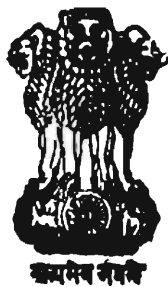


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CONTENTS

SAHA, NIVEDITA and MAITI, P. K.—On a collection of Scolytid-beetles (Scolytidae : Coleoptera) from Sikkim, India ...	1
HATI, A. K., PALIT, A., CHAKRABORTY, S., BHATTACHARYA, S., GHOSH, K. K. and DAS, S.— <i>Phlebotomus argentipes</i> Annandale and Brunetti (Diptera) caught on man baits at night in a clean biotope ...	9
KUMAR, ARUN—Studies on the life history of Indian dragonflies, <i>Diplacodes trivialis</i> (Rambur, 1842) ...	13
AGARWALA, BASANT K., SAHA, S. and GHOSH, A. K.—Studies on <i>Ceratovacuna silvestrii</i> (Takahashi) (Homoptera : Aphididae) and its predator <i>Anisolemnia dilatata</i> (Fab.) on <i>Bambusa arundinacea</i> ...	23
LAKSHMINARAYANA, K. V., MANI, M. S. and EICHLER, WD.—On the relationship of the fossil flea <i>Saurophthirus longipes</i> Ponomarenko (<i>Siphonaptera : Insecta</i>) ...	43
RADHAKRISHNAN, C.—Tephritidae (Diptera : Insecta) of Namdapha ...	49
PODDAR, S. C. and GHOSH, A. K.—Bionomics of an aphidophagous coccinellid predator <i>Pseudaspidimerus circumflexa</i> (Motschulsky) (Coccinellidae : Aspidimerini) ...	67
MUKHERJEE, R. P.—Breeding behaviour of Brow-Antlered deer of Manipur ...	77
CHOUDHURY, AMALESH, BHUNIA, ANIL BARAN and NANDI, SOUMEN—Preliminary survey on Macrobenthos of Prentice Island, Sundarbans, West Bengal ...	81
AGARWALA, BASANT K. and GHOSH, M. R.—Observation on aphids (Homoptera : Aphididae) Infesting bamboo plants in Sikkim, North East India ...	93

BHATTACHARYYA, T. P.—Notes on the export of Wild life and Products from Calcutta	...	105
SHARMA, R. M. and DAS, A. K.—Further contribution to the knowledge of Zooecidia of the mangrove, <i>Avicennia marina</i> (Forsk.) Vier	...	123
RAY, K. K.—Study on the collection of Psocoptera from certain parts of North Eastern India and Bhutan	...	127
MANDAL, A. K., RAY, R. and NAIR, K. N.—Studies on the Protozoan parasites of Orissa	...	137
MONDAL, B. K.—Two new Oribatid mites (Acari) from Indian soils	...	153
GHOSH, A. B. and GHOSE, S. K.—Descriptions of all female instars of the Mealybug, <i>Dysmicoccus brevipes</i> (Cockerell), (Homoptera : Pseudococcidae)	...	163
MONDAL, B. K.—A new Cryptostigmatid mite (Acari : Oribatei) from Darjeeling district, West Bengal, India	...	175
MURTY, M. RAMA and RAO, K. SRINIVASA. — <i>Cynoglossus itinus</i> (Snyder) (Pisces : Cynoglossidae) a new record from Indian waters (Bay of Bengal, off Visakhapatnam)	...	181
SAINI, R. S. and SINGH, Y. P.—Comparative studies on the larval forms of Odonata, head and its appendages	...	185
KUMAR, ARUN—Studies on the life history of Indian dragonflies, <i>Acisoma panorpoides panorpoides</i> Rambur, 1842 (Libellulidae : Odonata)	...	203
SARKAR, A. K.—Taxonomic and Ecological studies on the Amphibians of Calcutta and its environs	...	215
VERMA, S. C.—On a collection of termites (Insecta : Isoptera) from Kerala (India) with a new species of and keys to the Indian species of <i>Angulitermes</i> Sjöstedt	...	237
TILAK, RAJ and BALONI, S. P.—On the fish fauna of Tehri-Garhwal, Uttar Pradesh	...	255
HUSAIN, AKHLAQ and TILAK, RAJ.—On the fish fauna of district Faizabad, Uttar Pradesh	...	273
TILAK, RAJ, JAFFER, ZEBBA and HUSAIN, AKHLAQ.—Systematic status of <i>Barilius bendelisis</i> Hamilton (Cyprinidae : Pisces)	...	279

GUPTA, LAKSHMAN PRASAD.— <i>Indocandona krishnakanti</i> , Gen. et Sp. Nov. (Crustacea : Ostracoda : Candonidae) from subterranean water of Bihar, India	...	291
SEN, N. and DEY, S. C.—Fish Geography of Meghalaya	...	299
ROONWAL, M. L., BOSE, G. and VERMA, S. C.—The Himalayan termite, <i>Archotermopsis wroughtoni</i> (Synonyms <i>Radcliffei</i> and <i>Deodarae</i>). Identity, Distribution and Biology	...	315
PAL, TARUN KUMAR—Silvanidae (Coleoptera : Clavicornia) from southern India and Sri Lanka in Museum d' Histoire Naturelle de Genève	...	339
NAIR, B. UNNIKRISHNAN and PILLAI, N. KRISHNA—On three new species of <i>Asterocherid</i> Copepods, with a redescription of <i>Indomyzon quasimi</i> Ummerkutty	...	357
VENKATARAMANI, V. K. and NATARAJAN R.—Length-weight relationship in <i>Carangoides malabaricus</i> (Bl. and Schn.) and <i>Alepes kalla</i> (Cuv. and Val.)	...	373
KUMARI, K. R. NIRMALA and NAIR, N. BALAKRISHNAN —Studies on the life history of <i>Ranatra filiformis</i> Fab. (Hemiptera : Nepidae)	...	381
KUMARI, K. R. NIRMALA and NAIR, N. BALAKRISHNAN—On the Aquatic stick insect <i>Cercotmetus pilipes</i> Dall (Hemiptera : Nepidae)	...	395

ON A COLLECTION OF SCOLYTID-BEETLES (SCOLYTIDAE :
COLEOPTERA) FROM SIKKIM, INDIA

By

NIVEDITA SAHA & P. K. MAITI

Zoological Survey of India, Calcutta

INTRODUCTION

The bark- and timber-beetles belonging to the coleopterous family Scolytidae of Sikkim, a Himalayan State of the eastern India, are extremely poorly known so far. As early as in 1904, Hagedorn published a paper dealing with some scolytid species from Sikkim and Japan. In this paper, some six species have been recorded from Darjeeling which is now outside the limit of the newly defined political State of Sikkim. However, only two species, namely *Cnestus nitidipennis* (Schedl) and *Xyleborus asperipennis* Eggers are reported from the area so far. The first one was originally described as *Xyleborus nitidipennis* from Java by Schedl (1951) which was subsequently reported from Sikkim by the same author in 1969, as a species under the genus *Cnestus* Sampson. The other species was reported by Schedl (1969) which had now been transferred to the genus *Euwallacea* Hopkins.

However, in a recent collection trip to Sikkim undertaken by Zoological Survey of India, a small collection was made available to us on which the present report is based. A total of 9 species belonging to 7 genera has been dealt with in the present paper with particular regard to their synonymy, distribution and taxonomic remarks, etc. All the species reported here are recorded for the first time from the area. The two known species referred to above were not available in the present collection.

The most common genus *Xyleborus* Eichhoff containing a large number of heterogenous group of species is now splitted into a number of genera (Wood, 1980). Accordingly, some species, so far included under this genus have been transferred to some other genera in the present study as follows : The species *Xyleborus interjectus* Blandford has been transferred to the genus *Euwallacea* Hopkins, *Xyleborus mus* Eggers to *Microperus* Wood and *Xyleborus artestriatus* Eichhoff to *Xyleborinus* Reitter.

SYSTEMATIC ACCOUNT

Family : SCOLYTIDAE

Subfamily : SCOLYTINAE

Tribe (i) XYLEBORINI

1. *Euwallacea interjectus* (Blandford)

Xyleborus interjectus Blandford, W. F. H. 1891. *Trans. ent. Soc. Lond.*, pp. 576-577, ♀, *Type-locality* : Japan ; Eggers, H. 1923. *Zoöl. Meded. Leiden*, 7 : 198, ♂.

Xyleborus lopchuensis Beeson, C. F. C. (in literature) ; Schedl, K. E. 1972. *Ent. Arb. Mus. Frey.*, 23 : 258 ; Schedl, K. E. 1975. *Revue suisse Zool.*, 83 (3) : 451, Kerala.

Material : One Female (F. C. No. N8/17.4.1980) from Sikkim, jungle near P. W. D. Rest House, Gangtok, *B. Nandi and S. Chakraborty* coll., 17.iv.1980, ex. "at light" ; One female from Mantham, 20 km. N. of Rongpo, Sikkim (alt. 625m), *R. K. Varshney and party* coll., 7.iv.1981, ex. "soft wood of a unknown log".

Measurements (in mm) : Total length of body, 3.53-3.88 ; Max. width of head (across the eyes), 0.92-0.96 ; Max. length of pronotum, 1.30-1.46 ; Max. width of pronotum, 1.46-1.57 ; Max. length of elytra, 2.14-2.50 ; Max. width of elytra, 1.50-1.61.

Distribution : *Sikkim* : Gangtok and Mantham (Present record). *Elsewhere*. ORIENTAL REGION : *India* : Tamil Nadu, Maharastra, Madhya Pradesh, West Bengal, Assam, Andaman Islands and Kerala ; *China*, *Taiwan*, *Burma*, *Sri Lanka*, *Indonesia* and *Malaysia*. PALAEARCTIC REGION : *Japan*.

Remarks : The species, *E. interjectus* (Blandford) is predominantly distributed in the Oriental Region and is recorded for the first time from the Himalayan region in the Sikkim State. *Xyleborus lopchuensis*, an undescribed species of Beeson from Darjeeling Himalaya is very much identical to *E. interjectus* for which Schedl (1972) synonymised the same with the latter species. Subsequently, Schedl (1975) maintained its status as *X. lopchuensis*. But, after thorough examination of the types present in Forest Research Institute, Dehra Dun, in the present study, we are putting *Xyleborus lopchuensis* as a synonymy of *E. interjectus* (Blandford).

2. *Eccoptopterus spinosus* (Olivier)

Scolytus spinosus Olivier, 1794. *Entomologie, Ou Histoire Naturelle des Insects.*, 3 : 9, ♀, *Type-locality* : Indonesia : Java ; Eggers, H. 1927. *Philipp. J. Sci.*, 33 : 102, ♂, India : Dehra Dun ; Philippine : Luzon ; (as *Xyleborus sexspinosus*).

Eccoptopterus sexspinosus Motschulsky, V. 1863. *Bull. Soc. Imp. Nat. de Moscow*, 36 : 515-516, ♀, *Type-locality* : Sri Lanka.

Xyleborus abnormis Eichhoff, W. 1868. *Berl. ent. Z.*, 12 : 282, *Type-locality* : Sri Lanka.

Platydyctylus sexspinosus Motsch. var. *multispinosus* Hagedorn, M. 1908. *Dt. ent. Z.*, p. 377, *Type-locality* : Indonesia : Sumatra (Kamerun).

Eccoptypterus sexspinosus Motsch. var. *pleuridentatus* Schedl, K. E. 1942. *Tijdschr. Ent.*, 85 : 49, *Type-locality* : Sumatra.

Eccoptypterus spinosus (Olivier), Schedl, K. E. 1962. *Ent. Blatt.*, 58 : 201.

Material : One Female from Mamring near Rongpo, Sikkim (alt. 300 m), R. K. Varshney coll., 5.iv.1981, ex. "soft wood of an unknown log".

Measurements (in mm) : Total length of body, 3.10 ; Max. width of head (across the eyes), 0.84 ; Max. length of pronotum, 1.14 ; Max. width of pronotum, 1.46 ; Max. length of elytra, 1.53 ; Max. width of elytra, 1.23.

Distribution : *Sikkim* : Mamring and Rongpo (present record). *Elsewhere* : ORIENTAL REGION : *India* : Kerala, Tamil Nadu, Maharashtra, West Bengal, Assam and Andaman Islands ; *Burma*, *Philippines*, *Malaysia* (Borneo) and *Indonesia* (Sumatra, Java, Celebeys). AUSTRALIAN REGION, ETHIOPIAN REGION : East Africa, and MALAGASY REGION : Seychelles.

3. *Microperus mus* (Eggers)

Xyleborus mus Eggers, H. 1930. *Indian Forest Rec.*, 14 (9) : 203-204, ♀, *Type-locality* : Bangladesh : Chitagong Hill tract ; Beeson, C. F. C. 1930. *Indian Forest Rec.*, (*Ent.*), 14 (10) : 74 ; Beeson, C. F. C. 1941. *The Ecology and Control of Forest Insects of India and the Neighbouring Countries*, 308 p.

Material : 19 Females and two males from Fatak, near Mamring, North Sikkim, (alt. 925 m), R. K. Varshney coll., 12.iv.1981, ex. "under soft wood of an unknown broken branch".

Measurements (in mm) : Total length of body, 2.26-2.32 ; Max. width of head (across the eyes), 0.65-0.68 ; Max. length pronotum, 0.82-0.84 ; Max. width of pronotum, 0.88-0.90 ; Max. length of elytra, 1.42 ; Max. width of elytra, 0.90-0.92.

Distribution : *Sikkim* : Fatak (present record). *Elsewhere* : ORIENTAL REGION : *India* : West Bengal ; and *Bangladesh*.

Remarks : There is a wide variation in colour in different individuals of the species inhabiting in the same colony. The complete black specimens are not uncommon in addition to the total brown ones or combination of blackish elytra and brownish pronotum. The male of the species is so far undescribed which is being described elsewhere by the same authors.

4. *Xyleborinus artestriatus* (Eichhoff)

Xyleborus artestriatus Eichhoff, W. 1878. *Ratio descriptio emendato eorum Tomicino-*
rum, p. 507, ♀, *Type-locality* : India.

Xyleborus laticollis Blandford, W. F. H. 1896. *Trans. ent. Soc. Lond.*, p. 226, ♀, *Type-*
locality : India : Karnataka ; Schedl, K. E. 1958. *Tijdschr. Ent.*, 83 (3-4) : 152.

Material : One Female from Mantham (alt. 625 m), 20 km. of North Sikkim, Rongpo, R. K. Varshney and party coll., 7.iv.1981, ex. "soft wood of an unknown log".

Measurements (in mm) : Total length of body, 2.57 ; Max. width of head (across the eyes), 0.65 ; Max. length of pronotum, 1.05 ; Max. width of pronotum, 0.96 ; Max. length of elytra, 1.53 ; Max. width of elytra, 0.96.

Distribution : *Sikkim* : Mantham (present record). *Elsewhere* : ORIENTAL REGION : *India* : Maharastra, Madhya Pradesh, Uttar Pradesh, West Bengal, Assam ; *Burma, Malaysia, China* and *Vietnum*. AUSTRALIAN REGION : *Queensland*.

Remarks : The species is widely distributed in the Oriental and Australian Regions. The single specimen collected from Sikkim is very similar to that of West Bengal, except in having comparatively much blackish elytra and distinct tubercles on interstriae 3 on declivity.

5. *Xyleborus cristatus* Hagedorn

Xyleborus cristatus Hagedorn, M. 1908. *Dt. ent. Z.*, pp. 377-378, ♀, *Type-locality* : India : West Bengal, Darjeeling Dist., Kurseong ; Hagedorn, M. 1910. *Coleopt. Cat.* 26 (4) : 101 Himalaya ; Beeson, C. F. C. 1930. *Indian Forest Rec. (Ent.)*, 14 (10) : 55. India : West Bengal and Assam.

Material : One Female from Singla (alt. 1300 m), N. Sikkim, R. K. Varshney coll., 11.i.1981, ex. "soft wood of an unknown log".

Measurements (in mm) : Total length of body, 3.34 ; Max. width of head (across the eyes), 0.92 ; Max. length of pronotum, 1.38 ; Max. width of pronotum, 1.53 ; Max. length of elytra, 1.96 ; Max. width of elytra 1.53.

Distribution : *Sikkim* : Single (present record) *Elsewhere* : ORIENTAL REGION : *India* : West Bengal and Assam.

Remarks : The specimen from Sikkim is very similar in all essential Characters to that of the typical *Xyleborus cristatus* Hagedorn from north-eastern India. But, it differs in having more depressed incurved elytra at anterior one-third, comparatively more prominent tubercles on 3rd interstria and smaller in size.

6. *Xyleborus similis* Ferrari

Bostrichus ferrugineus Boheman, C. H. 1958-1959. *Voyage de kongliga Svenska Fregatten Euginies Resa*, 1851-1853, p. 88, ♀.

Xyleborus similis Ferrari, J. 1867. *Die forst und Baumzuchtscnädlichen Borkenkafer*, pp. 23-24 (mom. nov.), ♀. *Type-locality* : Keelings Island ; Schedl, K. E. 1942. *Tijdschr. Ent.*, 85 : 47, ♂. *Type-locality* : Indonesia : Java.

Anodius denticulus Motschulsky, V. 1863. *Bull. Soc. Imp. Moscow*, 36 : 512, ♀ and ♂.

Xyleborus parvulus Eichhoff, W. 1868. *Berl. ent. Z.*, 12 : 152, *Type-locality* : Sri Lanka.

Xyleborus dilatatus, Eichhoff, W. 1878. *Ratio. descriptio emendatio Tomycinorum*, pp. 64, 393-394, 484, ♀, *Type-locality* : Africa : St. Mauritius Island.

Xyleborus parvulus Eichhoff var. *submarginatus* Blandford, W. F. H. 1895. *Ann. Mag. nat. Hist.*, 15 (6) : 322, ♀, *Type-locality* : Sri Lanka.

Xyleborus submarginatus, Blandford, W. F. H. 1896. *Trans. ent. Soc. Lond.*, pp. 223-224, ♀, *Type-locality* : India : Belgaum.

Xyleborus bucco Schaufuss, C. 1897. *Tijdschr. Ent.*, 40 : 212-214, ♀, *Type-locality* : Seychelles ; La Digue.

Xyleborus capito Schaufuss, C. 1897. *Tijdschr. Ent.*, 40 : 215, ♂, *Type-locality* : Philippines.

Material : Two Females from Mantham (alt. 625m), 20 km. N. of near Rongpo, Sikkim, R. K. Varshney and party coll., 7.iv.1981, ex. "soft wood of an unknown log".

Measurements (in mm) : Total length of body, 2.34 ; Max. width of head (across the eyes), 0.50 ; Max. length of pronotum, 0.92 ; Max. width of pronotum, 0.80 ; Max. length of elytra, 1.38 ; Max. width of pronotum, 0.80.

Distribution : *Sikkim* : Mantham (present record) *Elsewhere* : ORIENTAL REGION : *India* : Andaman Islands, Assam, West Bengal, Bihar, Orissa, Maharastra, Madhya Pradesh, Uttar Pradesh, Karnataka. *Sri Lanka, Burma, Taiwan, Malaysia, Indonesia, Philippine Islands*, AUSTRALIAN REGION : Queensland ; PAPUAN SUB-REGION : *New Guinea*, the Solomon Islands, Guam and Chistsmas Island.

7. *Xylosandrus discolor* (Blandford)

Xyleborus discolor Blandford, W. F. H. 1898. *Trans. ent. Soc. Lond.*, p. 429, ♀, *Type-locality* : Sri Lanka.

Xyleborus posticestriatus Eggers, H. 1939. *Arb. morph. taxon. Ent., Berl.*, 6 : 119, ♂, Taiwan ; Schedl, K. E. 1950. *Tijdschr. Ent.*, 93 : 63-64, ♀.

Xylosandrus discolor (Blandford), Browne, F. G. 1961. *Malayan Forest Rec.*, no. 22, p. 169. *India, Sri Lanka, Burma, Sumatra, Java, Malaya*.

Material : One Female (F. C. No. N13/14.4.1980) from Rangpo (alt. 152 m), Ca. 3 km north-east of PWD Bungalow, Sikkim, *B. Nandi* and *S. K. Chakraborty* coll., 14.iv.1980, ex. "under bark of an unknown log".

Measurements (in mm) : Total length of body, 1.93 ; Max. width of head, 0.73 ; Max. length of pronotum, 1.03 ; Max. width of pronotum, 1.11 ; Max. length of elytra, 1.19 ; Max. width of elytra, 1.11.

Distribution : Sikkim, Rangpo (present record), *Elsewhere* : ORIENTAL REGION : *India* : West Bengal, Assam, Uttar Pradesh and Tamil Nadu ; *Sri Lanka, Burma, Taiwan, Indonesia and Malaysia.*

8. *Xyleborus gravidus* (Blandford)

Xyleborus gravidus Blandford, W. F. H. 1898. *Trans. ent. Soc. Lond.*, pp. 427-428, ♀, *Type-locality* : Bangladesh : Chittagong Hills ; Beeson, C. F. C. 1930. *Indian Forest Rec.*, 14 (10) : 61, Bangladesh ; Assam, West Bengal ; Kumar, A. and Chandra, A. 1977. *Oriental Ins.*, 11 (1) : 34 and 42, ♀, India and Malaysia.

Material : Two Females from Mantham (alt. 625 m), 40 km N. Sikkim, *R. K. Varshney and party* coll., 7.iv.1981, ex. "under soft wood of an unknown log".

Measurements (in mm.) : Total length of body, 4.90 ; Max. width of head, 1.5 ; Max. length of pronotum, 2.20 ; Max. width of pronotum, 2.65 ; Max. length of elytra, 2.60 ; Max. width of elytra 2.70.

Distribution : Sikkim : Mantham (present record), *Elsewhere* : ORIENTAL REGION : *India* : West Bengal, Assam ; *Bangladesh, Malaysia and China.*

Remarks : The broad and stout general appearance of the species indicates its inclusion under the genus *Xylosandrus* Reitter characterised by widely separated procoxae. But, the procoxae is contiguous in this species, for which the species has been retained as such under the genus *Xyleborus* Eichhoff in the present study.

Tribe (ii) DRYOCOETINI

9. *Coccotrypes cyperi* (Beeson)

Thamnurgides cyperi Beeson, C. F. C. 1929. *Insects of Samoa*, (Coleoptera) 4 (4) : 230, *Type-locality* : Apia, Samoan Island.

Thamnurgides indicus Eggers, H. 1936. *Ann. Mag. nat. Hist.*, 17 (10) : 631, *Type-locality* : Sakalaspur, Karnataka, India ; Wood, S. L. 1978. *Gt. Basin. Nat.*, 33 (4) : 397.

Xyleborus conspectus Schedl, K. E. 1936. *Archiv. Inst. Biol. Veg. Rio de Janeiro*, 3 : 110, *Type-locality* : Not given, presumably Brazil ; Wood, S. L. 1978. *Gt. Basin. Nat.*, 33 (3) : 179.

Poecilips piliforms Browne, F. G. 1970. *J. Nat. Hist.*, **4** : 568, *Type-locality* : Nilgiri Hills, India ; Schedl, K. E. 1972. *Ent. Arb. Mus. Frey.*, **23** : 257.

Coccotrypes cyperi (Beeson), Wood, S. L. 1978. *Gt. Basin. Nat.*, **38** (4) : 397.

Material : Two Females from Mantham (alt. 625 m), 20 km. N. Sikkim, R. K. Varshney and party coll., 7.iv.1981, ex. "tender soft wood of an unknown log".

Measurements (in mm) : Total length of body, 2.24 ; Max. width of head, 0.53 ; Max. length of pronotum, 0.92 ; Max. width of pronotum, 0.84 ; Max. length of elytra, 1.34 ; Max. width of elytra, 0.86.

Distribution : Sikkim : Mantham (present record), *Elsewhere* : ORIENTAL REGION : India : Assam, West Bengal ; *Burma* ; *Indonesia*, *Java* ; *China*, OCEANIAN SUB-REGION : Samoa.

SUMMARY

The present report is based on a small collection of scolytid-beetles collected from Sikkim during 1980-1981 by the survey parties of the Zoological Survey of India. Prior to the presentation of this report, only two species, namely, *Cnestus nitidipennis* (Schedl) and *Xyleborus asperipennis* Eggers are known from the area which have not been included here due to lack of material.

The paper deals with some nine species under seven genera with regard to their synonymy, measurement, distribution, taxonomic remarks, etc. All the species are recorded for the first time from Sikkim. The species are as follows : *Euwallacea interjectus* (Blandford), *Eccoptopterus spinosus* (Olivier), *Microperus mus* (Eggers), *Xyleborinus artestriatus* (Eichhoff), *Xyleborus cristatus* Hagedorn, *Xyleborus similis* Ferrare, *Xylosandrus discolor* (Blandford), *Xyleborus gravidus* Blandford and *Coccotrypes cyperi* (Beeson).

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Grateful acknowledgement is made to Dr. B. K. Tikader, Director, Zoological Survey of India, for providing necessary facilities, to Dr. R. K. Varshney and B. N. Nandi, Zoological Survey of India, for collection of material and to Prof. S. L. Wood, Professor of Entomology, Brigham Young University, Provo, Utah, U. S. A., for kindly confirming some of our identification.

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PHLEBOTOMUS ARGENTIPES ANNANDALE AND
BRUNETTI (DIPTERA) CAUGHT ON MAN
BAITS AT NIGHT IN A CLEAN BIOTOPE

By

A. K. HATI¹, A. PALIT², S. CHAKRABORTY³, S. BHATTACHARYA⁴,
K. K. GHOSH⁵ AND S. DAS⁶

(With 2 Tables)

INTRODUCTION

A longitudinal study on nocturnal man/*Phlebotomus argentipes* contact in a village in West Bengal has been documented (Hati et al, 1981) in and outside a cowshed where these sandflies usually breed. Do they come to suck human blood in a clean biotope situated near the cowsheds? To find out the answer the present study was designed.

MATERIALS AND METHODS

An isolated but well-ventilated brick built room 10m×5m×8m with cemented floor and plastered walls inside and outside, having no cracks and crevices, situated about 12m away from the three cowsheds at a locality in a village named Nudipur, about 80 km from Calcutta, was selected for indoor capture. It had one door (3m×1m) and two windows (10m×0.75m each), situated 1m–1.5m above the ground level. The alighting flies were caught off human baits indoors and outdoors from November 1980 to October 1981, following the method of Hati *et al* (loc. cit.), the only deviation was that the catch was performed four times a month including fullmoons and newmoons. Per manhour collection of *P. argentipes* in three cowsheds, conducted twice in a month in morning hours varied from 5.5 to 10.5. No sandfly was, however, obtained from the brick built room during the morning catches.

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RESULTS AND DISCUSSION

All the sandflies caught off human baits were identified as *P. argentipes*. Even from such a clean biotope altogether 153 *P. argentipes* were caught off human baits (Table 1) out of which thirty were females (13 from indoor baits and 17 from outdoor baits) and 123 were males (56 from indoors baits and 67 from outdoors baits). This phenomenon of attraction of a significantly greater number of males to human baits both indoors and outdoors, observed earlier (Hati *et al.*, loc. cit.) still remains unexplained though Smith (1959) reports that *P. argentipes* males have been sometimes known even to suck blood from open wounds.

TABLE 1. Mean number of *P. argentipes* per man per night in and around a clean biotope

Month	Indoor	Outdoor	Maximum temperature (0°C)	Minimum temperature (0°C)	Relative humidity (%)
November' 80	0.25	—	29.5	18.8	91.2
December	—	0.25	27.2	12.6	93.7
January' 81	0.50	—	25.4	11.4	86.7
February	0.25	—	28.6	14.2	89.8
March	0.25	0.75	31.7	16.7	89.7
April	0.50	0.75	35.4	20.3	91.6
May	—	0.25	28.8	22.4	82.1
June	—	0.75	32.0	31.0	84.4
July	0.25	1.50	31.2	28.6	91.6
August	0.75	—	30.4	29.4	88.2
September	0.50	—	29.7	29.2	89.1
October	—	—	32.9	24.1	93.0
Yearly mean	0.27	0.35			

There is no significant difference between indoor and outdoor catches in both the sexes (Tables 2). This finding varies significantly from the earlier observation of Hati *et al* (loc. cit.) which may be explained by the fact that in such a different biotope *P. argentipes* have dispersed from their original breeding places to the surrounding area in search of food and/or shelter and during this dispersion they may equally come in contact with indoor or outdoor baits. The nearest cowshed being about 12m from the baits, *P. argentipes* have travelled at least 12m in their search to suck human blood. During their search of food and/or shelter *P. argentipes* may enter not only the huts but also the brick built plastered rooms, where there is no facility for breeding.

TABLE 2. Total number of *P. argentipes* caught off human baits each hour of the night in and around a clean biotope (48 night observations in one year)

Hours	Indoor			Outdoor			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
18hoo—19hoo	5	1	6	5	1	6	10	2	12
19hoo—20hoo	2	0	2	2	1	3	4	1	5
20hoo—21hoo	1	1	2	2	0	2	3	1	4
21hoo—22hoo	7	3	10	7	1	8	14	4	18
22hoo—23hoo	7	1	8	8	1	9	15	2	17
23hoo—24hoo	11	1	12	12	0	12	23	1	24
24hoo—01hoo	14	1	15	13	7	20	27	8	35
01hoo—02hoo	7	2	9	3	4	7	10	6	16
02hoo—03hoo	1	2	3	14	2	16	15	4	19
03hoo—04hoo	1	1	2	1	0	1	2	1	3
04hoo—05hoo	—	—	—	—	—	—	—	—	—
05hoo—06hoo	—	—	—	—	—	—	—	—	—
Total	56	13	69	67	17	84	123	30	153

The dispersion of *P. argentipes* continued from 18hoo to 04hoo hours.

The maximum number of *P. argentipes* (both male and female) were caught off human baits between 24hoo and 01hoo hours.

The maximum number of males disperse in the second and third quadrants of night (42.27% in each quadrant). The rate of dispersion in female is significantly high in the third quadrant of night (60%).

The overall vector/man contact expressed as numbers of landing per man hour per night was 0.27 indoors and 0.35 outdoors (Table 1). The maximum vector/man contact was outdoors in July (1.5). The overall vector/man contact indoors and outdoors is not significantly different, which finding again differs from the earlier observation of Hati *et al* (loc. cit.), possibly owing to the unique location of the present clean biotope situated some distance away from the breeding site of the vector, indicating that man may contact the disease both indoors and outdoors.

Seventy-five per cent of sandflies were caught off the lower extremities of the human baits. No statistically significant difference in the numbers of sandflies being attracted to human baits during the different moon phases of the night was observed. These findings however tally with the earlier results of Hati *et al* (loc. cit.). This finding points out

that nocturnal *P. argentipes*/man contact is variable according to difference in biotopes and *P. argentipes* may invade even a clean room situated near their breeding places.

SUMMARY

P. argentipes during dispersion from their breeding places invaded a clean brick-built room and its surrounding area. Thirty female *P. argentipes* were caught off human baits in weekly all-night captures conducted indoors and outdoors of that well-ventilated room that had cemented floor and smooth plastered walls and was situated, about 12 m away from cowsheds, in a village in West Bengal. The overall mean number of vectors per man per night captured indoors (0.27) and outdoors (0.35) showed no significant difference, though the man landing rate was highest in July at outdoors (1.5), indicating the possibility of a man's contacting the disease even out of doors.

ACKNOWLEDGEMENTS

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STUDIES ON THE LIFE HISTORY OF INDIAN DRAGONFLIES,
DIPLACODES TRIVIALIS (RAMBUR, 1842)

(Libellulidae : Odonata)

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(With 3 Text-figures and 3 Tables)

INTRODUCTION

Studies on the larval stages and life history of Indian Odonata are very meagre (Kumar & Khanna, in press) and need a thorough investigation to have a better understanding of taxonomy and ecology of immature stages of these insects. The present paper is eighth in the series by the author, dealing with the larval stages and life history of Indian dragonflies.

Genus *Diplacodes* Kirby, 1889, comprises dragonflies of rather small size, which are widely distributed in tropical zones of the Old World. Within our limits the 3 species recorded (Fraser, 1936) have their larvae in swampy ponds and lakes bordered with thick vegetation. They are local as well as migratory in distribution. *Diplacodes trivialis* (Rambur) is one of the most common dragonflies in India and extends to the Old World tropics and subtropics of South Asia, Taiwan, Thailand, Ryukus, Timor, Sumba, Seychelles to Pacific, Japan, Sunda Island, Phillipines, Micronesia, Iraq and Australia (Kumar & Parsad, 1981).

Within India *D. trivialis* is widely distributed in Western Himalaya, Eastern Himalaya, Bihar and West Bengal.

MATERIAL AND METHODS

On 27. IV. 1976 eggs were collected from a female caught in the wheel position at a perennial pond at vill. Gorakhpur, Dehra Dun [77°-78° E. ; 29°-31° N.]. In the laboratory eggs were kept submerged in water in a glass vessel at Ca. (max.) temp. 28°C. Hatching started on 3. V. 76 and ended on 9. V. 76. Study on larval development was begun on 3. V. 76 by starting rearing of 6 larvae in 2nd instar, which emerged into imagos (2♂, 4♀) after passing through 11 instars (Ca. max. temp. 28°-36°C) and taking 50-53 days respectively from oviposition to emergence. Breeding record of the larvae reared in

TABLE 1. Breeding Record (1976) of larvae of *Diplacodes trivialis* (Rmb.)

Instar	Larva I	Larva II	Larva III	Larva IV	Larva V	Larva VI	Average (maximum) temperature during the period
	Duration (in days)	Duration (in days)	Duration (in days)	Duration (in days)	Duration (in days)	Duration (in days)	
2nd	2	3	3	3	3	3	29°—38°C
3rd	2	2	3	3	2	3	
4th	2	2	2	4	2	2	
5th	8	2	3	6	3	3	
6th	4	6	5	3	4	3	
7th	2	4	5	3	4	4	
8th	4	3	5	3	5	4	
9th	4	4	4	3	3	4	
10th	3	4	4	4	4	4	
11th	13	15	13	14	16	15	
Emergence	16.VI.76 (♀)	17.VI.76 (♂)	15.VI.76 (♀)	18.VI.76 (♀)	18.VI.76 (♂)	17.VI.76 (♀)	
Total No. of days (from oviposition to emergence)	51	52	50	53	53	52	

the laboratory is tabulated in table I. In early instars larvae were fed ad libitum on Paramecium and Cyclops and later on mosquito larvae.

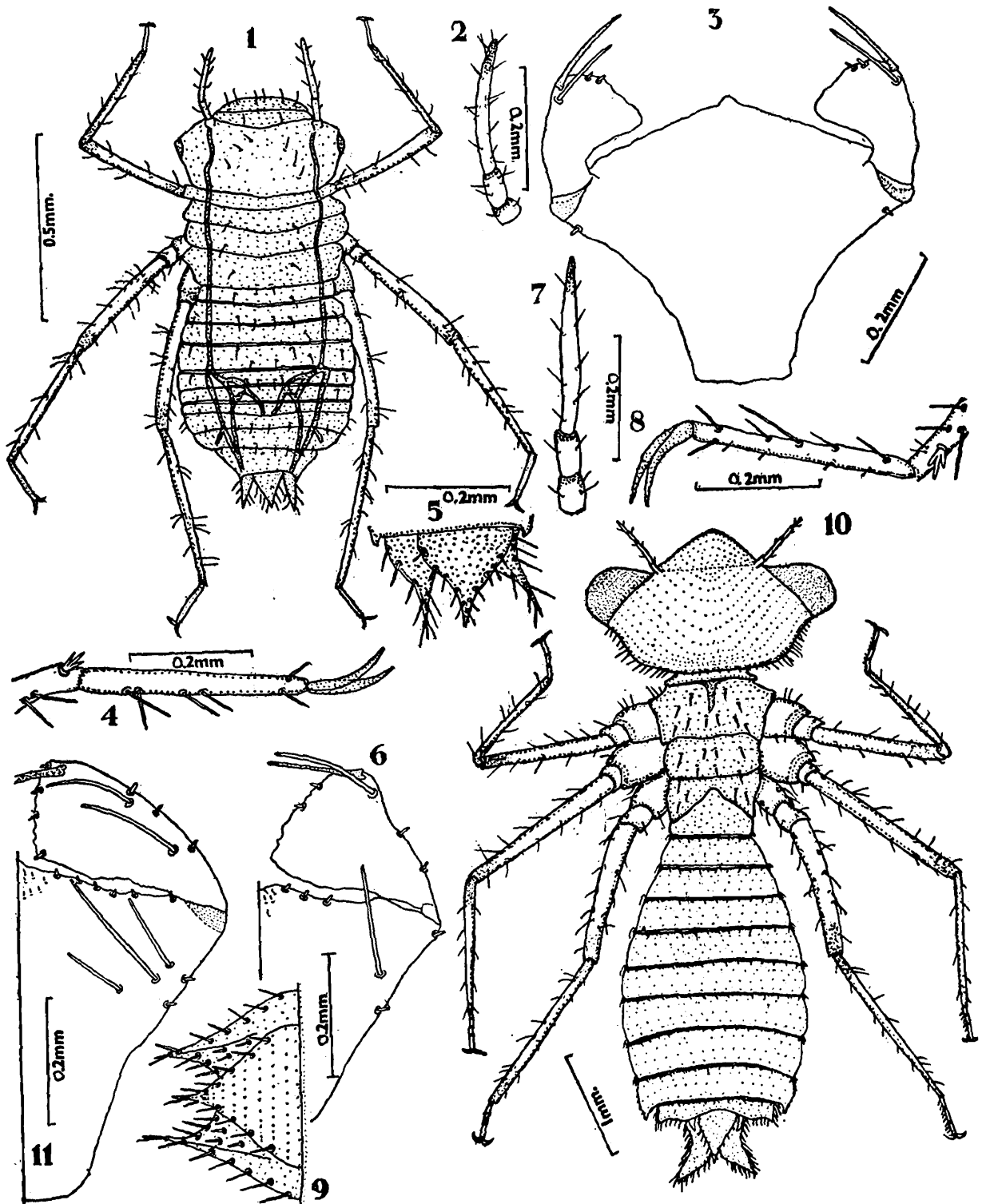
Studies on various instars are based on laboratory reared material. Collections of larval stages and adults by random sampling at monthly intervals were carried out from the above pond in the year 1976, and from other such biotopes in the year 1979, in order to study the life history of the species in field. The stage of instar was determined by its size and the development of wing buds.

The terminology used for the labium is that of Corbet (1953), for tibial comb and tarsi that of Mac Neill (1967), and for anal appendages that of Snodgrass (1954). Larval length was measured from tip of head to tip of anal appendages and is an average for that instar.

OVIPOSITION AND EGG

Oviposition is exophytic and is performed by the unattended female, which dips her abdomen regularly in water while hovering over the ponds.

Eggs are oval in shape, a little longer than broad. Their number vary between Ca. 450-500. Length 0.297 to 0.312 mm. Width 0.210 to



Text-figs. 1-11. (1-5) 2nd Instar Larva : 1, larva (D. V.), 2, antenna, 3, labium ; 4, tibial comb and tarsi ; 5, anal appendages ; (6-9) 3rd Instar larva : 6, labium ; 7, antenna ; 8, tibial comb and tarsi ; 9, anal appendages ; (10 & 11) 4th Instar larva : 10, larva ; 11, labium.

TABLE 2. Summary of larval development of *Diplacodes trivialis* (Ramb.)

Instar	1	2	3	4	5	6	7	8	9	10	11
Antennal Segments	|	3	3	4	4	5	6	7	7	7	7
Premental Setae	|	—	1+1	3+3	5+5	7+7	8+8	11+11	12+12	13+13	14+14
Palpal Setae	|	1 & 1	1 & 1	2 & 2	4 & 4	5 & 5	7 & 7	8 & 8	8 & 8	9 & 9	10 & 10
Tarsal Segments	|	1	1	2	2	3	3	3	3	3	3
Abdominal Segments covered with wing buds	|	—	—	—	—	$\frac{1}{2}$	$1\frac{1}{2}$	$3\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{1}{2}$	$6\frac{1}{2}$
Hind wing buds length (in mm)	|	—	—	—	—	1.5	4.2	5.8	6.6	7.0	7.5
Anal Cerci	|	—	—	—	+	+	+	+	+	+	+
Body length (in mm) including anal appendage	|	2.10	2.85	3.64	4.87	5.56	6.39	8.68	10.82	13.10	15.45
Range Body length (in mm)	|	(2.0-2.21)	(2.81-2.92)	(3.64-3.75)	(4.82-4.98)	(5.20-5.92)	(6.22-7.10)	(8.10-9.24)	(10.20-11.25)	(12.95-14.15)	(15.20-17.55)
Colouration	|	W	Y	Y	Y	Y	B	B	B	B	B

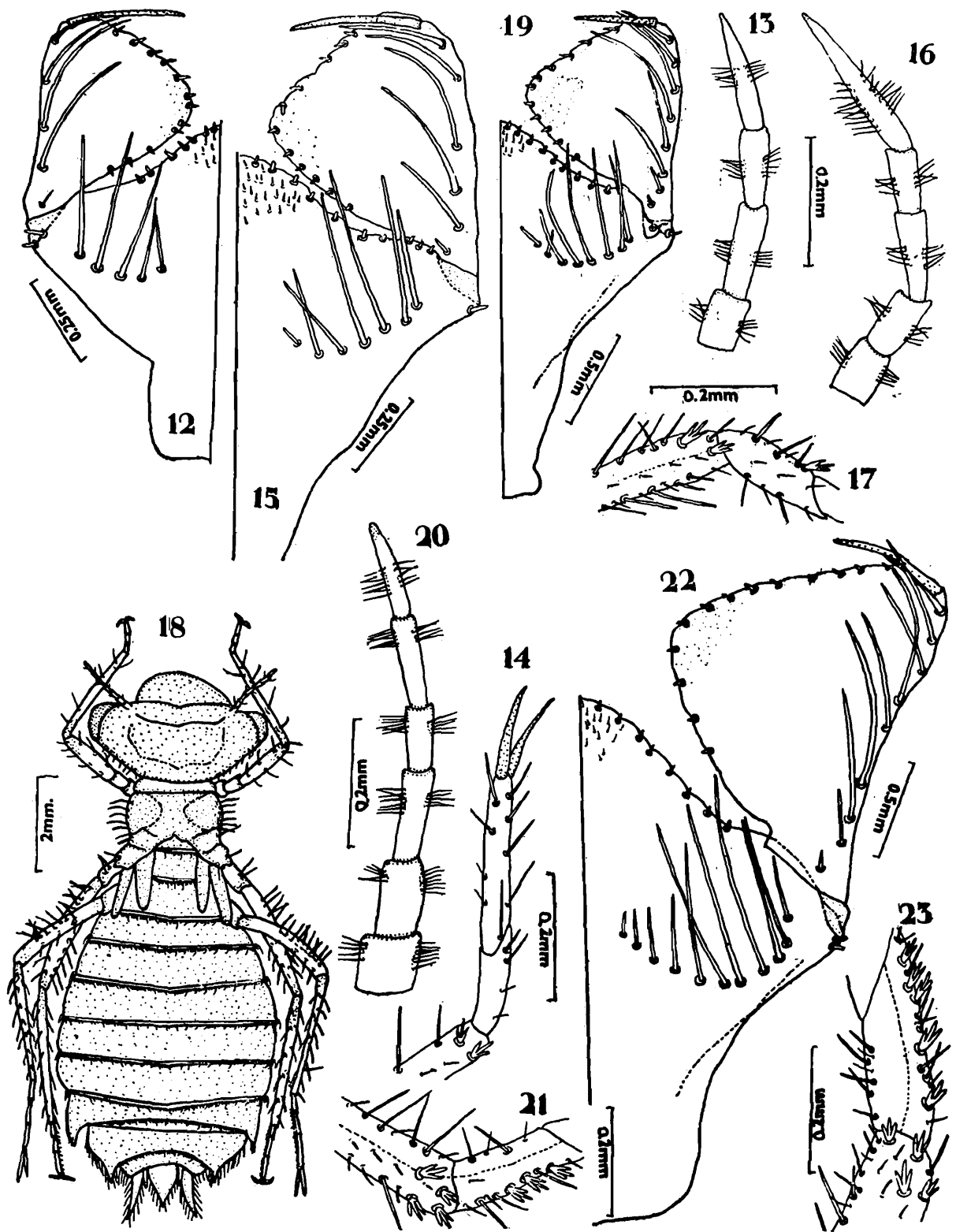
(-) absent

(+) present

(W) whitish

(Y) Yellowish

(B) Brownish



Text-fig. 12-23. (12-14) 5th Instar larva : 12, labium ; 13, antenna ; 14, tibial comb and tarsi ; (15-17) 6th Instar larva : 15, labium ; 16, antenna ; 17, tibial comb (18-21) 7th Instar larva : 18, larva (D. V.) ; 19, labium ; 20, tibial comb ; (22 & 23) 8th Instar larva : 22, labium ; 23, tibial comb.

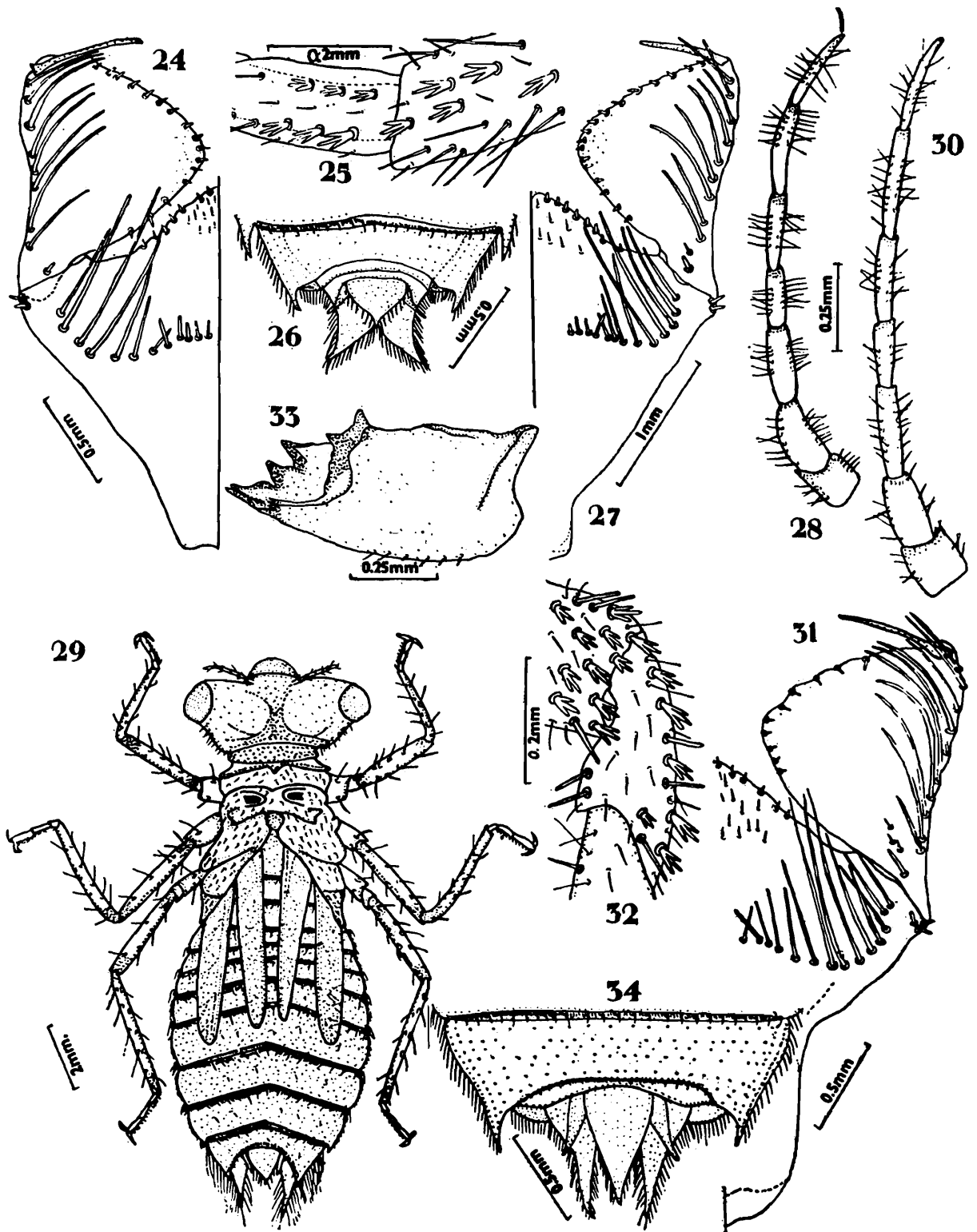
0.211 mm. Freshly laid eggs are white but become yellowish-brown within a few days. The incubation lasted 7 to 13 days (Ca. temp. 28°C).

LARVAL DEVELOPMENT

The prolarva has a very brief duration. The external morphological characters from 2nd to 11th instar are summarised in Table 2. The larval change in brief are as follows ;

TABLE 3. Average duration of life cycle of *Diplacodes trivialis* (Rambur) during different seasons of the year at Dehra Dun.

Egg laid (date)	Egg hatched (date)	Incubation period (in days)	Adult emerged (date)	Larval period (in days)	Total duration of egg & larval stages (in days)	Average temperature (max.) during the period	Remarks
27.IV.1976	3.V.1976	7	17.VI.1976	45	52		<i>Ist Larval generation</i>
"	"	7	18.VI.1976	46	53	29°—38°C	(April to July)
6.VII.1976	15.VII.1976	10	8.X.1976	85	95	24°—35°C	<i>IIInd Larval genera- tion</i> (July to October)
15.X.1979	30.X.1979	15	2.IV. 1980	154	169	16°—24°C	<i>IIIrd Larval generation</i> (October to April)



Text-fig. 24-34. (24-26) 9th Instar larva : 24, labium ; 25, tibial comb and tarsi ; 26, anal appendages ; (27 & 28) 10th Instar larva : 27, labium ; 28, antenna ; (29-34) 11th or Last Instar larva : 29, larva (D. V.) ; 30, antenna ; 31, labium ; 32, tibial comb and tarsi ; 33, mandible ; 34, anal appendages.

Head : During the development of *D. trivialis* the shape of head and eyes do not change distinctly. The head is broadly triangular with antero-dorsally placed eyes. In each instar the size and width of head increases considerably.

Antennae : In instar 2 the antennae are three-segmented (Text-fig. 2). They become four-segmented in instar 4, five-segmented in instar 6 and attains the final seven-segments in instar 8 (cf. Table 2).

Labium : From instar 2 to 11 the general shape of the labium does not change much and remain characteristically that of the family Libellulidae. Major changes occur in the form of addition of labial setae (cf. Table 2).

Wing-Buds : Rudimentary wing-buds in the form of pleural ridges on meso- and meta-thorax appear first in instar 5. They cover $\frac{1}{2}$ of first abdominal segment in instar 6. Thereafter they increase in size gradually (cf. Table 2).

Anal cerci : These appear first in instar 5 and, then during larval development increase in size.

Colouration : When hatched larvae are dirty white. Instar 2 to 6 larvae are yellowish and thereafter become brownish, being darker dorsally.

BIOLOGY

Diplacodes trivialis is also in the group of some multivoltine species occurring at Dehra Dun (Kumar, 1979). Adults could be observed on the wing amidst vegetation around ponds and marshy streams almost throughout the year save during extreme winters.

Life history of *D. trivialis* is almost identical to those of other multivoltine species of dragonflies occurring at Dehra Dun viz., *Ceragrion coromandelianum*, *Pseudagrion rubriceps* (Fam. Coenagriidae), *Crocothemis s. servilia* and *Acisoma p. panarpoides* (Fam. Libellulidae) (Kumar, 1979). Larvae occur in perennial ponds and at muddy banks amidst vegetation of slow running marshy streams in the flatter areas of the valley.

Larval development was studied both in the laboratory and in the field. Larval samples were made from the selected pond round the year at regular intervals. Larval development is rapid and with slight overlapping of broods the species is able to complete 3 larval generations in a year. The summer broods (i.e., March-April to May-June and June-July to August-September) are completed in about 2 months each (Ca. (max.) water temp. varies 24°C to 36°C) (cf. the breeding record presented in this paper, Table 1 & Table 3) thus the 1st batch of adult emergence in a year occurs during the months of March-April from perennial ponds, oviposition takes place soon after and the 2nd batch of emergence occurs in June-July. Adults of 2nd batch now

either oviposit in perennial ponds, from which they have emerged, or in temporary monsoon ponds which are formed during this period because of onset of S. W. monsoon. The 2nd larval brood is again completed rapidly like the preceding summer brood and the 3rd batch of adults emerge in September-October. These adults remain on the wing and soon oviposit in perennial ponds in fields and forests in the flat and sub-mountainous areas of the Valley. Development of this larval generation is slowed down and is completed in not less than 5-6 months due to the advent of the rather severe winter (*Ca.* (max.) temp. varies 16°C to 24°C); larvae in various intermediate instars, after passing the winter, start emerging into adults in the following March-April, thus adopting the pattern of other multivoltine species at Dehra Dun [*cf.* Table 3].

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for permission to undertake the present study and to Dr. B. S. Lamba, Deputy Director-in-Charge, Zoological Survey of India, Northern Regional Station, Dehra Dun, for laboratory and various other facilities.

SUMMARY

The life history of *Diplacodes trivialis* (Rmb.) has been studied in the field and the laboratory. Specimens were reared from egg to adult. The principal changes in external morphology in different instars and the characters which are helpful in distinguishing various instars are described in detail. The seasonal regulation of the Species has also been studied in the field.

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STUDIES ON *CERATOVACUNA SILVESTRII* (TAKAHASHI)
(HOMOPTERA : APHIDIDAE) AND ITS PREDATOR
ANISOLEMNIA DILATATA (FAB.) ON
BAMBUSA ARUNDINACEA

By

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(With 4 Text-figures and 4 Tables)

INTRODUCTION

Ceratovacuna silvaestrii (Takahashi) is chiefly infests bamboo and is known from India, Japan and Taiwan. In India this species occur widely in northeast India infesting bamboo plants of different species (Basu, R. C. *et al*, 1974 ; Ghosh and Raychaudhuri, 1971 ; Ghosh *et al*, 1971 ; Ghosh *et al*, 1974 ; Raha *et al*, 1977 ; Raychaudhuri 1973). So far the available information on this aphid was very scanty. In the present work, this aphid has been studied in detail regarding its field activity, nymphal taxonomy and life cycle of a dominating predatory beetle *Anisolemnia dilatata* (Fab.).

In recent times, field observations on aphids have assumed increasing importance because of the fact that such a study reveals the time of immigration, emigration, morph composition and population trend of the aphid species and also provides the information about the time when plants are more prone to aphid attack, symptoms of damage and the activity of the natural enemies. Such information is immensely helpful in planning out suitable control measures and plant protection strategy. However, such studies are lacking on most of the aphid species known from India.

Nymphal taxonomy of this aphid has also been attempted. This study helps in ascertaining the degree of differences between the developmental stages within the same species. Very often adults are not found in the collection of aphid samples. In such cases previous knowledge of the characters of nymphs helps in the identification of the aphids. Besides, nymphal taxonomy is also helpful in understanding the development of different characters within a species.

Life cycle study of coccinellid predator *Anisolemnia dilatata* (Fab.), an important predator of *C. silvestrii*, was also done under laboratory conditions. This predator was so far not known from this part of India and this is the first account of predator's life cycle and feeding habit being presented here.

The text of this communication has been divided into three parts ; first part deals with field observations, second part deals with nymphal taxonomy and the third part is devoted to the life cycle study of the coccinellid predator. This is followed by a summary and a list of references cited in this work.

The work presented in this communication began in the last week of November 1981 and continued till the end of August 1982. The area of study was Jogendranagar situated in the vicinity of College Tilla at Agartala, Tripura.

Following abbreviations have been used in this work :

L. Body	:	Length of body
W. Body	:	Width of body
L. Ant.	:	Length of antenna
L. Ant. III	:	Length of antennal segment III
Base III	:	Basal diameter of ant. segment III
p. t.	:	Length of processus terminalis
U. r. s.	:	Ultimate rostral segment
h. t. 2	:	Length of 2nd segment of hind tarsi
D. Siph.	:	Outer diameter of siphuncular pore
L. Horn	:	Length of frontal horn
F. T. C.	:	First tarsal chaetotaxy

All the material pertaining to this work are in the collection of the first author.

PART I—FIELD OBSERVATIONS

MATERIALS AND METHODS

Daily observations were made on bamboo plants between November 1981 and April 1982. Thereafter the frequency of observations was increased to one week intervals. Sampling of aphids and their natural enemies was made in 70% alcohol. Predators and the parasites of the aphid were reared into their adult stages in the laboratory. Predatory larvae were brought along with the aphid prey and allowed to grow in

paired petridishes to get the adults. Parasitized aphids were collected in clean dry empty tubes and allowed to rear into the adult stage.

In the beginning, daily observations covered 2-3 visits to the study site, spread over 6-7 hours interval. This procedure continued until the decline in population of aphids started in the beginning of March 1982.

Observations were made on the immigration, population build-up, emigration of aphid and their natural enemies and association of ants and other insects attending this aphid.

RESULTS AND DISCUSSION

I. *Immigration*

The first appearance of *C. silvestrii* was noted in the first week of December 1981. This comprised a few apterous viviparae infesting a few leaves. Unlike in most aphid species the immigration in this species appeared to have taken place through the apterous morph, perhaps by wind transport, as no alates were found. In this period no ant or natural enemy association was noticed. This situation persisted till the middle of December 1981.

II. *Population build up*

Subsequent observations during December 1981-January 1982 revealed gradual build-up of aphid population. The new aphid colony formation began with the laying of a few nymphs at the basal region of the young leaves. Gradually the colony size increased in the region of midrib but never went beyond $\frac{3}{4}$ th length of the leaf. Aphids were more concentrated on the central region of the leaf and less so towards the margin. Between the end of December 1981 and the end of January 1982 population build up was gradual and in this period, most of the young leaves were slowly covered by aphid colonies, comprising more nymphs and fewer adults. In contrast, the older leaves were mainly infested by adults. It was interesting to note that the nymphs laid by the adult on the older leaves, were seen moving towards the younger leaves and branchlets. Several observations along the stem of bamboo revealed continuous movement of first and second instar nymphs in both directions. This movement perhaps constitutes intermediate pathway of nymphs from the older leaves to the young ones and also the movement of nymphs from the overcrowded young leaves to less crowded or newly growing leaves. During the period end of January 1982 to the end of February 1982, population build up was maximum, and most of the leaves, branchlets and culms were covered with aphids.

During this period the population structure was stable and no visible increase or decrease was noticeable. From a distance, part of the bamboo plant looked blackish.

A decline in population was noticed towards the beginning of March when many of the older leaves were devoid of aphids. In the beginning of April, aphid population also dwindled on the younger leaves and towards the end of April aphid movement along the stem was minimum and only some leaves were infested by a few aphids. This condition continued until the third week of May. Thereafter until the middle of June only a few aphids were noticeable. In the last week of June there was no trace of aphid on the bamboo plant.

III. *Emigration*

Emigration of *C. silvestrii* appeared to have taken place through the nymphs. At no stage of this study, alate-morph was noticed. It is presumed that nymphs either sporadically or in batches left the bamboo plants with the help of wind. Aoki (1979) noted dispersal of *Pseudoregma alexandri* (Takahashi), another bamboo aphid species, through first instar larvae in the wind. The reason for such presumption is that adults were first to disappear from the older leaves and younger nymphs were last to leave the bamboo plant.

IV. *Predators and parasites*

i. *Predators*

a. *Syrphid larvae*

A few syrphid larvae were seen feeding on aphids on the leaves and branchlets. Throughout the month of December, syrphid larvae were the sole predator of this aphid on bamboo. But most of these larvae were soon parasitised by *Diplazon orientalis* (Cameron). In January only a few syrphid larvae could be noticed and the attempts to rear them to adult in laboratory failed.

b. *Anisolemnia dilatata* (Fab.)

This large, beetle species first appeared in the first week of January 1982. These beetles swiftly moved from leaf to leaf and along the branchlets devouring the aphids voraciously. In the 3rd week of January many grubs of this species were also seen preying on aphids. This predator occurred throughout the period of maximum aphid population. With the decline in aphid population in the beginning of March, a corresponding decline in predators' population of this

species was also noticed. During January-February batches of ovoid shaped eggs of this beetle occurred attached to leaf surfaces and branchlets.

c. *Scymnus* spp.

The larvae and adults of this beetle group were seen feeding on bamboo aphids during January to April. Mostly adults were seen moving along the stem and feeding on the nymphs. One interesting difference between this beetle and *Anisolemnia dilatata* was that the former preferred feeding on aphid nymphs while the later fed mostly on the adults of aphid. This difference in the feeding habit may be directly co-related with the size of the beetle. However, it can be mentioned here that *Scymnus* beetle fed on adult of other aphid species like *Aphis nerii* (Kaltenbach), *Aphis gossypii* Glover, *Aphis craccivora* Koch and *Toxoptera aurantii* (Boyer)

d. *Micromus* sp.

The larvae of this species were few in number and occurred mostly on the stem feeding on the nymphs sheltered on the adventitious roots and lower parts of the bamboo stem. A few larvae were also noticed on the young leaves at the basal region.

Previous to this, *Calliphora paltoni* and *Synoncha grandis* were known as the predators of this aphid from India (Raychaudhuri *et al.* 1978).

ii. *Parasites*

Only *Trioxys indicus* Subba Rao and Sharma could be reared as primary parasitoid of *C. silvestrii*. The parasitic activity was restricted to a brief period in March 1982. Several attempts before and after that did not succeed in the rearing of any other parasitoids.

Previous to this *Ephedrus plagiator* (Nees) was recorded as a parasite of this aphid (Agarwala *et al.* 1981) from India.

V. *Attendance of Ants and other insects*

Following insects were noticed attending on this aphid :

I. Hymenoptera :

Formiciidae

i. *Camponotus* sp.

ii. *Triglyphothrix lanuginosa* (Mayr)

II. Diptera :

Tebritidae

i. *Dacus diversus* Coquerel

Some members of following families also attended

C. silvestrii :

Drosophilidae

Muscidae

Empidae

Culicidae

It was interesting to note that ant species attended the aphids between sunrise and sunset whereas all other insects were seen attending on aphids on the dark hours. This combination of aphid attendance was hitherto unknown from India.

OTHER OBSERVATIONS

- i. The nymphs of *C. silvestrii* caused painful irritation when they fell on the hand and some other exposed parts of the body. The feeling of this irritation continued for a few minutes. Adults, however, caused very minor irritation and it lasted a few seconds only. Aoki (1979) observed biting of man in *Astegopteryx styracicola* making gall on *Styrax suberifolies*. But he assigned this biting behaviour to soldier morphs of the aphid. In *C. silvestrii*, however, no such morph differentiation was noticed after a careful study.
- ii. Mosquitoes, fruit flies and certain other flies attended the bamboo aphid in their own ways. Mosquito attendance was marked by their overriding a small group of closely placed aphids and "sucking" the honey-dew in an up-right position without disturbing its body for a long time. Other flies attended the aphids by frequently moving from one colony to other and halting at each colony for a brief period only. These flies moved in groups.

PART II—NYMPHAL TAXONOMY

MATERIAL AND METHODS

Apterous viviparous females were cultured in laboratory on potted plants. Newly emerged nymphs were taken out from the plant and placed on fresh potted plants for their attaining second, third, fourth

instar nymph and the adult stages. Ten nymphs of each instar and adults of apterae were kept in 70% alcohol and were processed for the preparation of permanent slides.

Thirteen characters of taxonomic importance were examined for each nymphal instar and the adult. Morphometric measurements were carried out and all the measurements were converted into millimetre (mm).



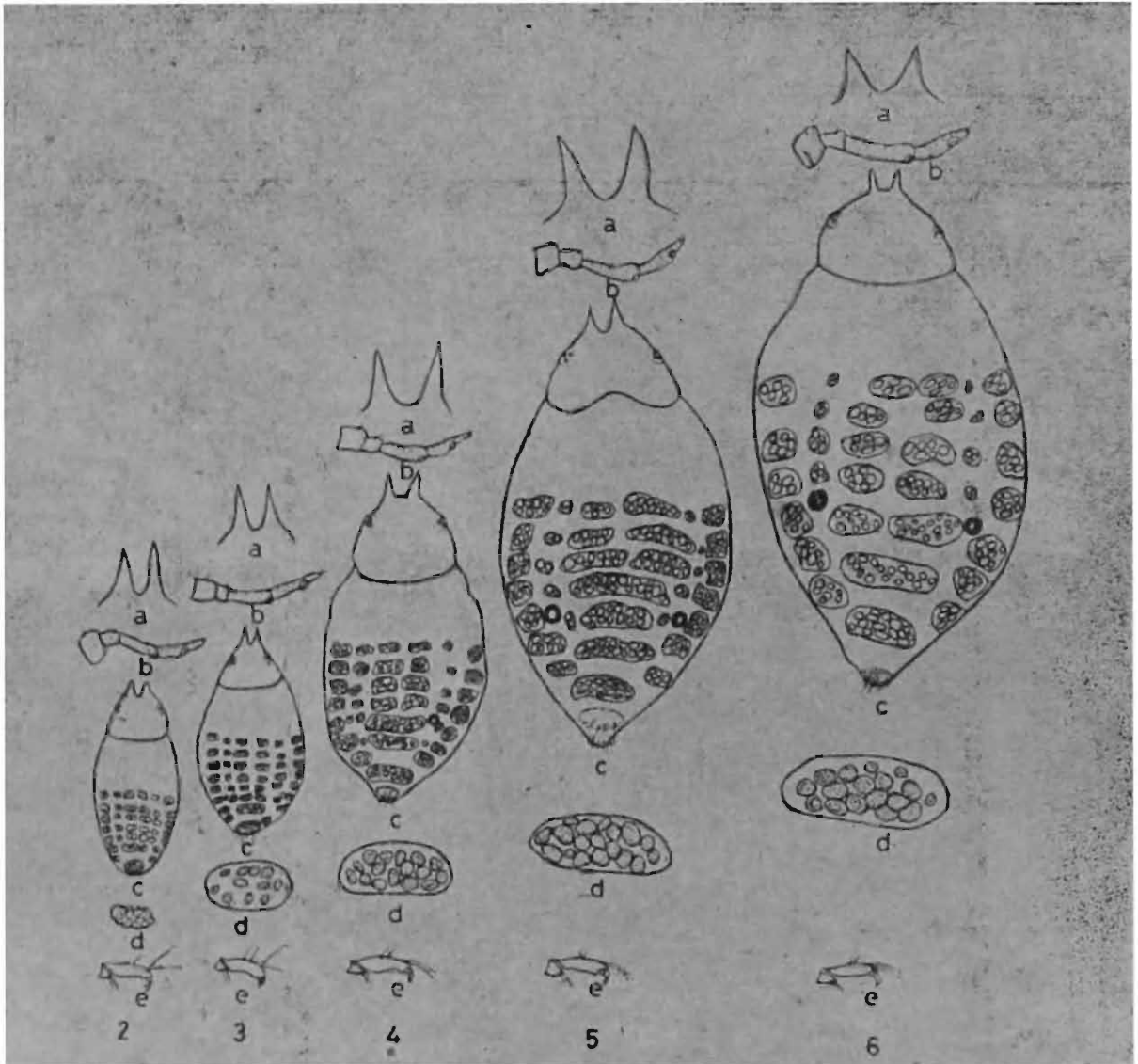
Text-fig. 1. A colony of *C. silvestrii* on *Bambusa arundinacea* infesting stem and branchlets

RESULTS AND DISCUSSION

First instar nymph : (Text-fig. 2a-e)

Body 0.81-0.90 mm long and 0.40-0.45 mm as maximum width. Head and prothorax fused. Frontal horns somewhat pointed at the apex and widest at the base, 0.07-10 mm long, placed on each side of the mid-dorsal region. Eyes 3-faceted, triommatidia prominent.

Antennae 4-segmented, 0.22-0.25 mm long, p.t. $0.5\times$ base of last antennal segment; primary rhinaria round, somewhat protuberant, finely ciliated. Ultimate rostral segment short and blunt, 0.08-0.10 mm long;

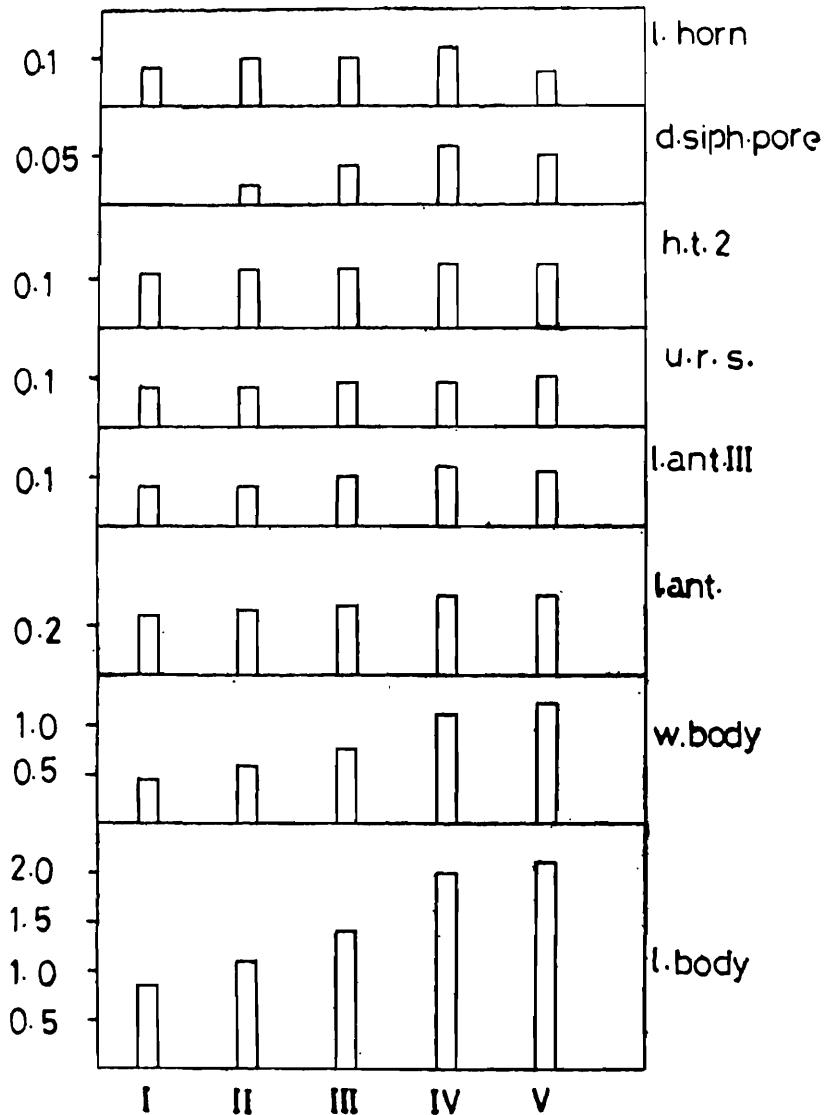


Text-fig. 2-6. First, second, third, fourth instar nymphs and adult of *O. silvestrii*—Apterous viviparous female

- a—Antenna
- b—Frontal horns
- c—Body
- d—Wax plate on tergite VIII
- e—Hind tarsi

without any secondary hairs. Legs stout; forefemora stouter; h.t.2 0.11-0.12 mm long; first tarsi with 2 long hairs on each leg; dorso-apical hairs long, two in number, with funnel shaped apices. Abdomen pale and membranous. Siphunculi absent. Cauda broadly rounded. Wax glands distributed throughout the body, on cephalothorax these arranged in groups of 3-4 wax cells; on thoracic and abdominal

segments in groups of 1-5. These are distributed segmentally along spinal, pleural and marginal rows ; those on segment 6 without spinal and pleural wax glands and the segment 8 with only spino-pleural wax glands ; all these wax glands consist of 2-7 wax cells grouped together except on the posterior abdominal segments where wax cells are indistinguishable.



Text-fig. 7. Histogram showing differential gradient in some characters of nymphal instars and adult of *C. silvestri*—Apterous viviparous female.

Second instar nymph : (Text-fig. 3a-e) :

Body 0.93-1.30 mm long and 0.50-0.67 mm wide in the middle of abdomen. Frontal horns 0.09-0.11 mm long. Antennae 4-segmented ; 0.26-0.27 mm long ; p.t. about 0.5× base of last antennal segment. Ultimate rostral segment 0.08-0.09 mm long. Fore femora slightly stouter than mid and hind femora ; h.t. 20.10-0.12 mm long. Siphunculi present, ring like, placed on a pigmented cone ; diameter of siphuncular pore 0.02-0.03 mm. Cauda rounded, bearing 6-7 hairs.

Wax glands present throughout the body, in cephalothorax this consisted of 5-6 wax cells and on thorax and abdomen it consisted of 11-19 wax cells placed close together, the maximum number being on tergite 8 ; all the wax cells are distinguishable. Other characters as in first instar nymphs.

Third instar nymph : (Text-fig. 4a-e) :

Body 1.28-1.49 mm long and 0.68-0.80 mm as maximum width. Frontal horns 0.10-0.11 mm long. Antenna 4-segmented, 0.26-0.27 mm long ; p.t. $0.62 \times$ base of last antennal segment. Ultimate rostral segment 0.08-0.09 mm long. Legs stout ; first tarsi with 3 hairs on each leg ; h.t. 2 0.11-0.13 mm long. Diameter of siphuncular pore 0.03-0.04 mm. Subanal plate undivided. Cauda transversely round. Wax glands present throughout the body ; in cephalothorax each gland consisted of 7-9 cells and those on thorax and abdomen, it consisted of 11-12 wax cells, the maximum number being present in the wax gland on 8th tergite. Other characters as in nymphs of first and second instars.

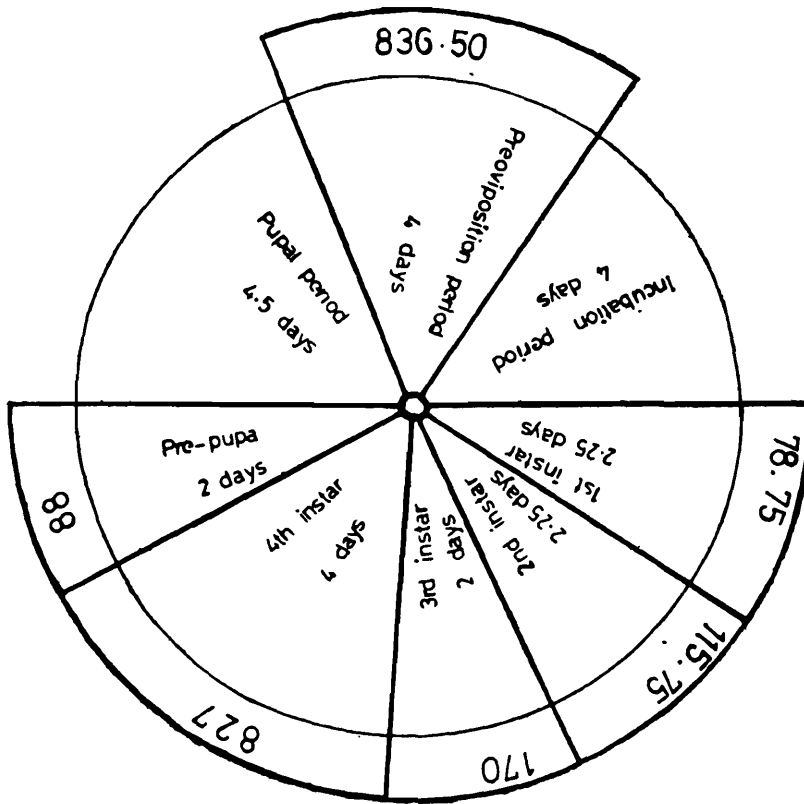
Fourth instar nymph : (Text-fig. 5a-e) :

Body 1.87-2.11 mm long and 1.04-1.26 mm as maximum width. Frontal horns 0.10-0.13 mm long. Antenna 4-, sometimes indistinctly 5-segmented, 0.30-0.34 mm long ; p.t. $0.4 \times$ base of last antennal segment. Ultimate rostral segment somewhat narrow at the apex ; 0.09-0.10 mm long. Legs stout ; first tarsal segments with 3 hairs ; h.t. 2 0.11-0.14 mm long. Diameter of siphuncular pore 0.04-0.07 mm. Subanal plate bilobed. Cauda knobbed. Wax glands sclerotized, distributed all over the body ; in cephalothorax each gland consisted of 7-9 cells and those on thorax and abdomen it consisted of 9-17 cells. Other characters as in nymphs of other instars.

Adult : (Text-fig. 6a-e) :

Body 2.03-2.20 mm long and 1.12-1.31 mm as wide in the middle of abdomen. Frontal horns bluntish, bearing a few minute hairs, 0.06-0.08 mm long. Antennae 4- or 5- segmented ; about 0.30-0.34 mm long ; p.t. about $0.5 \times$ base of last antennal segment ; primary rhinaria round, somewhat protuberant and finely ciliated. Ultimate rostral segment bluntish, 0.10 mm long, about $0.40-0.60 \times$ h.t. 2 and without any secondary hairs. Legs deep brown, first tarsal segments with 3 hairs ; h.t. 2 0.13-0.4 mm long. Diameter of siphuncular pore 0.05 mm. Cauda with a basal constriction, knobbed. Subanal plate

bilobed. Abdomen pale but pigmented around wax gland cells, in cephalothorax wax glands consisted of 7-9 wax cells and those on thorax and abdomen, it consisted of 12-16 cells. Other characters as in nymphs.



Text-fig. 8. Diagrammatic representation of Life cycle of *Anisolemnia dilatata* and mean feeding capacity at different stages.

In general, most of the characters exhibited a gradual increase in length from first instar to adult stages (Text-fig. 7). Depending on the degree of differences, three categories of the characters can be made as under :

- i. Characters with minimum difference
- ii. Characters with maximum difference
- iii. Characters with variable difference

i. *Characters with minimum differences :*

Second segments of hind tarsi, ultimate rostral segment and base of antennal segment III exhibited minimum degree of differences in between the developmental stages. The little existing differences (Table 1), however, seem to be overlapping in a narrow range. These characters are comparatively stable in nature.

ii. *Characters with maximum differences :*

Length of body, width of body and diameter of siphuncular pore exhibited maximum degree of difference. All the three characters

TABLE 1. Morphometric data of some important character of different developmental stages of *Ceratovacuna silvestrii* (Takahashi)

Characters	First Instar			Second Instar			Third Instar			Fourth Instar			Adult		
	Range Min	in mm Max	Mean value (mm)	Range Min	in mm Max	Mean value (mm)	Range Min	in mm Max	Mean value (mm)	Range Min	in mm Max	Mean value (mm)	Range Min	in mm Max	Mean value (mm)
L. Body	0.81	0.90	0.85	0.93	1.30	1.11	1.28	1.49	1.39	1.87	2.11	1.97	2.03	2.20	2.12
W. Body	0.40	0.45	0.43	0.50	0.67	0.57	0.68	0.80	0.74	1.04	1.26	1.10	1.12	1.31	1.22
L. Ant.	0.22	0.25	0.24	0.24	0.27	0.25	0.26	0.27	0.27	0.30	0.34	0.32	0.30	0.34	0.32
L. Ant. III	0.07	0.08	0.08	0.06	0.10	0.08	0.09	0.10	0.10	0.11	0.13	0.12	0.10	0.12	0.11
Base III	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03
U. r. s.	0.08	0.10	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.10	0.09	0.10	0.10	0.10
h. t. 2	0.11	0.12	0.11	0.10	0.12	0.12	0.11	0.13	0.12	0.11	0.14	0.13	0.13	0.14	0.13
D. Siph.	—	—	—	0.02	0.03	0.02	0.03	0.04	0.04	0.04	0.07	0.06	0.05	0.05	0.05
L. Horn	0.07	0.10	0.08	0.09	0.11	0.10	0.10	0.11	0.10	0.10	0.13	0.12	0.06	0.08	0.07
No. of wax gland cells															
Cephalothorax	3	4	3.5	5	6	5.5	7	9	8	7	9	8	7	9	8
Tergite V	not distinguishable			11	16	14	11	19	14	9	15	13	12	16	14
Tergite VIII	not distinguishable			13	19	16	15	22	17	12	17	14	12	16	14
F. T. C.	2,2,2	2,2,2	2,2,2	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3	3,3,3

exhibited persistent differences in between the developmental stages and seldom overlap. These characters seems to be of significant taxonomic value.

iii. *Characters with variable differences :*

All other characters fall in this category. In these characters the degree of differences was very variable in different stages (Table 1), sometimes overlapping and sometimes widely different.

An interesting point that emerged from this study is that the degree of differences in most of the characters from fourth instar to adult was lowest while in some other characters there was no difference (Table 1 & Text-fig. 7).

Key to the identification of NYMPHS AND ADULT :

(Apterous viviparous morph)

- | | | |
|------|--|--------------------------------|
| i. | Body without siphunculi ; F. T. C. 2, 2, 3 ;
maximum length of body 0.90 mm ... | <i>First instar nymph</i> |
| | Body with siphunculi, F. T. C. 3, 3, 3. ... | ... (ii) |
| ii. | Cephalothorax with each wax gland consisting
of 5-6 wax gland cells ; body 0.93-1.30 mm
and 0.50-0.67 mm wide ... | <i>Second instar nymph</i> |
| | Cephalothorax with each wax gland consisting
of 7-9 wax gland cells ; body never less than
long 1.28 mm long ... | ... (iii) |
| iii. | Cauda rounded ; subanal plate undivided ; body
and antenna 1.28-1.49 mm and 0.26-0.27
mm long respectively ; maximum diameter of
siphuncular pore 0.04 mm ... | <i>Third instar nymph</i> |
| | Cauda knobbed, subanal plate bilobed ; body
and antenna never less than 1.87 and 0.30 mm
long ... | ... (iv) |
| iv. | Frontal horns 0.10-0.13 mm long ; body 1.87-
2.11 mm long ... | <i>Fourth instar nymph</i> |
| | Frontal horns 0.06-0.08 mm long ; body 2.03-
2.20 mm long ... | <i>Adult apterae viviparae</i> |

PART III : LIFE CYCLE STUDY OF *ANISOLEMNIA DILATATA*
(Fab.)

MATERIALS AND METHODS

Adult beetles of both sexes were brought to the laboratory along with their aphid prey and allowed for mating and oviposition in dry

paired petridishes. The eggs were taken out and placed one each in 4 pairs of petridishes simultaneously. After the hatching of larva, counted number of sufficient aphids were supplied to each growing larva at an interval of 24 hours. This practice was continued till pupation. After the emergence of the adult beetles, aphid supply was resumed but could be maintained till the first oviposition only. Thereafter non-availability of aphids on bamboo plant became a limiting factor in further study. Observations were done in respect of daily feeding rate and duration of different developmental stages. The study was conducted from 6.3.1982 to 4.4.1982.

RESULTS

DEVELOPMENTAL STUDY : (Table-2)

- i. *Eggs* : The eggs were laid in batches, each batch consisting of 20-28 eggs arranged vertically in 2-3 longitudinal rows. The egg was yellow in colour and ovoid in shape. It remained attached to the surface of leaf or branchlet at its basal end.

TABLE 2. Developmental period of *Anisolemnia dilatata*

DEVELOPMENTAL STAGES	DURATION (DAYS)				MEAN (DAYS)
	Replications				
	I	II	III	IV	
INCUBATION PERIOD	4	4	4	4	4
FIRST INSTAR	1	3	3	2	2.25
SECOND INSTAR	3	1	2	3	2.25
THIRD INSTAR	2	2	2	2	2
FOURTH INSTAR	4	4.5	4	3.5	4
PRE-PUPA	1.5	1.5	1.5	2	1.87
PUPA	4.5	4.5	4.5	4.5	4.5
TOTAL	20	20.5	21	21	20.625 = 21

- ii. *Incubation period* : All the eggs hatched into first instar larvae on the 4th day within a difference of about 30 minutes.
- iii. *First instar larvae* : Black in colour ; duration 1-3 days, average 2.25 days ; initially fed on the egg case and gradually switched to aphid feeding ; slowly moved from one place to other in search of aphids ; fed on early instar nymphs only and avoided contact with older nymphs and the adults.
- iv. *Second instar larvae* : Black colour with yellowish bands on thorax and abdomen ; duration 1-3 days, average 2.25 days ;

wholly dependent on aphids for food, found actively moving in search of aphids ; fed mostly on early instar nymphs and rarely on third and fourth instar nymphs.

- v. *Third instar larvae* : Colour similar to second instar ; duration 2 days in all the cases ; actively feeding on aphids ; vigorously moved from one leaf to another in search of aphids ; fed on all the stages of nymphs but fewer adults only.
- vi. *Fourth instar larvae* : Colour similar to second and third instars but more prominent ; duration 3.5-4.5 days, average 4 days ; found very actively feeding on aphids ; fed on aphids of all stages with preference for older nymphs and adults.
- vii. *Pre-Pupa* : Colour of the larvae become more yellowish ; mobility reduced and body started downward bending, slowly fed on aphids ; toward the end of this stage prepupa attached to a point by its posterior end ; duration 1.5-2 days.
- viii. *Pupa* : Yellowish in colour with black spots on the dorsal side ; externally no visible activity ; duration 4.5 days in all the cases.
- ix. *Imago* : The adult beetle emerged from the puparium rupturing postero-dorsal side. Dorsal cuticle yellow in colour with blackish spots. Soon it started wandering around the petri dish. Given the aphids, beetle slowly fed on them. The feeding activity gradually increased.
- x. *Oviposition* : Beetles of opposite sexes were allowed to mate in order to get the eggs. First oviposition took place on the 4th day. Thereafter the study was discontinued for want of aphids. Starving beetles did not oviposit and died in 5-7 days.
- xi. *Total developmental period* : From the date of oviposition to the emergence of adult beetle developmental period varied in a narrow range of 20-21 days. However, it was interesting to note that the duration of first and second instars was very variable in four replications but when the two stages are considered together, the variation gap was limited to one day only (Table 2).

FEEDING STAGES AND THEIR CAPACITY : (Table 3 & 4)

First instar larvae : In the first few hours immediately after hatching, the larvae fed on the egg cases and did not move. After about 6-8 hours, slight movement was noticed and they started touching the aphids. After several such attempts, first aphid was caught hold of and larva chewed on it very slowly. However, the following day, larva

moved more actively and would choose the youngest nymphs for feeding. First instar larva consumed 21-54 aphids per day. Mean consumption was 78-75 aphids per larva.

TABLE 3. Rate of daily feeding in the life cycle of *Anisolemnia dilatata*

Date	Age of larvae (days)	No. of aphid consumed per day				average
		Replications				
		1	2	3	4	
14.3.82	0	till the larvae fed in the egg case				0
15.3.82	1	25	30	32	21	27
16.3.82	2	42	43	45	30	40
17.3.82	3	54	54	35	57	50
18.3.82	4	45	44	55	50	48.5
19.3.82	5	59	60	60	56	59
20.3.82	6	45	67	74	75	62.25
21.3.82	7	198	145	150	150	148.25
22.3.82	8	155	157	160	159	157.25
23.3.82	9	165	200	200	195	190
24.3.82	10	190	250	250	260	237.5
25.3.82	11	170	225	200	250	211.25
26.3.82	12	0	90	0	92	45.5
30.3.82	13-16	Pupal condition				
31.3.82	17	120	Pupal condition			120
1.4.82	18	180	104	110	90	121
2.4.82	19	200	180	176	180	184
3.4.82	20	240	293	280	273	271.5
4.4.82	21	220	260	230	220	230

TABLE 4. Mean of feeding by different stages in the life cycle of *Anisolemnia dilatata*

FEEDING STAGES	AVERAGE duration (days)	Average no. of aphid consumed per day				Mean
		REPLICATIONS				
		I	II	III	IV	
FIRST INSTAR	2.25	25	127	112	51	78.75
SECOND INSTAR	2.25	141	44	115	163	115.75
THIRD INSTAR	2	104	127	224	225	170
FOURTH INSTAR	4	658	977	810	864	827
PRE-PUPA	2	170	90	0	92	88
ADULT	upto 4-5	960	837	796	753	836.50
Total	16-17.5	2058	2202	2058	2148	2116.00

Second instar larvae: In the transition period of moulting from first instar to second instar, the larva was rather motionless and did not feed on aphids. After ecdysis, larvae started feeding on aphids

first slowly and then more actively. This instar also avoided contact with older nymphs and the adults but consumed aphids more vigorously. Second instar larvae consumed 42-60 aphids per day and mean consumption was 117.75 aphids per larva.

Third instar larvae : This instar devoured 59-573 aphids per day, the rate being 59-75 aphids on the first day after second moulting and 145-593 on the last day before third moulting. The average feeding rate ranged between 104-284 aphids per larva.

Fourth instar larvae : The larvae of this instar fed preferably on older nymphs and adults. This instar was more motile and fed very vigorously on aphids. This instar larvae consumed 145-260 aphids per day and mean consumption was 658-977 aphids per larva. In separate petridishes when this instar was provided with nymphs of first, second and third instar in one set and fourth and adult stages in another set, the larval feeding exceeded significantly in the second set.

Pre-pupa : In this stage feeding was interrupted by brief periods of rests. In this stage feeding depended more on aphids coming in close contact rather than moving about for the prey. Average feeding rate varied between 90-170 aphids per pre-pupa.

Adult : After emergence from the puparium, imago did not feed on aphids for sometime. In this period it moved randomly trying to negotiate in the surrounding environment. It soon started feeding on aphids first at a slower rate but subsequently much faster. The feeding capacity increased gradually from 90-170 aphids in the first 24 hours to 240-310 aphids in a day just preceding oviposition. Pre-oviposition feeding rate on an average varied between 543-740 aphids. The adult beetles equally fed on all stages of the aphids.

Total feeding : During the developmental periods from first instar to pre-pupal stages food capacity varied between 1098-1295 aphids. Considering pre-oviposition period of four days in addition to it, the food capacity extended to 2058-2202 aphids per beetle (Table 4).

DISCUSSION

Before this study, *Anisolemnia dilatata* was known to be a predator of *Pseudoregma bucktoni*, also a hormaphidine aphid infesting bamboo plants (Behura, 1963). This predatory beetle was not found among aphids of other plants present near the bamboo clusters where it occurred. Also, this beetle did not occur on any of the twentytwo

aphid species which were collected during the same period from different parts of Agartala and surrounding areas. The association of this beetle with the bamboo aphids appears to be specific.

This beetle species can eat more aphids than many other predatory species of aphids. In most cases of beetle predators of aphids, the total feeding usually does not exceed 700 aphids per beetle and rarely beyond 700 aphids. But in the present study, *A. dilatata* has been found to consume upto 2202 aphids upto first oviposition period and perhaps more than 3000 aphids during the entire life of a beetle. The enormous feeding potentiality of this species can be utilised in the control of certain aphid species which are of economic importance and before this can be achieved, a much more detailed study of biology and ecology of the predatory species is required.

SUMMARY

Ceratovacuna silvestrii (Takahashi) is chiefly a bamboo infesting aphid known from India, Japan and Taiwan. In India this species occurs widely in northeast India. This paper, however, reports this species for the first time from Tripura. So far, the information on this aphid has been very scanty. In this paper for the first time this aphid has been studied through its field observations, nymphal taxonomy and biology of a dominating predatory beetle *Anisolemnia dilatata*.

Field observations during the period of November 1981-August 1982 has revealed that this species immigrates on bamboo plant during the end of November and builds up its maximum population during January-February. Population decline occurs in March and emigration takes place in April-June. Both immigration and emigration take place through the wind dispersal of early instar nymphs. Parasites and predators of this aphid comprised 1 species of hymenopteran parasite and 4 species of predators. The predators included 1 species of Syrphidae (Diptera), 1 species of homerobiidae (Neuroptera) and 2 species of Coccinellidae (Coleoptera). Of these, *Anisolemnia dilatata*, a coccinellid species has been found to be the dominating predator.

Nymphal taxonomy has helped in the understanding of differences in different stages of this aphid. The least differences occurred between fourth instar nymph and the adult.

Life cycle study of *Anisolemnia dilatata* has revealed that this beetle completes its development within 20-21 days. First oviposition occurs on the fourth day. The total feeding before the pre-oviposition period was 1098-1395 aphids and after pre-oviposition period, it was 2058-2202

aphids. Maximum feeding occurred during the fourth instar larval period and minimum feeding occurred during the pre-pupal period (Text-fig. 8).

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ON THE RELATIONSHIP OF THE FOSSIL FLEA
SAUROPHTHIRUS LONGIPES PONOMARENKO
(*SIPHONAPTERA* : *INSECTA*)

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(With 1 Text-figure)

INTRODUCTION

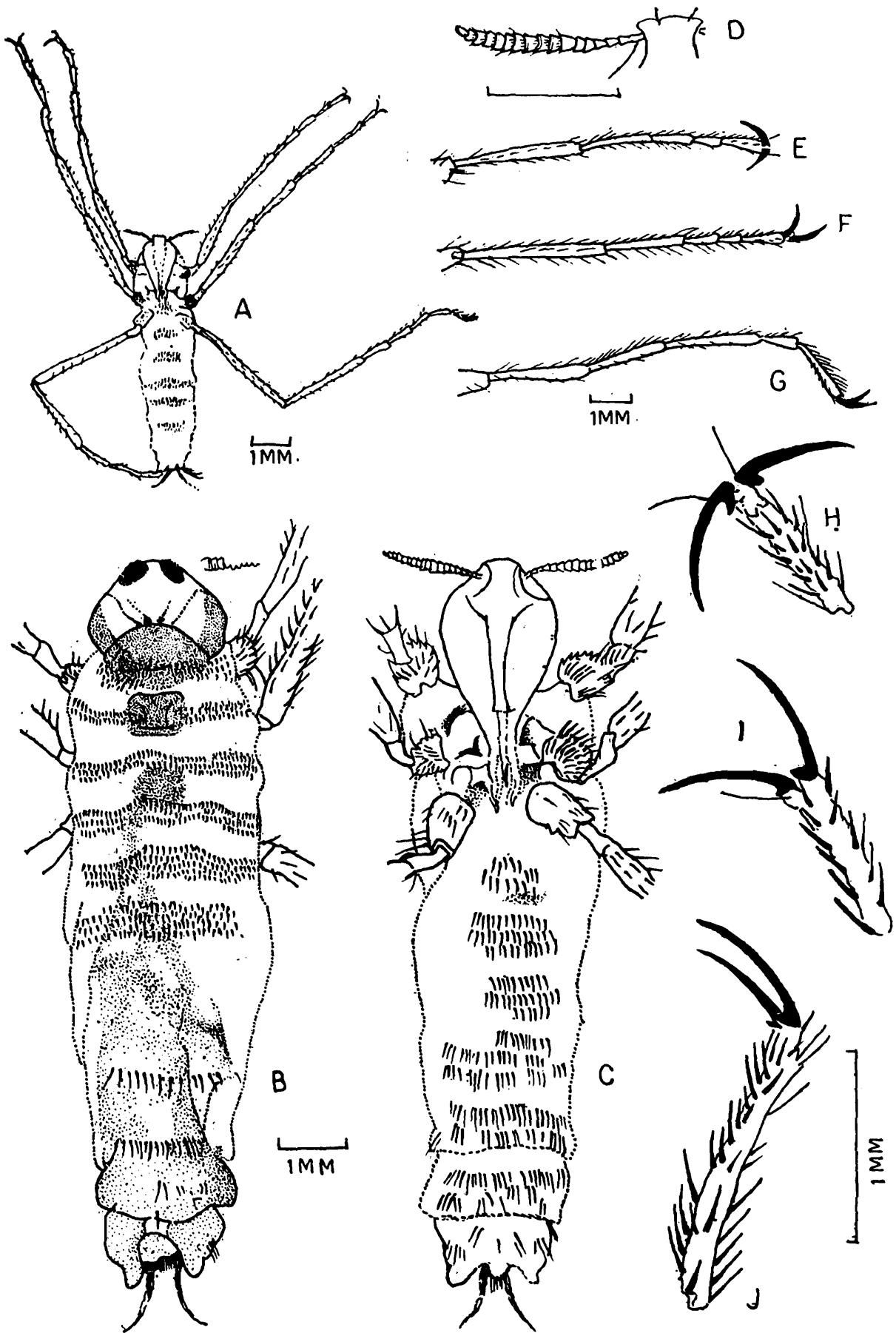
Ponomarenko (1976) described a new fossil genus *et* species, *Saurophthirus longipes* from the Lower Cretaceous beds of the Trans-Baikal Region in Russia as a primitive flea supposed to be parasitic on the flying reptiles, the Pterosauria. Though the author gave fairly detailed description with good figures, several inadvertencies have crept in. Firstly, the generic name with a suffix-*phthirus* connotes a louse and not a flea as the paper would indicate and is thus an unfortunate choice. Secondly, the author also spelt the genus differently in the text and the figures. Thirdly, in the English version on the contents page, the fossil is reported to have come from the Carboniferous instead of the Cretaceous beds as given in the Russian text. Lastly, the placement of the fossil in Siphonaptera itself is wholly erroneous, since its true affinities lie elsewhere.

DESCRIPTION

The authors have not been able to examine the fossil, but the relationship could be readily established on the basis of the rather detailed description and figures of Ponomarenko (1976).

The following is a brief description of the species and to facilitate easy understanding of our discussion of the true affinity, we reproduce here the redrawn figures of Ponomarenko (*op. cit.*).

The body dorso-ventrally flattened, quite unlike in a flea, heavily clothed with setae, arranged in number of nearly transverse rows on the tergites, the sternites and on legs. The head partly visible from above, but mostly ventrally oriented. Eyes partly dorsad and partly ventrad. Antennae 17-segmented, erroneously stated in the description to be located in ventral fossae, but really not so. Head along with the



Text-fig. 1. *Saurophthirus longipes* :

A. Ventral aspect of the fossil insect. B. Enlarged dorsal view ;
 C. Enlarged ventral view ; D. Enlarged view of the antennae ;
 E-G. Tarsi of the fore, mid and hind legs ; H-J. Enlarged view of
 the fifth tarsus of the respective legs (after Ponamarenko, 1976).

mouth parts drawn into a typical posteriorly directed rostrum, with distinctly biting mouthparts at the tip as in Mecoptera. Thorax three segmented, segments sub-equal. Prothorax partially projecting forwards over the occiput. Apterous, with legs long, slender, of generalized walking type with 5-segmented tarsi bearing a pair of long claws. Abdomen anteriorly as wide as the thorax, posteriorly some what narrowed, the ninth tergite appears quadrate to subquadrate as in Mecoptera. Ventrally two cerci-like or clasper-like lobed appendages are also noticeable in the fossil.

DISCUSSION

The fossil curiously seems to show a number of characters individually suggestive of its apparent relationship to more than one order, but the sum total leaves little doubt about its correct taxonomic placement. For example, the mouthparts superficially appear as sucking type of a bug, a louse, or piercing and biting type of a flea, but in reality of the rostral biting type as in Mecoptera. The legs are of generalized walking type, and not modified for swimming as in aquatic bugs, holding fast as in the louse, and certainly not saltatory as in a flea. The multi-segmented antennae wrongly interpreted as fitting in fossae like those of an Amblycerophthiran louse, or a flea, are really not inserted in a groove; the ventral impressions of the eyes have been mistaken as the antennal fossae by the author (Ponomarenko, 1976). The two styliiform processes at the end of the last abdominal sternite superficially resemble similar structures in Diplura, Plecoptera, the Orthopteroid insects, Embioptera, the caudal filaments of the Hemipteroidea, the gonapophyses (?) of the lice, the abdominal processes of the neuropteroid larvae, but are correctly recognizable as the claspers of the Mecoptera.

The rostral type of the mouthparts clearly excludes its inclusion in Diplura, the cerci-bearing Orthopteroid insects, and the Embioptera. The lack of wings or hemelytra, the non-swimming type of legs coupled with the multi-segmented antennae eliminate its inclusion either in the Hemipteroid or Neuropteroid complex, even if the mouthparts are confused with sucking or piercing type.

Though the unfortunate coining of the generic name denotes a louse, the number of antennal segments, exarate posteriorly directed mouthparts and the number of tarsal segments totally preclude its inclusion amongst the amblycerophthiran lice (with antennae set in fossae), though some of which are with modified piercing mouthparts. The mouthparts, typically mandibulate-piercing type placed at the end of the posteriorly directed rostrum, which with multisegmented antennae

excludes its inclusion in the ischnocerophthiran and rhynchophthiran lice as well, though some of them possess gonoapophyses like the siphunculophthiran lice. The number of antennal segments, tarsi, claws and backwardly directed mouthparts excludes the fossil from the latter group of lice. Therefore, the suffix-*phthirus* to the generic name is quite inapt.

Ponomarenko (*op. cit.*), however, considered it as a flea possibly parasitic on flying reptiles. The antennal shape, erroneously interpreted to be set in grooves, many segmental condition, the rostrate head, apterous condition, pentamerous tarsi, clasper-like abdominal processes might have led the author to confuse it with a flea. The extant and the fossil forms of fleas (Rick, 1970) have usually laterally compressed body, head devoid of eyes and with genal combs or 'ctenidia' on the latero-ventral border, the pronotal comb, and the saltatory hind legs. The dorsoventrally compressed body, presence of distinct and large eyes, absence of ctenidia, walking type of legs emphatically preclude its identification even remotely with a primitive flea. Though, Rick (1970) has reported Lower Cretaceous fleas, Phthiraptera (lice) and Siphonaptera (fleas) which are parasitic on birds and mammals must have evolved only at a later stage when mammals and birds appeared on the evolutionary ladder.

Taking all these facts based on the original description and the figures, we conclude its affinity lies actually with Mecopteroïd stock. In Mecoptera, the anterior region of the head is usually prolonged into a rostrum formed by the elongated parts of the head capsule, the clypeus, labrum and maxillae (Enderlein, 1910 ; Otnes, 1922 ; Seitz, 1928), held perpendicular to the body axis, which when pressed from above by the heavy sediments during fossilization account for the posteriorly directed aspect from a typical mecopteran type of head. The legs are long, walking type, with pentamerous tarsi bearing a pair of claws as in the fossil. In some scorpion-flies (eg. *Panorpa*) the ninth sternite is cleft, the two arms of which look like cerci or styliform processes with the corresponding ninth tergite also usually of quadrate or subquadrate form. The figures of the fossil fits in well in all these respects with the Mecoptera. Though Mecoptera are generally winged, apterous forms however, are also well known. The absence of the wings in the fossil may be due to true aptery, or the wings might have been lost and not fossilized along with the rest of the body. The Mecoptera are known as fossils from Lower Permian onwards, and the present record from Cretaceous (Carboniferous !), poses no problem for the assumption that it may be a mecopteran. Incidentally, it may be mentioned that Potter (1938) states that Siphonaptera exhibit certain

resemblances with Mecoptera and Diptera. Tillyard (1935) considers fleas belong to part of the *Panorpoid*, complex and they must have been derived directly from Mecoptera rather than from Diptera.

Amongst the Mecoptera, the fossil seems to come very close to Boreidae, in which the claws are double and wings vestigial (brittle and hair-like in males, and scale-like in female). The genus, *Boreus* for example, has the antennae with 16-20 segments (17 in the fossil), large widely separated eyes, ocelli absent, a hypognathous head, elongated as a rostrum pointing downwards with mouthparts, typically of biting type and set at the tip of the rostrum. The three thoracic segments are subequal, with long legs, elongate coxae and pentamerous tarsi as in the fossil. The male with hind margin of the ninth abdominal segment prolonged into a deeply cleft process, the two arms of which are styliform as depicted in Ponomarenko's figure. Since we have not seen the actual fossil, we hesitate to transfer the species *Saurophthirues* to the genus *Boreus*, but undoubtedly it belongs to the family Boreidae.

Carpenter (1930) states that some of the Permian Mecoptera show highly specialized characters that are now present in the extant families. It is also interesting to quote Martynova (1951) that we do not yet know from which ancient scorpionflies the specialized branch Boreidae arose, but the latter type are true Mecoptera. Therefore, we seem fully justified in concluding that *Saurophthirus longipes* Ponomarenko, 1976, actually belongs to the family Boreidae of the order Mecoptera, with which its affinities undoubtedly lie on the basis of the depicted morphology of the fossil.

SUMMARY

This paper discusses the affinities of a fossil flea, *Saurophthirus longipes* Ponomarenko (1976) from the Cretaceous beds of the Trans-Baikal Region of Russia. It is shown in this paper that it is a true Mecopteran instead of a flea.

ACKNOWLEDGMENTS

One of us (K. V. L.) is indebted to Dr. S. Khera, the then Deputy Director in-charge, Zoological Survey of India, the Secretary, Government of India, Department of Science & Technology, the Polish Academy of Sciences, the Government of German Democratic Republic for his visits abroad under the exchange programme of the specialists which gave him the opportunity to trace Ponomarenko's interesting

paper, and to draw the preliminary conclusions with the fellow parasitologist and the third author in the Museum für Naturkunde an der Humboldt Universität, Berlin. The first two authors sincerely thank Dr. B. K. Tikader, Director, Dr. A. Daniel, Joint Director and Drs. S. K. Bhattacharyya and R. S. Pillai, Deputy Directors of Zoological Survey of India for facilities and several other courtesies.

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TEPHRITIDAE (DIPTERA : INSECTA) OF NAMDAPHA

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(With 2 Plates)

INTRODUCTION

The material on which this report is based has been collected from Namdaha- the proposed biosphere reserve—in Tirap district of Arunachal Pradesh, during a faunistic survey tour conducted from the Eastern Regional Station of the Zoological survey of India by the author in the month of February 1982. In all, the author has examined 50 specimens which yielded 22 species under 13 genera and 4 sub families, of which 4 species and one genus are being recorded for the first time from India.

LIST OF SPECIES

The following sub families, genera and species are represented in the material studied.

Subfamily DACINAE

Genus **Dacus** Fabricius

1. *Dacus (Zeugodacus) scutellaris* (Bezzi)
2. *D. (Z) tau* (Walker)
3. *D. (Z) atrifacies* (Perkins)*
4. *D. (Hemigymnodacus diversus* Coquillett

Subfamily SCHISTOPTERINAE

Genus **Rhabdochaeta** de Meijere

5. *Rhabdochaeta bakeri* Bezzi

Subfamily TRYPETINAE

Genus **Hexacinia** Hendel

6. *Hexacinia radiosa* (Rondani)**

* Species New Record for India

** Genus New Record for India.

Genus **Acanthonevra** Macquart

7. *Acanthonevra hemileina* Hering
8. *A. formosana* Enderlein
9. *A. dunlopi* (van der Wulp)

Genus **Rioxa** Walker

10. *Rioxa parvipunctata* de Meijere*
11. *R. sexmaculata* (van der Wulp)

Genus **Anoplomus** Bezzi

12. *Anoplomus flexuosus* Bezzi

Genus **Xanthorrhachis** Bezzi

13. *Xanthorrhachis annandalei* Bezzi
14. *X. assamensis* Hardy

Genus **Gastrozona** Bezzi

15. *Gastrozona fasciventris* (Macquart)
16. *G. balioptera* Hardy*

Genus **Acrotaeniostola** Hendel

17. *Acrotaeniostola apiventris* Munro

Genus **Chaetellipsis** Bezzi

18. *Chaetellipsis paradoxa* Bezzi
19. *C. atrata* Hardy.*

Genus **Myoleja** Rondani

20. *Myoleja fossata* (Fabricius)

Subfamily TEPHRITINAE

Genus **Spathulina** Rondani

21. *Spathulina acroleuca* (Schiner)

Genus **Dioxyne** Frey

22. *Dioxyne sorrorcaula* (Wiedemann)

Key to Subfamilies

1. Chaetotaxy greatly reduced, lacking ocellars, postocellars, dorsocentrals, presuturals, sternopleurals and usually humerals. Cell M broad, 2 X wider than Cell Cu and usually about 2 X longer than wide. A row of prominent long hairs present on each side of third abdominal tergum of males and a patch of dense microtrichia over the cubital cell and lower margin of cell M₄. Third antennal segment 3 or more times longer than wide. Typically yellow and black flies with wings mostly hyaline except for a brown band and streak through Costal margin and cubital area respectively. ... Dacinae

- Not as above, chaetotaxy complete or nearly so, with cell M narrow equal in width to Cu and usually over 4 X longer than wide. 3rd antennal segment typically short, wings usually with elaborate markings ... 2

- 2 (1). Costa of wing without a deep cleft and a lobe at the end of subcostal vein ... 3

- Costa of with a deep cleft at the apex of subcostal vein and a prominent lobe at apex of 2nd costal; wing with distinctive markings Schistopterinae

- 3 (2) Occipitals thin, pointed, black or dark brown; 6th tergum of female generally shorter than fifth. Dorsocentral bristles usually behind supraalars. Wings variously marked but rarely spotted. Mesonotum rarely tomentose, never with scalelike, white, recumbent setae. ... Trypetinae

- Occipitals thick, flat, scale-like, mostly white or yellow white. 6th tergum equal or longer than 5th. Dorsocentral bristles before or near supraalars. Wings typically spotted. Mesonotum generally tomentose and covered with scale-like, white, recumbent setae ... Tephritinae

Key to the genera of Tephritidae from Namdapha

1. Chaetotaxy of head and thorax reduced (ocellar, postocellar, dorsocentral, presutural, sternopleural and usually humeral bristles absent); 3rd antennal segment 3 or more times longer than wide; wings hyaline, having brown band along costal margin and a brown streak through cubital area ... *Dacus* Fabricius

	Chaetotaxy complete or nearly so ; 3rd antennal segment typically short ; cell M narrow equal in width to Cu and 4 X longer than wide ; wings usually with elaborate markings. ...	...	2
2 (1)	Costa without a deep cleft and lobe at the end of subcostal vein. ...	...	3
	Costa with a deep cleft at the end of subcostal vein and forming a lobe at anterior side of the cleft which bears two bristles at its apex ; wing markings distinctive. ...	<i>Rhabdochaeta</i> de Meijere	
3 (2)	Occipital setae thin, pointed, black or dark brown ; 6th tergum of female typically shorter than 5th ; dorsocentral bristles usually behind supraalars ; wings variously marked but rarely spotted. ...	...	4
	occipitals thick, flat, rather scale-like, white or yellow-white ; 6th tergum of female equal or longer than 5th ; dorsocentrals situated in front of anterior supraalars. ...	...	12
4 (3)	Mesopleuron not with a bristle on lower median portion ; wings normal in shape. ...	...	5
	Mesopleuron with a prominent bristle near lower edge centrally ; wings broad, about 2 X longer than wide. ...	<i>Hexacinia</i> Hendel	
5 (4)	Two or more pairs of inferior fronto-orbital bristles. ...	...	6
	One pair of inferior fronto-orbitals ; subcostal cell as long as 2nd costal ; mesonotum sometimes with brownish vittae but not with isolated black spots. ...	<i>Acanthonevra</i> Macquart	
6 (5)	Subcostal vein not arched upwards (not convex) ; arista with dorsal and ventral rays or totally bare. ...	...	7
	Subcostal vein arched upwards (convex) ; subcostal cell longer than 2nd costal cell ; wings brown with hyaline spots mostly in margin ; arista with dorsal rays only but bare ventrally. ...	<i>Rioxa</i> Walker	
7 (6)	Humeral bristles strong. ...	...	8
	Humeral bristles absent ; mesonotum polished black ; scutellum mostly yellow. ...	<i>Anoplomus</i> Bezzi	
8 (7)	Wings with three yellow longitudinal bands, one on costa, one on vein M_{1+2} and one on vein M_{3+4}	<i>Xanthorrhachis</i> Bezzi	
	Wings not as above. ...	...	9

- 9 (8) Arista plumose; ocellars well developed at least as long as lower inferior fronto orbitals... .. 10
- Arista pectinate or bare; ocellars tiny, rudimentary, seta-like. 11
- 10 (9) Third antennal segment rounded. ... *Gastrozona* Bezzi
- Third antennal segment sharply pointed. ... *Acrotaeniostola* Hendel
- 11 (9) Arista pectinate; with 4-7 inferior fronto-orbitals in females and no inferior fronto-orbitals in males. ... *Chaetellipsis* Bezzi
- Arista bare; with 3 pairs of inferior fronto-orbital bristles. ... *Myoleja* Rondani
- 12 (3) Body shining black, rather light grey pollinose, especially in abdomen, usually not obscuring the ground colour except on thorax; wings dark brown with base and apex hyaline and with large hyaline wedges from anterior and posterior margins, but few hyaline spots in the middle of wing. ... *Spathulina* Rondani
- Body black in ground colour, very densely yellow-grey tomentose and covered with white scale-like setae; wings hyaline, with numerous somewhat diffused brown spots. ... *Dioxyna* Frey

SYSTEMATIC ACCOUNT

Subfamily : DACINAE

Genus *Dacus* Fabricius

Dacus Fabricius, 1805, *Syst. Antl.*, 272. Type species : *armatus* Fabricius, by subsequent designation (Hendel, 1927 : 24).

Dacus (Tridacus) Bezzi, 1915, *Bull. Ent. Res.* 6 : 88. Type species : *Dacus armatus* Fabricius, by subsequent designation (Collart 1935 : 9).

Key to the subgenera of Dacus from Namdapha

1. Posterior lobe of male surstylus elongate, about 6 X longer than anterior lobe; 5th sternum of male with a slight concavity on hind margin... .. 2
- Posterior lobe of male surstylus short, 5th sternum with a deep V-shaped concavity on hind margin extending about half length of the segment. ... *Bactrocera* Macquart
- 2 (1) Pecten present on third tergum of male. ... *Zeugodacus* Hendel
- Pecten absent on third tergum of male. ... *Hemigymnodacus* Hardy

Dacus (Zeugodacus) scutellaris (Bezzi)

Bactrocera scutellaris Bezzi, 1913, *Mem. Indian Mus.* 3 : 98. Type localities : India : Shillong, Assam ; Siliguri, N. Bengal ; Kurseong, E. Himalayas ; and Bhowali, Kumaon.

Material examined : 7 examples, E. R. S/Z. S. I. Reg. No. $\frac{A1}{5874}$, 36 th Mile, Namdapha ; 21-ii-1982.

Distribution : India, Nepal, Burma, Thailand.

Distinguishing characters : A pair of black spots on face ; mesonotum with 3 post sutural yellow vittae ; apex of scutellum black ; costal band greatly narrowed, almost interrupted in cell R_3 and expanded in to a small spot at apex ; apices of all femora broadly blackened ; abdomen predominantly black.

Dacus (Zeugodacus) tau (Walker)

(Pl. II, fig. 1)

Dasyneura tau Walker, 1849, *List Spec. Dipt. Ins. Brit. Mus.* 4 : 1074. Type locality : Foochow, China.

Dacus hageni de Meijere, 1911, *Tijdschr. Ent.* 54 : 375. Type locality : Tandjong Morawa, Serdang, Sumatra.

Zeugodacus nubilis heinrichi Hering, 1941, *Siruna Seva* 3 : 11 Type locality : Celebes.

Zeugodacus bezzianus Hering, 1941, *Arb. Morph. Taxon. Ent.* 8 (1) : 26. Type locality : Mou-pin, Szechwan, China.

Material examined : 3 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5875}$; 36th Mile, Namdapha and 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5876}$, 37 th Mile, Namdapha on 21-ii-1982 and 23-ii-1982 respectively.

Distribution : Oriental (Widespread).

Distinguishing Characters : Face with a pair of black spots ; mesonotum with 3 post sutural yellow vittae ; scutellum yellow except for a narrow black band at base ; costal band expanded distally forming a large brown spot occupying upper apical portion of cell R_5 .

Dacus (Zeugodacus) atrifacies (Perkins)

(Pl. II, fig. 2)

Zeugodacus atrifacies Perkins, 1938, *Proc. R. Soc. Qld* 49 (11) : 140.

Material examined : 2 examples E. R. S/Z. S. I Regd. No. $\frac{A1}{5877}$, 36th Mile, Namdapha, 21-ii-1982.

Distribution : Malayasia. This species is being recorded for the first time from India.

Distinguishing Characters : Lower half of the face black ; mesonotum with 3 postsutural yellow vittae ; front femora entirely dark brown to black and the middle and hind femora black on their apical half to two fifth ; abdomen predominantly black ; costal band very slightly enlarged at the wing apex.

Dacus (Hemigymnodacus) diversus Coquillett

Dacus diversus Coquillett, 1904, *Proc. Ent. Soc. Wash.* 6 : 139. Type localities : Colombo, Ceylon and Bangalore, India.

Asiadacus diversa. Perkins, 1937; *Proc. R. Soc. Qld* 48 (9) : 57 ; 1938, *Proc. R. Soc. Qld* 49 (11) : 134 (as *diversus*).

Dacus (Gymnodacus) diversus. Hardy, 1954, *Proc. Ent. Soc. Wash.* 56 (1) : 18.

Material examined : 2 examples, E. R. S/Z. S. I Regd. No. $\frac{A1}{5878}$, 36th mile, Namdapha, 21-ii-1982.

Distribution : Sri Lanka, India, Nepal, Burma and Thailand.

Distinguishing Characters : Male face entirely pale yellow, female face with a transverse black band over face ; mesonotum with three yellow vittae ; pecten absent on third tergum of male ; prescutellars present ; only 2 scutellar bristles present.

Sub Family : Schistopterinae

Genus : *Rhabdochaeta* de Meijere

Rhabdochaeta de Meijere, 1904, *Bijdr. Dierk.* 17 : 109. Type species : *pulchella* de Meijere, by monotypy.

Rhabdochaeta bakeri Bezzi

(Pl. II, fig. 3)

Rhabdochaeta bakeri Bezzi, 1913, *Philipp. J. Sci.* (D) 8 : 328 ; 1926, *spolia zeylanica* 13 : 311. Type locality : Los Baños, Laguna, Philippine islands.

Material examined : 1 example, E.R.S/Z.S.I. Regd. No. $\frac{A1}{5879}$, 40 th Mile, Namdapha, 20-ii-1982.

Distribution : Laos, Philippines, Vietnam, Thailand, India.

Distinguishing Characters : Characterised by a strong carinate projection in middle of face just below antennae and a black median spot below the projection ; six scutellar bristles and a pair of prominent apical cruciate setae ; subcostal cell with an incomplete brown streak through middle.

Subfamily : TRYPETINAE

Genus **Hexacinia** Hendel

Hexacinia Hendel, 1914, *Wien. Ent. Zeit.* **33** : 82 ; 1915, *Ann. Mus. Nat. Hung.* **13** : 459. Type species : *Acinia stellata* Macquart (1851), by original designation.

Hexacinia radiosa (Rondani)

(Pl. II, fig. 4)

Acinia radiosa Rondani, 1868, *Ann. Soc. Nat. Hist. Modena* **3** : 31. Replacement name for *stellata* Macquart, 1851. nec 1843.

Acinia stellata Macquart, 1851, *Mem. Soc. Lille* **1851** : 266. Type locality : Manila.

Hexacinia nigroantennata Hering, 1956, *Verh. Naturf. Ges. Basel* **67** (1) : 70. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* **31** : 104.

Material Examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5880}$,

Deban, Namdapha, 16-ii-1982.

Distribution : Sri Lanka, Philippines, Thailand, and S. Vietnam. This genus is being recorded for the first time from India.

Distinguishing Characters : Apical half of the antenna brown to black ; prominent brown to black spot on each side of posterior margin of mesonotum, immediately in line with dorsocentral bristles ; marginal wing spots enlarged, rather quadrate and the spot at apex of cell R_5 not filling the cell.

Genus **Acanthonevra** Macquart

Acanthonevra Macquart, 1843, *Dipt. Exot.* **3** : 317. Type species : *A. fuscipennis* Macquart, by monotypy.

Acanthonevra Schiner, 1868, *Reise Novara, Zool.* **2**. Abt. 1, Dipt., p. 288. Invalid emendation of *Acanthonevra*.

