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FOUR NEW SPECIES OF *ASTENUS* STEPH. (COLEOPTERA :
STAPHYLINIDAE : PAEDERINAE) FROM EASTERN INDIA

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ABSTRACT

Astenus asitus, sp. nov., *Astenus bisalicus*, sp. nov., *Astenus tanicus*, sp. nov., *Astenus jhopus* sp. nov. are described and *Astenus indicus* (Kraatz) is recorded for the first time from West Bengal, Sikkim and Uttar Pradesh.

The paper presents the descriptions of four new species of *Astenus* which are collected by us from Darjeeling District (West Bengal), Sikkim and Gorakhpur District (Uttar Pradesh) under the leadership of Dr T. Sen Gupta and Shri S. K. Saha respectively.

The genus *Astenus* Steph. can easily be separated from the related genera of the tribe Paederini by its head being oblong, labrum emarginate in the middle and fundus with two small teeth.

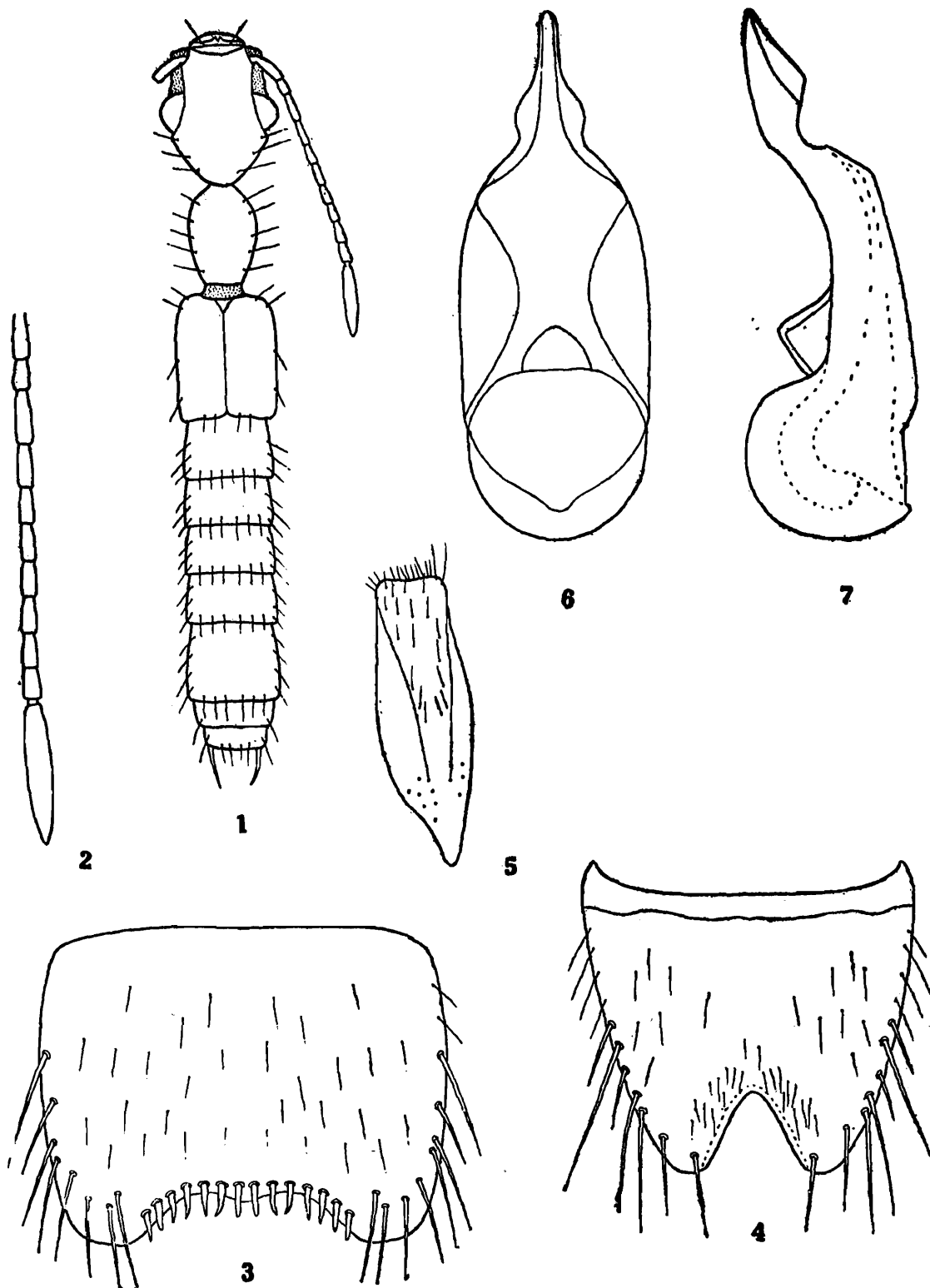
Cameron (1931) dealt with 30 species under the genus *Astenus*, of which 26 species are from the present territory of India and he (1943) added another 3 species from Darjeeling District (West Bengal) and Kashmir. Since then, the present study is first attempt to the knowledge of *Astenus* from India.

1. *Astenus asitus*, sp. nov.
(Figs. 1-7)

This is a unique species and differs from all other Indian species of the genus *Astenus* by its antennal segment 11 about 4 times longer than segment 10.

General appearance elongate, narrow, black, shining, antennae (except segment 11 infusate), palpi, mandibles and legs yellowish, body covered with dense gray pubescence mixed with some erect long black setae.

Head longer than broad, vertex distinctly convex and transversely impressed before eyes, post-ocular region rather straight and distinctly narrowed towards base, dorsal surface of head covered with reticulate-umblicate punctures, each puncture armed with a short seta. Eyes moderately large. Antennae (Fig. 2) longer than head and thorax combined and slender, scape long, pedicel short, segment 3 twice as long as pedicel, segment 4 slightly longer than segment 5, segments 5-9 equal, segment 10 slightly shorter than segment 9, segment 11 markedly long and about 4 times as long as segment 10. Prothorax oval, longer than broad, distinctly narrower than head, lateral margin rounded, slightly narrowed posteriorly, and armed with five long black setae, sculpture on pronotum similar as on head. Elytra slightly longer than prothorax, as broad as head, and parallel-sided, covered with densely and coarsely



Figs. 1-7. 1. Dorsal view of *Astenus asitus*, sp. nov., 2. Antennae, 3. sternite 5, dorsal view, 4. Sternite 6, dorsal view, 5. Sternite 7, dorsal view, 6. Aedeagus, ventral view, 7. Aedeagus, lateral view.

setiferous punctures. Abdomen parallel sided, segments 1-4 densely and coarsely punctured at the base and rest of the segments sparingly punctured. Sternite 6 (Fig. 4) of abdomen of male broadly and triangularly excised and its apex rounded and sides bordered; posterior margin of sternite 5 (Fig. 3) broadly emarginate and armed with fourteen long, black, pointed spines. Sternite 7 and aedeagus as figured (Figs. 5, 6 & 7).

Holotype : ♂, INDIA : SIKKIM ; Rangpo, 23. ii. 1979, D. N. Biswas Collection ; *Paratypes* 2 ♂ ♂, 1 ♂, Collection data same as holotype, 1 ♂, WEST BENGAL : Darjeeling District, Sevoke, 29. xii. 1980, D. N. Biswas collection.

All the materials are deposited in the Zoological Survey of India, Calcutta.

Measurements of holotype : Total length 4.20 mm ; width of head across the eyes 0.60 mm ; width of prothorax 0.50 mm and length of prothorax 0.70 mm ; width of elytra 0.70 mm and length of elytra 0.80 mm.

Distribution : INDIA : WEST BENGAL and SIKKIM.

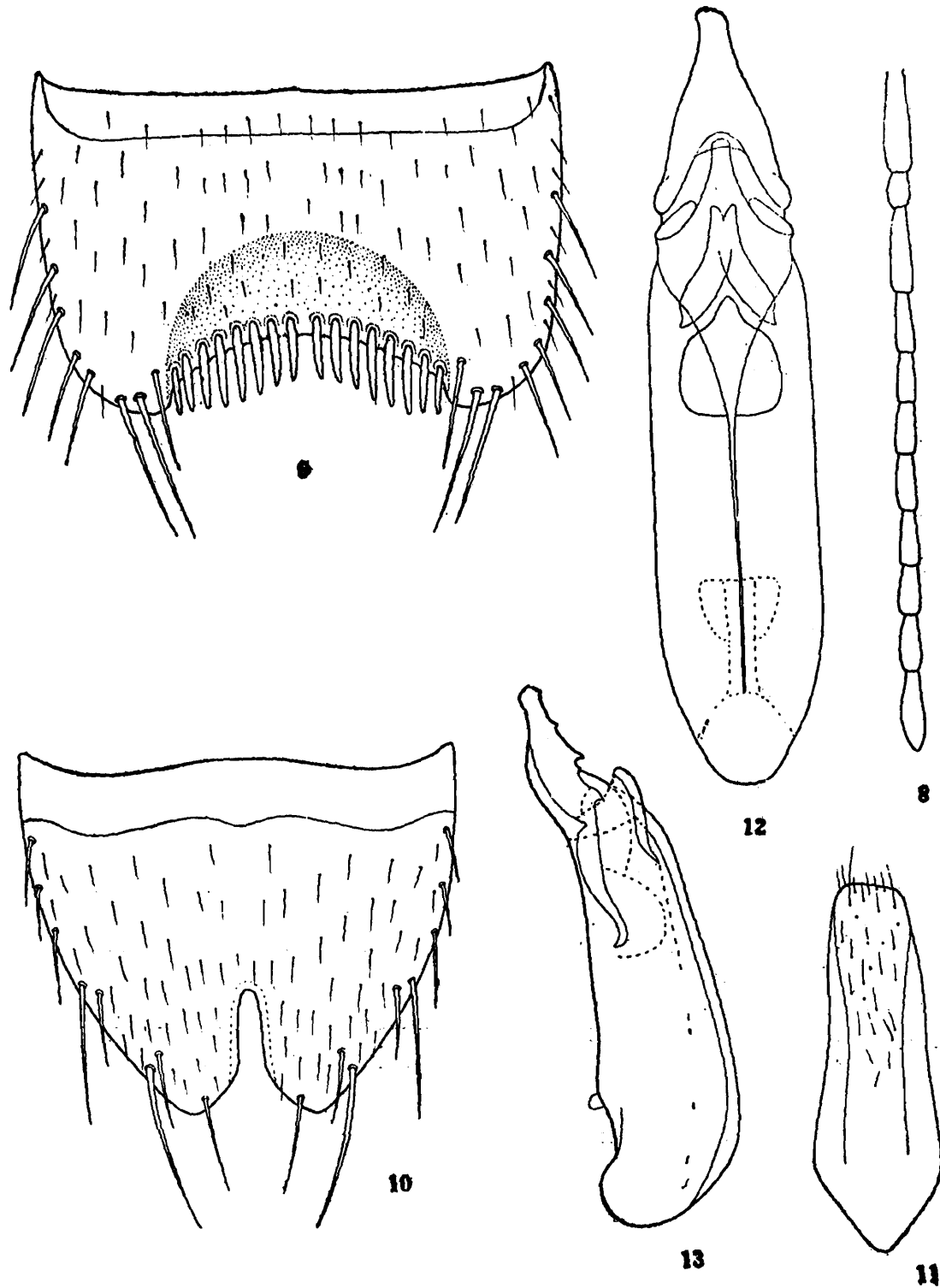
2. *Astenus bisalicus*, sp. nov. (Figs. 8-13)

This species is closely related to *Astenus biplagiatus* (Motschulsky) but differs from the latter species by its legs being yellowish, posterior margins of abdominal segments testaceous, posterior margin of abdominal sternite 6 of male with parallel-sided excision similar to *biplagiatus* but its sides bordered, posterior margin of abdominal sternite 5 of male deeply emarginate and armed with two markedly long black additional setae and front of emargination superficially impressed.

General appearance large and robust, black, shining, each elytron with a small oblong red patch at apex near suture, posterior margin of abdomen testaceous, antennae, palpi and legs yellowish.

Head large and distinctly widened in front of eyes, anterior part of vertex broadly and transversely impressed, temples rather straight in front and somewhat rounded at base, dorsal surface of head reticulate-umblicate punctured. Clypeus smooth. Eyes moderately large and not prominent. Antennae (Fig. 8) long and slender, scape distinctly long, pedicel short, segment 3 about two and half times longer than pedicel, segment 4 slightly longer than segment 5, segments 5-10 equal, segment 11 slightly longer than segment 10. Prothorax narrow and oval, anterior angles broadly rounded, parallel-sided, posterior margin slightly narrower than anterior margin, puncturations finer than that of head, lateral margins with four long black setae. Elytra slightly longer than prothorax, as broad as head, lateral margins parallel-sided and armed with some long black setae, dorsal surface densely and coarsely punctured. Abdominal segments 1-2 densely and coarsely punctured, rest rather finely punctured. Posterior margin of abdominal sternite 6 (Fig. 10) of male narrowly excised, excision almost parallel-sided, its sides bordered and apex rounded; posterior half of sternite 5 (Fig. 9) of male superficially impressed and its margin broadly and deeply emarginate, emargination armed with sixteen black spines and at each side of emargination with three distinct long black setae, of which inner one is slightly shorter. Sternite 7 and aedeagus as figured (Figs. 11, 12 and 13).

Holotype : ♂, INDIA : WEST BENGAL : Dar-



Figs. 8-13. 8. Antennae of *Astenus bisalicus*, sp. nov., 9. Sternite 5, dorsal view, 10. Sternite 6, dorsal view, 11. Sternite 7, dorsal view, 12. Aedeagus, ventral view, 13. Aedeagus, lateral view.

jeeling District, Tung, 28 km. from Tindharia, 25. iii. 1978. *D. N. Biswas* Collection. *Paratypes* : 2 ♀ ♀ , 1 ♀ , WEST BENGAL : Darjeeling District, Sevoke, 33 km. from Sukna, 10. iv. 1978, *D. N. Biswas* collection, 1 ♀ , Darjeeling District, Rangtong, 8 km. from Sukna, 13. iv. 1978, *D. N. Biswas* collection. Ex. Leaf litter.

All the materials are deposited in the Zoological Survey of India, Calcutta.

Measurements of holotype : Total length 7.65 mm ; width of head across the eyes 1.00 mm ; width of prothorax 0.85 mm and length of prothorax 1.15 mm ; width of elytra 1.05 mm and length of elytra 1.25 mm.

Distribution : INDIA : WEST BENGAL.

3. *Astenus jhopus*, sp. nov. (Figs. 14-19)

This species is closely related to *Astenus indicus* (Kraatz) but can be easily separated from the latter by new species being distinctly narrower and larger than *indicus*, its abdominal segments 5-7 completely black, lateral margins of prothorax with four long black setae, antennal segment 3 distinctly longer than pedicel, the excision on posterior margin of abdominal sternite 6 of male characteristic (Fig. 16), posterior margin of abdominal sternite 5 (Fig. 15) of male broadly emarginate at middle, in front of emargination a broad impression extending nearly to the anterior margin of segment, half of impressed area from posterior margin devoid of any setae.

General appearance narrow, shining, pale-yellow, abdominal segments 5-7 black, antennae, palpi and legs yellow.

Head slightly longer than broad, vertex

convex, post-ocular region broadly rounded at base, dorsal surface of head covered with densely and finely setiferous punctures, basal part of head with some long black setae. Eyes moderately large and prominent. Antennae (Fig. 14) short and slender, scape elongate, pedicel short, segment 3 distinctly longer than pedicel, segments 4-10 equal, segment 11 slightly longer than segment 10. Prothorax slightly longer than broad and narrower than head, lateral margins rounded and narrowed posteriorly, puncturations coarser than that of on head. Elytra slightly longer than prothorax and as broad as head, humeral angles with two long black setae, surface densely and distinctly punctured. Abdominal segments 1-4 densely and coarsely punctured, rest finely and superficially punctured. Sternite 7 and aedeagus as figured (Figs. 17, 18 & 19).

Holotype : ♂ , INDIA : SIKKIM : Mansong, 35 km. from Rangpo, 24. ii. 1979, *D. N. Biswas* collection ; *Paratypes* : 15 examples, 1 ♂ , 2 ♀ ♀ , collection data same as holotype, 6 ♂ ♂ , 6 ♀ ♀ , SIKKIM : Singtam, 12 km. from Rangpo, 24. xii. 1980, *D. N. Biswas* collection. Ex. Beating the bush.

All the materials are deposited in the Zoological Survey of India, Calcutta.

Measurements of holotype : Total length 3.60 mm ; width of head across the eyes 0.50 mm ; width of prothorax 0.40 mm and length of prothorax 0.60 mm ; width of elytra 0.50 mm and length of elytra 0.60 mm.

Distribution : INDIA : SIKKIM.

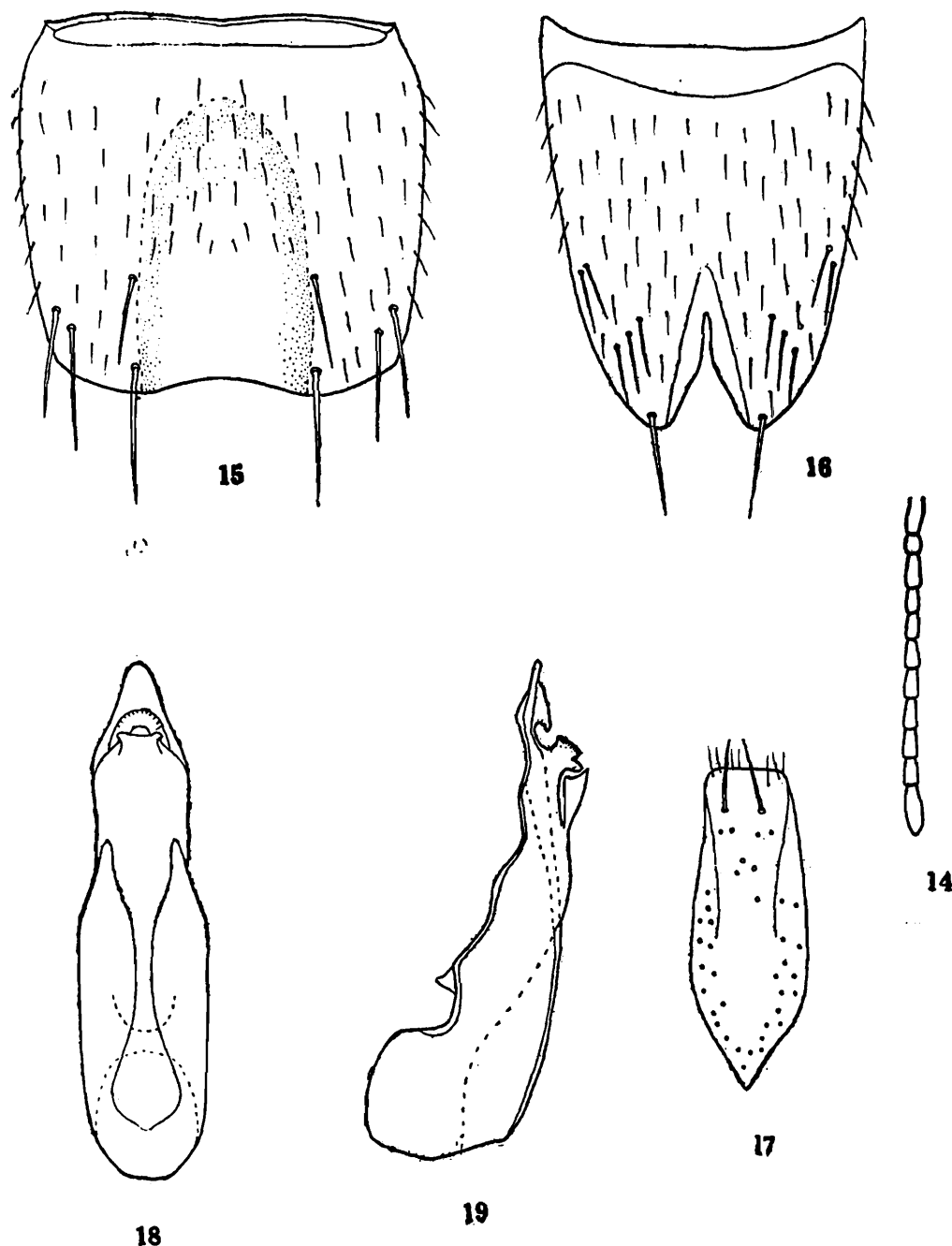
4. *Astenus tanicus*, sp. nov. (Figs. 20-25)

This species is closely related to *Astenus kraatzi* Bernhauer but can easily be separated from the latter species by its sutural line of

elytra being black, elytra distinctly longer and broader than prothorax ; abdominal segments 7 and 8 black, excision of posterior margin of sternite 6 (Fig. 22) of abdomen of male broadly triangular and its apex rounded, posterior margin of sternite 5 (Fig. 21) of abdomen of male armed with closely situated

sixteen short slender spines on each side of the middle line and median portion devoid of any spine, in front of emargination a narrow impression extending nearly to the anterior margin of the segment.

