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OAK INHABITING APHIDS (HOMOPTERA : APHIDIDAE) OF WESTERN AND NORTH WEST HIMALAYA

By

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(With 19 Figures and 1 Table)

INTRODUCTION

Among the major ecological groups, Oak vegetation (*Quercus* spp. Fam. Fagaceae) attains montane, subtropical and temperate forests (Mani, 1974) ranging between *c* 1700 m and *c* 4200 m in North West Himalaya. They are one of the major component of ever green forests and are found in association with Conifers, Birch, Rhododendron etc. Out of the 59 recorded species of *Quercus* (Hooker, 1885 ; Collet, 1971 ; Rau, 1974), only 8 species viz. *Q. semicarpifolia* Smith, *Q. incana* Roxb., *Q. dilatata* Lindl., *Q. glauca* Thumb, *Q. lamellosa* Smith, *Q. lanuginosa* D. Don, *Q. ilex* Linn. and *Q. floribunda* Lindl. have recorded from Western and North West Himalaya.

The Himalaya maintains its peculiarities by its enormous massiveness, the great elevations of the mountain ranges, their trendlines, their location in the middle of a vast continental mass, their Tertiary orogeny, the Pleistocene glaciation and continued Post-Pleistocene uplift. Humidity, altitudinal zonation, temperature stratification and monsoon rainfall determine the Himalayan flora and fauna. The extra-peninsular zone (Mani, 1974) of Himalayan ranges includes eastern Himalaya, Nepal or Central Himalaya, Western Himalaya and Northwest Himalaya. However, Western Himalaya and North West Himalaya can be subdivided into Kumaon range, Garhwal range, Simla range and Kashmir range.

In this paper an account of aphids infesting *Quercus* spp., their incidence and mode of life cycle have been discussed. A key to such species has also been provided for their identification.

TAXONOMY OF **Quercus** INHABITING APHIDS

Several species of aphids use Oak as their host plant. The foliage provides nourishment while barks as hibernating places to a considerable members of aphid species. During the surveys in the Western

Himalaya as many as 25 aphid species have been recorded to infest these plants in this area. Out of these, 12 species belong to the subfamily Greenideinae, 5 species to Lachninae and 4 species each to Drepanosiphinae and Hormaphidinae. Aphids belonging to subfamilies Aphidinae, Chaitophorinae, Anoeciinae and Pemphiginae have never been found to cherish this plant.

Oak inhabiting aphids may be autoecious or heteroecious as regard their life cycle. Different genera and number of species under each subfamily infesting Oaks and the type of their life cycle has been presented in Table 1.

Abbreviations

Aptera/e : Apterous viviparous female/s ; Alata/e : Alate viviparous female/s ; b. d. III : Basal diameter of antennal segment III ; p. t. : Processus terminalis ; u. r. s. : Ultimate rostral segment ; h. t. 2 : 2nd segment of hind tarsus ; Coll. : Collector ; H. P. : Himachal Pradesh ; U. P. : Uttar Pradesh.

TABLE 1. Subfamily wise distribution and mode of life cycle of *Quercus* inhabiting aphids.

Subfamilies	Genera	No. of species	Types of Life cycle
Greenideinae	*Eutrichosiphum* Essig & Kuwana	9	Autoecious
	Greenidea Schouteden	3	Autoecious
Lachninae	*Lachnus* Burmeister	2	Autoecious
	Nippolachnus Matsumura	3	Autoecious
Drepanosiphinae	*Globulicaudaphis* Hille Ris Lambers	1	Autoecious
	Myzocallis Passerini	2	Autoecious
	Serratocallis Quednau & Chakrabarti	1	Autoecious
Hormaphidinae	*Heminipponaphis* Chakrabarti & Raha	1	Heteroecious
	Neothoracaphis Matsumura	1	Heteroecious
	Pseudothoracaphis Raychaudhuri, Ghosh & Das	1	Heteroecious
	Reticulaphis Takahashi	1	Heteroecious

Following is the systematic account of aphids infesting *Quercus* spp. along with the available morphs recorded, locality and period of collection.

SYSTEMATIC ACCOUNT

A. SUBFAMILY GREENIDEINAE

1. **Eutrichosiphum garhwalense** Maity and Chakrabarti

Eutrichosiphum garhwalense Maity and Chakrabarti, 1980. *Annal. Zool.*, **35** (22) : 307.

Specimens examined : 19 apterae and nymphs, INDIA : U. P. : Mussoorie, 24.v.1978 (Coll. *S. P. Maity*).

Host plant : *Quercus incana.*

Distribution : India : Uttar Pradesh.

2. **Eutrichosiphum pyri** Chakrabarti, Ghosh and Raychaudhuri

Eutrichosiphum pyri. Chakrabarti, Ghosh and Raychaudhuri, 1972. *Oriental Ins.*, **6** (3) : 389.

Specimens examined : 2 apterae and nymphs, INDIA : U. P. : Chaubattia, 13.vi.1970 (Coll. *S. Chakrabarti*) ; Many apterae and nymphs, INDIA : U. P. : Gourikund, 1.vi.1978 ; Rambara, 2.vi.1978 (Coll. *D. K. Bhattacharya*).

Host plant : *Quercus* sp., *Pyrus communis* and an unidentified plant.

Distribution : India : Uttar Pradesh, Meghalaya, Assam.

3. **Eutrichosiphum taoi** Ghosh, Basu and Raychaudhuri

Eutrichosiphum taoi Ghosh, Basu and Raychaudhuri, 1970. *Oriental Ins.*, **4** (1) : 68 ; Chakrabarti, Ghosh and Raychaudhuri, 1972. *Oriental Ins.*, **6** (3) : 390.

Specimens examined : 6 apterae and nymphs, INDIA : U. P. : Bhowali, 5.iv.1970 (Coll. *S. Chakrabarti*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

4. **Eutrichosiphum (Eutrichosiphum) tapatii** Mondal, Chatterjee and Raychaudhuri

Eutrichosiphum (*Eutrichosiphum*) *tapatii* Mondal, Chatterjee and Raychaudhuri, 1979. *Entomon*, **4** (1) : 77 ; Raychaudhuri, Ghosh and Das, 1980. *Ins. Matsumurana*, **20** : 33.

Material reported : 2 apterae and many nymphs, INDIA : U. P. : Kemphy, 4.xi.1978 : (without collector's name).

Host plant : *Querces* sp.

Distribution : India : Himachal Pradesh, Uttar Pradesh and Sikkim.

5. **Eutrichosiphum (Neoparatrichosiphum) khasyanum** (Ghosh and Raychaudhuri)

Paratrichosiphum (*Neoparatrichosiphum*) *khasyanum* (Ghosh and Raychaudhuri, 1962. *J. Asiat. Soc. Cal.*, **4** (3 & 4) : 108.

Eutrichosiphum (*Neoparatrichosiphum*) *khasyanum* (Ghosh and Raychaudhuri) ; Raychaudhuri and Chatterjee, 1980. Aphids of North East India and Bhutan. D. N. Raychaudhuri, Ed., p. 334 ; Raychaudhuri, Ghosh and Das, 1980. *Ins. Matsumurana*, **20** : 34.

Material reported : 2 apterae and 4 nymphs, INDIA : H. P. : Barog, 31.x.1978. (without collector's name)

Host plant : *Quercus dealbata*, *Q. griffithi*, *Quercus* sp. and *Petunia violacea* (Solanaceae).

Distribution : India : Arunachal Pradesh, Himachal Pradesh, Meghalaya and Uttar Pradesh.

6. **Eutrichosiphum (Paratrichosiphum) alnicola** (Basu)

Paratrichosiphum alnicola Basu, 1967. *Bull. Entomology*, 8 (2) : 14 ; Ghosh, Ghosh, and Raychaudhuri, 1971. *Proc. zool. Soc. Cal.*, **24** : 50.

Eutrichosiphum (*Paratrichosiphum*) *alnicola* (Basu) ; Raychaudhuri and Chatterjee, 1980. Aphids of North East India and Bhutan, D. N. Raychaudhuri, Ed., p. 336 ; Raychaudhuri, Ghosh and Das, 1980. *Ins. Matsumurana*, **20** : 34.

Specimens examined : Many apterae and nymphs, INDIA : U. P. : Mussoorie, Laltibba, 1.xi.1977 (Coll. S. P. Maity).

Host Plant : *Quercus* sp., *Alnus nepalensis*.

Distribution : India : Himachal Pradesh, Uttar Pradesh.

7. **Eutrichosiphum (Paratrichosiphum) assamensis** (Ghosh and Raychaudhuri)

Paratrichosiphum tattakanum assamensis Ghosh and Raychaudhuri, 1962. *J. Asiatic Soc.*, **4** (3 & 4) : 112.

Eutrichosiphum (*Paratrichosiphum*) *assamensis* (Ghosh and Raychaudhuri) ; Chakrabarti and Maity, 1980. *Annal. Zool.*, 35 (9) : 100.

Specimen examined : Many apterae, alate oviparous females, alate males and nymphs, INDIA : U. P. : Mussorie, 30.x.1977, 1.xi.1977, 26.v.1978 (Coll. *S. P. Maity*) ; Gourikund, 31.v.1978 (Coll. *D. K. Bhattacharya*) ; Rambara, 2. vi. 1978 (Coll. *D. K. Bhattacharya*) ; Trijuginarayan, 5.vi.1978 (Coll. *D. K. Bhattacharya*) ; Sonprayag, 6.vi.1978 (Coll. *S. P. Maity*).

Host plant : *Quercus* sp.

Distribution : India : Assam, Himachal Pradesh and Uttar Pradesh.

Note : Verma (Per. Comm.) informed *Paratrichosiphum tattakanum* (Takahashi) from Himachal Pradesh. However, re-examination of this material show that these are *Paratrichosiphum* (*Neoparatrichosiphum*) ***khasyanum*** (Ghosh and Raychaudhuri). Raychaudhuri and Chatterjee (1980) considered *Eutric' osiphum* (*Paratrichosiphum*) *assamensis* (Ghosh and Raychaudhuri) as a synonym of *Paratrichosiphum* (*Neoparatrichosiphum*) *khasyanum* (Ghosh and Raychaudhuri). Raychaudhuri and Chatterjee (1977) considered *Paratrichosiphum* Takahashi as a subgenus of *Eutrichosiphum* Essig and Kuwana. However, we are of opinion to consider this as a separate distinct species.

8. **Eutrichosiphum (Paratrichosiphum) neoalnicola** Raychaudhuri, Ghosh and Das

Eutrichosiphum (*Paratrichosiphum*) *neoalnicola* Raychaudhuri Ghosh and Das, 1980. *Ins. Matsumurana*, **20** : 34.

Material reported : 3 apterae and nymphs, INDIA : H. P. : Nagwain, 7.vii.1970 (Coll. *S. K. Sen*) ; 1 aptera, H. P. : Narkanda, 27.ix.1974 ; 2 apterae, H. P. : Solan, 25.x.1978 (without collector's name).

Host plant : *Quercus* sp.

Distribution : India : Himachal Pradesh.

9. **Eutrichosiphum (Paratrichosiphum) querciphaga** Chakrabarti and Maity.

Eutrichosiphum (*Paratrichosiphum*) *querciphaga* Chakrabarti and Maity, 1980. *Annal. Zool.*, **35** (9) : 97.

Specimens examined : 3 apterae, INDIA : U. P. : Mussoorie, 16.x. 1976 (Coll. *S. P. Maity*).

Host Plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

10. **Greenidea (Trichosiphum) anonae** (Pergande)

Trichosiphum anonae Pergande, 1906. *Ent. News. Philad.*, **17** : 208.

Greenidea anonae (Pergande) Takahashi, 1931. Aphids of Formosa, pt. 6, p. 29 ; ————1941. *Ins. Matsumurana*, **15** (4) : 147. ; ————1950. *Ann. Ent. Soc. Amer.*, **43** (4) : 587.

Greenidea (*Trichosiphum*) *anonae* (Pergande) ; Raychaudhuri, 1956. *Zool. Ver.*, **31** : 47. ; Chakrabarti and Raychaudhuri, 1975. *Oriental Ins.*, **9** (2) : 208.

Specimens examined : 5 apterae and nymphs, INDIA : U. P. : Almora, Bharari, 10.x.1970 (Coll. *S. Chakrabarti*) ; 11 apterae and nymphs, Almora, Loharkhet, 11.x.1970 (Coll. *S. Chakrabarti*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh : Malaya Peninsula ; Sumatra ; Java ; Japan.

11. **Greenidea (Trichosiphum) haldari** Maity and Chakrabarti

Greenidea (*Trichosiphum*) *haldari* Maity and Chakrabarti, 1980. *Annal. Zool.*, **35** (22) : 310.

Specimens examined : Many apterae and nymphs, INDIA : U. P. : Mussoorie, 1.xi.1977 (Coll. *S. P. Maity*) ; 16 apterae, Mussoorie, 3.xi. 1977 (Coll. *S. P. Maity*).

Host Plant : *Quercus* sp.

Distribntion : India : Uttar Pradesh.

12. **Greenidea (Trichosiphum) kumaoni** Chakrabarti and Raychaudhuri

Greenidea (*Trichosiphum*) *kumaoni* Chakrabarti and Raychaudhuri, 1978. ***Entomon***, **3** (1) : 95.

Specimens examined : 1 aptera and 3 nymphs, INDIA : U. P. : Mussorie, 17.x.1976 (Coll. *S. P. Maity*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

B. Subfamily : Lachninae

13. **Lachnus acutihirsutus** Kumar and Burkhardt

Lachnus acutihirsutus Kumar and Burkhardt, 1970. *J. Kansas Ent. Soc.*, **43** (4) : 461.

Specimens examined : Many apterae, 1 alata and many nymphs, INDIA : U.P. : Mussoorie, 20.vi.1975 (Coll. *S. Chakrabarti*) ; Mussoorie, 20-21.vi.1976 ; 16.x.1976 ; 18.x.1976 (Coll. *S. P. Maity*).

Host plant : *Quercus incana*, *Quercus indica*.

Distribution : India : Uttar Pradesh, Himachal Pradesh.

14. **Lachnus tropicalis** (van der Goot)

Pterochlorus tropicalis van der Goot, 1916. *Rec. Indian Mus.*, **12** : 3.

Lachnus tropicalis (van der Goot) ; Takahashi, 1950. *Annal. Ent. Soc. Am.*, **43** : 592.

Lachnus (*Pterochlorus*) *tropicalis* (van der Goot) ; Tao, 1961 *Sci. Yb. Taiwan Mus.*, **4** : 41.

Lachnus tropicalis, (van der Goot) ; Paik, 1965 Aphids of Korea, Seoul, 13. ; Szelegiewicz, 1968 *Annal. Zool.*, **25** (12) : 468.

Specimens examined : Many apterae, alatae and nymphs, INDIA : U. P. : Sonprayag, 4.vi.1978 (Coll. *D. K. Bhattacharya*) ; Trijuginarayan, 5.vi.1978 (Coll. *D. K. Bhattacharya*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh, West Bengal, Meghalaya, Manipur, Sikkim ; Malaya ; China ; Japan ; Korea ; Vietnam ; Indoneshia.

15. **Nippolachnus bengalensis** Basu and Hill Ris Lambers

Nippolachnus bengalensis Basu and Hille Ris Lambers, 1968. *Ent. Ber. Amst.*, **28** : 9 : Ghosh, 1974. *Oriental Ins.*, 8 (2) : 171 ; Ghosh, 1982. Fauna of India, Pt. 2, Subfamily Lachninae, 112.

Material reported : 2 apterae and 3 nymphs, INDIA : H. P. : Solan, 25.x.1978 (without collectior's name).

Host plant : *Quercus* sp. but usually on *Eriobotrya dubia*, *Pyrus pashia*. Also recorded on *Photina arguta*.

Distributiou : India : Himachal Pradesh, Meghalaya, West Bengal.

16. **Nippolachnus himalayensis** (van der Goot)

Lachnus himalayensis van der Goot, 1971. *Rec. Indian Mus.*, **13** : 180 ; Tao, 1958. *Agric. Res.*, (Taiwan) 8 : 1.

Nippolachnus eriobotryae Basu and Hille Ris Lambers, 1968. *Ent. Ber., Amst.*, 28 : 11 ; Eastop and Hille Ris Lambers, 1976. Survey World's Aphids : 321 ; Ghosh, 1982. Fauna of India. Pt. 2, Subfamily-Lachninae, 115.

Material reported : 5 apterae, INDIA : H. P. : Solan, 30. x. 1978 (without collector's name).

Host plant : *Quercus* sp. but usually on *Eriobotrya petiolata*.

Distribution : India : Himachal Pradesh, West Bengal.

17. **Nippolachnus piri** Matsumura

Nippolachnus piri Matsumura, 1917. *J. Coll. Agric. Tohoku Univ.*, **7** (6) : 382.

Anoecia piri (Matsumura) ; Essig and Kuwana, 1928. *Proc. Calif. Acad. Sci.*, 8 (3) : 103.

Nippolachnus piri Matsumura ; Ghosh and Raychaudhuri, 1962. *J. Asiat. Soc. Cal.*, **14** (3 & 4) : 107 ; Ghosh, 1982. *Fauna of India*, Pt. 2, Subfamily—Lachninae, 118.

Material reported : 9 apterae, INDIA : H.P. : Barog, 31.x.1978 (without collector's name).

Host plant : *Quercus* sp. but usually on *Pyrus communis*, *P. khasiana*, *Prunus persica*.

Distribution : India : Himachal Pradesh, Meghalaya, West Bengal ; Japan ; Korea, Taiwan and Malaya.

C. Subfamily : DREPANOSIPHINAE

18. **Globulicaudaphis pakistanica** Hille Ris Lambers

Globulicaudaphis pakistanica Hille Ris Lambers, 1966. *Tijdschr. Ent.*, **109** (8) : 209.

Specimens examined : Many apterae, alate and nymphs, INDIA : U. P. : Hanuman Chatti, 13.vi.1980 (coll. *A. K. Mandal*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh ; Pakistan : Muree.

19. **Myzocallis (Agrioaphis) polychaetus** David

Myzocallis (*Dryomyzus*) *polychaetus* David, 1968. *Oriental Ins.*, **3** (1) : 80.

Myzocallis (*Agrioaphis*) *aptera* Richards and Kumar, 1971. *Can. Ent.*, **103** : 116.

Myzocallis polychaetus David ; Chakrabarti and Raychaudhuri, 1974. *Indian J. Ent.*, **36** : 129.

Specimens examined : Many apterae, 5 alatae and and many nymphs, INDIA : U. P. ; Gourikund, 1-2.vi.1978 (coll. *D. K. Bhattacharya*).

Host plant : *Quercus semicarpifolia*.

Distribution : India : Himachal Pradesh, Uttar Pradesh.

20. **Myzocallis (Hoplocallis) microsetosus** Quednau and Chakrabarti

Myzocallis (*Hoplocallis*) *microsetosus* Quednau and Chakrabarti, 1976. *Can. Ent.*, **108** : 466.

Specimens examined : 1 alata, INDIA : U. P. : Nainital, 7.iv.1970 (Coll. *S. Chakrabarti*).

Host plant : *Quercus incana*.

Distribution : India : Uttar Pradesh.

21. **Serratocallis takahashii** Quednau and Chakrabarti

Serratocallis takahashii Quednau and Chakrabarti, 1976. *Can. Ent.* **108** : 464.

Specimens examined : 10 alatae, 17 apterae and 37 alatoid nymphs, INDIA : U. P. : Loharkhet, Almora, 11.x.1970 (Coll. *S. Chakrabarti*) ; 3 alatae, 2 apterae and 4 alatoid nymphs, U. P. : Almora, Dhakuri, 11.x.1970 (Coll. *S. Chakrabarti*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

D. Subfamily : HORMAPHIDINAE

22. **Heminipponaphis querciphaga** Chakrabarti and Raha

Heminipponaphis querciphaga Chakrabarti and Raha, 1985. *Ann. Zool.*, **39** : 88.

Specimen examined : 5 apterae and nymphs, INDIA : U. P. : Fool Chatti, 19.x.1981 (Coll. *S. Saha*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

23. **Neothoracaphis garhwalensis** Chakrabarti and Raha

Neothoracaphis garhwalensis Chakrabarti and Raha, 1985. *Ann. Zool.*, **39** : 90.

Specimens examined : Many apterae and nymphs, INDIA : U. P. : Janaki Chatti, Jamunotri, 18.x.1981 (Coll. *S. Saha*).

Host plant : *Quercus* sp.

Distribution : India : Uttar Pradesh.

24. **Pseudothoracaphis himachali** Raychaudhuri, Ghosh and Das

Pseudothoracaphis himachali Raychaudhuri, Ghosh and Das, 1980. *Ins. Matsumurana*, **20** : 36.

Material reported : 40 apterae, INDIA : U. P. : Mashobra, 28.x.1978 (without collector's name).

Host plant : *Quercus* sp.

Distribution : India : Himachal Pradesh.

25. **Reticulaphis distylli rotifera** Hille Ris Lambers and Takahashi

Reticulaphis distylli rotifera Hille Ris Lambers and Takahashi, 1959. *Tijdschr. Ent.*, 102 : 12 ; Raychaudhuri, Ghosh and Das, 1980. *Ins. Matsumurana*, **22** : 38.

Material reported : 18 apterae, INDIA : H. P. : Mashobra, 28.x.1978 (without collector's name).

Host plant : *Quercus* sp.

Distribution : India ; Himachal Pradesh.

APHIDS OCCASIONALLY FOUND ON *Quercus* spp. ;

1. *Longicaudus himalayensis* Hille Ris Lambers
2. *Shivaphis celti* Das

APHID LIFE CYCLE ON *Quercus* :

In general, life cycle of the aphids is a very complex one. The life cycle may be of two types, Autoecious life cycle and Heteroecious life cycle. Majority of the aphids that live on *Quercus*, lead an autoecious type of life cycle, while a few of them may lead a heteroecious life. The members of the genera, viz., *Eutrichosiphum* Essig and Kuwana and *Greenidea* Schouteden under the subfamily Greenideinae, *Lachnus* Burmeister under the subfamily Lachninae, *Globulicaudaphis*

Hille Ris Lambers, *Myzocallis* Passerini and *Serratocallis* Quednau and Chakrabarti under the subfamily Drepanosiphinae lead autoecious life cycle. On the contrary, *Nipponaphis* Pergande and its related genera under the subfamily Hormaphidinae living on *Quercus* seem to use the plant as a secondary host.

(i) Greenideinae : These group of aphids attack several plant families including Fagaceae. Quite a few species is restricted to *Quercus* and related genera. In the tropics and subtropics, Greenideinae on the whole reproduce parthenogetically (Raychaudhuri, 1956). However, according to our collection and observation bisexual mode of reproduction is not completely lost in *Eutrichosiphum* (*Paratrichosiphum*) *assamensis* (Ghosh and Raychaudhuri) and *Eutrichosiphum* (*Paratrichosiphum*) *alnicola* (Basu).

(ii) Lachninae : In North West Himalaya two species of *Lachnus* Burmeister infest *Quercus* and are monophagous (Ghosh, 1982). In general, *Lachnus* spp. overwinter as diapause aggs (Bodenheimer and Swirski, 1957). So far, no sexual morphs of *Lachnus* is known from this continent and hence their autoecious holocyclic life as represented elsewhere could not be established in the area of study.

Members of the genus *Nippolachnus* Matsumura are restricted to Rosaceous plants (Ghosh, 1982). Raychaudhuri, Ghosh and Das (1980) reported 3 species of *Nippolachnus* viz. *bengalensis* Basu and Hille Ris Lambers, *himalayensis* (van der Goot) and *piri* Matsumura infesting *Quercus* in some localities of Himachal Pradesh during the month of October. This host association seems to be dubious and reconfirmation is necessary.

(iii) Drepanosiphinae : *Myzocallis* Passerini in general are monophagous and lead holocyclic life cycle (Bodenheimer and Swirski, 1957 ; Richards, 1968). The present findings also support the above work at least in *Myzocallis* (*Agrioaphis*) *polychaetus* David in the present locality. Information on the life cycle of *Globulicaudaphis* Hill Ris Lambers and *Serratocallis* Quednau and Chakrabarti are still meagre.

(iv) Hormaphidinae : *Nipponaphis* Pergande and allied genera are found to produce galls on *Distylium* sp. and alternate with *Quercus*. In India, no hormaphidine aphid has been collected from their primary host. They are presumably restricted to parthenogenetic viviparous life cycle on their secondary host, as in the case of South East Asian species (Takahashi, 1958).

KEY TO THE SPECIES INFESTING *Quercus*

1.	Head, thorax and 1st abdominal segment fused to form prosoma (Fig. 1) ; siphunculi absent ...	...	2
	Head, thorax and abdominal segments not fused to form prosoma ; siphunculi always present but may occasionally be represented by pores only ...	...	5
2.	Antennae 1 segmented (Fig. 8) ...	...	3
	Antennae 2-3 segmented (Fig. 9) ...	...	4
3.	Tarsi normal with claws (Fig. 2) ; dorsum corrugated, without any polygonal reticulation (Fig. 4) ; segment 8 with 2 hairs ...	*Heminipponaphis querciphaga* Chakrabarti and Raha	
	Tarsi rudimentary (Fig. 3) with 5-6 minute conical processi ; dorsum with mid dorsal polygonal reticulations (Fig. 5) ; segment 8 with 4 hairs ...	*Neothoracaphis garhwalensis* Chakrabarti and Raha	
4.	Tarsi atrophied without claws ; spinopleural dorsum of prosoma distinctly reticulated (Figs. 6a, 6b) ...	*Reticulaphis distylli rotifera* Hille Ris Lambers and Takahashi	
	Tarsi normal with claws ; dorsum of prosoma never reticulated but may be wrinkled and corrugated (Fig. 7) and reticulation may be faintly present in the marginal area ...	*Pseudothoracaphis himachali* Raychaudhuri, Ghosh and Das	
5.	First tarsal segment with 9 or more ventral hairs ; head with distinct median longitudinal suture ; siphunculi cone shaped (fig. 10) ; primary rhinaria nonciliated ...	...	6
	First tarsal segment never with more than 7 ventral hairs ; head without a median longitudinal suture ; siphunculi variously shaped but never as above ; primary rhinaria usually ciliated ...	...	10
6.	Eyes with distinct occular tubercles ; cephalic hairs short, utmost 1.5 times the b. d. III ; wings variegated ...	...	7
	Eyes without distinct occular tubercles ; cephalic hairs long, may be as long as 6.5 times the b. d. 1II ; wings thin and pale ...	...	8

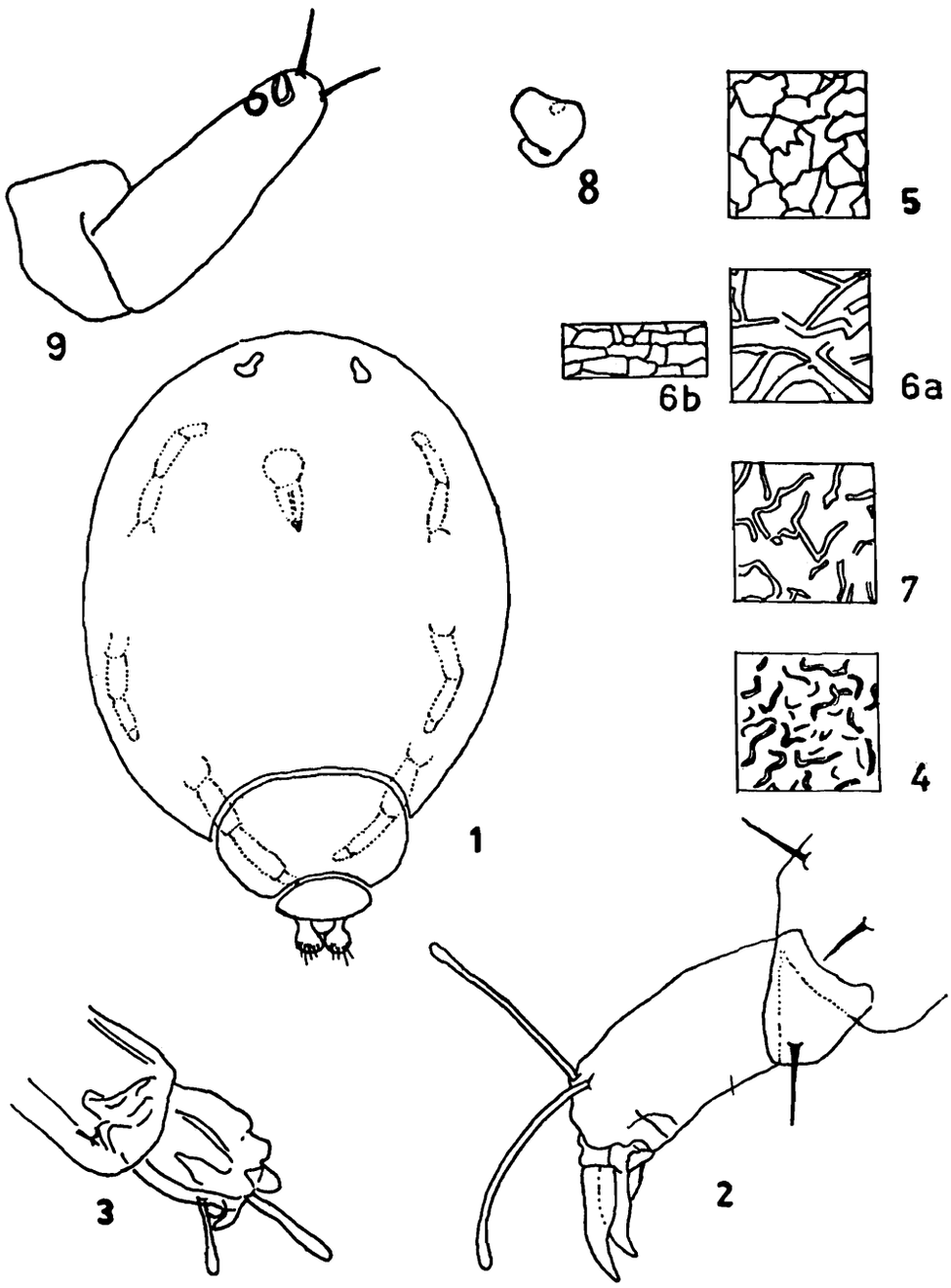


Fig. 1. *Reticulaphis distylii rotifera* Hille Ris Lambers and Takahashi. ... Apterous viviparous famale.

Figs. 2-3. Second joint of hind tarsus.

2. *Heminipponaphis queriphaga* Chakrabarti and Raha ; 3. *Neothoracaphis garhwalensis* Chakrabarti and Raha.

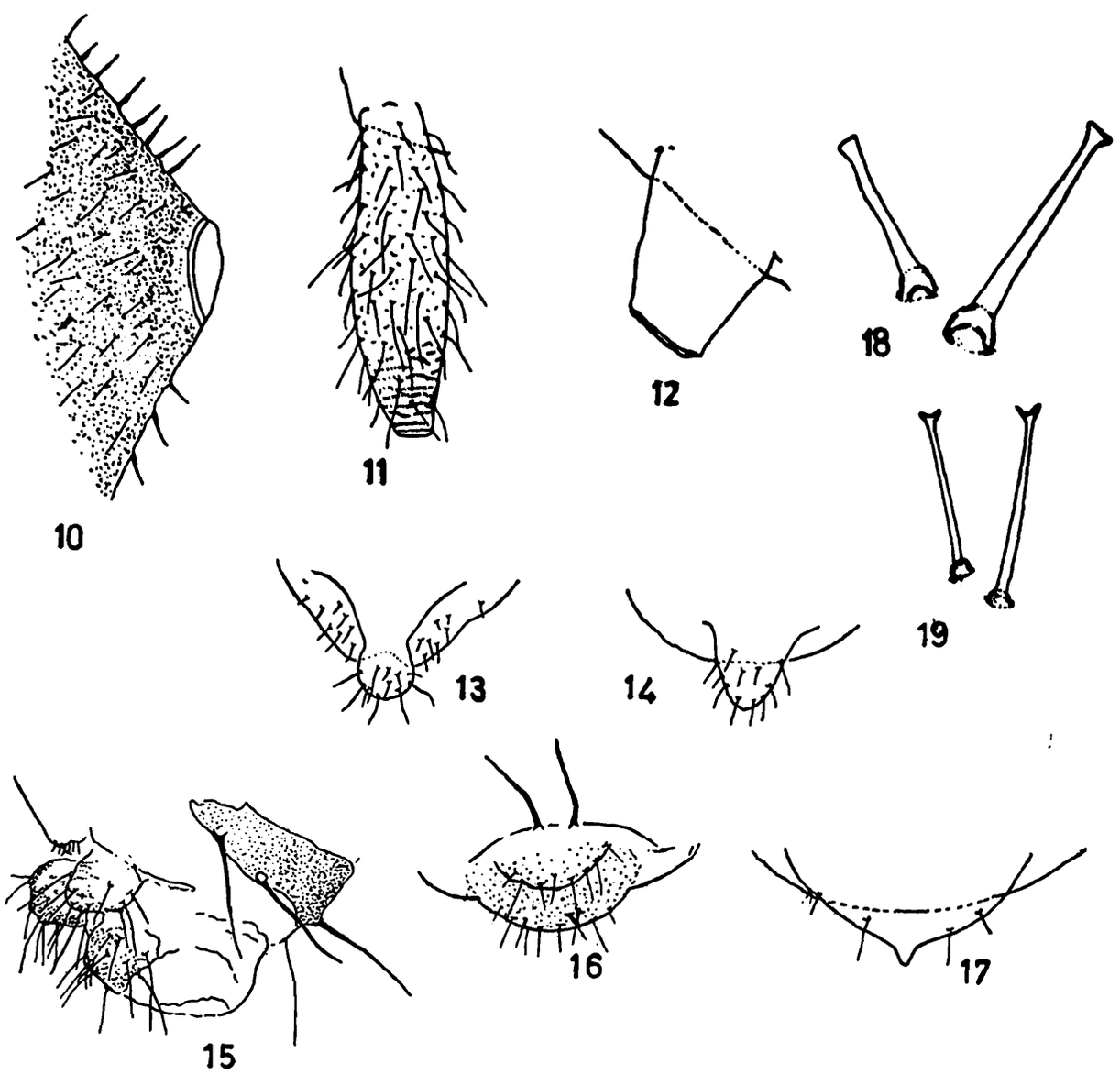
Figs. 4-7. Dorsal sclerotization.

4. *Heminipponaphis* sp., 5. *Neothoracaphis garhwalensis* Chakrabarti and Raha. 6a. *Reticulaphis distylii rotifera* Hille Ris Lambers and Takahashi, 6b. *Reticulaphis distylii rotifera* Hille Ris Lambers and Takahashi (on margin), 7. *Pseudothoracaphis himachali* Raychaudhuri, Ghosh and Das.

Figs. 8-9. Antennae

... 8. *Reticulaphis distylii rotifera* Hille Ris Lambers and Takahashi, 9. *Heminipponaphis* sp.

7.	U.r.s. with 11-14 accessory hairs : longest hair on vertex 1.25-1.50 times the b.d. III ; hairs on anterior abdominal tergites 1.30-1.60 times, on 7th tergite about 1.6-1.9 times, on 8th tergite 1.75-2.1 times the b.d. III respectively ; antennae 0.45 times the body ; segment III in alate with 6-7 secondary rhinaria ...	*Lachnus acutihirsutus* Kumar and Burkhardt
	U.r.s. with 18-22 accessory hairs ; longest hair on vertex as long as b.d. III ; longest hair on anterior abdominal tergite 0.8-0.9 times, on 7th tergite 0.85-1.0 times and on 8th tergite 1.33-1.46 times the b.d. III respectively ; antennae 0.5-0.6 times the body ; sagment III in alate with 12-23 secondary rhinaria ...	*Lachnus tropicalis* (van der Goot)
8.	Legs dark ; dorsal cephalic hairs 2.5-2.8 times the b.d. III ; segment III in alate with 40-60 and IV with 10-11 secondary rhinaria ...	*Nippolachnus himalayensis* (van der Goot)
	Legs pale ; dorsal cephalic hair 5.0-6.5 times the b.d. III ; segment III in alate with 12 and IV with 0-5 secondary rhinaria ...	... 9
9.	U.r.s. with 9-14 secondary hairs, about 0.65-0.71 times the h.t. 2 ; p.t. with 1 pair of terminal spines ; secondary rhinaria may be present on segments III, IV and V ; p.t. in alate about 0.25-0.35 times the base of segment VI ...	*Nippolachnus bengalensis* Basu and Hille Ris Lambers
	U.r.s. with 16-18 secondary hairs, about 0.75-0.80 times the h.t. 2 ; p.t. with 2 or more pairs of terminal spines ; secondary rhinaria always absent on antennal segments ; p.t. in alate about 0.45-0.57 times the base of the segment VI ...	*Nippolachnus piri* Matsumura
10.	Cauda knobbed or elongate but never semioval ; siphunculus usually truncate without any hair ; subanal plate bilobed or indented ...	... 11
	Cauda semioval (Fig. 16) ; siphunculus long, densely covered with hairs (Fig. 11) ; subanal plate entire ...	... 14
11.	Hairs on dorsum spine like and placed on tuberculate bases ; cauda tongue shaped and without constriction (Fig. 14) ...	*Serratocallis takahashii* Quednau and Chakrabarti
	Hairs ou dorsum normal but not spine like as above ; cauda knobbed or membranous bladder like but never as above ...	... 12



Figs. 10-12. Types of siphunculi.

10. *Lachnus acutihirsutus* Kumar and Burkhardt.,

11. *Eutrichosiphum garhwalense* Maity and Chakrabarti.

12. *Myzocallis* (*Hoplocallis*) *microsetosus* Quednau and Chakrabarti.

Figs. 13-17. Types of cauda.

13. *Myzocallis* (*Hoplocallis*) *microsetosus* Quednau and Chakrabarti. 14. *Serratocallis takahashi* Quednau and Chakrabarti. 15. *Globulicaudaphis pakistanica* Hille Ris Lambers. 16. *Eutrichosiphum pyri* Chakrabarti Ghosh and Raychaudhuri. 17. *Greenidea* (*Trichosiphum*) *kumaoni* Chakrabarti and Raychaudhuri.

Figs. 18-19. Types of hairs.

18. *Myzocallis* (*Agrioaphis*) *polychaetus* David.

19. *Eutrichosiphum* (*Neoparatrichosiphum*) *khasyanum* Ghosh and Raychaudhuri.

12. Cauda membranous, smooth, bladder like (Fig. 15) and with ventral sclerotic area ... *Globulicaudaphis pakistanica* Hille Ris Lambers

Cauda elongate, constricted basally to form a knob (Fig. 13) and not as above 13

13. Discal hairs single with broad flal apices (Fig. 18); each lobe of the anal plate bears 10 hairs; siphunculi raised with dark rims; apterous generation present ... *Myzocallis* (*Agrioaphis*) *polychaetus* David

Discal hairs in cluster with pointed or weakly capitate apices; each lobe of the anal plate bears 15 hairs; siphunculus without dark rim (Fig. 12); apterous generation absent ... *Myzocallis* (*Hoplocallis*) *microsetosus* Quednau and Chakrabarti

14. Cauda with a median stylus (Fig. 17) 15

Cauda without a median stylus 17

15. P.t. shorter than antennal segment III; siphunculi about 0.14-0.16 times the body ... *Greenidea* (*Trichosiphum*) *haldari* Maity and Chakrabarti

P.t. longer than antennal segment III; siphunculi about 0.22 times the body 16

16. U.r.s. with 10 secondary hairs; longest hair on 7th tergite about 3.6-4.2 times the b.d. III and those on 8th about 2.6-2.9 times the b.d. III .. *Greenidea* (*Trichosiphum*) *kumaoni* Chakrabarti and Raychaudhuri

U.r.s. with 14 secondary hairs; longest hair on 7th tergite about 1.1-1.5 times the b.d. III and those on 8th about 1.0-1.9 times the b.d. III ... *Greenidea* (*Trichosiphum*) *anonae* Pergande

17. Antennae 5 segmented 18

Antennae 6 segmented 21

18. Cauda with 2 hairs; u.r.s. with 12 secondary hairs ... *Eutrichosiphum garhwalense* Maity and Chakrabarti

Cauda with 6-8 hairs; u.r.s. with 6-11 secondary hairs 19

19. P.t. as long as base of segment V; dorsal abdominal hairs mostly with furcated apices; u.r.s. with 10-11 secondary hairs; body dark ... *Eutrichosiphum taoi* Ghosh, Basu and Raychaudhuri

P.t. 1.2-1.6 times the base of segment V; dorsal abdominal hairs mostly with blunt or acuminate apices; u.r.s. with 6-8 secondary hairs; body pale 20

20. Tergite 7 with 2 hairs, about 3.5-4.4 times the b.d. III and those on tergite 8 about 4.25-4.50 times the b.d. I11 ... *Eutrichosiphum pyri* Chakrabarti, Ghosh and Raychaudhuri

Tergite 7 with 6 hairs, about 2.5-3.2 times the b.d. III and those on teagite 8 about 2.0-2.7 times the b.d. III *Eutrichosiphum* (*Eutrichosiphum*) *tapatii* Mondal, Chatterjee and Raychaudhuri

21. Most of the hairs on basal 0.70 portion and a few apical hairs of siphunculi with furcated apices (Fig. 19) and rest with fine apices .. *Eutrichosiphum* (*Neoparatrichosiphum*) *khasyanum* (Ghosh and Raychaudhuri)

Hairs on siphunculi fine with more or less similar in length but sometimes 2-3 basal short hairs with furcated apices 22

22. Dorsum of abdonen with dark central patch on tergites 3-5 ; longest hair on antennal segment III about 3.0-3.50 times as long as b.d. III ... *Eutrichosiphum* (*Paratrichosiphum*) *querciphaga* Chakrabarti and Maity

Dorsum of abdomen may be sclerotic but never with a dark central patch on tergites 3-5 only ; longest hair on antennal segment III always less than 3 times as long as b.d. III 23

23. Rostral segment IV about 6.0-8.5 times as long as segment V ; p.t. about 1.20-1.60 times as long as the base of segment VI ; longest hair on anterior abdominal tergites 3.50-3.80 times as long as b.d. III ; siphunculi about 0.26-0.33 times the body 24

Rostral segment IV about 4.6-5.2 times as long as segment V ; p.t. about 1.63-2.16 times as long as the base of segment VI ; longest hair on anterior abdominal tergites about 2.22-2.77 times as long as b.d. III ; siphunculi about 0.34-0.45 times the body ... *Eutrichosiphum* (*Paratrichosiphum*) *alnicola* (Basu)

24. Cauda with 10 hairs ; p.t. about 0.65-0.70 times the antennal segment III ; longest hair on vertex about 2.5-3.1 times the b.d. III ... *Eutrichosiphum* (*Paratrichosiphum*) *assamensis* (Ghosh and Raychaudhuri)

Cauda with 6 hairs ; p.t. about 0.5-0.57 times the antennal segment III ; longest hair on vertex about 3.4-3.5 times the b.d. III ... *Eutrichosiphum* (*Paratrichosiphum*) *neoalnicola* Raychaudhuri, Ghosh and Das

SYNOPSIS

This paper embodies a comprehensive account of the Oak (*Quercus* spp.) inhabiting aphids of Western and North West Himalaya where altogether 25 aphid species under 11 genera are known to infest these plants. The life cycle of the aphids under four subfamilies are briefly discussed. A key to the species is provided.

ACKNOWLEDGEMENT

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AFFINITIES OF INDIAN NORTH-EASTERN BORDERLAND TERMITES WITH THOSE FROM OTHER PARTS OF THE ORIENTAL REGION

By

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INTRODUCTION

The North-Eastern borderland of the Indian subcontinent includes Assam, Meghalaya, Arunachal Pradesh, Manipur, Nagaland, Mizoram and Tripura in India and also Bangladesh, Bhutan and northern Burma. It lies approximately between 88°-98°E longitudes and 22°-29°N latitudes. This region is mainly covered with hills and mountains except for the Brahmaputra Valley in Assam, the eastern extension of the Gangetic Plains into Bangladesh and Tripura and the Chindwin and Irrawaddy Valleys in northern Burma. In North it is bounded by eastern Himalayas which curve southwards into Patkai, Naga and Chin Hills in north-south direction, separating India and Burma and extending into the Arakan Yomas in Burma and in its south is the Bay of Bengal. The valleys are fertile, otherwise most of the region is covered with evergreen forests. The central part has Garo and Khasi Hills running in East-west direction in India. The climate of the region is humid tropical and the annual rainfall varies with the situation from approximately, 1250-6500 mm with the highest rainfall in the world received at Cherrapunji (10,625 mm) in Meghalaya, India.

TERMITES OF NORTH-EASTERN BORDERLAND

(Table 1)

The Isoptera of this part has been studied rather extensively during the last few years. The more important works are those of Silvestri (1914), Gardner (1944), Roonwal and Chhotani (1959-1962), Mathur and Thapa (1965), Chhotani (1975, 1976), Sen-Sarma and Thakur (1979), Chhotani and Das (1983) and Chhotani and Bose (1985) on the Assam region (India) ; of Akhtar (1975) on Bangladesh ; of Roonwal and Chhotani (1977) on Bhutan ; and of Krishna (1965) on Burma. The studies by these workers brought to light as many as 109 species belonging to 32 genera distributed in the families Kalotermitidae (3 genera, 14 species), Rhinotermitidae (6 genera, 13 species), Styloter-mitidae (1 genus, 2 species), Termitidae (21 genera, 77 species) and

TABLE 1. Number of species of different genera found in Indian North-eastern Borderland and of those endemic and common to Indian subregion and other parts of Oriental region

Genus	No. of species											
	Total	Endemic	Common with other parts of Indian subregion					Common with other parts of Oriental region				Remarks
			Indian subregion	Eastern	N-W Belt	Andaman & Nicobar	Southern	Oriental region	Indo-Chinese subregion	Chinese subregion	Malayan subregion	
	1	2	3	4	5	6	7	8	9	10	11	12
Fam. Kalotermitidae												
1. *Neotermes*	6	4	—	—	1	—	1	—	—	—	—	
2. *Glyptotermes*	6	5	—	—	—	—	1	—	—	—	—	
3. *Cryptotermes*	2	—	1*	—	—	—	—	1*	—	—	—	*Also occur in other regions
Fam. Rhinotermitidae												
4. *Coptotermes*	4	1	1	1	—	—	—	1	—	—	—	
5. *Heterotermes*	1	—	1	—	—	—	—	—	—	—	—	
6. *Reticulitermes*	4	3	—	—	—	—	—	—	—	1	—	
7. *Prorhinotermes*	1	—	—	—	—	1	—	—	—	—	—	
8. *Parrhinotermes*	1	—	—	—	—	—	—	—	—	1	—	
9. *Schedorhinotermes*	2	—	—	—	—	—	—	—	—	—	2	
Fam. Stylotermitidae												
10. *Stylotermes*	2	2	—	—	—	—	—	—	—	—	—	
Fam. Termitidae												
11. *Anoptotermes*	1	1	—	—	—	—	—	—	—	—	—	
12. *Euhamitermes*	5	3	1	—	—	—	—	1	—	—	—	

TABLE 1. (*Concluded*)

	1	2	3	4	5	6	7	8	9	10	11	12
13. *Synhamitermes*	1	—	1	—	—	—	—	—	—	—	—	
14. *Microcerotermes*	6	3	—	—	1	—	—	—	2*	2*	—	*Common to both subregions
15. *Angulitermes*	3	3	—	—	—	—	—	—	—	—	—	
16. *Dicuspiditermes*	2	2	—	—	—	—	—	—	—	—	—	
17. *Pericapritermes*	6	2	1	—	1	—	—	2	—	—	—	
18. *Pseudocapritermes*	1	1	—	—	—	—	—	—	—	—	—	
19. *Procapritermes*	1	1	—	—	—	—	—	—	—	—		
20. *Mirocapritermes*	2	2	—	—	—	—	—	—	—	—	—	
21. *Malaysiocapritermes*	1	1	—	—	—	—	—	—	—	—	—	
22. *Macrotermes*	5	4	—	—	—	—	—	—	1*	1*	—	*Common to both subregions
23. *Odontotermes*	18	7	6	—	2	—	—	—	2+	2+	1	+same species
24. *Hypotermes*	3	1	—	—	—	—	1	—	1°	—	1°	°same species
25. *Microtermes*	3	1	2	—	—	—	—	—	1@	—	—	@Common also to Indian subregion
26. *Ancistrotermes*	1	—	—	—	—	—	—	1	—	—	—	
27. *Bulbitermes*	4	3	—	—	—	—	—	—	1	—	—	
28. *Ahmaditermes*	1	1	—	—	—	—	—	—	—	—	—	
29. *Hospitalitermes*	4	1	—	—	—	—	—	—	3	—	—	
30. *Nasutitermes*	8	8	—	—	—	—	—	—	—	—	—	
31. *Aciculitermes*	1	1	—	—	—	—	—	—	—	—	—	
Fam. Indotermitidae												
32. *Indotermes*	3	2	—	—	—	—	—	—	1	—	—	

Indotermitidae (1 genus, 3 species). The number of species known under each of the 32 genera and of those which are endemic or common with India and other parts of Oriental region is given in table 1. The families Mastotermitidae, Termopsidae, Hodotermitidae and Serritermitidae are not represented.

The family Kalotermitidae is known by genera *Neotermes*, *Glyptotermes* and *Cryptotermes*. They are all dry-wood termites and of the six species of *Neotermes*, 4 are endemic to this part, one extends in distribution to North-West to Dehra Dun (U. P., India) and one is common with that from southern India. *Glyptotermes* is represented by 5 endemic forms and one form common with southern India, and *Cryptotermes*, which are easily transportable, by two very widely distributed species known also from other zoogeographical regions.

Rhinotermitidae, also wood infesting termites, are represented by six genera and 13 species. Of the 4 *Coptotermes* species, one is endemic, one common with the rest of the Indian subcontinent, one common with eastern India and the remaining portion of the Oriental region, and one extends to eastern India. *Heterotermes*, reported only by a single species (*H. indicola*) from Bangladesh, is also very wide-spread in the Indian region above 16° latitude and extends through Pakistan to Afghanistan. *Reticulitermes* is known from this part by 4 species restricted to colder regions, 3 being endemic and one common with China. This genus is very well represented in China and extends in its distribution only into this part of the Indian subcontinent. *Prorhinotermes* and *Parrhinotermes* are reported by a single species each. The species of the former genus is from southern coastal Bangladesh and is common with that of the Andaman Islands and that of the latter genus from Meghalaya and Arunachal Pradesh, is coomon with China. *Schedorhinotermes* is known by 2 species both of which are common with those from the Malayan subregion.

Stylotermitidae (genus *Stylotermes*) is known by 2 endemic species. The genus, however, is mainly Chinese and extends in its distribution along the base of Himalayas to North-West Himalayas with one species reported from southern India.