Rioxoptilona Hendel, 1914, *Wien. Ent. Zeit.* **33** : 78. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* **31** : 81. Type species : *Trypeta vaga* Wiedemann by original designation.

Acanthonevra hemileina Hering

(Pl. II, fig. 5)

Acanthonevra hemileina Hering, 1939, *Verh. VII Intern. Kongr. Ent.* 1938, **1** : 173. Type locality : Trichinopoly, India.

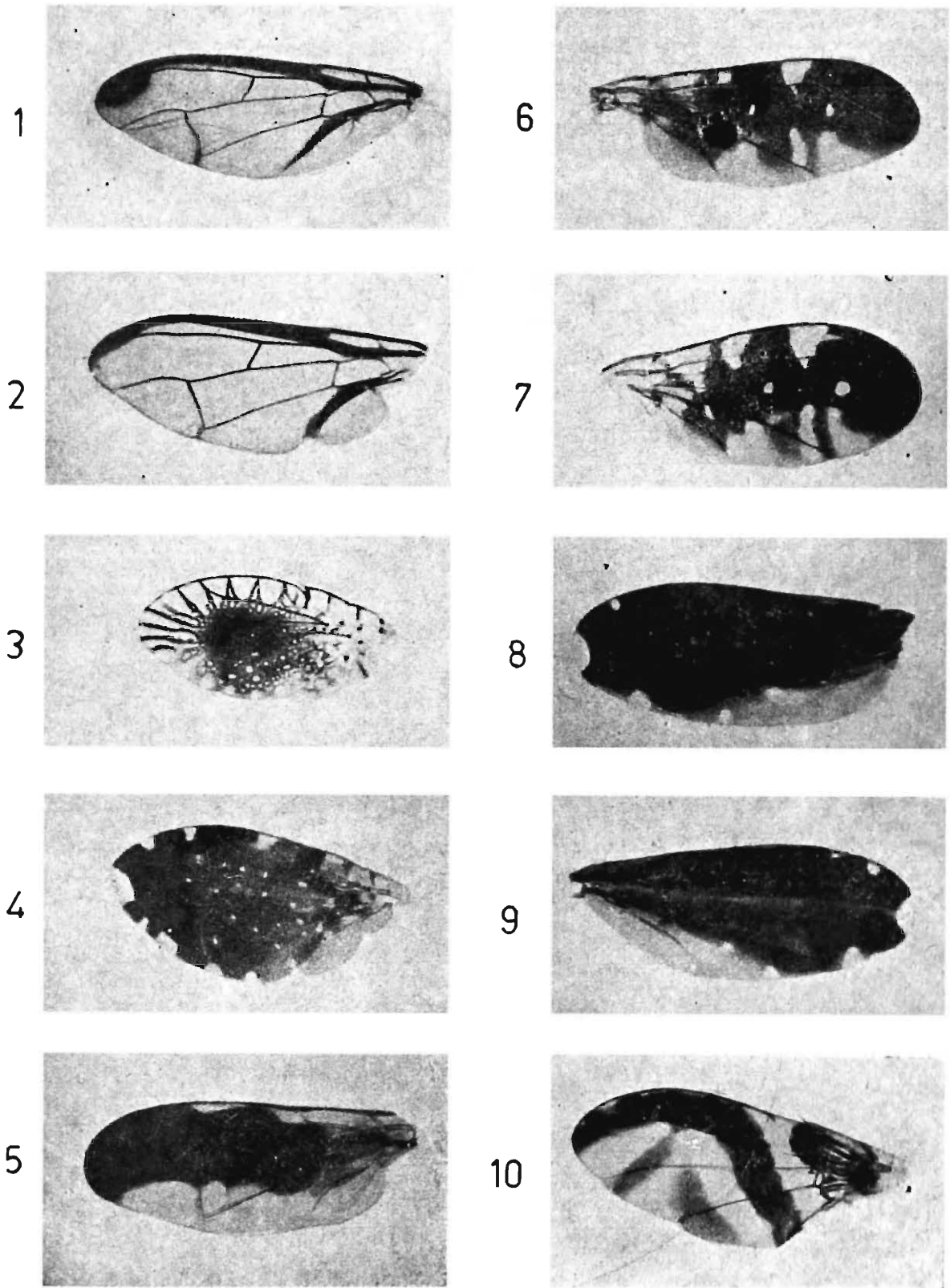
Material examined : 2 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5881}$,

40 th Mile, Namdapha, 20-ii-1982.

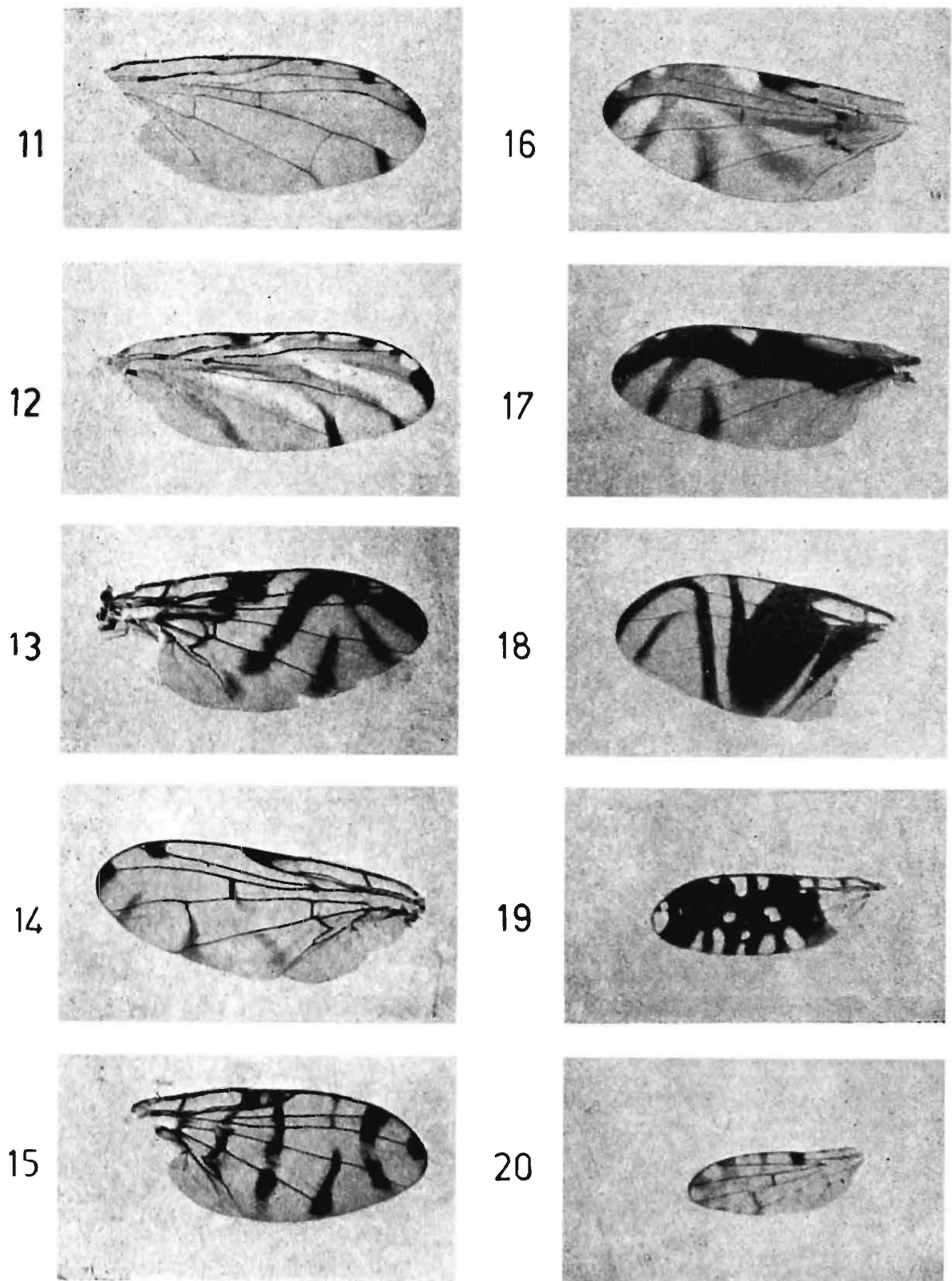
Distribution : India, Vietnam.

C. RADHAKRISHNAN

PLATE I



Figs. 1-10. 1. Wing of *Dacus (Zeugodacus) tau* (Walker). 2. Wing of *Dacus (Zeugodacus) atrifacies* (Perkins). 3. Wing of *Rhabdochaeta bakeri* Bezzi. 4. Wings of *Hexacinia radiosa* (Rondani). 5. Wing of *Acanthonevra hemileina* Hering. 6. Wing of *Acanthonevra formosana* Enderlein. 7. Wing of *Acanthonevra dunlopi* (van der Wulp). 8. Wing of *Rioxa parvipunctata* de Meijere. 9. Wing of *Rioxa sexmaculata* (van der Wulp). 10. Wing of *Anoplomus flexuosus* Bezzi.



Figs. 11-20. 11. Wing of *Nanthorrachis annandali* Bezzi. 12. Wing of *Nanthorrachis assamensis* Hardy. 13. Wing of *Gastrozona fasciventris* (Macquart). 14. Wing of *Gastrozona balioptera* Hardy. 15. Wing of *Acrotaeniostola apiventris* Munro. 16. Wing of *Chaetellipsis paradoxa* Bezzi. 17. Wing of *Chaetellipsis atrata* Hardy. 18. Wing of *Myoleja fossata* (Fabricius). 19. Wing of *Spathulina acroleuca* (Schiner. 20. Wing of *Diozyna sorrorcula* (Wiedemann).

Distinguishing Characters : Anterior two third of wing predominantly dark brown and the entire posterior margin broadly hyaline ; thorax predominantly yellow, with 4 faint brown vittae extending down mesonotum ; scutellum yellow ; legs entirely pale yellow.

***Acanthonevra formosana* Enderlein**

(Pl. I, fig. 6)

Acanthonevra formosana Enderlein, 1911, *Zool. Jahrb. (Syst.)* 31 : 419. Type locality : Kosempo, S. Formosa.

Acanthonevra pteropleuralis Hendel, 1927, In Lindner, *Die Flieg. Pal. Reg.* 49 : 58., Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 85. Type locality : Amur China.

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5882}$, 36th mile, Namdapha, 21-ii-1982.

Distribution : Formosa, China, Thailand, Burma, S. Vietnam, Laos, Japan, Korea, India.

Distinguishing Characters : Thorax largely yellow to rufous and mesonotum with 5 longitudinal brown to black stripes in male and 4 in female ; the lateral stripes are interrupted at the suture and the three median brown vittae in the males are joined together posteriorly between the dorsocentral bristles. Front femur of male with an abundance of black bristles on antero ventral and postero ventral surfaces ; front tibia densely black setose ventrally ; vein R_{2+3} distinctly curved and basal portion of wing largely dark brown.

***Acanthonevra dunlopi* (van der Wulp)**

(Pl. I, fig. 7)

Ptilona dunlopi van der Wulp, 1880, *Tijdschr. Ent.* 23 : 186. Type Locality : Padang, Sumatra.

Rioxa dunlopi. Bezzi, 1913, *Mem. Indian Mus.* 3 : 113.

Acanthonevra dunlopi. Hering, 1941, *Ark. Zool.* 33.B (11) : 4.

Material examined : 1 example, E.R.S/Z.S.I Regd. No. $\frac{A1}{5883}$, 40 th Mile, Namdapha, 20-ii-1982.

Distribution : Indonesia, India, Burma, Thailand and Pakistan.

Distinguishing Characters : Vein R_{2+3} , straight or nearly so ; the 4th costal section between tips of vein R_1 and R_{2+3} , nearly 2 X longer than 5th, between tips of R_{2+3} and R_{4+5} ; a prominent hyaline spot present in cell R_5 before the r-m cross vein ; basal portion of wing

largely hyaline ; thorax typically with a narrow pale brown vitta on each side of mesonotum from humerus to wing base and a faint streak of brown on each side over upper pleura ; front femur with 2 irregularly placed posteroventral rows of black bristles ; front tibia with 2 or more closely placed bristly ventral seta.

Genus *Rioxa* Walker

Rioxa Walker, 1857, *J. Linn. Soc. Lond.*, Zool. **1** : 35. Type species : *lanceolata* Walker by monotypy.

Ptilonina Enderlein, 1911, *Zool. Jahrb. (syst.)* **31** : 447. Type species : *Ptilonina sexmaculata* van der Wulp, by original designation.

Rioxa parvipunctata de Meijere

(Pl. I, fig. 8)

Rioxa sexmaculata Var. *parvipunctata* de Meijere, 1911, *Tijdschr. Ent.* **54** : 381. Type locality : Java.

Rioxa infirma Hering, 1941, *Siruna Seva* **3** : 21. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr* **31** : 109. Type locality : Ceylon.

Material examined : 2 examples, E.R.S/Z.S.I. Regd. No. $\frac{A1}{5884}$, Deban Namdapha, 18-ii-1982.

Distribution : Java, Sri Lanka, Thailand.

This species is being recorded for the first time from India.

Distinguishing Characters : Having only 4 marginal hyaline spots on the wing ; no spots present in cell R_1 or Sc ; 4 th costal section of male very short about $\frac{1}{2}$ as long as 5th ; lower lateral margins of the face yellow.

Rioxa sexmaculata (van der Wulp)

(Pl. I, fig. 9)

Ptilonina sexmaculata van der Wulp, 1880, *Tijdschr. Ent.* **23** : 185 ; 1886, Dipt. Sumatra. Type locality : Sumatra.

Rioxa sexmaculata van der Wulp, 1899, *Tijdschr. Ent.* **42** : 56.

Rioxa sumatrana Enderlein, 1911, *Zool. Jahrb. (Syst)* **31** : 449. Type locality : Sumatra.

Rioxa quinque maculata Bezzi, 1913, *Mem. Ind. Mus.* **3** : 115. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* **31** : 109. Type locality : Tenasserim, Burma.

Material examined : 5 examples, E.R.S/Z.S.I Regd. No. $\frac{A1}{5885}$, Deban Namdapha, 18-ii-1982.

Distribution : Burma, India, Indonesia, Philippines, Thailand, Sumatra, S. Vietnam.

Distinguishing Characters : Wing margin with 5 or 6 hyaline spots ; 4 th costal section of male almost equal in length to 5 th ; each lower lateral margins of the face with a shining dark brown to black spot.

Genus *Anoplomus* Bezzi

Anoplomus Bezzi, 1913, *Mem. Ind. Mus.* 3 : 100. Type species : *flexuosus* Bezzi by original designation.

Anoplomus flexuosus Bezzi

(Pl. I, fig. 10)

Tephritid fasciventris, Macquart, *Dipt. Exot. Suppl.* 3, 225 (65) ; not of Macquart, 1843.

Anoplomus flexuosus Bezzi, 1913, *Mem. Ind. Mus.* 3 : 100. Type localities : Sikkim ; Paresnath, W. Bengal & Karmatar, Bengal. As the species name *fasciventris* is preoccupied by Macquart himself, Bezzi has adopted the manuscript name of Bigot (*Tephritis flexuosa*, Bigot).

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5886}$,

36th mile, Namdapha, 21-ii-1982.

Distribution : India, Java, Philippines.

Distinguishing Characters : Wing apex rounded ; middle and hind femora broadly brown to black at apices ; 2nd costal cell all dark brown except for a small hyaline spot towards the basal portion.

Genus *Xanthorrhachis* Bezzi

Xanthorrhachis Bezzi, 1913, *Mem. Ind. Musm.* 3 : 137. Type species *annandalei*, Bezzi, by original designation.

Xanthorrhachis annandalei Bezzi

(Pl. II, fig. 11)

Xanthorrhachis annandalei Bezzi, 1913, *Mem. Ind. Mus.* 3 : 138. Type locality : Dawna Hills, Lower Burma.

Material examined : 2 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5887}$,

36th mile, Namdapha, 21-ii-1982.

Distribution : Burma, Thailand, Laos, Vietnam, India.

Distinguishing Characters : Entirely yellow to pale green species except for an opaque, densely black pubescent, small, black spot on each hind corner of the mesonotum, directly behind inner post alar bristles ; a tiny black spot behind each wing base and a shining black spot at base of each scutellar bristle.

Xanthorrhachis assamensis Hardy

(Pl. II, fig. 12)

Xanthorrhachis assamensis Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 283. Type locality : Assam, India.

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5888}$, 36 th mile, Namdapha, 21-ii-1982.

Distribution : India.

Distinguishing Characters : Entirely yellow to rufous species, having 3 black spots on margin of scutellum, a black spot on each humerus and 3 black spots on each side of mesonotum.

Genus Gastrozona Bezzi

Gastrozona Bezzi, 1913, *Mem. Ind. mus.* 3 : 105. Type species : *Tephritis fasciventris* Macquart, by original designation.

Gastrozona fasciventris (Macquart)

(Pl. II, fig. 13)

Tephritis fasciventris Macquart, 1843, *Dipt. Exot.* 3 : 382. Type locality : India.

Tephritis vittata Macquart, 1851, *Dipt. Exot.*, Suppl. 4 : 263. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 190. Type locality : Asia.

Gastrozona macquarti Hendel, 1913, *Ent. Mitteil* 2 (2) : 38. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 190. Type locality : Formosa.

Gastrozona melanistra Bezzi, 1913, *Mem. Ind. Mus.* 3 (3) : 107. Type locality : Calicut, Malabar Coast, India.

Gastrozona appendiculata Zia, 1938, *Sinensia* 9 (1-2) : 22. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 190. Type Locality : SE Kansu, China.

Gastrozona melanophila Hering, 1940, *Siruna Seva* 1 : 3. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 190. Type locality : Formosa.

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5889}$, 36 th mile, Namdapha, 21-ii-1982.

Distribution : Widespread from Formosa through China, India, Laos and Thailand.

Distinguishing Characters : The species is readily distinguished by the oblique band extending through upper portions of cell 2nd M₂ connected with the broad brown band at the wing margin, and a small indistinct hyaline spot present at apex of vein M₃₊₄.

Gastrozona balioptera Hardy

(Pl. II, fig. 14)

Gastrozona balioptera Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 188. Type locality : Thailand.

Material examined : 2 examples, E. R. S./Z. S. I. Regd. No. $\frac{A1}{5890}$, Deban, Namdapha, 16-ii-1982 and 1 example, E. R. S./Z. S. I. Regd. No. $\frac{A1}{5891}$, 36 th mile, Namdapha, 21-ii-1982.

Distribution : Thailand and Burma. This species is being recorded for the first time from India.

Distinguishing characters : Readily distinguished by the greatly reduced wing markings represented by spots at apices of veins R_{2+3} , R_{4+5} and M_{1+2} and lack of a continuous oblique band from margin over wing at level with r-m cross vein.

Genus Acrotaeniostola Hendel

Acrotaeniostola Hendel, 1914, *Wien. Ent. Zeit.* 33 : 80, 88. Type species : *sexvittata* Hendel, by original designation.

Acrotaeniostola apiventris Munro

(Pl. II, fig. 15)

Acrotaeniostola apiventris Munro, 1935, *Rec. Ind. Mus.* 37 : 19. Type locality : Pashok, Darjeeling, India.

Material examined : 1 example, E. R. S./Z. S. I. Regd. No. $\frac{A1}{5892}$, 37th mile, Namdapha, 23-ii-1982.

Distribution : India, Darjeeling.

Distinguishing characters : Characterised by the brown thorax with a yellowish bar from humeri along side of dorsum above wing base to scutellum expanding to pleura including the mesopleura ; wing with a series of disconnected brownish transverse bands ; 2nd segment of the abdomen greatly developed.

Genus Chaetellipsis Bezzi

Chaetellipsis Bezzi, 1913, *Mem. Ind. Mus.* 3 : 126. Type species : *paradoxa* Bezzi.

Chaetellipsis paradoxa Bezzi

(Pl. II, fig. 16)

Chaetellipsis paradoxa Bezzi, 1913, *Mem. Ind. Mus.* 3 : 127. Type locality : W. Bengal, India.

Poecillia judicanda Bezzi, 1913, *Mem. Ind. Mus.* 3 : 128. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 182. Type locality : W. Bengal, India.

Gastrozona flavostriata Hering, 1938, *Ark. Zool.* 30 A (25) : 12. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 182. Type locality : Kambaiti, Burma.

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5893}$,

Miao, Namdapha, 15-ii-1982.

Distribution : Common over the Indian sub continent.

Distinguishing characters : Characterised by its all yellow scutellum and by having the abdomen yellow except for a narrow black band across 4th tergum, a small black spot on each side of 3rd and a large black spot on each side of 5th, also the 6th tergum of male with a brown spot on each side.

***Chaetellipsis atrata* Hardy**

(Pl. II, fig. 17)

Chaetellipsis atrata Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 179. Type locality : Laos.

Material examined : 1 example, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5894}$,
40th mile, Namdapha, 20-ii-1982.

Distribution : Laos. This species is being recorded for the first time from India.

Distinguishing Characters : Characterised by the prominently shining black thorax with a pair of sub median yellow vittae on mesonotum in line with dorsocentral bristles extending posteriorly about two third the distance between dorsocentrals and prescutellar bristles and by the scutellum entirely yellow except for a very narrow black line along base.

Genus *Myoleja* Rondani

Myoleja Rondani, 1856, *Dipt. Ital. Prodr.* 1 : 112. Type species : *Tephritis lucida* Fallen, by original designation.

Myoleja, *Myioleia*, *Myiolia*, and *Myolia*, errors or emendations.

Philophylla Rondani, 1870, *Bull. Soc. Ent. Ital.* 2 ; 9 ; 1871, op. cit. 3 : 175. Type species : *Musca caesio* Harris, by original designation.

Euleia, of authors, not Walker.

Pseudospheniscus, of authors.

Hendelina Hardy, 1951, *Pacif. Sci.* 5 (2) : 179. Invalid replacement name for *Pseudospheniscus* Hendel, 1914.

Myoleja fossata (Fabricius)

(Pl. II, fig. 18)

Tephritis fossata Fabricius, 1805, *Syst. Antl.* p. 320. Type locality : "Tranquebariae".*Trypeta elimia* Walker, 1849, *List spec. Dipt. Ins. Coll. Brit. Mus.* 4 : 1033. Type locality : Philippines.*Ortalis regularis* Doleschall, 1859, *Nat. Tijdschr. Ned. Ind.* 17 : 119. Type locality : Amboina.*Myoleja fossata* (Fabricius). Combination by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 255.

Material examined : 2 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5895}$,
40th mile, Namdapha, 20-ii-1982.

Distribution : Japan, Formosa, Burma, India, New Ireland, Singapore, Philippines, Indonesia, Thailand, S. Vietnam, Laos.

Distinguishing Characters : A moderately small subshining black species characterised by an oblique pre-apical streak of brown extending from upper apex of cell 2nd M_2 to vein R_{4+5} , and a narrow longitudinal hyaline streak through entire length of Cell M_4 of the wing.

Subfamily TEPHRITINAE

Genus **Spathulina** Rondani

Spathulina Rondani, 1856, *Dipt. Ital. Prodr.* 1 : 113. Type species : *sicula* Rondani (nom. nud.), by original designation. Synonymy by Hendel (1927 : 117) as *Tephritis tristis* Loew

Spathulina acroleuca (Schiner)

(Pl. II, fig. 19)

Tephritis acroleuca Schiner, 1868, *Reise Novara, Dipt.* p. 268. Type locality : Sydney, Australia.*Trypeta undecimguttata* Thomson, 1869, *Eugen. Resa, Dipt.* p. 581. Synonymy by Hardy, 1973, *Pacif. Ins. Monogr.* 31 : 314. Type locality : Sydney, Australia.*Oxya parca* Bezzi, 1913, *Mem. Ind. Mus.* 3 : 159. Type locality : Calcutta, India.*Oxya nigrifemorata* de Meijere, 1914, *Tijdschr. Ent.* 57 : 220. Type locality : Java.

Material examined : 5 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5896}$,
40th mile, Namdapha, 20-ii-1982.

Distribution : Widespread throughout Africa and Asia extending to Australia through Pacific, Indonesia, Bonin islands, Japan, Formosa, Ryukyu islands, Solomon islands, New Guinea, New Caledonia, Philippines, Fiji and Micronesia.

Distinguishing Characters : A small dark coloured species with largely dark brown to black wings, containing hyaline spots along margin, with the apical portion of wing completely hyaline or with just a tiny dark brown spot at extreme apex of cell R_3 and with only 2 or 3 isolated hyaline spots in the wing field.

Genus *Dioxyna* Frey

Dioxyna Frey, 1944, *Comm. Biol. Soc. Fenn.* 8 (10) : 62. Type species : *Trypeta sorrorcula* Wiedemann, by original designation.

Dioxyna sorrorcula (Wiedemann)

(Pl. II, fig. 20)

Trypeta sorrorcula Wiedemann, 1830, *Aussereur. Zweifl. Ins.* 2 : 509. Type locality : Teneriffe.

Dioxyna sorrorcula. Frey, 1944, *Comm. Biol. Soc. Fenn.* 8 : 62.

Material examined : 3 examples, E. R. S/Z. S. I. Regd. No. $\frac{A1}{5897}$, 40th mile, Namdapha, 20-ii-1982.

Distribution : Widespread throughout the tropics and subtropics of the world.

Distinguishing characters : Characterised by having only 2 scutellar bristles and the head longer than high, longest on the lower margin, with the epistoma and sides of face protruded ; wings hyaline with numerous somewhat diffused brown spots.

SUMMARY

The paper deals with the systematic account of 22 species of Tephritidae (Diptera : Insecta) under 13 genera and 4 sub-families from Namdapha-the proposed biosphere reserve-in Tirap district of Arunachal Pradesh, collected by the author, of which 4 species and 1 genus is being recorded for the first time from India.

ACKNOWLEDGEMENT

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BIONOMICS OF AN APHIDOPHAGOUS COCCINELLID
PREDATOR *PSEUDASPIDIMERUS CIRCUMFLEXA*
(MOTSCHULSKY) (COCCINELLIDAE : ASPIDIMERINI)

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(With 4 Text-figures and 2 Tables)

INTRODUCTION

The genus *Pseudaspidimerus* was described by Kapur (1948) while revising the tribe Aspidimerini Weise to include *circumflexa* (Motschulsky), *uttami* Kapur, *flaviceps* (Walker), *mauliki* Kapur and *pulcher* (Weise). *Pseudaspidimerus circumflexa* (Motsch.) is the only determined species under the genus known to be aphidophagous from India (Kapur, 1948 ; Puttarudriah and Channa basavanna, 1955, '56 ; Behura, 1963 ; Rao, 1969 ; Pushpaveni and Krishnamurty, 1971 ; Jhonson, 1979). Very little information is known about the biology of the different species under the genus *Pseudaspidimerus*. Tao and Chiu (1971) recorded the developmental period of different immature stages i.e. egg, larva and pupa of *P. japonesis* Nakane et Araki, in Taiwan; they suggested that the beetle prefers to feed on *Aphis citricola* v. d. Goot. *A. gossypi* Glover, *Toxoptera citricicidas* (Kirk.), *T. aurantii* (Boyer) and *Aphis craccivora* Koch.

Pushpaveni and Krishnamurty (1971) recorded *P. circumflexa* to feed on sugarcane aphid viz., *Longiunguis sacchari* Zehntner and also noted the developmental period of egg, larva and pupa of this beetle in India. Besides, *P. circumflexa* (Motsch.) has also been recorded to be aphidophagous by several workers from India (Kapur, 1948 ; Puttarudriah and Channa basavanna 1955, '56 ; Behura, 1963 ; Rao, 1969 ; Puspaveni and Krishnamurthy, 1971 ; Jhonsen, 1979). However, bionomics of this beetle specially the external morphology of different immature stages remained unknown. During the course of present biological studies of *Aphis craccivora* Koch and its natural enemies in West Bengal, bionomics of five species of Coccinellids viz., *Coccinella septempunctata* Linnaeus, *C. transversalis* Fabricius, *Menochilus sexmaculatus* (Fabricius) under the tribe Coccinellini, *Pseudaspidimerus circumflexa* (Motschulsky) under the tribe Aspidimerini and *Scymnus (Pullus) pyrocheilus* Mulsant,

under the tribe Scymnini could be worked out. Of this, the present paper deals with the biological studies of *P. circumflexa* only.

MATERIALS AND METHODS

Studies on the seasonal occurrence of *P. circumflexa* (Motsch.) was made in the fields of Calcutta and its surroundings. These fields were visited at a fortnightly interval for two years. In order to study the developmental history, mode of feeding and voracity of this beetle following methods were adopted : A gravid female was collected in the field from *Dolichos lablab* which was found to be infested by *Aphis craccivora* Koch and this collection was made using glass vials (5" × 1") ; insect was then brought to the laboratory where it was transferred to a wide mouthed glass jar (6" × 4"). The open end of jar was then covered with a piece of cloth, tied with a rubber guarder. Eggs laid by the gravid female were used for the purpose of study ; single egg was transferred to each jar for studying either the life history or the voracity of the insect. Each of such jar was provided daily with sufficient but counted number of aphid i.e. *A. craccivora* with fresh plant parts. From the day of transference of the eggs, observations were made at twenty four hours interval in order to note the developmental period of egg, larva and pupa and also to note the rate of feeding of larva and adult. Ten and eight replications were used to study the life history and voracity respectively. This work has been carried out at the laboratory conditions from the end of December to end of February, 1980-1981, with temperature and relative humidity ranging between 23-29° C and 44-64% respectively and again during June to August, 1981 with temperature and relative humidity ranging between 30-36° C and 69-82% respectively.

RESULTS

A. Distribution and prey range :

The members of tribe Aspidimerini Weise, are known to be aphidophagous coccinellids (Kapur, 1848 ; Sasaji, 1971 ; Hodek, 1973), which are confined mainly to the Oriental region. The genus *Pseudaspidimerus* was originally reported from Burma, Sri Lanka, India, Java, Philippines and Thailand (Kapur, 1948) ; later the distribution of the genus *Pseudaspidimerus* has been extended to Taiwan (Tao and Chiu, 1971). Tao and Chiu (1971) suggested that *P. japonensis* Nakane et Araki, is known from southern Japan and Taiwan but Sasaji (1972) mentioned in the "Fauna Japonica" only two species viz., *Cryptogonus orbiculus* (Gyllenhal)

and *C. horishanus* (Ohta) from Japan. *P. circumflexa* is only known in India, Burma and Sri Lanka ; in India, the species being mostly found in eastern and southern part.

P. circumflexa has been recorded to feed on as many as six aphid species viz., *Aphis craccivora* Koch, *A. citricola* van der Goot, *A. gossypi* Complex, *A. nerii* Boyer de fonscolombe, *Aphis* Spp. and *Longiunguis sacchari* Zehntner. During the course of present study the predator has been found to feed on three species of aphids.

B. Predator—prey association and seasonal occurrence :

P. circumflexa (Motsch.) has been found to feed on *Aphis craccivora* Koch, *A. gossypi* Glover and *Lipaphis erysimi* (Kaltenbach) in the area of present investigations. These different aphids occur on a varied groups of plants. Occurrence of these aphids on their host plants appear to be somewhat seasonal and the incidence of aphid prey of this predator influences the incidence of the predator on such host plants (Table—1).

TABLE 1. Seasonal occurrence of *P. circumflexa* (Motsch.) preying on different aphids affecting their host plants.

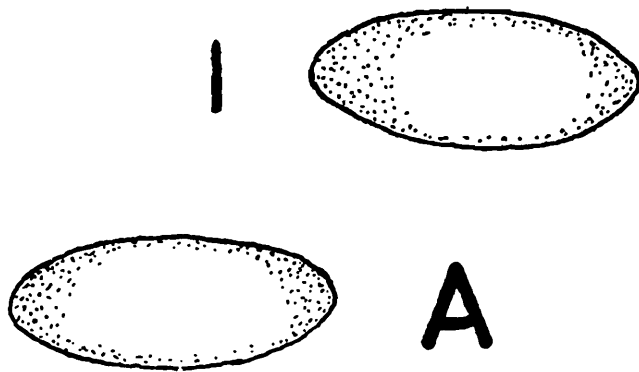
Aphid species	Plant species	Period
<i>Aphis craccivora</i> Koch	<i>Cassia alata</i>	VI—X, (1979 and 1980)
	<i>Cassia sophera</i>	VI—VIII (1979 and 1980)
	<i>Cassia tora</i>	VI—IX (1979)
		VI—VIII (1980)
	<i>Dotichos lablab</i>	IX—II (1979-80 and 1980-81)
	<i>Phaseolus mungo</i>	XIII—III (1979-80 and 1980-81)
	<i>Vicia faba</i>	X—II (1979-80 and 1980-81)
	<i>Vigna catjang</i>	VI—VII & XI—III (1979-80 and 1980-81)
<i>Aphis gossypi</i> Complex	<i>Gossyplum</i> sp.	XII—I (1979-80 and 1980-81)
	<i>Psidium guajava</i>	VI—VIII (1979 and 1980)
<i>Lipaphis erysimi</i> (Kaltenbach)	<i>Brassica nigra</i>	XII—I (1979-80 and 1980-81)

From table-1, it appears that this predator is polyphagous in habit. During winter-spring season the predator has been found to prey upon all the aphid species recorded in this locality which serve as its prey and on the same prey aphids infesting different host plants. During rainy season (June to August) the predator could be found to prey upon *Aphis craccivora* Koch infesting different *Cassia* and *Vigna* species and *Aphis gossypi* complex infesting *Psidium guajava*. Of the *Cassia*, *C. alata* is a perennial plant and the others are seasonal plant. On *C. alata*

the predator could also be found with the aphids, in the month of September and October, probably because of the physiological condition of the plant which is suitable for these insect. During rainy season these leguminous weeds act as reservoir of these insects. Here, it may be mentioned that though both the prey and predator could be found to occur during the different climatological period excepting the hottest months i. e. April and May, they appear to be more abundant during the cooler months.

C. Developmental Biology :

Egg (Text-fig. 1) : Eggs are usually laid in batches though sometimes laid singly under the aphid exuvae on the leaf near the aphid colony. The number of eggs laid in each batch varies from 2-8. These are about 0.62-0.64 mm. in length and about 0.36-0.39 mm. maximum width, oval in shape and brownish in colour. Incubation period lasts for 2-3 days during December to February and 2 days during June to August.

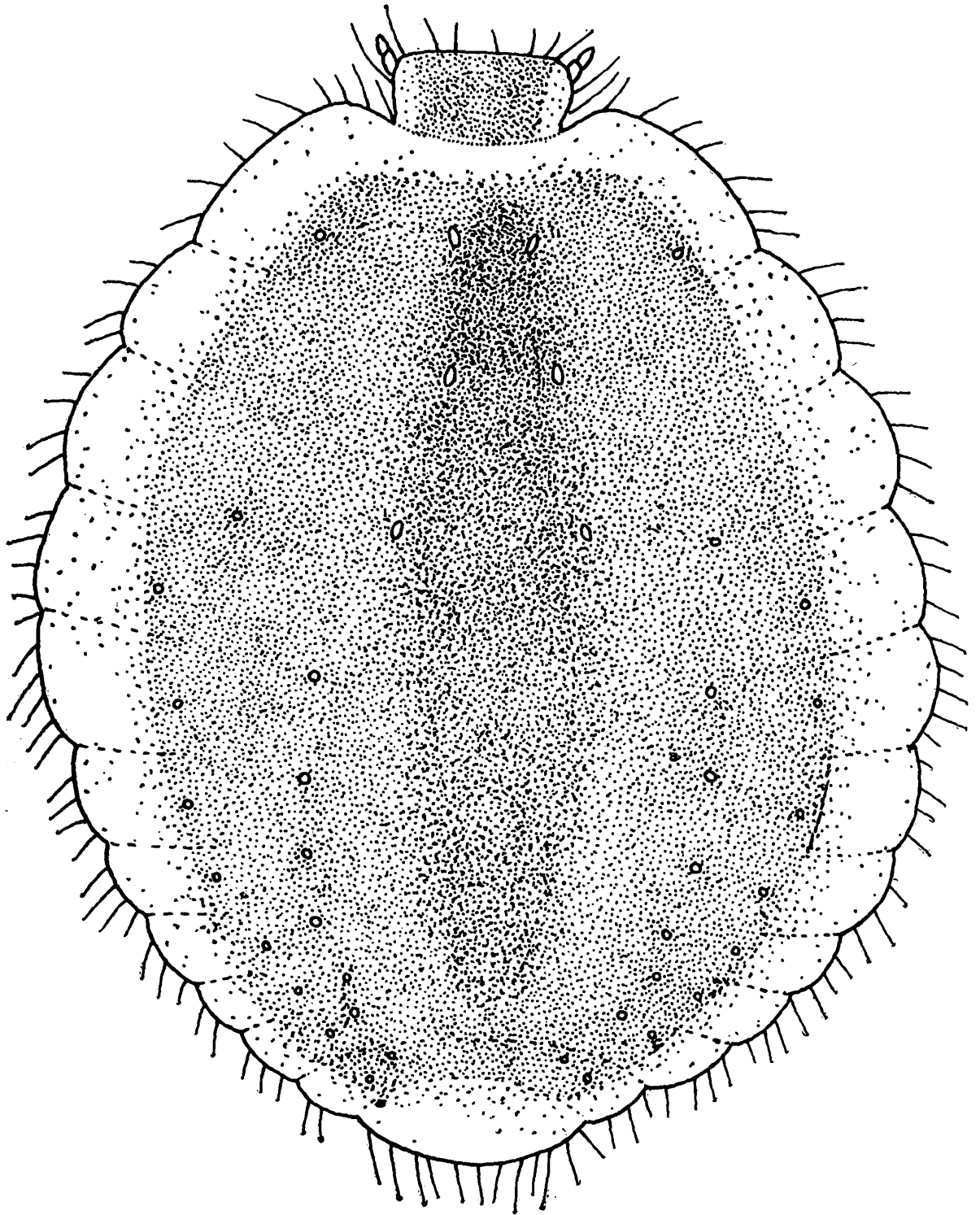


Text-fig. 1. Eggs of *Pseudaspidimerus circumflexa* (Motsch.)

Larva (Text-fig. 2) : Full grown larvae measure about 4.0-4.5 mm. in length and about 2.1-2.4 mm. in maximum width ; Head deep brown ; antennae whitish ; mouthparts pale yellow ; thorax and abdomen deep brown with the lateral aspect pale yellow, spiracular walls blackish ; coxae pale brown, femora and tibio-tarsi pale yellow.

Body broadly oval. Head slightly sclerotized, 1.5-1.7 times as broad as long, lateral margins medially concave, front margin with a few short hairs at the middle and 7-8 pair of long hairs on either side, about $\frac{1}{2}$ the length of the head, antennae 2-segmented, less sclerotized, basal segment broad and second segment 1.5 times as long as its width with a preapical hair which is as long as the apical one ; apical segment of maxillary palpi large and triangular ; mandibles elongated triangular with a pointed tooth ; coxae broad, quadrate, trochanters small, femora gradually broadened apically, tibio-tarsi wide with moderately long

dense hairs and apically with a pair of pointed claws, having a broad basal tooth ; margins of the spiracular walls more chitinized ; dorsum of thorax and abdomen with ten pair of smaller pores near the lateral margin and ten pair of relatively larger pores, which are 1.5-1.7 times as long as smaller ones, present medially ; lateral margins of thorax and first eight abdominal segments with short, dense hairs and the ninth segment surrounded with moderately long hairs.



2

Text-fig. 2. Larva of *Pseudaspidimerus circumflexa* (Motsch.)

The larval period lasts for 6-7 days during December to February and 6 days during June to August, and this small effect at difference of 7°C on development may perhaps be attributed to use of different host plant material (*Cassia* in Summer and *Dalichos* in Winter) in the laboratory.

Feeding behaviour of Larva : The predatory larva when reaches to its prey, strikes it by the mandibles and then by jerking of the head, punctures the prey body at the anterior abdominal dorsum. Sucking of the prey body is accomplished by the forward and backward movement of the head of larva and during feeding it keeps its head downward. The predator then holds the prey up by lifting its head forward and slightly upward. On completion of feeding, the larva lifts its head and anterior part of the thorax along with the prey as a result of which the fore- and mid legs remain above the substratum. The predator then discards the prey after one or two such lifting. The larva then again moves in search of another prey. It may be mentioned that during prey searching the movement of the predator appears to be rather slow as compared to the other Coccinellid larvae viz., *Coccinella septempunctata* Linnaeus, *C. transversalis* Fabricius, *Menochilus sexmaculatus* (Fabricius) and even *Scymnus (Pullus) pyrocheilus* Mulsant. The feeding behaviour and sluggishness of larva may be attributed to the peculiar shape of body, unlike other larvae.

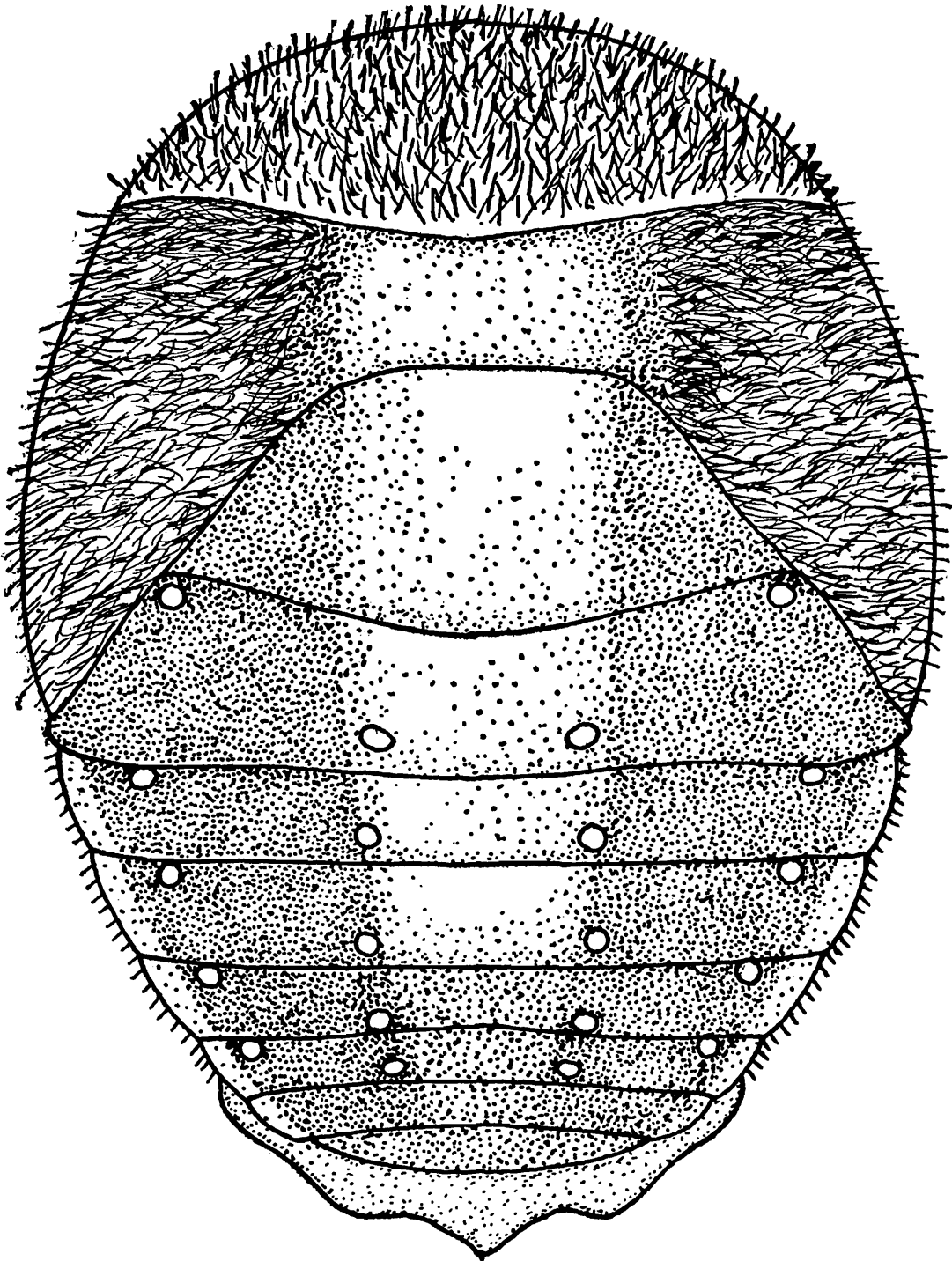
Voracity of larva : The larva of *P. circumflexa* consumes 110-126 individuals of a mixed population of *A. craccivora* to complete its development. Daily observations on the rate of consumption of aphids reveal (Table-2) that there is a progressive increase in the number of aphids consumption with the larval growth and on the penultimate day of active life, the consumption of aphid being maximum. During the last day, the rate of consumption has been lowered down abruptly due to its approach to a prepupal condition.

TABLE 2. Larval voracity of *P. circumflexa* (Motsch.) in days

Larval days	1st day	2nd day	3rd day	4th day	5th day	Total
Range	6—9	10—18	27—34	37—45	28—34	110—126
Mean	7.5	11.5	30.5	41	31	117.5

Pupation and pupa (Text-fig. 3) : The full grown larva usually prefers curled leaves for pupation. Before pupation the larva anchors itself to the substratum and remains motionless ; finally the membrane like cuticle is shed and pupa is formed. *Pupae* about 1.9-2.0 mm. in length

and about 1.5-1.7 mm. in maximum width. Head black ; thorax pale brown with two pale yellow large spots on the posterior end of the thoracic dorsum ; wing buds deep brown ; abdomen pale brown ; each of the first six abdominal segments with a pair of pale yellow small spots mid dorsally.



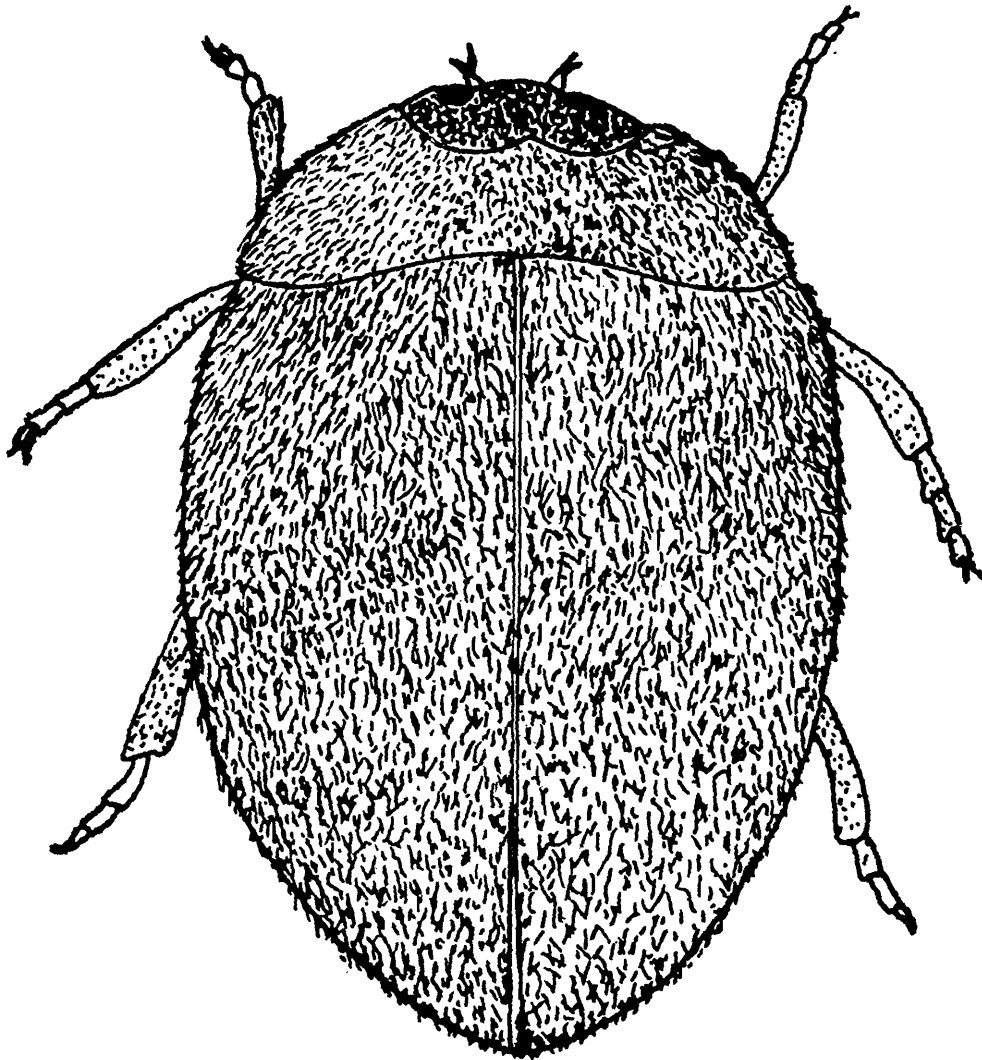
3

Text-fig. 3. Pupa of *Pseudaspidimerus circumflexa* (Motsch.)

Head projected downward and inward, with dense pubescence ; hairs short and fine ; prothorax bent downward with the rest flattened ;

distal part of wing buds and legs concealed under the body ; thorax and wing buds densely pubescent ; abdomen arched dorsally and flattened ventrally ; five pairs of small white apically bifurcated elevations present laterally on the dorsum of the first five visible abdominal segments.

Pupal period varies from 4-5 days during December to February and 4 days during June to August.



4

Text-fig. 4. Adult of *Pseudaspidimerus circumflexa* (Motsch.)
[all figures drawn in same scale]

Adult (Text-fig. 4) : Body about 2.0-2.5 mm. in length and about 1.8-2.0 mm. in maximum width. Head chasis red in colour ; eyes black ; antennae and mouthparts brown ; pronotum chasis red, lateral margin yellowish with a black spot laterally extending towards the middle, scutellum black ; elytra chasis red with a black spot at the basal $\frac{1}{3}$ of the suture and a subrounded discal spot at the middle near the sutural margin ; ventral surface chasis red with prosternum medially black ;

mesosternum yellowish and middle part of metasternum and first abdominal sternum blackish and legs brown.

Body covered with short recumbent hairs. Antennae 9-segmented and geniculate, situated anterior the eyes in the dorsolateral corner of the frons, first segment rather large, the second segment almost concealed by the first, rest of the segments together form a clump-shaped flagellum. Mandible with a bifid apex and a subcuspidate basal tooth ; labrum partially covered by clypeus ; prosternum broad medially and narrowed laterally, with two distinct longitudinal parallel carinae at the middle. Lateral margins of prosternum straight with the corners rather blunt, mesosternum small ; metasternum large with the middle part directed forward, the anterior margins of which rounded and the lateral margin straight, lateral margin of metasternum pointed at anterior angle which is blunt at the posterior angle ; elytra round with apices blunt ; trochanters and femora much broadened concealing the tibiae and tarsi ; first abdominal sternite large with middle part forwardly projected, the anterior margin of which straight, femoral line distinct. In case of male, the last abdominal sternum deeply emerged. [Adult has been described in details by Kapur, 1948].

DISCUSSION

From the predator prey association and seasonal occurrence it can be said that there is a close coincidence between the predator and aphid population, that is the predator becomes active and reproduces with the increasing prey populations and becomes quiescent or inactive when it faces scarcity of its prey. During the winter period or cooler months of the year the predator exhibits its greatest activity and usually respond by increasing rate of fecundity to the aphid preponderance, but during rainy period the predator becomes inactive with the less aphid abundance. During hottest months i. e. April and May the predator seems to disappear with the aphids.

Pushpaveni and Krishnamurty (1971) noted the developmental period of different immature stages i. e. egg, larva and pupa of *P. circumflexa* (Motsch.) feeding on sugar cane aphid viz., *Longiunguis sacchari* Zehntner in south India. Comparing their works with the present study it appears that *P. circumflexa* (Motsch.) has longer developmental period in south India than in this part of eastern India (egg, larva and pupa : 4-6, 10-12 and 9-10 days vs. 2-3, 6-7 and 4-5 days respectively). Present study on the voracity of this beetle reveals that the two active stages i. e. larva and adult, devour 22-25 and 21-23 individuals of *A. craccivora* Koch per day respectively.

SUMMARY

A study on bionomics of *Pseudaspidimerus circumflexa* (Motschulsky), one of the important Coccinellid predator of aphids, has been carried out. This paper deals with the distribution and prey range of the species, and presents results of study on developmental history, feeding behaviour and voracity and seasonal occurrence. *Lipaphis erysimi* (Kaltenbach) is recorded here for the first time as a aphid prey species of *P. circumflexa* from India.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. Ivo Hodek, Czechoslovak Academy of Sciences, Praha for his comments on the manuscripts. The authors are also thankful to late Prof. D. N. Raychaudhuri, Department of Zoology, University of Calcutta, in whose laboratory the present work was carried out and to Dr. B. K. Tikader, Director, Zoological Survey of India for many facilities.

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BREEDING BEHAVIOUR OF BROW-ANTLERED
DEER OF MANIPUR

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(With 6 Plates)

INTRODUCTION

The Brow-antlered deer, *Cervus eldi eldi* McClelland, 1842 which the Manipuris call as Sangai, is restricted in its distribution to Keibul Lamjao National Park in Manipur. In the past and during the Manipur Durbar this deer was strictly protected and was found in many parts of this tiny state. Very little has been done so far for the conservation of this beautiful deer with the result that its population has decreased considerably and now it is considered as one of the rarest and most threatened among the other deer of India.

In 1951 this Manipur sub-species of Brow-antlered deer was regarded as extinct but in subsequent search it was relocated about 50 km south of Imphal in Keibul Lamjao area, the part of which was declared as National Park in 1977.

The breeding behaviour of Sangai has not been thoroughly studied. Sankhala and Desai (1970) made a preliminary studies on the breeding behaviour of this deer at Delhi Zoo. This paper deals in brief the ecology of the habitat and the breeding behaviour of this deer at Keibul.

Ecology of the Keibul Lamjao National Park :

Imphal valley due to its elevation enjoys a good climate. The period from November to February is characterised by low temperature and heavy dew at night. Frost is common on winter nights. From December to February the fog at Keibul Lamjao National Park is usually very heavy in morning and it clears off long after the sun rise. In April and May the temperature rises rapidly though the temperature comes down often by thunder-storms and rains. The period from June to September is characterised by heavy rain. From December to February the humidity is very high. The monsoon generally breaks about the middle of June and continue untill about the middle of October. The heaviest rainfall is in the months of July and August.

Almost the entire area of the Park which is situated at the southern part of the Loktak lake is a floating swamp. The dead and decaying

vegetation forms a floating mat on which grows the reeds, grasses and other plants (Pl. III). This mat varies in thickness from place to place. During the dry months of summer the level of water recedes and the mat settles down at places. On the onset of monsoon the park is flooded and it takes some time for the submerged mat to float again. There are three small hills in the park and when the park is under water the deer take shelter on these hills and they return to the mat when it starts to float again. Water hyacinth has invaded some parts of the periphery of the park and if it is not checked this may invade the other parts of the park.

The park is surrounded by villages and the cultivated fields have extended right up to its boundary. Before the area was declared as National Park the grazing inside and around the park by village cattle was very heavy. There was no check of the villagers for entering in the park for fishing and for collection of wild vegetables and reeds prior to 1977.

Description of the ecology and the Brow-antlered deer of the Keibu Lamjao National Park have been dealt with in an earlier paper (Mukherjee, 1978).

Breeding Behaviour

The breeding behaviour of Sangais which were kept in an enclosure at Keibul, close to the National Park and by the side of the forest office, has been studied in the year 1975. One buck, two does and two fawns were kept in the enclosure which contained enough grass and shrub and a small tank which holds the rain water. One doe which was older than the other was procured from the Park some years back and gave birth to a fawn which was about a year and four months old. The deer were given concentrated food and the green grass, collected from the park every day. The water of the tank was used by the deer for drinking.

The Sangais under captive condition are breeding in many Zoological Gardens. However, the details of their breeding behaviour has not been known. Delhi and Ahmedabad Zoos recorded the mating of these deer in the months of March and April. In Delhi Zoo adult bucks shed their antlers in late June and the new set begin to grow within a few days of shedding. The antlers were cleared off the velvet by late November (Sankhala and Desai, 1970). The bucks shed their antlers yearly and it takes about five months for the hard antlers to develop from the day of shedding. Studies of the other species of deer revealed that they lost their hard antlers after the rut and the growth

R. P. MUKHERJEE

PLATE III



Fig. 1. Part of the Keibul Lamjao National Park showing the depth of the underneath water of the mat.

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PLATE IV



Fig. 2. Buck and the doe after formation of a breeding pair.

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PLATE V



Fig. 3. Buck testing the state of readiness of the doe.

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PLATE VI



Fig. 4. Buck with a "Flehmen" posture.

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PLATE VII



Fig. 5. Buck with submissive as well as aggressive posture.

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PLATE VIII



Fig. 6. Mounting by the buck.

of the new set is completed before the beginning of the next rutting season. The buck in the enclosure and all the bucks that were observed in the Keibul Lamjao National Park from December to February were in hard antlers.

The buck of the enclosure started to chase the older doe from the afternoon of 23rd January, 1975. Since then the buck remained constantly with the doe, following her and occasionally chasing her (Pl. IV). In the beginning when the buck chased the doe, she trots ahead. The buck mostly remained close and behind the doe, rarely staying parallel to her and also remained close to her when she was resting. The buck and the doe were less interested in food. The buck chased the doe with extending neck and with quick steps. The rutting behaviour of the buck was more apparent by occasional bellowing calls. The buck emitted this call usually at the time of chasing the doe and throws his tongue in and out. Occasional thrashing of the bushes and chasing out the other approaching members to the doe by the rutting buck were the common features that were recorded during this period. The buck occasionally poked and sniffed the vulva of the doe with his muzzle which stimulates the doe to urinate (Pl. V). Buck then held his nose in the stream of urine and licked it or sniffed the ground where the doe urinate. He then raised his head with an upcurled lip and presented the gesture which is known as flehmen (Pl. VI). This behaviour helps the buck to determine the state of receptivity of the doe. The frequency of the chasing, bellowing, flehmen and thrashing of the bushes by the buck increased on the 24th and 25th January, 1975. On these two days the buck occasionally lowered his neck and held parallel to the ground in some what "S" shaped with the eyes fixed on the doe, a behaviour of submissive nature, and the head is slightly raised with antlers directing back and the ears held laterally parallel, a behaviour of aggressive nature (Pl. VII). The doe was not scared by this submissive and aggressive posture of the buck. The buck occasionally stamped his fore foot on the ground. No mounting was observed upto the forenoon of 25th January, 1975.

The buck started to mount the doe from the after noon of 25th January, 1975 (Pl. VIII). The fully receptive doe at this stage made no attempt to move away when the buck chased her and remained stand still with her back humped and tail held horizontally when the buck mounted her. She occasionally stepped ahead causing the mounted buck to fall on the ground. In the initial stage two mountings in every minute by the buck were recorded. At this stage of breeding frequent licking of the various body parts of the doe by the buck was observed. In one copulation the buck thrust so strongly that it

throws the doe about two feet from the mounting buck and the buck fell down. He remained on the ground for about ten minutes when he finally got up and chased away one of the fawn which was trying to mount the doe. He then returned and sniffed the ground where he fell down and thrashed the bushes for about two minutes. Though the buck remained with the doe the next day also and chasing her and bellowing occasionally but no mounting was observed. The sex drive of the buck declined sharply.

The doe died a natural death before fawning. The last fawn delivered by this doe was in October, 1973. Based on the average gestation period of 240.4 days as recorded by Sankhala and Desai (1970) this doe was likely to deliver the fawn by the end of September, 1975.

This study indicates that at Keibul the fawning takes places once in every two years and the rut starts with the approach of the dry period when the water level of the park starts to recede as the settling of the Phumdi may helps the deer to breed. Further it shows that the rut at Keibul starts early than at Delhi or Ahmedabad.

ACKNOWLEDGEMENTS

My thanks are due to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for providing facilities and to the forest department of Manipur for their co-operation in the field.

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PRELIMINARY SURVEY ON MACROBENTHOS OF
PRENTICE ISLAND, SUNDARBANS,
WEST BENGAL.

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(With 3 Text-figures and 1 Table)

INTRODUCTION

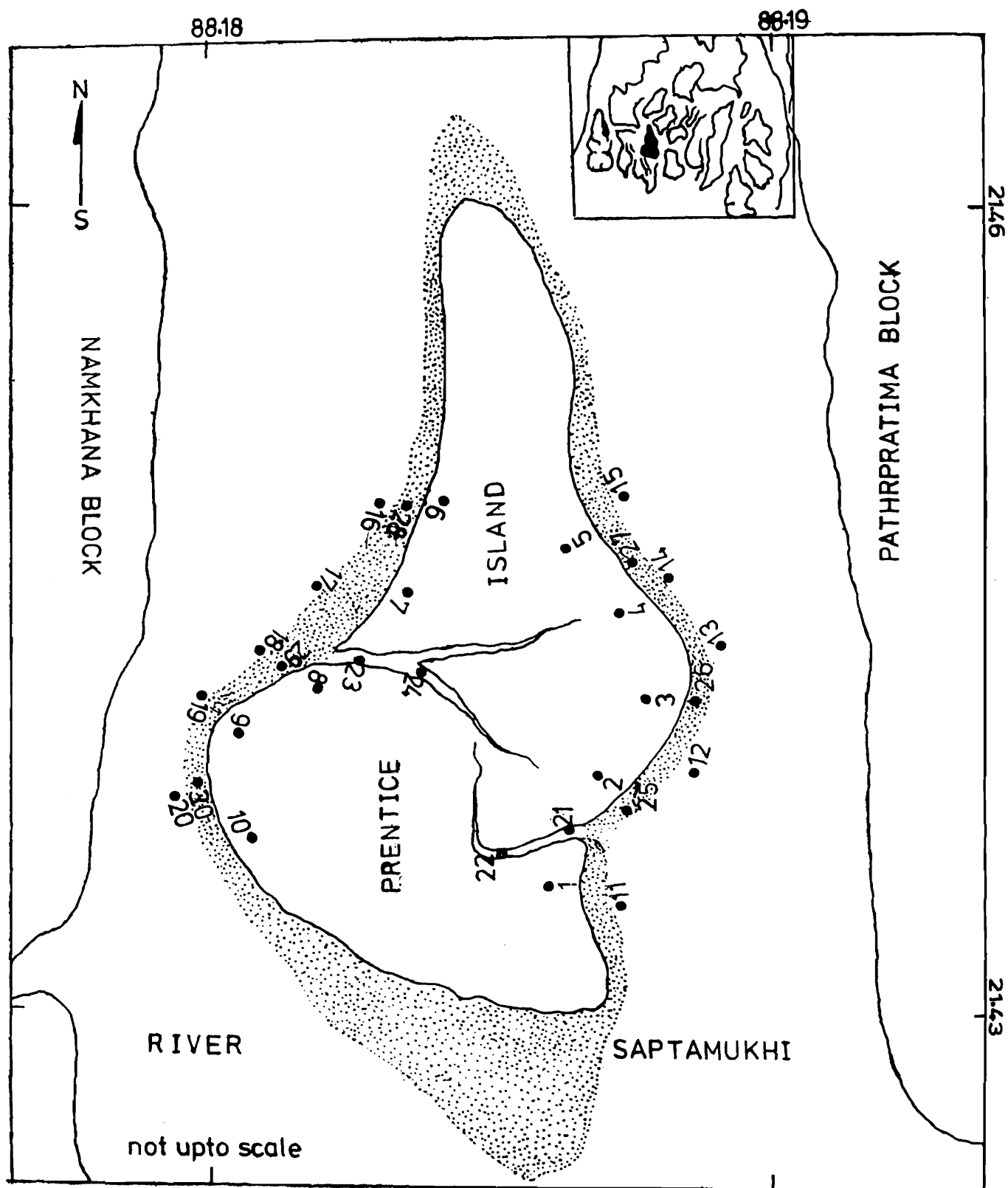
Mangrove ecosystem, a very specialised environment in the natural transition zone between the land and the sea, have gained momentum recently as it plays important role in protecting and extending coastline by trapping sediments, supporting fishery by developing detritus-based food chain and also controlling the regional climatic condition. Studies on the floristic structure of Indian mangrove forest have well been documented by Blatter (1905), Banerjee (1964), Ahmad (1972), Blasco (1975, 1977), Berry (1963, 1972), Sidhu (1963), Sasekumar (1974), Dwivedi *et al.* (1974), Joshi and Shinde (1979), Mukherjee and Mukherjee (1978), Choudhury (1979), Untawale *et al.* (1973) and Untawale (1980). After the works of Roonwal (1954a, b) a number of studies have been carried out on the faunal community of this ecosystem by Subbarao and Mukherjee (1975), Murty and Rao (1977), Radhakrishna and Janakiram (1975), Choudhury *et al.* (1980) and Bhunia and Choudhury (1981).

Physiography of study area :

Prentice island, a fractional component of virgin mangrove forest area of Sundarbans, lies between the latitude 21°43 and 21°46 N and longitude 88°18 and 88°19 E. The waterways bordering the island is formed by the river Saptamukhi (Fig. 1). It is traversed by a number of creeks of which two are well contoured with repeated ramification retaining considerable tidal water even during the lowest low tide.

Tidal variation :

The island is situated in a very close proximity to the sea and thus receives intensive tidal flux twice daily. The highest amplitude recorded



Text-fig. 1.

so far is 5 m, generally varies from 2 to 4.5 m in an average in a total lunar cycle.

MATERIALS AND METHODS

All together 30 sampling spots distributed over the two faces (eastern and western) of the island have been selected for the quantita-

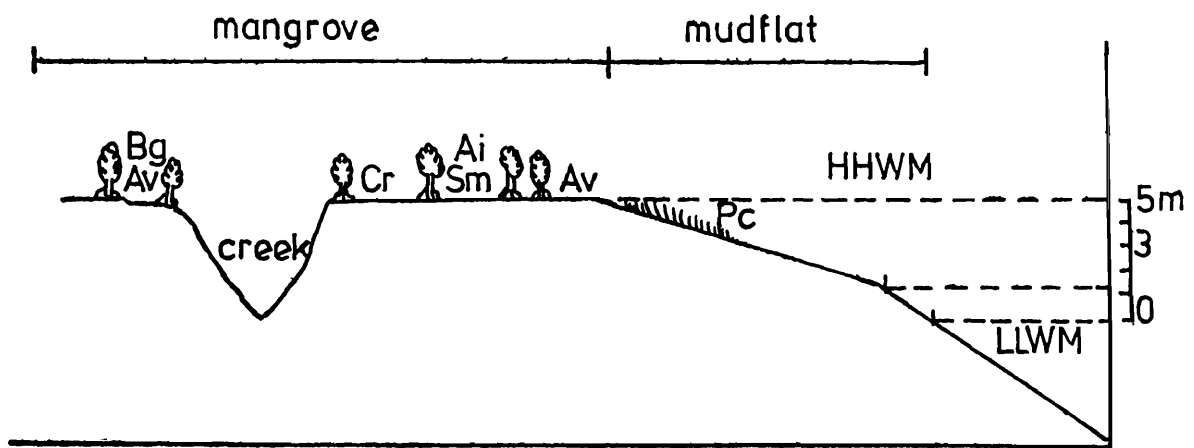
tive study of macrobenthos. The samplings were made from November 1981 to June 1982. Studies were conducted in a transect on either side of the island covering three biotopes, mangrove substratum, creeks and mudflats. Out of the 30 sampling spots 10 from mangrove biotope, 4 from the creeks and 16 from the mudflats were made (Fig. 1). A meter square quadrat was used for the sampling. Macrobenthos occupying the quadrat mud were sorted out and preserved in alcohol, sometimes buffered formaldehyde was used in the field.

The hydrological samples were collected from September 1981 to August 1982. The temperature was recorded in degree centigrade ; the salinity of the sample was estimated by 'Mohr-Knudsen' method. Winkler's method was followed to estimate the dissolved oxygen content of the sample and for pH colour comparator disc was used.

The texural analysis of soil was done following the procedure of Buchanon and Kain (1971). The organic carbon content of the soil was estimated following the method outlined by El. Wakeel and Riley (1956).

RESULTS

The structure of floristic community of the island though represented by a limited number of species, is more or less compact. The succession pattern of different species is steadily recognised throughout the island (Fig. 2). The forest edge is embodied with *Porteresia coarctata*. Among



HHWM. Highest High Water Mark
 LLWM. Lowest Low Water Mark

Pc. <i>Porteresia coarctata</i>	Cr. <i>Ceriops roxburghiana</i>
Av. <i>Avicennia officinalis</i>	Sm. <i>Suaeda maritima</i>
A. <i>Acanthus alba</i>	Bg. <i>Bruguiera gymnorhyza</i>
Ai. <i>Acanthus ilicifolius</i>	

Text-fig. 2.

the established floral components, the dominant community is represented by *Avicennia* spp. and is followed by *Acanthus ilicifolius* and *Suaeda* sp. and then by *Ceriops* sp. in order of succession. *Bruguiera gymnorhyza* is scarcely represented particularly at the creek bank. Various taxa comprising the forest community are given below :

Sl. No.	Family	Flora
1.	Gramineae	<i>Porteresia coarctata</i>
2.	Chenopodiaceae	<i>Suaeda maritima</i>
3.	Verbenaceae	<i>Avicennia officinalis</i>
4.	Rhizophoraceae	<i>Ceriops roxburghiana</i> <i>Bruguiera gymnorhyza</i>
5.	Acanthaceae	<i>Acanthus ilicifolius</i>

Hydrology :

The hydrological parameters of water temperature, salinity, dissolved oxygen and pH in particular did not show any significant variation. The temperature varied from 23.5 to 32.0°C as compared to salinity 6.2–26.8‰. The pH (8.1–8.3) was almost constant. The concentration of dissolved oxygen ranged from 2.5–4.6 ml/l. The data on hydrological parameters and the corresponding monthly values of humidity and rainfall are plotted in Text-fig. 3.

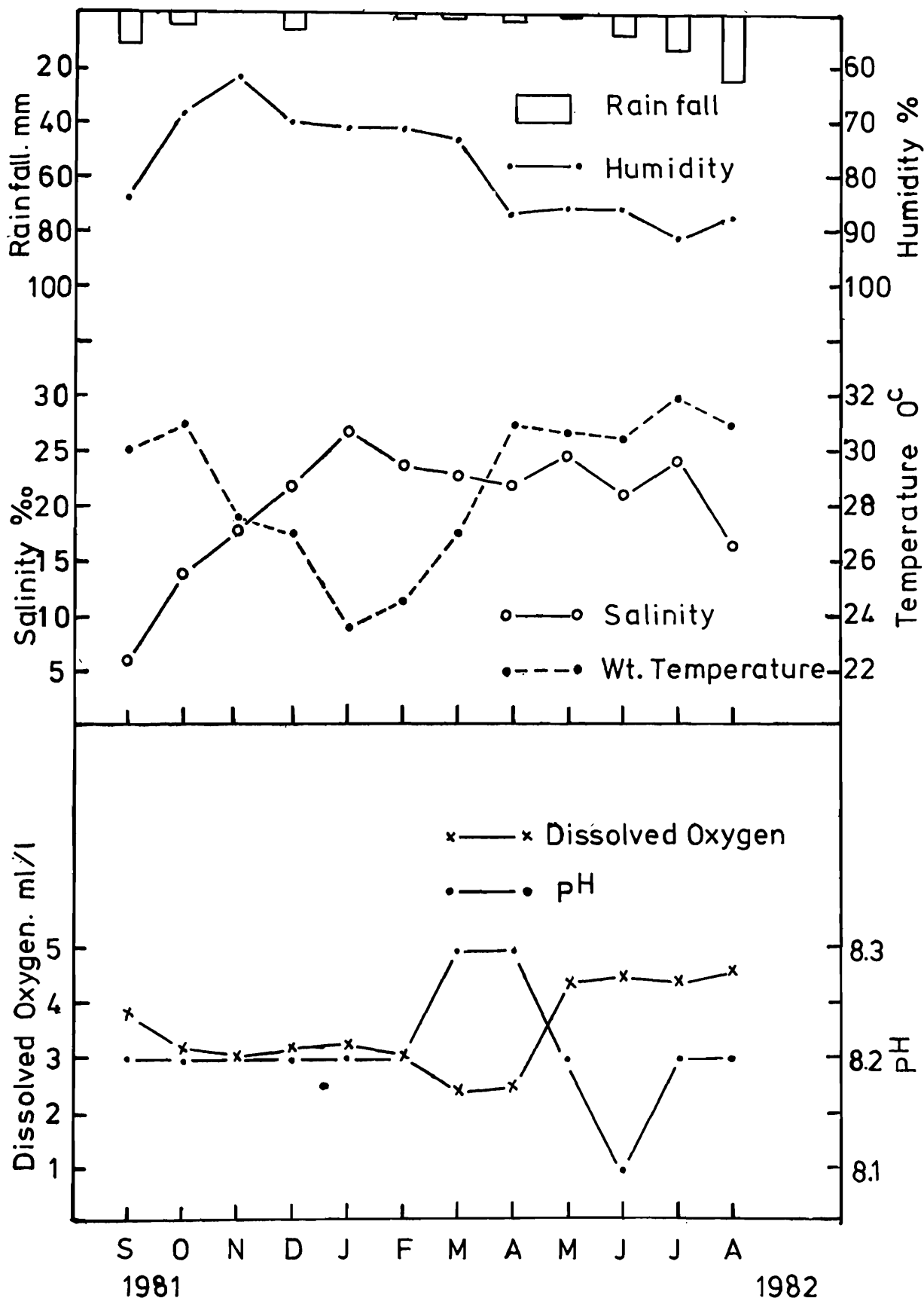
Soil :

The percentage variation of sand, silt, clay and organic carbon in three different biotopes is as follows :

	Sand	Silt	Clay	Organic carbon
Forest	40.0	30.1	29.9	0.84
Creek	48.3	28.0	28.7	0.83
Mudflat	44.4	24.4	31.2	0.82

MACROBENTHOS

Qualitative analyses of benthos through seasons presented a composite structure of faunal community of the island. Generally, the species composition varied according to the influence of prevailing hydrological conditions. The population size increased from November till March/April, with the increasing gradient of salinity but temperature played less significant role (Bhunja and Choudhury, 1981 ; Choudhury *et al.*, 1980). The purpose of the present study is to report a preli-



Text-fig. 3.

minary information on the benthic production potential of this virgin mangrove forest habitat. All together 35 species representing the different taxonomic groups have been encountered during the present study. A composite picture of the faunal community is given in Table 1.

The benthic macrofauna inhabiting the island environment predominantly are the molluscs, crustaceans, actinarians, polychaetes, nemertines among the invertebrates ; and gobiids represented the only vertebrate in the benthic community. The percentage composition of different faunal groups in three biotopes is presented below :

	Mangrove substratum	Creeks	Mudflats
Mollusc	72.10	46.2	19.9
Crustacea	10.00	18.7	4.1
Actinarian	8.01	1.2	65.1
Polychaete	4.30	7.5	5.4
Nemertine	1.70	6.2	2.4
Echiurid	0.08	11.2	1.4
Echinoderm	—	—	0.3
Gobiids	3.40	8.7	1.1

Mangrove substratum biotope :

The fauna inhabiting the mangrove substratum are well represented by various taxa of the community. Almost all the groups have been quantified from this biotope. The molluscs (Total No. 354) representing 12 species appear as the dominant group in the forest floor habitat. The second flourishing group is established by crustacean component (Total No. 49) of which 7 species have been encountered. Actinarians (Total No. 40) with 3 species and polychaetes (Total No. 20) having 4 species share the faunal association of the ecosystem as the third and fourth community members (Table 1).

Creeks :

In response to the production of benthos, creeks of this island play a secondary but no less an important role. Accumulated data (Table 1) reveal that almost all the principal groups though less in number do occur in this biotope. A certain exception is noticed for the members of the genera *Littorina*, *Nerita*, *Cerithidea* and most of the actinarians which are totally absent. Molluscs comprising 5 species have been recorded as the dominant group from this zone.

Mudflat :

The species composition as well as the number of fauna of the mudflat biotope are to some extent different from the adjacent forest habitat. The dominant group is represented by actinarians (Total No. 679) with only 4 species and the molluscs (Total No. 208) compri-

TABLE 1. Average density (No/m²) of species in different biotopes.

	Mangrove	Creek	Mudflat
Number of sample	10	4	16
Solenidae			
<i>Neosolen aquedalcioris</i>	2	1.8	1.6
<i>Macoma (Psammacoma) birmanica</i>	—	—	3.3
Arcidae			
<i>Anadara (Anadara) granosa</i>	1	0.8	0.4
Littorinidae			
<i>Littorina (littorinopsis) melanostoma</i>	3.9	—	—
<i>L. carinifera</i>	1.1	—	—
<i>L. undulata</i>	4.6	—	—
Onchidiidae			
<i>Onchidium tigrinum</i>	0.4	—	—
Assimineidae			
<i>Assimnia brevicula</i>	12.1	6.2	5.5
Nassaridae			
<i>Nassarius foveolatus</i>	1.3	—	—
<i>Cymia carinifera</i>	0.5	0.3	0.3
Potamididae			
<i>Cerithidea cingulata</i>	4.7	—	2.6
<i>Telescopium telescopium</i>	1.3	0.2	—
Ocypodidae			
<i>Uca dussumieri</i>	0.4	0.7	0.3
<i>Dotilla brevetarsis</i>	0.3	0.2	0.8
Grapsidae			
<i>Metaplex intermedia</i>	0.2	0.5	0.2
<i>Sesarma</i> sp.	2.5	0.5	0.2
Portunidae			
<i>Scylla serrata</i>	2.2	0.7	0.8
Synalpheidae			
<i>Alpheus crassimanus</i>	0.3	0.7	0.3
Stomatopoda			
<i>Squilla</i> (unidentified)	0.1	0.2	0.3
Glyceridae fam.	0.1	0.7	1
Nereidae fam.	0.4	0.7	1.3
Capitellidae fam.	0.7	0.2	0.8
<i>Polynoe</i> sp.	—	—	0.4

TABLE 1. (Concluded)

	Mangrove	Creek	Mudflat
Eunicidae			
<i>Lumbrineris</i> sp.	0.8	—	0.4
Actiniarians			
<i>Phytocoetiopsis rammuni</i>	2.5	—	37.1
<i>Pelocoetes exul</i>	1.3	0.2	1.6
<i>Edwardsia zonesi</i>	0.2	—	—
Anemone A (unidentified)	—	—	3.5
Nemertinea A (unidentified)	0.6	0.7	0.3
Nemertinea B (unidentified)	0.2	0.5	1.3
Echiurid worm (unidentified)	0.2	2.2	1
Holothuroides (unidentified)	—	—	0.2
Gobidae			
<i>Boleophthalmus bodderti</i>			
<i>Boleophthalmus viridis</i>			
<i>Scartelaos histophorus</i>	0.1	—	—
Gobid (unidentified)	0.3	0.2	0.1

sing 6 species stand as the second master component. The third and fourth grade of responsibility in the production potential of the community are shared by polychaetes (Total No. 57) with 5 species and crustaceans (Total No. 45) with 7 species respectively (Table 1).

DISCUSSION

Mangrove ecosystem is qualified by the soil substratum and aquatic subsystem together with the specialised halophyte community and thus provides a unique habitat for a large variety of estuarine fauna. The growth and propagation of the inhabitants are subjected to the continuous stresses of hydrological conditions, varying degrees of tidal innudation and periodical desiccation. The present study represents a preliminary investigation of flora and quantitative assessment of benthos in relation to environmental factors in three biotopes, viz., mangroves, creeks and mudflats. In total, 35 species of macrobenthos have been recorded of which 31, 20 and 26 species occurred in the mangroves, creeks and mudflats respectively. From the overall data it is pertinent to mention that the number, composition and the percentage variation of different species varied considerably between the biotopes. The molluscs dominated the other groups with the composition of 72.2% and 46.2% in mangrove habitat and associated creeks respectively ; whereas in mudflat, actiniarians stand as the most abundant group with 65.1% of the population.

It is interesting to note that the fauna which were more common in one biotope appeared very poor in other closely associated biotopes. The reason for impoverishment of benthic population in a biotope or an uneven distribution of species in different biotopes may be attributed to the nature of substratum, tidal flux, period of desiccation and availability of food. A certain exception was noticed for the members of Nemertines and Polychaetes which were found in each biotope indicating their high degree of accommodation in a wide range of fluctuation of macro- and microclimatic conditions of the system.

In the available data there appears a unique pattern of distribution of few species of the genus *Littorina* and actinarians by which the biotopes may be steadily characterised in respect of habitat preference of organisms. The *Littorina* spp. recorded 9.6/m² in mangrove biotope were totally absent from creeks and mudflats. Similarly, in the mudflats actinarians composing the highest population density (42.2/m²) were very poorly represented (4/m²) in mangrove biotope.

Comparisons of data on macrobenthos reported from different mangrove ecosystems are of considerable interest. Works of Dawn (1977) on forest and adjacent biotopes at Surin Island and also the report on fauna of mangrove shore of Phuket Island by Dawn *et al.* (1976) revealed that the population in these two areas were dominated by Crustacean and Molluscs. Data presented by Anuwat and Pitiwong (1980) on macrobenthos of mangrove forest at KO Yao Yai, Southern Thailand, suggested almost similar assessment of population size with greater abundance of crustaceans and molluscs. During the present study the number of the crustacean population varied from 3.0 to 6.0/m², a little low value as compared to molluscs and actinarians components.

Our knowledge on the ecology of molluscan fauna in Indian Mangroves are available through the works of Radhakrishna and Janakiram (1975) in Godavari and Krishna estuary, Murty and Rao (1977) in South Indian mangrove swamps. From the data on molluscs only *Littorina melanostoma*, *Assimnia brevicula*, *Cerithidea cingulata*, *Telescopium telescopium* and *Onchidium* sp. are the common forms found in Macchilipatnam mangrove area in Krishna estuary and in the present study; while the *Littorina undulata* is the only species occurred in mangroves of Godavari and in the present study too.

The results of the present findings indicate that the faunal community comprising a variety of species, form an integral component of the mangrove ecosystem but the degree of association and adaptation to such an environment differed from species to species. This is

attributed to the varied pattern of feeding habits and competition. At the same time the distribution and abundance of fauna are influenced by various physical and biotic factors of this complex ecosystem.

SUMMARY

The paper deals with the hydrobiological findings in and around Prentice Island, a typical and virgin forest delta of Sundarbans mangrove ecosystem. The floral components documented are mostly represented by members of the genus *Avecinnia*, *Ceriops*, *Bruguiera* and *Acanthus*. The salinity varied from 22.0-26.2‰ as compared to the temperature 26.0-29.5°C. The most common groups of macrobenthos accounted are molluscs, crustaceans, actinarians, polychaetes, nemertines and gobiids. The diversity as well as the density of various species composition comprising the faunal community are discussed in response to various ecological stresses in different biotopes.

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OBSERVATION ON APHIDS (HOMOPTERA : APHIDIDAE)
INFESTING BAMBOO PLANTS IN SIKKIM,
NORTH EAST INDIA

By

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(With 6 Text-figures and 1 Table)

INTRODUCTION

Bamboo plants constitute an important part of forest wealth in eastern India. In Sikkim, a state of north east India, warm temperate zone i. e. from about sea level to localities having altitude of c 2000 m bamboo plants occur either as dense forest or in scattered clusters. Livelyhood of people in the state depends mostly on the forest wealth, bamboo constituting a substantial share in it. Over 16 species of bamboos occur in Sikkim, including *Bambusa tulda*, *B. vulgaris*, *Dendrocalamus hamiltoni*, *D. hookeri*, *Pseudostachyum polymorphum*, *Melocanna baceifera*, *Arundinaria* sp. Rich belts of *Bambusa* spp. and *Dendrocalamus* spp. occur in well-drained parts of hills, slopes and valleys.

Ghosh A. K. (1974) published informations on aphids of economic importance in india, wherein 15 species have been reported from Bamboos, from all over Indian region. In Sikkim region, 10 of the 15 species have been noted, besides *Neoceratovacuna panivicola* (Takshashi), which is known from *Andropogon*, *Oplismenus* and *Panicium* elsewhere. As such aphids infesting bamboo plants in the state comprise of 11 species under 9 genera and 3 subfamilies. Of these, at least 3 species were found to be important from economic point of view as was revealed by the extent and intensity of other infestation. Frequent observations on these aphids in the field resulted in the collection of interesting information on their biology. This paper embodies these observations and provide a running key to the identification of aphids infesting bamboo-plant along with necessary diagrams.

MATERIALS AND METHODS

Survey for aphids was conducted in a systematic way by selecting localities at different altitudinal strata by random sampling method

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during the period 1969-1977. All species of bamboos were scrupulously and meticulously searched for presence of aphids at regular monthly intervals in each of the selected localities. A part of the colony was collected when encountered and records on the intensity of infestation, host plant species, effects on the host plant and other associated insects were maintained carefully. The aphids obtained were processed and mounted by the method of Eastop and van Emden (1972) and identified for the purpose of this study.

RESULTS AND DISCUSSIONS

The survey revealed the occurrence of as many as 11 species of aphids on different species of bamboos found in Sikkim. The names of the species arranged systematically is given in the following :

Subfamily APHIDINAE

1. *Melanaphis bambusae* (Fullaway)

Subfamily DREPANOSIPHINAE

2. *Takecallis arundinariae* (Essig)

Subfamily HORMAPHIDINAE

3. *Astegopteryx minuta* (van der Goot)
4. *Ceratoglyphina bambusae bengalensis* L. K. Ghosh
5. *Ceratovacuna indica* Ghosh, Pal and Raychaudhuri
6. *Ceratovacuna lanigera* Zehntner
7. *Ceratovacuna silvestrii* (Takahashi)
8. *Glyphinaphis bambusae* van der Goot
9. *Neoceratovacuna panicicola* (Takahashi)
10. *Paraoregma alexanderi* (Takahashi)
11. *Pseudoregma bucktoni* Ghosh, Pal and Raychaudhuri

KEY TO THE SPECIES

1. Empodial hair strap-like ; clypeus with nose-like process (Fig. 1) ; spinal hairs arranged in longitudinal rows excepting on tergite 7 where these apart ; only alate known. ... *Takecallis arundinariae* (Essig)
- Empodial hair never as above ; clypeus without any process 2

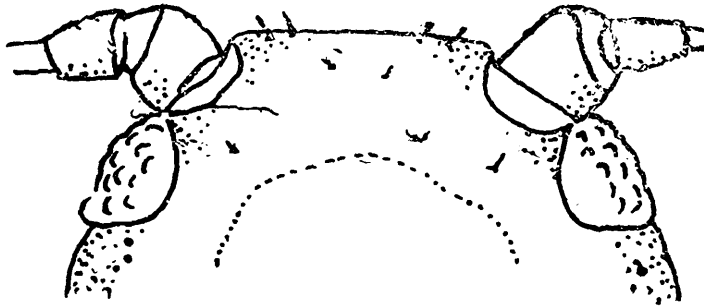


FIG. 2

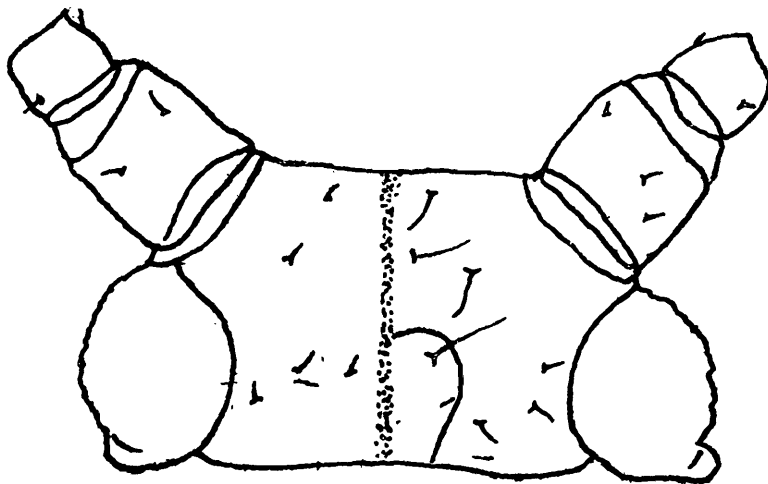


FIG. 1

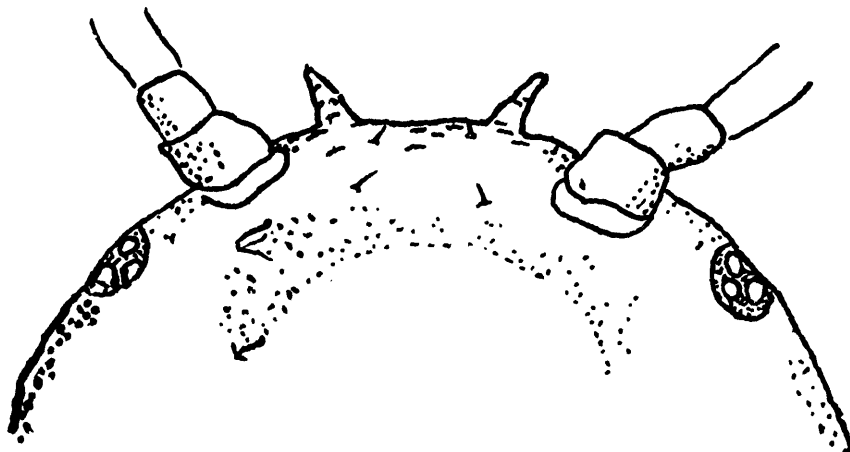


FIG. 3

- Text-figs. 1-3. 1. Head of *Takecallis arundinariae* (Essig) showing nose-like clypeus.
2. Head of *Melanaphis bambusae* (Fullaway) showing multifaceted eyes.
3. Head of *Ceratoglyphina bambusae bengalensis* Ghosh, showing frontal horns placed far apart.

2. Eyes in apterae multi-faceted (Fig. 2) ; siphunculi $0.06-0.08 \times$ length of body and $0.85-0.88 \times$ length of elongated cauda ; processus terminalis about $3.30-4.50 \times$ base of last antennal segment ; cauda with 4-5 hairs. ... *Melanaphis bambusae* (Fullaway)
- Eyes in apterae 3-faceted siphunculi poriform or cone-shaped ; cauda rounded or knobbed. ... 3
3. Head in apterae without any frontal horn ; subanal plate bilobed ; Siphunculi cone-shaped and without hair ; cauda knobbed and knobbed portion nearly pentagonal ; secondary rhinaria in alatae transversely elliptical or oval ... *Glyphinaphis bambusae* van der Goot
- Head in apterae with well-developed frontal horns ; subanal plate rounded or bilobed. ... 4
4. Cauda and subanal plate rounded ; frontal horns placed far apart (Fig. 3) ... *Ceratoglyphina bambusae bengalensis* Ghosh
- Cauda knobbed ; subanal plate indented or bilobed. ... 5
5. Wax-gland cells in apterae laterally compressed and arranged in a row on the margin of the body but those on abdominal segment 8 placed spinopleurally in two groups leaving the median area free in apterae ; both dorsoapical hairs on 2nd tarsal segments with funnel-shaped apices, in alata one of these hairs with acuminate to blunt apices. ... *Astegopteryx minuta* (van der Goot)
- Apterae with either rounded wax-gland cells or with cribriform wax pores ; in apterae either both dorsoapical hairs on 2nd tarsal segments with swollen apices or at least one with such apex and the other with blunt apex. ... 6
6. Cribriform wax-pores present over almost entire body ; one of the dorsoapical hair on 2nd tarsal segments with swollen apices, the other with blunt apices. ... 7
- Abdomen with rounded wax-gland cells ; both dorsoapical hairs on 2nd tarsal segments with swollen apices. ... 8
7. Abdomen in apterae with marginal sclerites on all segments ; wax-gland cells absent but cribriform wax-pores scattered all over the body ; cubitus and anal veins in forewing arising from a common stem. ... *Pseudoregma bucktoni* Ghosh, Pal and Raychaudhuri

- Abdomen in apterae with marginal sclerites only on antesiphuncular tergites which also with cribriform wax-pores, postsiphuncular tergites with wax-gland cells; cubitus and anal veins in forewing just touching each other near subcosta. ... *Paraoregma alexanderi* (Takahashi)
8. Cephalothorax mostly dark, bearing distinct cribriform sclerotic wax-pores; frontal horns of nymph short and blunt. ... *Neoceratovacuna panicicola* (Takahashi)
- Cephalothorax pale, with or without distinct wax-gland cells but never with wax-pores as above; frontal horns of nymphs pointed. ... 9
9. Dorsum of abdomen with spinal wax-gland cell groups at least on anterior segments and with hairs of normal and swollen apices occur intermingled. ... *Ceratovacuna silvestrii* (Takahashi)
- Dorsum of abdomen lacking spinal and pleural wax-gland cell groups. ... 10
10. Wax-gland cells on 8th abdominal tergite arranged in a transverse row. ... *Ceratovacuna indica* Ghosh and Raychaudhuri
- Wax-gland cells on 8th tergite arranged irregularly. ... *Ceratovacuna lanigera* Zehntner

BRIEF NOTES ON THE MORPHOLOGY AND BIOLOGY OF THE APHIDS

1. ***Astegopteryx minuta*** (van der Goot)
(Text-fig. 4)

Yellow insects of this species infest the undersurface of the leaves and form gregarious colonies. The species is always found in association of ants. Heavily infested leaves appeared pale and such bamboo plants sometimes appear to have retarded growth. November-January period has been found to be favourable for the species to colonise the bamboo plants in Sikkim.

Raychaudhuri (1980) reported the genus and the species for the first time from Sikkim.

Host plants : *Bambusa arundinacea*, *Bambusa* sp.,
Dendrocalamus sp.

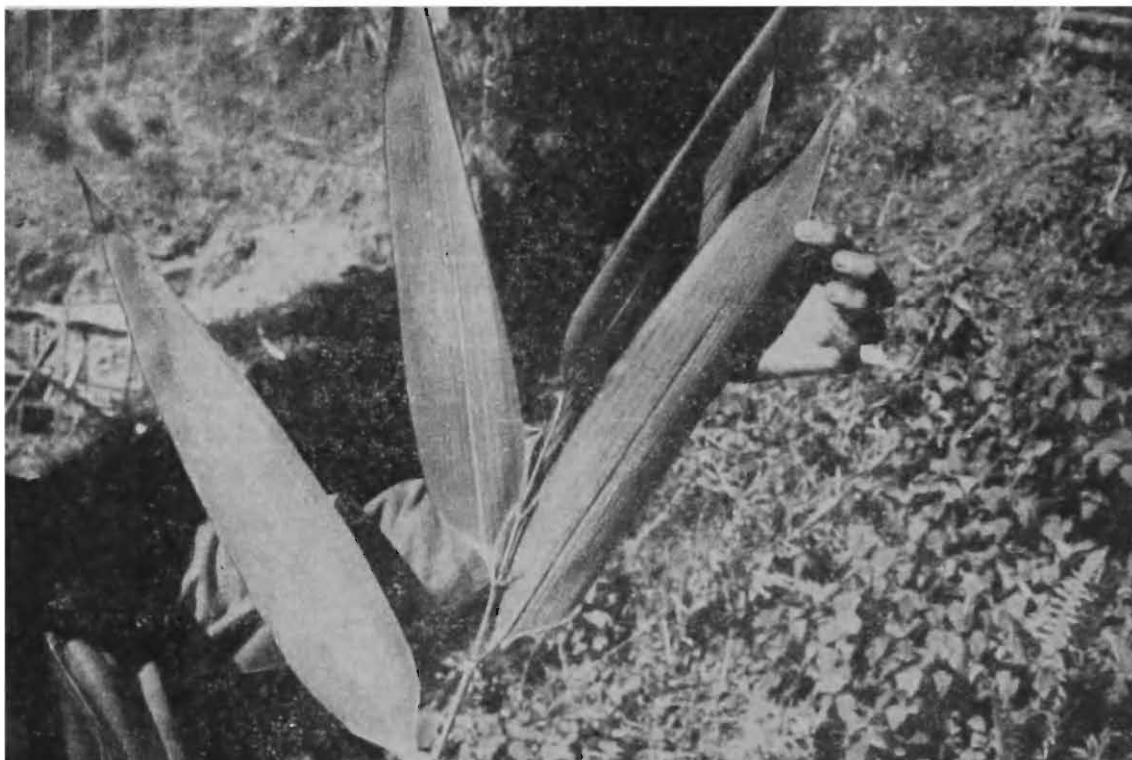
2. ***Ceratoglyphina bambusae bengalensis*** Ghosh
(Text-fig. 5)

Yellow to brown insects with faint waxy secretion infest mainly the nodal region of the host plant within the leaf sheath and are occasionally attended by ants. The species form gregarious colonies and

reproduces parthenogenetically in the climate of Sikkim. The species has been found to dwell on their hosts in between October-January.

Raychaudhuri (1980) reported the species from Sikkim for the first time.

Host plants : *Bambusa arundinacea*, *Fambusa* sp.



Text-fig. 4. Infestation of *Astegopteryx minuta* (v. d. Goot) on the leaves of *Bambusa* sp.

3. *Ceratovacuna indica* Ghosh, Pal and Raychaudhuri

Greenish yellow insects infest undersurface of the older leaves of the host plant and were found covered with faint waxy secretion. Black ants were noticed in association of the species. Summer months have been found to be favourable for the species to make gregarious colonies on their hosts.

The species is reported here for the first time on bamboos from Sikkim.

Host plants : *Bambusa* spp.

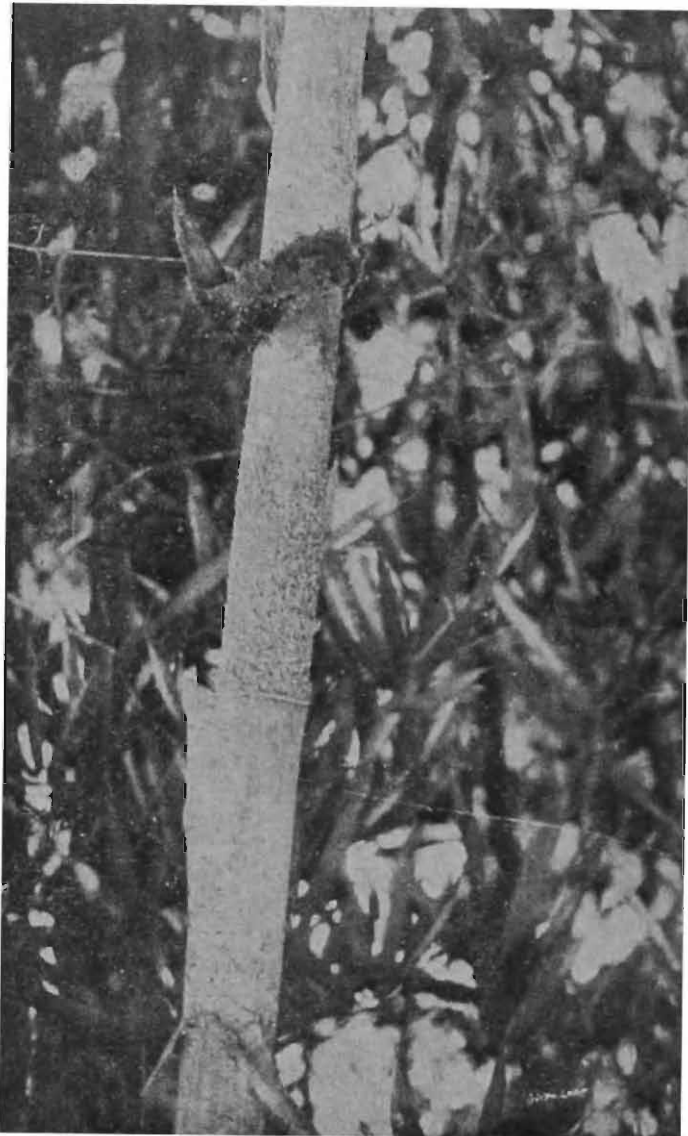
4. *Ceratovacuna lanigera* Zehntner

This species infest both the leaf surfaces of the host plants heavily during the months of September and October. Profuse wax secretion covered the body of pale green insects. The aphid also secretes profuse honeydew which causes the growth of sooty mold on their hosts bearing heavy infestation. The species is attended by black ants.

Ghosh A. K. and Raychaudhuri (1980) reported the species for the

first time from Sikkim. Besides bamboo plants, the species also infest sugarcane and some grasses.

Host plants : *Bambusa arundinacea*, *Bambusa* sp. *Saccharum officinarum* and grasses.



Text-fig. 5. Gregarious colony of *C. bambusae bengalensis* Ghosh on nodal and internodal regions of a bamboo plant.

5. ***Ceratovacuna silvestrii*** (Takahashi)
(Text-fig. 6)

Blackish insects mainly infest the undersurfaces of older leaves and produce wax and copiously secrete honeydew. Big colonies were always noticed in association of ants. The heavily infested areas of the leaves were found to become yellow. In Sikkim, the species is monophagous on bamboo plants and reproduced parthenogenetically. May-June in summer and November-December in cooler periods, this species form gregarious colonies on their hosts.

Raychaudhuri (1980) reported the species for the first time from Sikkim. Host plants : *Bambusa* spp. and indet. bamboo plants.



Text-fig. 6. Wax-covered *Paraoregma alexanderi* (Takahashi) on the leaves of *Bambusa* sp.

6. *Glyphinaphis bambusae* van der Goot

This species has light brown colour and infest the tender shoots of the host plants. These aphids secrete profuse waxy secretion and are always attended by red ants. The preferred host of the aphid is *Thysanolaena* spp. but occasional infestation on *Dendrocalamus* spp. has also been noted. May-June and October-November months have been found to offer favourable conditions for the aphids to colonise their hosts in sikkim.

Host plants : *Dendrocalamus* spp., *Thysanolaena* spp.

7. *Melanaphis bambusae* (Fullaway)

Brown to dark brown insects infest lower surfaces of the leaves and buds with faint powdery secretion all over the body. The species form small colony and is occasionally attended by ants. The species could be collected in the months of November, December and January. In summer months only a few nymphs and winged forms could be noticed.

8. *Neoceratovacuna panicicola* (Takahashi)

Brown insects mainly infest the undersurfaces of leaves and panicles. Aphids were found covered with white waxy deposition on dorsum and sometimes attended by ants. David (1959) reported that this

species is not attended by ants in south India. In Sikkim, the species chiefly infest bamboo plants and long grasses of *Oplismenus* spp. Occasional infestation were also noticed on *Andropogon* spp. and *Granolia* spp. The species could be encountered between November-January months only.

Ghosh, M. R. *et. al.* (1974) reported the species from Sikkim as *Pseudorema panicicola* (Takahashi).

Host plants : *Andropogon* spp., *Granolia* sp., *Oplismenus compositus*, *Oplismenus* spp., indet bamboo plants.

9. *Paraoregma alexanderi* (Takahashi)

Black insects infest almost all the aerial parts of a young bamboo plant and are covered with faint waxy secretions throughout the body. The species form gregarious colonies and on stem such colony run continuously. October-February months have been found to be most favourable for the species to colonise their hosts.

Host plants : *Bambusa arundinacea*, *Bambusa* spp.

10. *Pseudoregma bucktoni* Ghosh, Pal and Raychaudhuri

Dark green to black insects infest the stem at nodal and internodal regions and undersurface of leaves. The species make very dense colonies. The insects were found to be covered with powdery secretion and ants were noticed in association. In Sikkim the species is monophagous on bamboo plants and colonise their hosts mostly during the months of October-January.

Ghosh, M. R. *et. al.* (1974) reported the species from Sikkim as *Pseudoregma bambusicola* (Takahashi).

Host plants : *Bambusa* spp.

11. *Takecallis arundinariae* (Essig)

Light greenish insects of the species infest the undersurface of young and old leaves of bamboo plants. The infestation comprises of individual alata accompanied by a few nymphs. On a single leaf as many as 15-20 adult alatae could be observed. Usually the insect prefer to feed along the mid-rib or stout veins of the leaf. In Sikkim the species infested the bamboo plants in the months of March-May and November-January.

Ghosh, M. R. *et. al.* (1974) reported the species for the first time from Sikkim.

Host plants : *Bambusa arundinacea*, *Bambusa* spp.

DISCUSSION

Of the 11 species of aphid *A. minuta*, *Ceratovacuna silvestrii* and *Paraoregma alexanderi* were found to be important. These species frequently occurred in large numbers on their host plants and such plants revealed apparent symptoms of injury. *A. minuta* and *C. silvestrii* infested only the leaves and in severe cases of infestation, both the species cause yellowing and subsequent premature shedding of the heavily colonised leaves. In addition, *C. silvestrii* habitually secrete profuse honeydew which accumulate on the plant on which sooty mold grow. This phenomenon of honeydew accumulation and growth of sooty mold on leaves of plants deterred the normal physiological function of photosynthesis and respiration. This is reflected on the growth of the plant. *P. alexanderi* primarily infest the newly emerging bamboo stalks where it frequently cover the haulm, hardly leaving any free space. Such new canes, though may exhibit linear growth, the rate of growth is often much less as compared with un-infested ones and canes appear much thinner. It was apparent that *P. alexanderi* was of significant importance for production of normal bamboo.

TABLE 1. Occurrence of aphid species in different altitudinal strata (+ indicates occurrence, — not occurring)

Aphid species	Range of altitude		
	up to 1000 m	up to 1500 m	up to 2000 m
1. <i>Astegopteryx minuta</i>	—	+	+
2. <i>Caratoglyphina bambusae</i>	—	—	+
<i>bengalensis</i>			
3. <i>Ceratovacuna indica</i>	+	+	+
4. <i>Ceratovacuna lanigera</i>	+	+	+
5. <i>Ceratovacuna silvestrii</i>	+	+	+
6. <i>Glyphinaphis bambusae</i>	+	+	+
7. <i>Melanaphis bambusae</i>	+	—	—
8. <i>Neoceratovacuna panicicola</i>	+	+	+
9. <i>Paraoregma alexanderi</i>	—	+	+
10. <i>Pseudoregma bucktoni</i>	+	+	+
11. <i>Takecallis arundinariae</i>	—	+	+
No. of aphid species	7	9	10

Occurrence of aphid species exhibited some pattern with respect to the altitude of the locality. This becomes obvious when it is compared with the localities that are away from the direct influence of the Great Himalayas which Sikkim is subjected to. Bamboos grown in the plains of southern part of West Bengal do not harbour any aphid species at all. Considering Sikkim as an unit area having diverse ecological conditions, low-altitude areas show lesser number of aphid species as compared to high altitude areas. The distribution pattern further reveals that *M. bambusae* occur in localities only upto *c.* 1000 m while *A. minuta* *P. alexanderi* and *T. arundinacea* are restricted to localities above *c.* 1500 m. The remaining species though could be found all through the altitudinal ranges of the present study, were more frequently met within rather higher part of lowest stratum (i. e. between 700 m and 1000 m). This indicates, in general, the preference of lower temperature by the aphid species. (Table 1).

SUMMARY

Eleven species of aphids infest bamboo plants in Sikkim, a mountainous state of north-east India. Three of the 11 species has been found to cause injury on their bamboo hosts. A key to the identity of these aphid species has been provided along with the biological observations made during the period 1968-1977. It has been found that low altitude areas harbour lesser number of aphid species as compared to high altitude areas. This indicated, in general, the preference of the aphid species to lower temperature.

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NOTES ON THE EXPORT OF WILD LIFE AND PRODUCTS FROM CALCUTTA

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(With 9 Tables)

INTRODUCTION

In the year 1972, the Government of India imposed certain restrictions on the collection and possession of wild life and its products through a suitable act known as the Wild Life (Protection) Act, 1972. Export of wild life and their products is regulated through trade notices called Export (Control) Order issued from time to time. Moreover, the Export is allowed through four major ports of the country, *viz.*, Bombay, Calcutta, Madras and New Delhi.

The author in the capacity of Inspector, Wild Life preservation in Calcutta, had the opportunity to check all the outgoing consignments of wild life and its products. The data collected during the years 1977 and 1978 are presented in this paper. It includes the data on export by air and sea from Calcutta alone but not those by postal parcels which is meagre. The export figure for the years 1979 and 1980 could not be included as there was no export of live birds and mammals between May 1979 and June 1980, as a mark of protest by the exporters of this port against the rigid policy announced by the Government. However, between January and April, 1979 in total 63,025 numbers of live birds were exported at a value of Rs. 10,32,474.91 and 340 numbers of live mammals were exported at a value of Rs. 4687.16. During the year 1979, 2,92,000 numbers of Porcupine Quills were exported at a value of Rs. 1,24,561.00 and 1,58,000 numbers of peacock tail feathers were exported at a value of Rs. 49,599.00. Moreover, there was an export of 82,500 numbers of snake skins at a value of Rs. 21,42,216.65. Between January and June 1980 there was no export of wild life and its products.

The summary of export of wild life and its products is given in Table 1. The foreign exchange earning during the year 1977 was above Rupees 23 million while in 1978 it came down to 16 million. From the table it is obvious that there was a sudden decline in the export of live birds during 1978 as compared to 1977. This was mainly due to ban imposed on export of certain items like Munias (Family Ploceidae), Hill Myna (Family Sturnidae), etc. Further, following the ban imposed

on the export of snake skins and turtle/tortoise shells, there was a flare up in the export of mammalian skins, obviously to make up the possible loss in export business. However, decline in the export of stag horns and peacock tail feathers was probably due to less demand during that year for it was not connected with any ban on the export.

TABLE 1. Summary of Export of Wild Life and Products

	1977		1978	
	Quantity	Value	Quantity	Value
Living Birds	6,19,533 Nos.	Rs. 82,46,590.69	2,14,158 Nos.	Rs. 23,90,515.12
Living Mammals	783 „	Rs. 61,102.88	1,293 „	Rs. 1,05,814.53
Jackal Skins	6,685 „	Rs. 42,29,939.63	65,750 „	Rs. 80,49,393.76
Jackal Skin Products	4 „	Rs. 12,000.00	—	—
Indian Fox Skins	—	—	13,000 „	Rs. 6,15,590.96
Jungle Cat Skins	—	—	21,150 „	Rs. 8,47,663.62
Porcupine Quills	3,01,700 „	Rs. 95,525.17	8,42,130 „	Rs. 3,30,979.34
Stag Horns	91,300 kg	Rs. 9,12,571.00	20,220 kg	Rs. 8,07,535.08
Peacock tail feathers	42,97,000 Nos.	Rs. 5,86,947.44	2,90,000 Nos.	Rs. 1,06,604.24
Snake Skins	10,99,192 „	Rs.1,01,97,391.40	—	—
Turtle/Tortoise Shells	2,300 kg	Rs. 24,420.00	—	—
Froglegs	3,05,620 kg	Rs. 40,77,185.00	10,02,318 kg	Rs. 27,24,558.00
Total Value :		Rs.2,38,21,673.16	Total Value : Rs. 1,59,78,654.65	

The quantity of export of different species of living birds is given in Table 2 and the same has been summarised familywise in Table 3. From these, it is observed that during the year 1977 birds belonging to the family Ploceidae alone accounted for 85.54% of the total export quantity. Due to sudden ban imposed on the export of Munias (Family Ploceidae) from April 1978, export of the birds belonging to the families Psittacidae, Irenidae, Muscicapidae, Zosteropidae and Emberizidae increased considerably. However, due to ban imposed on the export of the Hill Myna (*Gracula religiosa*) the export of the birds belonging to the family Sturnidae declined considerably. It was observed that out of the total export of Munias 34.92% was artificially dyed during the year 1977 and 40.89% during the year 1978.

The quantity of export of different species of living mammals is given in Table 4. During the year 1978 there was no export of any Primates and Carnivora due to ban imposed on their export.

The percentage of total export of living birds to different countries is given in Table 5. From this table it is observed that Japan alone imports more than 50% of the total birds exported. The table shows considerable increase in the export of living birds to different countries during the year 1978 as compared to 1977 excepting to Holland and France where it declined drastically probably due to less demand or restrictions imposed on importation by their Governments.

TABLE 2. *Quantity of Export of different species of living birds*

	1977	1978
Family PELECANIDAE		
1. Rosy Pelican		
<i>Pelecanus onocrotalus</i> Linnaeus	—	20
2. Grey Pelican		
<i>Pelecanus philippensis</i> Gmelin	—	1
Family CICONIIDAE		
1. Painted Stork		
<i>Ibis leucocephalus</i> (Pennant)	10	10
2. Whitenecked Stork		
<i>Ciconia episcopus</i> (Boddaert)	—	12
3. White Stork		
<i>Ciconia ciconia</i> (Linnaeus)	4	28
4. Blacknecked Stork		
<i>Xenorhynchus asiaticus</i> (Latham)	13	4
Family THRESKIORNITHIDAE		
1. White Ibis		
<i>Threskiornis melanocephala</i> (Latham)	8	40
2. Black Ibis		
<i>Pseudibis papillosa</i> (Temminck)	—	3
3. Spoonbill		
<i>Platalea leucorodia</i> Linnaeus	—	1
Family ANATIDAE		
1. Barheaded Goose		
<i>Anser indicus</i> (Latham)	—	31
2. Ruddy Shelduck		
<i>Tadorna ferruginea</i> (Pallas)	—	75
3. Cotton Teal		
<i>Nettapus coromandelianus</i> (Gmelin)	2	—
Family ACCIPITRIDAE		
1. Brahminy Kite		
<i>Haliaster indus</i> (Boddaert)	—	8
Family GRUIDAE		
1. Eastern Common Crane		
<i>Grus grus lilfordi</i> Sharpe	—	16
2. Sarus Crane		
<i>Grus antigone</i> (Linnaeus)	14	37

TABLE 2 (Continued)

	1977	1978
3. Demoiselle Crane		
<i>Anthropoides virgo</i> (Linnaeus)	3	94
Family RALLIDAE		
1. Purple Moorhen		
<i>Porphyrio porphyrio</i> (Linnaeus)	—	57
Family PSITTACIDAE		
1. Alexandrine Parakeet		
<i>Psittacula eupatria</i> (Linnaeus)	8098	13178
2. Blossomheaded Parakeet		
<i>Psittacula cyanocephala</i> (Linnaeus)	4016	3614
3. Roseringed Parakeet		
<i>Psittacula krameri</i> (Scopoli)	25875	37543
4. Redbreasted Parakeet		
<i>Psittacula alexandri</i> (Linnaeus)	9800	12936
5. Bluewinged Parakeet		
<i>Psittacula columboides</i> (Vigors)	484	320
6. Statyheaded Parakeet		
<i>Psittacula himalayana</i> (Lesson)	100	—
Family CORACIIDAE		
1. Indian Roller		
<i>Coracias bengalensis</i> (Linnaeus)	22	4
Family CAPITONIDAE		
1. Himalayan Great Barbet		
<i>Megalaima virens</i> (Boddaert)	—	15
2. Large Green Barbet		
<i>Megalaima zeylanica</i> (Gmelin)	9	15
3. Bluethroated Barbet		
<i>Megalaima asiatica</i> (Latham)	565	765
4. Crimpsonbreasted Barbet		
<i>Megalaima haemacephala</i> (Müller)	1	89
Family PICIDAE		
1. Goldenbacked Woodpecker		
<i>Dinopium benghalense</i> (Linnaeus)	461	467
Family PITTIDAE		
1. Indian Pitta		
<i>Pitta brachyura</i> (Linnaeus)	14	36

TABLE 2 (Continued)

	1977	1978
2. Hooded Pitta		
<i>Pitta sordida</i> (Müller)	193	446
Family ALAUDIDAE		
1. Rufoustailed Finch-Lark		
<i>Ammomanes phoenicurus</i> (Franklin)	150	—
Family LANIIDAE		
1. Baybacked Shrike		
<i>Lanius vittatus</i> Valenciennes	12	10
2. Rufousbacked Shrike		
<i>Lanius schach</i> Linnaeus	86	22
Family ORIOLIDAE		
1. Golden Oriole		
<i>Oriolus oriolus</i> (Linnaeus)	3	—
2. Blackheaded Oriole		
<i>Oriolus xanthornus</i> (Linnaeus)	53	278
Family DICRURIDAE		
1. Racket-tailed Drongo		
<i>Dicrurus paradiscus</i> (Linnaeus)	11	24
Family STURNIDAE		
1. Greyheaded Myna		
<i>Sturnus malabaricus</i> (Gmelin)	835	2341
2. Blackheaded Myna		
<i>Sturnus pagodarum</i> (Gmelin)	1060	3490
3. Rosy Pastor		
<i>Sturnus roseus</i> (Linnaeus)	62	490
4. Pied Myna		
<i>Sturnus contra</i> Linnaeus	1485	—
5. Indian Myna		
<i>Acridotheres tristis</i> (Linnaeus)	1950	—
6. Bank Myna		
<i>Acridotheres ginginianus</i> (Latham)	510	—
7. Jungle Myna		
<i>Acridotheres fuscus</i> (Wagler)	150	—
8. Hill Myna		
<i>Gracula religiosa</i> Linnaeus	4246	—

TABLE 2 (Continued)

	1977	1978
Family CORVIDAE		
1. Redcrowned Jay		
<i>Garrulus glandarius</i> (Linnaeus)	3	16
2. Blackthroated Jay		
<i>Garrulus lanceolatus</i> Vigors	4	28
3. Green Magpie		
<i>Cissa chinensis</i> (Boddaert)	1	63
4. Redbilled Blue Magpie		
<i>Cissa erythrorhyncha</i> (Boddaert)	39	260
5. Tree Pie		
<i>Dendrocitta vagabunda</i> (Latham)	50	83
Family CAMPEPHAGIDAE		
1. Scarlet Minivet		
<i>Pericrocotus flammeus</i> (Forster)	10	30
2. Small Minivet		
<i>Pericrocotus cinnamomeus</i> (Linnaeus)	158	58
Family IRENIDAE		
1. Goldfronted Chloropsis		
<i>Chloropsis aurifrons</i> (Temminck)	3055	4776
2. Orangebellied Chloropsis		
<i>Chloropsis hardwickii</i> Jardine & Selby	150	494
3. Goldmantled Chloropsis		
<i>Chloropsis cochinchinensis</i> (Gmelin)	141	324
Family PYCNONOTIDAE		
1. Greyheaded Bulbul		
<i>Pycnonotus priocephalus</i> (Jerdon)	—	9
2. Blackcrested Yellow Bulbul		
<i>Pycnonotus melanicterus</i> (Gmelin)	27	63
3. Redwhiskered Bulbul		
<i>Pycnonotus jocosus</i> (Linnaeus)	1200	1300
4. White-eared Bulbul		
<i>Pycnonotus leucogenys leucotis</i> (Gould)	20	67
5. Whitecheeked Bulbul		
<i>Pycnonotus l. leucogenys</i> (Gray)	67	267
6. Redvented Bulbul		
<i>Pycnonotus cafer</i> (Linnaeus)	730	899

TABLE 2 (Continued)

	1977	1978
7. Striated Green Bulbul		
<i>Pycnonotus striatus</i> (Blyth)	7	—
8. Yellowthroated Bulbul		
<i>Pycnonotus xantholaemus</i> (Jerdon)	—	30
9. Rufousbellied Bulbul		
<i>Hypsipetes mcclellandi</i> Horsfield	—	7
10. Browneared Bulbul		
<i>Hypsipetes flavalus</i> (Blyth)	67	43
11. Black Bulbul		
<i>Hypsipetes madagascariensis</i> (Müller)	26	27
Family MUSCICAPIDAE		
1. Slatyheaded Scimitar Babbler		
<i>Pamatorhinus schisticeps</i> Hodgson	2	35
2. Rustycheeked Scimitar Babbler		
<i>Pamatorhinus erythrogenys</i> Vigors	1	16
3. Redheaded Babbler		
<i>Stachyris ruficeps</i> Blyth	4	22
4. Rufousbellied Babbler		
<i>Dumetia hyperythra</i> (Franklin)	—	4
5. Redcapped Babbler		
<i>Timalia pileata</i> Horsfield	21	48
6. Yellow-eyed Babbler		
<i>Chrysomma sinense</i> (Gmelin)	—	12
7. Common Babbler		
<i>Turdoides caudatus</i> (Dumont)	8	34
8. Striated Babbler		
<i>Turdoides earlei</i> (Blyth)	—	107
9. Jungle Babbler		
<i>Turdoides striatus</i> (Dumont)	3	10
10. Whiteheaded Babbler		
<i>Turdoides affinis</i> (Jerdon)	—	1
11. Whitethroated Laughing Thrush		
<i>Garrulax albogularis</i> (Gould)	—	6
12. Necklaced Laughing Thrush		
<i>Garrulax monileger</i> (Hodgson)	—	45

TABLE 2 (Continued)

	1977	1978
13. Blackgorgeted Laughing Thrush <i>Garrulax pectoralis</i> (Gould)	20	—
14. Whitecrested Laughing Thrush <i>Garrulax leucolophus</i> (Hardwicke)	20	364
15. Rufouschinned Laughing Thrush <i>Garrulax rufogularis</i> (Gould)	—	3
16. Streaked Laughing Thrush <i>Garrulax lineatus</i> (Vigors)	—	30
17. Redheaded Laughing Thrush <i>Garrulax erythrocephalus</i> (Vigors)	7	46
18. Silvereared Mesia <i>Leiothrix argentauris</i> (Hodgson)	24	187
19. Redbilled Leiothrix <i>Leiothrix lutea</i> (Scopoli)	293	1131
20. Bluewinged Siva <i>Minla cyanouroptera</i> (Hodgson)	169	560
21. Yellownaped Yuhina <i>Yuhina flavicollis</i> Hodgson	48	361
22. Rufousvented Yuhina <i>Yuhina occipitalis</i> Hodgson	—	2
23. Blackchinned Yuhina <i>Yuhina nigrimenta</i> Hodgson	101	335
24. Blackheaded Sibia <i>Heterophasia capistrata</i> (Vigors)	114	306
25. Redbreasted Flycatcher <i>Muscicapa parva</i> Bechstein	—	14
26. Large Niltava <i>Muscicapa grandis</i> (Blyth)	—	4
27. Small Niltava <i>Muscicapa macgrigoriae</i> (Burton)	6	10
28. Rufousbellied Niltava <i>Muscicapa sundara</i> (Hodgson)	22	74
29. Tickell's Blue Flycatcher <i>Muscicapa tickelli</i> (Blyth)	189	135
30. Verditer Flycatcher <i>Muscicapa thalassina</i> Swainson	61	301

TABLE 2 (Continued)

	1977	1978
31. Fantail Flycatcher		
<i>Rhipidura albicollis</i> (Vieillot)	4	6
32. Blacknaped Blue Flycatcher		
<i>Monarcha</i> [= <i>Hypothymis</i>] <i>azurea</i> (Boddaert)	10	2
33. Tailor Bird		
<i>Orthotomus sutorius</i> (Pennant)	40	110
34. Bluethroat		
<i>Erithacus svecicus</i> (Linnaeus)	68	234
35. Rubythroat		
<i>Erithacus pectoralis</i> (Gould)	368	617
36. Magpie-Robin		
<i>Copsychus saularis</i> (Linnaeus)	432	816
37. Shama		
<i>Copsychus malabaricus</i> (Scopoli)	2352	212
38. Redstart		
<i>Phoenicurus ochruros</i> (Gmelin)	74	56
39. Bluefronted Robin		
<i>Cinclidium frontale</i> Blyth	—	
40. Pied Bush Chat		
<i>Saxicola caprata</i> (Linnaeus)	3	22
41. Indian Robin		
<i>Saxicoloides fulicata</i> (Linnaeus)	—	70
42. Blue Rock Thrush		
<i>Monticola solitarius</i> (Linnaeus)	84	30
43. Malabar Whistling Thrush		
<i>Myiophonus horsfieldii</i> (Vigors)	—	7
44. Pied Ground Thrush		
<i>Zoothera wardii</i> (Blyth)	—	3
45. Orangeheaded Ground Thrush		
<i>Zoothera citrina citrina</i> (Latham)	440	657
46. Whitethroated Ground Thrush		
<i>Zoothera citrina cyanotus</i> (Jardine & Selby)	3	40
47. Greywinged Blackbird		
<i>Tardus bouboul</i> (Latham)	—	2

TABLE 2 (Continued)

	1977	1978
Family PARIDAE		
1. Grey Tit		
<i>Parus major</i> Linnaeus	—	44
2. Crested Black Tit		
<i>Parus melanolophus</i> Vigors	—	3
3. Yellowcheeked Tit		
<i>Parus xanthogenys</i> Vigors	6	41
4. Redheaded Tit		
<i>Aegithalos concinnus</i> Gould	—	20
Family SITTIDAE		
1. Chestnutbellied Nuthatch		
<i>Sitta castanea</i> Lesson	2	23
2. Velvetfronted Nuthatch		
<i>Sitta frontalis</i> Swainson	2	3
Family MOTACILLIDAE		
1. Yellowheaded Wagtail		
<i>Motacilla citreola</i> Pallas	13	5
2. Large Pied Wagtail		
<i>Motacilla maderaspatensis</i> Gmelin	15	—
Family DICAERIDAE		
1. Orangebellied Flowerpecker		
<i>Dicaeum trigonostigma rubropygium</i> Baker	—	32
2. Firebreasted Flowerpecker		
<i>Dicaeum ignipectus</i> (Blyth)	—	12
Family NECTARINIIDAE		
1. Rubycheek		
<i>Anthreptes singalensis</i> (Gmelin)	6	8
2. Sunbirds		
<i>Nectarinia</i> spp.	—	982
Family ZOSTEROPIDAE		
1. White-eye		
<i>Zosterops palpebrosa</i> (Temminck)	3180	4905
Family PLOCEIDAE		
1. Yellowthroated Sparrow		
<i>Petronia xanthocollis</i> (Burton)	143	—

TABLE 2 (Concluded)

	1977	1973
2. Baya Weaver Bird		
<i>Ploceus philippinus</i> (Linnaeus)	2680	1680
3. Red Munia		
<i>Estrilda amandava</i> (Linnaeus)	2,68,241	57,260
4. Green Munia		
<i>Estrilda formosa</i> (Latham)	14,545	—
5. Whitethroated Munia		
<i>Lonchura malabarica</i> (Linnaeus)	14,235	1160
6. Whitebacked Munia		
<i>Lonchura striata</i> (Hodgson)	4875	—
7. Spotted Munia		
<i>Lonchura punctulata</i> (Linnaeus)	76,265	3570
8. Blackheaded Munia		
<i>Lonchura malacca</i> (Linnaeus)	1,48,980	13,660
Family FRINGILLIDAE		
1. Spottedwinged Grosbeak		
<i>Mycerobas melanozanthos</i> (Hodgson)	—	5
2. Himalayan Green Finch		
<i>Carduelis spinoides</i> Vigors	590	569
3. Rosefinch		
<i>Carpodacus erythrinus</i> (Pallas)	—	5
4. Scarlet Finch		
<i>Haematospiza sipahi</i> (Hodgson)	—	5
Family EMBERIZIDAE		
1. Blackheaded Bunting		
<i>Emberiza melanocephala</i> Scopoli	970	22287
2. Redheaded Bunting		
<i>Emberiza bruniceps</i> Brandt	12370	14345
3. Crested Bunting		
<i>Melophus lathami</i> (Gray)	210	365

The percentage of total export of living mammals to different countries is given in Table 6. It is observed that Spain is the chief importing country as far as mammals are concerned. During the year 1978 there was no export of mammals to Holland and France, but there was export to countries like Greece, Belgium and U. S. A., where there was no export in the year 1977.