General appearance narrow, shining, reddish, elytra yellowish, a black median spot

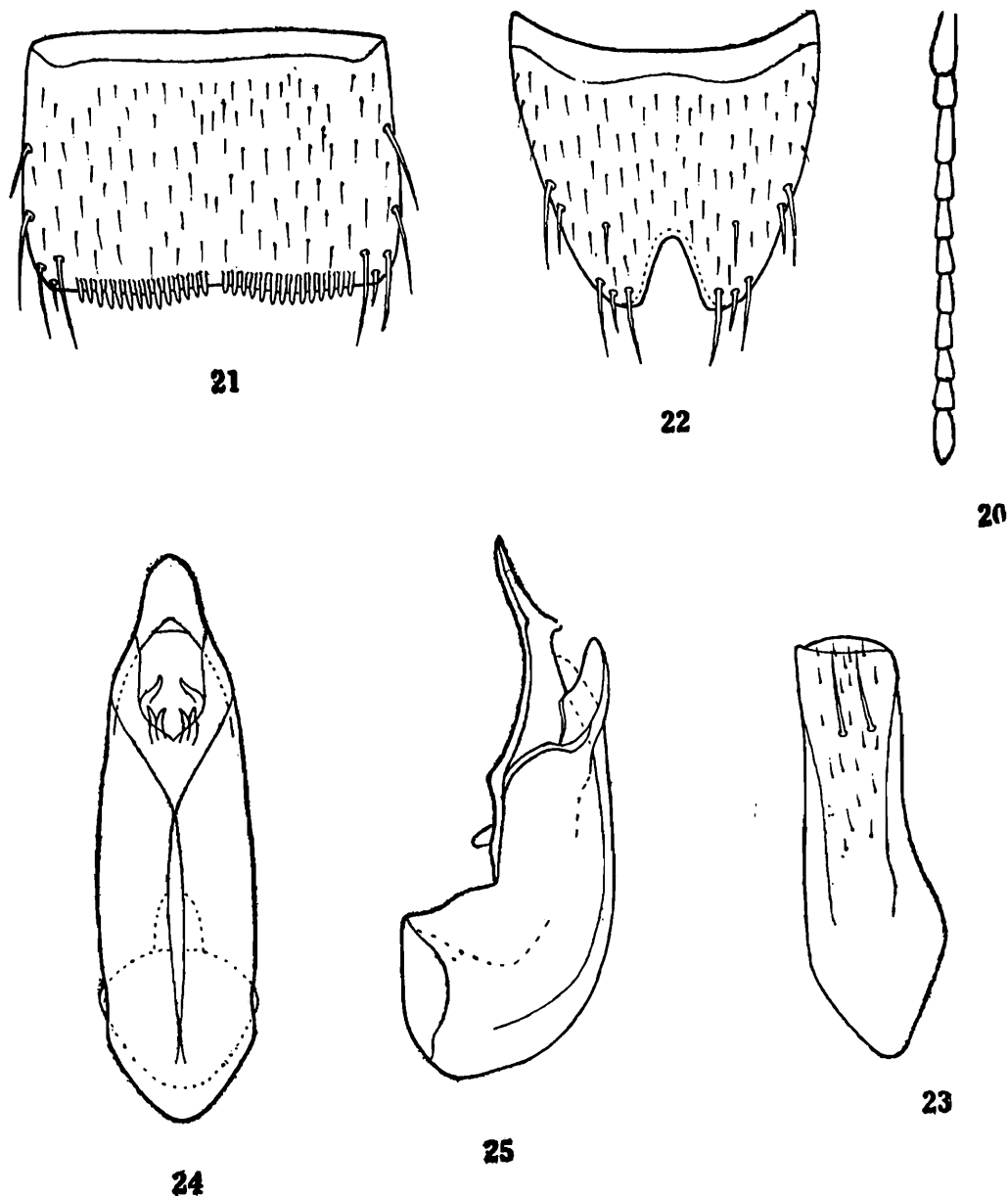


Figs. 14-19. 14. Antennae of *Astenus jhopus*, sp nov., 15. Sternite 5, dorsal view, 16. Sternite 6, dorsal view, 17. Sternite 7, dorsal view, 18. Aedeagus, ventral view, 19. Aedeagus, lateral view.

present on each elytron which extending to the epipleura, abdominal segments 7 and 8 black, antennae, palpi and legs yellowish.

Head subquadrate, broader than thorax, convex, post-ocular region broadly rounded at base, dorsal surface of head finely reticulate-umblicately punctured. Eyes moderately large. Antennae (Fig. 20) rather short and

slender, scape moderately long, pedicel short, segment 3 one and half times longer than pedicel, segments 4-8 equal, segments 9-10 slightly shorter than segment 8, segment 11 slightly longer than segment 10. Prothorax slightly longer than broad, its anterior portion broad and distinctly narrowed posteriorly, sculpture similar to that of on head. Elytra slightly longer than prothorax, surface



Figs. 20-25. 20. Antennae of *Astenus tanicus*, sp. nov., 21. Sternite 5, dorsal view, 22. Sternite 6, dorsal view, 23. Sternite 7, dorsal view, 24. Aedeagus, ventral view, 25. Aedeagus, lateral view.

rather densely and distinctly punctured. Abdomen densely and finely punctured. Sternite 7 and aedeagus as figured (Figs. 23, 24 & 25).

Holotype : ♂, INDIA : UTTAR PRADESH : Gorakhpur District, Singraha Falls, 22. xii. 1979, *T. Sen Gupta* collection ; **Paratype :** 1 ♂, Gorakhpur District : Nautanawa, 31. xii. 1979, *T. Sen Gupta* collection. Ex. Under heap of dry grasses.

All the materials are deposited in the Zoological Survey of India, Calcutta.

Measurements of holotype : Total length 3.80 mm ; width of head across the eyes 0.60 mm ; width of prothorax 0.50 mm and length of prothorax 0.60 mm ; width of elytra 0.60 mm and length of elytra 0.70 mm.

Distribution : INDIA : UTTAR PRADESH.

5. *Astenus indicus* (Kraatz) (Figs. 26-31)

Sunius indicus Kraatz, 1859, *Arch. Naturgesch.*, 25 (1) : 148 ; *Sunius oculatus* Sharp, 1874, *Trans. ent. Soc. Lond.*, 72 ; *Sunius pallidulus* Wollaston, 1864, *A Catalogue of the Coleopterous Insects from the Canaries in the Collection of the British Museum*, 8 : 648 ; *Astenus indicus* : Cameron, 1931, *The Fauna of British India, including Ceylon and Burma, Coleoptera : Staphylinidae*, 2 : 1-257, 94 figs, 1-2 plates.

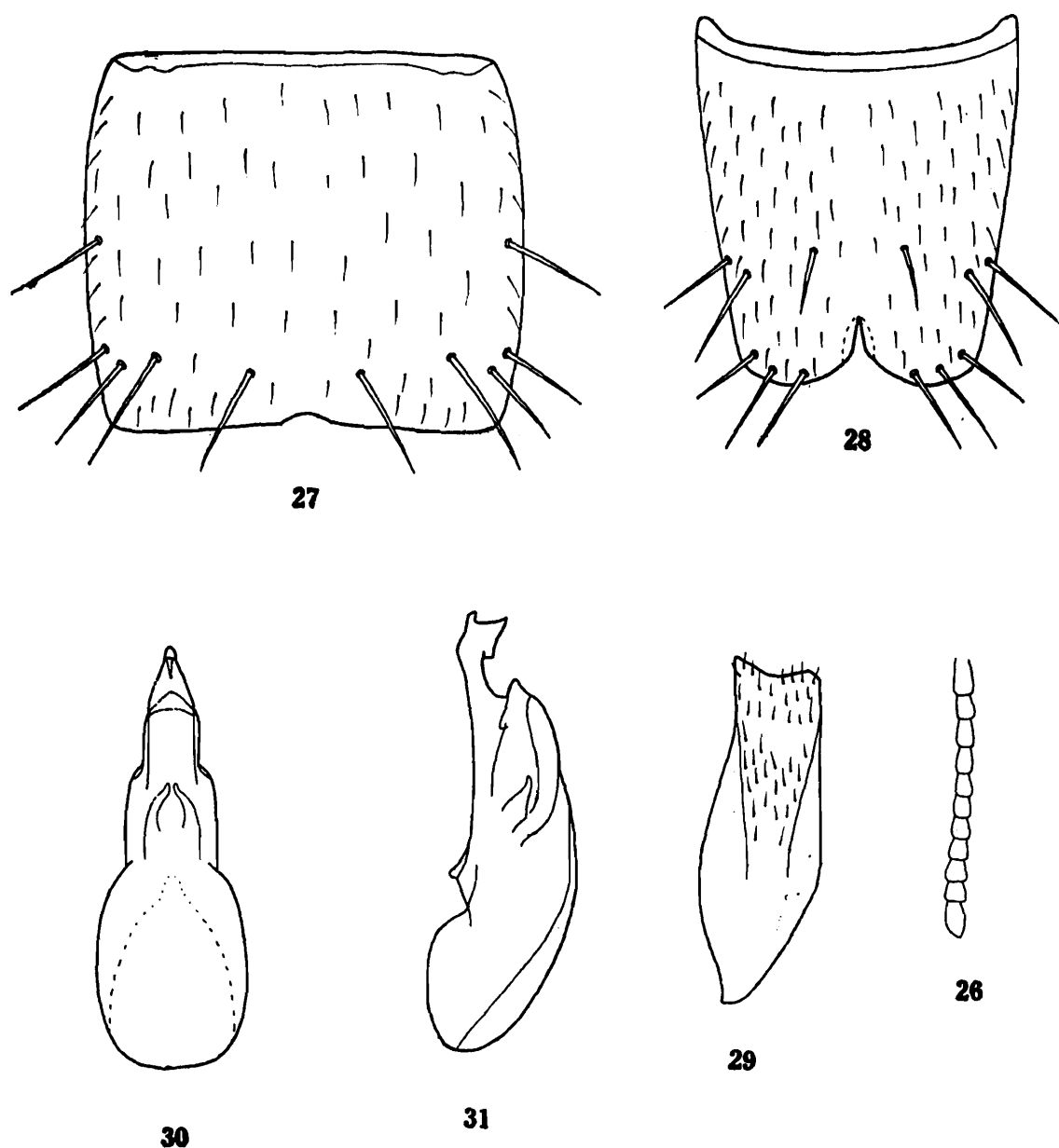
This species can be recognised by the following characters : form narrow, elongate, parallel, yellowish red, post-ocular region of head broadly rounded at base, antennal (Fig. 26) segment 3 slightly longer than pedicel,

prothorax slightly wider in front and lateral margin with five long black setae, and abdominal segment 7 black. Posterior margin (Fig. 28) of sternite 6 of abdomen of male acute, excision, triangular, externally bounded by a narrow groove ; posterior margin of sternite 5 (Fig. 27) of abdomen of male feebly emarginate at middle. Sternite 7 and aedeagus as figured (Figs. 29, 30 & 31).

Specimens examined : 8 exs., INDIA : SIKKIM : Rangpo, 23. ii. 1979, 1 ex., *D. N. Biswas*, collection ; SIKKIM : Mansong, 35 km. from Rangpo, 24. ii. 1979, 1 ex., *D. N. Biswas* collection ; Phungla, 25 km. from Rangpo, 26. ii. 1979, 1 ex., *D. N. Biswas* collection ; WEST BENGAL : Darjeeling District, Teesta Bazar, 27. ii. 1979, 1 ex., *D. N. Biswas* collection ; Nadia District : Suravisthan, Badkulla, 10 km. from Krishnagar, 16. v. 1978, 1 ex., *D. N. Biswas* collection ; Ex. at light ; UTTAR PRADESH : Gorakhpur District, Nichlaul, 21. xii. 1979, 1 ex., *T. Sen Gupta* collection ; Gorakhpur District : Monderoha, 25. xii. 1979, 1 ex., *T. Sen Gupta* collection. Ex. Beating the bush.

This species is recorded here for the first time from West Bengal, Sikkim and Uttar Pradesh.

Distribution : INDIA : MAHARASHTRA (Bombay), WEST BENGAL, SIKKIM and UTTAR PRADESH ; SRILANKA ; BURMA. Widely distributed in the Oriental Region, also in the Mediterranean, Canaries, East and West Africa,



Figs. 26-31. 26. Antennae of *Astenus indicus* (Kraatz), 27. Sternite 5, dorsal view, 28. Sternite 6, dorsal view, 29. Sternite 7, dorsal view, 30. Aedeagus, ventral view, 31. Aedeagus, lateral view.

ACKNOWLEDGMENT

We are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India for providing necessary facilities.

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including Ceylon and Burma. Coleoptera : Staphylinidae, Taylor and Francis, London. 2 : 1-257, 94 figs., 1-2 plates.

CAMERON, M. 1943. Descriptions of new Staphylinidae (Coleoptera). *Proc. R. ent. Soc. Lond.*, 12 (Series B) : 32-36,

ON THE NEW RECORDS OF CENTIPEDES (SCOLOPENDROMORPHA :
SCOLOPENDRIDAE) FROM MADHYA PRADESH, INDIA

S. AHMED

Zoological Survey of India, Calcutta

ABSTRACT

A brief account of Centipedes (Scolopendridae) from Madhya Pradesh has been given here. A total of 9 species under 4 genera have been recorded, 8 of which are reported for the first time from this area.

INTRODUCTION

The Scolopendromorph fauna of Madhya Pradesh has not been studied so far. Keeping this in view, the author undertook the study of the unnamed material present in the collection of Zoological Survey of India, Calcutta. The study reveals the occurrence of 9 species out of which 8 are not so far recorded from these areas. Variations from the published descriptions (Attems, 1930 ; Gravely, 1910 and Jangi, 1955) have also been recorded.

1. *Asanada agharkari* (Gravely)

1912. *Pseudocryptops agharkari* Gravely, *Rec. Indian Mus.*, 7 : 417.

Specimens examined. : 1 ex. Rest House at Bargi, Dist. Jabalpur, 29.vi.1965, *H. Khajuria* coll. ; 3 ex. Pachmarhi, 15.xii. 1927, *H. S. Pruthi* coll. ; 1 ex. Ghorela, Dist. Balaghat, 3.iii.1961, *B. S. Lamba* coll.

Measurements. : Body length varies from 25 mm to 31 mm.

Known distribution. : INDIA : MAHARASHTRA.

Remarks. : The characters of the speci-

mens agree well with the revised description of the same by Jangi (1978).

2. *Cormocephalus dentipes* Pocock

1891. *Cormocephalus* (C). *dentipes* Pocock, *Ann. nat. Hist.*, 7 (6) : 66.

Specimens examined. : 2 ex. Amarkantak, Dist. Shahdol, Jan. 1927, *H. S. Pruthi* coll. ; 1 ex. Lamata Ghat ; Dist. Jabalpur, 16.vii. 1966, *V V Rao* coll.

Measurements. : The length of the body ranges from 28 mm to 38 mm.

Known distribution. : INDIA : WEST BENGAL, and DELHI.

Remarks. : The number of spines on anal legs varies from 18-19. Tergal margination is restricted to the last 6-8 tergites.

3. *Rhysida longipes longipes* (Newport)

1845. *Branchiostoma longipes* Newport, *Trans. Linn. Soc. Lond.*, 19 : 411.

1930. *Rhysida longipes longipes* Attems, *Das Tierreich*, 54 : 194.

Specimens examined. : 3 ex. Ghorela, Dist.

Balaghat, 13.ii.1954, *A. Hossain* coll. ; 7 ex. Gala Sankar, 22.i.1954. *S. Biswas*.

Measurements : The length of the body varies from 43 mm to 72 mm.

Known distribution. : INDIA : MAHARASHTRA ; WEST BENGAL.

Remarks. : This is a medium sized centipede. The specimens agree fairly well with the characters of the species described by Attems (1930).

4. *Rhysida nuda immarginata* (Porat)

1876. *Branchiostoma immarginatum* Porat *Bih. K. svenska. Vetensk. Akad. Handl.*, 4 : 24.

1930. *Rhysida nuda immarginata* Attems *Das Tierreich*, 54 : 190.

Specimens examined. : 1 ex. Amkhas Vill. Dist. Jabalpur, 24.vi.1963, *S. Chakrapany* coll. ; 1 ex. Katangi Road, 20.vi.1961, *R. C. Sharma*, coll.

Measurements. : Body length varies from 38 mm to 53 mm.

Known distribution. : INDIA, ANDAMAN ISLAND, ASSAM, WEST BENGAL.

Remarks.—Antennal segments vary from 20 to 22 ; in one specimen, last three tergites marginate, in another only the last. Number of spines on anal legs varies from 3-4.

5. *Rhysida nuda nuda* (Newport)

1845. *Branchiostoma nudum* New port, *Trans. Linn. Soc. Lond.*, 19 : 412.

1930. *R. n. nuda* Attems, *Das Tierreich.*, 54 : 190.

Specimens examined. : 1 ex. Ghorella, Dist. Balaghat, 17.ii.1954, *H. Khajuria* coll. ; 1 ex. Gourighat, Dist. Jabalpur, 23.vii.1962, *S. Chakrapany* coll. ; 1 ex. Amarkantak, Dist. Shahdol, 20.v.1962, *P. Singh* coll.

Measurements. : The length of the body ranges from 50 mm -87 mm.

Remarks. : This is a medium sized centipede, found usually under stones, bricks and also in moist soil. A large and rare specimen is being reported for the first time from India.

6. *Scolopendra morsitans* Linn.

1758. *Scolopendra morsitans* Linn., *Syst. Nat. Ed.*, 10 : 638.

Specimens examined. : 1 ex. Forest Rest House at Joga, Dist. Hosangabad. 14.xii. 1965, *H. P. Agrawal* coll. ; 1 ex. Gopalpur vill., Dist. Jabalpur 14.i.1961, *H. K. Khajuria* coll., 1 ex. Kanha National Park, Dist. Mandala, 10.vi. 1964, *O. B Chhotani* coll.

Measurements : The length of the body ranges from 61 mm to 94 mm.

Known distribution. : Cosmopolitan in distribution.

Remarks : This is a most common centipede and is usually found in dwelling houses and in other habitats such as under bricks, stones or fallen wood in damp soil. Different patterns of spines arrangements on anal legs such as 2 : 3 : 2-2 : 2 ; 2 : 2 : 2-2 : 2 ; 3 : 3 : 3-2 : 2 are present.

7. *Scolopendra amazonica* Bucherl

1946. *S. morsitans amazonica* Bucherl, *Mem. Inst. Butantan*, 19 : 135.

1959. *S. amazonica* Jangi, *Ent. News*, 70 : 253.

Specimens examined. : 2 ex. Handia vill., Dist. Hoshangabad, 21.xii. 1965 ; *H. P. Agrawal* coll. ; 3 ex. Khetgaon, Rewa State, Fob. 1929, *H. S. Pruthi* coll. ; 2 ex. Sibia, Dist. Jabalpur, 24.xii.1961, *P. Singh* coll.

Measurements : Body length varies from 46 mm to 49 mm.

Known distribution : INDIA : ANDAMAN and NICOBAR ISLANDS, MAHARASHTRA.

Remarks : This is one of the commonest

centipede. Spines on anal legs vary from 14-17. The specimens have been collected from forest areas.

8. *Scolopendra subspinipes dehaani* Brandt

1840. *Scolopendra dehaani* Brandt *Bull. Ac.*, 7 : 152.

1930. *Scolopendra s. dehaani* Attems, *Das Tierreich*, 54 : 31.

Specimens examined. : 2 ex. Jabalpur, Dist. Jabalpur, 29. x.1929, S. H. Rebeiro coll.

Measurements : Body length varies from 149 mm to 151 mm.

Known distribution : INDIA : ANDAMAN and NICOBAR ISLANDS, TAMIL NADU (MADRAS), WEST BENGAL.

Remarks : This is a large variety of centipede and agrees well in characters described by Attems (1930). The specimens have been collected from under the stones.

ACKNOWLEDGEMENTS

The author is grateful to Dr. B. K. Takader, Director, Zoological Survey of India, Calcutta, Dr. S. K. Bhattacharya, Deputy

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ON THE TYPE SPECIMENS OF *AMBASSIS NOTATUS* BLYTH, 1861
(PISCES : AMBASSIDAE), WITH A REDESCRIPTION
OF THE SPECIES

(Miss) SAGARIKA GUHA AND P. K. TALWAR
Zoological Survey of India, Calcutta.

ABSTRACT

The rediscovery of the unique syntypes of *Ambassis notatus* Blyth, 1861, belonging to the family Ambassidae, in the collections of the Zoological Survey of India, is announced. Consequent to this discovery, the inadequate original description is expanded, and a lectotype is selected for the species and illustrated.

INTRODUCTION

New information about *Ambassis notatus* Blyth, 1861, is desirable since this fish has been rather rarely noted in the ichthyological literature. Blyth's (1861) original description based on specimens from Burma, is brief and most inadequate for specific determination, and further the species is not illustrated. Subsequent to its original discovery, Day (1869, 1875 ; Menon, 1974) considered it conspecific with *Ambassis baculis* (Hamilton—Buchanan, 1822) but later Day (1888) relegated it to the synonymy of *Ambassis ranga* (Hamilton—Buchanan, 1822). Fraser—Brunner (1954), however, resurrected *A. notatus* from the synonymy of *Chanda baculis* Hamilton-Buchanan, based on an examination of two of Day's specimens from Moulmein (Burma) in the repository of the British Museum (Natural History).

In the present communication the rediscovery of the type-specimens of *Ambassis notatus* Blyth is announced, having not

previously been recognised and segregated. Consequent to this discovery, they allow us to augment the original description and offer a good figure of the lectotype now selected from the syntypic series in accordance with Article 74 of the *International Code of Zoological Nomenclature*. The specimen selected as the lectotype is the largest specimen and in a good state of preservation, and has dorsal and anal ray counts (14) closest to those in the original description. The nature of the armature of the opercular bones indicates that the placement of the species in either of the genera *Ambassis* Cuvier or *Chanda* Hamilton-Buchanan *sensu stricto* by earlier ichthyologists, is most inappropriate. The generic relationship of this species, is, however, presently under study.

SYSTEMATIC ACCOUNT

Family : AMBASSIDAE

Ambassis notatus Blyth

Ambassis notatus Blyth, 1861, *J. Asiat. Soc. Beng.*, 29 :
138 (type-locality : Sittang R., Burma).

LECTOTYPE (Fig. 1), herein designated, 56 mm in standard length (SL), Pegu (Burma), coll. Maj. T. M. Berdmore; Zoological Survey of India ASB Cat. 28, recatalogued as F 7696/2.

