures 25-40mm in length and 6-10mm across the broadest part. The anterior tip of the trunk is pushed in to form a shallow cup in the centre of which opens the mouth. The inner body wall lining of this shallow cup is connected with the opposite body wall by means of a few strong muscles which probably act as retractors (Fig. 1, A). Two large ventral hooks are located close to the mouth ; the shaft of the hooks is 10-12 mm long and the bent tip is golden yellow

in colour, blunt and flattened. In some specimens two additional hooks of smaller size are present. Body wall is thick ; small flattened papillae are sparsely but uniformly distributed. Papillae are raised and dense surrounding the mouth.

Internally, the intestine and associated parts are decomposed or damaged owing to which the gut and the vascular system could not be studied. A strong interbasal muscle connects the two shafts of the hooks, also the shafts of the additional hooks where these are present. A pair of stout radiating muscles originate from the body wall in the vicinity of the genital pore in all the specimens. Gonoducts are two in number, 6-7mm long and tubular in females and small and oval in the male. Gonostome is basal and simple annular gonostomal lip is borne on a stalk which in some specimens is fairly long. In two female specimens dark pigments are there in the gonostome. Anal vesicles are two small tubes which in the specimen of station 35 are surrounded by yellow glandular tissue. The two vesicles join before opening into the cloaca by a single aperture.

Remarks : In the genus *Arhynchite* proboscis is absent or deciduous. In none of the present specimens a proboscis is present ; proboscis is absent in the original description of *A. inamoenus*. The animals of the present collection are smaller in size and from much deeper waters compared with those of the original description which were collected from depths of 70-450m off southern California (type locality : Monterey Bay). The gonostomal lip is leaf like or expanded with lacinated border in *A. arhynchite*, *A. hiscocki*, *A. puggetensis*, and *A. californicus*. Gonostomal lip is simple annular in both *A. inamoenus* and *A. rugosus* ; in the latter species, however, the anus is set on a low knob like protuberence besides ampulla like tubercles or papillae on the body wall.

***Bonellia suhmii* Selenka, 1885**

Bonellia suhmii Selenka, 1885 : 9-10.

Bonellia suhmii : Stephen & Edmonds, 1972 : 376-377.

Material : 1 female, NORDA-334, station 66 ; collected 11×81 : locality coordinates not given, depth 5900m.

Description : The preserved specimen is yellowish white in colour and long and cylindrical in shape. The posterior part of the specimen is damaged, nevertheless, the animal could be of the order of 40mm in length and 7mm across the broadest part. A proboscis and ventral hooks are absent. Body wall is thick, small rounded papillae are confined to the anterior end and transverse wrinkles throughout the body. Genital aperture is in a circular pit located about 4mm away from the mouth. Body wall surrounding the genital pit is smooth and thick. Mouth opening is a transverse oval slit.

Internally, only a small part of the fore gut is preserved. Single gonoduct is oval in shape and located on the right side of the ventral nerve cord. Gonostome is basal, simple gonostomal lip is borne on a short stalk. Anal vesicles could not be studied as the parts are missing.

Remarks : In *B. suhmii* proboscis is unknown and ventral hooks absent. Single gonoduct is perhaps the only criterion on the basis of which the species *suhmii* has been placed under the genus *Bonellia* which is also characterised by the presence of a well developed proboscis and 2 ventral hooks. Bonellidan genera with single gonoduct and without ventral hooks are *Achaetobonellia* (Fisher, 1953), *Choanostomellia* (Zenkevitch, 1964), *Eubonellia* (Fissher, 1946), *Ikedella* (Monro, 1927), *Jakobia* (Zenkevitch, 1958), *Nellobia* (Fisher, 1946), *Sluiterina* (Monro, 1927) and *Torbenwolffia* (Zenkevitch, 1966). Proboscis is anteriorly bilobed in *Achaetobonellia*. Gonoduct is characteristically folded in *Jakobia*, also the anterior tip of the proboscis is expanded in the form of a disc. In the rest of the genera the proboscis is well developed and variously modified. *B. suhmii* appears to be nearest to *Nellobia eusoma* (Fisher, 1946 : pp. 258—259) both of which are without proboscis or ventral hooks but with single gonoduct and basal gonostome. However, in *B. suhmii* the anal vesicles are two simple tubes covered with short stalked funnels and in *N. eusoma* the anal vesicles are two crescentic pouches the free border of which is produced into unequal dendritic divisions. The type locality of the species is

Challenger station 47, off Nova Scotia and later reported from a few localities of the North Atlantic Ocean.

***Kurchatovus epeedentatus* DattaGupta, 1986**

Kurchatovus epeedentatus DattaGupta, 1986 : 145-148.

Material : 2 females, station 58 ; collected 11 IX 81 : locality coordinates 13°42,5'N 67°41,8'W, depth 5008 m ; 1 female, station 91 ; collected 27 XI 81 : locality coordinates 13°30'N 64°45'W, depth 3453 m.

Description : The animals are damaged, 3—8.3 mm in length and 1.5—3 mm in breadth. One specimen of station 58 is glossy white in colour, the rest are sandy grey. A proboscis is absent ; mouth covered dorsally by a rudimentary collar. Body wall is thick and covered with conspicuous papillae. Two hooks with flattened bent tips are located closely ventral to the mouth.

Internally, the intestine is damaged but filled with decaying fibrous material of plant origin. Single oval gonoduct with basal gonostome is located on the left side of the ventral nerve cord posterior to the ventral hooks. A strong inter-basal muscle connects the two shafts of the hooks. Anal vesicles could not be studied.

Remarks : The species of the genus *Kurchatovus* are abyssal forms which live in decaying plant material and feed upon the material in which they live (DattaGupta, 1977, 1986 ; Wolff, 1979). Two species namely, *tridentatus* characterised by 3-clawed ventral hooks and *epeedentatus* characterised by single clawed flattened ventral hooks have been assigned to the genus. The type locality of *K. tridentatus* which is also the type species of the genus is Puerto Rico Trench and paratypes from Cayman Trench and Yucatan Basin of the Caribbean deep sea. The type locality of *K. epeedentatus* is Venezuela Basin which is also the locality of one paratype and duplicates ; one paratype was collected from coordinates 12°41,8'S 44°66,6'E, depth 750 m.

***Amalosoma eddystonense* Stephen, 1956**

(Fig. 1, E)

Amalosoma eddystonense Stephen, 1956 : 605-608.*Amalosoma eddystonense* : DattaGupta, 1981 : 375.

Material : 2 females including one badly damaged, station 93 ; collected 26 XI 81 : locality coordinates 13°32,3'N 64°40,5'W, depth 3429 m.

Description : Both specimens are cucumber shaped and sand coloured in the preserved state. The complete specimen measures 65 mm in length without the proboscis and around 16 mm across the broadest part. The proboscis appear to be broken at the region of its junction with the trunk and lost. The damaged specimen should be around 60 mm long. Body wall is uniformly thick in the damaged specimen ; but thin in the posterior 2/3 of the body of the complete specimen. Papillae large of irregular outline and arranged more or less in transverse rows on the body wall. Ventral hooks are absent. Genital pit conspicuous where two gonoducts open separately.

Internally, intestine is completely decomposed in both the specimens except a small part of the fore gut and a small part at the cloacal end. Body cavity is filled with soft mud and detritus, also pieces of white coralline rocks. Gonoducts two in number and elongated with basal gonostome ; gonostomal lip simple annular and borne on a short stalk. Only the proximal parts of the wide tubular anal vesicles are present.

Remarks : *A. eddystonense* after its discovery has been reported from two localities of the Bay of Biscay (DattaGupta, 1981). The type locality of the species is Plymouth, England. The more trenchant character of the genus *Amalosoma* is two gonoducts with basal gonostome which open to the exterior separately.

SUMMARY

Four species of Echiura namely, *Arhynchite inamoenus* (Thalassematidae), *Bonellia suhmii*, *Kurchatovus epeedentatus*

and *Amalosoma eddystonense* (Bonellidae) have been listed and described. These animals have been collected from the Venezuela Basin by the biology team of the Department of the Navy, Naval Ocean Research & Development Activity, NSTL, Mississippi, USA.

ACKNOWLEDGEMENTS

Grateful acknowledgements are made here to the Director General, Council of Scientific and Industrial Research, New Delhi, for the grant of research under the Emeritus Scientist scheme ; to the Director, Zoological Survey of India, Calcutta for allround facilities to work, and to Dr. Kevin B. Briggs, Naval Ocean Research and Development Activity, NSTL, Mississippi, USA, who very kindly left the disposal of the material of the present study at the discretion of the author.

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LAND MOLLUSCS OF TEIREI RIVER VALLEY
PROJECT, DARLAK (MIZORAM, INDIA)

By

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Calcutta

INTRODUCTION

During the course of Environmental Impact Assessment Survey of the Teirei river valley Project, Darlak (Mizoram) in February 1984, a team from the Zoological Survey of India, under the leadership of Dr. S. Biswas, collected a small lot of land molluscs. The collection proved very significant as all the species turned out to be first records from Mizoram. This has prompted the authors to present an account of these molluscs.

The total area under the Teirei river valley project is approximately 5,000 hectares. It comprises of two villages viz. Darlak and Naljal, situated in the valley of the river Teirei. It is more or less 3 kms. wide on an average, with a broken contour, which is caused by the drainage pattern and the soil deposition brought by the erosion in the upper reaches.

Darlak is a small village on the bank of the Teirei Lui, situated about 40 kms, as the crow flies, from Aizwal, but 125 kms by road passing through undulating countries. The climate is tropical, temperature and humidity fluctuate inversely during day and night. Natural vegetation is moist tropical evergreen in most parts but in certain sections it is moist tropical deciduous and montane subtropical. Soil is acidic with the pH varying between 5.50 to 6.50.

Mizoram constitutes a part of north-eastern India, which with its by and large wet evergreen vegetations, ample rainfall and forest-clad hill tracts, account for nearly one third of the

total Indian species of land molluscs (Dey *et al.*, 1985). A report on terrestrial molluscs of Mizoram is totally lacking. Our knowledge of land molluscs of north-east India in general, is derived chiefly from a few reports by Godwin-Austen (1876), Ghosh (1913), and Gude (1915), in addition to the Fauna of British India, mollusca series by Blanford and Godwin-Austen (1908) and Gude (1914, 1921).

The present paper deals with 23 species of land molluscs under 17 genera and 9 families. While most of the collections were made on grounds among low wild vegetations, or under foliage etc., the specimens of *Girasia* were collected from inside petioles of banana plants at a height of approximately one meter from ground. Obviously, these slug-like molluscs take shelter in such places for humidity, shade and moisture.

SYSTEMATIC ACCOUNT

Key to the families

- | | | |
|---|-----|------------------|
| 1. Shell with an operculum | ... | (2) |
| Shell without an operculum | ... | (3) |
| 2. Shell turreted, with irregularly coiled spire, higher than broad | ... | Cochlostomatidae |
| Shell flat or low conical, with regularly coiled spire, broader than high | ... | Cyclophoridae |
| 3. Shell imperforate, columella abruptly truncate below | ... | Glessulidae |
| Shell perforate, columella not truncate below | ... | (4) |
| 4. Shell with reflected peristome | ... | (5) |
| Shell with simple peristome | ... | (8) |
| 5. Shell with eccentric bodywhorl and a well developed parietal lamella | ... | Streptaxidae |
| Shell with regular bodywhorl, without parietal lamella | ... | (6) |
| 6. Shell smooth, polished, bodywhorl not descending near the aperture | ... | Camaenidae |
| Shell regularly sculptured, bodywhorl descending near the aperture | ... | (7) |

- | | |
|--|-----------------|
| 7. Shell sinistral, with spiral sculpture ... | Corillidae |
| Shell dextral, without spiral sculpture ... | Bradybaenidae |
| 8. Shell flat, widely umbilicate, aperture depressedly subquadrate. Extremity of foot without overhanging lobe ... | Trochomorphidae |
| Shell low conical, narrowly umbilicate, aperture lunate, (except in <i>Austeria</i> and <i>Girasia</i> where it is partly internal). Extremity of foot with overhanging lobe ... | Ariophantidae |

Class : GASTROPODA

Order : MESOGASTROPODA

Family : CYCLOPHORIDAE

Key to the genera

- | | |
|--|-----------------------------|
| 1. Shell discoidal, convex above, concave below, with an incision at the peristome ... | <i>Pterocyclus</i> Benson |
| Shell globosely conoid, without an incision at the peristome ... | (2) |
| 2. Shell small never above 10 mm in diameter, with a sutural tube ... | <i>Alycaeus</i> Gray |
| Shell moderately large, never below 10 mm in diameter, without a sutural tube ... | <i>Cyclophorus</i> Montfort |

Genus : *Alycaeus* Gray, 1850

1. *Alycaeus burti* Godwin-Austen

(Fig. 1 & 2)

Alycaeus burti Godwin-Austen, 1874. *J. Asiat. Soc, Beng.*, 43 (2) : 149, pl. 3, fig. 9.

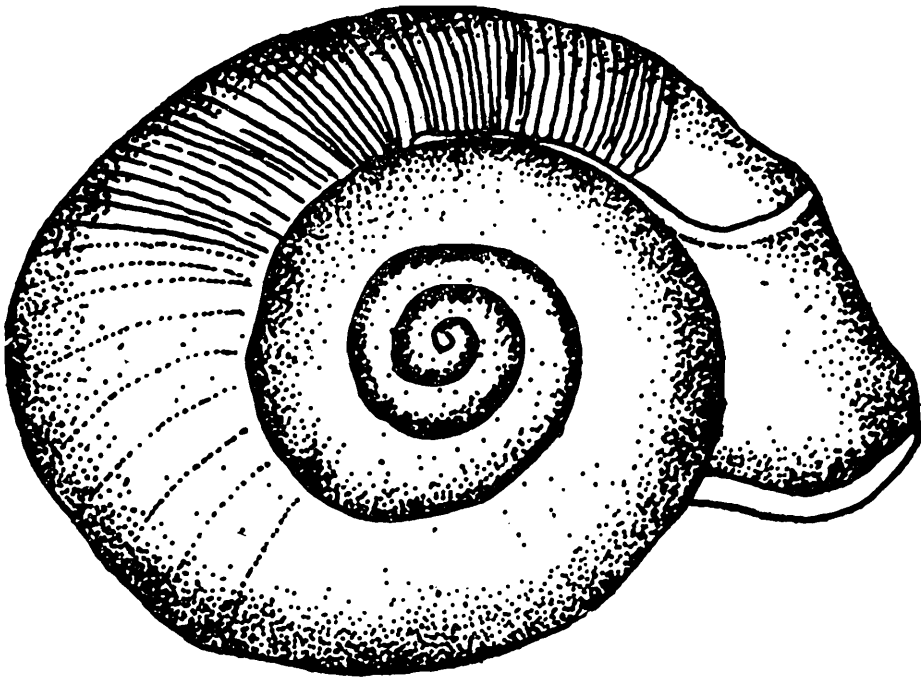
Alycaeus burti : Gude, 1921. *Fauna of British India, Mollusca*, 3 : 206.

Material examined : 25 exs., Darlak.

Measurements (in mm) :

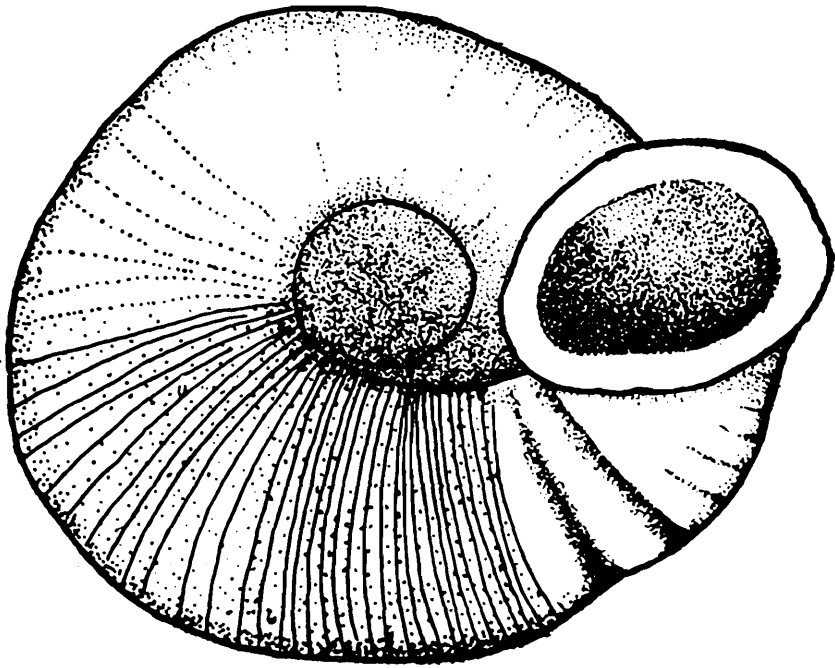
Height of the shell	Width of the shell	Height of the aperture
2.90-4.25	4.70-6.50	1.70-2.00

Distribution : India : Arunachal Pradesh, Assam, Mizoram.
Elsewhere : Bhutan.



5 MM

Fig. 1. *Alycaeus burti* Godwin-Austen (Dorsal view)



5 MM

Fig. 2. *Alycaeus burti* Godwin Austen (Ventral view)

Genus : **Cyclophorus** Montfort, 1810*Key to the species*

- Shell with zig-zag marking towards the apex, bodywhorl subangulate, umbilical cavity wide ... *C. theobaldianus* Benson
- Shell with zig-zag marking throughout, bodywhorl sharply carinate, umbilical opening contracted ... *C. zebrinus* (Benson)

2. **Cyclophorus theobaldianus** (Benson)

(Pl. II, figs. 1 & 2)

Cyclophorus theobaldianus Benson, 1857. *Ann. Mag. nat. Hist. Soc.*, (2) 19 : 206.*Cyclophorus theobaldianus* ; Gude, 1921. *Fauna of British India, Mollusca*, 3 : 86.*Material examined* : 22 exs., Darlak.*Measurements* (in mm) :

Height of the shell	Width of the shell	Height of the aperture
15.50-26.65	26.30-50.70	15.40-22.40

Distribution : India : Assam, Mizoram.*Elsewhere* : Burma, Bangladesh.3. **Cyclophorus zebrinus** (Benson)

(Pl. II, figs. 6 & 7)

Cyclostoma zebrinus Benson, 1836. *J. Asiat. Soc. Beng.*, 5 : 355.*Cyclophorus zebrinus* : Gude, 1921. *Fauna of British India, Mollusca*, 3 : 86.*Material examined* : 4 exs., Darlak.*Measurements* (in mm) :

Height of the shell	Width of the shell	Height of the aperture
21.55	23.80	11.00

Distribution : India : Arunachal Pradesh, Manipur, Maghalaya, Mizoram.*Elsewhere* : Burma, China and Mergui Archipelago.

Genus : **Pterocyclus** Benson, 1832

4. **Pterocyclus parvus** (Pearson)

(Pl. V, figs. 1 & 2)

Spiraculum parvus Pearson, 1833. *J. Asiat. Soc. Beng.*, 2 : 392, pl. 20, fig. 7.

Pterocyclus parvus : Gude, 1921. *Fauna of British India, Mollusca*, 3 : 108.

Material examined : 3 exs., Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
3.80-8.35	7.60-28.28	2.60-9.95

Distribution : *India* : Arunachal Pradesh, Assam, Meghalaya, Mizoram, Nagaland.

Elsewhere : Bangladesh, Burma.

Family : COCHLOSTOMATIDAE

Genus : **Diplommatina** Benson, 1849

5. **Diplommatina butleri** Godwin-Austem

(Figs. 3 a & b)

Diplommatina butleri Godwin Austen, 1892. *Proc. zool. Soc. Lond.*, p. 512.

Diplommatina butleri : Gude, 1921. *Fauna of British India, Mollusca*, 3 : 305.

Material examined : 12 exs., Darlak.

Measurements (in mm) :

Length of the shell	Width of the shell	Height of the aperture
4.65-6.10	2.65-3.65	1.00-1.40

Distribution : *India* : Manipur, Mizoram

Elsewhere ; Burma.

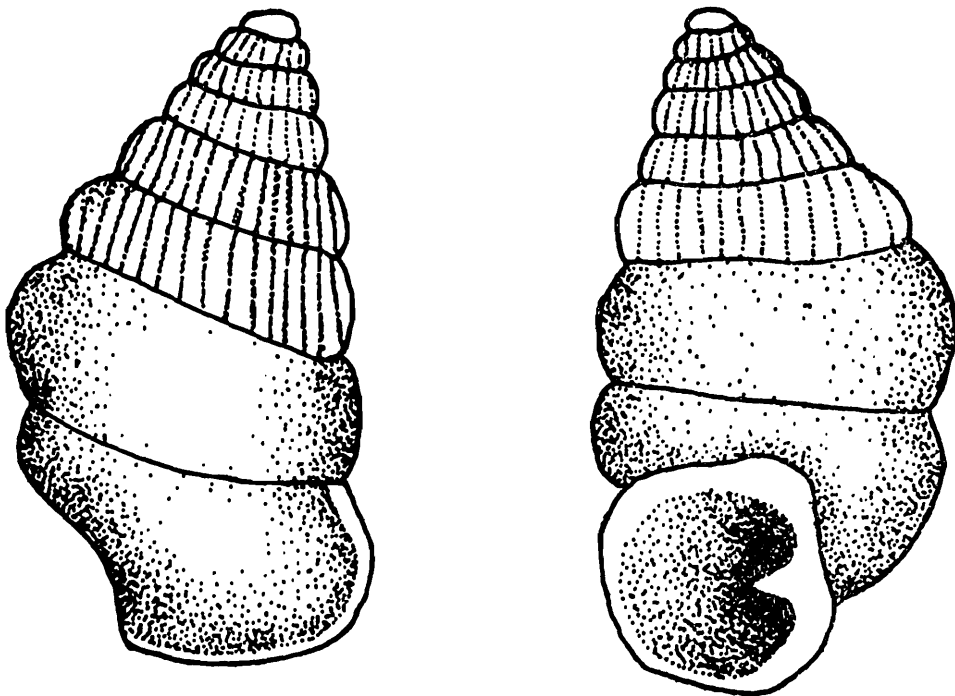
Family : CORILLIDAE

Genus : **Plectopylis** Benson, 1860

Key to the species

Bodywhorl with four rows of hairs, not placed on raised ridges ; parietal armature without horizontal fold ... *P. affinis* Gude

Bodywhorl with five rows of hairs, placed on raised ridges ; parietal armature with horizontal fold ... *P. plectostoma* Benson



2 MM

Fig. 3. *Diplommatina butleri* Godwin-Austen (Dorsal & Ventral view)

6. **Plectopylis affinis** Gude

(Pl. II, figs. 3 & 4)

Plectopylis affinis Gude, 1897. *Science Gossip.*, N. S. 3 ; 276, fig. 41.

Plectopylis affinis : Gude, 1914. *Fauna of British India, Mollusca*, 2 : 84.

Material examined : 10 exs. Darlak.

Measurements (in mm) ;

Height of the shell	Width of the shell	Height of the aperture
4.25-5.66	7.68-9.25	2.55-3.20

Distribution : *India* : Arunachal Pradesh, Meghalaya, Mizoram. Endemic to north-eastern India.

7. *Plectopylis plectostoma* (Benson)

(Pl. II, figs. 8 & 9)

Helix plectostoma Benson, 1836. *J. Asiat. Soc. Beng.*, 5 : 351.

Plectopylis plectostoma : Gude, 1914. *Fauna of British India. Mollusca*, 2 : 81.

Material examined : 8 exs., Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
4.15-4.60	7.53-8.30	2.70-3.10.

Distribution : *India* : Arunachal Pradesh, Meghalaya, Mizoram, Nagaland, Sikkim, West Bengal (Darjeeling).

Elsewhere : Bangladesh, Burma.

Family : BRADYBAENIDAE

Genus : ***Plectotropis*** Martens, 1860.

Following Solem (1966) this genus is tentatively placed under Bradybaenidae.

8. *Plectotropis tapeina* (Benson)

(Pl. III, figs. 1 & 2)

Helix tapoina Benson, 1836. *J. Asiat. Soc. Beng.*, 5 : 352.

Plectotrepis tapeina : Gude, 1914. *Fauna of British India, Mollusca*, 2 : 214.

Material examined : 5 exs., Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
6.80-7.60	12-15-15.85	4.00-4.30

Disrribution : *India* : Arunachal Pradesh, Assam, Meghalaya, Mizoram.

Elsewhere : Bangladesh, Burma.

Family : TROCHOMORPHIDAE

Genus : *Sivella* Blanford, 1863

9. *Sivella castra* (Benson)

(Pl. III. figs. 3 &4)

Helix castra Benson, 1852. *Ann. Mag. nat. Hist.*, (2) 10 : 349.

Trochomorpha (*Sivella*) *castra* : Gude, 1914. *Fauna of British India, Mollusca*, 2 : 3.

Sivella castra : Solem, 1966. *Spolia zool. Mus. haun.*, 24 : 29.

Material examined : 3 exs., Darlak.

Measurements (in mm.) :

Height of the shell	Width of the shell	Height of the aperture
4.25-5.78	10.20-11.38	3.10-3.40

Distttribution : *India* : Arunachal Pradesh, Assam, Meghalaya, Mizoram.

Elsewhere : Burma, Malayasia, Malay Penninsula, Thailand.

Family : ARIOPHANTIDAE

Key to the genera

- | | | |
|--|-----|-----------------------|
| 1. Shell partly internal, body not enclosed by the shell | ... | (2) |
| Shell external, body enclosed by the shell | ... | (3) |
| 2. Shell ear shaped with distinct coiling | ... | <i>Austenia</i> Nevil |
| Shell ovate, without coiling | ... | <i>Girasia</i> Gray |
| 3. Shell with keeled pheriphery, distinctly sculptured above | ... | (4) |
| Shell with rounded pheriphery, without distinct sculpture | ... | (5) |
| 4. Shell with decussating sculpture above, smooth below | ... | <i>Sesara</i> Albers |

Shell without decussating sculpture above,
costulate below ...

Khasiella Godwin-
Austen

5. Caudal gland at the extremity of foot
absent, peripodial groove with a single
margin. Dart sac large, cylindrical ...

Staffordia Godwin-
Austen

Caudal gland at the extrmity of foot
present, peripodial groove with double
margin. Dart sac small, globose ...

Macrochlamys Benson

Genus : *Austenia* Nevill, 1878

10. *Austenia* sp.

The single shell collected was unfortunately damaged during the journey and could not be identified upto the species.

Genus : *Girasia* Gray, 1855

Key to the species

Smaller in size, usually not exceeding
40 mm in length ; shell horny, dull white
in colour ...

G. burtii (Godwin-
Austen)

Bigger in size, usually above 40 mm in
length ; shell membranaceous, greenish in
colour ...

G. radha (Godwin-
Austen)

11. *Girasia burtii* (Godwin-Austen)

(Pl. III, fig. 9)

Helicarion (*Hoplites*) *burtii* Godwin-Austen, 1876. *J. Asiat. Soc. Beng.*,
45 (2) : 314, pl. 8, fig. 6.

Girasia burtii : Blanford and Godwin-Austen, 1908. *Fauna of British
India, Mollusca* (Testacellidae and Zonitidae) p. 202.

Material examined : 3 exs., Bangwa.

Measurements (in mm) :

Length of the shell
27.14-32.00

Width of the shell
6.50-12.05

Distribution : Assam.

12. **Girasia radha** (Godwin-Austen)

(Pl. V, fig. 7)

Helicarion (*Hoplites*) *radha* Godwin-Austen, 1876, *J. Asiat. Soc. Beng.*, 45 (2) : 314, pl. 8, fig. 4, (type locality, Bank of radha Pokri, near Narainpur, Darrang, Assam).

Girasia radha : Blanford and Godwin-Austen, 1908. *Fauna of British India. Mollusca* (Testacellidae & Zonitidae) p. 201.

Material examined : 5 exs., Darlak.

<i>Measurements</i> (in mm) :	Length of the shell	Width of the shell
	60.75-65.20	17.50-17.74

Distribution : Assam, Mizoram.

Genus : **Khasiella** Godwin-Austen, 1899

13. **Khasiella climacterica** (Benson)

(Pl. III, figs. 5 & 6)

Hellx climacterica Benson, 1836. *J. Asiat. Soc. Beng.*, 5 : 352.

Khasiella climacterica ; Blanford & Godwin-Austen, 1908. *Fauna of British India. Mollusca* (Testacellidae and Zonitidae), p. 160.

Material examined : 6 exs., 4 kms east of Darlak.

Measurements (in mm) :

Height of the Shell	Width of the shell	Height of the aperture
7.00-8.60	12-20-15.35	7.70-7.80

Distribution : INDIA : Arunachal Pradesh, Assam, Meghalaya, Mizoram.

Elsewhere : Burma

Genus : **Macrochlamys** Benson, 1832

Key to the species

shell depressed, bodywhorl scarcely wider than the penultimate : smaller in size (usually upto 10 mm in diameter) ...	<i>M. petasus</i> (Benson)
---	----------------------------

Shell depressedly globose, bodywhorl much wider than the penultimate ; bigger in size (usually more than 10 mm in diameter) ...	<i>M. vesica</i> Godwin-Austen
---	--------------------------------

14. **Macrochlamys petasus** (Benson)

(Pl. V. figs. 4 & 5)

Helix petasus Benson, 1859. *Ann. Mag. nat. Hist.*, (3) 3 : 388.*Macrochlamys petasus* : Blanford & Godwin-Austen, 1908. *Fauna of British India, Mollusca* (Testacellidae and Zonitidae) p. 115.*Material examined* : (i) 5 exs., 4 kms east of Darlak
(ii) 12 exs., Darlak (iii) 5 exs., Naljal.*Measurements* (in mm) :

Height of the shell	Width of the shell	Height of the aperture
3.7-4.80	6.75-8.70	3.00-4.00

Distribution : India : Mizoram*Elsewhere* : Burmu.

Remarks : This species is recorded for the first time from India. Shells recorded earlier from Assam and Darjeeling by Nevill (1878) were wrongly assigned to this species (Blanford & Godwin-Austen, 1908).

15. **Macrochlamys vesica** Godwin-Austen

(Pl. III, figs 7&8)

Macrochlamys vesica Godwin-Austen, 1910, *Land and Freshwater Mollusca of India*. Supplement to Theobald and Hanley, *Conch, Indica*, 2 : 248, pl. 118, figs, 2-2c.

Material examined : 14 exs., 4 kms east of Darlak.*Measurements* (in mm)

Height of the shell	Width of the shell	Height of the aperture
5.50-9.95	11.18-14.45	5.70-7.25

Distribution : India : Arunachal Pradesh, Assam, Meghalaya, Mizoram.*Elsewhere* : Bangladesh.Genus : **Sesara** Albers, 1860

Both the species *S. diplodon* and *S. galea* were included under *Sesara* by Blanford & Godwin-Austen-(1908) with some doubt. Following Solem (1966) these are retained under the same genus.

Key to the species

Shell with teeth in the aperture	...	<i>S. diplodon</i> (Benson)
Shell without teeth in the aperture	...	<i>S. galea</i> (Benson)

16. *Sesara diplodon* (Benson)

(Figs. 4-6)

Helix diplodon Benson, 1859, *Ann. Mag. nat. Hist.*, (3) 3 : 187.

Sesara ? diplodon : Blanford and Godwin-Austen, 1908. *Fauna of British India, Mollusca* (Testacellidae and Zonitidae), p. 247.

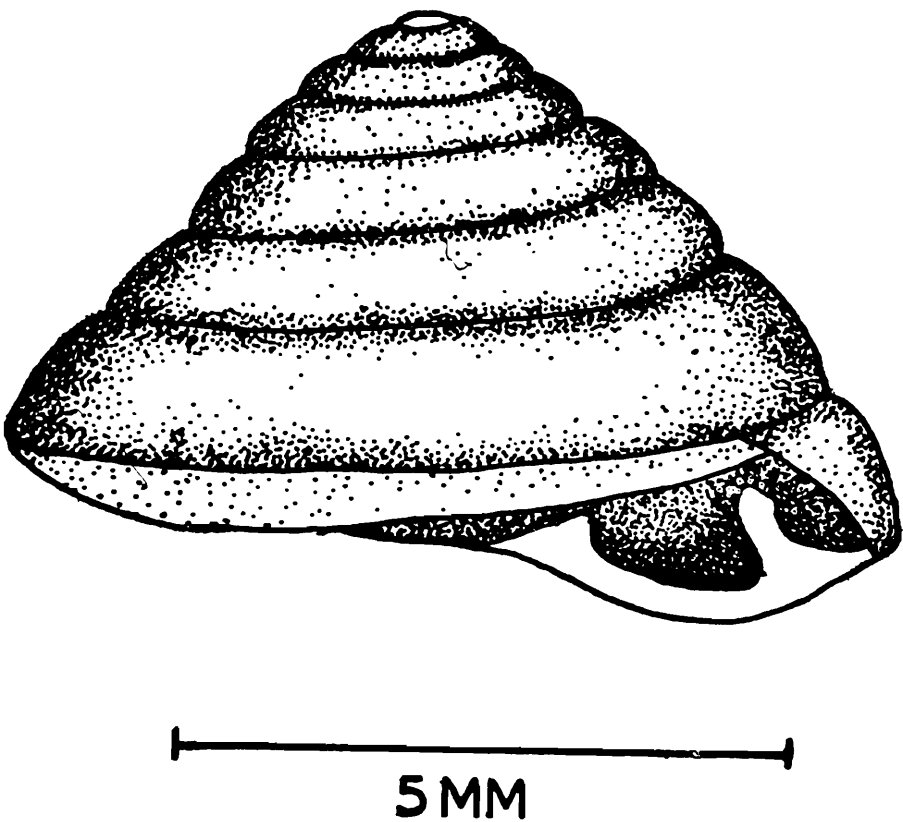


Fig. 4. *Sesara diploden* (Benson) (Lateral view)

Material examined : 3 exs., Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
4.35-4.45	6.70-6.80	2.50-2.95

Distribution : INDIA : Arunachal Pradesh, Assam, Mizoram.

Elsewhere : Bangladesh, Burma, Pakistan.

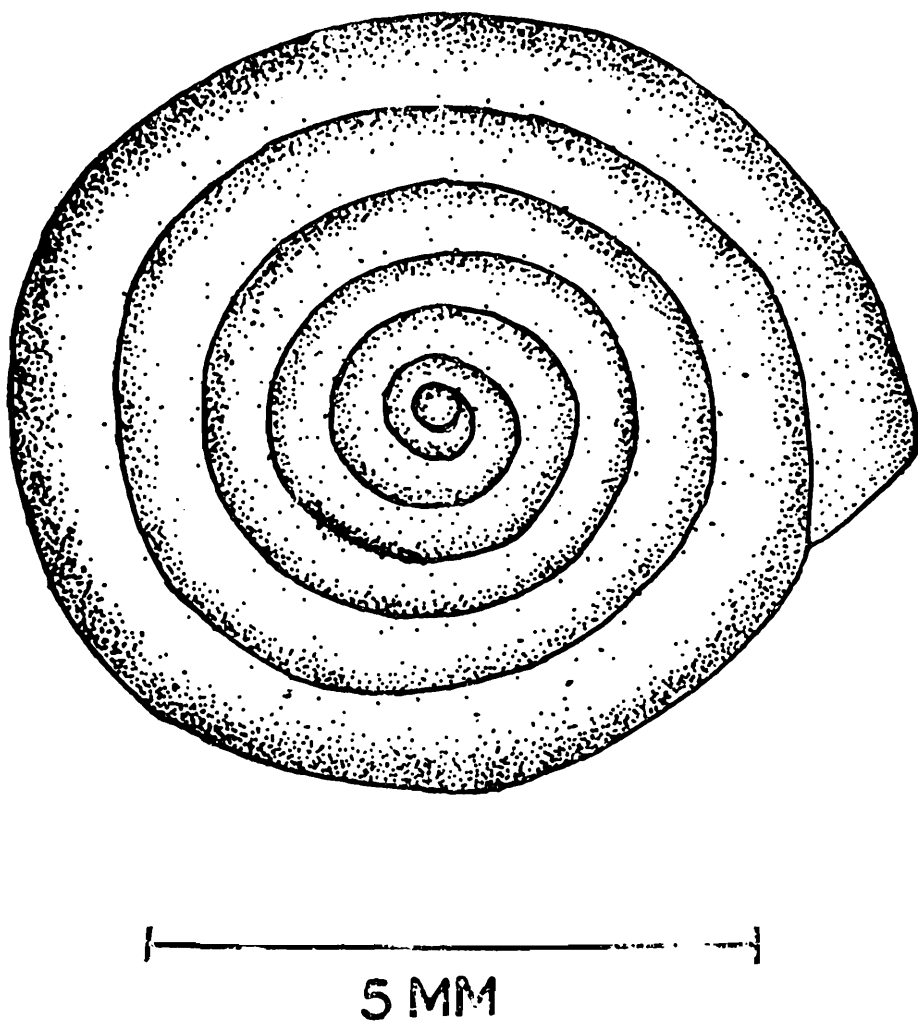


Fig. 5. *Sesara diploden* (Benson) (View from apex)

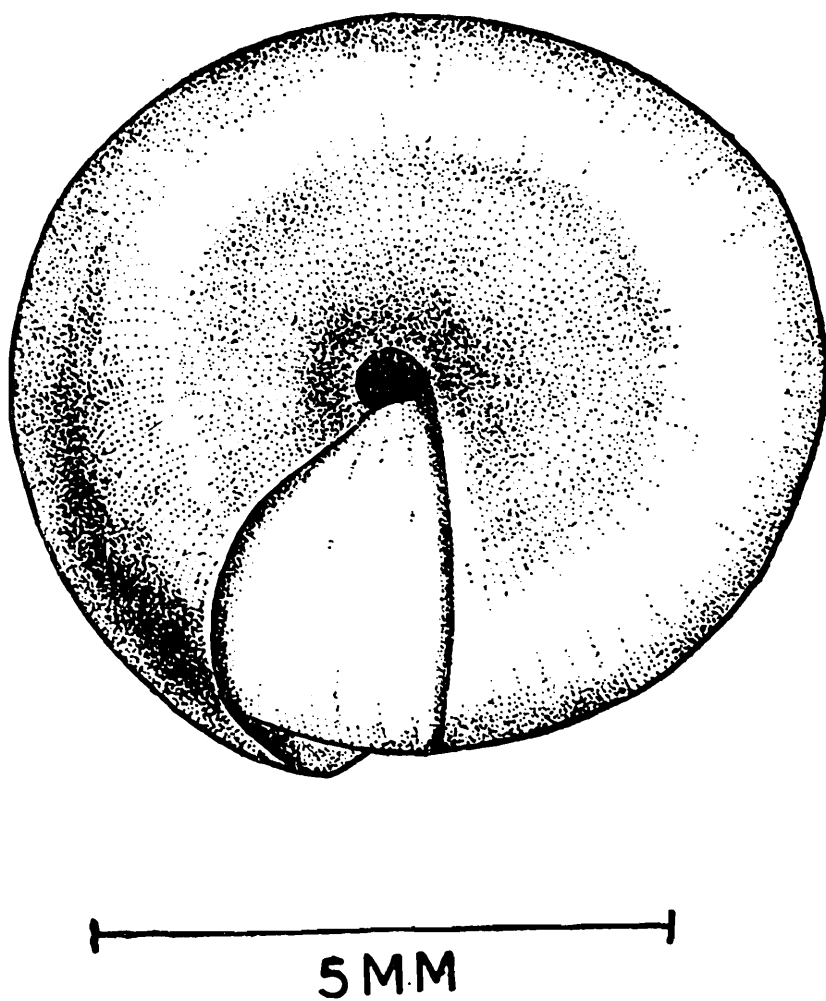


Fig. 6. *Sesara diploden* (Benson) (Ventral view)

17. *Sesara galea* (Benson)

(Figs. 7, 8 & 9)

Helix galea Benson, 1859, *Ann. Mag. nat. Hist.*, (3) 3 : 388,

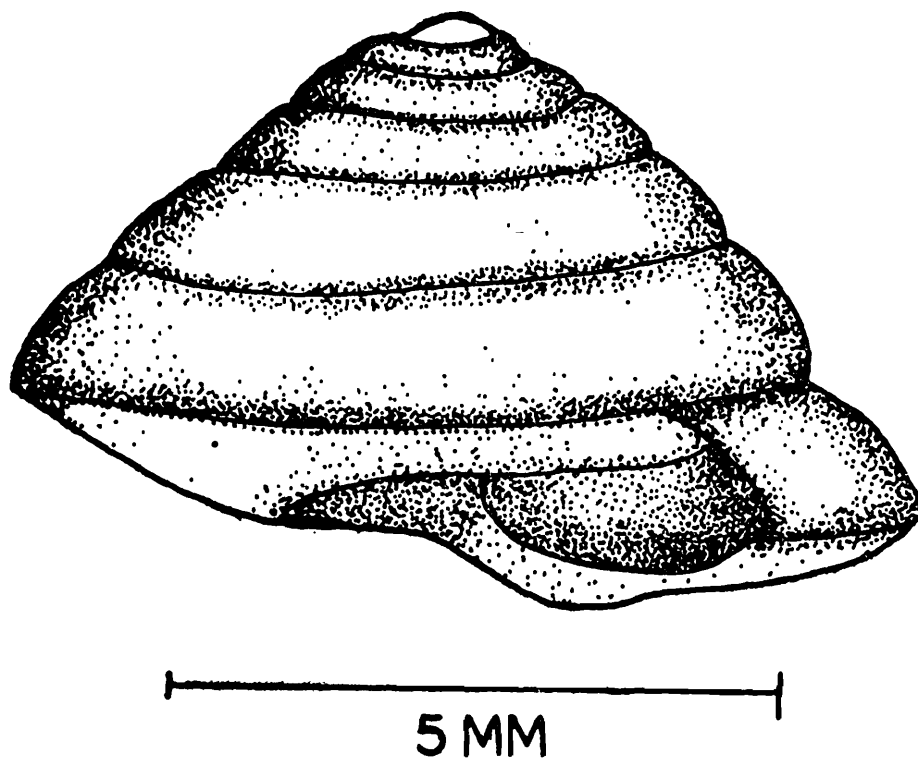


Fig. 7. *Sesara galea* (Benson) (Lateral view)

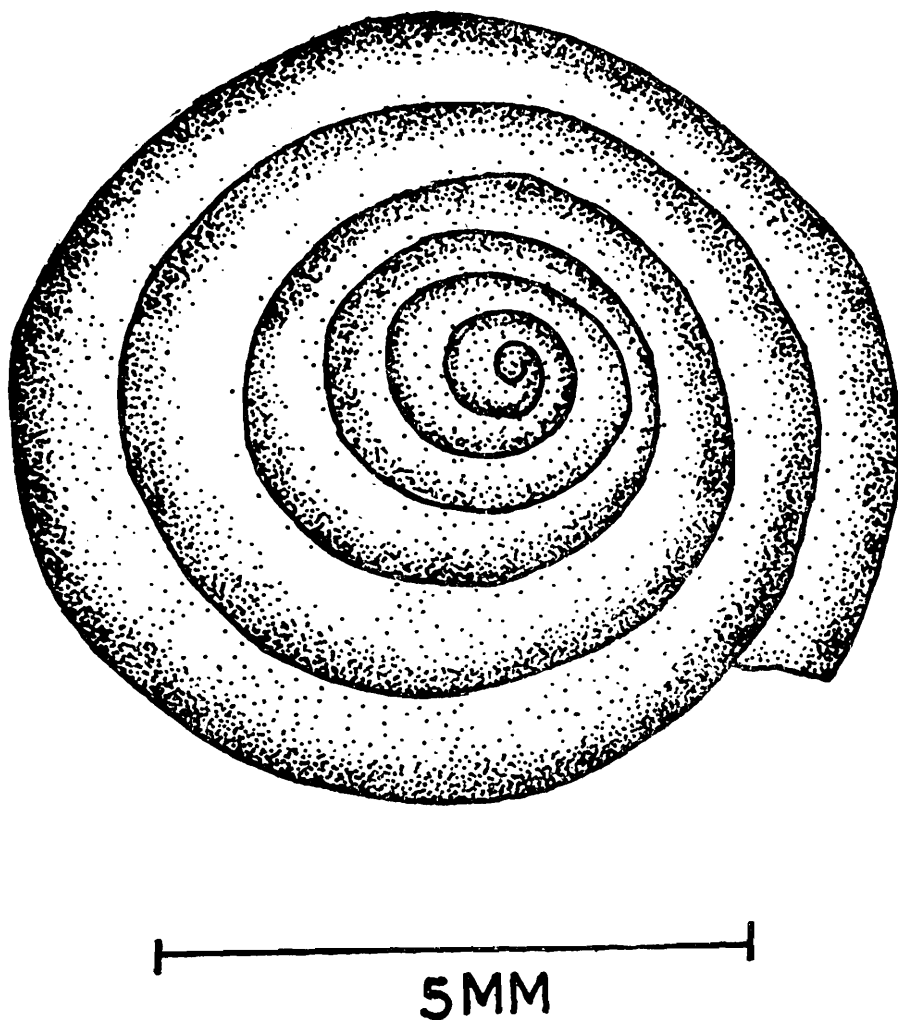


Fig. 8. *Sesara galea* (Benson) (View from apex)

Sesara ? galea : Blanford & Godwin-Austen, 1908, *Fauna of British India. Mollusca* (Testacellidae and Zonitidae), p. 249.