TABLE 3. *Quantitative Analysis of Export of Living Birds (Familywise)*

Family	1977		1978	
	Total No.	% of the total	Total No.	% of the total
Family Pelecanidae	—	—	21	0.01
„ Ciconiidae	27	0.004	54	0.03
„ Threskiornithidae	8	0.001	44	0.02
„ Anatidae	2	0.0003	106	0.05
„ Accipitridae	—	—	8	0.004
„ Gruidae	17	0.003	147	0.07
„ Rallidae	—	—	57	0.03
„ Psittacidae	48573	7.81	67591	31.56
„ Coraciidae	22	0.003	4	0.001
„ Capitonidae	575	0.09	884	0.41
„ Picidae	461	0.07	467	0.22
„ Pittidae	207	0.03	482	0.23
„ Alaudidae	150	0.02	—	—
„ Laniidae	48	0.008	32	0.01
„ Oriolidae	56	0.009	278	0.13
„ Dicruridae	11	0.002	24	0.01
„ Sturnidae	10298	1.66	6321	2.95
„ Corvidae	97	0.02	450	0.21
„ Campephagidae	168	0.03	88	0.04
„ Irenidae	3346	0.54	5594	2.61
„ Pycnonotidae	2144	0.35	2712	1.27
„ Muscicapidae	4991	0.81	7095	3.31
„ Paridae	6	0.001	108	0.05
„ Sittidae	4	0.001	26	0.01
„ Motacillidae	28	0.005	5	0.002
„ Dicaeidae	—	—	44	0.02
„ Nectariniidae	6	0.001	990	0.46
„ Zosteropidae	3180	0.51	4905	2.29
„ Ploceidae	529964	85.54	77330	36.11
„ Fringillidae	1794	0.29	1294	0.6
„ Emberizidae	13550	2.19	36997	17.28

The rate of export during the different parts of the year is analysed in Table 7. It is observed that more than 76% of the total export of living birds/mammals takes place between January and June.

The percentage of total export of skins of different carnivores is given in Table 8. It is observed that out of the total carnivore skins exported during the year 1978, Switzerland imported the maximum (54.05%) quantity, followed by West Germany (27.53%), U. K. (13.01%) and Italy (5.31%).

TABLE 4. *Quantity of Export of Different Species of Living Mammals*

	1977	1978
Family PATEROPIDAE		
1. Flying Fox		
<i>Pteropus giganteus</i> (Brünnich)	150	302
Family CERCOPITHECIDAE		
1. Assamese Macaque		
<i>Macaca assamensis</i> McClelland	115	—
2. Common Langur		
<i>Presbytis entellus</i> (Dufresne)	2	—
Family URSIDAE		
1. Himalayan Black Bear		
<i>Selenarctos thibetanus</i> (G. Cuvier)	15	31
Family VIVERRIDAE		
1. Small Indian Mongoose		
<i>Herpestes auropunctatus</i> (Hodgson)	17	—
2. Common Mongoose		
<i>Herpestes edwardsi</i> (Geoffroy)	34	—
Family SCIURIDAE		
1. Five striped Palm Squirrel	250	700
<i>Funambulus pennanti</i> Wroughton		
2. Three striped Palm Squirrel		
<i>Funambulus palmarum</i> (Linnaeus)	200	460

The percentage of total snake skins exported to different countries is given in Table 9. There was no export during the year 1978 due to ban imposed on export of this item.

The trade name used for different birds is given in Appendix 1 and the percentage of total live wild life carried by different airlines is given in Appendix 2.

Froglegs : It will be seen from Table 1 that 3,05,620 kg of froglegs were exported in the year 1977, which rose to 10,02,318 kg in 1978. Froglegs for export consist of processed hindlegs which are severed from the bodies of frogs (chiefly *Rana tigrina* and *Rana hexadactyla*). As per Export Policy, only legs of the size less than 80 pieces per kg is allowed to be exported. From this it is estimated that the total

TABLE 5. *Percentage of Total Living Birds Exported to Defferent Countries*

	1977	1978
Japan	58.35	52.04
Hongkong	2.48	5.28
Taiwan	3.28	11.13
Italy	0.09	5.82
Belgium	1.20	2.37
Holland	21.24	5.75
West Germany	3.59	9.64
France	7.03	0.65
Spain	2.24	3.91
Denmark	0.01	0.09
Greece	—	0.29
Austria	—	0.38
U. A. E.	0.06	—
U. K.	0.43	1.70
U. S. A.	—	0.95

TABLE 6. *Percentage of Total Living Mammals Exported to Different Countries*

	1977	1978
Japan	17.88	13.15
Taiwan	3.07	1.00
Spain	38.46	54.13
West Germany	3.32	13.15
Italy	10.22	1.55
Holland	29.50	—
France	2.55	—
Belgium	—	3.87
Greece	—	11.60
U. S. A.	—	1.55

TABLE 7. *Rate of Export During Different Parts of The Year*

	Percentage of total live stock exported	
	1977	1978
January to March	35.07	56.29
April to June	41.76	21.93
July to September	10.65	8.23
October to December	12.52	14.15

TABLE 8. *Percentage of Total Wild Life Products Exported to Different Countries*

	1977	1978
(i) Jackal Skins (<i>Canis aureus</i> Linnaeus)		
U. K.	37.10	15.21
West Germany	29.99	34.22
France	2.99	0.15
Switzerland	29.92	50.19
Italy	—	0.23
(ii) Indian Fox Skins [<i>Vulpes bengalensis</i> (Shaw)]		
U. K.	—	15.39
West Germany	—	38.46
Switzerland	—	46.15
(iii) Jungle Cat Skins (<i>Felis chaus</i> Güldenstaedt)		
U. K.	—	4.73
Switzerland	—	24.35
Italy	—	70.92

TABLE 9. *Percentage of Total Snake Skins Exported to Different Countries*

	1977	1978
U. K.	26.81	—
West Germany	32.43	—
France	4.01	—
Spain	8.80	—
Italy	19.61	—
U. S. A.	8.34	—

number of frogs sacrificed for export during 1977 was about 1,22,24,800, and 4,00,92,720 during 1978 !

From the above study it is observed that though our country has earned foreign exchange to the tune of rupees ten to twenty million from one port alone it appears to have overexploited some of the species. But, if export data of all the four ports *viz.*, Bombay, Calcutta, Madras and New Delhi are taken together into consideration it will certainly show a much more alarming figure.

If export of different birds and animals is continued at this rate, decimation of some of the species will be inevitable in the near future. In spite of this, it will not be wise at the same time to impose a complete ban on the killing and export of birds and animals, because culling is also necessary to maintain a proper balance and healthy growth of different wild life population in nature.

Hence, it is suggested that policy should be formulated after proper assessment of the population of various species of birds and animals in nature.

ACKNOWLEDGEMENT

I am indebted to the Assistant Director, Wild Life Regional Office, Calcutta, for providing facilities for this work. My sincere thanks are due to Dr. B. Biswas, Emeritus Scientist, Zoological Survey of India, Calcutta, for valuable suggestions and for going through the manuscript. I am thankful to Dr. V. C. Agrawal, Superintending Zoologist, Zoological Survey of India, Calcutta, for his guidance in preparing this note.

APPENDIX 1

Trade Name Used for Different Birds

<i>Common English Name</i>	<i>Trade Name Used</i>
1. Red Munia	Tiger Finch/Strawberry Finch
2. Whitethroated Munia	Silverbill/Silver Finch
3. Blackheaded Munia	Tricolour Nun/Blackheaded Nun/Two-colour Nun
4. Spotted Munia	Spice Birds/Speckled Munia/Silverbill
5. Green Munia	Green Avadavat/Green Finch

APPENDIX 1. (*Concluded*)

6. Whitebacked Munia	Blackheaded Nun/Softbill
7. Redbreasted Parakeet	Moustache Parakeet
8. Blossomheaded Parakeet	Plumheaded Parakeet
9. Striated Green Bullbul	Yellow-winged Bulbul
10. Redwhiskered Bulbul	Redeared Bulbul
11. Orangebellied Chloropsis	Redbreasted Harewa
12. Myna (Common, Pied, Bank)	Starling
13. Greyheaded Myna	Greyheaded Pagoda/Pagoda Starling
14. Blackheaded Myna	Blackheaded Pagoda Starling
15. Redstart	Singing Starling/Singing Finch
16. Orangeheaded Ground Thrush	Dama/Dama Thrush
17. Himalayan Green Finch	Siskin
18. Hooded Pitta	Bengal Pitta
19. Magpie-Robin	Dayal Thrush
20. Bush Chat	Blue Chat
21. Tibetan Siskin	Himalayan Singing Finch
22. Bluewinged Siva	Blue Robin
23. Redheaded Laughing Thrush	Redheaded Thrush
24. Blackchinned Yuhina	Lesser Yuhina
25. Yellownaped Yuhina	Greater Yuhina

APPENDIX 2.

*Percentage of Total Live Wild Life Carried By
Different Airlines*

	1977	1978
British Airways	24.70	46.32
Thai International	26.64	36.78
Aeroflot (Soviet Airlines)	48.60	1.12
Air-India	—	11.36
Scandinavian Airline Systems	—	4.42
Bangladesh Biman	0.06	—

FURTHER CONTRIBUTION TO THE KNOWLEDGE
OF ZOOCECIDIA OF THE MANGROVE,
AVICENNIA MARINA (FORSK.) VIER

By

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(With 1 Plate)

INTRODUCTION

Plants galls are very rare in mangroves. This may be due to relative high salt concentration in the internal tissues of mangrove plants, which is inimical to hatching of insect eggs and subsegment growth of the larvae as pointed out by Chapmann (1976). But, during the course of field investigations on the Zoocecidia of mangroves of Andaman islands, it has been found that a particular species of mangrove plant, *Avicennia marina* is highly susceptible to gall formation. This is quite evident from the fact that Sharma *et al* (1983, 1984) have reported six different Zoocecidia forming leaf galls on *A. marina* in South Andaman.

During a recent survey in Middle Andaman one more Zoocecidia has been collected on the stem/shoot axis of this mangrove species caused by Hymenoptera. Incidentally this is the first record of stem gall from the mangroves of Andaman islands. This gall which is identified by its number (Gall No. 7) is described in this paper.

In addition to this, two morphologically different leaf galls caused by the midge, *Dasineura* sp. (Diptera : Cecidomyiidae) have also been collected from *A. marina*. These galls are dealt with and a key to all the eight different galls of *A. marina* known so far from Andaman islands is given in this paper in order to facilitate identification and further study on this group.

The gall bearing plants and the gall insects are deposited in the collections of the Zoological Survey of India, Port Blair.

Incidentally, this is to mention that there is no record till date on the gall of *A. marina* from mainland India. Mani (1973) collected only one *Eriophyes* gall on *A. officinalis* from South Travancore (Gall No. 507), India.

DESCRIPTION

Stem gall

Gall No. 7 (Pl. IX, fig. 1, 2) by unknown Hymenoptera

Irregularly globose/sub-globose, verrucose, solid, hard, woody, solitary, indehiscent, persistent, unilateral cortical gall; light greenish-brown when young, brown on ageing. Gall cavity multi-chambered with a single larva in each chamber; chambers usually oval; pupation in gall itself. Size of the gall varies from 10-20 mm. in diameter and 1-3 galls appear on a small tender branch. Usually 5-7 exit holes seen on a mature gall. Deserted galls were observed to be occupied by ants. Coll. R. M. Sharma, 3.iii.1983.

Distribution : Betapur (Middle Andaman).

Leaf gall

Of the two leaf-galls of *A. marina* collected from Middle Andaman one is identical with Gall No. 3 (hypophyllous, globose/sub-globose swellings on the leaf surface) of Sharma *et al* (1984) while the other one is a mid-rib gall and identified as Gall No. 8 as detailed below.

Gall No. 3. (Pl. IX, fig. 3) by *Dasineura* sp.

In the earlier communication Sharma *et. al.* (*op. cit.*) described this gall in details and stated that this is caused by some unknown Diptera since adult insects could not be reared that time from the gall.

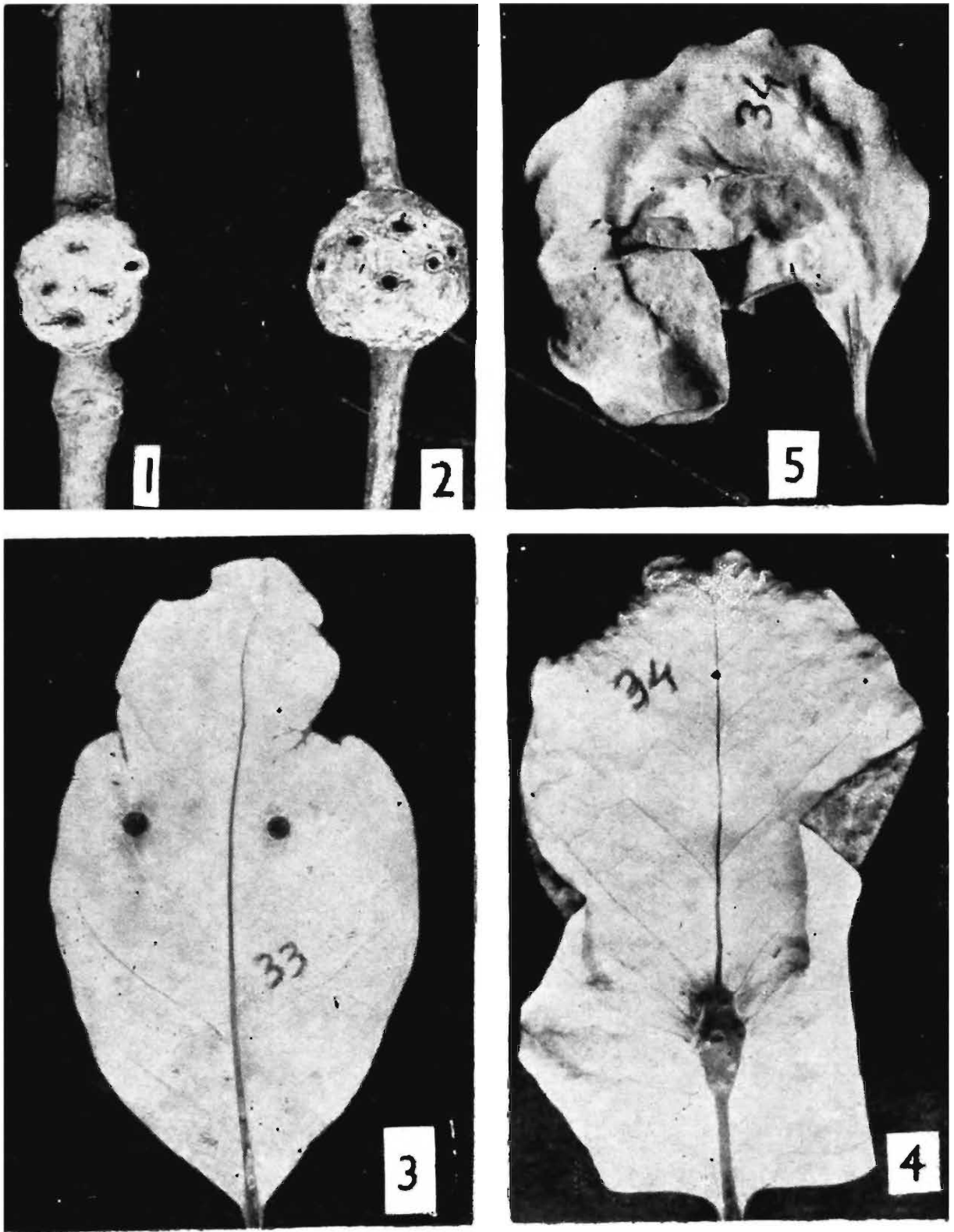
Recently in Middle Andaman the present authors have succeeded in rearing the adult midge, from this gall and identifying the same as *Dasineura* sp.

Gall No. 8. (Pl. IX, fig. 4, 5) by *Dasineura* sp.

Leaf gall; epi-hypophyllous, elongated, oval, irregular solid, glabrous, equally developed on both the surfaces of the leaf blade, confined to mid-rib only, at times all along the mid-rib (Fig. 5), indehiscent, persistent, greenish yellow when young, becomes dark brown to black as grow old. Gall cavity multilocular, pupation in gall itself. Adults emerge out by making exit holes at lateral side of the gall on lower or upper surface of the leaf blade. Size of the gall varies from 5-40 mm. long and 2-5 mm. high above the leaf surface. 1-3 galls may arise on mid-rib of a single leaf. Coll. R. M. Sharma, 23.ii.1983.

Distribution : Bakultala (Middle Andaman)

Remarks : Leaves with globose hypophyllous galls and leaves with midrib galls which were found to co-exist on the same host tree were collected on 23.ii.83 at Bakultala (M. Andaman) and kept separately to rear the adult insects. On 26.ii.83 midrib gall gave emergence to a



Galls on *Avicennia marina*.

- Figs. 1-5. 1. Cross Section of Gall No. 7 (a stem gall of Hymenoptera) showing larval chambers.
2. Gall No. 7 ; One entire stem gall of Hymenoptera.
3. Leaf gall No. 3 caused by *Dasineura* sp.
4. Gall No. 8 ; midrib gall caused by *Dasineura* sp.
5. Gall No. 8 ; gall all along the midrib.

single ♂ midge and on 4.iii.83 another single ♂ midge emerged from globose, hypophyllous gall. On closer examination it was found that both the forms are congeneric belonging to the genus *Dasineura* Rondani and have very close resemblance with each other. No clear diagnostic differences are traceable between the two forms except in the appearance and occurrence of the galls on leaf surface. Of course, the correct assignment of the species is possible only on further collection of males and females from these two morphologically different galls.

Therefore, for the present, on the basis of the differences in the appearance of the gall, the midrib gall is being described here as different from the earlier gall No. 3 of Sharma *et. al.* until further detailed information is obtained. Midrib gall is identified by its number (Gall No. 8).

As stated earlier, a key to all the galls of *A. marina* known so far is given below :

KEY TO GALLS OF *A. Marina*

- | | | | |
|---|-----|-------------------------------------|---|
| 1. Leaf gall | ... | ... | 2 |
| Stem gall | ... | | |
| Globose/sub-globose or irregular, solid, hard, woody, verrucose cortical swellings on stem or tender branch | ... | Gall No. 7. Hymenoptera | |
| 2. Acarocecidia | ... | ... | 3 |
| Entomocecidia | ... | ... | 4 |
| 3. Epi-hypophyllous, with very fine white hairs covering the gall, also occurs on petiole and midrib | ... | Gall No. 2. <i>Eriophyes</i> sp. | |
| Epiphyllous, small, agglomerated or solitary swellings without hairs, lower surface depressed and discoloured indicating site of the gall | ... | Gall No. 5. <i>Aceria avicennae</i> | |
| 4. Galls on leaf surface | ... | ... | 5 |
| Galls on midrib | ... | | |
| Epi-hypophyllous, elongated oval, irregular, equally developed on both sides, solid, glabrous, with a number of exit holes at lateral side of the gall on lower or upper surface of the leaf... | ... | Gall No. 8. <i>Dasineura</i> sp. | |
| 5. Barrel-shaped or globose galls | ... | ... | 6 |
| Discoid, depressed, lenticular galls | ... | ... | 7 |
| 6. Mostly hypophyllous, barrel-shaped, pyxidial gall, glabrous, solid, with discoid, depressed area above, operculate on lower surface | ... | Gall No. 6. Homoptera | |
| Mostly hypophyllous, globose / sub-globose, glabrous swellings, with flattened circular, area above | ... | Gall No. 3. <i>Dasineura</i> sp. | |

7. Discoid, depressed, lenticular gall, glabrous, greenish when young with a single exit hole on mature gall ... Gall No. 1. Lepidoptera
- Discoid, depressed, lenticular gall, wrinkled, dark-yellow or copper coloured when young with a number of exit holes on a mature gall ... Gall No. 4. Diptera : Cecidomyiidae

SUMMARY

One stem gall caused by Hymenoptera and two morphologically different leaf galls caused by *Dasineura* sp. (Diptera : Cecidomyiidae) on the mangrove, *Avicennia marina* (Forsk.) Vier. are described. A key to all the eight different galls of *A. marina* known so far from Andaman islands is also included.

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STUDY ON THE COLLECTION OF PSOCOPTERA
FROM CERTAIN PARTS OF NORTH
EASTERN INDIA AND BHUTAN

By

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(With 1 Table)

INTRODUCTION

Psocoptera collected from various surveys by the Zoological Survey of India, were studied, including material from Darjeeling (West Bengal), Shillong (Meghalaya), Tripura and Manipur (North Eastern India) and Bhutan. The study revealed 12 species representing 11 genera and 8 families ; of these 2 species (*Rhyopsocus afer* Badonnel and (*Psococerastis sinensis* Thornton), are recorded for the first time from India. The first represents a new family record e. g. Psoquillidae for India.

Material of Psocoptera from Bhutan were also studied. Study revealed 6 species under 5 genera and 4 families, of which 5 species are recorded for the first time which are (*Pseudocaecilius citricola* (Ashmead), *Stenopsocus pallidus* Thornton & Wong, *Kodamaius mirabundus* Datta, *Amphipsocus pilosus* McLachlan and *Lachesilla* sp.

The families, deal with, are Psoquillidae, Pachytroctidae, Caeciliidae, Stenopsocidae, Amphipsocidae, Lachesillidae, Peripsocidae, Hemipsocidae, Pseudocaecilliidae and Psocidae.

SYSTEMATIC ACCOUNT

Family PSOQUILLIDAE

1. *Rhyopsocus afer* (Badonnel)

1948. *Deinopsocus afer* Badonnel, *Revue Zool. Bot. afr.*, **40** : 267.

1949. *Rhyopsocus afer* (Pearman), Badonnel, *Bull. Inst. r. sci. nat. Belg.*, **25** : 9.

Material : 2 ♀ ♀, Amarpur, South Tripura, coll. N. Muralidharan, 17.x.1977 ; body-length (in alcohol) : 1.6 mm.

Remarks : The specimens were collected from a nest of the bird, *Ploceus* sp.

Distribution : INDIA (new record), CONGO ; IVORY COAST ; ANGOLA ; SOUTH AFRICA AND TANZANIA.

Family PACHYTROCTIDAE

2. *Tapinella formosana* Enderlein

1908. *Tapinella formosana* Enderlein, *Zool. Anz.*, **33** : 774.

1979. *Tapinella formosana* Enderlein, Ray, *Rec. Zool. Surv. India*, **75** : 354.

Material : 2 ♀♀ (alate forms), Amarpur, South Tripura ; coll. N. Muralidharan, 17.x.1977 ; body-length (in alcohol) : 1.4 mm.

Remarks : The specimens were collected from a nest of *Ploceus* sp.

Distribution : INDIA (Maharashtra, West Bengal, Tripura [new record]) and TAIWAN.

Family CAECILIIDAE

3. *Caecilius muggenburgi* Enderlein

1903. *Caecilius muggenburgi* Enderlein, *Annls. hist.-nat. Mus. natn. hung.*, **1** : 269.

1979. *Caecilius muggenburgi* Enderlein, Ray, *Rec. zool. Surv. India*, **75** : 255.

Material : 2 ♀♀, Shillong, Meghalaya ; Coll. B. K. Tikader, 1965 ; body-length (in alcohol) : 1.5 mm.

Distribution : INDIA ; SINGAPORE ; JAVA ; PHILIPPINES and TAIWAN.

4. *Caecilius pictifrons* Thornton & Wong

1966. *Caecilius pictifrons* Thornton & Wong, *Trans. R. ent. Soc. Lond.*, **118** (1) : 7-10.

1973. *Caecilius pictifrons* Thornton & Wong, *New, Oriental Ins.*, **7** (1) : 4.

Material : 10 ♂♂, 10 ♀♀, Shillong, Meghalaya ; Coll. B. K. Tikader, 1965 ; body-length (in alcohol) ; ♂ 2 mm., ♀ 2.2 mm.

Remarks : The population of the species seems to be high in this locality.

Distribution : INDIA.

5. *Dypsocus coleoptratus* (Hagen)

1858. *Psocus coleoptratus* Hagen, *Verh. zool. bot. Ges. Wien*, **8** : 474.

1969. *Dypsocus coleoptratus* (Hagen), Datta, *Zool. Anz.*, **189** (1/2) : 140-144.

Material : 1 ♂, 2 ♀♀, Shillong, Meghalaya ; coll. B. C. Das, 31.viii.1977 ; body-length (in alcohol) : ♂ 3 mm ; ♀ 4 mm.

Remarks : This is relatively larger than many psocids.

Distribution : INDIA ; SRI LANKA ; JAVA AND JAPAN.

6. *Fulleborniella persimilaris* Thornton & Wong

1966. *Fulleborniella persimilaris* Thornton & Wong, *Trans. R. ent. Soc. Lond.*, **118** (1) : 4-7.

1973. *Fulleborniella persimilaris* Thornton & Wong, *New, Oriental Ins.*, **7** (1) : 5.

Material : 2 ♂♂, 2 ♀♀, Shillong ; Meghalaya ; coll. B. K. Tikader, 1965 ; body-length (in alcohol) : ♂ 2.5 mm., ♀ 2.9 mm.

Distribution : INDIA.

Family STENOPSOCIDAE

7. *Kodamaius mirabundus* (Datta)

1969. *Stenepipsocus mirabundus* Datta, *Zool. Anz.*, **183** (1/2) : 145-146.

Material : 2 ♀♀, chasilakha, Bhutan ; coll. S. K. Mitra, 3.ii.1969 ; body-length (in alcohol) : 3.5 mm.

Distribution : INDIA ; BHUTAN (new record).

8. *Stenopsocus pallidus* Thornton & Wong

1966. *Stenopsocus pallidus* Thornton & Wong, *Trans. R. ent. Soc. Lond.*, **118** (1) : 13.

Material : 2 ♀♀, chasilakha, Bhutan ; Coll. S. K. Mitra, 3.ii.1969 ; body-length (in alcohol) : 3.2 mm.

Distribution : INDIA ; BHUTAN (new record).

9. *Stenopsocus nepalensis* New

1971. *Stenopsocus nepalensis* New, *Canad. Ent.*, **103** (2) : 207-209.

1978. *Stenopsocus nepalensis* New, *Ent. Basil*, **3** : 72.

Material : 1 ♀, Ganalakha, Bhutan ; Coll. S. K. Mitra, 26.i.1969 ; body length (in alcohol) : 2.6 mm.

Distribution : NEPAL ; BHUTAN.

Family AMPHIPSOCIDAE

10. *Amphipsocus pilosus* McLachlan

1872. *Amphipsocus pilosus* McLachlan, *Entomologist's mon. Mag.*, **9** : 77.

Material : 1 ♂, 1 ♀, Putlibir, Bhutan ; Coll. S. K. Mitra, 10.ii.1969 ; body-length (in alcohol) : ♂ 2.4 mm. ♀ 2.8 mm. 1 ♂, 1 ♀, Shillong, Meghalaya ; Coll. B. C. Das, 31.viii.1977 ; body-length (in alcohol) : ♂ 2.8 mm., ♀ 3.3 mm.

Remarks : The specimens were collected and recorded here after an interval of long period. A black spot in the pterostigma of the forewing is present.

Distribution : INDIA ; BHUTAN (new record).

Family LACHESILLIDAE

11. *Lachesilla* sp.

Material : 1 ♂, 1 ♀, Putlibir, Bhutan ; coll. S. K. Mitra, 7.iii.1969 ; body-length (in alcohol) ; ♂ 1.7 mm., ♀ 2 mm.

Remarks : Its specific identity was not possible due to lack of more material and host-tree record.

Family PERIPSOCIDAE

12. *Peripsocus quercicola* Enderlein

1906. *Peripsocus quercicola* Enderlein, *Stettin ent. Ztg.*, **67** : 316.

1966. *Peripsocus quercicola* Enderlein, Thornton & Wong, *Trans. R. ent. Soc. Lond.*, **118** (1) : 18.

Material : 1 ♂, Shillong, Meghalaya ; coll. B. K. Tikader, 1965 ; body-length (in alcohol) : 1.6 mm.

Distribution : INDIA ; SINGAPORE ; HONG KONG ; TAIWAN AND JAPAN.

Family HEMIPSOCIDAE

13. *Hemipsocus ornatus* Datta

1969. *Hemipsocus ornatus* Datta, *Zool. Anz.*, **182** (3/4) : 288-290.

Material : 1 ♂ ; Agartala Tripura ; Coll. K. K. Ray, 18.xii.1981 ; body-length (in alcohol) : 2.5 mm.

Remarks : The beautiful pigmentation on the veins of forewing is an attraction of the species, which was collected from a dry bamboo craft. It is a new record from Tripura.

Distribution : INDIA (Tripura).

Family PSEUDOCAECILIIDAE

14. *Pseudocaecilius citricola* (Ashmead)

1879. *Psocus citricola* Ashmead, *Can. Ent.*, **11** : 228.

1903. *Pseudocaecilius elutus* Enderlein, *Anns. hist.-nat. Mus. natn. hung.*, **1** : 261.

1976. *Pseudocaecilius citricola* (Ashmead), Turner, *Syst. Ent.*, **1** : 212.

Material : 2 ♀ ♀, Putlibir, BHUTAN ; Coll. S. K. Mitra, 7.iii.1969 ; body-length (in alcohol) : 1.9 mm.

Distribution : INDIA ; BHUTAN (new record) ; SINGAPORE ; MADAGASCAR ; SOUTH AFRICA ; MOSAMBIQUE ; CONGO ; PORTO RICA and NORTH AMERICA.

Family PSOCIDAE

15. *Amphigerontia nubila* Enderlein

1906. *Amphigerontia nubila* Enderlein, *Zool. Jh.*, **23** : 247.

1969. *Amphigerontia nubila* Enderlein, Datta, *Zool. Anz.*, **182** (3/4) : 291-292.

Material : 1 ♀, Morch, Manipur ; Coll. P. T. Cherian, 26.ii.1975 ; body length (in alcohol) : 4 mm.

Remarks : This is a large species and is generally collected from cool and shady places. Its pictured forewings are distinctive.

Distribution : INDIA (Manipur [new record]) and JAPAN.

16. *Psococerastis assamensis* Datta

1966. *Psococerastis assamensis* Datta, *J. Beng. nat. Hist. Soc.*, **35** (1) : 16-20.

Material : 2 ♂ ♂, 2 ♀ ♀, New charachandpur, Manipur ; Coll. M. S. Shishodia, 19.ix.1975 ; body length (in alcohol) ; ♂ 3.6 mm., ♀ 4 mm.

Remarks : Its hypandrium is apically bilobed, each on inner side with a set of teeth, each side laterally with a blunt projection ; and the penial structure is oval, stout, internally curved inwards and backwards, two arms apically free, well-sclerotised, acute, provided with flat structures beset with short spines.

Distribution : INDIA.

17. *Psococerastis sinensis* Thornton

1960. *Psococerastis sinensis* Thornton, *Trans. R. ent. Soc. Lond.*, **112** (10) : 248-252.

Material : 1 ♂, 1 ♀, Shillong, Meghalaya ; coll. B. K. Tikader 1965 ; body length (in alcohol) : ♂ 3.6 mm., ♀ 4.3 mm.

Remarks : Its hypandrium is apically bilobed, each lobe ending in a close set of teeth, a tract of spines only on right lobe ; and the penial structure is a stout closed frame, well sclerotised, with a "notch" posteriorly, a small pointed projection anteriorly.

Distribution : INDIA (new record) ; HONG KONG.

18. *Trichadenotecnum distinctum* Datta

1969. *Trichadenotecnum distinctum* Datta, *Zool. Anz.*, 183 (1/2) : 148-149.

Material : 1 ♀, Shillong, Meghalaya ; Coll. B. K. Tikader, 1965 ; body length (in alcohol) : 2.5 mm.

Distribution : INDIA.

SUMMARY

Psocoptera of North-Eastern India are now known to comprise 43 species and the fauna of Bhutan by 25 species. Records include 38 species recorded by McLachlan (1866), Enderlein (1903), Needham (1909), Banks (1914), Datta (1963, 1966, 1969 & 1970), Thornton & Wong (1966), Lee & Thornton (1967) and Badonnel (1981) and 20 species from the latter area by New (1978). A summary of Psocoptera so far recorded from the above two areas is shown in the following table [(+) marks indicate the recorded species whereas (-) marks are for the unrecorded ones].

TABLE 1.

Sl. No.	Name of the species	Family	N. E. INDIA	BHUTAN
1.	<i>Lepinotus indicus</i> Badonnel	Trogiidae	+	—
2.	<i>Rhyopsocus afer</i> „	Psoquillidae	+	—
3.	<i>Psyllipsocus ramburi</i> Selys-Longchamps	Psyllipsocidae	+	—
4.	(?) <i>Pseudoseopsis marginepunctata</i> New	Amphientomidae	—	+
5.	<i>Liposcelis entomophilus</i> (Enderlein)	Liposcelidae	+	—
6.	<i>L. bengalensis</i> Badonnel	„	+	—
7.	<i>Tapinella formosana</i> Enderlein	Pachytroctidae	+	—
8.	<i>Epipsocus conspersus</i> Banks	Epipsocidae	+	—
9.	<i>E. costalis</i> Banks	„	+	—
10.	<i>E. thimphuensis</i> New	„	—	+
11.	<i>Hinduipsocus annulipes</i> Badonnel	„	+	—
12.	<i>H. atratus</i> Badonnel	„	+	+
13.	<i>Caecilius ? himalayanus</i> Enderlein	Caeciliidae	+	—
14.	<i>C. ceylonicus</i> Enderlein	„	+	—
15.	<i>C. muggenburgi</i> „	„	+	—
16.	<i>C. pictifrons</i> Thornton & Wong	„	+	—
17.	<i>C. bengalensis</i> Badonnel	„	+	—
18.	<i>Dypsocus coleoptratus</i> (Hagen)	„	+	—
19.	<i>D. fucosus</i> Thornton & Wong	„	+	—
20.	<i>Fulleborniella persimilaris</i> Thornton & Wong	„	+	—
21.	<i>F. bhutanensis</i> New	„	—	+

TABLE 1. (Concluded)

Sl. No.	Name of the species	Family	N. E. INDIA	BHUTAN
22.	<i>Taeniosigma</i> (?) <i>ingens</i> Enderlein	Stenopsocidae	—	+
23.	<i>Stenopsocus pallidus</i> Thornton & Wong	„	+	+
24.	<i>Kodamaius mirabundus</i> (Datta)	„	—	+
25.	<i>Stenopsocus nepalensis</i> New	„	—	+
26.	<i>Stenopsocus signatipennis</i> New	„	—	+
27.	<i>Kodamaius wittmeri</i> New	„	—	+
28.	<i>K. besucheti</i> Badonnel	„	+	—
29.	<i>K. khasiensis</i> „	„	+	—
30.	<i>K. loebli</i> „	„	+	—
31.	<i>Amphipsocus pilosus</i> McLachlan	Amphipsocidae	—	+
32.	<i>Kolbea punctata</i> Banks	„	+	—
33.	<i>Amphipsocus heterothrix</i> Thornton & Wong	„	+	+
34.	<i>Dasypsocus chillcotti</i> New	„	—	+
35.	<i>Dasypsocus</i> sp.	„	—	+
36.	<i>Lachesilla</i> sp.	Lachesillidae	—	+
37.	<i>Peripsocus quercicola</i> Enderlein	Peripsocidae	+	—
38.	<i>P. minutus</i> Datta	„	+	—
39.	<i>P. sinensis</i> „	„	+	—
40.	<i>P. bhaktai</i> Badonnel	„	+	—
41.	<i>Ectopsocus briggsi</i> McLachlan	Ectopsocidae	+	—
42.	<i>Hemipsocus chloroticus</i> (Hagen)	Hemipsocidae	—	+
43.	<i>H. ornatus</i> Datta	„	+	—
44.	<i>Pseudocaecilius citricola</i> (Ashmead)	Pseudocaeciliidae	—	+
45.	<i>Allocaecilius heterothrix</i> Lee & Thornton	„	+	—
46.	<i>Heterocaecilius fuscipalpus</i> Lee & Thornton	„	+	—
47.	<i>Scytopsocopsis hirtipenna</i> Thornton	„	+	+
48.	<i>Psococerastis</i> (<i>Psococerastis</i>) <i>taprobanes</i> (Hagen)	Psocidae	+	+
49.	<i>Psococerastis nirvana</i> (Banks)	„	+	—
50.	<i>Ps. sinensis</i> Thornton	„	+	—
51.	<i>Ps. assamensis</i> Datta	„	+	—
52.	<i>Ps. nilae</i> „	„	+	—
53.	<i>Cerastipsocus subcostalis</i> Enderlein	„	+	—
54.	<i>Amphigerontia nubila</i> Enderlein	„	+	—
55.	<i>Trichadenotecnum distinctum</i> Datta	„	+	—
56.	<i>T. sclerotum</i> New	„	—	+
57.	<i>Psococerastis rhondae</i> New	„	—	+
58.	<i>Psocidus</i> (S. Str.) <i>samchiensis</i> New	„	—	+
59.	<i>Metylophorus fuscatus</i> New	„	—	+
60.	<i>M. paranebulosus</i> New	„	—	+
61.	<i>Myopsocus fraternus</i> (McLachlan)	Myopsocidae	+	—
62.	<i>M. pattoni</i> Datta	„	+	—
63.	<i>M. sanguensis</i> New	„	—	+

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STUDIES ON THE PROTOZOAN PARASITES OF ORISSA

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INTRODUCTION

Orissa state lies between 17°48' and 22°30' north latitude and 81°24' and 87°18' east longitude. The total land area of the state is 37 million acres. The hill ranges stretch from north to south and rise to an elevation of 762.0 to 1066.8 m. above sea level. On the north east region, there lies the Simlipal range in Mayurbhanj district. The central portion consists of dense forest and hills interposed with fertile valleys. The average temperature and annual rainfall in the state ranges from 20-30°C and 228.6-317.5 cm. respectively. The state with its diverse ecological niches affords suitable condition to accommodate various types of animals.

Several surveys were undertaken during 1971-1974 (4 years) covering almost all the districts of Orissa to study the Protozoan parasites of different group of animals. Only a few stray reports like Patnaik (1963), Patnaik and Ray (1965, 1966) Patnaik and Mohanty (1969), Patnaik and Acharjyo (1971, 1972) are available from this part of the country, who mainly studied the coccidian parasites of some domestic animals and zoo animals of Nandan Kanan Zoological garden, Orissa. A special emphasis was given to examine other group of freeliving animals in addition to the captive animals of Nandan Kanan Biological park for Protozoan parasites.

MATERIAL AND METHODS

Two hundred ninety eight examples of mammals belonging to 55 spp., 118 examples of birds belonging to 30 spp., 110 examples of reptiles belonging to 20 spp. and 35 examples of Amphibia consisting of 5 spp., were collected from Orissa and examined both for intestinal and blood parasites. Faecal samples were collected. A portion of it was kept in 2.5% Potassium dichromate solution for examination of

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coccidian parasites and another part of faecal sample was kept in 1% normal saline for examination of other intestinal protozoans. Blood was obtained by puncturing the brachial vein in case of birds and by cutting the tail tips and digits in case of reptiles and amphibians. When the animals were dead or sacrificed, blood was taken directly from the heart by means of syringe or capillary pipette. Blood smears were fixed in 100% methanol and stained with Romanowsky type of stains.

OBSERVATIONS

The protozoan parasites investigated during this survey have been broadly classified into two categories *viz.*, (A) Intestinal and (B) Blood inhabiting protozoans.

(A) Intestinal Protozoans :

A number of intestinal protozoa *viz.*, Coccidians, Ruminant ciliates, Nyctotherus and Opalinids were recorded from different group of animals.

The Barking deer (*Muntiacus muntjak*) was collected from Berbera forest, Puri district, Orissa and found to harbour the following rumen ciliates as endocommensals.

Family OPHRYOSCOLECIDAE

Entodinium dubardi Buisson, 1923

Material : 1 ex. on slide ; Z. S. I. Reg. No. Pt. 1704 ; locality—Berbera, Orissa ; host—Barking deer ; 23.7.73 ; habitat—stomach ; coll. Dr. A. K. Mandal.

Description : Body oval, length 1.5 times the dorso-ventral diameter. The anterior end is truncated, strongly flattened laterally. Cytostome is relatively small in appearance, single contractile vacuole is situated to the left of the anterior end of the macronucleus. Macronucleus large, band or sausage-shaped. Micronucleus elongated situated at or in front of the middle of macronucleus. The dimension is 35-45 μm \times 25-30 μm .

Remarks : Banerjee (1955) reported this ciliate from barking deer.

Entodinium ovinum Dogiel, 1927

Material : 2 exs. on slides Z. S. I. Reg. No. Pt. 1719, 1934 ; locality—Berbera, Orissa ; host—Barking deer ; 22.7.73 & 23.7.73 ; habitat—stomach ; coll. Dr. A. K. Mandal,

Description : Body is oval with somewhat truncated anterior and rounded posterior end. Ciliary apparatus and endoplasmic sack do not present any characteristic feature. The latter contains numerous small food-particles. A large contractile vacuole is situated to the left of the anterior end of the macronucleus. Macronucleus is sausage-shaped, beginning near the anterior end of the body and extending along the dorsal surface up to the posterior third of the body. Micronucleus lies on the middle of the macronucleus. The body measures 52-65 μm in length and 34-40 μm in breadth.

Entodinium ovoideum Kofoid and MacLennan, 1930

Material : 2 exs. on slides ; Z. S. I. Reg. No. Pt. 1710, 1936 ; locality—Berbera, Orissa ; host—Barking deer ; 23.7.73 & 24.7.73 ; habitat—stomach ; coll. Dr. A. K. Mandal.

Description : Body ovoidal. Anterior end is truncated, posterior end smoothly rounded, with no indication of a ventral lobe. Endoplasmic sack bounded by a fairly distinct boundary layer. Contractile vacuole is situated to the left of the macronucleus at its anterior end. Macronucleus long, slightly wedge-shaped, wider anteriorly, extending along the anterior two-thirds to three-fourths of the length of the body in the dorsal mid-line. Micronucleus small, ellipsoidal lies on the left ventral side of the anterior third of the macronucleus. The dimension is 35-45 μm in length.

Entodinium simplex Dogiel, 1925

Material : 2 exs. on slides ; Z. S. I. Reg. No. Pt. 1718, 1735 ; locality—Berbera, Orissa ; host—Barking deer ; 23.7.73 & 24.7.73 ; habitat—stomach ; coll. Dr. A. K. Mandal.

Description : Body elongated oval, unarmed, with rounded posterior end. Contractile vacuole situated to the left of the anterior end of the macronucleus. Macronucleus band-shaped, closely applied against the surface of the body, and confined to its anterior two-thirds. Micronucleus small, oval, usually close to the middle of the macronucleus. The dimension is 40-50 μm in length and 22-28 μm in breadth.

Diplodinium minor (Dogiel, 1925)

Material : 2 exs. on slides ; Z. S. I. Reg. No. Pt. 1699, 1700 ; locality—Berbera, Orissa ; host—Barking deer ; 23.7.73 ; habitat—stomach ; coll. Dr. A. K. Mandal.

Description : Body oval, truncated anteriorly. Dorsal zone of membranellae lies at the same transverse level of the body as the adoral zone. A narrow, longitudinal, cuticular line extends along the right dorsal surface from the base of outer dorsal furrow to dorsal edge of the anal opening. Operculum shallow, projecting a short distance anteriorly. Endoplasmic sack does not form an anterior diverticulum extending into the operculum. Macronucleus relatively stout, somewhat hatchet-shaped, lying under the right surface of the body, slightly dorsal to the lateral midline. Micronucleus small, ovoid, lying in a slight concavity on the antero-dorsal surface of the macronucleus. Contractile vacuoles two, usually subequal, lying along the dorsal mid-line of the body. The body dimension is 55-78 μm in length, dorsoventral diameter is 40-50 μm .

Eudiplodinium maggii Fiorentini, 1889

Material : 3 exs. on slides ; Z. S. I. Reg. No. Pt. 1701, 1702, 1737 ; locality—Berbera, Orissa ; host—Barking deer ; 22.7.73 & 23.7.73 ; habitat—stomach ; coll. *Dr. A. K. Mandal*.

Description : Body roughly triangular in side view, sharply truncated anteriorly and tapering to a smoothly rounded posterior end. Dorsal surface is convex. Dorsal membranellae zone relatively large, operculum relatively small and inconspicuous. Skeletal plate lies beneath the right surface and extends from the oral region dorsally across the middle of the body. Usually two contractile vacuoles lie beneath the dorsal surface near the mid-line. Macronucleus elongate, rod-like with the anterior end hooked dorsally, situated beneath the middle of the right surface adjacent to the dorsal border of the skeletal plate. Micronucleus ovoidal, lying in the concavity of the hook. The body dimension is 105-250 μm in length.

Remarks : Banerjee (1955) reported this ciliate for the first time from barking deer.

Metadinium medium Awerinzew & Mutafova, 1914

Material : One ex. Z. S. I. Reg. No. Pt. 1703 ; locality—Berbera, Orissa ; host—Barking deer ; 23.7.73 ; habitat—stomach ; coll. *Dr. A. K. Mandal*.

Description : Body large and heavy, flattened laterally. Anterior end blunt, posterior end truncated or slightly rounded. Dorsal membranellae zone also large. Operculum relatively very small. Two skeletal plates extend from the border of the oral area beneath the right surface towards the middle of the body. Endoplasmic sack relatively small,

usually with two distinct projections on the dorsal and ventral sides. Two large contractile vacuoles in the hollow between the lobes of the macronucleus. Macronucleus elongate, adjacent to the dorsal lobes of the skeletal plate. Micronucleus small, ovoid, lying in a slight depression along the anterior border of the middle portion of the macronucleus. The dimension is 110-250 μm in length.

The other intestinal forms which were recorded from different group of vertebrates already reported earlier are represented as follows :

Family BALANTIDIIDAE

Balantidium gracile Bezenberger, 1904

Material : 2 exs., on slide ; Z. S. I. Reg. Nos. Pt 1643, 1644 ; locality—Konark, Puri district, Orissa ; host—*Rana* sp. ; 28.7.73 ; habitat—Rectum ; coll. *Dr. A. K. Mandal*.

Description : Body cylindrical, tapering and rounded at both ends ; peristome excavate, extending up to about one - seventh the length of the body ; two contractile vacuoles ; macronucleus oval ; micronucleus rounded.

Family OPALINIDAE

Opalina coracoidea Bezenberger, 1904

Material : 1 ex. on slide ; Z. S. I. Reg. No. Pt. 1648 ; locality—Konark, Puri dist., Orissa ; host—*Rana cyanophlyctis* ; 30.7.73 ; habitat—intestine and rectum ; coll. *Dr. A. K. Mandal*.

Description : Body oval, anterior end narrower, posterior end broadly rounded ; nuclei numerous.

Protoopalina malabarica Uttangi, 1961

Material : 4 exs. on slides ; Z. S. I. Reg. Nos. Pt. 1683-1686 ; locality—Badrama, Sambalpur and Deogarh, Orissa ; host *Rana* sp. ; 23.12.72 & 31.12.72 ; habitat—Intestine and rectum ; coll. *Dr. A. K. Mandal*.

Description : Body elongated ; two pear shaped nuclei with a nuclear thread connecting the nuclei.

Family NYCTOTHERIDAE

Nyctotherus cordiformis (Ehrenberg, 1838)

Material : 1 ex. on slide ; Z. S. I. Reg. No. Pt. 1660 ; locality—Badrama, Sambalpur, Orissa ; host—*Rana* sp. ; 24.12.72 ; habitat—Intestine and rectum coll. *Dr. A. K. Mandal*.

Description : Body bean or kidney-shaped, somewhat pointed anteriorly ; cytopharynx reaching beyond the middle of the body ; contractile vacuole single, posteroterminal, with cytophyge close to it. Macronucleus kidney-shaped, with a minute centrally attached micronucleus.

Nyctotherus magnus Bezenberger, 1904

Material : 1 ex. on slide ; Z. S. I. Reg. No. Pt. 1661 ; locality—Badrama, Sambalpur, Orissa ; host—*Bufo* sp. ; 24.12.72 ; habitat—intestine and rectum ; coll. *Dr. A. K. Mandal*.

Description : Body flattened, kidney-shaped, with the posterior end slightly thicker than the anterior ; cytopharynx funnel-shaped ; contractile vacuole single, situated on the posterior part of the body ; macronucleus strongly flattened ; micronucleus lies in front of macronucleus.

Nyctotherus ovalis Leidy, 1849

Material : 9 exs. on slide ; Z. S. I. Reg. No. Pt. 1615-1623 ; locality—Badrama, Sambalpur, Orissa ; host—*Blata* sp. ; 26.12.72 ; habitat—hind gut ; coll. *Dr. A. K. Mandal*.

Description : Body broadly egg-shaped ; the anterior extremity rounded ; cytopharynx not reaching beyond the middle of the body, transverse in direction ; contractile vacuole single, subterminal ; macronucleus egg-shaped.

Plagiotoma dichogasteri Mandal and Nair, 1975

Material : 4 exs. on slides ; Z. S. I. Reg. Nos. Pt. 1745 (Holotype) and Pt. 1746-1748 (Paratype) ; locality—Khajuripada, Orissa ; host—Earthworm, *Dichogaster bolawi* ; 17.7.73 ; habitat—Coelom (posterior half) ; coll. *Dr. A. K. Mandal*.

Description : Body elongated, oval, anterior end bluntly pointed, posterior end rounded ; posterior portion below the cytopharynx vacuolated ; contractile vacuole single and located below the cytopharynx ; cytopharynx continues as a curved conical tube ; macronucleus an irregular fragmented mass ; micronuclei two, subspherical.

Remarks : This species was reported by Mandal and Nair (1975) for the first time in India.

Plagiotoma pellogasteri Mandal and Nair, 1976

Material : 5 exs. on slides ; Z. S. I. Reg. No. Pt. 1825 (Holotype) and Pt. 1826 to 1829 (Paratypes) ; locality—Biswanathpur, Koraput Dist.

Orissa ; host—Earthworm, *Pellogaster bengalensis* ; 10.7.74 ; habitat—Coelom ; coll. *Dr. A. K. Mandal*.

Description : Body elongated, flat, anterior end bluntly pointed, posterior end attenuated. Body ciliation uniform ; cytopharynx continuous as a conical tube ; peristome and cytostome provided with membranellae. Macronucleus consists of two unequal fragments ; micronucleus single, rounded.

Remarks ; The species was reported by Mandal and Nair (1976) for the first time from India.

Family HYSTERICINETIDAE

***Ptychostomum drawidi* Mandal and Nair, 1976**

Material : 6 exs. on slides ; Z. S. I. Reg. No. Pt. 1819 (Holotype) and Pt. 1820-1824 (Paratypes) ; locality—Biswanathpur, Koraput Dist., Orissa ; host—Earthworm, *Drawida willsi* ; 10.7.74 ; habitat—Intestine ; coll. *Dr. A. K. Mandal*.

Description : Body elongated, flat anterior half-narrow ending in a blunt cone, posterior half broad truncated. Prominent sucker with 6-7 kinetics ; cytopharynx is a small tapering tube 6-7 μm in length ; single contractile vacuole is prominent and located at posterior third ; numerous food vacuoles on the posterior part ; macronucleus palm-shaped ; micronucleus not observed.

Remarks : The species was reported by Mandal and Nair (1976) for the first time from Orissa.

Family EIMERIIDAE

***Eimeria polita* Péllerdy, 1949**

Material : 2 exs. on slide ; Z. S. I. Reg. Nos. Pt. 1641, 1642 ; locality—Nandan Kanan Zoo, Orissa ; host—wild boar (*Sus* sp.) ; 3.8.73 ; habitat—Intestine ; coll. *Dr. A. K. Mandal*.

Description : Oocyst ellipsoidal or broadly oval ; oocyst residuum absent ; sporocyst ellipsoid sporocyst residuum present ; sporozoites long. The cyst wall yellowish or colourless and thick.

Remarks : The species has been recorded for the first time from wild boar in India.

***Isospora felis* weynon, 1923**

Material : 1 ex. on slide ; Z. S. I. Reg. No. Pt. 1639 ; locality—Nandan Kanan Zoo, Orissa, host—Tiger Cub (*Panthera tigris*) ; 3.8.73 ; habitat—Intestine coll. *Dr. A. K. Mandal*.

Description : Oocyst egg-shaped, with one pole somewhat narrowed : sporocyst pyriform ; each sporocyst contains four club-shaped sporozoites ; and a large rounded, granular residual mass ; oocyst residuum absent.

Remarks : This species has been recorded by a number of workers in domestic cats, *Felis domesticus*. But this report is for the first time from tiger cub from Orissa.

Family TRICHOMONADIDAE

Trichomonas gallinae (Rivolta, 1878)

Material : 3 exs. on slides ; Z. S. I. Reg. Nos. 1694, 1695 & 1696 ; locality—Berbera, Puri Dist., Orissa ; host—*Streptopelia chinensis* ; 21.7.73 ; habitat—Buccal cavity ; coll. Dr. A. K. Mandal.

Description : Body is roughly pyriform ; 4 anterior long flagella arise from the blepharoplast ; axostyle narrow and protrudes a short distance from the body ; no chromatic ring ; parabasal body sausage shaped ; undulating membrane does not reach the posterior end of the body ; an accessory filament present ; cytostome absent.

Remarks : This species has been recorded from a new host *Streptopelia chinensis* from Orissa.

(B) Blood protozoans :

A number of blood inhabiting protozoans belonging to the genera *Trypanosoma*, *Haemogregarina*, *Haemoproteus* and *Plasmodium* were recorded from different group of vertebrates. These are represented as follows :

Family TRYPANOSOMATIDAE

Trypanosoma rotatorium (Mayer, 1843)

Material : 15 exs. on slides ; Z. S. I. Reg. Nos. Pt. 1586-1591, 1595-1600, 1755-1757 ; locality—Lathore, Bolangir, Orissa and Biswanathpur, Orissa ; 13.12.72 ; host—*Bufo* sp. ; habitat—Blood ; coll. Dr. A. K. Mandal.

Description : These are pleomorphic haemoflagellate having 4 distinct forms viz. juvenile, slender, flat-leaf like and large compact form. Amongst which the flat leaf-like forms are most predominant. Cytoplasm densely granular in the posterior two-third of the body, stains deep blue and has striated myonemes ; nucleus rounded ; kinetoplast very small, surrounded by a halo and situated at the extreme posterior end of the body. Free flagellum is very prominent ; undulating membrane very very conspicuous with many folds.

Remarks : *T. rotatorium* has been described by the junior author (Ray, 1979) from a number of anuran hosts in India.

Trypanosoma sp.

Material : 2 exs. on slides ; locality—Berbera, Puri district, Orissa ; 21.7.73 host—Stone lizard ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Flat leaf-like, sometimes slender ; cytoplasm densely granular ; nucleus median ; kinetoplast dot-like ; undulating membrane conspicuous with many folds ; free flagellum long.

Remarks : This haemoflagellate has been recorded for the first time from stone lizard. But due to insufficient materials it is not possible to name the parasite.

Family HAEMOGREGARINIDAE

Haemogregarina triedri Robertson, 1908

Material : 3 exs. on slides ; Z. S. I. Reg. Nos. 1604—1606 ; locality—Deogarh, Orissa ; 30.12.72 ; host—*Hemidactylus* sp. ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Two gametocytic forms present (1) Broad bean-shaped and (2) long, slightly recurved forms ; having double capsule—a delicate inner and a loose outer one ; nucleus fragmented.

Haemogregarina mirabilis Castellani & Willey, 1904

Material : 4 exs. on slides ; locality—Pulicot lake, Orissa, 28.7.73 ; host—*Xenochrophis piscator* ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Forms elongate, thick, gregarine-like, capsulated gametocyte ; cytoplasm stains uniform blue ; nucleus stains reddish-blue and is near the anterior pole.

Remarks : The species has been reported by a number of workers from India (Bhatia, 1938).

Haemogregarina sp.

Material : 2 exs. on slides, locality—Berbera, Puri district, Orissa ; 27.7.73 ; host—*Calotes versicolor* ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Body of the gametocyte kidney-bean shaped, capsulated ; nucleus oval or rounded ; some forms have compact nucleus and some have vesicular nucleus.

Remarks : Due to the paucity of material it is not possible to designate any name of this parasite.

Haemogregarina sp.

Material : 3 exs. on slides ; locality—Berbera, Puri district, Orissa 27.7.73 ; host—stone lizard ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Body of the gametocyte elongated with one end tapering ; capsule absent ; free forms also present ; rounded nucleus situated at the broader end.

Family HAEMOPROTEIDAE

Haemoproteus columbae Kruse, 1890

Material : Many exs. on slide ; Z. S. I. Reg. No. Pt. 1798 ; locality—Kalinga, Orissa ; host—*Streptopelia chinensis* ; 10.6.74 ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : The young gametocytes are elongated having granules of black pigments in cytoplasm. The fully developed gametocytes are distinguishable as macro- and microgametocytes. Male or microgametocyte possesses a hyaline cytoplasm staining pale blue and nucleus with fine chromatin granules. Female or macrogametocyte possesses dense cytoplasm which stains deep blue. The nucleus is more compact than the microgametocytes.

Remarks : Nandi and Mandal (1977) reported this parasite from Orissa for the first time.

Haemoproteus dicruri de Mello, 1935

Material : Many exs. on slides ; Z. S. I. Reg. No. Pt. 1743, 1744 ; locality—Kalinga, Orissa ; host—*Dicrurus adsimilis* ; 4.9.74 ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Gametocytes can be differentiated into macro or female and micro or male gametocyte. The female gametocyte stains deep blue with Leishman's stain but the poles and the borders remain unstained ; nucleus small, subcentral, stains pale rose. Male gametocytes are oval ; either light stained or not stained ; nucleus rod-like, subcentral, stained pale rose ; pigments in the form of large granules.

Haemoproteus fallisi Bennett & Campbell, 1972

Material : Many exs. on slide ; Z. S. I. Reg. No. Pt. 1796 ; locality—Kalinga, Orissa ; 4.7.74 ; host—*Copsychus saularis* ; habitat—blood ; coll. *Dr. A. K. Mandal*.

Description : Macrogametocyte—small slightly halteridial, not extending upto the poles of the host cell ; cytoplasm coarsely granular,

vacuolated and staining blue ; nucleus compact, rounded sometimes lodged in a vesicle. Microgametocyte—the cytoplasm finely granular staining light blue ; nucleus median, large, staining light pink.

Haemoproteus (Parahaemoproteus) fringillae Labbé 1894

Material : Many exs. on slides ; Z. S. I. Reg. Nos. Pt. 1741, 1742 ; locality—Kalinga, Orissa ; 2.9.74 ; host—*Copsychus saularis* ; habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte-halteridial with a marked constriction at the middle of the convex margin ; cytoplasm somewhat coarse with small scattered vacuoles, staining blue. Microgametocyte-cytoplasm granular staining light blue peripherally ; nucleus large central.

Remarks : While reviewing the haemoproteids of the family Turridae, Bennett and Campbell (1972) synonymised *Haemoproteus moruony* de Mello and Brazdesa, 1916 with *H. fringillae*.

Haemoproteus lanii de Mello, 1937

Material : Many exs. on slides ; Z. S. I. Reg. Nos. Pt. 1789 1790, locality—Kalinga, Orissa ; 3.4.77 ; host ; *Lanius schach* habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte halter-shaped, staining blue ; nucleus small, oval or triangular, generally subcentral ; pigment granules large scattered irregularly. Microgametocyte-irregularly halter-shaped, almost quadrangular, not stained or very light blue ; nucleus large, central, without definite outline ; pigment granules very minute, located at the poles.

Haemoproteus meropi Zargar, 1945

Material : Many exs. on slides ; Z. S. I. Reg. Nos. Pt. 1774, 1775, 1776 ; locality—Berbera, Orissa ; 28.7.73 ; host—*Merops orientalis*, habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte-sausage-shaped, encircling the host-cell nucleus ; cytoplasm finely granular, vacuolated, staining light blue ; nucleus compact, rounded or triangular, central or subcentral, staining light rose. Microgametocyte—cytoplasm finely granular, unstained or stained faint blue, vacuolated ; nucleus long, central.

Haemoproteus oryzivora Anschutz, 1909

Material : Many exs. on slides ; Z. S. I. Reg. No. Pt. 1875 ; locality—Kalinga, Orissa ; 2.7.74 & 3.7.74 ; host—*Terpsiphone paradisi* and *Turdoides striatus* ; habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte—broadly sausage-shaped to halteridial ; margin entire ; cytoplasm somewhat coarse, vacuolated, staining blue ; nucleus round to triangular, median to subcentral. Microgametocyte—same size and shape ; cytoplasm granular, faintly staining blue ; nucleus large, central, staining rose.

Haemoproteus passeris Kruse, 1890

Material : Many exs. on slide ; Z. S. I. Reg. No. Pt. 1640 ; locality—Deogarh, Orissa ; 30.12.72 ; host—*Passer domesticus* ; habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte—small, slender, vacuolated ; cytoplasm finely granular, staining light blue ; nucleus oval or triangular. Microgametocyte—cytoplasm unstained or faintly stained ; nucleus large, central, staining rose.

Haemoproteus sacharovi Novy and MacNeal, 1904

Material : Many exs. on slide, Z. S. I. Reg. No. Pt. 1798 (mixed infection with *H. columbae*) ; locality—Kalinga, Orissa ; host—*Streptopelia chinensis* ; 10.6.74 ; habitat—blood ; coll. Dr. A. K. Mandal.

Description : Macrogametocyte—broadly sausage-shaped to slightly halteridial, not amoeboid ; cytoplasm coarsely granulated with numerous vacuoles, staining blue ; pigments yellow black, rod-like, scattered. The cytoplasm of microgametocyte stained faint blue ; nucleus large, central.

Haemoproteus sp.

Material : 1 ex. on slide ; locality—Kalinga, Orissa ; 3.4.74 ; host—*Turdoides striatus* ; habitat—blood, coll. Dr. A. K. Mandal.

Description : Gametocyte sausage-shaped or halteridial ; cytoplasm coarsely granular ; nucleus central or subcentral staining rose.

Remarks : Due to insufficient material no name could be proposed.

Family PLASMODIIDAE

Plasmodium (Novyella) vaughani Novy & MacNeal, 1904

Material : Many exs. on slide ; Z. S. I. Reg. No. Pt. 1868 ; locality—Berbera, Orissa ; 21.7.73 ; host—*Ploceus philippinus* ; habitat—blood ; coll. Dr. A. K. Mandal.

Description : Trophozoite irregularly ring shaped ; schizonts many with 10-20 merozoites ; chromatin relatively large, prominent ; pigments yellowish brown.

Remarks : Nandi and Mandal (1977) reported this species for the first time in India. The same authors also recorded a *Plasmodium* sp. in *Terpsiphone paradisi* (Lin.) from Kalinga, Orissa.

DISCUSSION

A review of the literature on rumen ciliates revealed that Banerjee (1955) reported for the first time, 5 species of ruminant ciliates viz. *Entodinium dubardi*, *E. muntiacum*, *Diplodinium monacanthium*, *Eremoplas-tron asiaticus* and *Eudiplodinium maggi* from Barking deer of Darjeeling district, West Bengal. Roychoudhury and Choudhury (1981) reported six entodinal species from spotted deer (*Axis axis*) of Andaman Islands. The present survey reveals 7 species of Ophryoscolecoid ciliate comprising 4 genera from Barking deer (*Muntiacus muntjak*). Of which *Entodinium ovinum*, *E. ovoideum*, *E. simplex*, *Diplodinium minor* and *Metadinium medium* have been recorded for the first time from Orissa, India.

Other intestinal protozoans communicated in the present paper include 1 species of *Balantidium* from frogs, 3 species of *Nyctotherus* from frogs and cockroaches, 2 species of *Opalina* and 1 species of *Protoopalina* from frogs from different parts of Orissa. In addition, one species of *Eimeria* from wild boar and one species of *Isospora* from a tiger cub from Nandan Kanan Biological Park have also been recorded. Three species of coelomic protozoa viz., *Plagiotoma dichogasteri*, *P. pello-gasteri* and *Ptychostomum drawidi* have been reported by Mandal and Nair (1975, 1976) from earthworms *Dichogaster bolawi*, *Pellogaster bengalensis* and *Drawida willai* of Orissa respectively. *Trichomonas gallinae* has been found to infect a bird, *Streptopelia chinensis* which constitutes a new host record.

One haemoflagellate, *Trypanosoma rotatorium* has been detected from *Bufo melanostictus*. *Haemogregarina triedri* and *H. mirabilis* were found to infect a lizard and a snake respectively. In addition, 2 undetermined haemogregarine species were detected from lizards and snakes. Ten species of *Haemoproteus* and one species of *Plasmodium* have been recorded from the birds of Orissa state (Nandi and Mandal, 1977), of which *Haemoproteus passeris*, *H. sacharovi*, *H. fallisi* and one species of *Plasmodium* viz., *P. (Novyella) vaughani* are claimed to be reported for the first time from India. Infection with *Haemoproteus* spp. were common, occurring in 80% of the birds examined. The absence of infection with blood protozoa other than *Haemoproteus* and *Plasmodium* from these birds might possibly be attributed to the birds harbouring infections subpatent which went undetected in the blood smears or might

be due to the absence of specific vectors essential for spreading the infection.

It is evident from the present survey that the incidence of blood parasites in general is higher in comparison to intestinal protozoans. The endocommensal forms recorded from the Barking deer deserves worth mentioning.

SUMMARY

The present paper includes 36 protozoan parasites recorded from the Orissa survey during the period 1971-1974. Of which 5 species of rumen ciliates have been reported for the first time in Barking deer from this part of Indian subcontinent. This survey reveals a higher incidence of blood parasites in comparison to intestinal protozoans.

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TWO NEW ORIBATID MITES (ACARI) FROM INDIAN SOILS

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(With 4 Text-figures)

INTRODUCTION

As a result of investigations of the oribatid fauna from forests and tea estates of Darjeeling, the northernmost district of the state of West Bengal, India, two new species (*Flagrosuctobelba flabella* sp. nov. and *Peloribates intermedius* sp. nov.) were found. The genus *Flagrosuctobelba* was established by Hammer (1979) with *Flagrosuctobelba multipumosa* as the type-species from Java. Berlese (1908) erected the genus *Peloribates* with *Oribata peloptoides* Berlese, 1888 as the type-species. The genus *Flagrosuctobelba* is being reported here for the first time from India where as the other genus, *Peloribates* is being recorded for the first time from West Bengal. All measurements are in microns.

Flagrosuctobelba flabella sp. nov.

(Text-figs. 1-2)

Female : Colour yellowish ; length of the body : 196-200 ; width of the body : 108-112.

Prodorsum longer than broad ; rostrum projects like a nose, with four lateral teeth on each side, the posterior teeth largest and sharpest of all ; rostral tip broadly angular ; rostral setae strongly elbowed, bushy and knob-like at the middle resembling a painter's brush, simple distally with pointed tips, inserted above the anterior most rostral teeth laterally, 21-24 long, about two and half times as long as their mutual distance ; tectopedial fields large ; lamellae well developed ; lamellar knob large, with a large interior aperture ; lamellar setae discernible by their follicles only, situated on lamellar knob ; interlamellar setae also not discernible, their insertions located on broad interpseudostigmatic ridges anteriorly, the mutual distance of their follicles four times longer than that of the follicles of lamellar setae ; lamellar knob connected with the interpseudostigmatic ridges by a thin ridge ; bothridium depressed, rounded, posteriorly with a lobe ; sensillus flagellate,

with a slender, smooth stalk, distal three fourth moderately incrassate, densely ciliated exteriorly, 52-62 long, directed dorsomesad.

Notogaster rounded, nearly as long as broad, anterior margin straight; four notogastral teeth well developed, middle two broadly

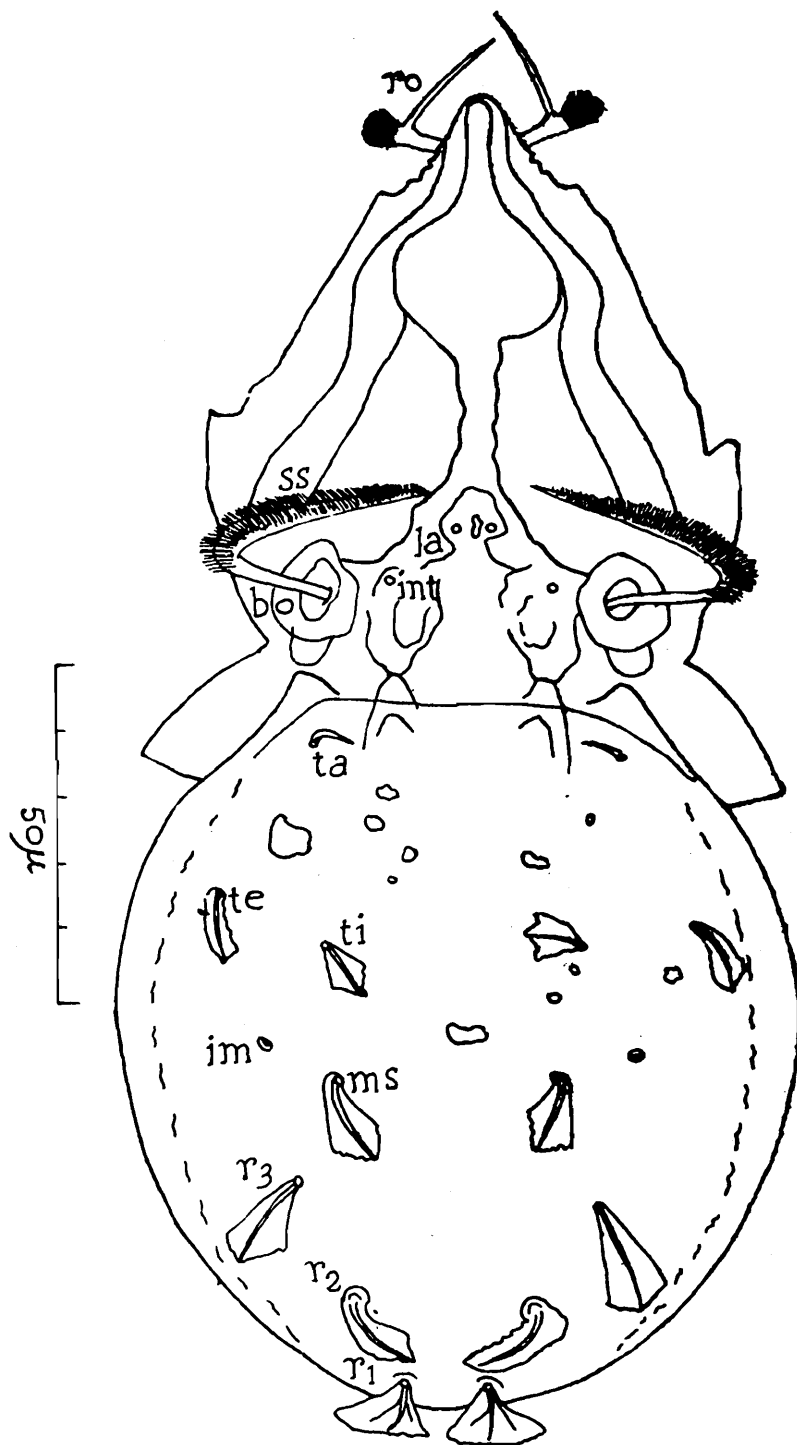


Fig. 1

Text-fig. 1. *Flagrosuctoelba flabella* sp. nov. (Dorsal view), *ro*=rostral seta, *la*=lamellar seta, *int*=interlamellar seta, *ss*=sensillus, *bo*=bothridium, *ta*, *te*, *ti*, *ms*, *r*₁, *r*₂, *r*₃=notogastral setae, *im*=dorsal fissure,

rounded, separated, touching anteriorly the interpseudostigmatic ridges, lateral two pointed, widely separated and extend below the posterior lobe of bothridium anteriorly; notogastral setae nine pairs, heterotrichous, 5-20 long; setae ta and p_2 smooth, simple and setiform, p_1 slightly thicker, ti , te , ms , r_1 , r_2 and r_3 fan-shaped, with distinct midribs

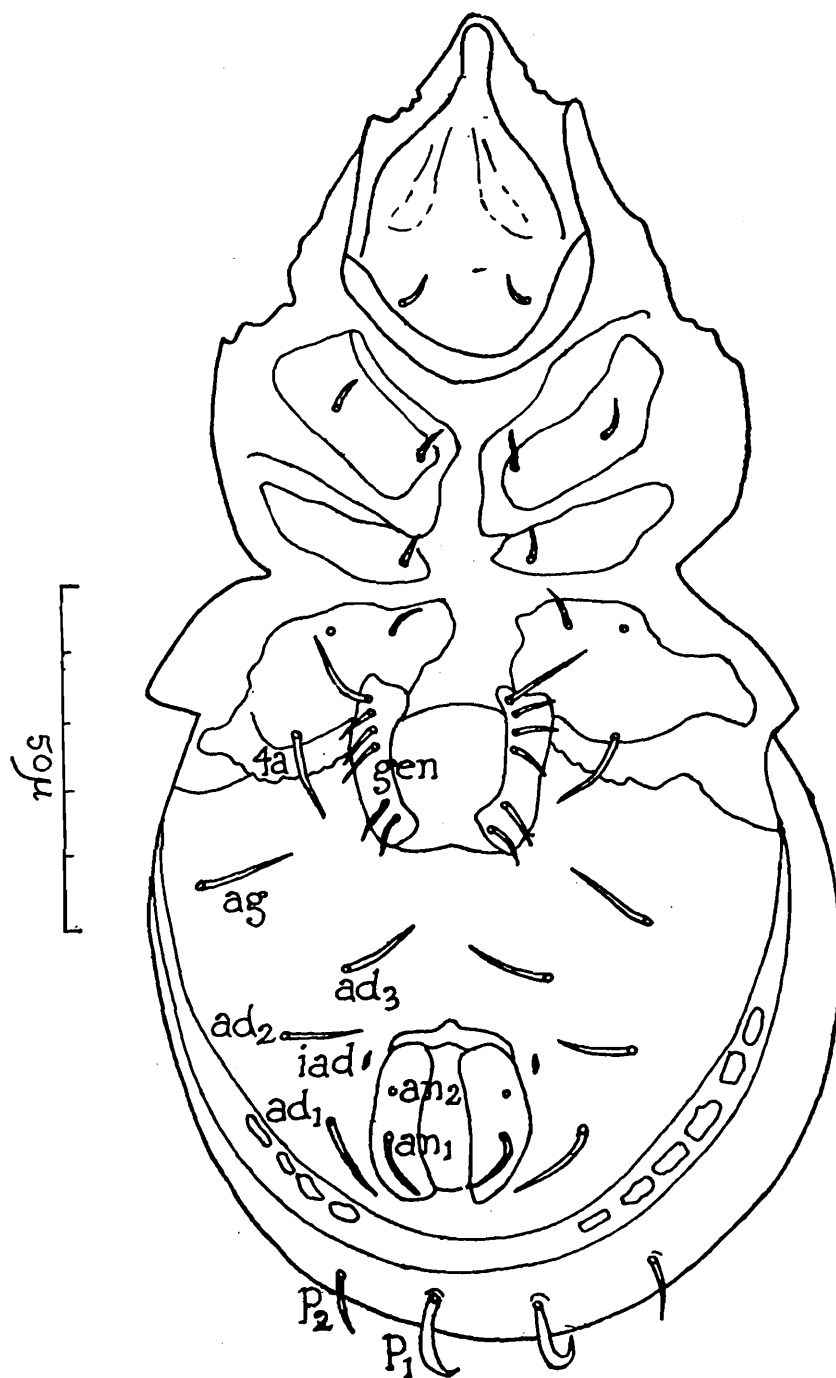


Fig. 2

Text-fig. 2. *Flagrosuctobelba flabella* sp. nov. (Ventral view), p_1 , p_2 = notogastral setae, an_1 , an_2 = anal setae, ad_1 , ad_2 , ad_3 = adanal setae, iad = adanal fissure, gen = genital plate, ag = aggenital seta, fa = epimeral seta.

and undulated anterior margins ; setae *ta* antero-lateral, *ti*, *ms* dorso-medial, *te* medio-lateral, *r₃* postero-lateral, *r₂* postero-medial and *r₁*, *p₁* and *p₂* postero-marginal ; distance between $ta - ta = r_3 - r_3 > ti - ti > ms - ms > r_2 - r_2$.

Each anal plate about two and half times as long as broad, with two smooth, simple setae, 7-8 long, inserted medially ; adanal setae three pairs, smooth, simple, 7-12 long, setae *ad₁* located at nearly middistance along the length of anal aperture, *ad₂* at the anterior back and *ad₃* in front of the anal aperture ; *iad* a small slit, aligned parallel to the lateral border of anal aperture anteriorly ; each genital plate nearly rectangular, about two and half times as long as broad, with six smooth, simple setae, 5-12 long, anterior most longer, others almost equal to each other ; aggenital setae smooth, simple, longer than adanal setae, 8-13 long, widely separated from each other, their mutual distance more than two and half times longer than the maximum width of the genital aperture ; mutual distances of aggenital and adanal setae : $ag - ag > ad_2 - ad_2 > ad_1 - ad_1 > ad_3 - ad_3$; $ag - ag > 2(ad_3 - ad_3)$.

Epimera I and II separated, III and IV fused ; epimera IV with several protuberances posteromarginally ; epimeral setae smooth, simple, 5-12 long, setae *4a* longest ; epimeral setal formula 2-1-2-1.

Legs monodactylous, claws slightly curved.

Holotype : Adult ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Ghum-Simana forest range, Sukiapokhri forest block (from decomposed leaves of *Cryptomeria japonica*), 2100 m., 21.ix.1978 (B. K. Mondal Coll.) ; paratypes : 2 adult ♀♀, same data as for holotype ; paratype : 1 adult ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Tonglu forest range, Palmajua forest bungalow area (from rotten leaves of *Cryptomeria japonica*), 2300 m., 16.viii.1977 (B. K. Mondal Coll.) ; deposited in the laboratory of the Department of Zoology, Presidency College, Calcutta.

This new species has its closest similarity with *Flagrosuctobelba multiplumosa* Hammer, 1979 but it can easily be separated from *multiplumosa* by possessing four rostral teeth, by the structure of rostral setae and medial pair of notogastral teeth, mostly fan-shaped notogastral setae, lesser number of epimeral setae.

***Peloribates intermedius* sp. nov.**

(Text-figs. 3-4)

Female : Colour chestnut brown ; length of the body : 266-296 ; width of the body : 200-206.

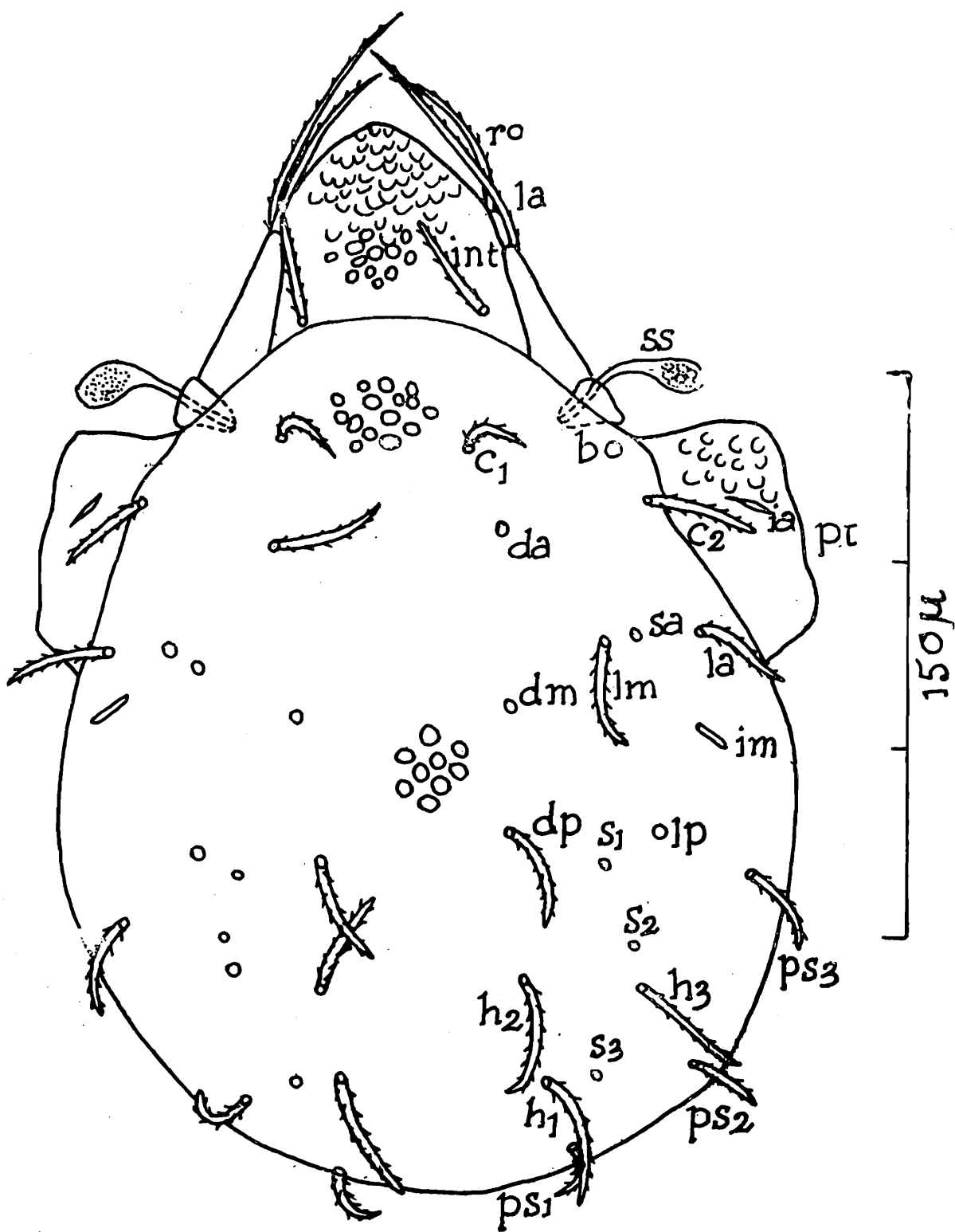


Fig. 3

Text-fig. 3. *Peloribates intermedius* sp. nov. (Dorsal view), *ro* = rostral seta, *la* = lamellar seta, *int* = interlamellar seta, *ss* = sensillus, *bo* = bothridium, *pt* = pteromorph, *c₁*, *c₂*, *da*, *la*, *dm*, *lm*, *dp*, *lp*, *h₁*, *h₂*, *h₃*, *ps₁*, *ps₂*, *ps₃* = notogastral setae, *ia*, *im* = dorsal fissures, *S₁*, *S₂*, *S₃* = sacculi on notogaster.

Prodorsum pitted ; rostrum broadly rounded ; rostral setae strongly incurved, almost meeting apically, unilaterally barbed outwards, situated laterally on either side of the rostrum in front of a sharp free

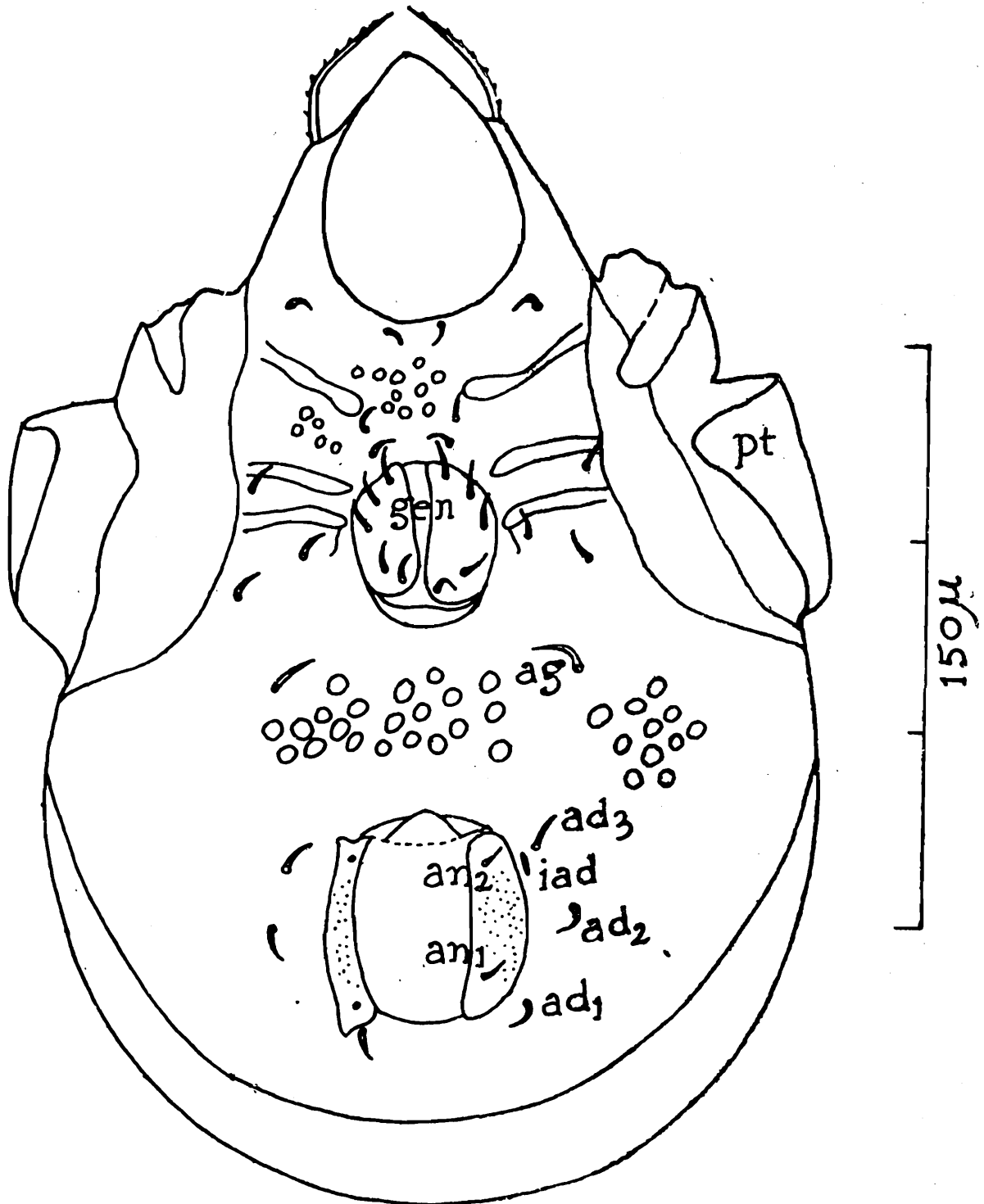


Fig. 4

Text-fig. 4. *Peloribates intermedius* sp. nov. (Ventral view), an_1 , an_2 = anal setae, ad_1 , ad_2 , ad_3 = adanal setae, iad = adanal fissure, gen = genital plate, ag = aggenital seta, pt = pteromorph.

tip of the tutorium, 40-48 long, nearly as long as their mutual distance ; lamellar setae long, exceed far beyond the tip of rostrum, faintly barbed outwards, with very thin and pointed tip, originate laterally from the tip of lamellae, 59-66 long, nearly as long as their mutual distance ; interlamellar setae thick, erect, beset with minute bristles, located a little above the dorsosejugal suture, 29-37 long, nearly half as long as their mutual distance ; bothridium more or less conical, broadest distally, directed antero-laterad ; sensillus with a thin stalk and club-shaped head beset with pseudoscales, 35-38 long, directed postero-laterad ; lamella marginal, gradually attenuating anteriorad, about half as long as prodorsum.

Notogaster somewhat oval in outline, longer than broad, covered with round, light pits ; dorsosejugal suture strongly arched anteriorly ; notogastral setae fourteen pairs, short, stiff, setose, 15-35 long ; setae c_1 , da antero-dorsal, dm , dp mid-dorsal, h_1 , h_2 postero-dorsal, lm , lp , h_3 dorso-lateral, c_2 , la antero-marginal and ps_1 , ps_2 and ps_3 postero-marginal ; distance $c_1 - c_1 = dp - dp < dm - dm < da - da$; distance $lm - lm = h_3 - h_3 < lp - lp$; setae $c_1 < c_2 < da$; setae da , la , lm , dp nearly equal, h_2 , h_3 nearly equal, h_1 longer than either of these two ; ps_1 , ps_2 nearly equal, ps_3 nearly one and half times as long as either of these two ; four pairs sacculi i.e., Sa , S_1 , S_2 , S_3 present, Sa adjacent to the insertion of lm , S_1 lateral to dp , S_2 above h_3 and S_3 lateral to h_1 ; two pairs of oblique notogastral fissures discernible, ia parallel to setae c_2 and im between la and lp ; pteromorphae short with light pits, nearly one fourth as long as the notogaster, about twice as long as broad, broadest anteriorly with slightly undulating lateral and concave anterior margin.

Ventral plate sculpture ; genital plates smooth, anal plates punctate, separated from each other by a distance slightly longer than the length of the genital plates ; each anal plate nearly as long as broad with two minute smooth setae, inserted at the anterior and posterior part of the anal plate in a para-axial row, 3-4 long, nearly equal ; adanal setae three pairs, nearly equal, 5-6 long ; ad_1 postero-lateral, ad_2 medio-lateral and ad_3 antero-lateral of the anal field ; iad minute, parallel, intimately adjacent to the lateral margin of anal field ; genital plate nearly twice as long as broad with five smooth, simple, minute setae, 4-6 long, of these two posteriorly and three anteriorly, closely approximated along the outer margin ; aggenital setae one pair, smooth, situated closer to genital than to anal plates, 7-9 long, their mutual distance nearly twice the maximum width of the combined genital plates.

All epimera pitted, sternal plate faintly chitinized; apodemata II, apodemata sejugalis and apodemata III are narrow, bar-like, almost parallel ridges; apodemata II with a median knot; apodemata sejugalis and apodemata III clasping the anterior part of the genital aperture; epimeral setae smooth, 4-6 long, all nearly equal in length; epimeral setal formula 2-1-2-2.

All the tarsi tridactylous, the middle claw being thickest while the lateral ones half as thick as the middle one.

Holotype: Adult ♀, INDIA: W. Bengal: Darjeeling, Sukna Tea Estate (from rotten leaves of *Thea sinensis*), 135 m., 24.x.1978 (B. K. Mondal Coll.); paratypes: 5 adult ♀♀, data same as for holotype; paratypes: 5 adult ♀♀, INDIA: W. Bengal: Darjeeling, Teesta Valley Tea Estate (from humus), 900 m., 23.x.1977 (B. K. Mondal Coll.); paratypes: 3 adult ♀♀, INDIA: W. Bengal: Darjeeling, Kalimpong forest Div., Neora forest range, Mal forest block (from decomposed leaves of *Dalbergia sissoo*), 200 m., 16.viii.1978 (B. K. Mondal Coll.); deposited in the laboratory of the Department of Zoology, Presidency College, Calcutta.

This species approaches close to one described species, *Peloribates rangiroaensis* Hammer, 1972 and one subspecies, *P. rangiroaensis asiaticus* Aoki et Nakatamari, 1974. It can however, be distinguished from the above mentioned species and subspecies by possessing pseudo-scales on the head of the sensillus, shorter length of interlamellar setae and setae *lm* located in a level parallel to *la*. Besides the above characters, it can be separated from *rangiroaensis* by possessing unprotruded broadly rounded rostrum, by the presence of pits also at the terminal part of the rostrum, by the structure of lamellae, nature of interlamellar setae, shorter length of the setae *c*₂ and in having smaller in body size. It can again be easily distinguished from *P. rangiroaensis asiaticus* by the mutual distances of notogastral setae (viz., the distance *da* - *da* is always somewhat longer than the remainder instead of *c*₁ - *c*₁) and by the position of notogastral sacculi (viz., *S*₁ is located closer to *lp* than to *dp* and *S*₂ antero-lateral instead of antero-medial to *h*₃). Hence, it is considered as a new species.

SUMMARY

This paper deals with the description of two new species of oribatid mites, viz., *Flagrosuctobelba flabella* sp. nov. and *Peloribates intermedius* sp. nov., from forest and tea soils in the district of Darjeeling, India. The genus *Flagrosuctobelba* is reported here for the first time from India and the other genus, *Peloribates* is recorded for the first time from West Bengal.

ACKNOWLEDGEMENTS

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DESCRIPTIONS OF ALL FEMALE INSTARS OF THE MEALYBUG,
DYSMICOCCLUS BREVIPES (COCKERELL),
(HOMOPTERA : PSEUDOCOCCIDAE)*

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(With 4 Text-figures)

INTRODUCTION

The mealybug, *Dysmicoccus brevipes* (Cockerell), is distributed in the Oriental, Australian, Palearctic, Ethiopian, Neotropical and Nearctic regions (CAB Map no. A 50). The main host of the species is pineapple and alternative hosts include sugarcane, groundnut, coconut, coffee and *Pandanus* (Hill, 1975). But its status as a pest and vector of wilt and spotting disease in severe form is only revealed in case of pineapple. It reproduces by both zygogenetically and parthenogenetically (Beardsley, 1960, 1965). In West Bengal the species reproduces parthenogenetically and therefore the males are absent (Ghose, 1983).

The intent of this study is to describe all the female instars of *D. brevipes* (Cockerell), to distinguish different instars and to reveal the significance of various wax secreting glands of the derm of the species in life.

METHODS

The specimens were mounted on slides following the usual methods (Ghose, 1971). Measurements in the descriptions are the averages of 5-10 specimens. Values are reported as the range and mean respectively. Roman numerals stand for abdominal segments.

DESCRIPTIONS

First instar female numphs (Text-fig. 1)

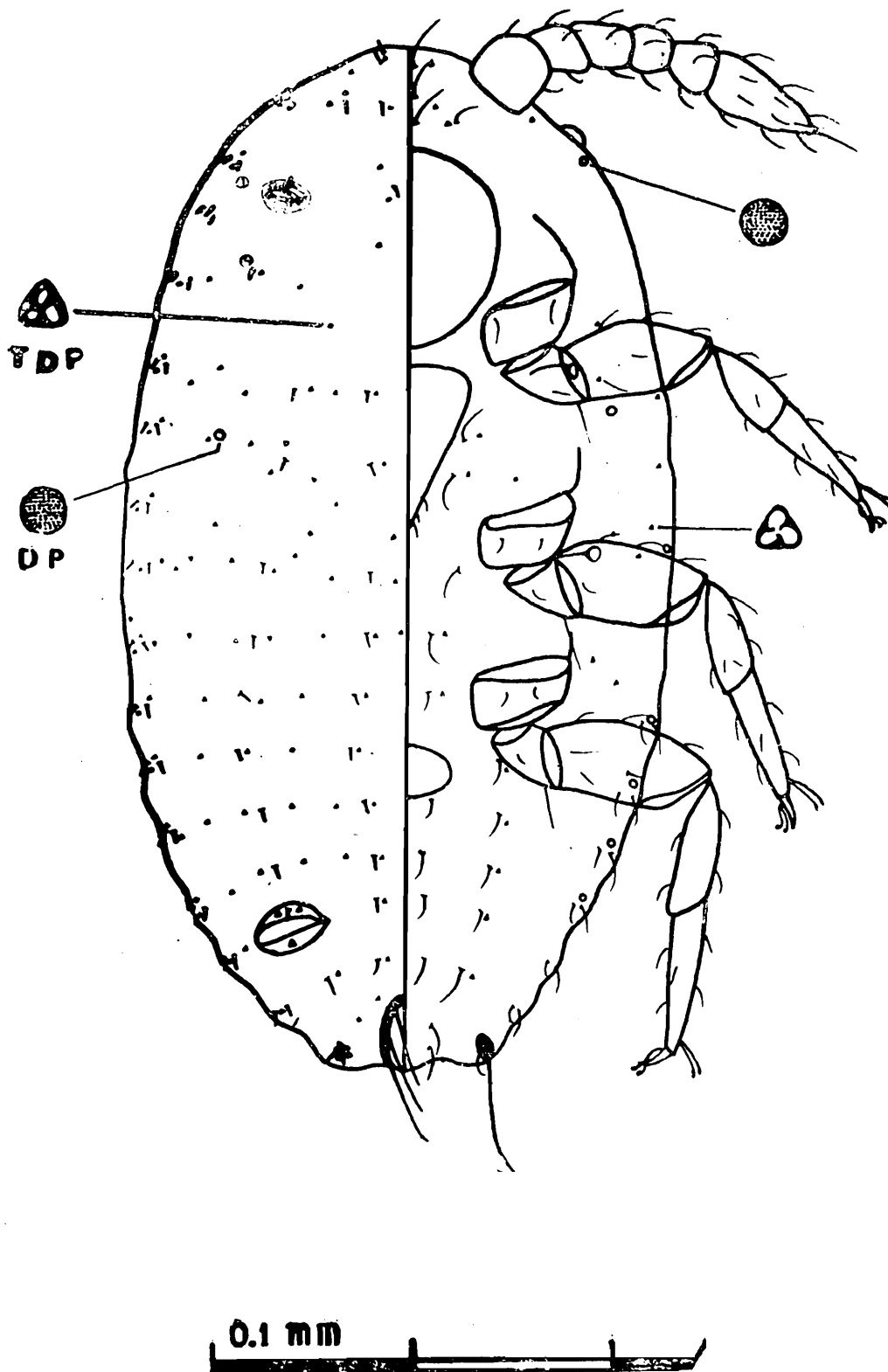
Body (mounted) 0.49-0.68 (0.55) mm long, 0.24-0.30 (0.27) mm wide.

Dorsum with 17 pairs of cerarii. Anal lobe cerarii each with 2 stout conical spines and 3 trilocular disc pores. Cerarii of other segments with 2 slender spines and 1-2 trilocular pores.

*A part of the Ph. D. thesis of first author.

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Discoidal pores on dorsum restricted to pro- and mesothorax. Trilocular pores present throughout dorsum, about 55 per cent being on thorax and head. Upper lip of both pairs of ostioles with 1 seta and 2 trilocular pores; their lower lip with 2 setae and 1 trilocular pore. Body setae of segment VIII slender and longer than those of other segments.



Text-fig. 1. First instar female nymph of *D. brevipes* (Cockerell). TDP, Trilocular Disc Pore; DP, Discoidal Pore.

Anal ring, 32-36 (34) μm in diameter with 6 anal ring setae, 48-52 (50) μm long.

Venter with discoidal and trilocular pores. Discoidal pores present on segments VI-IV, mesothorax and head and 1 attached to each eye. The number of trilocular pores, only about 28 per cent of dorsum. Anal lobes, a bit sclerotized; apical setae, 52-56 (54) μm long. Body setae, longer and flagellate.

Circulus, 36-40 (39) μm long and 48-56 (50) μm wide. Eyes, 14-16 (15) μm in diameter at base, 4-6 (5) μm high. Beak, 76-88 (82) μm long, 48-60 (54) μm wide at base. Both pairs of spiracles, 8 μm wide at atrium, 24-28 (26) μm long.

Hind legs with tibia + tarsus, 104-144 (125) μm long; apices of tarsal and claw digitules spatulated, 26-32 (29) μm and 24-28 (26) μm long respectively; claws, 16-20 (18) μm long. Antennae 6-segmented, length being 179-201 (189) μm .

Second instar female nymphs (Text-fig. 2)

Body (mounted) 0.61-0.88 (0.70) mm long, 0.30-0.45 (0.33) mm wide.

Dorsum with 17 pairs of cerarii. Each anal lobe cerarius with 2 stout conical spines, 1 auxilliary spine and 8-12 trilocular pores. The remaining cerarii having 2 short thin conical spines. The number of trilocular pores in cerarii of segments VIII-IV are 4-5, 4, 4, 3, 3 respectively; next 11 pairs of cerarii counting anteriorly each with 2, 2, 1-2, 2, 1-2, 1-2, 1-2, 1-2, 1-2, 1-2, 1-2, 1-2 trilocular pores respectively.

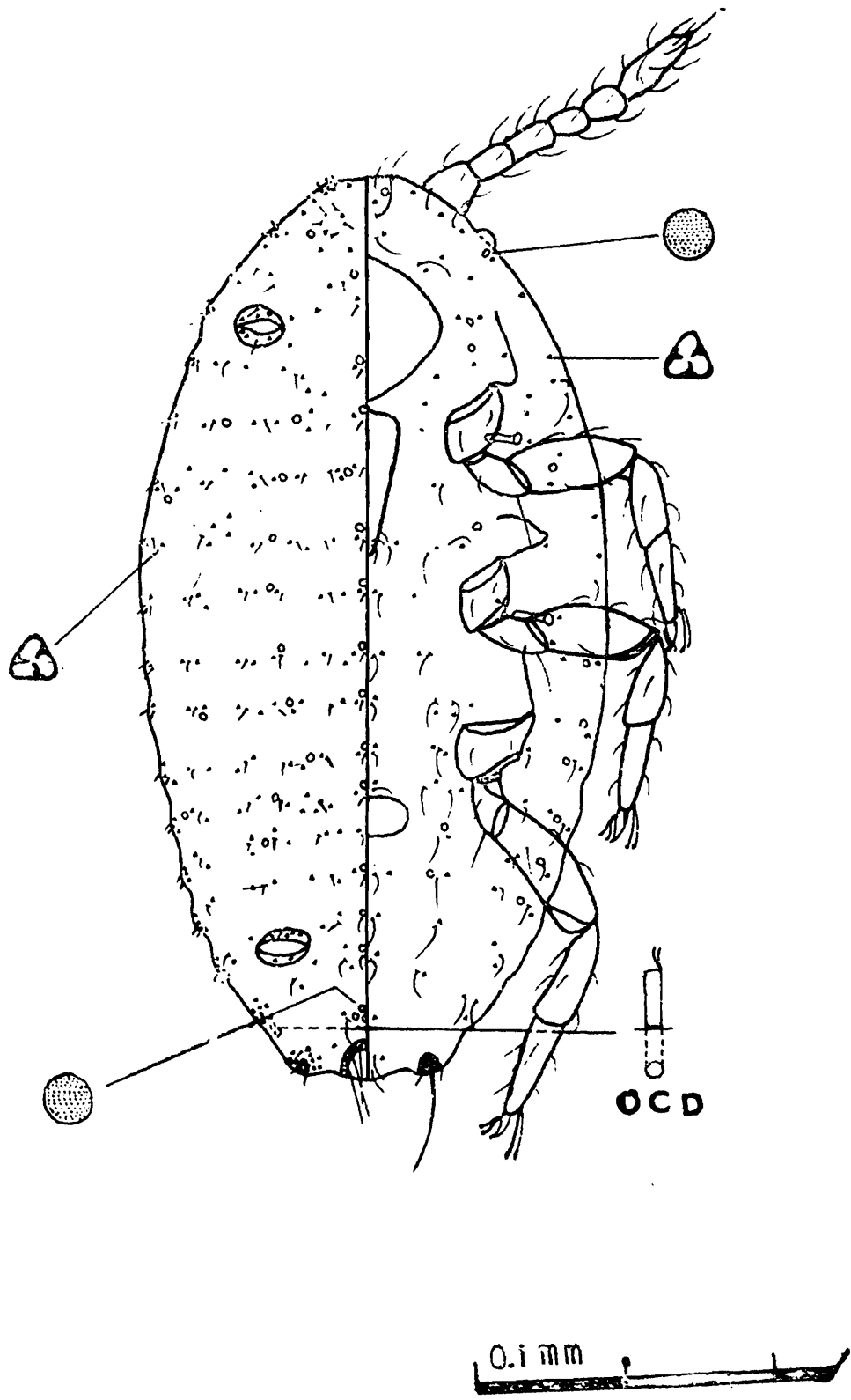
Dorsum with more discoidal pores than on venter. Trilocular pores throughout dorsum, maximum being on mesothorax. Both lips of anterior pair of ostioles with 1 seta and 3 trilocular pores; upper lip of posterior pair with 1 seta and 4 trilocular pores and lower lip with only 2 trilocular pores. Body setae short and thin, except in segment IX which are longer, 28-32 (30) μm .

Anal ring 38-44 (42) μm in diameter with 6 setae, each 52-60 (57) μm long.

Venter with discoidal pores in segments VI-head. Trilocular pores more numerous on segments of thorax and head. Only 1 oral-collar tubular duct on segment VIII. Anal lobes slightly sclerotized with apical setae, 68-88 (76) μm long. Body setae, long and flagellate.

Circulus, 40-56 (45) μm long, 60-72 (63) μm wide. Eyes, 18-21 (20) μm in diameter, 6-8 (7) μm high. Beak, 92-100 (96) μm long, 60-68 (62)

μm wide. Both pairs of spiracles, $12 \mu\text{m}$ wide and $24\text{-}32$ (28) μm long.
 Hind legs with tibia + tarsus $128\text{-}156$ (142) μm long; tarsal and claw
 digitules $28\text{-}34$ (31) μm and $16\text{-}24$ (18) μm long respectively; claws,
 $20\text{-}24$ (21) μm long. Antennae, 6-segmented, $200\text{-}228$ (213) μm long.



Text-fig. 2. Second instar female nymph of *D. brevipes* (Cockerell). OCD, Oral-Collar Duct.

Third instar female nymphs (Text-fig. 3)

Body (mounted) 0.97-1.30 (1.15) mm long, 0.51-0.79 (0.69) mm wide.

Dorsum with 17 pairs of cerarii. Each anal lobe cerarius with 2 stout conical spines, 3 auxilliary spines and 16-18 trilocular pores. Next seven pairs of abdominal cerarii counting anteriorly each with 12, 10, 10, 9, 8, 8, 6 trilocular pores respectively, also with 2 stout conical spines and 2 auxilliary spines. Next three cerarii, each with 2 stout conical spines, 1 auxilliary spine and 7 trilocular pores. Next cerarius of mesothorax with 3 conical spines, 1 auxilliary spine and 8 trilocular pores. Each of three cerarii of prothorax with 4 trilocular pores and 2, 2, 3 conical spines respectively. Each of two cerarii of head with 2, 3 conical spines and 7, 6 trilocular pores respectively with 1 auxilliary spine.

About 50 per cent of discoidal pores of dorsum are located on thorax and head. Trilocular pores more on segments of thorax, maximum being on mesothorax. Upper lip of anterior pair of ostioles with 3 setae and 5 trilocular pores ; their lower lip and upper lip of posterior pair with 3 setae and 7 trilocular pores ; lower lip of posterior pair with 2 setae and 7 trilocular pores. Body setae of segments IX and VIII long and flagellate, but those of other segments short and slender.

Anal ring, 52-26 (55) μm in diameter, with 6 setae, each 68-84 (78) μm long.

Venter with discoidal pores in segments VIII—head. Trilocular pores more numerous on segments of thorax and head. One oral-collar tubular duct in each segments of VIII, meso- and metathorax. Anal lobes sclerotized with apical seta 104-120 (114) μm long.

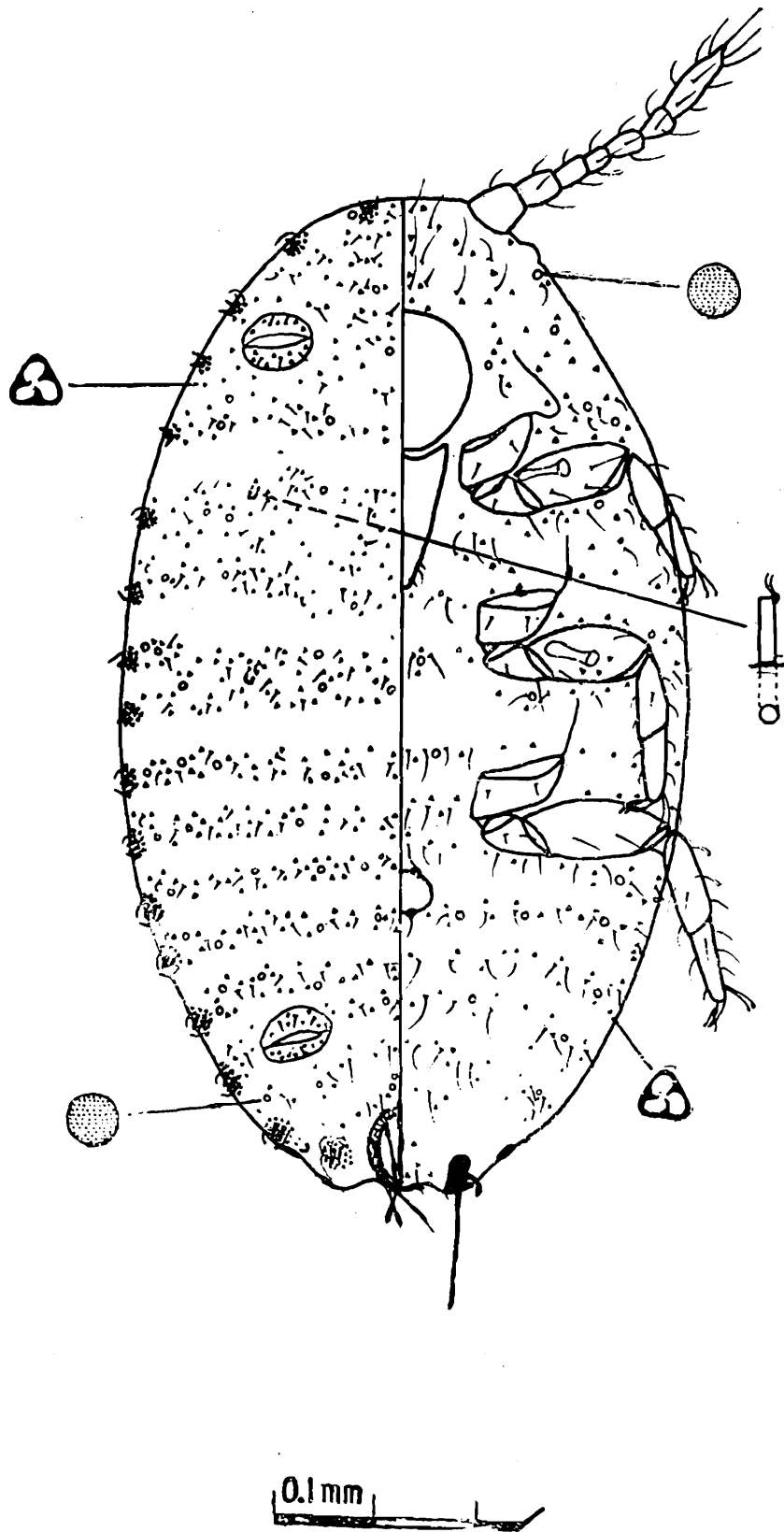
Circulus, 52-68 (62) μm long, 80-120 (97) μm wide. Eyes, 24-28 (27) μm in diameter, 8 μm high. Beak, 124-152 (137) μm long, 92-104 (97) μm wide. Both pairs of spiracles 40-44 (43) μm long, 20-24 (21) μm wide at atrium.

Hind legs with tibia+tarsus 180-192 (189) μm long ; tarsal and claw digitules 32-40 (35) μm and 22-26 (54) μm long respectively ; claw 22-26 (24) μm long. Antennae 7-segmented, 256-304 (281) μm long.

Adult females (Text-fig. 4) :

Body (mounted) 1.21-1.51 (1.37) mm long, 0.69-0.91 (0.81) mm wide.