Termitidae is represented by 77 species belonging to 21 genera. *Anoplotermes* known by a single species is recorded by Roonwal and Chhotani (1959) form Meghalaya. *Euhamitermes* with 5 species, has 3 endemic forms and one common with central India and one with remaining parts of the Oriental region. The single species of *Synhamitermes* is common with the rest of the Indian continent. *Microcerotermes* with 6 species has 3 endemics, one extending in distribution to

N-W Himalaya, and two (same species) are common with Indo-Chinese and Chinese subregions. The species of *Angulitermes* (3), *Dicuspiditermes* (2), *Pseudocapritermes* (1), *Procapritermes* (1), *Mirocapritermes* (2) and *Malaysiocapritermes* (1) are all endemics and of the 6 *Pericapritermes* 2 are endemics, one extending in distribution westwards upto Central India and one upto Dehra Dun (N-W Himalaya) and 2 are common with the remaining portion of the Oriental region East of this part. Of the genus *Macrotermes*, 4 species are endemic and one is common to this and Indo-Chinese subregions. *Odontotermes* is the most predominent genus with 18 species, of which 7 being exclusive to this part, 6 common with remaining portion of the whole of the Indian subregion (2 extending in distribution westwards along base of Himalaya), one to be found almost throughout the Oriental region except the Chinese and Malayan subregions, one each is common with Chinese and Malayan subregions and one with Chinese and Indo-Chinese subregions. *Hypotermes* (3 species) is represendted by a species endemic to this part, a species common with southern India and Sri Lanka and another, the third species. is widespread to East of this part in the Oriental region. *Microtermes* also with 3 species has one endemic, one common with rest of Indian subregion and one well spread all over the oriental region except in the Malayan and Chinese subregions. *Ancistrotermes* with a single species is known only from this part of the Indian subregion but otherwise is wide spread in the remaining portion of the Oriental region. Of the nasute termites, *Bulbitermes* with 4 species, has 3 endemics and a species common with Indo-Chinese subregion (Thailand) ; *Ahmaditermes* with a single endemic species ; *Hospitalitermes* with one endemic and 3 common to this part and Thailand ; and *Nasutitermes* has 8 endemics.

Indotermitidae with the single genus *Indotermes*, is known by 3 species, all exclusive to this part.

Zoogeography and Affinities

The Oriental zoogeographical region has been divided into four subregions, i. e. Indian (India, Sri Lanka, Pakistan, Bangladesh Bhutan, Nepal and Burma), Indo-Chinese (Thailand, Laos, Kampuchea and Vietnam), Chinese (Southern China and Taiwan) and Malayan (Malaysia, Singapore, Indonesia and the Philippines), for showing affinities and distribution of the genera found in the North-eastern borderland of the Indian sub-continent (Table 2).

Of the 21 Kalotermitid genera known from the world and 9 from Oriental Region only 3 primarily cosmotropical genera are reported.

The Rhinotermitidae, known by 13 genera from all over the world, is represented by the cosmotropical *Coptotermes* and *Heterotermes*, the essentially palaearctic *Reticulitermes*, the mainly oriental *Parrhinotermes*, the generally insular and mainly oriental *Prorhinotermes* and *Schedorhinotermes* which is mainly Oriental but is also reported from the Australian, Papuan and Ethiopian regions. The highly competitive and successful genus *Coptotermes* is very common. *Heterotermes*, otherwise well established in the Indian subregion, is reported only from Khulna in Bangladesh and forms the easternmost limit of distribution of the species *H. indicola*. *Parrhinotermes* is found only in this part and its absence in the main Indian subcontinent shows the western-most limit of this mainly Oriental genus which is otherwise quite well known in the malayan subregion. *Prorhinotermes* confined to islands and coastal regions, has a species reported only from southern coastal Bangladesh and is common with that of Andaman Islands. *Schedorhinotermes* has two species common with the Malayan subregion ; it is supposed to have evolved in the Oriental region but its absence from the intervening main Indian subcontinent and presence again in the Ethiopian region is puzzling.

Of the 21 genera of Termitidae found in this part, *Anoplotermes* is confined to this part and *Euhamitermes*, endemic to the Oriental region, is reportcd from all the four subregions. The record of *Synhamitermes*, which is endemic to the Indian subregion, shows the easternmost limit of the genus. *Microcerotermes* which is well established all over the tropics, *Angulitermes* and *Pericapritermes* which are wide spread in the Oriental and Ethiopian regions and the Oriental genera *Dicuspiditermes*, *Procapritermes*, *Pseudocapritermes*, *Mirocapritermes* and *Malaysiocapritermes* are expected to occur. But a number of genera such as *Eurytermes*, *Speculitermes*, *Dooritermes* known from India and also a number of very common genera such as *Globitermes*, which is well established in the Indo-Chinese and Malayan subregions, *Amitermes* which has a wide distribution in the Australian and Ethiopian regions and also reported from N-W India and the Indo-Chinese and Malayan subregions, and *Homallotermes* known from the Malayan and Chinese subregions and southern India, are not to be found here. *Macrotermes* common here and in the East of this part and the Ethiopian zoogeographical region with a species reported from southern India and the eastern coast of Orissa (India) is absent in the remaining portion of the Indian subcontinent, it is rather anamolous in distribution and same is true of *Ancistrotermes* as it is found here and in further East and in the Ethiopian Region. *Odontotermes* and *Microtermes*, well represented both in the Oriental and Ethiopian zoogeographical regions, are widespread all

TABLE 2. Distribution of Indian North-eastern Borderland termites in different subregions of Oriental Region

Genus	Subregions of Oriental Region				Remarks
	Indian	Indo-Chinese	Chinese	Malayan	
1	2	3	4	5	6
Fam. Kalotermitidae					
1. *Neotermes*	+	+	+	+	
2. *Glyptotermes*	+	+	+	+	
3. *Cryptotermes*	+	+	+	+	
Fam. Rhinotermitidae					
4. *Coptotermes*	+	+	+	+	
5. *Heterotermes*	+	—	—	+	
6. *Reticulitermes*	+	—	+	—	In Indian subregion only N-E borderland
7. *Prorhinotermes*	+	+	+	+	In Indian subregion in southern India, Andaman & Nicobar Isls. and Sri Lanka also
8. *Parrhinotermes*	+	—	+	+	In Indian subregion only in N-E borderland
9. *Schedorhinotermes*	+	+	+	+	Do : and Andaman & Nicobar Isls
Fam. Stylotermitidae					
10. *Stylotermes*	+	—	+	+	In Indian subregion in N-W India and southern India also
Fam. Termitidae					
11. *Anoplotermes*	+	—	—	—	In Indian subregion only in N-E borderland
12. *Euhamitermes*	+	+	+	+	
13. *Synhamitermes*	+	—	—	—	
14. *Microcerotermes*	+	+	+	+	
15. *Angulitermes*	+	—	—	—	
16. *Dicuspiditermes*	+	+	+	+	
17. *Pericapritermes*	+	+	+	+	
18. *Pseudocapritermes*	+	+	—	+	In Indian subregion in southern India also
19. *Procapritermes*	+	—	+	+	In Indian subregion only in N-E borderland
20. *Mirocapritermes*	+	+	+	+	—Do—
21. *Malaysiocapritermes*	+	+	—	+	—Do—
22. *Macrotermes*	+	+	+	+	In Indian subregion in southern India and eastern coastal Orissa also

TABLE 2. (*Concluded*)

1	2	3	4	5	6
23. *Odontotermes*	+	+	+	+	
24. *Hypotermes*	+	+	+	+	In Indian subregion in southern India and Sri Lanka also
25. *Microtermes*	+	+	—	+	
26. *Ancistrotermes*	+	+	+	+	In Indian subregion only in N-E borderland
27. *Bulbitermes*	+	+	—	+	—Do—
28. *Ahmaditermes*	+	+	+	—	—Do—
29. *Hospitalitermes*	+	+	+	+	In Indian region in Andaman & Nicobar Islands, southern India and Sri Lanka also
30. *Nasutitermes*	+	+	+	+	
31. *Aciculitermes*	+	+	—	+	In Indian region only in N-E borderland
Fam. Indotermitidae					
32. *Indotermes*	+	+	+	—	In Indian region only in N-E borderland

through the Orient. *Hypotermes* is found here and in East of this part and in southern India and Sri Lanka but is absent in the remaining part of the Indian subregion, this is an another anomally in distribution.

This part of the Indian subcontinent is the westernmost limit of *Bulbitermes*, *Ahmaditermes* and *Aciculitermes*. *Nasutitermes*, a cosmotropical genus, is of course expected to be found and the *Hospitalitermes* distribution in the Indian subregion is somewhat similar to that of *Hypotermes*. A number of nasute genera found in the Indo-Chinese and Malayan subregion have restricted distributions and do not occur here.

The Indotermitidae is known from this part, Thailand and Yunnan and Hainan (southern China) and is essentially Oriental.

Discussion

From the above data of distribution it is observed that none of the genera are endemic to the North-eastern Borderland of the Indian region; out of the 109 species recorded as many as 63 (i. e. 57.8 per cent) are endemic. In respect of the termite fauna of remaining part of the Indian subcontinent, 14 species are common to rest of the Indian subregion, 2 to eastern India, 5 to North-West belt along base of Himalaya, one to the Andaman Islands and 3 to southern India, alone;

and in respect of the remaining parts of the Oriental zoogeographical region, 6 species are common to whole of the region, 12 to Indo-Chinese, 7 to Chinese and 4 to Malayan, subregions. The absence of *Schedorhinotermes* (Rhinotermitidae) and *Ancistrotermes* (Termitidae : Macrotermitinae) in the remaining parts of the Indian subregion and the absence of *Homallotermes*, *Pseudocapritermes* and *Procapritermes* (Termitidae : Termitinae), *Macrotermes* and *Hypotermes* (Termitidae : Macrotermitinae) and *Hospitalitermes* (Termitidae : Nasutitermitinae) in the remaining portion of the Indian subregion except southern India and also Sri Lanka and the presence especially of *Homallotermes*, *Pseudocapritermes* and *Procapritermes* in the western portion of southern India are some of the anomalies in the distribution of these genera. In explanation of this, it may be mentioned that *Schedorhinotermes* and *Macrotermes* had a continuous distribution through the Indian subcontinent to the Ethiopian zoogeographical region, and *Homallotermes*, *Pseudocapritermes*, *Procapritermes*, *Hypotermes* and *Hospitalitermes* got distributed through this part to southern India and including Sri Lanka for *Hypotermes* and *Hospitalitermes*. It may be inferred that this North-eastern Boderland has been an important passage for to and fro transit of termites and that the flow of fauna has been through this part and in two directions one along the base of Himalaya and the other southwards ; similarly from North-West some elements diverged southwards and some through this passage further East and South-east as suggested by Kurup (1974) for mammals and Mani (1974).

Chhotani (1975a, 1977 and in press) has discussed the origin and distribution of Oriental genera in some detail. It may, however, be added that the present-day distribution suggests a probable continuity of tropical rain-forest conditions and that the discontinuous distribution is due to subsequent ecological changes. Since a number of genera and species are endemic to this part and further South-East, this region can be termed as a favourable seat of evolution for termites. High degree of endmicity, indicative of high rate of speciation, as suggested by Roonwal & Chhotani (1965) for termites of Assam region, is due to (i) favourable ecological conditions i. e., dense evergreen forests and (ii) low migration pressure due to ecological discontinuity to the West of this region and high ranges and valleys which restrict the movement of certain termites cutting them into small and medium sized populations confind to some pockets.

SUMMARY

The North-eastern borderland of the Indian subcontinent includes the north-eastern states in the Indian Union and also Bangladesh,

Bhutan and northern Burma. Termites of this part are known by 109 species belonging to 32 genera distributed in the families Kalotermitidae, Rhinotermitidae, Stylotermitidae, Termitidae and Indotermitidae. The distribution and zoogeography of these termites and their affinities with those from the other parts of the Oriental zoogeographical region are discussed. It is suggested that through this part of the Indian subcontinent there has been to and fro transit of termites, that this part and the area further East and South-east of it can be termed as a favourable seat of evolution for termites since a number of species and genera are endemic to this region and that discontinuous distribution of certain genera is due to subsequent changes.

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THE MEIOFAUNA AND MACROFAUNA OF DIGHA BEACH, WEST BENGAL, INDIA

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(With 4 Figures and 7 Tables)

INTRODUCTION

The distribution and ecology of fauna inhabiting the intertidal sediments of sea shore beaches have been intensively investigated in different parts of the world and the literature on the subject is too vast to be reviewed here. Hitherto, nothing is known of the meiofauna and macrofauna of the Digha beach located on West Bengal coast. Hence, the present investigation was undertaken to make a preliminary survey of the composition, density and distribution of the fauna in the beach. This paper presents the results of qualitative and quantitative investigations carried out on the beach for a period of 2 years from July 1978 to June 1980.

AREA INVESTIGATED

The Digha beach is situated close to the Gangetic mouths on the east coast of India facing the Bay of Bengal at latitude 21°36′ N and longitude 87°30′E. Here, the sea is quite shallow with very little wave action on the beach and an extensive area about 250 m of the intertidal zone is exposed during low water spring tides. The beach slope is very low upto the low water mark. The shore was subjected to considerable erosion in the recent past and the bank is presently protected with the construction of a sloping sea-wall. Three distinct seasons, summer from March to June with high temperature, monsoon from July to October with heavy rainfall and winter from November to February with low temperature, are experienced in this region.

METHODS

All the investigations on the sand flat were carried out during low tide. An intertidal transect was established on the beach with 6 sampling stations (A-F), each 40 m apart between MLWS and MHWS (Fig. 1). Beach profiles were recorded following the method of Emery (1961). For granulometric analyses, samples of the sediment were

collected from the top 10 cm, seived, different fractions weighed and cumulative curves ploted. Temperature of the sediment was recorded with a centigrade thermometer at depths of 1, 5, 10 and 15 cm below the surface. Salinity and oxygen determinations were made by Knudsen's and Winkler's methods, respectively. Particulate organic matter of the sediment was assessed with visual obsevation based on personal experience.

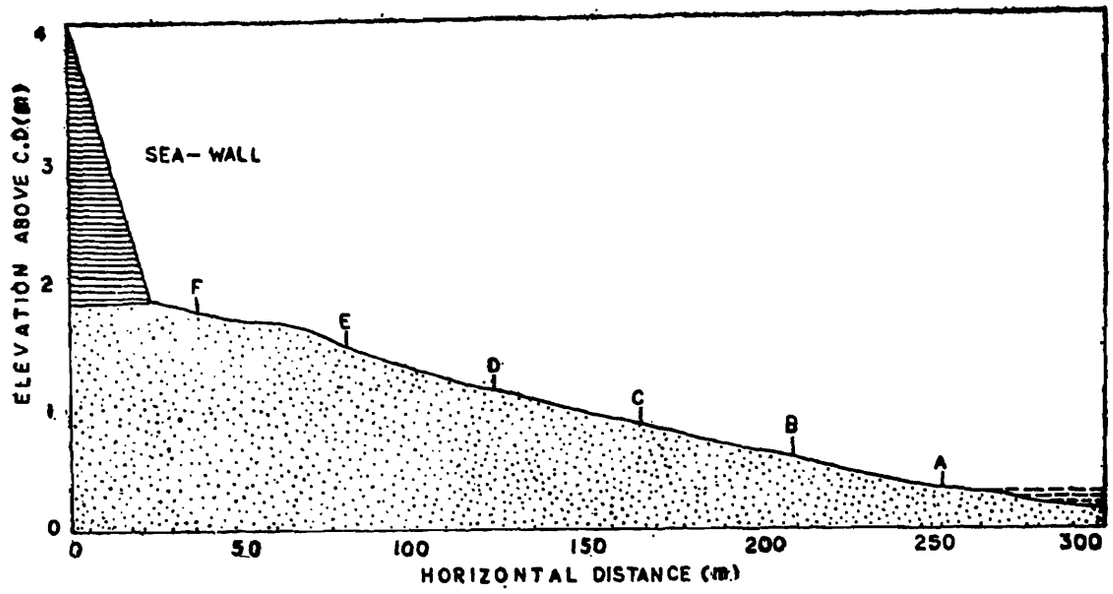

Fig. 1. Selected beach profile on Digha beach (18 August 1978), showing the position of 6 sampling stations (A-F) along the intertidal transect.

For quantitative study, the beach was sampled thrice in a year during summer, monsoon and winter periods to study the seasonal distribution of the fauna. Samples for meiofauna were collected using a hand operated matallic corer 30 cm in length and 20 cm^2 in internal cross sectional area. The core was cut into 5 cm segments to collect data on the vertical distribution of fauna. Meiofauna from these samples was extracted by means of decanting and sieving. The fauna passing through 1.0 mm sieve was collected, identified and counted. The meiofaunal densities are expressed as the number of individuals per 10 cm^2.

The macrofauna was collected using a square metallic frame 25×25×5 cm in dimensions. The quadrat was pushed into the sediment and the enclosed deposit dug out. This was repeated at the same spot to get another 5cm segment of the sediment below the first one to study the vertical distribution of fauna to a depth of 10 cm. All the fauna retained on a 1.0 mm sieve was collected. Faunal densities are given as the number of animals per m^2. As bulk of the meiofauna and macrofauna were confined to the top 10 cm of the sediment, the data presented here are limited to that depth.

RESULTS

The Envirorment

Beach profile : The beach slope was uniformly very low and the sand flat was nearly stable without any significant changes during the period of study. A selected beach profile recorded is shown in Fig. 1.

Grain size : The substrate on the beach was more or less unifom in character. It was mostly composed of fine silicious sand, with a considerable percentage of fine material as clay, silt, etc. which generally increased with depth in sediment. Selected cumulative curves showing granulometric characteristics at the 6 intertidal stations are shown in Fig. 2.

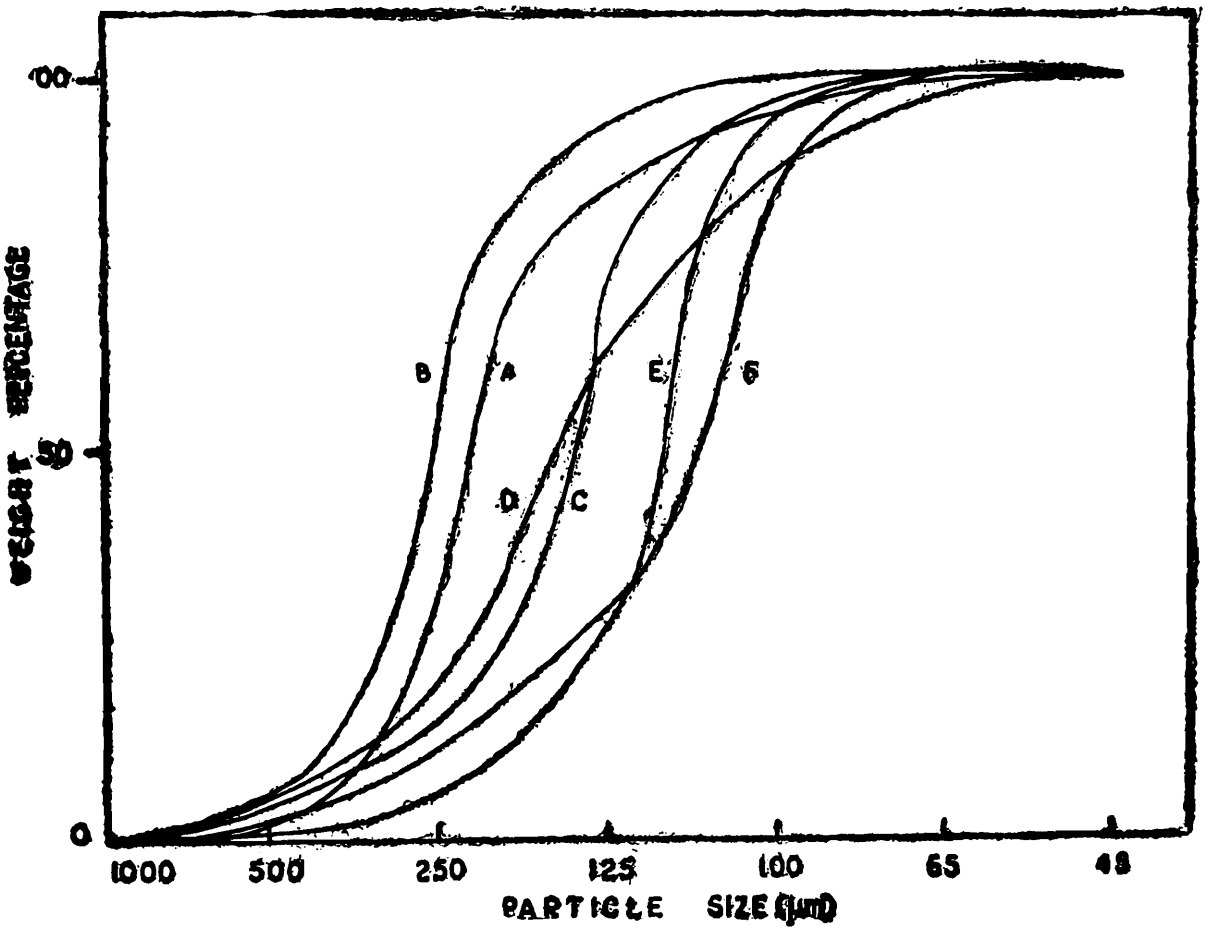

Fig. 2. Selected cumulative curves of sediment particle size for the 6 intertidal stations A-F.

Water content : The beach was fully saturated upto station D and the water table was very close to the surface. The degree of water permeability and desiccation in the beach were low due to the fineness of sediment.

Temperature : Temperature of ambient sea water varied between 20°C and 34°C. The beach values were very close to that of the sea

water, particularly on the lower shore. Temperature at higher tidal levels varied by 1—3°C depending on the prevailing climatic conditions. The upper 5 cm of sediment was usually subjected to diurnal variations in temperature, while the lower layers remained relatively unaffected.

Salinity : Salinity of sea water in the area varied between 22 and 34‰. The beach values upto station D were nearly the same as that of the ambient sea water. Salinity of interstitial water was lower by 2—12‰ near high water mark probably due to the steep elevation of adjacent land beyond the sea-wall that resulted in ground water seepage into the beach.

Oxygen : The concentration of dissolved oxygen in the beach generally decreased from low water level to high water level and particularly with depth in sediment. Oxygen values recorded to a depth of 10 cm ranged from 4.6 ml/L to 2.4 ml/L.

Organic matter : The beach sands were sufficiently rich in organic detritus due to the relatively sheltered condition of the sand flat that permits settlement of organic detritus. Apparently, it is concentrated more on the lower shore than at the higher tidal levels.

The Meiofauna

Composition : Nematodes, copepods, turbellariarians and polychaetes, constituted the major groups of meiofauna in this beach. Gastrotrichs, oligochaetes, ostracods, isopods, amphipods and halacarids, occurred in small numbers. The larval forms of annelids, crustaceans, insects and molluscs, were also present. Ciliates also occurred in the habitat in small numbers, but they were not included in the present study. The percentage abundance of the meiofauna groups encountered is shown in Fig. 3A. Numerically, Nematoda were the most abundant group followed by Copepoda. All the three ecological types of meiofauna, i.e. epipelic forms crawling on the surface of sediment, the endopelic forms burrowing into the substrate and the mesopelic forms truly interstitial in habit, were represented in the fauna. Bulk of the meiofauna in the beach, however, appeared to be of the burrowing type.

Horizontal distribution : The mean values of the meiofauna population densities recorded during the period are given in Table 1. The results did not indicate any appreciable variation in their spatial distribution within the beach and the fauna occupied almost the same horizontal levels all through the year. Maximum densities of the meiofauna (about 76%) occurred on the lower shore, showing a general decrease towards higher tidal levels. Of the total fauna collected at the

TBBLE 1. Mean population densities (nos./10 cm^2) of meiofauna in the upper 10 cm of the sediment at the six intertidal stations, A-F.

Group	Depth (cm.)	Stations					
		A	B	C	D	E	F
Nematoda	0-5	236	412	318	104	82	54
	6-10	140	186	134	76	60	76
Copepoda	0-5	152	264	160	82	32	42
	6-10	38	72	56	50	44	18
Nauplii	0-5	68	96	42	18	3	4
	6-10	22	18	28	6	2	0
Turbellaria	0-5	86	168	124	56	28	4
	6-10	28	64	78	32	30	12
Polychaeta	0-5	54	108	66	18	14	2
	6-10	18	34	30	26	16	18
Ostracoda	0-5	28	36	14	1	0	0
	6-10	1	2	0	0	0	0
Others	0-5	37	52	66	28	40	26
	6-10	18	14	21	18	12	14
Total meiofauna	0-5	661	1136	790	307	199	132
	6-10	265	390	347	208	164	138
	Totals	926	1526	1137	515	363	270

6 intertidal stations, 19.54% occurred at station A, 32.21% at station B, 24% at station C, 10.87% at station D, 7.66% at station E and 5.69% at station F. Maximum numbers of the nematodes, copepods, nauplii, turbellarians and polychaetes, were recorded on the lower shore, although their distribution extended to all levels of the intertidal zone. The ostracods were mostly confined to the lower shore, while the oligochaetes were more numerous on the upper shore. Isopods and amphipods occurred at all levels on the beach.

The horizontal distribution of the meiofauna species identified, is shown in Table 2. Although there was some amount of overlapping in their distribution, many of these species showed their occurrence limited to certain levels of the beach, apparently depending on their environmental preferences. The turbellarian *Macrostomum* sp. was collected only at station A. The nematodes *Halalaimus* sp. and *Viscosia cobbi*, the ostracod *Polycope* sp. and the copepod *Neocyclops* sp. have a wider distribution on the lower shore, while the gastrotrich *Chaetonotus* sp. and the nematode *Desmodora* sp. occured all

TABLE 2. Horizontal distribution of meiofauna species on Digha beach.

Species	Stations					
	A	B	C	D	E	F
Macrostomum sp.	+					
Halalaimus sp.	+	+	+			
Viscosia cobbi Filipjev	+	+	+			
Polycope sp.	+	+	+			
Neocyclops sp.	+	+	+	+		
Chaetonotus sp.	+	+	+	+	+	
Desmodora sp.	+	+	+	+	+	
Sphaerolaimus pacificus Allgen		+				
Araeolaimus elegans de Man		+				
Exogone sp.		+				
Tisbe furcata Baird		+				
Enhydrosoma sp.		+				
Monocelis lineata (O. F. Muller)		+	+			
Halalaimus filicollis Timm		+	+			
Hesionides sp.		+	+			
Potamodrilus sp.		+	+			
Harpacticus gracilis Claus		+	+			
Hesionides gohari Hartmann-Schroder		+	+	+		
Stenhelia sp.			+			
Southerniella simplex Allgen			+	+		
Microlaimus sp.			+	+		
Richtersia sp.			+	+		
Nannopus palustris Brady			+	+		
Paramesochra sp.			+	+	+	
Minona sp.				+		
Halectinosoma sp.				+		
Kliopsyllus sp.				+		
Dichromadora sp.				+	+	+
Enchytraeus sp.				+	+	+
Halicephalobus limuli Timm					+	+
Enchytraeus barkudensis Stephenson						+

along the beach. The nematodes *Sphaerolaimus pacificus* and *Araeolaimus elegans*, the polychaete *Exogone* sp. and the copepods *Tisbe furcata* and *Enhydrosoma* sp. werc collected only at station B. The turbellarian *Monocelis lineata*, the nematode *Halalaimus filicollis*, the polychaetes *Hesionides gohari* and *Hesionides* sp., the oligochaete *Potamodrilus* sp. and the copepod *Harpacticus gracilis* occurred at stations B and C. The nematodes *Southerniella simplex*, *Microlaimus* sp. and *Richtersia* sp. and the copepods *Stenhelia* sp., *Nannopus palustris* and *Paramesochra* sp. were common at stations C and D. The turbellarian *Minona* sp., the copepods *Halectinosoma* sp. and *Kliopsyllus* sp. were collected only at

station D. The nematode *Dichromadora* sp. and the oligochaete *Enchytraeus* sp. were found at all the 3 stations D, E and F. Two brackish water species, the nematode *Halicephalobus limuli* and the oligochaete *Enchytraeus barkudensis* occurred towards the high water mark.

Vertical distribution : The quantitative data collected on the vertical distribution of meiofauna in the beach indicated that all through the year the total fauna was confined to the top 10 cm of sediment. There was a steady decrease in number with depth. Some meiofaunal submergence was noticed at higher locations on the beach probably due to reduced water saturation in the upper layers. Nematodes were more numerous in the upper 5 cm, although they could penetrate upto 20 cm in the sediment. Copepods and nauplii were confined to the upper 10 cm. The ostracods were largely epipelic, crawling on the surface layers of the sediment, while the oligochaetes penetrated to greater depths at higher tidal levels. Other groups of animals mostly occurred within the top 10 cm of sediment.

Seasonal distribution : The seasonal abundance of meiofauna recorded at station B, where bulk of the fauna was represented during the period of study, is indicated in Table 3. Densities of total populations during different seasons of the year indicated only minor fluctuations in their numbers. But, distinct seasonal changes occurred for some groups of the meiofauna, particularly the nematodes, copepods and polychaetes. Maximum densities of the nematodes were recorded during winter months associated with lowest temperatures in the habitat, while their minimum numbers occurred in summer months. Maximum densities of the copepods, nauplii and polychaetes occurred in summer months associated with highest temperatures. Thus, there appears to be an inverse relationship in the seasonal abundance of

TABLE 3. Seasonal abundance (nos./10^2) of meiofauna at station B during 1978-80.

Months	Nematoda	Copepoda	Nauplii	Turbellaria	Polychaeta	Ostracoda	Others	Total meiofauna
1978, August	168	86	20	74	44	26	18	436
December	310	142	44	80	38	14	14	692
1979, April	96	184	83	56	76	36	24	555
August	220	106	37	124	42	18	16	563
1980, Jan.	272	112	38	92	50	22	8	594
May	134	225	62	110	94	28	27	680

nematodes and other groups of animals in general. The minor groups of animals that occurred in small numbers did not indicate any clear pattern in their seasonal distribution.

The Macrofauna

Composition : The macrofauna of the beach was dominated by the deposit and filter feeders. Burrowing sea anemones, annelids, crustaceans and molluscs comprised the major constituents of the macrofauna (Fig. 3B). Among these groups, the polychaetes, decapods, bivalves and gastropods occurred in considerable abundance. The oligochaetes, shrimps, isopods, amphipods and cumaceans were collected in small numbers. Qualitatively, out of the 44 species listed in Table 5, 10 (22.72%) are polychaetes, 6 (13.63%) are decapods, 10 (22.72%) are gastropods and 6 (13.63%) are bivalves.

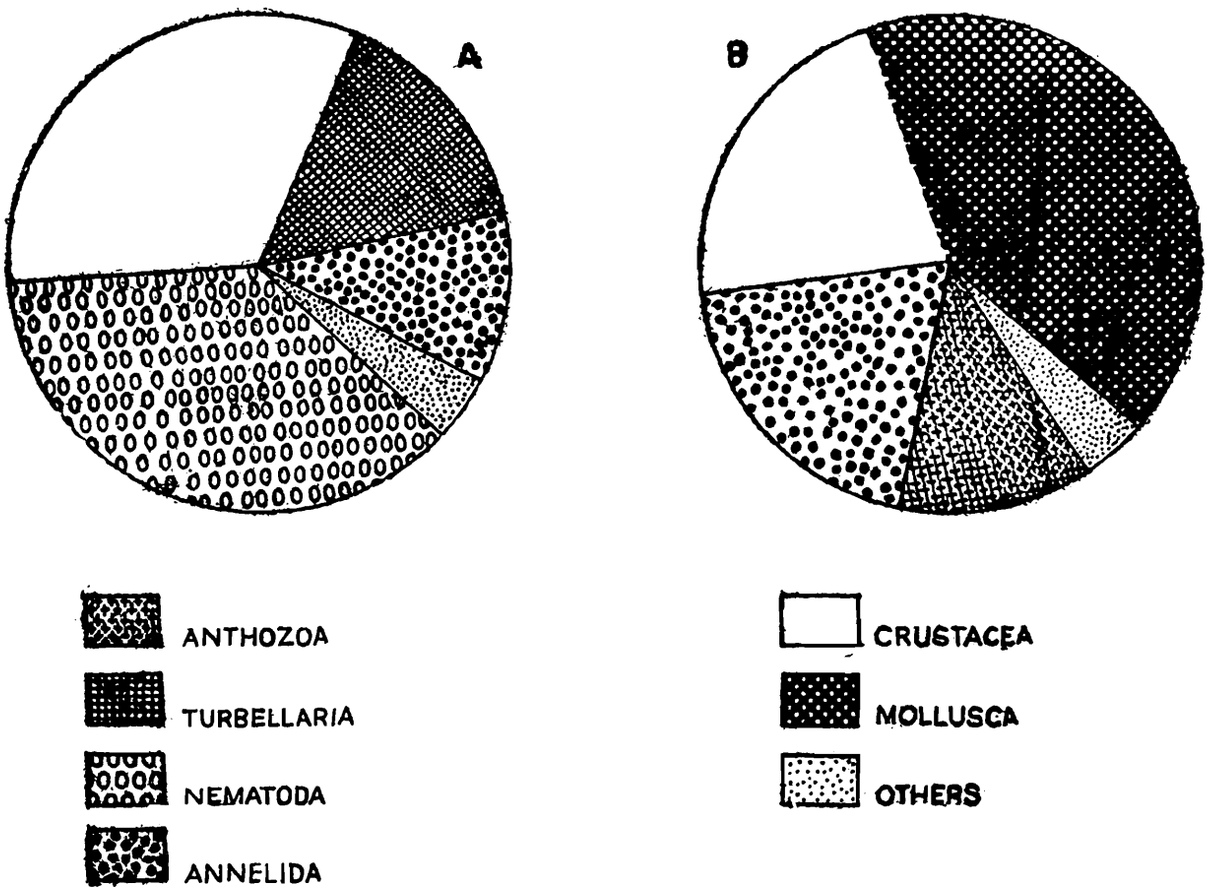

Fig. 3. Circle diagrams Illustrating the percentage composition of the diverse groups of meiofauna (A) and macrofauna (B).

Horizontal distribution : The total number of macrofauna recorded in the upper 10 cm of sediment at the 6 intertidal stations are represented in Table 4. Maximum densities of the fauna occurred in the middle beach, with a general decrease towards the low and high water

marks. Of the total fauna collected, 1.62% occurred at station A, 5.86% at station B, 9.78% at station C, 80.82% at station D, 1.10% at station E and 0.82% at station F. The high faunal density at station D was largely due to the molluscan beds comprising the populations of *Donax* and *Odostomia*. The macrofauna was also consideably patchy in its distribution on the beach.

TABLE 4. Seasonal abundance of macrofauna (nos./m²) in the upper 10 cm of the sediment at the 6 intertidal stations, A-F.

Month	A	B	C	D	E	F	Total
1978, August	136	1,044	1,732	15,416	216	192	18736
December	264	1,132	1,936	13,612	212	124	17280
1979, April	720	1,704	3,640	18,204	408	228	24904
August	364	1,396	1,276	15,820	112	176	19144
1980, January	172	948	1,080	18,136	96	108	20540
May	408	1,260	2,824	22,040	364	216	27112

The macrofauna species of this sand flat showed more or less a distinct zonal distribution along the intertidal transect with little overlapping in their occurrence (Table 5). The lowest zone of the beach at the proximity of station A is associated with the occurrence of the burrowing gastropods *Tonna dolium*, *Pyrene zebra* ane *P. versicolor*, the bivalve *Siliqua radiata*, the sea-pen *Virgularia* sp. and rarely the brachipod *Lingula anatina*, the king-crab *Carcinoscorpius rotundicauda* and the brittle-star *Ophiactis modesta*. Nearer to station B, large populations of the polychaete *Onuphis* sp. become conspicuous with their emerging heads during receding tide and withdrawing completely into the sediment on being exposed. *Prionospio krusadensis* and *Nerine cirratulus* are the other polychaetes occurring in this area and they along with *Onuphis* constitute the polychaete zone of the beach. Smaller numbers of the gastropods *Oliva gibbosa* and *Bursa spinosa* and the bivalves *Meretrix meretrix* and *Mactra luzonica* are also encountered in this zone. However, station B is mainly characterized by the presence of the giant sea-anemone *Paracondylactis* sp. associated with atleast another two anemone species (undetermined). The siphons of the deep-burrowing bivalve *Sanguinolaria acuminata* occur scattered at this station, the animal lying 35-40 cm below the surface. Three species of the hermit crabs *Diogenes avarus*, *D. rectimanus* and *D. investigatoris*, are also common in this zone. The starfishes *Astropecten indicus* and *A. euryacanthus* were collected from this area lying on the sand surface along with the sea urchin *Temnopleurus toreumaticius*. However, these echinoderms appear to be regular inhabitants of the sub-littoral region.

TABLE 5. Horizontal distribution of macrofauna species on Digha beach.

Species	Stations					
	A	B	C	D	E	F
Tonna dolium (Linnaeus)	+					
Pyrene zebra (Gray)	+					
Pyrene versicolar (Sowerby)	+					
Siliqua radiata (Linnaeus)	+					
Virgularia sp.	+					
Lingula anatina Linnaeus	+					
Carcinoscorpius rotundicauda (Latreille)	+					
Ophiactis modesta Brook	+					
Onuphis sp.	+	+				
Prionospio krusadensis Fauvel	+	+				
Nerine cirratulus Delle Chiaje	+	+				
Oliva gibbosa (Born)	+	+				
Bursa spinosa (Lamarck)	+	+				
Meretrix meretrix Linnaeus	+	+				
Mactra luzonica Deshayes	+	+				
Paracondylactis sp.		+				
Sanguinolaria acuminata (Deshayes)		+				
Diogenes avarus Heller		+				
Diogenes rectimanus Miers		+				
Diogenes investigatoris Alcock		+				
Astropecten indicus Doderlein		+				
Astropecten euryacanthus Lutken		+				
Temnopleurus toreumaticus Agassiz		+				
Cavernularia sp.		+	+			
Onuphis emerita Aud. & M. Edwards		+	+			
Scolelepis squamata (Muller)		+	+			
Scolaricia sp.		+	+			
Hemipodus sp.		+	+			
Nephtys sp.		+	+			
Macropthalmus transversus (Latr.)		+	+			
Polinices didyma Roeding		+	+			
Natica tigrina (Roeding)		+	+			
Natica sp.		+	+			
Nudibranch (undetermined)		+	+			
Thorsonia investigatoris (Kochler & Vaney)		+	+			
Diopatra cuprea cuprea Bosc			+			
Isopod (undetermined)			+	+		
Amphipod (undetermined)			+	+		
Cumacean (undetermined)			+	+		
Odostomia antelia Melville ?			+	+		
Donax incarnatus Gmelin			+	+		
Glycera alba Rathke			+	+	+	+
Dotilla blanfordi Alcock					+	+
Ocypode macrocera H. M. Edwards						+

The area between stations B and C is inhabited by the sea-pansy *Cavernularia* sp. and the polychaetes *Onuphis emerita*, *Scolelepis squamata*, *Scolaricia* sp., *Hemipodus* sp. and *Nephthys* sp. This zone is also characterised by the decapod crab *Macrophthalmus transversus*, the burrowing gastropods *Polynices didyma*, the crawling gastropods *Natica tigrina*, *Natica* sp. and a nudibranch (undetermined). A small sea-cucumber *Thorsonia investigatoris* was also collected in this area. The holothurian lies buried under the sand surface, with both the oral and anal openings at the surface, giving the appearance of widely broadened 'U'. Some specimens were also collected on the surface indicating that they were washed on to the beach from the sublittoral region. Large colonies of the tube-dwelling polychaete *Diopatra cuprea cuprea* occurred at station C, showing preference for a fine and stable substratum. The juveniles of anemones also occurred in abundance (9,000/m^2 to 12,000/m^2) in a wide belt at station C, although the adults were encountered only in the vicinity of station B. It may be that these juveniles migrate to lower levels with increasing size and thus avoid a longer exposure. Stations C and D support small populations of isopods, amphipods, shrimps and cumaceans (undetermined), forming a crustacean zone. The high-water polychaete *Glycera alba* makes its appearance here with their increasing numbers towards higher tidal levels.

The vicinity of station D was mainly characterised by the molluscan beds comprising the bivalve *Donax incarnatus* and the small gastropod *Odostomia antelia* ?, giving a honey-comb appearance to the whole sand surface in this area. Maximum counts of these bivalves were

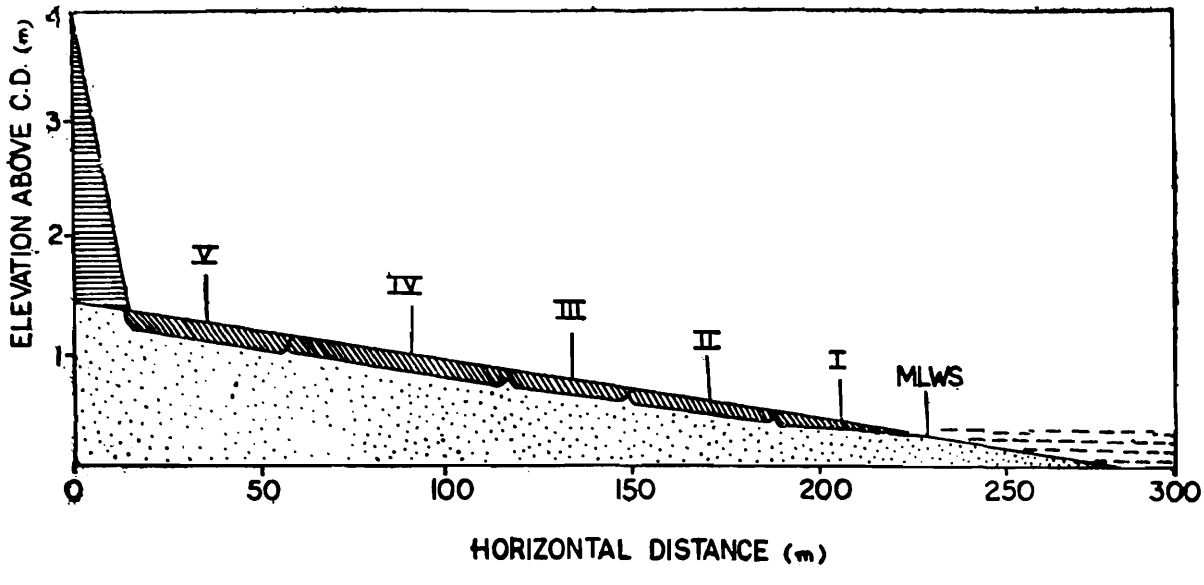

Fig. 4. Diagrammatic representation of zonation of macrofauna in the Digha beach. I. Polychaete zone. II. Anemone zone, III. Crustacean zone, IV. Bivalve zone, V. Decapod zone.

obtained between 2 cm and 6 cm depths below the surface. These animals largely colonized fine sands rich in organic detritus and high in water content. A very interesting associatlon was observed between the bivalve and the gastropod. One to three of these gastropods were usually found attached to some of these bivalves close to the hinged portion of shell. Our observations showed that the *Donax-Odostomia* populations were a regular feature of this zone stretching over 40 m in width. A quantitative study of these two molluscs from 4 sub-stations established 10 m apart showed that they tended to maintain more or less a constant numerical ratio between them at all the levels (Table 6). Further investigations on this association are likely to yield interesting results. *D. incarnatus* was the commonest bivalve species encountered on this beach.

TABLE 6. Quantitative distribution of *Donax-Odostomia* populations (nos./m^2) in the mid-water zone during monsoon, winter and summer. Sub-stations I-IV are 10 m apart.

Sub-station	Species	Ausust 1979	January 1980	May 1980
I	*Donax*	10080	1280	432
(Towards LWM)	*Odostomia*	2880	336	128
	Ratio	3.5:1	3.8:1	3.7:1
II	*Donax*	3276	12940	1440
	Odostomia	840	3080	400
	Ratio	3.9:1	4.2:1	3.6:1
III	*Donax*	544	6188	3360
	Odostomia	160	1820	960
	Ratio	3.4:1	3.4:1	3.5:1
IV	*Donax*	820	732	16420
(Towards HWM)	*Odostomia*	232	196	4480
	Ratio	3.5:1	3.7:1	3.6:1

Among the macrofauna encountered at stations E and F, the most conspicuous were the polychaete *Glycera alba* and the small decapod crab *Dotilla blanfordi*. This zone was readily recognised from a distance by the continuous blanket of pellets formed as a result of the constant activity of these crabs. Random counts show that the population density of this crab varied between 96/m^2 and 160/m^2. The ghost-crab *Ocypode macrocera* occasionally occurred living in burrows in the vicinity of high water mark. Laterally, this crab was more common below sand dunes on Digha beach beyond the sea-wall. The construction of sea-wall seems to have affected its natural habitat in the area investigated.

Vertical distribution : All through the year, bulk of the macrofauna on this beach was found to be confined to the upper 10 cm of the sediment. Again, it was the top 5 cm of the sediment that supported majority of these organisms. The fauna in general also showed an increasing submergence from low water mark to the high water mark. Bulk of the fauna occurred in the upper 1-2 cm of the sediment near LWM, between 2-4 cm towards MWM and between 3-5 cm towards the HWM.

Seasonal distribution : The seasonal abundance of macrofauna recorded at the 6 intertidal stations is shown in table 4. Maximum counts of the fauna were obtained during summer months of the year. Increase in the number of *Donax-Odostomia* populations and the polychaetes during summer appeared to be mainly responsible for the increased seasonal abundance of the total fauna in this area. During the 2 years of study, the peak periods nearly remained the same, although their population densities slightly varied. Interesting seasonal dynamics in the horizontal distribution of *Donax-Odostomia* populations were observed. The populations tended to migrate towards the lower shore during monsoon and gradually return to the upper beach during summer (Table 6). No distinct seasonal variations in the horizontal distribution of other macrofauna species were observed during the period. The sub-littoral molluscs and echinoderms were, however, more common on the lower beach during summer months, probably due to wave action created by strong breeze during the season that washes these animals ashore.

DISCUSSION

The Meiofauna

The present authors earlier studied the composition, density and distribution of meiofauna on a fine intertidal sand flat at Gangasagar on Sagar Island located at the Gangetic mouths (Rao and Misra, 1983). Due to the geographical proximity and the resemblance in the nature of substratum, both Gangasagar and Digha beaches shared many features in common, although the former is estuarine and the latter is marine. These two extensive sand flats with fine sediment showed close resemblance in the distribution of their meiofauna as well. Associated with fine substratum, the meiofauna in this area is predominatly of the burrowing type, and the major groups of fauna as usual consisted of nematodes, copepods, turbellarians and polychaetes. The meiofauna of Digha beach is, however, largely marine in character and has more number of interstitial species due to its comparatively coarser sediment.

Characteristic of flat extensive beaches, the horizontal distribtion of meiofauna on Digha beach is also remarkably wide, with the maximum concentration of fauna on the lower shore. The density and diversity of the fauna, in general, decreased towards the higher tidal levels. Many of the meiofauna species showed distinct preference to different levels of the beach, but the factors limiting distributions of of these species to a particular level are not completely understood due to nearly uniform conditions of temperature, salinity, grain size, water content, etc. through a greater part of the sand flat. The greater availabilability of oxygen and organic matter on the lower shore may, however, favour their colonization. Correlated with the greater fluctuating conditions at higher tidal levels, only the more tolerant species seemed to occupy those levels. This is reflected in the occurrence of brackish water species as the oligochaete *Enchytraeus barkudensis* and the nematode *Halicephalobus limuli* towards the high water mark, where lower salinities were experienced due to seepage of ground water into the beach. This freshwater seepage into the beach seems to have created estuarine conditions in the marine habitat as reported at Kames Bay (Smith, 1955). The restriction of meiofauna to the upper sediment in fine sandy beaches due to reduced oxygen tension in lower layers, is well known.

Seasonal changes in the population density of meiofauna are known to be related with their reproductive activity stimulated by fluctuations in temperature and salinity in the habitat, attaining their maximum development during summar. The present data, however, did not indicate distinct seasonal peaks in the total population of the meiofauna. This appears to be due to the seasonal variation in the abundance of the major groups as nematodes, copepods and polychaetes favouring different periods for their multiplication. The inverse relationship in the seasonal abundance of nematodes and some other groups of animals is also suggestive of the effects of predation, competition, etc. between them.

Probably due to its proximity to the Gangetic mouths, like the Gangasagar beach, the Digha beach also suppored a considerable amount of clay and silt in it. Compared with the world situations, the density and diversity of meiofauna in this beach are relatively poor, apparently due to the fine nature of sediment that inhibits the development of true interstitial populations. This may also explain the absence of typical interstitial macrodasyoid gastrotrichs, archiannelids, tradigrades, kinorhynchs and molluscs in this sand flat. Thus, as elsewhere, the quality of the substratum seemed to be most important ecological factor influencing the composition, density and distribution of meiofauna on Digha beach.

THE MACROFAUNA

The density and diversity of macrofauna on Digha beach proved to be sufficiently rich, apparently due to the relatively sheltered sand flat rich in organic detritus. Due to the fine nature of the substratum, the majority of the species colonising the beach are deposit and filter feeders. The abundant occurrence of *Donax-Odostomia* populations in the middle beach is probably related with the abundant supply of detritus on the beach. Fine intertidal deposits are also known to support rich populations of micro-organisms forming food for the bivalves. But, with the available data, it is difficult to explain the differences in density of macrofauna at other horizontal levels on the beach, However, the patchy distribution of macrofauna in the beach seems to be due to their environmental preferences and tolerances of the component species (McIntyre 1969). Like the meiofauna, the vertical distribution of macrofauna also seems to be restricted to the upper 10 cm of sediment due to reduced oxygen content in layers. The macrofauna also showed some submergence in the beach towards higher tidal levels, apparently seeking optimum conditions of water saturation in the habitat.

Due to fluctuations in biotic and abiotic factors of the environment, seasonal changes in population density of macrofauna are known to occur from season to season and from year to year. Maximum counts in the present study were obtained during summer months, probably related with higher temperature and salinity, as well as an undisturbed substratum during the period. While studying the zonation on a muddy flat, Brady (1943) showed that the distribution of fauna varied with season, occupying different tidal levels during different seasons. The seasonal dynamics exhibited by the *Donax-Odostomia* populations on Digha beach are apparently similar to the above pattern of distribution. The distinct downward migration of these populations during monsoon was probably to avoid low interstitial salinities at higher tidal levels resulting from heavy rainfall. Ansell *et al* (1972) also studied the population dyanamics of *Donax incarnatus* on two sandy beaches in South West India.