Material examined : 2 exs. Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
4.35-4.45	6.70-6.80	2.50-2.95

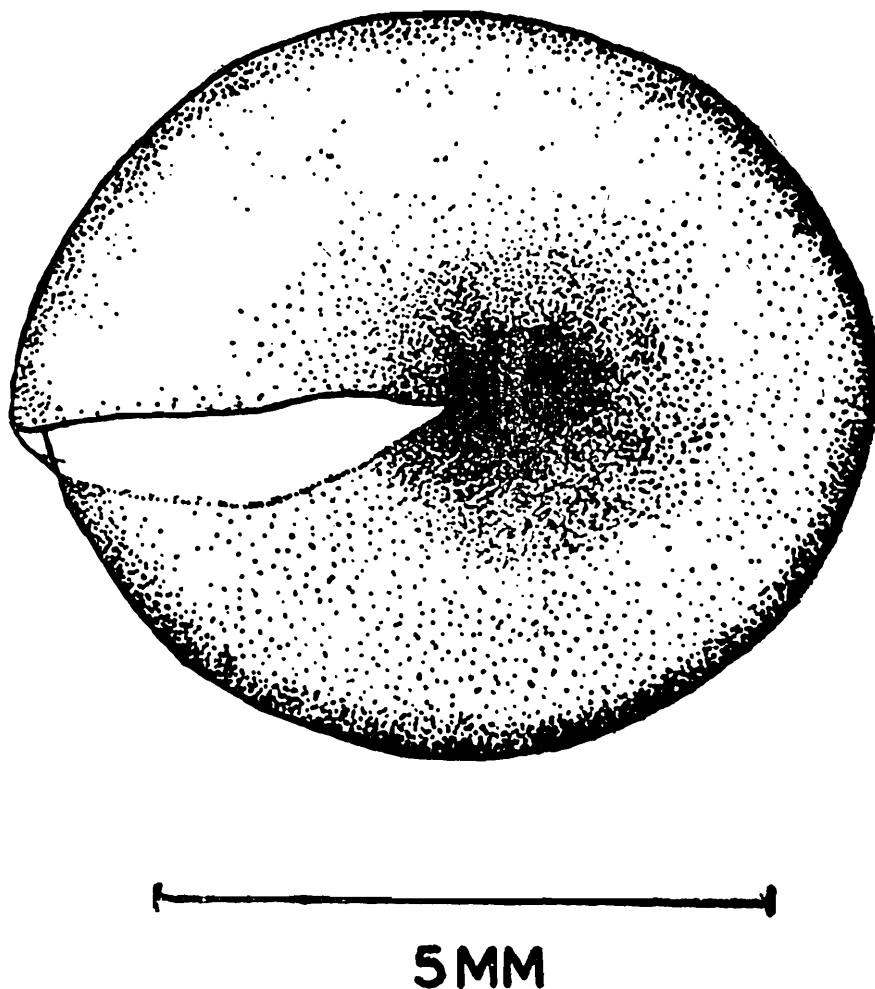


Fig. 9. *Sesara galea* (Benson) (Ventral view)

Distribution : Assam, Meghalaya, Mizoram.

Genus : **Staffordia** Godwin-Austen, 1907

18. **Staffordia daflaensis** Godwin-Austen

(Pl. IV. figs. 1 & 2)

Helix lubrica Bs. ? Godwin-Austen, 1876, *J. Asiat. Soc. Beng.*, 45 (2) : 311, pl. 8, fig. 9.

Macrochlamys daflaensis : Godwin-Austen, 1907, *Moll. India*, 2 : 185. pl. 113. figs. 1-11.

Staffordia daftaensis : Blanford and Godwin-Austen, 1908. *Fauna of British India, Mollusca* (Testacellidae and Zonitidae), p. 296.

Material examined : 2 exs. Darlak.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
9.60	28.55	10.20

Distribution : Arunachal Pradesh, Mizoram.

Family : CAMAENIDAE

Key to the genera

Shell higher than broad, aperture ovate ...	<i>Amphidromus</i> Albers
Shell broader than high, aperture lunate...	<i>Chloritis</i> Beck.

19. *Amphidromus sylheticus* (Reeve)

(Pl. IV, figs. 3 & 4)

Bulimus sylheticus Reeve, 1849. *Conch. Icon.*, pl. 77, fig. 564.

Amphidromus sylheticus : Gude, 1914. *Fauna of British India, Mollusca*, 2 : 180.

Material examined : 4 exs., Darlak.

Measurements (in mm) :

Length of the shell	Width of the shell	Height of the aperture
28.50-29.85	15.65-16.15	13.40-14.10

Distribution : INDIA : Meghalaya, Mizoram.

Elsewhere : Bangladesh,

Genus : *Chloritis* Beck, 1838

20. *Chloritis delibrata* var. *fasciata* (Godwin-Austen)

(Pl. IV, figs. 5 & 6)

Helix delibrata var. *fasciata* Godwin-Austen, 1875. *J. Asiat. Soc. Beng.*, 44 : 1, pl. fig. 1.

Chloritis var. *fasciata* : Gude, 1914. *Fauna of British India, Mollusca* : 2 : 173.

Material examined : 1 ex., Naljal.

Measurements (in mm) :

Height of the shell	Width of the shell	Height of the aperture
4.50	19.30	8.20

Distribution : Assam, Meghalaya, Mizoram.

Family : GLESSULIDAE

Key to the genera

Shell ovately conical, with 5-6 whorls,
smaller in size (usually upto 7 mm in
length) ... *G. gemma* (Reeve)

Shell turreted, with 10-11 whorls, bigger
in size (usually above 7 mm in length) ... *G. tenuispira* (Benson)

Genus : **Glessula** Martens, 1860

As suggested by Godwin-Austen (1920) the genus *Glessula* is placed under the family Glessulidae.

21. *Glessula gemma* (Reeve)

(Pl. V, figs. 3, 6 & Fig. 10)

Achatina gemma Reeve, 1850. *Conch. Icon.*, 5, pl. 22, fig. 123.

Glessula gemma : Godwin-Austen, 1920. *Land and Freshwater Mollusca of India*, 3 : 22.

Glessula gemma : Gude, 1914. *Fauna of British India, Mollusca*, 2 : 428.

Material examined : 3 exs., 4 kms east of Darlak.

Measurements (in mm) :

Length of the shell	Width of the shell	Height of the aperture
7.60-10.20	3.80-4.86	2.50-3.55

Distribution : Mizoram, West Bengal

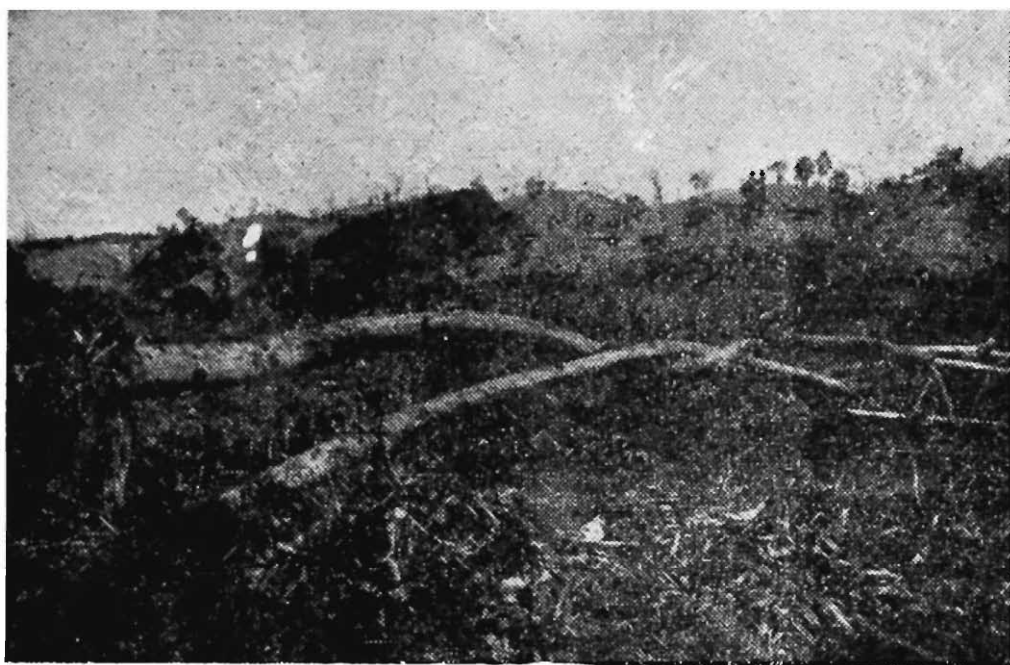
22. *Glessula tenuispira* (Benson)

(Pl. II, fig. 5)

Achatina tenuispira Benson, 1836. *J. Asiat. Soc. Beng.*, 5 : 353.

Glessula tenuispira : Godwin-Austen, 1920. *Land and Freshwater Mollusca of India*, 3 : 31.

Material examined : 4 exs., Darlak.

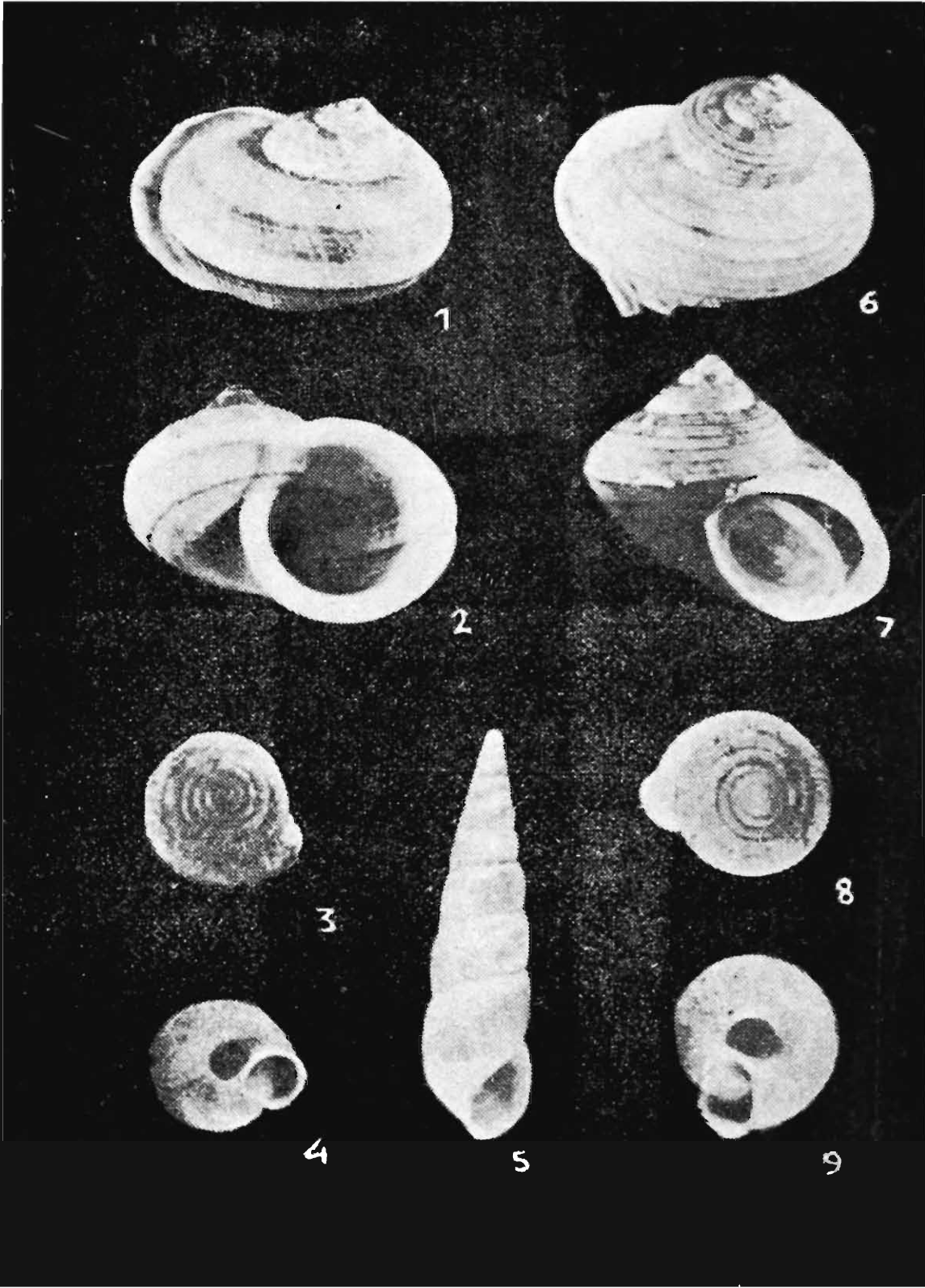


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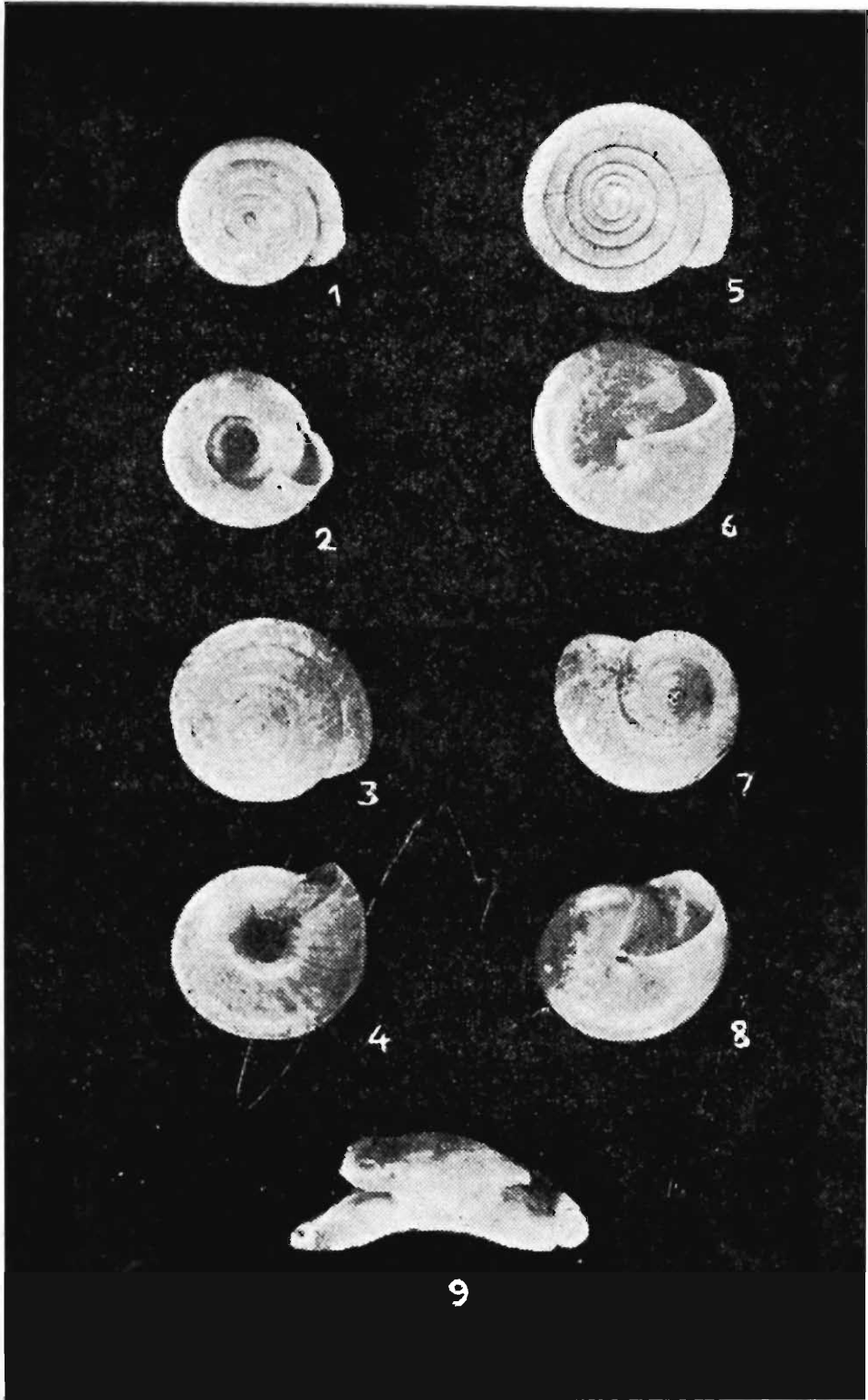


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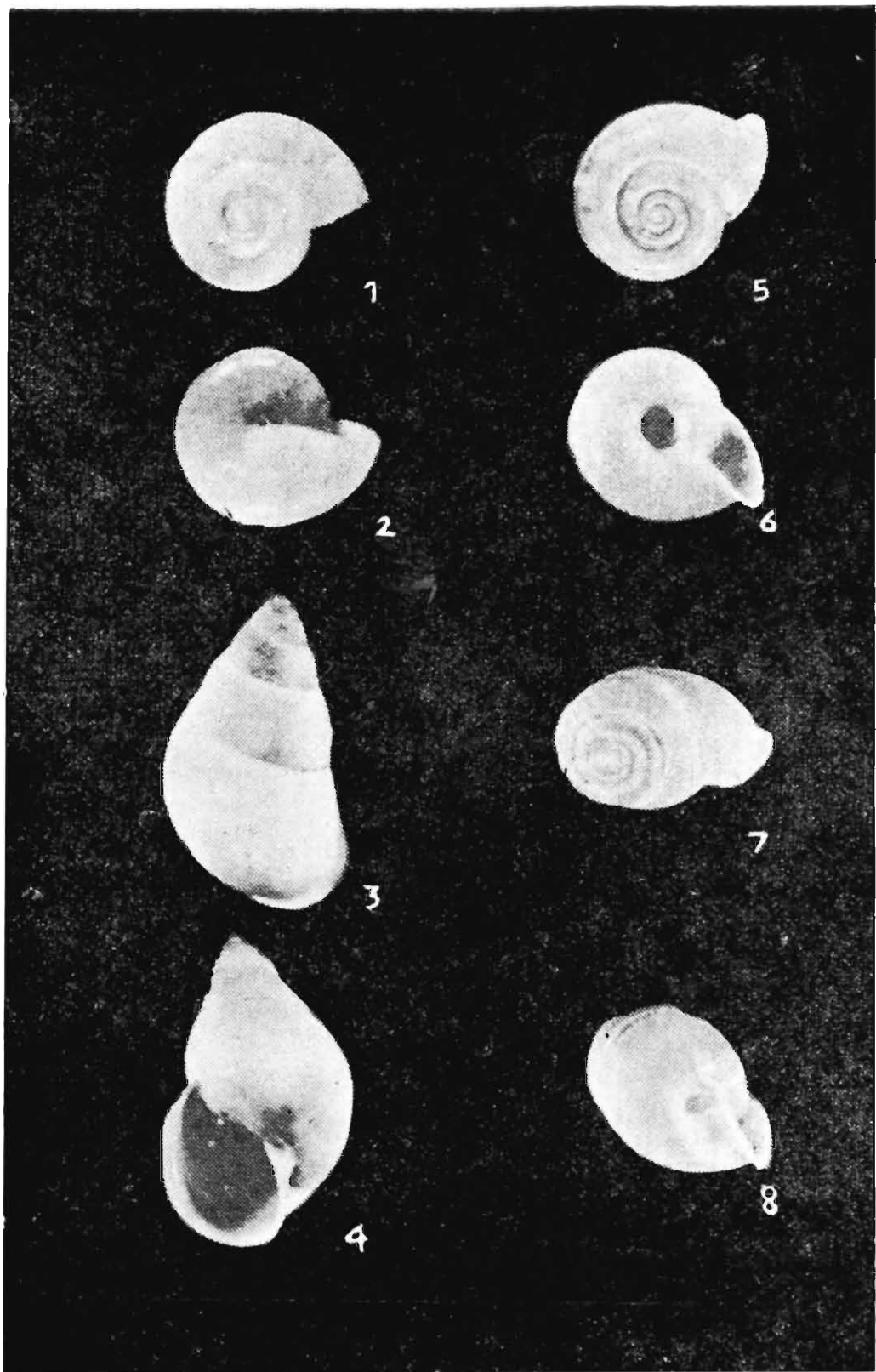
Figs. 1 & 2. Showing general ecology of Darlak (Mizoram)



Name of species	View	Height of the shell
1. <i>Cyclophorus theobaldia</i> Benson	Dorsal	25.10 mm
2. <i>Cyclophorus theobaldia</i> Benson	Ventral	25.10 mm
3. <i>Plectopylis affinis</i> Gude	Dorsal	5.66 mm
4. <i>Plectopylis affinis</i> Gude	Ventral	5.66 mm
5. <i>Glessula tenuispira</i> (Benson)	Ventral	23.00 mm
6. <i>Cyclophorus zebrinus</i> (Benson)	Dorsal	21.55 mm
7. <i>Cyclophorus zebrinus</i> (Benson)	Ventral	21.55 mm
8. <i>Plectopylis plectostoma</i> (Benson)	Dorsal	4.60 mm
9. <i>Plectopylis plectostoma</i> (Benson)	Ventral	4.60 mm



Name	View	Height of the Shell
1. <i>Plectotropis tapeina</i> (Benson)	Dorsal	7.60 mm
2. <i>Plectotropis tapeina</i> (Benson)	Ventral	7.60 mm
3. <i>Sivella castra</i> (Benson)	Dorsal	4.45 mm
4. <i>Sivella castra</i> (Benson)	Ventral	4.45 mm
5. <i>Khasiella climacterica</i> (Benson)	Dorsal	8.75 mm
6. <i>Khasiella climacterica</i> (Benson)	Ventral	8.75 mm
7. <i>Macrochlamys vesica</i> Godwin-Austen	Dorsal	8.60 mm
8. <i>Macrochlamys vesica</i> Godwin-Austen	Ventral	8.60 mm
9. <i>Girasia burtii</i> (Godwin-Austen)	Lateral	33.00 mm



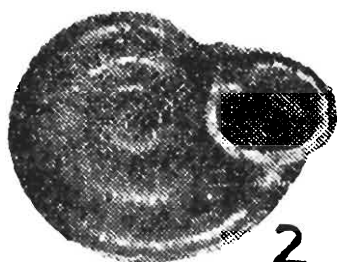
Name	View	Height of the Shell
1. <i>Staffordia daflaensis</i> Godwin-Austen	Dorsal	2.95 mm
2. <i>Staffordia daflaensis</i> Godwin-Austen	Ventral	2.95 mm
3. <i>Amphidromus sylheticus</i> (Reeve)	Dorsal	31.50 mm
4. <i>Amphidromus sylheticus</i> (Reeve)	Ventral	31.50 mm
5. <i>Chloritis delibrata</i> var. <i>fasciata</i> (Godwin-Austen)	Dorsal	4.50 mm
6. <i>Chloritis delibrata</i> var. <i>fasciata</i> (Godwin-Austen)	Ventral	4.50 mm
7. <i>Haploptychius burmanicus</i> (Blanford)	Dorsal	4.40 mm
8. <i>Haploptychius burmanicus</i> (Blanford)	Ventral	4.40 mm



1



4



2



5



3



6



7

Name	View	Height of the Shell
1. <i>Pterocyclus parvus</i> (Pearson)	Dorsal	8.35 mm
2. <i>Pterocyclus parvus</i> (Pearson)	Ventral	8.35 mm
3. <i>Glessula gemma</i> (Reeve)	Dorsal	7.60 mm
4. <i>Macrochlamys petasus</i> (Benson)	Dorsal	4.80 mm
5. <i>Macrochlamys petasus</i> (Benson)	Ventral	4.80 mm
6. <i>Glessula gemma</i> (Reeve)	Ventral	7.60 mm
7. <i>Girasia radha</i> (Godwin-Austen)	Lateral	65.20 mm

Measurements (in mm) :

Length of the shell	Width of the shell	Height of the aperture
15.62-23.00	5.10-6.08	4.20-5.20

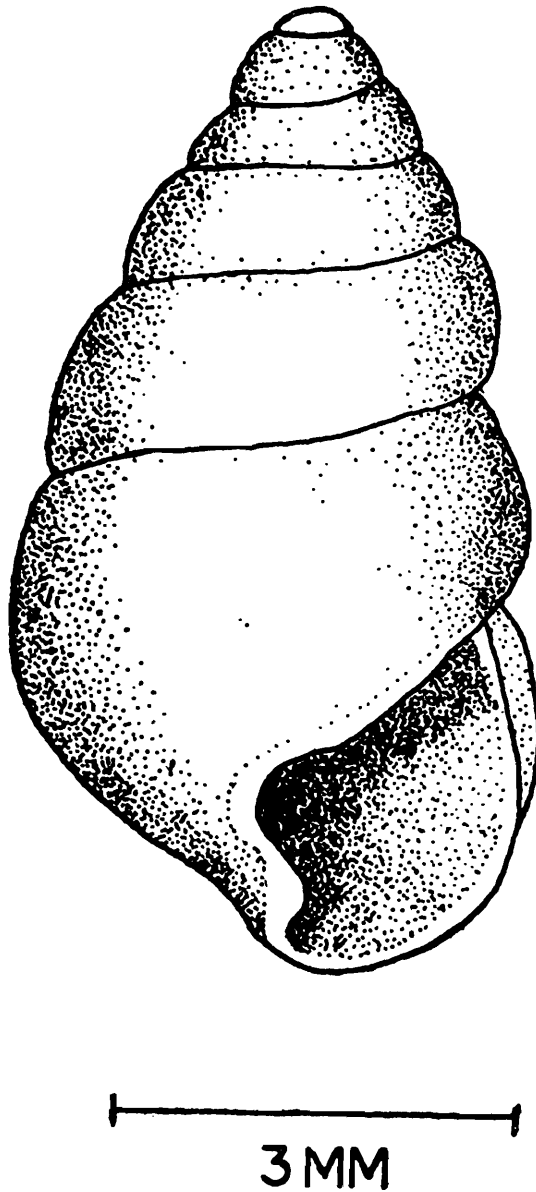


Fig. 10. *Glessula gemma* (Reeve) (Ventral view)

Distribution : INDIA : Meghalaya, Mizoram, West Bengal.
Elsewhere : Burma.

Family : STREPTAXIDAE

Genus : *Haploptychius* Von Mollendorff, 1906

22. *Haploptychius burmanicus* (Blanford)

(Pl. IV, figs. 7 & 8)

Streptaxis burmanicus Blanford, 1864. *J. Asiat. Soc. Beng.*, 33 : 245.

Streptaxis burmanicus : Blanford and Godwin-Austen, 1908. *Fauna of British India, Mollusca* (Testacellidae and Zonitidae), p. 6.

Material examined : 1 ex., Darlak.

Measurements (in mm) :

Height of the Shell	Width of the shell	Height of the aperture
4.40	7.75	2.00

Remarks : This species is for the first time recorded from India.

Distribution : India : Mizoram.

Elsewhere : Burma

SUMMARY

Twenty three species of land molluscs under 17 genera and 9 families are recorded in this paper. While all the 23 species are new records from Mizoram, two species *Macrochlamys petasus* (Benson) and *Haploptychius burmanicus* (Blanford) are new records from India, being hitherto known from Burma. Five species viz. *Plectopylis affinis* Gude, *Girasia burti* Godwin-Austen, *G. radha* Godwin-Austen, *Staffordia daflaensis* Godwin-Austen and *Chloritis delibrata* var. *fasciata* (Godwin-Austen) are endemic to north-eastern region of the country.

ACKNOWLEDGMENT

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ON *IDIOMERUS* IMMS (1912) FROM INDIA
(COLLEMBOLA ; ENTOMOBRYIDAE :
PARONELLINAE)

By

S. K. MITRA

Zoological Survey of India

INTRODUCTION

The queer "humped-back" paronelline genus, *viz.*, *Idiomerus* was described by IMMS (1912) from Western base of the Western Ghats, South India on the basis of following salient characters : (i) remarkable form of mesonotum, which projects upwards in the form of a cone above the level of the body ; (ii) Ocelli 16, 8 in each ocellar field ; (iii) post antennal organ absent ; (iv) antennae 5-jointed, basal segment shortest, and distal one longest ; (v) body scaled. Since its discovery, no detailed study of this genus has so far been undertaken. Examination of numerous topotypes of this species, collected by the author, as well as some collections from the Silent Valley, Kerala, South India, reveals the existence of many important features, which remain obscure so far in this genus.

Of the diagnostic characters, given by Imms (*l. cit.*), character (i) is the most distinctive, while others are common to the scaled genera of Paronellinae. Five segmented antennae, stated by IMMS, should better be considered as four segmented, first segment being antennal base as in other genera under Paronellinae. Moreover, the exaggeration of "umbonate" mesothorax remains linked with the age of the specimens (Pl. I). The genus is a good member of Callyntrurini in the presence of pseudoscales varying from lanceolate to round and truncated apices as in *Dicranocentroides* Imms. IMMS (1912) altogether overlooked the presence of two closely apposed rows of spines on dentes in *Idiomerus*, which is reported for the first time in

this genus. Further, the discovery of extra ocular structure (e.o.s.) in this genus makes it extremely interesting biogeographically ; this structure was noticed for the first time in some ethiopian and neotropical genera of Paronellinae (MITRA 1972 ; MITRA & DALLAI, 1980).

TAXONOMIC ACCOUNT

Idiomerus Imms, 1912

Redefinition : Large species, measuring 3-4 mm ; mesothorax prominently humped posteriorly, degree of prominence varying with the age of the specimens (Pl. I) ; antennae with four segments, subequal to body, Ants. I, II, III with long outstanding macrochaetae (cf. *Dicranocentroides*) ; clothed with transitional pseudoscales and flexed macrochaetae ; ocelli 8+8 ; e.o.s. characteristic (Fig. 6A) ; frontal spines 4+4 ; prelabral setae 4, apparently smooth, labral setae 5, 5, 4 ; legs all similar, unguis with prominent external basal, normal paired inner basal and a distal unpaired teeth ; unguiculi lanceolate, inner angles prominent, mid-rib appears serrated, if viewed laterally ; tenent hairs well-developed, clavate, tibiotarsal lobes prominent ; ventral tube long, anterior face with 4 ciliated macrochaetae and numerous apparently smooth, long slender setae ; rami of retinaculum each with 4 teeth, corpus with a median seta ; furcula long, mucrodens longer than manubrium ; each dentes armed with two closely apposed rows of spines, distally conspicuously ciliated, transiting into stiff setae ; mucrone short, broad with 6 prominent teeth, rest of the ventral margin variable ; dental scale appendage absent.

Type-species : *Idiomerus pallidus* Imms, 1912 by monotypy and original designation.

Idiomerus pallidus Imms, 1912

(Figs. 1-7, pl. I-III)

1912. *Idiomerus pallidus* Imms, *Proc. zool. Soc. London*, 1912, p. 114.

Colouration : Ground colour of body yellow with variable bluish black pigment, head capsule pigmented anteriorly almost

in all examples examined including juveniles, males darkest having head entirely, Th. II anteriorly and Abd. IV posteriorly pigmented, legs and antennae also pigmented (Pl. I, d) ; males



Fig. 1. *Idiomerus pallidus* Imms. A, mouth parts (mxl, maxilla ; l, lacinia ; hy, hypopharynx ; g, galea ; p, palpus) ; B, mandible, C, trochanter.

in life, exhibit beautiful golden pigment with shining metallic iridescence posteriorly on head, Ths. II, III, Abds. I, II, III and on proximal region of Abd. IV [cf. males of *Dicranocentroides fasciculatus* Imms (MITRA, 1975)] ; ventral tube dark

pigmented in males, devoid of pigment in juveniles and females.

Clothing : Body clothed with flexed macrochaetae, pseudoscales and dark scale primordia remaining interspersed on general surface of body ; nature of macrochaetae similar to those of *Campylothorax* (MITRA & DALLAI, 1980) ; antennae

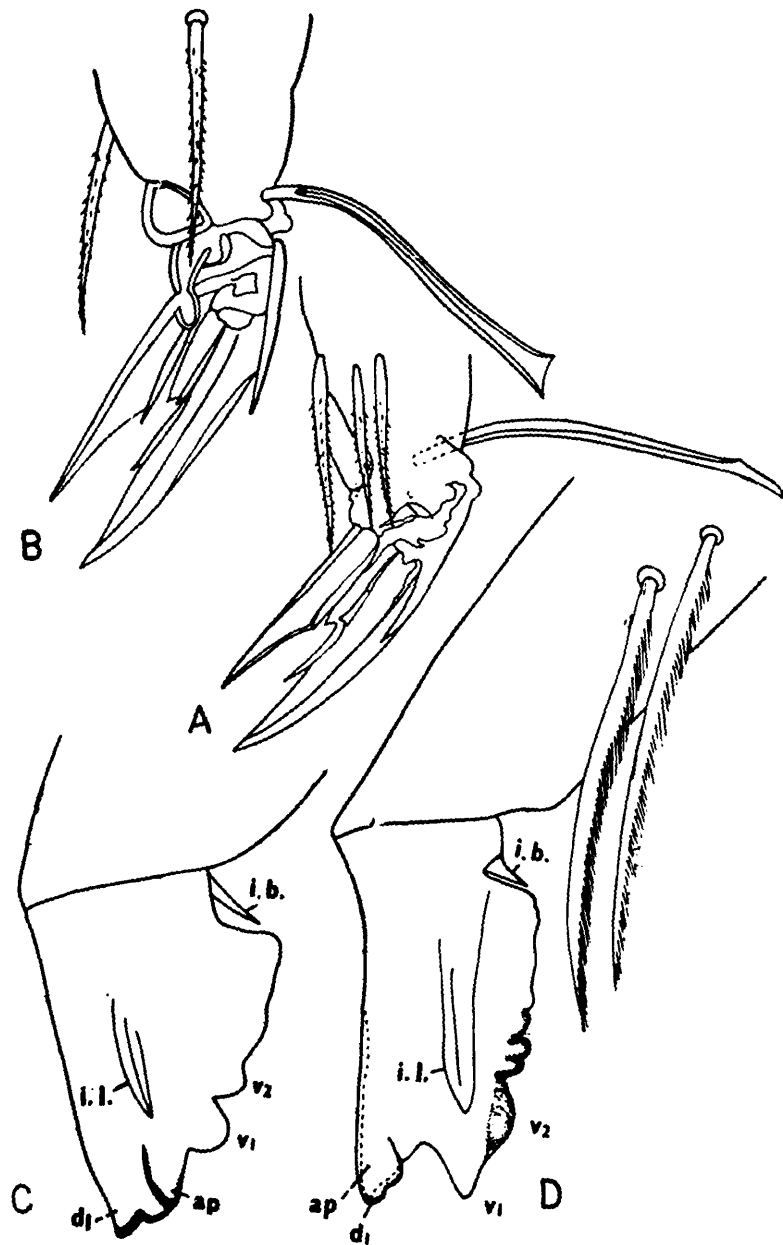


Fig. 2. *Idiomerus pallidus* Imms. A, foot complex of leg II ; B, foot complex of leg III ; C, D, mucrones.

and furcula clothed with long, claviform scales and setae, scales present dorsally on furcula ; Ants. I, II, III with some strikingly long outstanding setae ; legs clothed with setae only, femora with some very long, slender setae ; body scales

very coarsely ciliated (Pl. II, 5) and appear dark with blunt to acute apices and some time truncated, scale primordia dark, very coarsely ciliated.

CHAETOTAXY

Head (Fig. 6A) : Vertex with V_{1-4} , all macrochaetae, $V_1 - V_1$ located in a straight line, chaetotaxy of vertex



Fig. 3. *Idiomerus pallidus* 1mms. A, labrum ; B, chaetotaxy of ventral tube (anterior face) ; C, arrangement of spines on dentes.

characteristic ; subdorsal region represented by 25 microchaetae (sd_{1-25}), dorsal region with d_{1-4} , d_{1-2} unpaired, D_4 represented by a macrochaeta, besides, 5–6 variable micro-

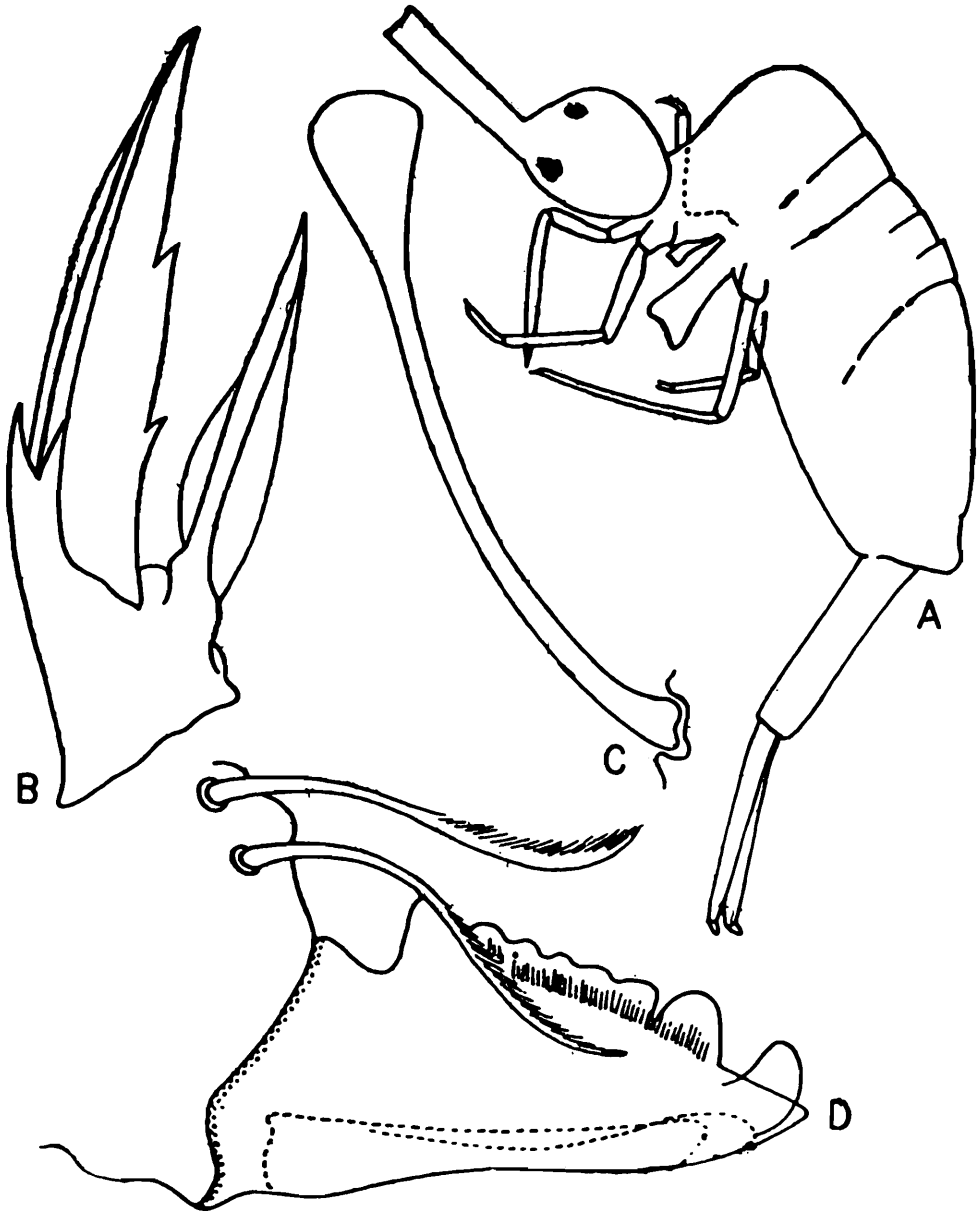


Fig. 4. *Idiomereus pallidus* 1mms. (Lectotype). A, profile ; B, foot complex ; C, tenent hair ; D, mucrone.

chaetae occur in this region ; ocular region with OC_{1-3} , OC_2 , a macrochaeta (cf. *Salina* McGillivray, *Callyntrura* Börner, *Yosiia* Mitra) ; parietal region with p_{1-3} , P_3 a macrochaeta ; postocular region with PO_1 , a macrochaeta.

Body (Fig. 5) : Th. II (20), Th. III (13), Abd. I (3), Abd. II (4) and 1 pseudopore on each side, Abd. III (1), Abd. IV medially with 13 macrochaetae on each side arranged in a

transverse row and postero-medially with 18 localized setae on each side, Abd. V with 2 unpaired median and 10 setae on each side.