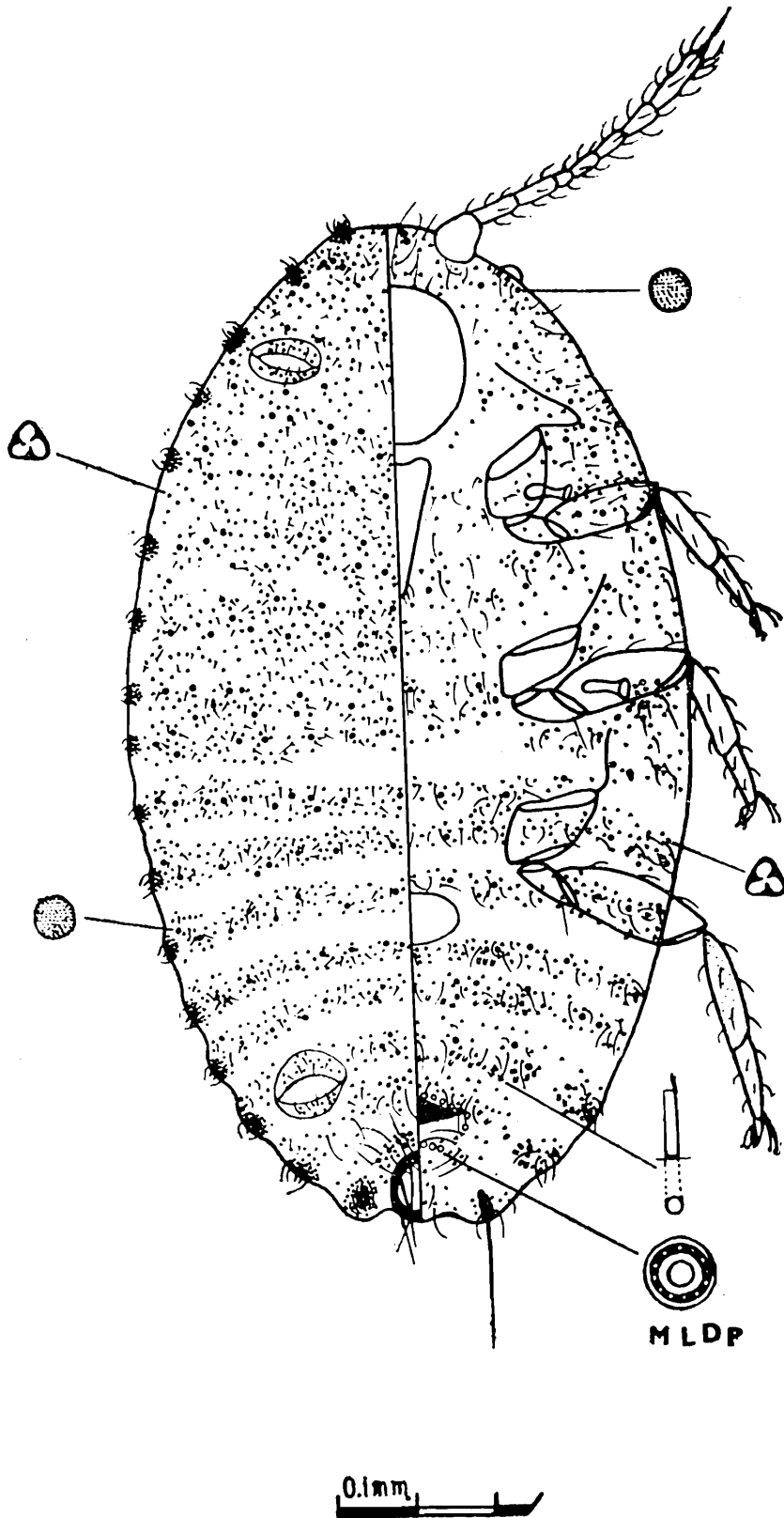
Dorsum with 17 pairs of cerarii. Each anal lobe cerarius with 2 stout conical spines, 6 slender auxilliary spines and 22-25 trilocular pores. The numbers of stout conical spines and auxilliary spines



Text-fig. 3. Third instar female nymph of *D. brevipes* (Cockerell).

respectively in remaining cerarii are : segments VIII, 2 and 4 ; VII, 3 and 2 ; VI, 2 and 2 ; V, 2 and 3 ; IV, 2 and 2 : III, 2 and 2 ; II, 2 and 1 ; metathorax, 2 and 1, 2 and 2 ; mesothorax, 2 and 2, 3 and 2 ; prothorax, 2 and 2, 2 and 2, 4 and 2 ; head, 2 and 2, 3 and 3. Trilocular pores in these cerarii are 15, 16, 15, 17, 14, 15, 11, 15, 15, 13, 16, 12, 13, 13, 15, and 15 respectively.

Dorsum with discoidal pores more numerous on thoracic segments. Trilocular pores in transverse rows on abdominal segments, scattered over thorax and head. Upper lip of anterior pair and lower lip of posterior pair of ostioles with 4 setae and 13 trilocular pores; lower lip of anterior pair and upper lip of posterior pair with 6 setae and 18 trilocular pores. Body setae of segment VIII noticeably longer



Text-fig. 4. Adult female of *D. brevipes* (Cockerell). MLDP, Multilocular Disc Pore.

with cluster of more than 8 large discoidal pores on dorsomedial area ; those of other segments 8-16 μm long.

Anal ring, 68-80 (77) μm in diameter ; 6 anal ring setae, 88-112 (95) μm long.

Venter with discoidal pores except segment IX ; 3 pores around the eyes. The number of trilocular pores is about half of dorsum but having similar arrangement. Multilocular pores around the vulva in segments IX and VII. Oral-collar tubular ducts are mainly located in segments VIII-VI and a few in V and head. Sclerotized anal lobes with 136-152 (148) μm long apical seta.

Circulus, 80-88 (82) μm long, 100-140 (121) μm wide. Eyes, 32-36 (33) μm in diameter, 8-12 (10) μm high. Beak, 176-184 (181) μm long, 112-132 (119) μm wide. Anterior pair of spiracles, 52-60 (55) μm long, 24-36 (32) μm wide at atrium ; posterior one, 60-64 (62) μm long, 32-40 (38) μm wide.

Hind legs with femur and tibia with 33-50 (4) and 45-65 (55) translucent pores respectively ; tibia+tarsus, 220-248 (238) μm long ; tarsal and claw digitule, 38-44 (42) μm and 28-32 (31) μm long respectively ; claw, 28-36 (32) μm long. Antennae, 8-segmented, the total length being 348-406 (372) μm .

KEY TO THE IDENTIFICATION OF FEMALE INSTARS OF
Dysmicoccus Brevipes (COCKERELL)

1.	6-segmented antennae.	...	...	2
	7-or 8-segmented antennae.	...	...	3
2.	Anal lobe cerarii with 2 spines and 3 triloculars.	...		1st instar-nymph.
	Anal lobe cerarii with 3 spines and 8-12 triloculars.	...		2nd instar-nymph.
3.	7-segmented antennae, anal lobe cerarii with 5 spines and 16-18 triloculars.	...		3rd instar-nymph.
	8-segmented antennae, anal lobe cerarii with 8 spines and 22-25 triloculars.	...		Adult.

DISCUSSION

The study on the morphology of all female instars of unisexual mealybug, *Dysmicoccus brevipes* (Cockerell) has resulted in some salient characters by which the different instars of the species can be differentiated.

The first and second instar female nymphs differ from all other instars in having 6-segmented antennae. The first instar nymphs have

3 trilocular pores in a cluster only in each anal lobe cerarius but the second instar nymphs have 3 or more pores in the cerarii of abdominal segments IX-IV, being 8-12 on IX.

The third instar female nymphs and adult females possess 7- and 8-segmented antennae respectively. The anal lobe cerarii of the former with 2 stout conical spines, 3 auxilliary spines and 16-18 trilocular pores and those of adult with 2 stout conical spines, 6 auxilliary spines and 22-25 trilocular pores.

Now an attempt is being made to throw light on the functions of dermal glands.

The trilocular disc pores are present both on the dorsum and venter and also in clusters of 3-25 in cerarian zones. The first instar nymphs possess no pores other than these on dorsum of abdomen. Therefore, the waxy dusts, found there in life, must be secreted by trilocular pores. It is, however, interesting to note that the secretions of these pores in clusters of 3 or more with the support of the stout conical spines of the cerarii form white waxy tassels.

The multilocular pores are found around the vulva of the adult females in addition to trilocular pores and oral-collar tubular ducts. Ghose (1971) is of opinion that oral-collar tubular ducts produce white cottony fibres of ovisac in *Maconellicoccus hirsutus* (Green). As the trilocular pores produce waxy dusts, the globular waxy particules found along with the cottony fibres must be the manifestation of the multilocular pores.

The discoidal pores of variable sizes are found both on dorsum and venter along with trilocular pores, but the function of these pores, if any, could not be revealed.

The glands associated with anal ring secrete a waxy tube.

The oral-collar tubular ducts are present mainly on segments VIII-V of adult females. These ducts secrete cottony fibres around the vulva to give protection to fully developed eggs after laying as well as to young off-springs after the hatching of eggs as the species is ovoviviparous (Ghose, 1983).

The presence of translucent pores on femur and tibia of hind leg is rather curious. Ferris (1950) did not mention about the possession of translucent and discoidal pores by the species. McKenzie (1964) in his key to the species of *Dysmicoccus* in North America included the presence of discoidal pores as one of the main characteristics of the species *brevipes* (Cockerell). Miller and McKenzie (1973) mentioned an interesting character of this species in the key to the species of

Dysmicoccus, i.e., the presence of noticeably longer body setae with cluster of more than 7 large discoidal pores on dorsomedial area of segment VIII.

SUMMARY

Descriptions and illustrations are given of all female instars of the mealybug, *Dysmicoccus brevipes* (Cockerell), the males of which are completely absent in this locality. All instars possess 17 pairs of cerarii, of which 1 and 6 pairs respectively of first and second instar nymphs have 3 and more trilocular pores on segment IX and IX-IV. The third instar nymphs and adult females have 7- and 8- segmented antennae respectively. The trilocular and multilocular pores secrete waxy dusts and globular waxy particles respectively. The clustets of 3 or more trilocular pores secrete white waxy tassels on cerarian zones. Oral-collar tubular ducts produce cottony fibres and the glands of anal ring secrete a waxy tube.

ACKNOWLEDGEMENT

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A NEW CRYPTOSTIGMATID MITE (ACARI : ORIBATEI)
FROM DARJEELING DISTRICT, WEST BENGAL,
INDIA

By

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(With 2 Text-figures)

INTRODUCTION

There is a few account of soil oribatid fauna that lives in close association with forest soils of Darjeeling district. A survey was therefore, made to explore the oribatid fauna from the forest floors of Darjeeling district since 1977. A new species, *Phyllhermannia berlesei* was found. *Phyllhermannia* was erected as a subgenus with *Hermannia phyllophora* Michael, 1908 as the type from New Zealand under the genus *Hermannia* by Berlese in 1916. Berlese (1916) however, did not give any diagnosis for his newly erected subgenus. van der Hammen (1959) while revising Berlese's primitive oribatid mites has expressed doubt regarding the systematic position of the type-species.

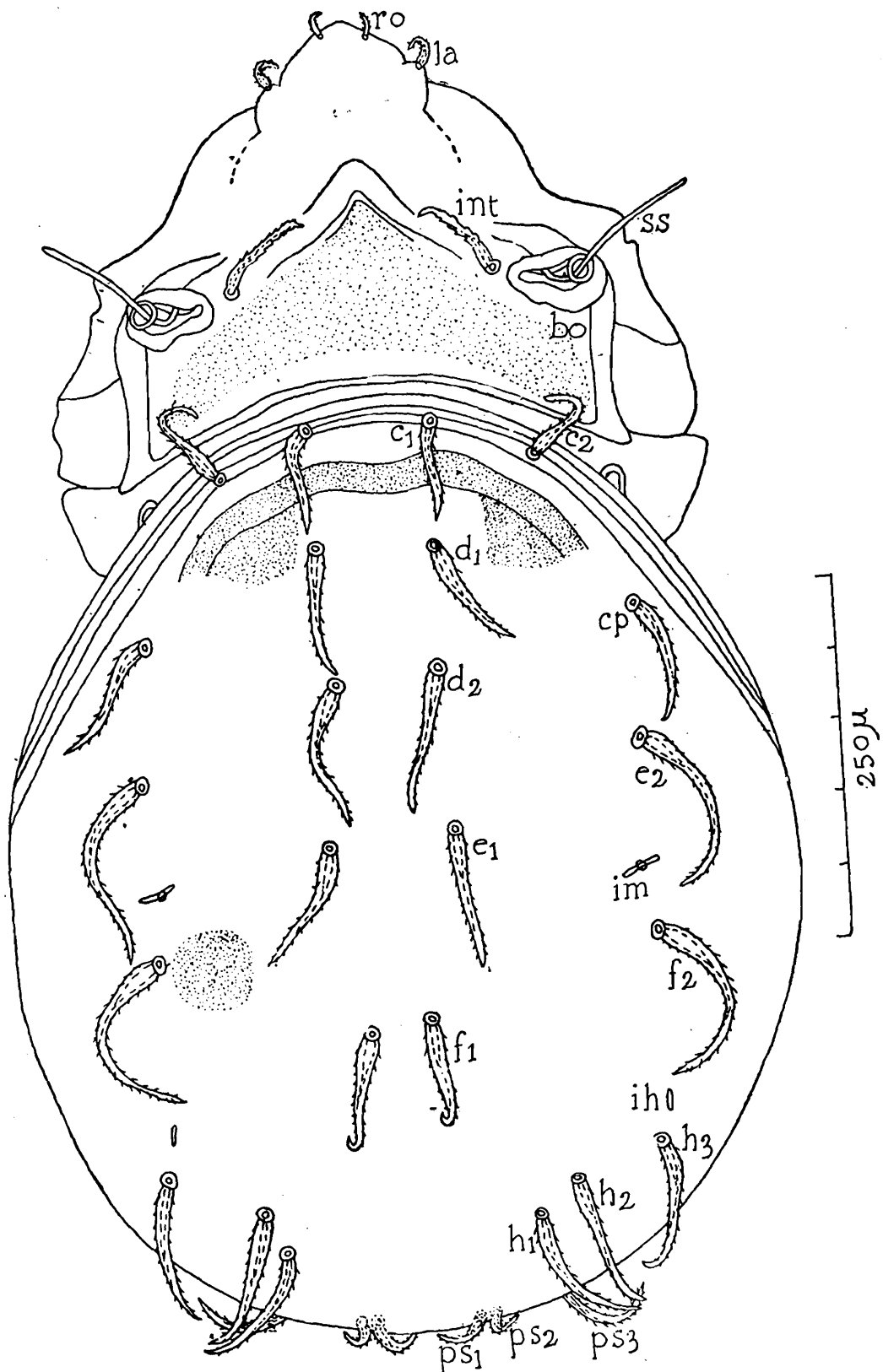
Trägårdh (1931) recognised *Phyllhermannia* as a distinct genus. All later workers accepted *Phyllhermannia* as a separate genus. The genus *Phyllhermannia* is being recorded here for the first time from India. All measurements are in microns.

***Phyllhermannia berlesei* sp. nov.**

(Text-figs. 1-2)

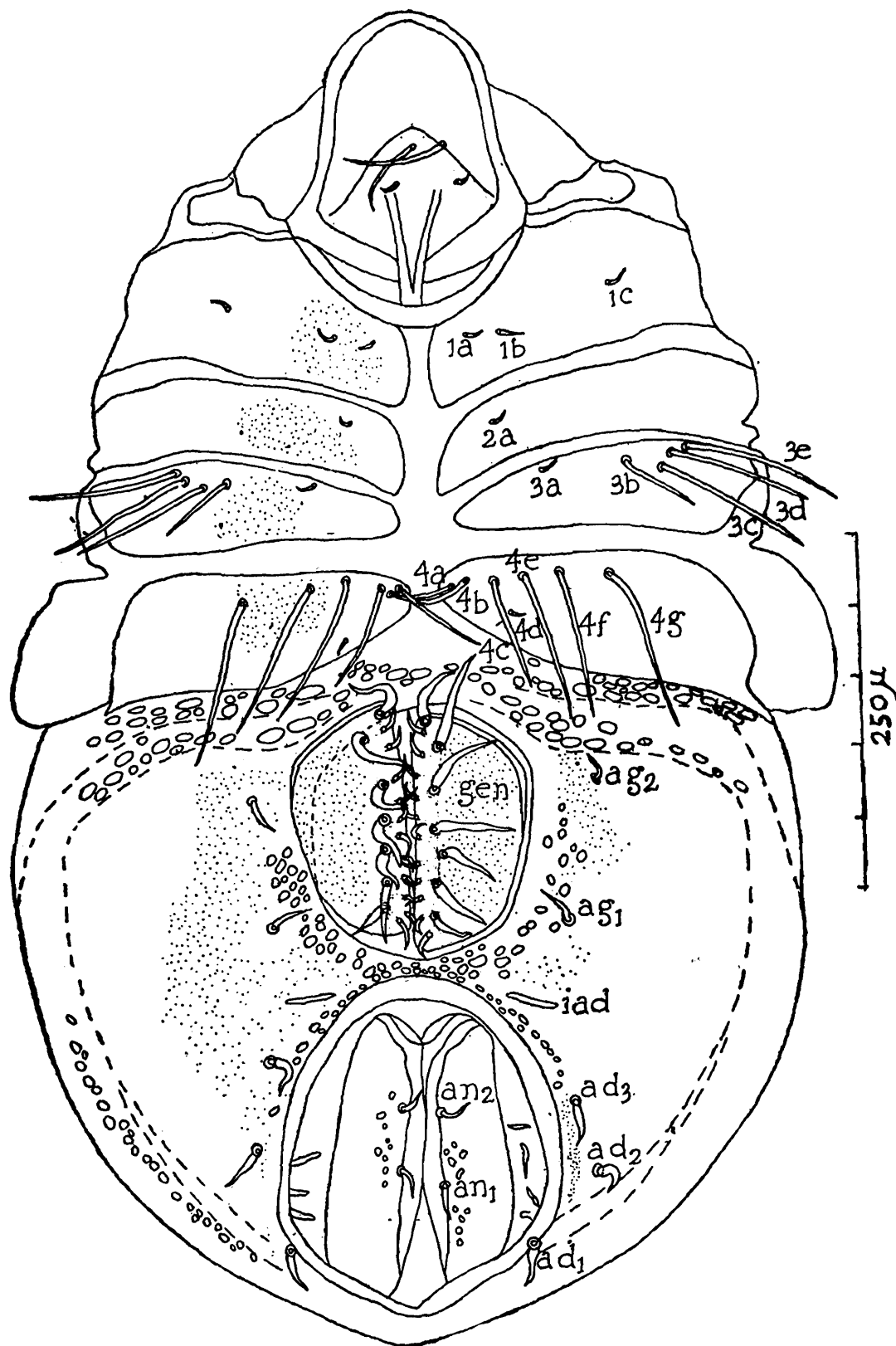
Female : Colour reddish to light brown ; length of the body : 828-914 ; width of the body : 473-545.

Prodorsum nearly $1\frac{1}{2}$ times broader than long ; a prominent, blunt in the middle, arch present between the pseudostigmata ; the posterior part of the prodorsum behind the arch densely punctate, the dots disappearing towards the posterior border of the prodorsum ; a strong ridge extends on either side laterally to the pseudostigmata, almost parallel to the lateral sides of prodorsum, connected by a thin transverse ridge, slightly arched, a blunt tooth posteriorly corresponding to a similar one on the anterior margin of the notogaster ; rostrum broadly rounded in the middle ; rostral setae incurved, short, thick, faintly barbed, with blunt tips, 11-14 long, situated a little below the tip of rostrum, nearly equal to their mutual distance ; lamellar setae



Text-fig. 1. *Phyllhermannia berlessei* sp. nov. (Dorsal view), *ro* = rostral seta, *la* = lamellar seta, *int* = interlamellar seta, *ss* = sensillus, *bo* = bothridium, *c*₁, *c*₂, *d*₁, *d*₂, *cp*, *e*₁, *e*₂, *f*₁, *f*₂, *h*₁, *h*₂, *h*₃, *ps*₁, *ps*₂, *ps*₃ = notogastral setae, *im*, *ih* = dorsal fissures.

strongly curved inwards, weakly barbed, thicker than rostral setae, with blunt tips, 27-30 long, originate from laterally elevated margin on the anterior part of prodorsum, their mutual distance about 4 times longer than that of rostral setae; interlamellar setae elongated, directed



Text-fig. 2. *Phyllhermannia berlesei* sp. nov. (Ventral view), an_1 , an_2 = anal setae, ad_1 , ad_2 , ad_3 = adanal setae, iad = adanal fissure, gen = genital plate, ag_1 , ag_2 , ag_3 = aggenital setae, $1a$, $1b$, $1c$, $2a$, $3a$, $3b$, $3c$, $3d$, $3e$, $4a$, $4b$, $4c$, $4d$, $4e$, $4f$, $4g$ = epimeral setae.

antero-dorsad, distinctly barbed with rounded follicles, broadest proximally, gradually attenuating, distally with indistinct longitudinal ribs, 63-68 long, situated just below the starting point of the prodorsal arch, nearly $2\frac{1}{2}$ times as long as their mutual distance; bothridium

flattened, cup-shaped, with a round rim anteriorly, directed dorso-laterad, longer than broad; sensillus rod-shaped, stalk and head uniformly thick throughout, smooth, 117-120 long, directed antero-laterad.

Notogaster oval in outline, coarsely punctate, with an anterior undulating, transverse, broad ridge, about $2\frac{1}{2}$ times as long as the prodorsum; notogastral setae 15 pairs, elongated, distinctly barbed bilaterally, with prominent rounded follicles, broadest proximally, gradually attenuating distally, with indistinct longitudinal ribs, tips pointed, curled ventrad (so in dorsal aspect for majority of the setae it seems to be not so), 20-148 long; setae c_2 antero-lateral, c_1 , d_1 , d_2 , e_1 and f_1 mid-dorsal, cp , e_2 and f_2 medio-lateral, h_1 , h_2 and h_3 postero-lateral, ps_1 , ps_2 and ps_3 postero-marginal; setae ps_2 smallest, mutual distance $f_1 - f_1$ half as long as $d_2 - d_2$; distance $c_2 - c_2$ about 3 times as long as $c_1 - c_1$; distance $c_1 - c_1 = e_1 - e_1 > d_1 - d_1 > d_2 - d_2 > f_1 - f_1$; distance $cp - cp$, $e_2 - e_2$ and $f_2 - f_2$ nearly equal to each other; distance $h_2 - h_3$ about twice or slightly more than twice the distance $h_1 - h_2$; notogastral fissures 2 pairs, *im* oblique, situated between e_2 and f_2 , *ih* longitudinal, situated between f_2 and h_3 .

Each anal plate irregularly foveolated, about 3 times as long as wide, with 2 short, simple and smooth setae, 14-18 long, situated at the inner margin of the anal plate medially; adanal setae 3 pairs, smooth, simple, thicker than anal setae, 22-34 long, placed very close to the medio-lateral and postero-lateral field of the anal opening; distance $ad_1 - ad_2 > ad_2 - ad_3$; *iad* a moderately long slit, as long as adanal setae, aligned nearly transversely close to the anterior margin of anal opening; genital and anal opening separated by a very short distance; each genital plate punctate, about twice as long as wide, with 18 smooth setae, stout, 10-59 long, arranged in 2 lines, 12 setae in the inner line and 6 in the outer, all setae of the inner row except the distal one simple, the remaining setae long and elongated, the distal setae of the outer row longer than the rest of genital setae; aggenital setae 2 pairs, simple, smooth, 14-27 long, situated at either end of the genital field, their mutual distance more than 2 times as long as the maximum width of a genital plate; distance $ag_1 - ag_1 < ag_2 - ag_2$; ventral plate punctate, medio-anterior and medio-posterior part surrounding the anogenital region foveolate, larger foveoles arranged in transverse undulating rows above the genital aperture.

Epimeral region punctate; epimera I, II, III and IV distinctly separated; epimeral setae two types, short and long, 5-113 in length; setae *1a*, *1b*, *1c*, *2a*, *3a* and *4d* short, smooth, simple; the remaining

setae long, smooth with pointed tips, setal formula of epimerata 3-1-5-7.

Claws monodactylous, strongly curved.

Holotype : ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Ghum-Simana forest range, Sukiapokhri forest block (from decaying leaves of *Cryptomeria japonica*), 2100m., 21.ix.1978 (*B. K. Mondal Coll.*); paratypes : 10 ♀ ♀, same data as for holotype ; paratypes : 3 ♀ ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Ghum-Simana forest range, Lepchajagat forest block (from humus under *Quercus lamellosa*), 2000 m., 13. viii. 1977 (*B. K. Mondal Coll.*); paratypes : 3 ♀ ♀, INDIA : W. Bengal : Darjeeling, Darjeeling forest Div., Ghum-Simana forest range, Manibhanjang forest block (from rotten leaves of *Quercus liniata*), 2200 m., 15. viii. 1977 (*B. K. Mondal Coll.*); deposited in the laboratory of the Department of Zoology, Presidency College, Calcutta.

Of all the described species under the genus *Phyllhermannia*, this new species bears the closest resemblance with *Phyllhermannia gladiata* Aoki, 1965 in a number of convincing characters. It can, however, be contrasted with Aoki's species by possessing a prodorsal arch, shorter rostral setae, elevated anterior part of prodorsum, punctate posterior portion of prodorsum, transverse, undulating, notogastral ridge, tooth like projection on anterior part of notogaster, 15 pairs of elongated, distinctly barbed notogastral setae, 18 pairs of genital setae besides a few other characters.

SUMMARY

The paper deals with the description of a new species of oribatid fauna, viz., *Phyllhermannia berleseii* from forest soils in the district of Darjeeling, India. The genus *Phyllhermannia* is recorded here for the first time from India.

ACKNOWLEDGEMENTS

I am thankful to Prof. S. K. Dasgupta, Head of the Department of Zoology, Presidency College, Calcutta for providing laboratory facilities and to Dr. D. K. Chakrabarti, Asstt. Prof. of Zoology, Presidency College, Calcutta for his helpful cooperation. My thanks are also due to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities to work.

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CYNOGLOSSUS ITINUS (SNYDER) (PISCES :
CYNOGLOSSIDAE) A NEW RECORD FROM INDIAN
WATERS (BAY OF BENGAL, OFF VISAKHAPATNAM)

By

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(With 1 Text-figure)

INTRODUCTION

Menon (1977) synonymised several of the *Cynoglossus* species described from Indian waters and considered thirteen of them as valid. More recent collections of flat fishes from Visakhapatnam revealed the availability in Indian waters of some species described from adjoining waters. During the period 1-4-81 to 5-2-83, 30 stray specimens (93.0 to 129.0 mm. SL), which did not fit into the described species of *Cynoglossus* from Indian waters were collected from the trawl catches at Visakhapatnam and Kakinada fish landing centres. Closer examination of the specimens revealed close resemblance with *Cynoglossus itinus* (Snyder), which were reported earlier from the waters off Japan and Hong Kong (Ochiai, 1963 and Menon, 1977). Since their occurrence in the Indian waters and particularly in the Bay of Bengal off the east coast of India is a new record, a detailed description of *C. itinus* (Text-fig. 1) is given and the range of their morphometric and meristic characters (Table 1) is compared with those of specimens from waters off Japan and Hong Kong (Ochiai, 1963 and Menon, 1977).

Diagnosis : It is easily distinguished by (1) the absence of posterior nostril on ocular side, (2) the presence of 8 caudal rays, and (3) the interlinear scale count which is 12-14.

Description : Body slender, deepest at anterior one third of body : Depth of body 23.00-29.12 ($M^*=27.17$), length of head 18.86-23.30 ($M=20.97$) percent of SL. Eye diameter 8.69-16.66 ($M=13.36$), interorbital space 1.92-4.54 ($M=3.35$) percent of length of head. Single tubular nostril (anterior) on ocular side in front of lower eye. Posterior nostril absent. Snout rounded, 28.84-37.50 ($M=33.35$) percent of length of head ; rostral hook short, not extending to below anterior margin of upper eye. Maxillary extending to below posterior half of

* M = mean of the range.

fixed eye ; angle of mouth extending to below vertical from middle of fixed eye, much nearer to tip of snout than to branchial opening. Tip of snout to angle of mouth 38.88-50.00 (M=44.58). Angle of mouth to branchial opening 53.84-61.11 (M=57.14) percent of length of head.



Text-fig. 1. Ocular side of *Cynoglossus itinus* (Snyder). 125.0 mm SL

Scales : Ctenoid on ocular side including those on lateral lines ; cycloid or weakly ctenoid on blind side of head and ctenoid behind head.

Lateral-Line System : Three lateral lines on ocular side, dorsolateral line slightly undulated, runs backward along dorsal contour of body entering dorsal fin usually between the 18th and 20th dorsal ray counted from the rear ; mid lateral-line with 70-79 (M=74) scales ; 12-14 (M=13) scales transversely between dorsal and midlateral lines : ventrolateral line present. No lateral line on blind side.

Fins : Dorsal with 105-114 (M=108), anal with 82-88 (M=86)

rays : Caudal rays 8 (in 8 alizarine stained specimens).

Vertebrae : 52-54 (M=53.5), comprising 9 abdominal and 43-45 caudal elements in 8 specimens (alizarine stained).

Colouration : Ocular side light brown with blackish brown spots and blotches ; median fins with blackish brown streaks ; blind side yellowish white in preserved specimens.

TABLE 1. Comparison of morphometric and meristic characters of specimens of *C. itinus*, off Visakhapatnam and Kakinada with the description given by Ochiai (1963) and Menon (1977).

Sl. No.	Character	Region		
		Bay of Bengal (Present collections) No. of specimens : 30	Japan (Ochiai)* No. of specimens : 58	Japan and Hong Kong (Menon) No. of specimens : 8.
1.	Depth of body (% of SL)	23.00-29.12(M = 27.17)	25.64-30.30(M = 27.77)	25.40-28.64(M = 27.07)
2.	Length of head (% of SL)	18.86-23.30(M = 20.97)	17.85-21.73(M = 19.60)	19.44-21.61(M = 20.56)
3.	Diameter of eye (% of HL)	8.69-16.66(M = 13.36)	9.09-20.00(M = 15.62)	10.87-15.38(M = 13.22)
4.	Interorbital width (% of HL)	1.92- 4.54(M = 3.35)	—**	2.08- 7.14(M = 4.35)
5.	Snout length (% of HL)	28.84-37.50(M = 33.35)	26.31-38.46(M = 31.25)	25.00-30.43(M = 27.24)
6.	Snout to angle of mouth (% of HL)	38.88-50.00(M = 44.58)	—**	36.54-45.24(M = 40.55)
7.	Angle of mouth to branchial opening (% of HL)	53.84-61.11(M = 57.14)	—**	55.77-69.05(M = 61.94)
8.	Mid lateral line scales on ocular side	70-79(M = 74)	68-77(M = 72.8)	71-78(M = 74)
9.	Interlinear scale rows	12-14(M = 13)	12	12-14(M = 13)
10.	Dorsal fin rays	105-114(M = 108)	100-114(M = 105.4)	102-103(M = 102)
11.	Anal fin rays	82-88(M = 86)	79-87(M = 84.2)	83-86(M = 84)
12.	Caudal fin rays	8	8-10	8
13.	Vertebrae	52-54	50-54	50-52

* The body dimensions given in fractions are converted to percentages.

**Data not given.

Remarks : The present specimens agree with the description of *C. itinus* given by Ochiai in all respects (Table I). However, it differs from the description given by Menon in having higher number of dorsal rays (105-114 instead of 102-103) and in having a longer snout (mean length 33.35 instead of 27.24 percent of length of head). These differences may be attributed to geographic variation.

ACKNOWLEDGEMENTS

We thank the Head of the Department of Zoology, Andhra University, Waltair, for providing research facilities.

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COMPARATIVE STUDIES ON THE LARVAL
FORMS OF ODONATA, HEAD AND ITS APPENDAGES

By

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(With 36 Text-figures.)

INTRODUCTION

The structure of head and its appendages in Odonata has been studied in a number of species by various workers (Butler, 1904 ; Corbet, 1953 ; Fraser, 1933 ; Kumar, 1972 ; Mathur, 1956). These accounts do not give detailed information on the degree of differentiation and limits of head sclerites. In view of this, it is difficult to judge on the basis of available information how far the different larval forms resemble or differ from one another with respect to the head and its appendages. An attempt has been made to elucidate this aspect in six species of larval Odonata and the observations are presented here.

MATERIAL AND METHOD

Six species of dragonfly larvae belonging to different sub-groups were examined. These are as follows :

SUBORDER : ZYGOPTERA

Family : COENAGRIIDAE

Subfamily : OENAGRIINAE

Pseudagrion decorum (Rambur)

Ceriagrion coromandelianum (Fabr.)

Ischnura senegalensis (Rambur)

Ischnura delicata (Hagen)

Family : PLATYCNEMIDIDAE

Subfamily : PLATYCNEMINAE

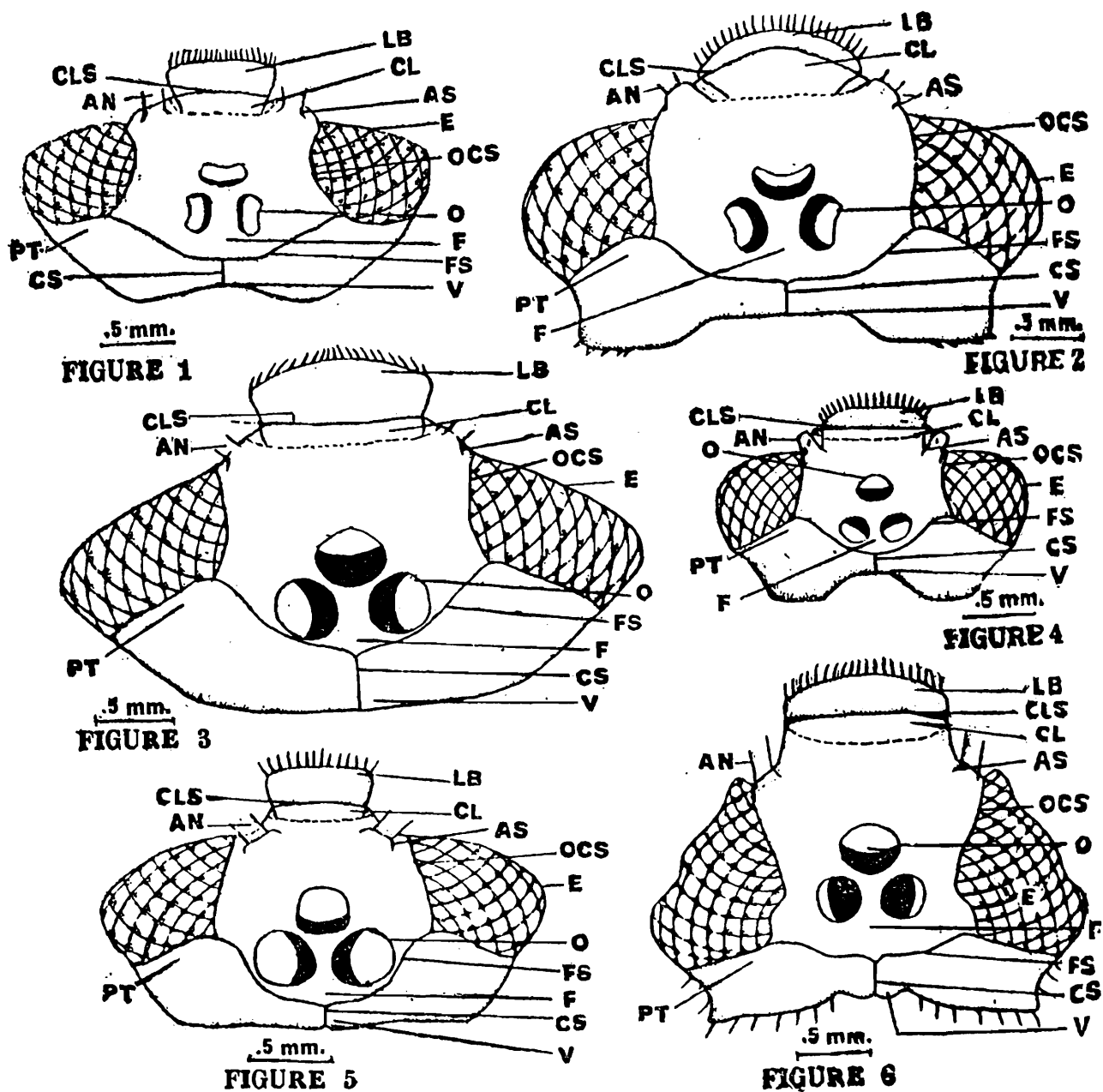
Copera marginipes (Rambur)

Family : CHOLOROCYPHIDAE

Subfamily : LIBELLAGINAE

Libellago lineata lineata (Burmeister)

The larvae were collected from different localities in Rewa (M. P., India) and were identified through British Museum Natural History, London. They were examined fresh as well as after preserving in the mixture of 70 per cent alcohol and Glycertne (10 : 1). For the study of sclerites, the insects were treated with 10 per cent hot solution of KOH for a few minutes and then washed in water. Specimens were then dissected and examined under a dissecting binocular microscope. They were also examined without treatment with KOH solution.



Text-figs. 1-6. Head of the larvae (Dorsal view) :

1. *Copera marginipes*, 2. *Pseudagrion decorum*, 3. *Ceriagrion coromandelianum*,
4. *Ischnura delicata*, 5. *Ischnura senegalensis*, 6. *Libellago lineata*.

HEAD

1. EXTERNAL STRUCTURE OF THE HEAD

The head (Text-figs. 1 to 12) is *prognathus* and is firmly attached to the prothorax by a small cervix. It is rather elongate and forms a kind of dorso-ventrally flattened cone. In facial view, it is pear shaped having a semicircular outline narrowing towards the apex. A pair of *compound eyes* (E) are located on the dorso-lateral sides. In addition to the compound eyes, there are three *ocelli* (O) which are situated symmetrically on the dorsal surface of the head. The *antennae* (AN) are situated on the upper part of the face. The posterior surface of the head is occupied by an opening from the head into the neck. The opening is a large aperture and is known as the *occipital foramen* (OCF). On the under surface of the head the *mandibles* (MD) and *maxillae* (MX) occupy the lateral regions ; the *labrum* (LB) projects from the anterior margins of the cranium. The base of the labium lies transversely below the occipital foramen. Thus the true ventral area is between the base of the appendages, median part of which forms the *hypopharynx* (HY). Anterior to it and immediately behind the base of the labrum is the mouth. The space enclosed by mouth appendages, which lies entirely outside the body and is merely an intergnathal space and is known as the preoral cavity.

2. SUTURES OF THE CRANIUM

Following sutures are evident in the cranium, they are the grooves on the surface of the head marking its endoskeletal ridges.

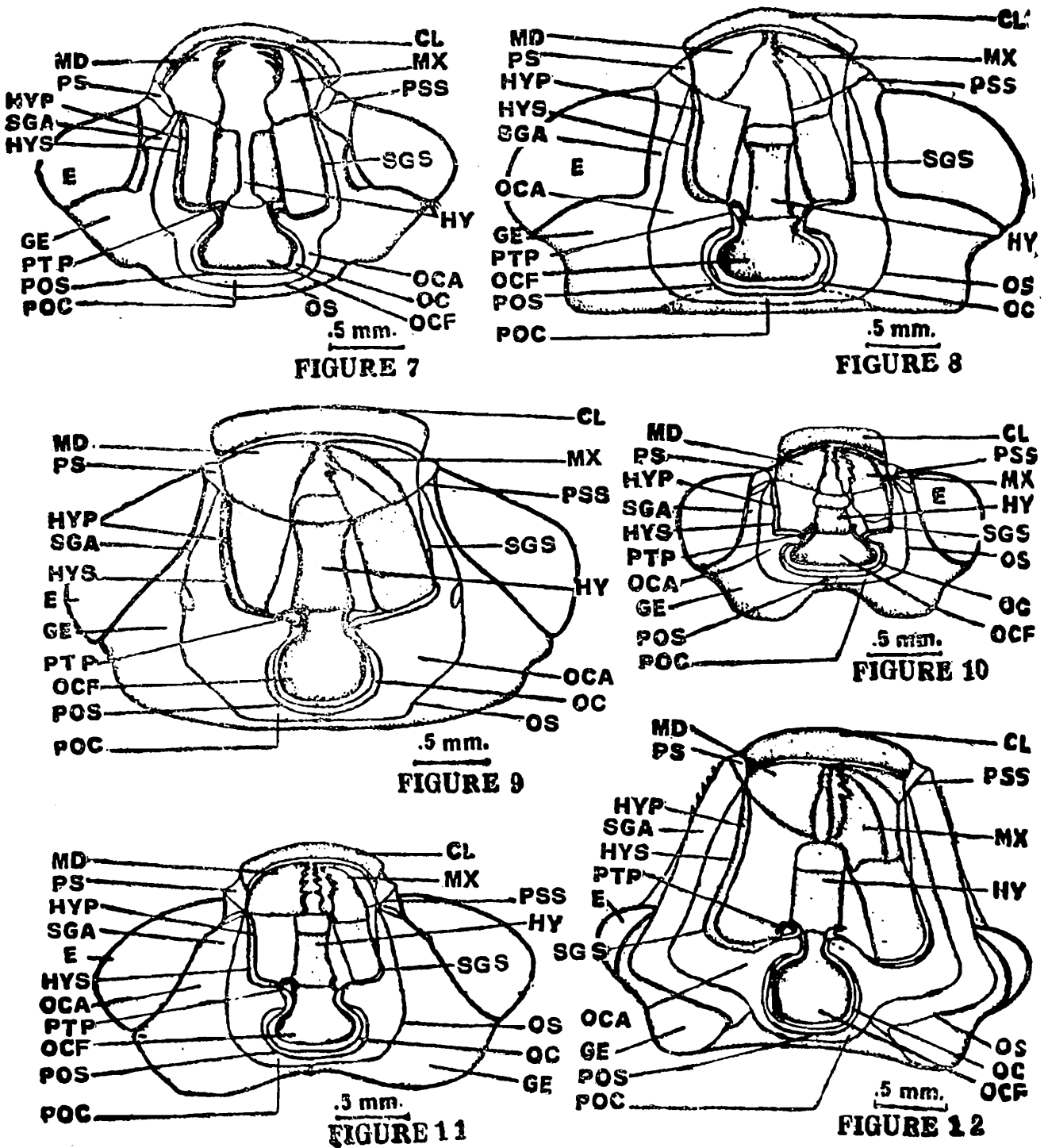
(a) *Epicranial suture* (Text-figs. 1 to 6). The epicranial suture is well marked being a 'Y' shaped groove on the dorsal surface of the head. Its mesial dorsal arm the *coronal suture* (CS) extends from posterior part of the head upto the level of the lateral ocelli, where it branches into anterior forks, the *frontal sutures* (FS). The two sutures diverge from the coronal suture near the lateral ocelli, run towards and along their lateral margins and extend laterally and anteriorly on the face towards ocular sutures (OCS).

(b) *The antennal suture* (Text-figs. 1 to 6). The antennal suture (AS) surround the antennal base.

(c) *The occipital suture* (Text-figs. 7 to 12). The occipital suture (OS) is horseshoe shaped and runs on the ventral surface of the head. Each of its arms, starting from a point slightly posterior to the ventral articulation of the mandible of its side, traverses the cranial wall in

an antero-posterior direction to meet the other, posteriorly behind the occipital foramen (OCF).

(d) *Post occipital suture* (Text-figs. 7 to 12). The post occipital suture (POS) lies on the extreme posterior part of the cranium where it closely surrounds the occipital foramen dorsally and laterally. Each lower end of the suture has a pit (PTP) which is the point of invagination of each posterior tentorial arm.



Text-figs. 7-12. Ventral view of the head with right maxillae removed showing position of the mandibles in different larval forms :

7. *Copera margiuiipes*, 8. *Pseudagrion decorum*, 9. *Ceriagrion coromandelianum*, 10. *Ischnura delicata*, 11. *Ischnura senegalensis*, 12. *Libellago lineata*.

(e) *Subgenal suture* (Text-figs. 7 to 12). The subgenal suture (SGS) is present on each side of the head close to the posterior edge of the lateral cranial wall, it extends from the *posterior tentorial pit* (PTP) to a point, just above the anterior articulation of the mandible and thus it arches upward over the mandible. The part of the subgenal suture which arches over the mandible is called the *pleuro-stomal suture* (PSS) and the part posterior the mandible is known as the *hypostomal suture* (HYS).

(f) *Ocular Suture* (Text-figs. 1 to 6). Each eye is externally surrounded by distinct circular groove, the *ocular suture* (OCS).

3. AREAS OF THE CRANIUM

The principal areas (Text-figs. 1 to 12) set off in the cranium by the cranial sutures are the *fronto-clypeal area*, this area is bounded by the frontal sutures (FS) dorsally, antennal bases and by the clypeo-labral sutures (CLS) ventrally. As the epistomal suture is absent, this area is not clearly demarcated into frons and the clypeus. The limits of the clypeus may be marked out by an imaginary line joining the two anterior tentorial pits. The *clypeus* (CL) is distinguishable into a dorsal heavily chitinised and pigmented area the post clypeus and a weakly chitinised non pigmented area the anticlypeus. Each dorso-lateral corner of the postclypeus bears a "U" like depression the *pricoila* into which is received the anterior articulatory condyle of the mandible.

The parietals (Text-figs. 1 to 6). The lateral areas separated by the coronal suture (CS) are the *parietals* (PT). They are bounded dorsally and ventrally by frontal (FS) and occipital sutures (OS) respectively. The dorsal surface of the two parietals forming the top of the head constitutes the *vertex* (V). The lateral parts of the parietals beneath the eyes are *genae*. Each *gena* (GE) is limited anteriorly by the pleuro-stomal suture (PSS) ventrally and posteriorly by the occipital suture (OS). The *occipital arch* (OCA) is a horse-shoe shaped sclerite on the posterior surface of the head between the occipital (OS) and post occipital sutures (POS). It is distinguishable into a narrow, posterior median strip, the *occiput* (POC), the area of the occipital arch between the occipital and post occipital sutures and the post gena. The post-gena areas are the lateral extensions of the occipital arch. Each post gena lies between the subgenal and the occipital sutures of its side. It starts behind the ventral articulation of the respective mandible as a narrow space and becomes broader and broader while approaching the occiput near the foramen. At its inner margin it possesses a cup

to receive the condyle of juxtacardo. Ventral to articulation point of maxilla there is another cup to receive the condyle of the mandible. The *post occiput* (POC) is narrow posterior rim of the cranium set off from the occipital arch by the post occipital suture (POS) and to which the neck membrane is attached. Laterally the posterior margin of the post occiput (POC) is produced on each side in small process, the *occipital condyle* (OC) to which is articulated the lateral cervical sclerite. The *sub genal areas* (SGA) are the two narrow marginal areas on each side of the cranium. Inner to the sub genal area and above the mandible is distinguishable the *pleurostoma* (PS), and the part behind the mandible as the *hypostoma* (HYP).

Position of ocelli differs from species to species (Text-figs. 1 to 6). The lateral ocelli in *Ceriagrion coromandelianum*, *Ischnura delicata* and *Ischnura senegalensis* are situated nearer to the frontal sutures, in *Copera marginipis*, *Pseudagrion decorum* and in *Libellago lineata* they are situated farther from it.

ANTENNAE

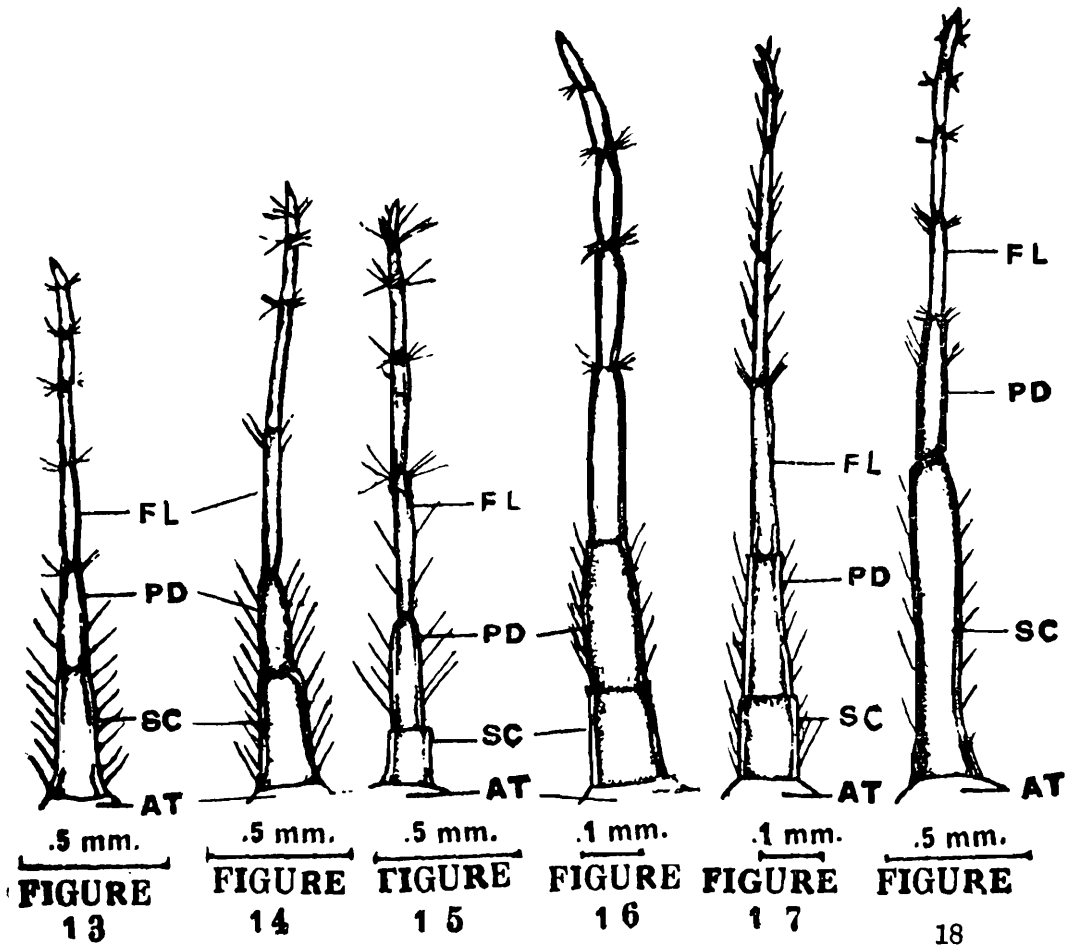
The antennae (Text-figs. 13 to 18) are filiform and are situated one on either side of the fronto clypeal area, between the anterior tentorial pits and the anteromesial margins of the compound eye ; each of them is set on a ridge. Each antennae is beset with hair-like process and consists of (i) a basal segment the scape (SC) (ii) a pedicel (PD) and (iii) a flagellum (FL).

The broad strongly built *scape* (SC) forms the first antennal segment and at its base it articulates latero-ventrally by means of its peg-like process within the head. The peg like process is known as *antartis* (AT).

The *pedicel* (PD) is a cylindrical structure, it proximally articulates with the scape and distally with the flagellum.

The *flagellum* (FL) follows the pedicel and consists of almost similarly formed segments, each joint has developed a convexity at its proximal, and a concavity at its distal end respectively, the convexity of a joint setting into the concavity of the preceding one so that all the joints of the flagellum are immovably articulated with each other. The size of the flagellar segments decreases towards the antennal tip.

The antennae (Text-figs. 13 to 18) consist of seven segments. Total length of the antenna is 4.5 mm. in *Copera marginipes*, *Pseudagrion decorum* and *Ceriagrion coromandelianum* ; where as it is only 2 m. m. in *Ischnura delicata*, 2.5 m. m. in *Ischnura senegalensis* and 4 m. m. in *Libellago lineata*.



Text-figs. 13-18. Antennae of the larvae :

13. *Copera marginipes*, 14. *Pseudagrion decorum*, 15. *Ceriagrion coromandelianum*,
 16. *Ischnura delicata*, 17. *Ischnura senegalensis*, 18. *Libellago lineata*.

THE MOUTH PARTS

The mouth parts consist of a labrum, a pair of mandibles, maxillae and the labium.

1. LABRUM

The *labrum* (LB) is a cuticular structure, convex dorsally and more or less concave ventrally (Text-figs 1 to 6). It projects anteriorly from the fronto-clypeal region. The concave ventral portion of the clypeus covers the toothed margin of the mandible. The clypeus remains separated from the fronto-clypeal area by clypeo-labral suture (CLS).

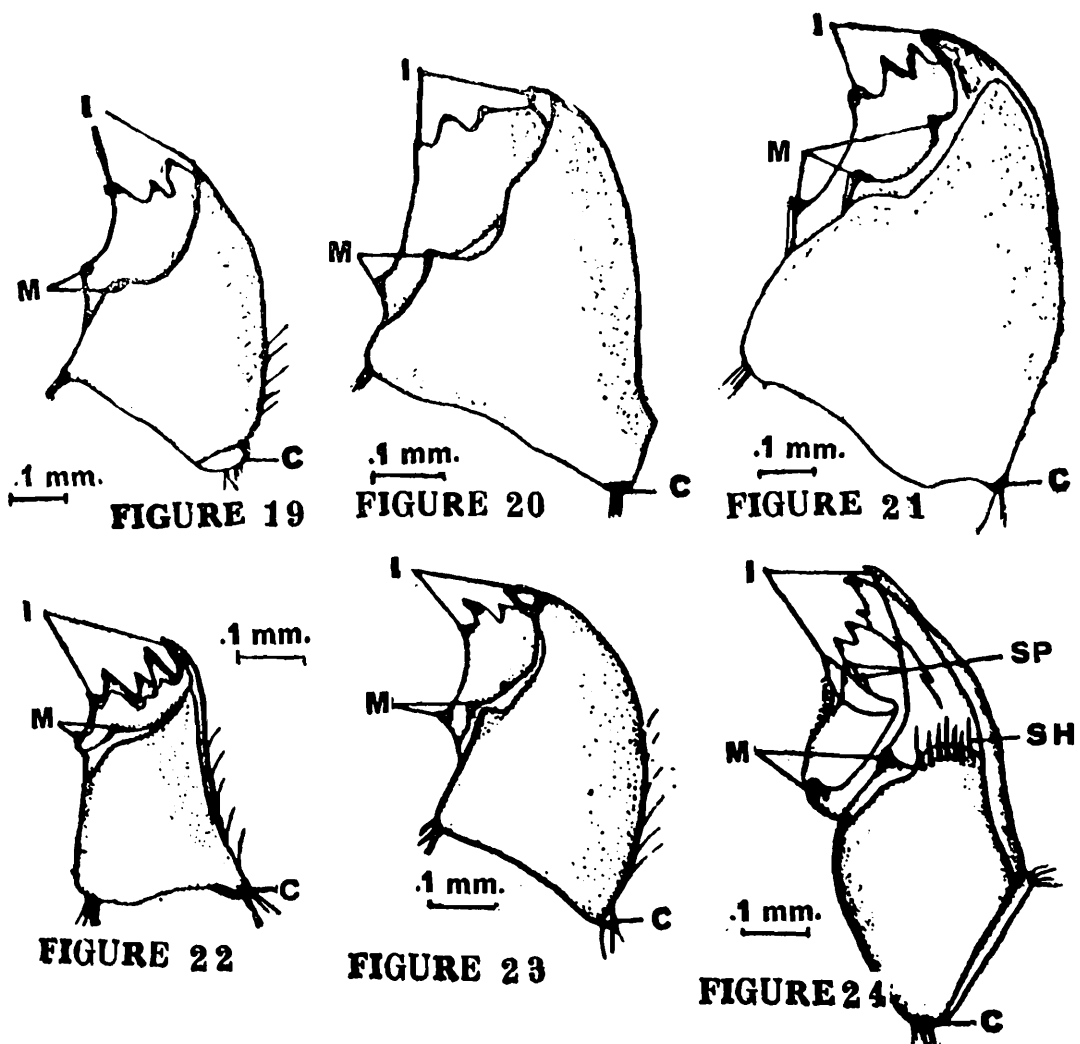
2. MANDIBLES

The *mandibles* (Text-figs. 19 to 24) are situated ventrally to the clypeus, one on each side of the middle line. Each mandible (MD) is a strongly sclerotised, subconical structure with triangular base and a broad cutting margin along its inner edge. The cutting edge is produced into strongly cuticularised structures these are differentiated into anterior *incisor* (I) and posterior *molar* (M) teeth.

The number and arrangement of teeth is similar on the right and the left mandibles, the left one is produced a little forward than the right one.

At the time of biting the cutting margin of the left mandible covers that of the right. Each mandible has two articular points at its proximal end, a dorsal and a ventral, the dorsal bearing a *condyle* (C) and a cavity both of which interlock with the corresponding notch and condyle of the clypeus. The ventral articular point, has a condyle which fits into the concavity on the ventral margin of the postgena. Both articulating points lie on the outer side of the base of the mandibles.

The number and arrangement of maxillary and mandibular teeth is specific in different species. The mandibles (Text-figs. 19 to 24) of *Copera marginipes*, *Ischnura senegalensis* and *Pseudagrion decorum* bear four incisors and two molars, *Ceriagrion coromandelianum* bears four incisors and three molars, *Ischnura delicata* bears five incisors and two molars, *Libellago lineata* bears six incisors and two molars. In *Copera marginipes*,



Text-figs. 19-24. Mandibles of larvae ;

19. *Copera marginipes*, 20. *Pseudagrion decorum*, 21. *Ceriagrion coromandelianum*,
22. *Ischnura delicata*, 23. *Ischnura senegalensis*, 24. *Libellago lineata*.

Pseudagrion decorum, *Ceriagrion coromandelianum*, *Ischnura senegalensis* and *Ischnura delicata* incisors are arranged in a single row. In *Libellago lineata* they are arranged in two rows. In *Copera marginipes*, *Pseudagrion decorum* and *Libellago lineata* the two molars form two apices. In *Ceriagrion coromandelianum*, *Ischnura delicata* and *Ischnura senegalensis* molar teeth are situated in two rows out of which one is dorsal and the other is ventral in position. In *Copera marginipes*, out of four incisors three are large and one is small. Incisors of *Pseudagrion decorum* and *Ceriagrion coromandelianum* are similar in shape. In *Ischnura delicata* all five incisors are arranged in a single row, out of which first, second and fourth are larger, third and fifth are smaller in size. In *Ischnura senegalensis*, first and third incisors are large, second and fourth are smaller. In *Libellago lineata*, incisors are arranged in two rows; the distal row contains five incisors out of which the first is the largest and the rest of them are smaller in size. The proximal row consists of only one broad incisor tooth.

3. MAXILLAE

The *maxillae* (Text-figs. 25 to 30) lie behind the mandibles laterally to the labium, one on either side of it. Each maxillae articulates with the lower margins of the post gena by means of single process at its inner most end, and consists of two pieces; (i) the proximal one is the cardo and (ii) the distal one the stipes, the two being hinged with each other by means of *Cardostipetal suture* (CDS).

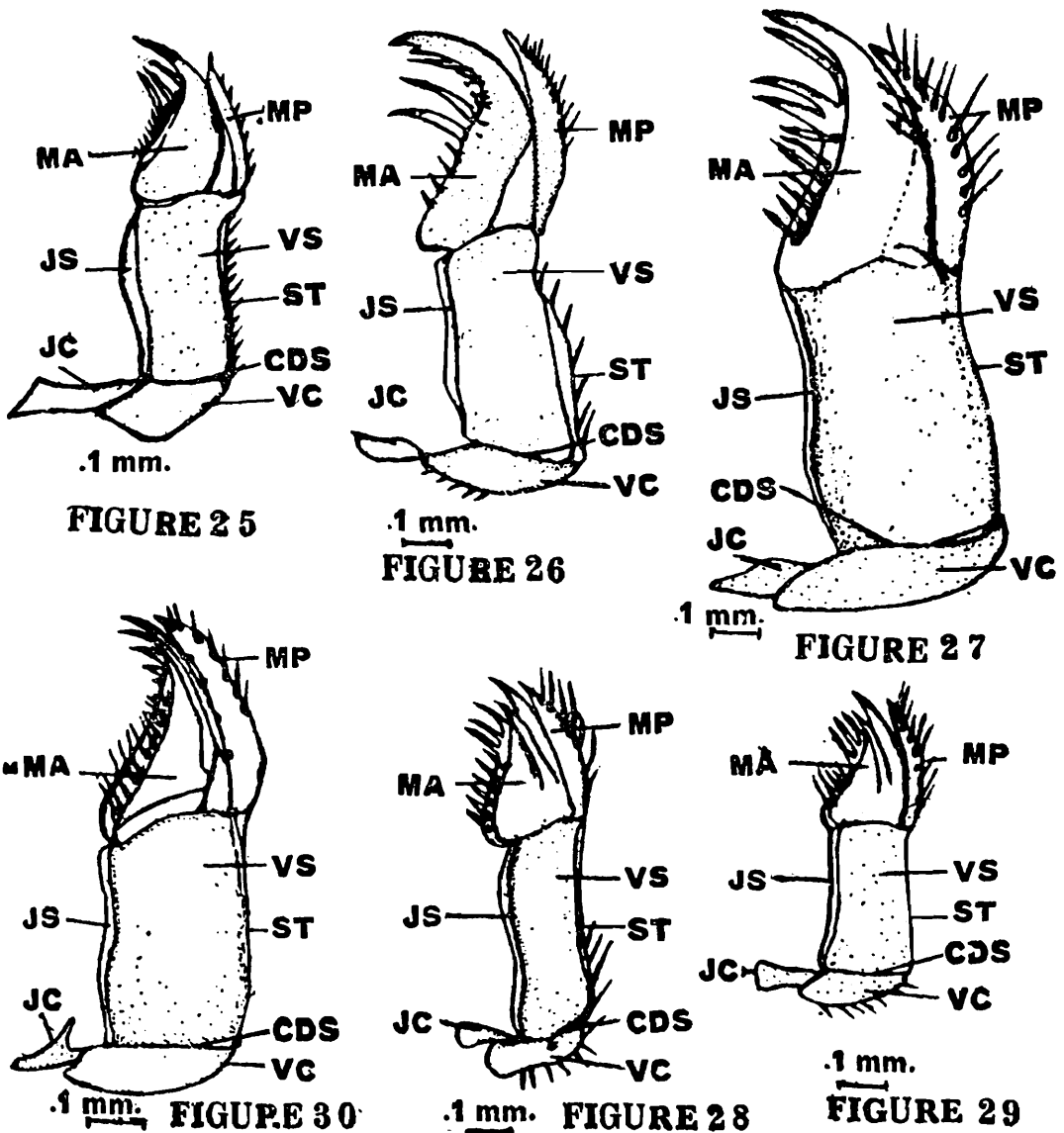
The *cardo* consists of a broad outer piece, the *veracordo*, and an inner piece the *Juxtacordo*. The *veracordo* (VC) is scooped on its dorsal surface to form a deep concavity, thus forming more or less cupshaped structure. The *Juxtacordo* (JC) is a short thinly sclerotised ventral process. This bears a condyle which articulates with the interior margin of the post gena outside the attachment of the labium.

The *stipes* is an elongated more or less a quadrate, structure and consists of two pieces, a narrow inner piece, the *Juxtastipes* (JS) and an outer rectangular piece, the *Verastipes* (VS) the two are separated from each other by a sutural groove which forms internally a sub-marginal ridge for articulation of the muscles. From the distal end of *vera stipes* arises the mala. The *mala* (MA) is strongly sclerotised and ends in an incisor point provided with two apical teeth and a row of hair, its inner curved margin bears stout bristles. The mala is movable on the end of the stipes and can be flexed mesally. The *maxillary palp* (MP) consists of a single segment. It is hinged poste-

riorly with the stripes and is long, cylindrical structure which bears stiff sensory setae.

The Juxtacardo (Text-figs. 25 to 30) is dumbbell shaped in *Copera marginipes*, spear-shaped in *Pseudagrion decorum* and *Ceriagrion coromandelianum*. It bears a protuberance in *Libellago lineata*. In *Ischnura delicata* and *Ischnura senegalensis*, it is club-shaped. The vera cardo is boat-shaped in all the larval forms.

In all the six species (Text-figs. 25-30) mala a constituent of verastipes ends in an incisor point provided with two apical teeth. Mala of *Libellago lineata*, *Ischnura delicata* and *Ischnura senegalensis* bears extra incisor at its mid length.

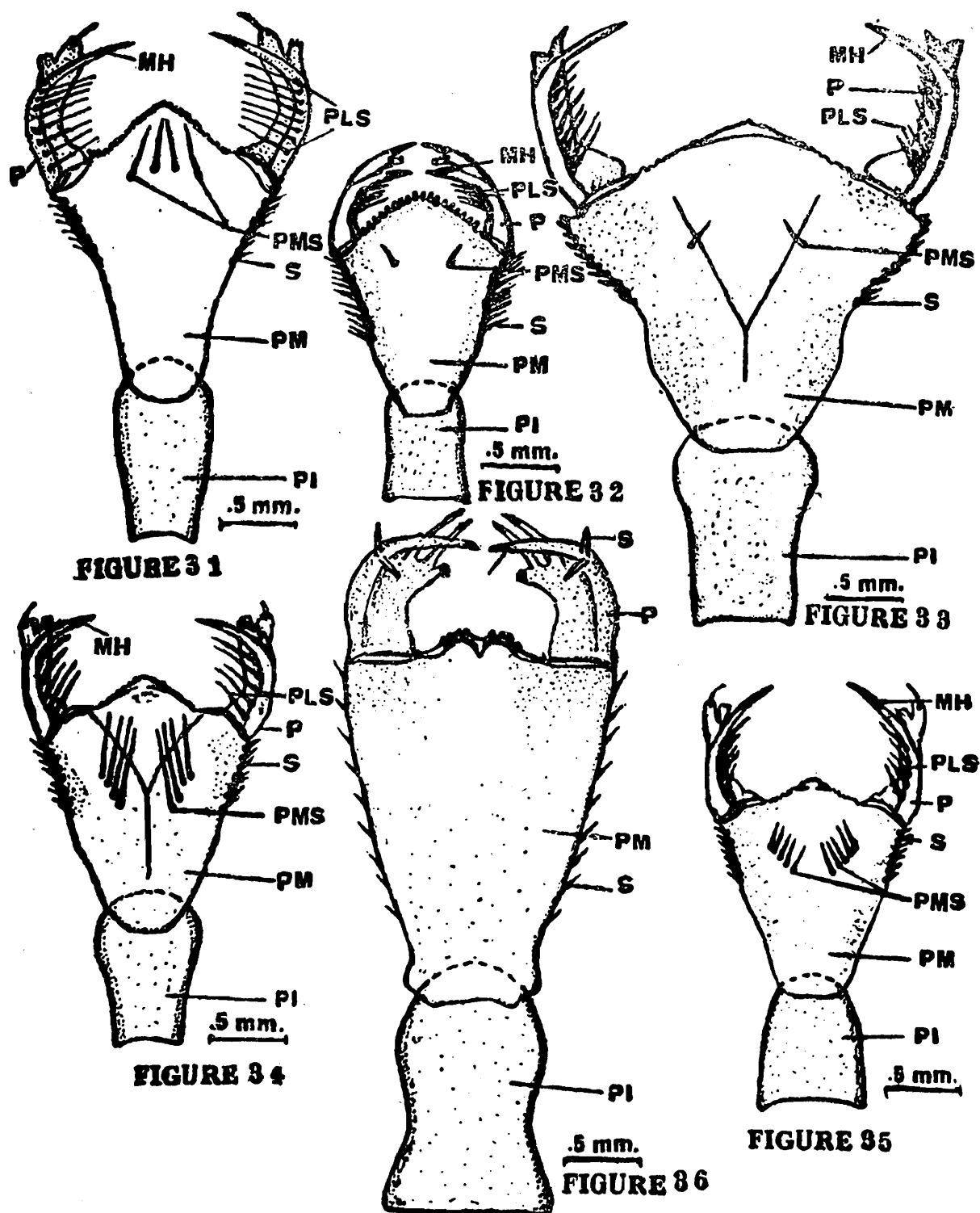


Text-figs. 25-30. Maxillae of the larvae :

25. *Copera marginipes*, 26. *Pseudagrion decorum*, 27. *Ceriagrion coromandelianum*,
28. *Ischnura delicata*, 29. *Ischnura senegalensis*, 30. *Libellago lineata*.

4. LABIUM

The *labium* (Text-figs. 31 to 36) is situated between the two maxillae. It is movably articulated to the head capsule in the ventromesal corner of the postgena, a little anterior to the pits of the posterior tectorial arms (PTP). It is modified for prehensile purposes and is known as the mask from the fact that it conceals the other mouth parts. The prementum and



Text-figs. 31-36. Labia of the larvae :

31. *Copera marginipes*, 32. *Pseudagrion decorum*, 33. *Ceriagrion coromandelianum*,
34. *Ischnura delicata*, 35. *Ischnura senegalensis*, 36. *Libellago lineata*.

postmentum are markedly lengthened and there is great freedom of movement between two parts. The postmentum (PI) is cylindrical and its dorsal surface is hollow in which in infolded position the prementum fits. The proximal end of postmentum articulates with the postgena, its distal part articulates with the prementum. *Prementum* (PM) is triangular in shape its narrower end articulates with the postmentum. The broader end of the prementum is directed anteriorly both in the folded as well as in the extended condition. Lateral sides of broader end bear the palpus its median part is convex and bears seta. The *palpus* (P) fits into the cup-shaped concavities of the prementum. These cavities are situated on the broader lateral sides of the prementum. Each palpus is a curved structure, broader at the base and narrower towards the apex, it bears *movable hook* (MH) and seta. Details of the premental seta (PMS), palpal seta (PLS) and shape of the prementum differs in various species and are as shown below :

The premental seta (Text-figs 31 to 36) are 2+2 in *Copera marginipes*, 1+1 in *Pseudagrion decorum* and *Ceriagrion coromandelianum*, 4+4 in *Ischnura delicata* and 5+5 in *Ischnura senegalensis*. In *Libellago lineata* premental seta are absent. The distal margin of prementum in *Copera marginipes* is serrated whereas serrations bear spiny projections in case of *Pseudagrion decorum*. The formation is wavy with small denticles in *Ceriagrion coromandelianum* and wavy with small serrations in *Ischnura delicata* and *Ischnura senegalensis*. In *Libellago lineata* it is bilobed and crenated.

Palpal seta (Text-figs. 31 to 36) are 8 & 8 in *Ceriagrion coromandelianum*, 5 & 5 in *Copera marginipes*, 4 & 4 in *Ischnura delicata*, *Ischnura galensis* and *Pseudagrion decorum*. Palpal seta are absent in *Libellago senelineata*. In all the larval forms the distal margin of the palpus is produced in two lobes. In *Ceriagrion coromandelianum* the outer lobe bears a curved-end hook : the inner lobe is produced into a number of denticles. In *Pseudagrion decorum* the outer lobe projects into a prominent curved-end hook, whereas the inner lobe is produced into short blunt teeth. In *Ischnura delicata*, and *Ischnura senegalensis* the outer lobe is produced into fine denticles, while the inner lobe bears a short-end hook. In *Ceriagrion coromandelianum* outer lobe is produced into curved-end hook : the inner lobe bears a number of denticles. In *Libellago lineata* the outer lobe consists of two parts : outer short conical tooth and an inner curved hook : inner lobe is serrated messaly forming long-end hook. In *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* the movable hook is half of the length of palpus. In *Ceriagrion coromandelianum* and *Libellago lineata* it is less than half of

its length whereas in *Pseudagrion decorum* it is two-third of the length of the palpus. Basal parts of movable hooks in *Libellago lineata* bear a pair of spines.

5. HYPOPHARYNX

The *hypopharynx* is a thick more or less irregular lobe, lying like trough in the preoral cavity, where it is attached to the head between the mouth and the labium. Its ventral wall is deflected into the adoral wall of the labium at the base of the prementum. The adoral surface of the hypopharynx is differentiated into a distal sclerotised area and a proximal more membranous part. The proximal part has a depression. The floor of the hypopharynx is continuous through the mouth with the ventral wall of the stomodium and it self forms the floor of the preoral chamber. The wall of the hypopharynx are strengthened by a group of sclerites, its distal end forms a beak like projection the salibos.

DISCUSSION

The discussion is mainly based on comparison with *Brachythemis contaminata* worked out by Mathur (1956) and *Lestes praemrosa* described by Kumar (1972). Works of Imhof (1910), Butler (1904), Corbet (1953) and Fraser (1933) are worth mentioning in this context.

The head is situated at the anterior end of the body carrying the eyes, antenna and the feeding organs. It is prognathus and ocelli are of equal size in all the larval forms. In *Brachythemis* (Mathur 1956) the head is hypognathus and ocelli are not of equal size.

In larval forms cranial suture forms U shaped frontal suture as mentioned by Duporte (1946). Antennal and subgenal sutures are as in *Brachythemis*. The two ocular sutures converge in *Brachythemis*, whereas these are situated away from each other in the larval forms.

In larval forms the vertex is divided by a clypeal suture, it is undivided in *Brachythemis* (Mathur 1956). Similar to *Brachythemis* epistomal sutures are absent in the larval forms ; hence frons and clypeus are not clearly demarcated. In larval forms, the lateral areas separated by coronal sutures form parietals. These are absent in *Brachythemis*. In last instar nymphs described the genal regions have descended to the level of the mouth bringing the primary mandibular articulation to the same level as the secondary ones. Between the two articulation, the base of the mandible is attached by membrane to the ventral edge of the gena. A narrow sclerite, the pleurostoma (PS), is developed between edges of gena and the base of the mandible and a pleurostomal sulcus in between gena and pleurostoma, as described by Duporte (1946).

Duporte's concept of the fronto parietal region, is that of a single sclerotised plate whose ventral region is partially divided by the fronto-genal inflections into a median and two lateral lobes. He defines the median lobe as frons, the lateral lobes as genae and dorsal region as vertex. These terms have the same morphological significance in different larval forms.

In larval forms the post occiput is narrow posterior rim of the cranium set off from occipital arch by post-occipital suture to which neck membrane is attached. Laterally the postocciput is produced in occipital condyle to which articulates the lateral cervical sclerite as in *Gryllotalpa* (Rakshpal 1972). In *Libellago lineata* the occipital condyle does not articulate with cervical sclerite as in *Brachythemis*.

As in *Brachythemis* the antennal sclerite and the antacorium are absent in various larval forms. Antennae are situated away from the median ocelli and not near to it as in *Brachythemis*. Antennal bases are bounded by antennal sutures as in *Brachythemis*. Antenna consists of scape, pedicel and flagellum as described by Imhof (1901).

In larval forms labrum hangs hinged from the clypeus through clypeo-labral suture similar to *Brachythemis* and *Gryllotalpa*.

In *Brachythemis* each mandible contains three incisors and molars bear four cusps. In larval forms the number of incisors and molar teeth is specific in different species as described earlier.

Veracardo of maxilla is boat-shaped in larval forms as in *Brachythemis*. Juxtacardo is strip-like in *Brachythemis*, whereas it is dumbbell-shaped in *Copera marginipes*, spear-shaped in *Pseudagrion decorum*, *Ceriagrion coromandelianum*, club-shaped in *Ischnura delicata* and *Ischnura senegalensis*. It bears a protuberance in *Libellago lineata*. In *Brachythemis* the distal end of mala possesses two small and four large incurved spines. In larval forms each mala contains an apical incisor teeth. Mala of *Libellago lineata*, *Ischnura delicata* and *Ischnura senegalensis* bear an extra incisor at the mid-length.

The larval labium is modified for prehensile purposes and is known as mask from the fact that it conceals the other mouth parts (Butler 1904) and consists of postmentum and prementum (Corbet 1953). In *Brachythemis* it consists of proximal and distal parts. The proximal part has submentum and mentum, the distal part is formed of squama. Postmentum is elongated and cylindrical in the larval forms, it bears a furrow in which prementum rests in the infolded condition. In *Brachythemis* the distal part of mentum bears paired squamae, median and lateral lobes, in larval forms mentum consists of a triangular plate bearing palpus on its lateral sides.

Premental seta are 6+6 in *Lestes* (Kumar 1972), they are 2+2 in *Copera marginipes*, 1+1 in *Pseudagrion decorum*, *Ceriagrion coromandelianum*, 4+4 in *Ischnura delicata* and 5+5 in *Ischnura senegalensis*. In *Libellago lineata* premental seta are absent.

In *Lestes* (Kumar 1972) the distal margin of prementum is serrated, in *Copera marginipes* serrations are small, whereas serrations bear spiny projections in *Pseudagrion decorum*. This formation is wavy with small denticles in *Ceriagrion coromandelianum* and wavy with small serrations in *Ischnura delicata* and *Ischnura senegalensis*. In *Libellago lineata* the same is crenated. In *Rhinocypha* (Fraser 1934) the distal margin of prementum is deeply bifid and edges of the fissure overlap to enclose a small foramen. In *Libellago lineata* as well the prementum is bifid but edges of the fissure do not overlap to enclose a foramen.

In *Lestes* palpal setae are 3 & 3, they are 8 & 8 in *Ceriagrion coromandelianum*, 5 & 5 in *Copera marginipes*, 4 & 4 in *Ischnura delicata*, *Ischnura senegalensis* and *Pseudagrion decorum*. Palpal seta are absent in *Libellago lineata*.

Similar to *Lestes* in larval forms the distal end of palpus is produced into two lobes. In *Lestes* the outer lobe consists of three parts : outer curved hook, short middle serrated part and an inner terminal lobe. The outer lobe in *Copera marginipes*, *Ceriagrion coromandelianum* and *Pseudagrion decorum* bears a curved end hook. In *Ischnura delicata* and *Ischnura senegalensis* it is produced into fine denticles, In *Libellago lineata* the outer lobe consist of two parts : outer short conical tooth and an inner curved hook. In *Lestes* the inner lobe is serrated mesally forming long hook. In *Ceriagrion coromandelianum* and *Copera marginipes* it is produced into fine denticles, in *Pseudagrion decorum* it forms a blunt teeth, in *Ischnura delicata* and *Ischnura senegalensis* it bears a curved hook while in *Libellago lineata* it terminates into a long end hook. In *Lestes* movable hook is long and slender, in *Copera marginipes*, *Ischnura delicata*, *Ischnura senegalensis* the movable hook is half the length of the palpus. In *Ceriagrion coromandelianum* and *Libellago lineata* it is less than half of its length, whereas in *Pseudagrion decorum* it is two-third of the length of palpus.

The ligula is undivided and is represented by a median lobe which is fused with the prementum.

SUMMARY

Head and mouth parts of six Zygopterous species of dragonfly larvae namely *Pseudagrion decorum*, *Copera marginipes*, *Ischnura deli-*

cata, *Ischnura senegalensis*, *Libellago lineata* and *ceriagrion coromandelianum* have been described.

The position of various sutures and areas of the head have been studied. Structure, shape and size of antennae and location of ocelli in various species have been noted and their interspecific variations discussed.

The number and arrangement of incisors and molar teeth on the mandibles are variable. The shape of Juxta-Cardo and constituents of stipes, the mala and maxillary palp differ in different species. Arrangement and number of pre-mental and palpal setae on the labium of different species as well are variable but there is no intraspecific variation of these characters.

ACKNOWLEDGEMENT

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ABBREVIATIONS

AN—Antenna, AS—Antennal suture, AT—Antartis, C—Condyle, CDS—Cardo-stipital suture, CL—Clypeus, CLS—Clypeo-labral suture, CS—Coronal suture, E—Eye, F—Frons, FL—Flagellum, ES—Frontal suture, GE—Gena, HY—Hypopharynx, HYP—Hypostoma, HYS—Hypostomal suture, JC—Juxtacardo, JS—Juxtastipes, I—Incisor, LB—Labrum, M—Molar, MA—Mala, MD—Mandible, MH—Movable hook, MP—Maxillary palp, MX—Maxilla, O—Ocelli, OC—Occipital condyle, OCA—Occipital arch, OCF—Occipital foramen, OCS—Ocular suture, OS—Occipital suture, P—Palpus, PD—Pedicel, PI—Postmentum, PLS—Palpal seta, PM—Prementum, POC—Postocciput, POS—Postoccipital suture, PMS—Premental seta, PSS—Pleurostomal suture, PS—Pleurostoma, PT—Parietal, PTP—Posterior tentorial pit, SC—Scape, SGA—Subgenal area, SGS—Subgenal suture, SP—Spine, ST—Stipes, V—Vertex, VC—Vera-Cardo, VS—Vera-stipes.

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STUDIES ON THE LIFE HISTORY OF INDIAN DRAGONFLIES,
ACISOMA PANORPOIDES PANORPOIDES RAMBUR, 1842
(LIBELLULIDAE : ODONATA)

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(With 37 Text-figures)

INTRODUCTION

The present communication is in continuation to my earlier studies on the life history of Indian Odonata (KUMAR, 1971, 1972a, 1972b, 1972c, 1973, 1979a, 1980 and in press). These studies have been undertaken to fulfill the long felt need to have a better understanding of morphology and bio-ecology of immature stages of Indian species of these amphibiotic insects. The present paper, ninth in the series, deals with larval stages of *Acisoma panorpoides panorpoides* Rambur.

Genus *Acisoma* Rambur, 1842, comprises small sized dragonflies, which are Oriental in distribution. Within Indian sub-region only one subspecies, i. e., *Acisoma p. panorpoides* has been recorded. It is widely distributed within our limits in western Himalaya, M. P., Assam, West Bengal, Sikkim and outside to Nepal, Sri Lanka, Phillipines, Malay-Archipelago, Indonesia, Celebes, Sumba, Lesser Sunda Islands, China, Japan, Thailand and Singapore (KUMAR & PRASAD 1981).

MATERIAL AND TECHNIQUES

Field observations were made during the year 1976 at a perennial pond in vill. Gorakhpur, Dehra Dun. Study on the life history in laboratory was started on 27.IV.1976 by collecting eggs from a ovipositing female. In laboratory eggs were kept submerged in water in a glass vessel. Hatching started on 3.V.76 and completed on 8.V.76. Study on larval development was begun on 3.V.76 by rearing 4 larvae in 2nd instar, of these 2 larvae emerged into imagos (♂), after passing through 12 instars and taking 67 and 69 days respectively from oviposition to emergence. Breeding record of the larvae reared in the laboratory is tabulated in Table 1. In early instars larvae were fed on paramecium and cyclops and later on mosquito larvae.

TABLE 1. Breeding record (1976) of larvae of *Acisoma panorpoides panorpoides* (Rmb.) Eggs collected on 27.iv.1976 Eggs hatched on 3. v. 1976 to 8. v. 1976.

INSTAR	LARVA I		LARVA II		LARVA III		LARVA IV		Average (maximum temperature during the period)
	Date of entry	Duration (in days)	Date of entry	Duration (in days)	Date of entry	Duration (in days)	Date of entry	Duration (in days)	
2nd	3.v.76	3	3.v.76	3	3.v.76	3	5.v.76	3	24°C-36°C
3rd	6.v.77	2	6.v.76	2	6.v.76	3	8.v.76	2	
4th	8.v.76	2	8.v.76	2	9.v.76	2	10.v.76	2	
5th	10.v.76	7	10.v.76	3	11.v.76	3	12.v.76	6	
6th	17.v.76	4	13.v.76	7	14.v.77	7	18.v.76	4	
7th	21.v.76	5	20.v.76	5	21.v.76	4	22.v.76	3	
8th	26.v.79	3	25.v.76	6	25.v.76	4	25.v.76	4	
9th	29.v.76	4	31.v.76	3	29.v.76	4	29.v.76	3	
10th	2.vi.76	7	3.vi.76	6	2.vi.76	15	1.vi.76	4	
11th	9.vi.76	14	9.vi.76	13	died on	17.vi.76	5.vi.76	11	
12th	23.vi.76		22.vi.76	13			5.vi.76	17	
Emergence	died on 27.vi.76		5.vii.76	—			3.vii.76		
Total number of days (from oviposition to emergence)				69					67

Studies on various instars are based on laboratory reared material. Field studies on seasonal regulations were made by larval and adult sampling from different biotopes.

Terminology used for the labium follows CORBET (1953) ; the tibial comb and tarsi follows MAC NEILL (1967) ; the anal appendages follow SNODGRASS (1954) and MAC NEILL (1960).

OVIPOSITION AND EGGS

Oviposition is exophytic and is performed by perched females at the oviposition sites. The egg laying is generally performed in those areas of the ponds which have thick growth of submerged aquatic vegetation, namely of *Nymphaeae*.

The female dips a number of times, posterior end of its abdomen in water amidst the floating vegetation. Unlike the fellow species *Diplacodes trivialis* (KUMAR, in press), the female of *Acisoma p. panorpoides* is guarded by hovering male during oviposition. Similar behaviour of male has also been recorded in the Nigerian form, *Acisoma panorpoides inflatum* Selys (HASSAN, 1978).

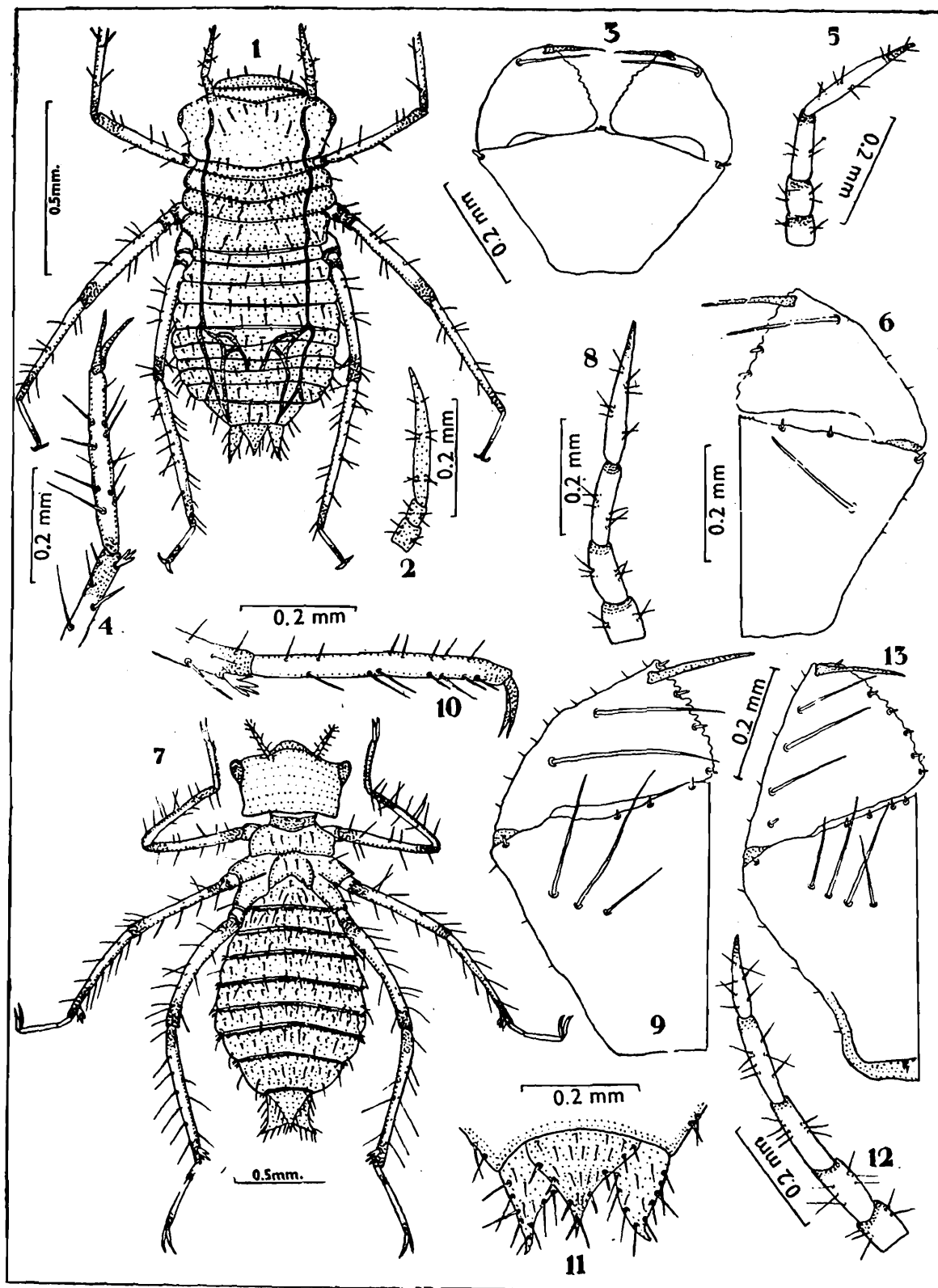
The eggs are oval in shape, a little longer than broader. Length 0.285 to 0.301 mm, width 0.204 to 0.209 mm. Eggs when laid are creamy but change to yellowish-brown within a day or two. Incubation lasted 7 days. Maximum temperature during this period varied from 24°C to 28°C.

LARVAL STAGES

1st instar or Prolarva : Hatches through ruptured longitudinal slit of the egg ; of very short duration. Head squarish, abdomen elongated with ventrally folded legs ; white-creamish ; antenna 3-segmented, folded downwards with labium ; anal appendages short.

2nd instar (Text-figs. 1-4) : Duration 3 days. Length 2.15 mm ; dirty white. Head almost rectangular ; eyes small, bead like. Antennae (Text-fig. 2) 3-segmented, comprising scape, pedicel and flagellum. Labium (Text-fig. 3) flat, squarish ; premental setae absent, a lateral spiniform seta present near the base of palpus ; palpal setae 1 & 1, upper distal margin of palpus wavy, lower straight. Tarsi (Text-fig. 4) single segmented ; tibial comb comprises a single furcate seta. Anal appendages comprising median epiproct and paired lateral paraprocts.

3rd instar (Text-figs. 5 & 6) : Duration 2 days. Length 2.90 mm ; become little darker. Head broader than long. Antennae (Text-fig. 5) 4-segmented ; flagellum divided into two unequal segments. Labium



Text-figs. (1-4) 2nd Instar Larva : 1, Larva (D. V.) ; antenna : 3, labium ; 4, tibial comb and tarsi ; (5-6) 3rd Instar larva : 5, antenna, 6, labium ; (7-11) 4th Instar larva : 7, larva (D. V.) ; 8, antenna : 9, labium, 10, tibial comb and tarsi ; 11, anal appendages ; (12-13) 5th Instar larva : 12, antenna ; labium.

(Text-fig. 6) : premental setae 1+1 ; palpal setae 1 & 1 ; distal margin of prementum and palpus bear a few claviform setae. Tarsi still single segmented.

TABLE 2. Summary of larval changes in *Acisoma panorpoides panorpoides* Rambur

INSTAR	2	3	4	5	6	7	8	9	10	11	12
Antennal segments	3	4	4	5	6	6	6	7	7	7	7
Premental setae	—	1+1	3+3	4+4	4+4	5+5	6+6	7+7	8+8	9+9	11+11
					2 2	2 2	1 1	1 1	2 2	1 1	
Palpal setae	1&1	1&1	2&2	3&3	5&5	6&6	6&6	8&8	8&8	8&8	8&8
Tarsal segments	1	1	1	2	2	2	3	3	3	3	3
Abdominal segments covered with wing buds	—	—	—	1/2	1½	2	2½	3½	4½	5½	6½
Anal cerci											
Head width [in mm]	—	—	—	—	+	+	+	+	+	+	+
Body length (in mm) including anal appendages	0.35	0.70	0.95	1.15	1.35	1.55	1.80	2.05	2.35	2.75	3.10
	2.15	2.90	3.71	4.95	5.60	6.50	8.75	10.90	13.25	15.60	17.10

.....PRO-LARVA.....

(-) absent ; (+) present.

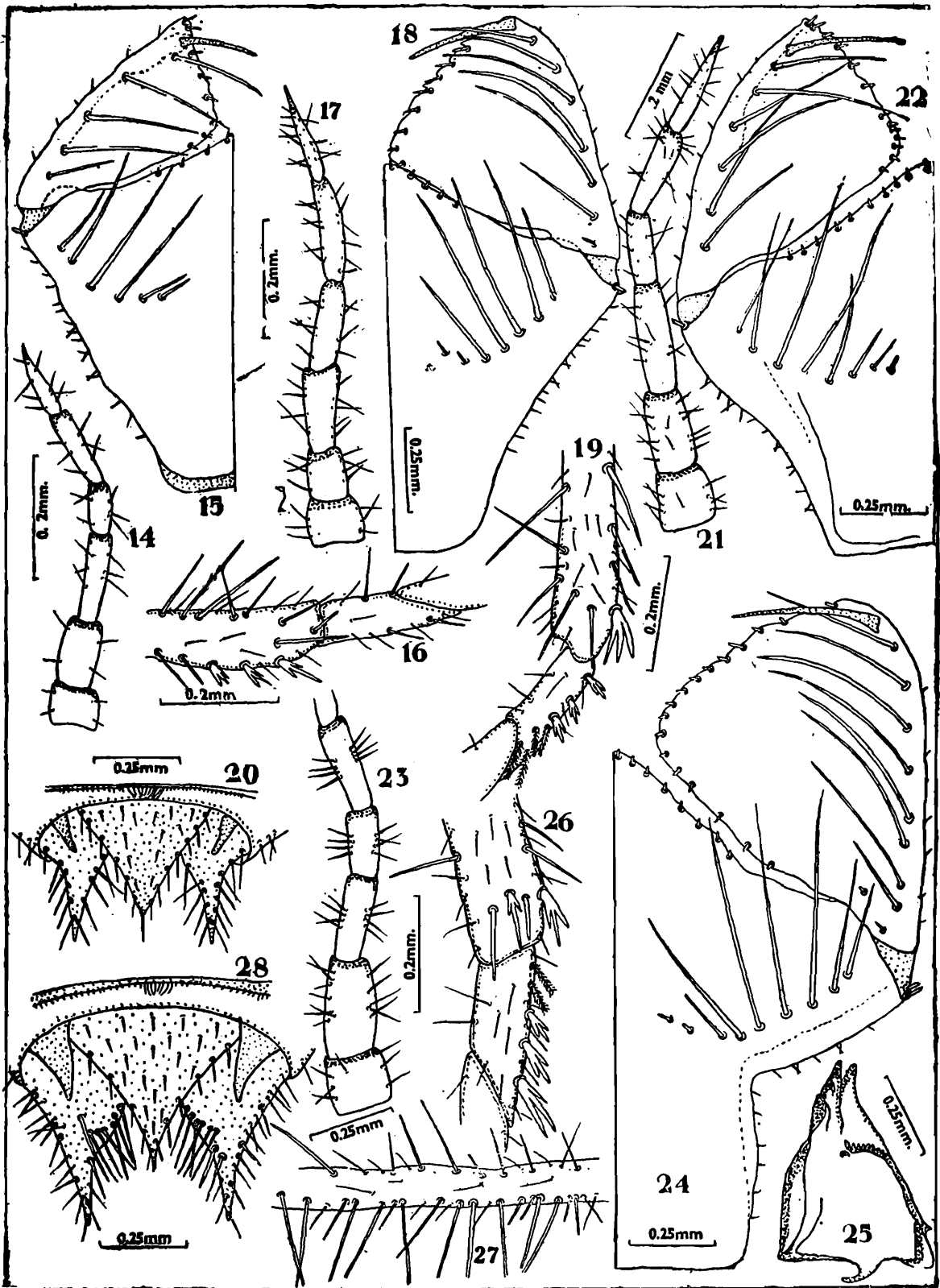
4th instar (Text-figs. 7-11) : Duration 2 days. Length 3.71 mm, dirty yellowish. Head rectangular ; eyes distinct protruding antero-dorsally. Antennae (Text-fig. 8) still 4-segmented, beset with sparse setae. Labium (Text-fig. 9) : premental setae 3+3, distal margin of prementum beset with 3 claviform setae ; another seta present near the base of palpus ; palpal setae 2 & 2, distal margin of palpus formed into crenations, a few of them beset with claviform setae. Tarsi (Text-fig. 10) still single segmented. Anal appendages (Text-fig. 11) comprising epiproct and paired paraprocts, beset with spiniform setae.

5th instar (Text-figs. 12 & 13) : Duration 6 days. Length 4.95 mm. Antenna (Text-fig. 12) 5-segmented, last flagellar segment divided in two unequal segments. Labium (Text-fig. 13) : premental setae 4+4, last added laterally, each crenation at distal margin beset with a claviform seta ; palpal setae 3 & 3, last seta added interpolated, a setella present near the base. Tarsi divided in two unequal segments. Anal appendages still comprising epiproct and paired paraprocts.

6th instar (Text-figs. 14-16) : Duration 4 days. Length 5.60 mm. Larva dark-yellowish and hairy. Antenna (Text-fig. 14) 6 segmented, 2nd flagellar segment having divided in two unequal segments. Labium (Text-fig. 15) : premental setae 4+4, 2 setella being added mesially on either side, a row of simple hair like setae present laterally on prementum, palpal setae 5 & 5, one seta each added at base and towards apex of palpus. Hind wing-buds extend upto the middle of 2nd abdominal segment. Tarsi (Text-fig. 16) 2-segmented, tibial comb comprises a number of furcate setae and scattered spiniform setae. Cerci appear as small appendages.

7th instar (Text-figs. 17-20) : Duration 5 days. Length 6.50 mm. Head transverse, vertex convex. Antenna (Text-fig. 17) still 6-segmented, beset with hair like setae. Labium (Text-fig. 18) : premental setae 5+5, last seta added mesially ; row of spiniform setae present on distal margin of prementum ; palpal setae 6 & 6, last seta added interpolated, each crenation at distal margin beset with a seta. Wing buds extending upto end of 2nd abdominal segment. Tarsi (Text-fig. 19) still 2-segmented ; a number of pectinate setae appear on 1st tarsal segment. Anal appendages (Text-fig. 20) with distinct cerci.

8th instar (Text-fig. 21 & 22) : Duration 6 days. Length 0.75 mm. Larva becoming more hairy and darker. Antenna (Text-fig. 21) still 6-segmented. Labium (Text-fig. 22) : premental setae 6+6, last seta added mesially ; palpal setae 6 & 6. Tarsal segments divide further and become 3, tibial comb comprises a number of furcate setae.



Text-figs. (4-16) 6th Instar larva : 14, antenna ; 15, labium ; 16, tibial comb and tarsi ; (17-20) 7th Instar larva : 17, antenna, 18, labium ; 19, tibial comb and tarsi ; 20, anal appendages ; (21-22) : 8th Instar larva : 21, antenna ; 22, labium ; (23-28) 9th Instar larva : 23, antenna ; 24, labium ; 25, mandible. 26, tibial comb and and tarsi ; 27, femur (E. V.) ; 28, anal appendages.

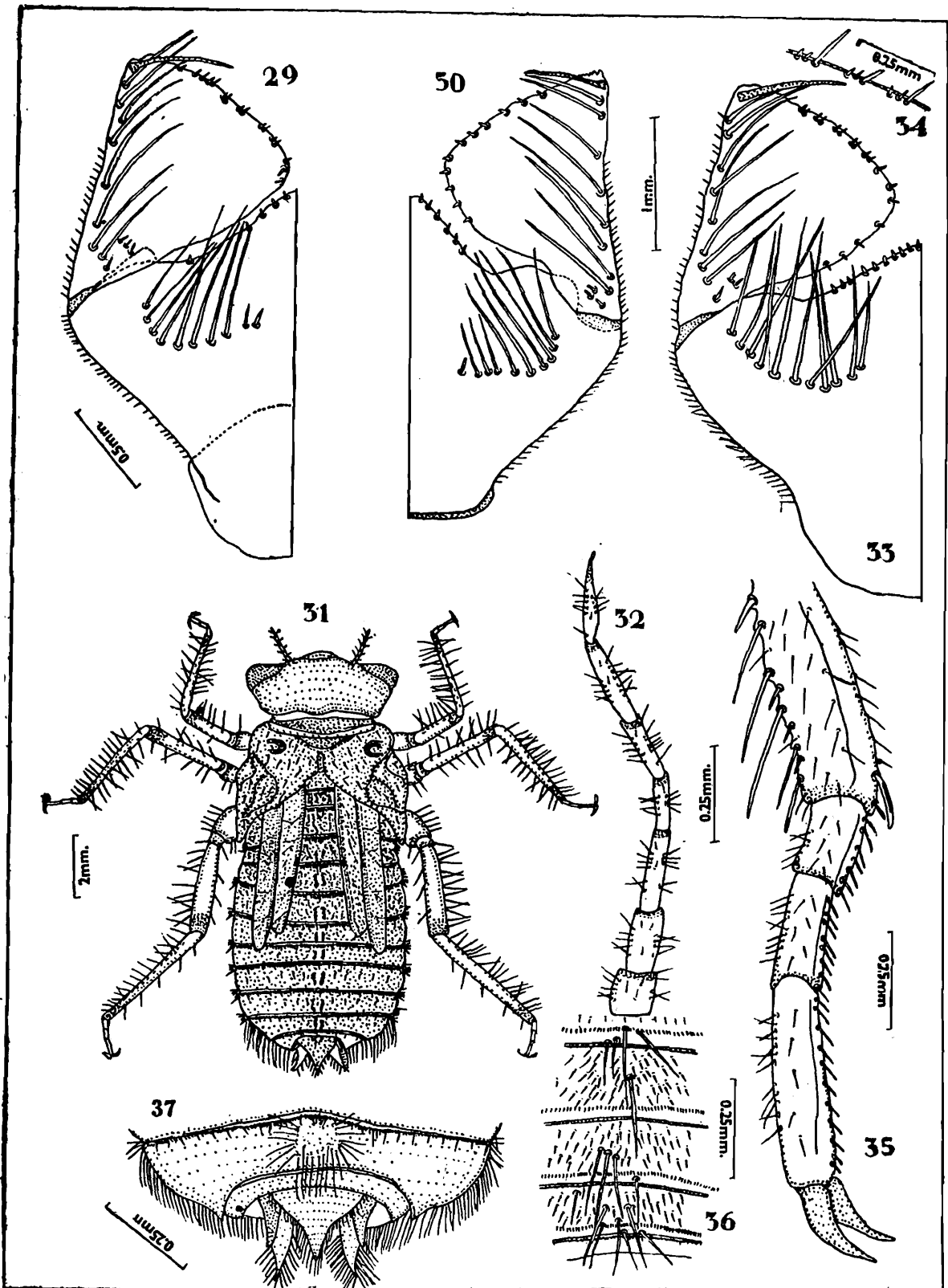
9th instar (Text-figs. 23-28) : Duration 3 days. Length 10.90 mm. Resembles final instar larva, except size. Antenna (Text-fig. 23) 7-segmented, last flagellar segment having divided into two unequal segments, thickly beset with setae. Labium (Text-fig. 24) premental setae 7+7, last seta added laterally, 2 setalla each, present mesially; palpal setae 8 & 8, one added at base and the other interpolarily. Femur (Text-fig. 27) beset with long, spiniform setae; tibial comb (Fig. 26) comprises a number of furcate and spiniform setae, while tarsi beset with paired row of pectinate and furcate setae. Median epiproct and paired lateral paraprocts thickly beset with spiniform setae (Text-fig. 28).

10th Instar (Text-fig. 29) : Duration 6 days. Length 13.25 mm. Antennal segments further increasing in length. Labium (Text-fig. 29) : Premental setae 8+8, last seta added laterally; palpal setae 8 & 8, as in preceding instar. Wing buds well developed and extend upto middle of 5th abdominal segment. A number of hairy setae present.

11th Instar (Text-fig. 30) : Duration 13 days. Length 15.60 mm. Antennal segments increasing further in length. Larva dark marked with greyish spots. Labium (Text-fig. 30) : premental setae 9+9, last seta added mesially, a pair of mesial setella present; palpal setae 8 & 8, 3 spiniform setae present near the base of palpus; thick row of hair like setae present at lateral margins of prementum and palpus. Wing buds extend upto the middle of 6th abdominal segment. Tibial comb and tarsi comprise a number of furcate setae.

12th (Ultimate) Instar (Text-figs. 31-37) : Duration 13 days. Length 17.10 mm. Larva (Text-fig. 31) small, hairy and compact in appearance. Dark dirty grey with darker wing buds. Antenna (Text-fig. 32) filiform, beset with simple setae.

Labium (Text-figs. 33 & 34) : spoon shaped; premental setae 11+11, last two setae added interpolated, distal margin of prementum strongly convex, formed into crenations, each crenation bear a claviform seta; palpal setae 8 & 8, 3 setella present near the base of palpus, distal margin of palpus formed into a number of crenations, some of which bear 3 claviform setae each (Text-fig. 34); laterally beset with row of hair like setae. Hind-wing buds extend upto the middle of 7th abdominal segment. Tibial comb and tarsi (Text-figs. 35) beset with a number of furcate, pectinate and simple setae on the ventral side. Tuft of long mid-dorsal setae present (Text-fig. 31 & 36) on abdominal segments 2-10. Anal appendages (Text-fig. 37) thickly beset with long setae on dorsal and lateral sides.



Text-figs. (29) 10th Instar larva : 29, labium ; (30) 11th Instar larva : 30, labium ; (31-37) 12th Instar larva : 31, larva ; 32, antenna, 33, labium ; 34, distal margin palpus (E. V.) ; 35, tibial comb and tarsi ; 36, three abdominal segments (dorsal E. V.) ; 37, anal appendages.

BIOLOGY

KUMAR (1979b) has recorded *Acisoma p. panorpoides* as one of the multivoltine species occurring at Dehra Dun. The adults are common

around weedy ponds for a major portion of the year. HASSAN (1978) also reported the occurrence of adults of *A. panorpoides inflatum* Selys round the year at Nigeria.

Adults generally perch on the floating vegetation of Nymphae in medium to large sized ponds. Larvae occur amidst weeds and roots of the aquatic vegetation.

Larval development is rather rapid and it takes about 2 months each for completion of two summer larval broods (i.e. March-April to May-June and June-July to August-September); thus the first batch of adults emerge from preceding larval brood in ponds during March-April, oviposition takes place soon after and the 2nd batch of emergence occurs in June-July. After being on the wing for some time the adults of 2nd batch oviposit in similar perennial ponds. The second larval brood is again completed rapidly like the preceding one and the 3rd batch of adults emerge in September-October. This is the period of the decline of monsoon, soon after, these adults oviposits in perennial ponds existing in fields and forests in the flat and sub-mountaneous areas of the valley. The third larval generation is slowed down and is completed by following March-April, thus taking not less than 5-6 months.

SUMMARY

The life history of *Acisoma panorpoides panorpoides* Rambur has been studied in the field and the laboratory. Specimens were reared from egg to the adult. The principal in changes external morphology in different larval instars and the characters which are helpful in distinguishing various instars are described in detail. The seasonal distribution of the species has been studied in the field.

ACKNOWLEDGEMENTS

My sincere thanks are due to B. K. Tikadar, Director, Zoological Survey of India, Calcutta, for permission to undertake the present study, and to Dr. B. S. Lamba, Deputy Director-in-charge, Zoological Survey of India, Northern Regional Station, Dehra Dun, for various other facilities and encouragement throughout the study.

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TAXONOMIC AND ECOLOGICAL STUDIES ON THE
AMPHIBIANS OF CALCUTTA AND ITS ENVIRONS

By

A. K. SARKAR

Zoological Survey of India, Calcutta

(With 13 Text-figures and 1 Map)

INTRODUCTION

While working out a large collection of amphibians accumulated in the Zoological Survey of India for the last 22 years it became apparent that quite a big lacuna existed regarding the knowledge of amphibian fauna of Calcutta and its surroundings. The work comprises the consolidated account on the amphibians of the said area. So far only a few stray records by Anderson (1871), Annandale (1909), Bhaduri (1945 & 1947), Boulenger (1890 & 1920), Mukerji (1933) and Parker (1934) are available on the amphibians of the area.

By keeping this in view a long-term amphibian survey project of Calcutta and environs was undertaken between July 1961 to March 1963 by Miss M. B. Kripalani (Mr. M. R. Mansukhani) and staff of the Amphibia Section. Weekly surveys within a radius of 60 km. of Calcutta were undertaken covering the vast area of four major districts namely, 24-Parganas, Nadia, Hooghly and Howrah of West Bengal (between latitudes $22^{\circ}7' - 23^{\circ}N$ and longitudes $87^{\circ}45' - 88^{\circ}40'E$). The work also includes the observations on the large collection from Salt Lake of Calcutta made by Dr. B. Biswas and party during May 1963 to February 1967. About 1713 examples of amphibians were collected from different ecological habitats like muddy drains, tanks, lakes, canals, bushes, trees, under fallen leaves, from moist ground and village huts, while undertaking the above surveys.

Amphibians are distributed among three orders namely, Apoda (or Gymnophiona), Caudata (or Urodela) and Anura. Amphibians of Calcutta and its environs are lacking former two orders and are only represented by the order Anura.

SYSTEMATIC ACCOUNT

Class : AMPHIBIA

Order : ANURA

Key to the families of Amphibians of Calcutta and environs :

- | | | | |
|---|------------|------------------|--------|
| 1. Jaws toothless. | ... | ... | 2 |
| Upper jaw toothed. | ... | ... | 3 |
| 2. Skin rough with spiny warts, parotoids present. | ... Family | BUFONIDAE | ... p. |
| Skin more or less smooth, parotoids absent. | ... Family | MICROHYLIDAE | ... p. |
| 3. No intercalary ossification (extra cartilaginous bone) between the distal and penultimate phalanges. | ... Family | RANIDAE | ... p. |
| An intercalary ossification between the distal and penultimate phalanges. | ... Family | RHACOPHORIDAE... | p. |

Family I. BUFONIDAE

This family is represented in Calcutta and environs by two species of the genus *Bufo* Laurenti, 1768 which can be distinguished by the following key.

- | | | |
|---|-------------------------------|--------|
| Head with bony ridges, parotoids kidney-shaped. | ... <i>Bufo melanostictus</i> | ... p. |
| Head without bony ridges, parotoids flat (not kidney-shaped). | ... <i>Bufo stomaticus</i> | ... p. |

Genus 1. *Bufo* Laurenti, 17681. *Bufo melanostictus* Schneider

(Common Indian Toad)

(Text-fig. 1)

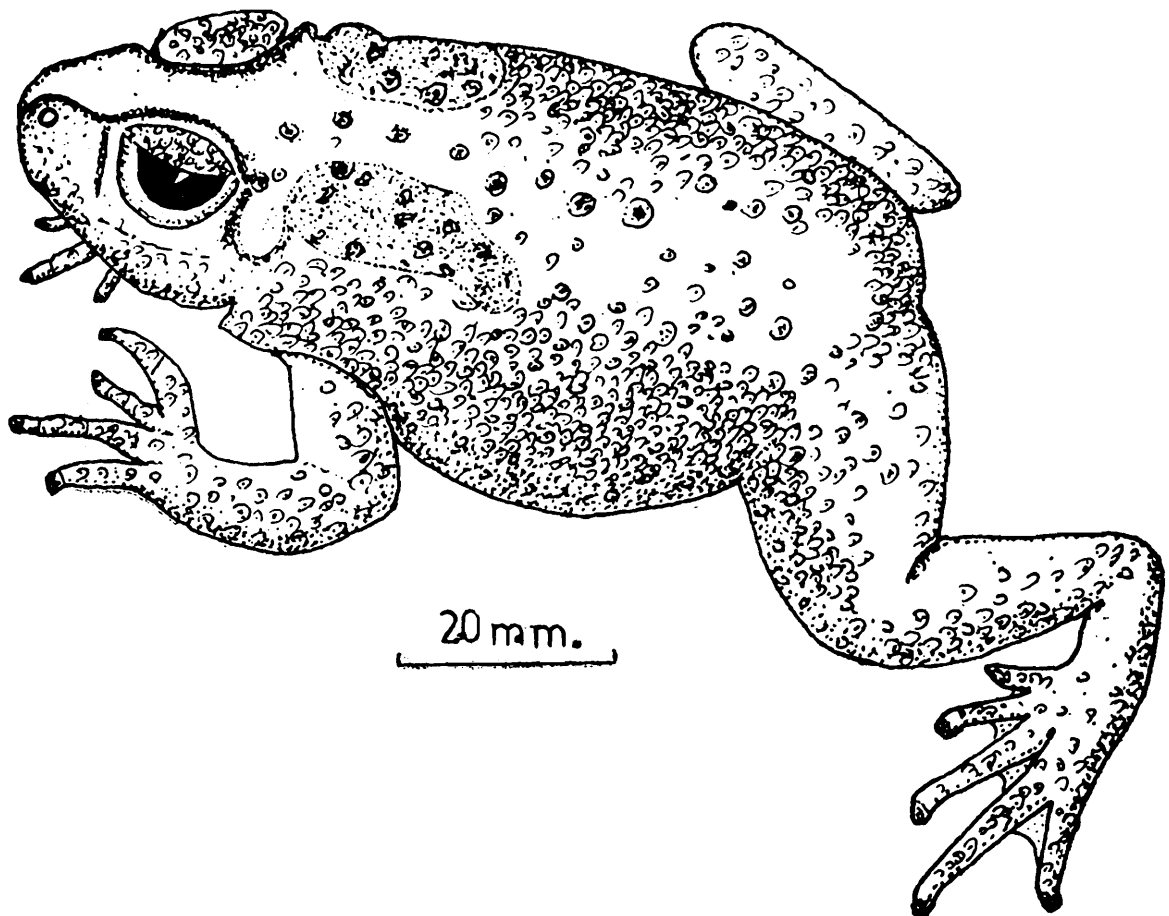
1799. *Bufo melanostictus* Schneider, *Hist. Amph.* 1 : 216.

Material : 177 toads collected from 24-Paragans district (Eden Garden (Calcutta), Zoological Garden (Calcutta), Budge Budge, Dhakuria, Diamond Harbour, Baruipur, Dakshin Baraset, Haliashahar, Baraset, Lauhati, Magrahat, Salt Lake); Hooghly district (Sheoraphuli, Sheakhala, Kristrampur, Tarakeshwar, Nalikul, Kamarkundu, Magra); Howrah district (Bagnan, Bally); Nadia district (Kalayani). Collections are available throughout the year except in January and February.

Distribution : Calcutta and environs, —As mentioned above. *Elsewhere*, —Common throughout the plains of India, Sri Lanka and Burma. Its range extends to Southern China, Malaya Peninsula and Archipelago.

Measurements : Snout to Vent length 11-114 mm.

Remarks : It is the most common toad available in Calcutta and environs. It is nocturnal in habit and generally found in gardens and on roadsides while preying on various arthropode and other invertebrates. Juveniles are found during the day also. Baring the breeding



Text-fig. 1. *Bufo melanostictus* Schneider

season adults are found inside the burrows and in dark corners of the village huts during the day. This toad is mainly terrestrial and found in and near the water only during breeding season. On provocation its parotid glands secrete a milky fluid which causes irritation on the human skin.

2. *Bufo stomaticus* Lutken

(Marbled Toad)

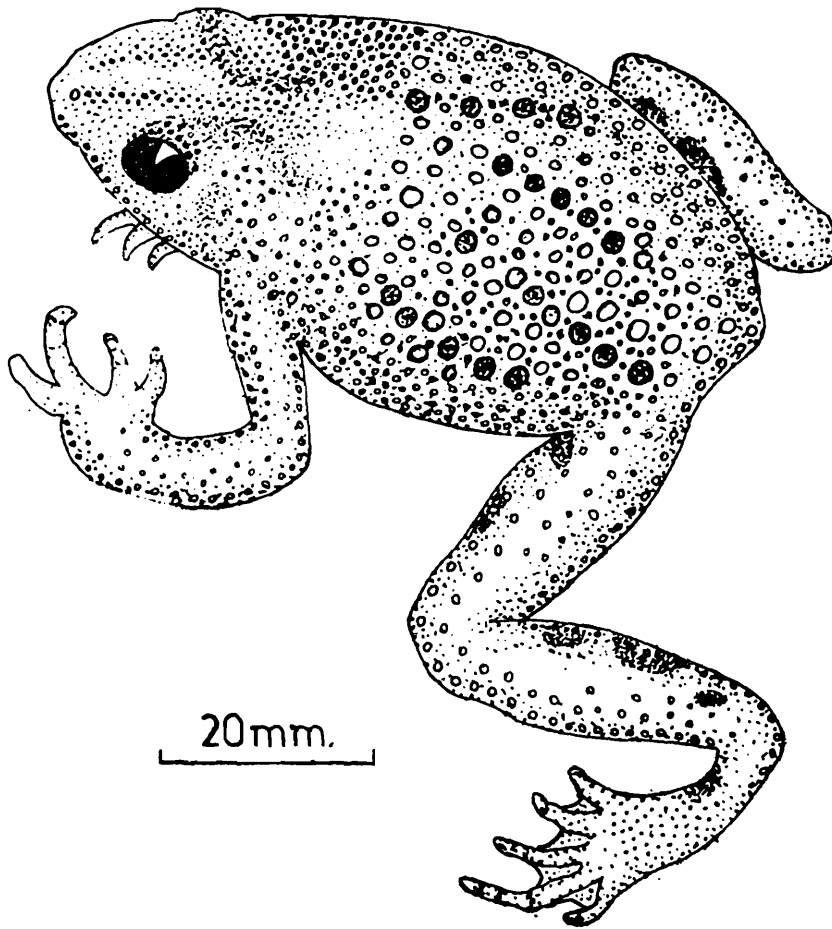
(Text-fig. 2)

1863. *Bufo stomaticus* Lutken, *Vidensk. Meddr dansk naturh-Foreni*, 14 : 305.

Material : 24-Pargans district : 47 ex. (4 adults, 37 juveniles and 6 tadpoles), Cemented tank of Eden Garden, Calcutta, 5.vii.1961. Coll. M. B. Kripalani. Nadia dist. : 7 ex., Phulia, 4.xi.1964. Coll. D. K. Ghosal.

Distribution : Calcutta and environs, —As mentioned above. Annandale (1909) had recorded it from Calcutta. *Elsewhere*, —Assam, West Bengal, Bihar, Andhra Pradesh (Nagarjun Valley), Rajasthan (Rajputana), Uttar Pradesh (Agra) and Maharashtra (Bombay) in India. Also Nepal, Burma, Sri Lanka, Pakistan and Arabia.

Measurements : Snout to Vent length 8-86 mm.



Text-fig. 2. *Bufo stomaticus* Lutken

Remarks : It is quite rare, nocturnal, terrestrial toad and found in or near water during the breeding season (April to September). Adult and juvenile toads were collected during July while inhabiting the muddy substratum beneath the large stones scattered in the Eden Gardens, Juveniles and tadpoles were also collected from a near by cemented tank.

Annandale (1909) has reported that *Bufo stomaticus* is common in Calcutta, but it is rarely seen owing to its strictly nocturnal habits. He has also mentioned that during rains large numbers of them are found to huddle together in the many crevices afforded by the tree-

trunk of the Peepuls (*Ficus religiosa*) on the *Maidan* area of Calcutta and they can reach upto a height of six feet from the ground through those crevices.

Family II. MICROHYLIDAE

This family is represented in Calcutta and environs by three genera each of which is again represented by a single species.

Key to the genera of the family MICROHYLIDAE.

- | | | |
|--|--|---|
| 1. Tips of fingers more or less blunt (or rounded), but not dilated into discs. ... | ... | 2 |
| Tips of fingers dilated into triangular discs. ... | ... | 3 |
| 2. Two strong and shovel-shaped metatarsal tubercles (inner larger) present. ... | Genus Uperodon Dumeril and Bibron. p. ... | |
| Two small but distinct, and normal (not shovel-shaped) metatarsal tubercles present. ... | Genus Microhyla Tschudi p. ... | |
| 3. A bony ridge on posterior margin of each choana. ... | Genus Kaloula Gray p. ... | |

Genus 2. **Uperodon** Dumeril & Bibron, 1841.