PARALECTOTYPES : 4 ex. (44-53 mm SL), same data as above; ZSI ASB Cat. 28, recatalogued as F 7697/2.

ridge dentate posteriorly only with 3 or 4 backwardly-directed spines; suborbital smooth; preorbital strongly serrated both on its edge and ridge, with a small distinct spine before and opposite middle in front of eye.

Mouth terminal, its cleft at about an angle of 35° with the horizontal; lower jaw

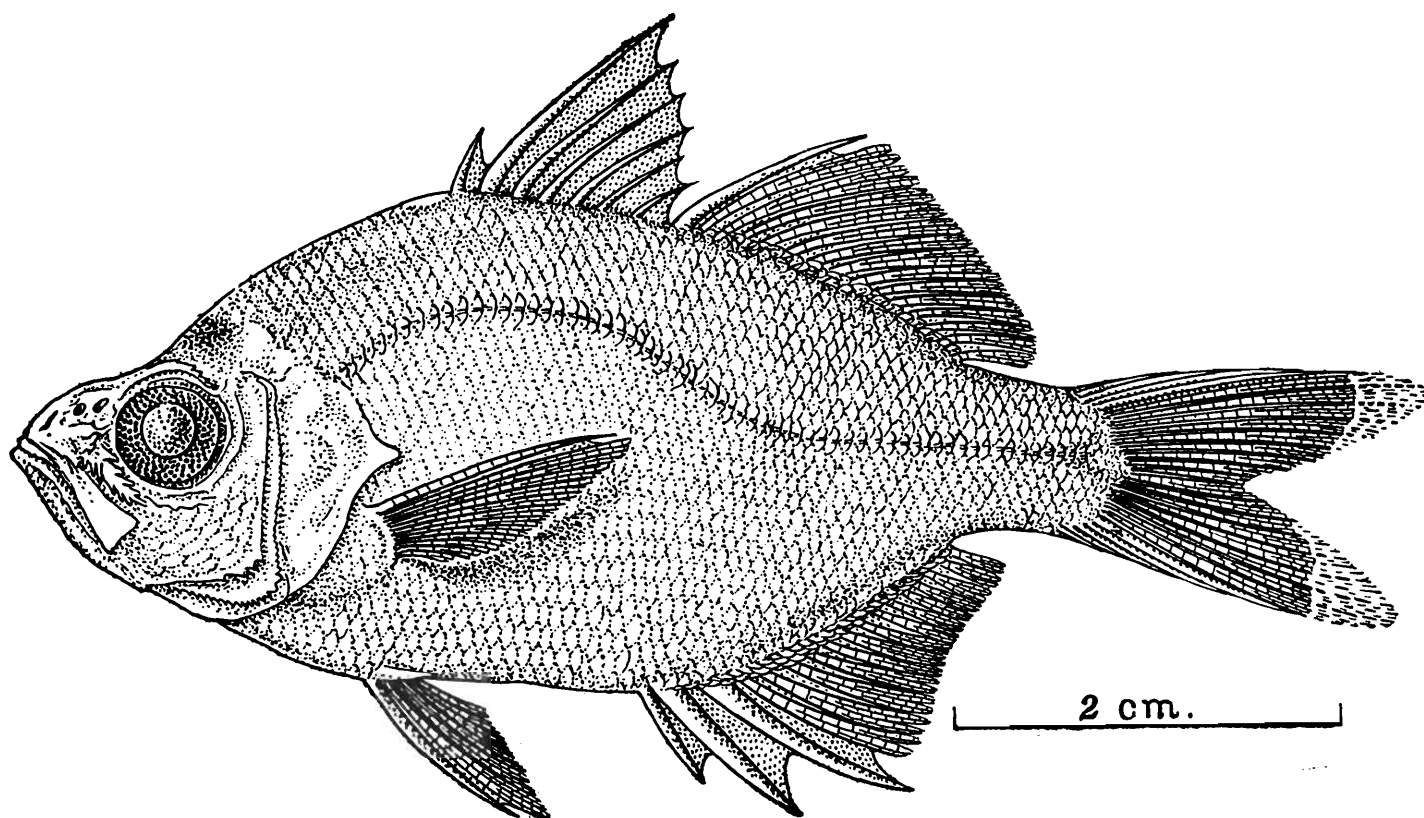


Fig. 1. *Ambassis notatus* Blyth, lectotype, 56 mm standard length, from Burma.

Description : Based on the lectotype and four paralectotypes. Measurements and meristic counts are presented in the table.

Body laterally compressed, its dorsal profile slightly more convex than the ventral profile. Opercular spine indistinct; posterior edge of preoperculum minutely denticulated, its lower arm strongly denticulated but its ridge entire except for 2 or 3 small spines at angle; interoperculum entire. Supraorbital

projecting with a definite chin, fitting with a symphyseal knob in a median toothless depression of upper jaw; upper jaw (maxillary) extending to below middle of eye.

Teeth in narrow bands on the jaws, well differentiated in size, the outermost series enlarged (particularly anteriorly on the upper jaw); upper outer firm and spaced, and near the symphysis small canines (more than twice as long as the other enlarged teeth); inner

series of tiny villiform teeth only, three or four teeth wide at its broadest point anteriorly. Fine teeth on vomer and palatines ; no teeth on tongue.

Gill-rakers on the first arch 6+1+ (15 or 16), finely lanceolate, the one uppermost and two lowest very short. Branchiostegals 6, pseudobranchia moderate, slightly less than eye-diameter.

Dorsal fin of two continuous parts defined by a deep notch between the last and penultimate spines ; first dorsal fin with 7 spines and a procumbent spine, the second spine longest ; last dorsal spine strong and

conspicuously long, about 3 times of penultimate dorsal spine. Anal spines strong, the third longest and slightly longer than the second spine. Pectoral fins long ; pelvic fin 15, the spine strong. Caudal fin forked.

Scales small, cycloid, 64-66 pierced by lateral line, 6 or 7 rows between origin of dorsal fin and lateral line ; predorsal scales 8 or 9. Lateral line continuous to caudal-fin base. A deep scaly sheath at bases of dorsal and anal fins. Pelvic fin with a well-developed axillary scale. Scales on cheek in 6 rows.

Colour : in alcohol, uniform light brown. Fins hyaline ; spinous dorsal fin dusky at tip,

TABLE 1. Selected meristic counts and measurements (in mm) of lectotype and paralectotypes of *Ambassis notatus* Blyth

	Lectotype F 7696/2		Paralectotypes F 7697/2		
Dorsal fin	VII+I 14	VII+I 14	VIII+I 16	VIII+I 15	VII+I 15
Anal fin	III 14	III 15	III 15	III 15	III 16
Pectoral fin	i 12	i 11	i 11	i 11	i 11
Standard length	56	53	46	44	44.5
Body depth	25	24	20	19	19.5
Head length	20.5	19.2	16	16	16
Eye diameter	6.5	6	5.5	5.5	5
Snout length	4.5	4	3	3.5	3
Interorbital width	5	4.5	4	4	4
Length of upper jaw	8	8	7	7	6
Length of lower jaw	10	9.5	8	8	8
Pectoral fin length	14.5	14	12	11	11
Pelvic fin length	11	11	9.5	9.5	9
Length of 2nd dorsal spine	14	13	13	11	11
Length of 1st spine of soft dorsal fin	11	9	9	8	9
Length of 2nd anal spine	10	10	9.5	8	8
Length of 3rd anal spine	12	11	11	8.5	11

DISCUSSION

Blyth (1861) described *Ambassis notatus* from the Sittang river (Burma) based on a collection by Major T. M. Berdmore, of which five syntypes are extant as discussed later, in the Zoological Survey of India. Blyth gave no size range or number of specimens, so there is no certainty which or how many specimens belonged to the type series.

We have recently discovered five specimens of *Ambassis notatus* from Burma in our collections, presumably Blyth's type series. The five presumptive syntypes from Pegu in the Sittang Valley (Burma), are accessioned under Asiatic Society catalogue number Cat. 28 as *Ambassis baculis* and originated from Major T. M. Berdmore's collections from Burma. There seems no doubt that these are syntypes of *A. notatus* both from their apparent history and study. The standing of these specimens as syntypes of *A. notatus* must now be examined.

Edward Blyth was the zoological curator of the Asiatic Society of Bengal from 1841 to 1862 and his contribution to the ichthyology of the Indian region was considerable. The only contemporary reference to Blyth's 'types' was made by Day (1869). Francis Day had become a member of the Asiatic Society in 1869 and in that year he had worked on their collections and especially on the types of species described by Blyth, 'most of whose type specimens I have thus had the opportunity of examining' The existence of the typical and original specimens of Blyth's contributions to ichthyology that had been transferred from the Asiatic Society of Bengal to the Indian Museum and now the Zoological Survey of India, has been known to one of

the authors (PKT) for a number of years and a great part of Blyth's types have been discovered during curation of the collections. The full history of Blyth's fish collections will be described elsewhere (Talwar, in preparation); a short account of these collections is, however, given by Whitehead and Talwar (1976, p. 131).

Blyth's (1861) report deals 'entirely to fluviatile species, mostly collected by the late Major Berdmore in the Sittang river and its tributaries, with a few notice of new or little known species from the Gangetic streams...'. Since the five specimens of *Ambassis* accessioned under number Cat. 28 were collected by Major Berdmore from the Sittang river and agree in other pertinent details, they are clearly the specimens on which Blyth drew up his original description of *Ambassis notatus*. Further clues to the identification are provided by the specimens themselves. Blyth gives the length of the specimens of *A. notatus* as '2½ in', the present specimens measure in total length 69, 64, 56, 52 and 53 mm (2.7, 2.5, 2.2, 2.1, 2.1 inches). The absence of the types of *A. notatus* in the Australian Museum (Whitley, 1958) and the British Museum which houses some of Blyth's fish types, supports the interpretation that the Zoological Survey of India specimens are the primary types of this species. These five specimens were evidently initially determined as *Ambassis baculis* and registered under this name. This is not at all surprising since several of Blyth's (1861) new taxa, based on Major Berdmore's collections from Burma, are registered under the binomials they were initially determined viz., *Platycara notata* Blyth as *Discognathus lamta* (regd. no. Cat. 150), *Silurichthys berdmorei* Blyth as *Silurus cochi-*

nensis (regd. no. Cat. 481) and *Systomus macularis* Blyth as *Barbus apogon* (regd. no. Cat. 754). It is curious, however, that Day (1869) did not make any mention of the typical material of *Ambassis notatus*, though he undoubtedly examined the types.

Fraser-Brunner (1954) considered *Chanda siamensis* Fowler (1937) from Thailand identical with *Ambassis notatus* Blyth. We have not seen specimens of the former species, but from its description and figure it warrants a distinct status.

ACKNOWLEDGEMENTS

The authors are grateful to Dr B. K. Tikader, Director, and Dr K. C. Jayaram, Joint Director, Zoological Survey of India, for their sustained encouragement. The authors are also thankful to Dr A. C. Wheeler (British Museum) and Dr. J. Paxton (Australian Museum) for information on Blyth's fish types.

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NOTES ON THE OCCURRENCE AND HERMAPHRODITIC NATURE OF
THE PARASITIC ISOPOD *NEROCILA MADRASENSIS* RAMAKRISHNA
AND VENKATARAMANIAH FROM THE HOOGHLY—
MATLA ESTUARY, SUNDARBANS, INDIA.

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ABSTRACT

The cymothoid isopod, *Nerocila madrasensis* Ramakrishna and Venkata Ramaniah, is reported for the first time from Hooghly—Matla estuarine system in ectoparasitic association with the fish host, *Trichiura* sp. and described adequately. Necessary comments have been made on the hermaphroditic characters of the species.

INTRODUCTION

The material for this study was collected by the authors during their field surveys to different areas in the Hooghly-Matla estuarine system, Sundarbans, in ectoparasitic association with the fish host *Trichiura* sp. as well as in the free living condition. After thorough examination, the material has been identified as *Nerocila madrasensis* described a couple of years ago as a new species by Ramakrishna and Venkata Ramaniah (1978) from the material collected as a parasite on the gills of the fish *Hemiramphus* sp. at Madras. The original description of the species was based on 3 females, one being the holotype, the rest as paratypes, and since it did not provide adequate information, an attempt has been made to study the same.

MATERIAL

4 exs. (2 ovigerous forms and 2 young males), Z. S. I. Reg. No. C 2583/2 Sagar

Island, A. Misra, 8. 3. 1979, attached to the skin of the fish host *Trichiura* sp., 16.5 mm.-20.8 mm, 6 exs. (Young and adult without broad pouch), Z. S. I. Reg. No. C 2584/2, Bakkhali, S. S. Ghatak, 21. 2. 78, free living (net collection), 14.5 mm-23.9 mm.

SYSTEMATIC ACCOUNT

Class CRUSTACEA

Order ISOPODA

Family CYNOTHOIDAE

Genus *Nerocila* Leach

Nerocila madrasensis Ramakrishna and Venkata Ramaniah.

DESCRIPTION

For the purpose of additional description and ovigerous form and a young male without marsupium were selected.

Ovigerous form (♂): Body size (Fig. 1), 20.8 mm : 8.6 mm ; head more or less longer than broad : 2.5 mm : 2.8 mm. Eyes

moderately large and indistinctly seen in postero-lateral angles of head. Postero-lateral angles of the 6th and 7th segments bluntly produced and not extending beyond the epimera. Epimera of the last three thoracic segments broad and wide but acutely produced extending beyond the posterior margin of the respective segments. Well developed marsupium with eggs on the ventral side of the thorax. Abdomen (Fig. 2) narrow, with five visible segments first one being immersed in the thorax. Epimera of the first two abdominal segments elongated and well developed. Pleotelson (Fig. 2) almost round posteriorly, broader than long 4.2 mm : 5.0 mm. Uropod (Fig. 2),

long and slender, endopod less than half the length of exopod, 3.5 mm : 7.7 mm.

First antennae (Fig. 3) composed of eight articles with prominent hairs at the apex and interarticulate joints. Second antennae (Fig. 3) somewhat longer and without hairs. Mandibles, maxillae and maxillipeds (Fig. 5, 6, 7, 8), show the characteristic structure of the genus.

All the paraepods prehensile (Fig. 9) as a rule with long and curved dactyli excepting the 6th and 7th that with short and curved ones. Only the tip of the dactyli brown. In 7th leg (Fig. 10), the inner margin of carpus with few and propodus with more

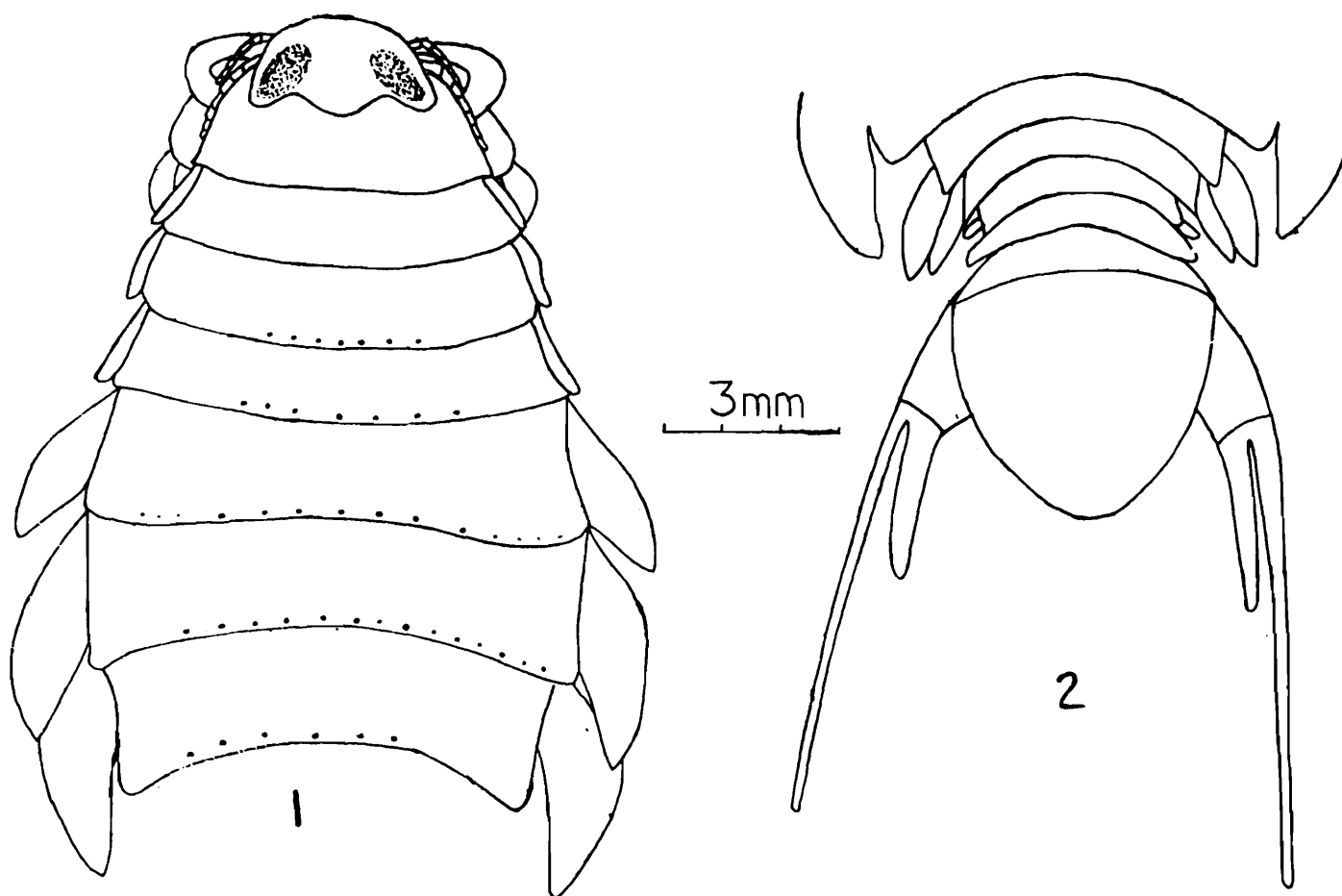


Fig. 1. Cephalothorax of the ovigerous form

Fig. 2. Abdomen, pleotelson and uropod of the ovigerous form

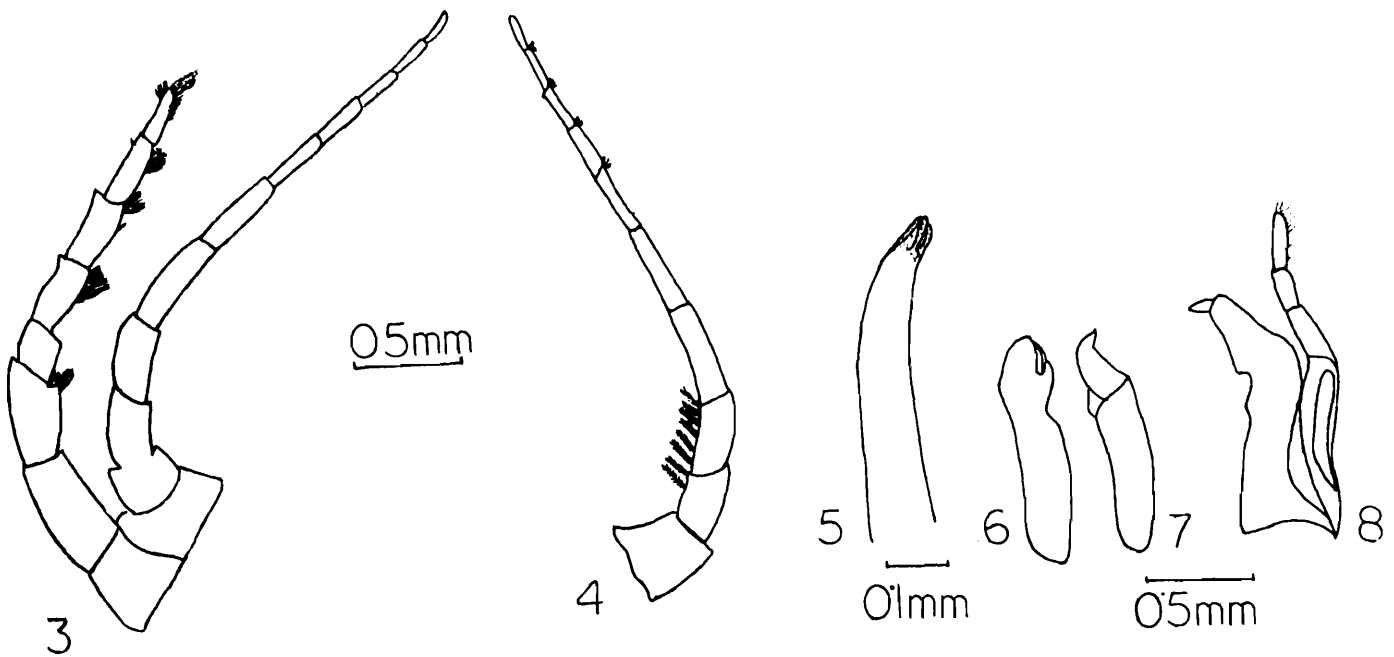
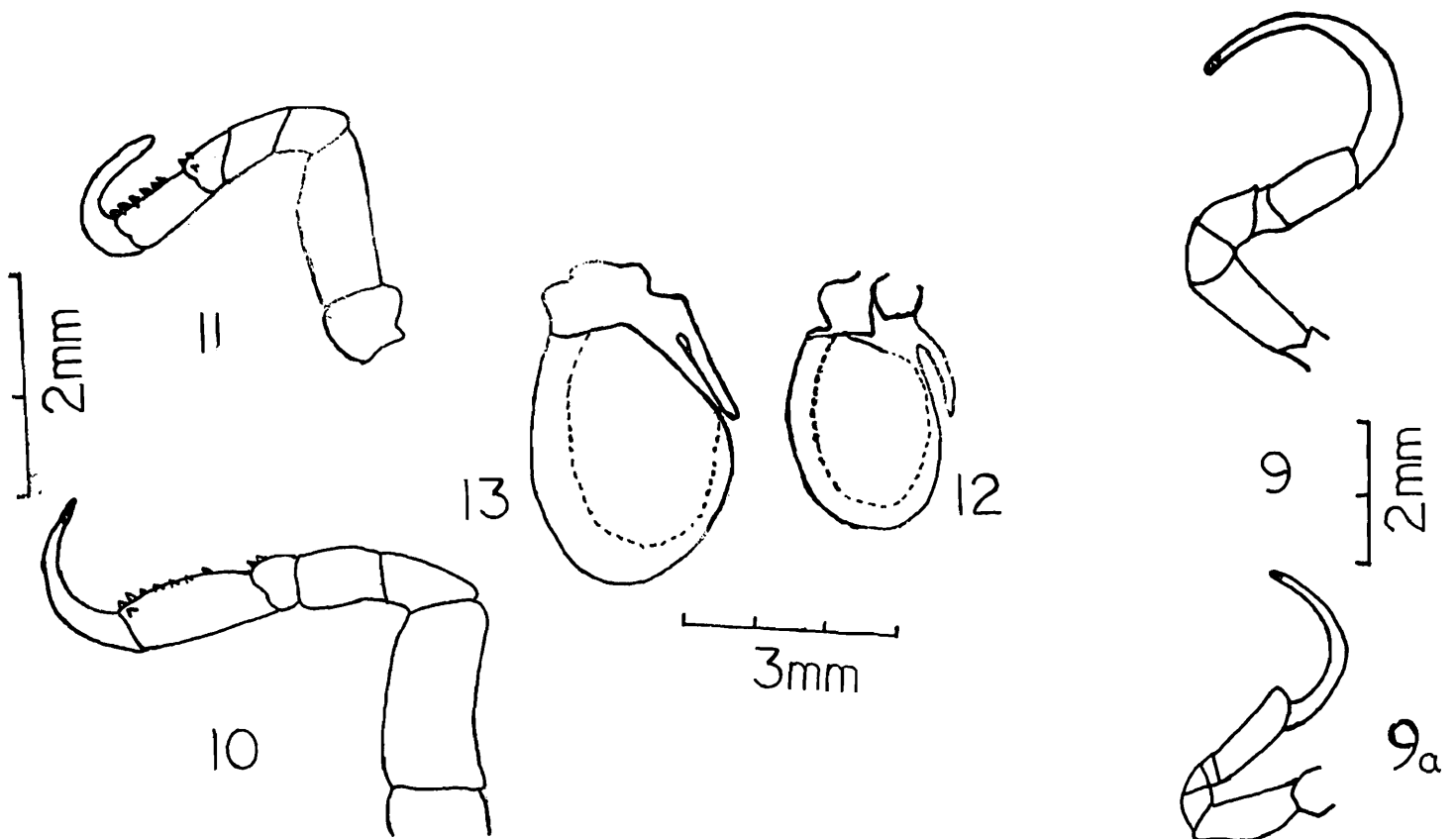


Fig. 3. 1st and 2nd antennae of the ovigerous form Fig. 4. 2nd antennae of young form
Figs. 5, 6, 7, 8. Maxilla—I, Maxilla—II, Maxilliped and Mandible with palp of ovigerous form.