Head : Pear shaped, longer than broad ; 8+8 ocelli, each group arranged in two longitudinal parallel rows, G and

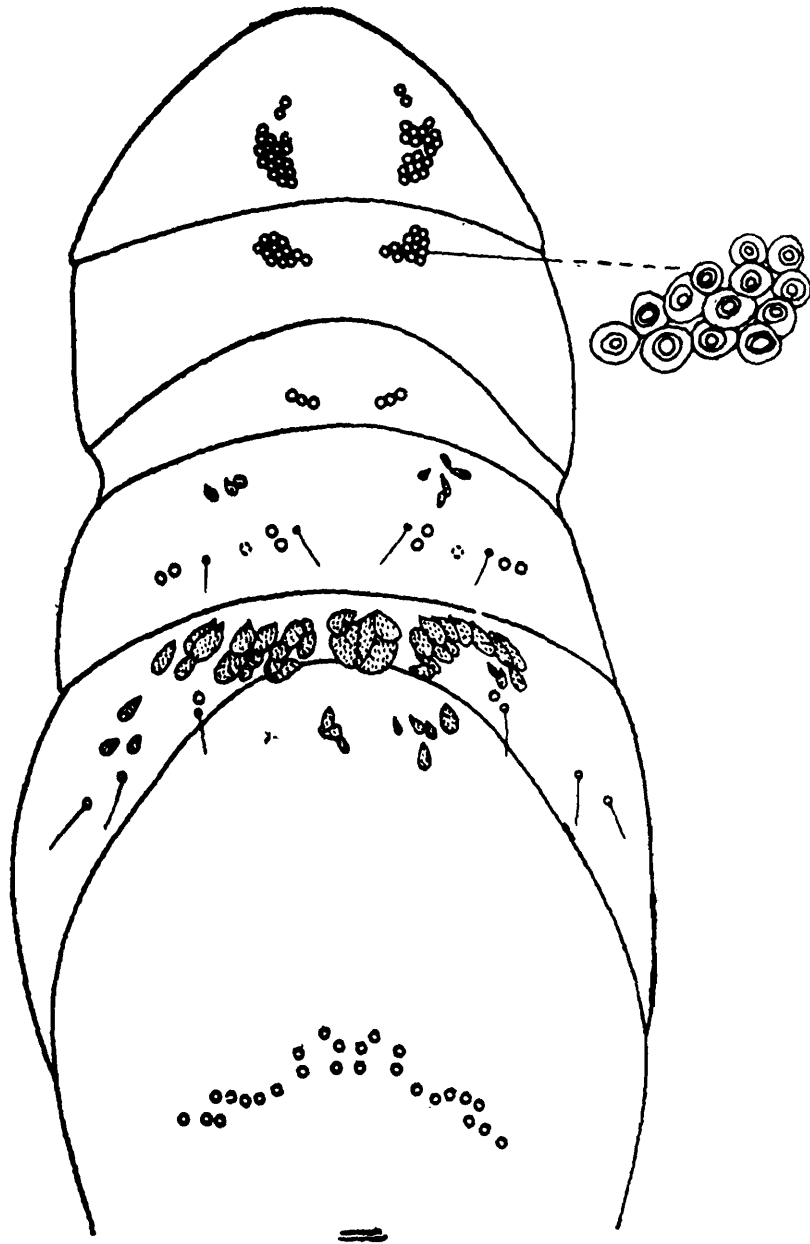


Fig. 5. *Idiomerus pallidus* Imms. Body chaetotaxy.

H smallest (Fig. 6, A ; Pl. II, 2, 3) ; antennae four segmented, subequal to the length of head and body, antennal base prominent, relative length index of Ants. I : II : III : IV = 25 : 27 : 24 : 38, antennal length variable ; head diagonal/Ant. I = 28/25 ; 4+4 frontal spines present (Cf. *Callyntrura*) ; sense-knob apically on Ant. IV inconspicuous guarded with

a few apparently smooth setae (sense rods) ; prelabral setae 4, apparently smooth, labral setae 5, 4, 4, anterior margin.

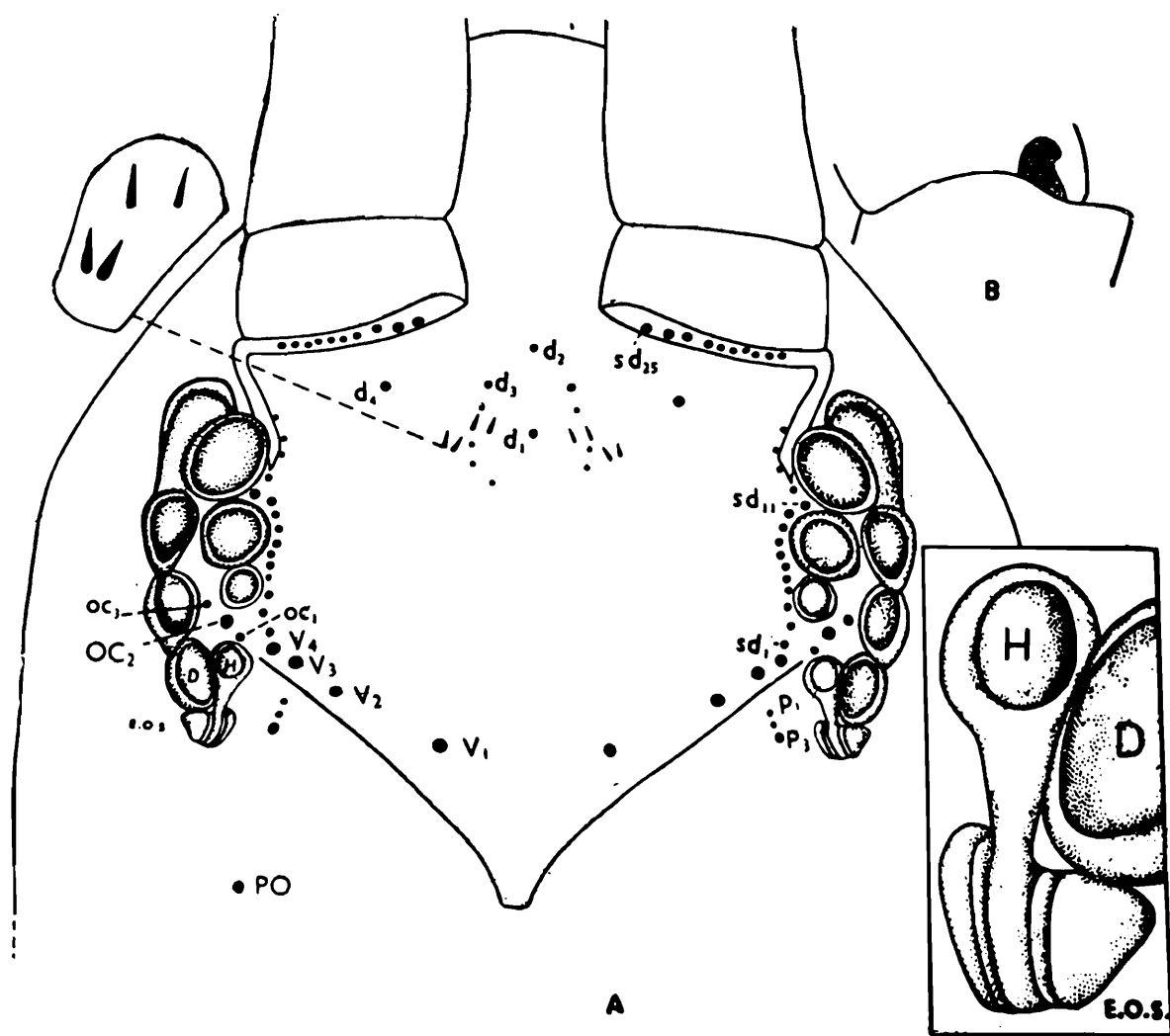


Fig. 6. *Idiomerus pallidus* Imms. A, chaetotaxy of head ; B, "thumb-like" appendage at the junction of manubrium and dentes.

with characteristic cuticular ledges (Fig. 3, A) ; e.o.s. characteristic for the genus, triangular in shape with a short stalk connected with the ocellus H (Fig. 6, A ; Pl. II, 2, 3) ; mouth-parts typical, mandible apically with 5 large and a small sixth tooth, molar area well developed with variable grinding ridges (Fig. 1, B) ; maxilla consists of a lacinia with 34-36 lamellae, dentate apically, hypopharynx broadened apically with a stylet and a serrated, semicircular, fan-shaped process medially, galea broad, palpus with two long smooth setae. (Fig. 1, A).

Thorax : Th. II prominently humped posteriorly, degree of prominence varies with the age of the individuals ; in juveniles, humping not so pronounced (Pl. 1, II), Th. III

considerably reduced, relative length index of Th. II: III = 18 : 5 ; legs all similar, tibiotarsi superficially divided, tibiotarsal lobes prominent ; ungues slightly curved with paired inner basal and single distal unpaired teeth, external basal

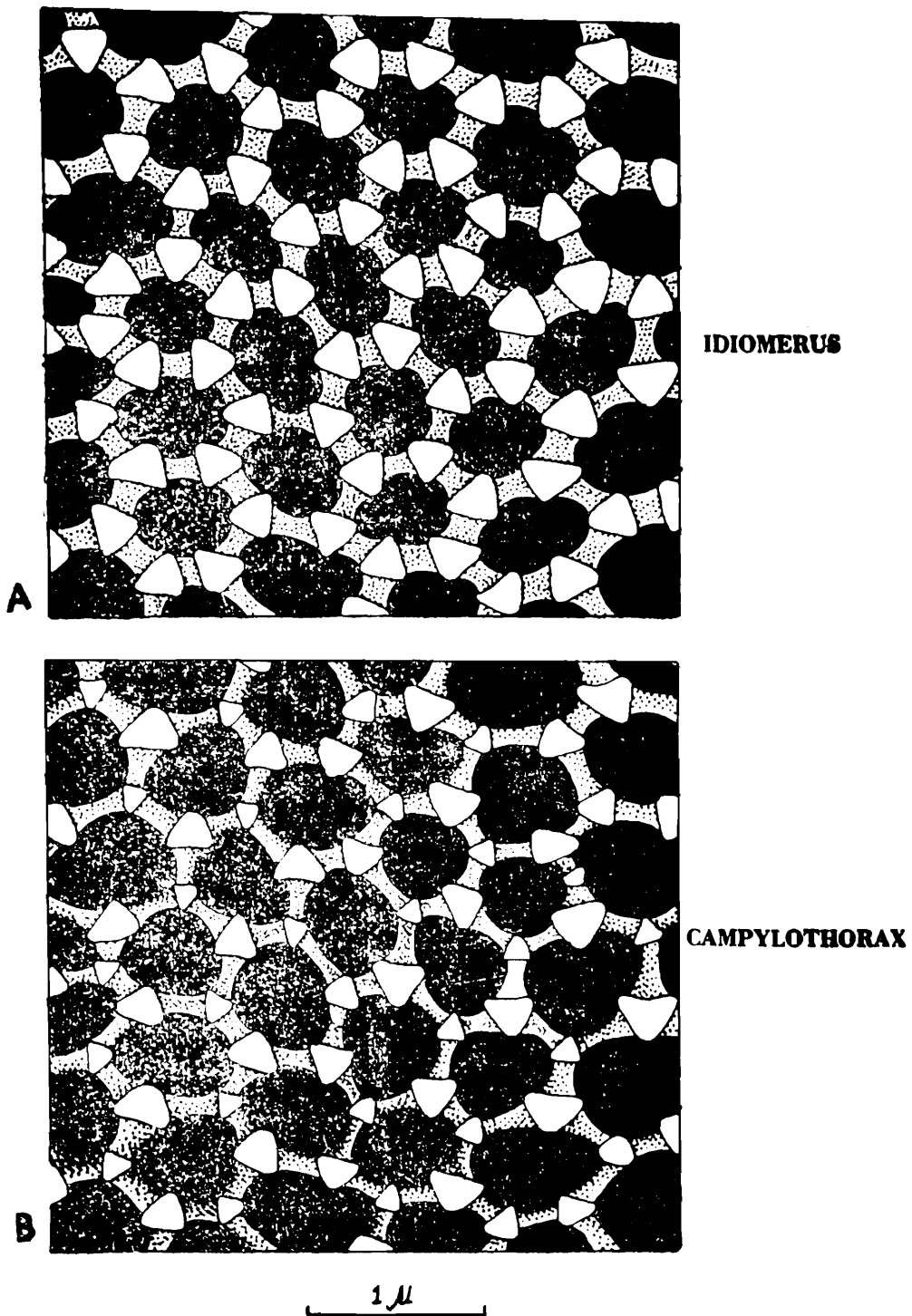


Fig. 7. Cuticular ornamentation (adopted from S.E.M. photomicrographs), A, *Idiomerus pallidus* Imms ; B, *Campylothorax longicornis* Schött.

teeth well developed ; unguiculi lanceolate, inner angles prominent, mid-rib appears serrated when viewed laterally ;

tenent hairs long, clavate (Fig. 2, A, B) ; distally on femur, near junction with tibiotarsus, two large spines occur ; trochanteral organ consists of *c.* 51 spines.

Abdomen : Relative length index of Abds. I : II : III : IV : V : VI = 4 : 8 : 4 : 40 : 9 : 3 ; ventral tube long, anterior face with 4+4 macrochaetae, general surface clothed with many slender non-ciliated setae (Fig. 3, B), rami of retinaculum each with 4 teeth, corpus with a median seta ; mucrodens long, stout, relative length index of manubrium : dentes = 30 : 40, dentes not crenulated, with two closely apposed rows of spines, spines present distally conspicuously ciliated, transiting into stiff setae (Fig. 3, C) ; dental scale appendage absent ; manubrium distally near the junction with dentes with a "thumb-shaped" sclerotized appendage — "manubrial hook" (Fig. 6, B) ; mucrones short, broad with six teeth *viz.*, ap., d_1 (showing tendency to differentiate into two teeth), V_1 , V_2 i.l., i.b. (spiniform), rest of the ventral margin variable (Fig. 2, C, D).

Length (excluding appendages) : 3-4 mm

(3.5-5 mm according to IMMS, 1912)

Material examined : Single syntype, existing in the British Museum (Natural History), London ; *topotypes* : From the sides of a hill stream, ex, surface of moist litter mostly composed of bamboo leaves, Venkolla, Madathara, Quilon district, Kerala, South India, *c.* 250 exs. (with juveniles) in several vials, S.K. MITRA & Party coll., 14th December, 1976 ; *other localities* : Silent Valley Expedition, 1980 : Valliaparathodu, from debris of hill stream, 10 km N.W. of of base camp, 6th September, 1980, 65 exs. ; Valliaparibodu, 2 km west of Camp-2, 18th April, 1980, 5 exs., A.K. HAZRA coll.

Type-specimens : IMMS' (1912) description of *I. pallidus* was based on five specimens (syntypes) out of which he deposited one syntype in the British Museum (Natural History), London. There is one vial, bearing the same Registration No. $\frac{4381}{16}$, as given by IMMS (1912), in the collections of the Zoological Survey of India, Calcutta, with

the label reading as "*Idiomerus pallidus*"; but this contains entirely a different specimen of Collembola. In the event of loss of those syntypes from "Indian Museum" the sole syntype remaining in the British Museum (Natural-History), London has the status of lectotype (Fig. 4, A-D). Further more, the label of the syntype, mounted on a slide, in the above museum bears the same marks of locality, date and collector, as given by IMMS (1912) in his original description.

Type-locality : Madathara (spelt by IMMS as "Maddathoray"), Quilon district, Kerala, India.

CUTICULAR CONFIGURATIONS

Attempt was made to study some specimens through the Scanning Electron Microscope at the Regional Sophisticated Instrumentation Centre (Bose Institute) and Geological Survey of India, Calcutta. In the absence of adequate facilities for preparation of the biological material, though good photomicrographs could not be obtained, it was, however, clear that the cuticular ornamentation of *I. Pallidus* is typical as that found in Entomobryomorpha (DALLAI & FERRARI, 1970 ; LAWRENCE & MASSOUD, 1973) consisting of a uniform hexagonal net work composed of triangular primary granules of the same dimension (Fig. 7, A).

AFFINITIES

HANDSCHIN (1925) considered *Idiomerus* Imms related to *Campylothorax* Schött on the basis of the "humped" nature of the thorax in both the genera (Th. II humped in *Idiomerus* vs. Th. III in *Campylothorax*).

Now, discovery of e. o. s. and dental spines in *Idiomerus* may appear to strengthen this contention. The genus has a mosaic of characters common to *Campylothorax*, *Callyntrura* Börner and *Dicranocentroides* Imms. Barring the mesothoracic hump and e. o. s., common characters which it shares with *Dicranocentroides* and *Callyntrura*, are the presence of pseudoscales, polychaetotic condition and 3 ocular setae. Since both *Callyntrura* and *Idiomerus* possess 4+4 frontal spines, *Idiomerus* appears close to *Callyntrura*.

With *Dicranocentroides*, *Idiomerus* shares the characters like, (i) apparently smooth prelabral setae, (ii) presence of very long outstanding macrochaetae on Ants. I, II, III, (iii) short, broad mucrones (general dentition pattern though different in two genera) and (iv) presence of dental spines in addition to aforesaid three features, common to *Callyntrura* and *Dicranocentroides*.

The spiniform inner basal tooth of mucrone in *Idiomerus*, however, reminds the basal spine of some genera of Entomobryinae, specially, *Lepidocyrtus*.

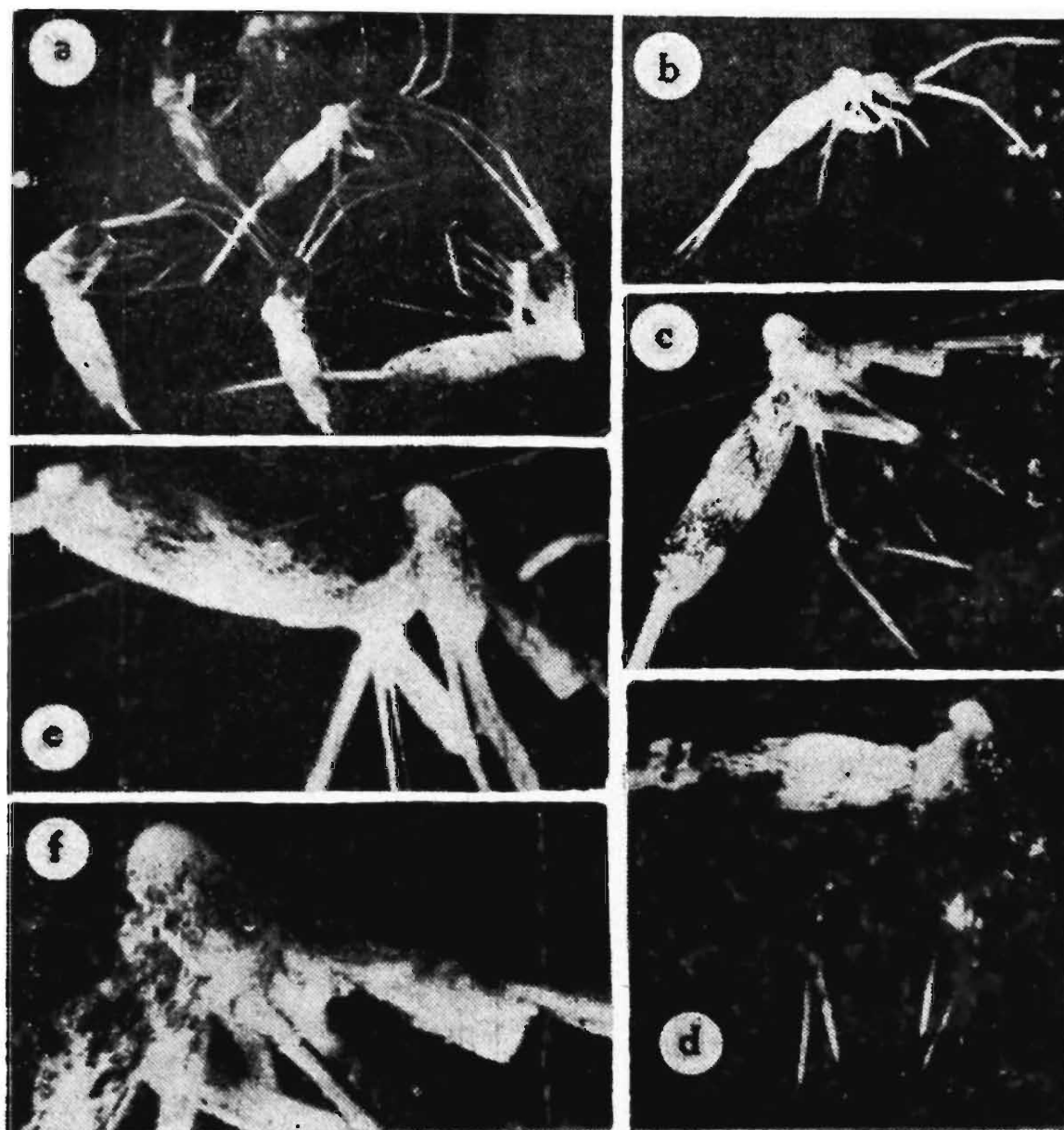
Idiomerus is unique in its cephalic chaetotaxy, specially that of vertex (by reduction of macrochaetae)—the only character which remains linked with its most specialised humped mesothorax including its characteristic mucronal pattern and body chaetotaxy.

PHYLOGENY AND BIOGEOGRAPHY

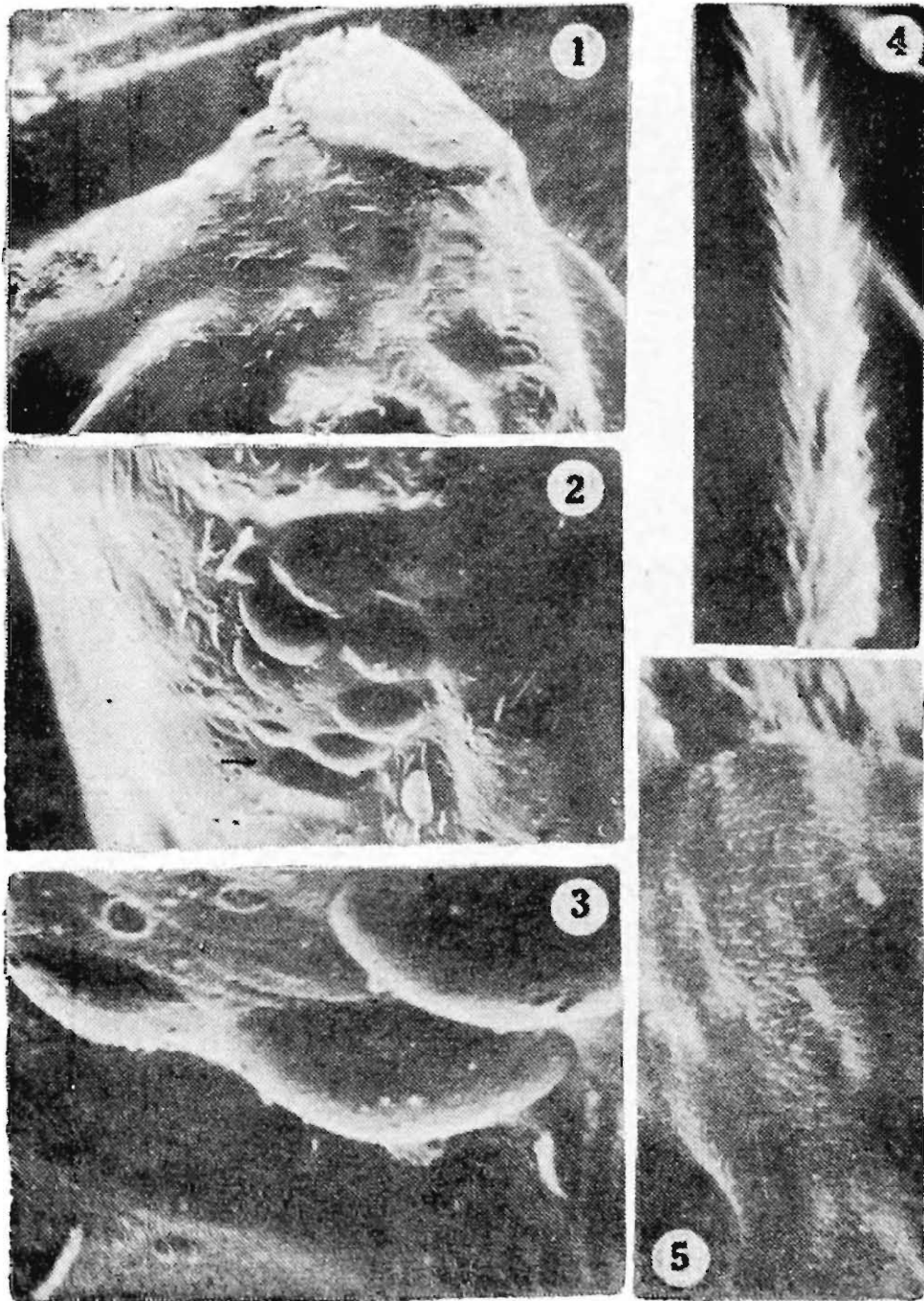
Presence of e.o.s. in *Idiomerus*, found only in the ethiopian and neotropical genera of Paronellinae like *Campylothorax* and *Paronella* (MITRA 1972 ; MITRA AND DALLAI, 1980), poses a question if the Indian genus is very primitive one having originated from the same precursor of the forms that gave rise *Campylothorax* and *Paronella*. If it is so, then the precursor of these forms might have existed in the Gondwanaland Continents. Conversely, if e.o.s. is an apomorphic character, developed independently as a consequence of parallel evolution in response to similar stimuli at a later period, then the genus is a specialized off-shoot from a common ancestral stock that gave rise to *Callyntrura* and *Dicranocentroides*. In fact, large number of characters shared by *Idiomerus* with *Dicranocentroides* and *Callyntrura*, mentioned above, leans heavily on the last possibility. Further, cuticular configurations at ultra structural level of *Idiomerus* (Fig. 7A) is widely different from *Campylothorax* but similar to *Callyntrura* and other entomobryomorph genera (DALLAI & FERRARI, 1970 ; LAWRENCE & MASSOUD, 1973 ; MITRA & DALLAI, 1980).



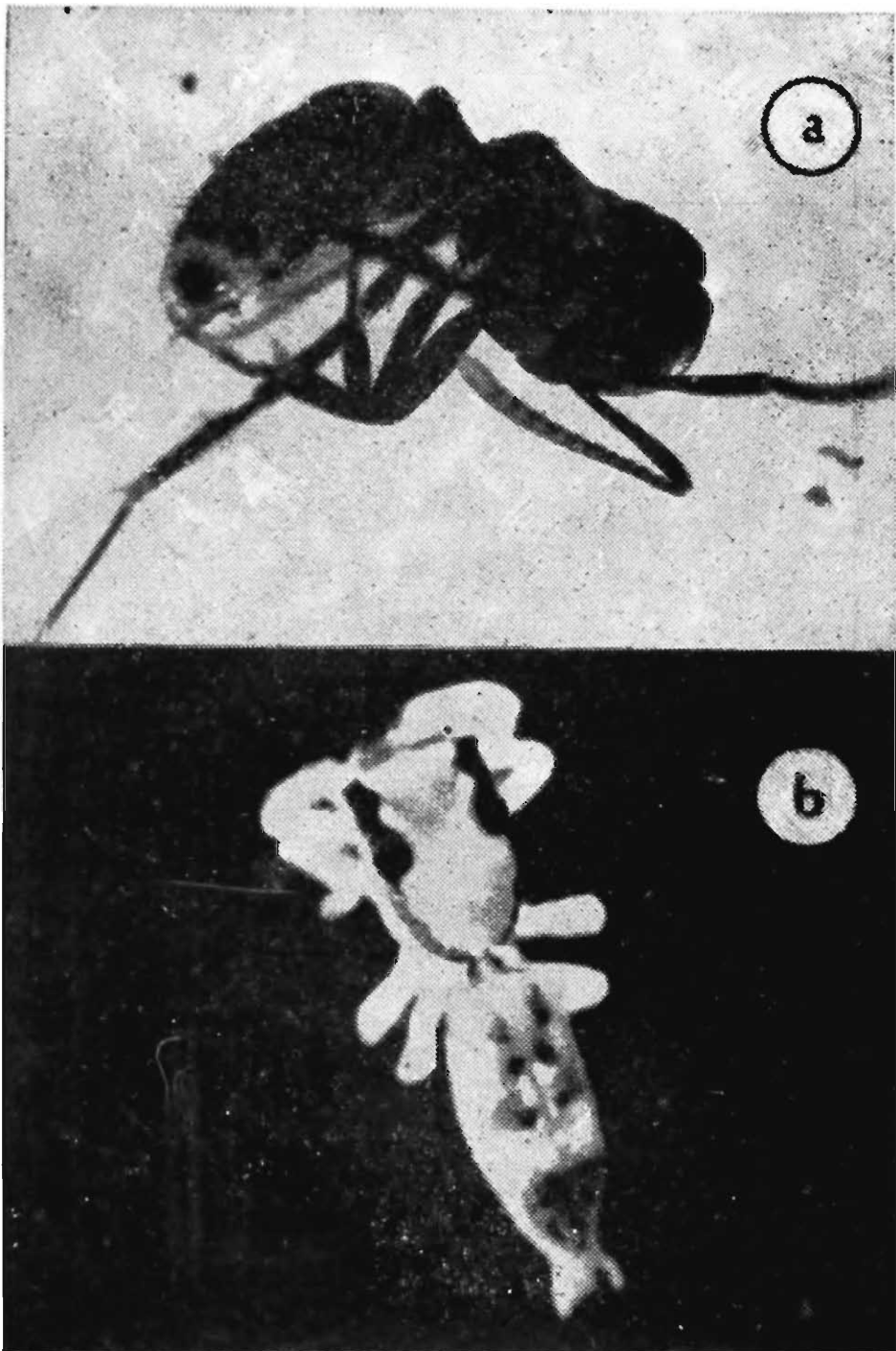
A view of the hill stream in
the type-locality of *Idiomerus pallidus*
(Madathara, Kerala, India)



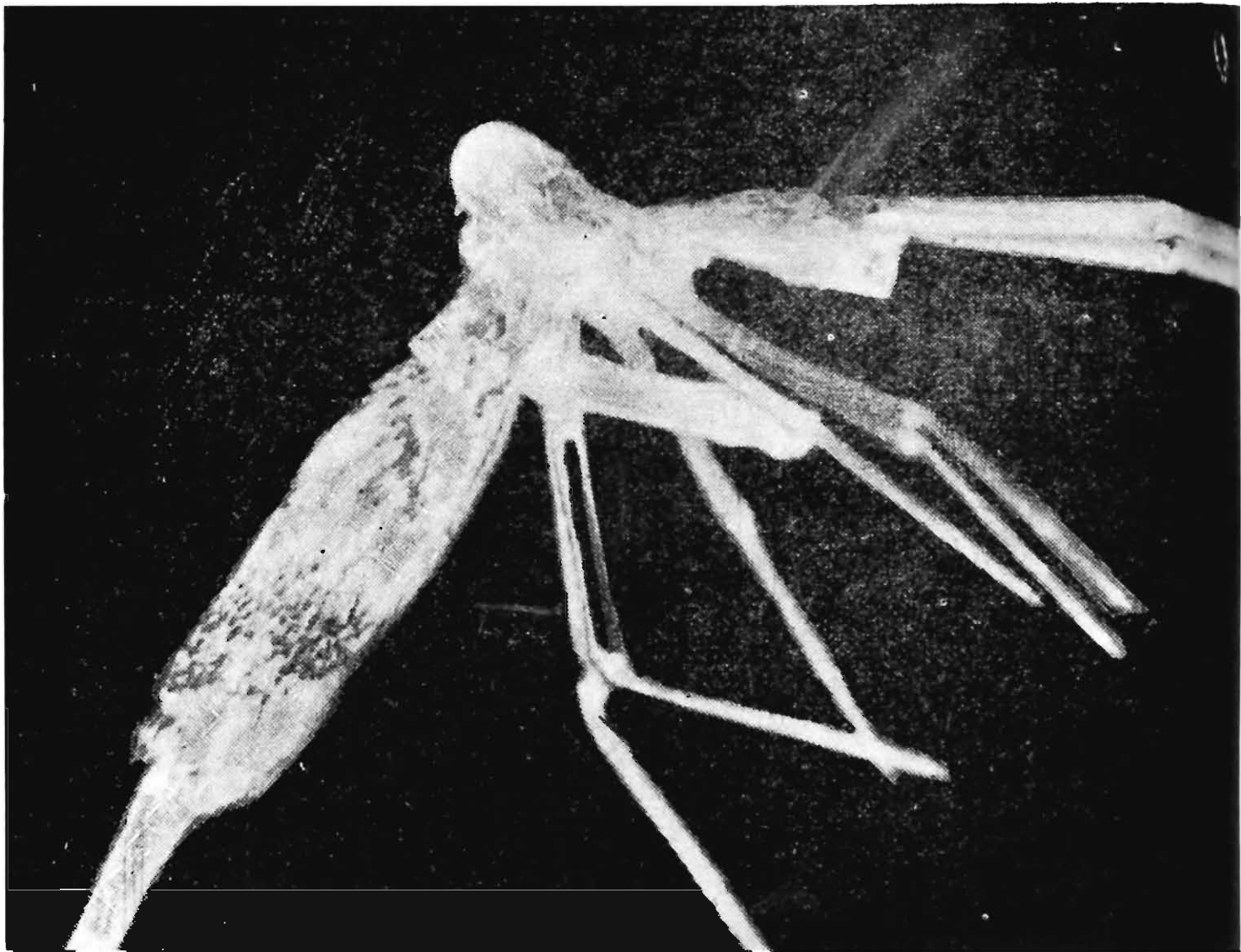
Idiomeres pallidus Imms. Profile : a, juveniles ; b, a very young juvenile ; c,e,f, females ; d, a male.



Idiomerus pallidus Imms. 1, body (anterior portion) showing "hump" on Th. II ; 2, Ocellar field (e.o.s., indicated by an arrow as seen underneath scales) ; 3, ocelli C, D, H, (e.o.s., underneath scales) : 5, a body scale.



Associates of *Idiomerus pallidus* Imms. a, ant (*Ponera* sp.) ; b, spider (*Marpissa* sp.)



Idiomerus pallidus Imms. Adult (Female).

HABITAT AND ASSOCIATION

Idiomerus pallidus is found to occur invariably by the sides of flowing hill stream at its type-locality and at Silent Valley. It creeps on the surface of moist litter, chiefly composed of the leaves of *Bambusa* at shady places besides the hill stream. At both the localities, it remains associated with a species of black ant, viz., *Ponera* sp. (Formicidae : Ponerinae) and their behaviour and orientation patterns are almost identical (Pl. III, a). A spider, viz., *Marpissa* sp. (Salticidae) was also found to occur in its association (Pl. III, b). It was not seen, however, that any of the two species is predating upon *I. pallidus*, though potentially they may act as predators.

SUMMARY

The queer "humped-back" paronelline genus, viz., *Idiomerus* was described by Imms (1921) from India. It is characterised by the presence of a conspicuous hump on mesothorax. Since its discovery, no detailed study on this genus was undertaken so far. The investigator had an opportunity to collect and study numerous topotypes and collections from other localities of Kerala, South India including the syntype in the British Museum (Natural History), London. In this investigation, many details of this genus like the presence of extra ocular structure, dental spines, pseudoscales, which remained obscure so far, are revealed. The genus is found to have a mosaic of characters common to *Campylothorax* Schött, *Callyntrura* Börner and *Dicranocentroides* Imms. Its affinities, phylogeny and biogeography are also discussed.

ACKNOWLEDGEMENTS

I am thankful to Mr. P. N. LAWRENCE, British Museum (Natural History), London for providing me an opportunity to examine the type-specimen of *I. pallidus* and also for numerous courtesies. Thanks are also due to the Director, Zoological Survey of India, Calcutta for providing laboratory facilities, to the authorities of the RSIC at Bose Institute and Geological Survey of India, Calcutta for providing S. E. M. facilities, to Dr. A. K. HAZRA for assisting in

the collection, to Dr. B. K. BISWAS for the identification of the spider and Mr. R. N. TIWARI for identification of the ant.

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ICHTHYOFAUNA OF MAHARASHTRA
—DHULIA DISTRICT

By

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INTRODUCTION

The Ichthyofauna of Maharashtra has been the subject of only a few studies. Annandale (1919) studied the fish fauna of Satara and Poona districts. Frazer (1942), Tonapi & Mulherkar (1963), Tilak & Tiwari (1976) of Poona district, Kalawar & Kelkar (1956) of Kolhapur while Singh & Kamble (1987) surveyed Jalgaon district.

As no attempt had been made in the past to explore the faunal wealth of Dhulia district, three surveys were conducted in 1985-86 for the first time, under the mopping survey programme. This paper is based on fish material collected during these three surveys. Over 428 fish specimens, collected from 41 stations have been studied.

Dhulia district, formerly known as West Khandesh, lies between 20°38' and 22°3' North latitude and 73°47' and 75°11' East of longitude. The district has the ranges of Satpudas in the north and the Sahyadris in the west and south. The Satpuda mountain ranges stretch in a wall-like fashion between the Tapi and Narmada river basins. The Toranmal plateau at an height of 1,155 m is a part of the Satpuda. A large lake of about 2 km area is present near its south west corner. The Sahyadris (Western Ghats) are present on the south western part of the district and their ridges are scattered one behind the other, running from SW to NE in direction.

Two major rivers, the Narmada and Tapi flow through the district. The former is of little use as the river banks are quite steep. Excepting a small area in the north, rest of the

district is drained by the Tapi and its tributaries like Arunavati, Aner, Gomai, Bori, Panjhra, etc.

COLLECTING STATIONS (Fig. 1)

I. *Dhulia taluka*

1. Bori river, Arvi 4.12.85
2. Tank near Deopalithara vill., Laling 3.12.85
3. Panjhra river, Dhulia 2.12.85

II. *Sakri taluka*

4. Borai river, Vajadara 4.1.86
5. Panjhra river, Samoda 21.12.85
6. Kan river, Dahival 19.11.85
7. Kan river, Sakri 23.12.85
8. Jamkhel river, Samoda 21.12.85
9. Stream near Dang Siravade 24.12.85
10. Stream near Pratapapur 24.12.85
11. Shelbari river, Shevali 22.12.85

III. *Navapur taluka*

- | | | |
|-----|-----------------------------|----------|
| 12. | Stream near Navegaon | 28.12.85 |
| 13. | „ „ Gadat | 27.12.85 |
| 14. | „ „ Panbara | 29.12.85 |
| 15. | „ „ Paula | 30.12.85 |
| 16. | „ „ Nagajhiri | 26.12.85 |
| 17. | „ „ Gangapur | 29.12.85 |
| 18. | „ „ Borapada | 26.12.85 |
| 19. | „ „ Vadakhut | 29.12.85 |
| 20. | „ „ Bedakipat | 28.12.85 |
| 21. | Rangavali river, Navapur | 20.11.85 |
| 22. | Sukhi river, Vadada | 16.11.85 |
| 23. | Dapurzira river, Patibedaki | 19.1.86 |
| 24. | Nasu river, Marod | 21.1.86 |

IV. *Sindkhede taluka*

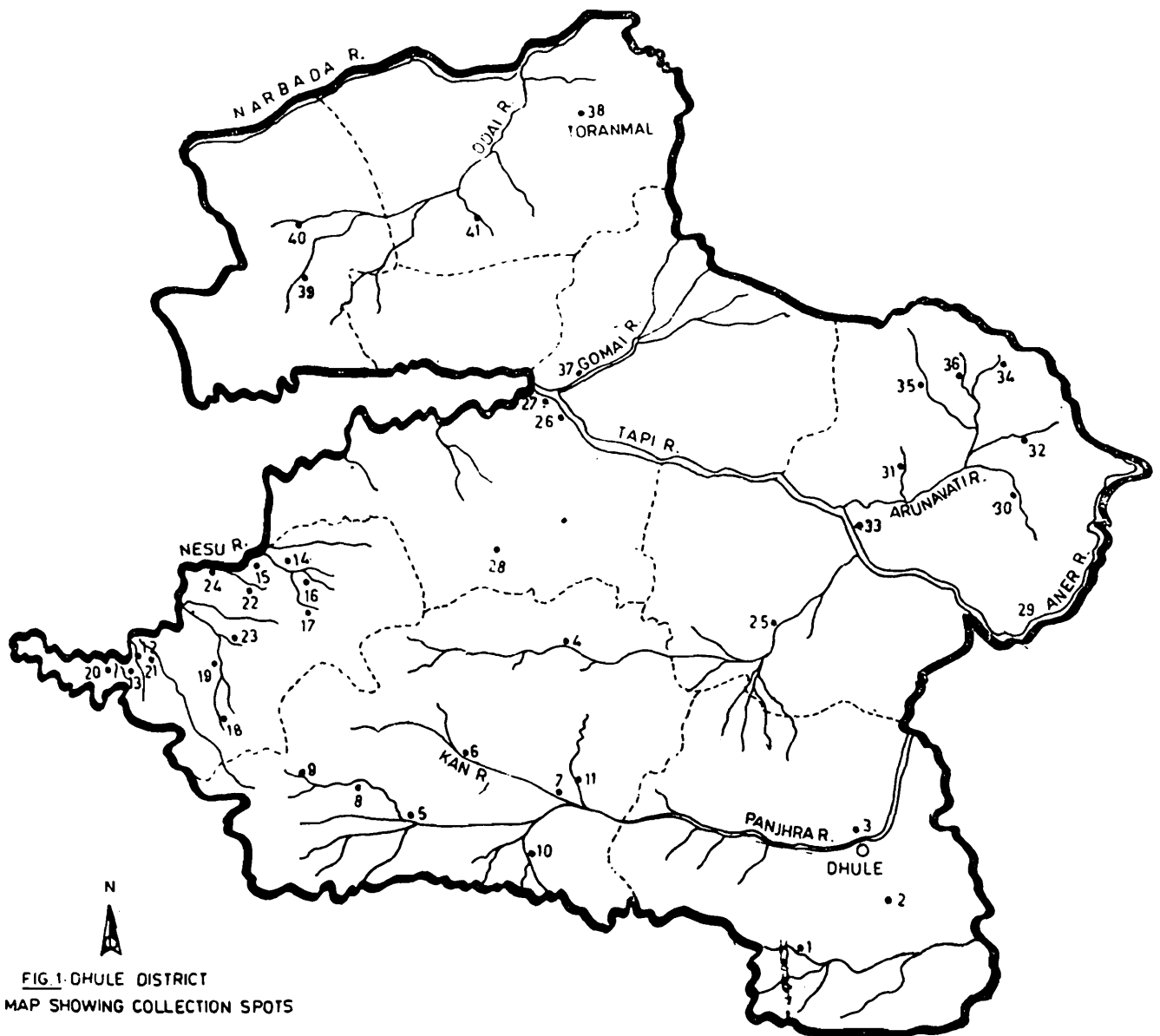
25. Borai river, Chimtane 2.12.85

V. *Nandurbar taluka*

26. Tapi river, Korut 18.11.85

27. " " , Gadartara 1.1.86

28. Ashta tank 4.1.86



VI. *Shirpur taluka*

- 29. Aner river, Khamkhed 30.11.85
- 30. Sherabai river, Sule 6.1.86
- 31. Bijapur nallah, Shirpur 6.1.86
- 32. Stream near Khambale 6.1.86
- 33. Tapi river, Gidhade bridge 27.11.85
- 34. Stream near Sendwa checkpoint (MS-MP border) 29.11.85
- 35. Arunavati river, Umarda 28.11.85
- 36. Stream near Boradi-Malkatar Road 28.1.86

VII. *Shahada taluka*

- 37. Gomai river, Shahada 2.1.86

VIII. *Akranimal taluka*

- 38. Lake, Toranmal 2.1.86
- 39. Stream near Molgi 22.11.85
- 40. Barekhat river, Bhagadari 23.11.85
- 41. Stream near Dhadgaon 25.1.86

SYSTEMATIC ACCOUNT

Class : Pisces
 Subclass : Teleostomi
 Order : Cypriniformes
 Family : Cyprinidae
 Subfamily : Rasborinae

Genus **Danio** Hamilton

1. **Danio aequipinnatus** (Mc Clelland)

1839. *Perilampus aequipinnatus* McClelland, *Asiatic Researches*, 19, p 393 (type loc : Assam)

Material : 42 ex. in total : * 11-4 ; 30-1 ; 31-7 ; 14-1 ; 15-5 ; 17-1 ; 4-6 ; 5-2 ; 8-1 ; 6-2 ; 33-1 ; 39-1 ; 34-2 ; 35-1 ; 40-6 ; 24-1.