3. **Uperodon globulosum** (Gunther)

(Baloon Frog)

(Text-fig. 3)

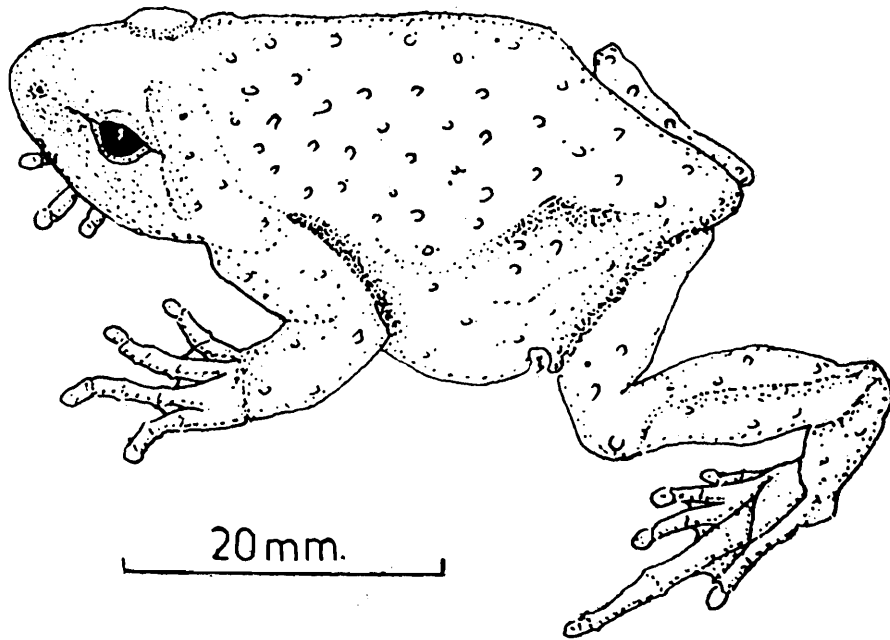
1864. *Cacopus globulosus* Gunther, *Rept. Brit. India*, p. 416.

Material : 24-Parganas dist. : 2 ex. (♀), Barackpore (near Vidyasagar Vidyapith), 20.i.1974, Coll. *D. K. Ganguly*; 1 ex. (♀), Budge Budge, 20.v.1978, *S. Chattapadhyaya*, Howrah dist. : 1 ex. (♂) Bally, 7.vii.1972, *A. K. Sarkar*. Hooghly dist. : 1 ex. (♂), Chinsura, —vii. 1977. *S. Chakraborty*.

Distribution : Calcutta and environs,—As mentioned above. *Ander* (1871) has recorded one example from Sibpur Botanical Gardens. *Mukherji* (1933) has recorded one example from Khardah (near Calcutta) and *Bhaduri* (1945) has recorded one example from Belghurria, Calcutta and another from Sibpur Botanical Gardens near Calcutta. *Elsewhere*. —Assam, West Bengal, Orissa, Madhya Pradesh, Maharastra, Gujarat and Karnataka in India.

Measurements : Snout to Vent length 49-66 mm.

Remarks : This is a very rare microhylid frog which leads a secretive subterranean life and found on the surface only during breeding season. Two examples from Barrackpore have been collected at a depth of *ca.* 3 feet while the foundation of a building was being dug.



Text-fig. 3. *Uperodon globulosum* (Gunther)

According to earlier authors these frogs are the strong predators on the white ants (Termites), thus helping the farmers in control of this severe pest.

Genus 3. *Microhyla* Tschudi, 1838

4. *Microhyla ornata* (Dumeril & Bibron)

(Ornate Microhylid)

(Text-fig. 4)

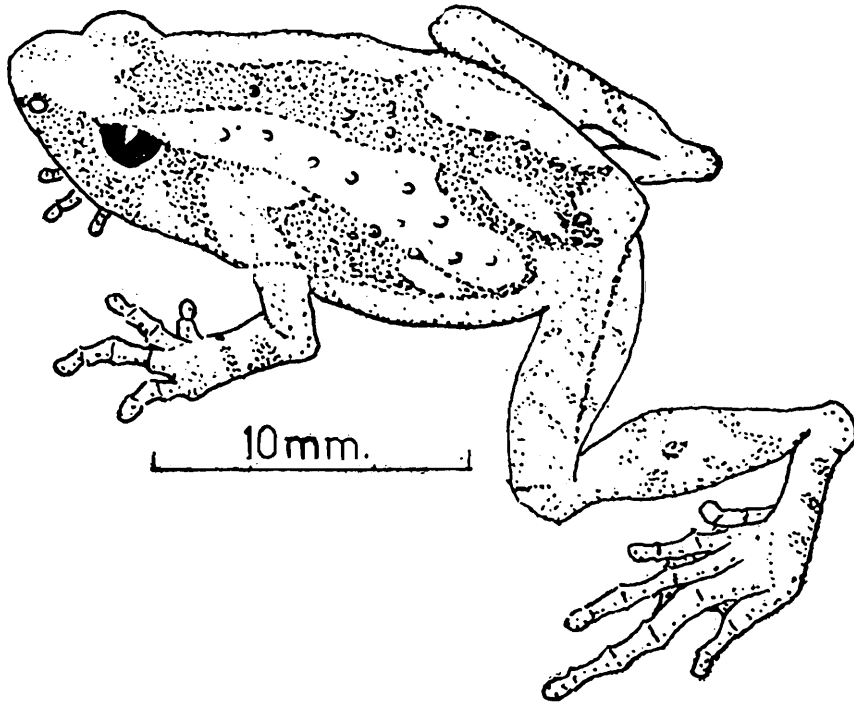
1841. *Engystoma ornatum* Dumeril and Bibron, *Erpet. Gen.* 8 : 745.

Material : 228 frogs and 1 tadpole, Collected from 24-Parganas district (Diamond Harbour, Baruipur, Guma, Halishahar, Baraset, Duttapukur, Magrahat); Hooghly district (Bandel, Chandernagar, Singur, Sheoraphuli, Champadanga, Sheakala, Kristrampur, Tarakeshwar, Magra, Tribeni); Howrah district (Jagatballavpur, Amta, Bagnan, Uluberia, Bally); Nadia district (Haringhata, Phulia). Collections are available throughout the year.

Distribution : Calcutta and environs,—As mentioned above. This species is being recorded for the first time from Calcutta and environs.

Acharji and Kripalani (1951) have recorded it from Sukhna in Darjeeling district, West Bengal. *Elsewhere.*—It is a widely distributed species in India and found all over the plains of the country upto an altitude of 1524 metres. Also Sri Lanka, Burma, South China, South-east Asia and Taiwan.

Measurements : Snout to Vent length 9-20 mm.



Text-fig. 4. *Microhyla ornata* (Dumeril & Bibron)

Remarks : This quite common toad-like tiny frog is mostly found in the grasses and under the dry leaves covering the moist soil. It has been noticed that ideal habitat of these frogs in the suburbs of Calcutta is under the fallen bamboo leaves on the banks of ponds and tanks. In comparison to its tiny size it can cover considerably a good distance by jumping. In monsoon days they are sometimes attracted by night-lamps and found inside the rooms.

Genus 4. **Kaloula** Gray, 1831.

5. **Kaloula pulchra taprobanica** Parker

(Ceylon Kaloula).

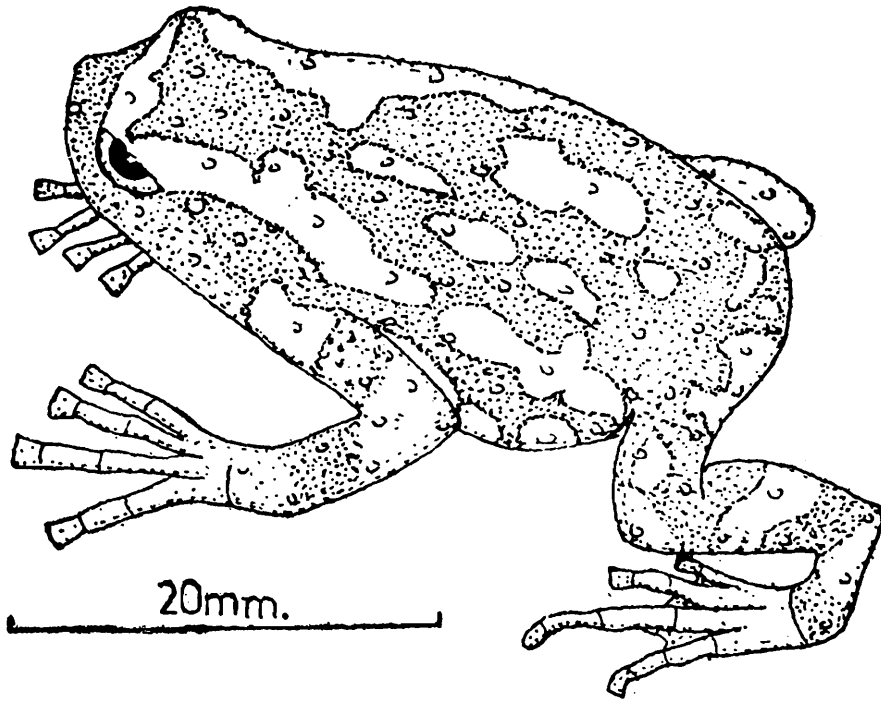
(Text-fig. 5)

1934. *Kaloula pulchra taprobanica* Parker, *Monogr. of the Microhylidae*, pp. 86-87.

Material : 24-Parganas dist., : 2 ex., New Barrackpore, 17.x.1966, Coll. D. P. Sanyal ; 1 ex., Dum Dum, 10.ii.1967. Coll. B. Biswas, 4 ex., (1 Frog and 3 tadpoles), Rain water pool, Habra, 8.v.1977, Coll. S. Roy.

Howrah dist. : 3 ex., Bally 5 & 20.x.1967 ; 2 ex., Bally 16.vi.1969. All Coll. A. K. Sarkar.

Distribution : Calcutta and environs.—As mentioned above. Parker (1934) reports it from Calcutta. *Elsewhere*.—Madhya Pradesh (Bastar), Karnataka (North Kanara), Tamil Nadu (Cauvery River and Tambaram) in India and Sri Lanka.



Text-fig. 5. *Kaloula pulchra taprobanica* Parker

Measurements : Adults,—Snout to Vent length 25-53 mm. Tadpoles, —Snout to vent length 13 mm. and vent to tip of tail length 7 mm.

Remarks : This toad-like painted frog is also quite rare and mostly found underground. In the evening of monsoon days it is sometimes found to climb moist boundary-walls of the houses in the suburbs of Calcutta. It inhales air, swells like a small balloon keeping its head a little down and secretes a milky sticky fluid through epidermal pores of skin, when disturbed. In captivity these frogs prefer white ants (Termites). Tadpoles of this species have been brought to the light of Science for the first time and being described separately. Three tadpoles have been collected from the stagnant rain water accumulated in an earthen pot at Hijalpukuria, Habra, 24-Parganas. Dorsum of tadpoles deep brownish with pinkish spots and ventrum light brownish with pinkish spots below the margin of lower lip. Abdulali (1962) found them in copula in temporary rain water pool in May in Western India.

Family III. RANIDAE

This family is represented in Calcutta and environs by seven species of the genus *Rana* Linnaeus, which can be distinguished by the following key.

1. Toes webbed upto the tips.	...	...	2
Toes webbed not upto the tips.	...	...	3
2. Inner metatarsal tubercle digitiform (toe-like).	...	...	4
Inner metatarsal tubercle not digitiform.	...	...	5
3. Tips of toes swollen or pointed, but not with discs.	...	...	6
Tips of toes with distinct discs.	...	<i>Rana erythraea</i>	... p. ...
4. Ventral surface smooth with no porous wart ; tips of toes swollen.	...	<i>Rana cyanophlyctis</i>	... p. ...
Ventral surface more or less granulated with porous warts on throat, under surface of thighs and sides of belly ; tips of toes pointed.	...	<i>Rana hexadactyla</i>	p. ..
5. Inner metatarsal tubercle blunt and not shovel-shaped.	...	<i>Rana tigerina</i>	... p. ...
Inner metatarsal tubercle sharp and shovel-shaped.	...	<i>Rana crassa</i>	... p. ...
6. Both inner and outer oval metatarsal tubercle present.	...	<i>Rana limnocharis</i>	... p. ...
Shovel-shaped inner metatarsal tubercle present, no outer metatarsal tubercle.	...	<i>Rana breviceps</i>	... p. ...

Genus 5. *Rana* Linnaeus, 17666. *Rana erythraea* (Schlegel)

(Leaping Frog)

(Text-fig. 6)

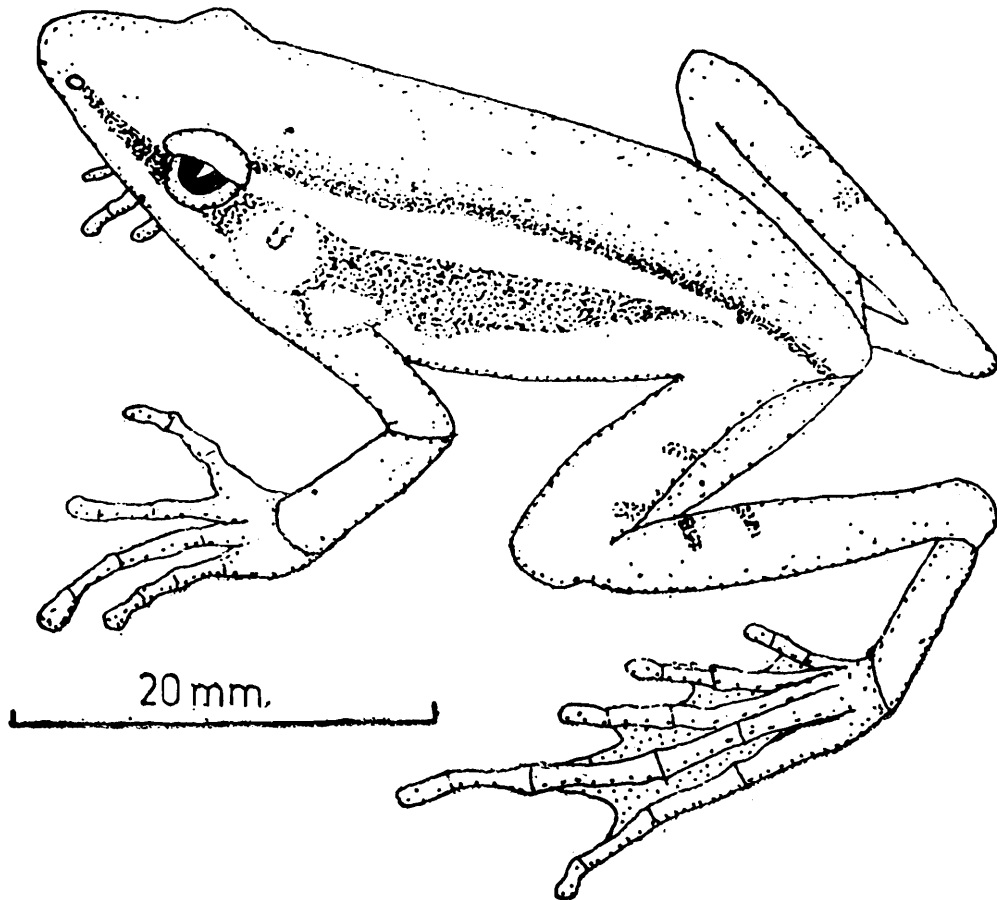
1837. *Hyla erythraea* Schlegel, *Abbild.*, p. 27.

Material : 24-Parganas dist. : 1 ex. North Salt Lake (opposite Ultadanga), Calcutta, 12.v.1963. Coll. *B. Biswas* and *M. B. Kripalani*. 1 ex., Nimta, 20.vii.1973. Coll. *P. S. Mahajan*. 1 ex., Bongaon, 16.ix.1974. Coll. *D. K. Moulick*. Howrah dist. : 1 ex., Botanical Garden, Shibpore, 6.viii.1964. Coll. *S. S. Saha*.

Distribution : Calcutta and environs, —As mentioned above. Boulenger (1920) has recorded it from Lower Bengal. It is being recorded for the first time from Calcutta and environs. *Elsewhere*. —Assam in India and South-east Asia.

Measurements : Snout to Vent length 41-45 mm.

Remarks : This is a slender medium-sized frog quite rare in Calcutta and its environs. This frog generally found in thick floating marshy vegetation and in the bushes grown at the edges of the water.



Text-fig. 6. *Rana erythraea* (Schlegel)

7. *Rana cyanophlyctis* Schneider

(Skipping Frog)

(Text-fig. 7)

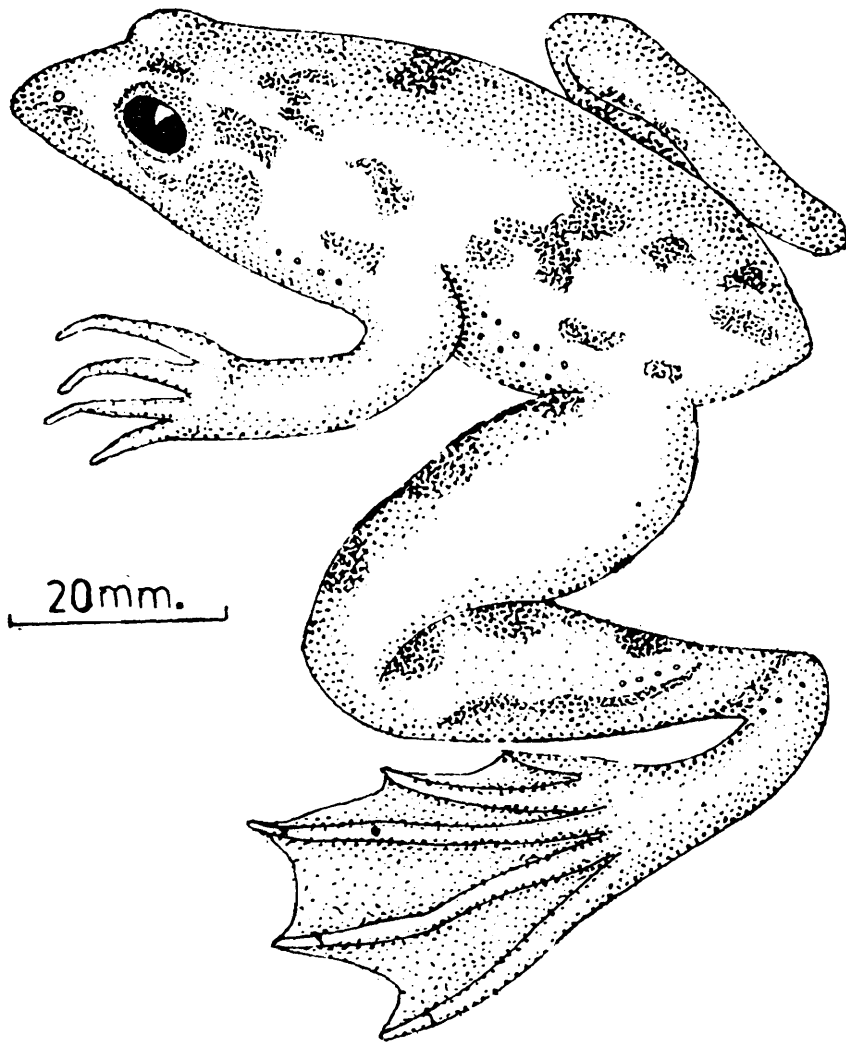
1799. *Rana cyanophlyctis* Schneider, *Hist. Amph.*, 1 : 137.

Material : 204 frogs and 14 tadpoles collected from 24-Parganas district (Budge Budge, Dhakuria, Baruipur, Diamond Harbour, Dakshin Barasat, Canning, Champahati, Guma, Naihati, Barasat, Duttapukur, Habra, Dogachhia, Lauhati, Magrahat, Salt Lake); Hooghly district (Bandel, Chandannagar, Singur, Champadanga, Sheakhala, Kristrampur, Tribeni); Howrah district (Botanical Garden, Amta, Uluberia, Bally); Nadia district (Kalyani, Haringhata). Collections are available throughout the year.

Distribution : Calcutta and environs, —As mentioned above. *Elsewhere*. —Throughout the plains of India and upto 6,000 ft. in the

Himalaya. Also Pakistan, Afghanistan, Beluchistan, Iran, South Arabia, Nepal, Thailand and Sri Lanka.

Measurements : Snout to Vent length 20-69 mm.



Text-fig. 7. *Rana cyanophlyctis* Schneider

Remarks : It is one of the commonest form of anuran recorded from the area. It is found floating in most of the ponds, ditches and other water bodies in and around Calcutta. The species is found to hibernate for a short period in the month of December-January in the environs of Calcutta. Sometimes when disturbed, frogs come out of their hibernation and float lazily.

8. *Rana hexadactyla* Lesson

(Pond Frog)

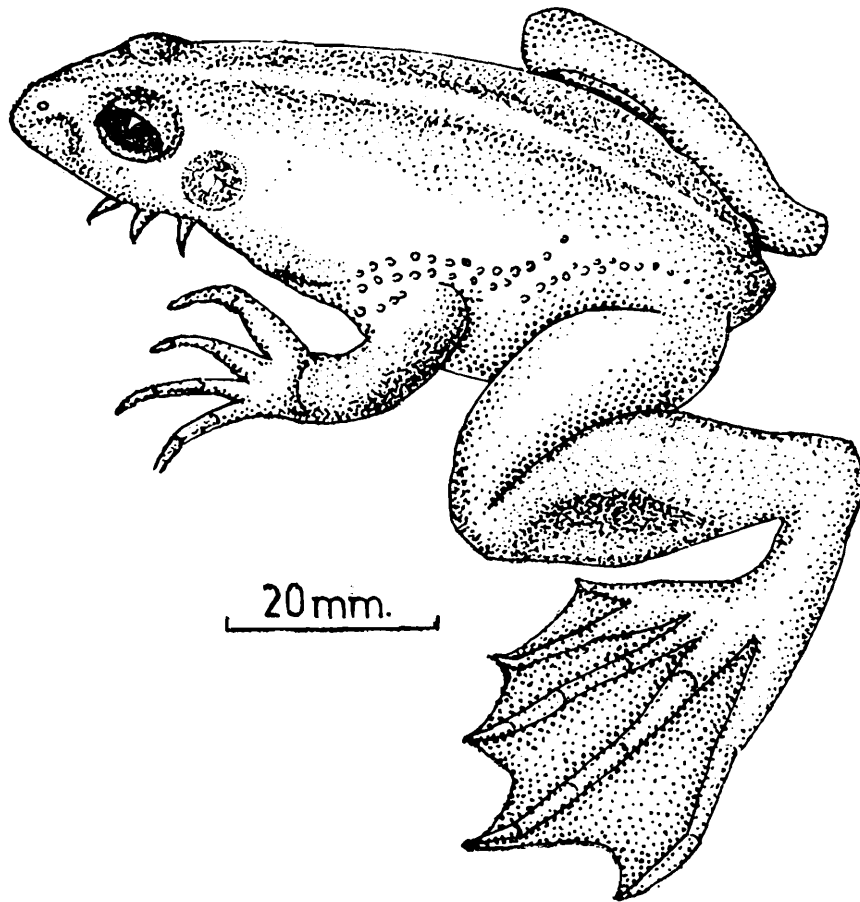
(Text-fig. 8)

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

Material : 38 frogs and 29 tadpoles. Collected from 24-Parganas district (Eden Garden (Calcutta), Budge Budge, (Canning, Magrahat,

Salt Lake); Hooghly district (Singur and Nalikul). Collections are available from February to November.

Distribution : Calcutta and its environs, —As mentioned above. Bhaduri (1947) records this species from Sonarpur (24-Parganas dist.),



Text-fig. 8. *Rana hexadactyla* Lesson

Konnagar (Hooghly dist.) and Duilla (Howrah dist.). *Elsewhere.* —It is common in South India and fairly common in Southern West Bengal. Records are there from Punjab, Rajasthan, Maharashtra and Goa in India and also from Sri Lanka.

Measurements : Snout to Vent length 22-144 mm.

Remarks : In Calcutta and environs this frog is generally found floating in the ponds with floating green aquatic vegetation in which it can hide properly to protect itself from the predators. Bhaduri (1947) records this frog from the environs of Calcutta and mentions that it can be obtained from old ponds with rich green aquatic vegetation. Dr. B. Biswas has collected specimen sitting on the bank of a pond in the evening and observed that it is very common in the ponds and fishing *bheries* with floating green vegetation in the suburbs of Calcutta. Author has come across with these frogs on land during

the night, when they probably came in search of food. Mondal (1970) has discussed on the culture possibilities and food of these frogs. The population of this species has declined in the area on account of exporting their legs abroad.

9. *Rana tigerina* Daudin

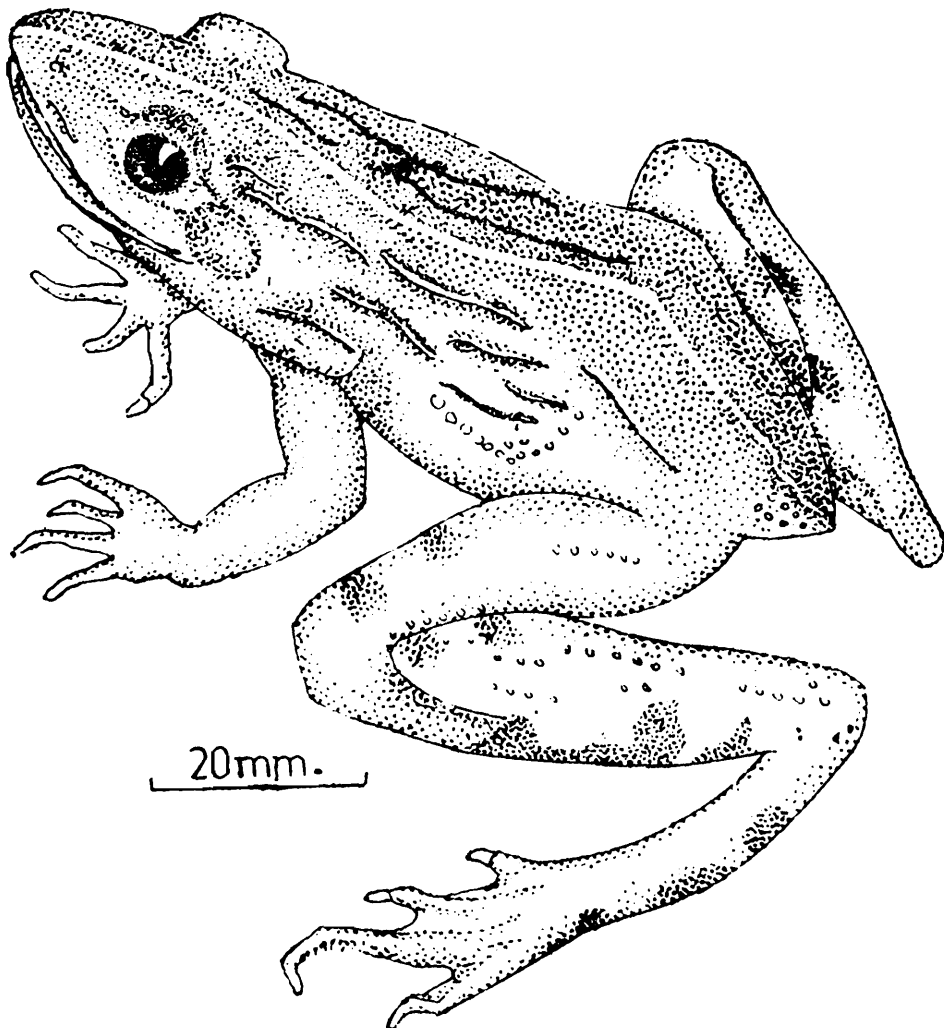
(Indian Bull Frog)

(Text-fig. 9)

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

Material : 124 frogs and 63 tadpoles. Collected from 24-Parganas district (Budge Budge, Dhakuria, Diamond Harbour, Baruipur, Hali-shahar, Barasat, Habra, Salt Lake); Howrah district (Botanical Garden, Jogatballavpur, Amta, Bagnan, Uluberia, Bally); Hooghly district (Sheakhala, Kristrampur, Tarakeshwar, Kamarkundu).

Distribution : Calcutta and its environs, —As mentioned above. *Elsewhere.*—It is common throughout India from the base of the Hima-



Text-fig. 9. *Rana tigerina* Daudin

laya to South India. Also Nepal, Sri Lanka, Burma, Thailand, South China and Taiwan.

Measurements : Snout to Vent length 18-172 mm.

Remarks : In Calcutta and its environs this giant edible frog generally found while resting inside the bushes grown on the banks of water bodies, where it retreats immediately even on a slightest disturbance. Frogs hide inside the burrows and under heaps of dry leaves to protect their moist skin from the scorching sun and dry weather. It was happened to be very common in Calcutta and its environs, but at present the population has reduced considerably on account of exporting their legs abroad to earn foreign exchange. It has been observed in 1982 that in a ditch at Bally (Howrah district) only two to five males have been found to croak with the start of pre-monsoon shower, whereas more than fifty frogs were found to do so in the pre-monsoon of 1972. Croaking is one of the signals of arrival of monsoon for the villagers of the plains of West Bengal, and this colourful harmless 'Bull Frog' locally known 'Kola Bang' has got a suitable place in village rhyme since old days.

It has been mentioned by earlier authors that Bull Frog feeds on squirrels, mice, shrews, small birds of consumable size, small snake upto a metre in length, spiny-tailed lizards (*Uromastyx*), land crabs, fishes etc., though its main diet consists of insects. Bhattacharya (1936) reported its tadpoles feeding on mosquito larvae. Due to merciless removal of this common frog from nature villagers in many areas in the suburbs of Calcutta are gradually feeling a sort of disturbance in the balance in nature and they are chasing the frog-collectors when met with. This frog is more active at night, though it is usually found in day-time. It can remember its hide-out well. Sometimes this frog has been found to spend day-time in some moist dark corner of human dwellings from where with little singh of disturbance it could easily escape and reach its proper hide-out, preferably a marshy ditch, even after traversing a zig zag path.

10. *Rana crassa* Jerdon

(Jerdon's Bull Frog)

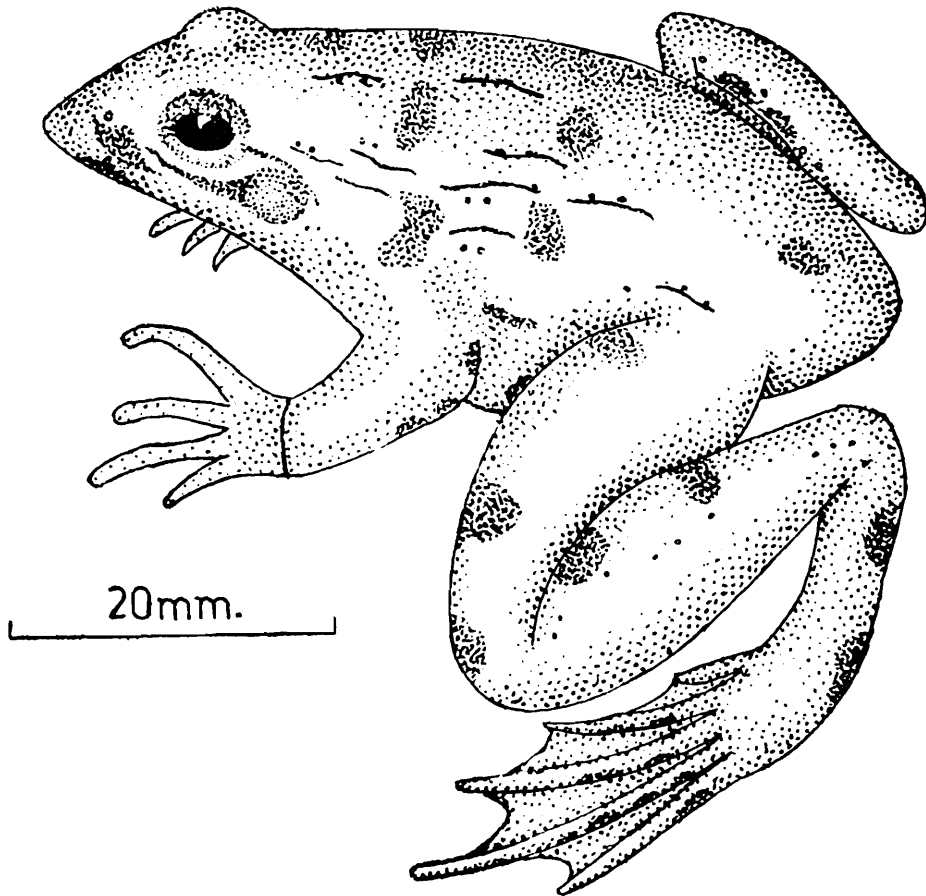
(Tex-fig. 10)

1853. *Rana crassa* Jerdon, *J. Asiat. Soc. Bengal*, 22 : 531.

Material : 24-Parganas dist. : 1 ex., Haliashahar, 4.x.1962 ; 1 ex., Duttapukur, 8.xi.1962. Nadia dist. : 2 ex., Haringhata, 25.x.1962. All Coll. *M. B. Kripalani*.

Distribution : Calcutta and environs,—As mentioned above. Bhaduri (1947) has recorded it from Garia (Near Calcutta) and Botanical Garden (Shibpur near Calcutta). *Elsewhere*.—Benaras and Agra (U.P.), Chandbally (Orissa), Gaya (Bihar), Madras town and Malabar in India. Also Sri Lanka.

Measurements : Snout to vent length 42-72 mm.



Text-fig. 10. *Rana crassa* Jerdon

Remarks : This is quite rare in Calcutta and its environs. The frogs have got burrowing habits and specimens collected are mostly from their burrows made on the elevated banks of ponds and ditches. The species is very closely allied to *Rana tigerina* and can be distinguished by its toad-like flabby shape of body and highly developed shovel-shaped metatarsal tubercle.

11. ***Rana limnocharis limnocharis* Wiegmann**
(Paddy-field Frog)
(Text-fig. 11)

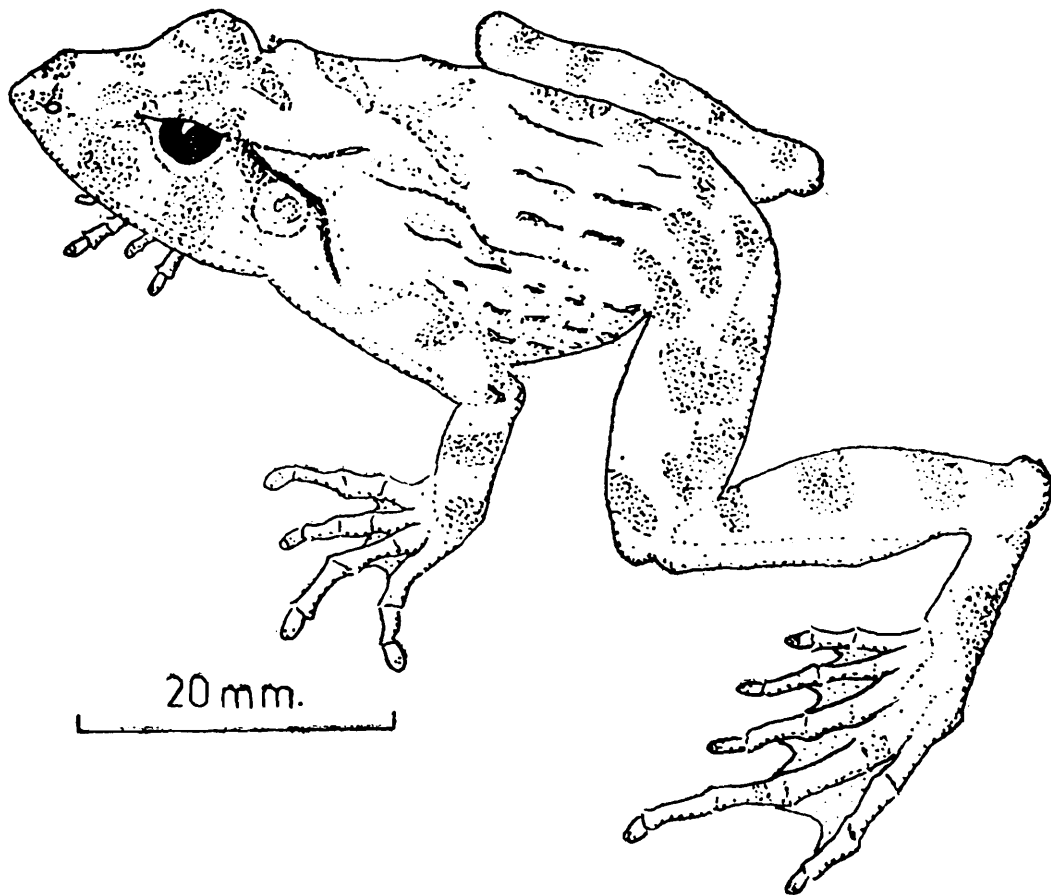
1835. *Rana limnocharis* (Boie) Wiegmann, *N. Acta. Ac. Leop.-Carol.*, 17 (i) : 255.

Material : 468 frogs and 270 tadpoles. Collected from 24-Parganas district (Eden Garden. Dhakuria, Budge Budge, Diamond Harbour,

Baruipur, Dakshin Barasat, Canning, Rajarhat, Champahati, Bishnupur, Guma, Naihati, Halishahar, Barasat, Duttapukur, Dogachhia, Lauhati, Magrahat, Salt Lake) ; Hooghly district (Bandal, Chandennagar, Singur, Sheoraphuli, Champadanga, Sheakhala, Kristrampur, Tarakeshwar, Kamarkundu, Magra, Tribeni) ; Howrah district (Botanical Garden, Jagatballavpur, Amta, Bagnan, Uluberia, Bally) ; Nadia district (Kalyani, Haringhata, Phulia). Collections are available throughout the year.

Distribution : Calcutta and environs,— As mentioned above. *Else-where*. It is a broadly distributed species in India and found in almost all the biotopes of the country. Also Eastern Asia from Pakistan, Nepal, Sri Lanka and China to Japan.

Measurements : Snout to Vent length 15-62 mm.



Text-fig. 11. *Rana limnocharis limnocharis* Wiegmann

Remarks : This is a common terrestrial frog generally found in Paddy-field and inside bushes near water. It jumps into water, when disturbed, but returns to the banks soon owing to inability of swimming for a long time for short webbing of toes. In monsoon days these frogs are occurred in almost grassy-patches found on the road-sides of suburbs of Calcutta. Five examples collected from Uluberia, Howrah

dist., on 2.7.1962 and two examples from Magra and Champadanga of Hooghly dist. on 20.9.1962 and 6.4.1962 respectively show some variations by possessing broader webbing of toes (2 to $2\frac{1}{2}$ phalanges of fourth toe free), strong overlapping of heels and stouter physique. These particular examples are found to prefer bushes grown near the water of big tanks.

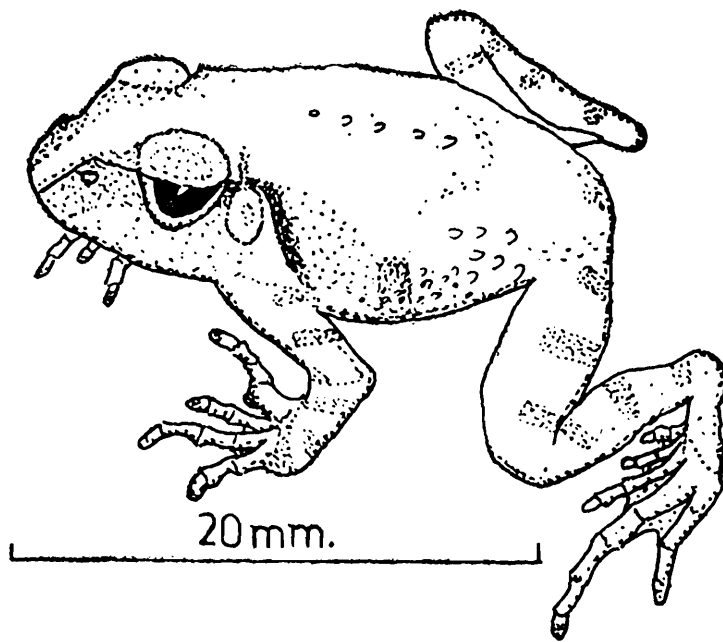
12. *Rana breviceps* Schneider

(Burrowing Frog)

(Text fig. 12)

1799. *Rana breviceps* Schneider, *Hist. Amph.* 1 : 140.

Material : 24-Parganas dist. : 1 ex., Narainpur, Diamond Harbour, 7.ix. 1961. Coll. *M. B. Kripalani*.



Text-fig. 12. *Rana breviceps* Schneider

Distribution : Calcutta and environs, —As mentioned above. This is the first record of the species from the area. *Elsewhere*.—Andhra Pradesh (Kuddappah), Gujarat (Surat Dangs), Himachal Pradesh (Simla), Kerala (Malabar and Travancore), Madhya Pradesh (Chanda), Maharashtra (Bombay, Khandala, Nagpur and Ratnagiri), Karnataka (Bangalore), Rajasthan (Jodhpur, Nagpur and Udaipur), Tamil Nadu (Anaimalai Hills and Madras) and Uttar Pradesh (Allahabad and Agra) in India. Also Sri Lanka, Nepal and Upper Burma.

Measurements : Snout to Vent length 18 mm.

Remarks : This is a very rare form of anuran recorded from the area. It is stout toad-like frog generally found sitting in the evening alongwith common Indian toads. Its strong shovel-shaped metatarsal tubercle is used for digging, and sometimes found to dig soil in search of food and shelter.

Family IV. RHACOPHORIDAE

This family is represented in Calcutta and environs by one species of the genus *Rhacophorus* Kuhl.

Genus 6. *Rhacophorus* Kuhl, 1827

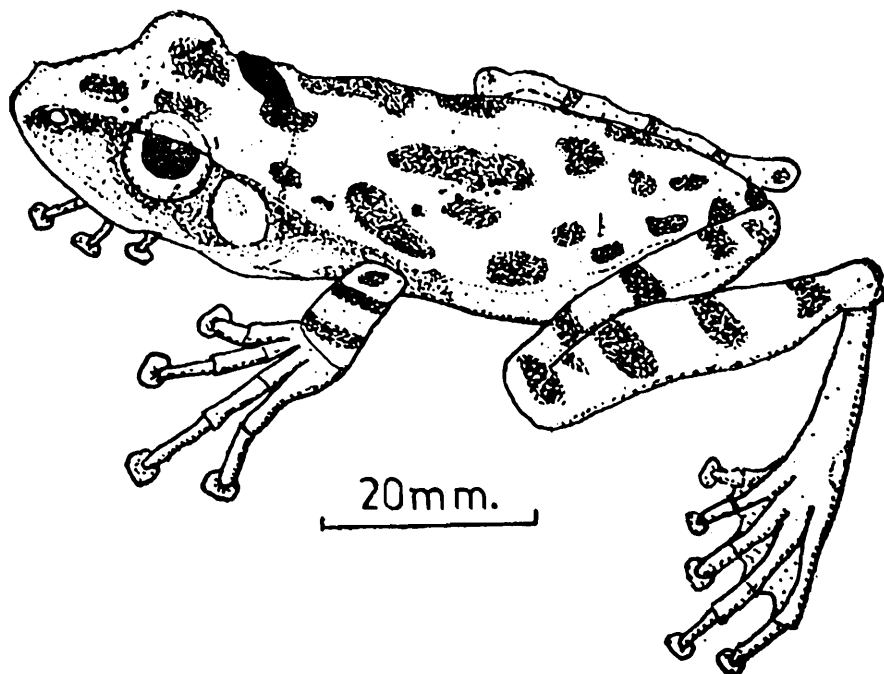
13. *Rhacophorus maculatus* (Gray)

(The Chunam Frog or Tree Frog)

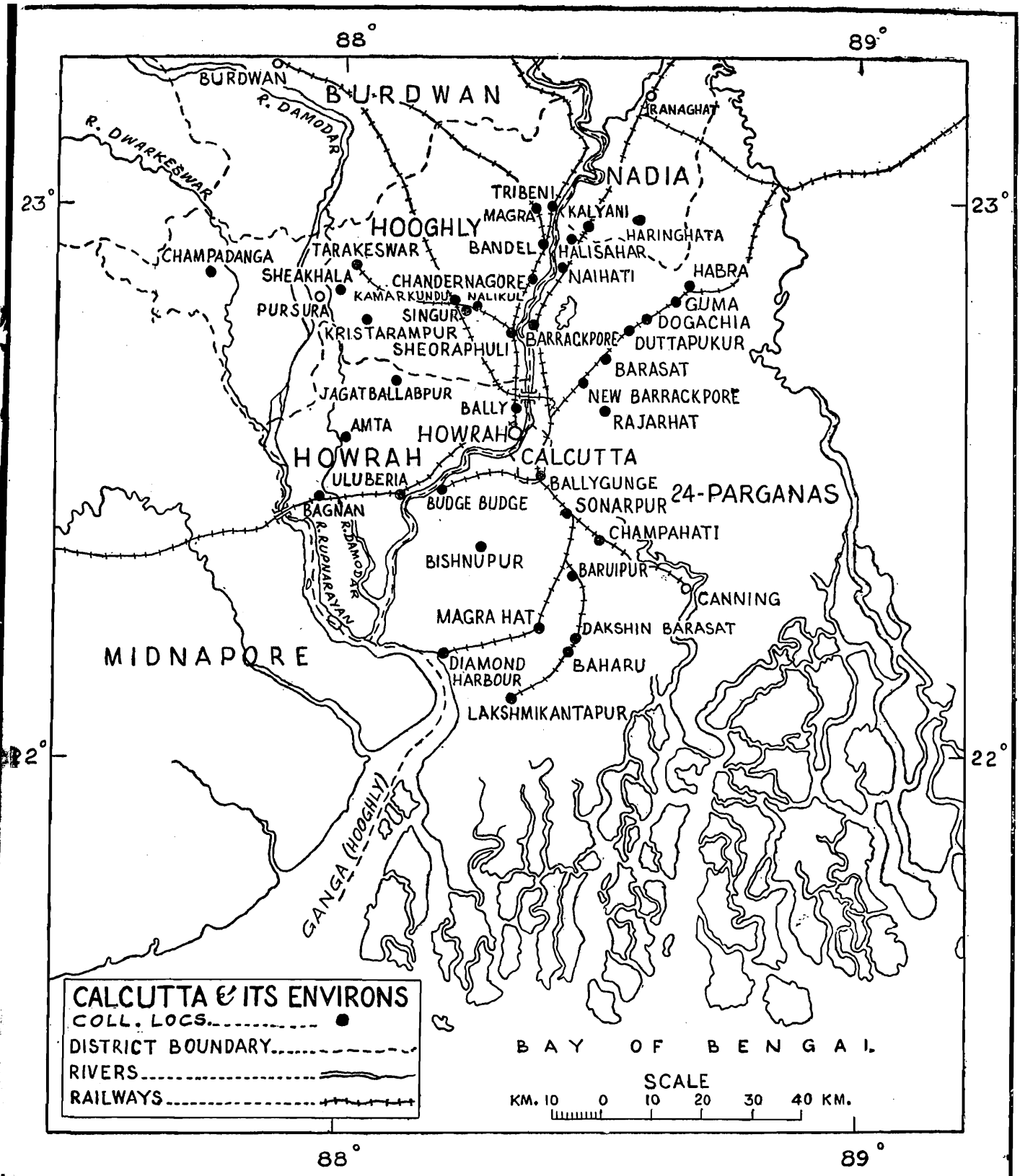
(Text-fig. 13)

1832. *Hyla maculata* Gray, *Ill. Indian Zool.* 1, pl. 82, fig. 1.

Material : 24-Parganas dist. : 1 ex., New Barrackpore, 15.iii.1964 ; 1 ex., New Barrackpore, 24.x.1975. All Coll. *D. P. Sanyal*. 1 ex., Kalikapore of Ballygunj, 28.vi.1964. Coll. *B. Biswas*. 1 ex., Rabindra Nagar, Nimta, 10.v.1975. Coll. *S. Mahajan*. 1 ex., Garia, 16.v.1975. Coll. *D. K. Khanra*. 1 ex., Garia, 8.iii.1977. Coll. *K. R. Haldar*. 2 ex., Sonarpore, -.viii.1978. Coll. *P. K. Mallick*. Howrah dist. : 1 ex., Bally -.v. 1969 ; 1



Text-fig. 13. *Rhacophorus maculatus* (Gray)



SOURCES: NATIONAL ATLAS OF INDIA, CALCUTTA PLATE 143. 1ST. EDITION 1959.

ex., Bally, 14.iv.1976. All. Coll. A. K. Sarkar. 1 ex., Chinsura, -vii.1977. Coll. S. Chakrabarty. 1 ex., (tadpole), Baruipur, 24-Parganas, 21.ix.1961; 6 ex., Haringhata, Nadia district, 25.x.1962. All. Coll. M. B. Kripalani.

Distribution : Calcutta and environs.—As mentioned above. *Elsewhere*. South India and plains of North India in general. Also Sri Lanka.

Measurements : Snout to Vent length 50-77 mm.

Remarks : This is more or less common and only species of tree-frog found in the area. It is nocturnal in habit and sometimes found inside the room in monsoon nights. It has been noticed in the suburbs of Calcutta that this frog prefers moist and dark atmosphere of bathroom and also found to rest inside thick leaves of plants like pines, and roofs of thatched village huts. This frog is locally known as 'Shepo-Bang' or Geccho-Bang' and avoided by human beings, because it secretes a large quantity of urin, when caught. Two examples collected from Sonarpur by Shri P. K. Mallick show a little difference by possessing more darker body-colour, more broader web of toes and rugose head. These examples have been reported to make their foamnest among the leaves of trees grown on the banks of ponds, whereas the foam-nests of this species are usually found to be made inside the bushes and grasses grown at the edge of water.

SUMMARY

This paper deals with the Amphibian fauna of Calcutta and its environs based on the collections mainly made during "Calcutta and environs Survey (M. B. Kripalani and Staff) from July 1961 to March 1963" and "Salt Lake Survey (B. Biswas and Staff) from May 1963 to February 1967", organised by the Zoological Survey of India. It consists of 1713 examples of Anurans (Frogs and Toads) belonging to four families, six genera and thirteen species, out of which *Microhyla ornata*, *Rana erythraea*, *Rana limnocharis* and *Rana breviceps* are recorded for the first time from the area. Tadpoles of *Kaloula pulchra taprobanica* have been brought to the light of Science for the first time since the description of the species by Parker in 1934.

ACKNOWLEDGEMENT

The author is highly indebted to Dr. B. K. Tikader, Director, Zoological Survey of India for the inspiration to carry out this work on the local fauna and for providing all the facilities; to Mrs. M.R. Mansukhani, Ex-Deputy Director of Z.S.I., for guidance; to Dr. B. Biswas, Ex-Joint Director of Z.S.I., for making such an excellent collection from Salt

Lake ; to Dr. R. C. Sharma, Superintending Zoologist, Herpetology Division, Z.S.I., for encouragement and going through the manuscript and to Shri D. P. Sanyal, Zoologist, Shri T. S. N. Murthy, Zoologist, and Shri M. L. Biswas, Sr. Zoological Assistant of the department for helping in the collection. Thanks are also due to Shri A. K. Chanda, Artist Gr. II, for drawing the map and mounting the drawings of the specimens.

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ON A COLLECTION OF TERMITES (INSECTA : ISOPTERA)
FROM KERALA (INDIA) WITH A NEW SPECIES OF
AND KEYS TO THE INDIAN SPECIES OF
ANGULITERMES SJÖSTEDT

By

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(With 3 Tables and 2 Text-figures)

INTRODUCTION

This paper is based on a collection received from the Kerala Forest Research Institute, Peechi and made by Drs. K. S. Nair and R. V. Varma, from the 13 localities (Table 1) during 1977-1980. Eighteen species belonging to eight genera under two families (Rhinotermitidae and Termitidae) are reported from the collection, the most common genus being *Odontotermes* Holmgren, with eleven species. Thakur (1981) has revised the Indian *Odontotermes* and has treated *O. guptai* Roonwal & Bose, *O. kushwahai* Roonwal & Bose and *O. vaishno* Bose, as synonyms of *O. bellahunisensis* Holmgren & Holmgren, *O. wallonensis* (Wasmann) and *O. obesus* (Rambur), respectively but these have been taken as valid species in this paper. The following four species are

TABLE 1. Termite collecting localities from Kerala

Locality	Latitude (N)	Longitude (E)	Altitude (meters)
1. Begur	11°45'	76°15'	803
2. Kalikuvu	11°10'	76°20'	120
3. Kondazhi	10°42'	76°27'	208
4. Konni	9°20'	76°30'	181
5. Mannamangalam	10°33'	76°27'	108
6. Nilambur	11°20'	76°20'	150
7. Peechi	10°33'	76°27'	108
8. Potta	10°42'	76°27'	208
9. Thachamala	11°5'	76°45'	588
10. Thuva	11°5'	76°45'	588
11. Trichur	10°30'	76°14'	105
12. Varavur	10°42'	76°12'	177
13. Vazhacha	10°18'	76°27'	447

first records from Kerala : *Odontotermes guptai* Roonwal & Bose, *Odontotermes indicus* Thakur ; *Odontotermes kushwahi* Roonwal & Bose, and *Odontotermes wallonensis* (Wasmann). A new species, *Angulitermes keralai*, is described and a key to Indian species of *Angulitermes* is given. Two vials contain workers and soldiers minor only of the genera *Macrotermes* and *Trinervitermes*, and such they could not be identified up to specific level.

Measurements are given for those species which were not earlier reported from Kerala State.

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

SYSTEMATIC ACCOUNT

Family : RHINOTERMITIDAE

1. *Coptotermes heimi* (Wasmann)

(Syn. *Coptotermes parvulus* Holmgren)

1902. *Arrhinotermes heimi* Wasmann, *Zool. Jb.*, 17 (1), p. 104, Im. *Type-Loc.* : India : Wallon.

Material : A vial with 10S. & 5W., Peechi, K. S. S. Nair coll., 17.8.79. A vial with 2S. & 1W., Potta, K. S. S. Nair coll., 11.7.80. A vial with 3S. & 2W. ; Trichur, K. S. S. Nair coll. 10.2.80.

Distribution : Widely distributed in Pakistan and India. Also recorded from Bhutan and Bangladesh. Present records : India Kerala (Peechi, Potta and Trichur).

Family : TERMITIDAE

2. *Microcerotermes fletcheri* Holmgren & Holmgren

1917. *Microcerotermes fletcheri* Holmgren & Holmgren, *Mem. Dep. Agric. India ent. Ser.* 5 (3), pp. 170-171. S. & W. *Type-loc.* : South India : Babubuddin Hills (Karnataka).

Material : A vial with 4S. & 2W., Varavur, K. S. S. Nair coll., 1.3.79. A vial with 5S. & 5W., Konni, Mathew coll., 5.7.79. (mixed with *Nasutitermes brunneus* Snyder).

Distribution : Recorded from India only from Karnataka, Uttar Pradesh, Tamil Nadu and Kerala States. Present record : India : Kerala (Varavur and Konni).

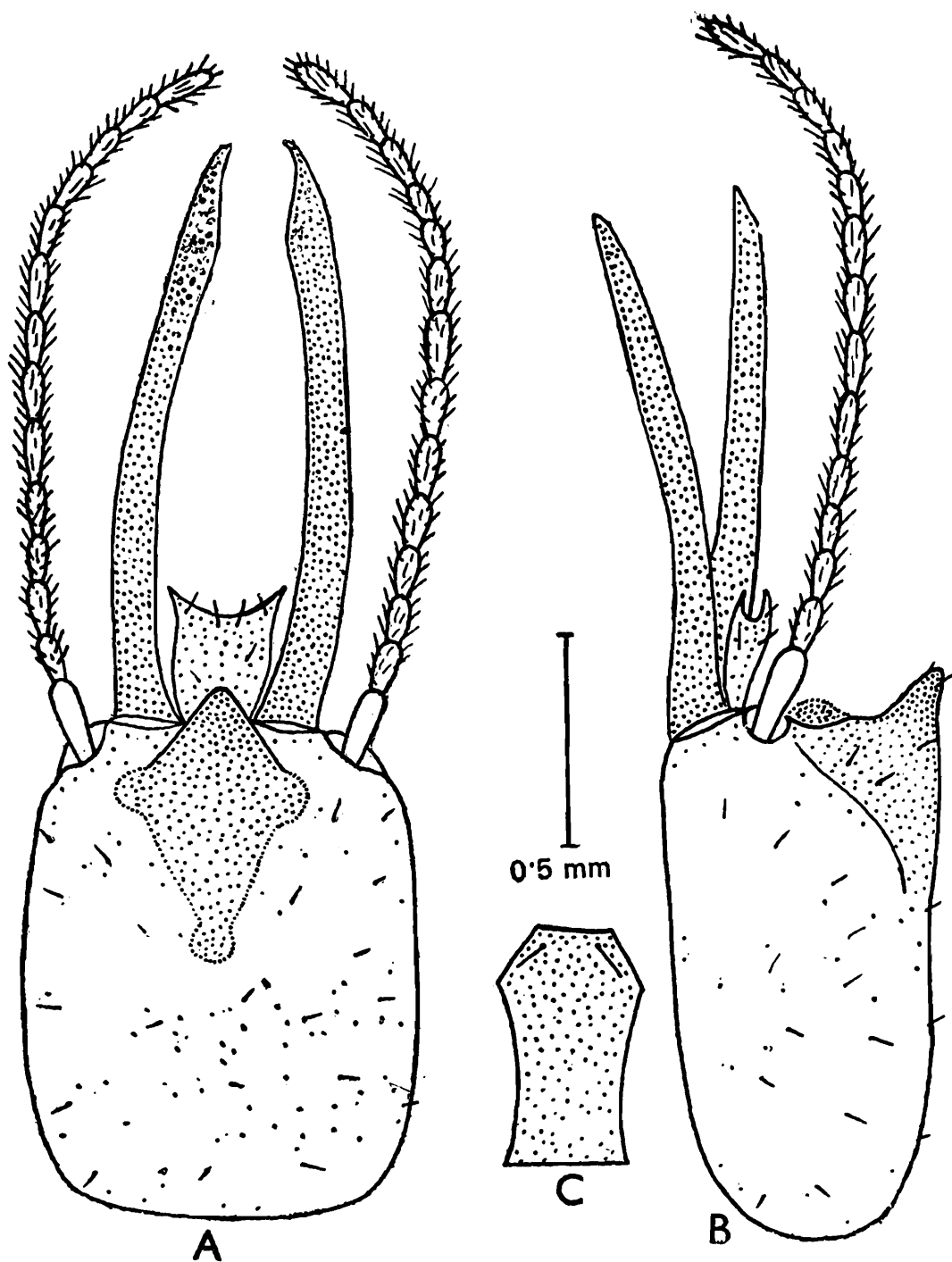
3. *Angulitermes keralai* n. sp.

Material : A vial with 3S. & 1W., Kondazhi (Kerala), K.S.S. Nair & W. A. Sands coll., 2.3.1979.

Description :

1. IMAGO : Unknown.
2. SOLDIER (Text-fig, 1, Table 2) :

Head capsule yellowish ; antennae, labrum and legs pale yellow ; rest of the body parts whitish yellow. Head and labrum fairly and



Text-fig. 1. *Angulitermes keralai* n. sp. Holotype. Soldier. (A) Head, in dorsal view (B) Head, in side view (C) Postmentum *in situ*.

body moderately pilose. Total body-length including mandibles *c.* 3.55-3.75.

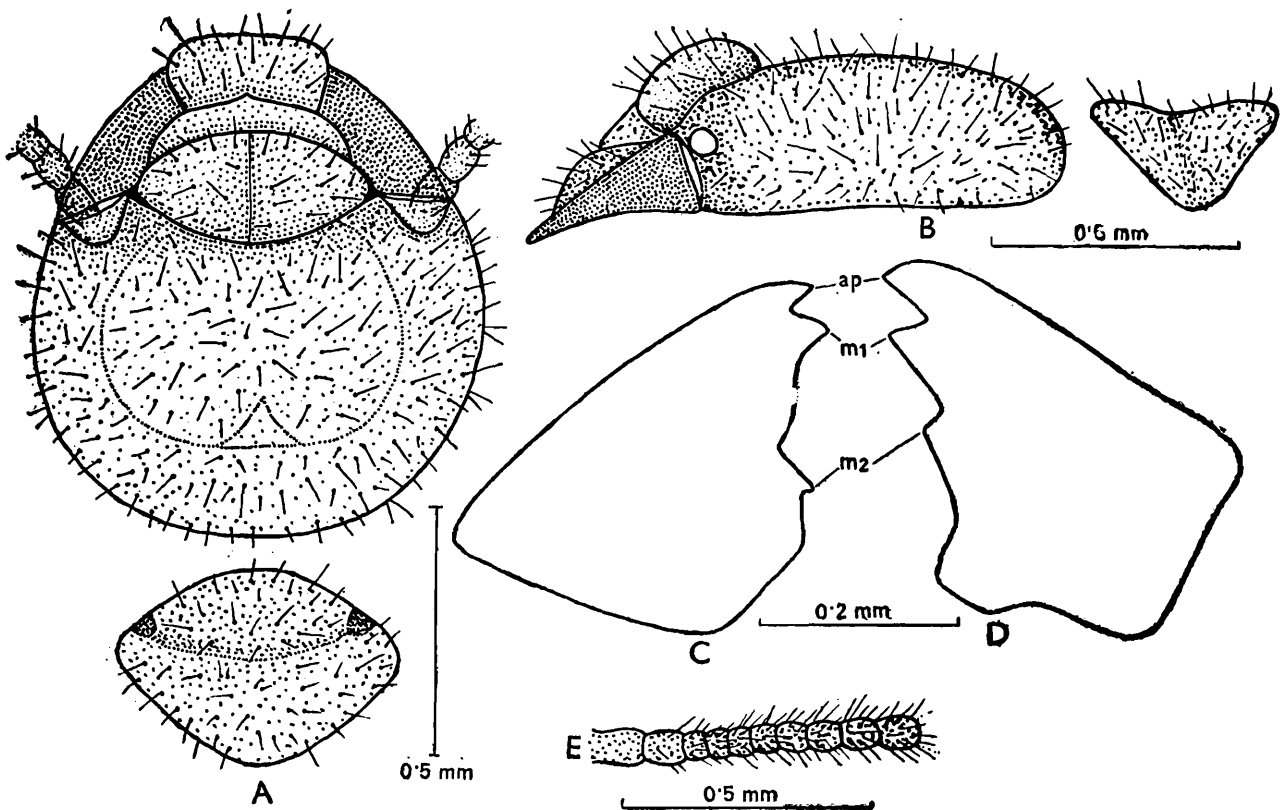
Head-capsule subrectangular ; longer than broad ; sides subparallel, slightly convex in middle ; posterior margin rounded ; frontal projection long, pointed and projected anteriorly from head (length 0.22 mm). Fontenelle lying below the frontal projection ; light brownish ; sparsely hairy. Antennae 14 segmented ; pilose ; segment 1 longest ; 2 cylindrical ; 3 longer than 2 ; 4 shortest ; 5-8 gradually increasing in length ; 9-14 gradually decreasing in length ; last conical, subequal to penultimate. Postclypeus yellowish, short and swollen. Anteclypeus white, apilose. Labrum yellowish ; sides convex and converging posteriorly ; anterior margin deeply concave ; anterolateral corners pointed. Mandibles snapping type ; long and slender, pointed and

TABLE 2. Body measurements (in mm) of Soldier of (3 exs.) *Angulitermes keralai* sp. n.

Body parts	Holotype	Range
1. Total body length with mandibles.	3.75	3.55-3.75
2. Length of head with mandibles	2.14	2.08-2.14
3. Length of head to lateral base of mandibles.	1.03	1.00-1.03
4. Length of head upto frontal projection.	1.25	1.22-1.25
5. Length of frontal projection	0.22	0.22
6. Max. width of head.	0.83	0.80-0.83
7. Max. height of head.	0.58	0.58
8. Head index I (Width/Length side base of mandibles).	0.81	0.80-0.83
9. Head index II (Height/Length to side base of mandibles).	0.56	0.56-0.58
10. Head index III (Height/Width).	0.700	0.700-0.725
11. Head index IV (Length upto frontal projection /Length to side base of mandibles)	1.21	1.21-1.22
12. Max. length of labrum upto middle of anterior margin.	0.22	0.22-0.25
13. Max. width of labrum.	0.28	0.25-0.28
14. Length of mandibles		
(a) Left mandible	1.11	1.08-1.11
(b) Right mandible.	1.11	1.08-1.11
15. Head mandibular Index (Left Mandible Length/Head length to side base of Mandibles).	1.08	1.08-1.11
16. Min. (Midian) length of postmentum.	0.42	0.42
17. Max. width of postmentum.	0.28	0.25-0.28
18. Min. width of postmentum.	0.22	0.19-0.22
19. Max. length of pronotum.	0.14	0.14
20. Max. width of pronotum.	0.42	0.42

weakly incurved at distal tips ; longer than head-length to lateral base of mandibles (index left mandible-length/head-length to lateral base of mandibles 1.08-1.11). Postmentum clubshaped, widest near the apical third ; moderately contracted in basal region (Postmentum contraction index i. e., minimum width/maximum width 0.76-0.79) ; anterior margin sub-straight ; posterior margin slightly substraight.

Pronotum saddle-shaped ; anterior margin convex ; posterior margin moderately convex ; both margins without median notch. Mesonotum broader than pronotum ; posterior margin substraight. Metanotum subequal to mesonotum ; posterior margin substraight. Legs short, slender and pilose ; tarsi 4-segmented ; tibial spur formula 3 : 2 : 2.



Text-fig. 2. *Angulitermes keralai* n. sp. Paramorphotype worker. (A) Head and pronotum, in dorsal view. (B) Ditto, in side view (C) Left mandible (D) Right mandible. (E) Antennae (broken)
ap., apical tooth ; *m*₁, *m*₂, 1st and 2nd marginal tooth.

Abdomen whitish yellow, sparsely hairy ; cerci 2-segmented (length 0.056 mm.) ; styli short, unsegmented.

3. WORKER (Text-fig. 2, Table 3) :

Head capsule yellowish white to pale yellow ; central glandular portion whitish ; mandibles brownish yellow with dark brown inner margins ; postclypeus of same colour as head capsule ; labrum semi-transparent, whitish yellow ; antennae, thorax, legs and abdomen

paler than head-capsule. Head-capsule sparsely and body moderately pilose. Total body-length c. 3.30 mm.

Head-capsule suboval ; wider than long ; widest near the base of antennae. Left antenna broken ; right antenna with only 10 segments present ; segment 1 longest ; 2 distinctly longer than 3 ; 3 shortest ; 4-10 progressively increasing in length. Postclypeus swollen, with few hairs ; length almost half its width ; median dividing line distinct. Anteclypeus trapezoid ; whitish ; translucent ; anterior margin projected in middle. Labrum whitish yellow ; moderately hairy ; anterior margin substraight ; wider than long. Left mandible with an apical and two marginal teeth ; right mandibles also with an apical and two marginal teeth.

Pronotum weakly saddle-shaped, wider than long ; anterior margin convex ; posterior margin substraight ; both margins without median notch. Mesonotum wider than pronotum ; posterior margin substraight ; more hairy than pronotum. Metanotum wider than mesonotum ; posterior margin substraight ; pilosity as in mesonotum. Legs short, slender and pilose ; tarsi 4-segmented ; tibial spurs 3 : 2 : 2.

TABLE 3. Body measurements (in mm) of worker of (1 ex.) *Angulitermes keralai* sp. n.

Body parts	Size
1. Total body length (excluding antennae)	3.30
2. Length of head to tip of labrum	0.94
3. Length of head to lateral base of mandibles	0.61
4. Max. width of head	0.80
5. Max. height of head	0.31
6. Max. length of post-clypeus	0.19
7. Max. width of post-clypeus	0.36
8. Max. length of labrum	0.19
9. Max. width of labrum	0.28
10. Max. length of pronotum	0.28
11. Max. width of pronotum	0.53

Abdomen oblong, hairy ; cerci short, hairy and 2-segmented ; styli short, unsegmented.

TYPE-SPECIMENS : *Holotype* : A soldier from above material, deposited in the National Zoological Collection, Zoological Survey of India (ZSI), Calcutta.

Paratypes : (i) A soldier and a paramorphotype worker, in vial, in Z. S. I., Calcutta (ii) A soldier, in vial, at Northern Regional Station, Zoological Survey of India, Dehra Dun.

COMPARISION : SOLDIER : In shape of frontal projection, *A. keralai* n. sp. come close to *A. quadriceps* Harris from Israel and *A. frontalis* (Silvestri) from South Africa, but however it definitely differs from them by its smaller size (Head length with mandibles 2.08-2.14 vs. 2.32 in *A. quadriceps* and 2.85-2.90 in *A. frontalis*; Mandibles length 1.08-1.11 vs. 1.23 in *A. quadriceps* and 1.40-1.62 in *A. frontalis*). It is differ from neighbouring South Indian species viz. *A. acutus* Mathur & Sen-Sarma; *A. fletcheri* (Holmgren & Holmgren) and *A. obtusus* (Holmgren & Holmgren) by its smaller size in all respect. None of the Indian species have frontal projection as long, pointed and upturned anteriorly from head as in *A. keralai* n. sp.

DISTRIBUTION AND KEYS OF *Angulitermes* SPECIES FROM INDIAN REGION

(A) *Distribution* : Roonwal & Chhotani (1971) in their paper reported 10 species of *Angulitermes* from the Indian Region. Later on five species have been added to this region. Akhtar (1974) described *A. punjabensis* from Pakistan (Punjab : Choa Saiden Shah) and Akhter (1975) *A. emersoni* from Bangladesh (Danadighi and Shishak forest); Roonwal & Verma (1977) have reported *A. jodhpurensis* from India (Rajasthan : Jodhpur); Sen-Sarma & Thakur (1979) described *A. mishrai* from India (Tripura : Zoolchara, Ambasa, Tiliamura); and presently *A. keralai* is described here (above) from India (Kerala : Kondazhi).

Thus 15 species of *Angulitermes* Sjöstedt are known from Indian Region as follows :

1. *acutus* Mathur & Sen-Sarma—India.
2. *akhorisainensis* Chatterjee & Thakur—India.
3. *dehraensis* (Gardner)—India ; Pakistan ; Afganistan.
4. *emersoni* Akhtar—Bangladesh.
5. *fletcheri* (Holmgren & Holmgren)—India.
6. *hussaini* Ahmad—Pakistan.
7. *jodhpurensis* Roonwal & Verma—India.
8. *kashmirensis* Roonwal & Chhotani—India.
9. *keralai* Verma—India.
10. *mishrai* Sen-Sarma & Thakur—India.
11. *obtusus* (Holmgren & Holmgren) —India.
12. *paanensis* Krishna—Burma.

13. *punjabensis* Akhter—Pakistan.
14. *resimus* Krishna—Burma.
15. *tilaki* Roonwal & Chhotani—India.

(B) KEYS TO *Angulitermes* OF INDIAN REGION

(a) IMAGO

Out of 15 species of *Angulitermes*, known from Indian Region, imagoes are known only in four species. The type of all species except *A. emersoni* have been examined by me. (Measurements given in key are in millimeter).

- | | | | |
|----|--|-----|---|
| 1. | Ocellus nearer to eyes, separated by a distance of less than short diameter of ocellus. ... | ... | 2 |
| | Ocellus separated from eyes by a distance equal to its short diameter. ... | ... | 3 |
| 2. | Larger species (Head-length to base of mandibles 0.68-0.80; Head-width with eyse 0.95-1.00; Pronotum-length 0.47-0.53, width 0.89-0.95). Minimum eye-ocellus distance 0.036-0.045. | | |

1. *A. jodhpurensis* Roonwal & Verma

Smaller species (Head-length to base of mandibles 0.57-0.60; Head-width with eyes 0.78-0.81; Pronotum-length 0.43-0.45, width 0.65-0.71). Minimum eye-ocellus distance 0.05.

2. *A. emersoni* Akhtar

3. Larger species (Body-length with wings 11-11.50, without wings 6-6.90; Head width with eyes 0.90-0.95). Eyes separated from the lower margin of head by half their short diameter. Postclypeus divided more prominently. Cubitus with 10-11 number of veins.

3. *A. akhorisainensis* Chatterjee & Thakur

Smaller species (Body-length with wings 10-10.5, without wings 5.5; Head-width with eyes 0.80-0.90). Eyes separated from lower margin of head by less than half their short diameter. Postclypeus divided less prominently. Cubitus with 10-14 number of veins.

4. *A. dehraensis* (Gardner)

(b) SOLDIER

(Key to soldier caste is partly based after Roonwal & Chhotani, 1971)

- | | | |
|---|------------|--------|
| 1. Frontal projection of head long (length 0.22-0.26).
Frontal projection of head short (length 0.10-0.17). | ...
... | 2
4 |
| 2. Frontal projection of head sharply pointed and strongly projected anteriorly (Head-length with frontal projection 1.22-1.25 Head-length to lateral base of mandibles 1.00-1.03 ; length of frontal projection 0.22 ; Head-width 0.80-0.83 ; Mandibles length 1.08-1.11 ; Postmentum max. width 0.25-0.28 ; Pronotum-width 0.42. Anterior margin of pronotum is deeply concave. Lateral sides of head substraight). | | |

1. *A. keralai* n. sp.

- | | | |
|---|-----|---|
| Frontal projection on head not sharply pointed and projected anteriorly (subconical). | ... | 3 |
| 3. Head shorter (Head-length to lateral base of mandibles 1.11-1.32) ; Pronotum wider (Max. width 0.58-0.63) and frontal projection longer (length 0.26). | | |

2. *A. jodhpurensis* Roonwal & Verma

Head longer (Head-length to lateral base of mandibles 1.37) ; Pronotum narrower (Max. width 0.53) and frontal projection smaller (length 0.23). ...

3. *A. fletcheri* (Holmgren & Holmgren)

- | | | |
|--|------------|--------|
| 4. Frontal projection of head inclined posteriorly.
Frontal projection of head not inclined posteriorly. | ...
... | 5
6 |
| 5. Anterior margin of frontal projection slightly concave. Smaller species (Head-length to lateral base of mandibles 0.84-0.98 ; Head-width 0.75-0.79 ; Mandible-length 1.00-1.06 ; Postmentum maximum-width 0.24-0.25 ; Pronotum-width 0.35-0.40). Anterior margin of labrum deeply concave. Lateral sides of head not depressed in middle. | | |

4. *A. emersoni* Akhtar

Anterior margin of frontal projection slightly convex. Larger species (Head-length to lateral base of mandibles 1.13; Head-width 1.05; Mandible-length 1.42; Postmentum maximum-width 0.30; Pronotum-width 0.49). Anterior margin of labrum shallowly concave. Lateral sides of head depressed in middle.

5. *A. punjabensis* Akhtar

6. Margin of frontal projection rounded in shape. (Head-length to lateral base of mandibles 0.90-1.00; Head-width 0.68-0.78; Mandible-length 0.93-1.00; Postmentum max. width 0.25-0.23; Pronotum-width 0.30-0.38. Anterior margin of labrum deeply concave. Lateral side of head shallowly depressed in middle).

6. *A. mishrai* Sen-Sarma & Thakur

- Margin of frontal projection not rounded but blunt or pointed in shape. ... 7
7. Smaller species (Head-length to side base of mandibles 0.87-1.00; Max. head-width 0.80-0.84). ... 8
- Larger species (Head-length to side base of mandibles 1.13-1.40; Max. head-width 0.90-1.05). ... 9
8. Head wider anteriorly and sparsely hairy. Frontal projection narrower and indented medially at anterior margin. Third antennal segment longer than second.

7. *A. hussaini* Ahmad

Head wider posteriorly and fairly densely hairy. Frontal projection broader and even at anterior margin. Third antennal segment subequal to second.

8. *A. paanensis* Krishna

9. Labrum broader (index maximum-width/maximum length 0.97), and strongly narrowed posteriorly; anterior margin broadly and shallowly concave.

9. **A. acutus** Mathur & Sen-Sarma

	Labrum narrower (index maximum width/maximum length 0.66-0.88), and weakly narrowed posteriorly ; anterior margin narrowly and deeply concave.	...	10
10.	Mandibles shorter (length 1.27-1.30).	...	11
	Mandibles longer (length 1.34-1.47).	...	12
11.	Head capsule uniformly wide ; frontal projection with an acute apex and sharply truncated in front.	...	

10. **A. obtusus** (Holmgren & Holmgren)

Head capsule wide in front and narrowed posteriorly ; frontal projection with a round apex and roundly truncated in front. ...

11. **A. tilaki** Roonwal & Chhotani

12.	Head-length with frontal projection slightly more than head-length to side base of mandibles (Index head-length up to frontal projection/head-length to side base of mandibles more than 1).	...	13
	Head-length with frontal projection slightly less than head-length to side base of mandibles (Index 0.97-0.98).	...	14
13.	Head fairly pilose ; frontal projection rounded and not turned upward apically.	...	

12. **A. dehraensis** (Gardner)

Head sparsely pilose, with only a few bristles ; frontal projection conical and turned upward apically.

13. **A. resimus** Krishna

14.	Head shorter (head-length to side base of mandibles 1.20-1.30). Mandibles longer compared to head-length (index left mandible-length/head-length to side base of mandibles 1.14-1.23). Labrum shallowly incurved at anterior margin (index median length/maximum length 0.72-0.75) and broader (index maximum-width/maximum-length 0.85-0.88).		
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14. *A. kashmirensis* Roonwal & Chhotani

Head longer (head-length to side base of mandibles 1.35-1.40). Mandibles shorter compared to head-length (index left mandible-length/head-length to side base of mandibles 1.0-1.04). Labrum deeply incurved at anterior margin (index median length/maximum length 0.68) and narrower (index maximum width/maximum length 0.80).

15. *A. akhorisainensis* Chatterjee & Thakur4. *Odontotermes anamallensis* Holmgren & Holmgren

1917. *Odontotermes (Odontotermes) anamallensis* Holmgren & Holmgren, *Mem. Dep. Agric. India ent. Ser.*, 5 (3), pp. 157-158. S. & W. *Type-loc.* : South India : Anamalai Hills.

Material : A vial with 2S. & 5W., Varavur, R. V. Varma coll., 20.1.79. A vial with 4S. & 5W., Varavur, K. S. S. Nair coll., 1.3.79.

Distribution : Recorded from India from the Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, and Madhya Pradesh States. Present record : Kerala (Varavur).

5. *Odontotermes ceylonicus* (Wasmann)

1902. *Termes (Termes) ceylonicus* Wasmann, *Zool. Jb.* 17 (1), p. 113, S. & W. *Type-loc.* : Srilanka : Nalanda.

1913. *Odontotermes (Odontotermes) ceylonicus* Holmgren, *K. svenska Vetenskakad Handl.*, 50 (2), pp. 124-125. Im.

Material : A vial with 2S. & 10 W., Thuva, R. V. Varma coll., 28. 2.80. A vial with 2S. & 1W., Potta, R. V. Varma coll., 14.3.80. A vial with 2S. & 10W., Peechi, R. V. Varma coll., 17.3.80.

Distributions : Widely distributed in Srilanka. From India recorded from Kerala State only. Present records : Kerala (Thuva, Peechi and Potta).

6. *Odontotermes feae* (Wasmann)

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

Material : A vial with 10S. & 10W. ; Varavur, K. S. S. Nair coll., 1.3.79. A vial with 3S. & 4 W. ; Kondazhi, K. S. S. Nair coll., 2.3.79.

Distributions : Widely distributed in India ; Bangla Desh ; Nepal ; Burma ; Bhutan and Thailand. Present records : Kerala (Varavur and Kondazhi).

7. *Odontotermes guptai* Roonwal & Bose(Syn : *O. lokanandii* Chatterjee & Thakur)

1960. *Odontotermes bellahunisensis guptai* Roonwal & Bose, *J. Bombay nat. Hist. Soc.*, **58** (3), pp. 588-593. S. & W. *Type-loc.* India : Rajasthan : Near Gudha Village (Nagaur Dist.)
1967. *Odontotermes lokanandii* Chatterjee & Thakur, *Indian Forest Rec. N. S. (ent.)*, **2** (1), pp. 38-41. S. & W. *Type-loc.* : India : Jammu : Residence Plot No. 6 near river Tavi.
1977. *Odontotermes lokanandii* Akhtar, *Biologia, Lahore*, **23** (2), pp. 175-177. Im. Locality : Pakistan : Lahore.
1977. *Odontotermes guptai*, Chhotani, *Rec. Zool. Surv. India*, **72**, p. 377 (New Synonymy).

Material : 19 vials with sev. S. & W., from Kondazhi, Mannamangalam, Nilambur, Peechi, Potta, Thachamala, Varavur, K. S. S. Nair and R. V. Varma coll., 1977-1980.

Measurements : Body measurements in mm. of 20 soldiers from Kerala).

1. Total body length with mandibles	...	4-5
2. Head length with mandibles	...	1.65-1.80
3. Head-length without mandibles	...	1.05-1.20
4. Max. width of head	...	0.70-1.0
5. Max. height of head	...	0.60-0.65
6. Max. length of mandibles	...	0.58-0.65
7. Distance of tooth from apex on left mandibles	...	0.18-0.20
8. Labrum (length × width)	...	0.25-0.28 × 0.23-0.28
9. Min. (Median) length of postmentum	...	0.55-0.60
10. Max. width of postmentum	...	0.45-0.50
11. Max. length of pronotum	...	0.48-0.55
12. Max. width of pronotum	...	0.76-0.85
13. No. of antennal segments	...	15

Distribution : Widely distributed in India, Pakistan and Bangladesh. Present records : Kerala (Kondazhi, Mannamangalam, Nilambur, Peechi, Potta, Thachamala and Varavur). This is the first record from Kerala State.

8. *Odontotermes indicus* Thakur

1981. *Odontotermes indicus* Thakur, *Indian Forest Rec. N. S. ent.*, **14** (2), pp. 70-75. Im., S. & W. *Type-loc.* : India : Bombay.

Material : A vial with 5S. & 5W., Potta, Padmnabhan coll., 30.10.70.

Measurements, etc. : Body measurements in mm. of 1 soldier from Kerala).

1. Total body length with mandibles	...	6.5
2. Head length with mandible	...	3.74
3. Head length without mandibles	...	2.36
4. Max. width of head	...	1.97
5. Max. height of head	...	1.39
6. Max. length of mandibles	...	1.39
7. Distance of tooth from apex on left mandibles	...	0.72
8. Labrum (length × width)	...	0.33 × 0.33
9. Min. (median) length of postmentum	...	1.58
10. Max. width of postmentum	...	0.83
11. Max. length of pronotum	...	0.83
12. Max. width of pronotum	...	1.58
13. No. of antennal segments	...	17

Distributions : Recorded from the following States of India : Goa, Madhya Pradesh, Karnataka, Tamil Nadu, and Maharashtra. Present records : Kerala (Vazhachal and Potta). This is the first record from Kerala.

9. *Odontotermes kushwahi* Roonwal & Bose

1964. *Odontotermes brunneus kushwahi* Roonwal & Bose, *Zoologica, Studtg.* **113**, pp. 33-36. S. & W. *Type-loc.* India : Rajasthan : Bhupalasagar (Udaipur District).

1977. *Odontotermes kushwahi*, Roonwal & Verma, *Rec. Zool. Surv. India*, **72**, p. 451.

Material : A vial with 4S. & 5W., Kondazhi, K. S. S. Nair coll., 2.3.79.

Measurements : (Body measurements in mm. of one soldier from Kerala : Kondazhi).

1. Total body length with mandibles	...	5.96
2. Head-length with mandibles	...	2.80

3. Head-length without mandibles	...	1.72
4. Max. width of head	...	1.34
5. Max. length of mandible	...	1.08
6. Distance of tooth from apex on left mandibles		0.44
7. Labrum (length × width)	...	0.40 × 0.35
8. Min. (median) length of postmentum	...	1.05
9. Max. width of postmentum	...	0.58
10. Max. length of pronotum	...	0.68
11. Max. width of pronotum	...	1.08
12. No. of antennal segments	...	17

Distributions : Distributed in Rajasthan, Gujarat, Tamil Nadu, and Maharashtra States of India. Present record : Kerala (Kondazhi). This is the first record from this state.

10. *Odontotermes obesus* (Rambur)

1842. *Termes obesus* Rambur, *Hist. natur. Insects Neuropters*, p. 304 Im. *Type-loc.* : India : Bombay.

Material : A vial with 10S. & 3W. ; Potta, K. S. S. Nair coll., 24.7.1979.

Distributions : Widely distributed in India, Pakistan, Bangladesh, Burma and Bhutan. Present record : Kerala (Potta).

11. *Odontotermes redemanni* (Wasmann)

1893. *Termes redemanni* Wasmann, *Wien. ent. Ztg.*, 12 (7), p. 239. Winged, Queen, S. & W. *Type-loc.* : Srilanka : Comombo.

Material : 3 vials with sev. S. & W. ; Kondazhi, K. S. S. Nair coll., 2.3.79. A vial with 6S. & 2W., Peechi, R. V. Varma coll., 29.9.79.

Distribution : Distributed in India from Maharashtra, Karnataka, Andhra Pradesh, Kerala, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Rajasthan, West Bengal, and Bihar States. Present records : India : Kerala : (Kondazhi and Peechi).

12. *Odontotermes roonwali* Bose

1975. *Odontotermes roonwali* Bose, *Oriental Insects*, 9 (2), pp. 157-161. S. & W. *Type-loc.* : India : Kerala, Nilambur (Malabar).

Material : A vial with 4S. & 4W., Varavur, K.S.S. Nair coll., 1.3.79. Two vials with 8S. & 1OW., Kondazhi, K. S. S. Nair coll.,

2.3.79. A vial with 5S. & 5W., Thuva, R. V. Varma coll., 28.2.80.
A vial with 5S. & 5W., Peechi, K. S. S. Nair coll., 5.3.80.

Distributions : From India : Kerala, Tamil Nadu and Karnataka States. Present records : Kerala (Varavur, Kondazhi, Thuva and Peechi).

13. *Odontotermes vaishno* Bose

1975. *Odontotermes vaishno* Bose, *Oriental Insects*, 9 (2), pp. 161-164. S. & W. *Type-loc.*, ; India : Kerala (Kannoth Forest Range, Wynaad Div., Malabar).

Material : A vial with 4S. & 4W., Varavur. K. S. S. coll., 1.3.79.

Distributions : From India recorded from Kerala and Karnataka States. Present record : India : Kerala (Varavur).

14. *Odontotermes wallonensis* (Wasmann)

1902. *Termes obesus* sub sp. *wallonensis* Wasmann, *Zool. Jb.* 17 (1), p. 106. Im., S. *Type-loc.* : Wallon : Sangamnour (Ahmadnagar Dist.).

Material : A vial with 3S. & 2W., Kondazhi, R. V. Varma coll., 28.7.79.

Measurements, etc. : (Body measurements in mm. of 1 soldier from Kerala).

1. Total body length with mandibles	...	5.3
2. Head length with mandibles	...	2.70
3. Head length without mandibles	...	1.63
4. Max. width of head	...	1.27
5. Max. length of mandibles	...	1.05
6. Distance of tooth from apex on left mandibles		0.44
7. Labrum (length × width)	...	0.40 × 0.37
8. Postmentum (Median length × width)	...	1.16 × 0.58
9. Pronotum (length × width)	...	0.61 × 0.95
10. Antennal segments	...	17

Distributions : From India : Andhra Pradesh, Bihar, Gujarat, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, Madhya Pradesh and Karnataka States. Present record : Kerala (Kondazhi). This is a new record from Kerala.

15. *Microtermes obesi* Holmgren

1918. *Microtermes obesi* Holmgren, *K. svenska Vetensk Akad. Handl.*, 50 (2), p. 150. Im., *Type-loc.* : India : Khandala near Bombay.

Material : A vial with 2S. & 4W., Begur, Sudheer coll., 17.8.79.

A vial with 4S. & 5W., Peechi, R. V. Varma coll., 29.9.79. A vial with 4S. & 10W., Kalikavu, Sudheer coll., 6.11.79.

Distribution : This species is common throughout India, Pakistan, Bangladesh, Burma, Srilanka and Thailand. Present record : India : Kerala (Begur, Peechi and Kalikavu).

16. *Macrotermes* sp.

Material : A vial with 2W., Varavur, K. S. S. Nair coll., 1.3.79.

Remarks : These 2 workers are mixed with *Odontotermes roonwali* Bose, could not be identified up to specific level.

17. *Nasutitermes brunneus* Snyder

1933. *Nasutitermes* (*Nasutitermes*) *fletcheri* Snyder (nec. Holmgren), *Proc. U. S. natn. Mus.*, Washington, 82 (16), pp. 10-11, pl. 1.

1934. *Nasutitermes* (*Nasutitermes*) *brunneus* Snyder, *Indian Forest Rec.*, 20 (11), p. 11.
Type-loc. : India : Anamalai Hills (Madras State).

Material : A vial with sev. S. & W., Varavur, K. S. S. Nair coll., 1.3.79. A vial with 3S. & 3W., Konni, Mathew coll., 5.7.79.

Distributions : India : Kerala, Karnataka and Tamil Nadu States. Present record : India : Kerala (Konni and Varavur).

18. *Trinervitermes* sp.

Material : A vial with 6 minor S., Varavur, K. S. S. Nair coll., 1.3.79.

Remarks : These 6 minor soldiers were mixed with *Nasutitermes brunneus* Snyder, could not be identified up to specific level.

SUMMARY

Eighteen species of termites of two families (Rhinotermitidae and Termitidae) are reported from Kerala. Four species viz. *Odontotermes guptai* Roonwal & Bose ; *O. indicus* Thakur ; *O. kushwahi* Roonwal & Bose and *O. wallonensis* (Wasmann) are reported for the first time from Kerala.

One new species, *Angulitermes keralai* is described from soldier and worker caste from Kondazhi, Kerala.

A key, based on imago and soldier characters is provided for identifications of 15 known species of *Angulitermes* from the Indian Region.

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ON THE FISH FAUNA OF TEHRI-GARHWAL, UTTAR PRADESH

By

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INTRODUCTION

The fishery resources of Himalaya and particularly of Tehri-Garhwal region are immeasurable although they are slowly and gradually annihilated because of a large number of natural and man-made factors. But conservation of this renewable resource of the area is very essential for stabilising the economy of the area and for maintenance of the biosphere which depends upon its judicious prospecting and exploitation. With a view to attaining these ends, it is essential that the various components of the aquatic biosphere are studied in detail. The role of the proper identification of fish of an area is manifestly of great importance. For this, a comprehensive knowledge on the fish species, inhabiting the waterways in the area, is very essential. The earliest record available on the fish fauna of Garhwal region is that of Day (1878) who made a general reference to fishes of Himalaya. Grover and Baloni (1977) reported 19 species of fishes from Tehri-Garhwal. The record of *Barilius barna* and *Clupisoma garua* by Grover and Baloni (op. cit.) is not correct and is due to misidentification.

The fish fauna of the areas adjoining Tehri-Garhwal has been worked out by a few workers and since that fauna has common elements with these of Tehri-Garhwal District, a mention of these works has been made here. Fowler (1924) reported 12 species of fishes from Dehra Dun and Hora and Mukerji (1936) surveyed the eastern Doon Valley and reported 21 species of fishes with certain notes on their habits. Lal and Chatterjee (1962) recorded 33 species from the Doon valley with certain notes on their bionomics. Singh (1964) also surveyed the western part of the Doon valley and reported 47 species of fishes. Tilak (1970) reported the presence of *Puntius carletoni* in Doon valley and gave description of the species. Grover (1971) collected fishes from the Song river in Doon valley, Uttar Pradesh and recorded 44 species of fishes. Tilak and Husain (1971 & 1973) gave

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distributional and morphological notes on some glyptothoracoid fishes of Doon valley. Badola and Pant (1973) reported 18 species of fishes from Uttarkashi District of the Garhwal region. Badola (1975) reported 43 species from Pauri-Garhwal, but in his list there are several species which are now not valid. Tilak and Husain (1976) described a new species of the genus *Glyptothorax* Blyth from river Yamuna, Uttar Pradesh. Tilak and Husain (1977) described a new species of the genus *Noemacheilus* (*N. doonensis*) from district Dehra Dun. Baloni (1980) reported 16 species of fishes from Kedar valley, Chamoli-Garhwal and gave certain notes on their adaptations and ecology. 22 species, have been recorded from Tehri-Garhwal area and an account of these is presented below.

SYSTEMATIC LIST

- Class : Osteichthyes
 Sub-Class : Actinopterygii
 Division : III
 Super-Order : Ostariophysi
 Order : Cypriniformes
 Sub-Order : Cyprinoidei
 Family : Cyprinidae
 Genus : *Barilius* Hamilton
1. *Barilius bendelisis* Hamilton
 2. *Barilius vagra* Hamilton
 Genus : *Crossocheilus* Van Hasselt
 3. *Crossocheilus latius* (Hamilton)
 Genus : *Garra* Hamilton
 4. *Garra gotyla gotyla* (Gray)
 Genus : *Labeo* Cuvier
 5. *Labeo dero* (Hamilton)
 Genus : *Schizothorax* Heckel
 6. *Schizothorax richardsonii* (Gray)
 Genus : *Schizothoraichthys* Misra
 7. *Schizothoraichthys* (*Racoma*) *progastus* (McClelland)

Genus : *Tor* Gray

8. *Tor chilinoides* (McClelland)
9. *Tor putitora* (Hamilton)
10. *Tor tor* (Hamilton)

Family : COBITIDAE

Genus : *Botia* Gray

11. *Botia dayi* Hora

Genus : *Noemacheilus* Van Hasselt

12. *Noemacheilus beavani* Guenther
13. *Noemacheilus botia* (Hamilton)
14. *Noemacheilus montanus* (McClelland)
15. *Noemacheilus rupicola* (McClelland)

Order : SILURIFORMES

Family : SISORIDAE

Genus : *Glyptothorax* Blyth

16. *Glyptothorax brevipinnis alaknandi* Tilak
17. *Glyptothorax cavia* (Hamilton)
18. *Glyptothorax garhwali* Tilak
19. *Glyptothorax pactinopterus* (McClelland)

Genus : *Pseudecheneis* Blyth

20. *Pseudecheneis sulcatus* (McClelland)

Family : SCHILBEIDAE

Genus : *Clupisoma* Swainson

21. *Clupisoma montana* Hora

Super-Order : ACANTHOPTERYGII

Order : MASTACEMBELIFORMES

Family : MASTACEMBELIDAE

Genus : *Mastacembelus* (Gronovius) Scopoli

22. *Mastacembelus armatus* Lacèpède

SYSTEMATIC NOTES

The material studied here has been collected from Laster stream, Badiyar stream, Bhardari stream, Jalkur stream, Bal Ganga stream, Nagni stream, Gular stream, Aglar stream, Alaknanda river, Mandakini river, Bhagirathi river and Bhilangna river in Tehri-Garhwal region.

1. *Barilius bendelisis* Hamilton

1807. *Cyprinus bendelisis* Hamilton, *Journey Mysore*, 3, p. 345, pl. 32. (Type-locality : rivers of Mysore).

Material examined : 56 specimens, 34-140 mm total length, collected from Badiyar stream, near Maliyasu Village, 19.3.76, 10.8.76, 22.6.77 ; Laster stream at Tilwara 2.9.75, 11.6.77 and 19.9.78 ; Jalkur stream at Lambagaun, 15.4.78 ; Bal Ganga stream at Ghansali 21.5.77 and 25.7.78.

Fin Formula :—

B. III, D. II/7, P. I/14, V. I/8, A. III/8-9, C. 18; L. 1. 43, L. tr. 8/5, Barbels 2 pairs.

Distribution : Badiyar, Laster, Jalkur and Balganga streams in Tehri Garhwal district, Uttar Pradesh, freshwaters all over India ; Pakistan, Bangladesh and Ceylon.

Remarks : This species is a predominant fish of hill streams and shows a marked sexual dimorphism. It closely resembles *Barilius vagra* from which it can be distinguished on the basis of fin ray counts, number of scales along the lateral line and a few other morphometric characters.

2. *Barilius vagra* Hamilton

1822. *Cyprinus (Barilius) vagra* Hamilton, *Fish Ganges*, p. 269, 385. (Type-locality : the Ganges at Patna).

Material examined : 21 exs., 75 mm-112 mm total length, collected from Nagani stream at Shiv puri on 31.5.78, 10.6.78, 15.8.78, 21.9.78, 1.10.78, 19.2.79 ; Gular stream at Gular on 30.5.78 and 16.8.78 and Aglar stream on 15.6.78.

Fin Formula :—

B. III, D. II/7, p. I/15, V. I/8, A. II/10-12, C. 19, L. 1. 42-44, L. tr. 7 1/2/4, Barbels 2 pairs.

Distribution : Rivers in the Himalaya (Nagani, Gular and Aglar streams of Tehri-Garhwal, U. P.) and Sub-Himalayan ranges, Jamuna and Ganges, Panjab, Assam, West Bengal, Bihar ; Nepal, Pakistan and Ceylon.

Remarks : The closest ally of this species is *Barilius bendelisis* from which it can be easily distinguished on the basis of morphometric and meristic characters as stated under *Barilius bendelisis*.

3. *Crossocheilus latius* (Hamilton)

1822. *Cyprinus latius* Hamilton, *Fish Ganges*, p. 345, 346, 393 (Type-locality : the Tista).

1934. *Crossocheilus latia latia* Mukerji, *J. Bombay. nat. Hist. Soc.*, 38, part I.

Material examined : 25 exs. (125-231 mm. total length), collected from Alaknanda river Kilkileshwar, 15.10.76 and 13.4.77 ; Bhagirathi river at Sirain on 18.11.76 and 17.5.78 ; Bhilangana river at Ghansali on 7.9.79 ; Mandakini river at Rudraprayag on 8.9.77, 15.10.77 and 19.10.78.

Fin Formula : B.III, D.III/8, P.I/15, V.I/8, A.II/5, C.19, L.1.39, L.tr. 6/6, Barbels 1 pair.

Distribution : Hill stream of Tehri Garhwal and other areas of Uttar Pradesh, Bihar, Orissa, West Bengal, Punjab, Deccan and all along the Himalaya ; Pakistan.

Remarks : Mukerjee (1934) divided *latius* into three sub-species,
1. *C. latius punjabensis*—from western Himalaya.

2. *C. latius latius*—from central part of Himalaya and eastern part of India.

3. *C. latius burmanicus*—from Burma.

Heckal (1838) described a species, *C. diplochilus* which has been found to be similar to *C. latius punjabensis* Mukerji. According to law of priority now this stock of *latius* is named *C. diplochilus* with *C. latius punjabensis* as its synonym. *C. latius* and *C. diplochilus* are systematically treated as two different species and can be easily distinguished from each other in morphometric characters.

4. *Garra gotyla gotyla* (Gray)

1832-33. *Cyprinus gotyla* Gray, *Ill. Ind. Zool. Hardwicke*, II, pl. 88, figs. 3, 3a (Type-locality : Northern India).

1964. *Garra gotyla gotyla* : Menon, *Mem. Indian Mus.*, 14, p. 233, pl. 13, figs. 1-4.

Material examined : 32 exs. (90-221 mm total length), collected from river Mandakini at Rudreprayag on 8.10.76, 12.4.77 ; 11.5.77. ; 24.7.78 ; Alaknanda near Chaurash on 16.3.76 ; 15.5.77, 7.8.78 ; and 16.8.78 ; river Bhagirathi at Serain on 11.9.76 ; 13.9.76 ; and Bilangna near Tehri on 17.4.78 ; 19.5.78 and 27.6.78.

Fin-Formula : B.III, D.II./9, P.I/15, V.I/8, A.II/5, C.17, L.1.32-35, L.tr.4½/3½-5, Barbels 2 pairs.

Distributions : Asia, India—Assam, all along the Himalaya, Chhota Nagpur plateau and Vindhya Satpura mountains of the Peninsula, Himachal Pradesh, Punjab, Uttar Pradesh (Mandakini, (Alaknanda, Bhagirathi and Bhilangna rivers of Tehri Garhwel) Burma and Pakistan.

Remarks : *Garra gotyla gotyla* is different from *Garra lamta* which is also found in northern India, particularly in the characters of the proboscis. Menon (1964) has clearly differentiated this species from the other species of the genus *Garra*.

5. *Labeo dero* (Hamilton)

1822. *Cyprinus dero* Hamilton, *Fish. Ganges*, p. 277, 385, pl. 17, fig. 78. (Type-locality : the Brahmaputra).

Material examined : 18 exs. (200-441 mm total length), collected from Bhilangana river on 19.10.78 at Tehri and on 12.6.78 at Ghansali ; Alaknanda river at Srinagar on 15.5.79 and at Rudraprayag on 30.6.79, 23.9.79 ; Bhagirathi River at Serain on 16.5.79 ; Laster stream at Tilwara on 10.8.78 and 19.8.78 ; and Nagani stream at Shiv Puri on 31.5.79.

Fin-Formula : B.III, D.II-III/9-10, P.I/16, V.I/8, A.III/5, C.19, L.1.41.43, L.tr. 8-9½/6½-9, Barbels 1 pair.

Distribution : Freshwaters of Assam, Derjeeling, Eastern Himalaya, Punjab, Uttar Pradesh (Bhilangana, Alaknanda, Bhagirathi and Nagani rivers of Tehri-Garhwal district), Western Himalaya ; Pakistan Bangladesh and China.

Remarks : It is an important species of *Labeo* in the hilly region and is differentiated from its closest ally, *Labeo dyocheilus* in the shape of the snout, the position of pores on the snout and cheek and the nature of the inner side of the lower-lip. The marked sexual dimorphism found in *Labeo dero* is absent in *Labeo dyocheilus*.

6. *Schizothorax richardsonii* (Gray)

1830-32. *Cyprinus richardsonii* Gray, *Ill. Indian Zool.*, I, pl. 94, fig. 2 (Type-locality : Unknown).

1838. *Schizothorax plagiostomus* Heckel, *Fisch. Caschmir*, p. 16, pl. 1. (Type-locality : Kashmir).

1965. *Schizothorax richardsonii* : Menon, *Rec. zool. Surv. India*, 63, p. 195-205.

Material examined : 115 exs. (25 mm to 560 mm total length), river Mandakini 15.8.78, 13.3.79 ; collected from river Alaknanda at Rudraprayag on 12.3.76, 25.4.77, 11.6.77 and 5.8.78 ; River Bhagirathi at Sirain 15.8.76, and 10.5.78 ; River Bhilangna at Ghansali 18.5.77 and

15.4.78 ; Badiyar stream at Seragaun 25.4.77, 7.5.77, 15.8.78 and 3.4.79 ; Bhardari stream near Kotali village 24.4.77 ; Aglar stream near Tuna village 1.6.78 ; Nagani stream at Shiv Puri 28.6.78 ; Laster stream on 16.7.77. This species is found in all rivers and streams of Garhwal.

Fin-Formula : B. III, D. III/8, P. I/16, V. I/9, A. II/5, C. 19, L. 1. 108-110, Barbels 2 pairs.

Distribution : Assam and Eastern Himalaya through Bhutan, Sikkim and Nepal to Punjab (Mandakini, Alaknanda, Bhagirathi, Bhilangna, Badiyar, Bhardasi, Aglar, Nagani and Laster streams of Tehri Garhwal), Jammu and Kashmir and Afghanistan.

Remarks : There are two species of genus *Schizothorax* in Himalaya for example, *S. richardsonii* and *S. kumaonensis*. They can easily be distinguished from each other in the ratio of head length to standard length. The head is smaller in *kumaonensis* than that of *richardsonii*.

7. *Schizothoraichthys (Racoma) progastus* (McClelland)

1839. *Oreinus progastus* McClelland. *Asiat. Res.*, 19, p. 274, 343, pl. 40, fig. 4 (Type-locality : Upper Assam).

1877. *Schizothorax progastus* : Day, *Fish. India*, p. 532, pl. CXXII, fig. 7.

Material examined : 6 exs. (150-429 mm total length), collected from River Alaknanda at Rudraprayag on 24.6.78, 3.12.78 ; Mandakini River at Tilwara on 13.3.79 ; Bhilangna river on 15.4.78 ; Bhilangna river on 15.4.78 ; Bhagirathi River at Theri on 12.7.78.

Fin-Formula : B.III, D.III/8-9, P.I/18, V.I/10, A.III/5, C.19, L.1 105-112, Barbels 2 pairs.

Distribution : From the head-waters of the Gangas and Alaknanda, Mandakini, Bhilangna and Bhagirathi rivers of Tehri-Garhwal to Upper Assam through Nepal, Sikkim, Bhutan and southern Tibet.

Remarks : This species resembles *S. richardsonii* but can be easily distinguished from in the absence of hard papillated strip at the chin and the post-labial groove uninterrupted. The uninterrupted groove forms an intermediate lobe and two lateral lobes of the lower lip which is a character of the sub-genus *Racoma* McClelland.

8. *Tor chilinoides* (McClelland)

1839. *Barbus cheilynoides* McClelland, *Asiat. Res.*, XIX pl. 2, p. 271, 340, pl. 57, fig. 5. (Type-locality : Assam).

Material examined : 84 exs. (25-248 mm Total length), collected

from Laster stream at Tilwara on 17.10.76, 5.5.77, 29.11.78 ; Badiyar stream near Kotali village on 21.2.77, 7.3.78 ; Mandakini river at Maiki Mandi on 18.1.76, 19.7.76 and 12.3.77 ; river Alaknanda at Rudraprayag on 23.6.78 and 27.4.73 ; river Bhagirathi at Sirain on 10.8.77 and 6.5.78 ; river Bhilangna at Tehri on 18.10.77 ; Aglar stream at Tuna Village on 1.6.78.

Fin-Formula : B.III, D.III/7, P.I/16, V.I/8, A.II/5, C.19, L.1. 32-35. L.tr. $5\frac{1}{2}/3\frac{1}{2}/2-6$, Barbels 2 pairs.

Distribution : Himalaya, as far to the east as Assam, also found in Ganges (Day 1878) and Laster, Badiyar, Mandakini, Alaknanda, Bhagirathi, Bhilangna and Aglar streams of Tehri Garhwal district.

Remarks : It is dark Mahseer which does not grow to a larger size and differ from *T. putitora* and *T. tor* in the number of scales along lateral line, ratio of the length of head with height of the body and condition of the lower-lip.

9. *Tor putitora* (Hamilton)

1822. *Cyprinus putitora* Hamilton, *Fish. Ganges*, p. 308, 388 (Type-locality : Eastern part of Bengal).

1939. *Barbus (Tor) putitora* : Hora, *J. Bombay nat. Hist. Soc.*, 41, p. 272-285.

Material examined : 33 exs., (60-650 mm total length), collected from river Alaknanda at Chaurash on 6.8.77, 14.4.78 and 19.10.78 ; Mandakini at Mai Ki Mandi on 5.7.76, 13.10.76, 23.6.78 ; Laster stream at Tilwara on 14.8.76, and 19.9.77 ; Badiyar stream near Kotali village on 24.5.77 ; Jalkur stream 24.5.76 ; Aglar stream on 1.6.78 ; Bhagirathi river, 16.5.79 ; Bhilangna, 19.10.79.

Fin-Formula : B.III, D.III/9, P.I/17, V.I/8, A.II/5, C.19, L.1.25-28, L.tr. $4\frac{1}{2}/2\frac{1}{2}$, Barbels 2 pairs.

Distribution : India-freshwaters of Punjab, Uttar Pradesh (Alaknanda, Mandakini, Laster, Badiyar, Jalkur and Aglar stream of Tehri Garhwal), Western Himalaya, Darjeeling, West Bengal, Assam, Eastern Himalaya ; Pakistan, Bangladesh and Nepal.

Remarks : This is normally called the yellow-finned Mahseer and grows to the much bigger size than the other species of Mahseer. The head in this species is much longer than that of *Tor tor* and *Tor chilinoides*.

10. *Tor tor* (Hamilton)

1822. *Cyprinus tor* Hamilton, *Fish. Ganges*, p. 305, 388 (Type-locality : the river Mahananda).

1940. *Barbus (Tor) tor* : Hora, *J. Bombay nat. Hist. Soc.*, 41 p. 518-525.

Material examined : 27 exs. (115-658 mm Total length), collected from river Alaknanda at Srinagar on 10.7.76 ; at Rudraprayag on 12.4.77, 27.6.78 ; Mandakini at Tehri Agustmuni, 2.8.76 and at Rudraprayag, 29.5.78 ; river Bhilangna at on 19.5.78 ; river Bhilangna at Tehri on 15.5.78 ; Laster stream at Tilwara on 10.8.78 ; Nagani stream at Shiv Puri on 30.5.78 and 2.6.78.

Fin-Formula : B.III, D.III/9, P.I/17, V.I/8, A.III/5, C.19, L.tr.4 $\frac{1}{2}$ /2 $\frac{1}{2}$, Barbels 2 pairs.

Distribution : India-freshwaters of northern India along Himalaya (Alaknanda, Mandakini, Bhagirathi, Bhilangna, Laster and Nagain river of Tehri Garhwal and extends southwards to Madhya Pradesh, Pakistan; Bangladesh and China.

Remarks ; This is normally called the red-finned Mahseer. This species can be distinguished from *Tor putitora* and *Tor chalinoides* in the number of scales along the lateral line and the ration of the head to the body depth.

11. *Botia dayi* Hora

1878. *Botia geto* : Day (*nec.* Hamilton) (in part), *Fish. India*, p. 606, pl. 154, fig. 2.

1932. *Botia dayi* : Hora, *Rec. Indian Mus.*, 34 ; p. 571-572. (Type-locality : the Mahanadi at the base of Darjeeling Hills).

1977. *Botia dayi* : Tialk and Husain, *Zool. Jb. (Syst.)*, 104 p. 268, 283, 297.

1979. *Botia dayi* : Tilak and Sinha, *Zool. Jb. (Syst.)*, 106 p. 180, 189.

Material examined : 6 exs. (65-119 mm total length), collected from river Alaknanda at Rudraprayag on 24.6.78, 3.12.78 ; Mandakini river at Tilwara on 13.3.79 ; Bhilangna river on 15.4.78 ; Bhagirathi river at Tehri on 12.7.78.

Fin-Formula : B.III.D.II/9, P.II/11-12, V.I/6, A.II/5, C.19, Barbels 4 pairs.

Distribution : Assam, West Bengal, Uttar Pradesh (Alaknanda, Mandakini, Bhilangna and Bhagirathi rivers of Tehri Garhwal), Himachal Pradesh, Jammu and Kashmir.

Remarks : The fish ia a bottom feeder and stays at the bottom for life functions. The population of this species is rather poor because

it is rarely represented in the fish catches from the area. The brightly coloured and compressed body with a clearly bifid caudal fin differentiate this fish from other cobitids in the area.

12. *Noemacheilus beavani* Guenther

1868. *Nemacheilus beavani* Guenther, *Cat. Fish. Brit. Mus.*, 7, p. 350, (Type-locality : River Kosi).

Material examined : 18 exs. (55-110 mm total length) collected from river Alaknanda on 21.7.79, 9.8.79 ; Badiyar stream near Kotali village on 24.5.77 and 4.6.78 ; Bhardari stream near Maliyasu village on 25.3.77 and 22.4.78 ; Laster stream 10.5.78 and 16.12.78 ; Jalkur stream on 17.7.78. Bol Ganga stream on 19.7.78.

Fin-Formula : B.III, D.II/8, P.I/9, V.I/6, A.I/5, C.19, Barbels 3 pairs.

Distribution : Assam, Eastern Himalaya and Uttar Pradesh (Alaknanda, Badiyar, Bhardari, Laster, Jalkur and Balganga streams of Tehri Garhwal district).

Remarks : It closely resembles *N. denisonii* Day but can be distinguished from it in the various morphometric and meristic characters and colouration of the body.

13. *Noemacheilus botia* (Hamilton)

1822. *Cobitis botia* Hamilton, *Fish. Ganges*, p. 350, 394 (Type-locality : the rivers of north-eastern parts of Bengal).

Material examined : 21 exs. (58-110 mm total length), collected from Nagani stream near Shiv Puri on 4.3.77, 30.4.78, 31.5.78, 15.8.78, 23.9.78 ; Gular stream on 17.8.78, 9.10.78 and 12.1.79.

Fin-Formula : B.III, D.II/10-12, P. I/12, V.I/7, A.II/5, C.18, Barbels 3 pairs.

Distribution : India-freshwaters of Punjab, Uttar Pradesh (Nagani and Gular streams of Tehri Garhwal), Western Himalaya, Darjeeling, West Bengal, Eastern Himalaya, Assam, Bihar ; Pakistan and Bangladesh.

Remarks : The species inhabits slow moving water and is distinguishable from all other species of *Noemacheilus* in colouration and more number of branched rays of the dorsal fin.

14. *Noemacheilus montanus* (McClelland)

1838. *Schistura montanus* McClelland, *J. Asiat. Soc. Beng*, 7 p. 947, pl. 55, fig. 1, (Type-locality : Mountain streams of Simla).

1839. *Schistura montanus* McClelland, *Asiat. Res.*, 19, pp. 307, 440, pl. 57, fig. 1.

Material examined : . 59 exs. (45-112 mm total length), collected from Laster stream at Tilwara on 15.4.76, 18.6.77, 29.11.78, 18.12.78 ; Badiyar stream near Maliyasu village on 25.5.77, 11.6.77, 7.4.78 ; Jalkur stream on 29.5.78 ; Nagani stream at Shiv Puri on 11.6.78, 15.6.78 ; Aglar stream on 28.5.77 ; Alaknanda river at Rudraprayag 11.7.78, 15.7.78 ; Mandakini river at Rudraprayag on 17.8.78.

Fin-Formula : B.III, D.II/7-8, P.I/9, V.I/6, A.II/5. C.19, Barbels 3 pairs.

Distribution : Himachal Pradesh and hills in Western Himalaya, Laster, Badiyar, Jalkur, Nagani, Aglar, Alaknanda and Mandakini rivers of Tehri Garhwal.

Remarks : This species inhabits fast flowing streams and has exclusive colouration which distinguished it from the other species of the genus found in the area.

15. *Noemacheilus rupicola* (McClelland)

1838. *Schistura rupicola* McClelland, *J. Asiat. Soc. Beng*, 7, pl. 55, fig. 3 (Type-locality ; mountain streams of Simla).

1839. *Schistura rupicola* McClelland, *Asiat. Res.*, 19, p. 309, pl. 57, fig. 3.

Material examined : 108 exs., (40-108 mm total length), Collected from Laster stream at Tilwara on 19.3.77, 15.5.77, 17.6.78 ; Badiyar stream near Seragaun on 18.10.77, 24.4.78, 7.5.78 ; Jalkur stream on 24.6.78, 13.8.78 ; Bal Ganga stream on 29.6.78 ; Nagani stream at Shiv Puri 1.6.78 ; Bhardari stream near Maliyasu village on 25.3.77, 22.4.78 ; Bhagirathi river at Tehri on 16.5.79 ; Bhilangna river at Tehri on 19.10.78 ; Alaknanda river at Rudraprayag on 11.7.78, 15.7.78 ; Mandakini river at Rudraprayag on 17.8.78.

Fin-Formula : B.III, D.II/7, P.I/10, V.I/7, A.II/5, C.18, Barbels 3 pairs.

Distribution : All along the Himalaya (Laster, Badiyar, Jalkur, Bal Ganga, Nagani, Bhardari, Bhagirathi, Alaknanda, Mandakini rivers of Tehri-Garhwal, U. P.) and Tibar at 5100 metres above the sea level.

Remarks : This species is very versatile and has been recorded in Himalaya from 450 metres to an altitude of 5100 metres. The coloura-

tion of the body and the depressed head with a peculiar spout formation of the lower jaw distinguish this species from all other species dealt within this work.

16. *Glyptothorax brevipinnis alaknandi* Tilak

1969. *Glyptothorax brevipinnis alaknandi* Tilak, *J. Inland Fish. Soc. India*, I, pp. 42-44, fig. 8, 9, 10 and 11.

Material examined : 22 exs. (34-105 mm total length), collected from Alaknanda river at Chaurash on 15.10.76, 9.3.77, 17.4.78 ; Bhardari stream near Kotali village on 7.8.78, 14.4.78, 27.6.78 ; Badiyar stream at Seragaun on 21.5.77, 29.6.77, 11.6.78 ; Laster stream at Tilwara on 17.3.78, 25.7.78, 27.7.78 ; Aglar stream near Tuneta village on 11.6.78 ; Mandakini river at Rudraprayag on 17.8.78 ; Bhilangna river at Tehri on 15.5.78.

Fin-Formula : B. VI, D. I/6, P. I/7, V. I/5, A. III/7, C. 17, Barbels 4 pairs.

Distribution : Tilak (1969) recorded the fish from Pauri-Garhwal, river Alaknanda for the first time with definite locality data. Bhardari, Badiyar, Laster, Aglar, Mandakini and Bhilangna rivers of Tehri Garhwal district, Uttar Pradesh.

Remarks : It is very close to *G. pectinopterus* and can be distinguished from it in the body colouration and length of head.

17. *Glyptothorax cavia* (Hamilton)

1822. *Pimelodus cavia* Hamilton, *Gangetic Fishes*, pp. 188, 378 (Type-locality : Northern rivers of Bengal).

1878. *Euglyptosternum lineatum* Day, *Fish. India*, p. 500, pl. CXVI, fig. 7 (Type-locality : Jumna and Suddya in upper Assam).

1929. *Glyptothorax burmanica* Prasad and Mukerji, *Rec. Indian Mus.*, 41, p. 184, fig. 5, pl. VII, fig. 3 (Type-locality : Burma).

Fin-Formula : B. VIII, D. I/6, P. I/9, V. I/5, A. III/9, C. 18, Barbels 4 pairs.

Material examined : 10 exs. (150-325 mm total length), collected from river Alaknanda at Srinagar on 17.4.77, 15.6.77 ; Bhagirathi river near Sirain on 19.5.78, 18.10.78 ; Bhilangna river at Tehri on 14.5.78, 14.10.78 ; Mandakini river at Tilwara on 21.5.78, 26.8.78, 19.7.79,

Distribution : Northern Bengal, Assam, Uttar Pradesh (Alaknanda, Bhagirathi, Bhilangna, Mandakini rivers of Tehri-Garhwal District), Bihar ; Burma and Nepal.

Remarks : According to Tilak and Husain (1969) the maximum length of the fish is 335 mm ; it is the largest size of this species so far recorded. The present specimen, measuring 325 mm is also the largest size of this species in the present collection. Its presence in Garhwal Himalaya extends its range of distribution further westwards along Himalaya (Tilak and Husain, 1969).

This species resembles very closely *G. garhwali* Tilak and can be easily distinguished from it in many morphometric characters as mentioned by Tilak (1969).

18. *Glyptothorax garhwali* Tilak

1969. *Glyptothorax garhwali* Tilak, *J. Inland. Fish. Soc. India*, I, p. 37-42, fig. 1-3.

Material examined : 45 exs. (118-162 mm total length), collected from river Alaknanda at Kilkileshwar Chaurash on 5.5.76, 9.4.77, at Rudraprayag on 25.4.77, 23.6.78 ; 27.4.79 ; Mandakini river at Tilwara on 15.8.77, 17.8.78, 13.3.79 ; Bhilangna river at Tehri on 10.8.78, 7.9.79 ; Laster stream at Tilwara on 16.7.77, 29.11.78, 18.12.78, Badiyar stream at Sevagaun on 5.8.78 ; Bhagirathi river at Tehri 19.5.78.

Fin-Formula : B. VIII, D. I/6, P. I/8-9, V. I/5, A. III/8, C. 17, Barbels 4 pairs.

Distribution : Tehri-Garhwal region, Uttar Pradesh, Tilak (1969) described this species from river Alaknanda, Pauri-Garhwal for the first time.

Remarks : This species closely resembles *Glyptothorax cavia* but differs from it in a number of characters, as mentioned earlier under *Glyptothorax cavia*.

19. *Glyptothorax pectinopterus* (McClelland)

1842. *Glyptosternum pectinopterus* McClelland, *Cal. J. nat. Hist.*, II, p. 587 (Type-locality : Simla Hills).

Material examined : 25 exs. (33-118 mm total length), collected from Badiyar stream on 14.3.76, 19.6.76, 1.5.77, 15.2.78 ; Laster stream on 16.11.76, 29.1.77, 12.6.78 ; Bhardari stream on 16.4.77, 7.6.78 ; Nagani stream at Shiv Puri on 31.5.78 ; Jalkur stream on 16.5.78 ; Aglar stream on 1.6.78 ; river Alaknanda and Rudraprayag, 5.8.78, 30.6.79 ; river Bhagirathi at Tehri 16.5.79 ; river Bhilangna at Tehri 19.10.78 ; river Mandakini at Rudraprayag on 17.8.78.