Figs. 9 & 9a. 3rd leg of ovigerous and young form, Figs. 10, 11. 7th leg of ovigerous and young form
Figs. 12, 13. 2nd pereopod of ovigerous and young form

than seven spines. The second pleopod (Fig. 12) with 'appendix masculina' extending up to the middle of the same.

Young form (δ): Body size (Fig. 14), 16.5 mm : 5.6 mm ; head wider than antero-posterior length 3.2 mm : 2.7 mm. Epimera (Fig. 14) of the last three thoracic segments narrow and slender. Other characteristic of thorax and abdomen resembling ovigerous

REMARKS

The specimens at our disposal agree with most of the characters already indicated in the description of *Nerocila madrasensis*. However, certain features such as blunt postero-lateral angled of the 6th and 7th thoracic segment, shape, length ratio of inner and outer rami of Uropod and shape

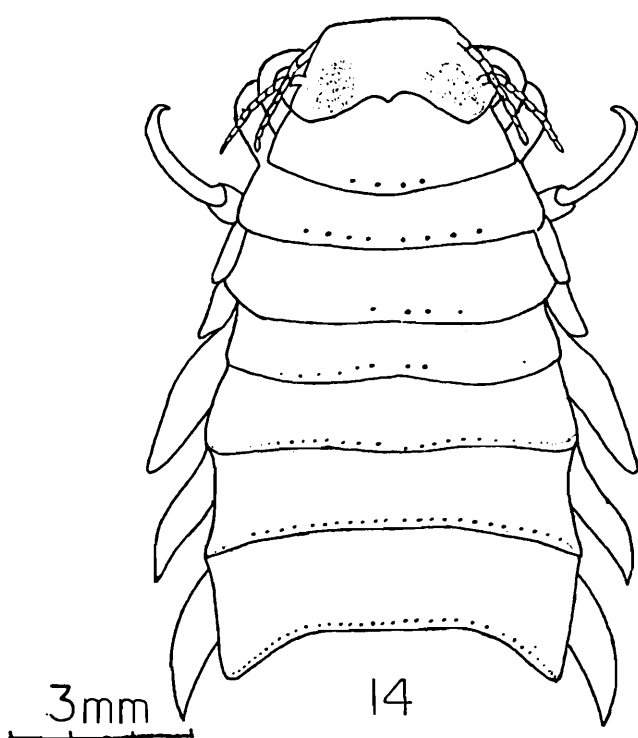


Fig. 14. Cephalothorax of young form

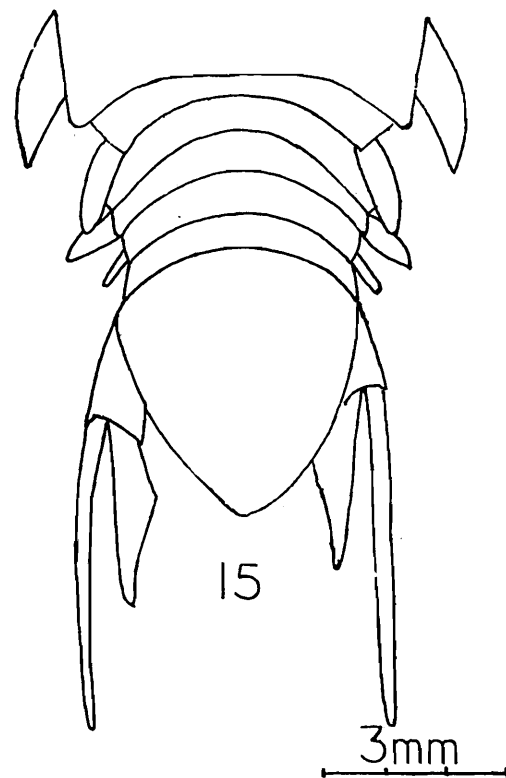


Fig. 15. Abdomen, pleotelson and uropod of the young form

form. Pleotelson (Fig. 15), broadly pointed, more or less as long as broad, 4.1 mm : 4.0 mm. Uropod (Fig. 15) lanceolate, endopod with broad base, more than half as long as exopod, 5.7 mm : 3.2 mm. Presence of spines on the carpus and propodus of the 7th leg. (Fig. 11). Second antennae (Fig. 4) with pinnate hairs on its second and third articles. Second pleopod (Fig. 13) with distinct 'appendix masculina',

and size of the maxilla mandible and antennae differentiate them to some extent.

From the literature (Males, 1976 Schultz, 1969) it is obvious that some Cymothoids are hermaphroditic in nature, the male stage appearing first. In the material at our disposal, the ovigerous forms are interesting in having a combination of male and female characters. The retention of 'appendix

masculina' on the second pleopod and spines on the 7th leg are male features, while much enlarged and strongly arcuate dactylus, broadening and posterior round shape of the pleotelson, reduction in width of inner rami, increase in length of outer rami of uropod and broadening of epimeral extensions confine to the feminine characters. It is probable that the young ones start their lives as males and with maturity develop female characters but at the same time retaining some of the male features.

ACKNOWLEDGEMENTS

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SOME ASPECTS OF POST-EMBRYONIC DEVELOPMENT OF PRAYING
MANTID [*EUANTISSA PULCHRA* (FABR.) : DICTYOPTERA :
MANTIDAE] WITH SPECIAL REFERENCE TO
MORPHOMETRICAL STUDIES

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ABSTRACT

Statistical analysis and graphical representation of morphometry, rate of growth and feeding, increase in weight and significance of colouration during the post embryonic development of *Euantissa pulchra* (Fabr.) were studied.

INTRODUCTION

The studies on the biology of mantids in the laboratory involve the difficult task of rearing them, because of lack of information on the food requirements just after hatching and nonavailability of the artificial food that could easily be provided in rearing them in the laboratory.

The present paper includes the results of the laboratory observation on the post-embryonic development of *Euantissa pulchra* (Fabr.) a small green mantid being commonly found in green shrubs. The green colour of its dorsal surface matches uniquely with the green leaves. In fact, the information on the post embryonic development of mantids in India is very limited except some fragmentary informations available in the works of Williams (1904), Mathur (1934), Mathew (1935) and Arora and Singh (1957). Mathew

(1935) and Nadkarny (1965) treated the species under the generic name *Evantissa* (?) which however does not appear in the monograph on mantidae by Giglio-Tos (1927).

The aim of the present observation is to obtain information on the duration of developmental stages, the morphometry, rate of feeding and growth in relation to weight in different instars under laboratory condition and with uniform food material.

MATERIAL AND METHODS

The material for the present study was a gravid female collected at Ranaghat, Dist. Nadia, W. Bengal, in the 3rd week of May, 1978. The female was kept in a specially built cage (8" × 6" × 9") the three sides of which contained alluminium seive and one side had glass. The top of the cage was provided with

a sliding glass cover to push in food. The cage was provided with a small amount of sandy soil and few leaves and twigs. *Drosophila* sp. was chosen during rearing in the laboratory as prey organism for all the developmental stages. The temperature and the relative humidity were recorded by a mercury thermometer and a dial hygrometer respectively. The nymphs were reared in separate cages to avoid cannibalism.

RESULTS

(I) Laying of Eggs and Formation of Oothecae

The captive female deposited three oothecae till death on the sixth day after its capture at an interval of four days, i.e. on 26.5.78, 30.5.78 and 3.6.78.

The oothecae were laid over the wooden frame on the top of the cage. The substance which formed the body and supported the oothecae appeared to be a sticky fluid pale yellow in colour. This froth like substance came out of an aperture just behind the lateral cerci below the last abdominal segment. The base was formed at first, then more fluid was deposited on the upper surface and somewhat less on the lower and lateral surfaces, which eventually formed a cavity. Inside such cavities the eggs were placed by large ventral valves. The movements of these valves also helped to spread the sticky fluid. The entire ootheca was constructed within three hours and it gradually hardened by coming in contact with air. The ootheca was dorsally convex and narrowed at both ends. The sides contained lateral vertical flaps (9-11 in number) and the spaces in between were filled up by a spongy material. About 20-22 round apertures were noted dorsally to faci-

litate the exit of the nymphs from the corresponding chambers. Each chamber was placed vertically but a little obliquely and remained closed by a valve like lid held by a silken thread.

A transverse section of the ootheca revealed the position of the chambers. There were usually cavities for four chambers. But, actually there existed two major chambers in the middle while two others were on the sides (one on each side). This was because the chambers were placed obliquely inwards towards their distal ends. In case of the unfertilised oothecae the chambers contained a fluid material unchanged after eight months. The structure of the ootheca of this species was more or less similar to that of *Creobroter apicalis* (Sauss.). The size of an ootheca was as follows :

Length—1.2-1.5 cm. ; Width—0.5-0.6 cm. ; Height—0.4 cm.

I (a) *Hatching of Oothecae* : The incubation period was 16 days. Altogether 62 nymphs emerged from the three oothecae, of which only 7 individuals could attain the adult stage. Incidentally all the 7 individuals were females on which the present observation was based. The hatching nymphs showed a consistent upward movement of the body and head. The nymphs came out by breaking the anterior end of the egg. After emergence of the abdomen but with the legs still inside the egg, the body experienced continuous forward and sidewise movements. The newly emerged nymphs were seen to aggregate around the ootheca for one and half hour and then to move about freely. The temperature and R.H. on the dates of hatching were given in Table 1.

TABLE 1. *Temperature and R.H. recorded in the laboratory.*

<i>Dates of hatching of nymphs</i>	<i>Max. Temp.</i>	<i>Min. Temp.</i>	<i>Max. R.H.</i>	<i>Min. R.H.</i>
11.6.78	96.6°F	82.6°F	90%	50%
15.6.78	95°F	75.0°F	97%	54%
18.6.78	97°F	82.1°F	96%	55%
Mean Temperature and RH during development	94.5°F	77.2°F	93.5%	53.2%

Developmental Stages and their Duration

The Table 2 showed the developmental time of different instars as well as the salient

characters of each instar. The total time taken for development in this study was 51 days. The time required from laying of

TABLE 2. *Development of E. pulchra (Fabr.): Age at successive moults of developments (in days) and their salient features.*

<i>Stages of development</i>	<i>Mean of ages and S. D.</i>	<i>Range of ages</i>	<i>No. of observations</i>	<i>Salient features</i>
Moult I	11.57±1.39	10-14	7	Body colour black, measured 5.2 mm.
Moult II	6.00±1.51	4-7	7	Body colour dull, measured 8.3 mm.
Moult III	6.86±1.31	5-9	7	Dorsal and ventral surfaces of legs dark brown ; general body colour dark reddish brown. Abdomen broader ; measured 9.6 mm.
Moult IV	6.86±0.9	6-8	7	Dorsal surface of body reddish brown and ventral surface whitish. Legs pale brown, three black spots on abdominal sternites ; measured 12.4 mm.
Moult V	7.43±9.40	7-8	7	Dorsal side greyish with green tinge ; ventral surface of straw colour ; lateral sides of abdomen and margin of eyes pinkish. Wing buds seen ; measured 15.05 mm.
Adult	12.0±0.82	11-13	7	Dorsal surface pale green ventrally bright yellow, wings clearly visible. Legs light green ; measured 17.8 mm.

ootheca to hatch was greater than the length of any other stage and the duration of the 1st and 6th instars were greater than any

other intermediate stages, as it was evident in the figure 1.

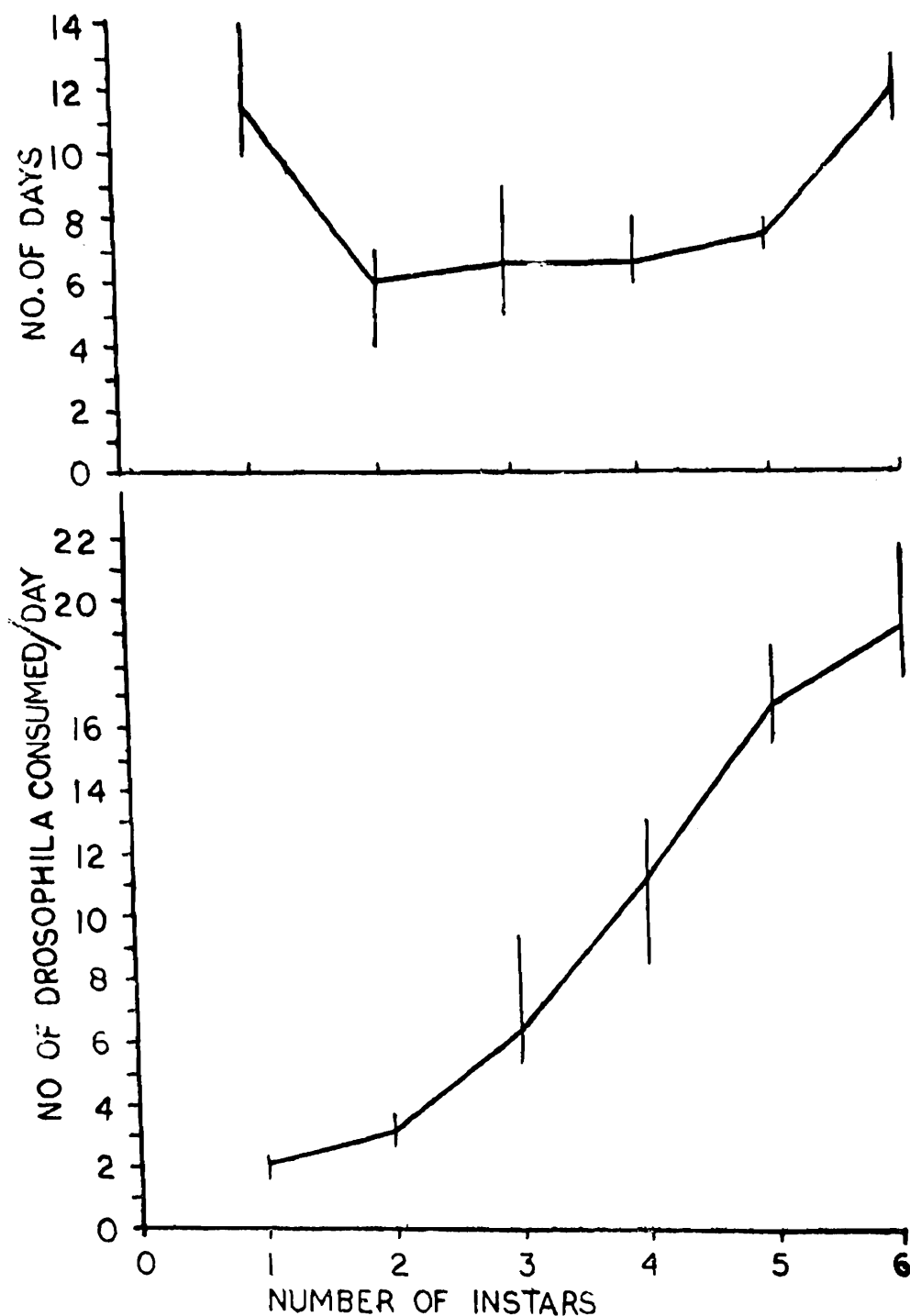


Fig. 1. Graph showing number of days taken for completion of different instars in *E. pulchra*.

Fig. 2. Graph showing consumption of *Drosophila* per day per instar of *E. pulchra*.

Growth in Relation to Weight

Live weight in different stages : Weight of insects at different instars during the period of development is presented in the Table 3. It was evident that the rate of increase in weight was more or less double upto the 3rd

a steady increase from the 1st instar to the 6th instar. As regards the length of the head growth rate was very slow in comparison to other parts and it remained constant from the 1st to the 4th instar, then slightly increased (0.25 mm.) from the 5th instar to

TABLE 3. *Weight in different moults (in mg.).*

Instars	I	II	III	IV	V	VI
	2.1	5.0	9.0	13.5	25.0	70.0
	2.4	7.0	10.0	14.0	35.0	65.0
	2.3	6.0	10.0	13.5	35.0	70.0
	2.2	5.0	10.0	14.0	30.0	67.0
	1.9	6.0	9.0	13.5	28.0	68.0
	2.0	6.0	9.5	13.4	27.0	70.0
	2.2	6.0	10.0	14.0	35.0	70.0

instars. From 3rd to 4th the increase in weight was proportionately lower. Thereafter, from the 4th instar to the 6th instar, weight increased more than double to the previous instars.

Growth in Relation to Length

From the table 4, it was evident that the rate of growth of different parts of the body

the 6th instar. In case of antenna there was a steady growth in length from the 1st instar to the 6th instar. Head-width increased very slowly in the different instars (Table 4).

Growth in Relation to Food Consumption

It was clear from the figure 2, that the consumption of number of *Drosophila* individuals per day within the instar and from

TABLE 4. *Growth in different parts of body of E. pulchra (Fabr.) (in mm.).*

Instars	I	II	III	IV	V	VI
Total body length	5.2	8.3	9.78	12.4	15.5	17.8
Head width	1.2	1.7	2.0	2.3	3.4	3.5
Antenna length	3.1	5.8	6.46	8.8	10.0	11.25
Head length	0.5	1.0	1.0	1.06	1.25	1.5
Pronotum length	1.4	2.1	2.56	3.4	4.45	5.25
Abdomen length	3.3	5.2	6.18	8.0	9.35	11.05

appeared to be irregular. The total body length and the length of the abdomen showed

one instar to the other were varied. It ranged from 1.6 nos. to 2.25 nos. of

Drosophila in 1st instar, 2.66-3.66 nos. in 2nd instar, 5.3-8.2 nos. in 3rd instar, 7.5-13.0 nos. in 4th instar, 15.5-18.5 nos. in 5th instar, and 17.5-21.66 nos. in 6th instar. But the number of consumption of *Drosophila* steadily increased from the 1st instar to the 6th instar. The rate of consumption was about double from the 1st instar to the 2nd instar.