The zonal distribution of macrofauna in stable sandy beaches has been well documented in several tropical and sub-tropical situations (Pearse *et al.* 1942, Colman and Segrove 1955, Gauld and Bauchanan 1956, Ganapati and Rao 1962, McIntyre 1968, Gopalakrishnan 1970, Trevallion *et al* 1970, Philip 1974). According to the universal scheme of zonation for sandy shores proposed by Dahl, in tropics the ghost-carbs (Ocypodidae) inhabit the upper littoral zone, the isopods (Cirolanidae) in the mid-

littoral zone and the anomuran crab (Hippidae) in the lower littoral zone. The present study indicated distinct zonation for some dominant species, these indicator organisms occupying almost the same ecological niches reported in other tropical regions. Five broad zones could be recognized on Digha beach based on the animal distribution (Fig. 4), although the density of these indicator organisms used in defining these zones was quite variable. They are *viz.*, (i) the polychaete zone reqresented by *Onuphis* sp., *Prionospio krusadensis* and *Nerine cirratulus*, (ii) the anemone zone with *Paracondylactis* sp. and 2 other anemones, (iii) the crustacean zone with shrimps, isopods and amphipods, (iv) the bivalve zone with *Donax incarnatus* and (v) the decapod zone with *Dotilla blandfordi*. These zones are also quite broad probably due to the extensively wide stretch of the sand flat. The pattern of zonation observed on Digha beach is in agreement with Dahl's universal scheme of zonation in so far as the crustacean zone is concerned. Higher on the beach the *Ocypode* zone is replaced by another crab *Dotilla blanfordi*. Lower down the beach the hippid crabs are absent and this zone is characterised by the polychaetes and a little above by anemones. Hippid crabs are characteristic of exposed and wave washed tropical beaches and their absence at Digha is due to the sheltered nature of the sand flat. Gauld and Buchanan (1956) suggested adding a *Donax* zone to Dahl's scheme and our observations at Digha lend support to this view. Deviations from Dahl's scheme were observed by previous workers (Colman and Segrove, 1955 ; Gauld and Buchanan, 1956 and Ganapati and Rao, 1962) and hence more work is probably necessary before we can decide on the number of zones to be recognised on sand beaches and the characteristic species on their ecological equivalents.

Comparison of Macrofauna and Meiofauna

The macrofauna and meiofauna on Digha beach largely exhibited a similar pattern in their spatial and temporal distribution, apparently due to the identical environmental parameters affecting them. Compared with the densities of intertidal fauna recorded in different world situations, the Digha beach supported considrably rich populations of the macrofauna than the meiofauna. With the available data it is, however, difficult to explain this variation in their abundance. The numerical relationship between these two size categories of the fauna collected in an area is known to be of considerable ecological significance (McIntyre 1969). The mean population densities and their ratios recorded at different horizontal levels on Digha beach are presented in Table 7. The data nearly showed an inverse relationship in their occurrence.

At levels where the macrofauna was rich, the meiofauna numbers were remarkably low. As suggested by McIntyre, this was probably due to the macrofauna affecting the density of meiofauna by predation, competition and physical disturbance of environment.

TABLE 7. Compaarison of mean values of macrofauna and meiofauna at different intertidal stations on Digha (numbers per m^2)

Stations	A	B	C	D	E	F
Macrofauna	344	1248	2081	17205	235	174
Meiofauna	66100	113600	79000	30700	19900	13200
Ratio (approx.)	1:192	1:91	1:38	1:1.8	1:85	1:76

SUMMARY

1. The paper presents the results of a preliminary investigation on the composition, density and distribution of meiofauna and macrofauna in the Digha beach made during 1978-80. The meiofauna is largely of the burrowing type, with a small percentage of interstitial species. Nematodes, copepods, turbellarians and polychaetes formed the major groups. The macrofauna largely comprised of the deposit and filter feeders. Anemones, annelids crustaceans and molluscs, constituted the major groups.
2. Greater number of meiofauna species and individuals were found on the lower shore, with their densities in the beach ranging from 132/10 cm^2 to 1136/10 cm^2. Richest macrofauna occurred on the middle beach due to the presence of molluscan beds composed of *Donax-Odostomia* populations. Total number of macrofauna individuals ranged from 96/m^2 to 22040/m^2.
3. Many meiofauna species occurred at different horizontal levels on the beach, without indicating a clear dominance. There was a distinct zonation of macrofauna in the beach, each zone being dominated by a group of organisms. Five broad zones could be recognised on the beach. The pattern of zonation on Digha beach is in close agreement with the universal scheme of zonation of sandy shores proposed by Dahl.
4. All through the year, bulk of the sand-living community was restricted to the upper 10 cm of sediment, with a higher concentration of the fauna in the top 5 cm. No seasonal vertical migrations of the fauna were observed.

5. The seasonal and annual dynamics in the population density of the beach fauna are described. The summer months, in general, appeared to be more favourable for their multiplication, while the monsoon months yielded their minimum numbers. The *Donax-Odostomia* populations tended to migrate downwards during monsoon and upwards during summer.

6. A comparison of the macrofauna and meiofauna encountered at different horizontal levels on the beach is suggestive of an inverse relationship in their numerical abundance.

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STUDY OF POPULATION FLUCTUATION ON THREE PSOCOPTERAN SPECIES

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Introduction

Practically no work has been initiated on population dynamics of foliage frequenting Psocoptera in India, except a single published record, (Prasad, et al 1975). Keeping this in view, the present investigation was undertaken, with three species of Psocoptera e. g. *Ectopsocus cinctus* Thornton, *Ectopsocus bengalensis* Datta (Ectopsocidae) and

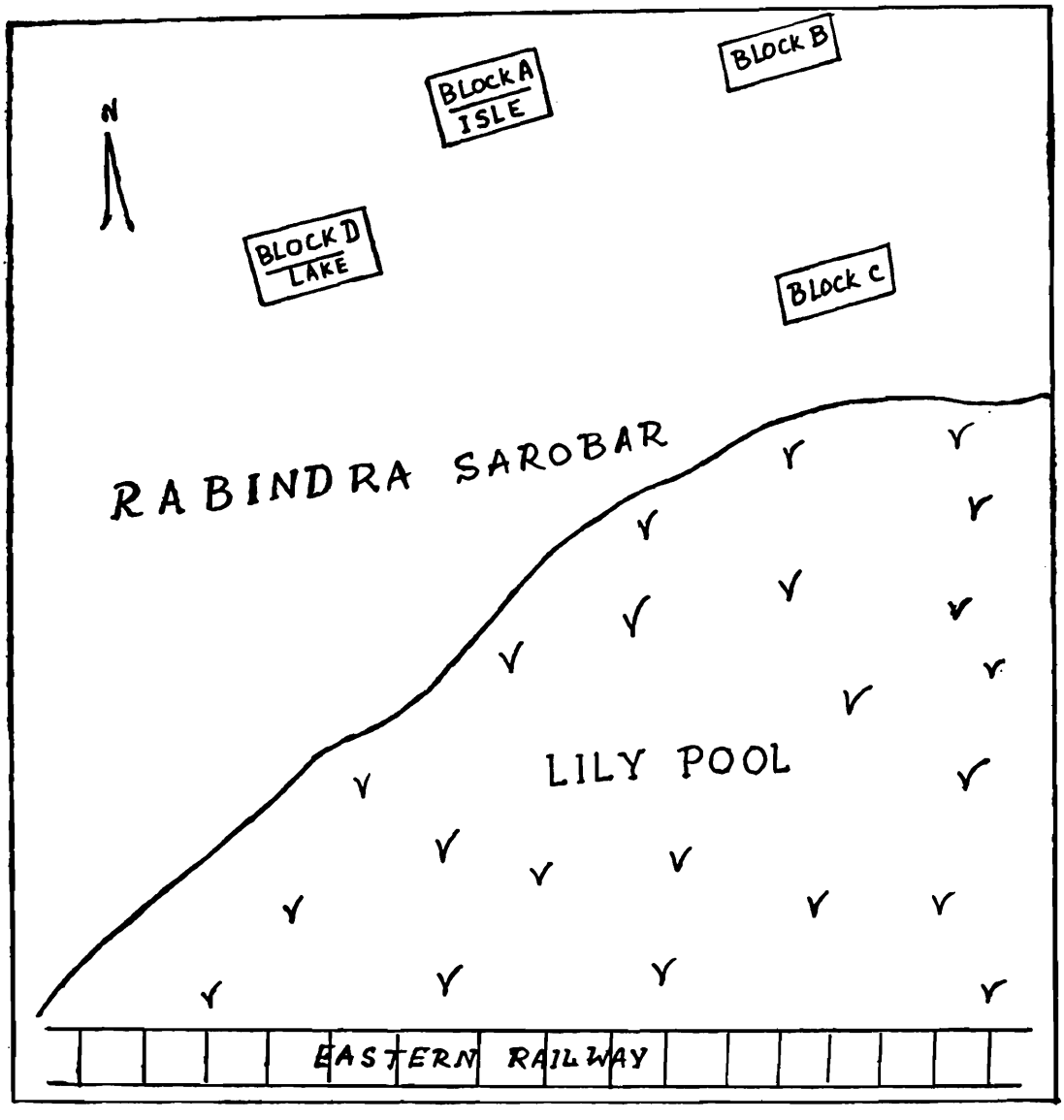

Fig. 1. Collection site with Host-plants

Tapinella fasciata Thornton & Wong (Pachytroctidae), which were available throughout the year on two species of garden host plants e. g. *Hibiscus rosa-sinensis* Linn. (Malvaceae) and *Corypha elata* Roxb. (Palmae) in natural environmental conditions.

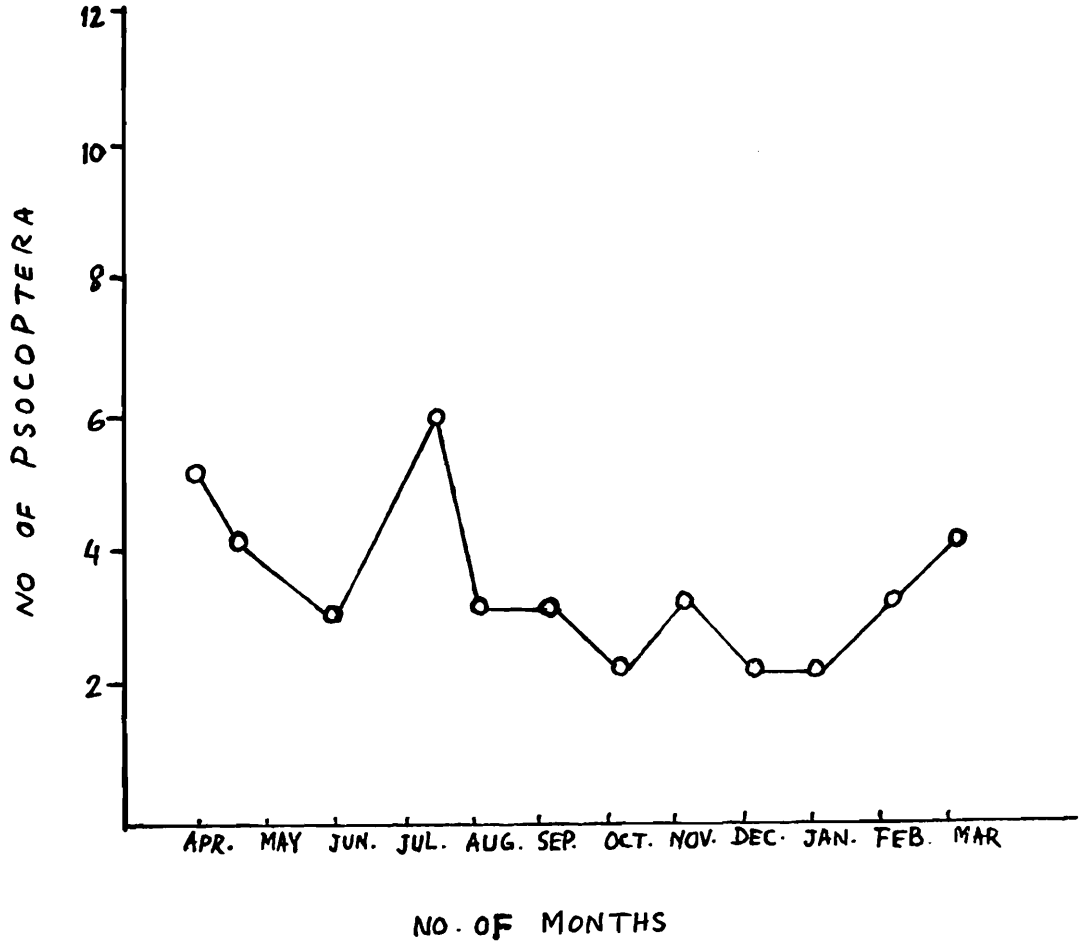

Fig. 2. *Tapinella fasciata* Th. & Wong.—Graphical representation.

Material and Method

The material for three species of Psocoptera was collected fortnightly, throughout the year, from April, 1983 to March, 1984, from two species of host-plants e. g. *Hibiscus rosa-sinensis* Linn. (Malavaceae) and *Corypha elata* Roxb. (Palmae), at Rabindra Sarobar area, south Calcutta (Fig. 1) by applying five beatings on each branch of the plants and collecting the foliage frequenting morphs (nymphs and adults) in a white enamel tray placed horizontally under the branches.

Observation

The investigation was carried out from April, 1983 upto March, 1984. The minimum and maximum temperature recorded at the time of collection in the field for these species ranged between 24.2°c to

26.9° c and 32.3°c to 37.9° c respectively with relative humidity of 31% to 69% at minimum and 78% to 98% at maximum and with rainfall range between 0.6 mm to 20.2 mm. The period of optimum infestation of these species could be observed in April and July in an annual cycle. During the entire course of investigation, each colony of these species was dominated for all the time by apterae and nymphs, the adults being lesser in number within the colonies. It was also observed that the psocids prefered the microflora of dry and semidry leaves of the plants studied. Two seasonal peaks were noticed i. e. April and July while studying their population fluctuation (Fig. 2 & 3). Total number of these three species of Psocoptera found on two host plants are represented, here, in a table (Tab. A)

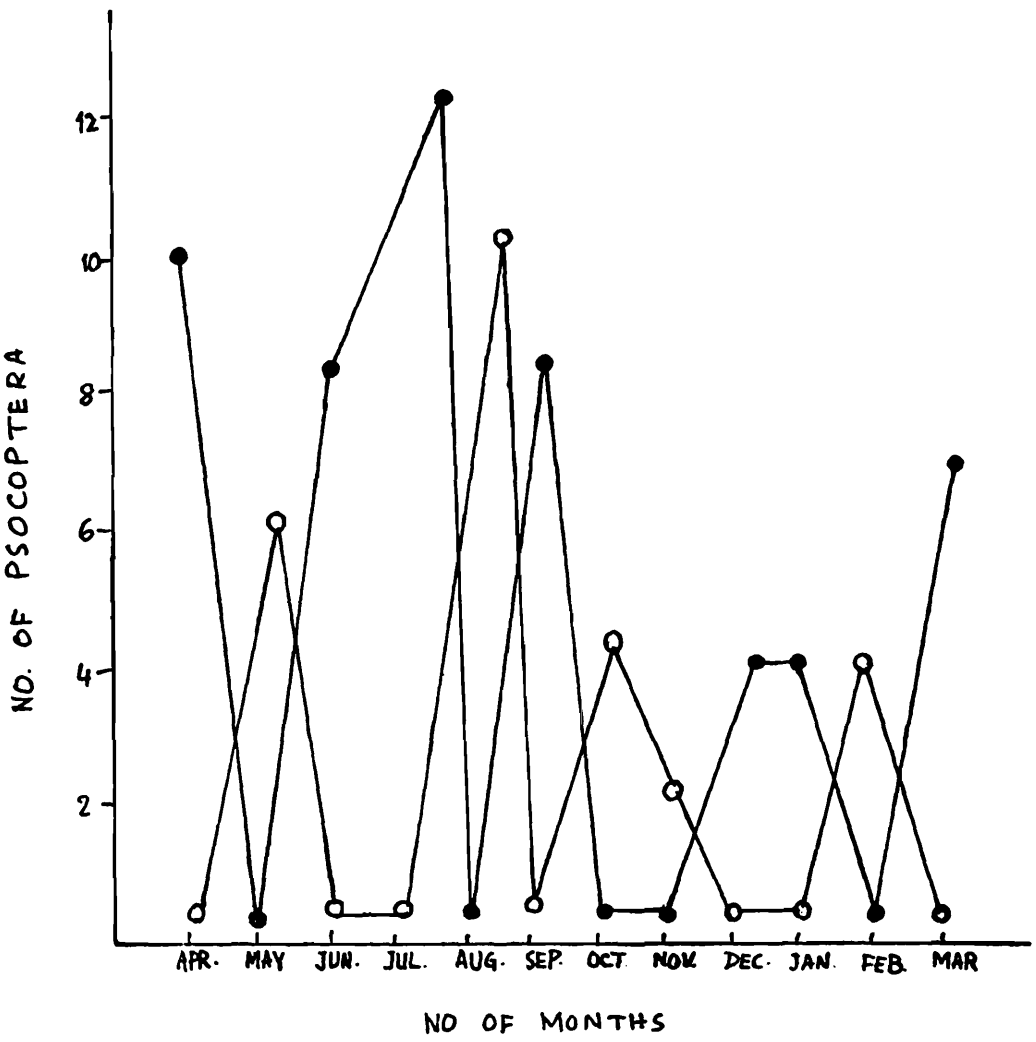

Fig. 3. *Ectopsocus cictus* Th. & *E. bengalensis* Datta—Graphical representation.

Few examples of *Anobus* sp. (Anobiidae : Coleoptera) and *Reduvius* sp. (Reduviidae : Hemiptera) were found in association with the psocid colony from *Hibiscus rosa-sinensis* Linn. (Malvaceae) and one example of *Cloeon* sp. (Baetidae : Ephemeroptera) from *Corypha elata* Roxb.

Tab. A. MONTHWISE COLLECTION RECORD FOR THREE SPECIES OF PSOCOPTERA

Months	*Species*	*Host-plants*	*No. of specimens*
April	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	10
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	5
May	*Ectopsocus bengalensis* Datta	*Hibiscus rosa-sineniss* Linn.	6
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	4
June	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	8
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	3
July	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	12
	Tapinella fasciata Th. & Wong.	*Corypha elata* Roxb.	6
August	*Ectopsocus bengalensis* Datta	*Hibiscus rosa-sinensis* Linn.	10
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	3
September	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	8
	Tapinella fasciata Th. & Wong.	*Corypha elata* Roxb.	3
October	*Ectopsocus bengalensis* Datta	*Hibiscus rosa-sinensis* Linn.	4
	Tapinella fasciata Th. & Wong.	*Corypha elata* Roxb.	2
November	*Ectopsocus bengalensis* Datta	*Hibiscus rosa-sinensis* Linn.	2
	Tapinella fasciata Th. & Wong.	*Corypha elata* Roxb.	3
December	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	4
	Tapinella fasiata Th. & Wong.	*Corypha elata* Roxb.	2
January	*Ectopsocus cinctus* Th.	*Hibiscus rosa-sinensis* Linn	4
	Tapinella fasciata Datta	*Corypha elata* Roxb.	2

Months	*Species*	*Host-plants*	*No. of specimens*
February	*Ectopsocus bengalensis* Datta	*Hibiscus rosa-sinensis* Linn.	4
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	3
March	*Ectopsocus Cinctus* Th.	*Hibiscus rosa-sinensis* Linn.	7
	Tapinella fasciata Th. & Wong	*Corypha elata* Roxb.	4

SUMMARY

It was noticed that infestation of these three species of Psocoptera i. e. *Ectopsocus cinctus* Thorn., *Ectopsocus bengalensis* Datta and *Tapinella fasciata* Th. & Wong on the particular host plants of *Hibiscus rosa-sinensis* Linn. and *Corypha elata* Roxb. was continued to be more or less throughout the season for natural controlling frctors like temperature humudity and rainfall. The population density of these three species was recorded more during the summer and monsoon months, whereas it was found to be less in winter months. A total number of 10 host-plants of *Hibiscus rosa-sinensis* and 5 in number of *Corypha elata* were utilised for each monthly observation. From the Tab. A., it is evident that *Tapinella fasciata* is present throughout the year at optimum population level while *E. cinctus* is present only during seven months in a discontinuous manner (January, March, April, June, July, September, December) and *E. bengalensis* during five months (February, May, August, October, November).

The host-specificity of these 3 species of Psocoptera are recorded, here, for the first time in India.

ACKNOWLEDGEMENT

The author acknowledges his grateful thanks to the Director, Zoological Survey of India, Calcutta, for facilities and offers sincere thanks to Dr. S. K. Bhattacharjee, Dep. Director, Ent. Div., Dr. S. K. Tandon, Suptg. Zoologist, Ent. Div. 'B' and Dr. V. D. Srivastava, O/C., Misc. Ins. Ords. Sec. for encourrgements during the course of work.

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Rec. zool. Surv. India, 83 (3 & 4) : 57-67, 1986

DUNG BEETLES FAUNA (COLEOPTERA : SCARABAEIDAE : SCARABAEINAE) OF PALAMOU TIGER RESERVE, BIHAR, WITH DESCRIPTION OF A NEW SPECIES.

S. Biswas and S. K. Chatterjee
Zoological Survey of India, Calcutta.

(With Fig. 1)

Introduction

Dung beetles play an important role in enriching forest habitat as these insects regularly collect and bury dungs of various animals into soils. In tropical environment this behaviour is immensely important as it saves thousands of tons of valuable plant nutriant from destruction and makes them available to plant community. Dung beetles, therefore occupy an important link in transformation and recycling of energy resources in terrestrial ecosystem. As no comprehensive account is available of these insects from any of the wild life sancturies, tiger reserves and national parks in India, an attempt is made here to make a beginning towards that end. Altogether 27 species including a new species under 8 genera have been recorded in this paper. Data on material studied, distribution and important synonymies have also been incorporated. Types are deposited in the Zoological Survey of India, Calcutta.

LIST OF SPECIES COLLECTED

Subfamily Scarabaeinae

1. Genus **Gymnopleurus** Illiger

1. *Gymnopleurus cyaneus* (Fabricius)
2. *G. gemmatus* Harold
3. *G. sinuatus* (Oliver)

2. Genus **Catharsius** Hope

4. *Catharsius pithecius* (Fabricius)

3. Genus **Copris** Geoffroy

5. *Copris magicus* Harold
6. *C. repertus* Walker

4. Genus **Caccobius** Thomson

7. *Caccobius vulcanus* (Fabricius)
8. *C. meridionalis* Boucamont
9. *C. inermis* Arrow

5. Genus **Onthophagus** Latreille

10. *Onthophagus bonasus* (Fabricius)
11. *O. quadridentatus* (Fabricius)
12. *O. dama* (Fabricius)
13. *O. ramosellus* Bates
14. *O. catta* (Fabricius)
15. *O. furcillifer* Bates
16. *O. ramosus* (Wiedemann)
17. *O. sagittarius* (Fabricius)
18. *O. spinifex* (Fabricius)
19. *O. ensifer* Boucamont
20. *O. centricornis* (Fabricius)
21. *O. cervus* (Fabricius)
22. *O. palamoui* sp. nov.

6. Genus **Oniticellus** Servelle

23. *Oniticellus pallipes* Fabricius
24. *O. spinipes* Roth
25. *O. cinctus* (Fabricius)

7. Genus **Drepanocerus** Kirby

26. *Drepanocerus setosus* (Wiedemann)

8. Genus **Onitis** Fabricius

27. *Onitis subopacus* Arrow

Systematic Account

Family Scarabaeidae

Subfamily Scarabaeinae

1. Genus **Gymnopleurus** Illiger

1. **Gymnopleurus cyaneus** (Fabricius)

1798. *Copriscyaneus* Fabricius, *Ent. Syst.*, Suppl., P. 34.

1931. *Gymnopleurus cyaneus*, Arrow, *Fauna Brit. India* (Coleoptera ; Lamellicornia), 3 : 49-50.

Material examined : 1 ex., Kemaldaha, 11.vi.1983 ; 2 ex., Kujrun, 16.vi.1983 ; 2 ex., Rud, 19.iv.1983 ; 1 ex., Parsa Nullah, Barwand, 22.vi. 1983 ; 1 ex., Garu, 22.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

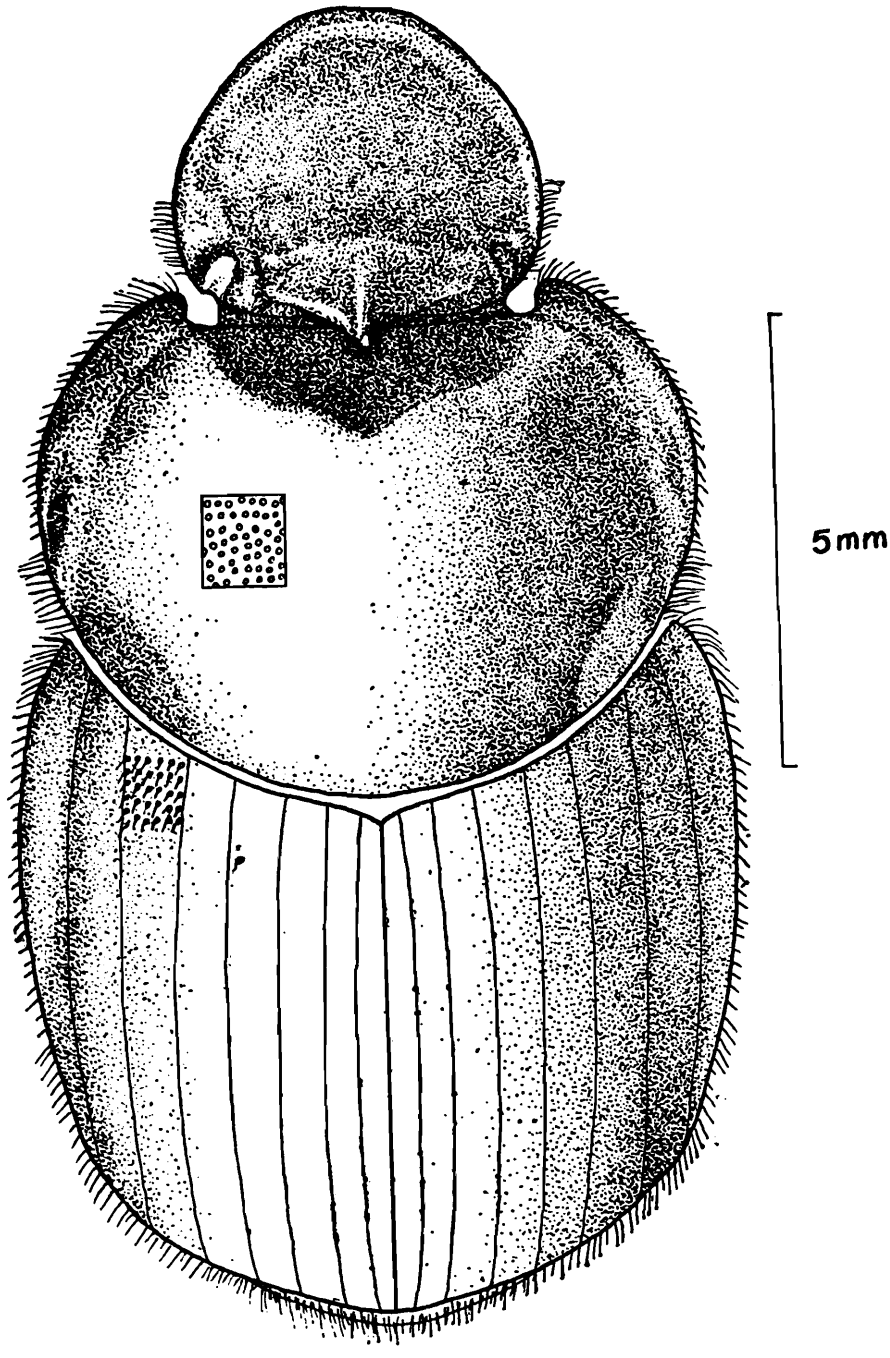

Fig. 1. Dorsal view of *Onthophagus palamoui* sp. nov.

Habitat : Gaur dung, Elephant dung and from dead Chicken.

Distribution : INDIA : West Bengal, Uttar Pradesh, Maharashtra, Tamil Nadu and Bihar (Palamou). BANGLADESH : Dacca, SRI LANKA : Kanthalai.

2. **Gymnopleurus gemmatus** Harold

1871. *Gymnopleurus gemmatus* Harold, *Col. Hefte*, 8 : 117.

Material examined : 1 ex., Kujurun, 16.vi.1983, *S. M. Ali* (Z.S.I. Coll.).

Habitat : Cowdung.

Distribution : INDIA : West Bengal, Uttar Pradesh, Madhya Pradesh, Mysore, Kerala, Tamil Nadu, Bihar (Palamou). SRI LANKA : Kanthalai.

3. **Gymnopleurus sinuatus** (Oliver)

1789. *Scarabaeus sinuatus* Oliver, *Entomologiae*, 1 (3) : 160, Pl. x, fig. 93.

1931. *Gymnopleurus sinuatus*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 62-63, Pt. III, fig. 12.

Material examined : 1 ex., Rud, 19.vi.1983, *S. M. Ali* (Z.S.I. Coll.).

Distribution : INDIA : Tamil Nadu, Maharashtra, Bihar (Palamou).

2. Genus **Catharsius** Hope

4. **Catharsius pithecius** (Fabricius)

1775. *Scarabaeus pithecius* Fabricius, *Syst. Ent.*, P. 21.

1931. *Catharsius pithecius* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 100-101, Pt. VII, fig. 1, 2.

Material examined : 3 exs., Maromar, 17.vi.1983, *S. M. Ail* (Z.S.I. Coll.).

Distribution : INDIA : Uttar Pradesh, Maharashtra, Mysore, Andhra Pradesh, Kerala, Tamil Nadu, Bihar (Palamou), SRI LANKA.

3. Genus **Copris** Geoffroy

5. **Copris magicus** Harold

1881. *Copris magicus* Harold, *Mitth. Munch. Ent.* Ver., 5 : 88.

Material examined : 2 ex. Kujrun, 16.vi.1983, *S. M. Ali* (Z.S.I. Coll.).

Distribution : INDIA : West Bengal, Assam, Manipur and Bihar (Palamou). BURMA, TONKIN, YUNNAN.

6. **Copris repertus** Walker

1858. *Copris repertus* Walker, *Ann. Mag Nat. Hist.*, (3) **2** : 208.

Material examined : 2 ex., Munder, 20.vi.1983, all collected by *S. M. Ali.* (Z.S.I. Coll.).

Distribution : INDIA : Madhya Pradesh, Maharashtra, Mysore, Tamil Nadu, Bihar (Palamou). SRI LANKA, BURMA.

4. Genus **Caccobius** Thomson

7. **Caccobius vulcanus** (Fabricius)

1801. *Copris vulcanus* Fabricius, *Syst. Eleut.*, **1** : 41.

1931. *Caccobius vulcanus*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 151-152.

Material examined : 8 ex., Betla, 11 and 12.vi.1983 ; 7 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

Habitat : Elephant dung.

Distribution : INDIA : Maharashtra, Mysore, Bihar (Palamou). SRI LANKA : Colombo.

8. **Caccobius meridionalis** Boucamont

1914. *Caccobius meridionalis* Boucamont, *Ann. Mus. Civ. Stor. Nat. Genova*, **47** : 239.

Material examined : 8 ex., Kujrun, 16.vi.1983 ; 12 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : Maharashtra, Mysore, Tamil Nadu, and Bihar (Palamou).

9. **Caccobius inermis** Arrow

1931. *Caccobius inermis* Arrow, *Fauna Brit. India* (*Coleoptera* : Lamellicornia), **3** : 147.

Material examined : 7 ex., Maromar, 17.vi.1983, *S. M. Ali* (Z.S.I. Coll.).

Distribution : INDIA : West Bengal, Sikkim, Uttar Pradesh, Maharashtra and Bihar (Palamou). SRI LANKA : Wirawila.

5. Genus **Onthophagus** Latreille

10. **Onthophagus bonasus** (Fabricius)

1775. *Scarabaeus bonasus* Fabricius, *Syst. Ent.*, P. 23.

1931. *Onthophagus bonasus*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 231-232, pl. XIII, fig. 5, 6.

Material examined : 6 ex., Kujrun, 16.vi.1983, *S. M. Ali* (Z.S.I. Coll.)

Habitat : Grur dung.

Distribution : INDIA : West Bengal, Uttar Pradesh, Punjab, Maharashtra, Madhya Pradesh, Mysore, Tamil Nadu and Bihar (Palamou). PAKISTHAN, SRI LANKA, BURMA, CAMPUCHIA, THAILAND, VIETNAM.

11. **Onthophaqus quadridentatus** (Fabricius)

1798. *Copris quadridentatus* Fabricius, *Ent. Syst.* Suppl., p. 34.

1931. *Onthophagus quadridentatus* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 282-283.

Material examined : 155 ex., Betla, 11 and 12.vi.1983 ; 28 ex., Kunjrun, 16.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : West Bengal, Assam, Madha Pradesh, Maharashtra, Tamil Nadu and Bihar (Palamou). SRI LANKA : Colombo.

12. **Onthophagus dama** (Fabricius)

1798. *Copris dama* Fabricius, *Ent. Syst.* Suppl., p. 32.

1931. *Orthophagus dama*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 280-281.

Material examined : 2 ex., Betla, 11 and 12. vi. 1983 ; 5 ex., Kujrun, 16.vi.1983 ; 2 ex., Maromar, 17.vi.1983 ; 1 ex., Rud, 18.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung, Gaur dung.

Distribution : INDIA : West Bengal, Sikkim, Uttar Pradesh, Maharashtra, Mysore, Tamil Nadu and Bihar (Palamou).

SRILANKA : Colombo, Bettaramulla.

13. **Onthophagus ramosellus** Bates

1891. *Onthophagus ramosellus* Bates, *Entom.*, p. 11.

Material examined : 6 ex., Barasand, 15.vi.1983 ; 4 ex., Kujrun, 16.vi.1983 ; 7 ex., Maromar, 17.vi.1983 ; 1 ex., Rud, 19.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : West Bengal, Assam, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Mysore and Bihar (Palamou). PAKISTAN, BURMA.

14. **Onthophagus catta** (Fabricius)

1787. *Scarabaeus catta* Fabricius, *Mant. Ins.*, **1** : 12.

1787. *Scarabaeus gazella* Fabricius, *Mant. Ins.*, **2** : 377.

1931. *Onthophagus catta* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 230-231.

Material examined : 16 ex., Betla, 10-13.vi.1983 ; 7 ex., Kujrun, 16.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : Himachal Pradesh, Maharashtra, Madhya Pradesh, Tamil Nadu and Bihar (Palamou). PAKISTAN, ARABIA, AFRICA, MADAGASCAR.

15. **Onthophagus furcillifer** Bates

1891. *Onthophagus furcillifer* Bates, *Entom.*, 24, Suppl. p. II.

Material examined : 30 ex., Maromar, 17.vi.1983, *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung.

Distribution : INDIA : Assam, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Kashmir and Bihar (Palamou).

16. **Onthophagus ramosus** (Wiedemann)

1823. *Copris ramosus* Wiedemann, *Zool. mag.*, **2**, 1 : 13.

1931. *Onthophagus ramosus*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 236-237.

Material examined : 1 ex., Kujrun, 16.vi.1983 ; 5 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung.

Distribution : INDIA : Madhya Pradesh, Uttar Pradesh, Himachal Pradesh, Punjab, Kashmir, Maharashtra, Mysore, Tamil Nadu and Bihar (Palamou). SHYAM.

17. **Onthophagus sagittarius** (Fabricius)

1775. *Scarabaeus sagittarius* Fabricius, *Syst. Ent.*, p. 24.

1931. *Onthophagus sagittarius*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 304-306, pl. XII, figs. 4 & 5.

Material examined : 1 ex., Kujrun, 16.vi.1983, *S. M. Ali* (Z. S. I. Coll.).

Habitat : Gaur dung.

Distribution : INDIA : West Bengal, Assam, Uttar Pradesh and Bihar (Palamou). BURMA, MALAYA PENINSULA, JAVA, SOUTH CHINA.

18. **Onthophagus spinifex** (Fabricius)

1781. *Scaraboeus spinifex* Fabricius, *Spec. Ins.*, 1 : 29.

1931. *Onthophagus spinifex* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 200-201, fig. 3. a, b, c.

Material examined : 1 ex., Barasand, 15.vi.1983 ; 2 ex., Kujrun, 16.vi.1983 ; 2 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Cow dung, Elephant dung and Gaur dung.

Distribution : INDIA : West Bengal, Maharashtra, Tamil Nadu and Bihar (Palamou). SRI LANKA.

19. **Onthophaqus ensifer** Boucamont

1941. *Onthophagus ensifer* Boucamont, *Ann. Mus. Civ. Stor. Nat. Genova*, **46** : 220.

Material examined : 7 ex., Maromar, 17.vi.1983, *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung.

Distribution : INDIA : Tamil Nadu, Kerala and Bihar (Palamou).

20. **Onthophaqus centricornis** (Fabricius)

1798. *Copris centricornis* Fabricius, *Ent. Syst.* Suppl., p. 33.

1931. *Onthophagus centricornis* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), 3 : 343-844.

Material examined : 2 ex., Betla, 12.vi.1983 ; 1 ex., Kujrun, 16.vi. 1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung.

Distribution : INDIA : Madhya Pradesh, Maharashtra, Tamil Nadu and Bihar (Palamou). SRI LANKA.

21. **Onthophagus cervus** (Fabricius)

1798. *Copris cervus* Fabricius, *Ent. Syst. Suppl.*, p. 31.

1931. *Onthophagus cervus* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 348-350.

Material examined : 6 ex., Betla, 12.vi.1983 ; 9 ex., Kujrun, 16.vi. 1983 ; 1 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z. S. I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : West Bengal, Uttar Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu, Bihar (Palamou) Andaman. SRI LANKA.

22. **Onthophagus palamuui** sp. nov.

Black, moderately shining, the antennal club yellowish, upper surface covered with short and lower surface and pygidium covered with long reddish brown hairs. Head little produced in front, clypeal margin rounded, moderately strongly reflexed, clypeal disc transversely rugosely punctured, clypeofrontal carina feebly rounded, moderately prominent, vertex with a conical projection in the middle.

Pronotum strongly, rugosely punctured, front angle moderately strongly produced, lateral margin almost straight in front, sinuate behind, margined at sides and at base. Pronotum little sloping in front of hind angle.

Elytra covered with broad but shallow striae, striae sparsely punctured, interval microscopically sculptured, and covered with small tubercles.

Pygidium margined at base and moderately strongly covered with setigerous punctures.

Length : 13-14.5 mm. Breadth : 6-7 mm. ;

♂. clypeus almost smooth in the middle, behind clypeal margin and ocular lobe covered with moderately strong punctures, clypofrontal carina vertex absent with broad triangular plate narrowing towards apex, last abdominal sternite emarginate in the middle.

♀. Clypeus strongly punctured, vertex with small conical projection, clypeofrontal carnia present. Last abdominal sternite with equal breadth throughout.

The species resembles *O. aencseens* (Wied.) but can be easily separated by cephalic armature and pronotal front angles moderately

produced. Holotype : ♂, Betla, 11.vi.1983 (Z. S. I. Reg. No. 10126/H_4A) and paratype ♀, Betla, 11.vi.1983 (Z. S. I. Reg. No. 10127/H_4A) all collected by *S. M. Ali.*

6. Genus **Oniticellus** Servelle

23. **Onticellus pallipes** Fabricius

1781. *Scarabaeus pallipes* Fabricius, *Spec. Ins.*, **1** : 33.

1931. *Oniticellus pallipes*, Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 375-377.

Material examined : 5 ex., Kujrun, 16.vi.1983, *S. M. Ali* (Z. S. I. Coll.).

Habitat : Cow dung and Gaur dung.

Distribution : INDIA : West Bengal, Uttar Prrdesh, Kashmir, Maharashtra, Tamil Nadu and Bihar (Palamou). BANGLADESH.

24. **Oniticellus spinipes** Roth

1851. *Oniticellus spinipes* Roth, *Arch. f. Nat.*, **7** : 128.

Material examined : 21 ex., Betla, 12 & 13.vi.1983 ; 1 ex., Barasand, 15.vi.1983 ; 3 ex., Kujrun, 16.vi.1983 ; 4 ex., Maroma, 17.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.)

Habitat : Cow dung, Elephant dung.

Distribution : INDIA : Uttar Pradesh, Madhya Pradesh, Maharashtra, Tamil Nadu and Bihar (Palamou). AFRICA, ABYSSINIA, UGANDA, RHODESIA, TRANSVAL.

25. **Oniticellus cinctus** (Fabricius)

1775. *Scarabaeus cinctus* Fabricius, *Syst. Ent.*, p. 30.

1931. *Oniticellus cinctus* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 379-380.

Material examined : 1 ex., Kujrun, 15.vi.1983 ; 1 ex., Marwar, 17.vi. 1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

Habitat : Elephant dung and Gaur dung.

Distribution : INDIA : West Bengal, Assam, Uttar Pradesh, Madhya Pradesh, Mysore, Tamil Nadu and Bihar (Palamou). BANGLADESH, BURMA, MALAYA PENINSULA, SHYAM, SOUTH CHINA.

7. Genus **Drepanocerus** Kirby

26. **Drepanocerus setosus** (Wiedemann)

1823. *Copris setosa* Wiedemann, *Zool. Mag.*, **2** (1) : 19.

1931. *Drepanocerus setosus* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 381-382.

Material examined : 15 ex., Betla, 12 & 13.vi.1983 ; 12 ex., Kujrun, 16.vi.1983 ; 6 ex., Maromar, 17.vi.1983, all collected by *S. M. Ali* (Z.S.I. Coll.).

Habitat : Cow dung, Elephant dung and Gaur dung.

Distribution : INDIA : Uttar Pradesh, Madhya Pradesh, Tamil Nadu and Bihar (palamou). SRI LANKA.

8. Genus **Onitis** Fabricius

27. **Onitis subopacus** Arrow

1875. *Onitis philemon* Lansberge, *Ann. Soc. ent. Belg.* p. 133.

1931. *Onitis subopacus* Arrow, *Fauna Brit. India* (Coleoptera : Lamellicornia), **3** : 395-396.

Material examined : 1 ex., Betla, 11 & 13.vi.1983, *S. M. Ali* (Z.S.I. Coll.).

Distribution : INDIA : West Bengal, Assam, Utter prardesh, Kashmir, Madhya pradesh, Tamil Nadu and Bihar (palamou). SRI LANKA, PAKISTAN, BURMA, SIAM, TENASSERIM, MALAYA PENINSULA.

SUMMARY

The present paper deals with 27 species under 8 genera of subfamilly Scarabaeinae from Palamou National Park. *Onthophagus palamoui* sp. nov. is described.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Zoological Survey of India, providing laboratory facilities during this work and Mr. S. M. Ali and S. S. Saha for collecting and making available the material for study.

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Rec. zool. Surv. India, **83** (3 & 4) : 69-81, 1986

NOTE ON THE ODONATA FAUNA OF CENTRAL INDIA.

By

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INTRODUCTION

Central India is a part of the triangular plateau of the Indian Peninsula which has mostly been a land area ever since the Cambrian period (Wadia 1966). References on the odonate fauna of the area is available in Fraser (1919 b, c & d ; 1920 ; 1933 ; 1934 ; 1936) ; Laidlaw (1917 ; 1919 ; 1920) ; Bhasin (1953) ; Baijal & Agarwal (1955). Where authors reported following species from different parts of the area viz., *Elattoneura nigerrima* (Laidlaw), *Disparoneura quadrimaculata* (Rambur), *Copera marginipes* (Rambur), *Pseudagrion microcephalum* (Rambur), *Pseudagrion hypermelas* Selys, *Ceriagrion olivaceum olivaceum* Laidlaw, *Coenagrion dyeri* (Fraser), *Cercion malayanum* (Selys), *Ischnura aurora aurora* (Brauer), *Rhodischnura nursei* (Morton), *Agriocnemis dabreui* Fraser, *Orolestes motis* Baijal & Agarwal, *Lestes viridula* Rambur, *Lestes umbrina* Selys, *Rhinocypha bisignata* Selys, *Onychogomphus grammicus* (Rambur), *Ictinogomphus rapax* (Rambur), *Potamarcha obscura* (Rambur), *Orthetrum taeniolatum* (Schneider), *Orthetrum sabina sabina* (Drury), *Orthetrum cancellatum cancellatum* (Linnaeus), *Orthetrum pruinosum neglectum* (Rambur), *Acisoma panorpoides panorpoides* Rambur, *Diplacodes trivialis* (Rambur), *Indothemis carnatica* (Fabricius), *Crocothemis servilia servilia* (Drury), *Crocothemis misrai* Baijal & Agarwal, *Brachythemis contaminata* (Fabricius).

The present paper reports twenty-one species for the first time from Mahadeo Hills of which *Pseudagrion decorum* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Ceriagrion coromandelianum* (Fabr.), *Ischnura senegalensis* (Rambur), *Enallagma parvum* Selys, *Aciagrion pallidum* Selys, *Agriocnemis pygmaea pygmaea* (Rambur), *Bradinopyga geminata* Rambur, *Neurothemis intermedia intermedia* (Rambur), *Trithemis aurora aurora* (Burmeister), *Tramea basilaris burmeisteri* Kirby are new records from Central India.

The specimens were collected by the author during the period from October 21 to December 7 of 1971 from the districts of Bhandara and Nagpur of Maharashtra ; Betul, Chhindwara and Seoni of Madhya Pradesh. The districts lie on Mahadeo hills (*Lat.* 21°-22° N., *Long.*

78°-80°E ; *Alt.* 600-900 meters). Besides the addition of species to the faunal list, variations are reported in morphological features either from the published descriptions or from the specimens of other localities, of India. Moreover, it contains some notes on habits and habitats of different species ; detailed geographical distribution of each species studied by the author, and a brief analysis of the fauna.

Systematics

Order : ODONATA

Suborder : ZYGOPTERA

Family : Platycnemididae

Genus : **Copera** Kirby

Copera marginipes (Rambur)

Material examined : 1 ♀ Chhindwara, 23 Nov. '71 ; 1 ♂, 1 ♀ (copulating pair), Chhindwara, 25 Nov. '71 ; 1 ♂, 1 ♀, Chhindwara, 26 Nov. '71, 1 ♂, Chhindwara, 27 Nov. '71, 2 ♀ ♀, Seoni, 3 Dec. '71.

Remarks. : Breeding activities of this species was noticed in the midday. Measurements of specimens agree with the measurements cited by Fraser (1933) ; the 'arc' in the specimens from Seoni is more distal to the distal antenodal nervure than in the specimens collected from Chhindwara. Moreover, the specimens from Seoni are paler than those from Chhindwara.

Distribution : *Present Records* : Chhindwara Seoni (Madhya Pradesh). *Past Records* : Parambikulum, Nagpur, Mormugaon (Laidlaw 1917) ; Mahabaleswar (Fraser 1921) ; Palni Hills, Fraser pet, Somarpet, Coorg, Poona, Khandala (Fraser 1924 b) ; Bollovompattis, Coorg, Malabar, Nilgiri, Deccan (Fraser 1931) ; Poona, Assam, North Bengal, Burma, throughout southern Asia and Sondaic Islands (Fraser 1933), Malayasia (Lieftinck 1954) ; South Andaman (Chhotani *et. al.* 1983).

Family : Coenagrionidae

Genus : **Pseudagrion** Selys

Pseudagrion decorum (Rambur)

Material examined : 1♂, Bhandara, 24 Oct.' 71 ; 2♂ ♂, Bhandara, 29 Oct. 1971.

Remarks : The specimens differ from Calcutta specimens being more olivaceous than the latter.

Distribution ; *Present Record* : Bhandara (Maharashtra). *Past Records* : Cochin, Coorg, Deccan, Kanara, Malabar, Nilgiris (Fraser 1931) ; widely distributed throughout the continental India and Burma (Fraser 1933) ; Nepal (St. Quentin 1970). Calcutta (Mitra 1983).

Pseudagrion rubriceps rubriceps Selys

Material examined : 1 ♀, Multai (Betul) 12 Nov. '71 ; 1 ♂, Chhindwara, 26 Nov., '71.

Remarks : The black lines on the thorax of the male are thinner in the specimens from Chhindwara than in those Calcutta forms.

Distribution : *Present Records* : Betul and Chhindwara (Madhya Pradesh). *Past Records* : Nagpur (Laidlaw 1919) ; Nilgiris, Coorg, Fraserpet, Poona, Khandala (Fraser 1924 b) ; Bollovompattis, Coorg, Deccan, Kanara, Malabar, Nilgiris (Fraser 1931) ; widely distributed throughout the plains and sub-montane areas of continental India and Burma except the desert tracts ; Java, Indo-China, Malayasia, Formosa (Fraser 1933) ; Calcutta (Mitra & Lahiri 1972) ; Dhanbad (Kumar & Prasad 1977) ; Assam (Lahiri 1979) ; Nepal (St. Quentin 1970) ; Malayasia (Lieftinck 1954).

Pseudagrion hypermelas Selys

Materal examined : 1 ♀, Bhandara, 29 Oct. '71 ; 1 ♂, Chhindwara, 20 Nov. '71.

Remarks : No variation was noticed in the specimens from the description provided by Fraser (1933).

Distribution : *Present Records* : Bhandara (Maharashtra), Chhindwara (Madhya Pradesh). *Past Records* : Kierpur (Laidlaw 1919) ; Deesa, Sombong, Sumatra (Laidlaw 1916) ; Central provinces, Deccan areas of the Bombay presidency and South Punjab (Fraser 1933).

Genus : **Ceriagrion** Selys

Ceriagrion coromandelianum (Fabricius)

Material examined : 1 ♂, Bhandara, 23 Oct. '71 ; 1 ♂, Bhandara, 24 Oct. '71 ; 1 ♂, Seoni, 2 Dec. '71.

Remarks : Specimens from Seoni agree with the colour of the specimens from Manipur ; but specimens from Bhandara agree with the colour of the specimens from Calcutta being more yellowith than the forms.

Distribution : *Present Records* : Bhandara (Maharashtra), Seoni (Madhya Pradesh). *Past Records* : Mahabaleswar (Fraser 1921) ; Bollovompattis, Cochin, Coorg, Deccan, Kanara, Malabar, Nilgiris (Fraser 1931) ; throughout India, Ceylon, Burma, Malayasia, Indo-China, South China (Fraser 1933) ; Calcutta, Manipur (Mitra 1975a). Dhanbad (Prasad & Kumar 1977) ; Assam & Mizoram (Lahiri 1979) ; Nepal (St. Quentin 1970).

Ceriagrion olivaceum olivaceum Laidlaw

Material examined : 1 ♀, Bhandara, 22 Oct. '71.

Remarks : The specimen from Bhandara is lighter in thoracic colour than that of the Manipur form.

Distribution : *Present Record* : Bhandara (Maharashtra). *Past Records* : Assam (Laidlaw, 1919 ; Lahiri 1979) ; Poona, Satara (Fraser 1924 b) ; Deccan (Fraser 1931) ; Meghalaya Burma (Fraser 1933) ; Manipur (Mitra 1975 a), Calcutta (Mitra 1983).