Fin-Formula : B.X, D.I/6, P.I/9, V.I/5, A.I/9, C.17, Barbels 4 pairs.

Distribution : Streams all along Himalaya (All streams of Tehri-Garhwal district, Uttar Pradesh).

20. *Pseudecheneis sulcatus* (McClelland)

1842. *Glyptosternum sulcatus* McClelland, *Cal. J. nat. Hist.*, II, p. 587, pl. 6 (Type-locality : Khasi-Hills Assam).

1923. *Pseudecheneis sulcatus* : Hora, *Rec. Indian Mus.*, 25, p. 43.

Material examined : 54 exs. (71-181 mm total length), collected from Laster stream at Tilwara on 15.3.76, 16.5.76, 5.1.77, 9.8.78 ; Badiyar stream at Sevagaun on 2.3.77, 5.9.77, 18.4.78 ; Jalkur stream on 11.3.77, Bal Ganga stream on 8.10.77, 6.10.78 ; Nagani stream on 15.6.78 ; Aglar stream on 1.6.78 ; Alaknanda river at Rudraprayag, 11.7.78, 15.7.78 ; Mandakini river at Rudraprayag on 17.8.78.

Fin-Formula : B.VII, D.I/6; P.I/13, V.I/5, A.IV/9, C.17, Barbels 4 pairs.

Distribution : All along Himalaya (all stream of Tehri-Garhwal district, Uttar Pradesh) from Yamuna to Assam ; Burma.

Remarks : The adhesive thoracic apparatus of this fish is peculiar in having horizontally arranged plaits. The evolution of glyptothoracid fishes has been discussed on the basis of the study of the development of adhesive thoracic apparatus of this species by Tīlak (1976).

21. *Clupisoma montana* Hora

1937. *Clupisoma montana* Hora, *J. Bombay nat. Hist. Soc.*, 39 (2), p. 673-677.

Material examined : 11 exs. (140-241 mm total length), collected from river Bhagirathi at Serain, 15.6.77, 23.11.77, at Tehri on 9.4.78, 12.7.78 ; Bhilangna river at Tehri on 8.10.77, 17.4.78 ; river Alaknanda at Chaurash on 6.8.77, 19.10.78.

Fin-Formula : B.VI, B.I/6-7, P.I/12, V.6, A.41-43, C.17, Barbels 4 pairs.

Distribution : Along base of Himalaya in Himachal Pradesh, Uttar Pradesh (Bhagirathi, Bhilangna and Alaknanda rivers of Tehri-Carhwal district) and West Bengal.

Remarks : Hora (1937) recognised three species under *Clupioma*.

1. *C. garua* (Hamilton)—from plains of India.

2. *C. montana* Hora—from sub-mountains of Himalaya.

3. *C. prateri* Hora-from extreme eastern part of Himalaya and Burma.

C. montana differs from the related species, *C. garua*, in the following characters.

1. Barbels are short in *C. montana* while they are relatively longer in *C. garua*.
2. The dorsal and pectoral spines of *C. montana* are weak ; they are stronger in *C. garua*.
4. Adipose dorsal fin is present in the adults of *C. montana* while it is absent in adults of *C. garua*.
3. A larger number of rays (41-43) is present in the anal fin of *C. montana*. Anal fin rays of *C. garua* are less in numbers (29-36).
5. In *C. montana*. teeth on the jaws form narrow bands which may be interrupted in the middle, those on the palate form two oblong and somewhat curved patches which may be continuous. The teeth on the upper jaw are in advance of the lower jaw. In *C. garua*, the palatine teeth are in a semilunar band, teeth on vomer continuous with those in palate, each patch being semicircular internally and the teeth on the upper jaw are not in advance of the lower jaw.

22. *Mastacembelus armatus* Lacépède

1800. *Macrognothus armatus* Lacépède, *Hist. nat. Poiss.*, II, p. 283-286 (Type-locality : Unknown).

1956. *Mastacembelus armatus* : Sufi, *Bull. Raffles Mus.*, 27 B. 134-143, pl. 25, figs. 29-32.

Material examined : 2B exs. (83-331 mm total length), collected from Aglar stream (below Mussoorie) on 14.6.76, 23.6.76, 11.6.77, 5.11.77, 15.6.78 ; Nagain stream near Nagani village on 5.10.76 and at Shiv Puri, 30.5.78 ; 12.6.78 ; Gular stream, 11.6.78.

Fin-Formula : B. VI, D. 32-39/74-90, p. 23-25, A. 3/75-88.

Distribution : India (Aglar, Nagain and Gular streams of Tehri Garhwal district, Uttar Pradesh) ; Baluchistan, Pakistan, Ceylon, Nepal, Burma, Siam, Malaya, Southern China, Sumatra and Java.

Remarks : It is one of the freshwater eels which is found in hill streams in this area. Only one species of this genus is present in the area. It is a carnivorous and predatory fish which wriggles through stony boulders at the bed of streams.

SUMMARY

Fish fauna of Tehri-Garhwal district of Uttar Pradesh has been studied in detail and 22 species have been recorded and classified. Taxonomic notes on the species have been provided.

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ON THE FISH FAUNA OF DISTRICT FAIZABAD,
UTTAR PRADESH

By

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INTRODUCTION

Faizabad is one of the districts in the eastern belt of Uttar Pradesh and is bordered by Gonda and Basti districts on the north, Azamgarh on the east, Sultanpur on the south and Barabanki on the west. The district is mainly traversed by the Ghaghara and Tons rivers. The Tons is a seasonal river with a few tributaries such as Marha or Tamsa nadi, Bisuhi nadi, Tori nadi, Pikia nadi etc. Apart from these waterways there are a few lakes in the eastern part of the district such as Deohat, Garha, Hanswar, Doman etc. The Ghaghara river and the lakes form an important source of fish in the district.

The fish fauna of the eastern part of Uttar Pradesh has been reported upon by Day (1878), Hora (1922, 1949), Swarup (1967), and Srivastava (1968, 1980) which concern Gorakhpur, Ghazipur, Mirzapur, Gonda, Basti and Deoria districts. The fish fauna of Faizabad, although an adjoining district to those named above, is not known and, therefore, a list of fishes of this area is given. The list is based on the local catches by the fishermen during summer months.

For smaller species, the commonly used gear in the area is *Jhugri jal*—a kind of cast net. It is generally 3 to 4 metres in length with 15 mm mesh size.

SYSTEMATIC LIST OF THE SPECIES AND THEIR LOCAL NAMES

- Order : Clupeiformes
Suborder : Clupeoidei
Family : CLUPEIDAE
1. *Gudusia chapra* (Hamilton) ... Khera
- Family : ENGRAULIDAE
2. *Setipinna phasa* (Hamilton) ... Phasia

Order : Osteoglossiformes

Suborder : Notopteroidei

Family : NOTOPTERIDAE

- | | | | |
|----|---------------------------------------|-----|---------------|
| 3. | <i>Notopterus chitala</i> (Hamilton) | ... | Moi |
| 4. | <i>Notopterus notopterus</i> (Pallas) | ... | Patra, Dhoota |

Order : Cypriniformes

Suborder : Cyprinoidei

Family : CYPRINIDAE

- | | | | |
|-----|---|-----|------------------|
| 5. | <i>Chela (Chela) cachiua</i> (Hamilton) | ... | Dhabai,
Jurwa |
| 6. | <i>Chela (Chela) laubuca</i> (Hamilton) | ... | Dendula |
| 7. | <i>Salmostoma bacaila</i> (Hamilton) | ... | Chilwa |
| 8. | <i>Esomus danricus</i> (Hamilton) | ... | Deola |
| 9. | <i>Rasbora daniconius daniconius</i> (Hamilton) | ... | Deola |
| 10. | <i>Amblypharyngodon mola</i> (Hamilton) | ... | Mola, Dhoi |
| 11. | <i>Catla catla</i> (Hamilton) | ... | Bhakur,
Katla |
| 12. | <i>Cirrhinus mrigala</i> (Hamilton) | ... | Nain |
| 13. | <i>Cirrhinus reba</i> (Hamilton) | ... | Rayya |
| 14. | <i>Labeo calbasu</i> (Hamilton) | ... | Karocho |
| 15. | <i>Labeo gonius</i> (Hamilton) | ... | Phursa |
| 16. | <i>Labeo rohita</i> (Hamilton) | ... | Rohu |
| 17. | <i>Osteobrama cotio cotio</i> (Hamilton) | ... | Gurdi |
| 18. | <i>Puntius chola</i> Hamilton | ... | Seri |
| 19. | <i>Puntius conchoniua</i> Hamilton | ... | Puthi |
| 20. | <i>Puntius sarana sarana</i> Hamilton | ... | Darahi-puthi |
| 21. | <i>Puntius sophore</i> Hamilton | ... | Puthi |
| 22. | <i>Puntius ticto</i> Hamilton | ... | Puthi |

Family : COBITIDAE

- | | | | |
|-----|--------------------------------------|-----|-------|
| 23. | <i>Botia lohachata</i> Chaudhuri | ... | Bagh |
| 24. | <i>Noemacheilus botia</i> (Hamilton) | ... | Nakti |

- Order : Siluriformes
Family : BAGRIDAE
25. *Aorichthys seenghala* (Sykes) ... Tengan
26. *Mystus bleekeri* (Day) ... Dhamsa
27. *Mystus cavasius* (Hamilton) ... Tengna
28. *Mystus menoda* (Hamilton) ... Belonda
29. *Mystus vittatus* (Bloch) ... Tengna
30. *Pseudeutropius atherinoides* (Bloch) ... Bajhai
31. *Rita rita* (Hamilton) ... Belgara
- Family : SILURIDAE
32. *Ompok bimaculatus* (Bloch) ... Gulwa
33. *Wallago attu* (Schneider) ... Parhin
- Family : SCHILBEIDAE
34. *Ailia coila* (Hamilton) ... Imirti
35. *Clupisoma garua* (Hamilton) ... Baikara
36. *Eutropichthys vacha* (Hamilton) ... Charkhi
- Family : PANGASIIDAE
37. *Pangasius pangasius* (Hamilton) ... Pyasi
- Family : SISORIDAE
38. *Bagarius bagarius* (Hamilton) ... Gonch
- Family : CLARIIDAE
39. *Clarias batrachus* (Linnaeus) ... Magur
- Family : HETEROPNEUSTIDAE
40. *Heteropneustes fossilis* (Bloch) ... Singhi
- Order : Atheriniformes
Suborder : Exocoetoidei
Family : Belonidae
41. *Xenentodon cancila* (Hamilton) ... Sua, Kawa
- Order : Channiformes
Family : CHANNIDAE
42. *Channa marulius* (Hamilton) ... Saur
43. *Channa punctatus* (Bloch) ... Girahi
44. *Channa striatus* (Bloch) ... Saur

- | | | | | | |
|-----|-------------------------------|-------------|------------------|---------|--|
| | Order | : | Perciformes | | |
| | Suborder | : | Percoidei | | |
| | Family | : | CENTROPOMIDAE | | |
| 45. | <i>Chanda nama</i> | Hamilton | ... | Chandri | |
| 46. | <i>Chanda ranga</i> | Hamilton | ... | Chandra | |
| | Family | : | NANDIDAE | | |
| 47. | <i>Nandus nandus</i> | (Hamilton) | ... | Dhebri | |
| | Suborder | : | Gobioidei | | |
| | Family | : | GOBIIDAE | | |
| 48. | <i>Glossogobius qutum</i> | (Hamilton) | ... | Puri | |
| | Suborder | : | Anabantoidei | | |
| | Family | : | ANABANTIDAE | | |
| 49. | <i>Anabas testudineus</i> | Bloch | ... | Koi | |
| 50. | <i>Colisa fasciatus</i> | (Schneider) | ... | Koi | |
| | Suborder | : | Mastacembeloidei | | |
| | Family | : | MASTACEMBELIDAE | | |
| 51. | <i>Mastacembelus armatus</i> | Lacépède | ... | Bam | |
| 52. | <i>Mastacembelus pancalus</i> | (Hamilton) | ... | | |

Commercially important fishes of the district help the local fisherman community to earn their livelihood. The catch of fish from the rivers, lakes and ponds is brought to the fish markets and *haats*. The commercially important fishes which are given preference are *Catla catla*, *Labeo rohita*, *L. calbasu*, *Aorichthys seenghala*, *Rita rita*, *Bagarius bagarius*, *Eutropiichthys vacha*, *Clupisoma garua*, *Wallago attu*, *Pangasius pangasius*, *Clarias batrachus*, *Heteropneustes fossilis*, *Channa marulius*, *C. punctatus*, *C. striatus*, *Notopterus chitala*, *N. notopterus* etc.

SUMMARY

This paper deals with the fish fauna of Faizabad district (Eastern Uttar Pradesh). 52 species belonging to 36 genera, 19 families and 7 orders have been recorded from the district and the local names of the species are given.

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SYSTEMATIC STATUS OF *BARILIUS BENDELISIS* HAMILTON
(CYPRINIDAE : PISCES)

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(With 8 Text-figures)

INTRODUCTION

Hamilton (1807, 1822) described *Barilius bendelisis*, *Barilius cocsa* and *Barilius tila* under the genus *Cyprinus* Linnaeus and since then various authors have treated these taxa at different levels (Day, 1878 ; Hora, 1921, Hora and Mukerji, 1936 ; Tilak, 1971 ; Menon, 1963, 1974). As such the systematic status of these taxa has remained in a state of confusion. These fishes are widely distributed in the streams and rivers along the base of hills and are economically important. In this paper it is proposed, therefore, to study the material of these taxa in detail and evaluate their taxonomic status.

HISTORY

Hamilton (1807), during his journey to Mysore, described *Cyprinus bendelisis* from the rivers of Mysore. Hamilton (1822) further described three more species allied to *C. bendelisis* viz *C. cocsa* from the northern rivers of Bengal and Bihar, especially the Mahananda and, *C. chedra* and *C. tila* from northern rivers of Bengal. Since then, the taxonomic status of *B. bendelisis* has been in great confusion. Day (1878) considered *C. tila* as synonym of *B. bendelisis*, and *cocsa* and *chedra* as subspecies of the latter. Incidentally, Day (1878) found *chedra* type of specimens with very stiff outer pectoral rays. Hora (1921) was probably influenced by the treatment of Day (1878) and, recognising *B. bendelisis chedra* Hamilton as a valid taxon, remarked "The paired fins are broad and well expanded and most of the outer rays in this have become stiff. The chest is flattened and the scales in this region are poorly developed. There are characteristic muscular pads in front of the bases of the pectorals. The open pores on the snout are absent". Hora and Mukerji (1936) tried to correlate the specially developed pectoral with digging in sand or holding on to the rocks in rapids. Sehgal (1974) probably followed Hora (1921) and Hora and Mukerji

(1936). Menon (1963) considered *B. bendelisis chedra* synonymous with *B. bendelisis* Hamilton with the view that with the growth of fish, the paired fins become much expanded and the characteristic muscular pads in front of the base develop ; he (Menon, 1974) included *cocsa*, *chedra* and *tila* under the synonymy of *Barilius bendelisis*. Tilak (1971) found the body scales in *chedra* type of specimens covered over with small tubercles arranged in two irregular rows which impart the fish a rough texture and the tuberculated snout, uniformly in both males and females. He (Tilak, 1971) however, felt that *chedra* and *cocsa* type of specimens might be independent in status but very recently Tilak and Jaffer (1982) studied the pectoral girdle and the fin of both male (*chedra*) and female (*cocsa*) specimens and found it to be correlated with the secondary sexual characters. In order to further strengthen this view, a long series of both *chedra* and *cocsa* type of specimens were dissected and studied in detail and it is established that *chedra* type of specimens are always mature males with thick cord-like paired testes and other external secondary sexual characters. The *cocsa* type of specimens are either females with immature to ripe ovaries or immature males with fine thread-like testes without the indication of any secondary sexual characters. The body proportions of all the three types of specimens of nearly similar total length (89-100 mm) were compared and were found overlapping within the range of the species (*B. bendelisis* Hamilton) except for the distance between the origin of pectoral and ventral fins. In *chedra* type specimens (=mature males), the distance between the origin of paired fins ranges between 5.47-6.62 and 4.55-5.38 times in total length and standard length respectively. In *cocsa* type specimens, it is between 4.54-5.35 and 3.72-4.71 times in immature males and 4.27-6.59 and 3.47-5.44 times in females.

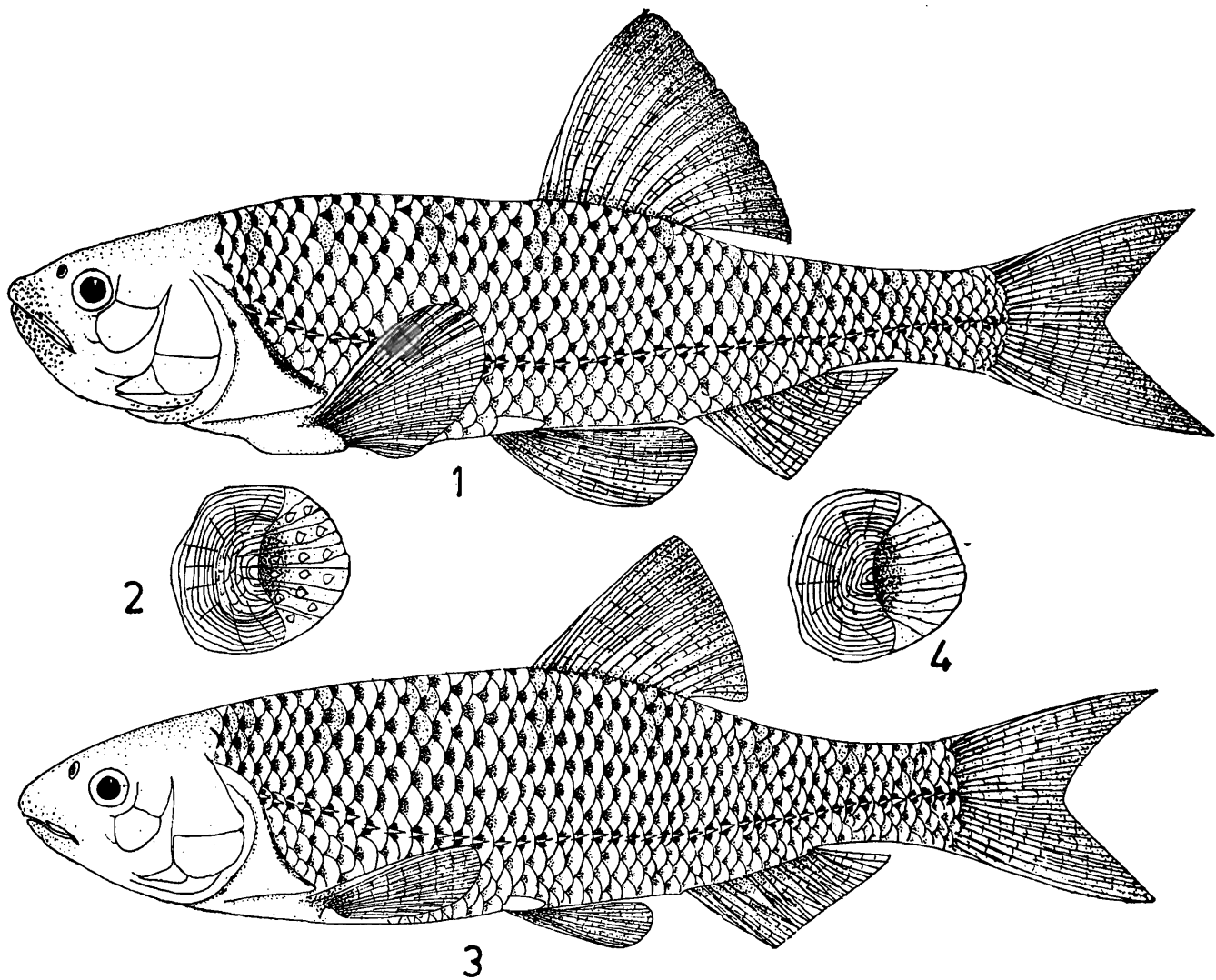
Barilius bendelisis Hamilton

(Text-figs. 1-2)

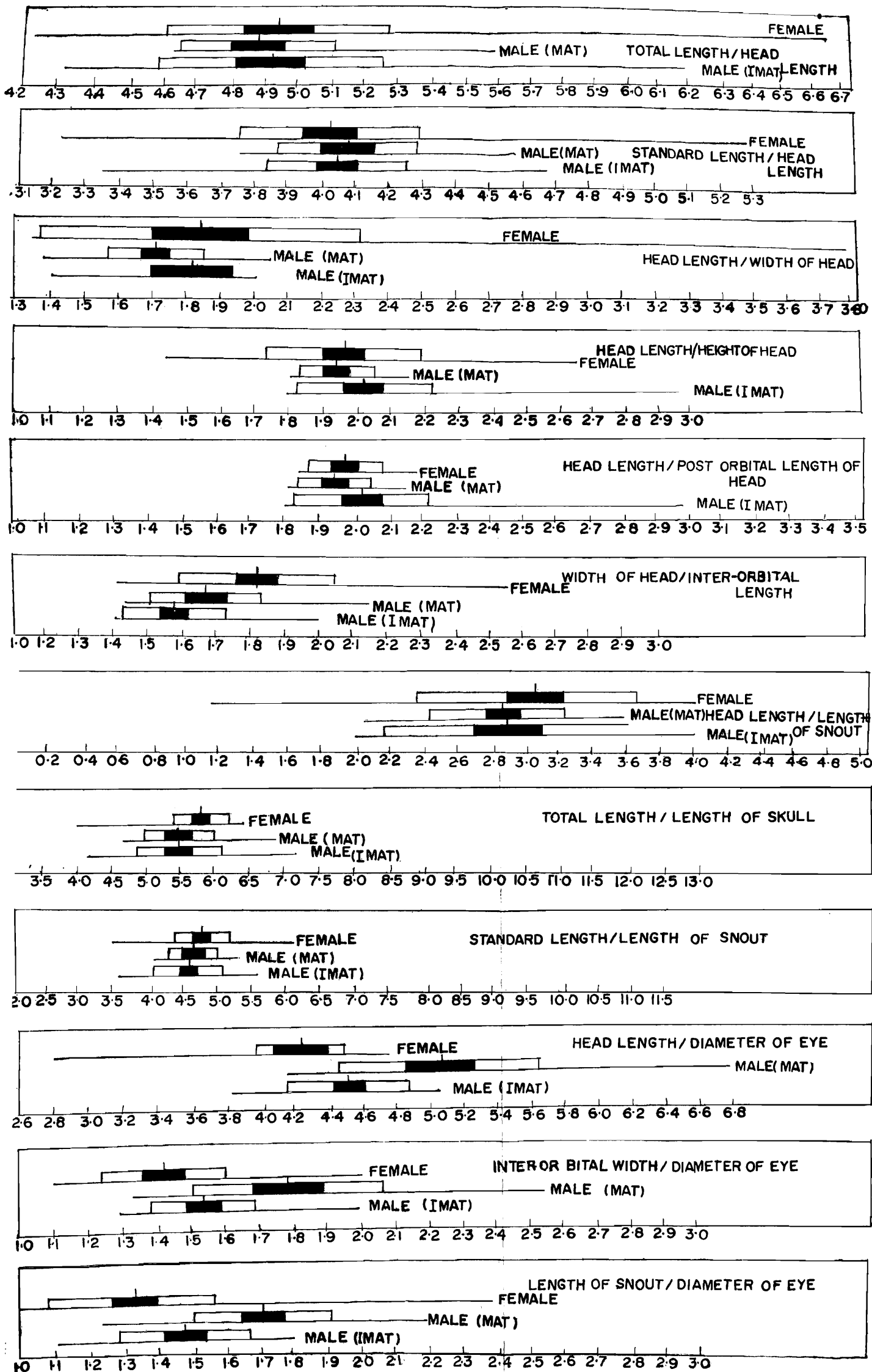
1807. *Cyprinus bendelisis* Hamilton, *Journey in Mysore*, 3 : 345, (Type-locality : Vedawati stream, head waters of the Kistna near Heriuru, Mysore).
 1822. *Cyprinus* (*Barilius*) *bendelisis*, *cocsa*, *chedra* and *tila* Hamilton, *Fish. Ganges* : 270-274, 385, pl. 3, fig. 77.
 1878. *Barilus bendelisis*, variety *cocsa* and *chedra* : Day, *Fish India* : 590-591, pl. CXLVIII, figs. 7-9.

Diagnostic characters :

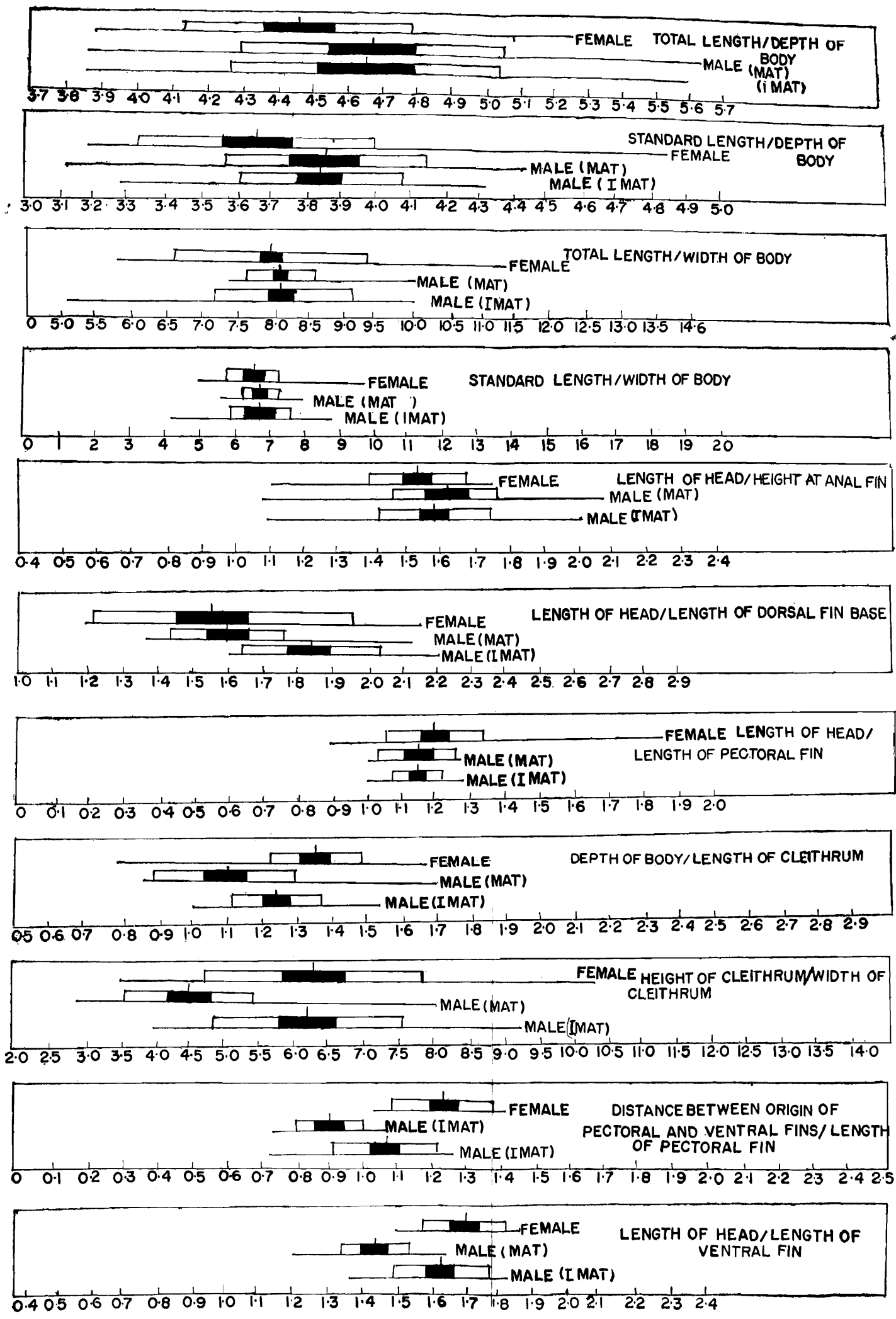
B III. D II/7, P.I/14, V.I/8, A.II-III/7-8, C.18, Scales : L1, 40-45, Ltr. 7-8/5, rows of scales between lateral line and base of ventral fin 2.5-5.5, predorsal scales 20, Barbels 4 or 2. Pharyngeal teeth 5, 4, 2/2, 4, 5.



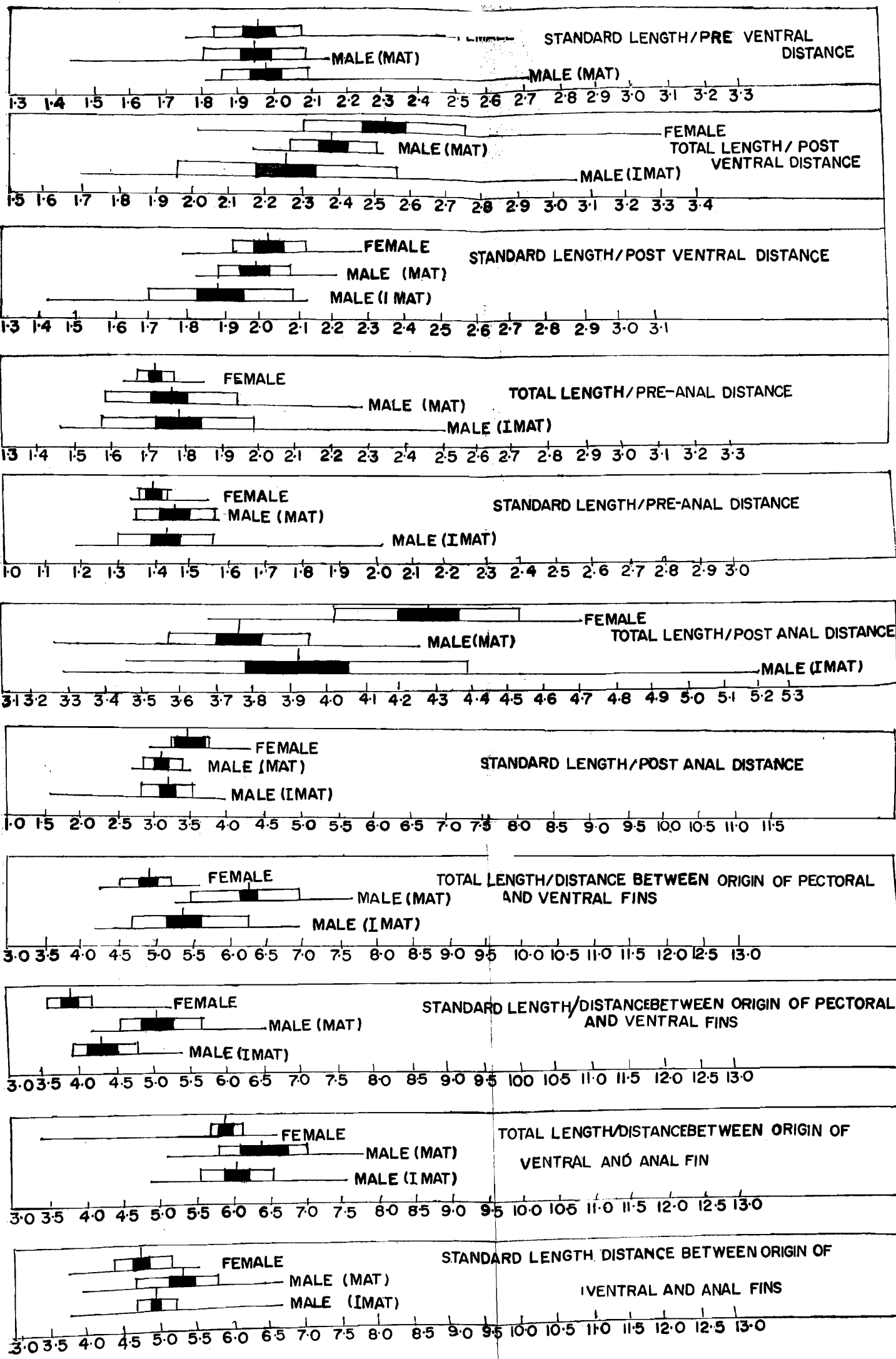
Text-figs. 1. Lateral view of the breeding male of *Barilius bendelisis* Hamilton.
2. A subdorsal scale of breeding male of *Barilius bendelisis* Hamilton.
3. Lateral view of the female of *Barilius bendelisis* Hamilton.
4. A subdorsal scale of the female of *Barilius bendelisis* Hamilton.



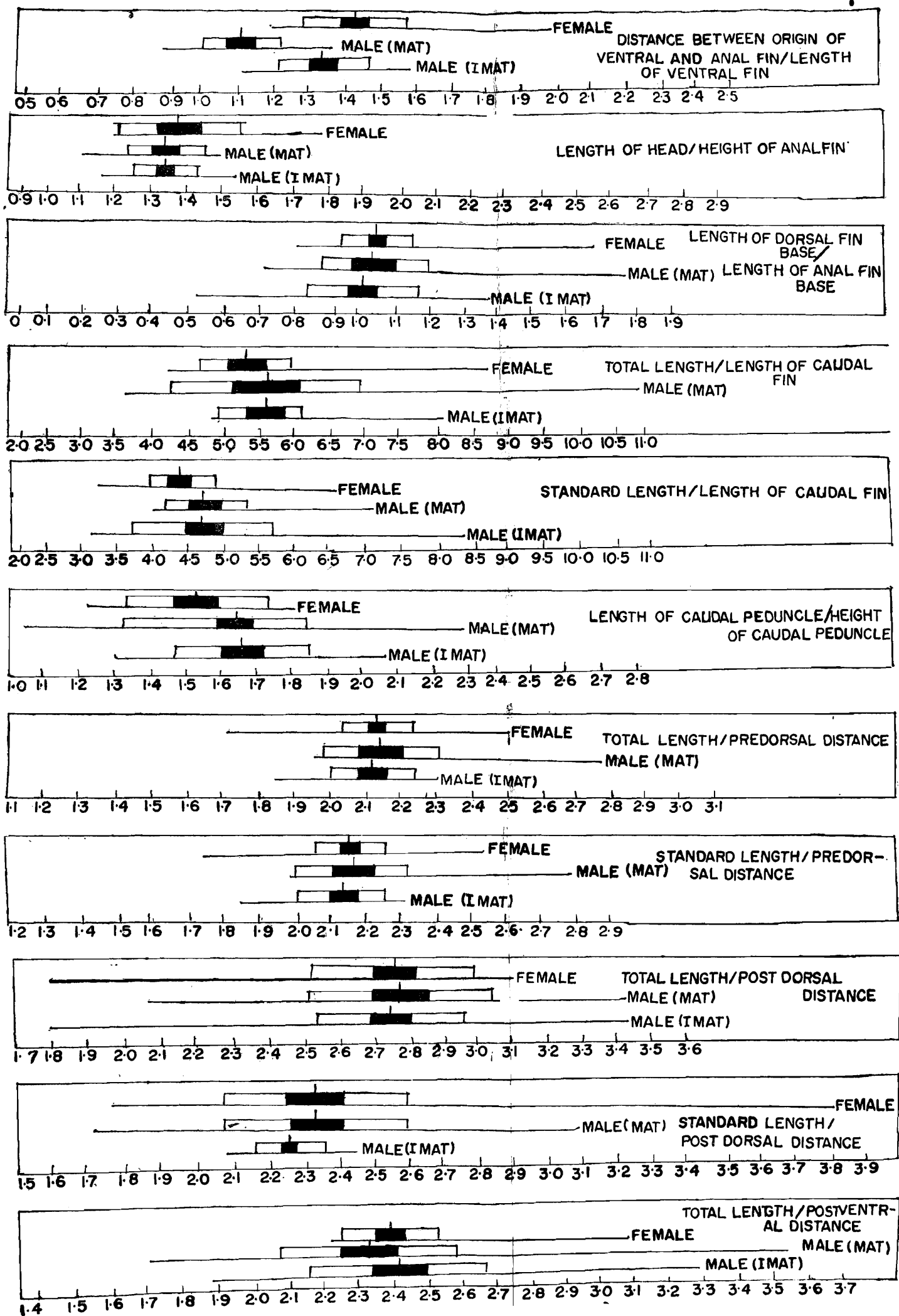
Text-fig. 5



Text-fig. 6



Text-fig. 7



Text-fig. 8

TABLE 1. Showing the differences between *Barilius bendelisis* and allied species described by Hamilton (1922).

<i>Cyprinus (Barilius) bendelisis</i> Hamilton	<i>C. (Barilius) cocsa</i> Hamilton	<i>C. (Barilius) chedra</i> Hamilton	<i>C. (Barilius) tila</i> Hamilton
1. B ₃ , D ₉ , P ₁₃ , V ₉ , A ₁₁ , C ₁₉	B ₃ , D ₉ , P ₁₃ , V ₉ , A ₁₁ , C ₁₉ .	B ₃ , D ₁₀ , P ₁₄ , V ₉ , A ₁₁ , C ₁₈ +	B ₃ , D ₈ , P ₁₄ , seu ₁₅ , V ₉ , A ₁₀ , C ₁₈ +
2. Barbels 2.	Barbels 4	Barbels absent	Barbels absent
3. Incomplete bars on side	With incomplete bars on side and a spot on the middle of each scale.	With a spot on the bottom of each scale on the sides.	With a spot on the middle of each scale on sides.
4. No scale-like appendage above the ventral fin.	Scale-like appendage above each ventral fin.	Scale-like appendage above each ventral fin.	Short scale-like appendage above each ventral fin.
5. —	—	Scale rough on the surface with little blunt grains.	—
6. —	Ventrals don't reach the vent.	Ventrals scarcely reach the vent.	Ventrals don't reach near the vent,
7. Lower lobe of caudal the longest	—	—	Lower lobe of caudal the longest.
8. Each gill-cover contains three plates.	—	—	Each gill-cover contains two plates.
9. Head small, sharp	Head small and sharp.	Head moderate in size and blunt.	Head small and sharp.
10. —	—	Many blunt tubercles on snout.	Both jaws rough with numerous crowded, sharp tubercles.
11. —	Eye moderate.	Eye small	Eye moderate.
12. —	Fins yellow, lower lobe of caudal stained with black.	Dorsal and pectorals dotted, the former brownish, the latter white like the ventrals. Anal and caudal fins reddish, the latter inclined to brown.	—
13. Shaped somewhat like the head of a lance.	Shaped like the head of a lance.	Deeper in form	Form like the head of a lance.
14. Bars descend almost to the lateral line.	A row of small oblong spots on each side of the lateral line.	Each spot diffused over a portion of more than one scale.	—
15. Grows to four or five inches long.	Grows to about a span in length.	Grows to about six inches in length.	Grows to about a span in length.
16. Found in the rivers of Mysore.	Found in the northern rivers of Bengal, Bihar especially in the Mahananda	Found in northern rivers of Bengal.	Found in northern rivers of Bengal.

For morphometric characters, a reference may be made to tables 1-2.

Body elongated, moderately compressed. Abdomen rounded. Mouth terminal. Jaws compressed; maxilla reaches to below the anterior $\frac{1}{3}$ of eye. 3rd suborbital bone varies in depth in relation to the uncovered portion of the cheek below it. Pores on the snout and on lower jaw present. Barbels short, the rostral and maxillary, the former pair reduced or occasionally absent. Dorsal fin higher than the length of its base; it commences nearer the base of the caudal fin than the tip of snout and does extend to over the anal fin and is inserted posteriorly to the ventrals. It is without osseous ray. Scales of moderate size. Lateral line complete, slightly concave, and runs in the lower half of the body. Body silvery with greyish back and 8-12 dark bands descending towards the lateral line becoming indistinct in older specimens. Lateral line scales with two black spots at the base. Cleithral bone silvery with black edge. Fins whitish, tinged with orange. Margin of dorsal and caudal greyish.

SEXUAL DIMORPHISM

The *chedra* type specimens or the breeding males are comparatively much larger in size and stoutly built (Text-fig. 1). The paired fins are enlarged and fan-like especially the pectorals with the outer three rays thickened and extending slightly beyond the insertion of ventrals. The bases of pectorals and area in front of them are highly muscular and robust. The pectoral girdle, especially the cleithral bone, is comparatively well developed and enlarged. The ventrals extend to the anal opening. The dorsal and anal fins are also expanded. The tip of snout and its sides and lower jaw are provided with a thick layer of spiny tubercles. The outer branchiostegal rays are studded with a few spiny tubercles. The body is rough due to the presence of fine tubercles on the scales especially of the dorso-lateral sides of the body (Text-fig. 2). The vertical colour bands almost vanish and the margin of dorsal fin becomes dark edged. The females lack all these characters (Text-figs. 3, 4).

It is finally concluded that *Cyprinus chedra*, *C. cocsa*, *C. tila* are synonyms of *B. bendelisis* Hamilton.

In order to assess the authenticity of this decision, a statistical analysis of the morphometric characteristics of 150 examples of the three populations of this species, viz. mature females, functional males and non-functional males has been conducted following Dice and Leraas (1936), Hubbs and Perlmutter (1942), Hubbs and Hubbs

(1953), Rao (1952) and Bailey (1959). Forty five ratios between different morphometric characters of these populations have been utilized in this exercise.

A graphic representation, showing the variation in 45 different characters of the female, functional male and immature male, has been delineated in graphs (Text-figs. 5-8) on the lines of the improved graphical method of Hubbs and Hubbs (1953). For each character, the range (a horizontal line), the mean (small vertical line), standard deviation on each side of the mean (white part of rectangle) and two standard errors on each side of the mean (black part of the rectangle) have been drawn. Through a careful examination of the graphs (Text-figs. 5-8), the extent of overlap in each character in the three populations has been studied and analysed. In order to find out the probability of these populations belonging to the same species and to assess the quantum of inter-population difference, STUDENT'S 't'-test has been applied, using the following formula.

$$t' = \frac{x^1 - x^2}{\sqrt{\frac{SD_1^2}{N_1} + \frac{SD_2^2}{N_2}}} = \frac{x^1 - x^2}{\sqrt{SE_1^2 + SE_2^2}}$$

x_1 = mean of first sample

x_2 = mean of second sample

SD₁ and SD₂ = Standard Deviation

n_1 and n_2 = number of each sample

SE1 and SE2 = Standard error

The 't' values have been worked out and shown in table 2. By analysing the data by way of Student's 't' test, it is possible to classify the characteristics under study here into a groups (A, B, C, Table 2). The significant and insignificant characteristics of the 't' values have been confirmed from the table given by Fisher & Yates (1970).

CATEGORY A

It pertains to those characteristics in which the difference of mean is insignificant amongst all the three populations of the species. This confirms the ascertainment that the three fishes studied belong to the same species as no significant difference exists between them.

CATEGORY B

It pertains to those characteristics in which the difference of the mean is significant and they are contrary to those of group-A. This

TABLE 2 : SHOWING 't' VALUES

Characters	Immature Male Vs Female		Female Vs Mature male		Mature male Vs ordinary male	
	't' values	Significance	't' values	Significance	't' values	Significance
CATEGORY A						
Total Length/head length	0.4685	Insignificant	1.0932	Insignificant.	0.6247	Insignificant
Standard length/head length	0.4243	„	1.0607	„	0.6000	„
Head length/width of head	0.3162	„	1.5811	„	1.8974	„
Head length/height of head	0.3162	„	0.8321	„	0.8944	„
Head length/length of snout	1.1660	„	1.5000	„	0.8894	„
Total length/width of body	1.5108	„	0.9945	„	0.6549	„
Standard length/width of body	0.8479	„	1.8565	„	0.8536	„
Head length/height of anal fin	1.2649	„	1.1094	„	0.00005	„
Length of dorsal fin base/	1.7889	„	0.3162	„	0.8321	„
Length of anal fin base.						
Length of caudal peduncle/ height of caudal peduncle	1.8856	„	0.8575	„	0.5145	„
Total length/pre dorsal distance	0.4472	„	0.3162	„	0.5547	„
Total length/post dorsal distance	0.2357	„	0.4000	„	0.6000	„
Standard length/post dorsal distance	0.3162	„	0.8479	„	0.9945	„
Total length/preventral distance	0.4851	„	1.3416	„	0.3536	„
Standard length/preventral distance	1.7889	„	0.8839	„	1.6977	„
Total length/pre anal distance	1.8974	„	1.2649	„	0.4714	„

TABLE 2. (Continued)

Characters	Immature Male Vs Female		Female Vs Mature male		Mature male Vs ordinary male	
	't' values	Significance	't' values	Significance	't' values	Significance
CATEGORY B						
Width of head/inter orbital width	5.2697	Significant	2.3570	Significant	2.4962	Significant
Head length/diameter of eye	4.7827	„	7.8032	„	4.5104	„
Length of snout/diameter of eye	3.7736	„	9.1981	„	5.4245	„
Inter orbital width/diameter of eye	3.6056	„	6.3454	„	4.4567	„
Depth of body/length of cleithrum	3.5355	„	6.9338	„	4.1603	„
Distance between pectoral and Ventral fin/length of pectoral fin	6.0104	„	11.6673	„	5.6569	„
Head length/length of ventral fin	2.4749	„	9.1924	„	6.7175	„
Distance between ventral and anal fin/length of ventral fin	3.1820	„	11.3137	„	8.1317	„
Total length/post ventral distance	5.6000	„	4.1602	„	2.9069	„
Total length/post anal distance	4.4653	„	10.4000	„	2.1001	„
Total length/distance between ventral & anal fin	9.6097	„	11.0072	„	5.6505	„
Standard length/distance between ventral & anal fin	2.7735	„	4.3732	„	2.8783	„
Standard length/distance between pectoral and ventral fin	4.9193	„	11.7917	„	6.4812	„

TABLE 2. (Concluded)

Characters	Immature Male Vs Female		Female Vs Mature male		Mature male Vs ordinary male	
	't' values	Significance	't' values	Significance	't' value	Significance
CATEGORY C						
Head length/post orbital head length	0.7071	Insignificant	1.3868	Insignificant	2.2188	Significant
Total length/depth of body	2.8169	Significant	2.2098	Significant	0.3254	Insignificant
Standard length/depth of body	3.2585	"	2.8289	"	0.1715	Insignificant
Head length/length of dorsal fin base	4.4590	"	0.6860	Insignificant	5.6569	Significant
Head length/length of pectoral fin	2.2361	"	1.7678	"	0.00005	Insignificant
Height of cleithrum/width of cleithrum	0.2018	Insignificant	6.3228	Significant	6.4812	Significant
Head length/height of anal fin	1.7678	"	2.2188	"	0.8321	Insignificant
Total length/length of anal fin	2.0788	Significant	1.6144	Insignificant	0.8396	"
Standard length/length of anal fin	2.2957	"	2.7610	Significant	0.0947	"
Standard length/pre-dorsal distance	0.4961	Insignificant	0.40000	Insignificant	0.6000	"
Standard length/post ventral distance	3.8829	Significant	1.4142	"	2.7735	Significant
Standard length/pre anal distance	1.3416	Insignificant	2.6893	Significant	1.0607	Insignificant
Standard length/post anal distance	3.9043	Significant	6.0000	"	0.8575	"
Total length/distance between pectoral and ventral fin	1.5185	Insignificant	4.1602	Significant	2.7189	Significant
Total length/length of skull	3.1081	Significant	3.9995	"	0.2357	Insignificant

indicates that the three populations belong to same species. These population groups are classified as the functional male, the non-functional male and the female.

CATEGORY C

This category includes characteristics overlapping between the previous two groups i. e. category A and category B. This intends to prove that there are certain characteristics which are common to functional and nonfunctional males but not found in the female. Similarly, there are certain characters which are found in non-functional male and the female but not in functional male. Characters of group C provide an additional proof that these fishes are of the same species but belonging to different population groups.

Distribution : India, Pakistan, Nepal and Bangladesh.

REMARKS

Hamilton (1822) described four different species, viz. *C. bendelisis*, *C. cocsa*, *C. chedra* and *C. tila* and in table I the important characters of these species, according to the author, are tabulated in order to find out whether the differences among these species shown by Hamilton (1822) are actually valid in the light of the present study. An analysis of some of the points of differences mentioned by Hamilton (1822) is given below :

Hamilton (1822) observed that there are two barbels in *C. bendelisis*, four in *C. cocsa*, and altogether absent in *C. chedra* and *C. tila*, but our observations reveal that there are four barbels in all the specimens and the population of this species is composed of functional and non-functional or immature males and the females. Hamilton (1822) observed that the lower lobe of the caudal is longer in the case of *C. bendelisis* and *C. tila* but made no comment on this feature for *C. cocsa* and *C. chedra*. In this connection, the present study shows that the lobes of the caudal fin are either equal in length or the upper lobe of the caudal fin is slightly longer in the females and ordinary males. On the other hand, the lower lobe of the caudal fin is always longer in functional males. Hamilton (1822) observed that the gill-cover of the *C. bendelisis* contains three plates and that of *C. tila* two and made no comment in the case of *C. cocsa* and *C. chedra*. It is well known that the gill-cover in cyprinids is always composed of four plates.

Hamilton (1822) observed rough surface of the scales with little blunt grains and many blunt tubercles on the snout in *C. chedra* and

both jaws rough with numerous sharp tubercles in *C. tila*. In the present material of functional males (i. e. *chedra* type specimens) the scales, the snout and the lower jaw are densely covered with tubercles.

On the basis of the characters of the four allied species viz. *C. bendelisis*, *cocsa*, *chedra* and *tila* described by Hamilton (1822), it is difficult to differentiate them from each other. However, from the table I, drawn from the characters given by Hamilton (1822), it is clear that *C. bendelisis* and *C. cocsa* are more closely related with each other while on the other hand *C. chedra* and *C. tila* are allied forms. In both *chedra* and *tila*, the tuberculated snout is a common feature together with tuberculated scales (this character has not been mentioned by Hamilton (1822) in *C. tila*, *C. bendelisis* and *C. cocsa*). During the present study, a dissection of a long series of specimens revealed that the *chedra* and *tila* group belongs to breeding males and *bendelisis* and *cocsa* group to both females and immature males. The observation on barbels in these specimens by Hamilton (1822) appears to be faulty as they are very minute, rudimentary and one or even both the pairs may be absent. Day (1878) has mentioned that rostral pair is occasionally absent. The colouration of the body is very variable especially the lateral bands. In younger specimens, there may be 8-12 bars on the sides which fade away partially or completely with the growth of the fish irrespective of the sex. The base of each scale, especially those of the dorsolateral sides of the body, is provided with single black spot and that on the lateral line with two smaller spots due to the presence of the lateral line canal. The spots are prominent in older specimens.

The characters of *bendelisis*, *chedra*, *cocsa* and *tila*, described by Hamilton (1822), fall within the range of variation of single species and therefore, the species name *bendelisis* has been recognised according to the "Law of Priority" with *chedra*, *cocsa* and *tila* as its synonyms.

ACKNOWLEDGEMENT

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SUMMARY

The systematic status of *Barilius bendelisis* Hamilton has been defined in this paper. Out of the taxa described by Hamilton (1822), *Cyprius chedra* and *C. tila* Hamilton have been found to be breeding males while *C. cocsa* Hamilton includes both immature or nonfunctional males and mature or immature females of *B. bendelisis* to which they are synonymous. A statistical analysis of the morphometric data of different populations of this species has been presented in support of the taxonomic conclusion.

A comparison of body ratios pertaining to 45 characters of males and females of almost the same total length and range of morphological variation among functional and nonfunctional or immature males and females has been given after studying a long series of specimens of *B. bendelisis*.

A comparison of the taxa described by Hamilton (1822) indicates that they fall within the morphological range of *B. bendelisis* which exhibits a vivid sexual dimorphism.

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INDOCANDONA KRISHNAKANTI, Gen. et Sp. Nov.
(CRUSTACEA : OSTRACODA : CANDONIDAE)
FROM SUBTERRANEAN WATER OF
BIHAR, INDIA.

By

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(With 3 Text-figures)

INTRODUCTION

Very few living and fossil species of the family candonidae (Ostracoda : Crustacea) belonging to the genera *Candona* Baird and *Candonopsis* Vavra have been reported from India (Bhatia and Singh, 1970, 1971; Mckenjee and Bhatia, 1971; Singh, 1972 and Victor and Fernando, 1979). Most of the records are from Kashmir valley.

The present paper records a new taxon of ostracoda from subterranean waters in Bihar. Since the material on which this paper is based can not be assigned to any known genus or species a new genus and species under the family candonidae are being established to accommodate specimens under the family candonidae.

INDOCANDONA Gen. nov.

Diagnostic characters : Five whorls of spicules in the Zenker's organ ; furca with only one long claw ; maxillary palps of the male symmetrically structured, only one exopodial seta on the maxilla ; lobe 'a' of the hemipenis slender and postero-distally oriented. Shape of the shell mytiloid, with longitudinal striations ; 2nd thoracic leg resembling that in *Mixtacandona*.

Type species : *Indocandona krishnakanti*, sp. nov.

Indocandona is closely allied to *Mixtacandona* Klie, in general appearance but only 5 whorls of spicules in the Zenker's organ, and furca with only one long claw, distinguish it from the latter.

***Indocandona krishnakanti*, sp. nov.**

(Text-figs. 1-3)

Male : Shell snow white, mytiloid (Text-fig 1B,) in lateral view, height 39-40 percent of the length ; width less than half the height ;

surface smooth with a few punctations ; free margin devoid of any tuberculations ; ventral margin excavate in the middle, dorsal margin convex, anterior broadly rounded, posterior broadly acuminate ; greatest height anteromedial. In dorsal view (Text-fig 1A) Subelliptical, narrowing at both extremities ; greatest breadth medial and about $1/5-1/6$ th of the length ; marginal pore canals few and straight at anterior margin, normal pore canals scattered, simple, open ; central muscle scar typical candonine ; left valve slightly longer than the right at the posterior extremity Internal lamellae broad anteriorly and posteriorly, narrow ventrally, with concentric lines converging at posterior end.

Antennule (Text-fig. 1C) : 7 segmented, segmental length ratios 10 : 4 : 3 : 3 : 3 : 4 : 5, natatory setae 4 on terminal and 5 on penultimate segments and 6-7 times as long as the 7th segment.

Antenna (Text-fig. 1D-H) : Natatory setae absent, endopod 4 segmented with length ratios 8 : 3 : 2.5 : 2 ; proximal seta pilose, Y. seta about 75 percent of first segment in length, distal segment of Y-seta 60 percent of its total length. Distal half of inner margin of second segment elevated and projected into 3 prominent round ridges (Text-fig. 1G) provided with setae Y_1 , T_4 and T_3 . Setae T_2 and T_1 arise from the distal margin of the segment. Seta Y_1 is a small aesthetasc while T_4 is serrated. T_2 & T_2 (Text-fig. 1G) are male bristles having bulbs pointed terminally.

Segment three, long narrow, distal end with 2 stout long claws (Text-fig. 1 H.....G2 G3) with serrated inner margin in distal $2/3$ rd, G small and Z_8 present in males.

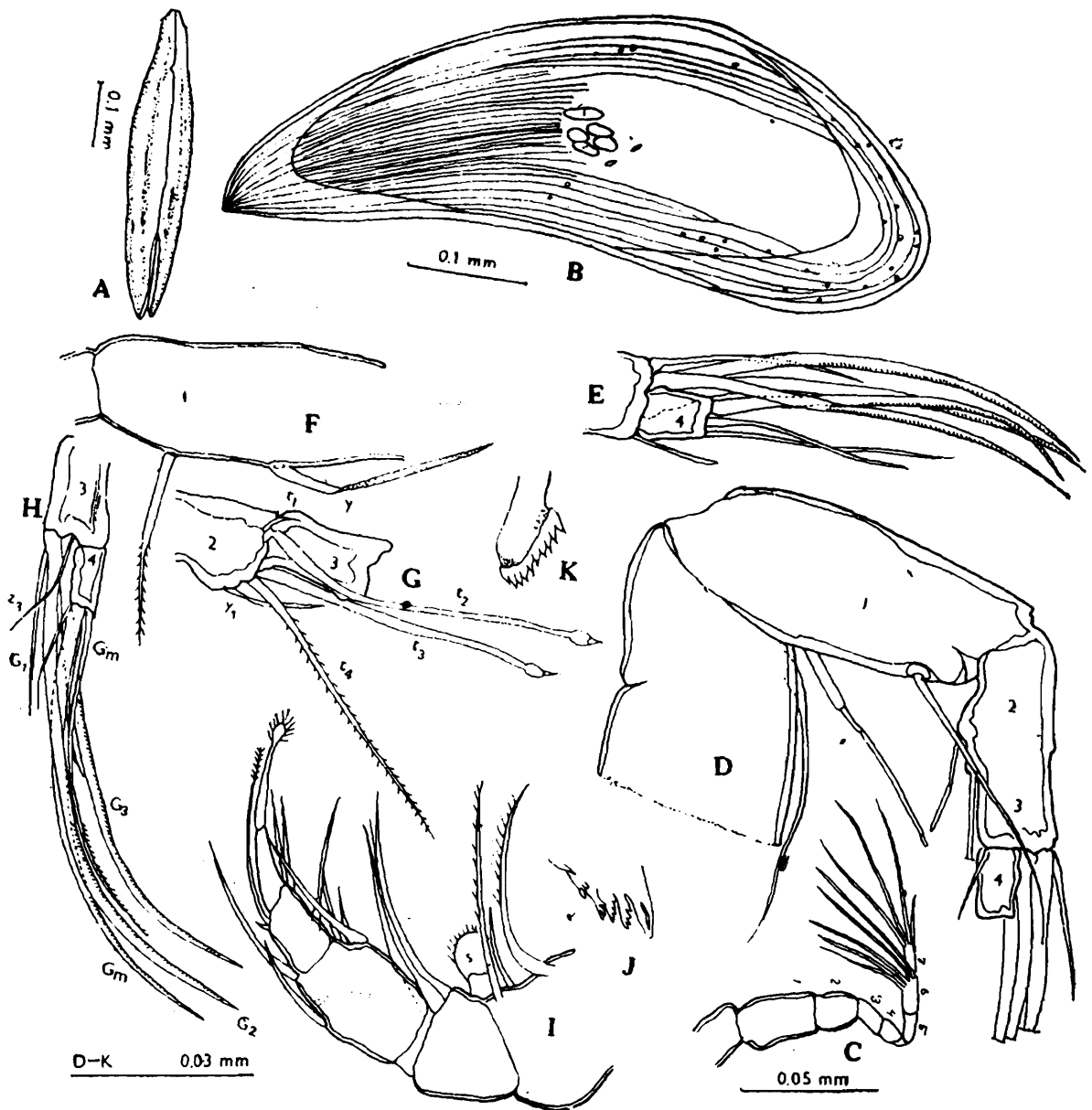
Segment four, narrow elongated with one serrated claw as long as G2 & G3. Other 3 setae narrow $1/3-1/2$ of the claw length.

Rake like organ (Text-fig. 1K) 10 denticles.

Mandible (Text-fig. 1J) : Multidentate teeth, mandibular palp (Text-fig. 1I) 4-segmented, segment 1, with 2 plumose and 1 simple small seta and a broad leaf like setose plate (Text-fig. 1 I, S) on its inner margin. Segment 2 with 3 long simple setae, segment 3 with 2 long and 2 small simple setae. Segment 4 with 2 simple setae. Palp terminates into a stout elongate tapering seta with setose bulbus tip.

Maxillule (Text-fig. 2 A) : First lobe with 6 simple bristles ; 2nd and 3rd with 5 simple bristles on each.

Maxilla (Text-fig. 2B, C) : Prehensile palps more or less symmetrical, a small hyaline toe like projection on its outer subapical region (Text-fig. 2C) ; exopod a single, simple seta.



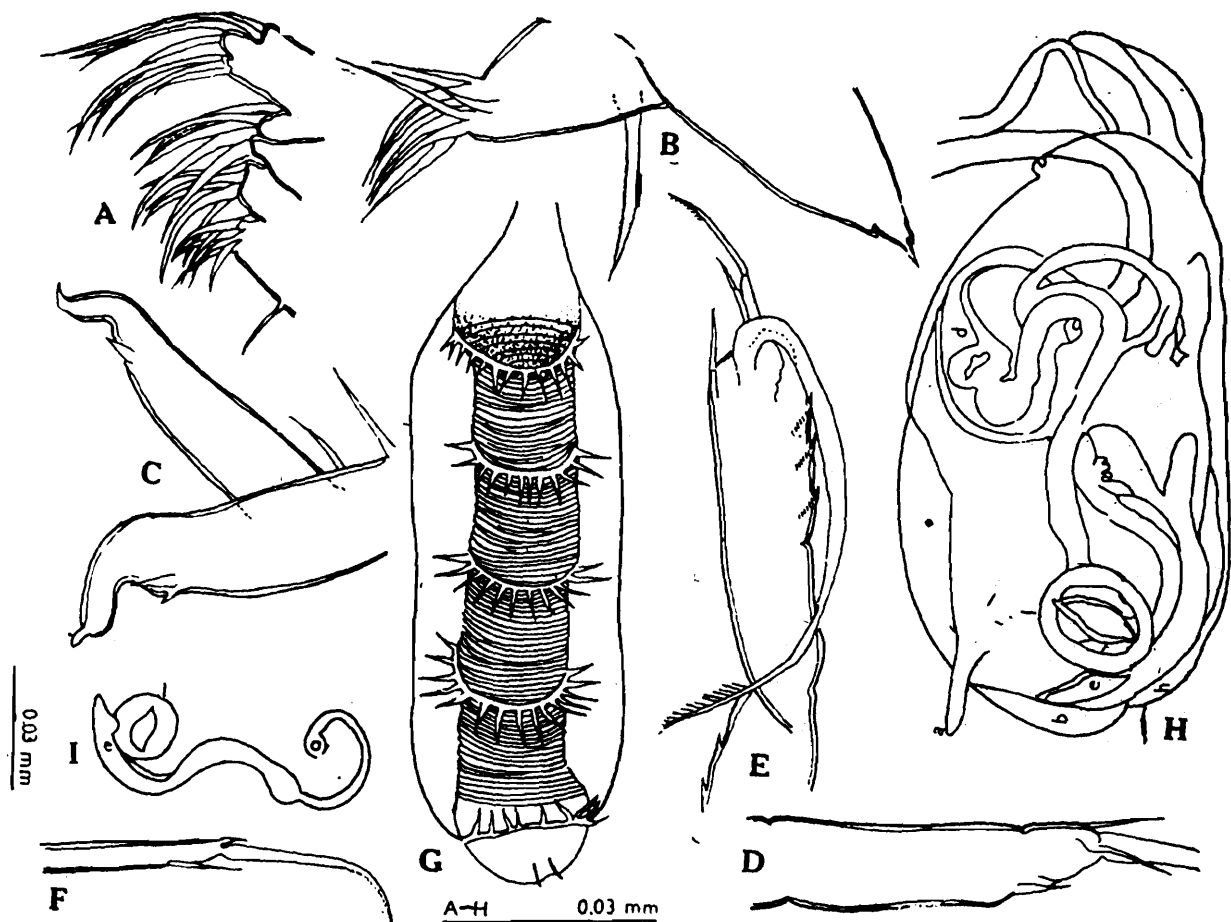
Text-fig. 1. A. Dorsal view of the shell
 B. Lateral view of the shell
 C. Antennule
 D-E. Antenna ♀
 F-H. Antenna ♂
 I. Mandibular palp ♂
 J. Mandibular teeth
 K. Rake like organ

Thoracopod I. (Text-fig. 2D) : Length ratio of the 4 distal segments 12 : 5 : 7 : 2, terminal claw little more than the last 3 segments combined.

Thoracopod II. (Text-fig. 2E) : Four segmented, penultimate segment sutured medially carrying a small simple, and a very long reflexed plumose seta ; terminal segment small but distinct with one terminal plumose and a minute subterminal seta. The inner or dorsal margin of the 2+3 segment with 3 equidistant minute spines having a row of microtrichs in each along their bases. There are 3 minute spines on the lower margin of the first segment but without any visible microtrich.

Furca (Text-figs. 2F & 3B): Straight, long with a single long curved claw weakly serrated in distal one third, one small terminal bristle and a dorsal seta much longer than the terminal bristle which is set back from the claw by a distance equal to 1/3rd of its own length behind the origin of the claw, length of the ramus 16 times the least width.

Zenker's organ—With five whorls (Text-fig. 2G) of spicules.



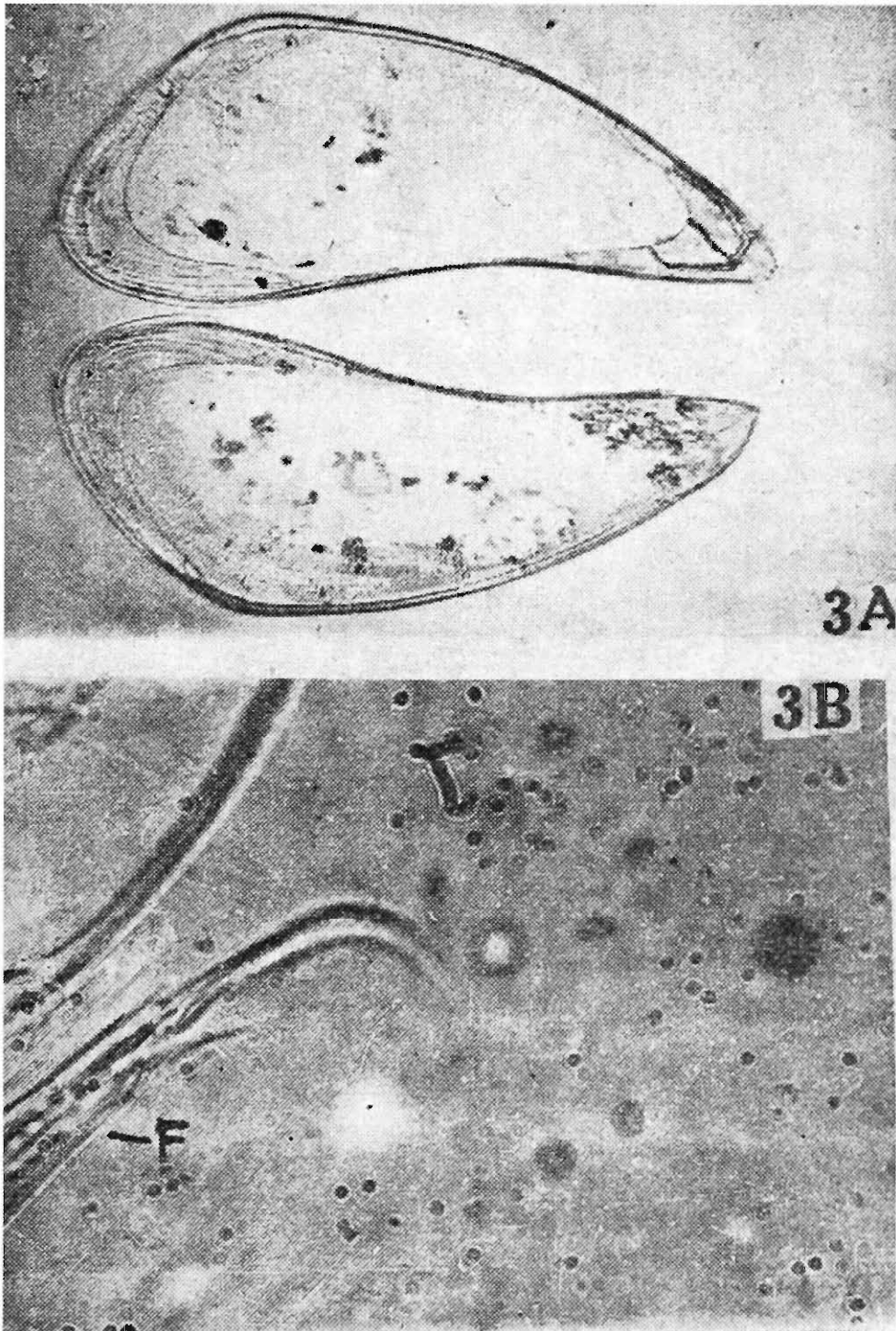
Text-fig. 2. A. Maxillule
 B. Maxilla ♀
 C. Maxillary palp ♂
 D. First thoracic leg ♂
 E. Second thoracic leg ♂
 F. Furca ♂
 G. Zenker's organ.
 H. Hemipenis General view.
 I. Bursa copulatrix and copulatory tube

Hemipenes (Text-fig. 2H): Elongated elliptical in outline, lateral lobe, 'a' slender and postero-distally oriented, lobes, 'b' and 'h' are rounded as shown in entire view (Text-fig. 2). Bursa copulatrix similar to *M. elegans* but apical lobe more elongated and narrow. Copulatory tube (Text-fig. 2) more or less rounded but flexible.

Eyes: Absent.

Female: Second antenna (Text-fig. 1D, E) with only 3 segments, 2 & 3 not clearly separated from one another, with only two ridges

(Text-fig. 1D) on the inner margin. Y-seta on first segment 77% of first segment, G_2 and G_8 (claws) long and serrated. Fourth segment wider than in male. Rake like organ with 9 denticles. Endopodite of maxilla conical, with one terminal and two subterminal, short projections. The female genital organ is poorly developed. The ratio of females to males 3 : 1 in natural habitat.



Text-fig. 3. A. Photograph of valves ♀
 B. Furca (♂) showing both ramii together,

Holotype : 1 ♂ (on slide Nos. 3a, 3b) Reg. No. A 1013 Zoological Survey of India, Gangetic Plains Regional Station, Patna ; Loc. Monghyr, Bihar, India ; from a well in Belan Bazar. Coll. Lakshman Ram (L. Prasad Gupta), 9-XII.-1977.

Paratypes : 1 ♂ (on slide No. 5) Reg. No. A-1014, 4 ♀ ♀ in Spirit Reg. No. A—1015,.....Zoological Survey of India, Gangetic Plains Regional Station, Patna. Details same as for the holotype.

3 ♀ ♀ (on slides No. 1, 6, 7, 8) Reg. No. A—1016, Zoological Survey of India, Gangetic Plains Regional Station Patna, details same as for the holotype.

Measurements : Male : length, 0.49-0.55, height 0.21, breadth 0.092 mm. Female : Length, 0.55, height, 0.22, breadth, 0.09 mm.

Discussion : The new genus *Indocandona* Gupta appears to be closer to *Mixtacandona*, a genus occurring in south east Europe and in Lake Baikal in the Soviet Union, and containing several species reported from subterranean waters. It can, however, be easily distinguished from the South European genus in the furca having a single long terminal claw and only five whorls of spicules in the Zenker's organ.

Indocandona krishnakanti bears similarities with *Mixtacandona elegans* in its shell outline. However in the detailed structures of the antenna it shows several differences more salient of which are detailed here.

The inner margin of second endopodial segment of male antenna in *I. krishnakanti* is produced into ridges while in all other it is more or less straight, the claws are serrated. The maxillary palps are small and stout in males and exopod is represented by a simple minute seta. Plumose nature of terminal and reflexed setae of 2nd thoracopod in *I. krishnakanti* is also important and minute spines and microtriches at their bases on the dorsal margin of 3rd segment resemble those in *M. juberthieae* Danielopol (1978). Zenker's organ with 5 whorls of spicules have been reported in *Candona morimoti*. (Mackenzie, 1972). *Indocandona krishnakanti* can be very well placed in *ljovuschkini* group of *Mixtacandona*, the shape of hemipenis is more or less elliptical and is much different from that in *M. elegans*. The copulatory tube has close similarity with that in *M. tabacarui* (Danielopol & Cvetkov, 1979) and the bursa copulatrix to that of *Mixtacandona elegans* in its outline. It seems that *Indocandona* was isolated much earlier from *Mixtacandona* in the evolutionary line. This is supported by the nature of spicules and shape and number of whorls on the Zenker's organ as given by Danielopol (1978, p. 91).

Biogeography :

Most of the species of *Mixtacandona* have been reported from the subterranean waters in South east Europe and lake Baikal and also fossils from the same region from the Pliocene period. All the above distributional records whether living or fossils suggest that these ostracods were once widely distributed in the South east Europe, U.S.S.R., and other parts of Northern hemisphere.

SUMMARY

A new genus and species of ostracod *Indocandona krishnakanti* has been described from the subterranean water of Bihar, India. Its relationship with the nearest genus *Mixtacandona* Klie, and biogeography have been discussed.

ACKNOWLEDGEMENTS

The author is thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and to the Officer-in-Charge, Zoological Survey of India, Patna for providing facilities. Thanks are due to Dr. Danielopol, Limnological Institute, Osterreichische Akademie der Wissenschaften, Wien, Austria, for confirming it to be a new genus and providing literature. Further, I am thankful to Dr. L. D. Delorme of Inland Waters Branch, Calgary, Alberta, Canada for helpful suggestions. I am also thankful to Shri Ram Babn Sharma, Photographer, ZSI Patna, for the Photographs.

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FISH GEOGRAPHY OF MEGHALAYA

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INTRODUCTION

The science of zoogeography is concerned with the geographical distribution of animals. Physiographically Meghalaya represents a remnant of the ancient plateau of precambrian Indian Peninsular shield. The plateau standing as a water shed between the Surma Valley of Bangladesh on the south and the Brahmaputra Valley on the north, is dissected by several rivers and a net-work of their tributaries. The drainage pattern in the region represents a good number of torrential streams. The fish fauna of Meghalaya comprising of 104 species exhibit a combination of both hill stream and plain water forms occupying diverse ecological conditions in their distributional ranges in the twin drainage systems of the northern or Brahmaputra and southern or Barak.

MATERIALS AND PROCEDURES

For convenience of study the entire drainage system of Meghalaya investigated has been divided into four Gradient Zones based on the altitudinal levels. The zones with their altitudinal coverages are : I (2000-1501 M), II (1500-1001 M), III (1000-500 M) and IV (Below 500 M). The justification of selecting such altitudinal gradation within the purview of the study lies in the fact that the tributaries of twin drainage system of Meghalaya exhibit individual variation in their topographical courses. Unless some uniformity in spatial zonation is made, the diverse findings may manoeuvre unavoidable complications to make a comparative assessment.

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ZOOGEOGRAPHICAL CLASSIFICATION

Zoogeographically Meghalayan fish fauna have been categorised into Primary and Peripheral forms. In fact the secondary form has not been found in the Maghalayan fauna.

1. *Primary freshwater fishes :*

95 species under 19 families and 49 genera have been grouped under present division.

95 species include 1 species of the genus *Notopterus*, 1 sp. of *Oxygaster*, 1 sp. of *Salmostoma*, 5 spp. of *Barilius*, 6 spp. of *Danio*, 1 sp. of *Esomus*, 2 spp. of *Rasbora*, 1 sp. of *Acrossocheilus*, 1 sp. of *Amblypharyngodon*, 1 sp. of *Chagunius*, 2 spp. of *Cirrhina*, 1 sp. of *Crossocheilus*, 8 spp. of *Garra*, 6 spp. of *Labeo*, 1 sp. of *Osteobrama*, 7 spp. of *Puntius*, 2 spp. of *Tor*, 3 spp. of *Psilorhynchus*, 2 spp. of *Botia*, 4 spp. of *Lepidocephalus*, 1 sp. of *Acanthocobitis*, 1 sp. of *Schistura*, 1 sp. of *Mesonoemacheilus*, 1 sp. of *Physoschistura*, 1 sp. of *Somileptes*, 4 spp. of *Mystus*, 1 sp. of *Ompok*, 1 sp. of *Wallago*, 1 sp. of *Ailia*, 1 sp. of *Pseudeutropius*, 1 sp. of *Amblyceps*, 1 sp. of *Bagarius*, 1 sp. of *Conta*, 2 spp. of *Gagata*, 3 spp. of *Glyptothorax*, 1 sp. of *Hara*, 1 sp. of *Pseudecheneis*, 1 sp. of *Clarias*, 1 sp. of *Heteropneustes*, 1 sp. of *Olyra*, 3 spp. of *Channa*, 1 sp. of *Badis*, 1 sp. of *Nandus*, 1 sp. of *Anabas*, 2 spp. of *Colisa*, 1 sp. of *Pillaia*, 2 spp. of *Mastacembelus*, 1 sp. of *Macrognathus* and 1 sp. of *Tetraodon*.

2. *Peripheral freshwater forms :*

Only 9 spp. under 7 genera and 6 families have been grouped under this division.

9 species include 1 sp. of the genus *Gadusia*, 1 sp. of *Setipinna*, 1 sp. of *Xenontodon*, 3 spp. of *Chanda*, 1 sp. of *Sicamugil*, 1 sp. of *Rhinomugil* and 1 sp. of *Glossogobius*.

DISTRIBUTIONAL TREND

Distributional pattern of the fish fauna of the twin drainage systems incidentally forms a unique feature of Meghalaya. Following categories have been selected for various studies on the Distributional trend of the fishes of Meghalaya : 1) General, 2) Inter-drainage distribution, 3) Intra-drainage distribution, 4) Altitudinal distribution, 5) Indian and Extra Indian distribution and 6) Ichthyological division.

1. *General* : Of the 104 species collected, 32 spp. are restricted to the northern tributary system, 25 spp. to southern river system while 47 spp. are having overlapping distribution.

2. *Inter-drainage distribution* : All the species observed have been presented below according to their broad and restricted occurrence between the twin drainages.

a) *Widely distributed species* :

1. *Salmostoma bacaila*, 2. *Barilius barila*, 3. *B. barna*, 4. *B. ben-delisis*, 5. *Danio (D) aequipinnatus*, 6. *D (D) dangila*, 7. *D (B) rerio*, 8. *Esomus danricus*, 9. *Rasbora daniconius*, 10. *Acrossocheilus hexagonolepis*, 11. *Ambly pharynogodon mola*, 12. *Crossocheilus latius latius*, 13. *Garra naganensis*, 14. *Osteobrama cotio cotio*, 15. *Puntius chola*, 16. *P. shalynius*, 17. *P. sophore*, 18. *P. ticto*, 19. *Psilorhynchus balitora*, 20. *Lepidocephalus guntea*, 21. *Schistura rupecola*, 22. *Mystus cavasius*, 23. *Amblyceps mangois*, 24. *Clarias batrachus*, 25. *Heteropneustes fossilis*, 26. *Channa orientalis*, 27. *C. punctata*, 28. *C. stewartii*, 29. *Chanda ranga*, 30. *Badis badis*, 31. *Pillaia indica*, 32. *Mastacembelus armatus*.

b) *Species having restricted occurrence* :

Occurring only in R. Umiam and Simsang : *Tor tor*. Occurring only in R. Umiam and Umsohryngkew : *Garra lissorhynchus* and *G. rupecula*.

Occurring only in R. Jingiram and Umlew : *Gadusia chapra*, *Pseudeutropius atherinoides* and *Chanda nama*.

Occurring only in R. Jingiram and Simsang : *D. devario*, *Puntius sarana*, *Botia dario*, *Lepidocephalus menoni*, *Acanthocobitis botia*, *Tetraodon cutcutia*.

Occurring only in R. Didram and Simsang : *Chagunius chagunio*.

Occurring only in R. Dudhnoi and Umlew : *Gagata viridescens*.

Occurring only in R. Dudhnoi and Ronga : *Olyra longicaudata*.

3. *Intra-drainage distribution* ;

BRAHMAPUTRA DRAINAGES :

a) *Widely distributed species* :

1. *Garra gotyla gotyla*, 2. *G. lamta*, 3. *Tor putitora*, 4. *Somileptes gongota*, 5. *Mystus bleekeri*, 6. *M. vittatus*, 7. *Hara hara*, 8. *Nandus nandus*, 9. *Glossogobius gutum*, 10. *Colisa sota*, 11. *C. fasciatus*, 12. *Mastacembelus pancalus*.

b) *Species restricted to particular river only* :

R. Umiam : *Danio deyi*, *D. meghalayensis*, *Garra annandalei*, *G. mcOlel-*

landi, *Psilorhynchus homaloptera*, *Lepidocephalus berdmorei*, *Meso-noemacheilus reticulofasciatus*, *Physoschistura elongata*, *Glyptothorax striatus*, *Pseudecheneis sulcatus*.

R. Jingiram : *Setipinna phasa*, *Ompok bimaculatus*, *Gagata cenia*, *Glyptothorax telchitta*, *Xenontodon cancila*, *Macrognathus aculeatus*.

R. Umtrew : *Puntius filamentosus*.

R. Ganol : *Garra nasutus*.

R. Dudhnoi : *Barilius tileo*, *Lepidocephalus annandalei*.

BARAK DRAINAGES :

a) *Widely distributed species :*

1. *Oxygaster gora*, 2. *Labeo boga*, 3. *L. calbasu*, 4. *L. pangusia*.

b) *Species restricted to particular river only :*

R. Simsang : *Notopterus chitala*, *Barilius bola*, *Rasbora elanga*, *Cirrhina mrigala*, *C. reba*, *Labeo dero*, *L. gonius*, *L. rohita*, *Puntius clavatus*, *Psilorhynchus sucatio*, *Botia rostrata*, *Mystus seenghala*, *Wallagonia attu*, *Bagarius bagarius*, *Conta conta*, *Chanda baculis*, *Sicamugil cascasia*, *Rhinomugil corsula*.

R. Umlew : *Ailia coila*.

R. Ronga : *Glyptothorax shawi* and *Anabas testudineus*.

4. *Altitudinal distribution :*

Altitudinally, the whole region of Meghalaya, investigated, has been divided into four gradient zones : these are G. Zone I (1501-2000 M), G. Zone II (1001 M-1500 M), G. Zone III (501-1000 M) and G. Zone IV (below 500 M).

TWIN DRAINAGES :

a) *Species of G. Zone I :*

1. *Danio (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D (B) rerio*, 4. *Acrossocheilus hexagonolepis*, 5. *Garra rupecula*, 6. *Puntius shaly-nius*, 7. *Lepidocephalus berdmorei*, 8. *L. guntea*, 9. *Schistura rupecola*, 10. *Heteropneustes fossilis*, 11. *Channa orientalis*, 12. *C. stewartii*, 13. *Badis badis*.

b) *Species of G. Zone II :*

1. *D (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D. deyi*, 4. *D. meghalayensis*, 5. *D (B) rerio*, 6. *Esomus danricus*, 7. *Rasbora daniconius*, 8. *A. hexagonolepis*, 9. *Amblypharyngodon mola*, 10. *Crossocheilus latius latius*, 11. *Garra annandalei*, 12. *G. lissorhynchus*, 13.

G. mcClellandi, 14. *G. naganensis*, 15. *Osteobrama cotio cotio*, 16. *Puntius shalynius*, 17. *Tor putitora*, 18. *T. tor*, 19. *Psilorhynchus balitora*, 20. *Psilorhynchus homaloptera*, 21. *Lepidocephalus berdmorei*, 22. *L. guntea*, 23. *Schistura rupecola*, 24. *Mesonoemacheilus reticulofasciatus*, 25. *Physoschistura elongata*, 26. *Mystus cavasius*, 27. *M. vittatus*, 28. *Glyptothorax striatus*, 29. *Hara hara*, 30. *Pseudecheneis sulcatus*, 31. *Clarias batrachus*, 32. *Heteropneustes fossilis*, 33. *Channa orientalis*, 34. *C. punctata*, 35. *C. stewartii*, 36. *Chanda baculis*, 37. *C. ranga*, 38. *Badis badis*, 39. *Glossogobius gutum*, 40. *Colisa sota*, 41. *C. fasciatus*, 42. *Pillaia indica*, 43. *Mastacembelus pancalus*.

c) *Species of G. Zone III :*

1. *Barilius barila*, 2. *B. bendelisis*, 3. *D (D) aequipinnatus*, 4. *D (D) dangila*, 5. *D (B) rerio*, 6. *Esomus danricus*, 7. *Rasbora daniconius*, 8. *Acrossocheilus hexagonolepis*, 9. *Garra gotyla*, 10. *G. lamta*, 11. *G. naganensis*, 12. *G. nasutus*, 13. *Puntius chola*, 14. *P. filamentosus*, 15. *P. shalynius*, 16. *Tor putitora*, 17. *Lepidocephalus guntea*, 18. *Schistura rupecola*, 19. *Amblyceps mangois*, 20. *Glyptothorax shawi*, 21. *Heteropneustes fossilis*, 22. *Channa orientalis*, 23. *C. punctata*, 24. *C. stewartii*, 25. *Badis badis*, 26. *Colisa sota*, 27. *C. fasciatus*, 28. *Pillaia indica*.

d) *Species of G. Zone IV :*

1. *Gadusia chapra*, 2. *Setipinna phasa*, 3. *Notopterus chitala*, 4. *Oxygaster gora*, 5. *Salmostoma bacaila*, 6. *Barilius barila*, 7. *B. barna*, 8. *B. bendelisis*, 9. *B. bola*, 10. *B. tileo*, 11. *Danio (D) aequipinnatus*, 12. *D (D) dangila*, 13. *D (D) devario*, 14. *D (B) rerio*, 15. *Esomus danricus*, 16. *Rasbora daniconius*, 17. *R. elanga*, 18. *Acrossocheilus hexagonolepis*, 19. *Amblypharyngodon mola*, 20. *Chagunius chagunio*, 21. *Cirrhina mrigala*, 22. *C. reba*, 23. *Crossocheilus latius latius*, 24. *Garra gotyla gotyla*, 25. *Labeo boga*, 26. *L. calbasu*, 27. *L. dero*, 28. *L. gonius*, 29. *L. pangusia*, 30. *L. rohita*, 31. *Osteobrama cotio cotio*, 32. *Puntius chola*, 33. *P. clavatus*, 34. *P. sarana sarana*, 35. *P. shalynius*, 36. *P. sophore*, 37. *P. ticto*, 38. *Psilorhynchus balitora*, 39. *P. sucatio*, 40. *Botia dario*, 41. *B. rostrata*, 42. *Lepidocephalus annandalei*, 43. *L. guntea*, 44. *L. menoni*, 45. *Acanthocobitis botia*, 46. *Schistura rupecola*, 47. *Somileptes gongota*, 48. *Mystus bleekeri*, 49. *M. cavasius*, 50. *M. seenghala*, 51. *M. vittatus*, 52. *Ompok bimaculatus*, 53. *Wallago attu*, 54. *Ailia coila*, 55. *Pseudotropius atherinoides*, 56. *Amblyceps mangois*, 57. *Bagarius bagarius*, 58. *Conta conta*, 59. *Gagata cenia*, 60. *G. viridescens*, 61. *Glyptothorax shawi*, 62. *G. telchitta*, 63. *Hara hara*, 64. *Clarias batrachus*,

65. *Heteropneustes fossilis*, 66. *Olyra longicaudata*, 67. *Xenontodon cancila*, 68. *Channa orientalis*, 69. *C. punctata*, 70. *C. stewartii*, 71. *Chanda nama*, 72. *C. ranga*, 73. *Badis badis*, 74. *Nandus nandus*, 75. *Sicamugil cascasia*, 76. *Rhinomugil corsula*, 77. *Glossogobius gutum*, 78. *Anabas testudineus*, 79. *Colisa fasciatus*, 80. *Mastacembelus armatus*, 81. *M. pancalus*, 82. *Macrornathus aculeatus*, 83. *Tetraodon cutcutia*.

BRAHMAPUTRA DRAINAGES :

a) Species of G. Zone I :

1) *Danio (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D (B) rerio*, 4. *Acrossocheilus hexagonolepis*, 5. *Garra rupecula*, 6. *Puntius shalynius*, 7. *Lepidocephalus berdmorei*, 8. *L. guntea*, 9. *Heteropneustes fossilis*, 10. *Channa orientalis*, 11. *C. stewartii*.

b) Species of G. Zone II :

1. *D (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D. deyi*, 4. *D. meghalayensis*, 5. *D (B) rerio*, 6. *E. danricus*, 7. *R. daniconius*, 8. *A. hexagonolepis*, 9. *A. mola*, 10. *C. latius latius*, 11. *G. annandalei*, 12. *G. lissorhynchus*, 13. *G. mcCllellandi*, 14. *G. naganensis*, 15. *O. cotio cotio*, 16. *P. shalynius*, 17. *T. putitora*, 18. *T. Tor*, 19. *P. balitora*, 20. *P. homaloptera*, 21. *L. berdmorei*, 22. *L. guntea*, 23. *S. rupecola*, 24. *M. reticulofasciatus*, 25. *P. elongata*, 26. *M. cavasius*, 27. *M. vittatus*, 28. *G. striatus*, 29. *H. hara*, 30. *P. sulcatus*, 31. *C. batrachus*, 32. *H. fossilis*, 33. *C. orientalis*, 34. *C. punctata*, 35. *C. stewartii*, 36. *C. ranga*, 37. *B. badis*, 38. *G. gutum*, 39. *C. sota*, 40. *C. fasciatus*, 41. *P. indica*, 42. *M. pancalus*.

c) Species of G. Zone III :

1. *B. barila*, 2. *B. bendelisis*, 3. *D (D) aequipinnatus*, 4. *D (D) dangila*, 5. *D (B) rerio*, 6. *E. danricus*, 7. *R. daniconius*, 8. *A. hexagonolepis*, 9. *G. gotyla, gotyla*, 10. *G. lamta*, 11. *G. naganensis*, 12. *G. nasutus*, 13. *P. chola*, 14. *P. filamentosus*, 15. *P. shalynius*, 16. *T. putitora*, 17. *L. guntea*, 18. *S. rupecola*, 19. *A. mangois*, 20. *H. fossilis*, 21. *C. orientalis*, 22. *C. punctata*, 23. *C. stewartii*, 24. *B. badis*, 25. *C. sota*, 26. *C. fasciatus*, 27. *P. indica*.

d) Species of G. Zone IV :

1. *G. chapra*, 2. *S. phasa*, 3. *S. bacaila*, 4. *B. barila*, 5. *B. barna*, 6. *B. bendelisis*, 7. *B. tileo*, 8. *D (D) aequipinnatus*, 9. *D*

(D) *dangila*, 10. *D (D) devario*, 11. *D (B) rerio*, 12. *E. danricus*, 13. *R. daniconius*, 14. *A. hexagonolepis*, 15. *A. mola*, 16. *C. chagunio*, 17. *C. latius latius*, 18. *G. gotyla gotyla* 19. *O. cotio cotio*, 20. *P. chola*, 21. *P. sarana sarana*, 22. *P. shalynius*, 23. *P. sophore*, 24. *P. ticto*, 25. *P. balitora*, 26. *B. dario*, 27. *L. annandalei*, 28. *L. guntea*, 29. *L. menoni*, 30. *A. botia*, 31. *S. gognota*, 32. *M. bleekeri*, 33. *M. cavasius*, 34. *M. vittatus*, 35. *O. bimaculatus*, 36. *P. atherinoides*, 37. *A. mangois*, 38. *G. cenia*, 39. *G. viridescens*, 40. *G. telchitta*, 41. *H. hara*, 42. *C. batrachus*, *H. fossilis*, 44. *O. longicaudata*, 45. *X. cancila*, 46. *C. orientalis*, 47. *C. punctata*, 48. *C. stewartii*, 49. *C. nama*, 50. *C. ranga*, 51. *B. badis*, 52. *N. nandus*, 53. *G. gutum*. 54. *C. fasciatus*, 55. *M. armatus*, 56. *M. pancalus*, 57. *M. aculeatus*, 58. *T. cutcutia*.

BARAK DRAINAGES :

a) Species of G. Zone I :

1. *D (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D (B) rerio*, 4. *A. hexagonolepis*, 5. *G. rupecula*, 6. *P. shalynius*, 7. *L. guntea*, 8. *S. rupecola*, 9. *C. orientalis*, 10. *C. stewartii*, 11. *B. badis*.

b) Species of G. Zone II :

1. *D (D) aequipinnatus*, 2. *D (D) dangila*, 3. *D (B) rerio*, 4. *A. hexagonolepis*, 5. *G. naganensis*, 6. *P. shalynius*, 7. *Ttor*, 8. *L. guntea*, 9. *S. rupecola*, 10. *C. orientalis*, 11. *C. stewartii*, 12. *C. baculis*, 13. *C. ranga*, 14. *B. badis*.

c) Species of G. Zone III :

1. *D (D) aequipinnatus*, 2. *D (D) dangila*, 3. *L. guntea*, 4. *G. shawi*, 5. *H. fossilis*, 6. *C. punctata*, 7. *C. stewartii*, 8. *B. badis*, 9. *P. indica*.

d) Species of G. Zone IV :

1. *G. chapra*, 2. *N. chitala*, 3. *O. gora*, 4. *S. bacaila*, 5. *B. barila*, 6. *B. barna*, 7. *B. bendelisis*, 8. *B. bola*, 9. *D (D) aequipinnatus*, 10. *D (D) dangila*, 11. *D (D) devario*, 12. *D (B) rerio*, 13. *E. danricus*, 14. *R. daniconius*, 15. *R. elanga*, 16. *A. hexagonolepis*, 17. *A. mola*, 18. *C. chagunio*, 19. *C. mrigala*, 20. *C. reba*, 21. *C. latius latius*, 22. *L. boga*, 23. *L. calbasu*, 24. *L. dero*, 25. *L. goniis*, 26. *L. pangusia*, 27. *L. rohita*, 28. *O. cotio cotio*, 29. *P. chola*, 30. *P. clavatus*, 31. *P. sarana sarana*, 32. *P. sophore*, 33. *P. ticto*, 34. *P. balitora*, 35. *P. sucatio*, 36. *B. dario*, 37. *B. rostrata*, 38. *L. guntea*, 39. *L. menoni*, 40. *A. botia*, 41. *S. rupecola*, 42. *M. cavasius*, 43. *M. seenghala*, 44. *W. attu*, 45. *A. coila*,

46. *P. atherinoides*, 47. *A. mangois*, 48. *B. bagarius*, 49. *Conta conta*, 50. *G. viridescens*, 51. *G. shawi*, 52. *C. batrachus*, 53. *H. fossilis*, 54. *O. longicaudata*, 55. *C. orientalis*, 56. *C. punctata*, 57. *C. stewartii*, 58. *C. nama*, 59. *C. ranga*, 60. *B. badis*, 61. *S. cascasia*, 62. *R. corsula*, 63. *A. testudineus*, 64. *M. armatus*, 65. *T. cutcutia*.

5. Indian and Extra Indian distribution :

Zoogeographically fish fauna of Meghalaya have been classified into 4 groups : I) Widely distributed species II) Species of Northern India III) Species of the Himalayas and IV) Species of southern India.

a) Widely distributed species :

It includes 60 species known to occur widely in all parts of India, Pakistan, Bangladesh, Sri Lanka, Burma and Malaya and are, therefore, of no significance. Fishes of different sub-division are as follows :

i) Present in India, Pakistan, Bangladesh, Sri Lanka, Burma and Malaya : *Esomus danricus*, *R. daniconius*, *P. sarana sarana*, *O. bimaculatus*, *W. attu*, *C. batrachus*, *X. cancila*, *C. orientalis*, *C. punctata*, *G. gutum*, *A. testudineus*, *M. armatus*, *M. aculeatus*.

ii) Present in India, Pakistan, Bangladesh, Burma, Malaya but absent in Sri Lanka : *G. chapra*, *N. chitala*, *C. chagunio*, *M. cavasius*, *A. mangois*, *B. bagarius*, *C. ranga*, *N. nandus*.

iii) Present in India, Pakistan, Sri Lanka, Bangladesh, Burma but absent in Malaya : *S. phasa*, *B. bendelisis*, *D (D) aequipinnatus*, *D (B) rerio*, *P. chola*, *P. ticto*, *A. botia*, *M. vittatus*, *H. fossilis*.

iv) Present in India, Pakistan, Bangladesh, Burma except Sri Lanka and Malaya : *S. bacaila*, *B. barila*, *B. barna*, *D (D) devario*, *A. mola*, *C. mrigala*, *C. reba*, *C. latius latius*, *G. gotyla ggotyla*, *L. boga*, *L. calbasu*, *L. gonius*, *L. rohita*, *O. cotio cotio*, *P. sophore*, *M. seenghala*, *P. atherinoides*, *C. nama*, *B. badis*, *C. fasciatus*, *M. pancalus*,

v) Present only in India, Bangladesh and Burma : *P. clavatus*, and *G. viridescens*.

vi) Present only in India, Pakistan and Bangladesh : *A. coila*.

vii) Present only in India and Pakistan : *L. pangusia*.

viii) Present only in India and Burma : *G. lamta*, *G. nasutus*, *C. conta* and *O. longicaudata*.

ix) Present only in India and Bangladesh : *S. gongota*,

b) *Species of Northern India :*

It includes 24 species having somewhat restricted distribution :

- i) *Present in Northern India, Sri Lanka, Pakistan, Bangladesh, Burma and Malaya : Nil.*
- ii) *Present in Northern India, Sri Lanka, Pakistan, Bangladesh and Burma but absent in Malaya : L. guntea.*
- (iii) *Present in Northern India, Pakistan, Bangladesh, Burma and Malaya but absent in Sri Lanka : M. bleekeri.*
- (iv) *Present in Northern India, Sri Lanka, Bangladesh and Burma : D. dangila.*
- (v) *Present in Northern India, Bangladesh, Burma and Malaya : A. hexagonolepis.*
- (vi) *Present in Northern India, Pakistan, Bangladesh and Burma : B. bola, L. dero, T. tor, G. cenia, C. baculis, R. corsula.*
- (vii) *Present in Northern India, Bangladesh and Burma : R. elanga, P. balitora and H. hara.*
- viii) *Present in Northern India, Bangladesh and Pakistan : O. gora, T. putitora and B. dario.*
- ix) *Present in Northern India, Bangladesh and Malaya : T. cutcutia.*
- x) *Present in Northern India, Pakistan and Sri Lanka : S. cascasia.*
- xi) *Present in Northern India and Burma : L. berdmorei.*
- xii) *Present in Northern India and Bangladesh : G. telchitta, and C. sota.*
- xiii) *Present in Northern India only : G. lissorhynchus, P. sucatio and S. rupecola.*

c) *Species of Southern India :*

Under the present division only those species restricted to southern region have been mentioned. Of these 57 species which are common to Meghalaya and Southern India, 55 are common to Northern India also, only 2 are restricted in southern region.

- i) *Present in southern India and Sri Lanka : P. filamentosus.*
- ii) *Present to southern India : G. mcClellandi.*

d) *Species of Himalayas :*

18 species are found under this group which are generally of hill stream or swift water habitat found along the Himalayas and its foot hills.

According to Burrard and Hayden (1933) the Himalayan rivers can be divided into four groups : 1) Assam Himalayas or Eastern Himalayas i. e. all the rivers between Brahmaputra and Teesta ; 2) Nepal Himalayas between R. Teesta and Kali, 3) Kumaon Himalayas between R. Kali and Sutlej and 4) Punjab Himalayas i. e. rivers west to Sutlej. Fishes of the subdivisions are as follows :

- i) Found in all the four section of Himalayas : Nil.
- ii) Found in Eastern, Nepal and Kumaon Himalayas : *B. rostrata*.
- iii) Found in Eastern and Nepal Himalayas : *G. annandalei*, *P. sucatio*, *C. stewartii*.
- iv) Endemic in Eastern Himalayas : 1. *B. tileo*, 2. *D. meghalayensis*, 3. *D. deyi*, 4. *G. naganensis*, 5. *G. rupecula*, 6. *P. shalynius*, 7. *P. homaloptera*, 8. *L. annandalei*, 9. *L. menoni*, 10. *M. reticulofasciatus*, 11. *P. elongata*, 12. *G. shawi*, 13. *G. striatus*, 14. *P. indica*.

6. Distribution on Ichthyological division :

Under the present category all the Meghalayan fishes available have been grouped under different Ichthyological divisions and distribution of each group has been analysed.

CLUPEIDS

Of the two species recorded from Meghalaya, under the present group, *G. chapra* exhibits overlapping distribution while *S. phasa* is restricted to Brahmaputra drainage only. Both the species are restricted to lower altitude (below 500 M).

NOTOPTERIDS

N. chitala is found only in the Barak drainage and at a lower altitude (below 500 M).

MAJOR CARPS

All the four species of Indian Major carps recorded from Meghalaya are collected from Barak drainages and only from lower altitude (below 500 M).

OTHER CARPS AND MINNOWS

Of the 45 species recorded under the present group, 11 spp. (*B. tileo*, *D. deyi*, *D. meghalayensis*, *G. annandalei*, *G. gotyla*, *G. lamta*, *G.*

McClellandi, *G. nasutus*, *P. filamentosus*, *T. putitora*, *P. homaloptera*) are restricted to northern tributary system and 9 spp. (*O. gora*, *B. bola*, *R. elanga*, *C. reba*, *L. boga*, *L. dero*, *L. pangusia*, *P. clavatus*, *P. sucatio*) to southern tributary system while the remaining 25 species (55.56%) are having overlapping distribution.

Altitudinally, *G. rupecula* is restricted to above 1500 M, 7 spp. (*D. meghalayensis*, *D. deyi*, *G. annandalei*, *G. lissorhynchus*, *G. McClellandi*, *T. tor*, and *P. homaloptera*) between alt. 1000 M to 1500 M. 3 spp. (*G. lamta*, *G. nasutus*, *P. filamentosus*) restricted to alt. between 500 M to 1000 M and 17 spp. (*O. gora*, *S. bacaila*, *B. barna*, *B. bola*, *B. tileo*, *D. devario*, *R. elanga*, *C. chagunio*, *C. reba*, *L. boga*, *L. dero*, *L. pangusia*, *P. clavatus*, *P. sophore*, *P. sarana*, *P. ticto* and *P. sucatio*) below 500 M alt. Five species i. e. *D. aequipinnatus*, *D. dangila*, *D. rerio*, *A. hexagonolepis* and *P. shalynius* are having wide range of distribution (below 500 to 2000 M). *E. danricus* and *R. daniconius* have been recorded between alt. below 500 to 1500 M. 4 species (*B. barila*, *B. bendelisis*, *G. gotyla* and *P. chola*) between alt. below 500 to 1000 M. *G. naganensis* and *T. putitora* are restricted between alt. 500 to 1500 M. 4 spp. (*A. mola*, *C. latius latius*, *O. cotio cotio* and *P. balitora*) shows some discontinuous distribution and have been recorded between alt. 1000 to 1500 M and below 500 M.

COBITIDS

Of the 11 species recorded in Meghalay, 5 spp. (*L. annandalei*, *L. berdmorei*, *M. reticulofasciatus*, *P. elongata*, and *S. gongota*) are restricted to northern tributary system, *B. rostrata*, to southern river system whereas the remaining 5 species (op. cit.) are having overlapping distribution.

Altitudinally, 6 spp. (*B. dario*, *B. rostrata*, *L. annandalei*, *L. menoni*, *A. botia* and *S. gongota*) are restricted to lower altitude (below 500 M), 2 spp. (*M. reticulofasciatus* and *P. elongata*) between 1000 to 1500 M, 1 sp. (*L. berdmorei*) between 1000 to 2000 M whereas *L. guntea* and *S. rupecola* are widely distributed (between alt. below 500 to 2000 M).

CATFISHES

Out of the 21 species recorded under this group from the State, 8 spp. (*M. bleekeri*, *M. vittatus*, *O. bimaculatus*, *G. cenia*, *G. striatus*, *G. telchitta*, *H. hara*, *P. sulcatus*) are restricted to northern tributary system, 6 spp. (*M. seenghala*, *W. attu*, *A. coila*, *B. bagarius*, *C. conta*, *G. shawi*) to southern river system and 7 spp. (op. cit.) are having overlapping distribution.

Altitudinally, 12 spp. (*M. bleekeri*, *M. seenghala*, *O. bimaculatus*, *W. attu*, *A. coila*, *P. atherinoides*, *B. bagarius*, *C. conta*, *G. cenia*, *G. viridescens*, *G. telchitta*, and *O. longicaudata*) are recorded to be restricted to lower altitude (below 500 M), 2 spp. (*G. striatus*, *P. sulcatus*) between 1000 to 1500 M, 4 spp. (*M. cavasius*, *M. vittatus*, *H. hara* and *C. batrachus*) are showing some discontinuous distribution and recorded between alt. 1000 to 1500 M and below 500 M. *A. mangois* is restricted between alt. below 500 to 1000 M and *G. shawi* and *H. fossilis* between altitude below 500 to 1500 M.

BELONIDS

Only single species *X. cancila* recorded under the present group of Meghalaya has been recorded from northern tributary system and from lower altitude only (below 500 M).

MURRELS

3 spp. (*C. orientalis*, *C. punctata*, *C. stewartii*) recorded under the present group from the State are occurring widely among the twin drainages and in all the G. Zones ; except only one species, *C. punctata*, which has not been recorded above 1500 M alt.

PERCIFORMIDS

Of the 11 spp. recorded under the present group from Meghalaya, 4 spp. (*N. nandus*, *G. gutum*, *C. sola*, *C. fasciatus*) are occurring only in northern tributary system, 4 spp. (*C. baculis*, *S. cascasia*, *R. corsula* and *A. testudineus*) to southern river system whereas remaining 3 spp. (op, cit.) are having overlapping distribution.

Altitudinally, 5 spp. (*C. nama*, *N. nandus*, *S. cascasia*, *R. corsula* and *A. testudineus*) are restricted to lower alt. (below 500 M). *C. baculis* between 1000 to 1500 M. *C. fasciatus* is restricted between alt. below 1500 M. *B. badis* is widely distributed between various alt. below 500 to 500 to 2000 M. *C. sola* is restricted between alt. 500 to 1500 M. *C. ranga* and *G. gutum* are showing some discontinuous distribution and recorded between alt. 1000 to 1500 M and below 500 M.

DISCUSSION

From the general trend of the fish species studied in Meghalaya, it is interesting to note that major percentage (45.19%) of fishes are having overlapping distribution. Occurrence of endemic forms are more (30.77%) in Brahmaputra drainage than in Barak drainage (24.04%).

The present investigation portrays some new traits of distribution of the fishes of Meghalaya.

From the foregoing analysis of Inter and Intra drainage distribution it can be concluded that all the regional species of Meghalaya may partly be distributed in Indian and Extra Indian regions, and partly restricted within E. Himalayan regions. Similarly widely distributed species are also partly distributed in India and Extra Indian regions and a few species (e. g. *G. naganensis*, *P. shalynius*, *C. stewartii* and *P. indica*) are restricted to Eastern Himalayas only. The reason for such type of incompatible distribution may be partly due to the altitudinal variation and partly due to the different ecological condition of water bodies.

After analysing the altitudinal distribution of the fish from the twin drainages it has been observed that minimum percentage (12.50%) of the total species occurs in gradient zone I and maximum (79.81%) in gradient zone IV whereas G. zone II and III represent 41.35% and 26.92% respectively leaving an overlapping percentage of fishes (60.58%) among the four gradient zones. It agrees with Yazdani's (1977) view that the distributional pattern of fishes is related to the altitude and habitat of the species and the sudden decline of species number over an elevation of 4000 ft.

It is interesting to note that in the Meghalayan fish fauna north Indian elements are more (79 spp) than Peninsular elements (57 spp.)

From the foregoing zoogeographical analysis it is to be noted that not a single Punjab Himalayan or Western Himalayan species is represented in Meghalaya. However, only a single species, *Botia rostrata*, is represented in first three sections of Himalayan rivers namely Eastern, Nepal and Kumaon Himalayas ; only 3 species in Eastern and Northern Himalayas whereas 14 species are endemic to E. Himalayas only. So it is clear that maximum number of endemic species are present in E. Himalayas and the number of Himalayan species decreases towards west, which otherwise agrees with the view of Menon (1954).

Geologically it is an established fact that the Shillong plateau is merely a severe portion of the peninsular region which has been isolated by the alluvium of the lower Ganges and Brahmaputra (Hora, 1944, p. 431). 79 species of Meghalaya are common to northern India and 57 species to southern India. Combination of northern and southern species in Meghalayan fauna reveals the fact clearly. Krishnan (1953) pointed out that "though now separated from the main peninsular area by a broad strip of the Ganges-Brahmaputra alluvium there is no doubt that the Assam plateau is part of the peninsular shield",

The fact that many freshwater fishes of India which are normally found in Eastern Himalayas and farther east did not extend westward along the southern face of Himalaya particularly beyond the Teesta river system initiated Hora in 1937 to propound a Hypothesis, known as Hora's "Satpura Hypothesis". Of the 40 species recorded from Satpura trend of mountains (Hora and Nair, 1941), 23 species are common to Meghalaya and Satpura range. From a zoogeographical view point the occurrence of *Amblyceps* in Satpura range, Hoshangabad district (Hora and Nair, op. cit.) shows the affinity of fish fauna of that region with that of the E. Himalayas. The remaining species are widely distributed and are of little zoogeographical importance. The above fact also suggests that Meghalayan hills are only spurs of the once extended part of Satpura mountains. The recent record of *Amblyceps* from Tungabhadra river (Govind and Rajagopal, 1977) reveals the fact that the species must have been dispersed along the Assam hills and Satpura mountains during the earlier waves of migration (Menon, 1951). Occurrence of *Mesonoemacheilus* in Meghalaya and also in Western Ghats (Singh, Sen, Banarescu and Nalbant, 1981) reveals the positive results of Satpura Hypothesis.

Fishes of Meghalaya occurring in twin drainages may broadly be classified into four distinct groups on the basis of their body form, adaptive modifications, habitat and ecological adjustment :

Group 1 : True hill stream dwellers (TH) : Fishes with specific modification to rheophilic abode. These are the fishes belonging to the genera *Garra*, *Glyptothorax*, *Pseudecheneis* and *Psilorhynchus*.

Group 2 : Semitorrential forms (ST) : Fishes having minimal body modifications and weakly body form belong to this group. They protect themselves by hiding under the boulders and other shelter. These are *Lepidocephalus*, *Acanthocobitis*, *Schistura*, *Mesonoemacheilus*, *Physoschistura*, *Somileptes*, *Botia*, *Crossocheilus*, *Gagata*, *Amblyceps*, and *Pillaia*.

Group 3 : Migratory forms (MF) : Well built fishes having the power of overcoming adverse and changed ecological conditions are included in this group. These are : *Acrossocheilus*, *Barilius*, *Chagunius*, *Danio* (except *devario*), *Labeo pangusia*, *Tor*, *Badis* and *Channa*.

Group 4 : Plainwater forms (PF) : This group includes fishes having minimal body modifications and insignificant migratory habits. *Gadusia*, *Setipinna*, *Notopterus*, *Amblypharyngodon*, *Chela*, *Cirrhina*, *Esomus*, *Labeo*, *Osteobrama*, *Oxygaster*, *Puntius*, *Rasbora*, *Ompok*, *Wallago*, *Clarias*, *Heteropneustes*, *Mystus*, *Hara*, *Ailia*, *Pseudeutropius*, *Bagarius*, *Conta*,

Olyra, *Xenontodon*, *Nandus*, *Anabas*, *Colisa*, *Chanda*, *Glossogobius*, *Tetraodon*, *Sicamugil*, *Rhinomugil*, *Mastacembelus*, *Macrogathus* are the genera of the fishes belonging to this group.

104 species of fishes of Meghalaya represent 15 TH, 16 ST, 19 MF and 54 PW forms.

The distributional pattern of the above mentioned groups in different G. Zones has also been analysed. In northern tributary system 11 species which are occurring above 1501 M altitude include 1 TH, 2 ST, 6 MF and 2 PW. 42 species occurring between 1001 to 1500 M include 8 TH, 7 ST, 12 MF, 15 PW ; 27 species occurring between 500 to 1000 M include 4 TH, 4 ST, 11 MF, 8 PW and 58 species occurring below 500 M include 3 TH, 10 ST, 13 MF and 32 PW. In southern tributary system 11 species occurring above 1501 M, include 1 TH, 2 ST, 7 MF, and 1 PW ; 14 species occurring between 1001 to 1500 M include 1 TH, 2 ST, 8 MF and 3 PW ; and 65 species occurring below 500 M include 3 TH, 9 ST, 14 MF and 39 PW.

The above analysis further shows that true hill stream fishes are more (16 spp.) in Brahmaputra drainages than Barak drainage (6 spp.) ; maximum number of true hill stream fishes (8 spp) occur between 1001 to 1500 M in northern tributary system whereas in southern river system, maximum number (3 spp) occurs below 500 M which is somewhat unusual. Another interesting point to be noted that all the 7 species which are only restricted to Meghalaya are found in Brahmaputra drainage only, out of which 6 occur between 1001 to 1500 M whereas only one below 500 M.

An overall analysis on the distributional trend of Meghalayan fishes based on ichthyological divisions reveals that the Clupeids, Notopterids, Belonids, Indian major carps and Tetraodontids are found only below 500 M. Other carps and minnows, Cobitids, Catfishes, Murrels and Perciforms are distributed widely covering all gradient zones. Interestingly Eels are found only within gradient zones II, III and IV. Besides the altitudinal distribution the ichthyological groups of Meghalaya do exhibit interesting trend of inter-drainage dispensation. Notopterids and Indian Major Carps are localised to Barak drainage, Belonid to Brahmaputra drainage and the remaining group portray more or less an overlapping distribution.

SUMMARY

Meghalaya which physiographically represents a remnant of the ancient plateau of pre-cambrian Indian Penninsular shield is gifted

with twin drainage system, the Brahmaputra and the Barak to signify its ichthyological prospects. The fish fauna of the province exhibit a combination of both torrential and plain water forms occupying diverse ecological regime in their distributional ranges.

Zoogeographically the ichthyospecies of Meghalaya are categorised in the present communication into Primary and peripheral forms. Of the 104 good species of fishes recorded, 95 species under 49 genera belong to primary form while the peripheral form includes 9 species belonging to 7 genera. In addition to this detailed analysis on the distributional trend of the fish fauna of the state from various perspectives namely inter drainage and intra drainage, altitudinal, Indian and Extra Indian as well as on the basis of Ichthyological division have been discussed in the paper under report.

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THE HIMALAYAN TERMITE, *ARCHOTERMOPSIS*
WROUGHTONI (SYNONYMS *RADCLIFFEI*
AND *DEODARAE*). IDENTITY,
DISTRIBUTION AND
BIOLOGY

By

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(With 4 Tables, 41 Text-figures and 2 Plates)

INTRODUCTION

The family Termopsidae (by some regarded as a subfamily of the family Hodotermitidae) is a small and primitive family of Oriental and Nearctic termites with three living genera, viz., *Archotermopsis* Desneux, *Hodotermopsis* Holmgren and *Zootermopsis* Emerson. The first one alone occurs in the Indian Region where it is represented by a single living species, *A. wroughtoni*, confined to the North-West Himalayas. A fossil form, *A. tornquisti* von Rosen, occurs in Baltic Amber (Upper Eocene or Lower Oligocene) of Eastern Europe.

A. wroughtoni has been well studied as regards morphology, but its taxonomy and distribution have in recent years been confused by the claim of a supposedly new species (really a junior synonym). Its true identity and distribution are discussed in some detail, and its biology has been summarised.

Abbreviations used : Termite castes : Im., imago (alate), Ny., nymph ; S., soldier ; Pw., pseudoworker.

Genus *Archotermopsis* Desneux

1904. Subgenus *Archotermopsis* (of genus *Termopsis* Heer), Desneux, *Genera Insectorum*, Fasc. 25, *Isoptera, Fam. Termitidae*, pp. 13-14 (Fig. 3, imago head).

1949. Genus *Archotermopsis*, Snyder, *Smithson. misc. Colls.*, Washington, 112, pp. 56 ; and 361-362.

Type of genus (by monotypy) : *Archotermopsis wroughtoni* Desneux, 1904, Kashmir (N. India).

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SYSTEMATIC ACCOUNT

Archotermopsis wroughtoni (Desneux)

(Text-figs. 1-41 ; Pls. X, XI)

(Syns. *radcliffei* Radcl. and *deodarae* Ch. & Th.)1. *Synonymies, etc.***1. Termopsis radcliffei** Radcliffe

1904. (Sept.), Radcliffe, *Indian Forester*, **30** (9) : 412-414. Type-locality ; Kashmir (India).

2. Termopsis wroughtoni Desneux

1904a. (Feb. 15). Desneux, *J. Bombay nat. Hist. Soc.*, **15** : 445-446. Im., S. Type-locality : Kashmir Valley (India).

1904b. (Mar. 29). Desneux, *Annal. Soc. ent. Belge.*, **48** : 280-285. India.

1934. Margabandhu, *J. Bombay nat. Hist. Soc.*, **37** : 711. Kashmir (India).

3. Termopsis (Archotermopsis) wroughtoni Desneux

1904. (Nov. 15). Desneux, *Genera Insectorum (Isoptera)*, Fasc. **25** : 13-14, Fig. 3, and Pl. 1, Fig. 3. N. India, including Kashmir.

1906. (Sept. 20). Desneux, *J. Bombay nat. Hist. Soc.*, **17** : 293-298. Fuller description.

1909. Lefroy, *Indián Insect Life*, **1** : 116, 119. Kashmir, India.

4. Archotermopsis wroughtoni (Desneux)

1911. Holmgren, *K. Sv. Vet. Acad. Handl.*, **46** (6) : 36, 2 pls. Im, S. and W. Kashmir, India.

1912. Fletcher, *Agric. J. India*, **7** (3) : 222-223.

1913. Holmgren, *K. Sv. Vet. Akad. Handl.*, **50** (2) : 31-32.

1919. Imms, *Philos. Trans. roy. Soc. Lond.*, (B) **209** : 75-180, 6 pls. Hazara and Kashmir in the west to Kumaon in the east (alt. ca. 4000-5000 ft.). Morphology and biology.

1920. Cutler, *Quart. J. micros. Sci.*, **64** : 383-412. Protozoa.

1920. de Mello, *Bull. Soc. Port. Sci. nat.* (Lisbon), **8** : 189-198. Protozoa.

1921. Cutler, *Quart. J. micros. Sci.*, **65** : 247-264. Protozoa.

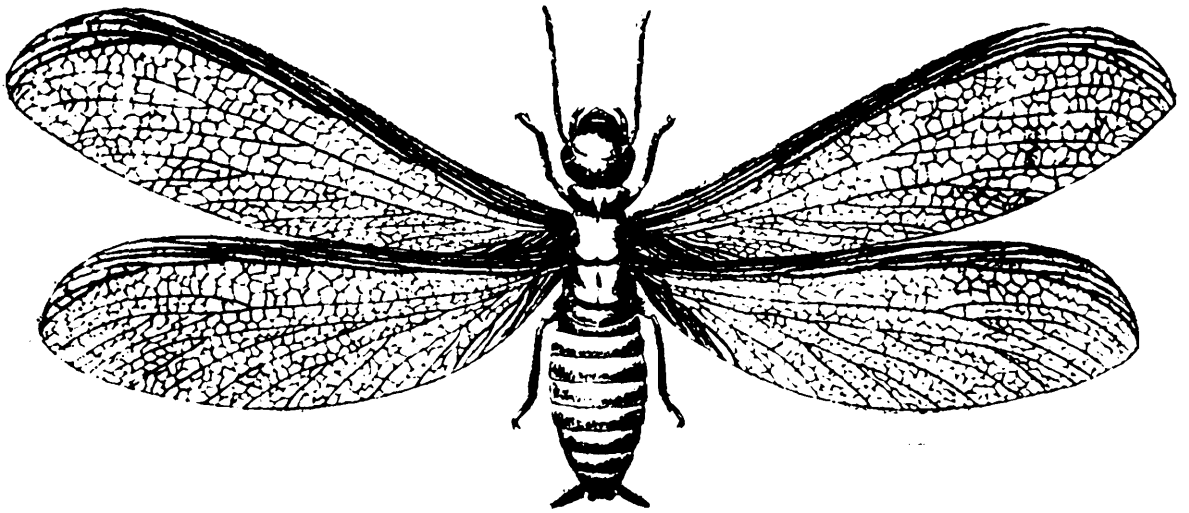
1922. Hegh, *Les Termites*, 45-46. Kashmir, India.