Genus **Rasbora** Bleeker

2. **Rasbora daniconius** (Hamilton)

1822. *Cyprinus daniconius* Hamilton, *Fish Ganges* p 327, (type loc : rivers of Southern Bengal)

Material : 64 ex in total. 29-4 ; 9-2 ; 11-9 ; 30-5 ; 32-12 ; 18-1 ; 4-8 ; 7-4 ; 8-3 ; 6-3 ; 2-5 ; 40-4 ; 23-4.

Genus **Barilius** Hamilton

3. **Barilius bendelisis** (Ham.)

1807. *Cyprinus bendelisis* Hamilton, *Journey Mysore*, 3, p 345, pl. 32 (type loc : rivers of Mysore).

Material : 9 ex in total. 38-3 ; 4-1 ; 7-4 ; 35-1.

Subfamily : CYPRININAE

Genus **Schismatorhynchus** Bleeker

4. **Schismatorhynchus (Nukta) nukta** Sykes

1841. *Cyprinus nukta* Sykes, *Trans. Zool. Soc. London*, 2 p 355 (type loc : Mahloongeh, 18 miles north of Poona from the Indranee river).

Material : 2 ex in total. 26-2.

Genus **Puntius** Hamilton

5. **Puntius conchonius** (Ham.)

1822. *Cyprinus conchonius* Hamilton. *Fish Ganges*, pp 317, 389. (type loc : North east Bengal and rivers Kosi & Ami).

Material : 17 ex in total. 29-1 ; 13-12 ; 21-4.

* The first number indicates the Station No., followed by the number of examples collected from that locality.

6. **Puntius ticto** (Hamilton)

1822. *Cyprinus ticto* Hamilton, *Fish Ganges* pp 314, 389, p 18, Fig. 87 (type loc : South-eastern parts of Bengal).

Material : 74 ex in total. 29-1 ; 37-7 ; 30-1 ; 27-15 ; 32-6 ; 15-4 ; 10-2 ; 9-3 ; 4-1 ; 20-12 ; 5-1 ; 8-6 ; 25-3 ; 6-2 ; 22-2 ; 35-1 ; 24-2 ; 36-2.

Genus **Labeo** Cuvier

7. **Labeo pangusia** (Hamilton)

1822. *Cyprinus pangusia* Hamilton, *Fish Ganges*, pp 285, 386 (type loc : River Kosi)

Material : 2 ex in total. 26-2.

Genus **Tor** Gray

8. **Tor mussullah** (Sykes)

1841. *Barbus mussullah* Syke, *Trans. Zool. Soc. London*, 2, p. 356 (type loc : Sirur on Ghod river near Poona).

Material : 1 ex in total. 26-1.

Genus **Catla** Valenciennes

9. **Catla catla** (Hamilton)

1822. *Cyprinus catla* Hamilton, *Fish Ganges* pp 287, 387, pl. 13, Fig 81 (type loc : in the river & tanks of Bengal).

Material : 1 ex in total. 1-1.

Subfamily : GARRINAE

Genus *Garra* Hamilton

10. *Garra mcClellandi* (Jerdon)

1849. *Gonorrhynchus mcClelland*. Jerdon, *Mudras J. Lit. Sci.* 15, p. 309
(type loc : Bhavani river at base of Nilgiri hills & also in the
Manantoddy river).

Material : 1 ex. 14-1.

11. *Garra gotyla* (Gray)

- 1832-33. *Cyprinus gotyla* Gray, *Ill. Indian Zoology*, 2, pl 88, figs 3, 3A
(type loc : Northern India).

Material : 2 ex in total. 33-2.

12. *Garra mullya* (Sykes)

1841. *Chondrostoma mullya* Sykes, *Trans. Zool. Soc. London*, 2, p. 359,
pl. 62, fig 3 (type loc ; Poona waterways).

Material : 2 ex in total. 41-2.

Family : COBITIDAE

Subfamily : NOEMACHEILINAE

Genus *Oreonectes* Gunther

13. *Oreonectes evezardi* (Day)

1878. *Nemachilus evezardi* Day, *Fish. India* p. 613, pl 153, Fig. 11
(type loc : Poona).

Material : 2 ex in total. 14-1 ; 34-1.

Genus *Noemacheilus* van Hasselt

14. *Noemacheilus (Acanthocobitis) botia* (Hamilton)

1822. *Cobitis botia* Hamilton. *Fish Gangcs*, pp 350, 358, 394, 395
(type loc : rivers of north-eastern parts of Bengal).

Material : 5 ex in total. 29-5.

15. *Noemacheilus denisonii* Day

1867. *Nemacheilus denisonii* Day, *Proc. Zool. Soc. London*, p. 287
(type loc : Nilgiri and Coorg hills)

Material : 40 ex in total. 29-1 ; 12-2 ; 8-1 ; 31-8 ; 27-1 ;
14-1 ; 16-1 ; 17-2 ; 4-1 ; 7-2 ; 8-2 ; 25-1 ; 21-1 ; 39-2 ; 34-3 ;
40-4 ; 23-3 ; 41-4.

Subfamily : COBITINAE

Genus *Lepidocephalus* Bleeker**16. *Lepidocephalus (Lepidocephalichthys) thermalis* (Val.)**

1846. *Cobitis thermalis* Valenciennes, *Hist. nat. Poiss.*, 17, p. 78 (type : Ceylon).

Material : 69 ex in total. 1-1 ; 5-3 ; 7-5 ; 11-10 ; 15-12 ; 19-1 ; 37-36 ; 41-1.

17. *Lepidocephalus (Lepidocephalichthys) guntea* (Ham.)

1822. *Cobitis guntea* Hamilton, *Fish Ganges*, pp. 353, 394 (type loc : Ponds & freshwater rivers of Bengal).

Material : 59 ex in total. 1-1 ; 4-12 ; 5-2 ; 6-4 ; 10-5 ; 16-2 ; 21-7 ; 25-12 ; 32-5 ; 35-9.

Order : SILURIFORMES

Family : BAGRIDAE

Genus *Mystus* Scopoli**18. *Mystus bleekeri* (Day)**

1846. *Bagrus keletius keletus* (nec. Valenciennes) *Nat & Geneesh. Arch. Ned. India*.

Material : 1 ex. 26-1.

Order : ATHERINIFORMES

Family : POECILIDAE

Genus *Gambusia* Poey**19. *Gambusia affinis* (Baird & Girard)**

1853. *Heterandia patruelis* Baird & Girard, *Proc. Acad. nat. Sci. Philad.* 6, p. 390 (type loc : Rio Sabinal, Texas).

Material : 7 ex in total. 3-7.

Family : CYPRINODONTIDAE

Genus *Aplocheilus* Moclelland**20. *Aplocheilus lineatus* (Valenciennes)**

1846. *Panchax lineatum* Valenciennes, *Hist. Nat. Poiss.*, 18, p. 381 (type loc : Bombay).

Material : 4 ex in total. 20-4.

Order : CHANNIFORMES

Family : CHANNIDAE

Genus *Channa* Scopoli

21. *Channa orientalis* Schneider

1801. *Channa orientalis* Schneider, *Syst. Ichth. Bloch.*, p. 496, pl. 90, fig. 2.

1822. *Ophiocephalus gachua* Hamilton, *Fish Ganges* pp. 68, 367, pl. 21, fig. 21 (type loc : ponds & ditches of Bengal).

Material : 11 ex in total. 6-1 ; 7-3 ; 8-2 ; 15-1 ; 20-1 ; 23-1 ; 35-1 ; 37-1.

22. *Channa punctatus* (Bloch)

1793. *Ophiocephalus punctatus* Bloch, *Naturges Ausland. Fisches*, 2, p. 139, pl. 358 (type loc : Coromandal coast).

Material : 2 ex in total. 21-2.

Order : PERCIFORMES

Family : CHANDIDAE

Genus *Chanda* Hamilton

23. *Chanda nama* Hamilton

1822. *Chanda nama* Hamilton, *Fish Ganges*, pp. 109, 371, pl. 39, fig. 37 (type loc : Bengal).

Material : 1 ex. 33-1.

Family : GOBIIDAE

Genus *Glossogobius* Gill

24. *Glossogobius giuris* (Hamilton)

1822. *Gobius giuris* Hamilton, *Fish Ganges*, pp. 51, 366, pl. 33, fig. 15 (type loc : ponds & freshwater rivers of Gangetic Provinces).

Material : 4 ex in total. 28-2 ; 33-2.

Order : MASTACEMBELIFORMES

Family : MASTACEMBELIDAE

Genus *Macrognathus* Lacepede

25. *Macrognathus aculeatus* (Bloch)

1795. *Ophidium aculeatum* Bloch, *Naturg. Ausland. Fische*, pl. 159, fig. 2 (type loc : not given).

Material : 1 ex. 33-1.

Genus *Mastacembelus* Scopoli

26. *Mastacembelus guentheri*, Day

1865. *Mastacembelus guentheri*, *Proc. Zool. Soc. London.*, p. 37.

Material : 5 ex in total. 6-1 ; 12-1 ; 20-1 ; 24-1 ; 29-1.

SUMMARY

This paper deals with a systematic account of fishes collected from Dhulia district of Maharashtra. 26 species of fishes are dealt with under 20 genera. All the species treated in the present work were hitherto unknown from this region.

ACKNOWLEDGEMENT

I am thankful to the Director, Zoological Survey of India, Calcutta for permission to undertake this work and to the Officer-in-Charge of W.R.S., Pune. I am also grateful to Drs. R. H. Kamble, M. S. Pradhan & R. M. Sharma who allowed me to work out the material collected during their tours.

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HITHERTO UNKNOWN MORPHS OF *CAVARIELLA INDICA* MAITY AND CHAKRABARTI (HOMOPTERA : APHIDIDAE) WITH NOTES ON ITS BIOLOGY

By

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INTRODUCTION

Cavariella indica Maity and Chakrabarti (in Maity *et al.*, 1982) was described from apterous viviparous female and apterous oviparous female morphs infesting the weeping willow, *Salix babylonica* in the Mussoorie hill tracts of Uttar Pradesh, India. This plant is commonly grown as ornamental one in North India, both in the plains as well as in the hills upto an altitude of about 2700 meter (Watt, 1972). During the 3 years' study (1982-1984) at Joshimath (c 1900 m), a locality of the Garhwal range of north west Himalaya, routine observations enabled us to collect its hitherto unknown alate viviparous females and alate males, which are described in this paper. Field observations on some garden willows were made with a view to know the seasonal activities, morph composition and natural enemies of this aphid, results of which are presented here under Morphology and Biology.

***Cavariella indica* Maity and Chakrabarti**

Cavariella indica Maity and Chakrabarti, In Maity, Bhattacharya and Chakrabarti, 1982. *Annales zool.*, 36 : 505.

MORPHOLOGY

Materials examined (Specimens mounted and preserved) :
INDIA : UTTAR PRADESH, Garhwal, Joshimath, 2 apterous viviparous females, 2 alate viviparous females and

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3 nymphs, 28.x.1982 ; 6 apterous oviparous females, 6 alate viviparous females, 7 alate males and 2 nymphs, 27.xi.1982 ; 1 apterous viviparous female, 2 alate viviparous females and 2 nymphs, 8.xi.1984 ; 2 apterous oviparous females, 3 alate viviparous females, 2 alate males and 1 nymph, 23.xi.1984 ; 2 apterous oviparous females, 1 alate viviparous female and 2 alate males, 9.xii.1984 (Coll. P. K. Medda) ; 1 apterous viviparous female and 3 nymphs, 18.v.1983 ; 3 apterous viviparous females, 1 alate viviparous female and 1 nymph, 26.v.1983 ; 1 apterous viviparous female and 2 alate viviparous females, 10.vi.1983 ; 2 apterous viviparous females and 2 nymphs, 18.vi.1983 ; 2 apterous viviparous females and 1 nymph, 8.vii.1983 ; 2 apterous viviparous females and 2 nymphs, 6.viii.1983 ; 5 apterous viviparous females and 3 nymphs, 30.ix.1983 ; 1 apterous viviparous female, 3 alate viviparous females and 2 nymphs, 12.x.1983 ; 2 apterous oviparous females, 2 alate viviparous females, 4 alate males and 2 nymphs, 10.xi.1983 ; 3 apterous oviparous females and 3 alate males, 16.xii.1983 (Coll. D. Ghosh) from *Salix babylonica*.

Hitherto unknown alate viviparous females and alate males are described below :

Alate viviparous female : Body 1.84-2.04 mm long and 0.67-0.83 mm wide. Head brown, almost smooth, with flat frons ; dorsum with 6 pairs of hairs including 1 pair on frontal sinus, with acuminate apices ; longest hair on vertex 12-14 μm long and 0.42-0.50 times the basal diameter of antennal segment III. Antennae brown, 0.54-0.62 times the body ; segment I with 5 hairs, segment II slightly scabrous ventrally, segment III with 19-29 round, distinctly protuberant secondary rhinaria distributed over the length except for basal 0.10 portion ; longest hair on segment III 7-12 μm long and 0.25-0.42 times the basal diameter of the segment ; processus terminalis 1.31-1.64 times the base of segment VI and 0.44-0.47 times the antennal segment III. Ultimate rostral segment 0.86-0.91 times the second joint of hind tarsus and without secondary hairs. Abdominal dorsum

sparsely spinulose; tergites 1, 6, 7 and 8 with separate brown spinopleural bands, tergites 2-5 with a fused spinopleural brown patch, marginal patch separately developed on tergites 2-7 ; dorsal hairs short, 4-6 per segment on anterior tergites, with acuminate apices, longest one on anterior tergites 9-12 μm long and 0.33-0.42 times the basal diameter of segment III ; tergite 7 with 2-4 hairs, longest one 9-14 μm long and 0.31-0.50 times the mentioned diameter. Siphunculi brown, narrow at basal 0.40 portion and rest distinctly clavate, poorly imbricated, 0.15-0.16 times the body, 1.85-2.14 times as long as cauda, 9.50-13.0 times its basal width, 4.75-6.17 times its maximum width and 9.25-13.0 times its apical width. Supracaudal process on 8th tergite 0.22-0.26 times the cauda and 1.0-1.67 times its basal width. Cauda with 5-6 hairs. Venter uniformly spinulose. Legs brown ; femora and tibiae sparsely spinulose on distal part ; tarsi imbricated. Other characters as in apterous viviparous female.

Measurements of one specimen in mm : Body length 2.01, width 0.82 ; antenna 1.08, antennal segments III : IV : V : VI 0.38 : 0.16 : 0.14 : (0.13+0.17) ; u.r.s. 0.10 ; h.t.2 0.11 ; siphunculus 0.30 ; cauda 0.14.

Alate male : Body 1.74-1.96 mm long and 0.58-0.74 mm wide. Head ventrally slightly scabrous with poorly developed lateral frontal tubercles ; dorsum with 5 pairs of hairs including 1 pair on frontal sinus with acuminate apices, longest hair on vertex 12-14 μm long and 0.38-0.43 times the basal diameter of antennal segment III. Antennae 0.64-0.76 times the body ; segment III with 40-46 round protuberant secondary rhinaria, segments IV, V and VI with 4-9, 5-8 and 1-2 similar rhinaria ; processus terminalis 1.11-1.31 times the base of segment VI and 0.30-0.36 times the antennal segment III. Ultimate rostral segment 0.91-0.93 times the second joint of hind tarsus. Abdomen dorsally spinulose, tergites 1-8 with separate brown spinopleural sclerotic bands, marginal sclerites separately developed on tergites 2-7 ; longest dorsal hair on anterior tergites 12-14 μm long and 0.36-0.46 times the basal

diameter of segment III ; those on 7th and 8th tergites 14-16 μm and 23-25 μm long, and 0.43-0.62 times and 0.77-0.85 times the mentioned diameter respectively. Siphunculi 0.15-0.16 times the body, 2.0-2.47 times as long as cauda, 9.0-12.67 times its basal width, 5.14-5.33 times its maximum width and 10.67-12.33 times its apical width. Supracaudal process indistinct. Male genitalia having aedeagus with 2 claspers at its base. Venter uniformly spinulose. Other characters as in alate viviparous female.

Measurements of one specimen in mm : Body length 1.74, width 0.58 ; antenna 1.31 ; antennal segments III : IV : V : VI 0.53 : 0.21 : 0.17 : (0.13+0.16) ; u. r. s. 0.11 ; h.t. 2 0.12 ; siphunculus 0.26 ; cauda 0.13.

BIOLOGY

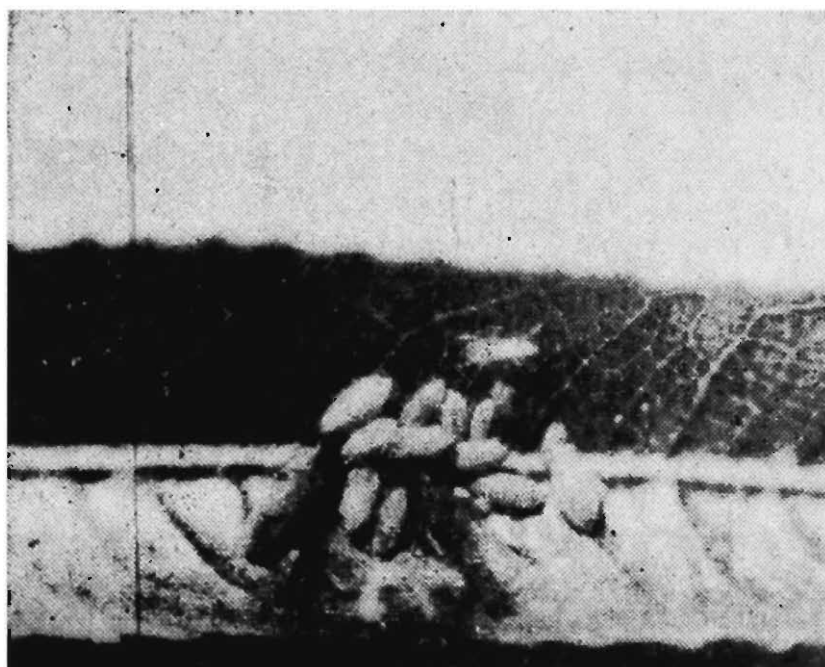
(i) MATERIALS AND METHODS

Two plants of weeping willow (*S. babylonica*) in a garden at Joshimath were selected for biological observations. Ten sample leaves collected at random were observed fortnightly during spring to winter of 1983 and 1984. The aphid samples were collected in 70% alcohol and taken to the laboratory for sorting of morphs. As and when necessary, aphids were processed for microscopical studies.

During the full tenure of the study, meteorological informations were collected using maximum and minimum thermometer, dry and wet bulb hygrometer and rain gauge.

(ii) OBSERVATIONS

(a) *Seasonal activities :* With the sprouting of flowering buds and subsequently leaf buds towards the end of January in *S. babylonica*, the overwintered eggs of *C. indica* start hatching into fundatrices which we, however, could not collect. In contrast to *S. tetrasperma* which is the primary host of *C. aegopodii* (Scopoli), bud sprouting in *S. babylonica* occurs much earlier. Thus, the eggs of *C. indica* overwinter only for a short period, i. e., approximately 45 days.



Sexual colony of *C. indica* on the leaf of *S. babylonica*.

Fundatrices after maturity give rise to apterous fundatrigeniae which either singly or in a group infest an emerging leaf, usually at the base of its dorsal surface. Later on, the general tendency of this aphid is found to infest the dorsal side of the apical most leaves of the long branches. When apical leaves grow older, the aphids migrate to the immediate tender leaves because of their greater succulence. The apterous fundatrigeniae develop within 10-11 days. The number of youngs produced by a fundatrigena ranges from 25-32, which are laid for a period of 12-14 days with daily rate of 0-4 nymphs. Alate viviparae first appear in small number in the 3rd generation. Alate production here is related to the spreading of colony rather than to crowding, since the population never tend to reach a high level. The occurrence of low alate morphs was also observed by Rabasse and Brunel (1977) for *C. aegopodii*.

By the end of October with lowering of temperature, alate viviparous females lay pinkish nymphs which develop into apterous oviparae, while other alate viviparae lay greenish ones giving rise to alate males (Plate 1). Number of alate males is lower than that of oviparae, which may be due to the fact that one male can mate with more than one ovipara. Mating continues for about 3 minutes. After about 8-9 days, the fertilised ovipara lays 3-4 pinkish, elongatedly oval eggs, measuring about 0.7-0.8 mm in length and 0.4 mm in maximum width. Egg laying continues for 1-2 days and the ovipara dies after 6-7 days of egg laying. Males live for about 14 days. Eggs are left at this stage on the buds for overwintering.

(b) *Population pattern and composition* : The building up of population of *C. indica* on *S. babylonica* is initiated by the hatching of overwintered eggs into fundatrices but become established by the progeny of the latter during March in 1983 (Fig. 1) and February in 1984 (Fig. 2) depending on the arrival of spring. In both the years, study could be started only from the middle of February. It is found that aphid population attains a peak during April in both the

years, followed by a slow decline and maintains a low level throughout the summer and monsoon months. Again with the development of sexuals, population shows another low peak in November and subsequently declines in December. It should be mentioned here that as the infestation gradually spreads towards the tender apical leaves, it never becomes so high as to cause malformations.

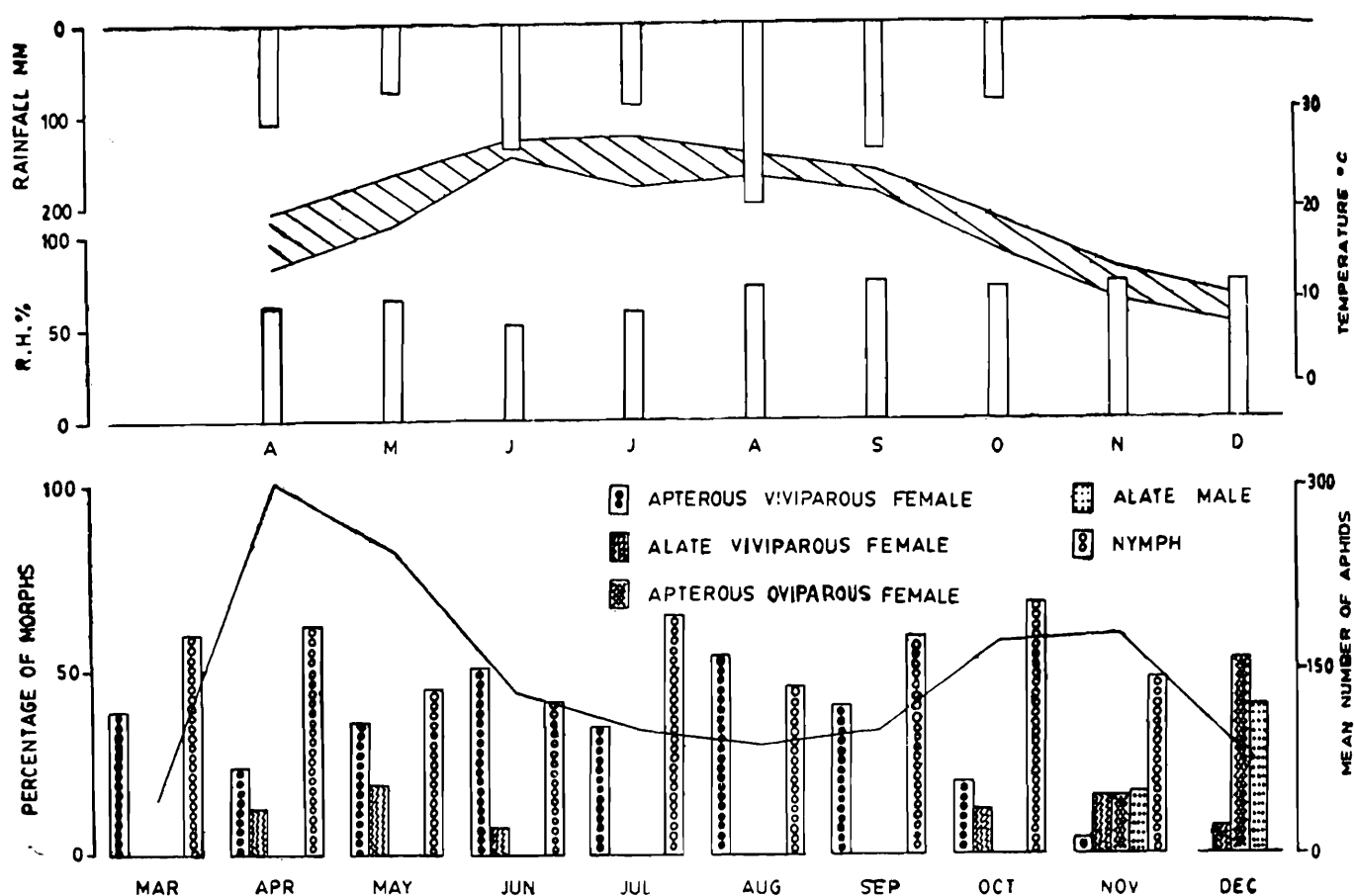


Fig. 1. Incidence pattern and morph composition of *C. indica* on *S. babylonica* in 1983.

From the available morphs (Figs. 1 and 2) a substantial change in the composition of alatoid and apteroid morphs is observed during different phases of aphid population growth. It is interesting to note that the nymphs almost always form the bulk of the population. The alate morphs are always low (7.06-19.28% in 1983 and 6.56-20.00% in 1984) with two phases, one during spring-summer and another during autumn with a off-period during monsoon. Incidence of apterous morphs in 1984 maintains a more or less stable condition till

arrival of autumn, while it is somewhat fluctuating in 1983 and declines from October onwards in both the years. Apterous oviparous female and alate male appear during November and decline in December.

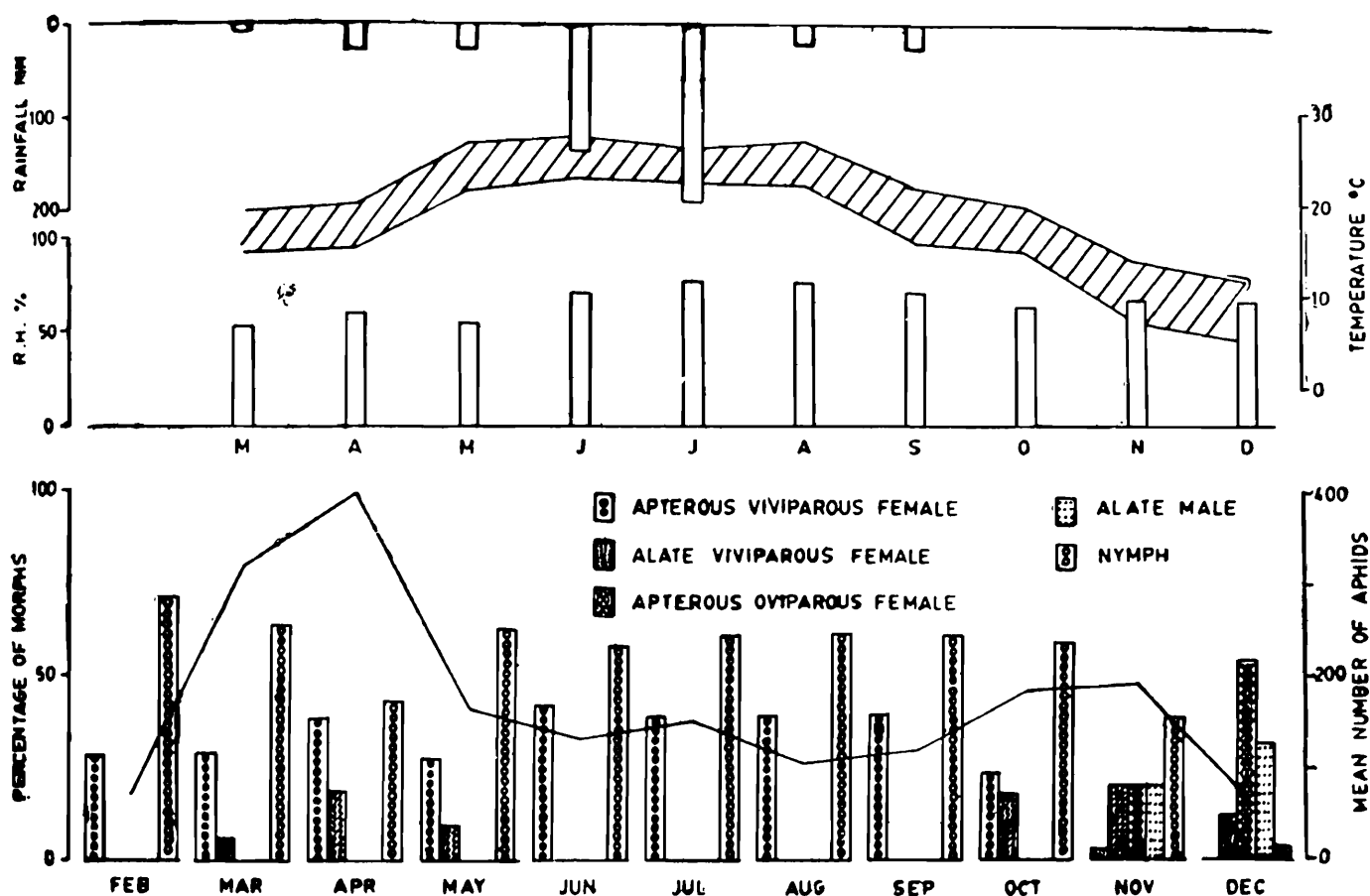


Fig. 2. Incidence pattern and morph composition of *C. indica* on *S. babylonica* in 1984.

(c) *Natural enemies* : In early spring, *Adalia tetraspilota* (Hope), *Coccinella septempunctata* L. and *Harmonia (Leis) dimidiata* (F.) are found to predate on this aphid, but from summer onwards *Oenopia sauzeti* Muls., *Menochilus sexmaculatus* F. and *Platynaspis* sp. seem to be abundant coccinellid predators. Surprisingly none of the above species are found to breed on this aphid. The only syrphid maggot collected is *Metasyrphus confrater* (Wied.).

DISCUSSION

C. indica, an endemic aphid to India, leads a holocyclic, autoecious life on weeping willow. This species differs from *C. aegopodi* (Scopoli), also commonly occurring in that

area, in the host-alternation since the latter species shows a heteroecious mode of life (Ghosh *et al.*, 1986). However, its infestation could never reach at the levels which can damage the weeping willow. High temperature and rainfall can affect its population build up in summer and monsoon, when we obtained a low level of population. Production of alate morphs is always low and completely absent in monsoon months. In aphid, alate production depends on population density (Hille Ris Lambers, 1966) and unsuitable condition of host plants through continuous exploitation of the plant sap by the aphids (Way, 1973). But in *C. indica*, summer production of alate seems to be necessary for dispersion to all available uninfested tender leaves, whereas winter alates account for the production of sexuals.

Predators appear to have some impact on the population decline in summer as most of the coccinellids are noted to be quite active in spring and summer after the termination of their hibernation quarters.

SUMMARY

The present paper provides a taxonomic description of so far unknown alate viviparous female and alate male morphs of *Cavariella indica* Maity and Chakrabarti. Biological activities, morph composition and natural enemies of this aphid in Garhwal range of north west Himalaya have also been discussed.

ACKNOWLEDGEMENTS

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TAXONOMIC AND ECOLOGICAL STUDIES ON THE
AMPHIBIANS OF ANDAMAN AND NICOBAR
ISLANDS, INDIA.

By

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INTRODUCTION

There is very little information about the amphibian fauna of Andaman and Nicobar Islands. Only a few isolated records and description of some new species by Stoliczka (1870), Boulenger (1890 and 1920), Annandale (1917), Smith (1941), Cherchi (1954), Pillai (1977), Mansukhani and Sarkar (1980) and Abdulali (1982) are available on the amphibians of the area. Whitaker (1978) in his cyclostyled list of herpetofauna of the Andamans merely listed some amphibians with no details.

This is the first account of amphibians of Andaman and Nicobar Islands with authentic taxonomic and ecological details. For these, material Collected from different islands of Andaman and Nicobar (between latitudes 5°40' and 14°15' N and longitudes 92°10' and 93°30' E) by eighteen surveys undertaken by both departmental and outside scientists have been taken into account for the study. As a result of this study 847 examples of anurans (679 adults and 168 tadpoles) belonging to four families, four genera and fourteen species have been determined. It includes two species of anurans namely, *Rana tigerina* and *Rana hexadactyla* which are determined by Dr. R. S. Pillai, Deputy Director, of this department, and deposited in the Collection of Andaman and Nicobar Regional Station of Zoological Survey of India. Apart from these, four species namely, *Kaloula baleata ghoshi*, *Microhyla chakrapani*, *Microhyla inornata* and *Rana hascheana* have been added to this paper to complete the list of amphibians of the area.

List of Surveys from which material for study were obtained.

Name of Survey	Year	Leader of Survey Party or Collector.
Andaman Survey	1930	Mr. D. D. Mukherjee
-Do-	1952	Dr. H. C. Roy
Andaman & Nicobar Survey	1959	Dr. K. K. Tiwari
Little Andaman Survey	1961	Dr. A. Daniel
Andaman & Nicobar Survey	1964	Dr. B. S. Lamba
Great Nicobar Survey	1966	Dr. A. Daniel
Andaman & Nicobar Survey	1969	Dr. T. D. Soota
-Do-	1970 &	
	1972	Dr. A. G. K. Menon
-Do-	1970 &	
	1971	Dr. B. K. Tikader
-Do-	1972	Dr. A. K. Mukherjee
Andaman Survey	1972	Dr. A. K. Mondal
Andaman & Nicobar Survey	1972	Dr. K. Reddiah
-Do-	1974-75	Dr. S. K. Bhattacharya
-Do-	1975-76	Dr. P. K. Maiti
-Do-	1976	Mr. H. Abdulali
-Do-	1977	Dr. K. K. Tiwari
-Do-	1979-80	Mr. M. K. Dev Roy
Andaman Survey	1982	Dr. S. Chakrabarti

SYSTEMATIC ACCOUNT

Class : AMPHIBIA

Order : ANURA

Family 1 BUFONIDAE

Genus 1. **Bufo** Laurenti, 1768

Family Bufonidae is represented in Andaman and Nicobar Islands by two species of the genus **Bufo**, which can be distinguished by the following key.

More than $3\frac{1}{2}$ penultimate phalanges of the 4th. toe free, skin with numerous well-developed spiny warts. ...

melanostictus

$2\frac{1}{2}$ to 3 penultimate phalanges of the 4th toe free, skin with a few less developed spiny warts. ...

camortensis

1. **Bufo melanostictus** Schneider
(Common Indian Toad)

1799. *Bufo melanostictus* Schneider, *Hist. Amph.* 1 : 216.

Material : 234 toads and 3 tadpoles. Collected from Andaman (Port Blair, Junglighat, Baratang, Wright Myo, Mount Harriet Range, Chiriatapu, Ross Island, Long Island, Interview Island, Rangat, Mayabunder, Diglipur); Little Andaman (Laitora, Tokoibrea, Kwata-in-Kwage); Car Nicobar (Kakana, Yelyanum, Tee-top); Great Nicobar (Campbell bay area, Galathea river area, Casuarina bay area, Lonna's hut Banana point, Magar nullah, Agricultural Farm, Jogindranagar). Collections have been made during the months of January to June,

Distribution : Andaman and Nicobar, as mentioned above. Smith (1941) recorded it from Andaman and Nicobars. *Elsewhere*, Main land of India, Pakistan, Bangla Desh, Sri Lanka, Burma, South, China and Malaysia.

Remarks : Big sized toad. The largest one from Andaman and Nicobar measures 122 mm. from snout to vent. Examples from Andaman, Little Andaman and Great Nicobar are stout with thick warty skin, while representatives from Car Nicobar possess elongated shape of body with less warty skin. In the months of February-March, 1969 these toads were found in good number under the street lamps in Port Blair and Mayabunder. In Car Nicobar they were found in abundance around the Nicobarese huts.

2. **Bufo camortensis** Mansukhani and Sarkar
(Camorta Toad)

1980. *Bufo camortensis* Mansukani and Sarkar, *Bull. Zool. Surv. India* 3 (1 & 2) : 97-101.

Material : 34 toads (excluding Types). Collected from Nicobars (Camorta and Car Nicobar) during January, March, April, October and December.

Distribution : This species has so far been known from its type locality (Camorta and Nan Cowry of Nicobar Islands). Now its range is being extended upto Car Nicobar by

recording it from Malacca, Kakana, Kynuka, Chukchucha, Arong and Kimus of Car Nicobar. Abdulali (1982) reports that these toads are available in Katchal Island, Central Nicobars.

Remarks : Medium sized toad. The largest one from Camorta measures 90 mm. from snout to vent. Abdulali (1982) records that in life "they were strikingly paler than the common Toad (*Bufo melanostictus* Schneider) and drew further attention by attempting to climb on to the tussocks of grass in their efforts to escape. When caught, they felt very cold to the touch, another character which appeared to separate them from *melanostictus*".

Family II. MICROHYLIDAE

This family is represented in Andaman and Nicobar by two genera which can be distinguished by the following key :

Clavicle absent ; procoracoid present, but confined to the mesial end of the coracoid and not reaching the scapula.	
Maxillary and Vomerine teeth absent ...	Genus <i>Kaloula</i>
Clavicle and procoracoid absent.	
Maxillary teeth absent. ...	Genus <i>Microhyla</i>

Genus 2. *Kaloula* Gray, 1831

3. *Kaloula baleata ghoshi* Cherchi (Ghosh's Painted Frog)

1954. *Kaloula baleata ghoshi* Cherchi, *Doriana*, 1 (47) : 1-4.

Material,—The subspecies has so far been recorded from Little Andaman Island only.

Genus 3. *Microhyla* Tschudi, 1838.

Genus Microhyla is represented by four species in Andaman and Nicobar, which can be distinguish by the following key :

1. Toes webbed.	...	2
Toes not webbed.	...	<i>inornata</i>
2. Toes with distinct discs.	...	3
Toes without discs.	...	<i>ornata</i>

3. Fingers not dilated into discs, a fine mid-dorsal white line from snout to vent, and sharply defined ()-shaped dark spots at the centre of dorsum absent. ... *chakrapani*

Fingers dilated into small terminal discs, a fine mid-dorsal white line from snout to vent, and sharply defined ()—shaped dark spots at the centre of dorsum present. ... *heymonsi*

4. *Microhyla inornata* Boulenger

1890. *Microhyla inornata* Boulenger, *Proc. Zool. Soc. London*, p. 37.

Material : Pillai (1977) records it on a juvenile grog (10mm from snout to vent) from South-Point, Port Blair, Andaman.

Distribution : Andaman and Nicobar,—as mentioned above.

Elsewhere : Burma, Thailand, Vietnam, Malaysia and Sumatra.

5. *Microhyla ornata* (Dumeril and Bibron) (Ornate Microhylid)

1841. *Engystoma ornatum* Dumeril and Bibron, *Erpet. Gen.*, 8 : 745.

Material : 28 frogs. Collected from Andamans, Port Blair (Dairy farm, Zoo-Garden, Juuglighat), Humphrygung, Baratang and Mayabunder. Collection have been made during January to April.

Distribution : Andaman and Nicobar, as mentined above. It is being recorded for the first time from Andaman.

Elsewhere : It is a widely distributed species in the mainland of India. Also Sri Lanka, Burma, South China, South-East Asia and Taiwan.

Remarks : Small sized frog. The largest one from Andaman measures 23 mm. from snout to vent. In March/April, 1969 these tiny frogs are found to be busy with mating call near the edge of water both in Port Blair and Mayabunder. They are nocturnal in habit and found under stone and inside crevices during the day, but not with the

association of *Rana limnocharis* and other frogs. The examples from South Andamans are with stout physique in general, but three examples collected from Mayabunder are with slender physique. Dorsum more or less smooth and reddish-brown with darker patches. Ventrums smooth and brownish with darker spots on the throat and breast. Tibiotarsal articulation of four examples from Port Blair and three examples from Mayabunder reaches beyond the eye.

6. *Microhyla chakrapani* Pillai

1977. *Microhyla chakrapani* Pillai, *Proc. Indian Acad. Sci.*, 86B (2) : 135-138

Material : This species has been described on a single adult male frog from Mayabunder, North Andaman and the specimen is still in author's disposal. I have not seen the specimen.

7. *Microhyla heymonsi* Vogt

1911. *Microhyla heymonsi* Vogt, *Sitzber. Ges. Natf. Fr. Berlin*, : 181.

Material : 1 frog. Collected from Campbell Bay, Great Nicobar, 25.iv.1966. Coll. A. Daniel.

Distribution : Andaman and Nicobar. As mentioned above. It is recorded for the first time from the area.
Elsewhere : Taiwan, South China, Hainan, Tonkin, Thailand, Vietnam, Malaysia, Nias and Sumatra.

Remarks : Small sized frog measuring 19 mm. from snout to vent. The specimen has been collected on ground. The specimen tallies the species in all the characters except in glandular fold from the posterior corner of the eye to the forelimb, which is not clear in the specimen. The tibiotarsal articulation reaches the end of the snout in the specimen.

Family III. RANIDAE

Genus 4. *Rana* Linnaeus, 1766.

Family Ranidae is represented in Andaman and Nicobar Islands by seven species and two sub-species/varieties of the genus *Rana*, which can be distinguished by the following key.