Genus : **Ischnura** Charpentier

Ischnura aurora aurora (Brauer)

Material examined : 1 ♂, Chhindwara, 29 Nov. '71.

Remarks : The specimen differs from Calcutta forms in having azure blue marking on the abdominal segments 8 to 10 which is black in specimens from Calcutta. It is a weak flier, rests off and on grass blades.

Distribution : *Present Record* : Chhindwara (Madhya Pradesh). *Past Records* : Maharashtra (Laidlaw 1919) ; Coimbatore, Cochin, Malabar, Nilgiris (Fraser 1931) ; throughout the southern Asia, India, Ceylon, Burma, Malayasia, the Sundaic Archipelago, Borneo, New Guinea, Australasia, Philippines and Samoa (Fraser 1933) ; Uttar Pradesh, Madras (Bhasin 1953) ; Calcutta (Lahiri & Mitra 1976) ; Dhanbad (Prasad & Kumar 1977) ; Arunachal Pradesh (Lahiri 1979) ; Malayasia (Lieftinck 1954) ; Nepal (St. Quentin 1970).

Ischnura senegalensis (Rambur)

Material examined : 1 ♀, Bhandara, 28 Oct. '71 : 1 ♀, Seoni, 2 Dec. '71.

Remarks : No remarkable variations from the description provided by Fraser (1933) and specimens of other localities were noticed.

Distribution : *Present Records* : Bhandara (Maharashtra), Seoni (Madhya Pradesh). *Past Records* : Calcutta, Orissa, Sarlake (Laidlaw 1916) ; Coorg (Fraser 1924 b) ; Barkuda island (Fraser and Dover 1922) ; Coorg, Deccan, Malabar Nilgiris, (Fraser 1931) ; throughout India, Burma, Ceylon, Japan, Philippines, Africa (Fraser 1933) ; Dhanbad (Prasad & Kumar 1977) ; Malayasia (Lieftinck 1954) ; Rajasthan (Bose & Mitra 1976) ; Andaman (Chhotani *et. al.* 1983), Calcutta (Mitra 1983).

Genus : **Enallagma** Charpentier

Enallagma paryum Selys.

Material examined : 1 ♂, Bhandara, 24 Oct. '71, 1 ♀, Bhandara, 28 Oct. '71, 2 ♀, Bhandara 29 Oct. '71, 1 ♂, 1 ♀ (in tandem), Bhandara, 29 Oct. '71.

Remarks : The male specimens from Bhandara are more olivaceous than the specimens from Calcutta.

Distribution Present Record : Bhandara (Maharashtra) *Past Records* : Throughout South Asia ; India, Burma, Ceylon (Fraser 1933) ; Ceylon (Laidlaw 1951) ; Calcutta (Lahiri & Mitra 1976).

Genus : **Aciagrion** Selys

Aciagrion pallidum Selys

Material examined : 1 ♀, Seoni, 2 Dec. '71.

Remarks : The antehumeral stripe in the specimen is broken hence it differs from Assam where it is complete.

Distribution : *Present Records* : Seoni (Madhya Pradesh). *Past Records* : Dibrugarh (Laidlaw 1914) ; Nurbong (bottom of the Mahanadi valley of Darjeeling), Nagpur, Mormugao, Kanara, (Laidlaw 1919) ; Poona, Satara, Khandala Mahabaleshwar (Fraser 1924 b) ; Assam, Arunachal Pradesh and Manipur (Lahiri 1979).

Genus : **Agriocnemis** Selys

Agriocnemis pygmaea (Rambur)

Material examined : 1 ♀, Bhandara, 24 Oct. '71, 1 ♂, Bhandra, 22 Oct. '71, 1 ♀, Chhindwara, 27 Nov. '71.

Remarks : The specimens do not differ from the specimens of eastern India.

Distribution : *Present Records* : Bhandara (Maharashtra), Chhindwara (Madhya Pradesh). *Past Records* : Calcutta (Selys, 1891 ; Mitra 1975 b) ; Java, Rainbode, Nicobars (Hagen 1858) ; Ceylon and Phillippines (Kirby 1898) ; Samarang, Sydney, N. S. Wales (Ris 1912) ; Rajasthan (Bose & Mitra 1976), Dhanbad (Prasad & Kumar 1977) ; Assam,Mizoram, Arunachal Pradesh (Lahiri 1979) ; Malayasia (Lieftinck 1954) ; Singapure (Brauer 1864) ; China (Klots 1947).

Suborder : ANISOPTERA

Family : LIBELLULIDAE

Genus : **Orthetrum** Newman

Ortherum sabina sabina (Drury)

Material examined : 1♂, Nagpur, 29 Oct. '71.

Remarks : The specimen appears as a subadult form.

Distribution : *Present Record* : Nagpur (Maharashtaa) *Past Records* : Mahabaleshwar (Fraser 1921) ; Barkuda island (Fraser & Dover 1922) ; Anaimalai, Mudi hills, Coimbaiore, Cochin, Coorg, Kanara, Malabar, Nilgiris and Palni Hills (Fraser 1931) ; Assam, Bihar, Punjab, Uttar Pradesh, Burma (Bhasin 1953) ; Nainital (Sahni 1964) ; Gwalior (Baijal & Agarwal 1955) ; Calcutta (Mitra & Lahiri 1974) ; Tripura (Mitra & Sen 1975) ; Dhanbad (Prasad & Kumar 1977) ; Assam, Arunachal Pradesh (Lahiri 1979) ; Burma (Laidlaw 1914) ; Ceylon, Mesopotamia (Fraser 1918) ; Holarctic (Needham 1932) ; Andaman islands, Phillippines, Mesopotami, Asia Miner, to North Africa (Fraser 1929 a) ; Nepal (Sr. Quentin 1970) ; Malayasia (Lieftink 1954) ; China (Khots 1947).

Orthetrum cancellatum cancellatum (Linnaeus)

Material examined : 3♂♂ Chhindwara, 25 Nov. '71 ; 1♂, 2♀♀, 27 Nov. '71, (one female was caught with the male in copulation over a rocky fast flowing stream at midday).

Remarks : The specimens do not vary much from the description provided by Fraser (1933).

Distribution : *Present Records* : Chhindwara (Madhya Pradesh) *Past Records* : Kasimir (Needham 1932) ; Gwalior (Baijal & Agarwal 1955) ; a palaearctic species extending from the British Isles across Europe, N. Africa to Asia Minor, Kashmir (Fraser 1936).

Orthetrum pruinosum neglectum (Rambur).

Material examined : 1 ♂, Betul, 6 Nov. '71 1 ♂ Chhindwara, 26 Nov. '71, 3 ♂ ♂ Chhindwara, 27 Nov. '71.

Remarks : The male hovers over the ovipositing female very seriously and attacks every intruder in the area.

Distribution : *Present Records* : Chhindwara, Betul (Madhya Pradesh), *Past Records* : Assam and Burma (Laidlaw 1914) ; Anaimalai and Mudi Hills, Bollovompattis, Cochin, Coorg, Deccan, Kanara, Malabar, Nilgiris, Palnis, Travancore (Fraser 1931) ; Burma and Ceylon (Needham 1932) ; Tripura (Mitra & Sen 1975 ; Lahiri 1976) ; Arunachal Pradesh, Mizoram, Manipur (Lahiri 1979) ; Dhanbad (Prasad & Kumar 1977) ; Malayasia (Lieftinck 1954) ; Nepal (St. Quentin 1970) ; Andaman, Indo-China, Ceylon, South China (Fraser 1924 a).

Genus : **Potamarcha** Karsch

Potamarcha obscura Rambur

Material examined : 1 ♀ , Chhindwara, 20 Nov. '71.

Remarks : The specimen does not show remarkable variation from the description provided by Fraser (1933).

Distribution : *Present Record* : Chhindwara (Madhya Pradesh), *Past Records* : Mahabaleswar (Fraser 1921) ; Nilgiris, Poona, Khandala, Coorg, Deccan, South Kanara, Malabar, Nilgiris (Fraser 1931), Dhanbad (Prasad & Kumar 1977) ; Burma and Ceylon (Needham 1932) ; Nepal (St. Quentin 1970) ; Malayasia (Lieftinck 1954).

Genus : **Diplacodes** Kirby

Diplacodes trivialis (Rambur)

Material examined : 1 ♀ , Bhandara, 22 Oct. '71 ; 1 ♀ , Chhindwara, 27 Nov. '71 ; 1 ♀ Seoni, 1 Dec. '71.

Remarks : The specimens do not vary much from the description by Fraser (1933) nor from the specimens from Calcutta and Manipur.

Distribution : *Present Records* : Bhandar (Maharashtra) ; Chhnidwara, Seoni (Madhya Pradesh), *Past Records* : Assam and Burma (Laidlaw 1914) ; Mahabaleswar (Fraser 1921) ; Barkuda island (Fraser & Dover 1922) ; Anaimalai, Mudi hills, Coimbatore, Cochin, Coorg, Deccan, Kanara, Malabar, Nilgiri hills (Fraser 1931) ; Maharashtra, Uttar Pradesh, and Burma (Bhasin 1953) ; Manipur (Mitra 1975) ; Assam Manipur, Mizoram (Lahiri 1979) ; Tripura (Lahiri 1976) ; Dhanbad (Prasad & Kumar 1977) ; Singapore, Java, New Guinea, Mesopotamia

(Fraser 1919) ; Ceylon, East Indies, and China (Needham 1932) ; Nepal (St. Quentin 1970) ; Philippines (Asahina 1968) ; Malayasia (Lieftinck 1954) ; Andaman islands, Japan, Australia, Philippines, throughout southern Asia to North Africa (Fraser 1924 a) ; China (Klots 1947).

Genus : **Crocothemis** Brauer

Crocothemis servilia servilia (Drury)

Material examined : 1♂, Chhindwara, 20 Nov. '71 ; 2♂♂, Chhindwara, 27 Nov. '71.

Remarks : The basal marking of the hind wing of the specimens are less extent than that of Calcutta forms.

Distribution ; *Present Record* : Chhindwara (Madhya Pradesh), *Past Records* : Barkuda island (Fraser & Dover 1922) ; Coorg, Deccan, Malabar, Nilgiri hills (Fraser 1931) ; Burma (Laidlaw 1914) ; Basra, Suez (Fraser 1919) ; Bihar, Uttar Pradesh, Iraq. (Bhasin 1953) ; Nainital (Sahni 1964) ; Calcutta (Mitra 1983), Dhanbad (Prasad & Kumar 1977) ; Assam, Arunachal Pradesh and Mizoram (Lahiri 1979) ; Malayasia (Lieftinck 1954), Nepal (St. Quentin 1970) ; South Andamans (Chhotani *et al.* 1983), China (Khots 1947).

Genus : **Bradinopyga** Kirby

Bradinopyga geminata Rambur

Material examined : 1♂, Nagpur, 29 Oct. '71.

Remarks : The specimen agrees with description provided by Fraser (1936).

Distribution : *Present Record* : Nagpur (Maharashtra) *Past Records* : Mahabaleswar (Fraser 1921) ; Coorg (Deccan, Malabar, Nilgiris, Coimtore (Fraser 1931) ; New Delhi, Gwalior (Baijal & Agarwal 1955) ; Nainital (Sahni 1964) ; Calcutta (Mitra 1983) ; Dhanbad (Prasad & Kumar 1979) ; Ceylon and Burma (Fraser 1919) ; Rajasthan (Bose & Mitra 1976),

Genus : **Neurothemis** Brauer

Neurothemis intermedia intermedia (Rambur)

Material examined : 1♂, Chhindwara, 27 Nov. '71.

Remarks : The specimen agrees with the description provided by Fraser in his Fauna of British India (1936).

Distribution : *Present Record* : Chhindwara (Madhya Pradesh), *Past Records* : Bombay, Khandala, Poona, Nilgiris, Malabar, Burma (Fraser

1924 b) ; Anaimalai, Mudi hills, Coorg, Deccan, Kanara, Malabar, Nilgiri (Fraser 1931) ; Assam, Arunachal Pradesh, Manipur, Mizoram (Lahiri 1979) ; Nepal (St. Quentin 1970) ; Great Nicobar (Chhotani *et. al.* 1983).

Genus : **Trithemis** Brauer

Trithemis aurora (Burmeister)

Material examined : 1♂, Betul, 4 Nov. '71 ; 1♂, Betul, 6 Nov. '71 ; 1♂, 1♂, Chhindwara, 20 Nov. '71 ; 3♀♀, Chhindwara, 21 Nov. '71 ; Chhindwara, 25 Nov. '71 ; 1♀, 2♂, Chhindwara, 26 Nov. '71 ; 1♀, Chhindwara, 27 Nov. '71.

Remarks : The specimens do not differ from the description provided by Fraser (1936).

Distribution : *Present Records* : Betul, Chhindwara (Madhya Pradesh). *Past Records* : Bengal (Selys 1891) ; Assam and Burma (Laidlaw 1914) ; Anaimalai and Mudi hills (Fraser 1931) ; Poona, Khandala, Mahabaleswar (Fraser 1924 b) ; Dhanbad (Prasad & Kumar 1977) ; Arunachal Pradesh, Manipur, Mizoram (Lahiri, 1979) ; Rajasthan (Bose & Mitra 1976) ; Nepal (St. Quentin 1970) ; Malayasia (Lieftinck 1954) ; China (Klots 1947).

Genus : **Tramea** Hagen

Tramea basilaris burmeisteri Kirby

Material examined : 1 ♂, Bhandara, 21 Oct. '71.

Remarks : The specimen was lying dead on the road at the time of collection, hence it is presumed that the specimen suffered from natural death. Similar observations were made by Mitra (1977) with other species in Calcutta.

Distribution : *Present Record* : Bhandara (Maharashtra). *Past Records* : Mahabaleswar (Fraser 1921) ; Barkuda island (Fraser & Dover 1922) ; Bombay throughout the continental India and extending into Tibet in the north and to Ceylon southwords ; Burma, Indomalaya (Fraser 1920) ; Coimbatore, Coorg, Deccan, Kanara, Malabar, Nilgiri hills (Fraser 1931) ; Bharatpur, Saugor, (Baijal & Agarwal 1955) ; Chilka lake (Dasgupta 1957) ; Calcutta (Mitra 1983) ; Dhanbad (Prasad & Kumar 1977) ; Nepal (St. Quentin 1970) ; Rajasthan (Bose & Mitra 1976).

Faunal characteristics : Analysis of distribution of species reveals that the area supports species which have following types of distribution.

1. Confined to Peninsular India : *Elattoneura nigerrima* Laidlaw, *Disparoneura quadrimaculata* Selys, *Pseudagrion hypermelas* Selys, *Coenagrion dyeri* (Fraser), *Orolestes motis* Baijal and Agarwal, *Rhinocypha bisignata* Selys, *Crocothemis misrai* Baijal & Agarwal.

2. Confined to India : *Rhodischnura nursei* (Morton), *Lestes viridula* (Rambur).

3. Confined to Oriental region : *Pseudagrion decorum* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Ceriagrion olivaceum olivaceum* Laidlaw, *Enallagma parvum* Selys, *Cercion malayanum* Selys, *Agriocnemis dabreui* Fraser, *Aciagrion pallidum* Selys, *Lestes umbrina* Selys, *Ictinogomphus rapax* (Rambur), *Orthetrum taeniolatum* (Schneider), *Orthetrum pruinosum neglectum* (Rambur), *Bradinopyga geminata* (Rambur), *Potamarcha obscura* Rambur, *Brachythemis contaminata* (Fabr.), *Indothemis carnatica* (Fabr.), *Neurothemis intermedia intermedia* (Rambur).

4. Confined to Old World : *Copera marginipes* (Rambur), *Ceriagrion coramandelianum* (Fabr.), *Ischnura aurora aurora* (Brauer), *Ischnura senegalensis* (Rambur), *Agriocnemis pygmaea pygmaea* (Rambur), *Orthetrum sabina sabina* (Drury), *Orthetrum cancellatum cancellatum* (Linn.), *Diplacodes trivialis* (Rambur), *Crocothemis servilia servilia* (Drury), *Tramea basilaris burmeisteri* Kirby.

Summary

This paper adds eleven species to the previously known twenty eight species from central India and reports a brief analysis of the fauna, gives detailed geographical distribution of 21 species studied by the author along with notes on habit and habitat of some species.

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SOME ASILIDAE (DIPTERA) PRESENT IN THE BRITISH MUSEUM (NATURAL HISTORY) FROM INDIA AND BANGLA DESH

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(With 6 text-figures)

Introduction

Through the courtesy of Dr. K. G. V. Smith of the British Museum (Natural History), London, we have received a small collection of robber flies, result of the study of this collection is given in this paper. Of the eleven genera dealt with here, it is observed that *Neoitamus* Osten-Sacken is so far restricted to Upper India and *Michotamia* Macquart and *Clephydroneura* Becker are predominant in South India.

Laphria Meigen

Laphria Meigen, 1803, *Illiger's Mag. f. Ins.* 2 : 270.

1. **Laphria nathani** Joseph and Parui

1981. *Laphria nathani* Joseph and Parui, *Ent. Scand.* **12** : 217.

Material : 2 ♂, India : Kerala : Travancore : Pirmed, 850 m, 4-6.v.1937, B.M.C.M. Expedition to South India.

Distribution : India : Kerala and Karnataka.

Remarks : This is the second record of the species.

Xenomyza Wiedemann

Xenomyza Wiedemann, 1817, *Zool. Mag.* **1** : 60.

2. **Xenomyza dravidica** Joseph and Parui

1984. *Xenomyza dravidica* Joseph and Parui, *Ent. Scand.* **15** : 441.

Material : 1 ♂, 1 ♀, India : Kerala : Travancore : Tenmalai, 12-15.v. 1937, B.M.C.M. Expedition to South India.

Distribution : India : Kerala and Karnataka.

Remarks : It is the second report of the species.

Michotamia Macquart

Michotamia Macquart, 1838, *Dipt. exot.* **1** (2) : 72.

3. **Michotamia fuscifemorata** Joseph and Parui

1984. *Michotamia fuscifemorata* Joseph and Parui, *Rec. Zool. Surv. India,* Occ. paper No. 66 : 26.

Material : 1♂, India : Kerala : Travancore : Tenmalai, 12-15.v.1937, B.M.C.M. Expedition to South India.

Distribution ; India : Kerala.

Remarks : This species is recorded for the second time.

Astochia Becker

Astochia Becker, 1913, *Ann. Mus. zool. Acad.* St. Petersbourg, **17** : 538.

4. **Astochia bengalensis** Joseph and Parui

1981. *Astochia bengalensis* Joseph and Parui, *Oriental Ins.* **15** (1) : 21.

Material : 1♀, India : Uttar Pradesh ; Mussoorie, vi.1905, no other data ; 1♂, West Bengal : Darjeeling, 13.v.1917 ; 3♂, 2♀, Darjeeling, 20-24.v.1917 ; 3♂, 2♀, Darjeeling, 4.vi.1917 ; 1♀, Darjeeling, 6.vi.1917 ; 2♂, 2♀, India, no other data ; all presented by E. Brunetti, B. M. 1927-84.

Distribution : India : West Bengal and Uttar Pradesh.

Remarks : This is the first report from Uttar Pradesh.

Clephydroneura Becker

Clephydroneura Becker, 1925, *Ent. Mitt.* **14** : 68.

5. **Clephydroneura distincta** Oldroyd

1938. *Clephydroneura distincta* Oldroyd, *Ann. Mag. nat. Hist.* (11) **1** : 467.

Material : 1♂, India : Tamil Nadu : Nilgiris : Coonoor, v.1912, *Coll. W.S.P.*

Distribution : India : Tamil Nadu.

Remarks : It is so far recorded only from Tamil Nadu.

6. **Clephydroneura karnatakaensis** Joseph and Parui

1984. *Clephydroneura karnatakaensis* Joseph and Parui, *Rec. zool. Surv. India,* Occ. paper No. 66 : 9.

Material : 1♂, India, no other data, *Coll. W. S. Patton.*

Distribution : India : Karnataka.

Remarks : This is the second report of the species.

7. **Clephydroneura mudigorensis** Joseph and Parui

1984. *Clephydroneura mudigorensis* Joseph and Parui, *Rec. zool. Surv. India*, Occ. paper No. 66 : 14.

Material : 1 ♂, India, T.R. Bell, B.M. 1934-394, no other data.

Distribution : India : Karnataka.

Remarks : Comparatively a large specimen.

Heligmoneura Bigot

Heligmoneura Bigot, 1858. *Arch. Ent.* **2** : 356.

Heligmoneura Bigot, *Hoplopheromerus* Becker, *Neomochtherus* Osten-Sacken, and *Orophotus* Becker are generally similar and because of their close similarity in our earlier paper (1980) we had placed *Hoplopheromerus armatipes* Macquart, *Neomochtherus gnava* Wulp and *Orophotus montanus* Ricardo, under *Heligmoneura*. Subsequent studies have shown the identity of these different genera because of their differences in characters of antenna, facial gibbosity, dorsoventral hairs of mesonotum, presence or absence of bristles on legs and structural details of male genitalia. The limitation of these genera has been problematic : Lal (1960) in his Catalogue has placed all the Indian species under *Heligmoneura* ; Hull (1962) suggests that the Oriental species belong to *Cinadus* Wulp and the African ones to *Heligmoneura* ; Tsacas and Oldroyd (1967) give a key for separation of these genera ; and Oldroyd (1975) follows it in the *Catalog of Oriental Diptera*. One more species included in our earlier paper (1980) is *Heligmoneura indiana* Ricardo, which actually belongs to *Neomochtherus*.

Key to Indian species of **Heligmoneura** *Bigot*

(After Joseph and Parui, 1984)

1.	Males with epandrium trifurcate, thorax with golden yellow bristles ...	*ricardoi* Joseph and Parui	
	Males with epandrium bifurcate, bristles of thorax other than golden-yellow ...	...	2
2.	Mystax white or light yellow ...	...	3
	Mystax mixed black and white or black and yellowish ...	...	7
3.	Legs yellowish, tips of mid and hind femora may be darker ...	...	4
	Legs yellowish-brown or black, in the latter fore and mid femora ferruginous at apex ...	...	5

4.	Epandrium shallowly furcate with the prongs curved inwards, abdomen yellow, mesonotum with two lateral spots on sides of mediolongitudinal stripes ...	*yenpengensis* (Bromley)	
	Epandrium distinctly bifurcate, abdomen yellowish-brown to dark brown, lateral spots of mesonotum absent ...	*cheriani* Joseph & Parui	
5.	Abdominal tergite V with four white spines on each side ...	*congeda* (Walker)	
	Abdominal tergite V with 2-3 bristles on each side ...	...	6
6.	Wings not infuscated, posterior branch of third vein almost straight, antennal arista and third segment almost equal ...	*kumaunensis* Joseph and Parui	
	Wings smoky at apex and along posterior cell, antennal style longer than third segment ...	*dravidica* Joseph and Parui	
7.	Mystax white with a few black bristles ...	...	8
	Mystax yellowish with a few black bristles ...	...	13
8.	Epandrium deeply incised ...	...	9
	Epandrium not distinctly incised ...	...	11
9.	Male sternite VIII ending in a rod-shaped projection bearing a fan-like row of hairs ...	*frommeri* Joseph and Parui	
	Sternite VIII only slightly produced ...	...	10
10.	Antennae black, tibiae yellow but tip of hind pair brownish, sternite VIII only slightly produced ...	*anamalaiensis* Joseph and Parui	
	Antennal segments 1 and 2 yellow, segment 3 yellowish-brown at base, rest dark brown, tibiae yellow but tip of hind pair brownish, sternite VIII produced, apex round with a row of black bristles ...	*shimogaensis* Joseph and Parui	
11.	Mediolongitudinal stripe of thorax undivided and extend the entire length, disc of scutellum pale-yellow haired, epandrium and hypandrium curved downwards apically ...	*tsacasi* sp. nov.	
	Mediolongitudinal stripe of thorax divided and extends midway between transverse suture and hind border, disc of scutellum black haired, epandrium and hypandrium not so curved ...	...	12

12.	Epandrium distinctly incised, hypandrium with a few long hairs, mystax white with black bristles above and below ...	*incisularis* sp. nov.
	Epandrium slightly incised, hypandrium with long bristly hairs, mystax white surrounded by black bristles ...	*bengalensis* sp. nov.
13.	Abdomen with a distinct series of three brown spots, superior forceps of male club-shaped ...	*ricardoi* Joseph and Parui
	Abdomen without such spots, superior forceps not club-shaped	14
14.	Facial tubercle highly produced, epandrium complicated	15
	Facial tubercle not so prominent, epandrium not complicated	16
15.	Sixth tergite on sides with a bunch of short black bristles, femora yellowish-brown with an anterior black stripe extending from base to beyond the middle, proctiger of male characteristic shape ...	*bigoti* Joseph and Parui
	Sixth tergite without bristles, femora yellow with dark tip, epandrium bears a few spines internally at apex ...	*andamanensis* Joseph and Parui
16.	Femora black, tibiae pale-yellow except hind tibia being black with pale yellow base, genital cavity of male tightly enclosed ...	*poonmudiensis* Joseph and Parui
	Femora yellowish, apex of mid and hind femora may be block.	17
17.	Hind femur yellow with black apex and black rings, hind tibia yellow except outside being black, antennae yellow ...	*tenuicornis* (Walker)
	Hind femur uniformly yellowish-brown	18
18.	Lower fork of superior forceps with a small protuberance, hind tibia uniformly yellowish-brown, scutellum black haired on disc and with black bristles on margin ...	*lavignei* Joseph and Parui
	Lower fork of superior forceps without any protuberance, hind tibia yellow on basal half while the rest black, scutellum with a submarginal row of erect fine black setae and marginal bristles ...	*chaetoprocta* (Hull)

8. **Heligmoneura bengalensis** sp. nov.

(Fig. 1)

A small black species with grey tomentum, concolourous legs, wholly white or white and black mixed mystax and distally infuscated wings. Male length 13 mm, wing 11 mm ; female length 13 mm, wing 12 mm.

Males : *Head* broader than thorax, black with grey and white tomentum ; mystax wholly white or white bristles surrounded by black ones, fronto-orbital plate with black hairs, ocellar bristles black, postcranium white haired, postocular bristles black. Antenna lost from segment 3 onwards, remainder black with black hairs, segment 1 ventrally also bearing a few black bristles, segment 2 longer than half of 1. Palpus and proboscis black with white hairs.

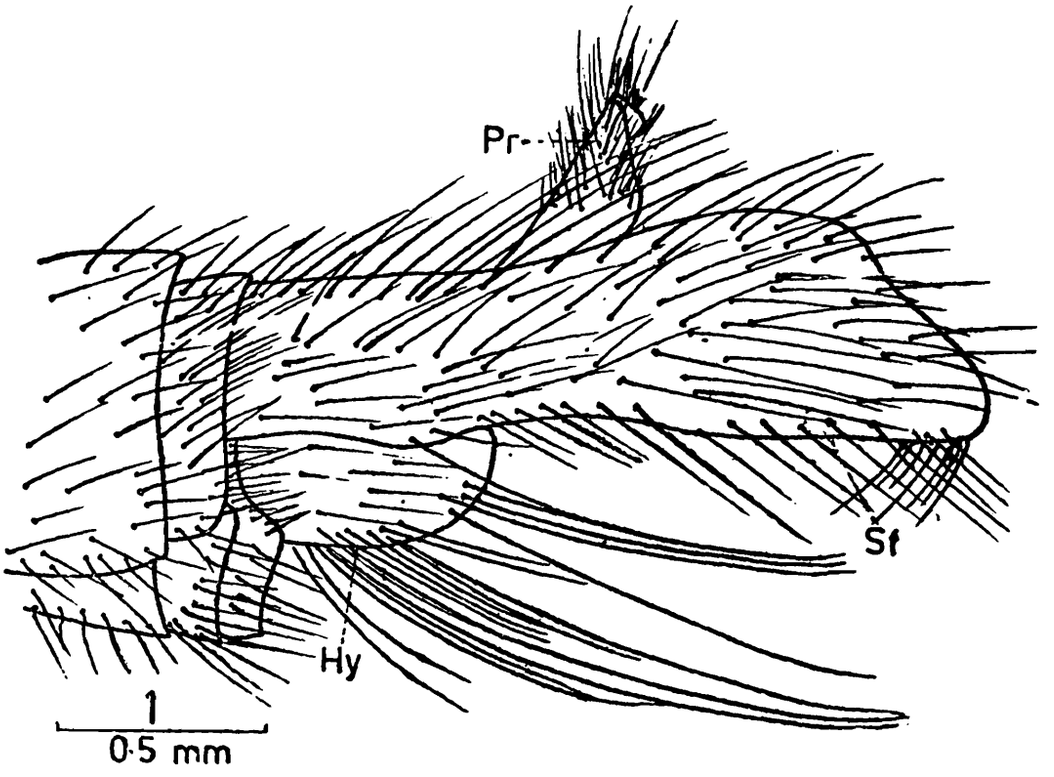

Fig. 1. *Heligmoneura bengalensis* sp. nov., lateral view of male genitalia.

Thorax black, grey tomentose ; pronotal hairs pale yellow with a median transverse row of four pale yellow or pale yellow and black bristles ; mesonotum with a mediolongitudinal black stripe divided by a narrow greyish-yellow stripe, the stripe extending from anterior end to midway between transverse suture and hind border, laterally with two large and one small black spots, vestiture black but for a few pale yellow hairs on humerus and posterolaterally, bristles black ; scutellum with the disc black haired, hind border bearing two black bristles. Haltere dark brown or yellowish-brown.

Legs uniformly black, grey tomentose ; fore femur ventrally with a row of long white hairs which gradually decrease in length from base to apex, mid and hind femora with anteroventral and posteroventral rows of bristles, mid femur also with an anterior bristle beyond middle, vestiture predominantly white with some black hairs also, bristles black and pale yellow, tibia and basitarsus bearing golden yellow pubescence anteriorly in fore leg and posteriorly in hind leg.

Wing infuscated, but medially and basally almost hyaline.

Abdomen black, sparsely grey tomentose, tomentum covering most of tergite 1 and anterior and posterior borders of tergite 2, it forms a narrow transverse hind border on tergites 3-7, tergite 1 laterally with a bunch of pale yellow and two or more black bristles, in succeeding tergites posterolaterally with about three bristles, vestiture black, bristles pale yellow and black. Male genitalia (Fig. 1) black with black hairs, distal half of epandrium bearing pale yellow hairs.

Female : Similar.

Holotype ♂, India : West Bengal : Darjeeling, 4.vi.1917, presented by E. Brunetti, B. M. 1927-184.

Paratypes : 1♂, 1♀, same data as holotype.

Heligmoneura bengalensis sp. nov. is closely similar to *H. incisularis* sp. nov., but is comparatively larger and the epandrium not as distinctly bifid.

9. **Heligmoneura incisularis** sp. nov.

(Fig. 2)

A small, black species with grey tomentum, concolourous legs, white and black mystax and infuscated wings. Male length 11 mm, wing 8 mm.

Male : *Head* broader than thorax, black with grey and white tomentum ; mystax white with black bristles above and below, frontoorbital plate with black hairs, ocellar bristles black, postcranium white haired, postocular bristles black. Antenna black with segment 2 yellowish-brown basally and distally, segments 1 and 2 with black hairs, the former also carrying a few black bristles ventrally, segment 2 longer than half of 1, 3 and segments 1+2 nearly equal in length. Palpus and proboscis black with white hairs.

Thorax black, grey tomentose ; pronotal hairs white with a median transverse row of four pale yellow and black bristles ; mesonotum with a mediolongitudinal black stripe divided by a narrow grey stripe, the stripe extending from anterior end to midway between transverse suture and hind border, sides with the usual three black spots, vestiture black but for a few pale yellow hairs on humerus and posterolaterally, bristles black ; scutellum with the disc black haired, hind border with a pair of black bristles. Haltere yellowish-brown and dark brown mixed.

Legs uniformly black ; fore femur with a ventral row of long white hairs which gradually decrease in length from base to apex, mid and hind femora with anteroventral and posteroventral rows of bristles, mid femur also with an anterior bristle beyond middle, vestiture predominantly white with some black hairs also, bristles pale yellow and pale yellow and black, tibia and basitarsus bearing golden yellow pubescence anteriorly in fore leg and posteriorly in hind leg.

Wing infuscated, but medially and basally lighter coloured.

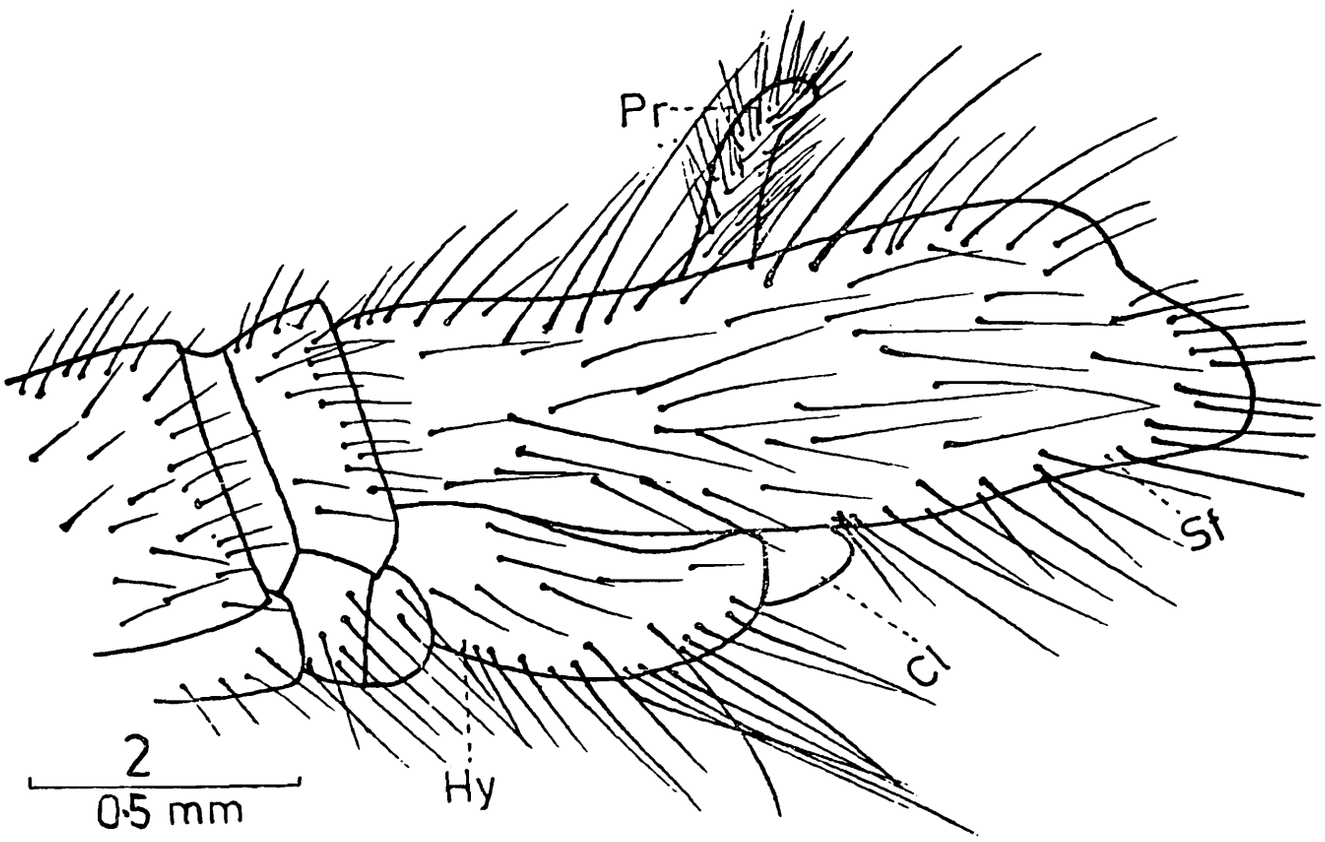

Fig. 2. *Heligmoneura incisularis* sp. nov., lateral view of male genitalia.

Abdomen black, sparsely grey tomentose, on tergite 2 tomentum form anterior and posterior transverse bands, on tergites 3-7 the transverse band restricted to hind border, tergite 1 on sides with a bunch of pale yellow hairs and one pair of black bristles ; tergites 2-5 with a pair of pale yellow bristles posterolaterally, vestiture black, bristles pale yellow and black. Male genitalia (Fig. 2) black with black and pale yellow hairs, epandrium apically with distinct incision.

Holotype ♂, India : Uttar Pradesh : Mussoorie, vi. 1905, presented by E. Brunetti, B. M. 1927-184, no other data.

Heligmoneura incisularis sp. nov. is allied to *H. bengalensis* sp. nov., the interrelationships between them are discussed under the latter.

10. **Heligmoneura tsacasi** sp. nov.

(Fig. 3)

A small black species with greyish-yellow and grey tomentum, black legs, white and black mystax, and distally infuscated wings. Male length 11-12 mm, wing 9 mm.

Male : *Head* broader than thorax, black, grey or greyish-yellow tomentose ; mystax white with a few black bristles above, fronto-orbital plate with black hairs, ocellar bristles black, postcranium predominantly pale yellow haired with a few black ones also, postocular bristles black and pale yellow. Antenna black with black hairs on the basal two segments, segment I also bears a few black bristles ventrally, segment 2 more than two-thirds length of 1, segment 3 longer than combined length of 1+2. Palpus and proboscis black, former black haired while latter pale yellow haired.

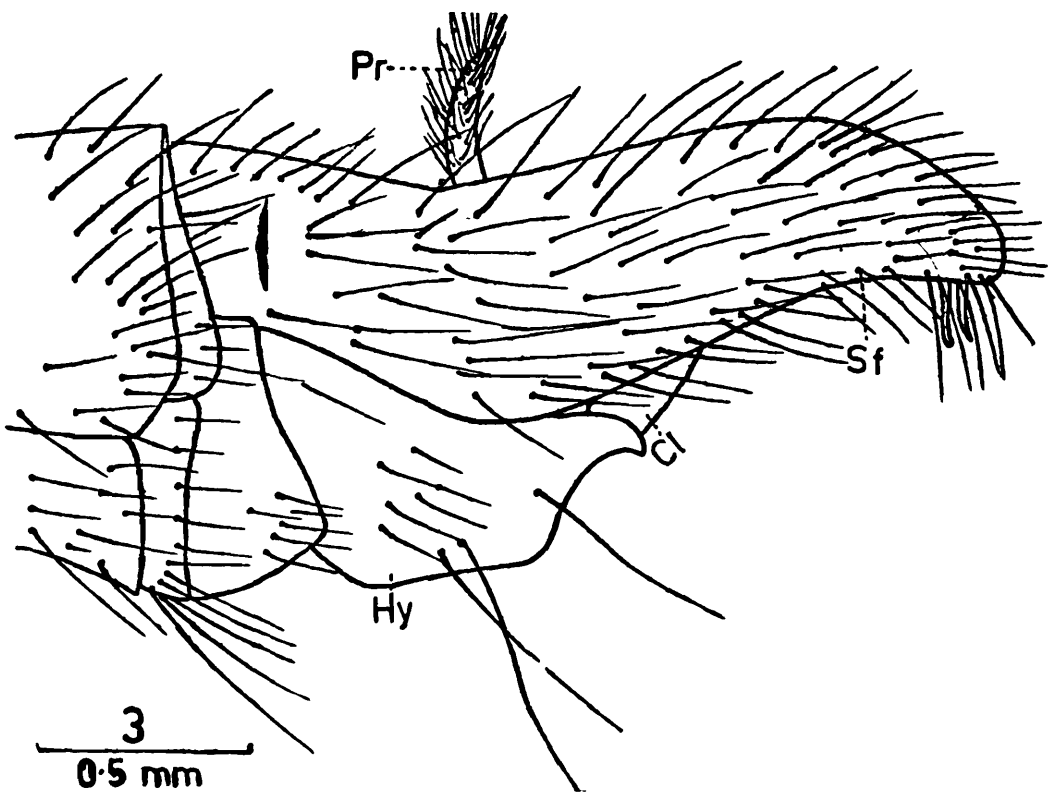

Fig. 3. *Heligmoneura tsacasi* sp. nov., lateral view of male genitalia.

Thorax black, grey and greyish-yellow tomentose ; pronotal hairs pale yellow ; mesonotum with a mediolongitudinal black stripe extending the entire length but without the dividing narrow line, lateral black spots confluent and form a stripe, vestiture black but for a few pale yellow hairs on humerus and posterolaterally, bristles black ; scutellum with the disc pale yellow haired, hind border bearing a pair of pale yellow bristles. Haltere yellowish-brown.

Legs uniformly black, fore femur ventrally with a row of thin long pale yellow hairs which decrease in length from base to apex, mid

and hind femora with anteroventral and posteroventral rows of bristles, the latter also with one anterior bristle beyond middle ; vestiture pale yellow with some black hairs also, bristles pale yellow and black, tibia and besitarsus of fore and hind legs with golden yellow pubescense, anteriorly in fore leg and posteriorly in hind leg.

Wing infuscated, but medially and basally hyaline.

Abdomen black, yellowish-grey tomentose, tomentum more or less covering the entire tergites, tergite 1 and sides with pale yellow bristles posterolaterally, vestiture and bristles pale yellow. Male genitalia (Fig. 3) black with black hairs, epandrium apically with a few pale yellow hairs and hypandrium wholly pale yellow haired.

Holotype ♂, India, presented by E. Brunetti, B. M. 1927-184, no other details.

Paratype ♂ (wings separately attached), same data as holotype.

It is generally similar to *Heligmoneura bengalensis* sp. nov. and *H. incisularis* sp. nov., but can be recognised by the differences in the shape of epandrium and hypandrium and the fewer number of pale yellow apical hairs of epandrium. This species is named in honour of L. Tsacas, the well known worker on Palaearctic Asilidae.

Machimus Loew

Machimus Loew, 1849, *Linn. ent.* **4** : 1.

11. **Machimus hirtipes** Ricardo

1919. *Machimus hirtipes* Ricardo, *Ann. Mag. nat. Hist.* (9) **3** : 49.

Material : 1♂, 1♀, India : West Bengal : Kalimpong, 1000 m, 27.iii.1924, Coll. Maj. R. W. G. Hingston ; 3♀, 26.iii.1924, rest data as in preceding.

Distribution : India : Meghalaya, West Bengal and Tamil Nadu.

Remarks : This is the first record from West Bengal.

12. **Machimus indianus** Ricardo

1919. *Machimus indianus* Ricardo, *Ann. Mag. nat. Hist.* (9) **3** : 50.

Material : 1♂, India : Uttar Pradesh : Mussoorie, vi.1905, no other data, presented by E. Brunetti, B. M. 1927-184.

Distribution : India : Uttar Pradesh.

Remarks : So far this species is reported only from Uttar Pradesh.

13. **Machimus inutilis** Bromley

1985. *Machimus inutilis* Bromley, *Rec. Indian Mus.* **37** : 222.

Material : 4♂, 4♀, India : Uttar Pradesh : Mussoorie, 20-26.v. 1905, coll. Brunetti ; 1♂, Himachal Pradesh : Simla Hills : Theog, 2000 m, 2.v.1907, coll. N. Annandale.

Distribution : India : Punjab and Uttar Pradesh ; Nepal.

Remarks : This is first time reported from Uttar Pradesh.

14. **Machimus nigrinus** Ricardo

1919. *Machimus nigrinus* Ricardo, *Ann. Mag. nat. Hist.* (9) 3 : 53.

Material : 1♂, India : Uttar Pradesh : Mussoorie, vi.1905, no other data, presented by E. Brunetti, B. M. 1927-184.

Distribution : India : Uttar Pradesh.

Remarks : So far the species is known to occur in Uttar Pradesh.

15. **Machimus pallipes** Ricardo

1922. *Machimus pallipes* Ricardo, *Ann. Mag. nat. Hist.* (9) **10** : 65.

1960. *Asilus* (*Machimus*) *pallipes* (Ricardo) : Lal, *Catalogue of Indian Insects* Part 29-Asilidae : Diptera, : 19.

1975. *Machimus pallipes* Ricardo : Oldroyd, *A Catalog of Diptera of the Oriental Region*, **2** : 145.

Material : 1♂, India, no other data, presented by E. Brunetti, B. M. 1927-184.

Distribution : India : Uttar Pradesh ; Nepal.

Remarks : As far as known the distribution of this species is restricted to the Himalaya.

16. **Machimus punjabensis** Bromley

1935. *Machimus punjabensis* Bromley, *Rec. Indian Mus.* **37** : 220.

Material : 1♂, 3♀, India : Uttar Pradesh : Mussoorie, 20-25.vi.1905, coll. Brunetti ; 1♂, Mussoorie, vi.1905, no other data ; presented by E. Brunetti, B. M. 1927-184.

Distribution : India : Punjab and Uttar Pradesh.

Remarks : It is the first report of the species from Uttar Pradesh.

17. **Machimus ricardoi** (Bromley)

1935. *Asilus ricardoi* Bromley, *Rec. Indian Mus.* **37** : 219.

1975. *Machimus ricardoi* (Bromley) : Oldroyd, *A Catalog of Diptera of the Oriental Region*, **2** : 146.

Material : 1♂, India : Himachal Pradesh : Simla, 14.viii.1916, no other details ; 1♂, 1♀, India, no other data ; both presented by E. Brunetti, B. M. 1927-184.

Distribution : India : Uttar Pradesh, Himachal Pradesh and Sikkim.

Remarks : Widely distributed in Uttar Pradesh.

Neoitamus Osten-Sacken

Neoitamus Osten-Sacken, 1878, *Smithson Misc. Colls.* **16** : 82, 235.

Key to Indian species of **Neoitamus** *Osten-Sacken*

1.	Hind femur uniformly reddish or black ...	...	2
	Hind femur not uniformly coloured ...	...	7
2.	Fore femur reddish-yellow with a broad black stripe, scutellar disc yellow haired, basal five abdominal segments yellowish, mystax yellowish white ...	*grandis* Ricardo	
	Fore femur black, may be yellowish striped ...	...	3
3.	Thorax with mediolongitudinal stripe and three lateral spots which form lateral stripes ; femora black with yellow apex and tibiae yellow with black apex, mystax white surrounded by black bristles ...	*inornatus* Ricardo	
	Thorax with or without mediolongitudinal stripe but no lateral spots or stripes ...	...	4
4.	Epandrium deeply cleft, wings infuscated at tip which extends posteriorly into the fifth posterior cell ...	*barsilensis* Joseph and Parui	
	Epandrium without cleft ...	...	5
5.	Fore and mid femora with a ventral row of pale yellow hairs, scutellum on disc pale yellow haired, wings infuscated distally which extends upto axillary cell ...	*calcuttaensis* sp. nov.	
	Fore femur with a ventral row of black hairs and middle one with bristles of similar colour ...	...	6
6.	Clasper obtuse with toothed apex, wings infuscated from base along the border upto axillary cell leaving medially hyaline, mystax straw coloured with some black bristles above ...	*himalayensis* Joseph and Parui	
	Clasper with a row of spines, wings infuscated distally and along hind border upto axillary cell, mystax golden yellow ...	*mussooriensis* Joseph and Parui	

7.	Wings wholly infuscated, hind femur yellowish-brown with brown stripe on distal half, mystax uniformly pale yellow, clasper apically bears minute spines ...	*grahami* sp. nov.
	Wings smoky towards tip which continues upto axillary cell or falls short of it ...	... 8
8.	Tibia yellow except hind pair being black distally, abdominal tergites 1 to 3 yellow haired on sides and 4 to 5 with yellow bristles ...	*bengalensis* Joseph and Parui
	Tip of tibiae of different colour than the remainder ...	... 9
9.	Femora and tibiae black with reddish-yellow apex, mystax dirty white with some black ones above ...	*tropicus* Ricardo
	Femora yellowish with a black line anterodorsally, tibiae yellow with black tip, mystax black with some white bristles below ...	*khasiensis* Bromley

18. **Neoitamus grahami** sp. nov.

(Fig. 4)

A medium sized black and grey species with yellowish-brown and brown legs, and completely infuscated wings. Male length 17 mm, wing 12 mm.

Male : *Head* broader than thorax, black with dense grey tomentum ; mystax pale yellow, fronto-orbital plate with pale yellow and black hairs, ocellar bristles black, postcranium pale yellow haired. Antennal segments 1 and 2 yellowish brown, remainder black, basal two segments with pale yellow and black bristles, segment 2 longer than two-thirds of 1, segment 3 longer than combined length of segments 1+2, style much longer than segment 3. Palpus drak brown whereas proboscis black, hairs of both pale yellow.

Thorax black, densely grey tomentose ; pronotal hairs pale yellow with a pair of black bristles laterally ; mesonotum with a faint mediologitudinal black stripe divided by a narrow grey stripe, the stripe extends from the anterior end to midway between transverse suture and hind border, vestiture black but for a few pale yellow hairs on humerus, bristles black except for one or two pale yellow ones posterolaterally ; scutellum pale yellow haired, a large number of pale yellow bristles present on hind border and just anterior to it. Haltere pale yellow.

Legs yellowish brown and brown ; coxa, trochanter and tarsus brown, remainder yellowish brown with a broad brown stripe on femur, the stripe extends the entire length and is situated anteriorly and antero-dorsally in fore and mid femora whereas it is restricted to slightly more than distal half and is present dorsally in hind femur, fore femur with a ventral row of bristles, mid and hind femora with anterior, antero-ventral and posteroventral rows of bristles, vestiture predominantly pale yellow with some black hairs also, bristles black and pale yellow.

Wing almost wholly infuscated.