Statistical Analysis of Data

The data pertaining to growth and

different parts of the body during the period of development were subjected to statistical analysis for finding out regression co-relation within the parameters considered in the study. The regression lines were obtained by pulling together data for the entire study period. The regression lines along with the respective scattered diagrams were shown in figures 3-9. The co-relation co-efficient study (3rd column of table 5) showed existence of highly significant positive correlation between the parameters, except

TABLE 5. Relationship between body weight and number of *Drosophila* consumed and different parts of the body of *E. pulchra*

Parameters	Mean	Correlation coefficient between different parameters	Regression line of different parameters ($Y=a+bx$)
Y : Body weight	42.26		
No. of <i>Drosophila</i> consumed	5.98	0.86 ***	$Y= 3.86+0.06x$
Body length	13.15	0.91 ***	$Y= 8.92+0.10x$
Y : Body length	13.15		
Weight of food consumed	5.98	0.98 ***	$Y= 3.08+0.69x$
Antenna length	8.24	0.96 ***	$Y= 1.67+0.50x$
Head width	2.51	0.96 ***	$Y= 0.67+0.14x$
Head length	1.11	0.89 ***	$Y= 0.5 +0.45x$
Pronotum length	3.66	0.99 ***	$Y= 0.04+0.27x$
Length of abdomen	8.44	0.80 **	$Y= -0.50+0.68x$
Y : Length of Antenna	8.24		
Head width	2.51	0.49 *	$Y= 2.18+0.04x$
Head length	1.11	0.95 ***	$Y= 0.29+0.10x$
Pronotum length	3.66	0.97 ***	$Y= -0.69+0.52x$
Length of abdomen	8.44	0.93 ***	$Y= -1.69+1.23x$
Y : Head width	2.51		
Head length	1.11	0.94 ***	$Y= .0.25+0.34x$
Pronotum length	3.66	0.48 *	
Length of abdomen	8.44	0.72 **	$Y= -1.52+3.96x$
Y : Head length	1.11		
Pronotum length	3.66	0.14 *	
Length of abdomen	8.44	0.16 *	
Y : Pronotum length	3.66		
Length of abdomen	8.44	0.41 *	

* Insignificant ; ** Significant at 5% level ; *** Significant at 1% level.

between the length of antenna and head width, between head width and length of pronotum, between head length and length of pronotum, length of abdomen and between length of pronotum and length of abdomen which were insignificant but positively correlated.

Some interesting Features during the Development of Mantid

(a) *Significance of Colouration* : In *E.*

pulchra, there occurred a gradual change in colour from black through brown to green. The first and second nymphs were black and very similar to black ants. During these two stages the colour was of protective type for the young helpless nymphs. In later stages the colour became brownish. The adult remained mostly in green shrubs. In adult the green colour of the body matched uniquely with green leaves making it difficult to spot out. The colouration and

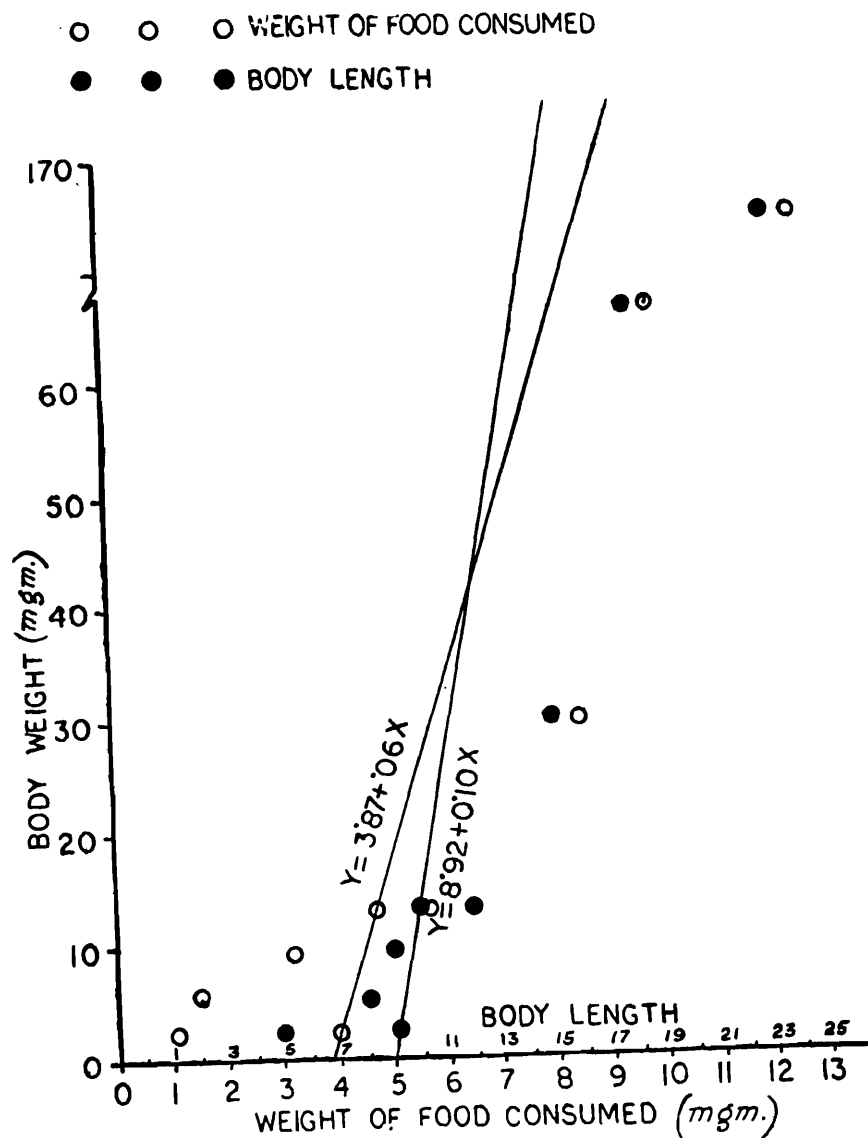


Fig. 3. Showing relationship between body weight and weight of food consumed and body length during the period of development of *E. pulchra*.

mimicry as found here might be illustrated as follows :

Stages	Colour
I & II	Black-Animate object (i.e. ants)
III to V	Dark brown-Inanimate object (i.e. bark)
VI	Light brown
VII	Green...Inanimate object (i.e. leaves)

The above findings perhaps signified that the gradation in colour was deceptive and was very important in the completion of the life cycle of mantid by exploiting the

natural surroundings. A similar observation was made by Mathew (1935) on a deceptive resemblance with the black ants *Camponotus compnexus* and in a bug *Riptortus pedestris*.

(b) *Moulting* : Generally, it took place early morning, but some nymphs moulted in the afternoon between 2-4 P.M. The nymphs became sluggish 24-36 hours before moulting. They took rest on the bottom of the cages and rarely consumed any food. During moulting, the skin splitted along the dorsomedian line of the body and the thorax came out dorsally through this slit like a loop. At this time the head was bent ventro-poste-

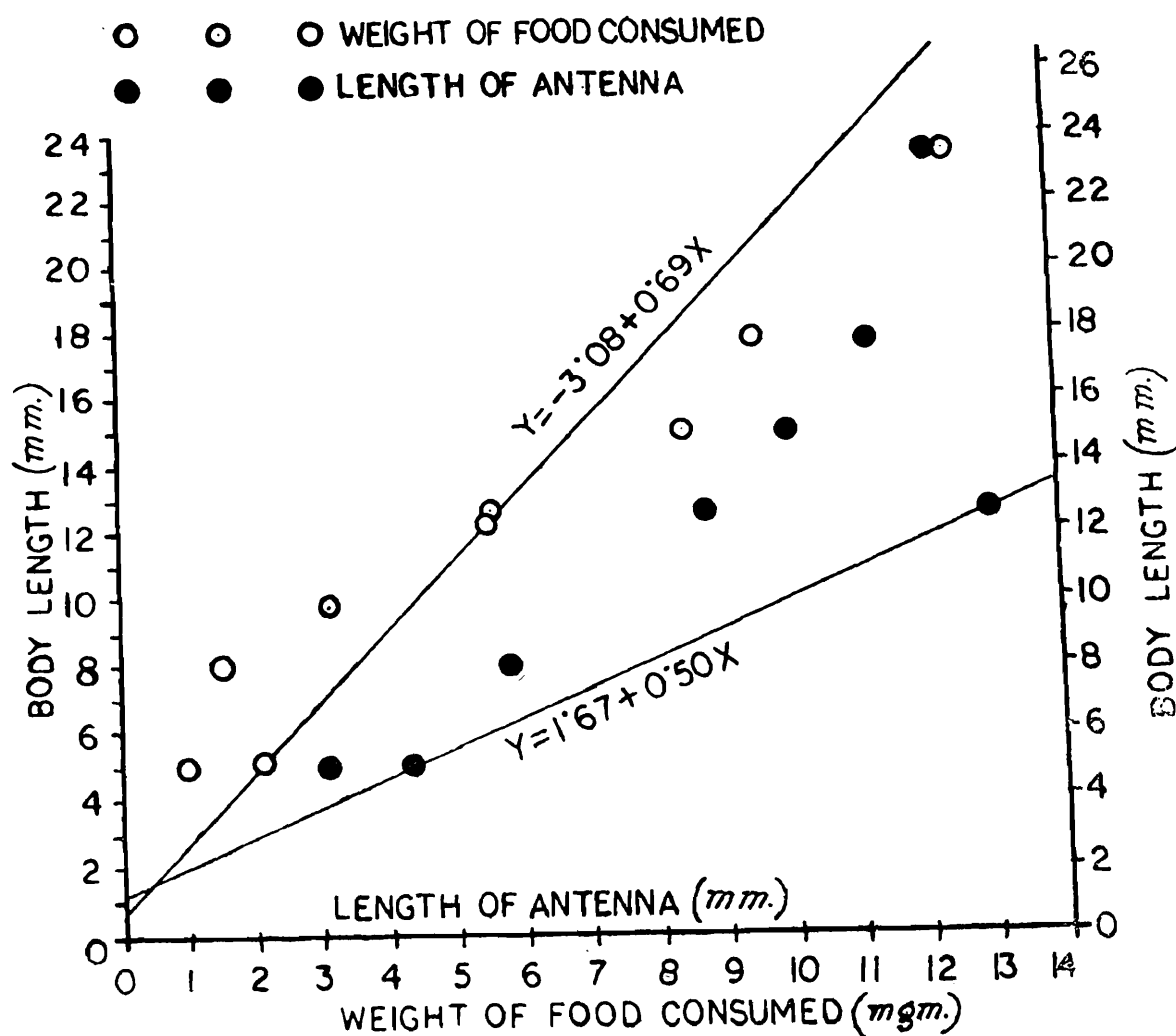


Fig. 4. Showing relationship between body length and weight of food consumed and length of antenna during the period of development of *E. pulchra*.

riorly which then started freeing itself from the exuviae. Then the antenna was drawn out of its covering. The legs were made free one after another after which the abdomen was drawn a little forward and swollen to make it free from the casting.

not die in general. The rate of mortality in the laboratory approximated to 35%. The reason seemed to be the failure to catch the prey. The newly emerged nymphs without proper food died within 24 hours. The first nymphs could thrive well on fine sugars

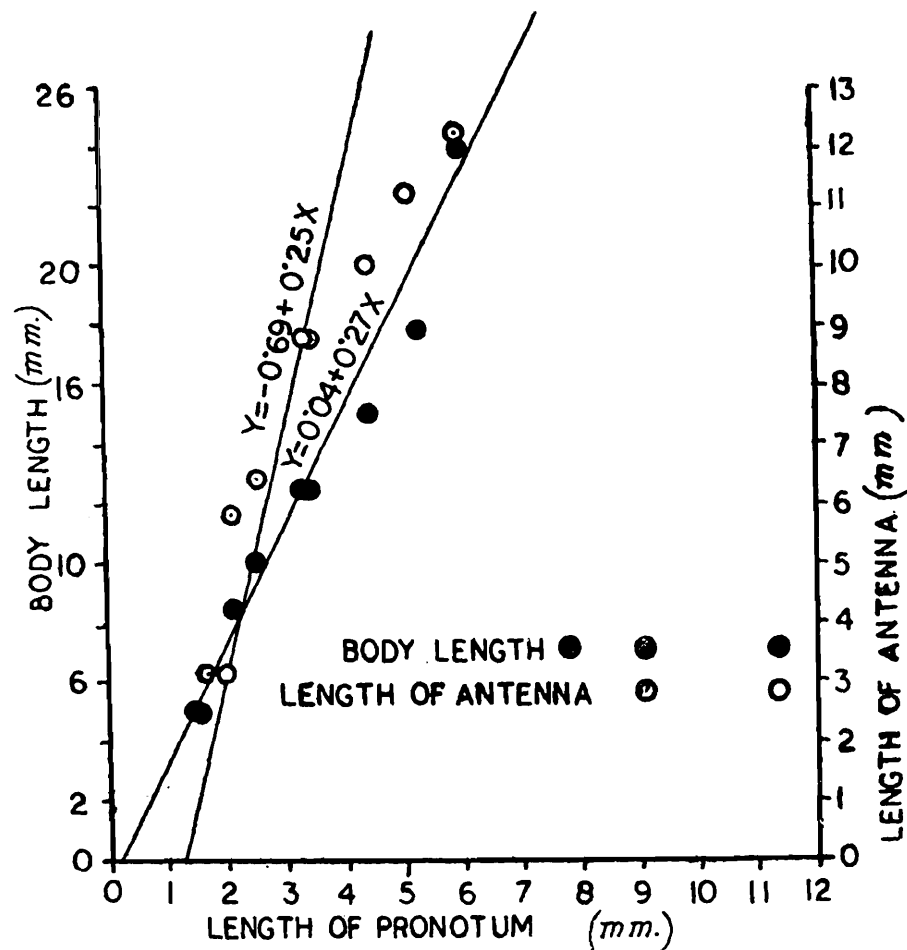


Fig. 5. Showing relationship between body length and length of pronotum and between the length of antenna and length of pronotum during the period of development of *E. pulchra*.

Half an hour after the completion of moulting, the newly hatched nymphs become very hungry and moved about actively. Its abdomen which was somewhat rounded finally became boat-shaped.

(c) *Mortality* : It was higher before the first moult after which the nymphs did

for 3-4 days. The high mortality, non-availability of proper food in different stages and lack of proper vegetation hindered their population in nature.

DISCUSSION

Several attempts had previously been

made to study the biology of mantids (Kramer 1960 ; Holling 1966 ; Gelperin 1968 ; Robinson 1969 and Kumar 1973) in different parts of the globe. In this species the major role in the formation of oothecae was played by the ventral valves. Perrier

taken in this study from the deposition of ootheca to hatching was 11 days in contrast to the finding of Kumar (1973) in *Phyllocarania paradoxa*. The cause of hatching within short period in this study might be due to the prevalence of high temperature

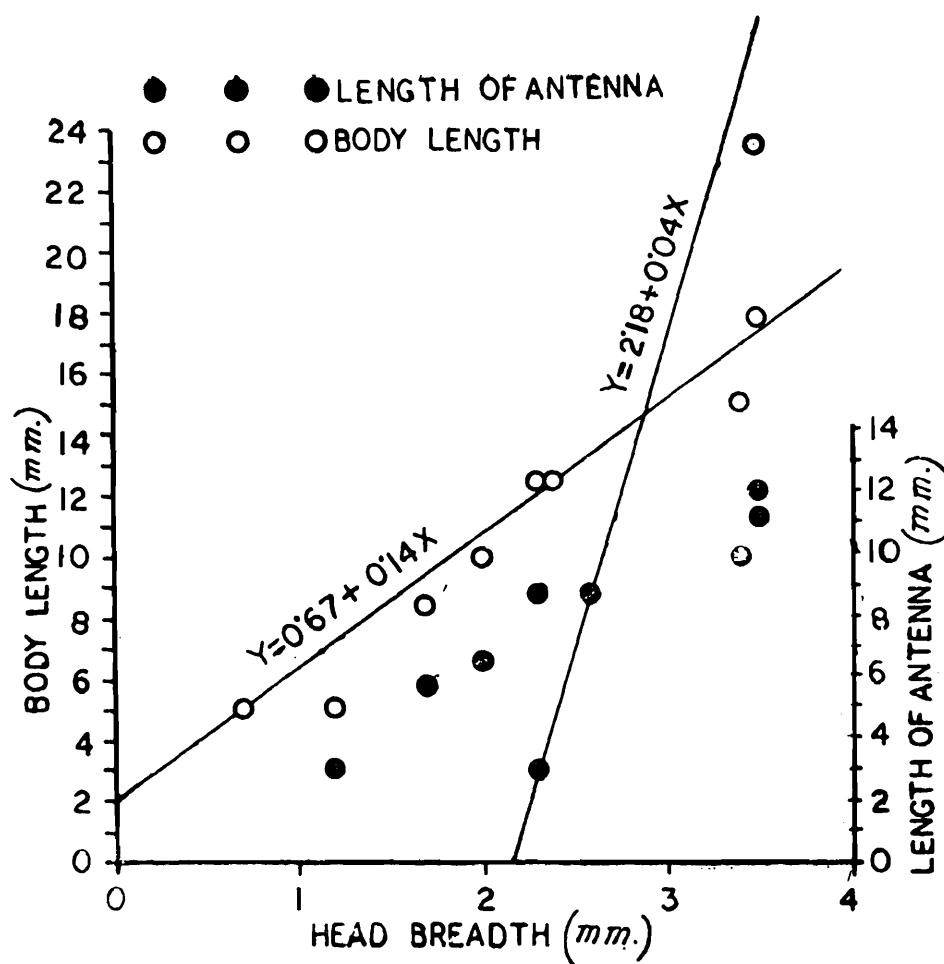


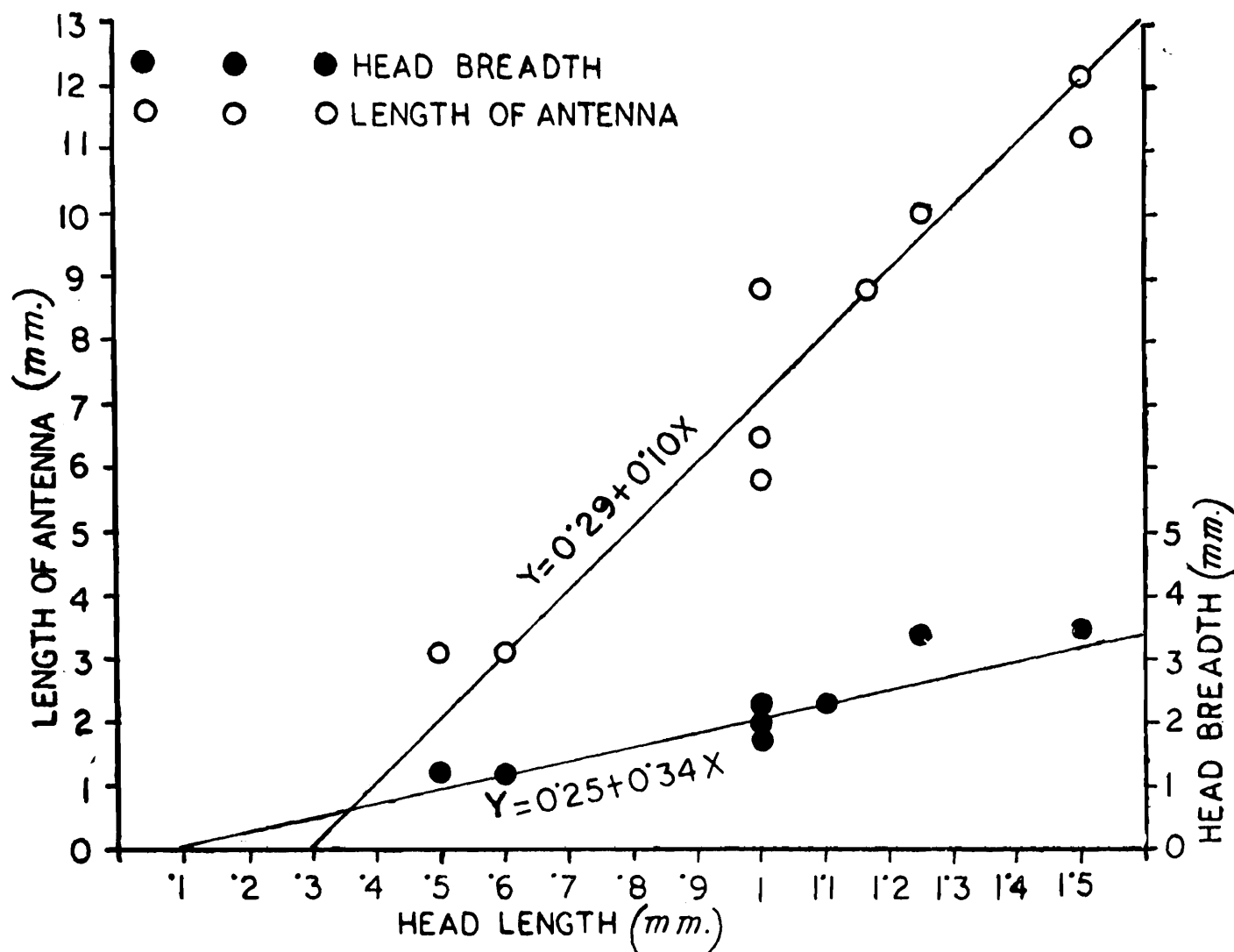
Fig. 6. Showing relationship between body length and head breadth and between length of antenna and head breadth during the period of development of *E. pulchra*.

(1870) reported in case of *Tenodera superstitiosa* the assistance of wings in the formation of oothecae, but in this investigation on such assistance was observed. The time

in the laboratory (Table 1). The total time for the development of *T. Superstitiosa* and *S. Lineola lineola* as given by Kumar (1973) were 238 and 228-295 days respectively.