- | | | |
|--|-----|-------------------------------------|
| 1. Toes webbed upto the tips | ... | <i>hexadactyla</i> |
| Toes webbed not upto the tips. | ... | 2 |
| 2. Tips of toes swollen or pointed, but not with discs. | ... | 3 |
| Tips of toes with discs. | ... | 6 |
| 3. Toes entirely webbed almost near the tips. | ... | <i>tigerina</i> |
| Toes not entirely webbed. | ... | 4 |
| 4. Generally one penultimate phalange of fourth toe free, no outer metatarsal tubercle. | ... | <i>cancrivora</i> |
| Generally more than two penultimate phalanges of fourth toe free, an outer metatarsal tubercle generally present.... | | 5 |
| 5. Dorsal surface of the head and body not rich in chestnut-brown Colour. | ... | <i>imnocharis</i> |
| Dorsal surface of head and body rich in chestnut-brown colour. | ... | <i>andamanensis</i> |
| 6. When adult, a broad/moderately broad and prominent glandular dorso-lateral fold from above the tympanum to the hip present. | ... | 7 |
| When adult, a broad/moderately broad and prominent glandular dorso-lateral fold from above the tympanum to the hip absent | ... | 8 |
| 7. Tibia as long as or shorter than foot. A small outer metatarsal tubercle very rarely present | ... | <i>erythraea</i> |
| Tibia usually longer than foot, never shorter. A round outer metatarsal tubercle present | ... | <i>nicobariensis</i> |
| 8. Nostril much nearer to the end of the snout than the eye. Tips of fingers obtuse or slightly swollen at the end, not dilated into discs | ... | <i>macrodon</i> var. <i>blythii</i> |
| Nostril nearly equidistant from the eye and the tip of the snout. Tips of fingers normally dilated into very small discs .. | | 9 |
| 9. Toes 3/4 to nearly entirely webbed, 1 or 2 phalanges of the 4th toe free | ... | <i>doriae</i> |
| Toes 1/3 to 1/2 webbed, 3 phalanges of the 4th toe free | ... | <i>hascheana</i> |

8. ***Rana hexadactyla* Lesson**
(Pond Frog)

1834. *Rana hexadactyla* Lesson, in Belang, *Voy, Indian or., Rept.*
: 331.

Material : 1 frog, Collected from Carbyn's Cave, Andaman, 6.ii.1980. Coll. K. K. Tiwari.

Distribution : Andaman and Nicobar : As mentioned above. It is being recorded for the first time from Andaman.

Elsewhere : Indian Mainland and Sri Lanka.

Remarks : The specimen is in the disposal of Andaman and Nicobar Regional Station of Zoological Survey of India at Port Blair.

9. ***Rana tigerina* Daudin**
(Indian Bull Frog)

1803, *Rana tigerina* Daudin, *Hist. Rain. Gren, Crap.*, : 64.

Material : 1 frog. Collected from Krishna Nagar, Havelock, Andaman, 10.iv.1980. Coll. H. L. Das.

Distribution : Andaman and Nicobar : As mentioned above. *Elsewhere* : Indian Mainland, Nepal, Burma, Thailand, South China and Taiwan.

Remarks : The specimen is in the disposal of Andaman and Nicobar Regional Station of Zoological Survey of India, Port Blair.

10. ***Rana cancrivora* Gravenhorst**
(Crab-eating Frog)

1829. *Rana cancrivora* Gravenhorst, *Deiic. Mus. zool, Vratisl.*, 1 : 41.

Material : 1 frog. Wright Myo, South Andaman, 20.iv.1977. Coll. K. K. Tiwari.

Distribution : Andaman and Nicobar : As mentioned above. The species is being recorded for the first time from the area. *Elsewhere* : Malaysia, Philippines, Thailand, Borneo, Java and Sumatra.

Remarks : Medium sized frog. The specimen measures 74 mm. from snout to vent. It possesses the following remarkable characters. Tibio-tarsal articulation reaches anterior border of eye. Toes not completely webbed, two

penultimate phalanges of fourth-toe free. Dorsum smooth with no longitudinal fold and brownish with light darker spots. Ventrums smooth and dull whitish in colour. Skin on dorsum is loose, and with lateral flaps, breadth of which at the middle of the body in preserved specimen is about 6-7 mm. These lateral flaps run from behind the eye to the vent, on both the sides of the body.

11. *Rana limnocharis* Boie (Paddy-field Frog)

1835. *Rana limnocharis* Boie Wiegmann, *N. Acta. Ac. Leop. Carol.*, 16 (1) : 255.

Material : 279 frogs and 165 tadpoles. Collected from Andaman (Port Blair, Humphrygunj, Interview Island, Baratang Island, Mayabunder), Car Nicobar (I. A. F. Camp), Great Nicobar (Campbell Bay). Collections were made during the months of January to July.

Distribution : Andaman and Nicobar : As mentioned above. Only one example is being recorded here from Car Nicobar. The species is being recorded for the first time from Andaman and Nicobar Islands.

Elsewhere : Mainland of India, Eastern Asia from Pakistan, Nepal, Sri Lanka and China to Japan,

Remarks : Medium sized frog. The largest one from Great Nicobar measures 59 mm. (from Andaman 52 mm.) from snout to vent.

In March/April 1969 I got the opportunity to survey the Islands of Andaman and Car Nicobar and found that these frogs are very common on moist grassy land, open drains and inside the ditches at Port Blair and Mayabunder. They are nocturnal in habit and have been collected under stones and inside crevices.

In general, these frogs from Andamans are with stouter physique. Variations are found on the external characters. Seven examples out of thirty collected from Dairy farm (Port Blair) in 1969 possess reddish-brown mid-dorsal broad stripe from snout to vent, but others do not have. Most of the

examples are with stout fore limbs that possess thick palmer pads and highly developed subarticular tubercles. Upper skins of some frogs are thickly tuberculated. Inner metatarsal tubercles of most of the examples are well developed and strong, so the frogs might be possessing digging habits. Dorsum rough and darker. Ventrums smooth and reddish-brown, pinkish tinge on the undersurface of the hind limbs.

Examples from Great Nicobar possess the following remarkable characters. Body elongated; head a little broader than long; web reaches to the base of the third penultimate phalange of the hind limb. Inner metatarsal tubercle distinct, oval, not digging-form; outer metatarsal tubercle nearly indistinct. Skin on dorsum smooth with a few elongated warts followed by some small tubercles; ventrum smooth with the lower part of belly slightly tuberculated. Darker above with a few dull whitish spots behind the head, mid-dorsal yellowish stripe absent; throat and undersurface of lower lip spotted with chocolate, belly brownish.

12. *Rana andamanensis* Stoliczka

1870. *Rana gracilis*, var *andamanensis* Stoliczka, *J. Asiat. Soc. Bengal*, 39 : 143.

Material : 11 frogs. Collected from Andaman (Port Blair and Baratang Island) during January to April.

Distribution : Andaman and Nicobar : As mentioned above.

Remarks : It is closely allied to *Rana limnocharis* excepting its chocolate-brown dorsal surface which is demarcated laterally by darker coloration. Sometimes a lateral fold, often interrupted, separates the two areas of different colorations.

At Port Blair these frogs are found to roam in association with *Rana limnocharis* at night and spend in the same crevices in daytime.

13. *Rana erythraea* (Schlegel) (Leaping Frog)

1837. *Hyla erythraea* Schlegel, *Abbild.* : 27.

Material : 12 frogs, Campbell Bay, Great Nicobar, 27. iii. 1977. Coll. K. K. Tiwari.

Distribution : Andaman and Nicobar : As mentioned above. It is being recorded for the first time from the area.

Elsewhere : Indian Mainland and South-east Asia including Borneo and Sumatra.

Remarks : Medium sized frog. Largest one from great Nicobar measures 50 mm. from snout to vent. In general the specimens from the area are with darker dorsum. The white-yellow dorsolateral folds are not very prominent as in the mainland forms.

The specimens have been collected from a hill stream puddle with aquatic vegetations.

14. *Rana nicobariensis* (Stoliczka) (Nicobar Frog)

1870. *Hylorana nicobariensis* Stoliczka, *J. Asiat. Soc. Bengal*, 39 : 150.

Material : 57 frogs. Collected from Car Nicobar : 1 ex., Yelyanum Forest, 10.iii.1969 ; 8 ex., Forest area, 13.iii.1969 ; 29 ex., Dense Forest, Ca. 2 km. South-east of Tee-top, 15.iii.1969. All coll. T. D. Soota & A. K. Sarkar. 13 ex., Tee-top, 23.ii.1972, A. K. Mukherjee. 4 ex., -.ii.1976, H. Abdulali. 2 ex., Campbell Bay, Great Nicobar, 27.iii.1977, K. K. Tiwari.

Distribution : Andaman and Nicobar,—As mentioned above. **Elsewhere :** Sumatra, Malaysia, Borneo, Mentavei and Java.

Remarks : Medium sized frog. The largest one from Great Nicobar measures 52 mm. from snout to vent. The frogs are soft and delicate bodied. At Car Nicobar in March 1969 author found them in good number hopping on moist ground wrapped with rotten leaves inside deep forest. The area is shaded with thick canopy made by lofty trees where penetration of sunlight is very poor. As a result the frogs could not be traced properly even in a bright sunny-day. In life the frogs are not very active, and they are darker

in colour. Dorso-lateral glandular folds of the examples from Great Nicobar are feebly prominent.

15. *Rana macrodon* var. *blythii* Boulenger

1920. *Rana macrodon* var. *blythii* Boulenger, *Rec. Indian Mus.*, 20 : 43.

Material : 1 frog, Tribeni Nullah, Campbell Bay, Great Nicobar, 30.iii.1977, Coll. K. K. Tiwari.

Distribution : Andaman and Nicobar : As mentioned above. It is being recorded for the first time from the area and as well as from India too. *Elsewhere* : Burma, Thailand, Sumatra, Borneo, Philippines.

Remarks : Medium sized frog. The specimen measures 56 mm. from snout to vent. It has been collected from a marshy nullah with water weeds.

16. *Rana doriae* Boulenger

1887. *Rana doriae*, Boulenger, *Ann. Mus. Genov.* 5 (2) : 482.

Material : 16 frogs. Collected from Andaman : 2 ex., Andaman, 15.ix.1870, coll. F. Stoliczka. 2 ex., 3.i.1873, coll. Dobson & Wood-mason. 3 ex., Thick jungle, West of Mount Harriate, South Andaman, -.xi.1923, coll. N. Annandale. 1 ex., Rutland Island, 6 km. from Chiriatapu, 19.vii.1972 ; 4 ex., Wright Mayo, S. Andaman, 25-26.vii.1972. All coll. A. K. Mondal. Nicobar : 1 ex., 15.ix.1870, coll. F. Stoliczka. Great Nicobar : 3 ex., Campbell Bay, 27.iii.1977, coll. K. K. Tiwari.

Distribution : Andaman and Nicobar,—As mentioned above. *Elsewhere* : Tenasserim, Thailand and Malaysia.

Remarks : Medium sized frog. The largest one from Andaman measures 57 mm. (from Great Nicobar 49 mm.) from snut to vent. Toes of the frogs from Andamans 2/3 webbed, and with small but distinct disc at the tips, two penultimate phalanges of the fourth toe mostly free. Two examples from Andaman are with smooth skin possessing very thin and faint elongated interrupted warts, while others are with warty skin, of which two examples possess broad yellow-

wish mid-dorsal stripe. Colouration of the specimens is dark-greyish above and deep brownish below.

Most of the specimens have been collected from marshy areas of the deep forests in South Andaman.

17. ***Rana hascheana* (Stoliczka)**

1870. *Polypcdates hascheanus* Stoliczka, *J. Asiat soc. Bengal*, 39 : 147.

Distribution : Andamans. Also Malaysia.

Remarks : I have got no specimen in my disposal. Boulenger (1920) seperated one of the types of *Rana gracilis* var. *andamanensis* Stoliczka, 1870 and referred to this species.

Family IV. RHACOPHORIDAE

This family is represented in Andaman and Nicobar by one species of the genus *Rhacophorus*.

Genus 5. ***Rhacophorus* Kuhl, 1827.**

18. ***Rhacophorus leucomystax* (Kuhl)**
(Tree Frog)

1829. *Hyla leucomystax* Kuhl in : C. Gravenhorst, *Delic. Mus. vralislav*, : 26.

Material : 1 ex., Campbell Bay, Great Nicobar, 6.iii.1966, coll. A. Daniel. 2 ex., Campbell Bay, Great Nicobar, 27.iii. 1977, coll. K. K. Tiwari.

Distribution : Andaman and Nicobar : As mentioned above. It is being recorded for the first time from the area, *Elsewhere* : Indian Mainland and South-east Asia including South China.

Remarks : Medium sized frog. Largest one from Great Nicobar measures 70 mm. from snout to vent. In general, the specimens from the area are with smooth dorsum. Belly and skin around the vent granulated. Specimen collected by Dr. Daniel is light-brownish in colour and with some chocolate sports on the dorsum. But the examples collected by Dr. Tiwari are with darker dorsum, and dull brownish ventrum with a few darker spots on the gular region.

SUMMARY

This paper deals with the Amphibian fauna of Andaman and Nicobar Island based on the collections mainly made by various survey-parties of the Zoological Survey of India. It consists of 847 examples of Anurans (Frogs and Toads) belonging to four families, four genera and eighteen species (including three species/subspecies of the family Microhylidae described by Dr. Pillai and Dr. Cherchi, and one species of the genus *Rana* described by Stoliczka). Of these, *Microhyla ornata*, *Microhyla heymonsi*, *Rana cancrivora*, *Rana limnocharis*, *Rana erythraea*, *Rana macrodon* var. *blythii* and *Reacophorus leucomystax* are recorded for the first time from Andaman and Nicobar Islands, and *Rana macrodon* var. *blythii* for the first time from Indian soil too.

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Amphibians of Andaman and Nicobar Islands are only represented by the order Anura.

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ON THE CONCEPTS OF *PARONANA* WOMERSLEY
(1939) AND *PARASALINA* SALMON (1944)
(COLLEMBOLA : ENTOMOBRYIDAE : PARONELLINAE)
FROM NEWZEALAND

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INTRODUCTION

The genus *Paronana* was established by WOMERSLEY (1939) with the type-species *Paronella bidenticulata* Carpenter, 1925. WOMERSLEY (1939) diagnosed the new genus and redescribed the type-species on the basis of a single specimen collected from Belgrave, Victoria. SALMON (1941) added six species to the genus and at the same time redescribed *Paronana bidenticulata* (Carpenter, 1925) from a paralectotype in the Canterbury Museum. SALMON (1965) erected a new genus viz., *Parasalina* and transferred three species which he had previously described under *Paronana* to his new genus and simultaneously added two new sub-species and one species to it. From these species SALMON (1941) described some setae as scales. The present investigator found in the lectotype of *P. bidenticulata* (Carpenter, 1925) and other species, described by SALMON (1941), that these are in fact short, ciliated setae and do not conform to any type of scales found in the scaled genera under Paronellinae and are similar to those which occur in *Salina*, a well known member of scaleless Cremastocephalini. However, SALMON (1944) changed his earlier contention and commented, "that the structures occurring in those species placed in the genus *Paronana* Wom. and *Glacialoca* Salm. which previously I had regarded as scales, are not true scales but flattened ciliated setae..... There are, therefore, no scaled species of Paronellinae occurring in New Zealand". Thus, SALMON (1944) erected his new genus *Parasalina* on the character that his

new genus is not clothed with scales in contrast to *Paronana* Wom. which is scaled. However, examination of the single specimen from Belgrave, Victoria (*vide*, photomicrograph on Pl. II, G) on which WOMERSLEY (1939) based the redescription of *Paronana bidenticulata* (Carpenter, 1925) revealed that the specimen is a member of the genus *Pseudoparonella* and two "scale like lobes" mentioned by WOMERSLEY (1939) are actually the sockets of dorsal spiny appendages and is clothed with distinct pseudoscales (Fig. 9, A-N). Nevertheless, WOMERSLEY (1939) in erecting his new genus *Paronana* had definitely and specifically fixed "Genotype *Paronella bidenticulata* Carpenter 1925", although his specimen was different. Thus the oldest available generic name for the species *bidenticulata* of Carpenter (1925) other than *Paronella* is *Paronana*. Examination of the lectotype of *Paronella bidenticulata* Carpenter (1925) shows that the species has a chaetal clothing similar to the species of *Parasalina* described by SALMON and it does not possess any scale on body. Moreover, its all other features are similar to *Parasalina* Salmon (1944). Thus the genus *Paronana* Womersley, 1939 is to be conserved with the type-species *Paronella bidenticulata* Carpenter, 1925 (originally designated by WOMERSLEY, 1939) [Article 68 (a) of the Code] and as it has natural priority over *Parasalina* Salmon 1944 (Article 23 of the Code). *Parasalina* Salmon, 1944, at least in part, is, therefore, a junior synonym of *Paronana*. The original diagnosis of the genus *Paronana*, given by WOMERSLEY (1939), is now modified on the basis of the lectotype of the type-species, viz., *Paronella bidenticulata* Carpenter (1925) (= *Paronana bidenticulata*) and other species, added by SALMON (1941, 1944) to this genus. SALMON (1964) in his "An index to the Collem-bola" again considered the genus *Paronana* as scaled and he (SALMON, 1964) placed the species like *bidenticulata* (Carpenter, 1925), *karoriensis* (Salmon, 1937), *maculosa* (Salmon, 1937), *pigmenta* Salmon (1941) under the genus contradicting his earlier comment of 1944 that no scaled species occur in New Zealand. To emphasise, it must again be stated that examination of the paratypes and other

representative collections of the species of *Paronana* and *Parasalina* from New Zealand described by SALMON (1941, 1944) along with the lectotype of *Paronella bidenticulata* Carpenter (1925) confirms that all such species are without clothing of scales on body. Although, SALMON (1964) fixed *Paronana dorsanota* Salmon (1941) as the type-species of his new genus *Parasalina* which does not possess dental scale appendage, in diagnosis of *Parasalina* he (SALMON, 1944, 1964), however, clearly mentioned that "at junction with mucro are ventrally, one or two scale-like plates". *Paronana dorsanota* Salmon (1941) is the only species under the genus *Paronana* which is without dental scale appendage although it possesses all other characteristics as that of the other species of the genus. Thus the name *Parasalina* Salmon (1944) is to be retained as a sub-generic name for this species of *Paronana* without dental scale appendage and also for convenience in taxonomic placement; the diagnosis of *Parasalina* given by SALMON (1944) is now modified. The species viz., *Parasalina dorsanota sufflava* (Salmon, 1941), *Parasalina tasmasecta boldensis* Salmon (1944), *Parasalina pilosa* Salmon (1944) which were treated by SALMON (1964) under *Parasalina* are now transferred to *Paronana* as all of them possess distinct dental scale appendage and are without any investment of scales.

UCHIDA (1943) described a new genus *Salinella* (now a subjective synonym of *Akabosia* Konoshita, 1919) with the type-species of *S. konoshitai* from Japan. This author found apparently before the journal is issued out that the genus *Salinella* is preoccupied by *Salinella* Frenzel, 1891 in Mesozoa. UCHIDA (1943), therefore, proposed a new name *Parasalina* for his *Salinella* and issued some correction slips which were pasted over *Salinella* in some of the copies of his publication. This correction unfortunately was not carried out in all the copies as evident from the records in the Biological Abstracts. A question has arisen, therefore, whether the *nom. nov. Parasalina* Uchida, 1943 pro *Salinella* Uchida, 1943 has priority over that of *Parasalina* Salmon, 1944. As only some of the copies in circulation carried this correction,

while others did not, the name *Parasalina* Uchida, therefore, fails to fulfil the criteria of publication and is not available in the meaning of the Code (Articles 8 and 9). Therefore, *Parasalina* Uchida pro *Salinella* Uchida, 1941 has neither any status nor priority over *Parasalina* Salmon and the latter is to be conserved as the available, valid name.

I. TAXONOMIC ACCOUNT

Paronana Womersley, 1939 (New status)

Paronana Womersley, 1939, *Primitive Insects of South Australia*, Adelaide, 322 pp. (nec. S. Str.) ; Salmon, 1941, *Trans. Roy. Soc., N. Z.*, 70 : 398-407 ; 1964, *Bull. Roy. Soc., N. Z.*, (7) 1 : 103-144 ; 1964b, *Bull. Roy. Soc., N. Z.*, (7) 2 : 145-644 ; 1965, *Bull. Roy. Soc., N. Z.*, (7) 3 : 645-651.

Redefinition : Body facies large ; antennae usually twice the total length of head and body ; not clothed with scales, clothing of body as that of *Salina* involving microchaetae which may be darker and little flattened but not comparable with scales even those of *Parachaetoceras* ; obliquely truncated ciliated macrochaetae (brush setae) present ; frontal spines absent ; ocelli eight on each side ; tibiotarsi divided ; unguis little curved with paired inner teeth located near the middle of the inner margin, unpaired inner distal and external basolateral teeth prominent ; unguiculus lanceolate ; tenent hairs clavate, dentes long, slightly taper distally, not crenulated and annulated ; each dentes armed with a row of distinct simple spines ; dorsally near base of mucrones 2-3 stout, spiny, ciliated appendages present ; dental scale appendage present or absent.

Type-species : *Paronella bidenticulata* Carpenter, 1925, fixed by WOMERSLEY (1939).

Interrelationships : *Paronana* is related to *Parachaetoceras* Salmon, a member of the tribe Callyntrurini, but distinctly differs from it in the absence of lanceolate scales and long, outstanding, stiff macrochaetae on antennal segments and legs. It is also related to *Glacialoca* Salmon in the general

organisation of body but is distinct from it in the nature of attachment of mucro to dentes (apically attached *vs.* ventrally attached in *Glacialoca*) and nature of dental spines (simple spines *vs.* foliate, ciliated spines in *Glacialoca*). Further, no ventral dental spiny appendage occur in *Paronana*. *Paronana* also resembles to *Pseudosalina* Mitra, 1973 in the presence of larger number of macrochaetae on head and body. Presence of a transverse row of macrochaetae anteromedially on Abd. IV is a characteristic feature of the genus (*vs.* 2+2 in *Pseudosalina*). The genus appears to have a distant connection with entomobryomorpha. This is indicated by the fact that in *Paronana (Paronana) pilosa* (Salmon) the structure of mucro is somewhat close to entomobryomorph genera (Fig. 6, D). In addition, the dentes in this species taper considerably distally (Fig. 6, A ; Pl. III, C) suggesting further its affinity with entomobryomorphs and its less specialisation than any other species of this genus. This species, even though possesses a distinct dental scale appendage, a feature restricted only to some of the genera under Paronellinae, nevertheless its entomobryomorph body-facies in addition to the characters, mentioned above, serves as a definite link between entomobryomorph and paronelline genera supporting Christiansen's (1958) contention that *Homidia* (a genus having a row of distinct dental spines as *Paronana*) is somewhat distantly connected with Paronellinae. In cephalic chaetotaxy, *Paronana* is more evolved than its closely related genera under Cremastocephalini.

Distribution : Members of *Paronana* are endemic to New Zealand ; its endemism and abundance in New Zealand, a temperate country, indicates its low range of adaptation. It is interesting to note that New Zealand is the only temperate country which has such specialised and endemic representatives of Paronallinae. *Paronana (Paronana) tasmasecta*, recorded from Tasman Glacier, goes to prove its adaptability even to very cold climatic conditions.

II. KEY TO THE SUBGENERA OF *PARONANA*

Single dental scale appendage present
ventrally on each dentes, either

simple or superficially or deeply lobed* or crenulated at apex	...	Subgenus : <i>Paronana</i>
Dental scale appendage absent	...	Subgenus : <i>Parasalina</i>

Subgenus : **Paronana** Womersley, 1939. New Status

Paronana Womersley, 1939, *Primitive insects of South Australia*, Adelaide. 322 pp. (nec, S. Str.)

Panasalina Salmon, 1944, *Rec. Dom. Mus.*, Wellington, 1 (2) : 123-182. New Synonymy (in part).

Type-species : *Paronella bidenticulata* Carpenter, 1925.

III. KEY TO THE SPECIES AND SUB-SPECIES

The author had an opportunity to examine series of specimens of *Paronana* (*Paronana*) *karoriensis* (Salmon, 1937) and *Paronana* (*Paronana*) *maculosa* (Salmon, 1937) and the paratypes of other species and subspecies, described by SALMON (1941, 1944), mounted on slides. It is noted that while *P. (P.) karoriensis* exhibits constancy in colour pattern, *P. (P.) maculosa* exhibits striking intrapopulation variation in colour pattern as observed in the species of *Salina* (MITRA, 1973), *Pseudosalina* (MITRA, 1974) and *Dicranocentroides* (MITRA, 1975). Much constancy is encountered in the nature of dental scale appendage and no intrapopulation variation could be detected for this structure. The dimension of mucrones and the nature of mucronal teeth vary strikingly within the same population of a species as observed in *P. (P.) karoriensis* and *P. (P.) maculosa*. In *P. (P.) pilosa* the dentes considerably tend to taper distally which is not seen in any other species of this subgenus.

On the basis of the characters, discussed above, following species and sub-species are recognised in this study and a key is given in aid of their identification. Probable cases of synonymy of the species and subspecies, which are known primarily on the basis of colour patterning, are also discussed.

*CARPENTER (1925) and SALMON (1941, 1944, 1964) considered such deeply lobed dental scale appendage as multiple scale appendages.

- 1 Dentes distinctly tapering distally ;
dental scale appendage simple ;
devoid of dark pigmented patches *P. (P.) pilosa*
Dentes not tapering appreciably dis-
tally ; dental scale appendage simple
or crenulated ; dark or lightly
pigmented ... 2
- 2 Head, thorax, Abds. I, II dorsally
entirely pigmented with deep blue
black pigment, other segments devoid
of such pigment ; colour pattern
seldom variable ... *P. (P.) bidenticulata*
- a Dental scale appendage lobed or
crenulated ... *P. (P.) bidenticulata biden-
ticulata*
- b. Dental scale appendage simple ... *P. (P.) bidenticulata karori-
ensias*
- Head, thorax and all abdominal
segments with variable patches and
streaks of pigment of various shades ;
forms without any trace of pigment
not of rare occurrence (cf. *sufflava*) *P. (P.) maculosa*
- a Dental scale appendage lobed
or cranulated ... *P. (P) maculosa tasma-
secta* [? Synonyms : *P.
(P.) tasmasecta boldensis*;
P. (P.) sufflava]
- b. Den'al scale appendage simple ... *P. (P.) maculosa macu-
losa* [Synonym : *P. (P.)
pigmenta*]

IV. DESCRIPTIONS OF THE SPECIES

Paronana (Paronana) bidenticulata bidenticulata (Carpenter,
1925). New Status.

1925. *Paronella bidenticulata* Carpenter, *Manchester Museum Publ.*,
89 (28) : 1-16.

1941. *Paronana bidenticulata* Salmon, *Trans. Roy. Soc., N. Z.*, 70 :
282-431 ; nec, *Paronana bidenticulata* sensu Womersley, 1939,
Primitive Insects of South Anstralia, Adelaide, pp. 320.

Material : Lectotype of *Paronana bidenticulata* (Carpenter) :
Mounted on a slide from Manchester University Museum,
Manchester ; label on the slide reads as "*Paronella bidenti-
culata* Carp. ; Rakaia Gorge, Canterb., N. Z., Nov. 1913,
T. Hall Coll."

Colouration : Blue-black pigment on Ths. II, III, Abds. I, II, III (Pl. II, A) ; Abds. IV and V pale, without darker pigment dorso-medially ; Abd. IV laterally and posteriorly with faint bluish pigment ; colour pattern similar to *P. karoriensis*

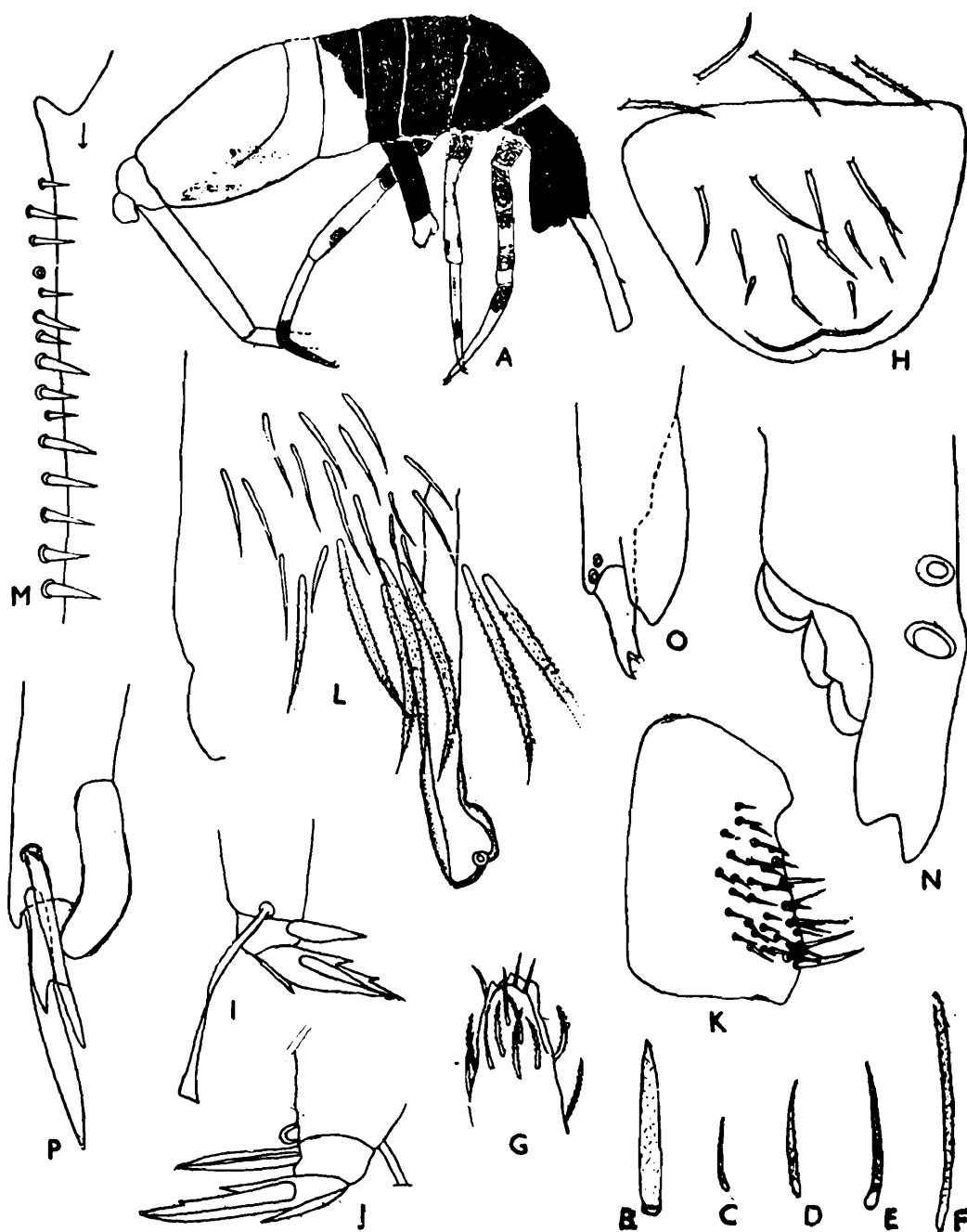


Fig. 1. *Paronana (Paronana) bidenticulata karoriensis* (Salmon). A, profile showing colour pattern. B, a dental spine. C, a microchaeta from body. D, a microchaeta from subdorsal region of head. E, a microchaeta from Abd. IV. F, a macrochaeta from "Collar". G, apex of Ant. IV. H, labral chaetotaxy. I, foot-complex of leg I. J, foot-complex of leg III. K, trochanteral organ. L, chaetotaxy of the anterior face of ventral tube. M, proximal portion of dentes showing arrangement of spines. O, P, mucrodens complex. *Paronana (Paronana) bidenticulata bidenticulata* (Carpenter). N, mucrodens complex from lectotype.

(Salmon) ; anterior part of tibiotarsus near its segmentation pigmented.

Clothing : Clothed with microchaetae and obliquely truncated, ciliated macrochaetae most of which cast off ; obliquely truncated macrochaetae (as ascertained from sockets) present on Ths. II, III, Abds. I, II, III ; acuminate macrochaetae in a transverse row medially on Abd. IV ; femora and tibiotarsi with acuminate, slender setae ; Abds. V and VI posteriorly with short, blunt somewhat broad ciliated setae ; dentes clothed with acuminate ciliated setae.

Chaetotaxy : Polychaetotic ; but the chaetotaxy could not be studied in detail from the lectotype, mounted on a slide.

Head : Lacking in the lectotype.

Thorax : Tibiotarsi clearly divided ; unguis large, little curved apically, paired inner and unpaired distal teeth moderately developed ; unguiculus lanceolate : tenent hair long ; clavate ; trochanteral organ could not be seen in the mounted specimen.

Abdomen : Abd. IV conspicuously long and at least $5\frac{1}{2}$ times longer than Abd. III ; ventral tube with 5 macrochaetae anteriorly on anterior face, general surface of anterior face and posterior face with microchaetae ; rami of retinaculum each with 4 teeth, corpus with a median seta ; furcula long, relative length index of manubrium : mucrodens = 23:44 ; dentes with a single inner row of spines which transit distally into stiff spiny setae ; mucro broad bidentate, dental scale appendage trilobed at apex (Fig. 1, N) ; sockets of dental spiny appendages distinctly visible near the base of mucrones.

Length (excluding head and appendages) : 2.6 mm.

Type-specimens : Lectotype (examined) in the Manchester University Museum, Manchester, England ; single paralectotype, as mentioned by SALMON (1941), in the Canterbury Museum, New Zealand.

Type-locality : Near Mount Algidus, Rakaia Gorge, Canterbury, New Zealand.

Comments : *Paronana bidenticulata bidenticulata* (Carpenter 1925) is characterised by the presence of dark blue-black pigment on head, Th. II and Abd. I, thick, broad mucrones and lobed dental scale appendage. *Paronana karoriensis* (Salmon, 1937), also from New Zealand, resembles perfectly to the above mentioned species in colour pattern. However, *P. karoriensis*, as has been observed, is always with simple dental scale appendage. With such difference it is felt pertinent to consider *P. karoricnsis* (Salmon) as the sub-species of *P. bidenticulata*.

Some specimens identified by Prof. Salmon as *Parasalina bidenticulata* (Carpenter) were available for study from the South Australian Museum, Adelaide (Pl. II, F ; Fig. 8, D). These specimens, however, have no similarity with *Paronana* (*P.*) *bidenticulata bidenticulata* (Carpenter, 1925) and they appear closer to *Paronana* (*Paronana*) *maculosa maculosa* (Salmon, 1937) than any other species so far known under this sub-genus.

***Paronana* (*Paronana*) *bidenticulata karoriensis* (Salmon, 1937)**

New Status

1937. *Salina karoriensis* Salmon, *Trans. Roy. Soc., N. Z.*, 67 : 352-358.

1941. *Paronana karoriensis* Salmon, *Trans. Roy. Soc. N. Z.*, 70 : 398-407.

Material : 1 paratype Slide No. N. Z. 3/200 (Dominion Museum, N. Z.), labelled as "*Parasalina karoriensis*, Loc. Awahuri, Palm. Nth. In debris under Kowhai trees, 17/12/39, Coll. J. T. Salmon, Det. J. T. Salmon. Mounted Euparal (*P. type*)" ; 8 exs., Voge Hown, Wellington, New Zealand, 7.10. 1968, R. G. Ordish coll. (ex. mixed grasses) ; 20 exs., Wellington, 24.5.1969, R. G. Ordish coll. (ex. grass and fern).

Colour pattern similar to the principal form, tibiotarsi dark pigmented (Pl. I, A ; Fig. 1, A) ; relative length index of Ants. I : II = 26 : 34 ; body clothed with microchaetae similar to those which occur in *Salina* (Pl. I, C, E ; Fig. 1, C, D, E) ; Ants. I, II with a few outstanding, stiff and dark

macrochaetae in addition to normal ciliated acuminate setae ; Ant. IV at apex with an inconspicuous sense-knob and with a few smooth setae (Fig. 1, G) ; prelabral setae 4, ciliated,

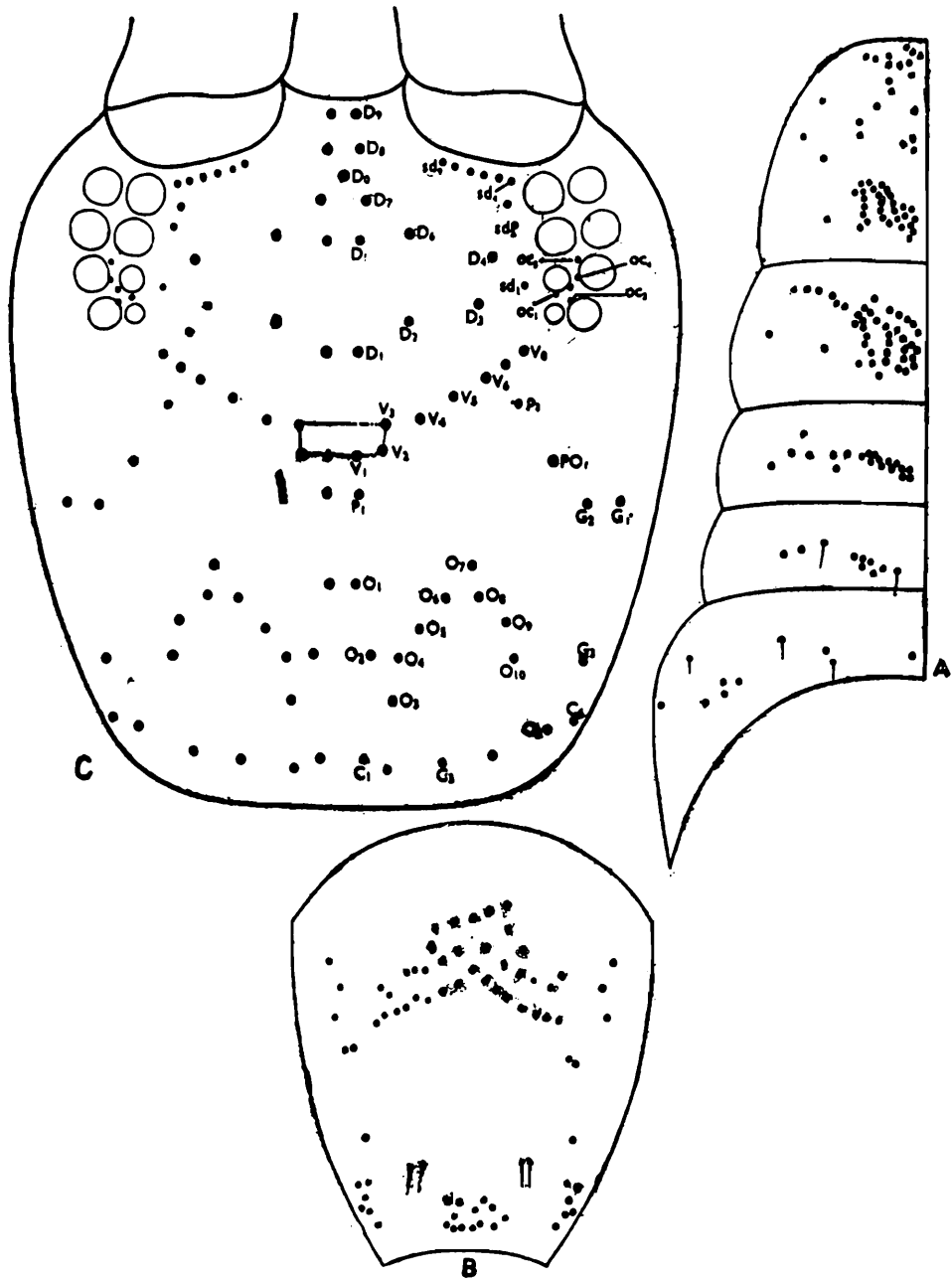


Fig. 2. *Paronana (Paronana) bidenticulata karoriensis* (Salmon). A, Chaetotaxy of Ths. II, III, Abds. I, II, III. B, chaetotaxy of Abd. IV. C, cephalic chaetotaxy.

labral setae 5, 5, 4, smooth, labrum near anterior margin with a distinct transverse thickening (Fig. 1, H) ; Ths. II : III = 21 : 13 ; unguis moderately curved with paired inner teeth located at middle of the inner margin and a distal conspicuous inner unpaired tooth, external basolateral teeth well

developed ; unguiculi lanceolate ; tenent hair long, clavate (Fig. 1, I, J) ; trochanteral organ with *c.* 38 spiny setae (Fig. 1, K) ; relative length index of Abds. I : II : III : IV : V : VI = 11 : 9 : 7 : 38 : 8 : 3 ; ventral tube long, anteriorly on anterior face with 5+5 macrochaetae, rest of the anterior face and posterior face clothed with acuminate microchaetae (Fig. 1, L) ; relative length index of manubrium : mucrodens = 28 : 38 ; dentes slightly taper distally, each with a single row of simple spines (Fig. 1, M ; Pl. 1, D) ; mucro slender bidentate, the teeth little curved upward, dental scale appendage well developed, simple (i. e., not crenulated at apex) (Fig. 1, O, P) ; two dorsal dental spiny appendages present.

CHAETOTAXY

Head : Vertex with V_1-8 , all macrochaetae, V_1, V_2 on each side located almost in a straight line and joining them with V_3 on each side yields a trapezium or a rectangle ; dorsal region with D_0+D_{1-9} , all macrochaetae ; subdorsal region usually represented by microchaetae (sd_{1-9}) ; ocular region has 5 microchaetae (oc_{1-5}) ; postocular region with a macrochaeta (PO_1) ; parietal region represented by 1 macrochaeta only (P_1), p_2 usually represented by a microchaeta ; occipital region represented by O_{1-10} , all macrochaetae, arranged in a characteristic manner ; cervical region represented by 6 macrochaetae (C_{1-6}) ; genal region represented by 3 macrochaetae on each side (C_{1-3}) (Fig. 2, C).

Body : Number of macrochaetae on each tergite ranges as follows : Ths. II (30-52), III (20-42) ; Abds. I (18-20), II (8), III (7) ; Abd. IV medially with a transverse row of macrochaetae varying from 19-20 on either side (Fig. 2 A, B).

Length : (excluding appendage) : 3.2 mm.

Type-specimens : Holotype mounted on a Slide No. 3/199 and paratype, Slide No. 3/200 (examined) are deposited in the collection of the Dominion Museum, Wellington, New Zealand.

Comments : *P. (P.) bidenticulata karoriensis* differs from the principal form in the possession of simple dental scale appendage.

Paronana (Paronana) maculosa maculosa* (Salmon, 1937).*New Status**

1937. *Saïna karoriensis* var. *maculosa* Salmon, *Trans. Roy. Soc. N. Z.*, 67 : 352-358.