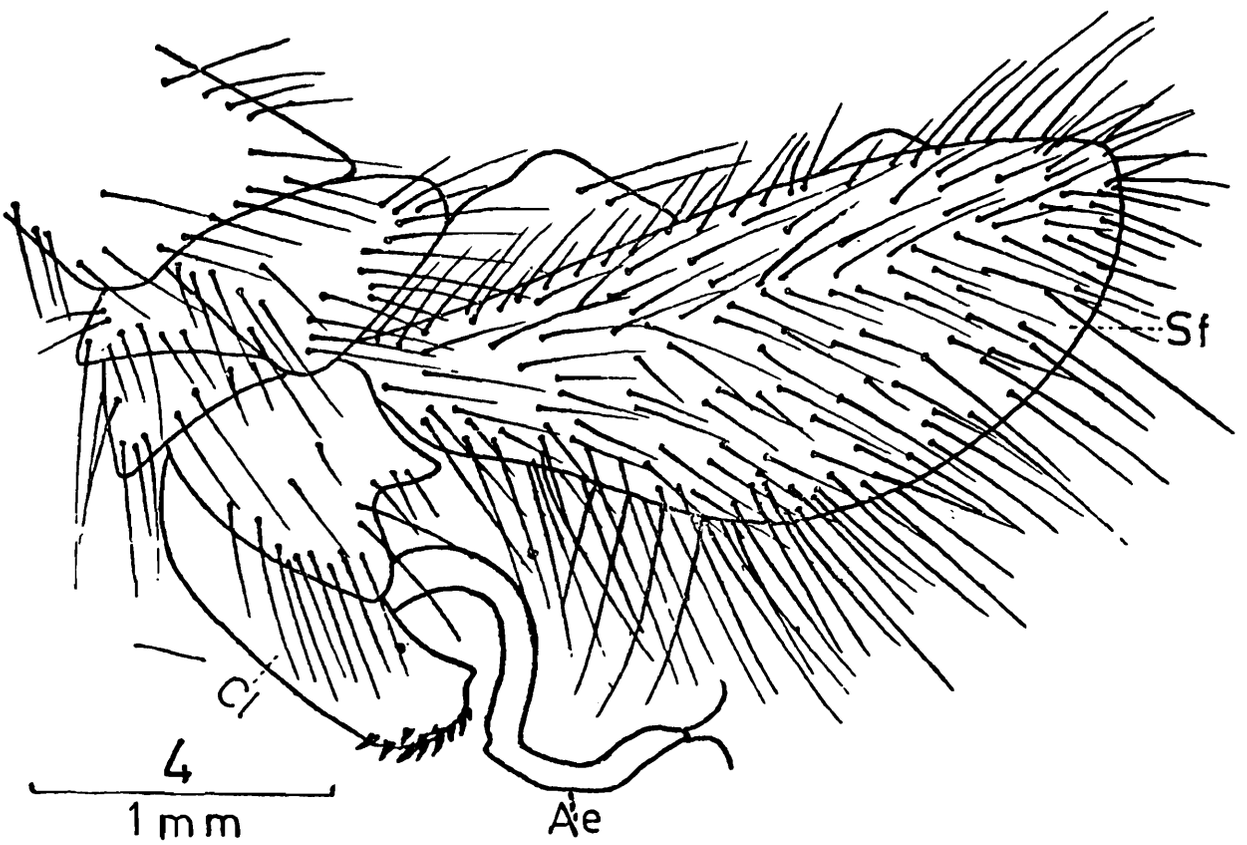

Fig. 4. *Neoitamus grahami* sp. nov., lateral view of male genitalia.

Abdomen black, sides grey and greyish-yellow tomentose, tergites 1-4 laterally with white hairs and bristles. Male genitalia (Fig. 4) black with golden yellow and black hairs, clasper apically with minute spines.

Holotype ♂, India : Uttar Pradesh : Naini Tal, 1920 m, 28.iii.1934, coll. J. A. Graham.

Of the various Indian species of *Neoitamus*, the present one is generally similar to *N. grandis* Ricardo from which it differs in the lighter colouration, wholly pale yellow mystax and the shape of epandrium. This species is named after the collector.

Neoitamus bengalensis (Joseph and Parui)

Astochia bengalensis Joseph and Parui, 1981, *Oriental Ins.*, **15** (1) : 21.

Neoitamus bengalensis (Joseph and Parui), New Comb.

19. **Neoitamus calcuttaensis** sp. nov.

(Fig. 5)

A medium sized black species with grey tomentum, black and yellowish-brown legs and distally infuscated wings. Male : length 14 mm, wing 11 mm.

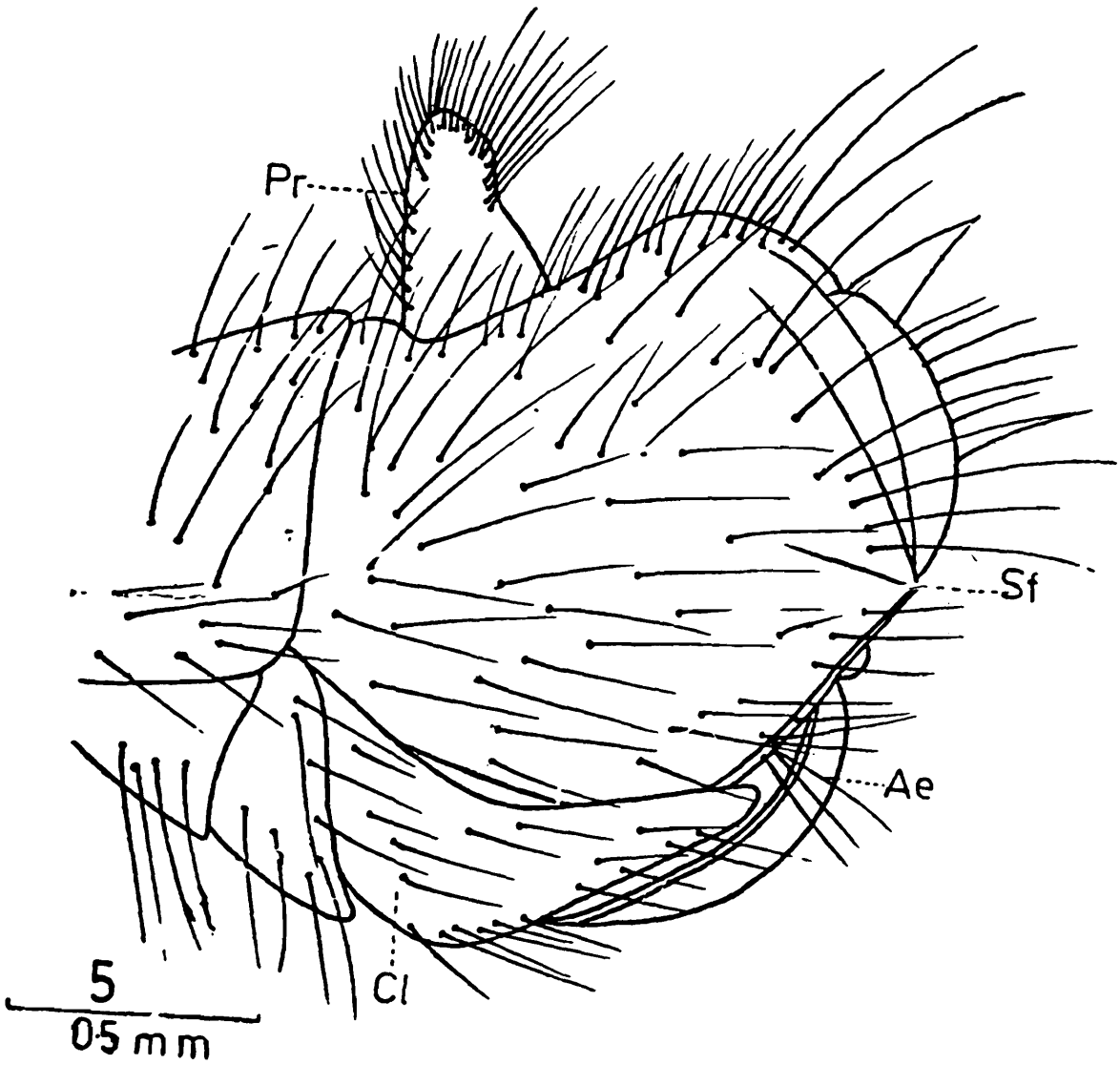

Fig. 5. *Neoitamus calcuttaensis* sp. nov., lateral view of male genitalia.

Male : *Head* broader than thorax, black, grey tomentose ; mystax white with a few black bristles above, fronto-orbital plate bearing black bristles, ocellar bristles black, postcranium black haired, postocular bristles black, postgena pale yellow haired. Antennae lost. Palpus and proboscis black, former black haired whereas latter pale yellow haired.

Thorax black, sparsely grey tomentose ; pronotal hairs pale yellow with a median transverse row of black bristles ; mesonotum with a mediolongitudinal black stripe divided by a narrow grey stripe, the stripe extending from anterior end to almost hind border, vestiture black but for some pale yellow hairs on humerus and on side, bristles

black; scutellum with the disc pale yellow haired and hind border bearing four black bristles. Haltere yellowish-brown.

Legs black and yellowish-brown; coxa, trochanter and femur black except tip of fore femur being yellowish-brown, tibia and tarsus yellowish-brown with a gradual deepening of colouration at the apex of tibia and tarsus from fore to hind legs so much so they are wholly dark brown in hind legs, fore and mid femora with a ventral row of pale yellow hairs, hind femur with anterior, anteroventral and posteroventral rows of bristles, vestiture and bristles pale yellow and black.

Wings infuscated distally, which extends posteriorly to the axillary cell.

Abdomen black, sparsely grey tomentose, tomentum forms a narrow hind border on tergites 3-5, tergites 1-5 laterally with white hairs and bristles, which decrease in number and size in posterior segments. Male genitalia (Fig. 5) black with a few pale yellow hairs.

Holotype ♂, India : West Bengal : Calcutta, 6.xi.1913, presented by E. Brunetti, B. M. 1927-184, no other details.

Neoitamus calcuttaensis sp. nov. is closely similar to *N. bengalensis* (Joseph and Parui) but differs that in the former the femora black except for an apical yellowish-brown marking of fore femur, and in the shape of epandrium.

20. **Neoitamus grandis** Ricardo

1919. *Neoitamus grandis* Ricardo, *Ann. Mag. nat. Hist.* (9) **3** : 61.

1960. *Cerdistus grandis* (Ricardo) : Lal, *Catalogue of Indian Insects* Part 29-Asilidae : Diptera, : 27.

1975. *Neoitamus grandis* Ricardo : Oldroyd, *A Catalog of Diptera of the Oriental Region* **2** : 146.

Material : 1 ♂, India : Sikkim : Rangli Chu, 750 m, 29.iii.1924, coll. *Maj. R. W. G. Hingston* ; 1 ♂, Gangtok, 1600 m, 22.iv.1924, coll. *Maj. R. W. G. Hingston.*

Distribution : India : Uttar Pradesh and Sikkim ; Nepal.

Remarks : This is the first report of it from Sikkim.

21. **Neoitamus himalayensis** Joseph and Parui

1984. *Neoitomus himalayensis* Joseph and Parui, *Oriental Ins.* **18** : 64.

Material : 1 ♂, India : Himachal Pradesh : Simla, 7.vii.1918, coll. *Brunetti, Brit. Mus.* 1927-184.

Distribution : India : Himachal Pradesh.

Remarks : This is the second report of the species.

22. **Neoitamus inornatus** Ricardo

1919. *Neoitamus inornatus* Ricardo, *Ann. Mag. nat. Hist.* (9) **3** : 63.

1960. *Cerdistus inornatus* (Ricardo) : Lal, *Catalog of Indian Insects*, Part 29-Asilidae : Diptera, : 27.

1975. *Neoitamus inornatus* Ricardo : Oldroyd, *A Catolog of Diptera of the Oriental Region*, **2** : 146.

Material : 1 ♂, India : Uttar Pradesh : Mussoorie, 4.v.1905, no other data, presented by *E. Brunetti*, B. N. 1927-184 ; 5 ♂, 3 ♀, Mussoorie, 1750 m, 20-26.v.1905, coll. *E. Brunetti*. 1 ♀, Mussoorie, 10.vi.1905, coll. *Brunetti*.

Distribution ; India : Uttar Pradesh and Punjab.

Remarks : It is of common occurrence in Mussoorie.

23. **Neoitamus mussooriensis** Joseph and Parui

1984. *Neoitamus mussooriensis* Joseph and Parui, *Rec. zool. Surv. India*, Occ. paper No. 66 : 21.

Material : 1 ♂, India : Uttar Pradesh : Mussoorie, 1750 m, 20-24.vi.1905, coll. *Brunetti*.

Distribution : India : Uttar Pradesh.

Remarks : It is also from the type locality.

Orophotus Becker

Orophotus Becker, 1925, *Ent. Mitt.* **14** : 137.

24. **Orophotus montanus** (Ricardo)

1922. *Asilus montanus* Ricardo, *Ann. Mag. nat. Hist.* (9) **10** : 47.

1960. *Heligmoneura montana* (Ricardo) : Lal, *Catalogue of Indian Insects* Part 29-Asilidae : Diptera, : 34.

1975. *Orophotus montanus* (Ricardo) : Oldroyd, *A Catalog of Diptera of the Oriental Region*, **2** : 148.

Material : 1 ♂, India : Sikkim : Gangtok, 1250 m, 9.v.1924, coll. *R. W. G. Hingston*.

Distribution : India : Meghalaya, Sikkim and West Bengal.

Remarks : This is the first report from Sikkim.

Philodicus Loew

Philodicus Loew, 1848, *Linn. Ent.* **3** : 391.

25. **Philodicus femoralis** Ricardo

1921. *Philodicus femoralis* Ricardo, *Ann. Mag. nat. Hist.* (9) **8** : 190.

1975. *Philodicus femoralis* Ricardo : Oldroyd, A catalog of Diptera of the Oriental Region, **2** : 149.

Material : 1 ♂, Calcutta, slaughter house, 6.xi.1913, no other data, presented by *E. Brunetti* to *B. M.* 1927-184 ; 1 ♂, 1 ♀, Bangla Desh : Dacca, 1.vii.1945, coll. *D. Liston*, *B. M.* 1945-86 ; 1 ♂, India, coll. *H. M. Parish*, no other data, Brit. Mus. 1923-247.

Distribution : India : Meghalaya, West Bengal, Bihar and Uttar Pradesh ; Burma.

Remarks : A very common species of the genus.

26. **Philodicus javanus** (Wiedemann)

1819. *Asilus javanus* Wiedemann, *Zool. Mag.* (Wied.). **1** (3) : 4.

1975. *Philodicus javanus* (Wiedemann) : Oldroyd, *A Catalog of Diptera of the Oriental Region*, **2** : 149.

Material : 1 ♀, India : West Bengal : Calcutta, 30.v.1907 ; 1 ♀, Calcutta, 12.vi.1907 ; 1 ♂, Calcutta, 20.vi.1907 ; 1 ♀, Calcutta, 27.vi. 1907 ; 1 ♂ Calcutta, 11.vii.1907 ; on other data. 1 ♂, Calcutta, 12.vi. 1908, coll. *Brunetti*, *Brit. Mus.* 1927-184 ; 2 ♂, 2 ♀, Calcutta, 1-10.viii. 1908 ; 1 ♂, Calcutta, presented by *E. Brunetti*, *B. M.* 1927-184 ; 1 ♂, Calcutta, Indian Mus. Calcutta colln ; no other data. 1 ♂, Bangla Desh : Dacca, 17.v.1945 ; 1 ♀, Dacca, 28.v.1945 ; 1 ♂, Dacca, 20.vii. 1945 ; 1 ♀ Dacca, 13.viii.1945 ; all collected by *D. Leston.*

Distribution : It is the most common species of the genus in India.

27. **Philodicus pruthii** Bromley

1935. *Philodicus pruthii* Bromley, *Rec. Indian Mus.* **37** : 224.

1975. *Philodicus pruthii* Bromley : Oldroyd, A catalog of Diptera of the Oriental Region, **2** : 150.

Material : 1 ♂, India : Madhya Pradesh : Jabalpur, 4.vii.1907 ; 2 ♂, 1 ♀, Jabalpur, iv.1908, all collected by *C. G. Nurse.* 1 ♀, Tamil Nadu : Tinnevelly : Dohnavur, 90 m, 4-7.iii.1936 ; 1 ♀, Tamil Nadu : Coonoor, 1500 m, 22-23.iv.1937 ; both collected by *B. M. C. M.* Expedition to South India.

Distribution : India : Madhya Pradesh and Tamil Nadu.

Remarks : This is the first record from Madhya Pradesh.

Promachus Loew

Promachus Loew, 1848, *Linn. ent.* **3** : 390.

Key to Indian species of *Promachus* Loew
(After Joseph and Parui, 1981)

1.	Legs wholly black ...	...	2
	Legs not wholly black ...	...	9
2.	Male genitalia with a tuft of white hairs, abdomen yellow haired, legs brownish, darker at apex and ventrally ...	*nicobarensis* Schiner	
	Tuft of hairs absent on male genitalia ...	...	3
3.	Each abdominal tergite with two black spots	...	4
	Abdominal tergites with or without the usual black marking ...	...	5
4.	Legs black with black bristles ...	*leucotrichodes* Bigot	
	Legs black with white bristles ...	*tristis* Bigot	
5.	Basal three or more abdominal tergites with tuft of reddish hairs ...	...	6
	Similar tufts absent or restricted to first tergum ...	...	7
6.	Eighth sternite produced with short black bristles on its border, an obscure streak present in the marginal and first submarginal cell ...	*duvaucelii* (Macquart)	
	Eighth sternite not produced but with a tuft of black hairs, wings clear, femora and tibiae with long yellow hairs on underside ...	*binghamensis* Ricardo	
7.	Wings yellowish with brownish extremities, abdomen black with whitish segmentations, moustache yellowish ...	*westermannii* (Macquart)	
	Wings uniformly yellowish ...	...	8
8.	First posterior cell open, scutellum with pale yellow hairs and bristles on disc and a row of yellow bristles on margin, first abdominal tergum with tufts of reddish hairs ...	*jabalpurensis* Joseph and Parui	
	First posterior cell closed, scutellum white haired, abdominal tergites without tufts of reddish hairs ...	*heteropterus* (Macquart)	
9.	Male genitalia with a tuft of white hairs ...	...	10
	Male genitalia without such hairs ...	...	17
10.	Femora entirely black ...	...	11
	Femora not entirely black ...	...	13
11.	Tibiae entirely reddish yellow, scutellum with orange red pubescence, the tuft of white hairs at the base of male genitalia ...	*leoninus* Loew	
	Tibiae yellow to yellowish brown with black tip, scutellar pubescence not orange red, the tuft of white hairs at tip of male genitalia ...	...	12

12.	Eighth sternite of male genitalia well produced, scutellum on the disc pale yellow and black haired and on sides with a pair of black bristles ...	*indicus* sp. nov.
	Eighth sternite of male genitalia not so produced, scutellum on the disc with only pale hairs and without bristles on sides ...	*ramakrishnai* Bromley
13.	Fore tibia reddish-yellow with black apex, moustache yellow, white hairs present on frons below antennae, mesonotum with four brown stripes ...	*contractus* (Walker)
	Fore tibia entirely reddish-yellow ...	... 14
14.	Fore femur red dorsally and black ventrally, palpi yellow haired, male genitalia with a tuft of white hairs ...	*varipes* (Macquart)
	Fore femur uniformly reddish or with black apex ...	... 15
15.	Scutellum reddish with white hairs, moustache yellow and black, first and second antennal segments red ...	*calanus* (Walker)
	Scutellum brownish with pale hairs and black bristles, moustache wholly yellow ...	... 16
16.	Eighth sternite distinctly produced, hind femur with an anterodorsal black stripe ...	*fuscifemoratus* Joseph and Parui
	Eighth sternite not produced, hind femur uniformly reddish ...	*maculatus* (Fabricius)
17.	Oral aperture with some black bristles, mystax predominantly yellowish with a few black bristles, femora bearing long white hairs ventrally except for the hind pair with mixed black and white hairs ...	*yerburiensis* Ricardo
	Oral aperture without black bristles, mystax predominantly black with a few yellow bristles, femora with thick yellowish pile and some black bristles and hairs ...	*ghumtiensis* Bromley

28. **Promachus indicus** sp. nov.

(Fig. 6)

A large black species with grey and greyish-yellow tomentum, black and yellowish-brown legs and infuscated wings. Male length 28 mm, wing 15 mm ; female length 27 mm, wing 15 mm.

Male : *Head* broader than thorax, black, densely greyish-yellow and grey tomentose ; mystax pale yellow, fronto-orbital hairs pale yellow and black, ocellar bristles black, postcranium pale yellow, yellow and black haired, postocular bristles black above and pale yellow below. Antennae

lost from segment 3 onwards, remainder black with black bristles, segment 2 slightly more than half of 1. Palpi and proboscis black with pale yellow hairs.

Thorax black with grey and greyish-yellow tomentum ; pronotum pale yellow haired but for a few black ones in middle, medially with a transverse row of black bristles ; mesonotum with a black medio-longitudinal stripe extending from anterior end to midway between transverse suture and hind border, the stripe divided by a longitudinal narrow stripe which is faint medially, on either side with two black spots, bristles black ; scutellum on the disc pale yellow and black haired, laterally with a pair of and on hind border with a row of black bristles, pleura moderately tomentose with pale yellow hairs. Haltere with brown head and pale yellow stalk.

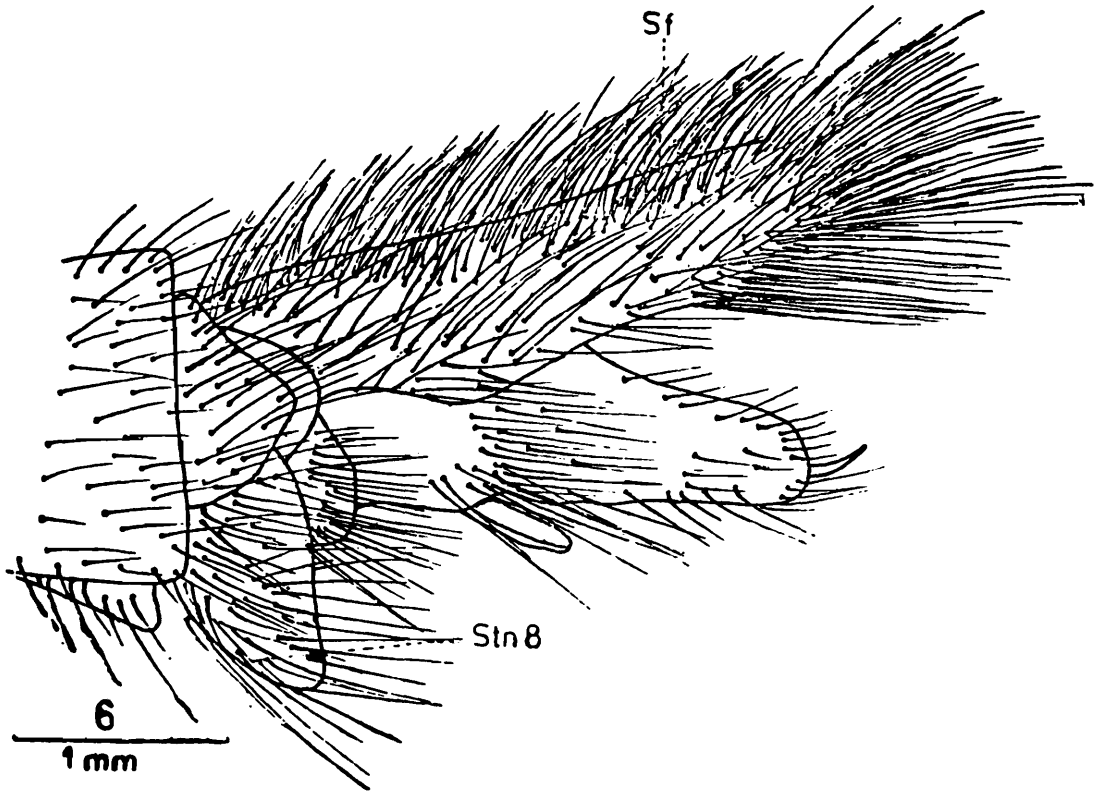

Fig. 6. *Promachus indicus* sp. nov., lateral view of male genitalia.

Legs black except for tibia which is yellowish-brown with apical black marking, fore femur with a ventral row of black bristles from base to beyond middle, mid femur with anteroventral and posteroventral rows of bristles, hind femur with anterior and anteroventral rows of bristles and ventrally bearing a row of thin long black hairs, vestiture black and pale yellow, bristles black.

Wing lightly infuscated, but medially and basally still lighter coloured, first submarginal cell with a grey streak.

Abdomen black with grey and greyish-yellow tomentum, each tergite medially black and laterally and posteriorly tomentose, tergite 1

laterally with dense golden yellow hairs, vestiture golden yellow and black, more or less in confirmity with the background of their origin. Male genitalia (Fig. 6) shining black, eighth sternite produced, hairs black, also with an apical tuft of white hairs.

Female : Similar.

Holotype ♂, India, B. M. 1934-394, coll. T. R. Bell, no other data.

Paratype ♀, data as in holotype.

It is closely similar to *Promachus ramakrishnai* Bromley from which it can be easily distinguished by the lack of paired, stout, elongate bristles on epandrium.

29. **Promachus duvaucelii** (Macquart)

1830. *Trupanea duvaucelii* Macquart, *Ditp. exot.*, **1** (2) : 97.

1975. *Promachus duvaucelii* (Macquart) : Oldroyd, *A Catalog of Diptera of the Oriental Region*, **2** : 152.

Material : 1♂, India : Uttar Pradesh : Dehra Dun, 30.ix.1913 ; 1♀, Dehra Dun, 1.x.1913 ; no other data.

Distribution : India : Gujarat, Punjab, Delhi, Uttar Pradesh, Madhya Pradesh and West Bengal.

Remarks : Most widely distributed species of the genus.

Summary

This paper deals with 29 species of Asilidae under 11 genera, of which 6 are new species : *Heligmoneura bengalensis* sp. nov., *H. incisularis* sp. nov., *H. tsacasi* sp. nov., *Neoitamus grahami* sp. nov., *N. calcuttaensis* sp. nov., and *Promachus indicus* sp. nov., *Astochia bengalensis* Joseph and Parui has been brought under *Neoitamus* Osten-Sacken. Key to species of genus is included under three genera, *viz.*, *Heligmoneura* Bigot, *Neoitamus* Osten-Sacken and *Promachus* Loew, wherein new species are described.

Types are deposited in British Museum (Natural History) and Zoological Survey of India, Calcutta.

Acknowledgements

It is with pleasure we express our gratitude to Dr. K. G. V. Smith of British Museum (Natural History), London, for loaning the material. We are also indebted to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for permitting us to work out the material and to his colleague, Dr. S. K. Bhattacharya, Deputy Director for encouragements.

Abbreviations used in figures

Ae, aedeagus ; Cl, clasper ; Hy, hypandrium ; Pr, proctiger ; Sf, superior forceps (epandrium) ; Stn_8, eighth sternite.

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Rec. zool. Surv. India, **83** (3 & 4) : 107-108, 1986

A NOTE ON FIRST RECORD OF *ANADASTUS BIFASCIATUS* (MOTSCHULSKY) [LANGURIIDAE : COLEOPTERA] FROM WEST BENGAL, INDIA.

A. K. Mukherjee and D. N. Biswas
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Introduction

Pére Cardon collected the species *Anadastus bifasciatus* (Motschulsky) from Barway which was stated in Bengal according to Fauna British India, Clavicornia by Arrow (1925). But Barway is located in Bihar not in West Bengal. So this species is now being recorded first time from West Bengal. One of us D. N. Biswas collected this material (2 examples) from Suravisthan, Badkulla, Nadia which is geographically located east of Calcutta and ten kilometers away from Krishnanagar in Nadia. Its distributional range in India is in Kumaon and Haldwani of Uttar Pradesh, Malabar in South India ; Ceylon ; Siam and Hongkong recorded by Arrow (1925). Now, it is being recorded first time from West Bengal in India. The material was collected from grasses while collecting Staphylinid beetles.

Systematic Account

Class INSECTA

Order Coleoptera

Anadastus bifasciatus (Motschulsky)

1860. *Languria bifasciata* Motschulsky, *Schrenek's Reisen im Amurl.* **ii** : 241.

1925. *Anadastus bifasciatus* (Motschulsky), Arrow, *Fauna British India, Erotylidae, Languriidae & Endomychidae* : 230-31.

Material examined : 2 examples, Suravisthan, Badkulla, Nadia, 10 kms. away from Krishnanagar, on grass, 14.3.1982, *D. N. Biswas.*

Species is easily recognised by the banded elytra which is orange in colour. It is under the genus *Anadastus* Gorham because of elytral epipleurae sharply defined, eyes finely facetted, head not dilated in front of the eyes, symmetrical in both sexes. It can easily be determined as a species, *bifasciatus* by its clypeus straight not toothed at its front edge, basal sternite without longitudinal lines, elytra banded and club of antennae composed of 5 joints, elytral extrimities separately rounded which is exception in the genus *Anadastus* Gorham ; head,

terminal segments of the abdomen, club of antenna, outer half of the femora black ; elytra dark blue except the presence of broad transverse median orange band on the elytra.

Further, the species becomes new to National Zoological Collection which will be incorporated accordingly.

Summary

The distributional record of *Anadastus bifasciatus* Motschulsky is noted & discussed.

Acknowledgement

Authors are grateful to Director, Zoological Survey of India and Officer-in-Charge (Scientist 'B') of Coleoptera Section for providing laboratory facilities and guidance to work out the paper.

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Rec. zool. Surv. India, 83 (3 & 4) : 109-120 , 1986

ON A COLLECTION OF THE LEPIDOPTERA FROM RAJASTHAN

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AND

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Among the Lepidoptera occurring in Rajasthan, butterflies have been reported from Jodhpur and Mount Abu by Macpherson (1927), from Pilani by Mathur and Champakavalli (1961), from Udaipur by Kushwaha *et al.* (1963) ; moths from Udaipur by Kushwaha *et al.* (1964) ; and moths and butterflies in general from Rajasthan by Pruthi and Bhatia (1952). The present account deals with 36 species and subspecies in 24 genera and 10 families of Lepidoptera, represented in the collection of Desert Regional Station, Zoological Survey of India, Jodhpur. Of these 36 species and subspecies, 19 are new records for Alwar, Bharatpur, Chittorgarh, Durgapur, Jhunjhunu, Jodhpur and Pali. The common name, forewing length, nomenclatural changes (if any) and distribution of each species have been given.

Family PAPILIONIDAE

Subfamily PAPILIONINAE

1. **Papilio polytes romulus** Cramer

(The common Morimon)

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

1939. *Papilio polytes romulus*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 178.

Material examined : Jhunjhunu, Police line, 1 ex., 6.xi.1962. (*Survery party colln.*). *Fore wing length.*—44 mm.

Distribution : India, Burma and Sri Lanka. This subspecies was previously recorded from Jodhpur, Mount Abu, Pilani and Udaipur. It is a new record for Jhunjhunu.

Change of Address :

DR. R. K. THAKUR, Sandal Research Centre, Malleswaram Bangalore-3.

2. **Papilio demoleus demoleus** Linnaeus
(The Lime Butterfly)

1758. *Papilio demolus* Linnaeus, *Syst. Nat.* (ed. 10), **1** : 464.

1939. *Papilio demoleus demoleus*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 189.

Material examined : Udaipur (Udaisagar), 2 exs., 20.iii.1964 ; Jodhpur (Agloi), 1 ex., 2.ix.1965 (*Coll. V. C. Agarwal*). *Fore wing length.*—38-40 mm.

Distribution : Persia, India, North Burma to China, Taiwan, and Sri Lanka. This nominate subspecies was reported earlier from Jodhpur, Mount Abu, Pilani and Udaipur.

3. **Atrophaneura aristolochiae aristolochiae** (Fabricius)
(The common Rose)

1775. *Papilio aristolochiae* Fabricus, *Syst. Ent.*, : 443.

1981. *Atrophaneura aristolochiae aristolochiae*, Varshney *et al.*, *Rec. zool. Surv. India, Occ. Paper* no. 31 : 24-25.

Material examined ; Jodhpur (Sardarsamand), 2 exs., 26.ix.1963 (*Coll. Moti Lal*) ; Paota (Patodi House), 3 exs., 27.ix.1966 (*Coll. N. K. Parida*) ; Hemawas Dam (Pali), 1 ex., 12.xi.1975 (*Coll. T. G. Vazirani*). *Fore wing length.*—46-50 mm.

Distribution : India, Burma and Sri Lanka. This nominate subspecies was earlier recorded from Jodhpur, Mount Abu, Pilani and Udaipur. It is a new record for Pali.

4. **Graphium nomius nomius** (Esper)
(The Spot Swordtail)

1785-1798. *Papilio nomius* Esper, *Aust. Schmett.* : 210, pl. 52, fig. 3.

1939. *Graphium nomius nomius*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 207.

Material examined : Jodhpur (Mandore), 2 exs., 22.vii.1966 (*Coll. P. D. Gupta*). *Fore wing length.*—42-44 mm.

Distribution : Southern India to Sikkim low lands and Sri Lanka. This nominate subspecies was reported earlier from Mount Abu. It is a new record for Jodhpur.

5. **Graphium agamemnon menides** (Fruhstorfer)
(The Tailed Jay)

1904. *Papilio agamemnon menides* Fruhstorfer, *Insektenk.* **21** (no. 23) : 181.

1939. *Graphium agamemnon menides*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 232.

Material examined : Hemawas Dam (Pali), 2 exs., 15.ix.1975 (*Coll. T. G. Vazirani*). *Fore wing length.*—46-48 mm.

Distribution : (Peninsula) India and and Sri Lanka. This subspecies was previously recorded from Mount Abu and Udaipur. It is a new record from Pali.

Family PIERIDAE

Subfamily PIERINAE

6. **Delias eucharis** (Drury)
(The Common Jezebel)

1773. *Papilio eucharis* Drury, *Ill. exot. Ent.*, **2** : 16, pl. 10, figs. 5, 6 (♂).

1939. *Delias eucharis*, Talbot, *Fauna of British India* (*Butterflies*), 1 : 352.

Material examined : Alwar (Pandoki pole via Sarilesa), 3 exs., 11.xi. 1973 (*Coll. Y. P. Sinha*). *Fore wing length.*—34-42 mm.

Distribution : Lower slopes of the Himalayas, peninsular India and Sri Lanka. This species was previously recorded from Jodhpur, Mount Abu and Udaipur. It is a new record for Alwar.

7. **Colotis danae dulcis** (Butler)
(The Crimson Tip)

1876. *Teracolus dulcis* Butler, *Proc. zool. Soc. Lond.* : 157, pl. 7, fig. 13 (♂ ♀).

1927. *Colotis danae dulcis*, Macpherson, *J. Bombay nat. Hist. Soc.*, **32** (1) : 229.

Material examined : Bharatpur (Uncha Nagala), 4 exs., 15.x.1973 (*Coll. Y. P. Sinha*). *Fore wing length.*—20-25 mm.

Distribution : Baluchistan and India. This subspecies is earlier known from Jodhpur and Mount Abu. It is a new record for Bharatpur.

8. **Colotis etrida etrida** (Boisduval)
(The Little Orange Tip)

1836. *Anthocharis etrida* Boisduval, *Sp. Gen. Lep.*, **1** : 576.

1939. *Colotis etrida etrida*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 465.

Material examined : Jodhpur (Chandel Village tank *ca* 40 kms. South of Jodhpur), 1 ex, 18.xi.1965 (*Coll. V. C. Agarwal*) ; Balasmand, 1 ex., 5.x.1962 (*Coll. K. C. Kansal*). *Fore wing length.*—13-22 mm.

Distribution : India (Kathiawar), Sind to Baluchistan. This nominate subspecies was previously reported from Jodhpur, Mount Abu, Udaipur and Pilani.

9. **Colotis fausta faustina** (Felder & Felder)
(The Large Salmon Arab)

1865. *Idmais faustina* Felder & Felder, *Reise novara*, **2** : 190.

1939. *Colotis fausta faustina*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 460.

Material examined : Jodhpur, Sangaria Kuri Village, 5 exs., 29.x. 1963 (*Coll. Moti Lal*). *Fore wing length.*—20-30 mm.

Distribution : Pakistan (Sind) and India (Old Punjab, Karwar). This subspecies was previously reported from Jodhpur and Mount Abu.

10. **Colotis calais amata** (Fabricius)
(The Small Salmon Arab)

1775. *Papilio amata* Fabricius, *Syst. Ent.* : 476.

1939. *Colotis calais amata*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 454.

Material examined : Jodhpur, Paota (Patodi House), 2 exs., 24.x.1966 (*Coll. N. K. Parida*), Salawas village ; 3 exs., 21.xii.1962, (*Coll. Moti Lal*). *Fore wing length.*—18-20 mm.

Distribution : India (except North-East India) and Sri Lanka. This subspecies was earlier recorded from Jodhpur and Udaipur.

11. **Colotis phisadia protractus** (Butler)
(The Blue Spotted Arab)

1876. *Tetracolus protractus* Butler, *Proc. zool. Soc. Lond.*: 137.

1939. *Colotis phisadia protractus*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 456.

Material examined : Jodhpur, Paota, 12 exs., 18. viii. 1961 (*Coll. Ramneet Singh*). *Fore wing length.*—20-22 mm.

Distribution : Baluchistan, Persia, Pakistan and India. This subspecies was earlier known from Jodhpur.

12. **Ixias marianne** (Cramer)
(The white Orange Tip)

1782. *Papilio marianne* Cramer, *Pap. Exot.* 3 : pl. 217, figs. C-E.

1939. *Ixias marianne*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 440.

Material examined : Alwar, 4 exs., 11.x.1973 (*Coll. Y. P. Sinha*). *Fore wing length.*—25-27 mm.

Distribution : India and Sri Lanka. This species was previously recorded from Mount Abu and Udaipur. It is a new record for Alwar.

13. **Anaphaeis aurota aurota** (Fabricius)
(The Pioneer)

1793. *Papilio aurota* Fabricius, *Ent. Syst.* **3** (1) : 197.

1939. *Anaphaeis aurota aurota*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 380.

Material examined : Jodhpur, Lombia talab, 1 ex., 23.xi.1963, Luni, 1 ex., 8.vii.1963 (*Coll. K. C. Kansal*) ; Beriganga village, 3 exs., 21.ix.1963 (*Coll. Moti Lal*) ; Mandore, 1 ex., 9. ix. 1964 (*Coll. V. C. Agarwal*) ; Patodi House, 14.xii.1966 (*Coll. N. K. Parida*). *Fore wing length.*—20-27 mm.

Distribution : India (except Assam) and extends to Palestine and Africa. This nominate subspecies was earlier reported from Jodhpur, Mount Abu and Pilani.

Subfamily COLIADINAE

14. **Eurema hecabe simulata** (Linnaeus)

(The Common Grass Yellow)

1758. *Terias simulata* Moore, *Lep. Ceylon*, **1** : 119.

1939. *Eurema hecabe simulata*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 52.

Material examined : Jodhpur, Public garden, 4 exs., 17.viii.1962 (*Coll. Moti Lal*) ; Nalah near Abu Road, Railway Station, 2 exs., 6.iii.1964 (*Coll. V. C. Agarwal*) ; Durgapur, Surpur Ki Nadi, 4 exs., 20.iii.1964 (*Coll. R. N. Bhargava*) ; Jodhpur Paota, (Patodi House), 9 exs., 25.x.1966 (*Coll. N. K. Parida*) ; Hemawas Dam (Pali) 2 exs., 15.ix.1975 (*Coll. T. G. Vazirani*). *Fore wing length.*—20-25 mm.

Distribution : India, Burma and Sri Lanka. This subspecies was previously recorded from Jodhpur, Mount Abu and Pilani. It is a new record for Durgapur and Pali.

15. **Eurema brigitta rubella** (Wallace)

(The Small Grass Yellow)

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

1939. *Eurema brigitta rubella*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 515.

Material examined : Alwar (Pando Ki Pole via Sariska), 7 exs., 11.x.1973. (*Coll. Y. P. Sinha*). *Fore wing length.*—16-19 mm.

Distribution : South China, India (including Nicobar Islands) ; Burma and Sri Lanka. This subspecies earlier known from Jodhpur, is a new record for Alwar.

16. **Catopsilia crocale crocale** (Cramer)

(The Common Emigrant)

1775. *Papilio crocale* Cramer, *Pap. Exot.*, **1** : 87, pl. 55. Figs. C, D, ♀.

1939. *Catopsilia crocale crocale*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 492.

Material examined : Jodhpur, Public Garden, 6 exs., 14.viii.1962 ; Salawas, 3 exs., 21.xii.1962 ; Beriganga village, 3 exs., 21.ix.1963 (*Coll. Moti Lal*) ; Luni, 1 ex., 8.vii.1963 (*Coll. K. C. Kansal*) ; Paota, Patodi House, 1 ex., 14.xii.1966 (*Coll. N. K. Parida*). *Fore wing length.*—27-37 mm.

Distribution : India, Burma and Sri Lanka. This nominate subspecies was previously reported from Jodhpur, Mount Abu, Udaipur and Pilani.

17. **Catopsilia florella gnoma** (Fabricius)

(The African Emigrant)

1775. *Papilio gnoma* Fabricius, *Syst. Ent. App.* : 828.

1939. *Catopsilia florella gnoma*, Talbot, *Fauna of British India* (*Butterflies*), **1** : 500-501.

Material examined ; Jodhpur, Paota (Patodi House), 25 exs. 4.x.1966 (*Coll. N. K. Parida*). *Fore wing length.*—25-34 mm.

Distribution : India, Burma and Sri Lanka. This subspecies was earlier recorded from Mount Abu, Jodhpur, Udaipur and Pilani.

Family DANAIDAE

18. **Danaus chrysippus chrysippus** (Linnaeus)

(The Plain Tiger)

1758. *Papilio chrysippus* Linnaeus, *Syst. Nat.* (ed. 10), **1** : 471.

1917. *Danaus chrysippus chrysippus*, Talbot, *Fauna of British India* (*Butterflies*), **2** : 19-23.

Material examined : Jodhpur, Balamand, 2 exs., 5.ix.1962 (*Coll. K. C. Kansal*) ; Kuri village, 1 ex., 26.vi.1964 ; Agloi, 1 ex., 18.ix.1964 ; Bharatpur, Naoh village, 3 exs., 18.x.1973, Hemawas Dam (Pali) 2 exs., 17.x.1978 (*Coll. J. C. Tripathi*). *Fore wing length.*—35-40 mm.

Distribution : India, Burma and Sri Lanka. This nominate subspecies was earlier known from Jodhpur, Mount Abu, Pilani and Udaipur. Donahue (1962) reported *D. chrysippus* form *dorippus* Klug erroneously referred to by Donahue as Cramer) from Pali. It is a new record for Bharatpur.

19. **Danaus genutia** (Crammer)

(The Common Tiger)

1779. *Papilio genutia* Cramer, *Pap. exot.*, **3** : 23, pl. 203.

1981. *Danaus genutia*, Varshney *et al.*, *Rec. zool. Surv. India, Occ. Paper*, No. **31** : 13.

Material examined : Jodhpur, Kailara, 1 ex., 18.iv.1962 (*Coll. Survey party*), 1 ex., 20.iii.1963, Chittorgarh, 2 exs., 13.iii.1964, Udaipur, Fatehsagar, 2 exs., 18.iii.1964, Yakhat Sagar, 1 ex., 15.iv.1965 (*Coll. V. C. Agarwal*) ; Kailana, 1 ex., 17.ix.1963. (*Coll. R. C. Sharma*) ; Durgapur, Gope Nagar, Gope Sagar, 2 exs., 23.iii.1964, Jodhpur, Bijolai, 1 ex.,

24.iv.1965 (*Coll. R. N. Bhargava*) ; Bharatpur, Noah Village, 2 exs., 18.x.1973 (*Coll. Y. P Sinha*) ; Hemawas Dam (Pali) 1 ex., 17.x.1978 (*Coll. J. C. Tripathi*). *Fore wing length.*—37-42 mm.

Distribution : Indo-Malayan Subregion, Sulawesi and Key Islands. This subspecies was previously reported from Jodhpur, Mount Abu, Pilani and Udaipur. It is a new record for Bharatpur, Chittorgarh, Durgapur and Pali.

20. **Euploea core core** (Cramer)

(The Common Indian Crow)

1780. *Papilio core* Cramer, *Pap. exot.* 3 : pl. 266, figs. E, F, ♂.

1947. *Euploea core core*, Talbot, *Fauna of British India* (*Butterflies*) **2** : 66-67.

Material examined : Raghunath, Sikar, 1 ex., 27.ix.1973. (*Coll. Y. P. Sinha*) ; Jodhpur, Kuchaman Road, 23.viii.1974 (*Coll. T. G. Vazirani*) ; Hemawas Dam (Pali) 3 exs., 17.x.1978 (*Coll. J. G. Tripathi*). *Fore wing length.*—40-45 mm.

Distribution : India and Burma. This nominate subspecies was earlier recorded from Jodhpur, Mount Abu, Udaipur and Pilani. It is a new record for Pali.

Family SATYRIDAE

21. **Melanitis leda ismene** (Cramer)

(The Common Evening Brown)

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

1947. *Melanitis leda ismene*, Talbot, *Fauna of British India* (*Butterflies*), **2** : 366-369.

Material examine l : Jodhpur (Agricultural Field Ca 14 Kms. North of Jodhpur), 6 exs., 10.ix.1964 (*Coll. R. N. Bhargava*). *Fore wing lengt*^{h}. —30-40 mm.

Distribution : Japan, South China (Taiwan), India, Burma, Sri Lanka, Malaya, Sumatra and Borneo. This subspecies was previously reported from Jodhpur, Mount Abu, Udaipur and Pilani.

Family NYMPHALIDAE

22. **Phalanta phalantha phalantha** (Drury)

(The Common Leopard)

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

1980. *Phalanta phalantha phalantha*, Varshney *et al.*, *Rec. zool. Surv. India, Occ. Paper* No. 31 : 18-19.

Material examined : Jodhpur, Mandore Garden, 1 ex., 22.xii.1966 (*Coll. P. D. Gupta*). *Fore wing length.*—26-30 mm.

Distribution : Baluchistan, India, Burma and Sri Lanka. This nominate subspecies is previously recorded from Jodhpur, Mount Abu and Udaipur.

23. **Precis almana almana** (Linnaeus)
(The Peacock Pansy)

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

1932. *Precis almana almana*, Evans, *Identification of Indian Butterflies* : 176.

Material examined : Jodhpur, Salawas village, 3 exs., 21.xii.1962 (*Coll. Moti Lal*). *Fore wing length.*—30-32 mm.

Distribution India, Burma and Sri Lanka. This nominate subspecies is earlier known from Jodhpur, Mount Abu and Udaipur.

24. **Precis hierta hierta** (Fabricius)
(The Yellow Pansy)

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

1932. *Precis hierta hierta*, Evans, *Identification of Indian Butterflies* : 176.

Material examined : Jodhpur, Public Garden, 2 exs., 17.viii.1962, 4 exs., 20.ix.1963 (*Coll. Moti Lal.*) ; Paota (Patodi House), 3 exs., 12.ii. 1964 (*Coll. V. C. Agarwal*) ; Alwar, Siliserta Bund, 3 exs., 10.x.1973 (*Coll. Y. P. Sinha*). *Fore wing length.*—20-30 mm.

Distribution : Baluchistan, India and Sri Lanka. This nominate subspecies was previously reported from Jodhpur, Mount Abu, Udaipur Palani. It is a new record for Alwar.

25. **Precis lemonias vaisya** Fruhstorfer
(The Lemon Pansy)

1912. *Precis vaisya* Fruhstorfer, In Seitz : *The Macrolepidoptera of the world*, **9** : 520.

1932. *Precis lemonias vaisya*, Evans, *Identification of Indian Butterflies* : 176.

Material examined : Jodhpur, Paota (Patodi House), 3 exs., 19.ix1966 (*Coll. N K. Parida*). *Fore wing length.*—22-30 mm.

Distribution : India and Sri Lanka. This subspecies is earlier known from Jodhpur, Mount Abu and Udaipur.

26. **Precis orithya swinhoei** (Butler)
(The Blue Pansy)

1885. *Junonia orithyia swinhoei* Butler, *Ann. Mag. nat. Hist. London*, (5) **16** : 309.

1932. *Precis orithya swinhoei*, Evans, *Identification of Indian Butterflies* : 176.

Material examined : Jodhpur, Paota (Patodi House), 6 exs., 19.xii.1966 (*Coll. N. K. Parida*). *Fore wing length.*—20-30 mm.

Distribution : Baluchistan, India and Sri Lanka. This subspecies was earlier reported from Jodhpur, Mount Abu, Udaipur and Pilani. However, Pruthi and Bhatia (1952) referred to its common occurrence in Rajasthan.

Family LYCAENIDAE

27. **Tarucus callinara** Butler

(The Spotted Pierrot)

1886. *Tarucus callinara* Butler, *Ann. Mag. nat. Hist. Lond.*, (5) **18** : 185.

1927. *Tarucus theophrastus*, Macpherson, *J. Bombay nat. Hist. Soc.* **32** (1) : 230.

1962. *Tarucus callinara*, Cantlie, *The Lycaenidae portion (except the Arhopala Group) of Brigadier Evans' the Identification of Indian Butterflies* : 33.

Material examined : Jodhpur, Paota (Patodi House), 7 exs., 21.ix.1966 (*Coll. N. K. Parida*). ***Fore wing length.***—12-13 mm.

Distribution : Pakistan (Peshwar) to India ; and North Burma. This species was earlier known from Jodhpur and Mount Abu.

Family SPHINGIDAE

Subfamily ACHERONTIINAE

28. **Acherontia styx styx** (Westwood)

(The Til Leaf Caterpillar)

1848. *Sphinx* (*Acherontia*) *styx* Westwood, *Cab. Or. Ent.* : 88, pl. 42, Fig. 3.

1937. *Acherontia styx styx*, Bell and Scott, *Fauna of British India* (*Moths*), **5** : 58.

Material examined : Jodhpur, Paota, 3 exs., 15.ix.1961 (*Coll. K. C. Kansal*), Bijolai, 2 exs., 12.ix.1979 (*Coll. K. V. Rama Rao*). ***Fore wing length.***—45-60 mm.

Distribution : India, Burma and Sri Lanka.

29. **Psilogramma menephron menephron** (Cramer)

(The Stout Grey Moth)

1780. *Sphinx menephron* Cramer, *Pap. Exot.*, **3** : 164.

1937. *Psilogramma menephron menephron*, Bell and Scott, *Fauna of British India* (*Moths*), **5** : 77.

Material examined : Jodhpur, Paota, 1 ex., 18.vii.1963. (*Coll. V. C. Agarwal*). ***Fore wing length.***—50 mm.

Distribution : India, China and eastwards to Solomon Islands. This nominate subspecies previously recorded from Udaipur is a new record for Jodhpur.

Subfamily CHEROCAMPINAE

30. **Celerio euphrobiae nervosa** Rothschild & Jordan.

1903. *Celerio euphorbiae nervosa* Rothschild & Jordan, *Revis. Sphing.* : 721.

Material examined : Jodhpur, Mandore, 1 ex., 9.ix.1964 (*Coll. V. C. Agarwal*), Paota ; 2 exs., 10.ix.1964 (*Coll. R. N. Bhargava*). *Fore wing length*.—36-38 mm.

Distribution : Western Himalayas (Ladakh, foot of the Zolila pass, Kashmir, Changla Gali and Sabathu). This subspecies is a new record for Jodhpur.

31. **Hippotion boerhaviae** (Fabricius)

1775. *Sphinx boerhaviae*, Fabricius, *Syst. Ent.* : 542.

1937. *Hippotion boerhaviae*, Bell & Scott, *Fauna of British India* (*Moths*), **5** : 424.

Material examined : Bharatpur, 3 exs., 15.x.1973. (*Coll. Y. P. Sinha*). *Fore wing length*.—32 mm.

Distribution : Southern China, Western and Eastern Himalayas, Southern India, Sri Lanka, Malaya and Philippines.