According to Mathew (1955) in *Evantissa pulchra*, the time taken for the development was 70 days. The corresponding period in the present work for *E. pulchra* was 51 days.

that the weight of consumption of food was directly proportional to the body weight and body length. The similar observation was made in case of grasshopper *Eyprepocne-*



between 2.20 mg. and 67.40 mg. The weight increased steadily upto the final nymphal instar.

parts of the body except in a few cases (Figs. 3-9). Further it was evident that only the head length remained constant from the 2nd

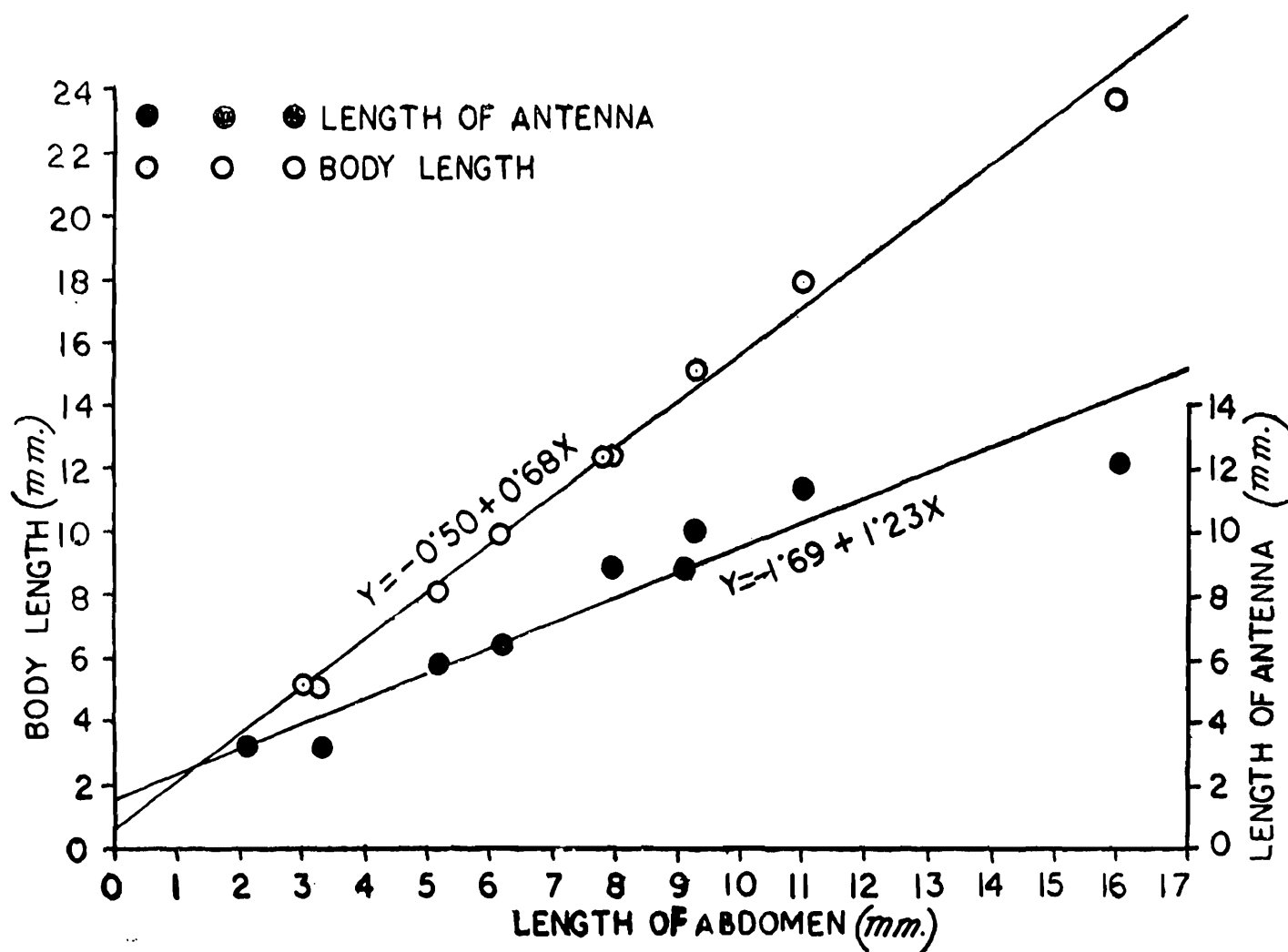


Fig. 8. Showing relationship between body length and length of abdomen and between length of antenna and length of abdomen during the development of *E. pulchra*.

The morphometrical studies showed that there existed a strong positive and highly significant correlation among the different

to the 4th nymphal instars, but in the rest of the body parts the length increased in different nymphs.

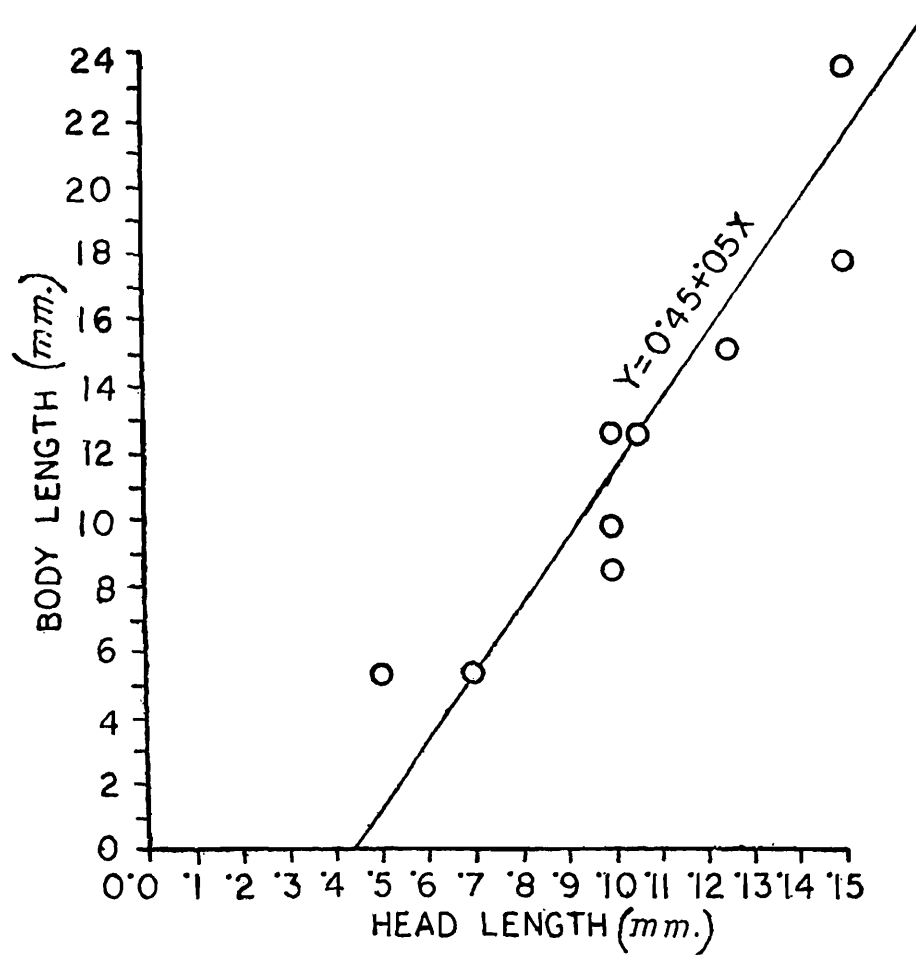


Fig. 9. Showing relationship between body length and head length during the period of development of *E. pulchra*.

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* Original not seen.

CLADOCERANS OF THE PLANKTON COMMUNITY IN ENNORE ESTUARY, MADRAS

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ABSTRACT

The present communication deals with the cladoceran fauna and hydrographic features of Ennore estuary based on the samples collected from November 1976 to December 1978. Seasonal variation in the distribution of cladocerans has been correlated with parameters like temperature, salinity and dissolved oxygen. A comparative study on the distribution of cladocerans from other estuaries of India with that of Ennore estuary has also been made.

INTRODUCTION

The present investigation was made with the idea of studying the species composition of cladocerans in Ennore estuary, their seasonal distribution and succession in relation to hydrographic features. Studies on the plankton community of Ennore estuary are very few and so far no previous study was undertaken on the cladoceran component. Along the east coast of India, the cladocerans of Portonovo waters (Vellar estuary) were studied by Vijayalakshmi and Venugopalan (1972), Santhanam *et al.*, (1975) and Sundaraj and Krishnamurthy (1975). Further the occurrence of cladocerans from Pulicat lake was reported by Kaliyamurthy (1975). Cladocerans of the Cochin backwaters along the west coast are well known (George, 1958; Nair *et al.*, 1972; Menon *et al.* 1972; Pillai and Pillai, 1975).

MATERIAL AND METHODS

The topography of the Ennore estuary

has been dealt with elsewhere (Raghunathan and Srinivasan, 1983). Zooplankton samples were collected from a fixed station at fortnightly intervals for over a period of two years from November 1976 to December 1978. For plankton collections a half M. nylon net (0.3 mm. mesh size) was towed horizontally for ten minutes from the Regional Station's fibreglass boat 'Matsya'. Plankton samples were fixed in 5% formalin and the volume was determined by the displacement method. Then the plankton was diluted to 250 ml. After stirring well a subsample of 2 ml. was quickly pipetted out and examined in a Sedgewick-rafter cell for enumeration. For identification purposes assorted specimens of cladocerans were sorted out and identified. With the help of camera lucida, diagrams were drawn and ocular and stage micrometers were used for measurements.

Water samples collected were analysed for salinity (Mohr's titration method), dissolved oxygen (Winkler method with

Azide modification) and pH (By using a Philips pH meter). A secchi disc was used for water transparency and other parameters like depth, air-temperature, water temperature, tide and weather conditions were noted.

RESULTS

Two species, namely *Evadne tergestina* Claus and *Penilia avirostris* Dana were recorded during the present study. The length of the specimens selected from various samples at random varied from 0.70 to 1.10 mm. (Mean-

0.87 mm) for *P. avirostris* and from 0.45 to 1.00 mm. (Mean-0.86 mm) for *E. tergestina*.

E. tergestina Claus (Fig. 1A)

Specimens of this species occurred in the samples collected during April, 1977 and April, May, June and July 1978. In April and May 1978 this species was abundant from the plankton samples. As the number of specimens obtained during April 1977 was negligible it is not shown in the figure.

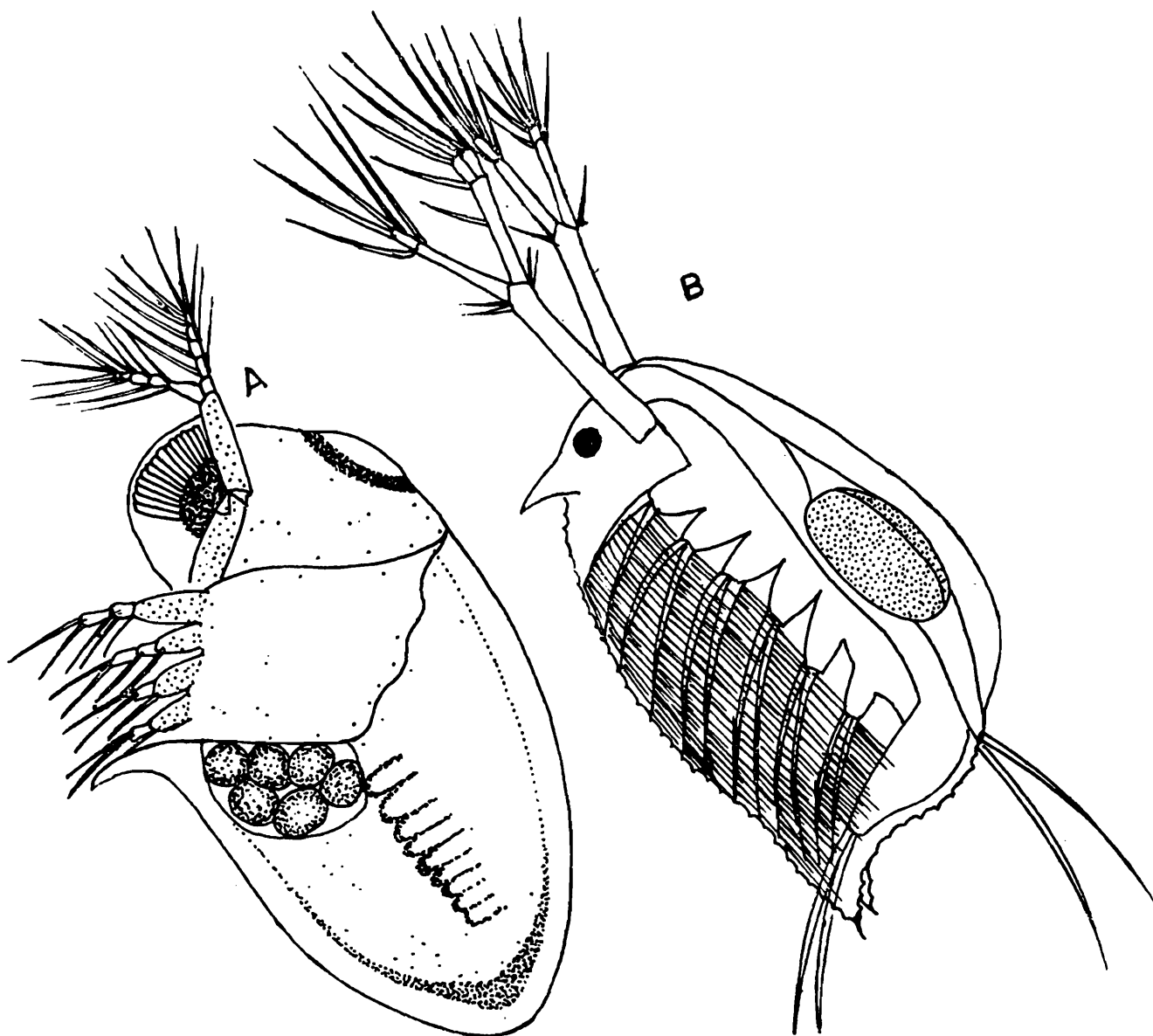


Fig. 1. A. *Evadne tergestina*, B. *Penilia avirostris*,

***P. avirostris* Dana (Fig. 1B)**

This species was recorded from the samples only in April, May and June 1978 with maximum numbers in April. During the rest of the period this species was not found in the samples.

DISCUSSION

Out of the four species of cladocerans recorded from the Indian ocean viz. *Evadne tergestina*, *E. spinifera*, *Podon polyphemoides* and *Penilia avirostris*, the two species found in the present investigation are *E. tergestina* which is generally present in the oceanic and coastal waters, and *P. avirostris* seen mostly in the coastal waters.

One of the important observation made during the present study on the distribution pattern of cladocerans is that the commencement of their swarming is more abrupt than their tapering off. Cladocerans were present only during April, May, June and July 1978, with very few *E. tergestina* during April 1977. The volume of zooplankton collected from Ennore estuary has enormously increased due to the influence of sudden bloom of cladocerans during April, May and June 1978. The cladocerans occupied from 85 to 90% of the plankton volume collected during the above said period. During the same period the salinity was between 22 and 24‰ with temperature ranging from 27 to 29°C. The dissolved oxygen values were between 1.5 to 3.0 mg/l. Maximum transparency value was noted during April 1978 when both these species were seen in large numbers (Fig. 2).

However, in the Gulf of Mannar both these two cladocerans were common during January-April period (Prasad, 1954). In the Madras coast swarms of *Evadne* were observed

during March, April, May and July (Muthu, 1956). From the Madras coastal waters Rajagopal (1962) has recorded *Evadne* during March, April and May and *Penilia* during October. From Portonovo waters, Krishnamurthy (1967) has reported these two cladocerans during November-May. Sundarraj and Krishnamurthy (1975) observed near Portonovo, that *Penilia* was abundant during October and in the backwater both *Penilia* and *Evadne* were found during March and April. Also it has been reported that during the abundance of *Evadne* there was no record of *Penilia*. Santhanam *et al.* (1975) have observed *P. avirostris* in the neritic waters off Portonovo during February, March, May, June, August, September and October with abundance during March. However *Evadne* sp. was recorded during February, March, August, September and October with an abundance during March and August. In the backwaters *P. avirostris* was recorded during September and October with an abundance in October. Kaliyamurthy (1975) has stated that *Evadne* and *Penilia* were encountered sporadically with swarms during March and April in the Pulicat lake. These reports indicate the occurrence of cladocerans in the neritic waters of east coast of India during February, March, May, June, August, September and October with abundance during March and October. The entry of cladocerans from the neighbouring coastal waters to estuaries may either be probably due to their abundance in the inshore waters or due to their active breeding habits. Hence it is probable that cladocerans occur during most seasons of the year in the neritic waters and increase in numbers during March-April period. During this period if the conditions are favourable they are seen in

large numbers in the estuaries. Similarly from west coast Mukundan (1967) has recorded cladocerans in the Calicut coast in almost all the samples except during the peak of the south-west monsoon. Also Dellacroce and Venugopal (1972) have observed *E. tergestina* from the coastal waters of Arabian sea throughout the year.

E. tergestina and *P. avirostris* exhibit a distribution pattern that depends on the hydrographical conditions. Earlier records on the occurrence of cladocerans in relation to salinity show that they are recorded in a wide range of salinity (George, 1958 : 2 to 11‰ ; Rajagopal, 1962 : 33.11 to 34.45‰ ; Menon *et al.* 1972 : 0.6 to 32.8‰). Present

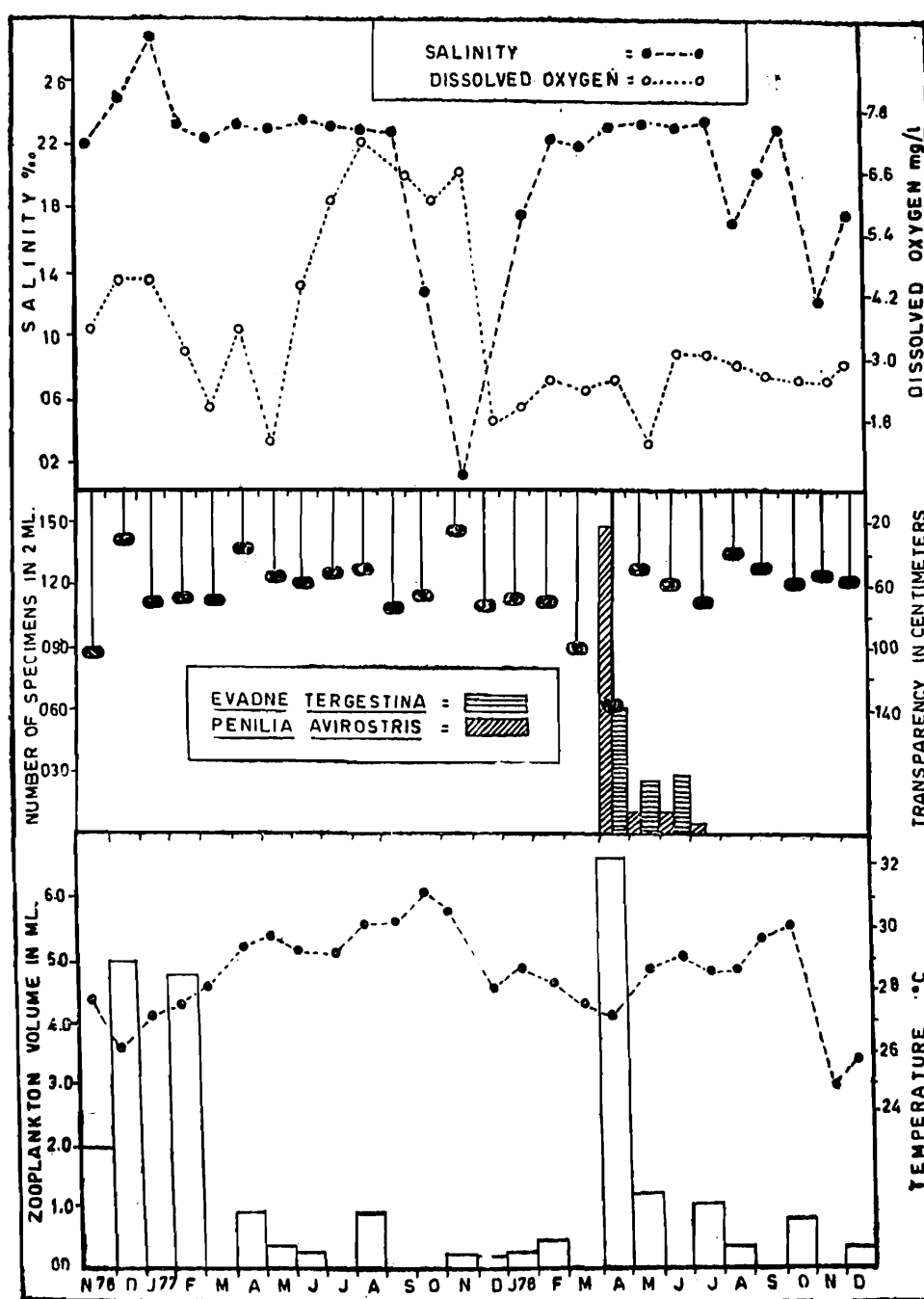


Fig. 2. Fluctuation of zooplankton, *P. avirostris*, *E. tergestina*, salinity, temperature, transparency, and dissolved oxygen during November 1976 to December 1978.

study on the temperature, salinity relationship of the two species of cladocera, shows that they are abundant during the period when salinity and temperature are relatively moderate (salinity 22 to 24‰; temperature 27 to 29°C). The maximum transparency value was recorded during April 1978 when both *Evadne* and *Penilia* were in their maximum (Fig. 2). Low turbidity accompanied with moderate temperature and salinity values are probably favourable for these two cladocerans. According to Dutta *et al.* (1954) for freshwater cladocerans temperature between 21-22°C accompanied with low turbidity in presumably most favourable for occurrence. According to Pillai and Pillai (1975) *P. avirostris* is more restricted in distribution, while *E. tergestina* occurs in a wide range of salinity and both the species showed an abundance during the period when the salinity and temperature values were relatively low (temperature 27.5 to 28.0°C; salinity 10 to 20‰). Also it is interesting to note during the present investigation that cladoceran swarms were noted only during April-May 1978 and not during April-May 1977. During these months in 1977, the volume of plankton itself was very low (Fig. 2) and the main components were decapod larvae, copepodites and few fish eggs. Here again, turbidity might have played a role since salinity and temperature values were almost similar during these months in 1977 and 1978. (Transparency values: April-May 1977—20 to 60 cm. April-May 1978—140 to 60 cm.).

It has been observed by Sundarraj and Krishnamurthy (1975) that during the abundance of *Evadne* there was no record of *Penilia* at Portonovo waters. According to

Mukundan (1967) *Evadne* swarms appear a few weeks before *Penilia* swarms. Contrary to this, in the present investigation, both *Penilia* and *Evadne* were abundant during April 1978.