1941. *Paronana maculosa* Salmon, *Roy. Soc. N. Z.*, 70 : 398-407.

1941. *Paronana pigmenta* Salmon, *Trans. Roy. Soc., N. Z.*, 70 : 398-407. ? Synonym.

Material : 1 paratype, Slide No. N. Z. 3/46 (Dominion Museum, New Zealand) labelled as "*Parasalins maculosa*, Loc.

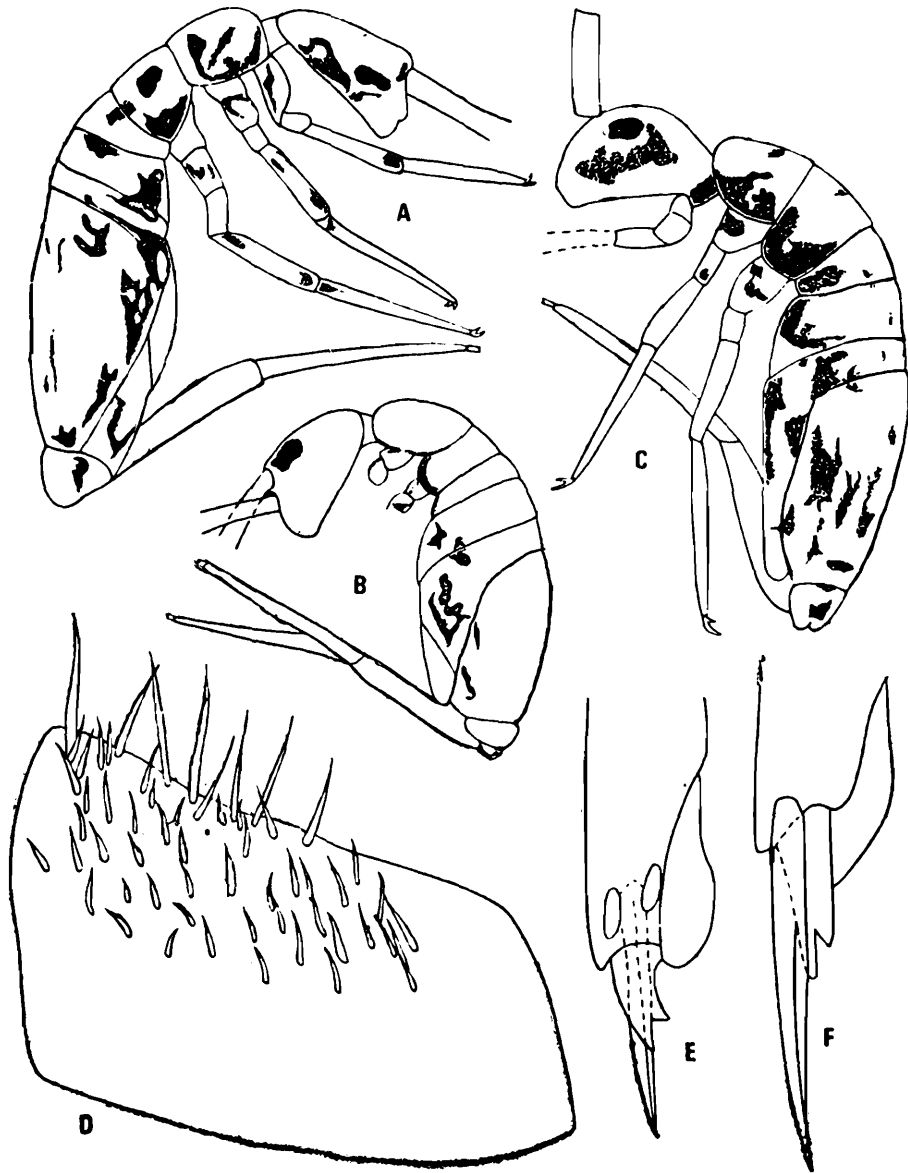


Fig. 3. *Paronana (Paronana) maculosa maculosa* (Salmon). A-C, profile showing variation in pigment patterning. D, trochanteral organ. E, F, mucrodens complex.

Karori, in soil in garden, coll. J. T. Salmon. Det. J. T.

Salmon. Mounted Euparal (P. type)" ; 5 exs., Wellington, 24.5.1969, exs grass and fern. R. G. Ordish, coll., S. K. Mitra det. ; 1 paratype Slide No. N. Z. 3/932 (Dominion Museum, N. Z.), labelled as "*Parasalina pigmenta*, Loc. Tnatapere, South land. In old log in bush, 8/1/1940, coll. J. T. Salmon.

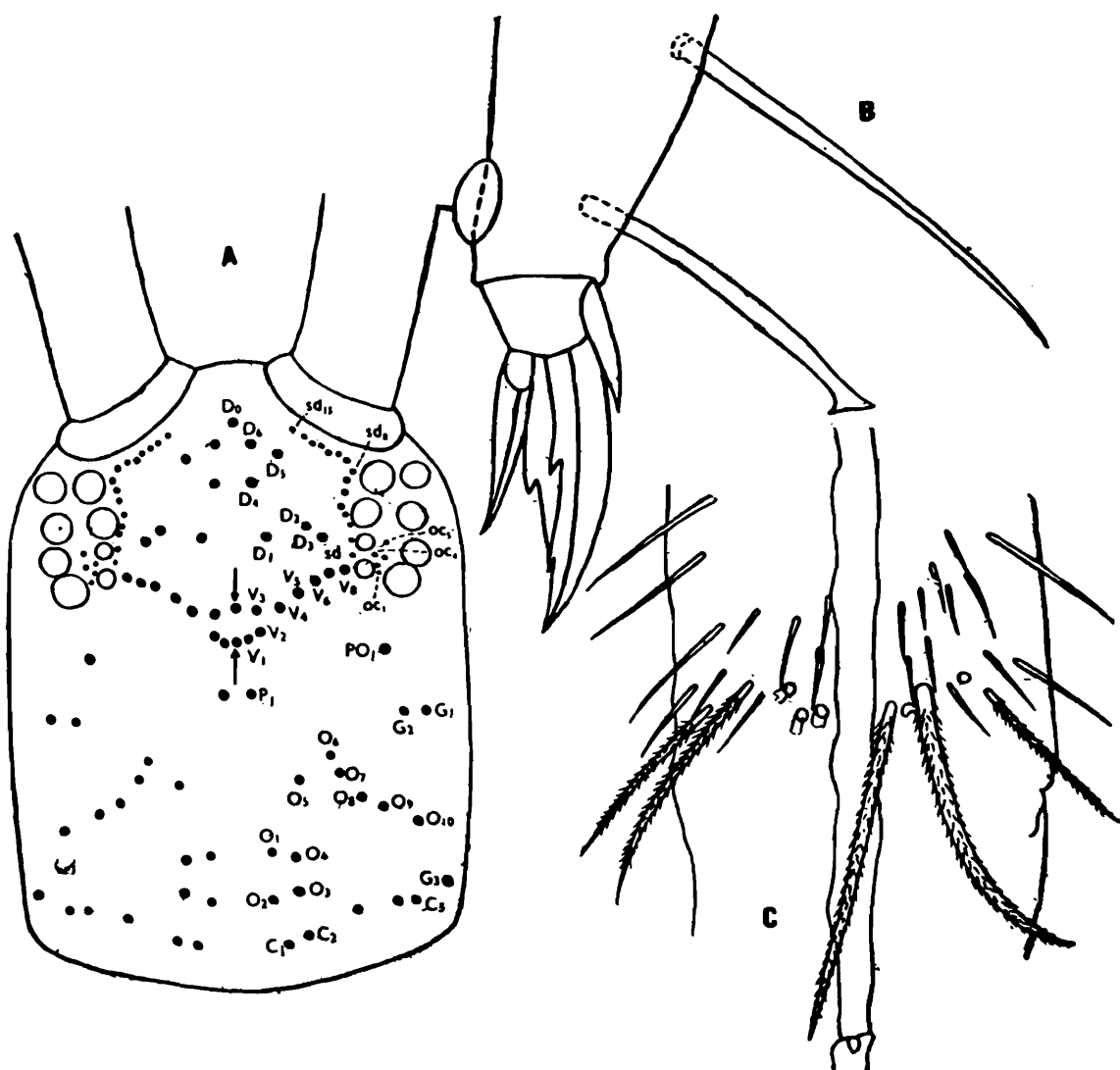


Fig. 4. *Paronana (Paronana) maculosa maculosa* (Salmon). A, cephalic chaetotaxy. B, foot-complex from leg III.

Det. J. T. Salmon. Mounted Euparal (P. type)" ; 1 ex. mounted on a slide from South Australian Museum, Adelaide, No. Nil, slide bears two labels : (a) reads as "*Collembola, Pseudopuronella bidenticulata* (Carp.), Loc. amongst taraire (?) leaves, Waiheke Is., Auckland, N. Z., 14/1/33, E. D. P. Det. H. Womersley ; (b) reads as "*Insecta, Paraslina dorsanota* subsp. *sufflava* Det. J. T. Salmon" ; 1 ex. mounted on a slide from South Australian Museum, Adelaide, Microslide No. 1, labelled as "*Parasalina bidenticulata* (Carp.), Loc. Cleddau,

2,500, beaten from *Danthonia cunninghamensis*, coll. J. T. Salmon, 17/12/1944, MNT. P. N. A. Det. J. T. Salmon, 1945'' ; 1 ex. mounted on a slide, No. Nil, from South Australian Museum, Adelaide, labelled as "Collembola, *Pseudoparonella bidenticulata* Carp., Loc. Belgrave. VIC., 1/38,

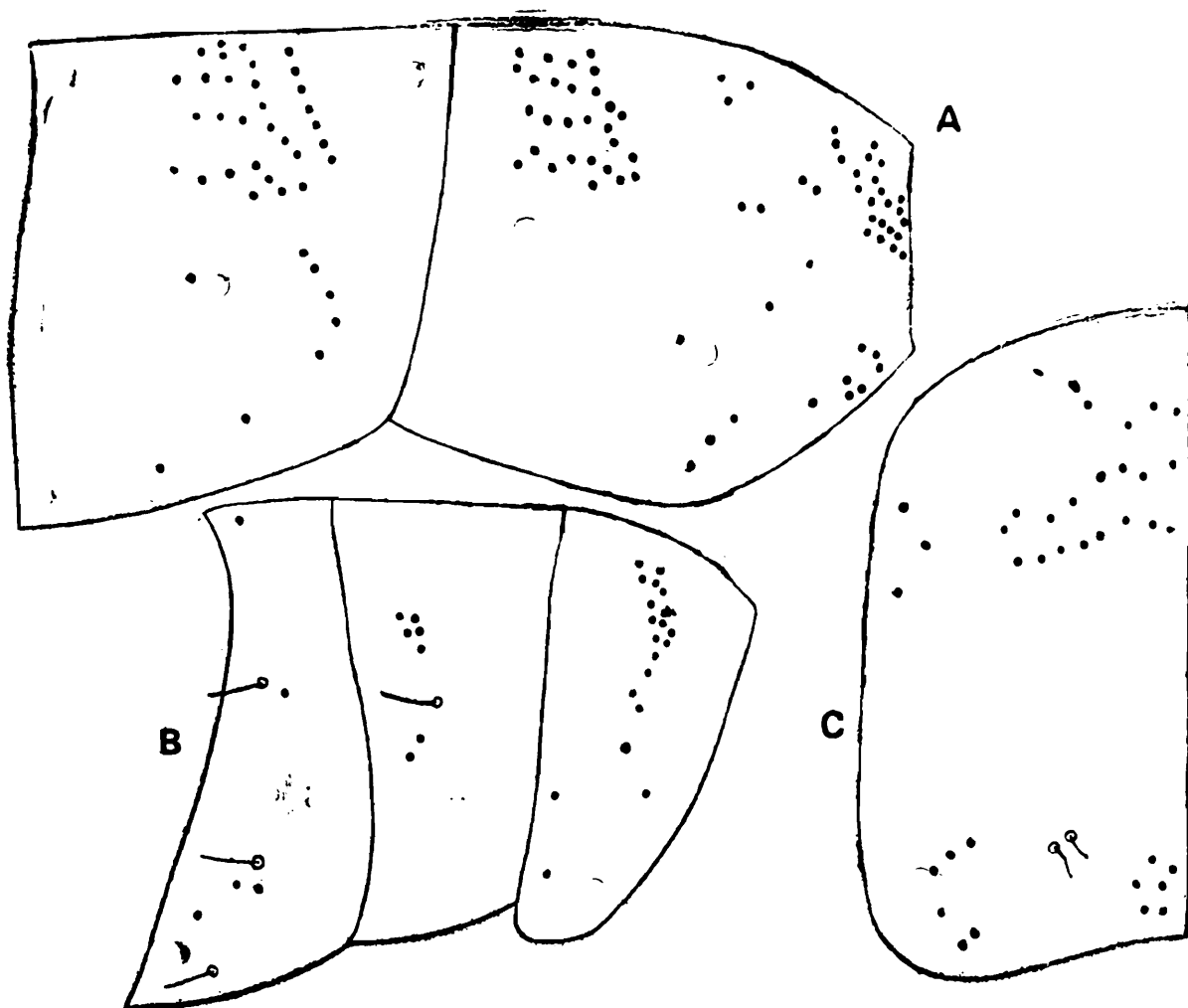


Fig. 5. *Paronana (Paronana) maculosa maculosa* (Salmon). Chaetotaxy of Ths. II, III (A), Abds. I, II, III (B), IV (C).

O. W. T. Det. H. Womersley" [The specimen is a member of *Pseudoparonella*. Womersley (1939) misidentified the specimen and published it as *Paronana bidenticulata* (Carpenter, 1925)].

In general colour pattern of the species variable and forms with reduced pigmented patches also not rare in the examples examined (Fig. 4, A-C ; Pl. II, B, C, F) ; ground colour pale yellow with variable violet to blue-black patches often suffused with reddish brown pigment irregularly distributed

laterally on head, thoracic and abdominal segments, some smaller streaks dorsally on these segments also noted in some examples ; coxae, subcoxae, femora and tibiotarsi with or without such pigmented patches.

Body clothed with microchaetae and obliquely truncated ciliated macrochaetae ("brush setae") ; femora and tibiotarsi with acuminate slender setae.

Ocelli 8+8, G and H reduced ; Ant. 1 only retained in examples examined ; prelabral setae 4, ciliated, labral setae 5, 5, 4 smooth ; frontal spines absent ; Ths. II : III=16 : 10 ; unguis with paired inner basal and distal unpaired teeth, external basal teeth prominent ; unguiculus lanceolate, non-dentate ; tibiotarsal lobe prominent ; tenent hairs clavate, well developed (Fig. 5, B) ; trochanteral organ with c. 54 spine-like setae (Fig. 4, D) ; relative length index of Abds. I : II : III : IV : V+VI=7 : 9 : 6 : 38 : 7 ; ventral tube long, anteriorly on anterior face with 5+5 macrochaetae, rest of the anterior face with acuminate microchaetae ; relative length index of manubrium : dentes=29 : 42 ; dentes slightly taper distally, each with a characteristic row of simple spines ; mucrones straight or little curved upward, bidentate, apical tooth larger than anteapical tooth ; dental spiny appendage represented by a single large, stout spine-like seta ; dental scale appendage simple (Fig. 4, E, F).

CHAETOTAXY :

Head : General plan similar to *P. (P.) bidenticulata karoriensis* but differs from it in the presence of 2 additional macrochaetae at the middle of vertex and reduction of dorsal (cf. D_7 , D_8 , D_9 of *P. bidenticulata karoriensis*) and cervical macrochaetae (C_{1-5}) ; subdorsal setae represented by sd_{1-5} (Fig. 5, A).

Body : Polychaetoic ; chaetotaxy of Ths. II, III/Abds, I, II, III, IV=72 (29, anteriorly ; 10, medially ; 23, on anterior margin ; 10, on lateral region), 40/20, 8, 6, 37, 25+1 distributed anteriorly in three apparent distinct rows and 12 posteriorly) ; lasiotrichia present as 2+2 (Abds. II, IV) and as 3+3 on Abd. III (Fig. 5, A-C).

Length (excluding appendages) : 2.5 mm.

Type-specimens : Holotype, mounted on a slide and paratype, Slide No. N.Z.3/932 (examined) remain deposited in the collection of the Dominion Museum, New Zealand.

Comments : *Paronana* (*Paronana*) *maculosa maculosa* differs from the preceding species and subspecies in the possession of dark, variable blue-black patches on the thoracic and abdominal segments, in the chaetotaxy of head and body and from *P. P. tasmasecta*, *s. str.* in the possession of simple dental scale appendage.

***Paronana* (*Paronana*) *maculosa tasmasecta* Salmon, 1941.**

New Status

1941. *Paronana tasmasecta* Salmon, *Trans. Roy. Soc., N. Z.*, 70 : 398-407.

1941. *Paronana sufflava* Salmon, *Ibid.* ? Synonym.

1944. *Parasalina tasmasecta* Salmon, *Rec. Dom. Mus.*, 1 : 123-182 ; 1964, *Bull. Roy. Soc., N. Z.*, (7) : 546.

1944, 1964. *Parasalina tasmasecta boldensis* Salmon, *Ibid.* ? Synonym.

1944, 1964. *Parasalina dorsanota sufflava* Salmon, *Ibid.*

Material : 1 paratype, Slide No. N.Z. 3/885 (Dominion Museum, N. Z.), labelled as "*Parasalina tasmasecta*, Loc. Tasman Glacier, under stones. On terminal moraine, 31/12/1939, coll. J. T. Salmon. Mounted xylol-balsam (P. type)" ; 1 paratype, Slide No. N.Z. 3/1541 (Dominion Museum, N. Z.) labelled as "*Paronana tasmasecta boldensis*, Loc. Bold peak 3000', under log in beech forest, 11/2/1943, coll. J. T. Salmon, Det. J. T. Salmon. Mounted Diaphane (Paratype)" ; 1 paratype, Slide No. N. Z. 3/931 (Dominion Museum, N. Z.) labelled as "*Parasalina snfflava*, Loc. Bench Island, Dunedin, 17/12/1938, coll. Prof. Marpels. Det. J. T. Salmon. Mounted Euparal."

Paronana (*Paronana*) *maculosa tasmasecta* differs from the principal form in the dental scale appendage being crenulated at apex (Fig. 8, (A—E) ; species like *P. (P.) sufflava* and subspecies, viz., *P. (P.) iasmasecta boldensis* do not differ significantly from *P. (P.) maculosa tasmasecta* except in the details of colour pattern which is extremely

variable as seen in *P. (P.) maculosa maculosa* ; variation of length and colour pattern according to altitudinal difference is frequent in insects, specially in Collembola. These forms agree in all respect in other morphological details. Further studies on chaetotaxy are required to establish their actual relationship which could not be undertaken for non-availability of a lcohol-preserved specimens. Chaetotaxy as far as could be noted from specimens, mounted on slides, conform to the general pattern of chaetotaxy of *Paronana*.

***Paronana (Paronana) pilosa* (Salmon, 1944)**

New Combination

1944 *Parasalina pilosa* Salmon, *Rec. Dom. Mus., N. Z.*, 1 (2) : 123-182 ; 1964, *Bull. Roy. Soc., N. Z.*, (7) : 546.

Material : 1 paratype, Slide No. N. Z. 3/1435 (Dominion Museum, N. Z.) labelled as "*Parasalina pilosa*, Loc. Kennedy's Bush, Ch'. ch'. , Beaten off Manuka, 4/3/1943, coll. J. T. Salmon. Det. J. T. Salmon. Mounted Diaphane (paratype)".

General ground-colour of body ochre-yellow ; no dark pigmented patches except a frontal patch in between two antennal bases (Pl. II, E ; Fig. 7, A). General clothing of body involves microchaetae, clusters of obliquely truncated ciliated macrochaetae ("brush setae") present on thoracic and first three abdominal segment, rest of the abdominal segments with acuminate flexed macrochaetae. Exact chaetotaxy of head and body though could not be studied for non-availability of alcohol-preserved specimens, nevertheless, the species is polychaetoic like other members of this genus ; unguis slightly curved with paired inner basal teeth located at middle and single unpaired inner basal tooth, external basal teeth well developed, unguiculus lanceolate, non-dentate, tibiotarsal lobe overhanging the base of unguiculus well developed ; tenent hairs long, clavate (Fig. 7, B) ; SALMON (1944) notiaed an additional "much smaller tooth" at half way between this (= "a single strong tooth at two thirds", also seen and illustrated by the present author) and the claw tip.

But in his figure (Pl. 62, Fig. 158), the "much smaller tooth" as referred by him, appears stronger than the "strong tooth

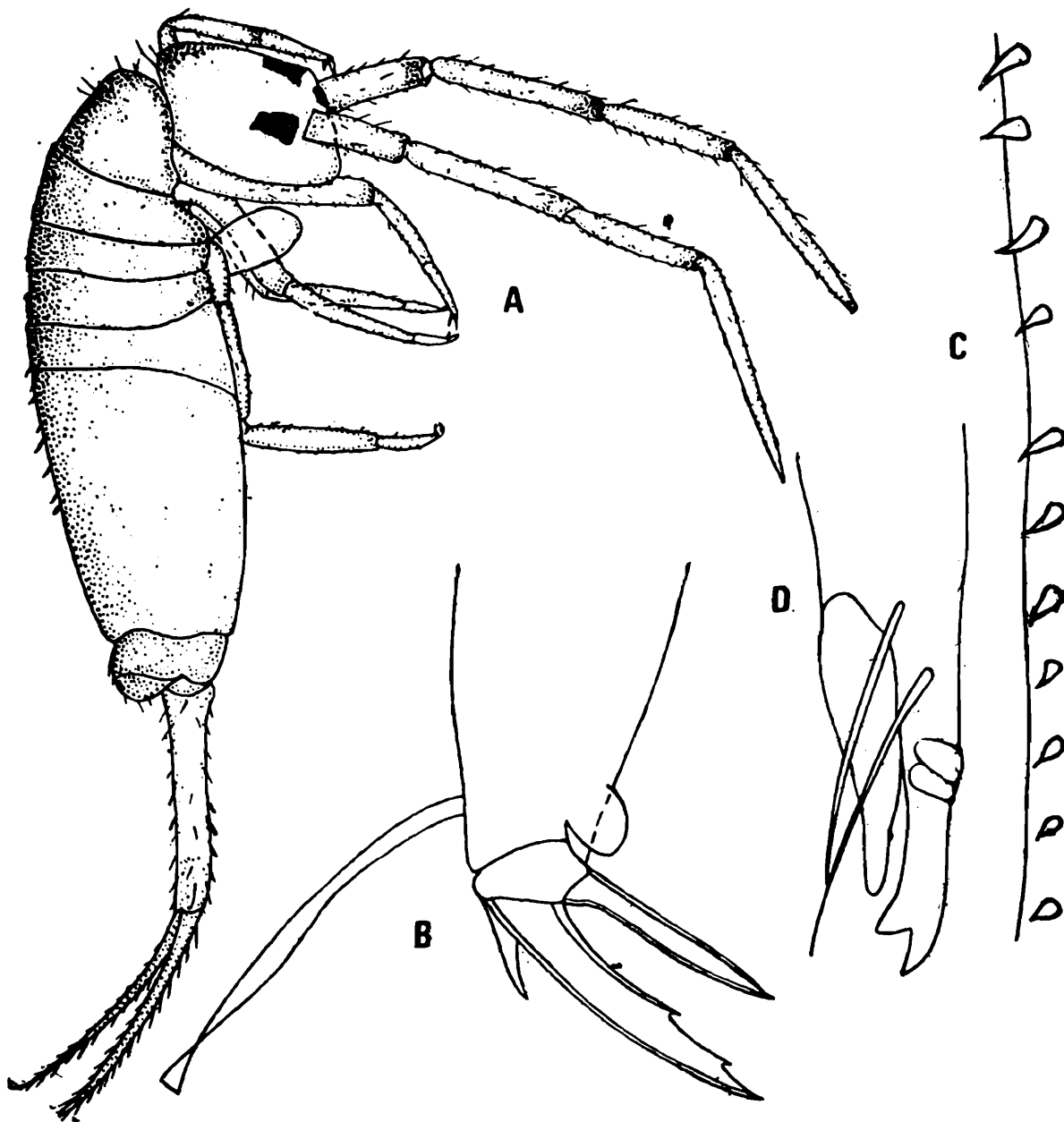


Fig. 6. *Paronana (Paronana) pilosa* (Salmon). A, profile (Paratype). B, footcomplex from leg III. C, arrangement of spines on dentes. D, mucrodens complex.

at two-thirds" of unguis ; this smaller unpaired tooth, however, was not noticed in the paratype examined by the author ; ventral tube well developed ; dentes considerably taper distally (cf. Entomobryomorpha), a unique character of the species (Pl. 3, C) ; dentes with a row of simple spines (Fig. 7, C), mucrones bidentate, dental scale appendage simple, closely apposed to dentes along most of its length (Fig. 7, D).

Type-specimens ; Holotype, mounted on a slide and paratype, Slide No. N. Z.3/1435 (examined) remain deposited in the collection of Dominion Museum, New Zealand.

Comments : *Paronana* (*Paronana*) *pilosa* (Salmon) is a unique species of the genus in having gradually tapering dentes with a dental scale appendage, entomobryiform body facies and mucrones not to be seen in any other species of this genus. Such characters in this species serve as a definite link between entomobryomorph and paronelline genera.

Sub-genus : **Parasalina** Salmon, 1944. New Status.

Parasalina Salmon, 1944, *Rec. Dom. Mus.*, 1 (2) : 123-182 ; 1964, *Bull. Roy. Soc., N. Z.*, (7) 1 : 103-144.

Redefinition : Dental scale appendage absent ; other features same as given under *Paronana*.

Type-species : *Paronana dorsanota* Salmon, 1941, fixed by Salmon, 1964.

***Paronana* (*Parasalina*) *dorsanota* Salmon, 1941. New Status**

1941. *Paronana dorsanota* Salmon, *Trans. Roy. Soc., N. Z.*, 70 : 398-407.

1944. *Parasalina dorsanta* Salmon, *Rec. Dom. Mus., Wellington*, 1(2) : 123-182 ; 1964, *Bull. Roy. Soc., N. Z.*, (7) 2 : 145-644.

1944. *Parasalana dorsanota intermedia* Salmon, *ibid.* New Synonymy.

Material : 1 paratype of *Paronana* (*Parasalina*) *dorsanota* Salmon, Slide No. N. Z. 3/880, details as mentioned above under material of the genus. 1 paratype of *Paronana* (*Parasalina*) *dorsanota intermedia* (Salmon), Slide No. N. Z. 3/1582, details as mentioned above under material of the genus.

Colouration : Ground colour yellowish brown, with dirty brown pigment dorsomedially on Ths. II, III and Abds. I to VI, which unite to form a continuous longitudinal band ; such pigment present as spots laterally on Ths. II, III, Abds. I, II, III, but somewhat in the form of a uniform lateral patch on Abd. IV, pigment also present on general surface of Abds. V and VI ; antennae and legs with dark brown pigment, pigment intense anteriorly on each antennal segment and on

the margins of appendages, Ants. III and IV dark purple ; furcula without pigment (Pl. III, A, B).

Clothing : Body clothed with slender, thin microchaetae and flexed macrochaetae ; macrochaetae on Ths. II, III and

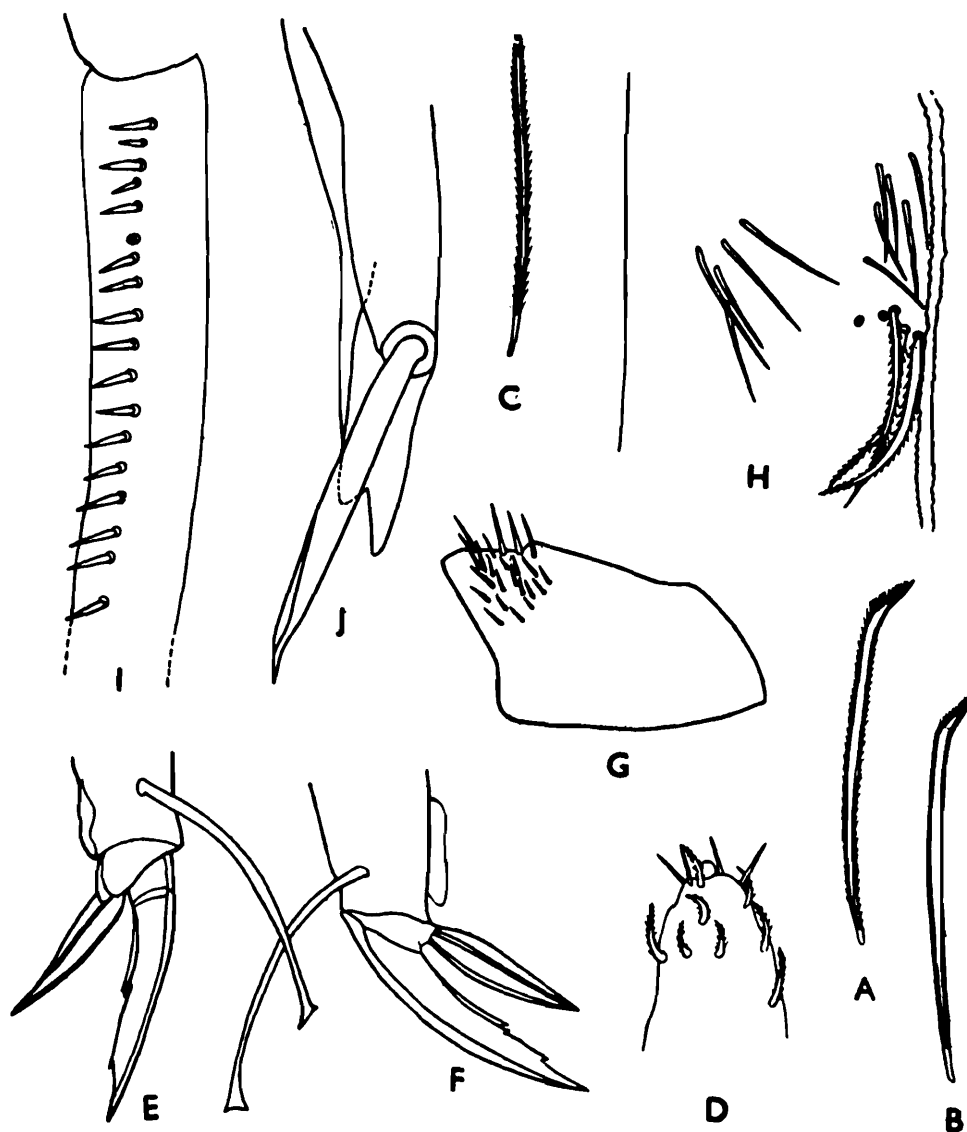


Fig. 7. *Parasalina (Parasalina) dorsanota* Salmon. A, B, flexed macrochaetae from thorax. C, a flexed macrochaeta from Abd. IV. D, apex of Ant. IV. E, foot-complex of leg I. F, footcomplex of leg III. G, trochanteral organ. H, Chaetotaxy of anterior face of ventral tube. I, a portion of centes showing arrangement of spines. J, mucrodens complex (All drawn from Paratype).

Abds. I, II obliquely truncated, ciliated, those present on Abds. IV, V broadly acuminate (Fig. 7, A-C) ; antennae and legs clothed with slender acuminate setae interspersed with certain outstanding long setae, Ants. III and IV, in

addition, with certain apparently smooth setae ; furcula clothed with short, slender, acuminate setae.

Head : Pear-shaped when viewed from above : frontal spines absent ; eight ocelli on each side in dark ocellar field,

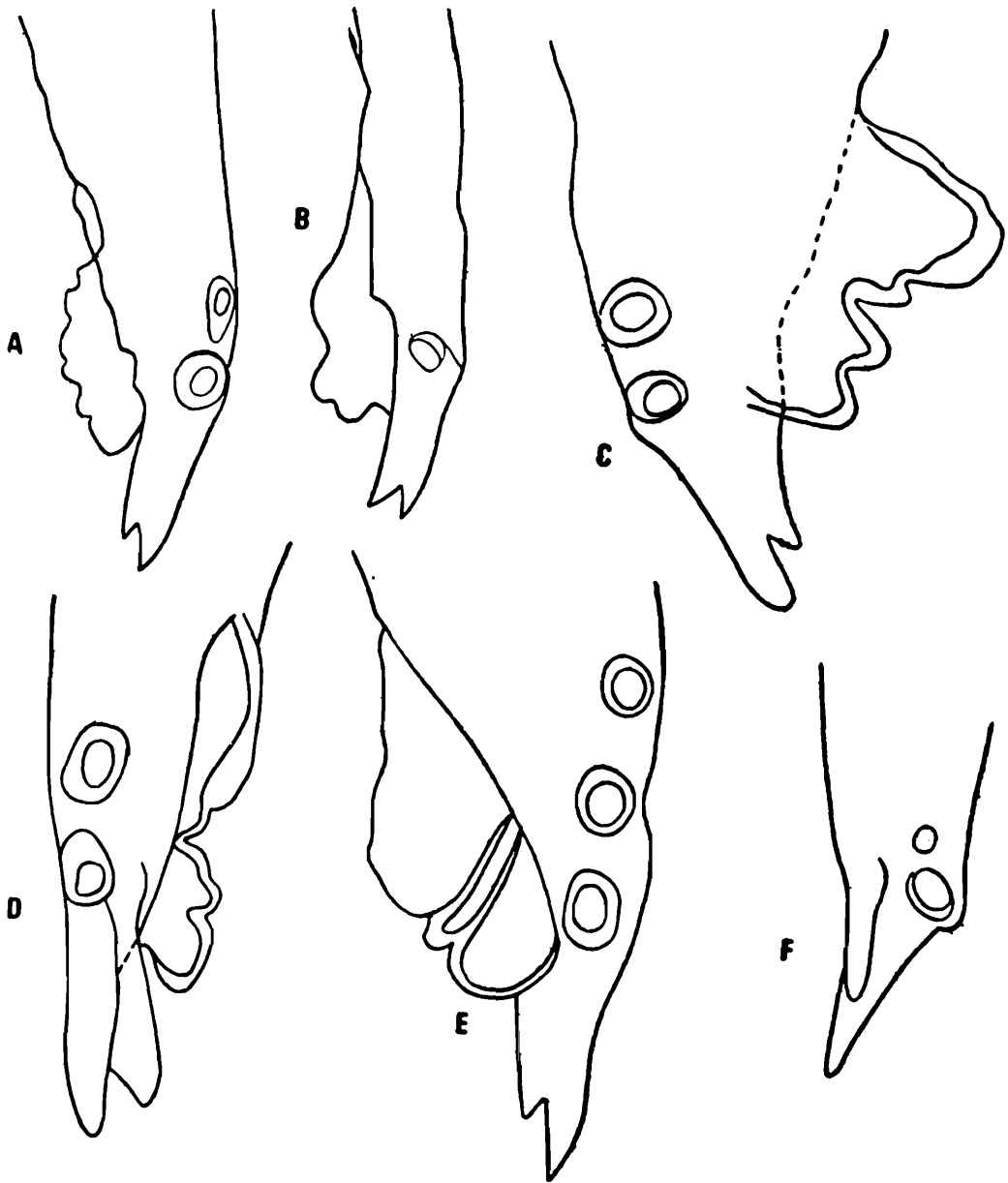


Fig. 8. Mucrodens complex in *Paronana*. A,B, *Paronana (Paronana) sufflava*. C, *Paronana (Paronana) tasmasecta*. D, *Paronana (Paronana) masculosa maculosa* (from a specimen in South Australian Museum, Adelaide ; det. Salmon as *Parasalina bidenticulata*). E, *Paronana (Paronana) tasmasecta boldensis*. F, *Paronana (Parasalina) dorsanota intermedia* (from Paratype).

each group arranged in two longitudinal parallel rows ; antennae c. twice the length of head and body, relative length index of Ants. I : II : III : IV = 21 : 31 : 21 : 51 ; Ant. IV

with an apical sense-knob guarded with a few apparently smooth setae (Fig. 7, D) ; prelabral setae, 4, ciliated, labral setae 5, 5, 4.

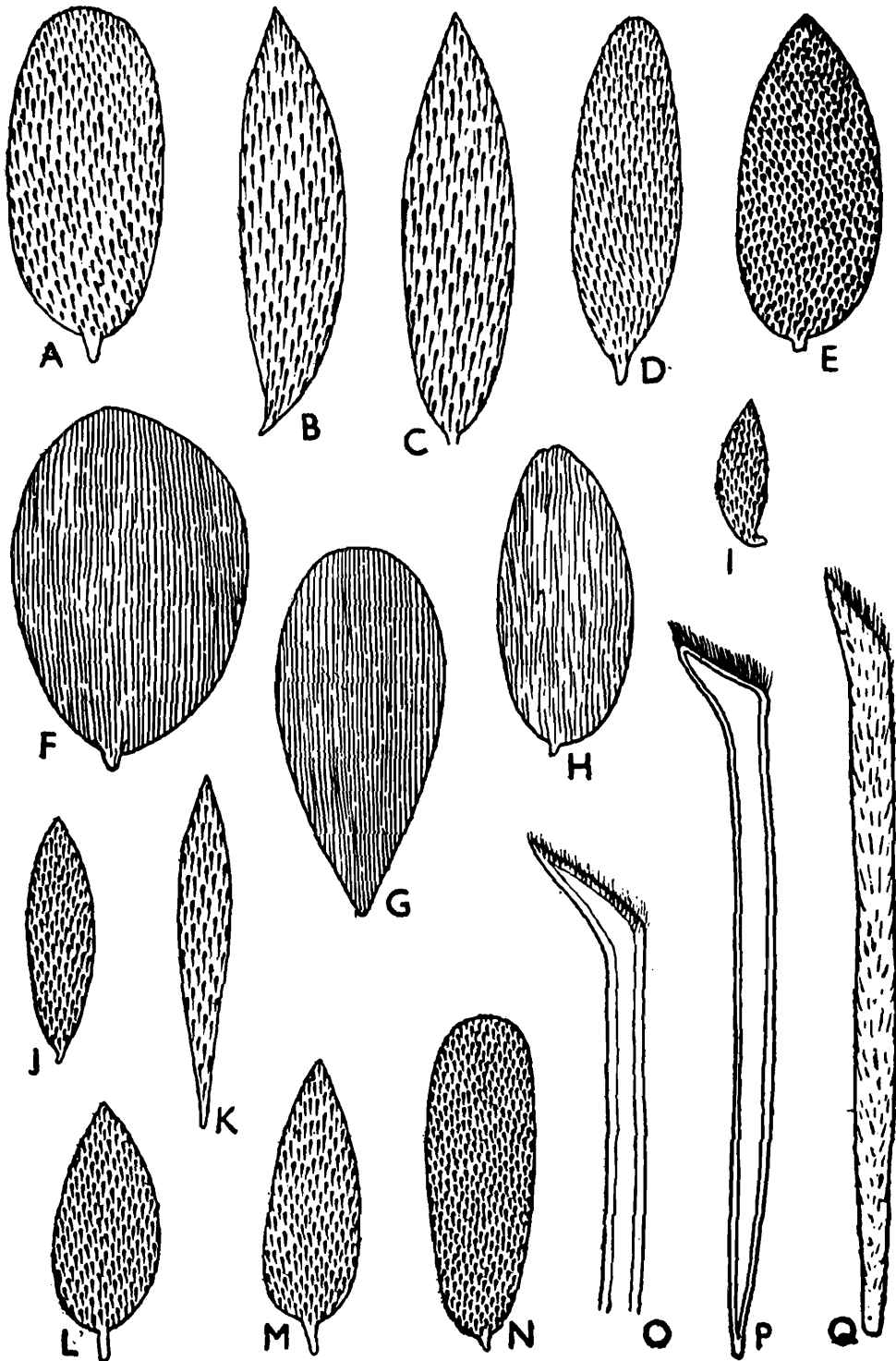


Fig. 9. Typical clothing in *Pseudoparonella*. A-N, Pseudosales. O-Q, flexed "brush setae".

Thorax : Relative length index of Ths. II : III = 13.9 ; unguis with paired inner basal teeth located near the middle of the inner margin, single unpaired distal tooth sub-apically

located and quite exaggerated ; unguiculi lanceolate, non-dentate ; tenent hair well developed, minutely ciliated, clavate (Fig. 7, E, F) ; trochanteral organ with c. 22 short spines (Fig. 8, G).

Abdomen : Relative length index of Abds. I : II ; III : IV : V : VI = 5 : 6 : 3 : 34 : 5 : 2 ; ventral tube long with protrusible vesicles retracted ; 5+5 macrochaetae anteriorly on the anterior face of ventral tube, the rest of the anterior and posterior faces with slender microchaetae only (Fig. 7, H) ; relative length index of manibrium : mucrodens = 81 : 112, dentes slightly taper distally ; each dentes with a row of simple spines which gradually transit into stiff ciliated setae distally (Fig. 7, I) ; mucro bidentate ; dental spiny appendage single, ciliated on margins ; dental scale appendage absent (Fig. 7, J).

Length (excluding antennae and furca) : 2.4 mm.

Type-specimens : Holotype (Slide No. 3/875) and paratype (Slide No. 3/880, examined) are in the Dominion Museum, Wellington, New Zealand.

Type-locality : Mount Cargill, Dunedin, New Zealand. SALMON (1941) did not select any type-locality and the author takes this opportunity to select the above-mentioned place as the type-locality.

Comments : *Parasalina* is a monotypic sub-genus consisting of the species *Paronana* (*Parasalina*) *dorsanota* and its one sub-species *intermedia*. The sub-species was erected by SALMON (1944) only on the basis of slight difference in colour pattern which is frequent in the genera under Paronellinae. In other morphological details the sub-species is similar to the principal form. Short antennae in the sub-species appears to be due to their imperfect regeneration. In fact the paratype examined, shows deformed antennae (Pl. III, B). The sub-species is considered here as a synonym of the principal form.

Interrelationships : *Parasalina* is apparently close to *Paronellides* in the nature of mucrones and in the absence of dental scale appendage but differs from it in the presence of

distinct dental spines. The subgenus can be differentiated from *Glacialoca* Salmon in the nature of dental spines and in the presence of dental spiny appendage dorsally at apex of dentes.

Distribution : The type-species of the sub-genus is known from Dunedin and Otago in New Zealand and appears to be an endemite of this country.

ACKNOWLEDGMENTS

I am thankful to the following individuals and their institutions for kindly providing me an opportunity to examine the type-specimens and other identified collections dealt with in this investigation : Dr. R. G. Ordish, Entomologist, Dominion Museum, Wellington, New Zealand, and the authorities of the South Australian Museum, Adelaide, South Australia.

Thanks are also due to the Director, Zoological Survey of India, Calcutta, for providing laboratory facilities.