Family AGANAIDAE

32. **Aganais ficus** (Fabricius)

1794. *Noctua ficus* Fabricius, *Ent. Syst.* **3** (2) : 27, 62.

1964. *Aganais ficus*, Kushwaha *et al.*, *Univ. Udaipur Res. Studies*, **2** : 113.

Material examined : Bharatpur, Uchara village, 6 exs., 17.x.1973 (*Coll. Y. P. Sinha*). *Fore wing length*.—29-32 mm.

Distribution : India and Sri Lanka. The species is a new record for Bharatpur.

Family AGARISTIDAE

33. **Aegocera venulia** (Cramer)

(The Orange Yellow Moth)

1777. *Phalaena venulia* Cramer, *Pap. Exot.*, **2** : pl. 165, Fig. C, D.

1894. *Aegocera venulia*, Hampson, *Fauna of British India* (Moths), **2** : 158.

Material examined : Jodhpur, Mandore, 4 exs., 8.xi.1963 (*Coll. Moti Lal*) ; Hemawas Dam (Pali) 12 exs., 29.xi.1971. (*Coll. P. D. Gupta*). *Fore wing length*—32-34 mm.

Distribution : Sub-Himalayan tracts of Kashmir and Sikkim, plains of India, Burma and Sri Lanka. The species is a new record for Jodhpur.

Family ARCTIIDAE

34. **Utetheisa pulchella** (Linnaeus)

(The White Moth)

1767. *Tinea pulchella* Linnaeus, *Syst. Nat.*, **1** (2) : 884.

1961. *Utetheisa pulchella*, Kundu *et al.*, *Proc. Rajasthan Acad. Sci.* 8 (1-2) : 81.

Material examined : Jodhpur, 12 exs., 10.iv.1975. (*Coll. T. G. Vazirani*) ; Kailana Lake, 5 exs., 7.ii.1976 (*Coll. N. S. Rathore*). *Fore wing length*.—20-23 mm.

Distribution : Africa, Europe, India, Sri Lanka, Malaya Archipelago, New Guinea, Australia and the Pacific groups. The species was earlier known from Pilani and Udaipur and is now recorded from Jodhpur. However, Pruthi and Bhatia (1952) referred to this moth being common in Rajasthan.

35. **Grammodes stolida** (Fabricius)

(The Linseed Caterpillar)

1781. *Noctua stolida* Fabricius, *Sp. Ins.*, **2** : 218, No. 54.

1894. *Grammodes stolida*, Hampson, *Fauna of British India* (*Moths*), **2** : 532.

Material examined : Jodhpur, Paota (Patodi House), 11 exs., 4-5, viii.1975 (*Light Trap Colln.*). *Fore wing length*.—15-20 mm.

Distribution : Africa, Europe, India and Aden. This species previously recorded from Udaipur, is a new record for Jodhpur.

Family : PYRALIDAE

Subfamily : PYRAUSTINAE

36. **Diaphania indica** (Saunders)

1851. *Eudioptes indica* Saunders, *Trans. ent. Soc. Lond.*, **1** (2) : 163, pl. 12, figs. 5-7.

1980. *Diaphania indica*, Mandal and Bhattacharya, *Rec. zool. Surv. India*, **77** : 325.

Material examined : Jodhpur, Paota (Patodi House), 6 exs., 4-5.viii. 1975 (*Light Trap Colln.*). *Fore wing length*.—12-13 mm.

Distribution : Ethiopia, Pakistan, China, India, Burma, Sri Lanka, Taiwan, Sulawesi, Java and Australia. The species is a new record for Jodhpur.

SUMMARY

Butterflies and Moths were previously mainly known from Jodhpur, Mount Abu, Pilani and Udaipur. Of the 36 species and subspecies presently dealt with, 19 constitute new records for Alwar, Bharatpur, Chittorgarh, Durgapur, Jhunjhunu, Jodhpur and Pali.

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Rec. zool. Surv. India, **83** (3 & 4) : 121-125, 1986

STATUS OF THE SPECIES OF *DJOMBANGIA* BOVIEN, 1926 (CESTOIDEA : CARYOPHYLLIDEA : LYTOCESTIDAE)

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INTRODUCTION

So far three species have been described in the genus *Djombangia* Bovien, 1926 from India, in addition to the type species *D. penetrans* Bovien, 1926, from Java. An attempt to prepare a key to these species to separate them failed. After examining the type material (Z.S.I. Reg. No. W 7476/1) of *Djombangia clariae* Kundu, Bhattacharya and Datta (1985) and other material of the genus in the collection of Mr. D. K. Kundu (by his kind courtesy), it was discovered that the three Indian species, have been described on the basis of characters which are inconstant, transient, disputed or erroneous. So the author considers them as synonyms of the type species, rendering *Djombangia* monotypic so far.

The citations marked with asterisk were not consulted in original by the author.

SYSTEMATIC ACCOUNT

Class : CESTOIDEA RUDOLPHI, 1808

Subclass : CESTODA CARUS, 1863

Order : CARYOPHYLLIDEA VAN BENEDEN (IN CARUS, 1863)

Family : LYTOCESTIDAE Wardle and Mcleod, 1952 (Syn. *Lallidae* Johri, 1959)

Genus **Djombangia** Bovien

1926. *Djombangia* Bovien, *Vidensk Meddr. dansk naturh. Foren.*, **82** : 157.

Remarks : The genus *Djombangia* was proposed by Bovien (1926)* from the duodenum of the air-breathing catfish, *Clarias batrachus* (Linn.), recovered at Djombang from river Bantas in East Java. Unlike other lytocestids it is structurally peculiar in being distinctly divided into three parts—an anterior globular or triangular scolex, followed by an attenuated neck region and a posterior flattend oval body proper. The scolex almost invariably has a terminal introvert and profusely

provided with glandular cells below the body wall. Quite many of them get concentrated around the introvert which, when the worm is flattened, sometimes give the appearance of a muscularly weak sucker-like structure. Actually there is no sucker. Sahay and Sahay's (1977) Fig. 1 is the most correct illustration of the scolex in *Djombangia*. The neck region is highly contractile, and thus may be short or long after fixing. In overflattened specimens it may look sharply marked off from the body proper. The neck region is also provided with a layer of glandular cells below the body wall. The body proper is flattened and forms more or less shoulders with the neck, depending upon the condition of contraction and relaxation at the time of fixation. It contains all the organ systems of the worm.

The salient features of the genus are :

1. The peculiar division of the body into three regions as discussed above.
2. The formation of a terminal introvert in the scolex and the concentration of glandular cells around it giving a sucker-like appearance ; no actual sucker is present.
3. Highly contractile character of neck region.
4. The ascending coils of the uterus extend anteriorly as far as the testicular field near the shoulder ; the eggs are operculate, may or not be spinuous and embrygnated in the uterus.
5. Seminal receptacle being a transient structure may or may not be distinctly formed.
6. External seminal vesicle is absent.
7. The circus sac, although muscular, is sometimes seen with difficulty ; its orientation is opposite of the orientation of the body, and is disposed so as the genital atrium comes to lie in front of the ovarian commissure.
8. The vitellarian follicles are cortical, surrounding the lateral medullary testicular field, and not at all intruding into the postovarian region. However, in overflattened specimens a few follicles may be pushed behind the medullary ovary.

The normal host of the genus *Djombangia* seems to be the walking catfish, *Clarias batrachus*, but *Heteropneustes fossilis*, another air-breathing catfish, may also serve as possible host as Sahay and Sahay (1977) have reported. They are the parasites of duodenum of the gut of the host. The scolex serves as the holdfast as well as the penetrating organ. Due to the action of the glandular cells of the scolex and the

neck regions on the duodenal wall of the host, 'diverticulosis' is caused. The diverticula so formed in the duodenal wall may or may not be perforated, depending upon the severity of the action of the glandular cells. The report of occurrence of the genus in intestine or stomach of the host needs corroboration, the genus probably being location-specific in the duodenum.

Djombangia penetrans Bovien

1926. *Djombangia penetrans* Bovien, *Vidensk Meddr. dansk naturh. Foren.*, **82** : 157.

1974. *Djombangia indica* Satpute and Agarwal, *Indian J. Expl. Biol.*, **12** (4) : 373.

1977. *Djombangia caballeroi* Sahay and Sahay, In : *Excerta Parasitologica en memoria del doctor Eduardo Y Caballero,* Institute de Biologia Publicaciones Especiales, Mexico, **4** : 371.

1980. *Djombangia indica* : Satpute and Agarwal, *Proc. Indian Acad. Parasitol.*, **1** : 13.

1985. *Djombangia clariae* Kundu, Bhattacharya and Datta, *Bull. zool. Surv. India*, **7** (2-3) : 151.

Remarks : Since the description of the type species, *D. penetrans* Bovien, 1926 from the duodenum of *Clarias batrachus* from Java, three more species have been added to the genus from India. They are :

D. indica satpute and Agarwal, 1974 in the duodenum of *Clarias batrachus* from Raipur, Madhya Pradesh ; *D. caballeroi* Sahay and Sahay, 1977 in the stomach of *Heteropneustes fossilis* from Chotanagpur, Bihar State ; *D. clariae* Kundu *et al.*, 1985 in the intestine of *Clarias batrachus* from Bongaon, West Bengal.

The type species, *D. penetrans*, is originally described to possess minute spines on the eggs. In *D. caballeroi* and *D. clariae* the eggs are reported to be smooth and unspined. Satpute and Agarwal (1974) observed that the eggs in their species *D. indica* are "smooth unspined", whereas, while giving detailed taxonomical account of the species on the basis of the same material, they (1980) mentioned the eggs to be "covered with 3 μ spinuous projections". Mackiewicz (1972) referred Bovien (1926)* and Löser (1965)* to state that the eggs in *D. penetrans* and *Khawia iowensis* become finely spinuous due to the secretion of the glandular part of the uterus when they pass through it and not before. But he does not loose time to remark on the same page that "These data, however, do not explain their functions with respect to non-spinuous eggs, which include most caryophyllidean eggs." The remark seems to be cryptic and meaningful. The exact nature of these fine structures, which have been called 'spines,' is not known. It is also not known whether they are part and parcel of the eggs and remain attached or disappear after doing the needful. That is why

the author is not much inclined to give weight to this character in *Djombangia* to separate species till more information becomes available. Mackiewicz (1981) has opined that seminal receptacle in *D. penetrans* is a transient structure which may or may not be distinctly formed. So, it should not be used for distinguishing species. The author concurs with him. Sahay and Sahay (1977) have mentioned that the vitelline follicles in their species remain restricted up to the ovarian level, but in overflattened specimens a few of them may slip into the post-ovarian space as reported in *D. indica*.

The three Indian species have been differentiated from the type species of the genus or among themselves on the basis of characters which are incostant, transient and disputed or develope due to overflattening of the worm. Such characters have been discussed above at length, and therefore they are not of systematic value. The author therefore considers *D. indica* Satpute and Agerwal, 1974, *D. caballeroi* Sahay and Sahay, 1977, and *D. clariae* Kundu *et al.*, 1985 as synonyms of the type species, *D. penetrans* Bovien, 1926. The genus *Djombangia* Bovien, 1926 is therefore monotypic so far.

Summary

The genus *Djombangia* Bovien, 1926 is reviewed. *D. caballeroi* Sahay and Sahay, 1977 is believed to have been in part erroneously described so far as the male & female terminal ducts are concerned. A careful comparision of *Djombangia indica* Satpute and Agarwal, 1964, *D. caballeroi* Sahay and Sahay, 1977 and *D. clariae* Kundu, Bhattacharya and Datta, 1985 with the type species *D. penetrans* Bovien, 1926 and among themselves reveals that they have been described and distinguished on the basis of inconstant, transient and disputed characters, or features which develope due to overflattening of the worm. So, they are relegated to synonymy with the type species. The genus *Djombangia* is therefore monotypic so far.

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Rec. zool. Surv. India, **83** (3 & 4) : 127-134, 1986

OBSERVATION AND DESCRIPTION OF TWO NEW SPECIES OF CRAB *DEMANIA INDIANA* SP. NOV. AND *D. ALCOCKI* SP. NOV. FROM EAST COAST OF INDIA

By

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INTRODUCTION

The genus *Xantho* (*Lophoxanthus*) as cited by Alcock in 1898, is now known as *Demania* Laurie 1906. The status of two new varieties of Alcock are now raised to species level as *D. baccalipes* (Alc.) and *D. cultripes* (Alc.) by Guinot (1979 : 59). Alcock's eight specimens of three species of *Demania* were arranged with the named general collection of Z.S.I. and did not bear any specific labels for the type catagory and two specimens were wrongly named and misidentified. But I could recognise both the types from the localities, measurements and descriptions given by Alcock.

Present literature reveals that both the misidentified and wrongly labelled Indian specimens of *X* (*L*) *soaberrimus* designated and described by Alcock belong to different species, both of them are new species. One of them is a very large crab apparently almost similar to *D. toxica* Garth 1971, a poisonous crab of Philippine Island, but differs from the *D. toxica* in several significant points.

Demania Laurie

Demania Laurie 1906 : 396 ; Guinot 1967 : 704 ; 1969 : 234 ; 1979 : 57 : 1981 : 1118 ; Takeda and Miyake 1969 ; 456 ; Garth 1971 : 179 ; Sakai 1976 : 420.

Lophoxanthus M. Edwards 1861 : 256 ; Alcock 1898 : 116 ; Sakai 1934 : 309 ; Buitendijk 1950 : 77.

Xantho Walker 1887 : 109 ; Rathbun 1910 : 350 ; Odhner 1925 : 79 ; Sakai 1936 : 149 ; 1939-461.

Carapace not very broad, somewhat pentagonal in shape, convex antero posteriorly and less so from side to side. Regions and subregions of carapace well marked, studded with convex lobules, granules etc. Upper surfaces of these lobules are smooth, rounded or conical or scaly. Anterolateral sides either thick, blunt or thin, continued below the eye towards the anterolateral angle of buccal cavern and divided into four, shallow lobes or conical teeth excluding the outer orbital

angle. Posterolateral sides concave or straightly convergent. Front prominent, in some cases projected beyond the orbit. Orbital edge rough, with three sutures near the outer angle. Antennules obliquely fold. Efferent branchial channel present upto the side of buccal cavern. Chelipeds massive, equal or almost so, fingers bluntly pointed, upper edge of arm of chelae crested, toothed upper edge of palm toothed bluntly or pointedly. Leg joints broad, compressed or rounded, narrow. Upper edges of merus carpus and propodus of legs either crested or crenate, or entire and ends bluntly or in a spine. Lower edges of merus and propodus crested entirely. Dactylus rounded and with an upper and a lower band of valvety, short hairs. Male abdomen five jointed.

Remarks : The genus *Demania* comprises 12 world record of known species so far and three species viz. *D. toxica* Garth, *D. alcalai* Garth, *D. reynaudii* (M. Edw.) are found to be highly toxic to man and domestic animals. The poisonous nature of the other Indian species has yet to be ascertained.

Distribution : Tropical Indo Pacific, ranges from Bay of Bengal, E. Coast of India, Sri Lanka to Philippines, northern Queensland and Japan and said to inhabit coral reefs, rocky beaches and bottoms ; cervices in rocks or coral reefs at a depth, range from 0-125 m.

Key to the species from India and Sri Lanka

1.	Frontal lamina rather broad and horizontal.···	*alcocki*
2.	Frontal lamina rather narrow, medially produced, free edge of lamina concave. ···	··· 3
3.	Upper edge of merii of walking legs created. ···	··· 4
	Upper edge of merii of walking legs beaded. ···	*baccalipes*
4.	Last two antero-lateral teeth prominent, triangular. ···	*cultripes*
	Last two antero-lateral teeth low, shallow lobes. ···	··· 5
5.	Regions of carapace well demarcated, tubercular all over. ···	*splendida*
	Regions of carapace well demarcated, faintly scabrous only posteriorly. . .	*indiana*

Demania alcocki sp. nov.

(Pl. I, fig. 1)

Xantho (*Lophoxanthus*) *scaberrimus* Alcock 1898 : 116.

Holotype Male, Z.S.I. Regd. no. 317/7 ; collected from Orissa coast, 11 fms. on 15.1.1889. Width—7 mm, Length—6 mm.

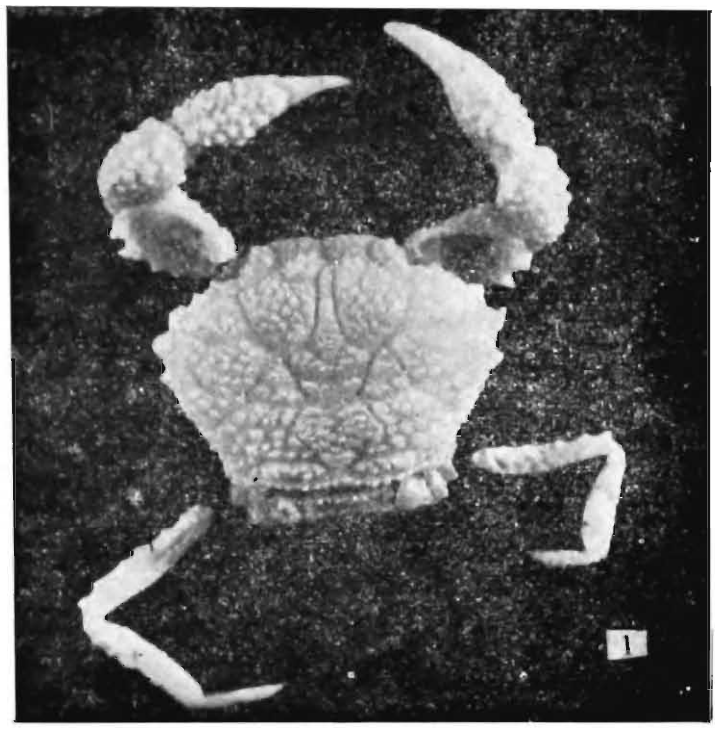

Fig. 1. *D. alcocki* sp. nov.

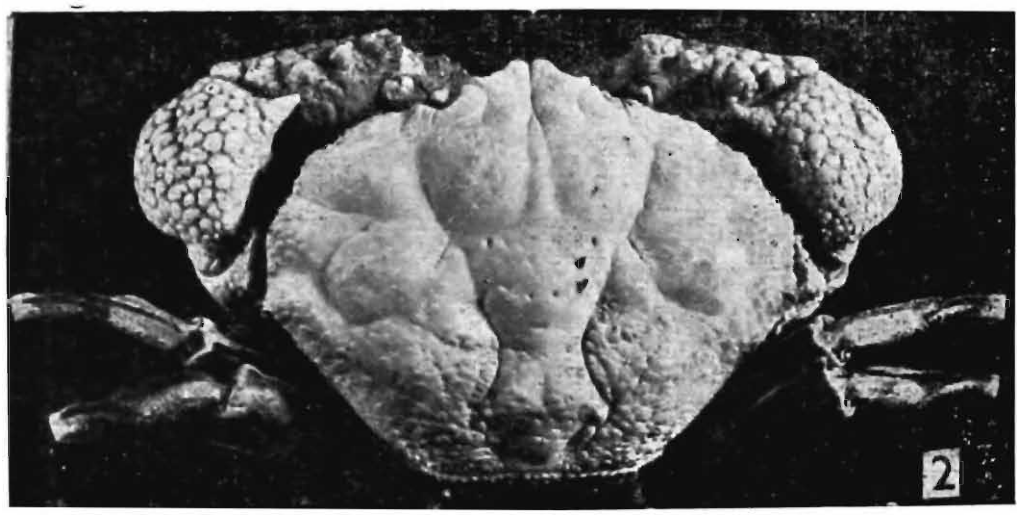

Fig. 2. *D. idiana* sp. nov.

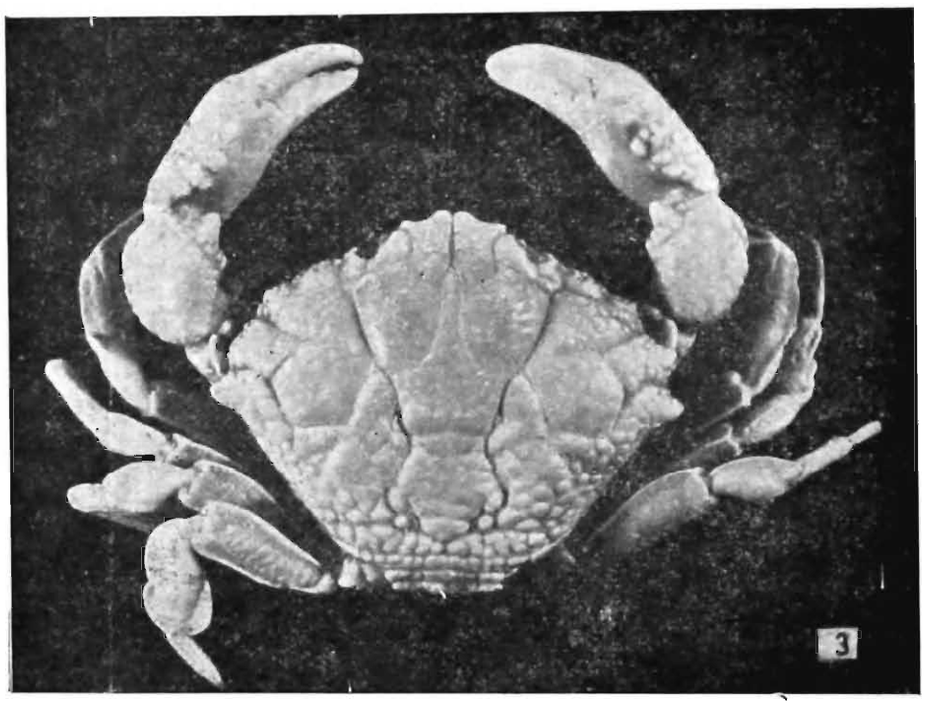

Fig. 3. *D. cultripes* (Alcock)

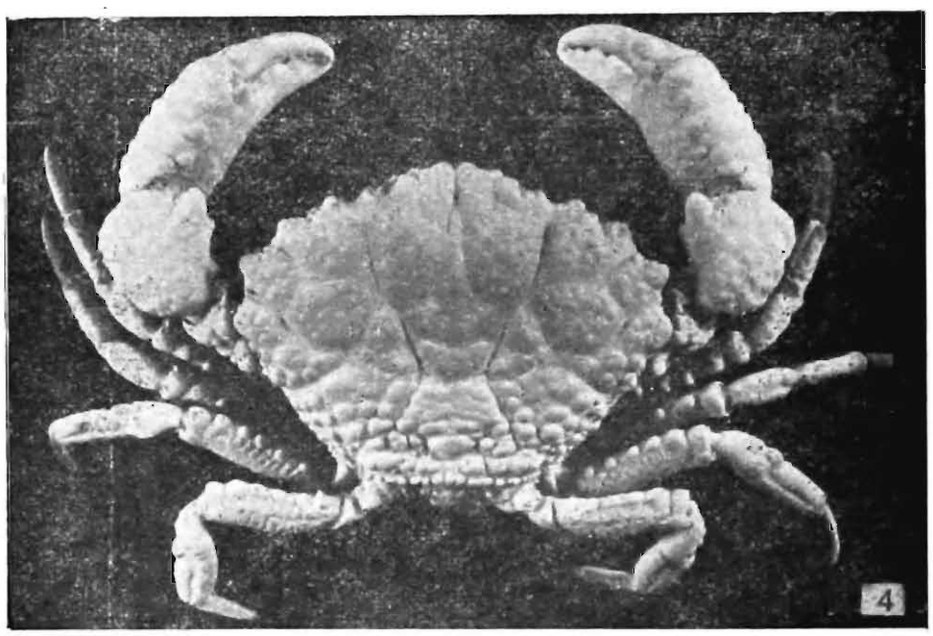

Fig. 4. *D. baccalipes* (Alcock)

Diagnostic characters : Carapace somewhat hexagonal in shape, not much broader than long, it is very convex antero-posteriorly at the region of last two anterolateral teeth and not so from side to side. Entire carapace divided by smooth, deep, broad grooves into regional lobules. The entire surface of carapace, its under surface and chelipeds are covered with smooth granules, these granules are neither uniform in shape and size nor confluent in nature. The granules on the male abdominal or pareopods are small and pearly in nature. Front horizontal, rather broad, about one third of the greatest width of carapace, bilaminar, not produced beyond the orbital edge. Frontal lamina obliquely deflexed downwards, free edge granular, outer angle distinct but not notched off. Anterolateral sides adorned with four, conical teeth, other than the outer orbital angle. First tooth low, small, second and fourth teeth same in size and the third tooth most prominent, directed forward, and the carapace is widest at the level of third tooth. Posterolateral sides beaded, convergent. Posterior margin of carapace is beaded and measures slightly more than half of the greatest width of carapace. Orbits rather larger than the other known Indian species, margins rough, eye stalks thick, eyes large and are almost exposed entirely. Antennules fold transversely.

Chelipeds equal in male, upper edge of arm dentate, the two subterminal dents most prominent spinelike. Outer and lower sides of arm, wrist and all the surfaces of palm thickly covered with sharp, prominent, granules. On lower outer sides of palm these granules are arranged in longitudinal rows. Inner corner of wrist bidentate ; fingers longitudinally grooved and pointed at tips. The specimen is accompanied with a pair of detached legs, the joints of these legs are long, narrow and compressed. Uper edges of merus armed with 5-6 beads, of carpus with four and of propodus with 5-6 granules ; the lower edges of the same joints are also adorned with few sharp, granules near their proximal ends. Dactylus covered with thick band of hairs along its upper and lower edges.

Male abdomen five jointed, 3-5 joints fused. Anterior male pleopod is wanting in the unique specimen, may be because of the juvinile stage of the specimen.

The alchol preserved specimen is light brown in colour.

Remarks : The specimen was described by Alcock (1898 : 116) as *Xantho* (*Lophoxanthus*) *scaberrimus* but the literature reveals that the specimen is distinctly different from the species *scaberrimus* Walker and hence the specimen is renamed as *Demania alcocki* sp. nov. in the present paper. The specimen is closer to *D. garthi* Guinot 1981, than

to any other known species of the genus. But differs from *garthi* by the presence of large granular or pimply, textural pattern of carapace, chelipeds and legs, versus the minute, sharp, granules on the carapace and appendages of *D. garthi*. Length breadth ratio of *D. alcocki* and *D. garthi* are also different, and gives them a different shape of their carapaces. The antero lateral teeth of *D. alcocki* Deb are blunt, conical in shape and not as small, sharp, spines as in the *D. garthi*. The absence of pleopod in the *D. alcocki* Deb prevents its study and comparison with the pleopods of other known allied species.

Distribution : So far the species is known only from its type locality i. e. Bay of Bengal, Orissa coast.

Demania indiana sp. nov.

(Pl. I, fig. 2)

Material examined : One large male crab from Balasore Bay, Orissa coast, Bay of Bengal, collected by "Golden Crown B. F." a Trawler, on August 1908.

Measurements : Width : 84 mm ; Length : 82 mm ; Fronto orbital edge—35 mm ; Front—18 mm.

Diagnosis : Carapace pentagonal in shape, very convex fore and aft and moderately so from side to side. Regionl convexities are well marked by deep, smooth grooves. The regional areoles covered with squamiform tubercles, most apparent and pointed along the anterolateral sides, almost absent or indistinct in the middle and anterior part ; large, smooth and pea like on the posterior third of the carapace. Anterolateral sides rounded, edge thick, divided into four crenulate, shallow lobes, excluding the outer orbital corner. Posterolateral sides granular and convergent. Posterior margin of carapace beaded, straight. Front angularly produced medially, bilobed, lobes concave and obliquely sloping, outer angle distinct. Supra orbital edge tumid and rough edged. Whole under surface of carapace including maxillipeds, sternum, male pareopods are closely covered with large granules.

Chelipeds equal, upper, outer and lower surfaces of arm, wrist and palm covered by smooth, flat topped, wart like tubercles, which are largest on outer surface of palm and arranged in longitudinal rows, which continues on the fixed finger. Upper edge of arm terminating in two, broad, foliaceous lobes, inner angle of wrist is a strong spine and a much smaller tubercle beneath. Upper edge of palm armed with three, large, conical teeth, upper edge of dactylus tuberculate and rough. Fingers grooved, tips pointed, cutting edges dentate. Leg

joints except dactylus, are sharply creasted on their upper edges, only the upper distal corner of merii drawn into a prominent, triangular, teeth or a blunt spine. Outer surfaces of leg joints roughened with granules. The dactylus of all legs rounded and covered with an upper and a lower band of thick, brownish fur.

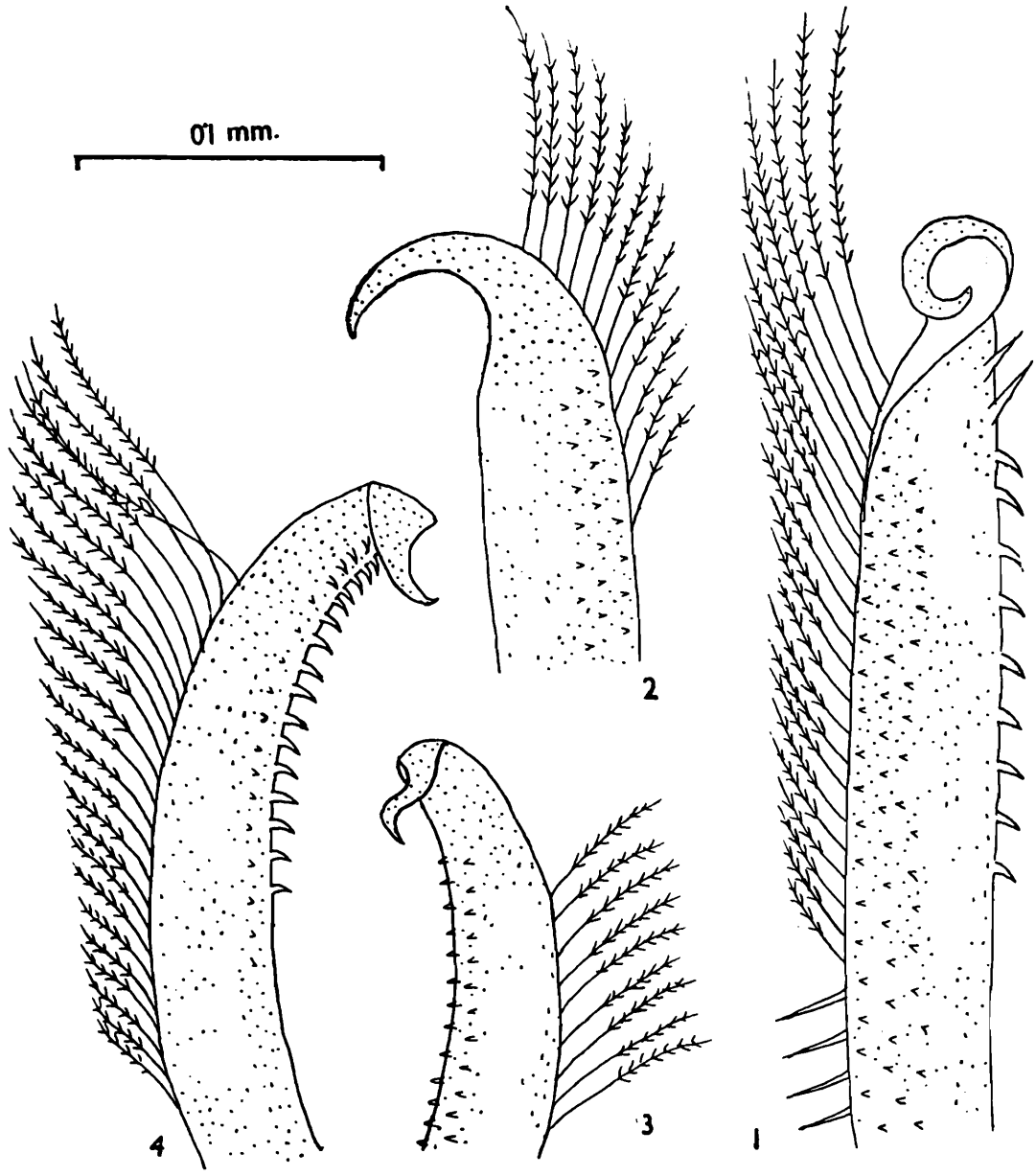

Fig. 1-4. 1 & 2. Anterior male pleopol, two aspects of *Demania indian* Deb.
3 & 4. Anterior male pleopod, two aspects of D. baccalipes (Alcock).

Anterior male pleopod (Fig. 1 and 2) is a tubular, grooved process, gradually tapering into an acutely drawn twisted, spiral, recurved spine. Inner subapical area adorned with a row of 25-30 long, feathery setae and outer side of sub apical region armed with small spinules and one or two setae only.

Remarks : This unique specimen was wrongly identified and labelled as *Xantho* (*L*) *scaberrimus* Walker, but now its apparrent similarity and distinct differences with *D. toxica* is very clear.

The presence of a prominent, blunt spine or teeth on the upper distal corners of merii of walking legs of *D. indiana* Deb are the main recognisable difference with the type of *D. toxica* Garth specimen. Other major differences of *D. indiana* are the presence of spirally coiled, recurved spine like distal apex of the anterior male pleopod ; and less scabrous nature of the carapace owing to the flatness of tubercles etc, which at once differentiate the *D. indiana* Deb from *D. toxica* Garth.

Distribution : East coast of India, Bay of Bengal.

Demania baccalipes (Alcock)

(Pl. II, fig. 4)

Xantho (*Lophoxanthus*) *scaberrimus* var. *baccalipes* Alcock 1897 : 117 ; Chhapgar 1957 : 29.

Xantho reynaudii var. *baccalipes*, Balss 1938 : 51.

Damania scaberrima baccalipes, Guinot 1971 : 1074.

Demania baccalipes Sakai 1976 : 421 ; Garth and Alcala 1977 : 650 ; Guinot 1979 : 59 ;

Material examined : Type male Z.S.I., Regd no. C 5079/1, from Sri Lanka, measuring width-61 mm ; Length—47 mm.

One male from Bombay and four males from Sri Lanka, are also examined.

Diagnosis : Front slightly produced beyond the orbital edge, free edges of lobes concave and little oblique. Upper and lower surfaces of crab distinctly tuberculate, surfaces of maxillipeds, sternum and male pareopods are worn in apparance. Four, triangular antero lateral teeth are low and finely crenulate. Upper edges of arm of chelaepeds adorned with a raw of large tubercles, the last two tubercles are very prominent. Outer surfaces of wrists and palms covered with irregular and worn tubercles, inner corner of wrist adorned with one large and one small teeth, inner surface of palm rough. Upper edges of merii of legs adorned with a row of large berry like tubercles, the upper edges of carpus and propodus are roughly crenulate.

Remarks : *D. baccalipes* (Alc.) is a large distinctive species, its poisonus nature is yet to be ascertained. Beaded upper edges of merii of walking legs differentiate *D. baccalipes* from other allied species.

Distribution : West coast of India, Sri Lanka, Malacca Strait, Japan.

Demania cultripes (Alcock)

(Pl. 2, fig. 3)

Xantho (*Lophoxanthus*) *scaberrimus* var. *cultripes* Alcock 1898 : 117.

Demania scaberrima cultripes ; Guinot 1969a : 235 ; 1971 : 1074 ;

Demania cultripes ; Guinot 1977 : xxii, pl. 6 fig. 7-8 ; 1979 : 61 ; 1981 : 1122.

Material examined : Type male from Singapore, Z. S. I., Regd. no. 4733/9, measuring width—64mm, Length—50 mm.

Diagnosis : Carapace pentagonal, frontal lobes produced, oblique, free edge concave. Surface tubercles faint, worn except on antero-lateral sides, posterior one third of the carapace and upper outer s-urfaces of wrists and palms. First two anterolateral teeth low, last two teeth prominent. Upper edge of arm of chelipeds adorned with two, rounded, broad lobes. Crests of merus, carpus and propodus of legs sharp, entire. The merus is bicarinate and propodus creted on their lower edges.

Distribution : Singapore, New Caledonia.

SUMMARY

Demania alcocki sp. nov. and *D. indiana* sp. nov. two crabs from India are described and their relationship with other allied species discussed. Diagnosis for the other existing species, a key for easy identification and necessary illustrations for them are provided.

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CONTRIBUTION TO THE STUDY OF LITTORAL DIPTERANS I. ON A COLLECTION OF CERATOPOGONIDAE, CHIRONOMIDAE, PSYCHODIDAE AND TABANIDAE FROM SAGAR ISLAND, SUNDARBAN.

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INTRODUCTION

This paper deals with the Dipteran insects collected during July, 1982 to December, 1983 from the intertidal zone of Ganga estuary, Sagar Island.

The families dealt with are Ceratopogonidae, Chironomidae, Psychodidae and Tabanidae.

Soils were collected at every fortnight from the intertidal zone and larvae and pupae were isolated in the laboratory of Susama Devichoudhurani Marine Biological Research Institute, Sagar Island by standardized floatation technique (Davies and Linley, 1966). After isolation, larvae and pupae were reared in the laboratory and adult Dipterans were collected.

SYSTEMATIC ACCOUNT

Order : DIPTERA

Suborder : NEMATOCERA

Family : CERATOPOGONIDAE

Tribe : **Ceratopogonini**

1. **Alluaudomyia maculosipennis** Tokunaga

1940. *Alluaudomyia maculosipennis* Tokunaga Tenthredo **3** : 181.

1942. *Alluaudomyia maculosipennis* Okada, Trans. Nat. Hist. Soc. Formosa **32** : 316 (Tiwan)

1959. *Alluaudomyia maculosipennis* Tok. and Mur. Ins. Micronesia **12** : 353 (Palau and Yap Is.)

1964. *Alluaudomyia maculosipennis* Wirth and Delfinado Pacific Insect **6** (4) : 627.

Materials : 4 ex (1♂ 3♀), Dhablat, Sagar South and Beguakhali, 19.ix.1984.

Distribution : Formosa, Java, Malaya, Philippines (Mindanao), Thailand, Viet Nam, Caroline Islands, Sri Lanka (Ceylon), India.

Remark : The species is being reported from India for the first time.

2. **Alluaudomyia formosana** Okada

1942. *Alluaudomyia maculipennis* (Carter, Ingran and Macfie) var. *formosana* Okada, Trans. Nat. Hist. Soc. Formosa 32 : 317.

Materials : 5 ex (5♀ ♀), Dhablat, Sagar South and Beguakhali, 19.ix.1984.

Distribution : Formosa, Malaya, Thailand, Sri Lanka (Ceylon) and India.

Remark : The species is being reported from India for the first time.

Tribe : **Culicoidini**

3. **Culicoides oxystoma** Kieffer

1910. *Culicoides oxystoma* Kieffer, Mem. Indian. Mus. 2 : 193 (♀).

1913. *Culicoides kiefferi* Patton, Ind. J. Med. Res. **1** : 336 (♂ ♀ Pl ; Prcoce. Goetghebuer 1910).

1921. *Culicoides pattoni* Kieffer, Bull. Soc. Ent. Fr.

1921. (n name for kiefferi Patton)

1938. *Culicoides housei* Causey, Am. J. Hyg. **27** : 407 (♂).

1951. *Culicoides punctigerus* Tokunaga, Scient. Rep. Saikyo. Univ. (Agric) **1** : 101 (♂ ♀).

1956. *Culicoides alatus* Dasgupta and Ghosh, Bull, Cal. Sch. Trop. Med. Hyg. **4** : 162 (♀).

Materials : 7 ex (4 ♂ ♂, 3 ♀ ♀), Sagar South, Dhablat and Beguakhali, 19.ix.1984.

Distribution : India, Bangkok, Thailand, Batavia (Djakarta), Java.

4. **Culicoides peliliouensis** Tokunaga

1936. *Culicoides peliliouensis* Tokunaga, Mushi **9** : 55 (♀).

1961. *Culicoides ejercitoi* Delfinado, Fieldiana. zool. **33** : 643 (♀).

Materials : 21 ex (14 ♂ ♂, 7 ♀ ♀) Sagar South, Beguakhali 19.ix.84.

Distribution : Akarokuru, Peliliou Island, Palan, Sink, Calamianes (Cuilon) Island, Palawan, Philippines, India.

Remark : This species is also being reported from India for the first time.

5. **Culicoides similis** Carter, Ingran and Macfie.

1920. *Culicoides similis* Carter, Ingran and Macfie Ann. Trop. Med. Parasitol. **14** : 255 (♂ ♀).

Materials : 4 ex (2 ♂ ♂, 2 ♀ ♀), Dhablat, Sagar South and Beguakhali, 19.ix.1984.

Distribution : India, Laos, Malaya, Thailand and Africa.

Tribe : **Sphaeromieni**

6. **Nilobezzia acanthopus** (de Meijere)

1907. *Ceratopogon* (*Bezzia*) *acanthopus* de Meijere Tijdschr. Ent. **50** : 215 (♀).

1931. *Bezzia* (*Nilobezzia*) *acanthopus* (de Meijere) Johannsen 439.

1931. *Bezzia* (*Nilobezzia*) *raphaelis* var. *Conspicua* Johannsen 441.

1934b. *Nilobezzia conspicua* (Johannsen) 441.

Materials : 4 ex (4 ♀ ♀) Dhablat, Sagar South and Beguakhali, 19.ix.1984.

Distribution : Java, Sumatra, Thiland, India.

Remarks : The species is being reported from India for the first time.

Family : CHIRONOMIDAE

Tribe : **Chironomini**

7. **Chironomus barbatitarsis** Kieffer

1911. *Chironomus barbatitarsis* Kieffer, Rec. Indian. Mus **6** : 154.

Materials : 4 ex (2 ♂ 2 ♀) Dhablat, Beguakhali and Sagar South.

Distribution : Burma, India.

Superfamily : PSYCHODOIDEA

Family : PSYCHODIDAE

Subfamily : PSYCHODINAE

8. **Psychoda nigripennis** Brunetti

1908. *Psychoda nigripennis* Brunetti, Rec. Indian. Mus. **2** : 376 (♂ ♀).

Material : 4 ex (2 ♂ 2 ♀) Dhablat, Beguakhali and Sagar South, 6.iii.1983.

Distribution : India.

Suborder : BRACHYCERA

Family : TABANIDAE

Subfamily : TABANINAE

Tribe : **Tabanini**

9. **Tabanus striatus** Fabricius

1778. *Tabanus striatus* Fabricius, Mantissa Insect 2 : 356 (sex ?).

1827?. *chinensis* Thunberg Nova. Acta. Soc. Sci. Upsal 9 : 61 (? sex).

1842?. *dorsilinea* Wiedemann, Analecta Ent. ?? (♂).

1850. *Tabanus hilaris* Walker, Insecta Saundersiana 1 : 49 (♂).

Materials : 4 ex, (3♂1♀), Dhablat, Beguakhali and Sagar South (Sex ?)

Distribution : Ceylon, China, India, N. Thailand, N. Viet Nam. W. Pakistan and Africa.

10. **Atylotus agrestis** (Wiedemann)

1828. *Atylotus agrestis* (Wiedemann) Aussereurop. zweifl. Insekt. 1 : 557 (♂ Tabanus).

1838. *Atylotus ditoeniatus* Maequart, Dept. exot. 1 (1) : 126 (130) (♂♀ as *Tabanus ditoeniatus*, p. 215 (219).

1850. *Atylotus pyrrhus* Walker, Insecta Saundersiana 1 : 47 (♂♀ Tabanus).

1868. *Atylotus agricola* of Schiner, not Wiedemann, mis identification.

SUMMARY

The present paper is based on a collection of Dipterans from littoral zone of the Ganga estuary. Six species of Ceratopogonidae, one species of Chironomidae, one species of Psychodidae and two species of Tabanidae are reported in this paper. Four species viz. *Alluaudomyia maculosipennis* Tokunaga, *Alluaudomyia formosana* Okada *Culicoides pelilioensis* Tokunaga and *Nilobezzia acanthopus* (de Meijere) are being recorded from India for the first time.

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Rec. zool. Surv. India, **83** (3 & 4) : 141-154, 1986

THE TICKS OF LOCHINVAR NATIONAL PARK, ZAMBIA (ACARINA : IXODIDAE)

Part 1. Taxonomic Account

By

S. K. Tandon*+ and G. W. Howard**

Introduction

Large wild mammalian herbivores are regarded in many cases as being reservoirs of diseases and parasites transmissible to domestic animals in southern Africa (Neitz, 1967 ; Young, 1969 ; Howard, 1976). Among such pathogens, various species of *Borrelia*, *Rickettsia*, *Coxiella*, *Anaplasma*, *Babesia* and *Theileria* as well as arboviruses and other parasites are transmitted from infected to susceptible animals by ticks. Accordingly, during a study of the health of some of the wild animals at Lochinvar National Park in Zambia, an opportunity presented itself to study the ticks which are usually found on these animals and which may act as vectors of parasites and diseases.

Information on the biology of ticks in Africa is very limited. Checklists of the ticks infesting wild animals in Zambia have been compiled by Colbo (1973) and Ganagarajah (1976) but no information on incidence, prevalence or seasonality is given in these reports. Ecological studies on the ticks of cattle in Zambia have been carried out by MacLeod (1970) MacLeod & Colbo (1976), MacLeod *et al.* (1977) and MacLeod & Mwanaumo (1978), while some Zambian wild-life hosts have been investigated by MacLeod (1970), Colbo & MacLeod (1976) and MacLeod & Mwanaumo (1978) ; but in most cases specific collection data is lacking.

The present study has resulted from systematic tick collections from wild animals taken for other specific purposes in the years 1973 to 1979 and from other animals which occasionally became available in the National Park. It represents part of a study of the arthropod ecto- and endoparasites of wild animals in southern and western Zambia (Howard, 1976, 1977).

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The first step in evaluating the potential of ticks to cause problems for man and domestic animals is an accurate survey of the species that occur in a given area. The present work is intended to provide background information on host-ectoparasite relation for any future epidemiological studies that may be undertaken in the Lochinvar National Park in particular and Kafue flats in general. In all 14 species comprising 7 genera are recorded from the Lochinvar National Park. The present paper gives information by species regarding hosts, distribution taxonomic status and includes a classified host-parasite list of ticks infesting large mammals in Lochinvar National Park. Infestation patterns, seasonal incidence and potentials for disease transmission by these ticks is the subject of a subsequent publication (Howard and Tandon 13, in preparation).

Study Area and Methods

Lochinvar National Park is a small nature reserve of 410 km^2 on the southern side of the Kafue River in the southern Province of Zambia. It covers representative regions of the Kafue flood plain and surrounding woodland and contains a number of large wild mammals as well as many species of birds ; the fauna, flora and topography have been described adequately by Sheppe and Osborne (1971), Sayer and Van Lavien (1975). The most prevalent large mammals are the abundant lechwe antelope and the zebra and wildebeest which often graze with them. Other large herbivores present in smaller numbers are eland, kudu, bushbuck, impala, oribi, duiker and buffalo (Howard, 1977). There is considerable interaction between some of the wild animals and the cattle which graze on three sides of the Park and which are permitted to pass through the Park during their annual migrations to and from the flood plain grazing areas.

Ticks were collected from some of the larger mammals during the course of other research into their health and nutritional status. The animals were shot in the National Park under Special Licences and were immediately examined for ticks before they were skinned. In the case of zebra, a thorough examination was made to ensure that all ticks present were collected. Other specimens were collected as they became available as a result of conservation measures by the Department of National Parks and Wildlife Service.

Adult ticks were placed alive into 75% ethanol and were kept in this preservative for subsequent study. When possible immature ticks were collected alive and then reared to adulthood on laboratory mammals to establish their identity.

The large mammals examined were the following species : Burchell's zebra (*Equus burchelli* Gray), Kafue lechwe (*Kobus leche kafuensis* Haltenorth), blue wildebeest (*Connochaetes taurinus* Burchell), eland (*Taurotragus oryx* Pallas), bushbuck (*Tragelaphus scriptus* Pallas), common duiker (*Sylvicapra grimmia* Linnaeus), impala (*Aepyceros melampus* Lichtenstein) and African buffalo (*Syncerus caffer* Sparrman).

TAXONOMIC ACCOUNT

Order ACARINA

Suborder IXODIDES

Family IXODIDAE

Genus **Amblyomma Koch**, 1844

Amblyomma sparsum Neumann, 1899

Amblyomma sparsum Neumann, 1899. *Me'm. Soc. zool. France*, **12** : 247-248.

Material examined : 10 ♂♂ and 1 ♀ off buffalo ; 1 ♂ off impala ; 16 ♂♂ and 8 ♀♀ off tortoises, (*Kinixys belliana* (Gray).

Host : *A. sparsum* is found usually on the common tortoises rhinoceros and buffalo. In Lochinvar this species has also been found on impala, which is a new host record for Zambia. Yeoman and walker (1967) collected 35 specimens from lion in Tanzania.

Distribution : *A. sparsum* is widely distributed in central and southern Kenya and northern Tanzania. It has been found consistently in Uganda and southern Sudan and scattered records are available from Eritria, Ethiopia, French equatorial Africa, Malawi, Mozambique, Angola, Cameroun, Somalia, Senegal and Zambia (Elbl and Anastos, 1966 a).

Remarks : The specimens referred to in this paper agree well with the description given by Elbl and Anastos (1966a).

Amblyomma variegatum (Fabricius 1794)

Acarus variegatus Fabricius, 1994, *Entomologia systematica* : 353.

Material examined : x.1977, 7 ♂♂ and 1 ♀ off buffalo ; 24.xi.1977, 3♂♂ and 1 ♀ off bushbuck ; 1 ♂ off eland ; 17.iii.1974, 1♂ off lechwe ; 25.iii.1975, 2 ♂♂ off lechwe, 6.iv.1977, 1 ♂ and 1 ♀ off wildebeest ; 10.iv.1975, 3 ♂♂ and 2 ♀♀ ; 10.iii.1977, 1 ♂ ; 27.iv.1977, 4 ♂♂ and 2 ♀♀ ; 1.ix.1977, 4 ♂♂ and 1 ♀ ; ix. 1977, 1 ♂ ; 23.ii. 1978, 4 ♂♂ and 1 ♀ ; 31.iii.1978, 11 ♂♂ ; 29.v.1978, 1 ♂ ; 7.vi.1978, 2 ♂♂ ; 23.i.1979, 5 ♂♂ all off Zebra.

Host : *A. variegatum* is primarily a parasite of cattle and practically every reference in the literature pertains to parasitism of cattle by this species. Besides cattle it also attacks a large variety of domestic and game animals throughout Africa. Hoogstraal (1956) and Theiler (1962) gave detailed host lists of this species.

Distribution : According to Hoogstraal (1956) "*A. variegatum* is distributed generally throughout the Ethiopian Faunal Region except in northern Sudan, most of South-West Africa, much of Mozambique and the entire Union of South Africa."

Remarks : The specimens recorded in this paper agree well with the criteria given by Elbl and Anastos (1966a) for the identification of this species. The scutum of some of these specimens was coarsely punctate.