Considering the reasons for cladocerans blooms, the most important one is the presence of phytoplankton. Rajagopal (1962) recorded that maxima of cladocera followed the diatom abundance. According to Vijayalakshmi and Venugopalan (1972) maximum number of *Penilia* was recorded in the Portonovo waters during April, which coincided with the month of diatom abundance. Subrahmanyam (1959) has stated that the peak in the zooplankton abundance occurs immediately after phytoplankton blooms. Also it has been observed that on certain occasions when the phytoplankton is mainly composed of setoid forms like *Chaetoceros* sp., *Bacteriastrum* sp. and *Rhizosolenia* sp. a fall in the biomass of smaller zooplankton like copepods, cladocerans and tintinnids occurs. However during the present investigation in Ennore estuary no correlation could be noted between phytoplankton and cladocerans.

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STUDIES ON THE MALACOFAUNA OF MURIGANGA ESTUARY, SUNDERBANS, WEST BENGAL.

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ABSTRACT

An ecological survey of malacofauna of river Muriganga around Kakdwip and Namkhana in 24-Parganas, West Bengal established presence of 21 species of gastropods and bivalves. Depending on their ecological niche molluscs of Muriganga estuary fall under two categories ; (1) Plant dwellers and (2) mud dwellers. The former category includes those living on the surface (e.g. *Littorina*) or burrowing into dead or living plant material (e.g. *Teredo*). Mud dwellers include those that crawl on the substratum or burrow into it. Gastropod species of *Assiminea*, *Telescopium*, *Cerithidea*, *Onchidium* and *Haminea* generally crawl on the substratum. *Nerita* species is found on mangrove trees and in areas having no such plantation it clings to the crevices, as near Kachuberia. The burrowing forms include six species of bivalves namely *Dosinia excisa* Schröter, *Tellina iridescens* (Benson), *Strigilla splendida* (Anton), *Siliqua albida* Dunker, *Solen kemp* Preston, *Theora opalina* (Hinds).

Majority of the gastropods are found in all the collecting stations. The species in the order of relative abundance are *Assiminea brevicula* (Pfeiffer). *Assiminea beddomeana* Nevill and *Telescopium telescopium* (Linnaeus). Bivalves are restricted to the central part of canals. The bivalve species in the order of their abundance are *Dosinia excisa* Gmelin, *Tellina iridescens* (Benson) and *Strigilla splendida* (Anton). The population density of other species is considerably low.

Breeding observations were recorded for some of the gastropods like *Assiminea brevicula* (Pfeiffer) and bivalves like *Strigilla splendida* (Anton).

INTRODUCTION

Many descriptive and general studies have been made on the ecology of mangroove swamps. Our knowledge on the molluscs is mostly restricted to that of Indo-West Pacific region (Macnae, 1968) : Malaysia (Lim, 1963 ; Berry, 1963, 1972, 1975 ; Sase Kumar, 1974). In India mangroove malacofauna has been recorded from Godavari and Krishna estuary (Radha Krishna and Janakiram, 1975), Mahanadi estuary (Subba Rao and Mukherji, 1975), Machilipatnam, Andhra Pradesh (Murty and Balaparameswara Rao,

1977). The malacofauna of Sunderbans was reported by Annandale and Prashad (1919). The earlier studies were concentrated on epifaunal elements only and included mostly gastropods. Knowledge on bottom fauna comprising mostly bivalves, is still meagre.

This paper records the ecology, distribution and abundance of malacofauna of 'Muriganga, a part of Hooghly estuary.

Muriganga is a branch of the river Hooghly and debouches into Bay of Bengal near Fraserganj. The river separates Kakdwip

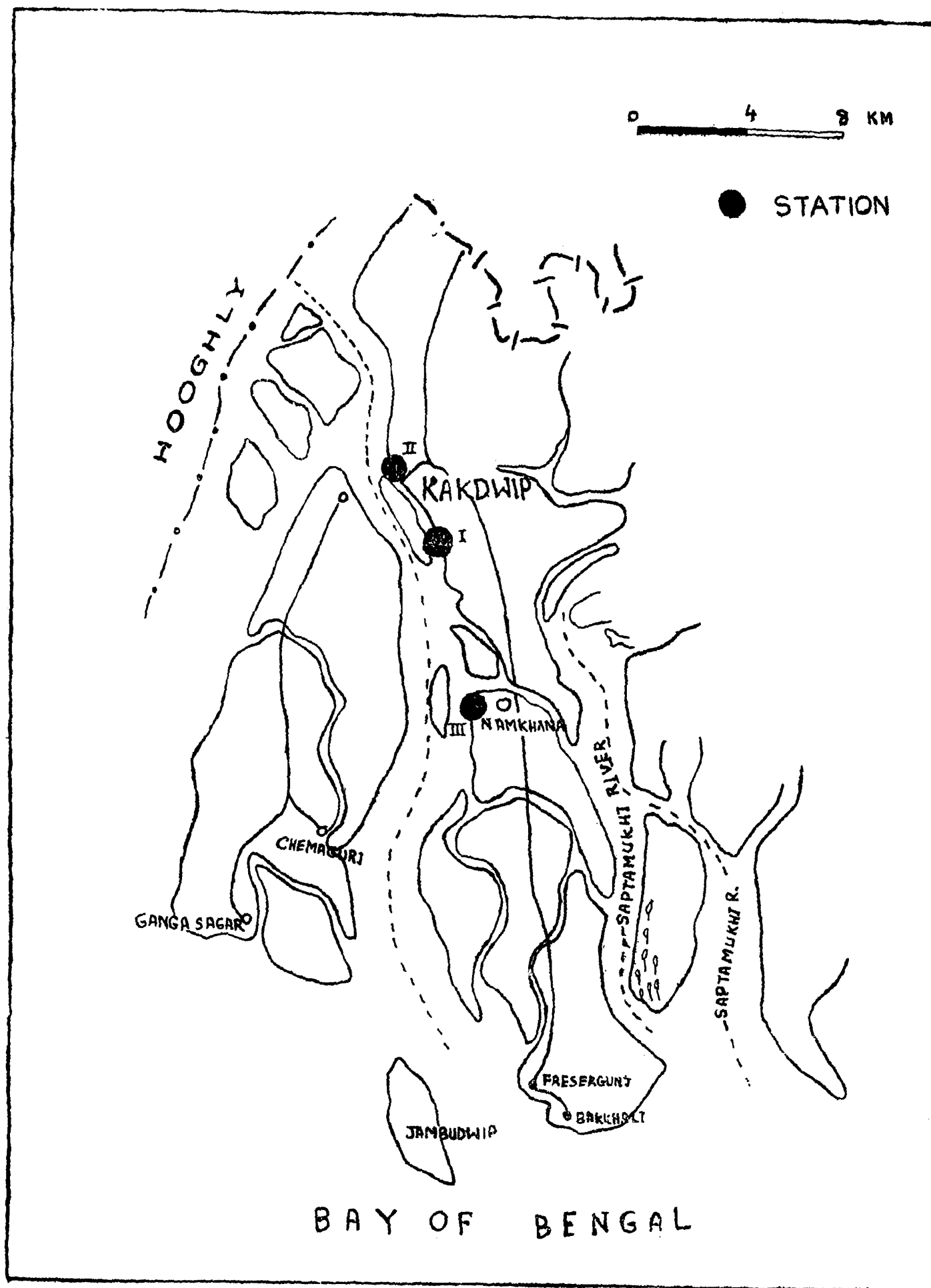


Fig. 1. Map of Muriganga estuary showing the place of study.

from Sagar Island and has a number of small islands near its mouth, like Ghoramara, Lohachara, Kankramarichara, Mousumi etc. At Kakdwip a small branch, locally known as Ghiapata river, separates from the main river Muriganga. The Ghiapata branch receives a few tributaries from Kakdwip side, takes a winding course and meets the main river about 3 kms. south-west of Kakdwip town. A small island called Maina Chara has come up between the main river and its branch. During low tide Ghiapata river gives the appearance of a small channel with water remaining in the central part only (Pl. I,

fig. 1). The substratum is of silty mud. At Namkhana, the Muriganga gives off a branch, Hathaniya-Duyania which connects it with Saptamukhi river. The area of study is shown in the Figs. 1 & 2.

The temperature range was 19.3° to 32.29° C in 1959-62 and 19° to 32.5° C in 1963-67 period. Yearly temperature distribution is bimodal with peaks in May-June and September-October.

Salinity range was wide-1.5‰ to 32.77‰ with only one peak in pre monsoon (March-June ; Jhingran, 1978).

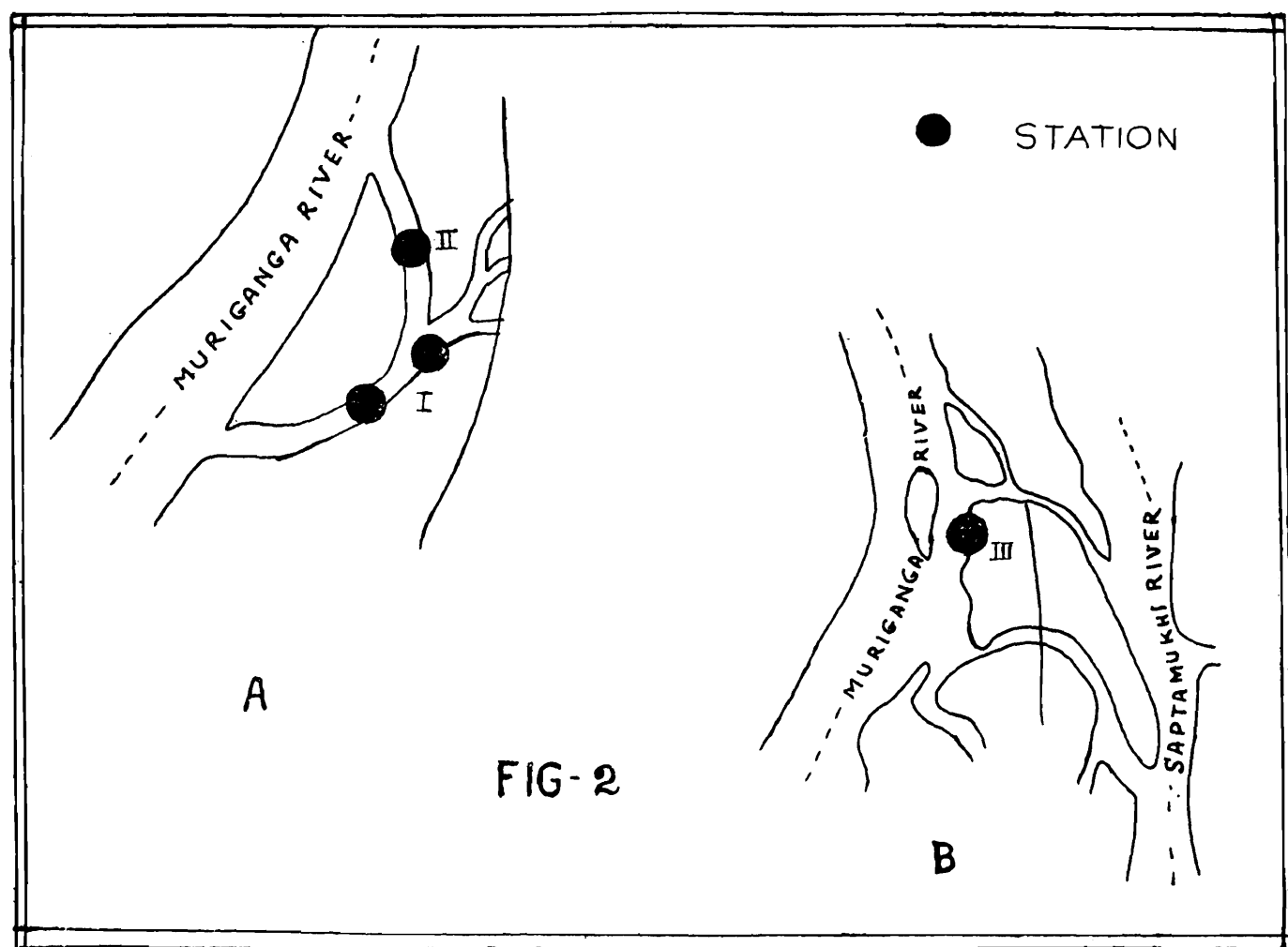


Fig. 2. A, Diagrammatic map of Kakdwip area showing the place of study (Station I and Station II)
B, Diagrammatic map of Narayanganj, Namkhana area showing the place of study (Station III)

List of the species recorded in Muriganga estuary :

- Class GASTROPODA
Order ARCHAEOGASTROPODA
Family NERITIDAE
1. *Nerita articulata* Gould
 2. *Neritina (Dostia) violacea* Gmelin.
 3. *Pseudonerita sulculosa* Martens.
- Order MESOGASTROPODA
Family LITTORINIDAE
4. *Littorina (Littoraria) melanostoma* Gray
 5. *Littorina (Littorinopsis) scabra scabra* Linnaeus
- Family STENOTHYRIDAE
6. *Stenothyra deltae* Benson
- Family ASSIMINEIDAE
7. *Assiminea beddomeana* Nevill
 8. *Assiminea brevicula* (Pfeiffer)
- Family POTAMIDIDAE
9. *Telescopium (Telescopium) telescopium* Linnaeus
10. *Cerithidea obtusa* Lamarck
- Order CEPHALASPIDEA
Family ATYIDAE
11. *Haminea crocata* Pease
- Family ELLOBIIDAE
12. *Auricula gangetica* Benson
 13. *Pythia plicata* Ferrussac
- Order ONCHIDIACEA
Family ONCHIDIIDAE
14. *Onchidium tigrinum* Stoliczka
- Class BIVALVIA
Order MYTILOIDA
Family MYTILIDAE
15. *Modiolus undulatus* (Dunker)
- Order VENEROIDA
Family SOLENIDAE
16. *Solen kempii* Preston

Family CULTELLIDAE

17. *Siliqua albida* Dunker

Family TELLINIDAE

18. *Tellina (Pharaonella) iridescens* (Benson)
19. *Strigilla (Aeretica) splendida* (Anton)

Family SEMELIDAE

20. *Theora opalina* (Hinds)

Family VENERIDAE

21. *Dosinia excisa* Schröter

MATERIAL AND METHODS

Monthly surveys of Muriganga river near Kakdwip, Narayanganj (Namkhana) and nearby islands were undertaken at three stations.

Station—I.

Ghiapata river near Mainapara. The banks on both the sides were of soft mud, with small grasses above the high tide mark (Pl. I, figs. 1-2).

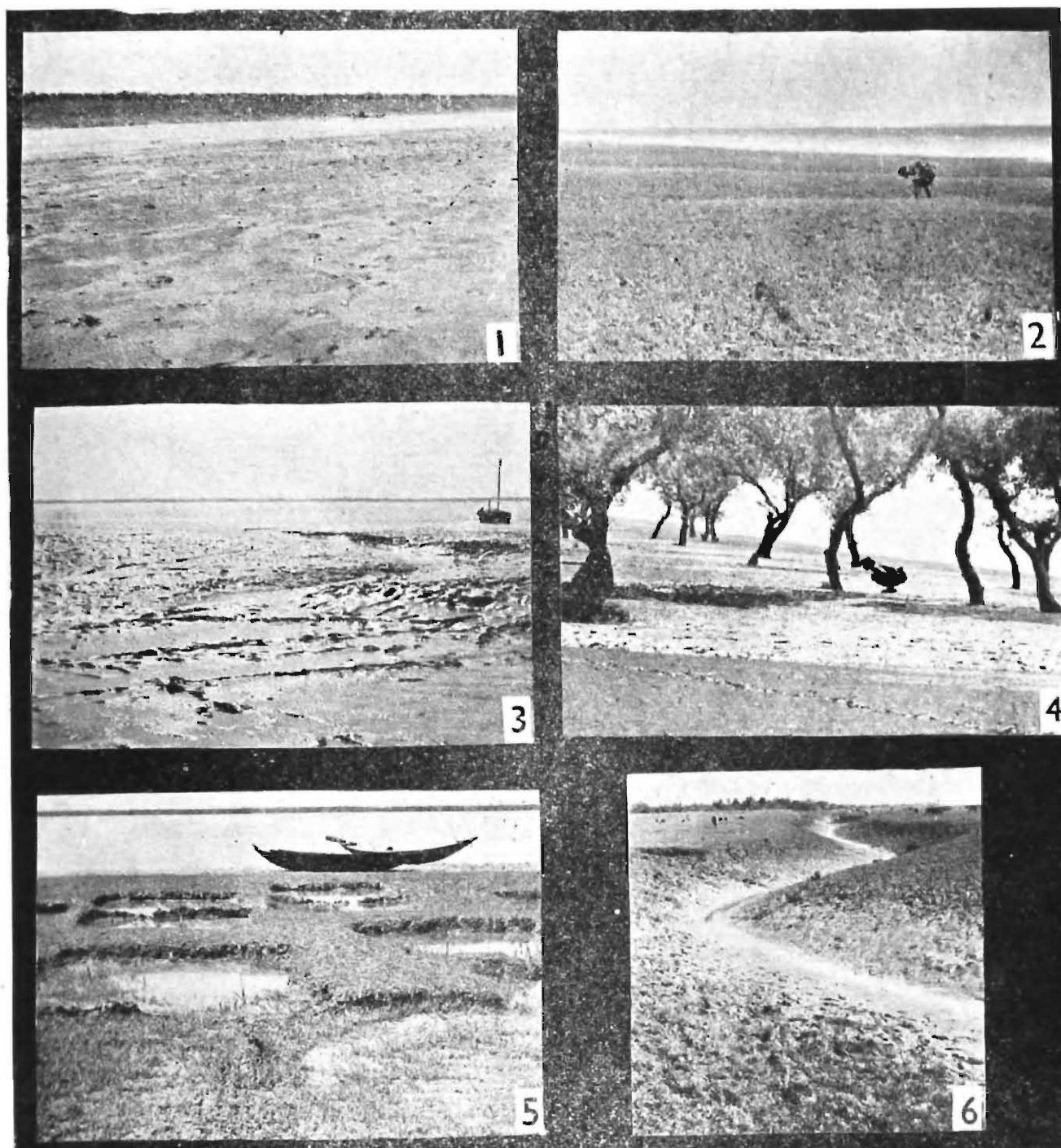
Station—II.

The point of origin of Ghiapata river from Muriganga. Here also the banks were muddy (Pl. I, fig. 3).

Station—III.

Hathaniya-Duyania river, 3 kms. south of Namkhana near Narayanganj. An area of about 40-50 meters was exposed with small grasses ; water touches the area only during the spring tide, and it was all soft mud above the high tide mark (Pl. I, fig. 5). Mangrove vegetation extends scarcely for about 400 meters in this region (Pl. I, fig. 4).

The population counts of gastropods were made from one square meter area. An average of five counts was taken as mean value of the population. For bivalve population from one cubic meter area was



- Figs. 1 & 2 : Ghiapata river (Kakdwip) during low tide.
Fig. 3 : Muriganga—Ghiapata confluence during low tide
Fig. 4 : A part of Hathaniya-Duyania river near
Narayanganj (Namkhana) showing vegetation.
Fig. 5 : Muddy area with grasses at Narayanganj
(Namkhana) above high tide mark.
Fig. 6 : A branch canal at Kakdwip.

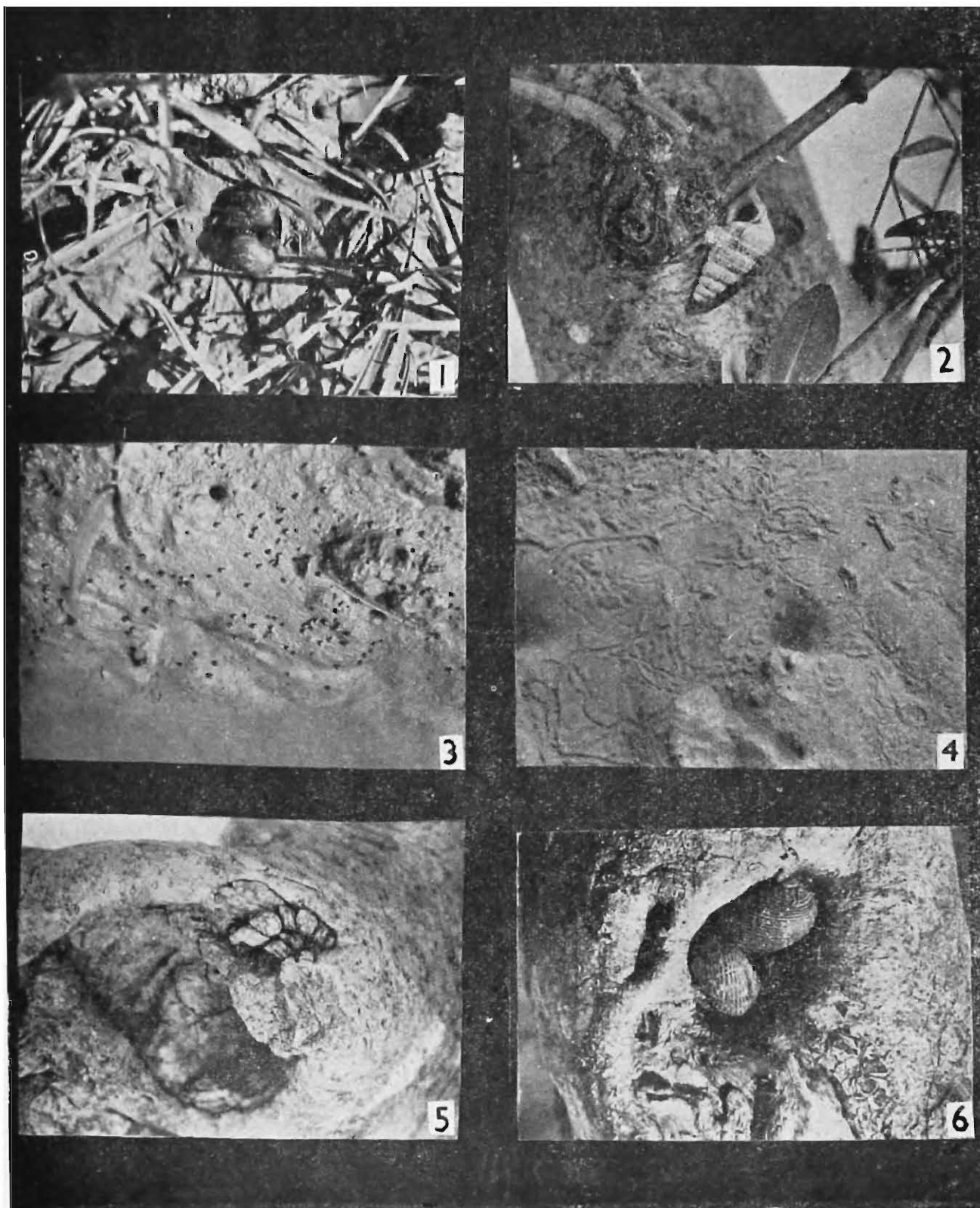


Fig. 1 : Copulating pair of *Haminea crocata* at Station III.
Fig. 2 : *C. obtusa* attached to mangrove plant at Station III.
Fig. 3 : *A. brevicula* crawling on the mud at Station I.
Fig. 4 : *S. deltae* crawling on the mud at Station II.
Fig. 5 : *L. scabra scabra* attached to the mangrove at Station III.
Fig. 6 : *N. articulata* attached in a crevice of mangrove plant at Station III.

considered. To determine the area or the volume a square steel frame, each wall measuring $\frac{1}{3} \times 1$ meter was taken. The frame was fixed on the substratum; for counting gastropods it was kept superficially, but for bivalves it was inserted deep into the substratum. The mud within the frame was collected and sieved through 1 mm. net to retain even the juveniles. For determining the concentration of bivalves a 100 m. transect was taken and ten samples were collected at an equal distance of 10 meter each.