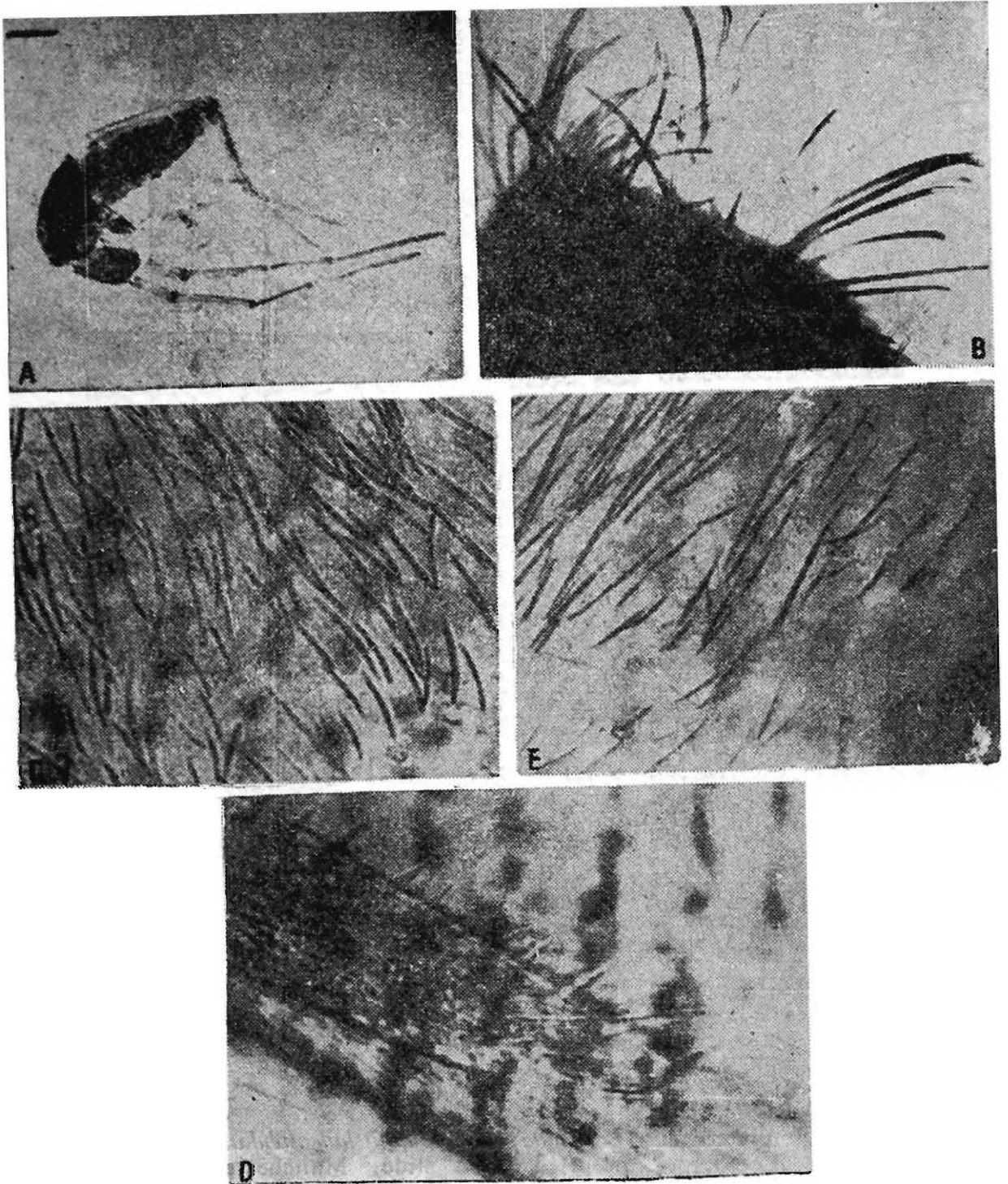
SUMMARY

In this study the confusions existing on the concepts of *Paronana* Womersley and *Parasalina* Salmon are resolved on the basis of the exsmination of type-specimens of the type-species and other species known under these taxa. Detailed studies reveal that *Parasalina* Salm. should be considered as a subgenus of *Paronana* Wom. and the latter is widely different from *Pseudoparonella* Handschin. Keys to the subgenera, species and subspecies are provided on the basis of newly evaluated characters.

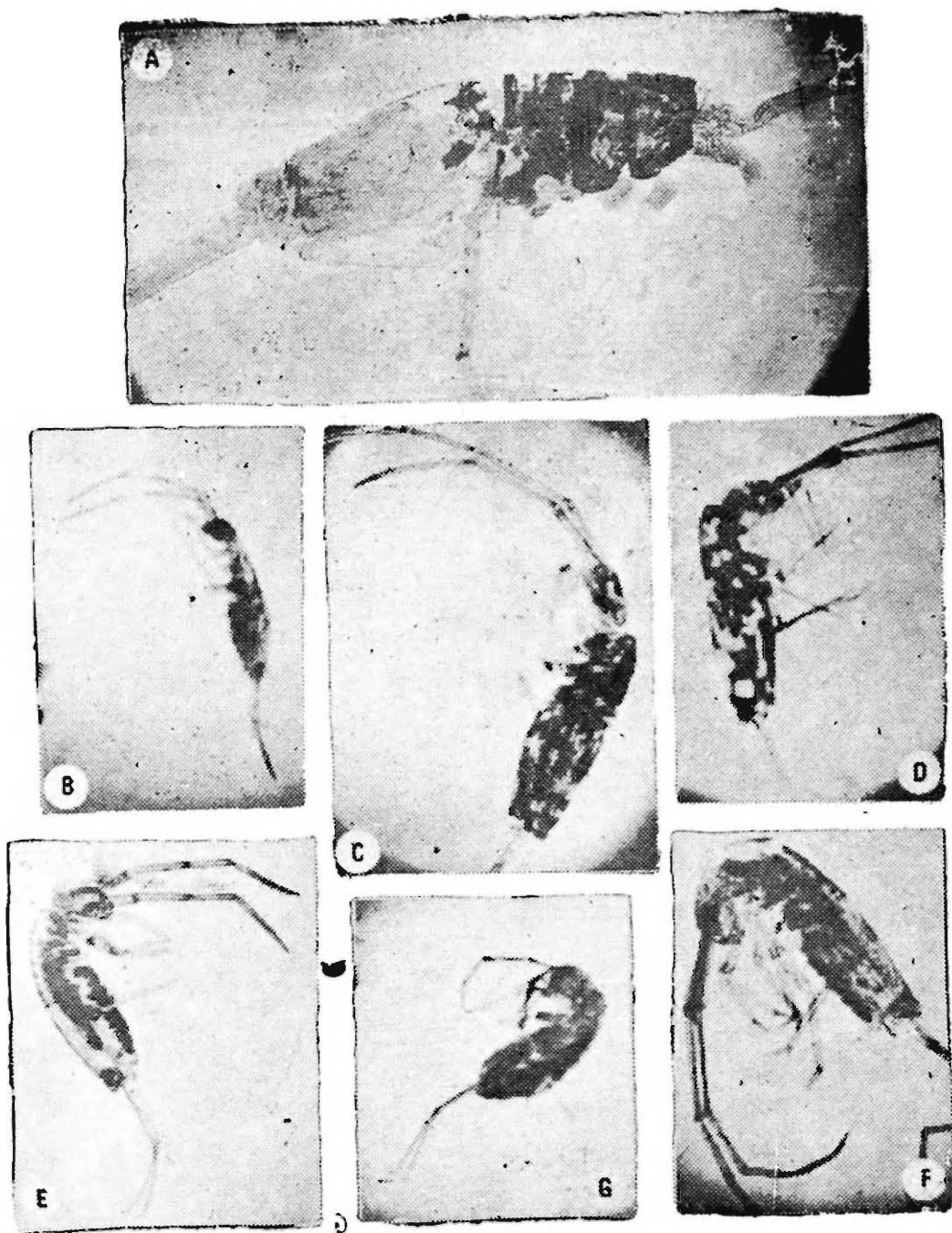
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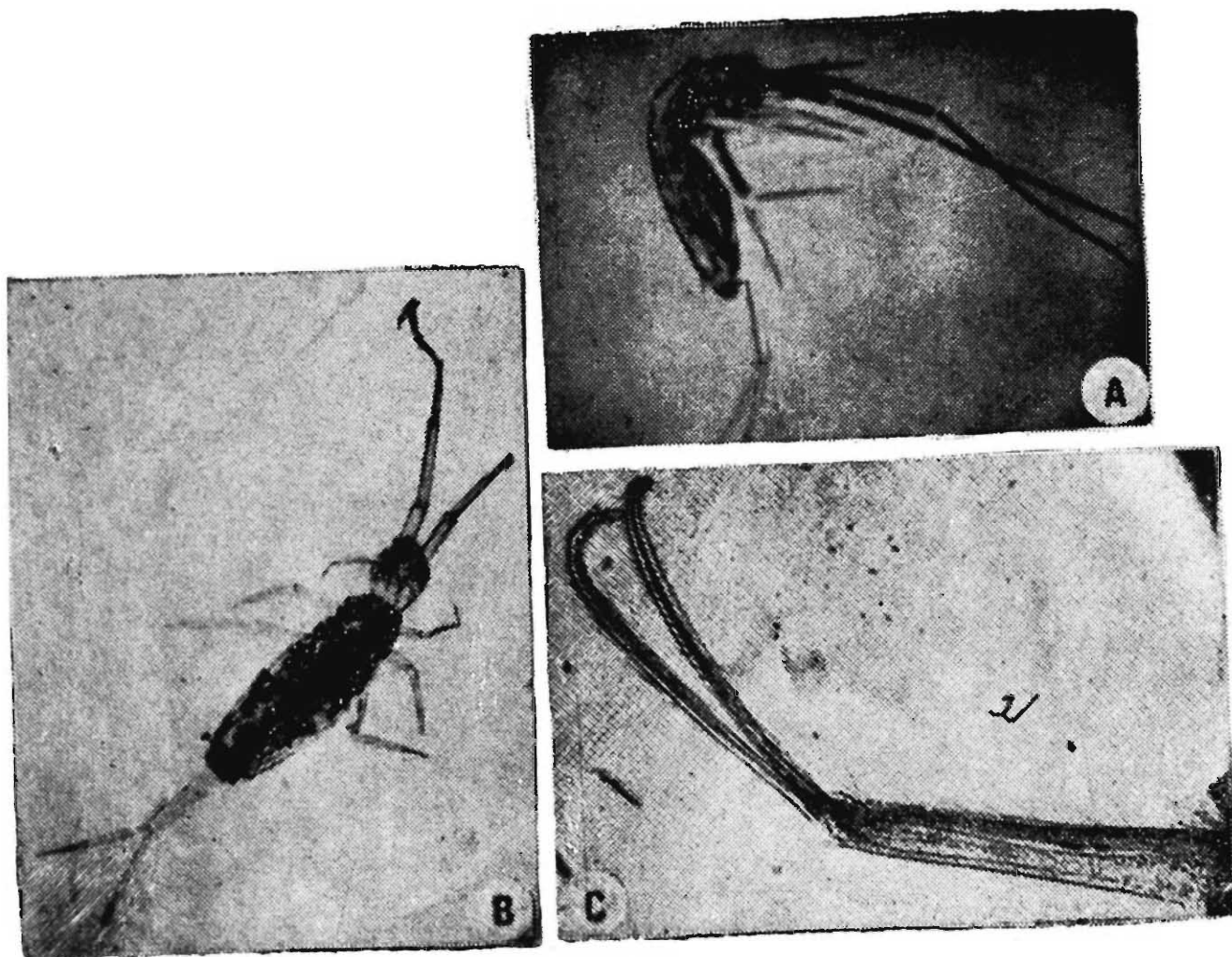
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Paronana (Paronana) bilenticulata karoriensis (Salmon). A, Profile (Paratype, Slide No. N. Z. 3/200, Dominion Museum, New Zealand). B, portion of Th. II of the same paratype showing flexed macrochaetae. D, a portion of dentes showing spines from paratype. E, nature of microchaetae in *Paronana* (from Abd. IV of the paratype). C, nature of microchaetae in *Salina* (from Abd. IV).



A, *Paronana (Paronana) bidenticulata bidenticulata* (Carpenter) Lectotype, mounted on a slide, Manchester University Museum, England (Note: Pigment on Abds. III, IV are displaced flakes of pigment from other segments). B, *Paronana (Paronana) maculosa maculosa* (Salmon) (Paratype). C, *Paronana (Paronana) pigments* Salmon (Paratype). D, *Paronana (Paronana) tasmasecta boldensi* (Salmon) (Paratype). E, *Paronana (Paronana) pilosa* (Salmon) (Paratype). F, *Paronana (Paronana) cf. maculosa maculosa* (Salmon) [from South Australian Museum, Adelaide, det. Salmon as *Parasalina bidenticulata* (Carpenter)]. G, *Pseudoparonella bidenticulata*; The specimen from Belgrave, Victoria det. Womersley (1939) as *Paronana bidenticulata* (Carpenter) (in South Australian Museum, Adelaide).



A, *Paronana (Parasalina) dorsanota* Salmon (Paratype). B, *Paronana (Parasalina) dorsanota intermedia* (Salmon) (Paratype). C. *Paronana (Paronana) pilosa* Salmon, from the paratype (Note : The nature of dentes in the species).

COMPARATIVE ANATOMY OF THE THORAX OF LARVAL ODONATA, PROTHORAX

By

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REWA (M. P.)

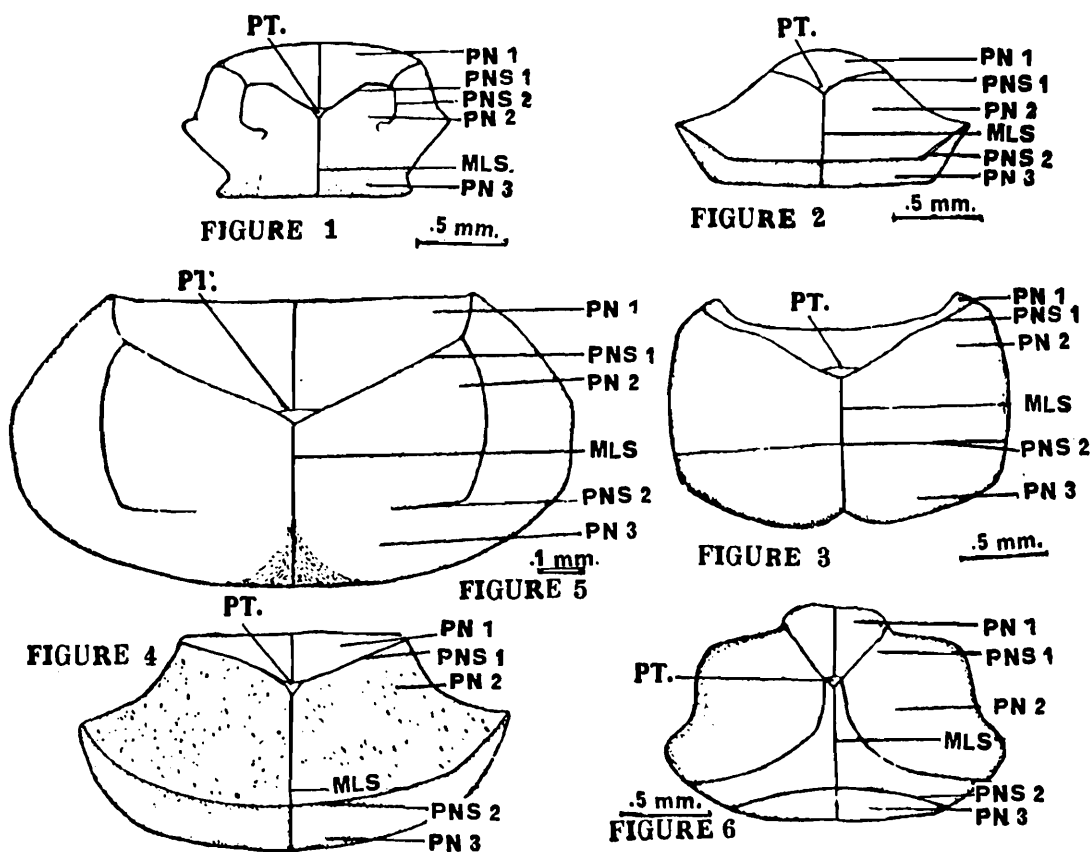
Both adult and larval thorax in Odonata have been studied by several morphologists. Asahina (1954) and Chao (1953) have taken up the thorax of adult Azygopterous forms. Cowley (1941) gave descriptive terms to the pterothorax. Hakim (1963) has described the thorax of twelve species of adult Odonata and Trottier (1969) has made attempts at the morphology of certain *Sympetrum* larvae. But none of the workers have however, paid attention to the thorax of the larvae of Zygopterous forms. In the present paper detailed morphology of the prothorax of six species of zygopterous larvae namely *Pseudagrion decorum*, *Copra marginipes*, *Ischnura delicata*, *Ischnura senegalensis* of the Coenagriidae family, *Ceriagrion coromandelianum* of Platycnemidae and *Libellago lineata* belonging to the Chlorocyphidae family have been taken up in order to elucidate this aspect. The methods employed are the same as described by Hakim (1963).

THE PROTHORAX

It is the shortest of the three thoracic segments and is separated from the mesothorax by a membrane.

The *pronotum* (Fig. 1 to 6). It is a strongly sclerotised plate and is divisible into three sub-regions, an anterior, a middle and a posterior. The anterior pronotal sclerite (PN 1) occupies about one fourth of the entire pronotal region. It is demarcated from the middle sclerite by the first pronotal sulcus (PNS 1). In the middle of this sulcus is a pit (PT) which leads into a long pronotal apophysis. The middle pronotal sclerite (PN 2) lies in between the first and the third divisions of pronotum ; it is usually the largest

of the three sub-divisions and constitutes about half of the pronotum. The hind limit of this sclerite is marked by the second pronotal sulcus (PNS 2). The middle sclerite is



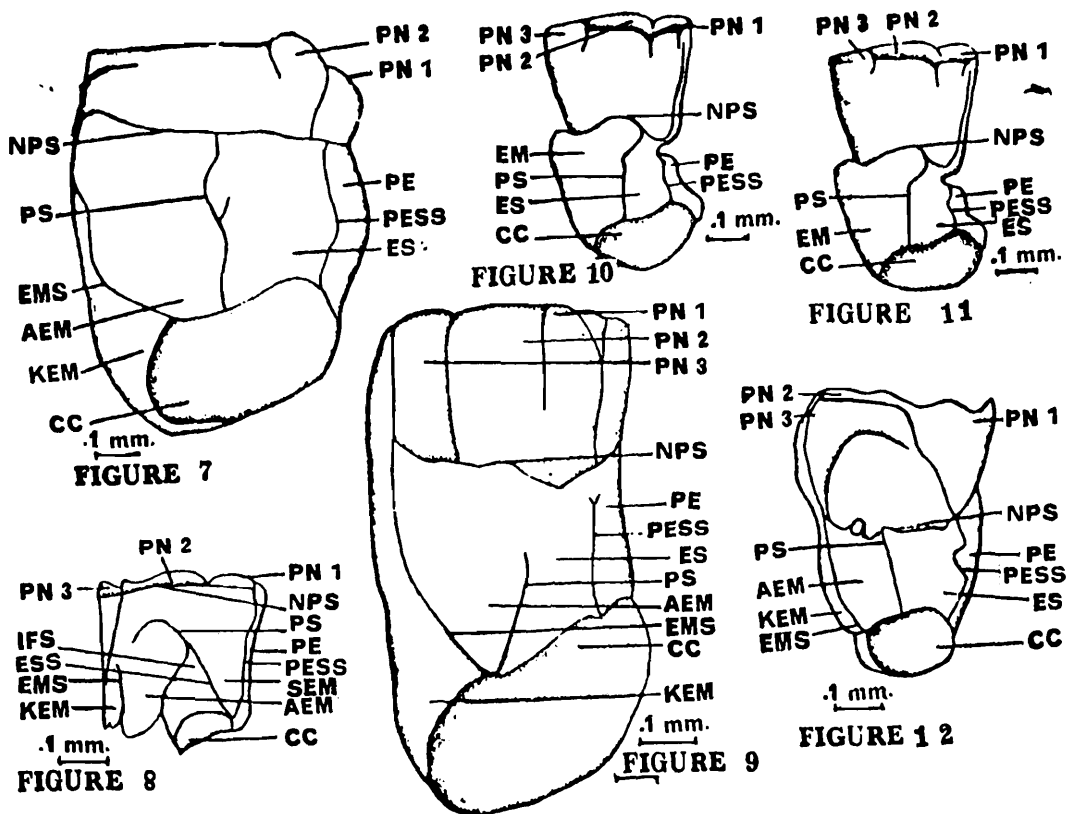
Figs. Dorsal view of the Prothorax of Larva. 1. *Copera marginipes*, 2. *Pseudagrion decorum*, 3. *Ceriagrion coromandelianum*, 4. *Ischnura delicata*, 5. *Ischnura senegalensis*, 6. *Libellago lineata*.

traversed by a short mid longitudinal sulcus (MLS) which join the first pronotal sulcus in the front and the second pronotal sulcus behind. The posterior pronotal sclerite (PN 3) is almost as large as the anterior sclerite.

In *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* and *Libellago lineata* the anterior pronotal sclerite is subdivided into two lateral parts by a median longitudinal sulcus (MLS) it remains undivided in *Pseudagrion decorum* and *Ceriagrion coromandelianum*. The sclerite is triangular in all the species. The middle pronotal sclerite remains clearly differentiated from the posterior pronotal sclerite by a complete second pronotal sulcus (PNS 2) in *Pseudagrion decorum*, *Ceriagrion coromandelianum*, *Ischnura delicata* and *Libellago*

lineata. Second pronotal sulcus is incomplete in *Copera marginipes* and *Ischnura senegalensis*.

The *propleuron* (Fig. 7 to 12). It is also a large sclerotised plate and is united with the notum above, the junction being marked by a sulcus the notopleural sulcus (NPS). Ventrally



Figs. Lateral view of the Prothorax of Larva. 7. *Copera marginipes*, 8. *Pseudagrion decorum*, 9. *Ceriagrion coromandelianum*, 10. *Ischnura delicata*, 11. *Ischnura senegalensis*, 12. *Libellago lineata*.

the pleuron is united with the sternum in its front and in the hind part it forms the dorsal margin of the coxal cavity (CC). The propleuron is differentiated into three parts, the pre-episternum, episternum and epimeron which are situated one behind the other.

The *pre-episternum* (PE) is the anterior most of the pleuron and is slightly overlapped by the second lateral cervical sclerite. Its shape, relative size and position vary in different forms. The pre-episternum extends from notopleural to the sternopleural junction. It is a narrow, biconvex sclerite. This sclerite remains marked posteriorly by the pre-spisternal sulcus (PESS).

The *episternum* (ES) is some what triangular, the base of which is formed by its ventral margin and its apex is dorsal. It occupies about half of the pleuron, the episternum is demarcated from epimeron behind by a pleural sulcus (PS). The front part of the base of the episternum is limited by the sternopleural sulcus and the hind part by the coxal cavity (CC). The entire ventral margin of the episternum forms the upper boundary of the coxal cavity.

In *Copera marginipes*, *Ischnura del cata*, *Ischnura senegalensis* and *Libellago lineata* the pleural sulcus is complete and reaches the noto pleural sulcus (NPS). It is incomplete in *Pseudagrion decorum* and *Ceriagrion coromandelianum*.

The *epimeron* (EM) is also some what triangular and occupies almost half of the pleural region. Its dorsal and anterior limits are marked by notopleural (NPS) and pleural sulcus (PS) respectively. The posterior margin is slightly wavy in *Copera marginipes* rounded in *Pseudagrion decorum*, *Ischnura delicata*, *Libellago lineata* and straight in *Ceriagrion coromandelianum* and *Ischnura senegalensis*. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum*, *Libellago lineata* the epimeron is differentiated into an anterior large *anepimeron* (AEM) and a posterior, narrow, *katepimeron* (KEM) by an epimeral sulcus (EMS) which extends from the ventral ends of the pleural sulcus, dorsal upto the notopleural junction.

The *prosternum* (Fig. 13 to 18). It is a well sclerotised mid ventral area of the segment which is broader than long. Laterally the sternum is united with the pleuron. The sternum consists of presternum, basisternum and the furcasternum, situated one behind the other.

The *presternum* (PST) shows remarkable differences in its position, shape and size in different forms. In *Copera marginipes*, *Pseudagrion decorum*, *Ischnura delicata* and *Ischnura senegalensis*, it is characterized by broad lateral areas and a narrow middle region which forms a bridge uniting the two lateral areas. The latter are situated one on either side of basisternum and the middle area lies in front of the basis-

ternum. The uniting bridge is much reduced in *Ceriagrion*

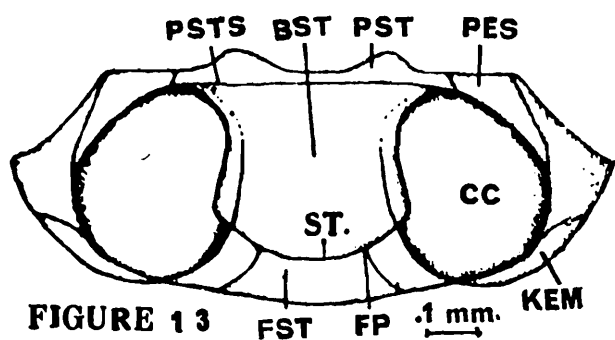


FIGURE 13

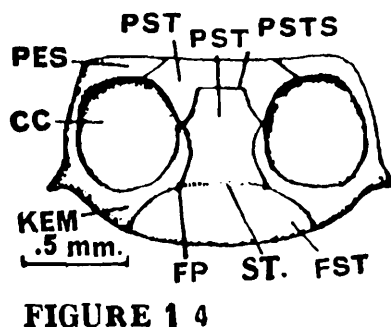


FIGURE 14

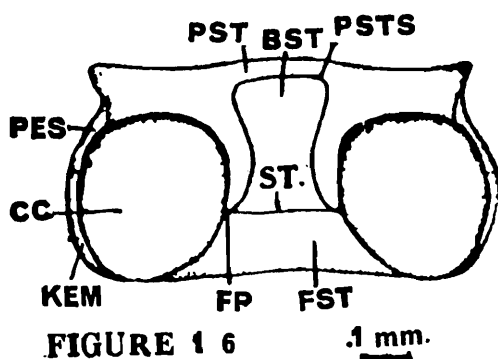


FIGURE 16

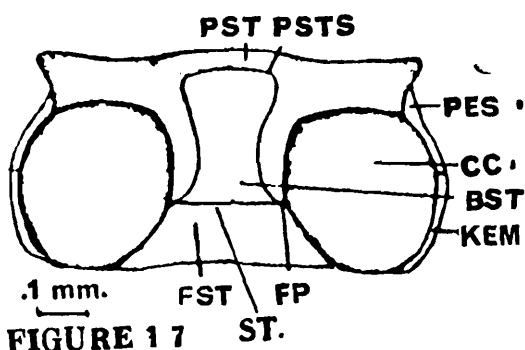


FIGURE 17

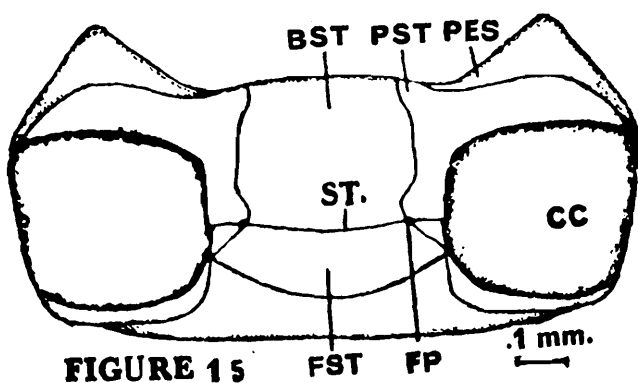


FIGURE 15

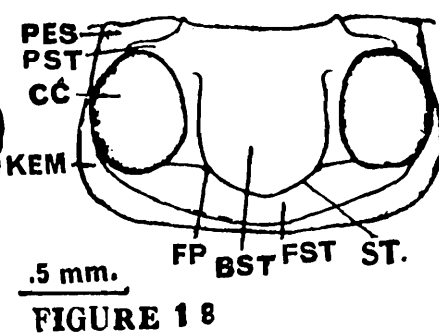


FIGURE 18

Figs. Ventral view of the Prothorax of Larva. 13. *Copera marginipes*, 14. *Pseudagrion decorum*, 15. *Ceriagrion coromandelianum*, 16. *Ischnura delicata*, 17. *Ischnura senegalensis*, 18. *Libellago lineata*.

coromandelianum and *Libellago lineata*. The pre-episternum is demarcated from the basisternum by a presternal sulcus (PSTS).

The *basisternum* (BST) is broad, plate like structure. It lies behind presternal sulcus, the sternal suture (ST) separates the basisternum and the furcasternum (FST). A pair of furcal pits lie between the two coxal cavities. The position of furcal pits differs from species to species. The furcal pits in *Ischnura delicata* and *Ischnura senegalensis* are situated some what nearer to the coxal cavities, in *Copera marginipes*,

Pseudagrion decorum, *Ceriagrion coromandelianum* and *Libellago lineata* they are situated at a farer distance from it.

DISCUSSION

In larval forms the *pronotum* is divisible into three regions, an anterior (PN 1), a middle (PN 2) and a posterior (PN 3) as in adult Odonata (Hakim 1963). The anterior pronotal sclerite is demarcated from the middle sclerite by first pronotal sulcus (PNS 1) bearing pronotal apophysis. This has been regarded as phragma of the pronotum by Garman (1917), Clark (1940) and Asahina (1954). Hakim (1963) interpretes this as an apophysis. We agree to Hakim's interpretation. In *Copera marginipes*, *Ischnura delicata*, and *Libellago lineata* the anterior pronotal sclerite is traversed by a mid longitudinal sulcus while in *Pseudagrion decorum*, and *Ceriagrion coromandelianum*, the mid longitudinal sulcus is absent as in adult forms (Hakim, 1963). The hind limit of first pronotal sclerite is marked by second pronotal sulcus (PNS 2) which is incomplete in *Copera marginipes*, and *Ischnura senegalensis* as in *Hemimax* and complete in *Ceriagrion coromandelainum*, *Ischnura delicata*, and *Libellago lineata* as in *Ictinogomphus* and *Crocothemis* (Hakim, 1963). The middle pronotal sclerite is also traversed by a mid longitudinal sulcus which joins the first pronotal sulcus in front and second pronotal sulcus behind as in adult Odonata (Hakim, 1963). The mid longitudinal sulcus extends on the posterior pronotal sclerite through out it's mid length and not for a short distance as in *Hemianax* (Hakim, 1963).

In all the larval forms the *propleuron* is united with the notum above, the junction is marked by a complete notopleural sulcus (NPS) as in *Lestis* (Hakim, 1963). Ventrally the pleuron is united with the sternum in its front part and in the hind part it forms the margin of the coxal cavity (CC) as in adults forms (Hakim, 1963). The propleuron is differentiated into pre-episternum, episternum and epimeron. The *per-episternum* (PE) is the anterior most region of pleuron. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum* and *Libellago lineata*, it extends from notopleural

to sterno pleural junction as in *Lestes*, it is narrow and by convex sclerite in *Ischnura delicata*, and *Ischnura senegalensis* as in *Ictinogomphus* (Hakim, 1963). This sclerite is marked posteriorly by the pre-episternal sulcus (PESS) in all the larval forms while it is absent in adult Libulids (Hakim, 1963). The *episternum* (ES) occupies about half of the pleuron in all the larval forms as in adult Zogoptera, it occupies only one third of it in Azygopterous adult forms (Hakim, 1963). The episternum remains demarcated from the epimeron by a pleural sulcus (PS). The pleural sulcus is complete in *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* and *Libellago lineata* as in adult *Lestes*, *Hemianax*, *Ictinogomphus* and *Crocothemis*, it is incomplete in *Pseudagrion decorum* and *Ceriagrion coromandelianum*, as in adult *Pseudogrion* (Hakim, 1963). The episternum is undivided and is not differentiated into supra and infra episternum as in adult *Hemianax* (Hakim, 1963). *Epimeron* (EM) occupies half of the pleural region and is differentiated into an anterior large anepimeron (EM) and a posterior narrow *Katepimeron* (KEM) by a epimeral sulcus (EMS) as in adult forms (Hakim, 1963). These observations are at variance with those of previous workers (Snodgrass, 1909 ; Tillyard, 1917 ; Garman, 1917 and Chao, 1953), who regarded the epimeron as an undifferentiated sclerite and consider the kat-epimeron as the ventral extention of the posterior notal sclerite.

The *prosternum* consists of pre-sternum (PST) ; basisternum (BST) and furca sternum (FST). In *Copera marginipes*, *Pseudagrion decorum*, *Ischnura delicata* and *Ischnura senegalensis* the presternum (PST) is characterised by broad lateral and a narrow middle region which form a bridge uniting the two lateral areas as in *Ictinogomphus* and *Hemianax* (Hakim, 1963). The uniting bridge is much reduced in *Ceriagrion coromandelianum*. In *Copera marginipes*, *Ceriagrion coromandelianum* and *Libellago lineata* the pre-sternal sulcus is transverse as in *Ictinogomphus* and *Hemianax*, it is inverted V shaped in *Pseudagrion decorum*, *Ischnura delicata*, and *Ischnura senegalensis*

as in adult pseudagrion (Hakim, 1963). The *basisternum* is plate like the sternal suture separates the basisternum (BST) and the furca sternum (FST). In *Ischnura delicata*, *Ischnura senegalensis* furcal pits (FP) are situated nearer to the coxal cavities. In *Copera marginipes*, *Pseudagrion decorum*, *Ceriagrion coromandelianum* and *Libellago lineata* these lie at a distance from the coxal cavities. The *furcasternum* is quite large and forms half of the sternal region as in adult zygepterous forms (Hakim, 1963).

SUMMARY

The prothorasic pronotum is divisible into anterior, middle and posterior pronotal sclerites. The first pronotal sulcus demarcates the anterior sclerite. The second pronotal sulcus separates middle and the posterior sclerites. Middle and posterior pronotal sclerites are traversed by a mid longitudinal sulcus.

The propleuron is demarcated from notum by, notopleural and from sternum by sterno pleural sulcus. The pro pleuron is differentiated into three parts the pre-episternum, episternum and epimeron. The pre-episternum extends from noto pleural the sternopleural junction. The episternum is a triangular plate like structure and remains demarcated from epimeron to behind by a pleural sulcus. The epimeron is differentiated into an anterior epimeron and a posterior katepimeron by an epimeral sulcus.

The prosternum is longer than its breadth. It forms the ventral boundary of the coxal cavities. It consists of presternum, basisternum and the furcasternum situated one behind the other. The presternum is demarcated from the basisternum by presternal sulcus. The sternal suture separates the basi sternum and the furca sternum. The position of furcal pits differs in various species.

Extent of various sclerites of prothorax and demarcations of Sulci have been described and their interspecific variations discussed.

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ABBREVIATIONS

AEM—Anepimeron, BST—Basisternum, CC—Coxal cavity, EM—Epimeron, EMS—Epimeral sulcus, ES—Episternum, ESS—Episternal sulcus, FP—Furcal pit, EST—Furca sternum, IFS—Infra episternum, KEM—Ket epimeron, MLS—Mid longitudinal sulcus, NPS—Notopleural sulcus, PE—Pre-episternum, PES—Pre-episternum, PESS—Pre-episternal sulcus, PN1—Anterior pronotal sclerite, PN2—Middle pronotal sclerite, PN3—Posterior pronotal sclerite, PNS-1—First pronotal sulcus, PNS2—Second pronotal sulcus, PS—Pleural sulcus, PST—Pre-sternum, PSTS—Pre-sternal sulcus, PT—Pit, ST—Sternal suture.

DROVING BEHAVIOUR OBSERVED IN THE FIDDLER
CRABS INHABITING THE ADYAR ESTUARY
AND BACKWATER

By

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INTRODUCTION

Several species of shore living crustaceans leave their burrows when the near by substrate start drying up, in search of food and areas of richer food supply at the water's edge or moist areas in the lower intertidal zones. Such movements which mainly occur in summer in large groups known as droving have been reported in fiddlers as well. It is implied that droving has adaptive value either in locating areas of richer food supply (Murai *et al.*, 1982) or to colonise new areas where living conditions are more compatible.

Drove formation is related to both food productivity of the burrowing habitat and the ambient temperature (Murai *et al.*, 1983). Foraging activity of fiddlers is more noticed during daylight low waters. Sandy habitat has less food supply and hence droving occurs in crustaceans inhabiting the sandy areas (Murai *et al.*, 1982). The available literature on droving is limited and includes the studies of Miller (1961), Cameron (1966), Herrnkind (1968), Hockett and Kritzler (1972), Crane (1975), Robertson *et al.*, (1980), Murai *et al.*, (1982, 1983) and Nakasone (1982) on *U. pugilator* in the Southern United States, *U. tangeri* in Angola, *U. vocans* in Japan, *Dotilla* sp. in Zanzibar and Western Australia and *Mictyris* sp. in Australia. The three species of fiddlers recorded to drove so far belong to the three different subgenera, *Celuca*, *Afruca* and *Thalassuca*. The capacity to drove is not indicated by the carapace morphometry since the fiddlers which have narrow, moderate to narrow and

moderate to wide fronts exhibit this phenomenon. The intrinsic details of droving still remain unknown and mostly the fiddlers whose habitat lies near to the seashore drove.

For the first time droving of fiddlers in India is reported here. This includes migration in large numbers. Crane (1975) remarked that a season-long study will be more valuable as it is greatly needed and hence this work.

OBSERVATIONS

Observations were made in the Adyar estuary and backwater from Kotturpuram area to the mouth of the estuary (approximately 4 kilometers) during May and October, 1983 and 1984 for 12 days at a stretch during the forenoons (from 0600 to 1200 hrs) and day time low tides. The burrow densities have been worked out for these areas (presented elsewhere) and the emerging of fiddlers for droving has been observed using Super Zenith low power optical binoculars. Movement of the crabs to and from the waterline and from the burrow area (6 to 12 meters) has been noted. In addition, long distance migration to approximately 200 meters could be observed during hot summer when the atmospheric temperature fluctuated between 35 and 41°C. Short distance migrants were also considered as drovers. Droving for feeding purposes lasts for 10 to 15 minutes after emerging from the burrows. Long distance migration occasionally (beyond 20 meters, by the side of waterline) lasts for about 90 minutes with frequent deviation towards water's edge in *lactea annulipes* and its congener *triangularis bengali* does not exhibit such a phenomenon. The burrows vacated by *lactea annulipes* were occupied by *triangularis bengali* almost immediately during hottest days of summer. 9% of the males marked with Camlin indelible marker ink could be easily located beyond 100 meters from the burrow area in the estuary within two days. Resident crabs were generally smaller than the wanderers and mainly consisted of females. Amongst the wanderers, near the low water mark more numerous were

the youngones (both male and female) in the case of *lactea annulipes* while in *triangularis bengali* such a condition does not exist. When muddy areas start drying up resulting in the formation of high saline water puddles *lactea* tends to leave the scene on long distance migration and *triangularis* inhabiting the upper burrow areas start moving toward the areas near the pools whose waters indicate salinity upto 70 parts per thousand. During October, females and youngones of *triangularis* remain in the upper burrow areas while males of more than 7 mm carapace width could be seen droving near the waterline. The ovigerous females and youngones of *triangularis* wander only in the upper burrow areas where organic deposits of sullage, domestic refuse and city's solid wastes form the substratum. *U. (C.) triangularis* does not exhibit long distance migration and when compared with *lactea annulipes* droving toward waterline to feed is also less.

RESULTS

The results are presented in Tables I and II. It appears that droving for feeding is a round-the-year phenomenon while long distance migration is tied to the summer months. The number and composition of droves vary according to species and the nature of the burrowing habitat. Inhabitants of sandy and sandy mud areas tend to drove more while those inhabiting burrows in steeper gradients of clayey substratum do not exhibit droving. *U. (C.) lactea annulipes* exhibits droving in large numbers (more than one hundred individuals) and the drove mainly consists of males. Females with high ovarian index do not drove near the waterline. This reaffirms the view of Bergin (1981) that females would be more vulnerable to predation if exposed at the water's edge. Males drove farther from the burrow areas than the females and youngones. Long distance migration toward the mouth of the estuary characteristic of *lactea annulipes* does not occur in *triangularis bengali* but during the hotter months and especially in May *triangularis* moves in smaller batches toward the high saline water puddles from the dried up clay areas.

TABLE I. MIGRATION AND DROVING TOWARD WATERLINE DURING MAY, 1983 AND 1984.

AREA	COMPOSITION	DIRECTION OF MOVEMENT	DURATION
I NEAR ADYAR BRIDGE	<i>lactea</i> males in large numbers	Toward the mouth of estuary parallel to the dried up waterline	Minimum 20 minutes Maximum 90 minutes Start before 06 30 hrs.
	<i>lactea</i> males and juveniles	Toward waterline Moist areas at centre	Minimum 5 minutes Maximum 10-12 minutes
	<i>triangularis</i> males, smaller females in batches of 10-15 crabs	Occasional foraging toward waterline	Minimum 5 minutes Maximum 10-12 minutes
II NEAR CHETTINAD PALACE	<i>lactea</i> males and occasional females 10-50 crabs	Toward the lowtide line for foraging	Minimum 5 minutes
III NEAR SANDBAR	—	—	—
IV BACKWATER AT MRC NAGAR	<i>triangularis</i> males in groups of 10-15 adults with occasional smaller females	Toward high saline areas farther from sea sea	Minimum 15 minutes Maximum 30 minutes.

TABLE II. *MIGRATION/DROVING DURING OCTOBER, 1983 and 1984.*

AREA		COMPOSITION	DIRECTION OF MOVEMENT	DURATION
I	NEAR ADYAR BRIDGE	<i>luctea</i> in large groups, more males than females	Toward waterline for feeding and no long distance migration	Minimum 5 minutes Maximum 20 minutes
II	NEAR CHETTINAD PALACE	" "	" "	" "
III	NEAR SANDBAR	" "	" "	" "
IV	BACKWATER AT MRC NAGAR	NIL	NIL	NIL

DISCUSSION

Migration of groups of fiddlers along the beach, their movements and return to the specific burrows after foraging have been elucidated by Altevogt (1957), Altevogt and von Hagen (1964), Herrnkind (1968, 1972). Robertson *et al.*, (1980, 1981) reported that the concentrations of Chlorophyll 'a' possibly in edaphic algae determined the foraging behaviour atleast in *U. pugilator* and that the fiddlers move long distances in search of rich algal gradients. One (1965) established that the Nitrogen content of the substrate significantly determined the droving and feeding behaviour in fiddlers. He postulated that more the percentage of finer particles more is the N-content of the substrate contributing to the growth of microbial organisms which maintain the food supply. Aspey (1978) opined that the behavioural variability has a survival advantage in fiddlers due to their periodical movement to different environments. Wilkens and Fingerman (1965) observed wandering of fiddlers on hot days for about 15-20 minutes and disappearance into the burrow for 3-4 minutes to escape sunlight and to lower body temperature.