Genus **Aponoma Neumann**, 1899

Aponoma latum (Koch, 1844)

Amblyomma latum Koch 1844, *Arch. Naturgesch* **10** : 231.

Material examined : 2♂♂ and 6 ♀♀ off monitor lizard (*Varanus niloticus*, Linnaeus) no date.

Host : *A. latum* chiefly parasitizes large poisonous snakes ; the occurrence of this species on a monitor lizard in Lochinvar is unusual and is the first record on this host in Zambia.

Distribution : *A. latum*, the snake tick, is found throughout the Ethiopian Faunal Region.

Remarks : The specimens reported in this paper agree well with the criteria given by Hoogstraal (1956) for the diagnosis of this species.

Genus **Boophilus Curtice**, 1891

Boophilus decoloratus (Koch)

Rhipicephalus decoloratus Koch, 1844, *Arch. Naturgesch.*, **10** : 239.

Material examined : 1♂, 3♀♀ off eland ; vii.1977 3♂♂ and 2♀♀ off impala ; 6.iv.1977, 2♂♂ ; 10.viii.1977, 3♂♂ ; 1.xi.1977, 2♂♂ and 9♀♀ ; 7.vi.1979, 1♀ ; 26.ii.1979, 12♂♂ and 47♀♀ ; 25.iii.1979, 3♂♂ all off Zebra.

Host : *Boophilus decoloratus* is typically a parasite of cattle but is also found on sheep, goats, donkeys, dogs, and cats. Large game animals are also attacked by this species. Extensive information on its host-specificity is given by Hoogstraal (1956) and Theiler (1962).

Distribution : This tick is very widely distributed throughout most of the African continent. Theiler (supracit) has summarised in detail the distribution of this species in Africa.

Remarks : The specimens recorded in this paper agree well with the criteria given by Hoogstraal (supracit) for the identification of this species.

Genus **Haemaphysalis Koch**, 1844

Haemaphysalis (Rhipistoma) leachii (Audouin) 1827

Ixodes leachii Audouin, 1827, in Savingy, *Descrition del' Egypte, 2 Ed., 22. Zool.*, : 428.

Material examined : 2♂♂ and 5 ♀♀ off leopard *Panthera pardus* (Linnaeus), on date.

Host : *H. (R) leachii* in the adult stage chiefly parasitizes domestic dogs, cats and also some wild carnivores. The reported host-lists also include birds. Hoogstraal (1956 and 1958) and Theiler (1962) summarize the available host data on this species.

Distribution : This tick is found throughout most of the Ethiopian Region. Its occurrence at Lochinvar may persist on the smaller cats, but leopard, lion and cheetah are now very rare in this National Park (Howard, 1976).

Remarks : The specimens listed here agree well with the criteria given by Hoogstraal (1956) for identification of species.

Haemaphysalis (Rhipistoma) spinulosa Neumann, 1906.

Haemaphysalis spinulosa Neumann, 1906, *Arch. Parasit. Paris* **10** : 212-213.

Material examined : 9.iii.1971, 4♂♂ and 1 ♀ off slender mongoose (*Herpestes sanguineus* Ruppell).

Host : This species is known to parasitise Canidae, large cats and mongoose.

Remarks : *H. spinnlosa* was first described and figured by Neuman (1906) from two females from Uganda. Hoogstraal (1964) redescribed this tick from the lectotype female and from a male specimen from Kenya. Our specimens agree with the criteria given by Hoogstraal (1964) for identification of this species.

Genus **Hyalomma** Koch, 1844

Hyalomma rufipes Koch 1844

Hyalomma rufipes Koch, 1844, *Arch. Naturgesch.* **1** : 221.

Material examined : vii.1977, 3♂♂ and 5 ♀♀ off buffalo ; and viii.1977, 3 ♀♀ off buffalo ; x.1977, 1♂ and 1 ♀ off buffalo ; 27.iv.1978, 1♂ off zebra ; 23.i.1979, 1 ♀ off zebra.

Host : *H. rufipes* is known to infest a wide range of mammals and birds. Hosts of the adults are usually bigger animals like cattle, sheep, goats, horses and certain wild ungulates. Theiler (1962) has given a detailed list of hosts attacked by this species.

Distribution : According to Hoogstraal (1956) *H. rufipes* is widely distributed in many drier parts of Africa. Theiler (1962) has given a detailed summary of its distribution in Africa.

Remarks : The specimens listed here agree well with the criteria given by Hoogstraal (1956) for identification of this species.

Hyalomma truncatum Koch, 1844

Hyalomma truncatum Koch, 1844, *Arch. Naturgesch.* **1** : 222.

Material examined : vii.1977, 1 ♀ off buffalo ; viii.1977, 1 ♂ on buffalo ; x.1977, 3 ♂ ♂ off buffalo ; 25.iii.1978, 2 ♂ ♂ off lechwe ; 24.xi. 1975, 3 ♂ ♂ and 1 ♀ of bushbuck ; 22.v.1976, 6 ♂ ♂ and 2 ♀ ♀ off wildebeest ; 13.vii.1976, 1 ♂ off wildebeest 6.vi.1977, and 3 ♀ ♀ off wildebeest ; 10.iv.1975, 24 ♂ ♂ and 12 ♀ ♀ ; 27.iv.1977, 17 ♂ ♂ and 5 ♀ ♀ ; ix.1977, 2 ♂ ♂ ; 23.ii.1978, 5 ♂ ♂ ; 31.iii.1978, 8 ♂ ♂ and 2 ♀ ♀ ; 4.v.1978 4 ♂ ♂ and 3 ♀ ♀ ; 23.i.1979, 2 ♂ ♂ ; 26.ii.1979 1 ♂ ; 25.iii.1979 15 ♂ ♂ and 4 ♀ ♀ all off zebra.

Host : *Hyalomma truncatum* chiefly parasitizes domestic cattle and goats, but other large game and domestic animals may be infested. Small mammals, wild carnivores, birds and tortoises are very rarely recorded as hosts. Hoogstraal (1956) and Theiler (1962) have given detailed host lists of this species in Africa.

Distribution : *Hyalomma truncatum* is endemic to Ethiopian region and has been recorded from almost everywhere in Africa except in the forests of Western Africa.

Remarks : The specimens listed here agree well with the criteria given by Hoogstraal (1956) for identifying this species. The scutum of majority of these specimens were reddish black, however a few were entirely black.

Genus **Ixodes** Latrelle, 1795

Ixodes cavipalpus Nuttal and Warburton, 1908

Ixodes cavipalpus Nuttal and Warburton, 1908, *Proc. Cambridge Phil. Soc.*, **14** : 394.

Material examined : 16.iii.1973, 1 ♀ off eland ; 21.iii.1974, 1 ♀ off eland.

Host : The hosts reported for *I. cavipalpus* include a variety of domestic and wild animals. Theiler (1962) summarizes the host-list of this species in Africa. In Zambia this tick has been collected mainly from domestic cattle, goats, and cats. Amongst game animals it is recorded from eland and hartebeest (*Alcelaphus lichtensteini*) (Peters), but hartebeest are no longer found at Lochinvar.

Distribution : *Ixodes cavipalpus* is well distributed in Africa and it ranges in southern Africa from South Africa to Zimbawe, Malawi, Zambia in the north to Angola, Zaire, as well as to Camerouns in Central Africa, to Tanzania, Kenya and Uganda in east Africa. The northern limit of its distribution is the Sudan (Hoogstraal, 1956).

Remarks : The specimens recorded in this paper agree well with criteria given by Arthur (1965) for the identification of this species.

Genus **Rhipicephalus** Koch, 1844

Rhipicephalus appendiculatus Neumann, 1901

Rhipicephalus appendiculatus Neumann, 1901, *Me'm. Soc. Zool.* **14** (2-3) : 270.

Material examined : 23.ii.1978, 6♂♂ and 5♀♀ ; 31.iii.1978, 4♂♂ and 1♀ ; 23.i.1979, 2♂♂ and 2♀♀ ; 26.ii.1979, 2♀♀ all zebra.

Host : *R. appendiculatus* parasitizes mainly domestic cattle while other frequent hosts are goats, sheep and buffalos, antelope and zebras in National Parks. It has also been found to infest wild carnivores and domestic dogs. Its absence on the Lochinvar buffalo is surprising.

Distribution : In the Ethiopian region this tick is mainly a Central and East African species. Hoogstraal (1956) and Theiler (1962) have summarised in detail the distribution of *R. appendiculatus* in Africa.

Remarks : The specimens listed here agree well with the criteria given by Hoogstraal (1956) for identification of this species. The majority of these specimens were usually heavily punctate in comparison with specimens from domestic stock.

Rhipicephalus evertsi evertsi Neumann, 1897

Rhipicephalus evertsi Neumann, 1897, *Me'm. Soc. Zool. Fr.*, **10** : 405.

Material examined : 2♂♂ off buffalo (no date) ; 26.iii.1975, 22♂♂ and 6♀♀ of buffalo ; 16♂♂ and 5♀♀ off buffalo (no. data). iii.1977. 1♂ off duiker ; 24.xi.1975, 2♂♂ and 1♀ off bushbuck ; 7.vii.1977, 3♀♀ off bushbuck ; 11.v.1974, 1♀ ; 25.iii.1975, 1♂ ; 23.vi.1975, 1♂ and 3♀♀ ; 23.ix,1976, 16♂♂ and 2♀♀ All specimens off lechwe. 13.vii.1976, 5♂♂ and 4♀♀ ; 23.xi.1976, 16♂♂ and 2♀♀ ; 6.iv.1977, 6♂♂ and 6♀♀ ; 29.ix.1977, 5♂♂ and 5♀♀ ; 4.v.1977, 50♂♂ and

18♀♀. All specimens off wildebeest. 10.iv.1975, 19♂♂ and 2♀♀; 10.iii.1977, 6♂♂ and 1♀; 27.iv.1977, 126♂♂ and 20♀♀; 29.ix.1977, 5♂♂ and 2♀♀; 1.xi.1977, 15♂♂ and 4♀♀; 23.ii.1978, 13♂♂ and 13♀♀; 31.iii.1978, 48♂♂ and 3♀♀; 4.v.1978, 41♂♂ and 13♀♀; 29.v.1978, 21♂♂ and 3♀♀; 7.vi.1978, 50♂♂ and 2♀♀; 23.i.1979, 66♂♂ and 11♀♀; 26.ii.1979, 22♂♂; 25.iii.1979, 50♂♂ and 2♀♀. All specimens off zebra.

Host: According to Hoogstraal (1956) *R. evertsi evertsi* is usually found on domestic cattle, equines, goats and sheep and on wild antelopes, zebras and few other large game animals. Mathyssee (1954) recorded this tick in Zambia besides domestic animals on sable antelope, eland, wildebeest and hartebeest. In Lochinvar the red-legged tick is fairly common on lechwe, wildebeest and zebras.

Distribution: *R. evertsi evertsi* is widely distributed throughout most of the Ethiopian faunal region including the mountains of Yemen (Hoogstraal, 1956). It ranges from Ghana in the west to Somalia in the east and from South Africa in the south to the Sudan in the north. There are no records of its occurrence so far from Mauritania, Gambia, Sierra Leone, Liberia, Ivory Coast and Dahomey (Elbl and Anastos, 1966b).

Remarks: The specimens examined agree well with the description given by Elbl and Anastos (1966b). The majority of these specimens were usually thickly punctate, however a few had still heavier punctation.

Rhipicephalus sanguineus (Latreille, 1806)

Ixodes sanguineus Latreille, 1806, *Gen. Crust. et. Ins.* **1** : 157.

Material examined: 22.vii.1975, 1♀ off lechwe, 1♂ (No. date) off slender mongoose. 27.iv.1977, 1♂ and 5♀♀; 23.ii.1978, 2♂♂ and 2♀♀; 31.iii.1978, 1♂; 4.v.1978, 1♂ and 1♀ 29.v.1978, 6♂♂ and 9♀♀ all off zebra.

Host: *R. sanguineus* is known to parasitise a large variety of wild birds and mammals, as well as dogs and various other farm and domestic animals throughout its natural zones of distribution (Hoogstraal 1956). Its occurrence on the slender mongoose is the first record for this host in Zambia.

Distribution: Hoogstraal (surapcit) "This species is present almost everywhere in Africa except possibly in the most extreme situations of the great deserts of northern and south-western Africa and perhaps in

a few of the most isolated oases". Theiler (1962) givea a summary of the distribution up to 1962.

Remarks : The specimens examined here agree well with the criteria given by Hoogstraal (1956) for the identification of this tick.

Rhipicephalus simus simus Koch, 1844

Rhipicephalus simus Koch, 1844, *Arch. f. Naturagesch.*, **10** : 238.

Material examined ; 10.iv.1975. 2 ♂♂ and 1 ♀ off zebra ; 23.iv. 1979, 1 ♂ off zebra.

Host : *R. simus simus* infests a wide range of mammals both domestic and wild animals. Zumpt (1958) recorded a single female from a bird which he consideres as incidental. According to Hoogstraal (1956), "the buffalo and pigs are also favourite hosts, whereas antelopes are usually second choice-hosts". Humans are frequently attacked by this tick and it is known to cause paralysis in man (Zumpt and Glychen, 1950). Its restriction to zebra as the only host at Lochinvar is surprising.

Distribution : This tick is widely distributed throughout all the Ethiopian region ; in west Africa it is more or less widely replaced by the subspecies *senegalensis* Koch. A good regiew of its distribution is given by Hoogstraal (1956) and Theiler (1962).

Remarks : The specimens listed here agree well with the criteria given by Hoogstraal (1956) for the identification of this tick.

Rhipicephalus tricuspis Donitz, 1906

Rhipicephalus tricuspis Donitz, 1906, *Sitzungsber Ges, Naturf. Fr. Berlin*, **5** : 146.

Material examined : 23.ii.1978, 1 ♂ off zebra ; 23.i.1979, 3 ♂♂ and 1 ♀ off zebra.

Host : *R. tricuspis* infests a wide variety of domestic and larger wild animals. Detailed information on the hosts can be found in Hoogstraal (1956) and Theiler (1962). In Tanzania Yeoman and Walker (1967) have found this tick mainly on cattle and to a lesser extent on dogs in rather localized areas.

Distribution : *R. tricuspis* is distributed throughout most of Africa.

Remarks : The specimens identified in the collections as *R. tricuspis* agree with the published description of Theiler (1947).

Discussion

The material examined in this study represents specimens that become available from time to time and does not purport to be a comprehensive coverage of the ticks of all the wild animals of Lochinvar National Park. The availability of hosts for collection is obviously limited in a National Park to those animals that are found by coincidence or are sacrificed for some justifiable purpose. For this reason, a systematic survey of hosts is impossible under the conditions of protection of animals that must occur in a National Park. Accordingly, we emphasise the need for such collections to continue when possible so that eventually a more complete picture of the distribution of ticks will emerge. Such an overall view of tick infestation is essential in understanding the epidemiology and epizootiology of tick-borne diseases, especially in an area like Lochinvar N. P. which is not only surrounded by human habitation but is in one of the most important cattle rearing areas of the country. A summary of the information listed above is given in Appendix 1 together with other records of tick infestations from Lochinvar N. P.

Equally important in the study of tick-borne diseases of an area is an understanding of the distribution and abundance of ticks in relation to hosts and seasons. This aspect has been analysed for most of the ticks recorded above and is the subject of a subsequent report (Howard and Tandon, 13, in preparation) which also includes a summary of the potential tick-borne diseaess of the region.

Summary

Fourteen species of ticks in seven genera are recorded for Lochinvar National Park from wild animals as follows : *Amblyomma sparsum*, *A. variegatum* ; *Aponoma latum* ; *Boophilus decoloratus* ; *Haemaphysalis* (*Rhipistoma*) *leachii* ; *H.* (*R.*) *spinulosa* ; *Hyalomma rufipes*, *H. truncatum* ; *Ixodes cavipalpus* ; *Rhipicephalus appendiculatus* ; *R. evertsi evertsi* ; *R. sanguineus*, *R. simus simus* and *R. tricuspis*. Host and locality records are given for each species with notes on distribution and hosts. A classified host-parasite list of ticks infesting large mammals in the Park is also provided.

Acknowledgements

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Many of the wild animals sampled in this study were sacrificed under Special Licences granted by kind permission of the Minister of Lands, Natural Resources and Tourism, Government of Zambia. Permission to work in the National Park was granted by the Director, National Parks and Wildlife Service and considerable assistance was given by the Biologist and Ranger-in-charge of Lochinvar National Park whose services are gratefully acknowledged. Our thanks are also due to Messrs M. M. Seemani and M. M. Chilapatisha of NCSR for technical assistance. Part of this work was supported by the Kafue Basin Research Committee and the Research Grants Committee of the University of Zambia. Transport was made possible by the invaluable services of a landrover generously donated by the Zambia Electricity Supply Corporation Ltd.

APPENDIX 1

Classified parasite list of ticks infesting wild animals at Lochinvar National Park with their recorded hosts.

ACARINA : IXODOIDEA : IXODIDAE

Genus **Amblyomma** Koch, 1844

1. *Amblyomma sparsum* Neumann, 1899 HOSTS : Buffalo, impala tortoise.
2. *Amblyomma variegatum* (Fabricius, 1794) HOSTS : Buffalo, bushbuck, eland, lechwe, wildebeest, zebra.

Genus **Aponomma** Neumann, 1899

3. *Aponomma latum* (Koch, 1844) HOST : Monitor lizard

Genus **Boophilus** Curtice, 1891

4. *Boophilus decoloratus* (Koch, 1844) HOSTS : Eland, impala, zebra.

Genus **Haemaphysalis** Koch, 1844

5. *Haemaphysalis* (*Rhipistoma*) *leachii* (Audouin, 1827) HOST : leopard
6. *Haemaphysalis* (*Rhipistoma*) *spinulosa* Neumann, 1899 HOSTS : Slender mongoose

Genus **Hyalomma** Koch, 1844

7. *Hyalomma rufipes* (Koch, 1844) Hosts : Buffalo, zebra.
8. *Hyalomma truncatum* Koch, 1844 Hosts : Buffalo, bushbuck, lechwe, wildebeest, zebra.

Genus **Ixodes** Latreille, 1795

9. *Ixodes cavipalpus* Nuttal & Warbuton, 1908 Host : Eland.

Genus **Rhipicephalus** Koch, 1844

10. *Rhipicephalus appendiculatus* Neumann, 1901 Hosts : Lechwe, zebra.
11. *Rhipicephalus evertsi evertsi* Neumann, 1897 Hosts : Buffalo, bushbuck, duiker, eland, impala, lechwe, wildebeest, zebra.
12. *Rhipicephalus sanguineus* (Latreille, 1806) Hosts : Lechwe, mongoose, zebra,
13. *Rhipicephalus simus simus* Koch, 1844 Host : Zebra.
14. *Rhipicephalus tricuspis* Donitz, 1906 Host : Zebra.

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Elbl, A. and Anastos, G. 1966c. Ixodid ticks (Acarina : Ixodidae) of Central Africa. Volume IV. Genera *Aponoma* Neumann, 1899, *Boophilus* b. *F.* 1891, *Dermacentor*, Koch, 1844, *Haemaphysalis* Koch, 1844, *Hyalomma* Koch, 1844 and *Rhipicentor* Nuttal and Uarburton, 1908. Lists and Bibliography. *Ann. Mus. R. Afr. Cent., Ser. 8vo, s. Sci. Zool.*, (148), 412pp.

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THE IDENTITY OF THE SOUTH ASIAN TERMITE *INDOTERMES RONGRENSIS* (R. & C.) (SYNONYMS *SPECULITERMES CYCLOPS RONGRENSIS* AND *I. BANGLADESHIENSIS*) (ISOPTERA, INDOTERMITIDAE)

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(With 6 Figures)

INTRODUCTION

The species under consideration was initially described, from the worker caste from Meghalaya, by Roonwal and Chhotani (1962) as *Speculitermes cyclops rongrensis* (Termitidae, Amitermitinae). The imago was later described, as *S. rongrensis*, from Thailand by Morimoto (1973) and from Bhutan by Roonwal and Chhotani (1977, pp. 50-53, Fig. 5 ; actually the block above Fig. 6 on p. 54 is *S. rongrensis*. Later, a complete collection of all three castes (with associated imagoes, soldiers and workers) from Meghalaya became available to us.+ A careful examination of this material, and a re-examination of the earlier ones, showed the examples to be *Indotermes* Roonwal and Sen-Sarma 1960 (family Indotermitidae Roonwal and Sen-Sarma). The revised taxonomic position is discussed below, and the soldier re-described more fully. *Indotermes pakistanicus* Chaudhry and Ahmad (1972, *nom. nudum*) and *I. bangladeshiensis* Akhtar (1975), both from Bangladesh, are junior synonyms.

RESULTS

Indotermes rongrensis (Roonwal and Chhotani) **comb. nov.**

(Figs. 1-6)

Synonyms :

1. **Speculitermes cyclops rongrensis** Roonwal and Chhotani

1962. Roonwal and Chhotani, *Proc. natnl. Inst. Sci. India*, New Delhi, (B) **28** (4) : 310. Worker. Type-locality : Rongrengiri (Garo Hills, Meghalaya, India).

1965. Roonwal and Chhotani, *J. Bombay nat. Hist. Soc.*, **62** : 21, 28, Meghalaya.

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*Zoological Survey of India, Calcutta-12.

+Meghalaya, NE India : Station No. 7, along Dawki Road from Pynursila to Pomshutia (25°16′ N, 90° 50° E), coll. *G. K. Srivastava.*

2. **Speculitermes rongrensis** Roonwal and Chhotani

1973. Morimoto, *Bull. Govt. Forest Sta.*, No. 257 : 62-63. Thailand. Imago. *Status nov.* (vide remarks infra).

1977. Roonwal and Chhotani, *Ent. Basiliensia*, Basel, **2** : 50-53. Imago. Bhutan.

1980. Roonwal and Verma, *Proc. Indian natnl. Sci. Acad.*, New Delhi, **(B) 46** (3) : 253-254. Wing microsculpturing.

3. **Indotermes pakistanicus** Chaudhry and Ahmad

1972. Chaudhry and Ahmad, *Termites of Pakistan* (*Final Tech. Rept., P. L. 480 Program.*), Peshawar, p. 24. Soldier and Worker. Bangladesh. *Nom. nudum* (vide Akhtar, 1975, p. 116, foot-note).

4. **Indotermes bangladeshiensis** Akhtar

1975. Akhtar, *Bull. Dept. Zool. Punjab Univ.* (Lahore), (N. S.), Art. 7, pp. 113 et seq. Imago and soldier. Type-locality : Ukhia (SE Bangladesh).

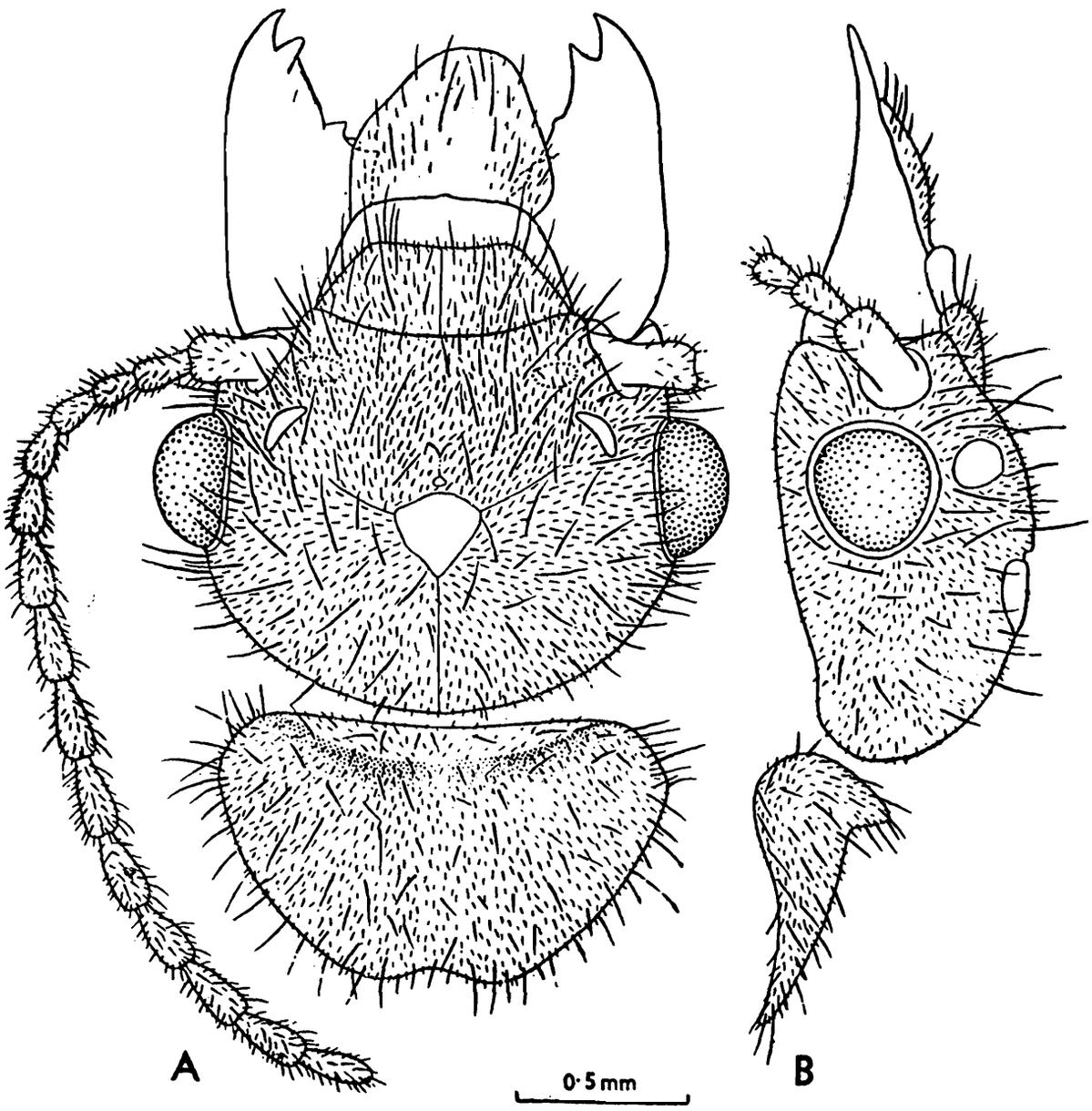

Fig. 1. *Indotermes rongrensis* Imago. Bhutan. A. Head and pronotum, in dorsal view. B. Same, in side view.

1. IMAGO (Figs. 1-3). A description is available in Morimoto (1973, pp. 62-63) and in Roonwal and Chhotani (1977, pp. 50-53*). The wings are re-described here more fully (with a different interpretation of venation) and the tarsi (given earlier as 4-segmented) are shown to be 3-segmented (Fig. 3). Head hypognathus. Wings

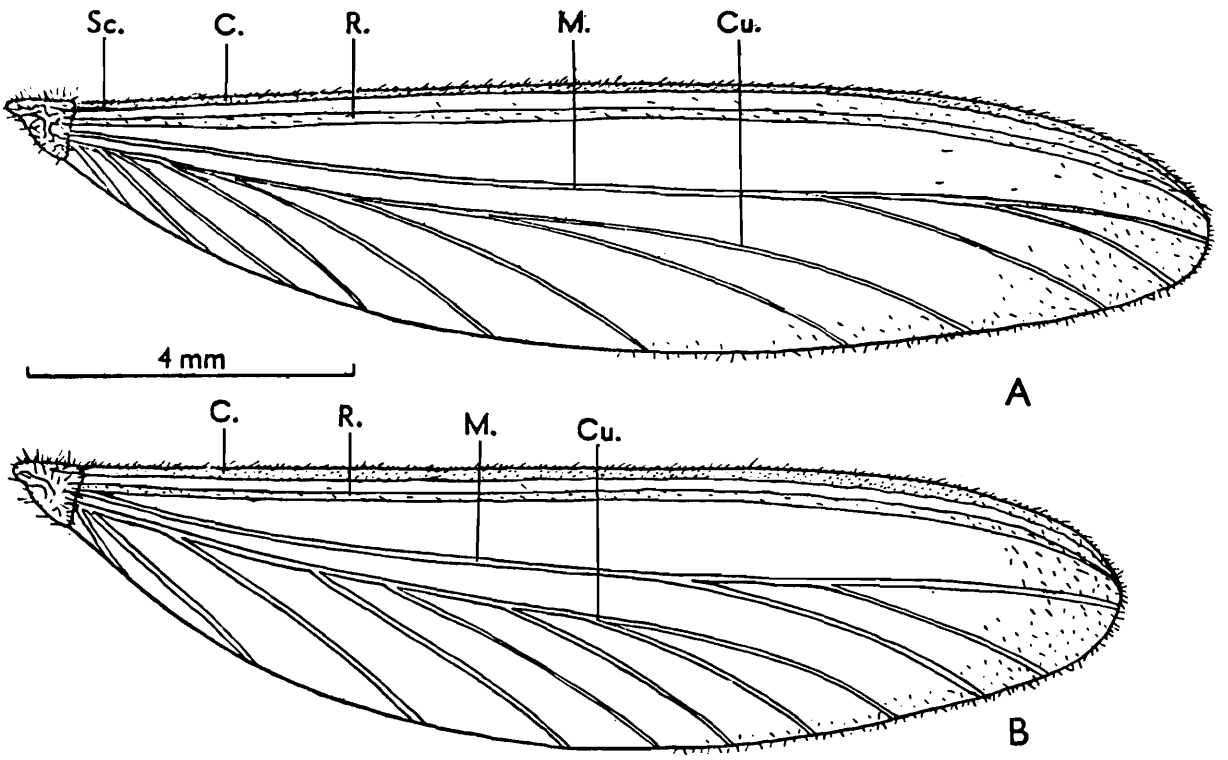

Fig. 2. *Indotermes rongrensis.* Wings (imago from Meghalaya, India). A. Forewing. B. Hindwing.
C, costa ; Cu, cubitus ; M, media ; R, radius ; Sc, subcosta.

(Fig. 2) transparent, colourless, scales and base brownish ; weakly hairy. Length with scale : forewings 13.0-16.0 mm, hindwings 12.0-14.5 mm ; maximum width : forewings 3.3 mm, hindwings 3.5 mm. Forewing scale not covering hindwing scale. Costa and radius long, well marked, running parallel and close to each other all along the length of wings ; subcosta small in forewing, absent in hindwing ; media arising independently in forewing and from radius in hindwing, and with 3-5 branches ; cubitus with 8-12 branches. Wings covered on both sides by micro-sculpturing consisting of a row of pointed papillae on the anterior margin and minute (size 2-6 μm), simple, nonasteroid micrasters (with 1-3 arms) on the membrane ; density 3100-3800/mm^2 (Roonwal and Verma 1980).

2. SOLDIER (Figs. 3 and 4). Head brown with reddish tinge. Pronotum darker, with a white, median streak extending to 9th abdominal tergum. Head and pronotum densely covered with small hairs

*The blocks of Fig. 5 and 6 were mistakenly transposed in printing. The block above Fig. 6, on p. 54, really belongs to *S. rongrensis*.

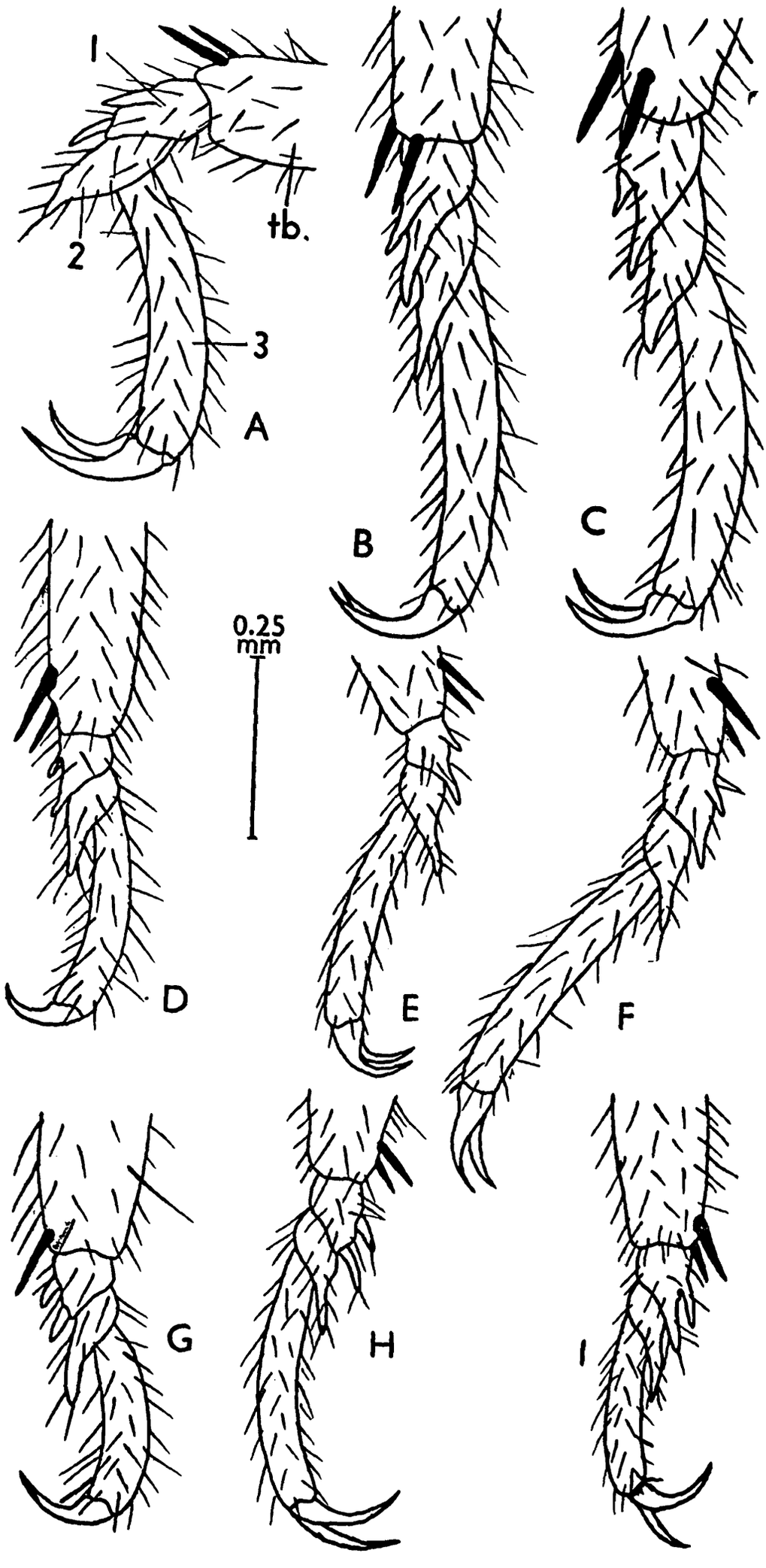

Fig. 3. *Indotermes rongrensis.* Distal parts of legs. A, B, C, Imago. Fore, middle and hind legs, respectively. D, E, F. Soldier. Fore, middle and hind legs, respectively. G, H. I. Worker. Fore, middle and hind legs, respectively.

tb., tibia ; 1, 2, 3, first, second and third tarsal segments, respectively.

and a few long bristles. Total length 7.2-7.3 mm. Head subrectangular, slightly longer than wide (length to base of mandibles 2.24-2.50 mm, maximum width 1.91-2.18 mm ; index Width/Length 0.82-0.87) ; strongly hypognathus ; Y-suture faint ; mid-dorsal spot absent. Eyes and ocelli absent. Antennae long, with 14 segments, segment 2 shortest.

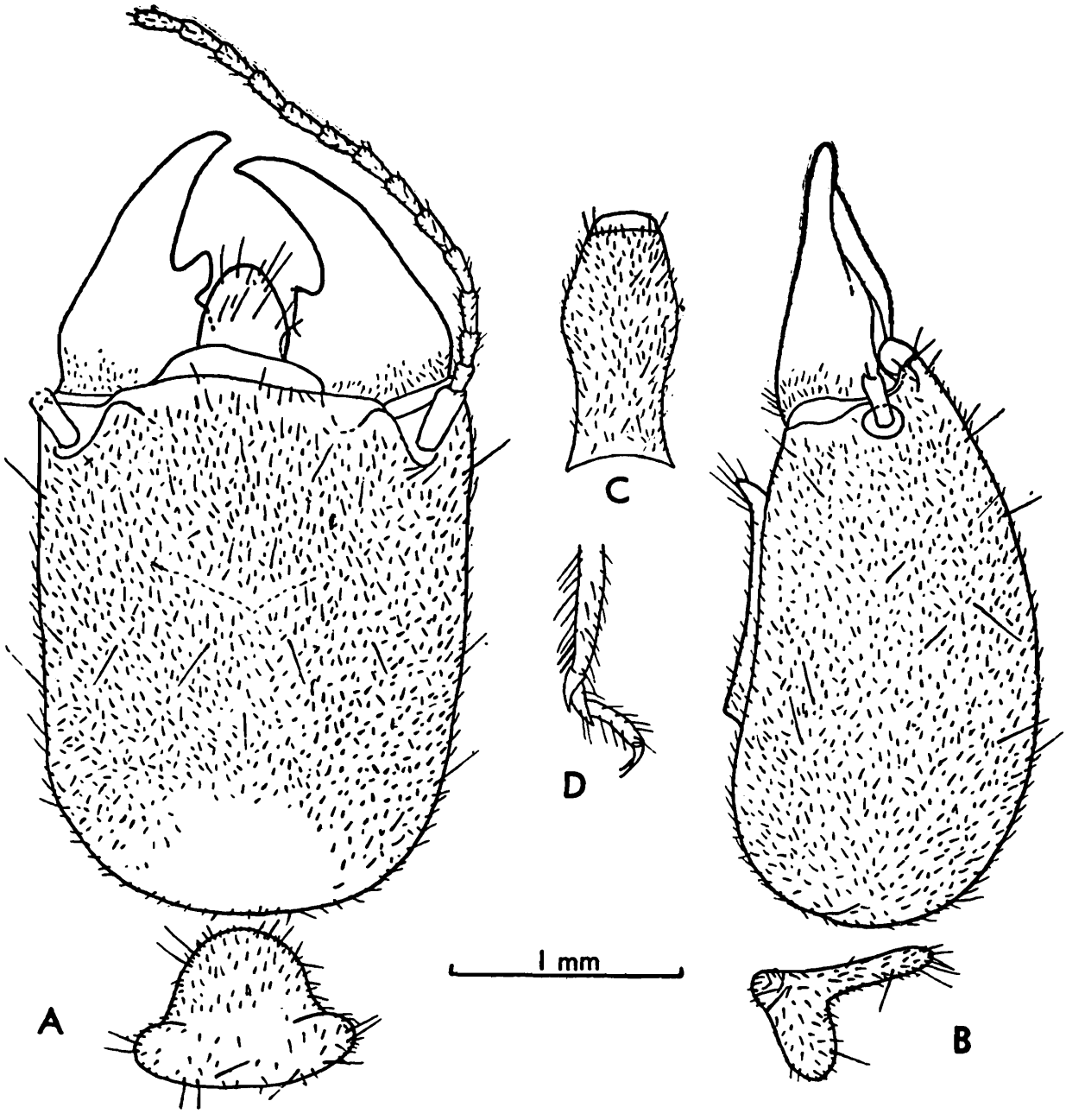

Fig. 4. *Indotermes rongrensis*. Soldier. Meghalaya. A. Head and pronotum, in dorsal view. B. Same, in side view. C. Postmentum. D. Distal part of hind leg.

Anteclypeus hyaline, apilose, anterior margin substraight. Postclypeus demarcated from frons only at the lateral corners ; with a few hairs. Labrum very small (in relation to the massive head), tongue-shaped, slightly longer than wide (length 0.44-0.47, width 0.44 mm). Mandibles much shorter than head (slightly longer than half the head-length 1.37-1.40 mm ; index Mandible-length/Head-length 0.55-0.56) ; massive, with a large basal platelet and a more slender, attenuated, incurved,

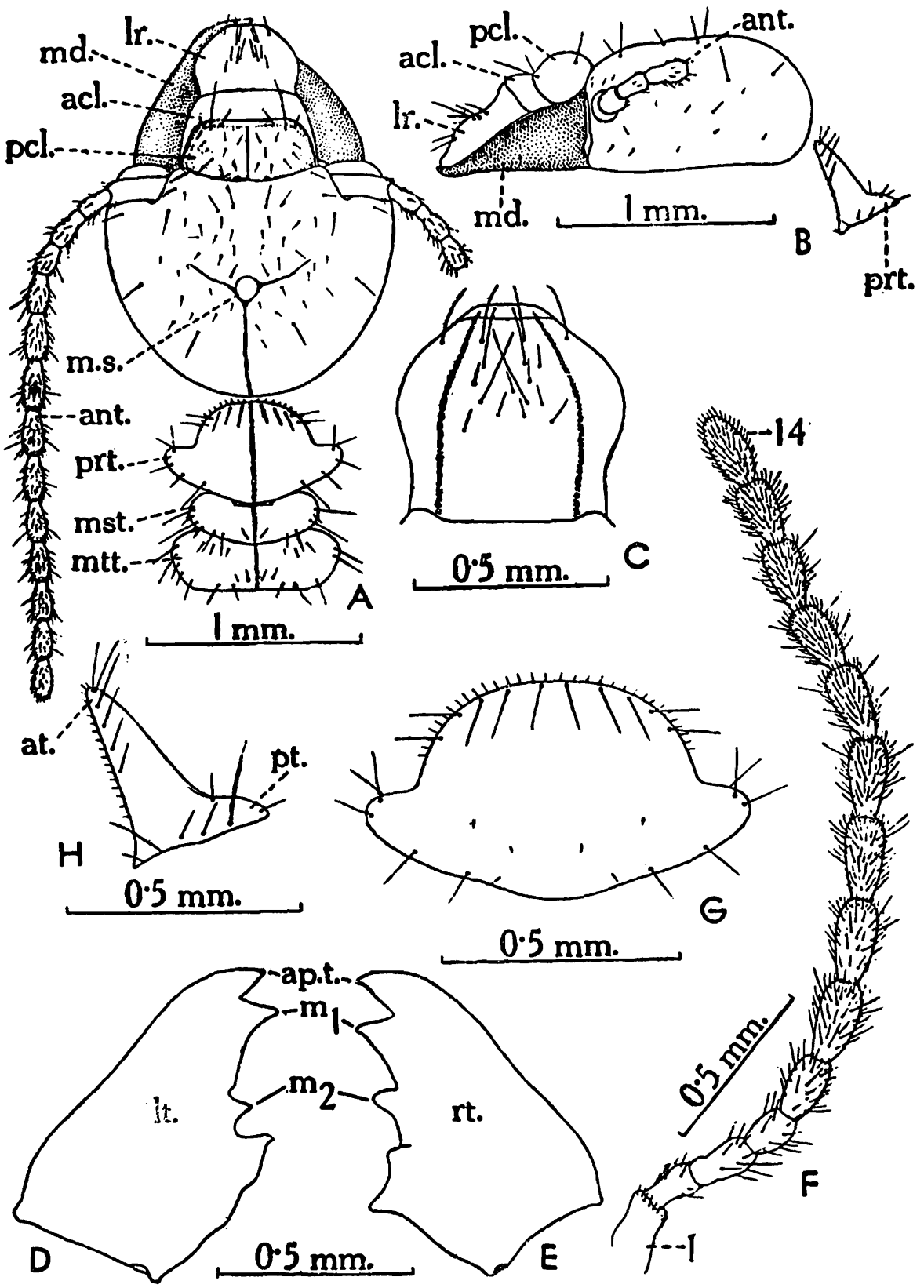

Fig. 5. *Indotecrmes rongrensis.* Worker. Meghalaya. A. Head and thorax, in dorsal view. B. Head and pronotum, in side view. C. Labrum (mounted on slide), in dorsal view. D, E. Left and right mandibles. F. Antenna. G. Pronotum, in dorsal view. H. Same, in side view. (Ex Roonwal and Chhotani 1962).

acl., anteclypeus ; ant., antenna ; apt., apical tooth of mandible ; at., anterior ; lr., labrum ; lt., left ; m1-m2, first and second marginal teeth of mandibles ; md., mandibles ; m. s., mid-dorsal spot ; mst., mesonotum ; mtt., metanotum ; pcl., postclypeus ; prt., pronotum ; pt., posterior ; rt., right.

pointed apical part ; with a large, pointed tooth at the junction of the two parts on the inner margin ; the left tooth larger than the right. Postmentum club-shaped, slightly raised, with a bulge in the middle ; short (in relation to head ; length 0.93-1.25, maximum width 0.50-0.56 mm ; index Postmentum-length/Head-length 0.6) ; the anterior margin weekly convex, the posterior slightly incurved. Pronotum much smaller than head (length 0.72-0.82, maximum width 0.99-1.06 mm) ; strongly saddle-shaped, anterior lobe much longer than posterior ; anterior margin convex, strongly rounded, posterior margin weakly incurved. Legs long, thin ; tarsi 3-segmented ; apical tibial spur formula 2 : 2 : 2. Abdomen oblong, weak and delicate (in relation to the massive head). Cerci 2-jointed ; styli absent.

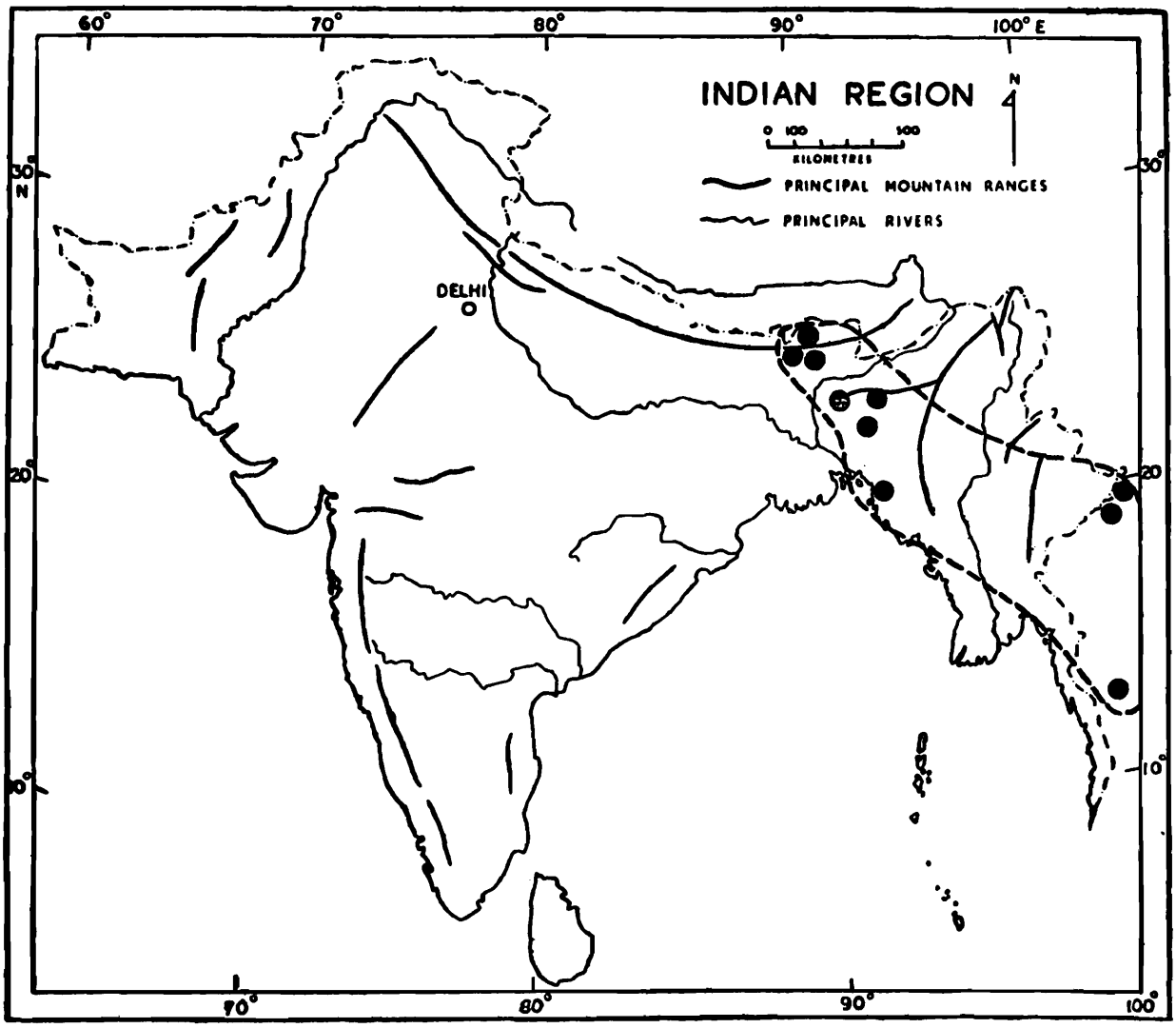

Fig. 6. Map of Indian Region, showing the distribution of *Indotermes rongrensis.*

3. WORKER (Figs. 3 and 5). A description is available in Roonwal and Chhotani (1960), but the tarsi are 3-segmented.*

*Earlier, Roonwal and Chhotani (1962, p. 315) gave the tarsi as 4-segmented. On re-examination of the holotype and paratypes, we found them to be 3-segmented.

Distribution (Fig. 6).

South and South-east Asia. From NE India east to Thailand, as follows :—BHUTAN : Thimphu river bank ; Samchi (300 m) and Puntsholing (200-400 m). INDIA (NE part, e. g., Meghalaya) : Rongrengiri (Garo Hills, 25°30'N and 90°30'E, the type-locality) ; Umsa Nongkharai (Khasi and Jaintia Hills, 25°40'N and 91°50'E) ; along the Dawki Road from Pynursila to Pomshutia, 25°15'N, 90°50'E). BANGLADESH : (Ukhia, Chittagong District). THAILAND (Fang, 19°55'N, 99°20'E), Chiong Dao (19°15'N, 98°40'E), Mae Klang Waterfall, (ca. 15° N, 99°E) [N and SW Thailand].

Discussion

I. rongrensis is the most widely distributed of the seven known species of the genus *Indotermes* Roonwal and Sen-Sarma (syn. *Sinotermes* He and Xia) which occurs in South and South-east Asia to southern China (Bhutan, NE India, Bangladesh, Burma, Thailand, S. China). The Thailand examples of *I. rongrensis* (Morimoto 1973, imagoes) are somewhat smaller than those from elsewhere, but are otherwise quite similar ; the tarsi, stated to be 4-segmented by Morimoto, are really 3-segmented, and segment 2 (in his figure 5) is incomplete and too ill-marked to be regarded as a true segment.

Acknowledgements

We are indebted to Dr. N. S. Rathore (Zoological Survey of India, Jodhpur) for considerable assistance with the figures ; and to the Director, Map Publication officer, Survey of India, Dehra Dun, for the exact positions of the localities in Thailand.