1924. Cleaveland, *Biol. Bull.*, **44** : 191-193, Protozoa.

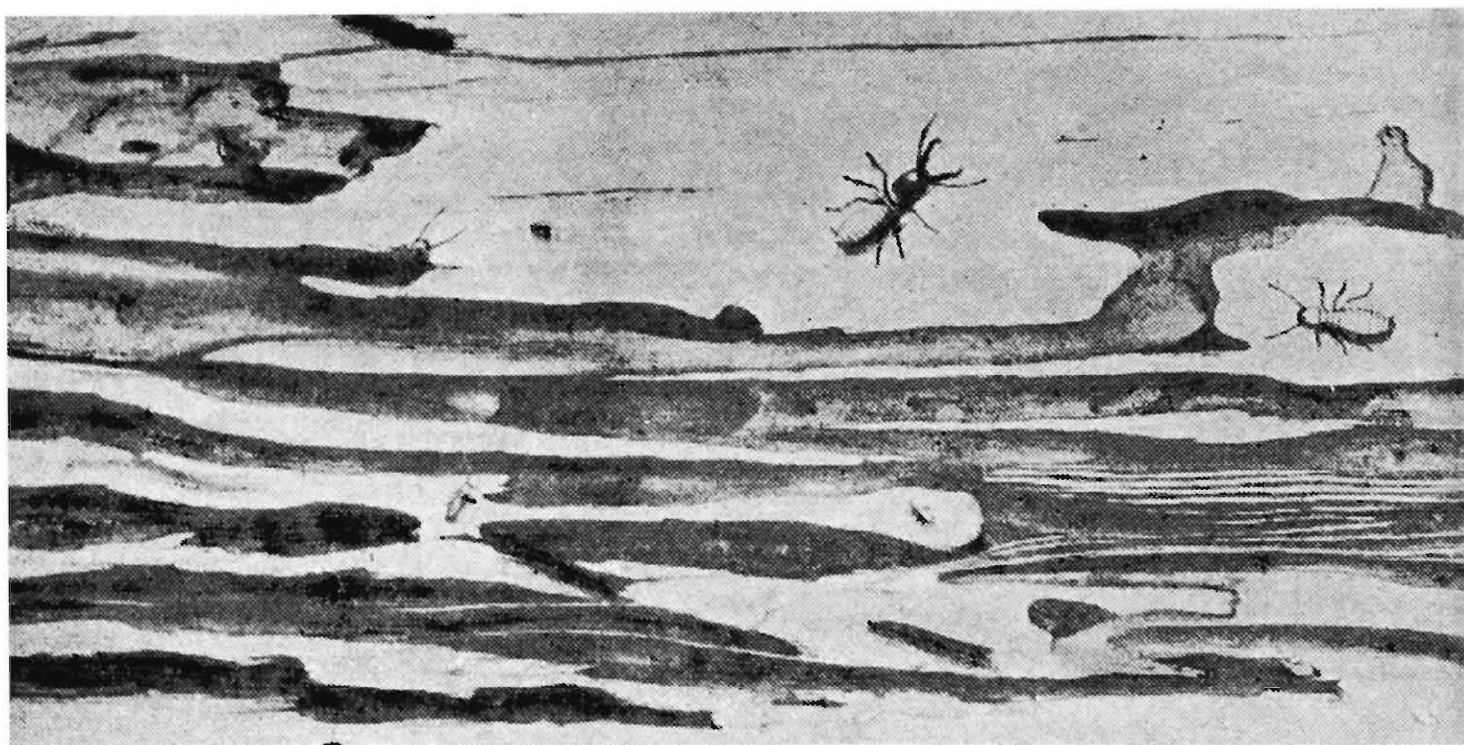
1941a. Beeson, *Indian Forest Rec. (Ent.)*, **4** : 53.

1941b. Beeson, *Ecology and Control of Forest Insects of India, etc.*, Dehra Dun, : 539-540. (Reprint Ed. 1961, Delhi : 415-416.)

1949. Snyder, *Smithson. misc. Colls.*, **112** : 55. North India.



Archotermopsis wroughtoni. Imago, male. Bhowali. (Ex. Imms.).



Archotermopsis wroughtoni Galleries excavated in dead log of deodar, *Cedrus deodara*. Right half, outer zone of sapwood. A pseudoworker and a soldier are also seen. (Ex. Imms.)

1953. Rattan Lal and Menon, *Catal. Indian Insects*, Pt. 27, *Isoptera* : 6-7.
1953. Roonwal and Pant, *Indian Forest Leaflet (Ent.)*, No. 12 (Pt. 3) : 46. Himalayas and foothills (India).
1954. Choudhry, *Pakistan J. Forestry*, **4** : 31-32.
1955. Saleem, *Biologia (Lahore)*, **2** (1) : 34-39. Murree Hills (Punjab, Pakistan). Protozoa.
1955. Ahmad, *Biologia (Lahore)*, **1** : 208-210. Hazara Dist. (Pakistan) and Muzaffarabad Dist. (Kashmir, India).
1955. Weidner, in *Die Termiten* (Ed. Schmidt), : 37, 50. Kumaon to Kashmir.
1956. Roonwal, *J. zool. Soc. India*, **7** (1955) : 107-114 ; and in *Taxonomist's Glossary of Genitalia* (Ed. Tuxen) : 34-38. Genitalia.
1958. Bhasin, Roonwal and Singh, *Indian Forest Bull. (Ent.) (N. S.)*, No. 171 (2) : 102.
1962. Mathur and Thapa, *Indian Forest Leaflet (Ent.)*, No. 161 : 6.
1967. Chatterjee and Thakur, *Indian Forest Rec. (N. S.) (Ent.)*, **11** (1) : 8-10.
1967. Harris, *Acta Mus. Moravise (Sci. nat.)*, **52** (Suppl.) : 211, 214. E. Afghanistan.
1970. Roonwal, In *Biology of Termites* (Eds. Krishna and Weesner), Vol. 2 : 328-329.
1970. Roonwal and Bose, *Sci. and Cult.*, **36** : 673. Serrations on tibial spines and spurs.
1972. Choudhry and Ahmad, *Termites of Pakistan* (Final Technical P. L. 480 Report) : 9. NW Pakistan.
1973. Chhotani and Bose, *Zool. Anz.*, **190** : 233.
1974. Akhtar, *Pakistan J. Zool.*, **6** : 90-91.
1977. Chhotani, *Proc. 8th int. Congr. int. Un. Study soc. Ins.* : 116.
1978. Roonwal, *Mem. School of Entom.* (St. John's College, Agra), No. 6 : 102.
1980. Sen-Sarma and Thakur, *Indian Forest Rec. (N. S.) (Ent.)*, **14** (1) : 7-8.
1981. Roonwal, *Proc. Indian natnl. Sci. Acad.*, (B) **47** (4) : 469-470. Microsculpture on wings.
- 1983a. Roonwal, *Zool. Anz.*, **211** : 138-139. Microsculpture on wings ; serrations on tibial spines and spurs.
- 1983b. Roonwal, *Proc. Indian natnl. Sci. Acad.*, (B) **49** : 377-378.
1984. Roonwal, *Mem. ent. Soc. India*, No. 9 : 11, etc., Abdomen and genitalia.

5. *Archotermopsis deodarae* Chatterjee and Thakur

1967. Chatterjee and Thakur, *Indian Forest Rec. (N. S.) (Ent.)*, **11** (1) : 10-13, pl. 1, S. Pw. and imago nymph. Kashmir Valley (India). (New synonymy.)

2. *Material Examined*

1. *At the Forest Research Institute, Dehra Dun.*

(1) Sev. S., Bhowali (ca. 1746 m. alt., Kumaon Hills, U. P.), 15. viii.1913, ex. "Chir pine".

(2) Im., S., Pw., Bardyar (ca. 2440 m. alt.) (near Chakrata, Dehra Dun Dist. U. P.), 17.vi.1915.

(3) 1 S., 2 Pw., Kunain (near Chakrata, Dehra Dun Dist., U. P.), 10.v.1917, ex *Cedrus deodara*.

(4) 1 S., 1 Pw., Larabatach (near Chakrata, Dehra Dun Dist., U. P.), 2315 m. alt., 9.vi.1924.

(5) S., Pw., Tulu, Garhwal, U. P., x.1932, ex rotten *Pinus longifolia* stump.

(6) Im., S., Pw., Mundali (Chakrata Hills, U. P.), 14. iv. 1933, ex *Cedrus deodara* and *Abies* sp.

(7) Im., Pw., Airadeo (Almora Dist., U. P.) 27.v.1937, ex *Pinus longifolia*.

(8) 1 S., deodar forest, Achabal, Anantang (Kashmir, India), 19. v.1962, ex rotten stumps of *Cedrus deodara*, Holotype of *A. deodarae* Ch. and Th.

(9) S., Pw. and Ny. Ditto. Paratypes of *A. deodarae* Ch. and Th.

2. At the Indian Agricultural Research Institute, New Delhi.

Five vials, Im. (alates), S. and Pw., Yusimarg (Kashmir, India), 2255 m alt., 1923, as follows :—

(1) 3 Im., 5.viii.1923. "at light". (2)—(5). Four vials, Im., S., Pw., 8.viii.1923, ex "in rotten log".

3. At the Zoological Survey of India, Calcutta.

(1) 1 S., 3 Im., 3 Pw., Yusimarg (ca. 33.30 N. lat., 74.25. E long.), 25 miles SW of Srinagar, Kashmir, India, 2000 m., 8.viii.1923, ex "in rotten long".

(2) 1 S., 1 Pw., Mundali near Chakrata (Dehra Dun Dist., U. P.), 14.iv.1933, ex *Abies* sp.

(3) 2 S., 4 Pw., Mundali, 16.iv.1933, ex *Cedrus deodara*.

(4) 1 Im., Manali (Kulu Valley, Himachal Pradesh), 6.vii.1956, "at light"

4. At the Northern Regional Station, Zoological Survey of India, Dehra Dun.

(1) 1 Im., sev. S. and Pw., Jharmala-Mari Road (2 km from Jharma Forest Rest House, Uttar Kashi Dist., U. P.), 10.vi.1981, ex. wood.

- (2) 1 Im., 3 S., sev. Pw., Ditto, 11.vi.1981, ex. rotten wood.
 (3) 1 Im., 15 S., sev. Pw., Ditto, 13.vi.1981, ex rotten pine stump.
 (4) 2 Im., Kanatal (2350 m, Tehri Dist., U. P.), 24.vi.1981, ex swarm at light in heavy rain, 8 P.M.

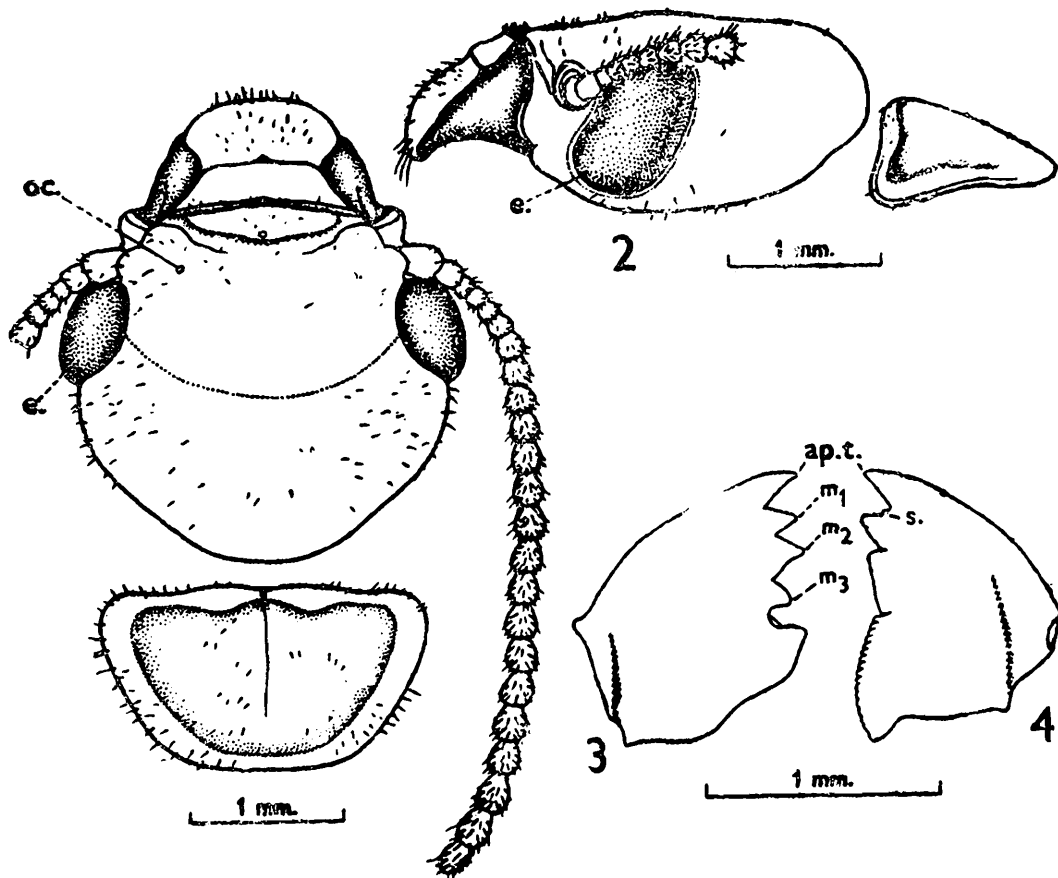
5. *At the American Museum of Natural History, New York.*
(Formerly with Prof. A. E. Emerson, Chicago.)

- (1) 1 Im., 1 S., Kashmir Valley (India).
 (2) 1 Im., Jhajra (Dehra Dun Dist., U. P., 843 m), 13.xi.1915.
 (3) 1 S., 1 Ny., Bardyar (near Chakrata, Dehra Dun Dist., U. P.), 2400 m, 17. v.1915.
 (4) 1 Im., 2 S., sev. Ny., Ditto.
 (5) 1 Im. (dealate), 1 S., sev. Ny., Chakrata (Dehra Dun Dist., U. P.), 2500 m, 26.iv.1933.

3. *Description of Species*

1. IMAGO (Table 1 ; Text-figs. 1-13 and 20-23 ; and Pl. 1)

Head reddish brown to pale brown ; anteclypeus hyaline ; postclypeus and mandibles dark brown ; labrum, antennae, thoracic terga,



Text-figs. 1-4. *Archotermopsis wroughtoni*. Imago.

1. Head and pronotum, in dorsal view. 2. Same, in side view. 3. Left mandible. 4. Right mandible.

ap. t., apical tooth ; oc., ocellus ; e., eye ; m₁—m₃, first to third marginal teeth ; s. subsidiary tooth.

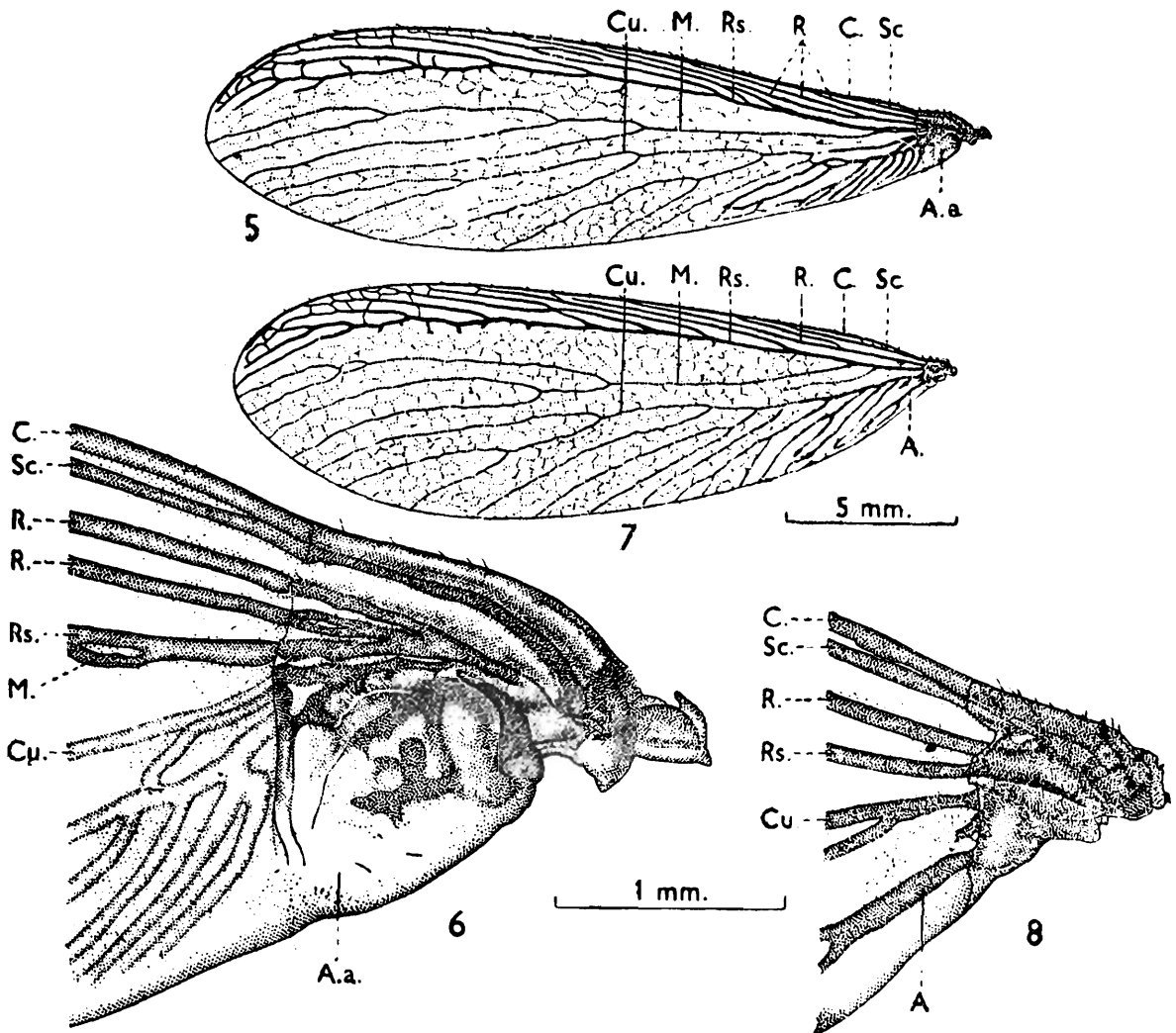
legs, wings and abdomen pale golden yellow; wing veins darker. Head and body moderately pilose. Total body-length with wings 23.6-26.0, without wings 10.7-14.0 mm. Head-capsule subcircular, a little broader than long (maximum width 2.25-2.70 mm, head-length to base of mandibles 1.88-2.40 mm), broadest at level of eyes, whence curving to a rounded posterior margin; a faint semicircular suture-like line present on head-dorsum between eyes, dividing the head into almost

TABLE 1. *Archotermopsis wroughtoni*. Measurements of imago.

Body-parts	Range (mm)
1. Total body-length with wings	23.6 — 26.0
2. Total body-length without wings	10.7 — 14.0
3. Length of head to lateral base of mandibles	1.88 — 2.40
4. Maximum width of head (with eyes)	2.25 — 2.70
5. Maximum height of head	1.20 — 1.35
6. Maximum length of labrum	0.50 — 0.75
7. Maximum width of labrum	0.83 — 1.05
8. Maximum diameter of eyes (with ocular sclerite)	0.85 — 1.10
9. Minimum diameter of eyes (with ocular sclerite)	0.57 — 0.77
10. Minimum eye-antennal distance	0.08 — 0.13
11. Maximum length of pronotum	0.97 — 1.22
12. Maximum width of pronotum	1.80 — 2.22
13. Length of forewing with scale	20.50 — 22.50
14. Length of forewing scale	1.00 — 1.70
15. Length of hindwing with scale	18.80 — 20.50
16. Length of hindwing scale	0.75 — 1.20

equal anterior and posterior halves. Fontanelle absent. Eyes large, subreniform, anterior margin shallowly incurved, posterior margin substraight. Ocelli as indistinct spots on head-dorsum. Antennae with 19-25 segments; 1 longest; 2 about half of 1; 3 shortest; 4 to last progressively increasing in length. Anteclypeus hyaline, subtrapezoidal, apilose; anterior margin straight with a slight median projection. Postclypeus narrow, a little depressed; not well differentiated from frons; with a few short, bristle-like hairs near anterior margin. Labrum large, subquadrangular, much broader than long, with rounded, slightly bulging sides; with a few long hairs at anterior margin and short ones on body. Left mandible with a long, finger-like apical and 3 marginal teeth; 1st marginal shorter than apical, also finger-like; 2nd subequal to 1st and subtriangular; 3rd shortest and directed backwards. Right mandible with a finger-like apical and 2 well developed marginal teeth and, in addition, a small subsidiary tooth at the front end of the first marginal; molar plate striated and forming about half of

toothed margin of mandible. Pronotum subtrapezoidal, flat, narrower than head, much broader than long; anterior margin weakly convex, with a weak median notch; anterior angles broadly rounded; sides curving to a substraight posterior margin without a median notch; with a row of hairs on margins and a few shorter ones on body. Mesonotum suboval, a little broader than long; broader than pronotum. Metanotum suboval, as broad as mesonotum. Wings covered on the both upper and lower surface with microscopic, cuticular, distally directed papillae (size 6-8 $\mu\text{m} \times 4-6 \mu\text{m}$); 4-5 such rows of thorny papillae present on the anterior margin and single rows of rounded to subs crescentic ones on the larger veins (Text-fig. 10) (vide Roonwal 1981, 1983b). Forewing ca. 22.5 mm long. Membrane covered with an irregular reticulum of fine cross-veins, forming cells. Basal scale large, separated from rest of wing by an incomplete suture; roots of all principal veins lying inside scale. Costa (C) arising at base of scale



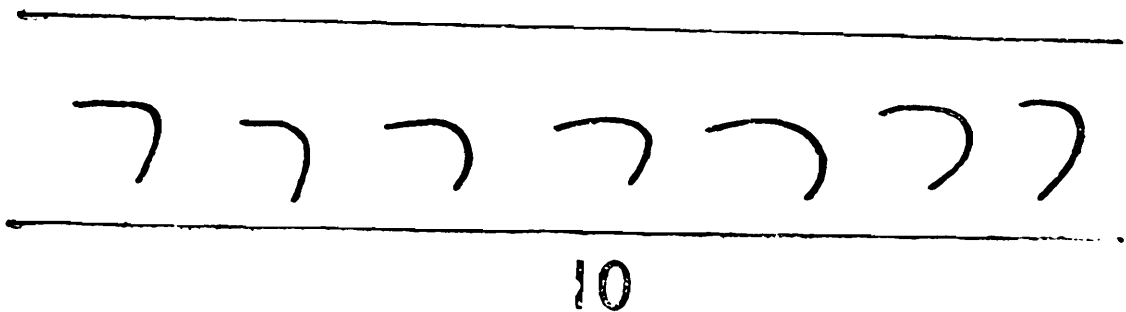
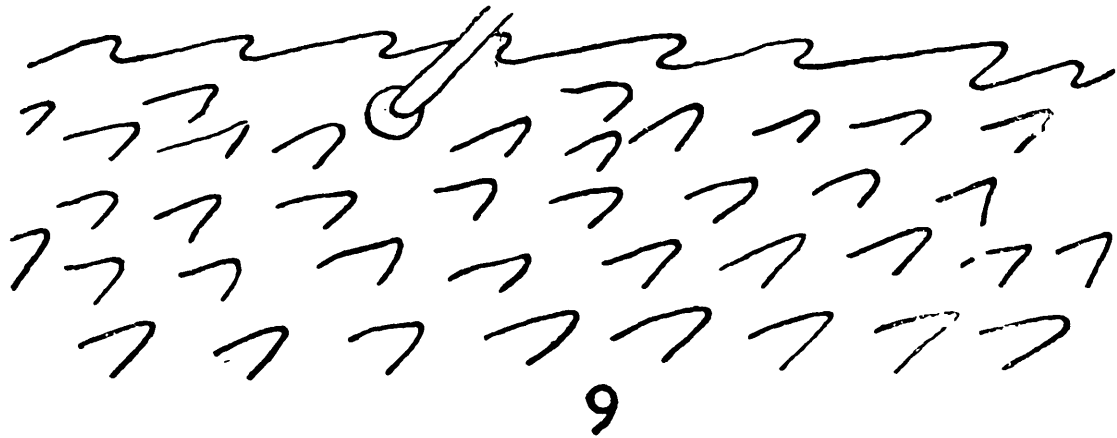
Text-figs. 5-8. *Archotermopsis wroughtoni*. Wings.

5. Left forewing. 6. Same, basal scale, enlarged. 7. Left hindwing.

8. Same, basal scale enlarged.

A., anal; A. a., anal area; C., costa; Cu., cubitus; M., media; R., radius; Rs., radial sector; Sc., subcosta.

and running all along anterior margin. Subcostata (Sc) short and quickly joining the costa. Radius (R) and radial sector (Rs) arising jointly inside scale and separating inside scale. R dividing inside scale into two main branches (R1, R2); R1 quickly joining the costa; R2 dividing into two branches which run to costal border before middle of wing. Rs. with 5-6 prominent branches, some with interconnecting, oblique cross-veins and loops. Media (M) thin, hyaline, arising jointly with Rs, separating just outside the scale and branching into 6-7 branches running to distal margin of wing. Cubitus (Cu) with 6 branches running to posterior margin of wing. Anal area



Text-figs. 9-10. *Archotermopsis wroughtoni*. Parts of dorsal surface of forewing, to show microsculpturing by cuticular papillae. Greatly enlarged. 9. Anterior margin of wing. Thorny papillae in several rows. 10. Lower down, part of a vein; papillae becoming more rounded, almost subcrescentic.

small; vein (A) absent. Hindwings 20.5 mm long. Reticulated as in forewing. Scale small and with incomplete suture. Main veins arising, as in forewing, within the scale. C and Sc almost as in forewing. R and Rs arising jointly within scale and dividing into two at the scale margin. R dividing in two branches which meet the costal border before middle of wing. Rs dividing outside scale into 7-8 branches running to costal border of distal margin of wing, the branches, in turn, giving off smaller branches with intercalated veinlets and loops. M thin, hyaline, arising outside scale from Rs and dividing into 4 branches. Cu arising independently inside scale and giving off 13-14 branches to the lower margin of wing. Anal arising independently inside scale

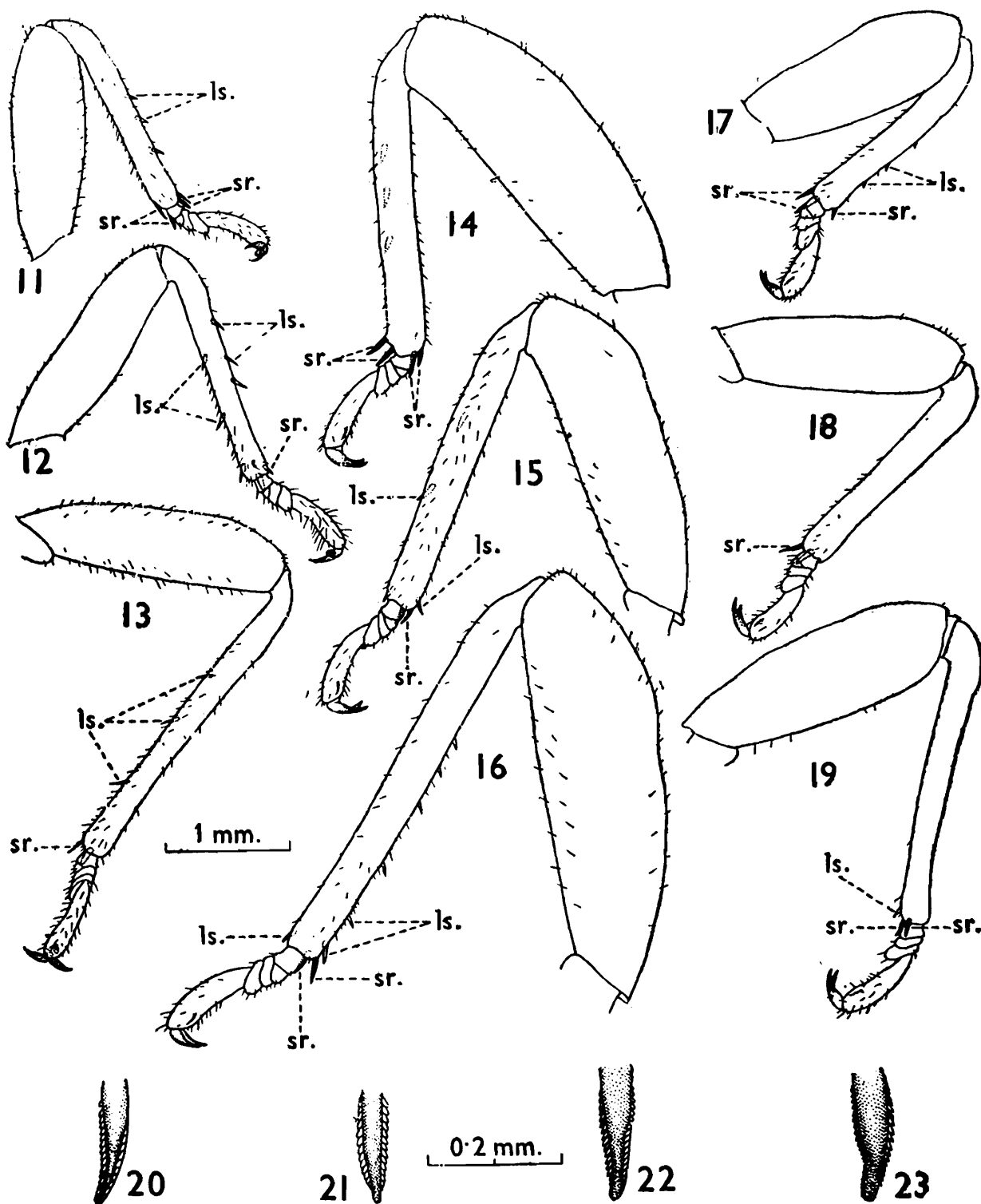
and present as a small 2-branched vein near wing base. Legs Long, stout, lightly pilose. Tarsi imperfectly 5-segmented (4 visible above, 5 below); with pulvilli; arolium present between claws. Fore tibia with 3-4 spines on outer margin and 4 apical spurs; middle tibia with 2-4 spines on inner margin, 1-3 spines on outer margin and 3-4 apical spurs; hind tibia with 4-6 spines on inner margin and 2 apical spurs. Apical tibial spur formula thus variable. 4 : 3-4 : 2. Outer and inner edges of apical spurs and larger tibial spines bear several microscopic (size 27-54 μm \times 18-54 μm), lamellar, cuticular papillae (26-36 on a spur) (Roonwal and Bose 1970, Roonwal 1983a, and in press). Abdomen oval, elongate, moderately hairy. Cerci (on 10th sternum) long, 6- to 8-jointed; length 1.00-1.48 mm. Styli (on 9th sternum) in male, one-jointed, ca. 0.40-0.58 mm long, extending beyond tip of abdomen; absent in female. Sternum 7 enlarged in female and covering 8 and 9; narrower in male (vide Roonwal 1984).

2. SOLDIER (Table 2; and Text-figs. 14-15 and 24-31)

Head anteriorly deep reddish brown, posterior part of head, pronotum and legs paler; labrum pale yellowish to creamish brown,

TABLE 2. *Archotermopsis wroughtoni*. Measurements of soldier.

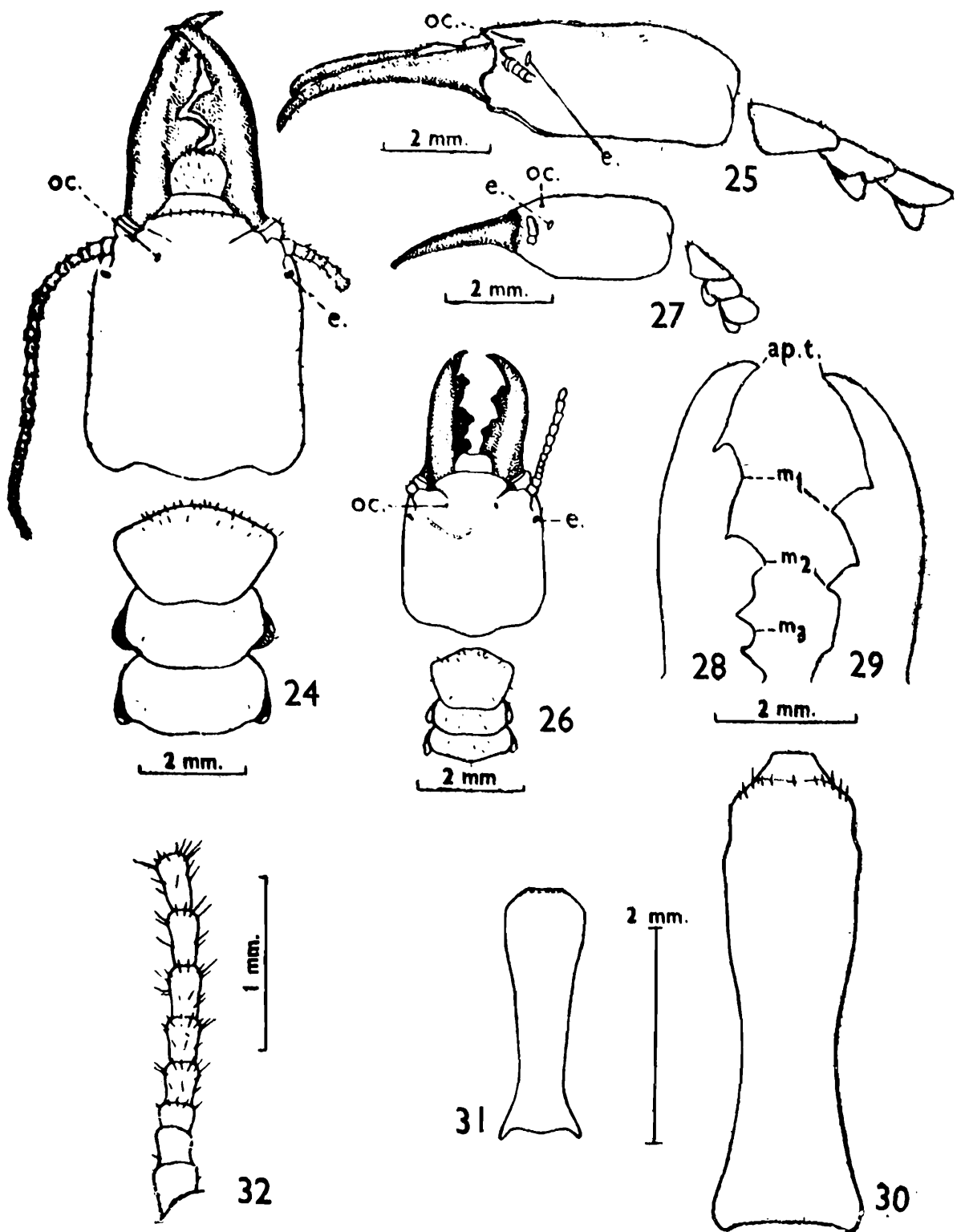
Body-parts	Range (mm)
1. Total body-length	11.4 — 21.1
2. Length of head with mandibles	6.37 — 7.00
3. Length of head to lateral base of mandibles	2.80 — 5.20
4. Maximum width of head	2.55 — 4.60
5. Width of head-capsule at anterior end	2.10 — 3.90
6. Maximum height of head	1.43 — 2.15
7. Head Index I (Width/Length)	0.85 — 0.95
8. Head Index II (Height/Width)	0.45 — 0.56
9. Head Index III (Height/Length)	0.41 — 0.51
10. Maximum length of labrum	0.33 — 0.80
11. Maximum width of labrum	0.63 — 1.10
12. Length of mandibles from upper base of condyle to tip :	
Left mandible	2.10 — 4.80
Right mandible	2.20 — 4.40
13. Minimum median length of postementum	2.23 — 4.43
14. Maximum width of postementum	0.70 — 1.20
15. Width of postementum at waist	0.43 — 1.00
16. Maximum length of pronotum	0.95 — 1.95
17. Maximum width of pronotum	1.53 — 3.03
18. Pronotum-Head Index (Pronotum-width/Head-width)	0.60 — 0.70
19. Pronotum Index (Length/Width)	0.59 — 0.70



Figs. 11-23. *Archotermopsis wroughtoni*. Legs of imago, soldier and pseudo-worker. 11-13. Fore, middle and hind legs respectively of imago. 14-16. Fore, middle and hind legs respectively of soldier. 17-19. Fore, middle and hind legs respectively of pseudoworker. 20-23. Apical tibial spurs of fore leg of imago, greatly enlarged to show the marginal serrations (papillae).

ls., lateral spine of tibia ; sr., apical tibial spurs.

anteclypeus paler ; mandibles blakish red ; antennae reddish brown proximally, paler distally ; rest of thorax and body pale creamish yellow. Head and body sparsely pilose ; total length with mandibles ca. 11.4-21.1 mm. There is an enormous degree of size variation, but



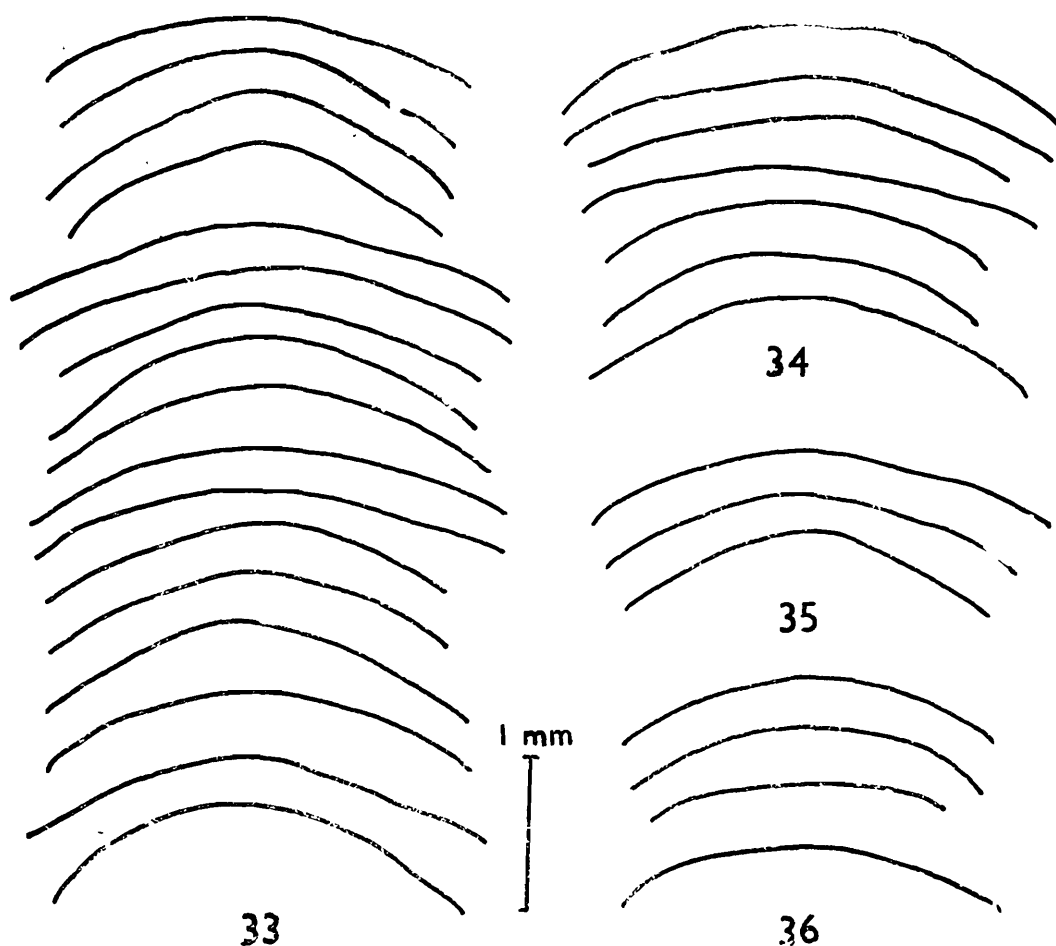
Text-figs. 24-32. *Archotermopsis wroughtoni*, Soldier, large and small (there is a graded size series, and no separation into major and minor soldiers is possible). 24. Head and thorax of large soldier, in dorsal view; note the pleural processes of meso- and metanota. 25. Same, in side view. 26. Same, small soldier, in dorsal view. 27. Same, in side view. 28. Left mandible of large soldier. 29. Same, right mandible. 30. Postmentum of large soldier, in ventral view. 31. Same, of small soldier. 32. Basal part of antenna of large soldier. ap. t., apical tooth of mandible; e., eye; m1—m3, first to third marginal teeth of mandible; oc., ocellus.

there is a graded series and no separation into major and minor soldiers is possible. Head-capsule subsquarish, a little longer than broad (head-length to base of mandibles 2.80-5.20 mm ; maximum head-width 2.55-4.60 mm) ; slightly narrowing anteriorly, broader posteriorly ; posterior margin with a pair of shallow depressions. Fontanelle absent. Eyes present as a pair of small, lateral, brown patches just below base of antennae. Ocelli present as a pair of small, whitish spots on head-dorsum in level of antennae. Antennae with 22-27 segments ; 1 longest ; 2 about half of 1 ; 3 shortest ; 4 longer than 3, subequal to 5 ; 6 longer than 5, shorter than 7, or 6-12 subequal and longer than 5 ; 13 to the last gradually decreasing in size. Anteclypeus narrow, trapezoidal, apilose ; much broader than long. Postclypeus not clearly differentiated from frons, somewhat depressed, with a few very short hairs on anterior margin and on body. Labrum subsquarish ; sides swollen ; broader than long ; broadest in middle (maximum length 0.33-0.80 mm ; maximum width 0.63-1.10 mm) ; anterior margin with a shallow, median incurving ; with several short, bristle-like hairs at tip and on body. Mandibles long and stout, basally broad, distally strongly incurved and pointed. Right mandible with an apical and 2 marginal teeth on inner margin ; apical long, incurved, pointed and finger-like ; 1st marginal small, blunt and pointed upwards, with a curved, elongated posterior margin ; 2nd larger and more pointed laterally. Left mandible with an apical and 3 marginal teeth ; apical long, incurved pointed and finger-like ; 1st marginal large and pointed laterally ; 2nd also large and pointed laterally ; 3rd present as a small tooth at the beginning of the molar plate. Postmentum long, narrow and with a gentle waist below the middle (median length 2.23-4.43 mm, maximum width 0.70-1.20 mm) ; with a few hairs near anterior end, the latter projecting as a short, blunt, hyaline tip ; anterior margin straight ; posterior angles rounded ; posterior margin weakly concave. Pronotum flat, with sides slightly sloping downwards, rhomboidal, much broader than long (maximum width 1.53-3.03 mm, maximum length 0.95-1.95 mm) ; sides converging towards posterior margin ; anterior margin substraight to convex, without a median notch ; posterior margin substraight, with a weak median notch ; a few hairs present around margins and on body. Mesonotum suboval, much broader than long ; broader than pronotum ; margin with a weak median incurving ; sparsely pilose. Below both meso- and metanota the pleura expanded laterally to form small, subtriangular flaps (the epimera). Legs long, stout, pilose ; tibial spines almost as long as spurs ; tarsi with 5 imperfect segments as in imago. Fore tibia with 3-5 spines on inner margin and 3-4 apical spurs ; middle tibia with 1-3 spines on

inner margin, 2-4 spines on outer margin and 2-3 apical spurs; hind tibia with 2-6 spines on inner margin and 2 apical spurs. Apical tibial spur formula variable, thus : 3-4 : 2-3 : 2. Outer and inner edges of spurs and larger spines bear several microscopic (size smaller than in imagoes) papillae (12-13 on a spur). Abdomen oblong, sparsely pilose. Cerci (on 10th sternum), ca. 1.85-2.40 mm long, with 6-7 joints. Styli (on 9th sternum), one-jointed, ca. 0.53-0.93 mm long; present in both sexes. Sexes separable; in female sternum 7 enlarged and covers 8; normal in male.

3. PSEUDOWORKER (Table 3; and Text-figs. 17-19 and 39-40)

Posterior part of head and mandibles deep creamish yellow; mandibular teeth darker; anterior part of head, labrum, thorax and legs



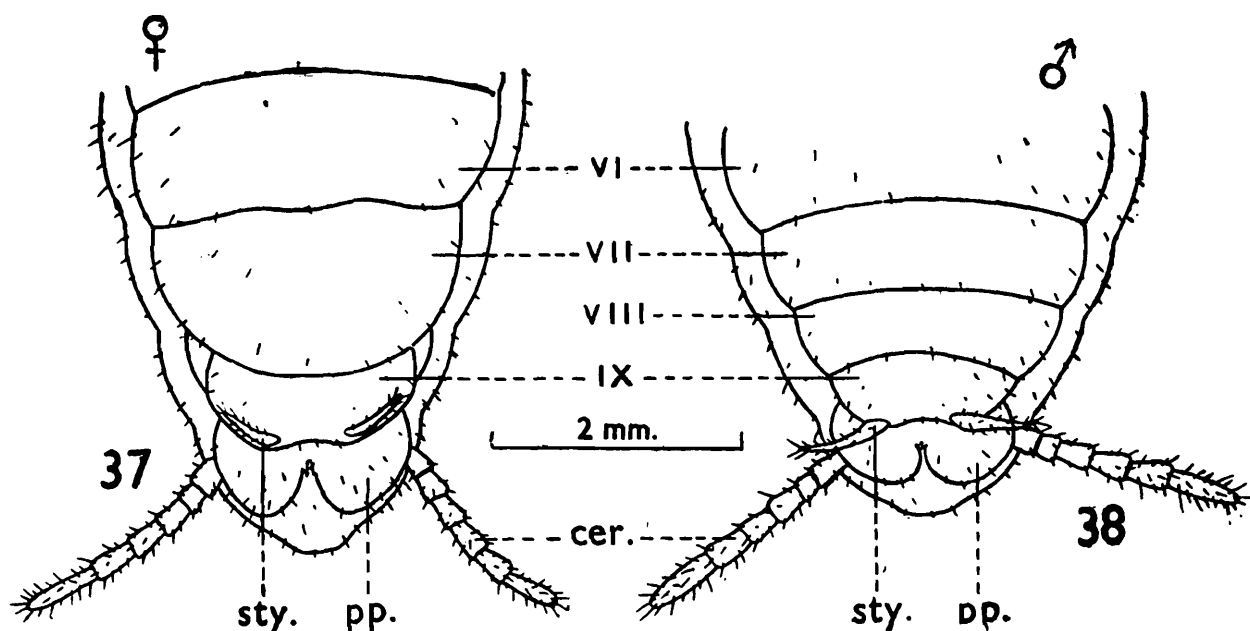
Text-figs. 33-36. *Archotermopsis wroughtoni*, soldier. Anterior margins of pronotum of soldiers from various populations. 33. Jharmala Dhar (Dist. Uttar Kashi, U. P.). 34. Mundali (near Chakrata, U. P.). 35. Bardyar (near Chakrata, U. P.). 36. Achhabal (Anantang, J. & K.) (*A. deodarae* Ch. & Th.).

paler; antennae pale creamish yellow; anteclypeus whitish, hyaline; abdomen pale creamish white. Head and body sparsely pilose. Total length ca. 7.8-13.1 mm. Head-capsule subquadrate, much broader than

TABLE 3. *Archotermopsis wroughtoni*. Measurements of pseudoworker

Body-parts	Range (mm)
1. Total body-length	... 7.8 — 13.1
2. Length of head to tip of labrum	... 1.95 — 3.25
3. Length of head to lateral base of mandibles	... 1.45 — 2.38
4. Maximum width of head	... 1.70 — 2.60
5. Maximum height of head	... 0.90 — 1.40
6. Maximum length of labrum	... 0.43 — 0.68
7. Maximum width of labrum	... 0.60 — 1.10
8. Maximum length of pronotum	... 0.63 — 1.15
9. Maximum width of pronotum	... 1.45 — 1.90

long (maximum width 1.70-2.60 mm); length to lateral base of mandibles 1.45-2.38 mm); sides slightly converging anteriorly; posteriorly rounded; posterior margin with a weak median bulge. Fontanelle absent. Eyes present as a pair of small, lateral, brownish patches below



Text-figs. 37-38. *Archotermopsis wroughtoni*, soldier: Ventral views of hind end of abdomen. 37. Female (7th sternum enlarged). 38. Male.
cer., cerci; pp., paraproct; sty., styli. VI—IX., 6th-9th sterna.

antennal sockets. Ocelli absent. Antennae with 19-23 segments; 1 longest, 2 a little longer than half of 1; 3-4 or 6 short, subequal; from 5 or 7 gradually increasing in size to the ovate, apical segment. Mandibles as in imago, except that the teeth are somewhat shorter and more blunt. Pronotum broader than long and narrower than head (maximum length 0.63-1.15 mm; maximum width 1.20-1.90 mm); anteriorly and laterally somewhat upturned and weakly saddle-shaped; anterior margin weakly convex, with a weak median notch; posterior margin substraight, with a shallow medial depression; sides substraight and strongly

narrowing posteriorly. Meso- and metanotum as in soldier ; below both these the pleura giving out small, subtriangular flaps (the epimera). Legs long, sparsely pilose ; apical tibial spur formula variable, thus : 4 : 2-3 : 2. Outer and inner edges of spurs and larger spines bear some microscopic, cuticular papille, smaller and fewer (4-5 on a spur) than in soldiers. Abdomen broadly elongate. Cerci 5- to 7-jointed, ca. 0.85-1.25 mm long. Styli short, one-jointed, ca. 0.63-0.70 mm long. Sexes separable ; sternum 7 enlarged in female ; smaller in male.

4. *Taxonomic Remarks*

A. wroughtoni has date priority over *radcliffei*. *A. deodarae* has been separated from *wroughtoni* (in soldiers) on minor and inconsequential characters all of which fall well within the range of the latter. The supposed differences in the anterior margin of soldier pronotum (misprinted as "interior" in Chatterjee and Thakur, 1967) (with a weak depression in *deodarae*, vs. convex) do not hold good and there is a wide range even in local populations (Text-gs. 33-36).

5. *Geographical Distribution* (Table 4 ; and Text-fig. 41)

Oriental (temperate region), just entering the Palaearctic (eastern Afghanistan). North-West Himalayas in India, northern Pakistan and eastern Afghanistan. Associated with coniferous forests ; at ca. 900-3000 m attitude above m.s.l., mostly above 1250 m. Details are as follows :

TABLE 4. List of known localities of *Archotermopsis wroughtoni*.

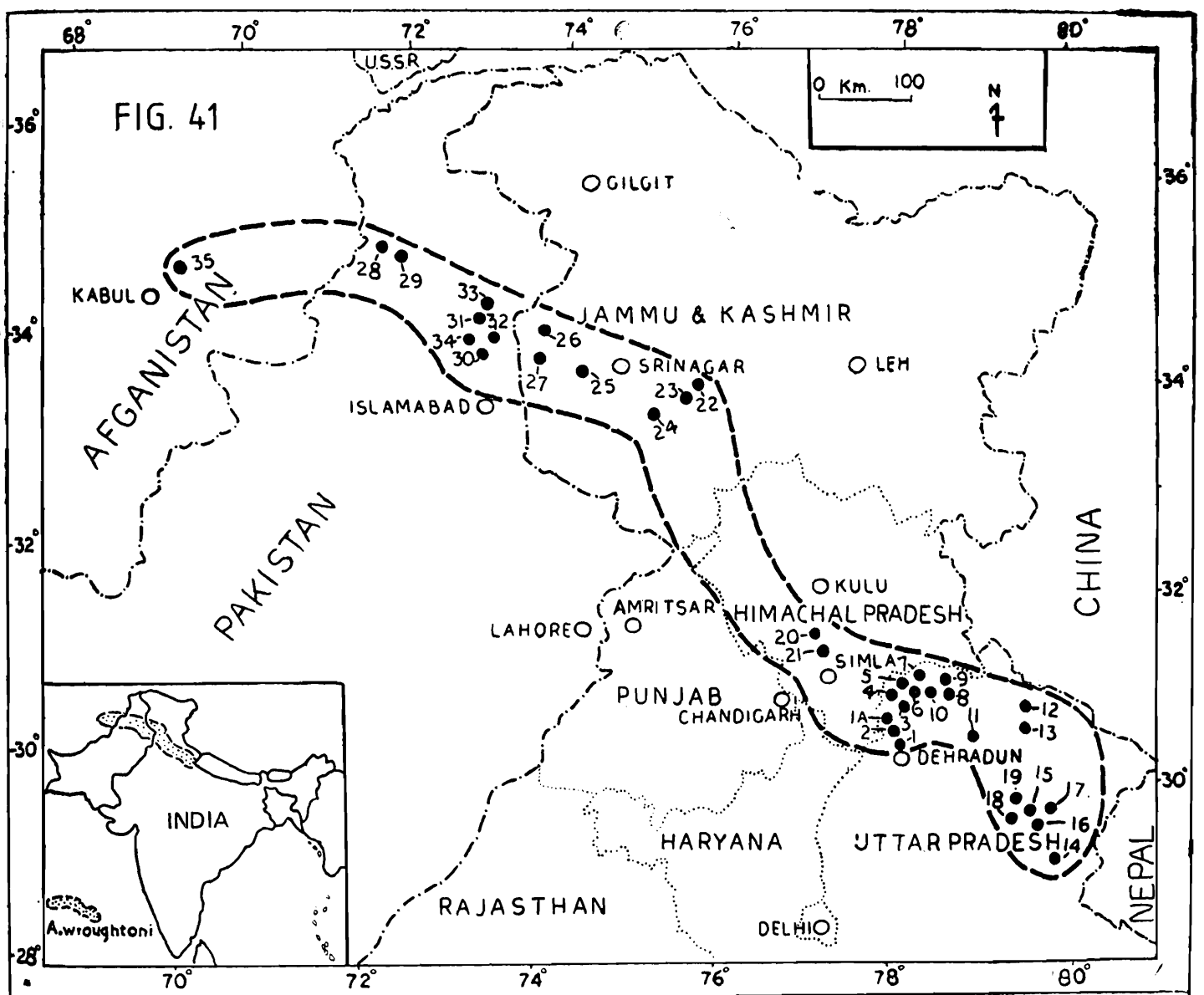
Country/State	District	Approx. latitude (N)	Approx. longitude (E)	Approx. altitude (metres)
1	2	3	4	5
(A) INDIA				
(a) <i>Uttar Pradesh</i>				
1. Jhajra	Dehra Dun	30.19	78.02	900
1a. Bardyar (not Bodyar)	"	30.43	77.51	2440
2. Chakrata	"	30.42	77.52	2200
3. Deoban	"	30.45	77.52	2800
4. Kanasar	"	30.47	77.50	2150
5. Kunain	"	30.48	77.53	2300
6. Mundali	"	30.50	77.57	2600
7. Nada	"	30.48	78.02	1600

TABLE 4 (Concluded)

1	2	3	4	5	
8.	Jharmala-Dhar	Uttar Kashi	30.58	78.05	1940
9.	2 km. from Jharmala F.R.H. on Jharmala- Mori Road	„	30.59	78.04	1600
10.	Uttar Kashi	„	30.45	78.28	1150
11.	Kanatal	Tehri	30.25	78.20	2350
12.	Kunwari Pass (not Kauri Pass)	Chamoli	30.27	79.34	3900
13.	Ramni	„	30.24	79.30	2100
14.	Bhowali	Nainital	29.22	79.31	1750
15.	Airadeo	Almora	29.45	79.35	2100
16.	Almora	„	29.40	79.40	1650
17.	Bajwar	„	29.36	79.41	1200
18.	Chaubhattia	„	29.37	79.28	2120
19.	Dalmoti (not Dhar- moti)	„	29.38	79.30	1600
(b) <i>Himachal Pradesh</i>					
20.	Manali (Kulu Valley)	—	31.07	77.00	2000
21.	Tikkar (near Narkanda)	Mahasu	31.30	77.10	2450
(c) <i>Jammu and Kashmir</i>					
22.	Achabal (Anatnag)	Srinagar	33.41	75.13	1650
23.	Pahalgam	„	34.01	75.20	2130
24.	Yusimarg	—	33.30	75.00	2000
25.	Gulmarg	Baramula	34.03	74.95	2700
26.	Chakar	Muzaffarabad	34.15	73.55	—
27.	Lun Bagla	„	34.10	73.50	—
(B) PAKISTAN					
28.	Gumrat (Dir)	—	35.07	71.45	—
29.	Kalam (Swat)	—	34.42	72.30	—
30.	Hazara	Hazara	34.10	73.15	—
31.	Kaghan	„	34.45	73.30	—
32.	Mahandri (near Kaghan)	„	34.46	73.30	—
33.	Naran	„	34.50	73.40	—
34.	Shogran (near Kaghan)	„	34.45	73.29	—
(C) AFGHANISTAN					
35.	Barikot (NE of Kabul)	Nengrahar Prov.	34.50	69.20	1000

INDIA (states of Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir).

Uttar Pradesh : Mostly the hilly areas of Kumaon, Garahwal and Chakrata area. Bardyar, Deoban, Kanasar, Kunain, Larabatach, Mundali, Nada, Jhajra (near Dehra Dun), Bhowali (Nainital Dist.), plentiful. Kanatal, Kunwari Pass, Ramni, Tehri and Tulu, Uttar Kashi (Garhwal area), Airadeo, Almora, Bajwa, Chaubhattia, Dalmoti (not Dharmoti) and Ranikhet (Almora Dist.).



Text-fig. 41. Map of North India and neighbouring countries, to show the distribution localities of *Archotermopsis wroughtoni*. (Localities are serially numbered as in Table 4 in text.)

Himachal Pradesh: Manali (ca. 31.09 N. lat., 77 E long.) in Kulu Valley, 2000, m; Tikkar near Narakanda (Mahasu Dist.), 2450 m.

Jammu and Kashmir: Kashmir Valley (Achalabal, Anantang, Gulmarg, Pahalgan, Yusimarg): Muzaffarabad Dist. (Lun Bagla, Chakar).

PAKISTAN (NW mountain area): Hazara District: Kaghan Vally Shorgran, Kaghan, Dunga Gali, Chhangla Gali, Naran, Mahandri, Gumrat (Dir), Kalam (Swat), Murree Hills.

AFGHANISTAN (eastern part): Barikot (Nengrahar Province, eastern Afghanistan, NE of Kabul near Pakistan border), 1000 m (Harris 1967).

BIOLOGY

The biology of *A. wroughtoni* has been studied by Radcliffe (1904), Imms (1919), and Chaudhry and Ahmad (1972); and we have, in addition, field notes from various collections.

1. Habitat

The species is found under bark and inside the dead and decaying stumps and logs of fallen conifers (deodars and pines), e. g., *Cedrus deodara*, *Abies pindrow*, *Pinus excelsa*, *Pines longifolia*, *Pinus roxburghii*, *Pinus wallichiana* and *Picea morinda*. It does not attack sound felled timber or living trees.

2. Habits

It bores irregular, longitudinal tunnels in decayed wood. The galleries mostly run longitudinally along the grain of the wood and end just beneath the bark (Pl. 2). No outside earth encrustations are produced on the surface and there is no outward sign of the termite's presence in the wood. When necessary, the galleries are closed with masticated ligneous or excrementous material cemented with saliva.

Colonies are generally small (perhaps 30 or 40 individuals). They seem to be confined to the wood but there is no well marked nest. A soil connection is wanting. The castes consist of soldiers, pseudo-workers* and reproductives. (There are no true or mature workers, and the immature workers perform the latter's duties.)

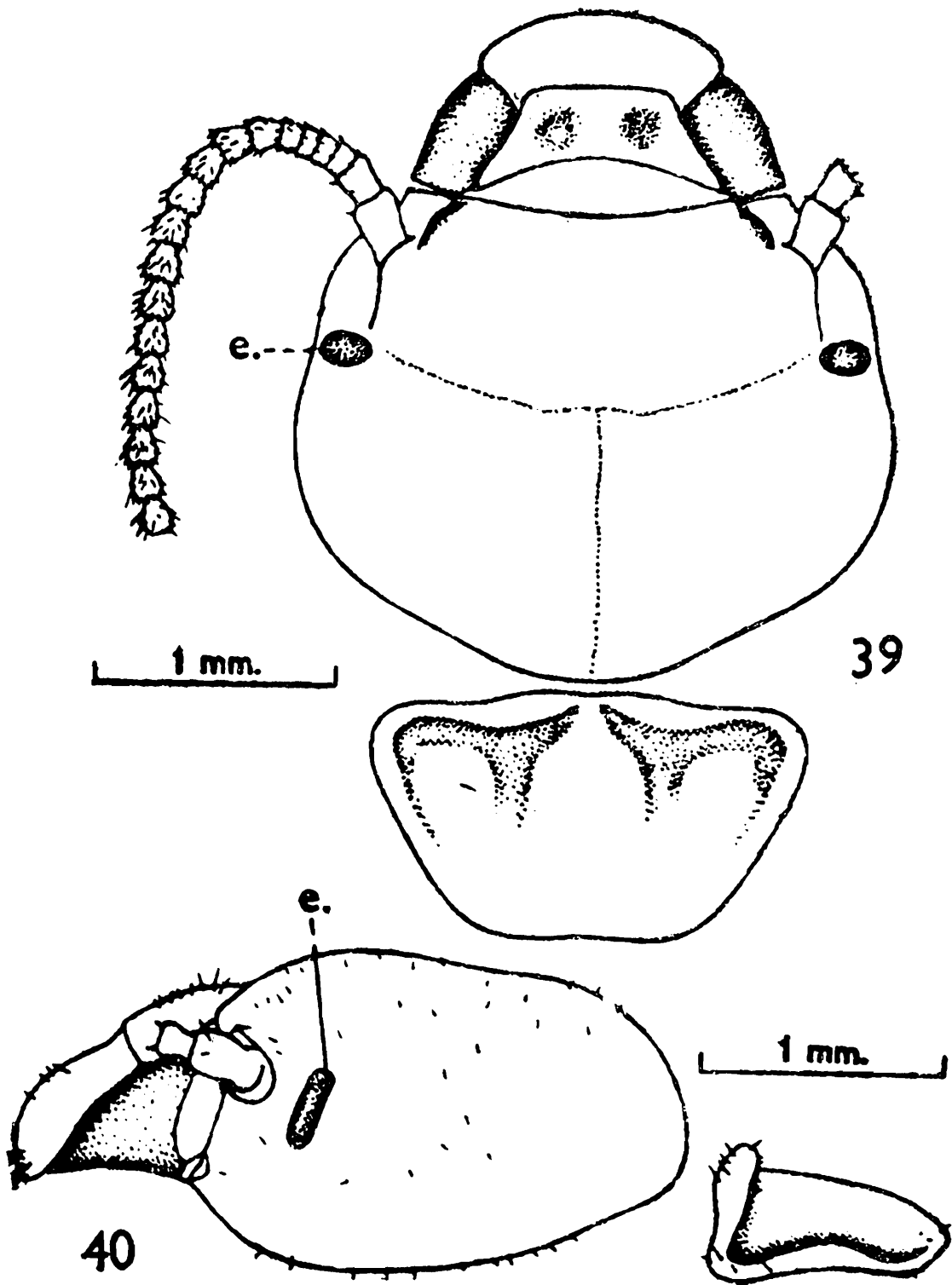
*According to Imms (1919), the majority of the colonies were without examples which could definitely be called pseudoworkers. In Bhowali, in May and June, he found 80 of them in one colony and 40 in another, and he believed that they occur seasonally. They had well developed gonads and one individual even laid eggs in captivity; he, therefore, regarded them as "gynecoids." These eggs are similar in size and form to those laid by queens.

The centre of the colony is occupied by eggs (which may lie in layers of excreta) and very young larvae, and close by are found the reproductives (kings and queens). Imms sometimes found three or four kings and queens together, and believed that this had resulted from the confluence of neighbouring colonies. No true neotenicis have been found. A large tree trunk may harbour several groups of eggs and larvae and several queens. Surrounding them are found the older larvae and nymphs, and soldiers are most numerous near the periphery. The fully formed alates at first remain in the centre of the colony, but later on they move to the periphery of the tunnels which lead to the exterior.

3. *Breeding and swarming*

The queen seems to lay eggs for a considerable part of the year, and young larvae have been found in February and July. During June and July older larvae and nymphs as well as winged adults are found in abundance. The eggs are whitish and ovoid (diameter ca. 0.45-0.50 mm), and have a smooth surface without any sculpturing. They are laid in groups of 10-25 in small, rounded chambers (ca. 8-9 mm in diameter) gnawed out of the wood in the central part of the colony. They are laid close to one another but are not held together by means of a secretion; and are sometimes covered by layers of excreta.

Swarming : Fully winged individuals seem to remain in the nest for sometime before swarming out. Swarming occurs at irregular intervals during the monsoon (June to August). Exceptionally, a swarm was noted by Imms in Bhowali (Kumaon) two weeks before the regular monsoon arrived, but just before swarming a heavy local rain-shower of half an hour's duration had occurred, and it is probable that high temperature and high humidity induced the swarming. Swarms are composed of both sexes; they emerge from tree trunks on hill slopes and first fly a few hundred metres before alighting. Swarming generally occurs in clear weather in the afternoons, but there is a record from Kanatal (Tehri Dist., U. P., 2400 m) of swarming in the night at 8 P. M. in heavy rain. It is possible that the swarming period and hours may vary with location and altitude. We have the following dates and records from collection notes : (i) Uttar Pradesh : Tehri Dist. (Kanatal, 2400 m). 24th June, 8 P. M. (ii) Himachal Pradesh : Manali (Kulu Valley), 6th July. (iii) Kashmir Valley : Yusimarg, 2255 m, 8th August. (iv) Afghanistan : Barikot, 1000 m., 11th August.



Text-figs. 39-40. *Archotermopsis wroughtoni*. Pseudoworker, head and pronotum.
 39. In dorsal view. 40. In side view.
 e., eye.

4. Food

They mostly feed on moist decaying wood, solid excretory matter ejected from the anus of other members of the colony, fluid diet ejected by older larvae and cast off exuvial skins; they also occasionally eat up the dead members of their colony. In captivity they imbibe drops of water sprinkled near the tunnels. The older larvae (4 mm long and upwards), nymphs and pseudoworkers feed mostly

on decaying wood and solid excretory matter. The soldiers, due probably to the form of their mandibles, seem to prefer the softest and the most decaying portions of the wood. The "unfertilized winged adults" take much less food than the nymphs. The young larvae (under 4 mm in length) and the kings and queens are fed upon a fluid substance of uncertain origin provided by the older larvae and pseudoworkers.

5. *Convulsive movements in colony*

According to Imms (1919) at times members of a colony exhibit convulsive movements in captivity. These movements mostly occurred after the individuals were disturbed. The whole body quivers, and this is repeated at irregular intervals. This may be a warning signal of danger.

6. *Intestinal Protozoa*

An abundant fauna of symbiotic flagellate Protozoa (families Trichonymphidae and Lophomonadidae) occurs in the hind intestine of *A. wroughteni* (Imms 1919, Cutler 1920, 1921, de Mello 1920, 1927, Saleem 1955, Uttangi and Joseph 1962, summary; Tiwari's list, 1977, is very incomplete). The Protozoa occur in abundance and help in the digestion of wood. They seem to be less common in imagoes than in the other castes and in larvae and nymphs. Six species have been found, as follows :

ORDER HYPERMASTIGIDA

1. *Pseudotrichonympha pristina* (Imms 1919). (Saleem 1955, places it in a new genus, *Prototrichonympha*.)

ORDER POLYMASTIGIDA

2. *Trichomonas termitis* Cutler 1919.
3. *Microjoenia axostylis* Cutler 1920.
4. *Joenopsis cephalotricha* Cutler 1920. (Saleem 1955, places it in a new genus, *Parajoenopsis*.)
5. *Joenopsis polytricha* Cutler 1920.
6. *Ditrichomonas termitis* Imms 1919.

SUMMARY

1. The identity of *Archotermopsis wroughtoni* (Desneux) is clarified in relation to its junior synonyms (*radcliffei* Radcliffe and *deodarae* Chatterjee and Thakur).

2. Taxonomic descriptions are provided for the various castes (imago, soldier and pseudoworker).

3. Its geographical distribution is given. It extends from the Kumaon and Kulu Valleys in NW India (the Himalayan area) via the Kashmir Valley to Hazara and Murree Hills in NW Pakistan and to SE Afghanistan. At 900-3000 m attitudes. Associated with coniferous forests.

4. Its biology is discussed briefly, especially habitat, breeding, swarming and food. A list of the six flagellate Protozoa symbionts which occur in the hind gut is given.

ACKNOWLEDGEMENTS

We are obliged to Dr. R. C. Sharma (Superintending Zoologist, Desert Regional Station, Zoological Survey of India, Jodhpur) for assistance with some of the drawings.

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SILVANIDAE (COLEOPTERA : CLAVICORNIA) FROM
SOUTHERN INDIA AND SRI LANKA IN MUSEUM
D' HISTOIRE NATURELLE DE GENÈVE

By

TARUN KUMAR PAL

Zoological Survey of India, Calcutta

(With 21 Text-figures)

Family : SILVANIDAE

Subfamily : SILVANINAE

1. *Silvanoprus cephalotes* (Reitter)

(Text-figs. 1, 2)

Silvanus cephalotes Reitter, 1876, *Col. Hefte* 15 : 62 (Japan).

Silvanoprus cephalotes (Reitter) : Grouvelle, 1912, *Annls Soc. ent. Fr.* 81 : 343.

This species (Text-fig. 1) can be distinguished by its very short temple, lateral margin of prothorax slightly rounded and anterior spine of prothorax minute ; aedeagus (Text-fig. 2) with median lobe slightly tapered at apex, each paramere with a pair of long and short setae. Length 2.20-2.42 mm.

Specimen examined : INDIA : TAMIL NADU, Coimbatore, 420 m., 1 ex., ii. 1970, T. R. S. Nathan.

Distribution : India ; Bhutan ; Sri Lanka ; Indonesia (Java) ; Japan ; China.

2. *Silvanoprus longicollis* (Reitter)

(Text-figs. 3, 4)

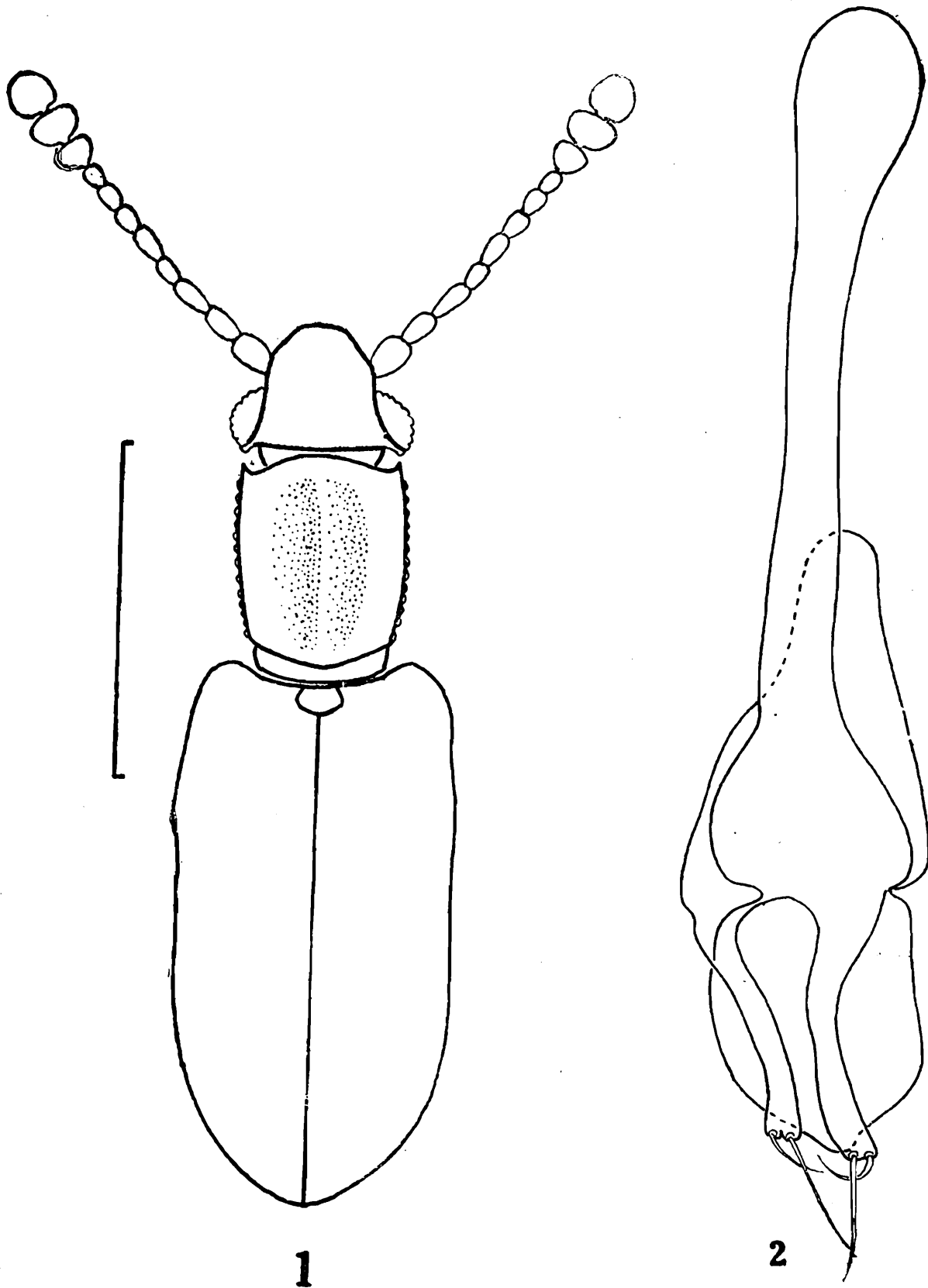
Silvanus longicollis Reitter, 1876, *Col. Hefte* 15 : 60 (Sri Lanka)

Silvanoprus longicollis (Reitter) : Grouvelle, 1912, *Annls Soc. ent. Fr.* 81 : 341.

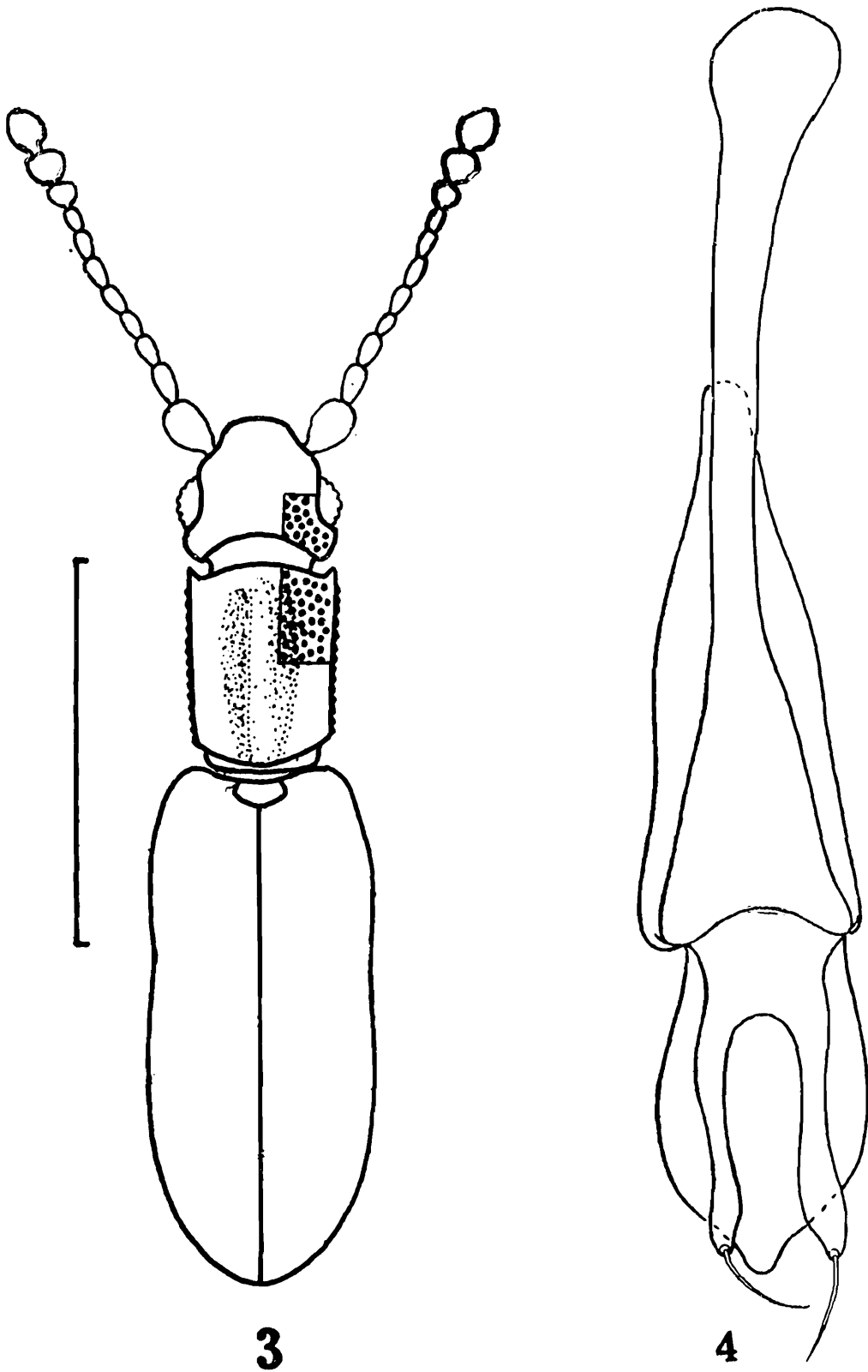
This species (Text-fig. 3) is characterized by its long temple, large antennal scape, and ocellate punctures of head and prothorax ; aedeagus (Text-fig. 4) with median lobe slightly tapered at apex, each paramere with a long apical seta.

Specimen examined : INDIA : TAMIL NADU, Coimbatore, 420 m.,
1 ex., ii. 1970, T. R. S. Nathan.

Distribution : India ; Sri Lanka ; Malaysia ; Indonesia (Java) ;
China ; Japan ; Madagascar ; East Africa.



Text-figs. 1-2. 1. *Silvanoprus cephalotes* (Reitter), Dorsal view (scale=1 mm.).
2. Aedeagus of *Silvanoprus cephalotes* (Reitter), Dorsal view.



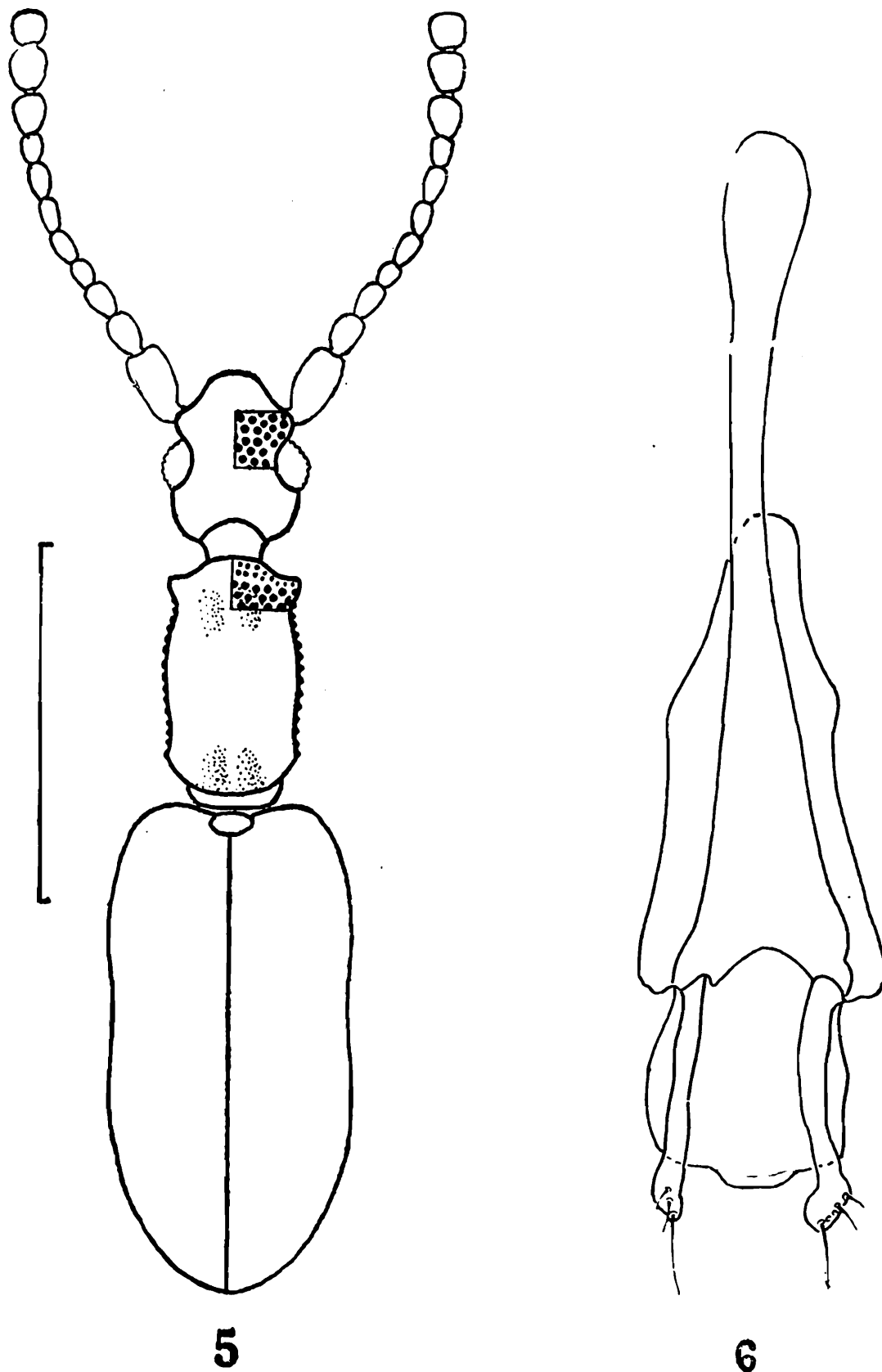
Text-figs. 3-4. 3. *Silvanoprus longicollis* (Reitter), Dorsal view (scale=1 mm.).

4. Aedeagus of *Silvanoprus longicollis* (Reitter), Dorsal view.

3. *Silvanoprus* sp.

(Text-figs. 5, 6)

This species (Text-fig. 5) is closely related to *Silvanoprus longicollis* (Reitter) but can be easily separated by its antennal scape about two times as long as broad, antennal joints 9 and 10 distinctly elongated



Text-figs. 5-6. 5. *Silvanoprus* sp., Dorsal view (scale=1 mm.).

6. Aedeagus of *Silvanoprus* sp., Dorsal view.

temple slightly longer than length of eye, anterior spines of prothorax situated beneath the level of anterior margin of prothorax, and lateral margins of prothorax distinctly sinuate across anterior one-fourth; aedeagus (Text-fig. 6) with its apical projection of median lobe broad and blunt, apex of each paramere abruptly broadened and with one

long and two shorter apical setae. The detailed description of this species will be published elsewhere.

Specimens examined : SRI LANKA : North Central, Medawachiya, 2 ex., 6.ii.1970, Mussard Besuchet Löbl.

4. *Oryzaephilus surinamensis* (Linnaeus)

(Text-figs. 7, 9)

Dermestes surinamensis Linnaeus, 1758, *Systema Naturae* ed. 10, 1 : 357 (Surinam, Dutch Guinea).

Tenebrio cursor Linnaeus, 1758, *Systema Nature* ed. 10, 1 : 418.

Tenebrio surinamensis (Linnaeus) : Degeer, 1775, *Memoires pour Servir a l' Histoire des Insectes* 5 : 54.

Anobium frumentarium Fabricius, 1775, *Systema Entomologia* : 62.

Ips sexdentata Herbst, 1783, *Archiv der Insectengeschichte* 4 : 31.

Silpha sexdentata (Herbst) : Gmelin, 1790, *Systema Nature* 1 (4) : 1619.

Silpha surinamensis : Gmelin, 1790, *Systema Naturae* 1 (4) : 1620.

Ips frumentaria (Fabricius) : Olivier, 1790, *Entomologie, ou Historie Naturelle des Insectes* 2 (18) *Ips* : 10.

Scarites cursor (Linnaeus) : Fabricius, 1792, *Entomologia Systematica* 1 : 96.

Colydium frumentarium : Fabricius, 1792, *Entomologia Systematica* 1 : 496.

Dermestes sexdentatus Fabricius, 1792, *Entomologia Systematica* 1 : 232.

Lyctus sexdentatus (Fabricius) : Kugelann, 1794, *Schneider's Magazine* 1 : 566.

Colydium sexdentatum (Fabricius) : Paykull, 1800, *Fauna Suecica, Insecta* 3 : 313.

Corticaria frumentaria (Fabricius) : Marsham, 1802, *Coleoptera Britanica* : 107.

Silvanus sexdentatus (Fabricius) : Gyllenhal, 1813, *Insecta Suecica Classis, I, Coleoptera sive Eleuterata* 1 (3) : 406.

Silvanus surinamensis : Stephens, 1829, *A Systematic Catalogue of British Insects* : 92.

Silvanus bicornis Erichson, 1846, *Naturgeschichte der Insecten Deutschlands* 1, *Coleoptera*, 3 : 337.

Silvanus surinamensis var. *bicornis* : Reitter, 1890. *Wien. ent. Ztg.* 9 : 255.

Silvanus (Oryzaephilus) surinamensis : Ganglbauer, 1899, *Die Käfer von Mitteleuropa* 3 : 584.

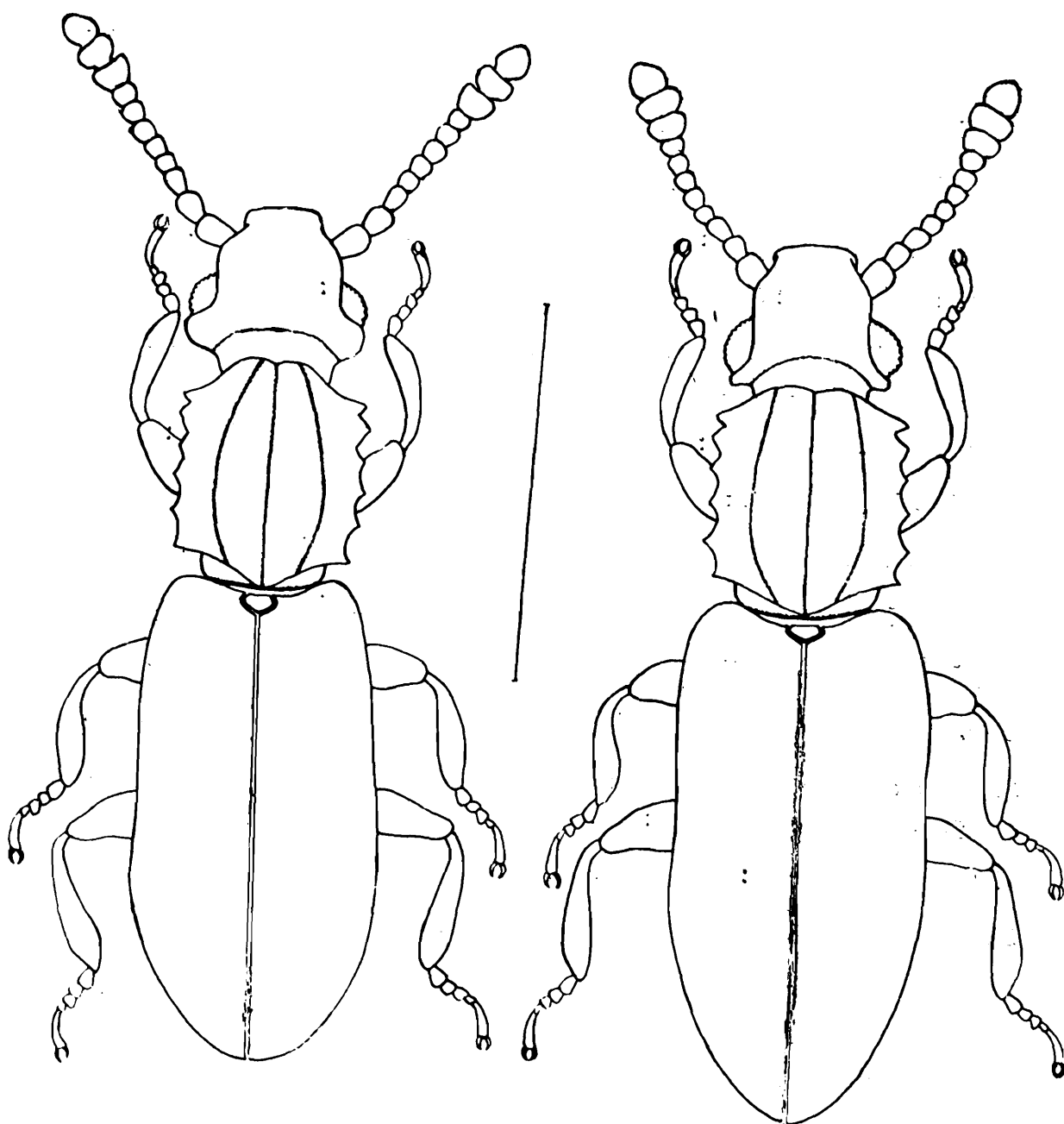
Oryzaephilus surinamensis : Reitter, 1911, *Fauna Germanica* 3 : 46 ; Grouvelle, 1912, *Annls Soc. ent. Fr.* 81 : 318 ; Halstead, 1980, *Zool. J. Linn. Soc.* 69 : 286-290.

Common name : Saw-toothed grain beetle.

This is a most notorious insect pest that attacks almost all stored food products of vegetable origin and has a world-wide distribution. This species (Text-fig. 7) can easily be recognised by its prothorax with six lateral teeth on each side and three longitudinal carinae on pronotum, temple about as long as 3.5 to 4 eye facets and about as long as eye ; aedeagus (Text-fig. 9) with parameres long and slender, each paramere with numerous short setae and a few long apically forked setae on outer margin and apex. Length 2.75-3.50 mm.

Specimen examined : INDIA : TAMIL NADU. Coimbatore, 440 m., 1 ex., ii. 1970, T. R. S. Nathan.

Distribution : Cosmopolitan.



7

8

Text-figs. 7-8. 7, *Oryzaephilus surinamensis* (Linnaeus), Dorsal view ; 8, *Oryzaephilus mercator* (Fauvel), Dorsal view (scale=1 mm.).

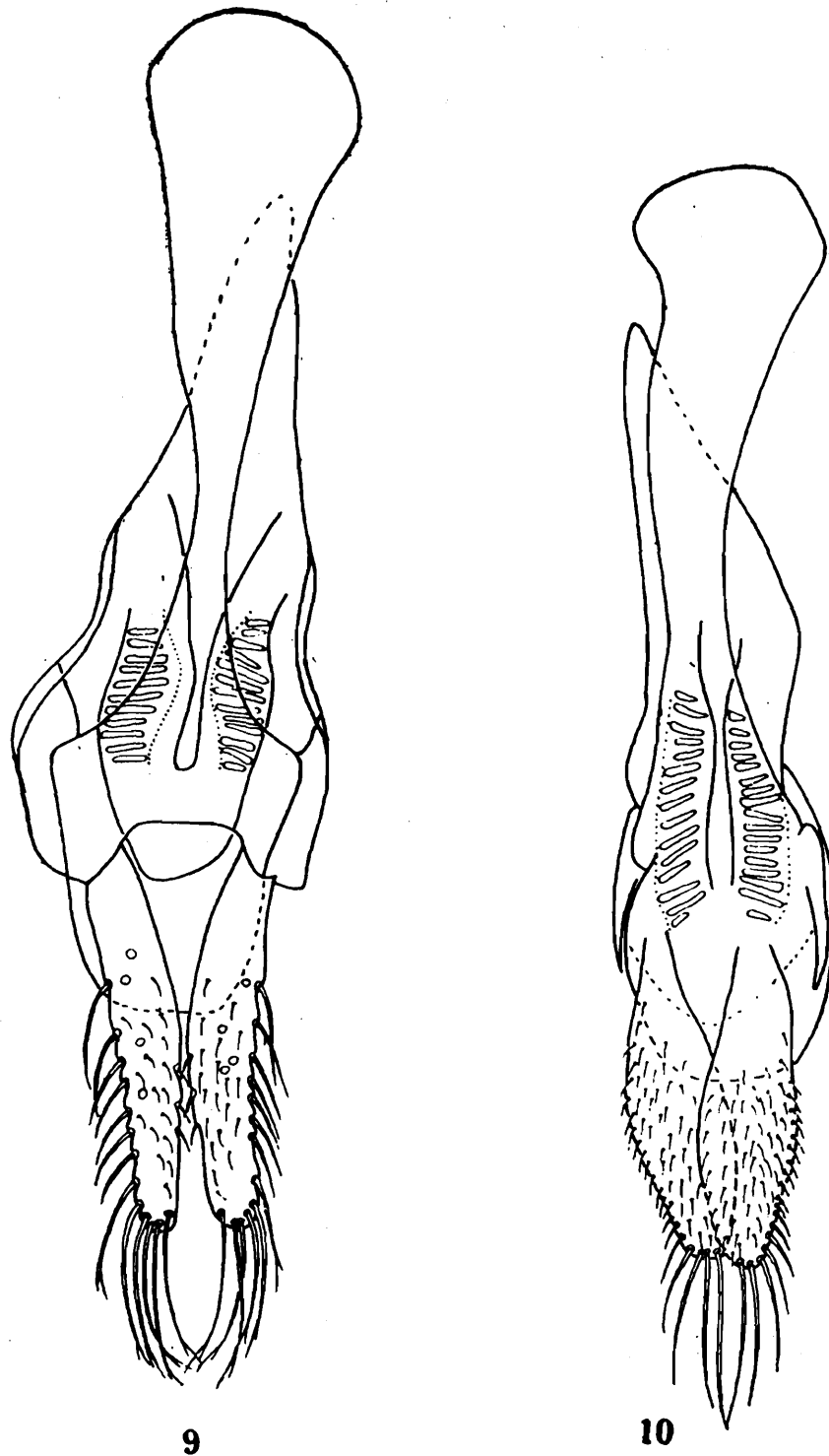
5. *Oryzaephilus mercator* (Fauvel)

(Text-figs. 9, 10)

Silvanus mercator Fauvel, 1889, *Revue Ent.* 9 : 132 (France, Africa, New Caledonia);
Reitter, 1890, *Wien. ent. Ztg.* 9 : 255.

Silvanus gossypii Chittenden, 1897, *Bull. Bur. Ent. U. S. Dep. Agric.* 8 : 13.

Silvanus (*Oryzaephilus*) *mercator*; Ganglbauer, 1899, *Die Käfer von Mitteleuropa*
3 : 585.



Text-figs. 9-10. Aedeagus, Dorsal view : 9, *Oryzaephilus surinamensis* (Linnaeus);
10, *Oryzaephilus mercator* (Fauvel).

Oryzaephilus mercator : Reitter, 1911, *Fauna Germanica* 3 : 46 ; Slow, 1958, *Bull. ent. Res.* 49 : 27 ; Halstead, 1980, *Zool. J. Linn. Soc.* 69 : 306-309.

This is also a well known stored grain pest, closely related to *O. surinamensis* but can easily be separated by its temple about as long as 2 to 2.5 eye facets or about one-third as long as eye (Text-fig. 8) ; its aedeagus (Text-fig. 10) with parameres slightly broader across posterior half, and each paramere with numerous small setae and a few long setae only at apex. Length 3.00-3.50 mm.

Specimen examined : INDIA : TAMIL NADU, Coimbatore, 440 m., 1 ex., ii. 1970, T. R. S. Nathan.

Distribution : Cosmopolitan.

6. *Monanus concinnulus* (walker)

(Text-figs. 11, 12)

Monotoma concinnulus Walker, 1858, *Ann. Mag. nat. Hist.* (3) 2 : 207 (Sri Lanka).

Emporius concinnulus (Walker) : Grouvelle, 1908, *Annls Soc. ent. Fr.* 77 : 489.

Monanus (s. str.) *concinnulus* (Walker) : Grouvelle, 1912, *Annls Soc. ent. Fr.* 81 : 371 ; Pal, 1981, *Oriental Ins.* 15 : 247.

Grouvelle (1908 and 1912) dealt with this species and mentioned its distribution as cosmopolitan. Pal (1981) recorded it from the different States of India. A distinct transverse spot on elytra is the most conspicuous character for recognising this species (Text-fig. 11). The aedeagus (Text-fig. 12) with parameres elongated, each paramere with an apical long and two short setae. Length 1.60-2.35 mm.

Specimen examined : INDIA : TAMIL NADU, Anaimalai Hill, Aliyar Dam, 550 m., 1 ex., 17. xi. 1972, Besuchet Löbl Mussard.

Distribution : India : Assam, West Bengal, Bihar, Uttar Pradesh, Delhi, Tamil Nadu, Karnataka. Outside India this species is widely distributed both in the Old and New Worlds.

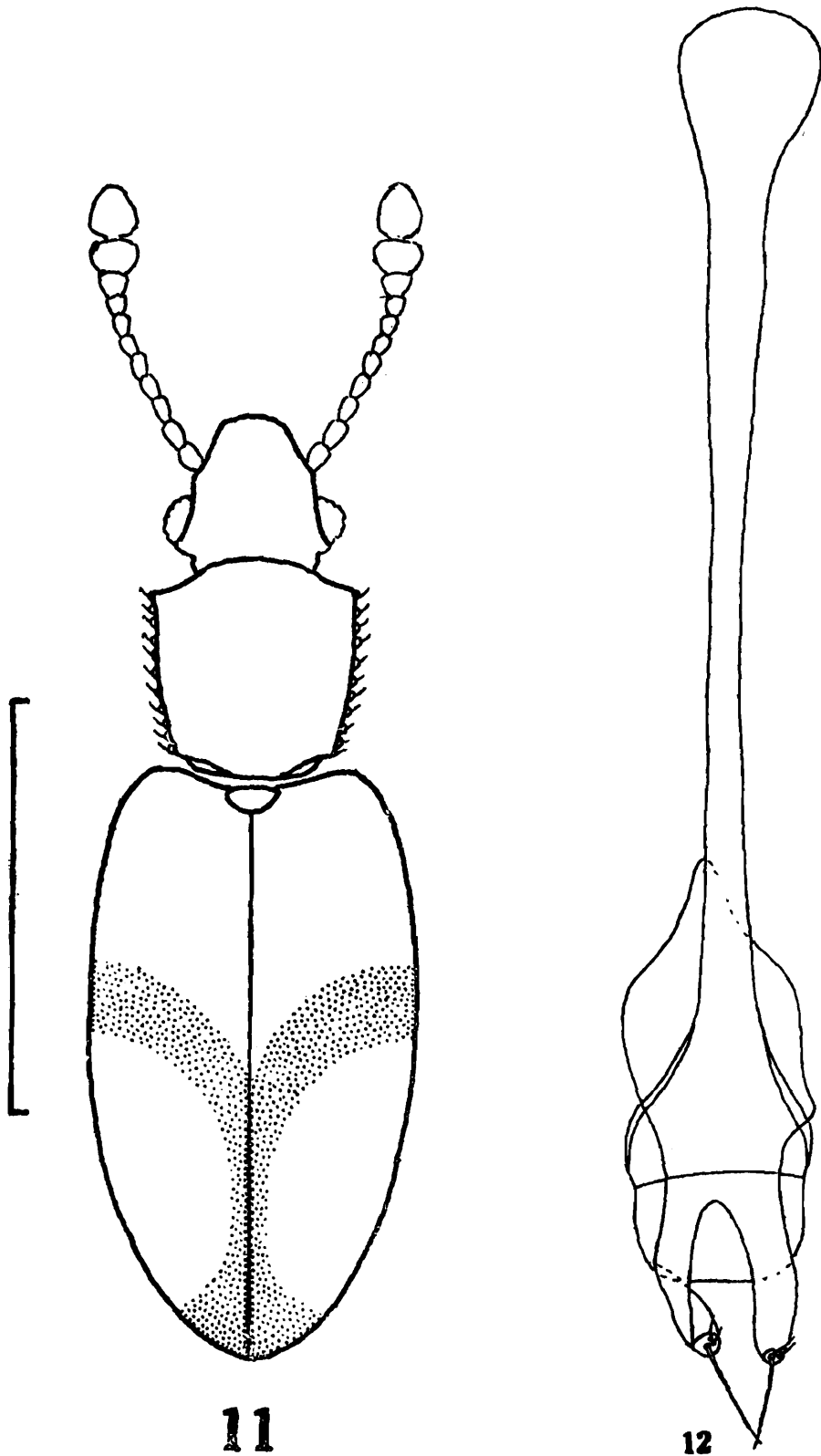
Subfamily : PSAMMOECINAE

7. *Psammoecus andrewesi* Grouvelle

(Text-fig. 13)

Psammoecus andrewesi Grouvelle, 1908, *Annls Soc. ent. Fr.* 77 : 476 (Nilgiri Hills : India).

Grouvelle (1908) recorded this species from Tamil Nadu (South India) and Pal and SenGupta (1979) recorded this species from Meghalaya. This is a distinct species and can be easily recognised by



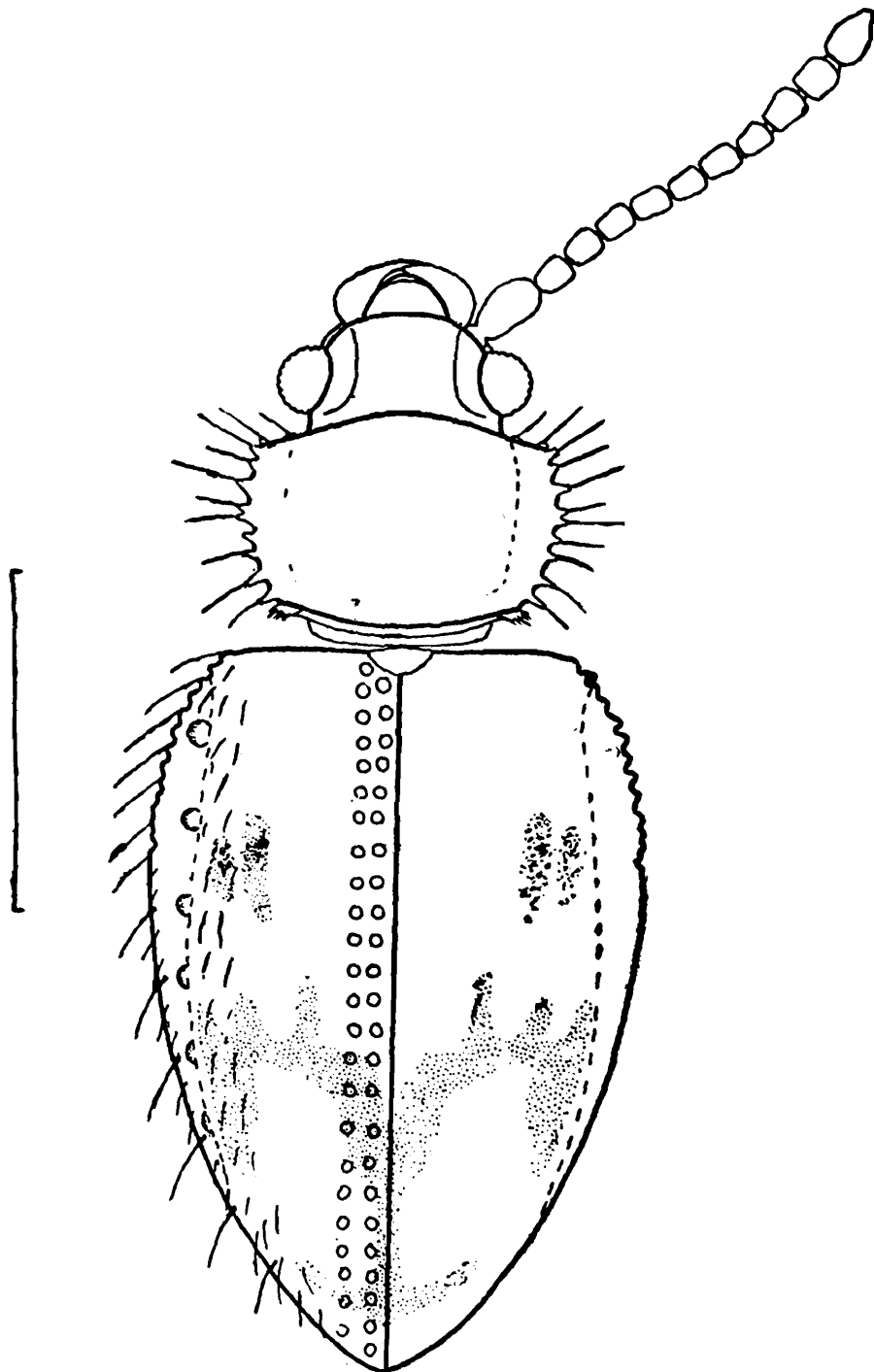
Text-figs. 11-12. 11. *Monanus concinnulus* (Walker), Dorsal view (scale=1 mm.).

12. Aedeagus of *Monanus concinnulus* (Walker), Dorsal view.

its elytra being distinctly narrowed behind middle and subacuminate at apex, antenna unicolourous, blackish linear longitudinal spots on each elytron, head across eyes distinctly narrower than prothorax across anterior margin, lateral margins of prothorax and elytra explanate and six large glandular punctures along lateral margin of each elytron, Length 2.60-3.35 mm.

Specimen examined : INDIA : TAMIL NADU, Nilgiri Hills, 71 km. E. Coonoor, 1350m., 1 ex., 19. xi. 1972, Besuchet Löbl Mussard.

Distribution : India : Meghalaya, Tamil Nadu.



13

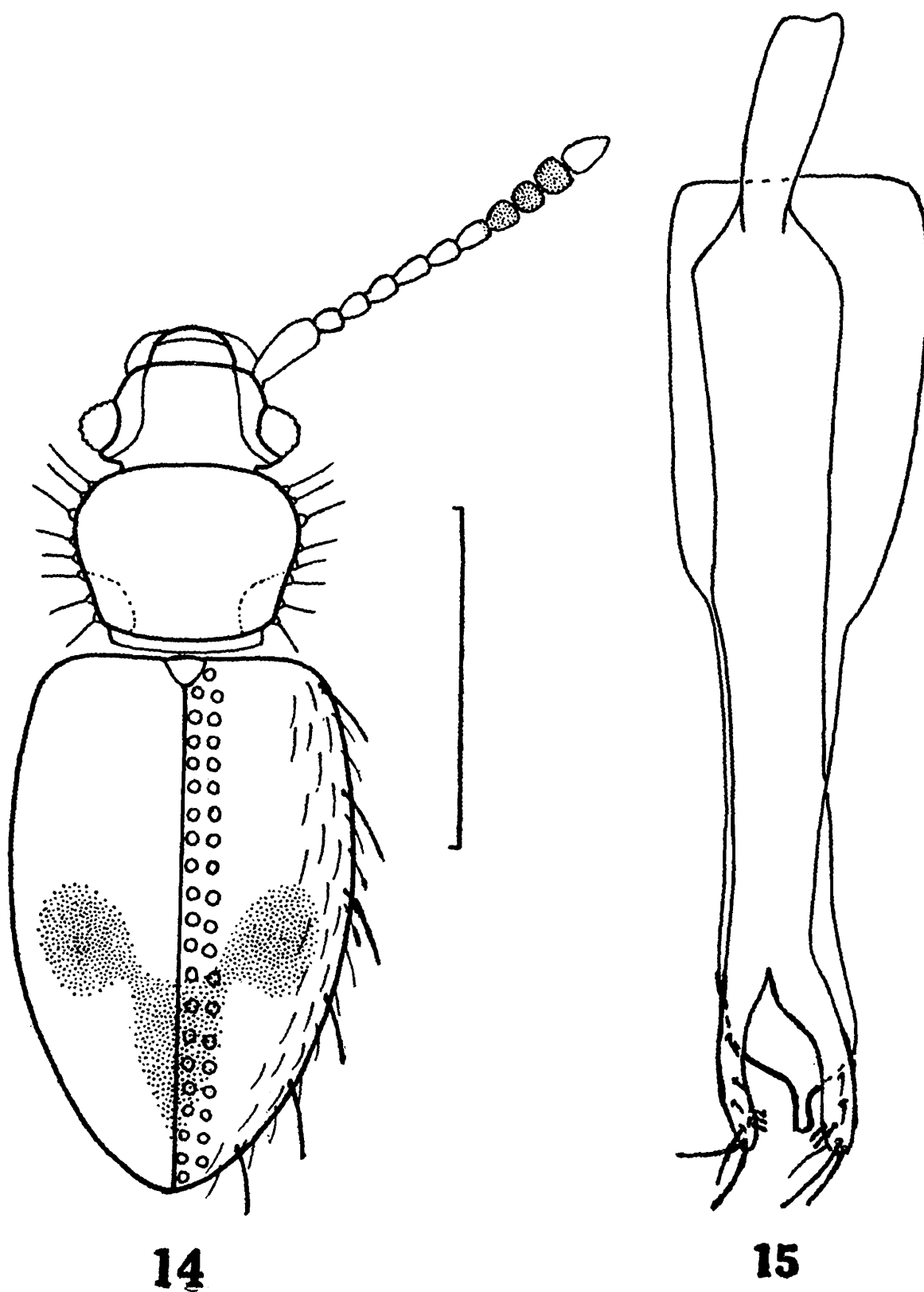
Text-fig. 13. *Psammoecus andrewesi* Grouvelle, Dorsal view (scale=1 mm.).

8. *Psammoecus lepidus* Grouvelle

(Text-figs. 14, 15)

Psammoecus lepidus Grouvelle, 1908, *Annls Soc. ent. Fr.* 77. 483 (Shembaganur, Madura district : India).

Grouvelle (1908) described this species from Madura district : Tamil Nadu (South India) and Pal and Sengupta (1979) recorded this

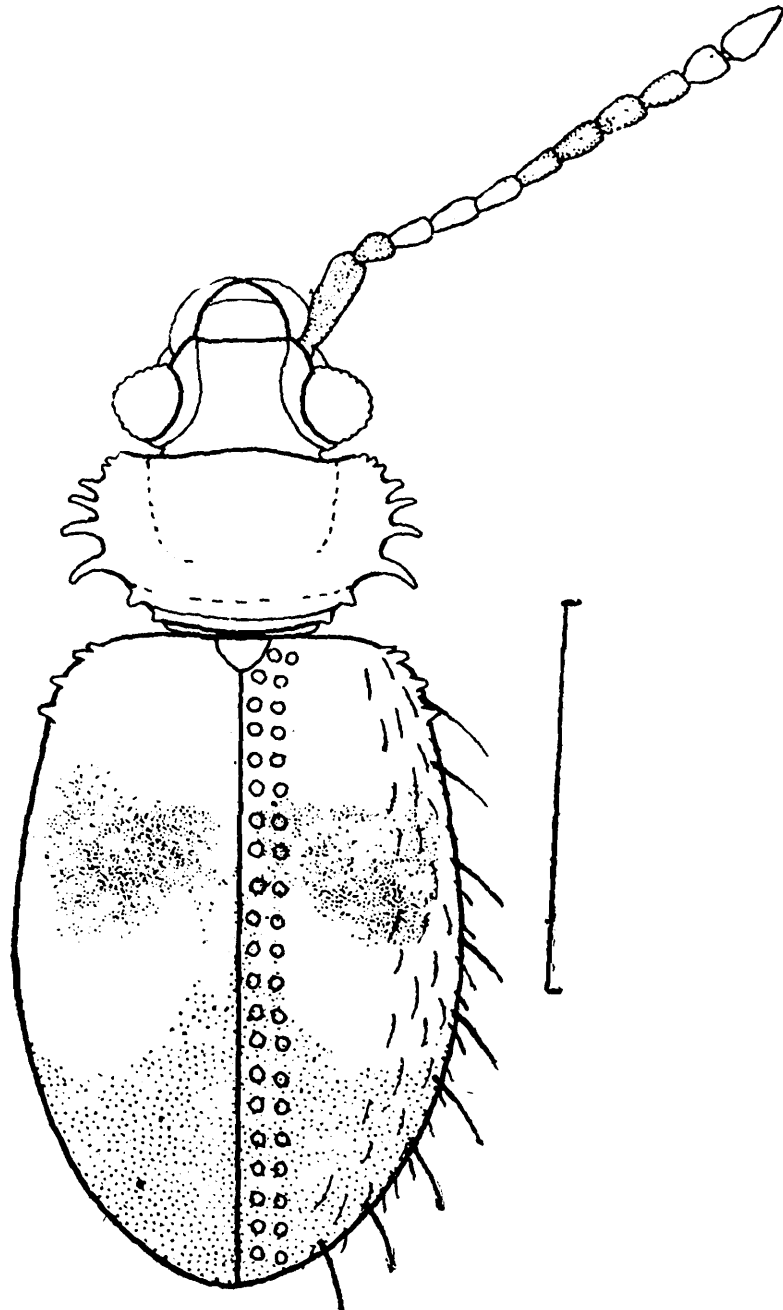


Text-figs. 14-15. 14. *Psammoecus lepidus* Grouvelle, Dorsal view (scale=1 mm.).

15. Aedeagus of *Psammoecus lepidus* Grouvelle, Dorsal view.

species from Bhutan. This species (Text-fig. 14) is closely related to *P. harmandi* Grouvelle but can be separated by its apical part of antennal joint 7 and joints 8-10 blackish, head and prothorax blackish and elytra reddish brown with blackish spots, lateral margin of prothorax slightly wavy and sinuate before posterior angle ; aedeagus (Text-fig. 15)

with median lobe broad, abruptly narrowed and rather broadly pointed at apex, parameres long and slender, each paramere with a few apical long setae and few short setae on its surface. Length 2.25-2.85 mm.



16

Text-fig. 16. *Psammoecus delicatus* Grouvelle, Dorsal view (scale=1 mm.).

Specimens examined : INDIA : KERALA, Cardamom H., Multapalti pres Munnar, 1700 m., 1 ex., 24. xi. 1972, Besuchet Löbl Mussard ; TAMIL NADU, Palni H., Berijam Lake, 2150 m., 56 ex., 14. xi. 1972, Besuchet Löbl Mussard ; Kodaikanal, 2100 m., 14 ex., Besuchet Löbl Mussard ; 10 km. N-O Kodaikanal, 2150 m., 6 ex., 15. xi. 1972, Besuchet Löbl Mussard.

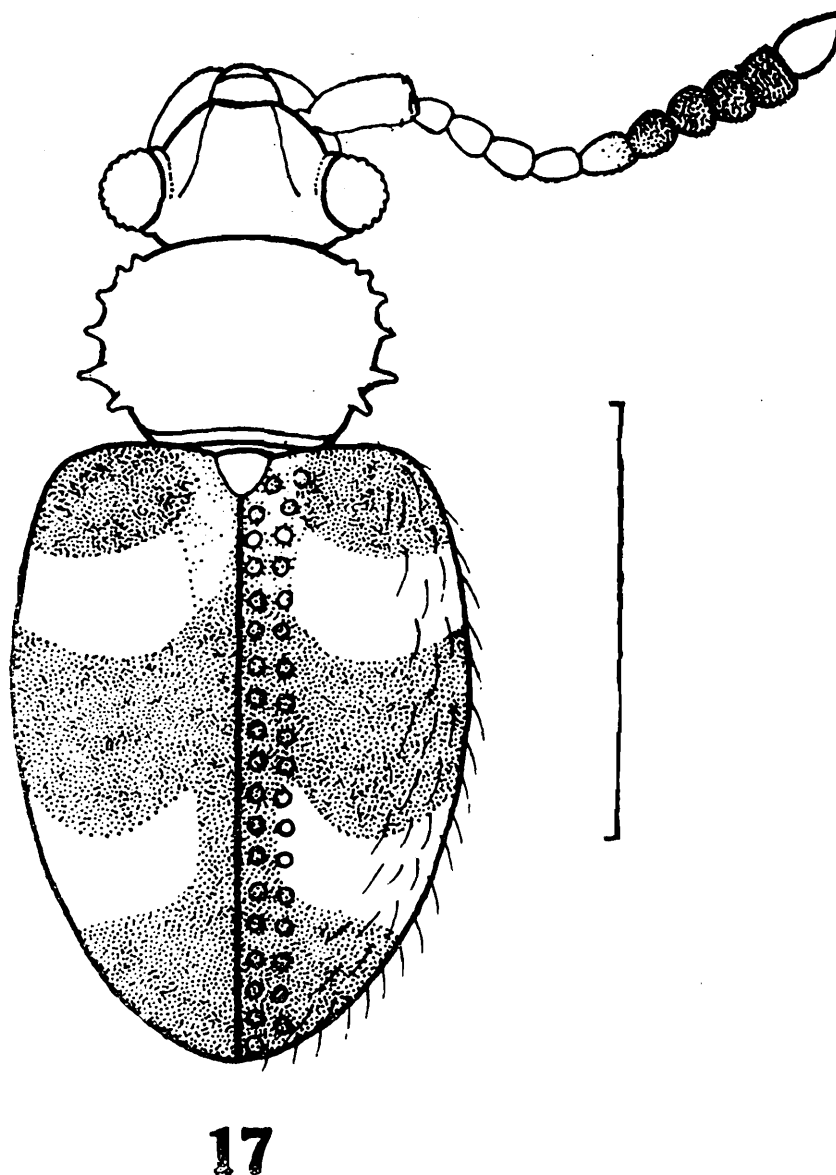
Distribution : India : Kerala, Tamil Nadu ; Bhutan.

9. *Psammoecus delicatus* Grouvelle

(Text-fig. 16)

Psammoecus delicatus Grouvelle, 1908, *Annls. Soc. ent. Fr.* 77 : 487 (Sri Lanka) ; Pal, 1985, *Misc. publ. Rec. zool. Surv. India, Occ. pap.* 71 : 21.

This species (Text-fig. 16) can be recognised by its prothorax being markedly transverse, strongly depressed in front of prothoracic base and its lateral sides widely explanate ; teeth on lateral margin of



Text-fig. 17. *Psammoecus simoni* Grouvelle, Dorsal view (scale=1 mm.).

prothorax narrow, markedly long and a few of them about four times as long as broad ; antennal joints distinctly elongated, scape at least three times longer than wide ; antennal scape and pedicel, apical part of joint 6 and joints 7-9 blackish and joints 10 and 11 yellowish white. Length 2.41-2.57 mm.

Specimens examined : INDIA : KERALA, Cardamom H., Vallara fall, 450-500 m., 1 ex., 25. xi. 1972, Besuchet Löbl Mussard ; SRI LANKA (Central), Kandy, 600 m., 1 ex., 15. i. 1970, Mussard Besuchet Löbl ; 1 ex., (particular locality not given), i. 1965, R. Mussard.

Distribution : India : Kerala ; Sri Lanka.

10. *Psammoecus simoni* Grouvelle

(Text-fig. 17)

Psammoecus simonis Grouvelle, 1892, *Annls Soc. ent. Fr.* 61 : 287 (Philippines).

Psammoecus simoni Grouvelle : Grouvelle, 1908, *Annls Soc. ent. Fr.* 77 : 488.

This is a distinct species and can be recognised by its two transverse characteristic spots on elytra and two small rounded spots near humeral angles, and transverse spots interconnected by longitudinal sutural spot. Length 2.13-2.58 mm.