Murai *et al* (1983) found that in *U. vocans* droving occurs more from the upper burrow areas of lower N-content in sandy areas where the content of organic matter and microbial organisms are less. In the Adyar estuary also droving occurs mainly in areas of sand where populations of *U. (C.) lactea* are present. Comparison of *lactea annulipes* and *triangularis bengali* of different areas indicates that droving may not be a species specific trait. Murai *et al* (1983) observed that *lactea* occupying sandy mud areas do not drove at all in Japan while the same species occupying sandy areas of Adyar estuary droves. *U. (C.) triangularis* which occupies irregular clayey areas where trapping of organic matter from receding water occurs does not drove to noticeable extent. Should droving occur, it happens for a shorter distance, probably to compensate the deficiency in the energy budget.

In both *lactea* and *triangularis*, crabs with hard carapace only exhibit droving tendency. No fiddler, whether male or

female droves or wanders immediately after moulting. This is indicated by the presence of moulting or recently moulted large males in the upper beach area resident populations. Murai *et al* (1983) opined that N-content of the burrowing habitat is not the only factor that has an effect on droving behaviour. Since droving for long distances or migration occurs mostly in summer, it may be one of the effective means of reducing body temperature by evaporation of water from epithelial membranes, in addition to seeking better habitats and feeding. Bliss (1968) expressed that the fiddler can reduce body temperature through transpiration and Edney (1960, 1961) found that body temperature of crabs in unsaturated air was 1-2°C below that of crabs in saturated air in the laboratory, while outside in the field live crabs exposed to sun registered a body temperature 5-8°C lower than that of similarly exposed dead dried crabs. It is possible that *lactea* droves to beat the effect of radiation of the sandier habitat.

The droving tendency has been observed to continue throughout the day from dawn to dusk for foraging while long distance migrations occurred mostly in the forenoons. Semi-terrestrial crabs like *Uca* carry small amount of water within branchial chambers, the remainder of each chamber being filled with air (Edney, 1960). It is probable that larger fiddlers drove or migrate to longer distances from the resident burrow areas due to the presence of more water in the branchial chambers. The migrants invariably enter into the nearest available burrows proximal to the waterline and spend a few minutes before resuming migration or go to the waterline itself to replenish the lost branchial water. Since *triangularis* does not expose itself to sunrays much when compared to *lactea* there may not be a necessity to drove for reducing body temperature or for food which is available in the burrow area itself.

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REPRODUCTION IN *UCA (CELUCA) TRIANGULARIS*
BENGAL CRANE, 1975 INHABITING THE
ADYAR ESTUARY AND BACKWATER,
MADRAS, INDIA.

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AND

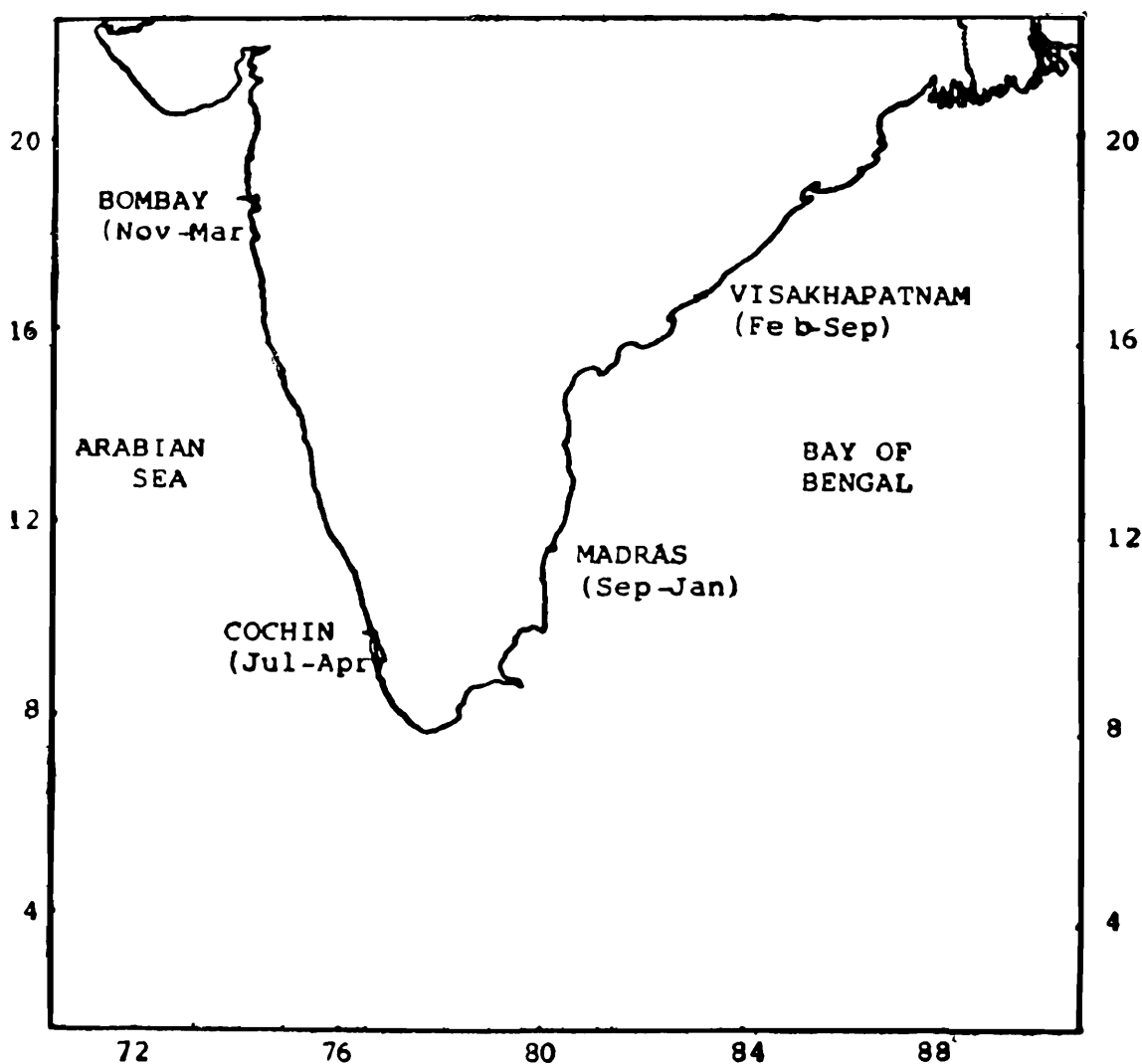
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INTRODUCTION

The annual reproductive cycles of estuarine crustaceans vary in periodicity and intensity in the East and West coasts of India due to differences in the "monsoon rains" (Panikkar and Jayaraman, 1966). Semi-annual breeding patterns have been reported for a number of species in the East coast (Giese and Pearse, 1974) where the South-west monsoon brings little rain during summer months and its receding phases telescope into the North-east monsoon regime which produces considerable rain (Hu-Cheng, 1967). Quite a number of species exhibit breeding activities round the year (Panikkar and Aiyar, 1939 ; Subramoniam, 1977 ; Varadarajan and Subramoniam, 1982). Chhapgar (1959) indicated that the majority of shore crabs breed during November-March on the West coast at Bombay while Nair and Pillay (1975) observed that the maximal breeding activity occurred during the post-monsoon (South-west) though the breeding season extended for several months at Cochin on the West coast. They observed that the gonad index remained high in the female *U. annulipes* from July to April

with a peak in December indicating the ability of the crab to breed for a period of ten months at a stretch in a year. Panikkar and Aiyar (1939) concluded that the shore crabs breed mostly from September to January along the Madras coast (East coast). Rao *et al* (1986) found that the shore crabs breed from February to September at Visakhapatnam on the east coast (Map 1).

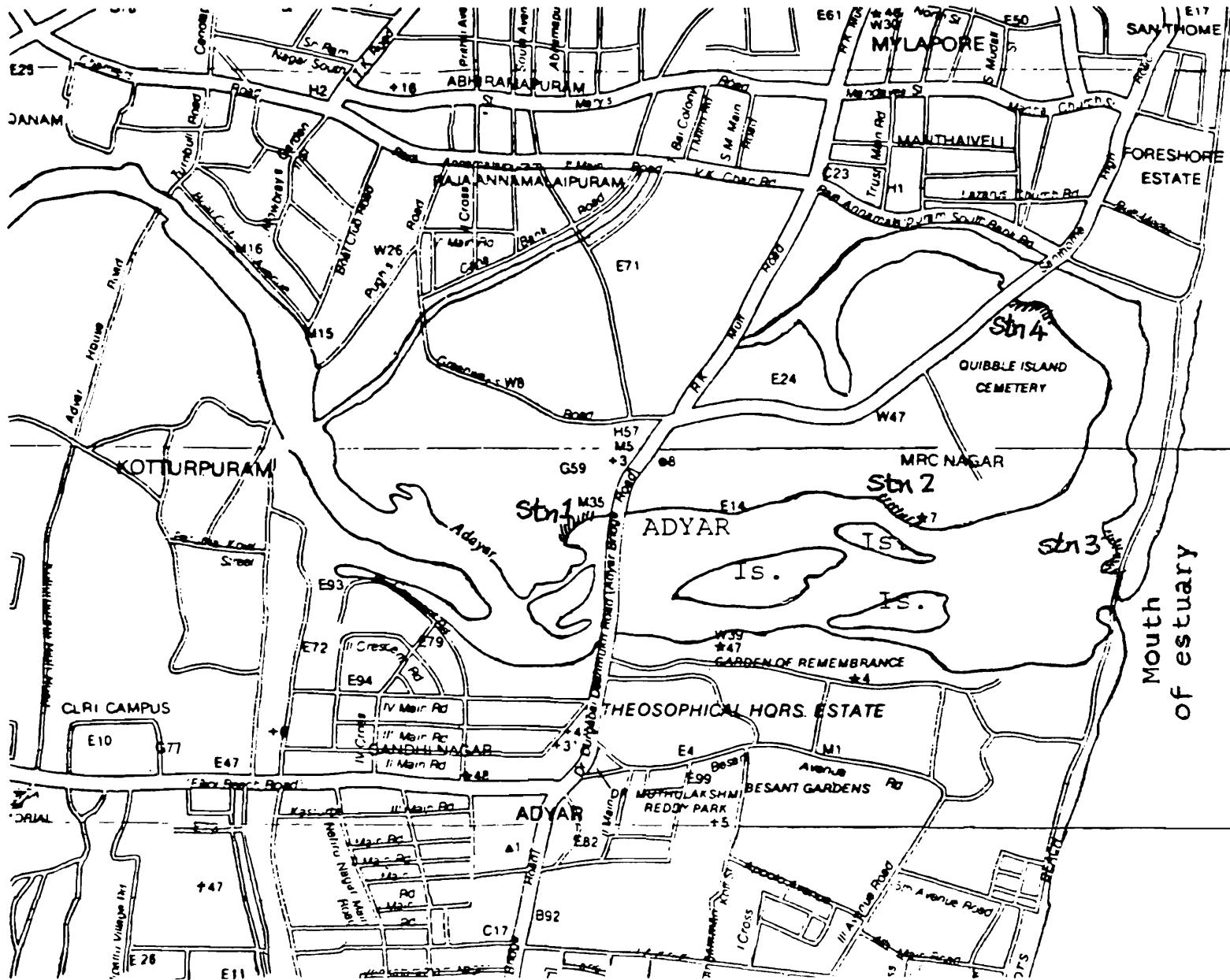
REPRODUCTIVE SEASONS OF SHORE CRABS IN INDIA



Map 1

Occasionally the summer monsoon results in more rainfall in the Madras coast, the waning period of which is continued as the setting period of the winter monsoon and during these years, there is a possibility of continued reproduction in the fiddlers. Altevogt (1957) studied the physiology of reproduction, waving seasons and patterns in two species of

Map No. 2



BAY OF BENGAL

fiddler crabs from South India. Feest (1969) established that the females of *Uca triangularis* breed during the two monsoons in South-India. Reproductively active males could be located through out the year but courtship activities were considerably more after the first rainfall. The occurrence of berried females becomes scarce during summer months when atmospheric temperature maxima shoot up beyond 38°C and the relative humidity percentage dips below 60 accompanied by the failure of the summer monsoon. Little information is available on the breeding activities and reproductive cycles of the fiddlers of the Madras coast and specifically no literature is available on *Uca (Celuca) triangularis bengali* inhabiting the Adyar estuary and backwater and hence this work.

MATERIAL AND METHODS

The experimental material *Uca (Celuca) triangularis bengali* was collected at random from four different stations located in the Adyar estuary and backwater (Map-2). A minimum of ten females were collected from each station once every fortnight following the procedures of Boolootian *et al* (1959). The samples were brought to the laboratory and wet weights were taken in a single pan electrical balance. Females were sacrificed and ovaries were removed by thin stainless steel blade and needles. The ovaries were either preserved in 5% formaldehyde (Anal R Grade) or utilised for experimental procedures afresh. Following the procedures of Gray (1942) the egg diameter was estimated with an ocular micrometer mounted on a Meopta stereomicroscope by placing a 1 mm grid graph paper under a Corning petridish containing either fresh or preserved eggs. Clutch sizes were calculated by counting the number of ova attached to a single pleopod of an egg bearing female under a dissection microscope and the resultant number was multiplied by the number of pleopods to estimate the total number of eggs per female. Gonad index was calculated by dividing the wet weight of the gonad by the wet weight of the whole female and multiplying this factor by a hundred. Courtship activities were observed through a pair of low power Super Zenith optical binoculars

and a limited number of still photographs were taken using 400 ASA colour film loaded in a Zenith TTL camera during day light.

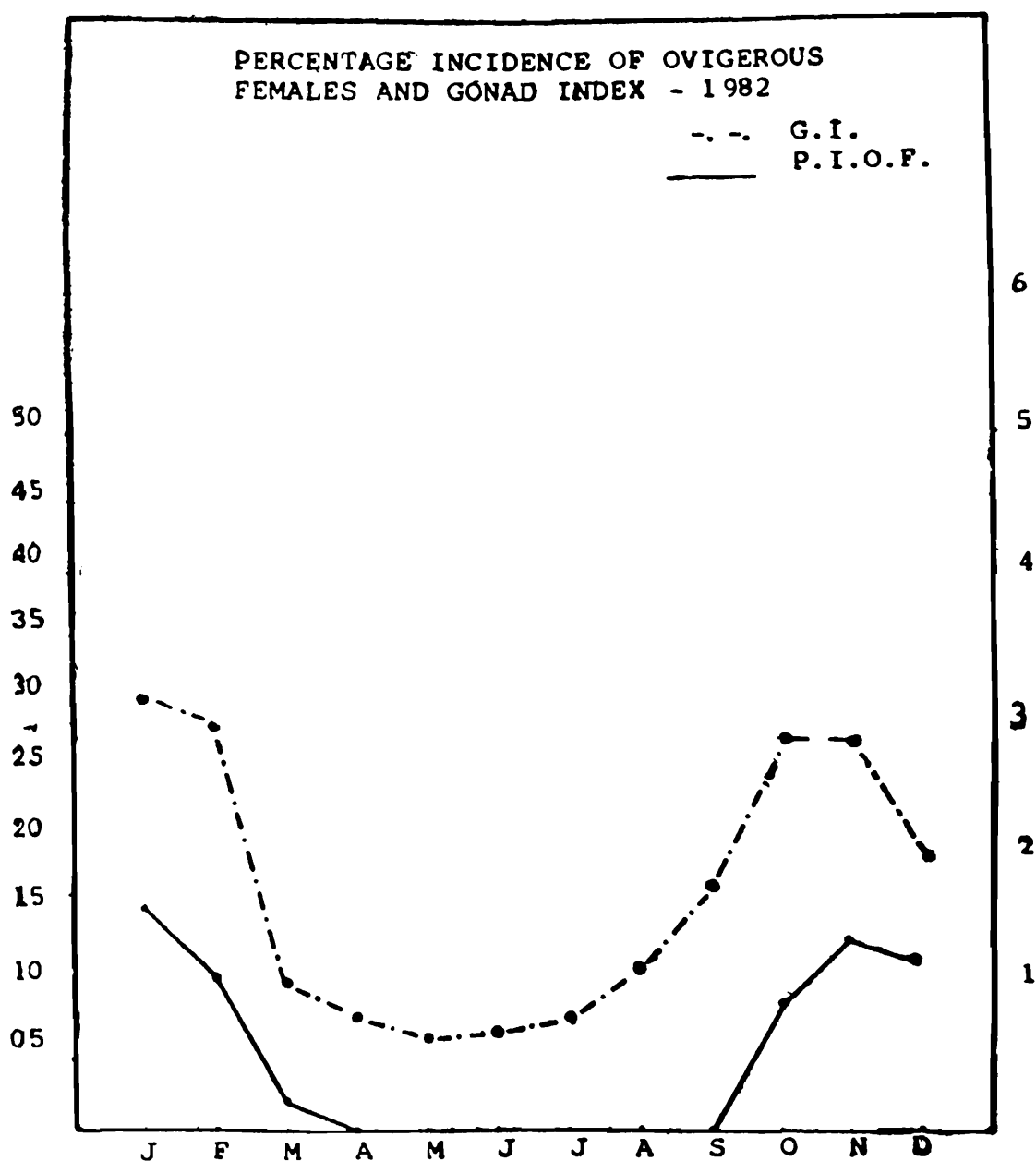


Fig. 1

Releasing of developed eggs for hatching has been observed during nocturnal high tides of the full and new moon. Such observations were restricted to July and November, 1983; October, 1984 and January, 1985. Statistical analyses were carried out with the aid of a HCL fourth generation computer at the Statistics Department of Annamalai University.

RESULTS

Fluctuations in the mean gonad index over a period of

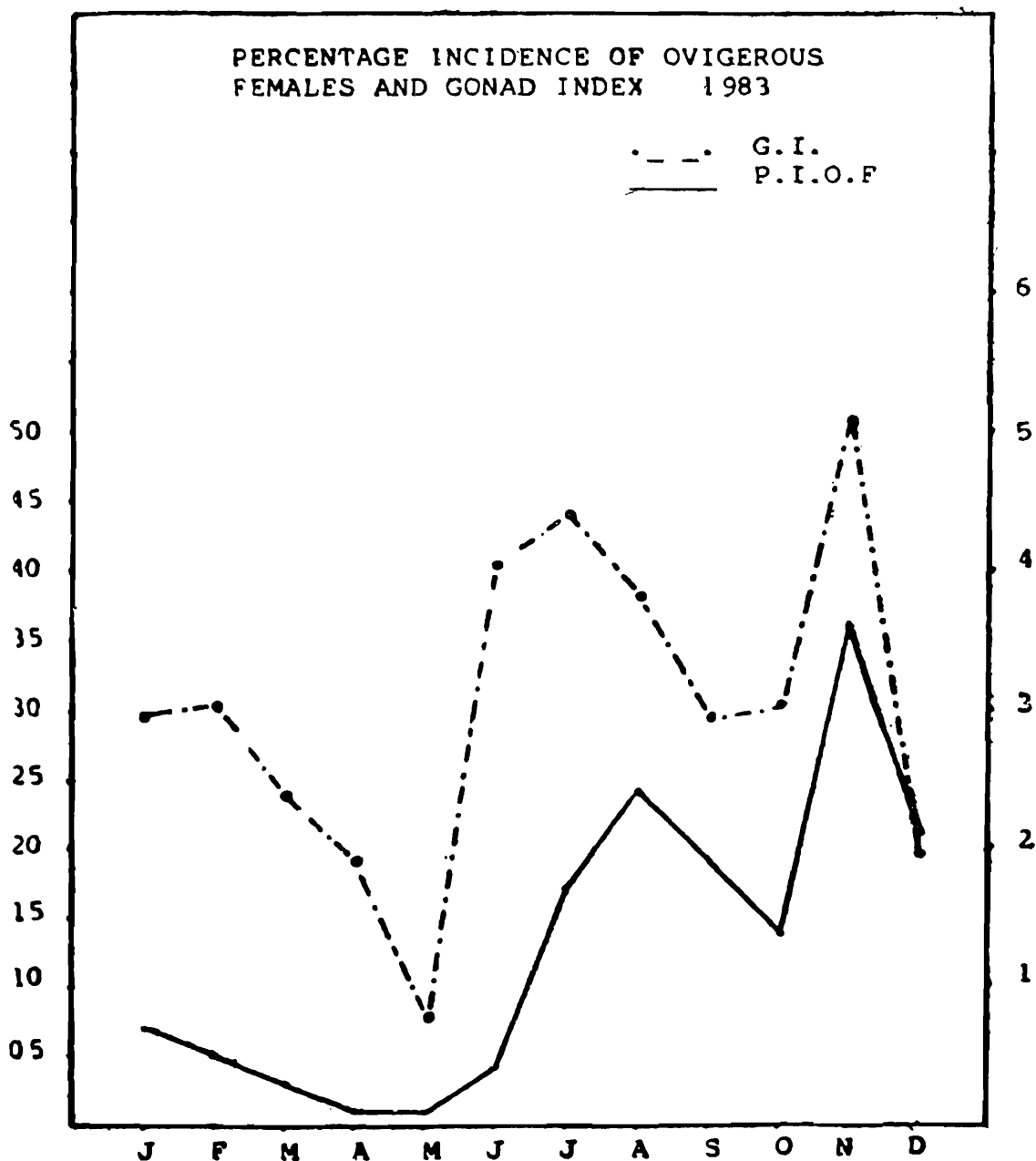


Fig. 2

four years indicate that the monsoons have pronounced effect on breeding (Figure 1, 2, 3 & 4 and Table 1, 2, 3 and 4).

During 1982, both the monsoons failed resulting in drought condition. The Adyar river upto four kilometers from the coast line dried up except for the streams of sullage and stagnated high saline ponds near the Maraimalai Bridge

and the tenements located on one side near Sathya Studios and Kotturpuram. No male courtship activity could be

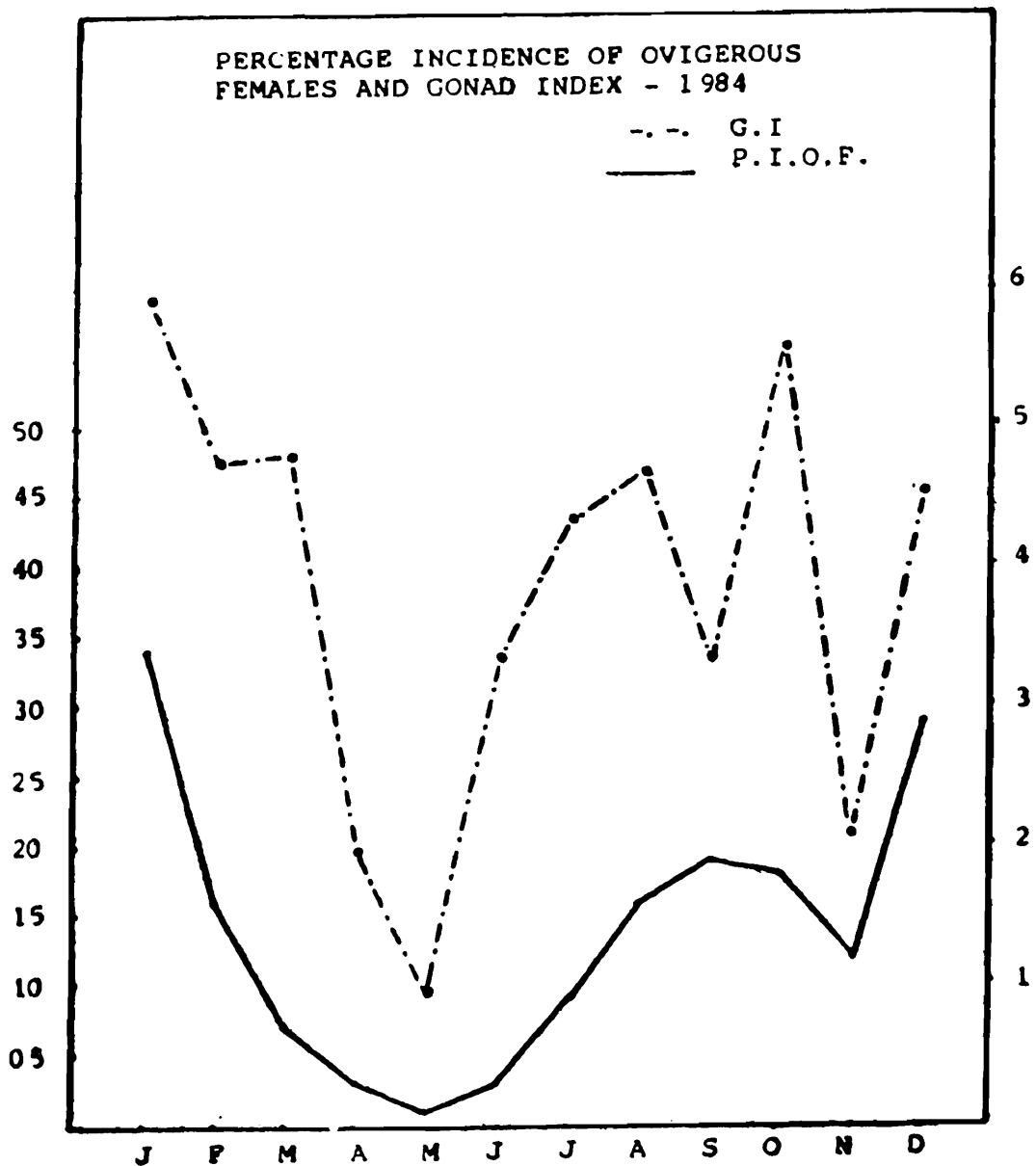


Fig. 3

observed from March to August. Berried females were scarcely available between February and August. However, during September-October a short spell of male courtship activity occurred possibly due to the decline in atmospheric temperature and increase in relative humidity. The highest female gonad index for the year was recorded during October November, which fell in December.

During 1983, ovigerous females were scarce from January

to July and the female gonad index dipped to the minimum in May. In June, the few females collected during the last

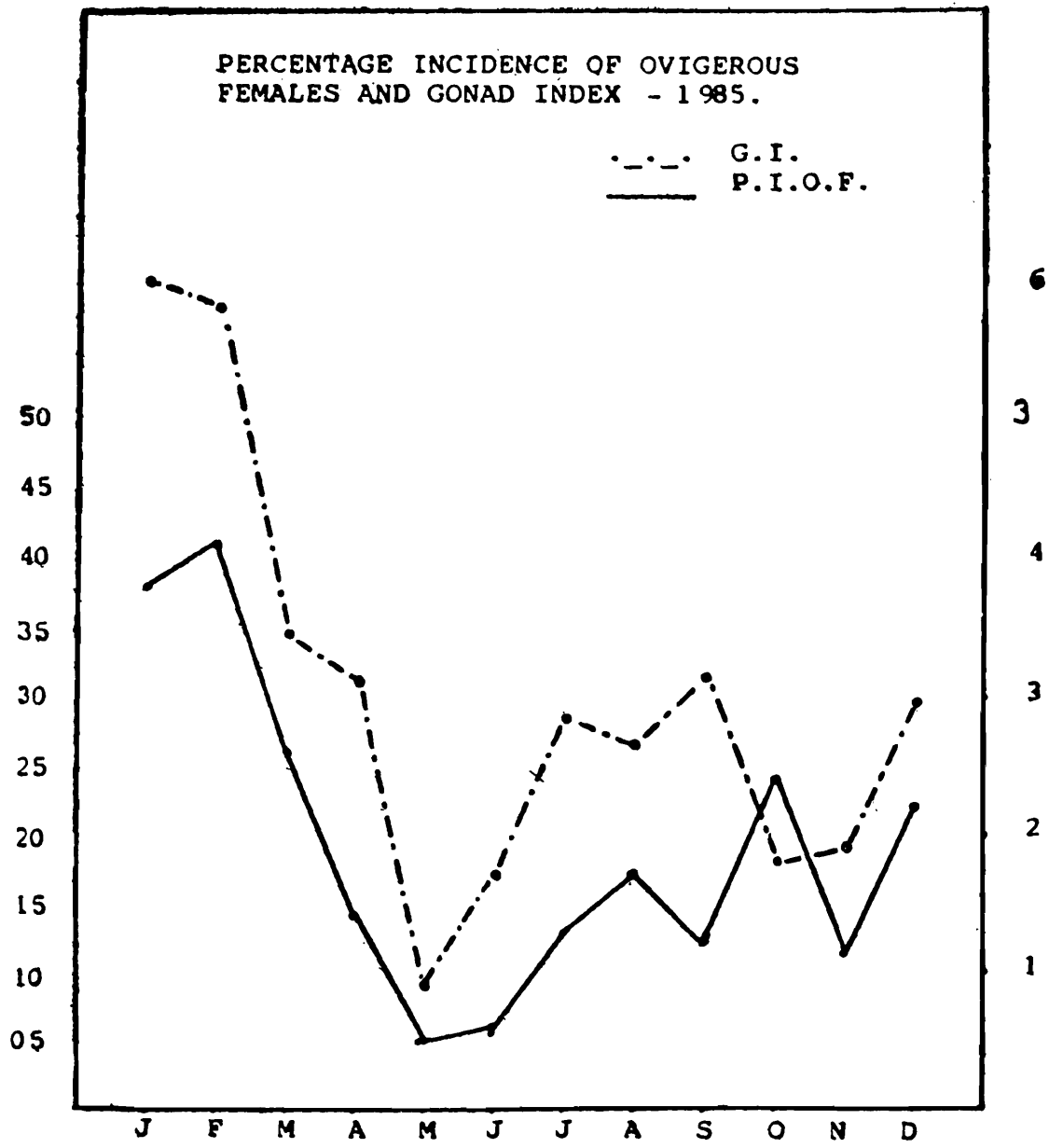


Fig. 4

week were all ovigerous. A peak in the gonad index was recorded in July. Madras experienced heavy rainfall during August-October and in this period majority of the females were not in berry. However, the females occupying burrows farther from the banks high on clay exhibited the presence of ripe ovaries. No male courtship activity could be noticed during this period. The maximum of gonad index was recorded in November, possibly due to the interplay of optimal rainfall, lower humidity and atmospheric temperature.

TABLE 1. Climatic factors in relation to reproduction in *Uca (Celuca) triangularis bengali*.

Months	Average Atmospheric Temperature Maximum °C	Mini- mum °C	Relative Humidity Percen- tage	Monthly Rainfall in mm	Percen- tage Ovigerous females	Gonad Index
1982						
January	28.8	20.1	74.0	—	16	3.08
February	31.1	21.5	71.5	—	11	2.91
March	33.0	23.6	68.5	—	2	1.03
April	35.8	26.3	68.5	—	—	0.82
May	36.9	27.6	62.5	—	—	0.68
June	37.3	27.0	54.5	—	—	0.70
July	35.6	26.3	62.5	—	—	0.82
August	35.0	25.9	64.5	—	—	1.14
September	34.8	25.5	65.5	—	—	1.78
October	32.5	24.4	72.5	—	9	2.83
November	30.2	23.2	77.0	—	13	2.78
December	29.1	21.0	70.0	—	11	2.01

TABLE 2. Climatic factors in relation to reproduction in *Uca (Celuca) triangularis bengali*.

Months	Average Atmospheric Temperature Maximum °C	Mini- mum °C	Relative Humidity Percen- tage	Monthly Rainfall in mm	Percen- tage Ovigerous females	Gonad Index
1983						
January	29.3	19.7	67.0	—	7	2.96
February	32.6	23.1	72.0	—	5	3.01
March	34.9	24.1	66.0	—	3	2.67
April	35.9	25.9	65.5	—	1	1.92
May	38.0	27.7	62.5	—	1	0.78
June	38.2	28.1	52.0	71.4	9	4.04
July	35.0	26.7	64.5	93.4	17	4.66
August	34.1	25.1	73.0	194.4	24	3.81
September	32.8	24.1	78.5	248.7	19	2.96
October	31.9	24.5	78.0	401.6	14	3.02
November	30.1	22.3	70.0	119.9	36	5.08
December	27.9	22.2	80.5	400.5	21	1.94

TABLE 3. Climatic factors in relation to reproduction in *Uca (Celuca) triangularis bengali*.

Months	Average Atmospheric Temperature Maximum °C	Mini- mum °C	Relative Humidity Percen- tage	Monthly Rainfall in mm	Percen- tage Ovigerous females	Gonad Index
1984						
January	28.7	21.9	77.0	38.8	34	5.96
February	28.6	22.6	78.0	283.8	16	4.73
March	32.2	23.5	73.0	2.2	7	4.81
April	34.9	26.0	68.5	1.4	3	1.99
May	38.5	27.8	60.5	—	1	0.97
June	37.9	27.4	51.5	78.6	3	3.34
July	33.8	24.7	69.0	182.1	9	4.34
August	35.8	26.3	60.0	39.2	16	4.69
September	33.7	25.2	71.0	295.9	19	3.33
October	31.7	24.3	75.0	125.4	18	5.61
November	28.8	22.5	77.0	467.1	12	2.08
December	29.0	21.1	75.5	117.0	29	4.56

TABLE 4. Climatic factors in relation to reproduction in *Uca (Celuca) triangularis bengali*

Months	Average Atmospheric Temperature Maximum °C	Mini- mum °C	Relative Humidity Percen- tage	Monthly Rainfall in mm	Percen- tage Ovigerous females	Gonad Index
1985						
January	28.4	21.3	76.5	125.6	38	6.01
February	31.2	21.6	72.5	NIL	41	5.83
March	34.1	24.1	70.0	NIL	26	3.46
April	36.5	26.6	68.0	26.4	14	3.10
May	38.4	27.9	58.5	6.0	5	0.91
June	36.6	26.8	58.0	68.1	6	1.70
July	33.9	25.0	65.5	200.7	13	2.83
August	34.3	25.1	68.0	108.4	17	2.66
September	33.5	24.7	75.5	342.8	12	3.12
October	32.1	24.2	71.0	132.5	24	1.82
November	28.4	21.9	77.5	1071.4	11	1.89
December	28.5	21.6	77.5	137.5	22	2.94

In December, due to floods, the Adyar river was in spate and the backwater extended considerably wiping off the habitats of *U. (C) triangularis*.

During 1984, the maxima of female gonad index were observed during January, October and December. The number of ovigerous females dropped drastically from January to June. Maximum male courtship activities could be seen during February, July and August and the maximum number of ovigerous females occurred in January and December only.

In 1985, the maximum number of ovigerous females occurred in February while the maximum in gonad index was recorded in January. Similar to the previous year the number of ovigerous females and gonad index fell deeply down to the minimum in May. Madras witnessed the worst floods during November and the populations were washed away leaving a few patches near the MRC Nagar, backyard of Andhra Mahila Sabha and the embankments at Kotturpuram area. The larger ovigerous females which survived showed a low gonad index and fewer eggs.

Mating and courtship behaviour as a rule were restricted to the burrows or the vicinity of the burrows of males. Peak of male courtship activity occurred between 0.930 hours and 1100 hours. Surface copulation right on the rims of male burrow was common. Mass waving was very rare and when seen, not more than 10-12 individuals exhibited synchronized waving. Aggressive wandering of sexually active males when compared to the congener *U. (C.) lactea* was very restricted and the number of wanderers was also limited. Only on one occasion courtship activities and consequent copulation could be observed during the full moon right near the female's burrow, between a wandering male and resident female. Lateral waving display though present was observed occasionally. Underground copulation could not be noticed. Females of more than 7 mm carapace width only respond to courtship display of males. Copulations between larger males and more or less equal sized females were numerically more and sexual activity involving larger female and a smaller

male (female carapace width 14.5 mm ; male 9.5 mm) was also seen. In every case, courtship display preceded copulation. The approximate time taken to complete copulation varied from 2 to 4 minutes. Male courtship display normally occurred either before the first showers or coinciding with the setting of it and the peaks were recorded only during the second half of the year, either twice or thrice when atmospheric conditions were favourable.

The number of ova carried by ovigerous female increased with the size of the crab. Larval release occurred during the night time spring tides of full and new moon. During the entire period of study, not more than one third of the female population was found to be in berried condition at any point of time excepting during February, 1985 when it touched the 40% mark. The total number of eggs carried by the female in berried condition varied from 2,800 to 4,100, the minimum in crabs inhabiting the MRC Nagar backwater area and the maximum in the populations of the Adyar estuary near the Maraimalai Bridge. Similar to the observations of Pillay and Nair (1973) in *U. annulipes*, development of a new brood occurs within 15 days after shedding the first batch of eggs. Colonisation of new areas by settlement has not been seen as the young ones choose the clay substratum with undulating or irregular margins on a steeper incline of the shore unlike *annulipes* inhabiting the same estuary.

DISCUSSION

The shore living crabs including the fiddlers have been recorded to breed at different times of the year in the East and West coasts of India by Chhapgar (1959), Nair and Pillay (1975), Panikkar and Aiyar (1939) and Rao *et al* (1986) (Map 1). In *U. annulipes* the breeding period extends from July to April with three distinct periods of gonadal activity in the West coast at Cochin (Pillay and Nair, 1971) while in the East coast Panikkar and Aiyar (1939) recorded that the shore living crabs including the fiddlers breed mostly from September to January. Some shore living crabs like hermit crabs (Varadarajan and Subramoniam, 1982) breed continuous-

ly throughout the year with dispersed breeding peaks indicating that the breeding seasons of shore living crabs vary much and that a generalization will be meaningless. Feest (1969) indicated that in *triangularis* breeding seasons occur twice a year and that the seasons depend on the monsoons. This study confirms that the breeding of *triangularis* is tied to the monsoons and that there need not be two seasons in a year should one of the monsoons fail. Panikkar and Aiyar (1939) stated that discontinuously breeding brackish water forms of Madras concentrate their reproductive activities mainly to the rainy seasons while Nair and Pillay (1975) concluded that the rainy season is essentially a period of inactivity on the West coast. In the present observation it is evident that if the rains consequent to the monsoons are of milder intensity activate and if heavy deter breeding and hence it is the intensity of rain that matters rather than the season.

Nair and Pillay (1975) inferred that medium and high saline conditions of pre and post monsoon seasons are the most favourable for breeding activity in the West coast while in the East coast at Madras the low saline periods upto March (Muthu, 1956) are the periods of upwelling increasing the availability of food to the planktivores. The present study-results tend to deviate from that of Nair and Pillay (1975) and conform to that of Muthu (1956) since *triangularis* breeds during the low saline periods of upwelling. In the case of *triangularis* which is found on the clayey areas near the high saline water ponds in the estuary and back water, lowering of salinity appears to trigger reproductive activities rather than an increase. Should the South-west monsoon rains of moderate intensity follow similar rains of North-east monsoon, reproduction may occur continuously for a period of 7 to 9 months. High summer temperatures at times shooting upto 42°C in May arrest continuity of reproduction since the crabs spend most of their time in choosing a better habitat nearer to the source of water and for other survival activities. The reproductive seasons of *triangularis* differ from *rapax* and *cumulanta* of other tropical areas (Ahmed, 1976) which reproduce continuously throughout the year and

U. (C.) lactea annulipes of the Adyar estuary at Madras itself (personal observation) which reproduces similar to its relatives on the West coast.

Tropical shore crabs do not reach 100% berried condition while in temperate regions it is common (Booolootian *et al.*, 1959). Nair and Pillay (1975) could locate only 67% berried females in the sample collected during the peak season in *U. lactea annulipes* in the west coast and Varadarajan and Subramoniam, (1982) 66% in *Clibanarius clibanarius* of the East coast. In *U. (C.) triangularis* less than 45% of the females only were in ovigerous condition during the peak breeding season. Its courtship components are also limited when compared to its congener *lactea annulipes*. It is a well known fact that *triangularis* is a lethargic species in every activity.

Wear (1974) observed the presence of ovigerous females active on the surface daily even toward the end of incubation period, while Christy and Salmon (1984) reported that the ovigerous females were seen rarely moving about or feeding on the surface. In *triangularis* also active females in berried condition could be located foraging near the burrow area farther from the low tide mark on the clayey mud. Similar to *lactea annulipes*, in *triangularis bengali* males defend the breeding burrows and the mating occurs near the male's burrow as observed by Altevogt (1957) and Crane (1975) but in contrast to Yamaguchi's (1971) *Uca lactea* in Japan. Christy and Salmon (1984) expressed that the reversal in Yamaguchi's observation may be due to low population density. In *triangularis bengali* which populate the estuary and backwater with less than 40 burrows per square meter did not indicate any copulation activity near the female's burrow, and even in *lactea annulipes* such a phenomenon does not occur in the Madras coast.

Thurman (1985) observed that egg diameter is independent of female size in *U. subcylindrica*. It appears to be a universal phenomenon and in *triangularis* the egg diameter did not significantly differ in females from 9 mm carapace width. von

Hagen (1970 a, b) found that mating of fiddlers occurred on the new and full moon days suggesting the release of larvae after two weeks. In *triangularis* courtship activities and copulation occurred during day time low tides of the pre-monsoons predominantly and no such restriction of copulation to these two days of the lunar month has been seen. The release of larvae occurred during nocturnal spring tides of the full and new moons similar to the other fiddlers (von Hagen, 1970 a, b ; wheeler, 1978 ; Bergin, 1981 ; Christy, 1982 b and Salmon and Hyatt, 1983). In *lactea annulipes* the ovigerous females forage farther on the land from water line and in *triangularis bengali* the berried females and young ones remain farther from the waterline and forage on the trapped material in the puddles filled during high tides.

A statistical analysis on the model

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + E$$

where Y = percentage of ovigerous females

X_1 = Maximum temperature

X_2 = Minimum temperature

X_3 = Relative humidity

X_4 = Rainfall

X_5 = Gonad index

Yields a fitted regression

$$Y = 7.012 + 0.8232X_1 + 0.1943X_2 + 0.2212X_3 + 0.00063X_4 + 4.4066X_5$$

SE = (0.359223)	(1.3348)	(1.5271)	(0.2643)	
T = (0.1951)	(0.6169)	(0.1225)	(0.8407)	
(0.00656)	(0.7300)			
(0.096)	(6.036)			

for which $R^2 = 0.6602$.

The F ratio for testing the regression was 16.31 with 5, 142 d.f. This value being significant, it can be inferred that all the dependent variables under study, X_1 through X_5 have a combined predictive capacity of 48%. But a closer look reveals all coefficients except that of X_5 (Gonad index) were not significant. Gonad index has a positive coefficient.

Hence, a fresh analysis was done using X^5 (Gonad index) as the explanatory variable, the results of which are

$$Y = -0.3079 + 0.5423X_5$$

SE (0.2310) (0.7045)

T (1.333) (7.6976)

indicating $R^2 = 0.5599$

The increase in R^2 due to inclusion of X_1 , X_2 , X_3 and X_4 is about 10% which is not quite significant because the ratio corresponding to the decrease in residual sum of squares due to the additional variables was found to be only 1.85 which is not statistically significant.

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