Summary

The confusion regarding the identity of an interesting South Asian species, *Indotermes rongrensis* (Roonwal and Chhotani) (family Indotermitidae) is clarified. It was initially described from workers from NE India (Meghalaya) by Roonwal and Chhotani (1962), as *Speculitermes cyclops rongrensis* (Termitidae, Amitermitinae). The imago was described by Morimoto (1973, from Thailand) and by Roonwal and Chhotani (1977, from Bhutan). Akhtar (1975) described the various castes from Bangladesh as *Indotermes bangladeshiensis* (placing it in the subfamily Apicotermitinae of family Termitidae). The availability of a complete collection (of associated imagoes soldiers and workers) from Meghalaya India, has made it possible for us to re-examine and clarify the taxonomic position of the species which is a true *Indotermes*,

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ADDENDUM

The paper of Tsai, Huang and Zhu (1984) came to our attention too late for incorporation. They describe a new species of *Indotermes* (*I. menggarensis* Tsai and Zhu) and of *Sinotermes* (*S. luxiensis* Huang and Zhu) from southern China, viz., from Menggar (alt. 1375—1380 m.), Luxi County, Yunnan Province, China. This adds to the number of known species of *Indotermes* (for phylogeny, etc., vide Roonwal 1975).

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POLYMORPHIC VARIATIONS IN *GREENIDEOIDA CEYLONIAE* v. d. GOOT 1917 (FAMILY APHIDIDAE)

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(With 9 Figures)

INTRODUCTION

Polymorphism is a general rule in both holocylic and anholocyclic species of Aphididae. However, the degree and nature of polymorphism is rather dissimilar in various groups of aphids. Hille Ris Lambers (1966) presented a comprehensive account on this subject. Oriental genera of Greenideinae stand distinct from all other aphid groups in having fundatrix, oviparae, and males mostly alate and this may be attributed to the primitive characters in the ancestors of aphids which were alate amphigonic oviparous insects and from this condition the present day aphids have developed a system in which each species has at least one parthenogenetic viviparous morph and at least one wingless female morph.

Inspite of several works now available on polymorphism in aphids, tree-infesting greenideines remains neglected.

Greenideoida ceyloniae v. d. Goot, 1917 feeding exclusively on the foliage of *Mesua ferrea* of family Guttifereae, is endemic to Indian Sub-continent. In north-east India, this species occurs at least in two localities, Agartala in Tripura and Jorhat in Assam. This study records the morphological variations in males, oviparous females, fundatrix, alate viviparous females and apterous viviparous females and relate the sequences of their occurrence to the apparent host condition and the seasons.

MATERIALS AND METHODS

The study is based on periodic collections of available morphs of *G. ceyloniae* in the aforesaid localities and mounting the specimens for

their microscopic study following the method of Stroyan (van Emden 1972). Morphometric measurements were carried out under light microscopy and converted in to mm.

Results

A. Morphological variations

(i) Fundatrix (Fig. 1)

Smallest in length (± 2.49 mm) among all the morphs ; body stout, light green in life. Antenna 5-segmented, 0.50×body ; segment III bearing 8 secondary rhinaria ; processus terminalis (p. t.) 1.14×base of last antennal segment, in all other morphs p. t. much shorter than the base. Ultimate rostral segment 0.25 mm long and longer than in

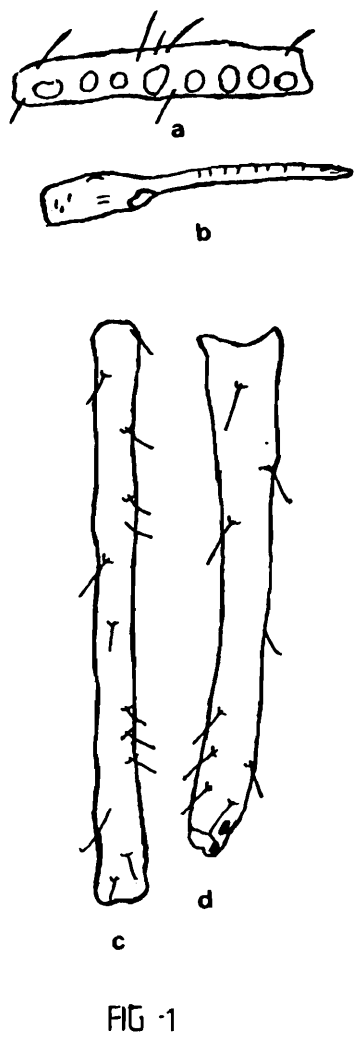


FIG -1

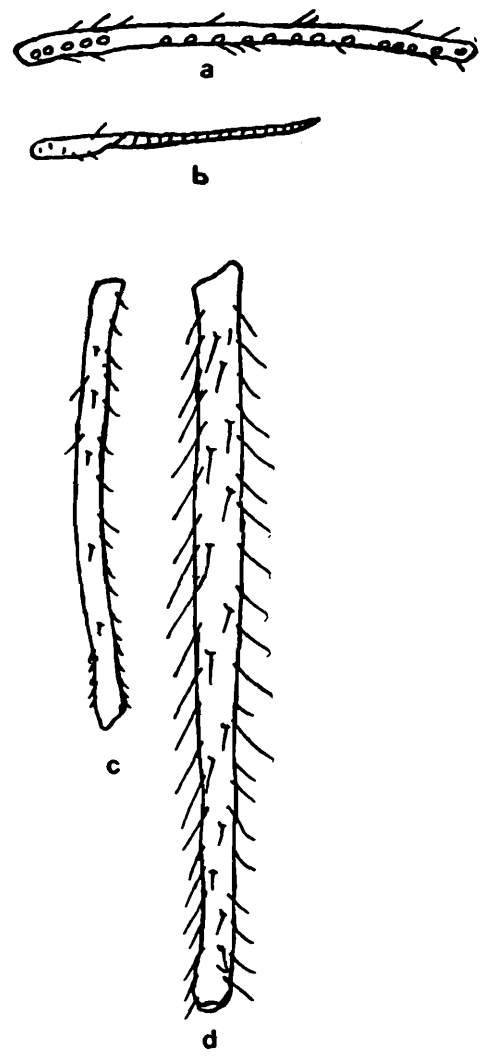


FIG • 2

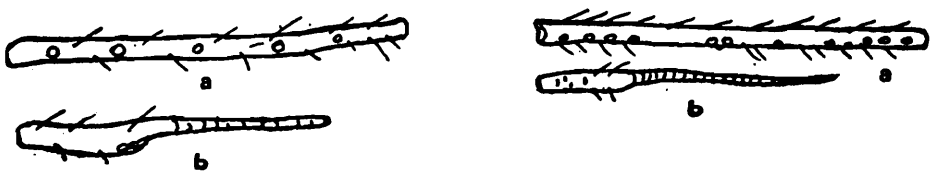
Figs. 1 & 2. 1. Alate fundatrix : a. antennal segment III, b. processus terminalis, c. hind tibia, d. siphunculus.

2. Alate Viviparous Female : a. antennal segment III, b. processus terminalis, c. hind tibia, d. siphunculus.

all other morphs. Siphunculi much shorter than in other alate morphs and slightly but distinctly bent at the apical-most portion. Dorsal hairs short, the longest one on antennal segment III 0.30 mm long.

(ii) Alate viviparous Female (Fig. 2)

Body slightly longer (± 2.92 mm) than antenna, yellowish green to green in life. Antenna light brown, 6-segmented, segment III bearing about 25 secondary rhinaria, highest in number among all the alate morphs; p. t. 0.40 × base of last antennal segment. Ultimate rostral segment 0.20 mm long, 1.40 × as long as second segment of hind



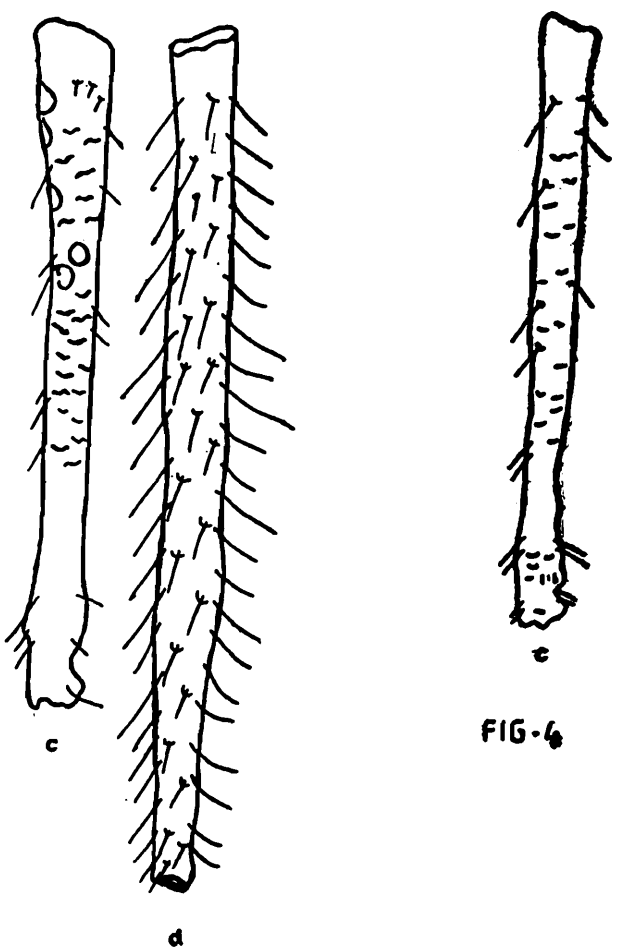


FIG · 3

FIG·4

Figs. 3 & 4. 3. Alate Oviparous Female : a. antennal segment III, b. processus terminalis, c. hind tibia, d. siphunculus.

4. Alate male : a antennal segment III, b. processus terminalis, c, hind tibia.

tarsus (h. t. 2). Siphunculi broadest at base and somewhat narrow at the apex, 2.28 mm long and 0.78 × body.

(iii) Alate oviparous Female (Figs. 3, 8)

Longest body size (± 4.02 mm) among all the morphs, also true of hind tibiae and siphunculi. Colour in life yellowish green. Antenna 0.81 × body, segment III bearing 11 secondary rhinaria, p. t. 0.86 × base of last antennal segment. Dorsal hairs longer than in other morphs, longest one on antennal segment III 0.10 mm long. Female genitalia well-developed.

(iv) Alate male (Figs. 4,9)

Body somewhat shorter (±2.68 mm) than the alate viviparous morph. Colour in life reddish green. Antenna longest among all the morphs, 1.28 × body ; segment III bearing 11 secondary rhinaria ; p.t. 0.48 × base of last antennal segment. Hind tibiae longer than in the fundatrix and the alate viviparae but somewhat shorter than in oviparae. Male genitalia well-developed.

Three morphs of apterae seen to exist. Careful observation in successive three years revealed that all the morphs may occur simultaneously for part of their period of occurrence on the host. Green specimens with light green and long siphunculi were the first generation apterae which infest the young foliage. Second generation apterae were slightly brownish with central pale area and somewhat shorter and brown siphunculi. The third generation apterae infesting new leaves were much smaller, brown in colour and with siphunculi much shorter in length. These trimorphic apterae viviparae have been respectively designated as (a) long siphunculus morph, (b) intermediate morph and (c) short siphunculus morph depending on the length of their siphunculi.

(a) Long-siphunculus morph (Fig. 5)

Body 3.58 mm long. Antenna 6-segmented, 0.83×body ; p.t. 0.54× base of last antennal segment. Ultimate rostral segment 0.23 mm long, 1.42×h.t.$_2$. Hind tibiae and siphunculi much longer than in other two apterous morphs. Longest hair of antennal segment III 0.07 mm long. In most of the characters and in general appearence this morph is very close to alate viviparae. Occassionally intermediate alatoid morph with characters of apterae are noticed. Dorsum of abdomen with scattered spinules, more so on the pleuro-marginal areas. Siphunculi cylindrical, only slightly curved outward at the apex.

TABLE 1. Morphometric data of some characters in different morphs of *G. ceyloniae* (measurements in mm, average)**

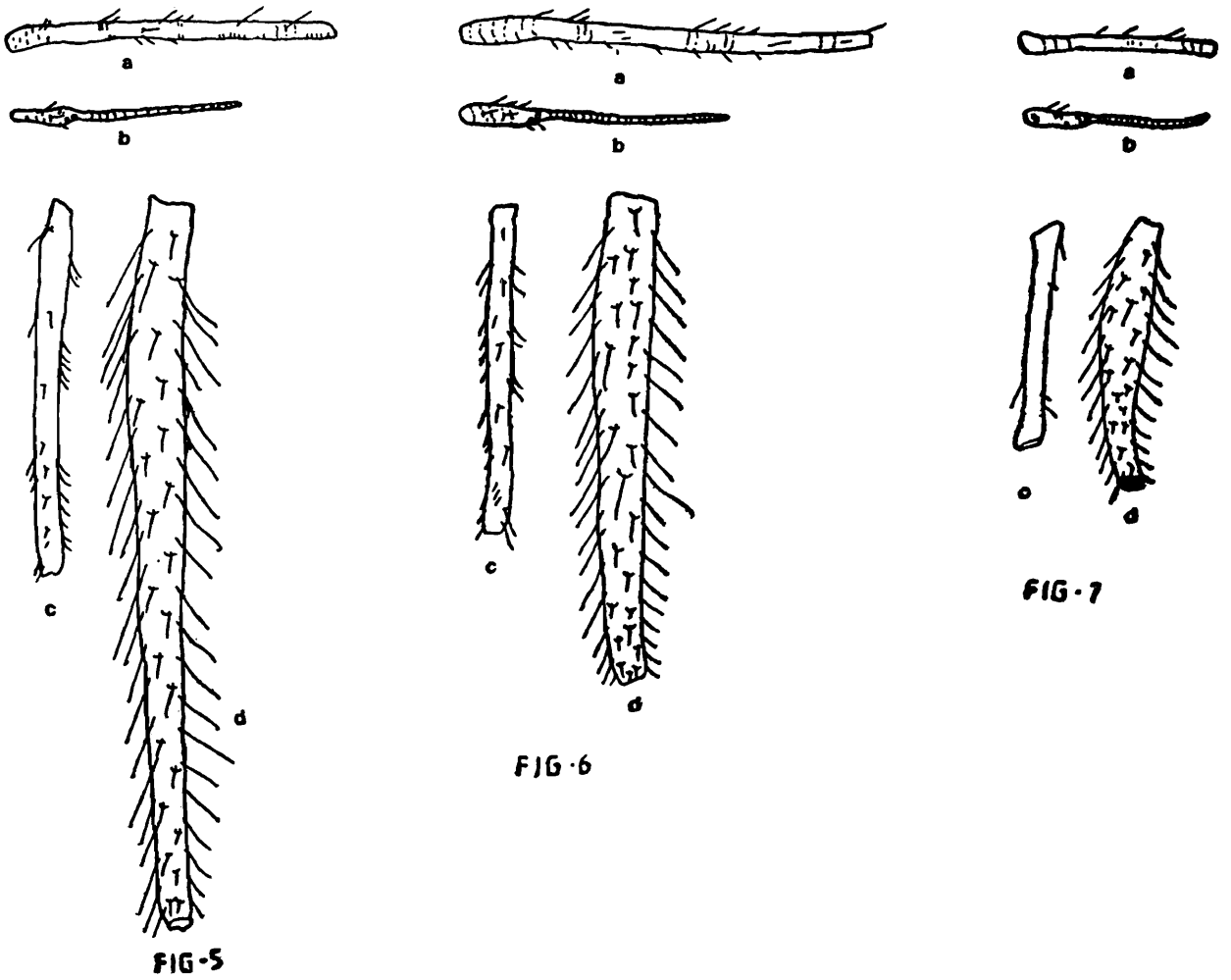
Characters	*Alt. Fundatrix*	*Alt. viviparae*	*Alt. oviparae*	*Alt. males*	Apt. viviparae		
					Long-siph.	*Intermediate*	*Short-siph.*
L. body	2.49	2.92	4.02	2.68	3.58	3.21	2.78
L. ant.	1.22	2.76	3.25	3.42	2.98	2.39	1.88
ant III	0.43	1.05	1.12	1.32	1.13	0.84	0.64
„ IV	0.22	0.30	0.51	0.37	0.29	0.26	0.14
„ V	0.20+0.22	0.36	0.51	0.48	0.42	0.29	0.24
„ VI base	—	0.65	0.45	0.68	0.57	0.52	0.54
„ VI p.t.	—	0.26	0.39	0.32	0.30	0.24	0.19
u.r.s.	0.25	0.20	0.24	0.20	0.23	0.19	0.19
h. t_2	0.15	0.14	0.19	0.16	0.16	0.15	0.14
Hind tibia	1.04	1.28	1.51	1.38	1.44	1.01	0.84
Siphunculus	0.75	2.28	2.58	*	2.05	1.45	0.95
Number Sec. rhin	8	25	11	11	—	—	—
L.h. ant. III	0.03	0.08	0.10	0.08	0.07	0.05	0.08
Ant./body	0.50	0.94	0.81	1.28	0.83	0.74	0.68
p.t./base	1.14	0.40	0.86	0.48	0.54	0.47	0.35
u.r.s./h.t.$_2$	1.67	1.40	1.30	1.26	1.42	1.29	1.31
Hind tib/body	0.42	0.44	0.37	0.51	0.40	0.31	0.30
Siph./body	0.30	0.78	0.64	*	0.57	0.45	0.34
Collection month	Sept.	Oct.-March	March	March	(Oct.	——to——	March)
**No. of Specimens	4	8	6	2	8	8	8

* Missing in macerated specimens

Abbreviations used in the Table : L. body—Length of body, L. ant.—Length of antenna, L. ant. III, IV, V—Length of antennal segments III, IV, V, L. ant VI—Length of base of antennal segment VI, L. ant p.t.—Length of processus terminalis, u.r.s.—Ultimate rostral segment, h.t.$_2$—Second segment of hind tarsus, Number Sec. rhi.—Number of Secondary rhinaria on antennal segment III.

(b) Intermediate morph (Fig. 6)

Body 3.21 mm long. Antenna 6-segmented, 0.74×body ; p.t. 0.47× base of last antennal segment. Ultimate rostral segment 0.19 mm long, 1.29×h.t.$_2$. Hind tibiae and siphunculi shortest among all apterous morphs. Longest hair on antennal segment III 0.05 mm long. Dorsum



Figs. 5-7. 5. Apterous Viviparous Female ; Long Siphunculus Morph : a antennal segment III, b. processus terminalis, c. hind tibia, d. siphunculus.

6. Apterous Viviparous Female : Intermediate Morph : a. antennal segment III, b. processus terminalis c. hind tibia, d. siphunculus.

7. Apterous Viviparous Female : Short Siphunculus Morph : a. antennal segment III, b. processus terminalis, c. hind tibia, d. siphunculus.

of abdomen deep brown with nodular impressions on the pleuro-marginal sides ; spinules present but sparse. Siphunculi stout, curved, bears less hairs than in long-siphunculus morph.

(c) Short-siphunculus morph (Fig. 7)

Body 2.78 mm long. Antenna 6-segmented, 0.68×body ; p.t. 0.33× base of last antennal segment. Ultimate rostral segment 0.19 mm long, 1.31×h.t.$_2$. Hind tibiae and siphunculi shortest among the apterous morphs. Longest hair on antennal segment III 0.88 mm long. Dorsum of abdomen deep brown with nodular impressions on pleuro-marginal

sides ; spinules present but sparse. Siphunculus stout, curved outward, bears less hairs than in long-siphunculus morph.

B. HOST CONDITION AND SEASONALITY

Appearence of fundatrix coincides with the budding of the host which corresponds to post-monsoon or autumn season (September-October) in the study area. Individual fundatrix was seen feeding on the growing bud. Not all the trees under observation show infestation by the fundatrix although later gneration of aphids infest most of the trees to a variable extent. Fundatrix lived for less than a month.

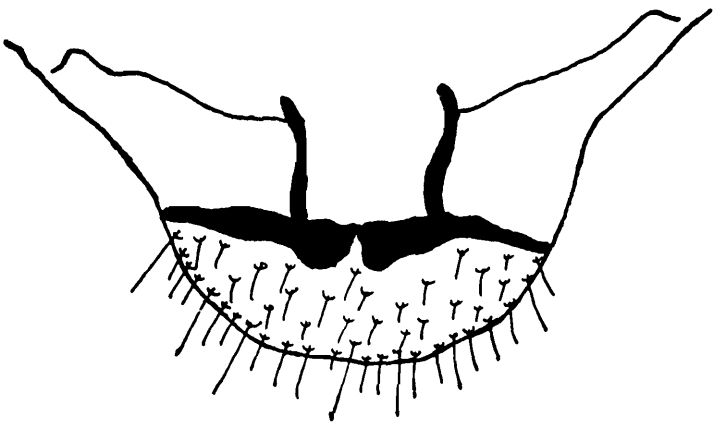


FIG. 8

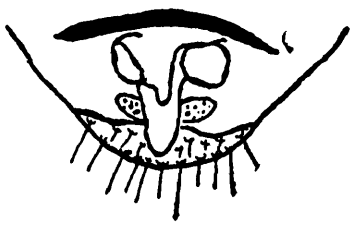


FIG. 9

Figs. 8 & 9. 8. Alate Oviparous Female : Female genitalia.
9. Alate Male : Male genitalia.

Alate viviparae appear about 16 days after the first appearence of the fundatrix and exclusively infest the young leaves. Climatic condition remain the same i. e. post-monsoon or autumn (October). First apterous morph to appear have long-siphunculus. This morph is produced on the young leaves and remain there through out the winter even when the leaves become mature. Alate viviparae and this apterous morph occur together and seldom move to young foliage even when the leaves become heavily infested.

Intermediate apterous morph preferably colonise such mature leaves which are not earlier colonised by any morph. Although no alate viviparae is noticed in its association, presumably some of the alate viviparae and the apterous morph with long siphunculus contribute in the production of this morph, which occur during the months of November to March.

Occurrence of the apterous morph with short siphunculus coincide with the sprouting on the basal part of the tree-canopy and soon these

invade the emerging new red leaves. This morph can produce dense colony in a short period but this condition do not last long and diminishes well before the disappearance of other apterous morphs.

With the onset of spring in March, most of the apterous morphs began to produce alatoid offsprings and the resulting adult-alate viviparae leaves the trees and the locality. During the same months sexuales, both males and oviparae, could be found in another locality (Jorhat) alongwith some viviparous alates possibly representing gynoparae. Males appear ±15 days of first appearence of the oviparae.

Discussion

Each morph in the life cycle of an aphid is a short-lived unit, each being present in a particular time of the year and influenced by seasonal changes and habitat-quality. Thus each morph bears the testimony of specificity in its function and timing. Host-alternating aphids exhibit greater changes between their morphs than non-host alternating ones, however even in these species differences could be noticed.

Alate fundatrix, alate viviparae, alate oviparae and alate males of *G. ceyloniae* are easily distinguishable in their key morphological characters and occupy almost exclusive periods in the total time-table of infestation. Shorter body, 5-segmented antennae, fewer secondary rhinaria and shorter hind tibiae and siphunculi separates fundatrix from other alate morphs. Both oviparae and males are characterised by much longer antennae, equal number of secondary rhinaria (11 each) and longer hind tibiae and siphunculi. Alate viviparae are distinguishable in possessing higher number of secondary rhinaria (25) and p.t. 0.40× base of last antennal segment. Trimorphic apterous morphs seen to be an unusual feature in this greenideine aphid although such instances are not rare in other aphid groups as reviewed by Hille Ris Lambers (1966).

Dixon (1974) noted the changes in the length of the appandages and the number of rhinaria in successive generations of sycamore aphid. Dixon and Wellings (1982) attributed much of the changes in the morphs due to reproductive strategies in the biology of aphids based on advance anticipation of host condition and seasonal changes. Harrweijn (1978) postulated that the production of different morph can be connected with succession and of generation. It is complex seasonal phenomenon influenced by number of intrinsic and extrinsic factors.

Although much of the present study is based on preliminary investigation on the polymorphic trends in this greenideine aphid, this study is a definite pointer towards the interesting phenomenon involved in the generation-succession of different morphs and associated morphological changes.

SUMMARY

Polymorphism in *G. ceyloniae* comprises of Alate funcatrix ; Alate viviparous female ; apterous viviparous females which may be trimorphic with long siphunculi, intermediate and with short siphunculi ; alate male and alate oviparous female. Distinct morphological and morphometric variations are noticeable among the morphs and these are elaborated. Sexuales are produced in late spring and eggs are laid which oversummer. Alate fundatrix is produced in early autumn. Parthenogenetic generations occurs throughout the autumn, winter and early spring or summer. Occurrence of trimorphic apterous viviparous females is an unusual phenomenon in this greenideine species.

ACKNOWLEDGEMENTS

Authors are grateful to Dr. A. K. Ghosh, ZSI, Calcutta, for loaning of some of the mounted preparations of sexual morphs, reported here, for our re-examination and also critical apprisal of the manuscript.

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CHANGES IN POPULATION STRUCTURE OF COLLEMBOLA AND ACARINA IN AN AGRICULTURAL ECOSYSTEM

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Introduction

The agricultural ecosystem is intermediate between natural ecosystems, such as grasslands and forests and man-made ecosystems, such as cities, industrial complexes and so on. Various factors, affecting the faunal distribution in such fabricated ecosystems, being rather harsh, drastically reduce the density and diversity of the species.

Experimental Sites and Methods

324 soil samples were drawn monthly from adequately replicated experimental plots at the Jute Agricultural Research Institute, Barrackpore, West Bengal (India) where long-term fertilizer experiments are being conducted since 1971 with rotation of three crops, *viz.*, wheat, jute and paddy with the application of various doses of N. P. K. and F. Y. M., adoption of plant protection measures, periodic irrigation, etc. (Table-I).

TABLE—I

Treatments	Jute	Paddy	Wheat
T_1	$N_{30}P_{15}K_{30}$+H.W.	*$N_{60}P_{30}K_{30}$	*$N_{60}P_{30}K_{30}$
T_2	$N_{90}P_{45}K_{30}$+H.W.	*$N_{120}P_{90}K_{90}$	*$N_{120}P_{90}K_{90}$
T_4	$N_{60}P_{30}K_{60}$+H.W.	*$N_{120}P_{60}K_{60}$+H.W.	*$N_{120}P_{60}K_{60}$+H.W.
T_6	$N_{60}P_{30}K_0$ +H.W.	*$N_{120}P_{60}K_0$	*$N_{120}P_{60}K_0$
T_7	$N_{60}P_0$ K_0 +H.W.	*$N_{120}P_0$ K_0	*$N_{120}P_0$ K_0
T_8	$N_{60}P_{30}K_{60}$+H.W.+ F.Y.N. @10t/ha	*$N_{120}P_{60}K_{60}$	*$N_{120}P_{60}K_{60}$
T_9	$N_{60}P_{30}K_{60}$+C.W.	$N_{120}P_{60}K_{60}$+C.W.	$N_{120}P_{60}K_{60}$+C.W.
T_{10}	Control+H.W.	*Control	*Control
F			

*Hoeing

Quantitative Analysis

An overall analysis of data shows that Acarina quantitatively dominated over Collembola during all the months and in all the plots.

Population maxima for Acarina was observed during January (wheat cultivation) followed by another during November (paddy cultivation) while, for Collembola, the highest peak was observed during April (jute cultivation) and another moderate peak during January (wheat cultivation).

Lowest population of Collembola was observed during May (jute cultivation) while no population was obtained from soil samples, drawn during July, August and December. Acarina exhibited lowest population during August (paddy cultivation) (Figs. 1, 2).

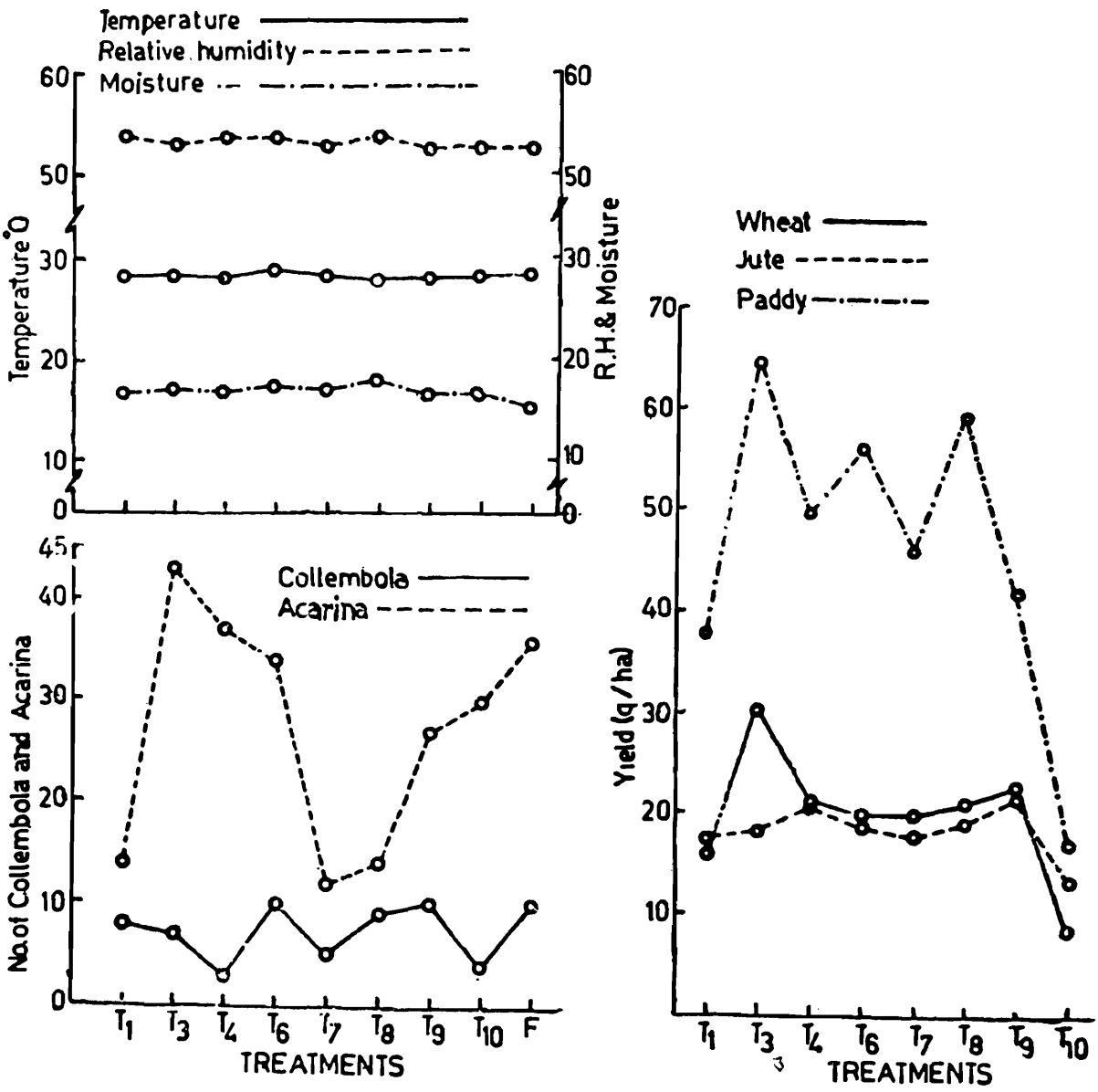

Fig. 1. Dynamics of Collembola and Acarina in fertilizer treated plots with reference to crop yield, temperature, relative humidity and moisture.

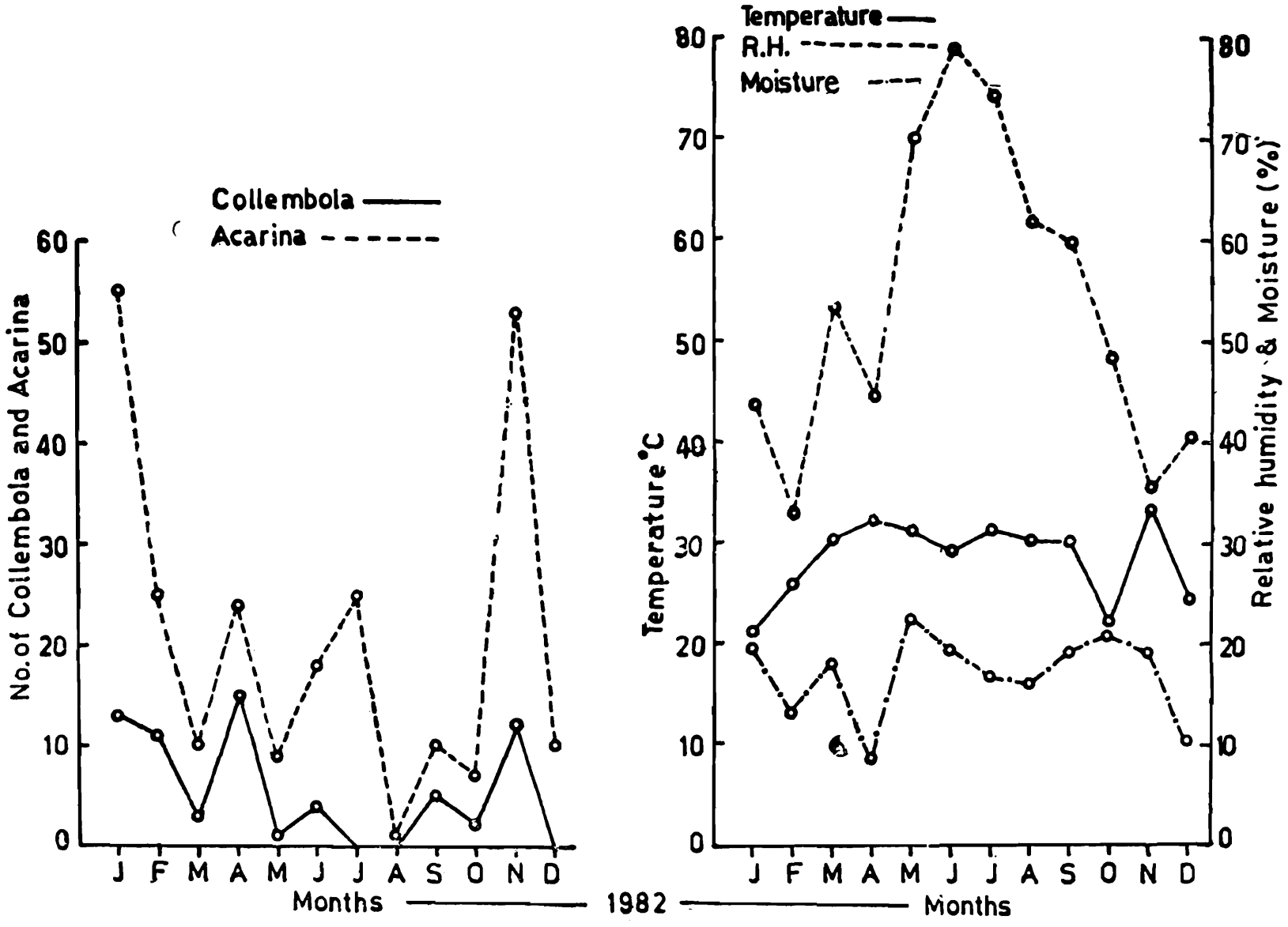

Fig. 2. Monthly changes in the population of Collembola and Acarina in agro-ecosystem with reference to three physical parametres.

The highest build-up of both Collembola and Acarina populations were observed during wheat cultivation (December-March) [40.90% *vs.* 40.48%] followed by jute (April-July) [30.30% *vs.* 30.76%] and paddy [28.78% *vs.* 28.74%].

Plot-wise analysis of collembolan population shows that T_6, T_9 supported the highest population (15.1%) followed by T_8 (13.59%), T_1 (12.08%), T_3 (10.57%), T_7 (7.55%), T_{10} (6.04%), and T_4 (4.53%). Similarly, T_8 exhibited highest population of Acarina (17.37%) followed by T_4 (14.94%), T_6 (13.73%), T_{10} (12.12%), T_9 (10.90%). It is seen that T_1 and T_8 supported the same Acarina population (5.65%) followed by T_7 (4.84%).

Qualitative Analysis

In the experimental plots, altogether 5 species of Collembola occurred during the period of this investigation of which the most dominants were *Isotomurus balteatus* (Reuter) [33.33%] and *Cryptopygus thermophilus* (Axelson) [33.33%] followed by *Lepidocyrtus* (*Lepidocyrtus*) sp. [15.15%], *Cyphoderus javanus* Boerner [12.12%] and *Entomobrya* sp. [6.06%].

I. balteatus and *Entomobrya* sp. were most predominant during wheat cultivation, *C. thermophilus* during jute cultivation, *C. javanus* and *Lepidocyrtus* (*Lepidocyrtus*) sp. during paddy cultivation.

Other species were moderately predominant, infrequent or absent during cultivation of all the three crops (Table-II).

TABLE—II

Occurrence of the species of Collembola according to vegetation types

Species	Vegetation		
	Wheat	Jute	Paddy
Isotomurus balteatus (Reuter)	+++	+	++
Cryptopygus thermophilus (Axelson)	++	+++	+
Lepidocyrtus (*Lepidocyrtus*) sp.	+	++	+++
Cyphoderus javanus Boerner	++	++	+++
Entomobrya sp.	+++	–	–

+++ Predominant; ++ Moderately predominans;
+ Infrequent; – Absent

A plot-wise analysis of the species of Collembola indicates that the maximum population build up of *I. balteatus* was in T_1 and T_7 while minimum in T_3, T_4, T_8 and Fallow. It occurred in moderate numbers in T_6, and T_9. *Cryptopygus thermophilus* exhibited highest population in Fallow followed by T_8. It was absent in T_4, T_7 but seldom found in T_1. T_3 mostly supported the population of *Lepidocyrtus* (*Lepidocyrtus*) sp. followed by T_6 where it occurred in moderate numbers. Its minimum population was observed in T_1 while T_4, T_7, T_8, T_9 and T_{10} were completely devoid of this species. Maximum population of *C. javanus* was noticed in T_8 and T_9 which supported a moderate population. T_3, T_6, T_7, T_{10} and Fallow supported no population of the species and its minimum population was observed in T_1.

TABLE—III

Correlation coefficient between Collembola and Acarina populations, relative humidity, soil temperature and moisture.

	Y : Collembola	Y : Acarina
X : — Relative humidity	0.036*	— 0.365
— Temperature	0.323*	0.209*
— Moisture	—0.032	—0.330
— Acarina	—0.050	

* Significant at 5% level

Relationship between population and Physical factors

The correlation coefficient between Collembola-Acarina and physical factors and also between Collembola and Acarina was analysed (Table-III). It is seen that a positive correlation exists between relative humidity and temperature and Collembola while for Acarina though the correlation is positive for temperature, it is negative for relative humidity. Correlation between both Collembolan and acarine populations with moisture is negative and so also between Collembola and Acarina populations.

DISCUSSION

Round the year cultivation, at the studied agro-ecosystem, is found to reduce the population of both Collembola and Acarina. Effect, however, is found to be more drastic on Collembola than Acarina.

Great reduction in species-diversity of Collembola has been observed. Mitra *et al* (1983) recorded fourteen species of Collembola from the

same agro-ecosystem as compared to give species, recorded in the present observation.

Highest population build-up of Collembola during wheat cultivation may be ascribed to the application of least pesticides during this period.

Summary

Effects of agronomic practices and crop-rotation on Collembola are presented. It is seen that continuous cultivation affects collembolan population both qualitatively and quantitatively.

Acknowledgemetts

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Short Communication

SOME FIELD OBSERVATIONS ON A LEPIDOPTEROUS PEST *METANASTRIA HYRTACA* CRAMER (FAMILY LASIOCAMPIDAE)

Metanastria hyrtaca Cramer, a lasiocampid moth, is typically nocturnal both in respect of its adult as well as immature stages. During a course of general field studies on pests of Jaman tree *Syzygium cumini* (Linn.) Skeels (Syn. *Eugenia jambolana* Lamk.) in late June, 1984, it was observed that a large number of caterpillars (over a hundred in numbers) and later identified as belonging to this species, had been forming a gregarious assemblage on the tree trunk at about two feet from the ground level. The place of assemblage invariably changed everyday from as close as two feet to about five feet from the ground level. However, later in the next generation the caterpillars were found to congregate upto as high as ten feet from the ground level.

The first group contained caterpillars as small as two cm long and one-third cm wide and as big as seven cm long and one cm wide. Since the emergence of the first-stage larvae has not been observed, the author is not aware of the measurements of the smallest caterpillar of the group in this species, but obviously the larger ones belonged to the late-larval stages, as the process of pupation among the caterpillars started around first week of July, 1984 and continued till the first week of August, 1984.

It was interesting to observe that all the caterpillars remained inactive, almost motionless, throughout the day. It may be mentioned here that almost all the caterpillars had their head pointing downwards. After about 20-25 minutes of sunset and on the progressive increase of darkness caused due to sunset, the caterpillars started showing their activity, generally, by raising their head, moving the same to & fro over the bodies of other caterpillars to arouse them from deep slumber. Sometimes they would raise their posterior half only to discharge a pallet of faecal matter. Within a matter of another 20-30 minutes. nearlly all the caterpillars showed some or the other sort of activity. The more developed one turned about 180° and started an upward journey towards natural green foliage of the tree. This was possibly a signal to others which started turning about and followed their leader. It was a sight to see caterpillars marching in a file, singly or in twos and threes, led by a single well-developed one at the head of the march, or interrupted by the ones which crawled for some distance only to descend in search of some place for pupation.

In the first instance when the observations were made, it took nearly 30-40 minutes for the last larva to leave its place of rest.

These caterpillars continued to remain in an upper part of the tree containing green foliage and came down well before sunrise, for rest throughout the day and continue to remain in this temporary dormant stage till a little after sunset.

This rhythmic behaviour of caterpillars and their moving in a line, singly or in twos or threes, from the place of rest to foliage and *vice-versa* is not only interesting but is precisely regulated by the onset of dusk and dawn period of the day, since these have never been seen moving about in their daily routine or for the purpose of pupation during day-light. This clearly indicates their nocturnal behaviour.

The number in the group continued to dwindle everyday, since all those which had assembled did not return to their place of nocturnal activity. Of all the caterpillars which had attained maturity, some crawled only a few inches upwards but turned again and started moving downwards and were found moving about restlessly on the road, inside the adjoining houses and bushes. All those which had, fortunately, secured themselves a place, managed to spin a cocoon around themselves and pupated. One such larva pupated on 7th July, 1984, and the adult emerged on 18th July, 1984 and has been deposited in the National Zoological Collections at Zoological Survey of India, Calcutta (3407/H10). On the 31st of July, 1984, it was interesting to note that only a single larva remained which returned to its place of diurnal rest. It continued to stay throughout the day but on the onset of dusk it journeyed upwards but did not go beyond a foot and a half upwards when it turned again, descended and came onto the road in search of a place for pupation. This larva was captured and was allowed to pupate in laboratory. It pupated on 3rd August 1984, and a female emerged on 13th August, 1984, which was subseqently released in the nature, almost at the same place of the tree-trunk where the larva had its last 'Siesta'.

It is not known why some of the caterpillars preferred to come down on to the ground, whether to pupate or in search of an alternative host-plant, when most of the caterpillars moved upwards. It seems certain that all those which had moved upwards did not always return on the following day, obviously by the dwindling number in their group. While some of them pupated up there, others came down on to the ground and possibility of their search for the alternative host-plant seems to be very remote since most of these pupated wherever convenient to them, i. e., on twigs, wire-nettings, in the folds of wall

curtains, corners, etc. It may be mentioned here that their gregarious way of life ended with the completion of larval stage of the life cycle.

Roonwal (1979) made an exhaustive study in another moth, *Lymantria mathura* Moore (Family : Lymantriidae) which occurs all along the Sub-Himalayan areas from Western Uttar Pradesh to Assam, extending farther East to Southeast Asia. The species also showed a similar rhythm regulated by the onset of dusk and dawn period of the day. A detailed field observation, including a mass eruption, has also been made.

The present species is distributed in India (Tamil Nadu ; Maharashtra ; Madhya Pradesh ; Orissa ; Eastern Himalayas and Assam) and Sri Lanka (*Vide* Hampson, 1892 and Fletcher, 1914).

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Zoological Survey of India,
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LANGURIID BEETLE (COLEOPTERA) OF SILENT VALLEY KERALA, INDIA.

During 1979—'80 Zoological Survey of India surveyed Silent Valley and made interesting collections of various groups of animals.

In these collections the family Languriidae of the order Coleoptera of the Class Insecta of the Phylum Arthropoda is represented by a single species of *Labidolanguria mucronata* Fowler which is not new to South India. Earlier according to Arrow (1925) recorded in Fauna of British India series from Nilgiri Hills of South India. Now it is first time recorded from Silent Valley in Kerala in South India.

In the present study the specimens, two examples, collected from Silent Valley agree with the description of *L. mucronata* Fowler by Arrow (1925). Now, it extends its distribution in South India further to Silent Valley in Kerala which is worth to mention.

A short description of this species is provided.

Genus : **Labidolanguria** Fowler

1908. *Labidolanguria* Fowler, Wytsman's Gen. Insect, Languriinae, p. 9.

1925. *Labidolanguria* Fowler : Arrow, *Fauna British India including Ceylon & Burma* Coleptera, Clavicornia : Erotylidae, Languriidae & Endomchidae : 178,

This genus of the subfamily Languriinae can easily be recogised by its elytra acuminate at the extremity and scutellum long and pronotum margined at the base by Arrow (1925). Eyes lateral, large and prominent, coarsely facetted. Antennae short, joints 3, 4, and 5 feebly elongate, 6 & 7 short and the last four joints abruptly dilated, strongly transverse and compact. Prothorax longer than width, cylindrical, margined at the base and hind angles acute & produced behind and closely applies to the shoulders of the elytra. Scutellum, not transverse, Elytral apices acutely produced.

Only one species is knwn from India.

Range : South India.

Labidolanguria mucronata Fowler

1908. *Labidolangurea mucronata* Fowlor, *Wytsman's Gen. Insect,* Languriinae, p. 10, note, pl. i, fig. 4,

Material examined : 2 exs., Silent Valley, Kerala, 1980, *R. J. Pillai.*

Length : 10-12 mm.

Species (Fig. 1) elongate, slender, brassy-green in colour, the antennae & legs blue-black, Head and pronotum strongly & closely punctured, the front angles blunt and the hind angles acutely produced

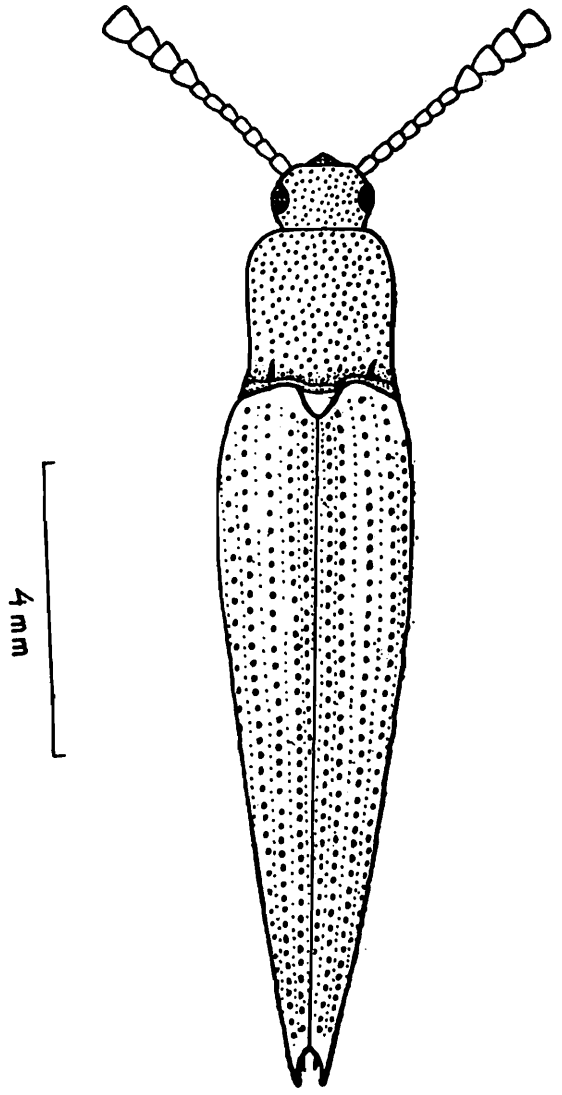

Fig. 1. *Labidolanguria mucronata*

behind, the pronotal base margined and the lateral fovae deeply incised. Scutellum pentagonal and not transverse. Elytra bear rows of deep puncture with intermediate rows of fine punctures, the apices acuminate and with a minor spine on each side near the divergence of the apices. Large & deep puncture on the pronotum and fine puncture on the prosternum and fine punctures on the abdomen.

There is no representation of *Labidolanguria mucronata* Fowler in Zoological Survey of India reference collection and it becomes new addition to the collection.

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A. K. MUKHERJEE

OCCURRENCE OF THE SEA SNAKE, *ENHYDRINA SCHISTOSA* IN THE CHILKA LAKE, ORISSA

No research is reported on the snakes of the Chilka Lake since the time of Annandale (1915) who has first focussed our attention on the faunal wealth of the unique lake. Recently I had the opportunity to survey the lake at Rambha Bay and Barakul with herpetology as the primary objective. In the course of field investigations over twenty days spent mostly cruising the shallow and deeper portions of the lake by motor and country boats, I had on several occasions noticed the abundance of three species of snakes i.e. 1. *Chersydrus granulatus* (Acrochordidae). 2. *Cerberus rhynchops* (Colubridae), and 3. *Hydrophis obscurus* (Hydrophiidae). Annandale (*op. cit*) recorded all these three species but failed to report the presence of the Common Sea Snake, *Enhydrina schistosa*. I was, therefore, pleasantly surprised to find a specimen of this species caught in the fishermen's nets near Barakul. Thus, this specimen is not only an additional record to the snake fauna of the Chilka but also is the first record of the species from the lake.

The only specimen picked up is a juvenile, measuring 790 mm in total length. It is grey above with distinot black crossbands broadest in the middle and tepering to a point on the sides and whitish below. The head is greenish, devoid of markings and the chin and throat are white. When it was captured and placed out of water, it became very active and its disposition was not inoffensive. Although another sea snake, *Hydrophis obscurus* is common in the lake with which the fishermen are quite familiar, they are able to identify the Common Sea Snake as more deadly and hence they prefer to call it 'Dusta sarp' which in Oriya means a bad snake.

Although this species is common in the tidal waters of the Bay of Bengal, Smith (1943) has made on mention of its probable occurrence in the estuaries. Mutthy (1977) has, however, collected this snake in good number from the shallow and muddy estuaries of Ennore, Adyar, and Kovelong, near Madras.

It can be concluded from the above account that the recent collectors have failed to record this species from the Chilka Lake because no attention was paid to the herpetology and it is probable that further investigations may yield interesting results to ascertain the distribution of the Common Sea Snake in the Chilka Lake.

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