Specimen examined : SRI LANKA (Central), Mahaweli Ganga, à 7 miles de kandy, 450 m., 1 ex., 15. i. 1970.

Distribution : Sri Lanka ; Malaysia ; Indonesia ; Philippines ; Seychelles Is. ; Madagascar.

11. *Psammoecus trimaculatus* Motschulsky

(Text-figs. 18, 19)

Psammoecus trimaculatus Motschulsky, 1858, *Etud. ent.* 7 : 45 (Sri Lanka) ; Grouvelle, 1908, *Annls Soc. ent. Fr.* 77 : 476.

? *Cucujus incommodus* Walker, 1859, *Ann. Mag. nat. Hist.* (3) 3 : 53.

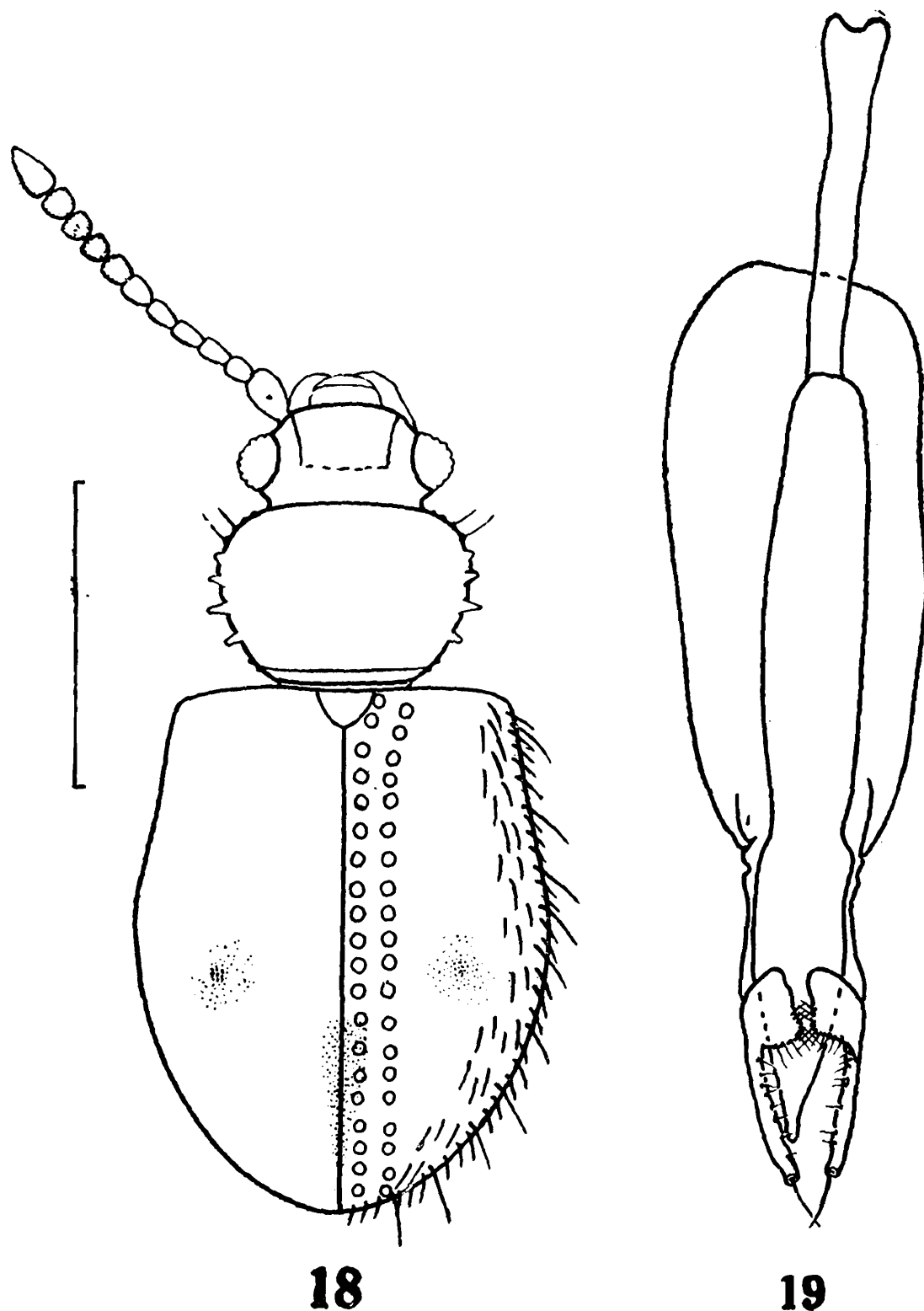
Telephanus cruciger Waterhouse, 1876, *Entomologist's mon. Mag.* 13 : 125.

Motschulsky (1858) described this species from Sri Lanka, Grouvelle (1908) synonymised ?*Cucujus incommodus* Walker and *Telephanus cruciger* Waterhouse with this species. Pal and Sengupta (1979) recorded this species from Bhutan. *P. trimaculatus* (Text-fig. 18) is closely related to *P. impressicollis* Grouvelle but can be easily separated by the presence of longitudinal sutural spot on elytra, prothorax less transverse and transverse depression in front of prothoracic base indistinct, and lateral teeth hardly twice wider than long. Aedeagus (Text-fig. 19) with median lobe long, gradually narrowed and pointed at apex ; parameres long and slender, each paramere with a long apical seta and few short setae along its inner margin, a few short and rather dense setae also at its broad base. Length 2.23-2.94 mm.

Specimens examined : INDIA : TAMIL NADU, Coimbatore, 440 m., 3 ex., 22. xi. 1972, Besuchet Löbl Mussard ; KERALA, Cardamom H.

Periyar env. Aranya Nivas, 950 m., 1 ex., 4. xi. 1972, Besuchet Löbl
Mussard.

Distribution : India : Tamil Nadu, Kerala ; Bhutan ; Sri Lanka,
Burma ; Malayasia ; Japan ; Madagassar,

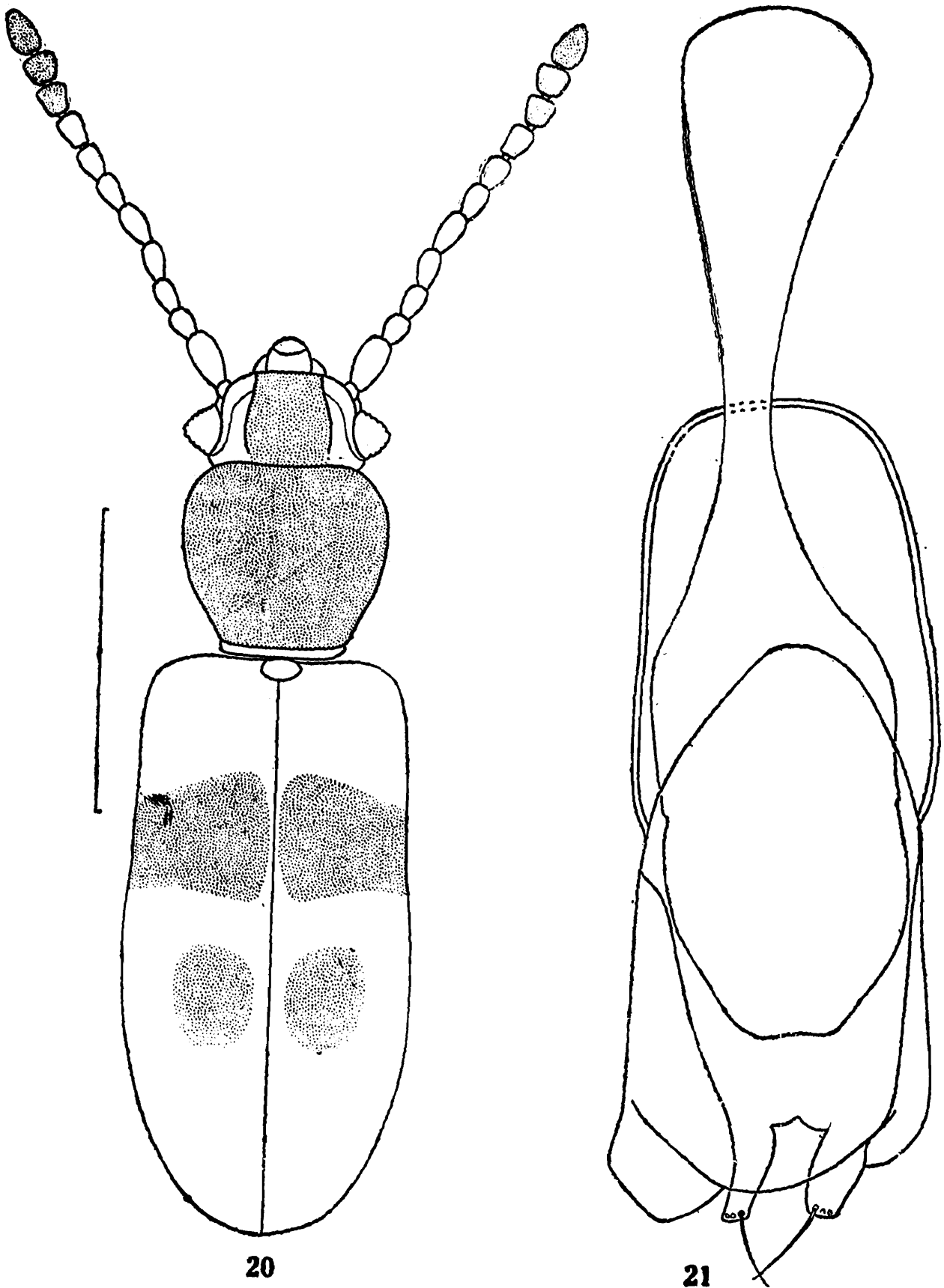


Text-figs. 18-19. 18. *Psammoecus trimaculatus* Motschulsky, Dorsal view (scale=1 mm.).
19. Aedeagus of *Psammoecus trimaculatus* Motschulsky, Dorsal view.

Subfamily CRYPTAMORPHINAE

12. *Cryptamorpha infans* Grouvelle

(Text-figs. 20, 21)

Cryptamorpha infans Grouvelle, 1908, *Annls Soc. ent. Fr.* 77 : : 474 (Madura : India).Text-figs. 20-21. 20. *Cryptamorpha infans* Grouvelle, Dorsal view (scale=1 mm.).21. Aedeagus of *Cryptamorpha infans* Grouvelle, Dorsal view.

This (Text-fig. 20) is a distinct species, can be easily separated from other Indian species of *Cryptamorpha* by its longitudinal grooves on vertex of head converging posteriorly but not united, eyes projected, and puncturation on vertex and pronotum coarse and dense ; aedeagus (Text-fig. 21) with median lobe broadly pointed, parameres short and each paramere with one long apical seta. Length 2.33-2.69 mm.

Specimens examined : INDIA : TAMIL NADU, Palni Hills, Kodaikanal, 2250 m., 3 ex., 12. xi. 1972, Besuchet Löbl Mussard ; Palni Hills, Berijam Lake, 2150 m., 1 ex., 14. xi. 1972. Besuchet Löbl Mussard.

Distribution : India : Tamil Nadu.

SUMMARY

96 specimens of *Silvanidae* collected from South India (Tamil Nadu and Kerala) and Sri Lanka present in Museum d' Histoire Naturelle de Genève comprise 12 species under 5 genera. *Psammoecus delicatus* Grouvelle is recorded for the first time from India.

During 1965 to 1972 Besuchet, Mussard and Löbl collected 96 specimens of *Silvanidae* from Southern India, chiefly from Nilgiri Hills, Cordamom Hills and Sri Lanka. These specimens were made available to the writer for study which represent 12 species under 5 genera. One species of the genus *Silvanoprus* Reitter is new to science which has also been recorded by Dr. D. G. H. Halstead of Pest Infestation Control Laboratory Slough, England.

ACKNOWLEDGEMENTS

The author is indebted to Dr. T. Sengupta who borrowed the material from the Museum d' Histoire Naturelle, Genève and kindly provided the author an opportunity to examine this interesting collection. He is also grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, for providing the laboratory facilities. Council of Scientific and Industrial Research, New Delhi provided a Research Associateship for undertaking this work.

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ON THREE NEW SPECIES OF ASTEROCHERID COPEPODS, WITH
A REDESCRIPTION OF *INDOMYZON QUASIMI* UMMERKUTTY

By

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(With 63 Text-figures)

INTRODUCTION

Family Asterocheridae contains about 24 valid genera differing mainly in the segmentation of the urosome, the first antenna and the pereopods. Several attempts have been made to study the family as a whole (Sewell, 1949; Ummerkutty, 1966 and Stock, 1965, 1975) but a thorough revision of the family is yet to be undertaken. As the family is somewhat heterogeneous one often finds difficulty in assigning a species to its proper genus.

I am describing below two new species of *Asterocheres* Boeck, 1859, and one new species of *Asteropontius* Thompson & Scott, 1903. A detailed description of *Indomyzon quasimi* Ummerkutty, 1966, is also included, as the original and only description of this species available, is not detailed and my material shows some difference from that of Ummerkutty.

The holotypes and allotypes will be deposited in the Indian Museum, Calcutta.

DESCRIPTION OF SPECIES

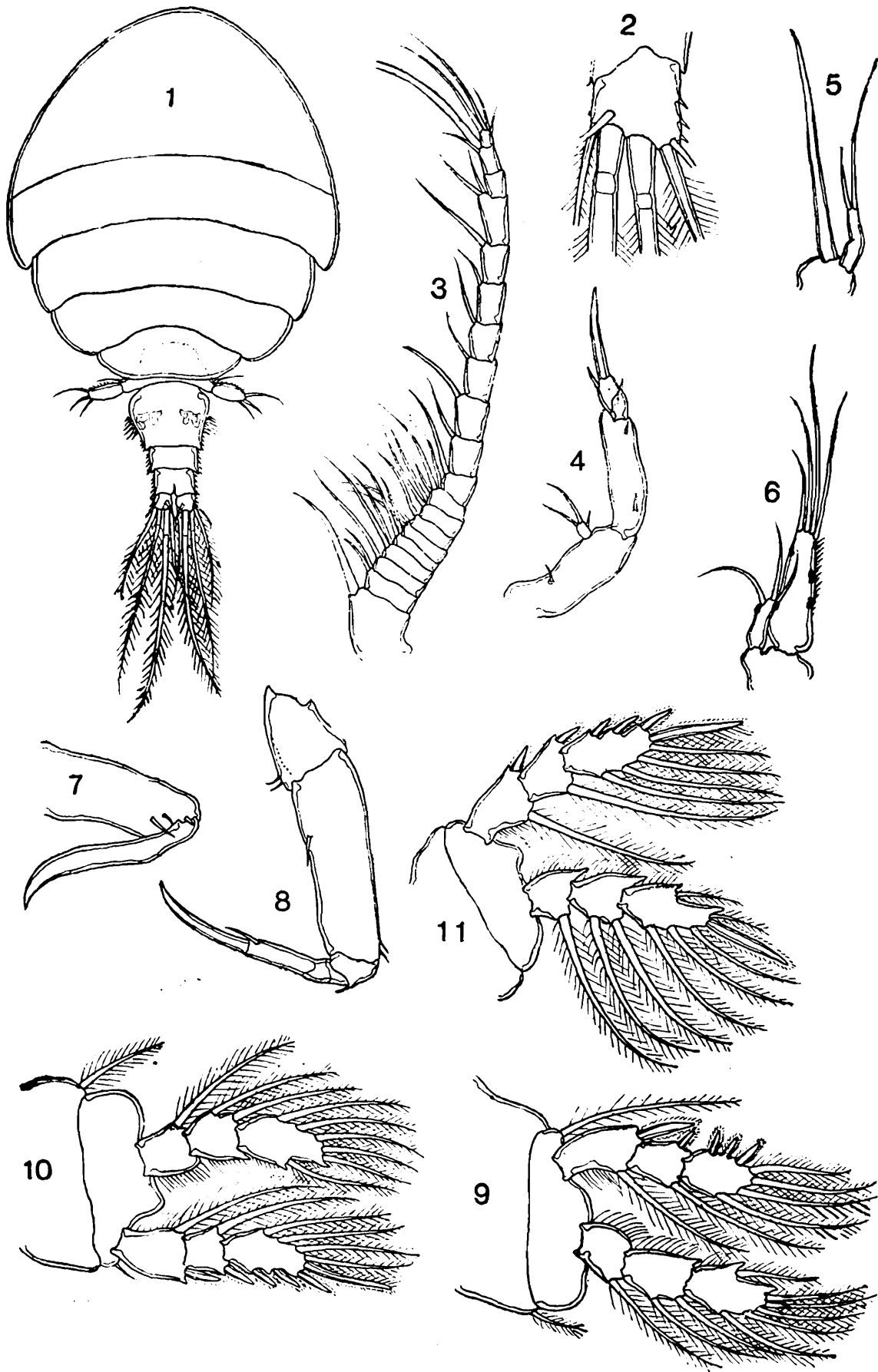
***Asterocheres stocki* sp. nov.**

(Text-figs. 1-19)

Material: Two females and two males from the coral, *Porites* (*Synaraea*) *convexa* (Dana), examined at Chetlat Island, Lakshadweep, Arabian Sea.

Female: Prosome disproportionately large and urosome small, producing a very characteristic shape. Ratio of length of prosome to that of urosome 2.3 : 1. Total length 0.67 mm, maximum width 0.44 mm. Cephalosome fused with first pedigerous segment, the line of fusion faintly indicated. Cephalothorax a broad-based triangle, posterolaterally projecting. Second pedigerous segment clearly narrower than

cephalothorax, third still narrower and shorter. Fourth pedigerous segment relatively very narrow and overlapping a major part of the fifth segment. Ratio of length to width of prosome 1.1:1. Fifth



Text-figs. 1-11. *Asterocheres stocki* sp. nov., 1. female, dorsal view (b); 2. caudal ramus (g); 3. first antenna (e); 4. second antenna (f); 5. mandible (f); 6. first maxilla (f); 7. second maxilla (f); 8. maxilliped (f); 9. leg 1 (f); 10. leg 2 (e); 11. leg 3 (e).

leg-bearing segment proximally narrow, $64\ \mu\text{m}$ broad, distally drawn out to give attachment to the legs and consequently much broader than long, $60 \times 124\ \mu\text{m}$. Genital segment broader than long, $84 \times 103\ \mu\text{m}$, proximally broad and regularly narrowing backwards, median part of lateral borders with a pencil of stiff hairs. Post-genital segments two, first broader than second and the latter longer, measuring $32 \times 64\ \mu\text{m}$ and $36 \times 52\ \mu\text{m}$ respectively. Caudal ramus broader than long, $20 \times 24\ \mu\text{m}$, each with six setae, two of the distal setae long and stout. Posterolateral angles of genital and post-genital segments produced into small apically acute prolongations making the segments telescope. Lateral borders of genital and post-genital segments and caudal rami spiny.

Oral siphon very long and slender, reaching the hind border of the fifth leg-bearing segment.

First antenna twenty-segmented and moderately narrowing distalwards. First segment fairly stout, segments two to nine relatively short, last three segments perceptibly narrowed; penultimate segment with an aesthete. Length of segments 27, 10, 8, 8, 7, 7, 8, 10, 8, 13, 19, 24, 21, 21, 21, 21, 26, 14, 14, and $10\ \mu\text{m}$: setation 1, 2, 1, 2, 2, 2, 1, 2, 3, 1, 1, 1, 1, 1, 1, 1, 1, 2, 0, 1 and 4 respectively.

Second antenna four-segmented, basis as long as first endopod segment but slightly stouter, with a proximal spine. Exopod one-segmented, with one inner and two distal setae. First segment of endopod with a proximal and a distal short spine, second segment short, triangular and underriding third, with an inner distal seta, third segment with an outer seta and long apical spine.

Mandible with slender stylet, distally narrowed and smooth; palp one-segmented and moderately long, with two unequal setae.

First maxilla with highly dissimilar rami, outer lobe small, with three setae, inner lobe basally swollen and narrowing distalwards, with four apical setae, distal half of outer border spinulose.

Second maxilla uncinata, basal segment stout, with three distal spines; second segment long and claw-like, moderately stout and apically curved.

Maxilliped six-segmented, basal segment short, with two setae and a row of tubercles; second segment long and stout, gradually narrowing distalwards, with one inner spine and two outer distal spinules; segments three and four short, the former with an outer spine, partitions indistinct; fifth segment longer, with inner spine; sixth segment a strong stout claw.

Legs one to four subsimilar, with three-segmented rami. First leg relatively short, basal segment of exopod with a relatively stout claw. Endopod of fourth leg rather slender. Basal segment of fifth leg with a stout outer distal seta. Distal segment oblong, externally spinulose and internally spiny, distal part with three setae.

P1 exp. I-1 ; I-1 ; III, 4

end. 0-1 ; 0-2 ; 1, 5

P2 exp. I-1 ; I-1 ; III, I, 4

end. 0-1 ; 0-2 ; 1, 5

P3 exp. I-1 ; I-1 ; III, I, 4

end. 0-1 ; 0-2 ; 2, I, 3

P4 exp. I-1 ; I-1 ; III, I, 4

end. 0-1 ; 0-2 ; 2, I, 2

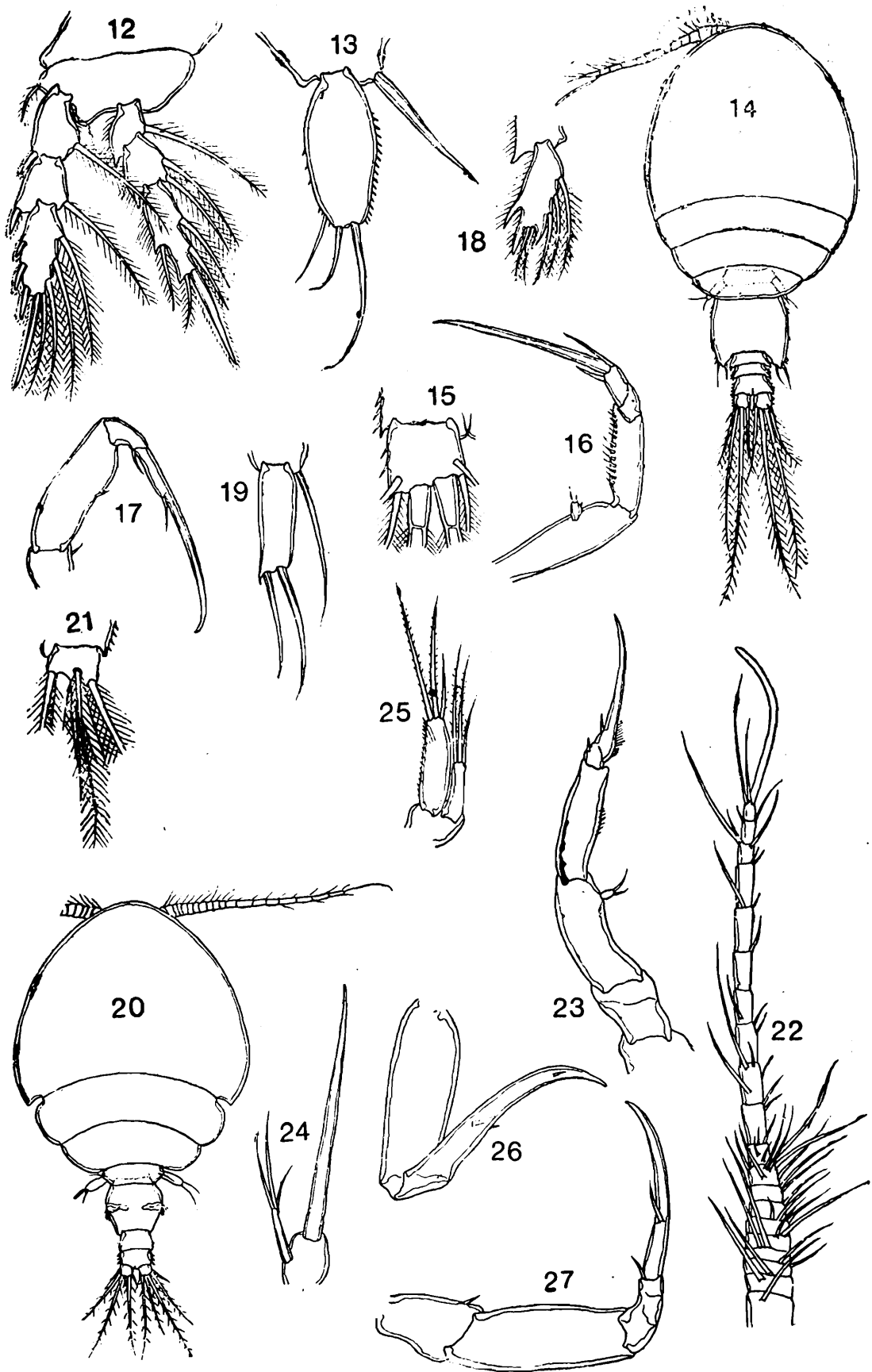
Male : Prosome perfectly ovate, without even a trace of the septum demarcating the first pedigerous segment. Urosome of moderate size. Ratio of length of prosome to that of urosome 1.7 : 1. Ratio of length to width of prosome 1.2 : 1. Total length of body 0.43 mm, maximum width 0.24 mm. Cephalothorax about one and a half times as long as the rest of the prosome. Pedigerous segments two to four regularly narrowing backwards, second and third subequal in length, fourth narrow and transversely oblong, overlapping the fifth leg-bearing segment and a part of the genital segment. Fifth leg-bearing segment very short. Genital segment enlarged, $112 \times 87 \mu\text{m}$, postero-laterally expanded into large triangular lobes. Post-genital segments successively increasing in length, 13×46 , 13×44 and $21 \times 44 \mu\text{m}$, first two segments subsimilar, third longer ; all postero-laterally slightly produced. Lateral borders of genital and post-genital segments spiny. Caudal ramus clearly broader than long, $15 \times 9 \mu\text{m}$, with a few lateral spines.

Oral siphon relatively short, only slightly overreaching the middle of the cephalothorax.

Second antenna more slender than in female, second segment externally spiny, fourth segment with two long setae, claw very long. Exopod with three short setae.

Maxilliped six-segmented, more slender than in female, first and second segments with an inner spine, fourth and fifth with an inner distal spine, claw long and moderately curved, its inner distal part spinulose.

Third endopod segment of leg two distally produced into three long processes as illustrated, with five setae.



Text-figs. 12-27. *Asterocheres stocki* sp. nov., 12. leg 4 (e) ; 13. leg 5 (g) ; 14. male, dorsal view (c) ; 15. caudal ramus (b) ; 16. second antenna (g) ; 17. maxilliped (f) ; 18. last segment of endopod of leg 2 (f) ; 19. leg 5 (h). *Asterocheres longisetosus* sp. nov., 20. female, dorsal view (a) ; 21. caudal ramus (e) ; 22. first antenna (f) ; 23. second antenna (f) ; 24. mandible (f) ; 25. first maxilla (f) ; 26. second maxilla (f) ; 27. maxilliped (f).

Seta on basal segment of fifth leg overreaching the free segment, latter roughly rectangular, with a very short process and two long apical setae.

Remarks : Among the several species of *Asterocheres*, *A. stimulans* Giesbrecht, 1897, *A. siphonatus* Giesbrecht, 1897, and *A. proboscidens* Stock, 1966a, form a group, distinct from the rest, in having a long slender oral siphon. *A. stocki* clearly belongs to this group.

In *A. stimulans* the siphon extends only to the base of the third legs ; but according to G. O. Sars, 1918, to the middle of the genital segment. In *A. stocki* it extends upto the base of the fifth legs. In *A. proboscidens* the siphon over-reaches the caudal rami. *A. stocki* hence occupies a position between *A. stimulans* and *A. proboscidens*.

A. stocki can be distinguished from *A. siphonatus* by the spiny post-genital segments, relatively shorter genital segment, by the shape of the exopod of the second antenna and by the length of the mandibular palp.

Stock's, 1966, observation that this group of species possesses an one-segmented mandibular palp and lacks an inner seta on the coxal segment of the fourth leg holds good in the case of *A. stocki*.

This species is named to honour Professor J. H. Stock who has done excellent work on Asterocheridae.

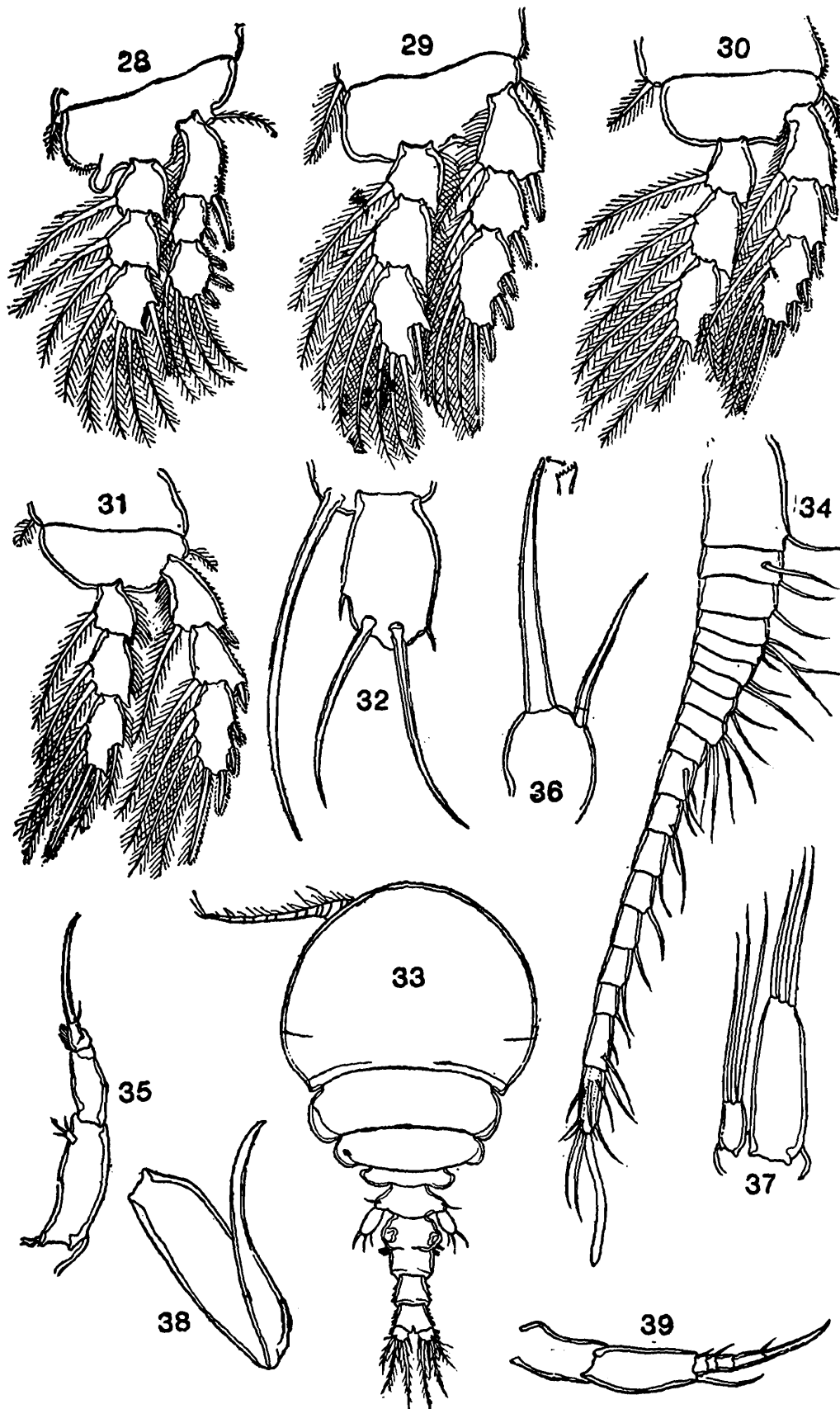
***Asterocheres longisetosus* sp. nov.**

(Text-figs. 20-32)

Material : Five females from the coral, *Porites (Synaraea) convexa* (Dana), examined at Chetlat Island, Laskshadweep, Arabian Sea.

Female : Prosome ovate, relatively much larger than urosome. Total length 0.84 mm, maximum width 0.53 mm. Cephalosome completely fused with the first pedigerous segment. Cephalothorax longer than the rest of the prosome and postero-laterally projecting. Second pedigerous segment demarcated from cephalothorax by small but distinct lateral gaps. Third pedigerous segment narrower than second and slightly longer ; fourth segment relatively small, overlapping fifth and part of the genital segments. Fifth leg-bearing segment very short, $32 \times 132 \mu\text{m}$. Genital segment pyriform, moderately enlarged and narrowing backwards, $120 \times 132 \mu\text{m}$, lateral borders medially hairy. Post-genital segments together slightly shorter than genital segment, measuring 38×82 and $44 \times 75 \mu\text{m}$, second post-genital segment laterally spiny. Caudal ramus much broader than long, $19 \times 32 \mu\text{m}$, with six setae, two of the distal setae very long.

Rostrum proximally broad, suddenly constricted in the middle and apically slightly widened, distal border subtruncate. Oral siphon elongated, long and fairly broad, only gradually narrowing, apex trilobed.



Text-figs. 28-39. *Asterocheres longivetosus* sp. nov., 28. leg 1 (f) ; 29. leg 2 (f) ; 30. leg 3 (f) ; 31. leg 4 (f) ; 32. leg 5 (h). *Asteropontius laccadivensis* sp. nov., 33. female, dorsal view (a) ; 34. first antenna (e) ; 35. second antenna (d) ; 36. mandible (f) ; 37. first maxilla (g) ; 38. second maxilla (e) ; 39. maxilliped (e).

First antenna twenty-segmented and regularly narrowing distalwards, segments two to ten relatively short and well armed with strong setae ; beyond the tenth segment the appendage suddenly narrowed. Apical segment with a long aesthete. Length of segments 15, 10, 7, 7, 7, 8, 8, 7, 10, 13, 21, 20, 20, 18, 18, 22, 21, 10, 10 and 8 μm ; armature 1, 2, 2, 2, 3, 3, 1, 2, 6, 5, 4, 2, 1, 1, 2, 2, 3, 2, and 2 respectively.

Second antenna four-segmented and slender ; first segment stout, second slightly narrower than first and spiny. Exopod very small, with two setae. Third segment short and triangular, underriding fourth and with a short spine, fourth segment a long claw with swollen base carrying an inner spine and outer spinules or hairs.

Mandibular stylet long, fairly stout and apically drawn out ; palp short and one-segmented, with three setae.

Inner lobe of first maxilla twice as long and as broad as the outer, with three apical setae, inner border spinulose, outer lobe with three long setae.

Second maxilla uncinata, basal segment fairly stout, distal a stout claw, longer than basal segment, and with two median and one distal spinules.

Maxilliped six-segmented ; basal segment with an inner spine, second segment long and stout, third, fourth and fifth segments poorly demarcated, fourth and fifth with an inner seta, sixth segment a well developed claw.

Legs one to four with three-segmented rami. First leg relatively short, its basis produced at the inner distal part into a conspicuous lobe. Rami of third leg more slender than those of second. Endopod of fourth leg clearly shorter than exopod. Free segment of fifth leg only slightly longer than broad, with two long setae and two very short spines, basal segment with an unusually long seta.

P1 exp. I-1 ; I-1 ; III, 4

end. 0-1 ; 0-2 ; 1, 5

P2 exp. I-1 ; I-1 ; III, I, 4

end. 0-1 ; 0-2 ; 1, 5

P3 exp. I-1 ; I-1 ; III, I, 4

end. 0-1 ; 0-2 ; 1, 5

P4 exp. I-1 ; I-1 ; III, I, 3

end. 0-1 ; 0-2 ; 2, I, 2

Remarks : *A. longisetosus* shows some resemblance to *A. scutatus* Stock, 1966 and *A. ovalis* Sewell, 1949, collected from the Red Sea and

Arabian Sea respectively, both localities close to that of *A. longisetosus*. However *A. scutatus* has a relatively broader genital segment and longer fifth legs.

A. ovalis resembles *A. longisetosus* in many characters but its female is unknown. On the other hand my collection includes only females. The male of *A. ovalis* has a fourteen-segmented first antenna (twenty-segmented in *A. longisetosus*). The absence of a process on the second exopod segment of legs one and three, the slender nature of the rami of the third leg and the presence of a plumose inner seta on the coxa of the fourth leg are characters common to these three species. There is also some similarity in the second antenna, mandible and first maxilla.

The shape of the fifth leg, particularly the long seta associated with it and the presence of a prominent lobe on the basis of the first leg easily distinguish *A. longisetosus* from the rest.

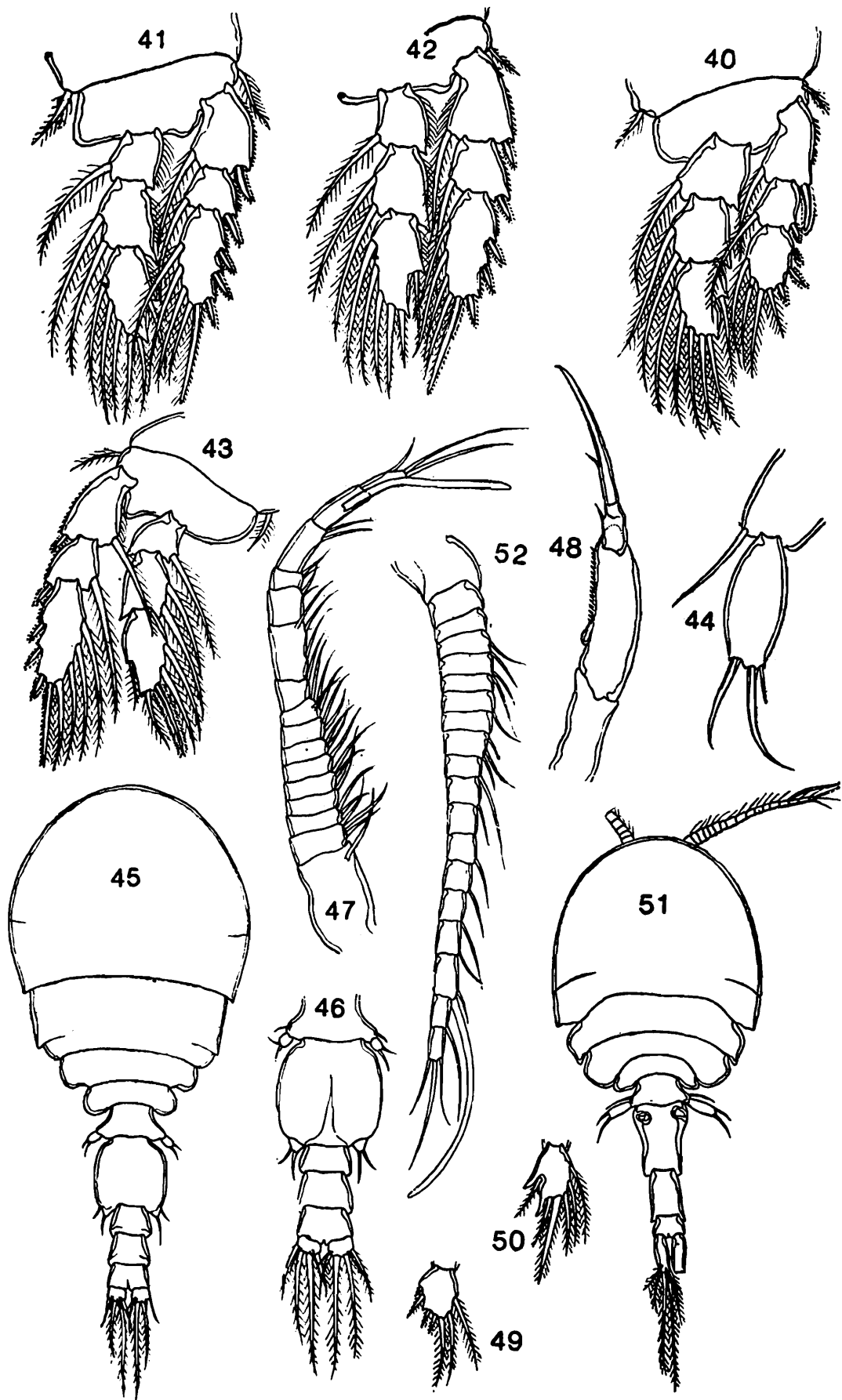
The trivial name refers to the long setae on the fifth leg which is a unique character.

***Asteropontius laccadivensis* sp. nov.**

(Text-figs. 33-50)

Material : Nine females and twenty two males from *Acropora formosa* (Dana) examined at Agatti Island, Lakshadweep, Arabian Sea.

Female : Prosome comparatively broad and large, urosome slender and elongated, the ratio of their lengths 2 : 1. Total length of body 1.04 mm, maximum width 0.57 mm. Cephalosome a perfect semicircle with evenly curved borders, fully fused with the first pedigerous segment. The line of fusion between these just indicated laterally and the cephalothorax suddenly narrowed beyond and postero-laterally forming small triangular lobes. Second pedigerous segment clearly narrower than cephalothorax, much longer than the succeeding ones, laterally rounded and with faint indication of epimeral lobes. Third pedigerous segment postero-laterally angular, with small epimeral lobes. Fourth pedigerous segment overlapped by third and laterally curving forwards. Fifth leg-bearing segment drawn outwards and hence much broader than long, $82 \times 170 \mu\text{m}$. Genital segment longer than broad, $151 \times 138 \mu\text{m}$, anteriorly forming a pair of rounded lateral lobes and suddenly constricted beyond, the middle of the lateral borders hairy. Post-genital segments two, subequal in length, second segment widening distalwards, both segments laterally spiny, measuring 63×82 and $69 \times 95 \mu\text{m}$ respectively. Caudal ramus broader than long, $31 \times 34 \mu\text{m}$, with six setae, one of the distal setae very long and basally swollen.



Text-figs. 40-52. *Asteropontius laccadivensis* sp. nov., 40. leg 1 (e) ; 41. leg 2 (e) ; 42. leg 3 (e) ; 43. leg 4 (e) ; 44. leg 5 (f) ; 45. male, dorsal view (b) ; 46. urosome (dorsal) (d) ; 47. first antenna (e) ; 48. maxilliped (e) ; 49. third segment of exopod of leg 1 (e) ; 50. third segment of endopod of leg 3 (e). *Indomyzon guasimi* Ummerkuty, 51. female, dorsal view (a) ; 52. first antenna (g).

First antenna nineteen-segmented, proximal half fairly broad and distal relatively slender ; first segment longest, second to ninth short, tenth to seventeenth subequal in length, penultimate segment with a stout aesthete. The length of the segments 72, 16, 22, 14, 11, 11, 10, 11, 12, 22, 27, 22, 26, 24, 21, 24, 22, 32 and 40 μm and armature 1, 2, 1, 2, 2, 1, 1, 2, 3, 1, 3, 2, 1, 1, 1, 1, 1, 3 and 8 setae respectively.

Second antenna 238 μm long. Coxal segment short, basis rather stout bearing on its outer distal part a small exopodal lobe carrying three setae ; endopod apparently three-segmented, ending in a long slender slightly curved claw, third segment externally hairy and with an inner distal seta.

Oral siphon conical, as long as broad and just reaching the base of the maillipeds.

Mandibular stylet fairly stout, regularly narrowing and apically expanded into a transverse dentate blade, palp very short and one-segmented with a long stout seta, the whole appearing as a single long seta ; nearly as long as the stylet.

Inner lobe of first maxilla about twice as broad and three times as long as the outer, each lobe armed with three long setae.

Second maxilla two-segmented and uncinata, second segment longer than first and basally rather swollen, reclining against the basal segment.

Maxilliped six-segmented, first two segments subequal in size, second with a long outer distal process, third, fourth and fifth with an inner seta, sixth segment a long strong claw.

Legs one to four with three-segmented rami. Third leg largest. Outer border of exopod segments spiny and that of endopod segments hairy. Basal exopod segment of first leg with a flanged claw instead of the usual spiny one, third exopod segment lacking the long partly hairy and partly spiny claw. Basal segment of fifth leg stout, with a long seta, distal segment oblong, with one small and two stout setae ; its distal border produced into two low processes.

P1	exp.	I-1 ; I-1 ; III, 4
	end.	0-1 : 0-2 : 1, 5
P2	exp.	I-1 ; I-1 ; III, I, 4
	end.	0-1 ; 0-2 ; 1, 5
P3	exp.	I-1 ; I-1 ; III, I, 4
	end.	0-1 ; 0-2 ; 1, 5
P4	exp.	I-1 ; I-1 ; III, I, 4
	end.	0-1 : 0-2 ; 1, 1, I. 2

Male : General shape of body very much like like that of female. Cephalothorax postero-laterally less projecting. First pedigerous segment relatively longer and the fourth shorter. The overall shape of the post-cephalothoracic part of the prosome different from that of female. Fifth leg-bearing segment relatively narrower. Genital segment roughly squarish, $116 \times 104 \mu\text{m}$, postero-laterally produced into triangular lobes carrying the sixth legs. Post-genital segments three, middle segment slightly longer than the others, measuring 44×64 , $48 \times 60 \mu\text{m}$ respectively. Caudal ramus as in female, $24 \times 24 \mu\text{m}$. with six setae. Total length of body 0.77 mm ; maximum width 0.3 mm. The ratio of length of prosome to that of urosome 1.7 : 1 ; ratio of length to width of prosome 1.3 : 1.

First antenna stouter but shorter than that of female, only sixteen-segmented, penultimate segment with a stout aesthete. Other cephalic appendages as in female.

Maxilliped six-segmented, first segment relatively longer ; second distally produced over the third, its inner proximal part with a projecting lobe and inner border beyond this lobe spiny ; third and fifth segments with a seta, claw slightly longer than in the female.

Legs one to four generally as in female but the third exopod segment of leg one and the third endopod segment of leg three different from the corresponding segments in the female as shown in the figure. Fifth leg relatively short, with two highly unequal apical setae. Sixth leg represented by a short and a long setae placed postero-laterally on the genital segment.

Remarks : *A. laccadivensis* differs from *A. coralliphilus* Stock, 1966a, in its longer and more rounded cephalothorax, in the number of setae on the first maxilla, and in the shape of the cephalothorax and first pedigerous segment of the male.

Compared with *A. laccadivensis*, *A. parvipalpus* Stock, 1975, has a much broader cephalothorax, a longer exopod on the second antenna, a minute seta representing the mandibular palp, differently setose first maxilla and a differently shaped male.

A. ungelatus Stock, 1975, differs from *A. laccadivensis* in the shape of the cephalothorax, in the very small mandibular palp, in the shape of the exopod of the second antenna and in the setation of the first maxilla.

A. longipalpus Stock, 1975, is closest to *A. laccadivensis*, but the general shape of the body, the nature of the mandibular palp and the

slender distal segment of the second maxilla distinguish it from *A. laccadivensis*.

A. laccadivensis differs from *A. typicus* Thompson & Scott, 1903, mainly in the shape of the body. According to the key provided by Stock (1966a) these two species have III, I, 4 armature for the distal segment of the exopod of the fourth leg and 2, I, 2 armature for the third segment of the endopod.

The males of *A. typicus* and *A. longipalpus* are unknown. In all the others the second segment of the maxilliped of the male has an identical swelling. It is likely that this may prove to be a character which distinguishes *Asteropontius* from *Asterocheres*.

The specific name alludes to the place of collection.

***Indomyzon quasimi* Ummerkutty**

(Text-figs. 51-63)

Indomyzon quasimi Ummerkutty, 1966, p. 27, figs. 18-29.

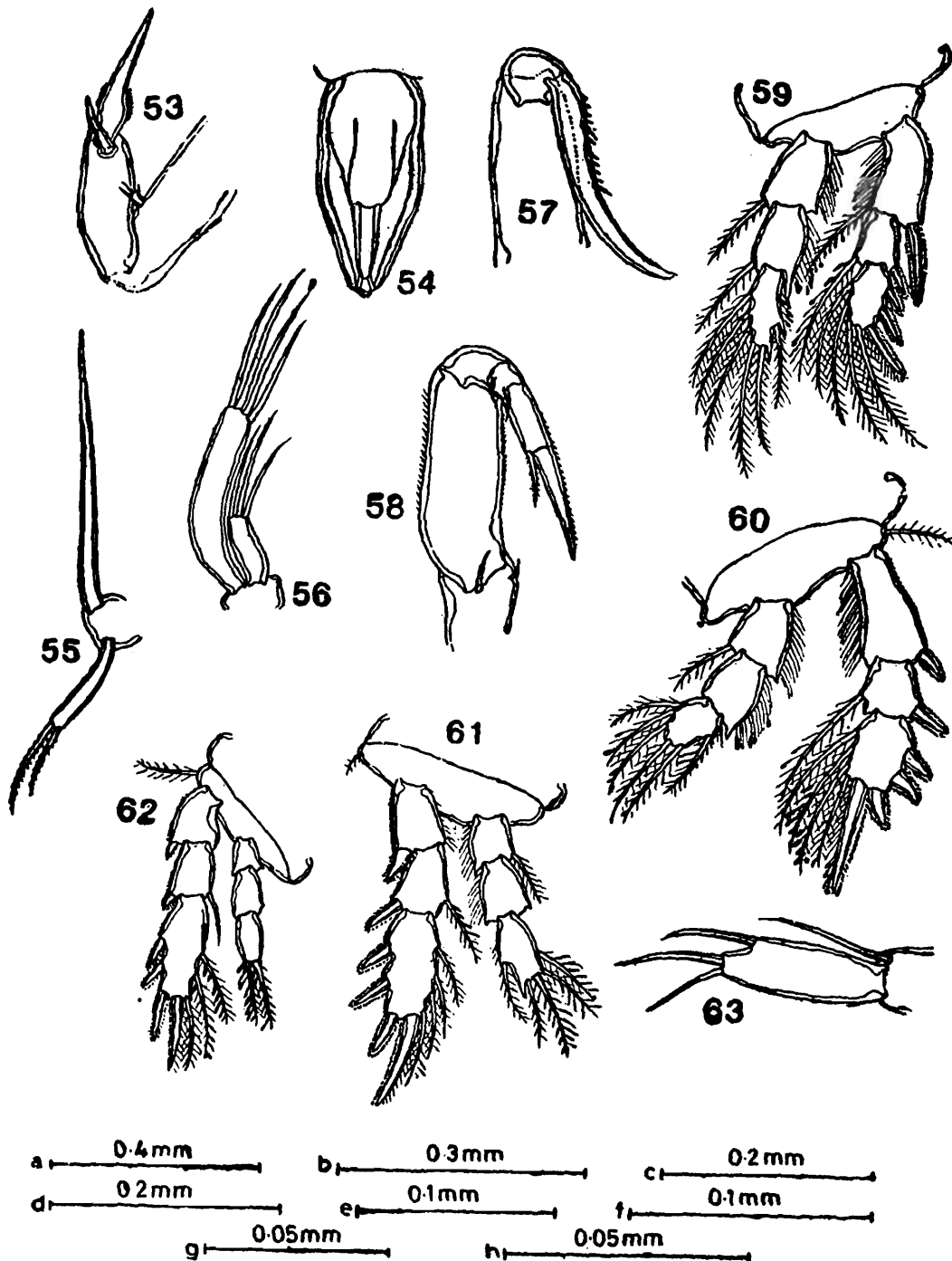
Material : Four females from the sponge *Sigmatocia pumila* (Lendenfeld) examined at Rameswaram Island, Gulf of Mannar, Bay of Bengal.

Female : Prosome broad and subcircular ; urosome long and slender ; the ratio of their lengths 1.2 : 1. Total length of animal 1.02 mm, maximum width 0.49 mm. First pedigerous segment fused with cephalosome, the line of fusion indicated laterally. Cephalothorax anteriorly evenly rounded and postero-laterally forming large blunt lobes projecting beyond the second pedigerous segment ; second pedigerous segment narrower than cephalothorax and demarcated from the latter by well marked lateral incisions ; epimeral lobes posteriorly angular. Third pedigerous segment with large rounded epimeral lobes. Fourth segment small, highly arched and sunk into the third segment, epimeral lobes indistinct and angular. Fifth leg-bearing segment much narrower than fourth, bulging postero-laterally. Genital segment not much swollen, basally somewhat enlarged and narrowing distalwards, longer than broad, $170 \times 126 \mu\text{m}$. Post-genital segments two, first very long and second very short, both widening backwards ; first, like the genital segment, with sharp postero-lateral corners. Caudal ramus elongated, longer than the second post-genital segment, $76 \times 57 \mu\text{m}$, basally swollen and distally subtruncate, two of the distal setae fairly long.

First antenna moderately stout and steadily narrowing distalwards, nineteen-segmented ; length of segments 18, 11, 6, 5, 8, 5, 7, 6, 9, 8, 9, 11, 8, 11, 11, 11, 13, 12 and $11 \mu\text{m}$; setation 0, 0, 0, 2, 2, 0, 1, 0, 3, 1, 1,

0, 1, 1, 1, 1, 1, and 3 respectively ; seventeenth segment with a long aesthete.

Basal segment of second antenna very short, second segment stout, third only slightly shorter and narrower than second, with a strong distal spine, fourth segment short and underriding fifth, latter with swollen base and drawn out into a short but strong claw. Exopod very small and one-segmented, with three setae.



Text-figs. 53-63. *Indomyzon quasimi* Ummerkutty, 53. second antenna (g); 54. oral siphon (f); 55. mandible (g); 56. first maxilla (g); 57. second maxilla (g); 58. maxilliped (g); 59. leg 1 (g); 60. leg 2 (g); 61. leg 3 (g); 62. leg 4 (g); 63. leg 5 (p).

Oral siphon short but broad, its basal half roughly squarish, distal steadily narrowing and reaching the base of the maxillipeds.

Mandibular stylet apically drawn out and smooth, palp one-segmented and fairly long, with two pectinate setae, as long as the segment.

Outer lobe of first maxilla short, with three apical setae, inner two and a half times as long as outer and characteristically curved, proximally narrow, with four long apical setae.

Second maxilla uncinata, second segment a stout long claw with proximal inner spinules.

Maxilliped six-segmented ; basal segment with two spines, second segment stout, with spiny inner and hairy outer borders, segments three to five with a seta, sixth segment a short, stout, straight claw with spiny borders.

Legs one to four with three-segmented rami ; claw on first segment of exopod of first leg long, reaching beyond the second segment. Endopod of legs one to four successively decreasing in length in relation to the exopods. Basal segment of fifth leg with a long seta, distal segment elliptic, with three setae.

P1	exp.	I-1 ; I-1 ; II, I, 4
	end.	0-1 ; 0-1 ; 1, 2, 3
P2	exp.	I-0 ; I-1 ; III, I, 4
	end.	0-1 ; 0-0 ; 1, 3, 2
P3	exp.	I-0 ; I-1 ; III, I, 4
	end.	0-1 ; 0-0 ; 1, 2, 2
P4	exp.	I-0 ; I-1 ; III, I, 3
	end.	0-0 ; 0-0 ; 2

Remarks : Ummerkutty's illustration of the whole animal is essentially correct but he has not shown the epimeral lobes of the free pedigerous segments. The first post-genital segment is narrower basally than shown by Ummerkutty. The illustration showing the oral siphon and cephalic appendages provided by Ummerkutty does not allow a detailed comparison. The legs do not show any difference worth pointing out. I have provided whatever details could be observed. The free segment of the fifth leg is quite different from what Ummerkutty has shown.

Distribution : Gulf of Mannar.

SUMMARY

Detailed illustrated descriptions of *Asterocheres stocki* sp. nov., *Asterocheres longisetosus* sp. nov., *Asteropontius laccadivensis* sp. nov. and *Indomyzon quasimi* Ummerkutty are presented.

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LENGTH-WEIGHT RELATIONSHIP IN *CARANGOIDES*
MALABARICUS (BL. & SCHN.) AND *ALEPES*
KALLA (CUV. & VAL.)*

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INTRODUCTION

A study of length weight relationships has two purposes (Lecren, 1951), first to establish the mathematical relationship between two variables, length and weight and secondly to know the variations from the expected weight for various length groups. Weight of a fish is a function of its length and it is observed that the length weight relationship could be expressed by the hypothetical cube law, $W=CL^3$ where 'W' represents the weight, 'L' the length and 'C' a constant. This formula could be used only if density and form are constant. LeCren (1951) pointed out that it is better to fit a general parabolic equation of the form $W=aLn$ (which expresses the relation between two factors better than the cubic formula) where 'W' and 'L' represent weight and length of a fish respectively, 'a' a constant equivalent to 'c' and 'n' a constant to be determined empirically, i. e. from the data.

MATERIAL AND METHODS

Presently, in two carangid fishes viz., *C. malabaricus* and *A. kalla*, the length weight relationships have been calculated. Total length was measured from the tip of the snout to vertical through tip of the longest caudal fin lobe ; weight was recorded to the nearest 0.01 milligram. Specimens where the tails are broken, were rejected.

RESULTS AND DISCUSSION

The parabolic equation $W=aL^n$ can be expressed in the logarithmic form as $\log W=\log a+n \log L$ i.e. $Y=a+bx$; where, $a=\log a$; $b=n$; $y=\log n$ and $x=\log L$ which is a linear relation between y and x . This linear equation was fitted separately for males, females and indeterminants in both the species and the estimates of parameters 'a' and 'b' for each category was obtained by the method of least squares. The

*This paper formed part of a thesis submitted by the first author to Annamalai University for the award of Ph. D. degree.

regression equations for males, females and indeterminants of *C. malabaricus* and *A. kalla* are given below.

C. malabaricus

For males : $\text{Log } W = -4.6642 + 2.8870 \text{ Log } L$;

For females : $\text{Log } W = -4.1144 + 2.6348 \text{ Log } L$;

For indeterminants : $\text{Log } W = -4.7356 + 2.9239 \text{ Log } L$.

A. kalla

For males : $\text{Log } W = -5.1033 + 3.0250 \text{ Log } L$;

For females : $\text{Log } W = -4.8888 + 2.9288 \text{ Log } L$;

For indeterminants : $\text{Log } W = -3.9541 + 2.4411 \text{ Log } L$.

During fish growth, when it does not change form or density, the weight will be proportional to the cube of any linear dimension. According to Hile (1936) and Martin (1949), the value of the exponent 'n' in the parabolic equation usually lies between 2.5 and 4.0. For an ideal fish which maintain the shape throughout without any change, the value of 'n' is equal to 3.0 (Allen, 1938). Generally the value of 'b' is '3' in the length-weight relationship of fishes, but due to changing of specific gravity and shape of the body contour the cube law need not always hold good (Rounsefell & Everhart, 1953). Morphological changes due to age also cause the coefficient of regression of logarithm of weight on logarithm of length, to depart substantially from 3.0.

The regression equations of males, females and indeterminants, of the above two species were subjected to analysis of covariance as done by James (1967), Narasimham (1970) and Mojumder (1971). Significant differences were obtained on comparing the regression equations of males, females and indeterminants of *C. malabaricus* (Tables 1-3). On comparing the regression equations of females and indeterminants (Tables 6 & 7), males and females (Tables 8 & 9), significant differences could be noted. Only insignificant differences were obtained on comparing the regression equations of males (Tables 4 & 5) with indeterminants.

Significant differences were obtained on comparing the regression equations of males, females and indeterminants of *A. kalla* (Tables 10-12). Significant differences were also obtained between males and indeterminants (Tables 13-14) and between females and indeterminants (Tables 15-16), while differences between males and females (Tables 17-18) were insignificant.

TABLE 1. Statistics on the length-weight relationship of males, females and indeterminants of *C. malabaricus*.

Sex	N	Sx	Sy	Sx ²	Sy ²	Sxy
Males	250	545.0397	407.4662	1188.9400	670.0242	890.2666
Females	182	396.5735	296.0851	864.7594	486.6015	646.8368
Indeterminants	250	514.3073	319.8573	1059.0504	417.9587	660.9510

N = Number of fish

Sx², Sy², Sxy = Sum of squares and products

Sx, Sy = Sum of logarithmic values of length and weight respectively

TABLE 2. Regression data for the length-weight relationship of males, females and indeterminants of *C. malabaricus*.

Sex	D. F.	Sum of squares and products			b	Errors of Estimate	
		x ²	xy	y ²		D. F.	S. S.
Males	249	0.6670	1.9256	5.9094	2.8870	248	0.3503
Females	181	0.6356	1.6747	4.9181	2.6348	180	0.5055
Indeterminants	249	1.0025	2.9312	8.7239	2.9239	248	0.1534

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 3. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression within sexes	676	1.0092	0.0015		
Differences between regression 2		0.0352	0.0176	11.7333	3.000
Deviation from total regression	678	1.0444	0.0191		
				Significant	

TABLE 4. Regression data for the length-weight relationship of males and indeterminants of *C. malabaricus*.

Sex	D. F.	Sum of squares and products			b	Errors of Estimate	
		x ²	xy	y ²		D. F.	S. S.
Males	249	0.6670	1.9256	5.9094	2.8870	248	0.3503
Indeterminants	249	1.0025	2.9312	8.7239	2.9239	248	0.1534

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 5. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression	496	0.5037	0.0010		
Differences between regression	1	0.0005	0.0005	0.5000	3.000
Deviation from total regression	497	0.5042	0.0016		
Insignificant					

TABLE 6. Regression data for the length-weight relationship of females and indeterminants of *C. malabaricus*.

Sex	D. F.	Sum of squares and products				Errors of Estimate	
		x^2	xy	y^2	b	D. F.	S. S.
Females	181	0.6356	1.6747	4.9181	2.6348	180	0.5055
Indeterminants	249	1.0025	2.9312	8.7239	2.9239	248	0.1534

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 7. Test of significance.

Source of variation	D. F.	Sum of squares	Mean square	Observed F	5% F
Deviation from individual regression	428	0.6589	0.0015		
Differences between regression	1	0.0325	0.0325	21.6667	3.000
Deviation from total regression	429	0.6914	0.0340		
Significant					

TABLE 8. Regression data for the length-weight relationship of males and females of *C. malabaricus*.

Sex	D. F.	Sum of squares and products				Errors of estimate	
		x^2	xy	y^2	b	D. F.	S. S.
Males	249	0.6670	1.9256	5.9094	2.8870	248	0.3503
Females	181	0.6356	1.6747	4.9181	2.6348	180	0.5055

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 9. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression	428	0.8558	0.0020		
Differences between regression	1	0.0207	0.0207	10.35	3.000
Deviation from total regression	429	0.8765	0.0227		

Significant

TABLE 10. Statistics on the length-weight relationship of males, females and indeterminants of *A. kalla*.

Sex	N	Sx	Sy	Sx ²	Sy ²	Sxy
Males	80	171.1297	109.3990	366.2991	151.8196	234.7192
Females	250	536.5012	349.0990	1152.0433	494.7335	751.2452
Indeterminants	132	250.1510	88.7079	475.2592	67.5245	171.0436

N = Number of fish
 Sx², Sy², Sxy = Sum of squares and products
 Sx, Sy = Sum of logarithmic values of length and weight respectively

TABLE 11. Regression data for the length-weight relationship of males, females and indeterminants of *A. kalla*.

Sex	D. F.	Sum of squares and products				Errors of Estimate	
		x ²	xy	y ²	b	D. F.	S. S.
Males	79	0.2319	0.7015	2,2178	3.0250	78	0.0958
Females	249	0.7092	2.0771	7.2531	2.9288	248	1.1697
Indeterminants	131	1.2022	2.9347	7.9102	2.4411	130	0.7463

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 12. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression within sexes	456	2.0118	0.0044		
Differences between regression	2	0.1396	0.0698	15.8636	3.000
Deviation from total regression	458	2.1514	0.0742		

Significant

TABLE 13. Regression data for the length-weight relationship of males and indeterminants of *A. kalla*.

Sex	D. F.	Sum of squares and products				Errors of Estimate	
		x^2	xy	y^2	b	D. F.	S. S.
Males	79	0.2319	0.7015	2.2178	3.0250	78	0.0958
Indeterminants	131	1.2022	2.9347	7.9102	2.4411	130	0.7463

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 14. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression	208	0.8421	0.0040		
Differences between regression	1	0.0662	0.0662	16.55	3.000
Deviation from total regression	209	0.9083	0.0702	Significant	

TABLE 15. Regression data for the length-weight relationship of females and indeterminants of *A. kalla*.

Sex	D. F.	Sum of squares and products				Errors of estimate	
		x^2	xy	y^2	b	D. F.	S. S.
Females	249	0.7092	2.0771	7.2531	2.9288	248	1.1697
Indeterminants	131	1.2022	2.9347	7.9102	2.4411	130	0.7463

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 16. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression	378	1.9160	0.0051		
Differences between regression	1	0.1061	0.1061	20.8039	3.000
Deviation from total regression	379	2.0221	0.1112	Significant	

TABLE 17. Regression data for the length-weight relationship of males and females of *A. kalla*.

Sex	D. F.	Sum of squares and products				Errors of Estimate	
		x^2	xy	y^2	b	D. F.	S. S.
Males	79	0.2319	0.7015	2.2178	3.0250	78	0.0958
Females	249	0.7092	2.0771	7.2531	2.9288	248	1.1697

D. F. = Degrees of freedom ; b = Regression co-efficient ; S. S. = Sum of squares.

TABLE 18. Test of significance.

Source of variation	D. F.	Sum of squares	Mean squares	Observed F	5% F
Deviation from individual regression	326	1.2655	0.0039		
Differences between regression	1	0.0016	0.0016	0.41036	3.000
Deviation from total regression	327	1.2671	0.0055		
				Insignificant	

SUMMARY

The length-weight relationships in *C. malabaricus* and *A. kalla* were calculated separately for males, females and indeterminants. Significant differences were obtained on comparing the regression equations for males, females and indeterminants of *C. malabaricus* and *A. kalla*. The regression equations for males and females, females and indeterminants and males and indeterminants of *C. malabaricus* and *A. kalla* was also compared.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. F. Williams, Chairman, Division of Biology and Living resources, School of Atmospheric Sciences, University of Miami, University of Florida and Dr. C. T. Samuel, Dean, Department of Industrial Fisheries, Cochin for their valuable comments. For financial support and facilities, they thank the University Grants Commission, New Delhi and the authorities of Annamalai University.

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STUDIES ON THE LIFE HISTORY OF *RANATRA FILIFORMIS*
FAB. (HEMIPTERA : NEPIDAE)

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(With 10 Text-figures)

INTRODUCTION

Information relating to the bioecological aspects of aquatic Hemiptera in India has been limited to the species *Ranatra filiformis* (Nowrojee, 1911), *Sphaerodema rusticum* (Presswala & George, 1936), *Ranatra elongata* (Rao, 1932) and *Sphaerodema annulatum* (Hati & Ghosh, 1963). The larvae and adults of *R. filiformis* cause much harm in fish nurseries by destroying fingerlings. On the other hand they are beneficial to man by predated mosquito larvae. So an understanding of the life history of *R. filiformis* is essential for assessing the beneficial as well as the harmful aspects of these insects. So the study of the life history of *R. filiformis* has been attempted by collecting specimens from the field and rearing from egg to the adult in the laboratory. The principal in the external morphology of the different instars and the characters helpful in distinguishing the various instars are described in detail. Growth rates were studied using standard statistical methods (Snedecor & William, 1975).

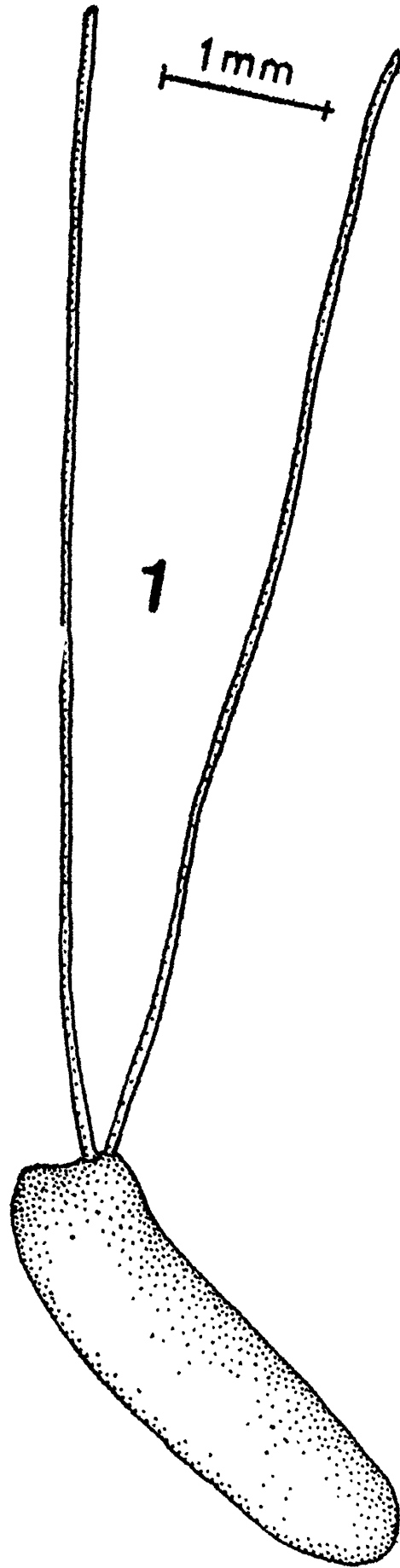
MATERIALS AND METHODS

Adults of *R. filiformis* collected from Chakai canal 4 km west of Trivandrum city were kept in large glass troughs containing mud, water and aquatic vegetation. After oviposition the eggs were collected along with the oviposited stem of the water plants and kept in another trough containing water. The hatched nymphs were isolated and reared separately until the final moult. Mosquito larvae, small fish fry and tadpoles were given as food. The data were subjected to statistical analyses. The correlation analysis was used to find out the nature of relationship between instar and the body measurements.

OBSERVATIONS AND RESULTS

Breeding record : The study was started with ten nymphs, five survived the third instar, four eventually reached the final instar. Breeding record of one of the nymphs is presented in Table I. Life cycle was gradual. Various stages are

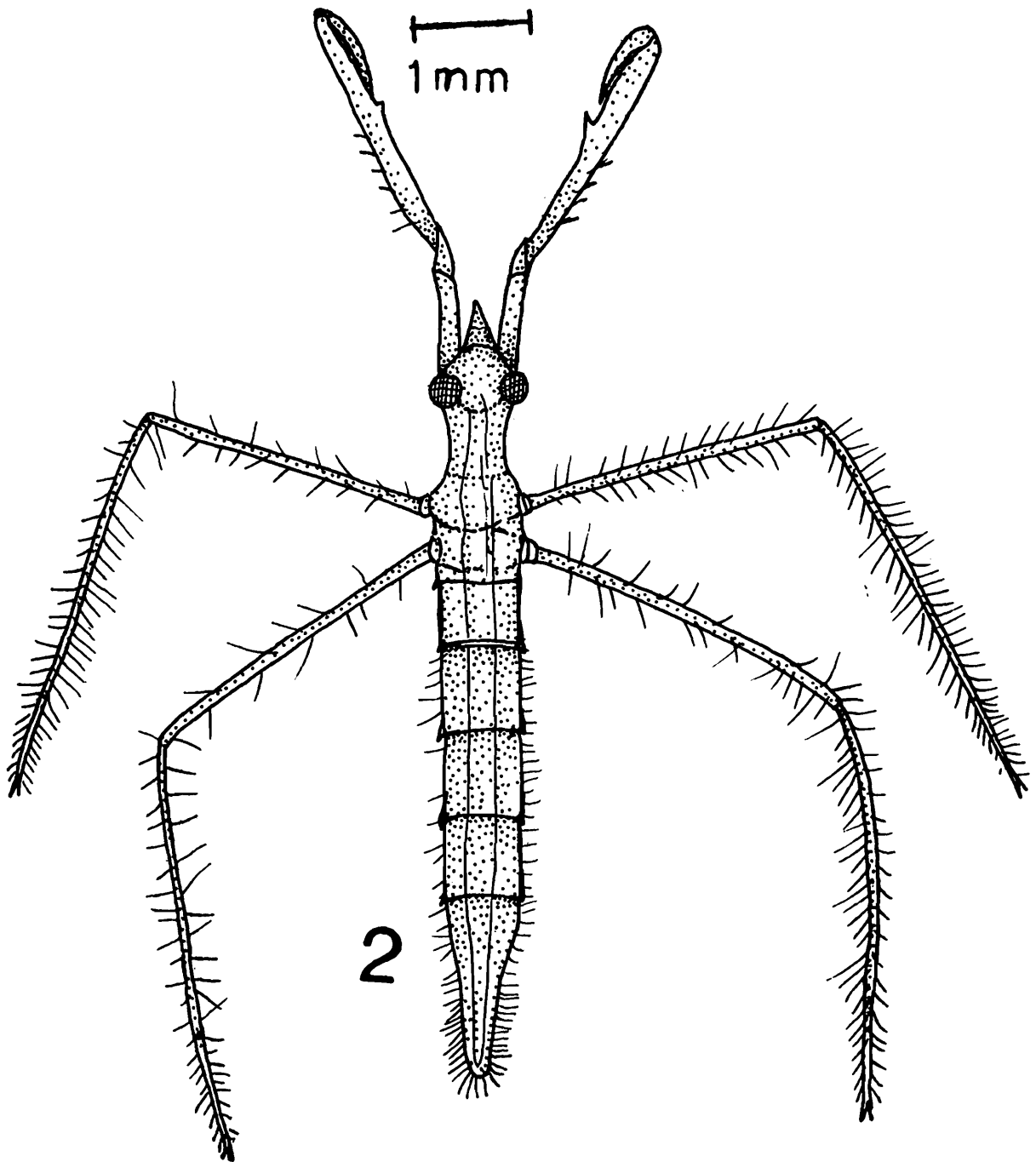
Egg → Nymph → 4 instars → Imago.
Egg (Text-fig. 1)



Ranatra filiformis Fab.
Text-fig. 1. egg.

TABLE I. Breeding record of *Ranatra filiformis* Fab.

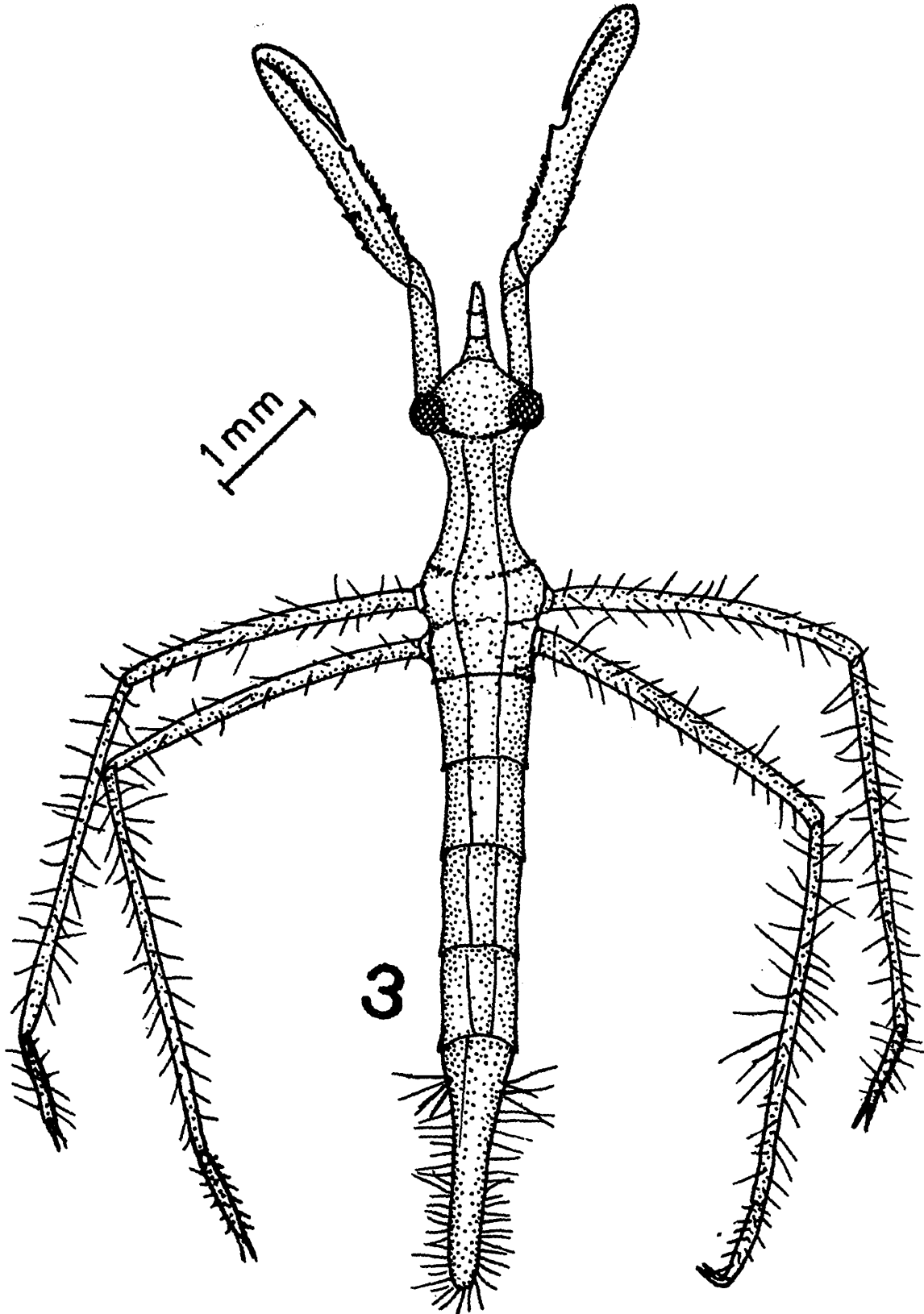
Stage	Date of entry	Duration (in days)
Eggs	20th April, 1978	9
Nymph	29th April „	7
I instar	6th May „	11
II instar	17th May „	9
III instar	26th May „	9
IV instar	4th June „	13
Emergence	17th June „	—
Total number of days from oviposition to emergence=		58 days

*Ranatra filiformis* Fab.

Text-fig. 2. nymph.

Length: 2.5 mm (excluding the length of the filament which is 6 mm) *width*: 0.5 mm. Elongated and cylindrical provided with a pair of apical filaments; whitish in colour turning creamy white later on. The number of eggs laid by a single female was 22 ± 0.45 . The incubation period lasted 7-9 days.

Nymph (Text-fig. 2)



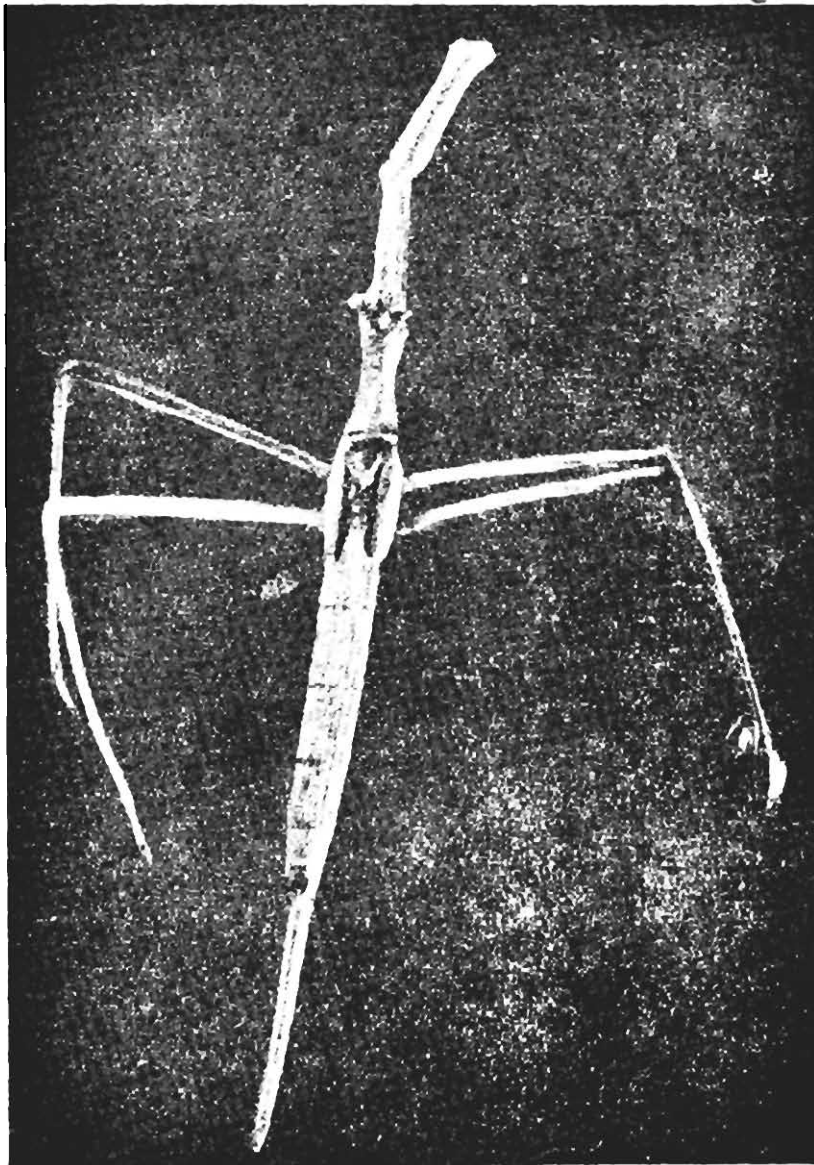
Ranatra filiformis Fab.

Text-fig. 3. I instar nymph.

Length : 6 mm ; rostrum : 0.5 mm ; respiratory siphon : 1 mm ; duration 7 days. Small, long, slender and a miniature of the adult. Pale yellowish at the time of hatching, turning yellowish brown later on. Head prognathous ; rostrum three-segmented and pointed forwards ; ocelli absent, eyes rounded and prominent ; antennae hidden ; anterior legs raptorial without claws. The tibia and tarsus may be folded back against the femur. Mid and hind legs bearing paired claws are adapted for walking. Abdominal segments are broader posteriorly and the postero-lateral margins with angular projections. Respiratory siphon single and short, legs and the anal siphon beset with a number of hairs, banded with brown markings.

I instar (Text-fig. 3)

Length : 7.5 mm ; rostrum : 0.75 mm ; respiratory siphon : 1.5



Ranatra filiformis Fab.

Text-fig. 4. IVth instar nymph.

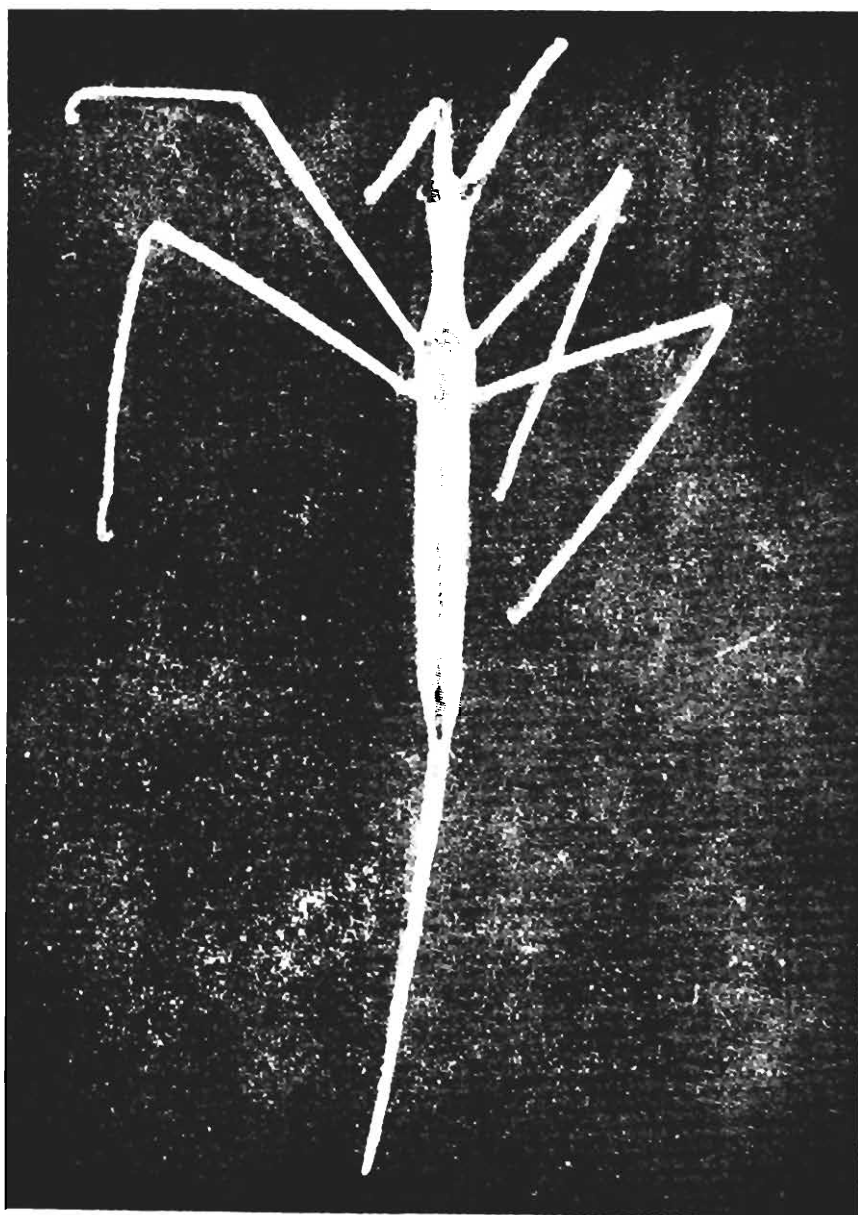
mm ; maximum width : 1.5 mm across the thorax ; duration 11 days. Body slender, elongated and yellowish brown in colour. Wing buds rudimentary. All the other characters just as the nymph throughout the four instars with minor differences.

II instar

Length : 17.75 mm ; rostrum : 1 mm ; respiratory siphon : 4 mm ; maximum width ; 2 mm across the thoracic region ; duration 9 days. Pale yellowish just after moulting but turns to straw yellow later on. Tibiotarsi of the mid and hind legs beset with small spines.

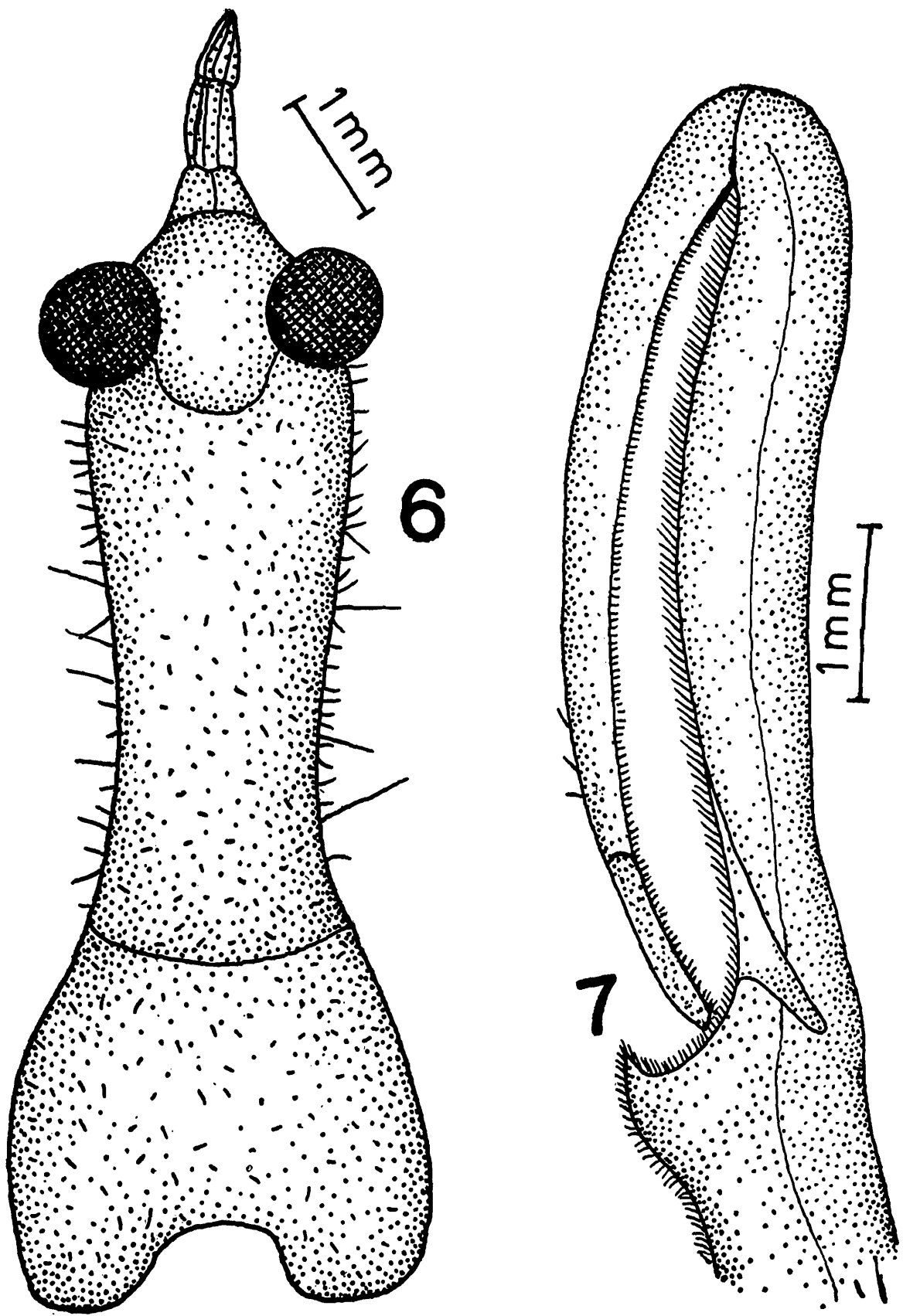
III instar

Length : 23.75 mm ; rostrum : 1.5 mm ; respiratory siphon : 5.5 mm ; duration 9 days. The tip of the respiratory siphon fringed with regularly arranged hairs on the lateral sides.



Ranatra filiformis Fab.

Text-fig. 5. adult.



Ranatra filiformis Fab.

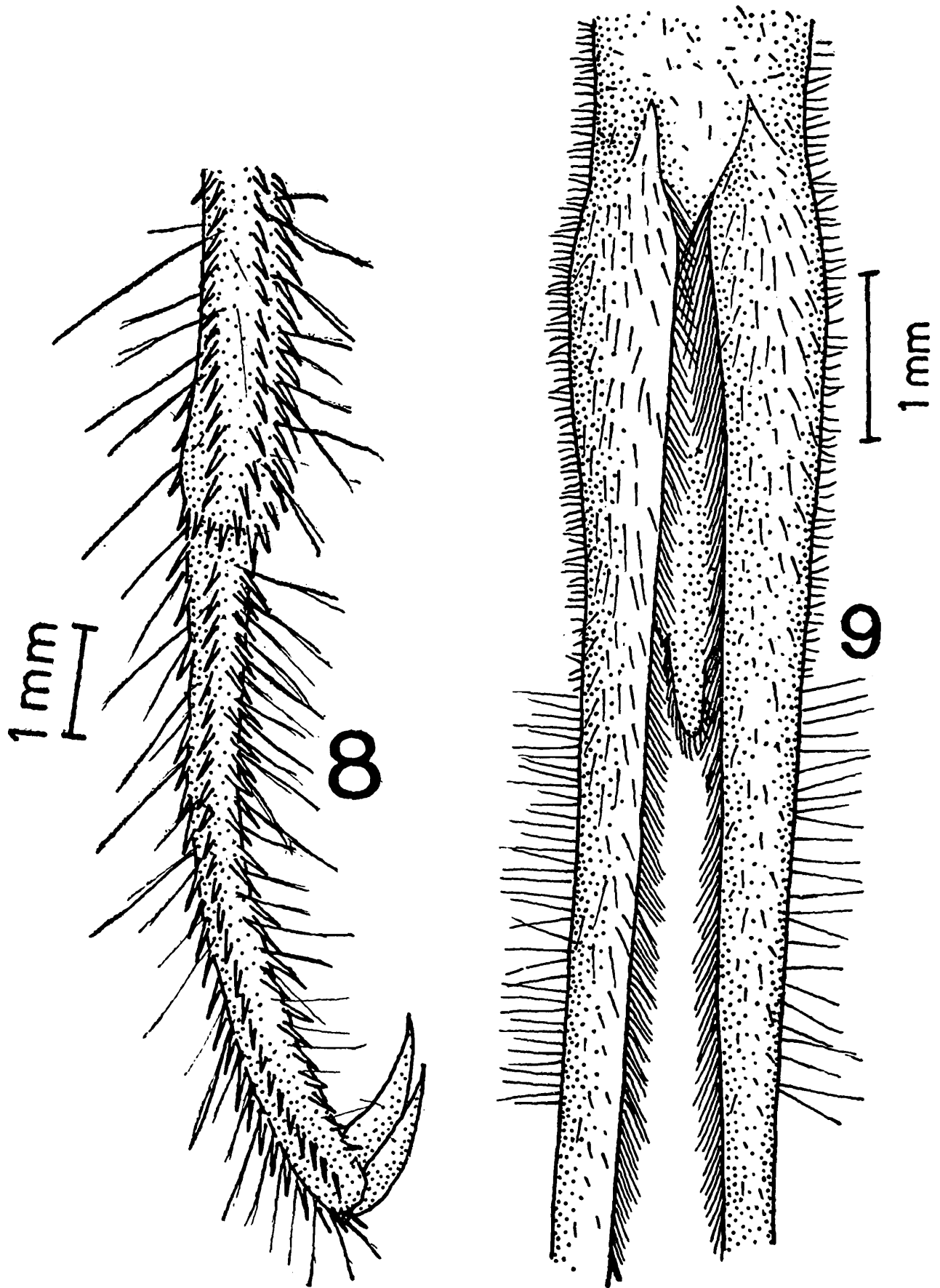
Text-figs. 6. head with prothorax. 7. anterior part of the foreleg.

IV instar (Text-fig. 4)

Length : 28 mm ; *rostrum* : 1.5 mm ; *respiratory siphon* : 6.5 mm ;
maximum width : 3 mm, *duration* 13 days.

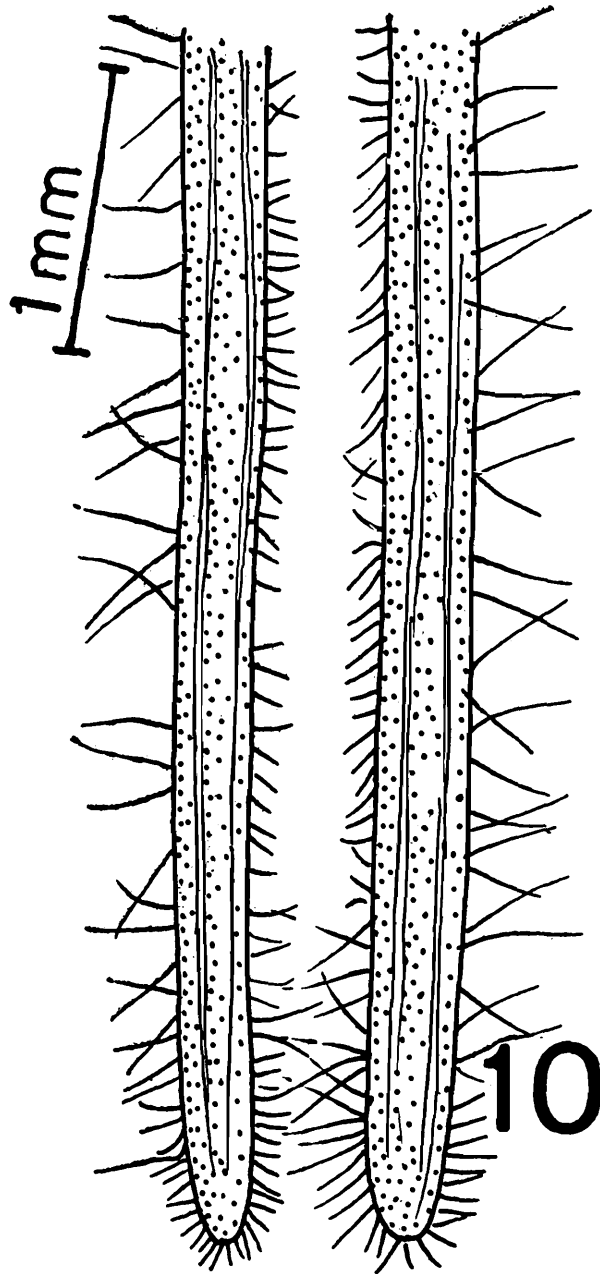
Adult (Text-figs. 5-10)

Length : 42.34 mm ; rostrum : 2 mm : respiratory filaments : 16.67 mm ; maximum width : 3.17 mm. Straw yellow in colour. Legs banded



Ranatra filiformis Fab.

Text-figs. 8. hind tibiotarsus. 9. posterior end of the abdomen showing the proximal part of the caudal filament.

*Ranatra filiformis* Fab.

Text-fig. 10. distal end of the caudal filament.

with brown markings. Head prognathous. Mouth parts are greatly modified to form a three-jointed, piercing and sucking beak or rostrum inserted near the anterior end of the head. Eyes large, rounded and prominent; ocelli absent; antennae hidden. Prothorax free, slender and elongated. Meso and metathorax are united. The forelegs are prehensile without claws, the femur of which is longer, stouter and the tibiotarsus folded back against the femur to work as a scissor. Mid and hind legs long and slender, adapted for walking. Tarsi single segmented with paired claws. Tibiotarsi beset with a double row of simple spines arranged laterally and fringed with hairs. Abdomen slender, elongated and cylindrical. Paired wings (fore wings modified to form the hemelytra) folded back over the abdomen. Membranes

TABLE II. Measurements of various organs of the different stages of *Ranatra filiformis* Fab. Each value represents the mean of 6 individuals \pm S. L.

Stage	Body length mm	Head		Thorax		Abdomen	
		Length mm	Width mm	Length mm	Width mm	Length mm	Width mm
Nymph	6.00 \pm 0.056	0.25 \pm 0.002	0.50 \pm 0.005	1.25 \pm 0.006	0.75 \pm 0.005	3.00 \pm 0.057	0.75 \pm 0.004
I instar	7.75 \pm 0.013	0.50 \pm 0.008	1.00 \pm 0.068	1.50 \pm 0.016	1.25 \pm 0.004	3.50 \pm 0.010	1.00 \pm 0.026
II instar	17.75 \pm 0.002	0.75 \pm 0.006	1.50 \pm 0.006	3.50 \pm 0.004	2.00 \pm 0.052	8.50 \pm 0.003	1.50 \pm 0.006
III „	23.75 \pm 0.002	1.00 \pm 0.045	1.75 \pm 0.003	5.00 \pm 0.068	2.50 \pm 0.026	11.00 \pm 0.068	2.00 \pm 0.026
IV „	28.00 \pm 0.139	1.25 \pm 0.012	2.00 \pm 0.045	6.25 \pm 0.013	3.00 \pm 0.026	12.50 \pm 0.013	2.50 \pm 0.009
Adult	42.34 \pm 0.089	1.50 \pm 0.016	2.33 \pm 0.008	8.17 \pm 0.009	3.17 \pm 0.008	14.00 \pm 0.052	2.67 \pm 0.005

TABLE II (Concluded)

Stage	Rostrum mm	Respiratory siphon mm	Foreleg mm	Midleg mm	Hind leg mm
Nymph	0.50 \pm 0.037	1.00 \pm 0.025	2.00 \pm 0.077	4.80 \pm 0.004	5.00 \pm 0.057
I instar	0.75 \pm 0.007	1.50 \pm 0.068	4.50 \pm 0.009	6.90 \pm 0.044	7.00 \pm 0.037
II instar	1.00 \pm 0.068	4.00 \pm 0.026	10.00 \pm 0.068	14.70 \pm 0.058	15.00 \pm 0.068
III „	1.25 \pm 0.005	5.50 \pm 0.026	12.00 \pm 0.100	17.80 \pm 0.063	18.00 \pm 0.068
IV „	1.50 \pm 0.037	6.50 \pm 0.058	14.00 \pm 0.045	20.00 \pm 0.052	20.50 \pm 0.036
Adult	2.00 \pm 0.045	16.67 \pm 0.002	17.00 \pm 0.037	26.40 \pm 0.089	26.67 \pm 0.007

of the hemelytra reticulately veined. Posterior end of the abdomen bears two long, slender, non-retractile caudal filaments with hairs all over it. Each of these has a groove on the median surface and when fitted together the filaments constitute a respiratory tube which is a striking feature of the family. At intervals its tip is placed at the surface film so that the oxygen in the tracheal system may be replenished.

BIOMETRIC STUDIES

For studying the growth rate of *R. filiformis* observations were made on the different instars. The measurements of body length, head length and width, thorax length and width, abdomen length and width, length of rostrum, respiratory siphon, fore leg, midleg and hind leg were taken. The measurements were based on the average of six individuals (Table II). In order to find out the nature of relationships the correlation coefficients between the instars and the different body dimensions were worked out, after converting the latter to their logarithms. x =stage and y =log of body measurements. All the correlation coefficient values obtained are significant ($P < 0.05$) (Table III).

Regression equation was calculated by the formula $y = bx + a$ where b is the growth rate. The regression equations between the instars

TABLE III. Correlation coefficients and regression equations between stages and the different body measurements of *Ranatra filiformis* Fab.

Body measurements	Growth rate (Regression coefficients)	Correlation coefficients	Regression equations
Body length	0.1727	0.9772	$Y = 0.1727x + 0.6292$
Head length	0.1488	0.9676	$Y = 0.1488x + 0.3534$
Head width	0.1232	0.9360	$Y = 0.1232x + 0.6999$
Thorax length	0.1740	0.9745	$Y = 0.1740x + 0.0716$
Thorax width	0.1248	0.9540	$Y = 0.1248x + 0.8380$
Abdomen length	0.1462	0.9421	$Y = 0.1462x + 0.8608$
Abdomen width	0.1165	0.9807	$Y = 0.1165x + 0.7883$
Rostrum length	0.1146	0.9917	$Y = 0.1146x + 0.6236$
Respiratory siphon length	0.2331	0.9795	$Y = 0.2331x - 0.2237$
Fore leg length	0.1301	0.9282	$Y = 0.1301x + 0.6315$
Mid leg length	0.1134	0.9073	$Y = 0.1134x + 1.1690$
Hind leg length	0.1461	0.9609	$Y = 0.1461x + 0.6075$

X = Stage and Y = log of body measurements.

and the different body dimensions are given in Table III. In all cases the instars and the logarithms of different body dimensions were linearly related.

DISCUSSION

The present study reveals that in Kerala the incubation period of *R. filiformis* is 7-9 days. The nymph lasted for 7 days. The first and the final instar nymphs had a longer duration.

The egg of *Ranatra* has been the subject of investigation by many authors. Petit (1902) attributed a protective function to the filaments against predators. The mode of oviposition in plant tissues by *R. quadridentata* was described by Bueno (1906) and Holmes (1907).

The incubation period and the post embryonic duration varies from species to species and even for the same species in different places. An incubation period of 4 days was reported by Nowrojee (1911) for *R. filiformis* while Hoffmann (1930) reported a period of 9-10 days for the same species at Canton. In Madras the incubation period was 6-12 days (Rao, 1977).

For incubation and post embryonic development of *R. filiformis* in Delhi (Nowrojee, 1911) about 34 days are needed which may be due to the warm climatic conditions prevailing in April when the studies were conducted. Thirty five days are required for *R. chinensis* and 42.5 days for *R. filiformis* (Hoffmann, 1930). Similar observations were made by Rao (1977) for *R. filiformis* at Madras. But, he noticed that the the eggs laid during rainy months took a longer time to hatch, while those laid in summer took less time. Venkatesan (1981) while studying the influence of temperature and salinity variations on the aquatic bug *Diplonychus indicus* reported that males are less susceptible to changes in these parameters.

In the present study even though the studies were conducted during the warm month of April, the eggs took an average of 58 days whereas it was only 38 days at Delhi during the same month. At Delhi the temperature is comparatively higher in April than at Trivandrum during this month.

ACKNOWLEDGEMENTS

One of us (KRN) is grateful to U. G. C. for the award of a fellowship during the tenure of which the present study was conducted. Thanks are due to Mr. N. K. Balasubramanian, Department of Aquatic Biology and Fisheries, Kerala University, for his help rendered in the statistical analysis of the data.

SUMMARY

The life history of the nepid *Ranatra filiformis* has been studied by collecting specimens from the field. The insects were reared from egg to the adult in the laboratory. The nymph hatched out from the egg passed through four instars to become the adult. Breeding record is presented. The principal changes in external morphology in different instars are given with full illustrated descriptions. *R. filiformis* took 58 days for the attainment of adulthood. The growth rates are statistically interpreted.

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ON THE AQUATIC STICK INSECT *CERCOTMETUS*
PILIPES DALL (HEMIPTERA : NEPIDAE)

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Beach P. O. Trivandrum

(With 3 Text-figures)

INTRODUCTION

Aquatic nepids pose a serious menace in fish cultural operations by destroying fish fingerlings and even small fishes. Effective control of mosquito larvae can be carried out by these insects. On account of the above mentioned importance, in the present paper a detailed description of *Cercotmetus pilipes* Dall, hitherto not been reported from India is given.

***Cercotmetus pilipes* Dall**

(Text-fig. 1)

1849. *Ranatra* (*Cercotmetus*) Dall, *Tr. E. S.* p. 2.

1908. *Cercotmetus pilipes* Montand, *Bull. Soc. Sci. Bucarest*, XII, 110.

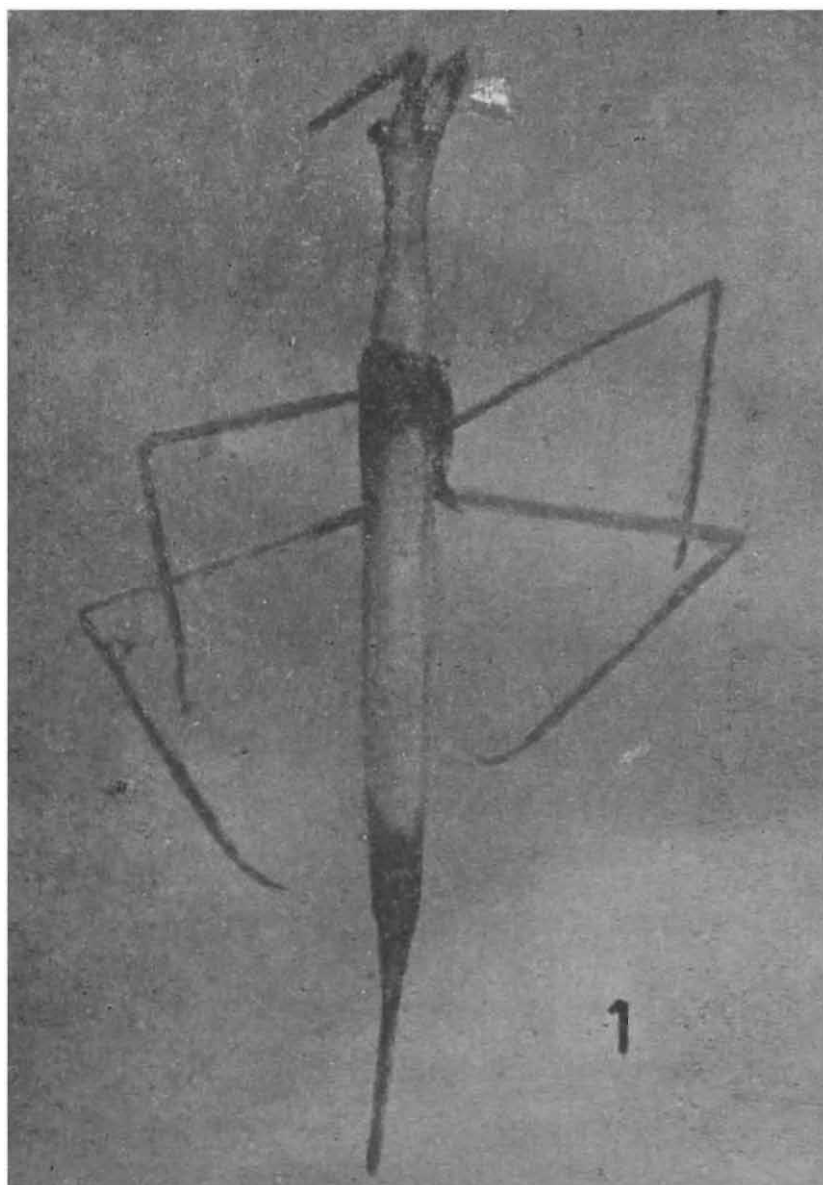
MATERIALS AND METHODS

Four adult insects were collected from a slow running canal on 9th August and two on 14th September, 1978 from a pond both in Chackai about 4 km west of Trivandrum city. The figures were drawn with the help of a camera lucida and the specimens are deposited in the Museum of the Department of Aquatic Biology & Fisheries, Aquarium, Kerala University.

Measurements : Body length : 44 mm (excluding anal appendages), Head length : 2 mm, width : 4 mm, Thorax length : 15 mm, width : 5 mm, Abdomen length : 24 mm, width : 4 mm, rostrum : 3 mm, respiratory filament : 11 mm, wings : 21 mm, Legs : 20 mm, 26 mm, 36 mm.

Description : Body elongated, cylindrical. Length 44 mm and maximum width 5 mm across the thoracic region.

Colour yellowish brown or dark brown. Legs banded with pale brown markings. Head prognathous, small and subconical. An acute tubercle on the vertex between the eyes.



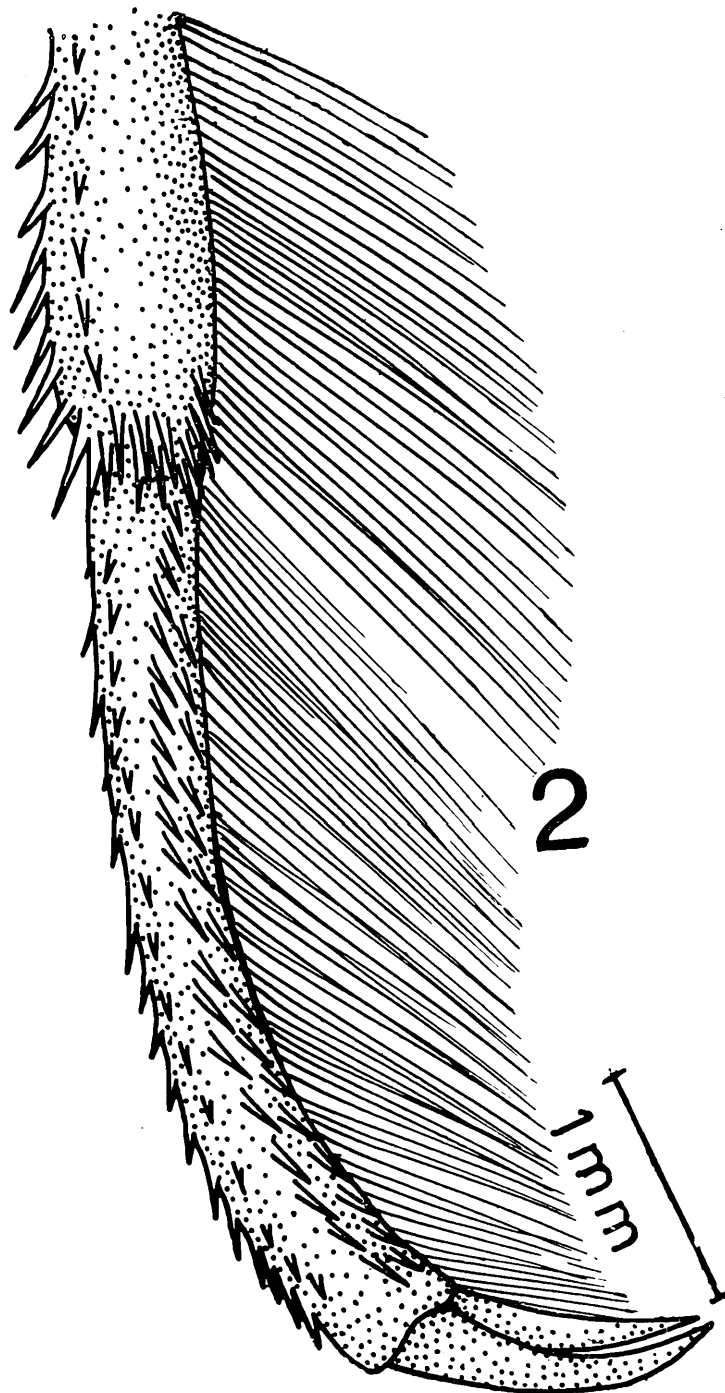
Cercotmetus pilipes Dall

Text-fig. 1. Adult

Eyes large, rounded, prominent and placed anterolaterally. Ocelli absent. Mouth parts are greatly modified to form a three-jointed piercing and sucking beak inserted near the anterior end of the head. Antenna small, three-segmented and hidden.

Prothorax narrower than head. Narrower anteriorly and progressively broader posteriorwards. Elongated, slender and free. Meso and metathorax are united. Prosternum with two deep, long longitudinal furrows extending its whole length. The front coxae inserted at the front margin of the prosternum. Coxae are shorter. Forelegs are strongly prehensile and claws are absent. Femur of the foreleg is considerably shorter than the pronotum, stouter and the tibia and tarsus may be folded back against the femur. The whole set up thus acts as a scissor. Pronotum longer than the intermediate femora. The mid and hind legs are longer and adapted for walking. Beset with

a double row of spines laterally and fringed with a double row of regularly arranged long yellow hairs on the inner sides (Text-fig. 2). Tarsi one-segmented bearing spines and hairs and paired claws are present.

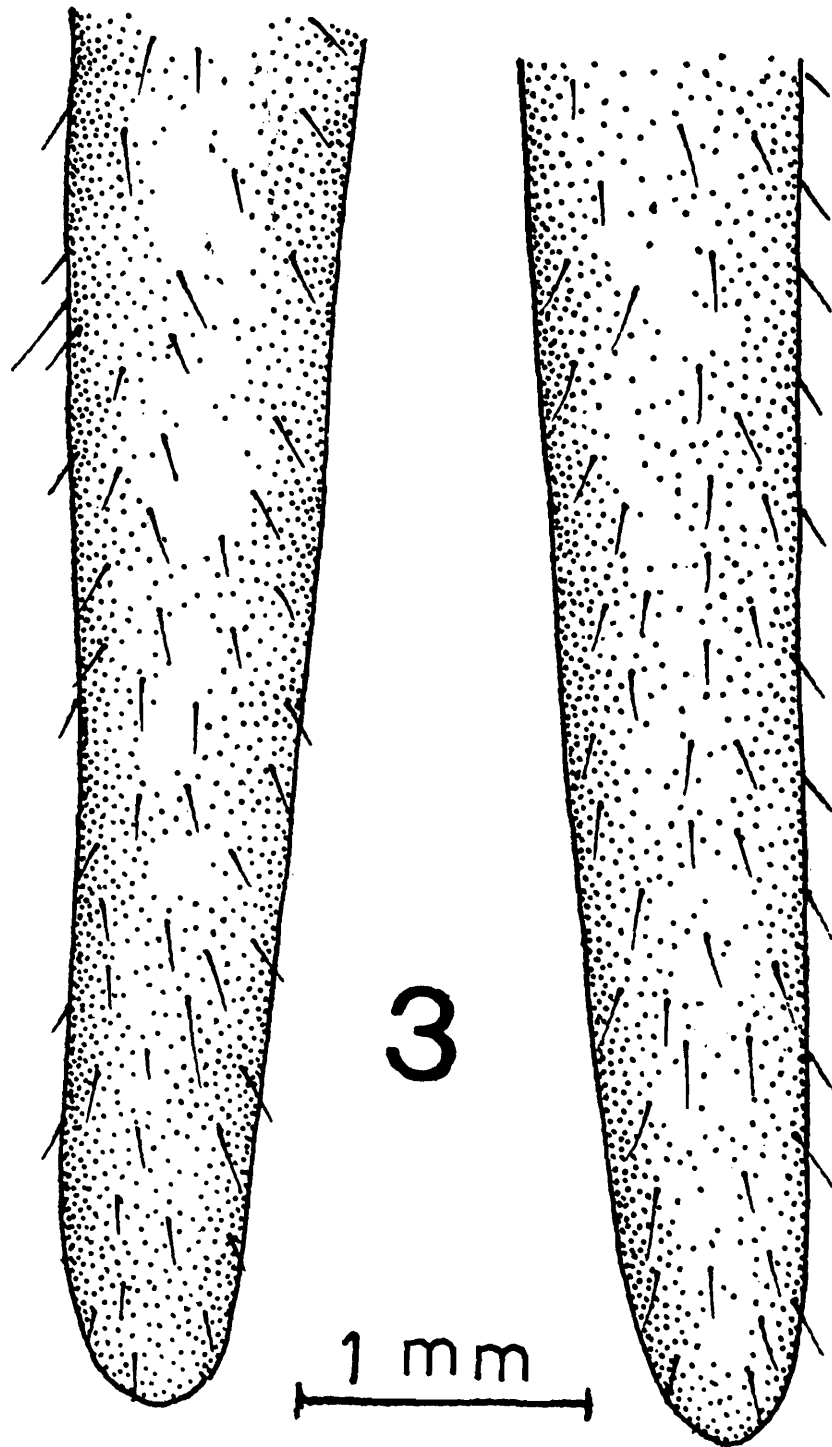


Cercotmetus pilipes Dall

Text-fig. 2. Hind tibiotarsus showing long yellow hairs

Abdomen slender, elongated and cylindrical. The two pairs of wings are straw yellow in colour and are folded back over the abdomen. Hemelytra not reaching the apex of the penultimate abdominal segment. Membrane of the hemelytra reticulately veined. Ventral part of the abdomen brownish in colour with sloping lateral sides. The abdomen beneath strongly keeled, the keel continued upwards along the sternum,

disappearing about the centre of the mesosternum. Three pairs of false spiracles are present on the third, fourth and fifth segments ventrally. Posterior end of the abdomen bears a pair of caudal filaments which a striking feature of the family (Text-fig. 3). They are very short, not more than $\frac{1}{4}$ th the length of the body, broad, compressed and strongly pilose externally.



Cercotmetus pilipes Dall

Text-fig. 3. Distal end of the caudal filaments enlarged

Biological note : *Cercotmentus pilipes* is a comparatively rare species as compared with cosmopolitan *Ranatra filiformis*. Linear and elongated this species closely resembles floating straws and sticks. They are inconspicuous owing to their protective colouration against the back-

ground of dead leaves, decaying vegetation and also because of their sluggish movements. They usually cling on to the substrate but remain in close contact with the surface film. They differ from *Ranatra filiformis* in the darker colour, larger size, shorter coxae and the shorter fore femora. The eggs resemble those of *Ranatra filiformis* and are laid on the stems of aquatic vegetation just like *Ranatra filiformis*. Each egg bears two long thin filaments at its apex, and is laid inside the stems floating on the water. These bugs are highly voracious and attack fish fry, tadpoles, mosquito larvae and even small fishes.

Previous record : Bhutan.

Remarks : *Cercotmetus pilipes* has been previously collected by Dall (1849) and Montand (1903) from Bhutan. Based on the description of *C. pilipes* by the above authors Distant (1906) has given a brief description of this species in the Fauna of British India. Since the previous description is brief without proper illustrations a more detailed description with appropriate diagrams are given in the present study.

The present specimen differs only in the length of the body (44 mm) which is longer than the specimens collected from Bhutan (41 mm) and the colouration. Previously described insects have yellowish brown colouration while the present collection represented both yellowish brown and dark brown specimens. This species is apparently quite distinct from any other *Cercotmetus* species by virtue of the presence of the border of long yellow hairs to the intermediate and posterior tibiae and tarsi.

SUMMARY

Full illustrated description of the aquatic nepid *Cercotmetus pilipes* Dall which has, hitherto not been reported from this country is presented on the basis of materials collected from a slow running canal and a pond in Trivandrum, Kerala, India.

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