OBSERVATIONS

Gastropoda :

Family : NERITIDAE. Three species viz. *Nerita articulata*, *Neritina violacea* and *Pseudonerita sulculosa* were common in the area. They were observed at Namkhana, Kachuberia, attached to the mangrove plants (Pl. II, fig. 6) upto a height of 2 meters above the ground level. They were either solitary or in clusters of 7-9 individuals.

Family : LITTORINIDAE. Two species, viz. *Littorina* (L.) *melanostoma*, and *L. (L.) scabra scabra*, common to all the stations were found mostly attached to the mangroves (Pl. II, fig. 5) upto a height of 1.5 meters above the ground level. The population density of these species varied with season and locality. For *L. melanostoma* the density was 3 to 52/m² and for *L. (L.) scabra scabra* it was 2 to 12/m² (Table 2).

Family : STENOTHYRIDAE. *S. deltae* has been recorded in all places from Kakdwip to Namkhana. It was found crawling on the mud (Pl. II, fig. 4). The population density varied from 2 to 408/m². The population level was highest in Sept. 1980 (Table 2).

Family : ASSIMINEIDAE. *A. brevicula* and *A. beddomeana* were abundant. *A. brevicula* generally either crawl on the mud (Pl. II, fig. 3) or remain attached to grasses in all muddy localities. Vertical distribution is restricted to 10 meters downwards from high water mark. Adult population was 8 to 108/m² from August, 1979 to Feb., 1980, which increased to 200 to 250/m² from Mar., 1980 onward. Copulation among adults was observed during Aug., 1979 to Dec., 1979 and the juveniles were recorded from Oct., 1979 to April, 1980. The number of young snails varied from 350 to 2106/m². The adult population of this species reduced to 29 to 40/m² at Stations I & II in Sept., 1980, the reasons for which could not be ascertained. No mass mortality was, however, observed.

A. beddomeana was recorded in the holes, and crevices of the muddy area. The population varied from 2 to 544/m². Juveniles were present in Jan., 1980 and they grew to adults by April, 1980, when copulating pairs were very common.

Family : POTAMIDIDAE. *T. telescopium*, was common on the banks of small ditches or canals with a little flow of water. It was found crawling on the mud. The population varied from 1 to 10/m². But during the month of April, 1980 a large concentration of the species was found near Narayanganj where there was some water flow. Juveniles counted for nearly 50% of the total population.

C. obtusa was found crawling on the mud or on plants which were wet with spring tides. It was recorded from a height of 0.5 meter from the ground level. Population

ranged from 2 to 8/m². It remains attached to plants (Pl. II, fig. 2) with the aperture facing upwards, with the help of mucus which on drying appears like a thread.

Family : ATYIDAE. *Haminea crocata* was common on the muddy areas and in the small ditches on the bank. In August, 1980 adults were found crawling on the mud. Population density ranged from 2 to 3/m². Juveniles crawling on the ground had a density of 205 to 208/m² in Jan., 1980. No adults were noticed in this period. (Perhaps the species is semelparous). By April, 1980 Juveniles attained sexual maturity and copulating pairs were observed (Pl. II, fig. 1). The population density ranged from 10 to 15/m², sometimes extending to 23/m².

Family : ELLOBIIDAE. *Pythia plicata* and *Auricula gangetica* were seen in the holes and crevices at Namkhana. Population density ranged from 1 to 3/m².

Family : ONCHIDIIDAE. *Onchidium tigrinum* was found crawling on the bricks near the jetty of Kachuberia and also no. 8 jetty of Kakdwip.

Bivalves :

Seven species of bivalves were common in and around Kakdwip and Namkhana. Their population density varied from season to season. The bivalves were mostly absent in situations where the water column was high even during the extreme low tide.

Family : SOLENIDAE. *Solen kemp* was recorded at Stations I & II. Juveniles were found only in April, 1980 at the density of 2.8/m². Adults were not found.

Family : CULTELLIDAE. *Siliqua albida* was found at Stations I & II. Juveniles were recorded from Jan., 1980 to April, 1980 at 2 to 8.6/m². on an average.

Family : TELLINIDAE : *Tellina iridescens*

TABLE I. Showing population density of bivalves 1/m² along a transect of 100 meters.
(Samples collected at equidistance of 10 meters)

October, 1979

Station	<i>Tellina</i>		<i>Strigilla</i>		<i>Dosinia</i>		<i>Solen</i>		<i>Siliqua</i>		<i>Theora</i>	
	I	II	I	II	I	II	I	II	I	II	I	II
Sample— 1	nil	nil	1	nil	1	nil	nil	nil	nil	nil	nil	nil
Sample— 2	nil	1	nil	nil	1	2	nil	nil	nil	nil	nil	1
Sample— 3	2	1	2	1	nil	2	nil	nil	nil	nil	nil	nil
Sample— 4	1	3	3	5	11	5	nil	nil	nil	nil	nil	5
Sample— 5	4	5	4	3	12	14	nil	nil	nil	nil	nil	4
Sample— 6	3	2	5	4	12	13	nil	nil	nil	nil	nil	5
Sample— 7	2	1	nil	2	2	8	nil	nil	nil	nil	nil	1
Sample— 8	1	2	3	2	4	4	nil	nil	nil	nil	nil	nil
Sample— 9	nil	1	2	2	nil	1	nil	nil	nil	nil	nil	nil
Sample—10	1	nil	nil	nil	nil	1	nil	nil	nil	nil	nil	nil

January, 1980

[illegible]

April, 1980

Station	<i>Tellina</i>		<i>Strigilla</i>		<i>Dosinia</i>		<i>Solen</i>		<i>Siliqua</i>		<i>Theora</i>	
	I	II	I	II	I	II	I	II	I	II	I	II
Sample— 1	2+11	1+2	1+ 1	1	12	4	nil	nil	nil	nil	nil	2
Sample— 2	1+23	1+1	2+ 5	nil	18	1	2	nil	1	nil	nil	1+nil
Sample— 3	4+14	nil	3+11	1	32	4	2	nil	1	1	nil	2+1
Sample— 4	2+ 3	1+10	nil+1	nil	3	nil	nil	nil	1	1	nil	nil
Sample— 5	nil+1	1+nil	nil	1	nil	3	nil	nil	nil	nil	nil	1+2
Sample— 6	nil+1	nil+1	nil+1	nil	nil	nil	nil	nil	nil	2	nil	nil
Sample— 7	3+ 9	1+3	2+6	nil	28	2	1	nil	1	nil	nil	1+1
Sample— 8	2+12	nil	1+9	1	41	nil	2	nil	nil	1	nil	1+nil
Sample— 9	4+16	1+1	5+8	1	26	2	nil	nil	1	1	nil	1+1
Sample—10	3+ 5	nil	2+8	nil	7	1	nil	nil	nil	nil	nil	nil+1

September, 1980

[illegible]

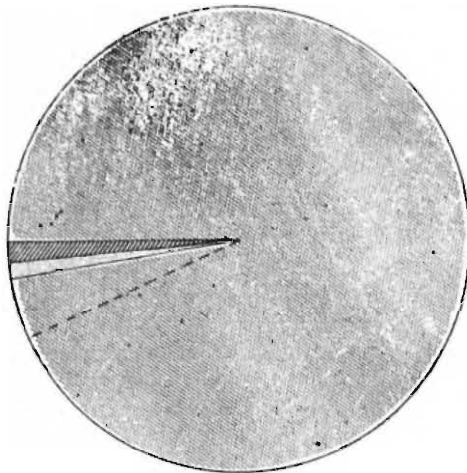
TABLE II. Showing population density of molluscs/m² at different stations during different periods.

Name of the species	October, 1979			January, 1980			April, 1980			September, 1980		
	Station I	Station II	Station III	Station I	Station II	Station III	Station I	Station II	Station III	Station I	Station II	Station III
1. <i>Assiminea brevicula</i> (Pfeiffer)	81+1908	92+2106	108+2008	8+1069	6+2005	210+1050	250+1103	203+1101	6+350	40	29	153
2. <i>A. beddomeana</i> Nevill	14	12	46	10	12	544	12	11	nil	nil	2	30
3. <i>Littorina melanostoma</i> Gray	nil	nil	40	nil	nil	4	nil	nil	3	nil	nil	52
4. <i>L. scabra</i> Linnaeus	nil	nil	12	nil	nil	2	nil	nil	2	nil	nil	2
5. <i>Telescopium telescopium</i> Linnaeus	2-10	2-6	7-9	2-8	2-10	4-10	2-5	2-5	632	2-3	1-2	1-2
6. <i>Haminea crocata</i> Pease	nil	nil	3	nil	nil	208	15	12	12	nil	nil	nil
7. <i>Stenothyra deltae</i> Benson	nil	nil	nil	nil	nil	nil	nil	nil	nil	258	219	408
8. <i>Nerita articulata</i> Gould	nil	nil	4	nil	nil	3	nil	nil	5	nil	nil	1-6
9. <i>Tellina iridescens</i> (Benson)	5.6	6.4	nil	9.2	11.6	nil	46.4	9.6	nil	41.5	8	nil
10. <i>Sirigilla splendida</i> (Anton)	0.8	7.6	nil	nil	nil	nil	26	2	nil	3	2	nil
11. <i>Dosinia excisa</i> Schröter	17.2	22.4	nil	0.4	nil	nil	66.8	6.8	nil	21.7	9.2	nil
12. <i>Siliqua albida</i> Dunker	nil	nil	nil	8.6	2.4	nil	2	2.4	nil	nil	nil	nil
13. <i>Theora opalina</i> (Hinds)	nil	5.6	nil	nil	1.6	nil	nil	6	nil	nil	10	nil
14. <i>Solen kemp</i> Preston	nil	nil	nil	nil	nil	nil	2.8	nil	nil	nil	nil	nil

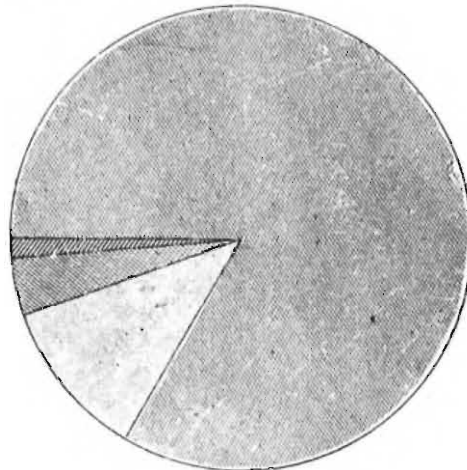
RAO *et al.*

PLATE III

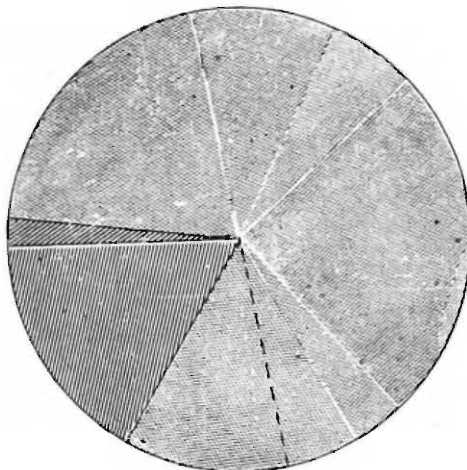
GASTROPODS



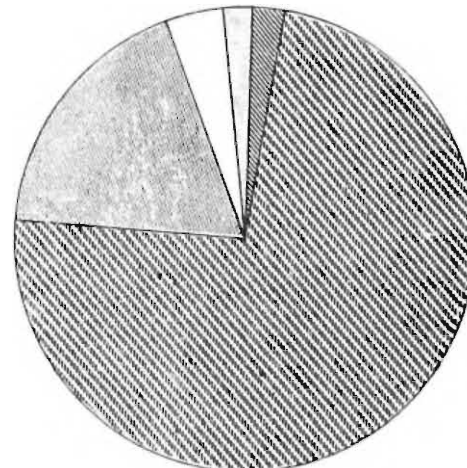
OCT 79



JAN 80



APR 80



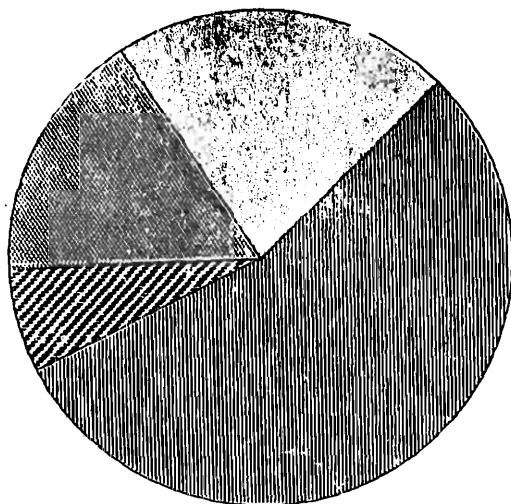
SEPT 80

-  ASSIMINEA BREVICULA (PFEIFFER)
-  ASSIMINEA BEDDOMEANA NEVILL
-  LITTORINA (LITTORINOPSIS) MELANOSTOMA GRAY
-  TELESCOPIUM (TELESCOPIUM) TELESCOPIUM (LINNAEUS)
-  HAMINEA CROCATATA PEASE
-  STENOTHYRA DELTA BENSON
-  OTHERS

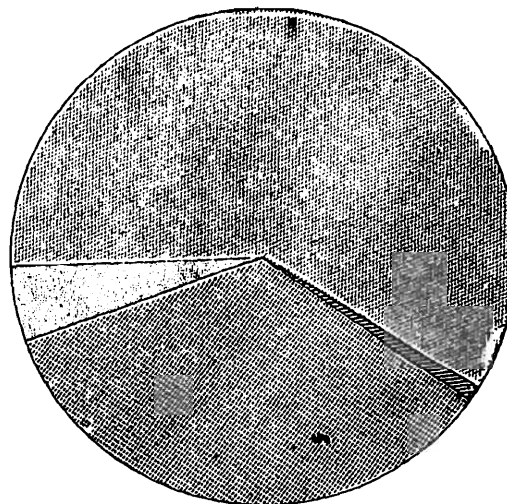
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PLATE IV

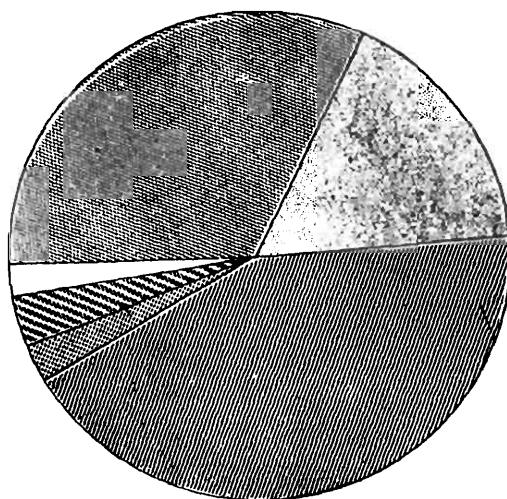
BIVALVES



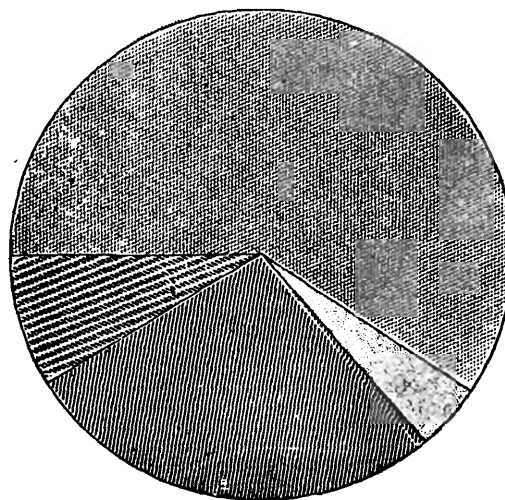
OCT 79



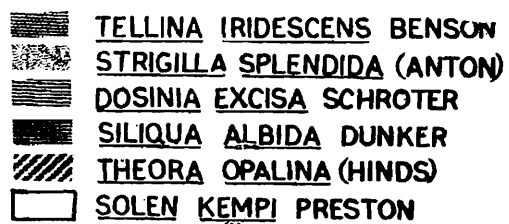
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and *Strigilla splendida* were found in the mud at a depth of 4 to 10 cms. in the canals at Stations I & II. Population density of *T. iridescens* ranged from 5.6 to 11.6/m² in an average, but increased to 46.4/m² during the month of April, 1980. The juveniles were recorded from Jan., 1980 and onward upto April, 1980 and population density ranged upto 97/m². Population of *S. splendida* varied from 2 to 26/m². Juveniles were found from January, 1980 to April, 1980 with the density of 18/m².

Family : SEMELIDAE : *Theora opalina* was recorded from the small canal near Kakdwip (Pl. I, fig. 6). It was absent in the main canal. Population density was 1.6 to 10/m² on an average. Juveniles were observed from Jan., 1980 to April, 1980.

Family : VENERIDAE : *Dosinia excisa* is commonly found in the mud of the canals near Kakdwip and Namkhana. The young ones were noticed more during April, 1980. Population density varied from season to season and it was 1-2/m² from October, 1979 to February, 1980 and increased to 104 to 108/m² from March, 1980 and onward.

DISCUSSION

The above study reveals, that depending upon the ecological niche the malacofauna of Muriganga estuary can be broadly divided into two categories : (1) Plant dwellers and (2) Mud dwellers. Among the plant dwellers, while species like *Littorina melanostoma*, *L. scabra* and *Nerita* spp. inhabit the surface of the plants, there are species like *Teredo* which burrow into dead or living plant material. Only dead specimens of *Teredo* were observed. Mud dwellers include species of *Assiminea*, *Telescopium*, *Stenothyra*, *Haminea*, *Auricula*,

Pythia, *Nerita* and *Onchidium* which inhabit the surface of the muddy substratum, or the crevices whereas all bivalves, viz. *Dosinia*, *Tellina*, *Strigilla*, *Solen*, *Theora*, burrow inside.

Among gastropods, *A. brevicula* is the dominant species accounting for about 81.3% to 97.5% of the total molluscan population, but during September, 1980 it reduced to 18.4% only (Pl. III). The population density of this species reaches its peak in the month of October (Table 2 & Pl. III). The less abundant species are *Nerita* spp. which occurs only 1-6/m², that too on mangrove trees.

Pairing was common in *A. brevicula* in the period of August to December and in *A. beddomeana* in April. In *Haminea crocata* pairing was noticed in December and April.

The two sympatric species of *Assiminea* occupy different ecological niches. *A. brevicula* crawl on the mud whereas *A. beddomeana* live in the holes and crevices of the muddy substratum. Breeding seasons were also different—the former in December and the latter in April. The breeding season of *Assiminea* started in the monsoon when there was a large influx of freshwater and continued for three months after that.

More bivalves were collected from the samples 4, 5, and 6 which is just above the low water mark on both sides of the river. *T. iridescens* was present in all the samples and it was the dominant species, but its place was taken by *D. excisa* during the month of October, 1979 and April, 1980 (Pl. IV). Young ones of *Tellina*, *Strigilla*, and *Siliqua* were recorded from Jan., to April. Juveniles of *Solen* were recorded only in the month of April, 1980 and following which no *Solen* either juveniles or adult was seen. *Tellina*,

Strigilla, *Dosinia*, *Siliqua* and *Solen* were common in the main branch of Muriganga, but *Theora* was found only in the small sub-branches or canal.

Burrowing in the case of *S. splendida* was completed in 4-6 jerks which take 30 to 60 seconds. The foot was protruded from between the two valves and forwarded at the anterior end and the body jerked repeatedly till the whole animal got inside the mud. The animal remained vertical after completion of burrowing with extruded siphons moving around in the water.

ACKNOWLEDGEMENTS

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SOME OBSERVATIONS ON THE POPULATIONS OF *NALA NEPALENSIS*
(BURR) AND *FORCIPULA QUADRISPINOSA* (DOHRN) (DERMAPTERA :
INSECTA) COINHABITING A SUBAQUATIC HABITAT

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ABSTRACT

Data gathered during the period June 1978—May 1979 indicate certain seasonal fluctuations in the populations of *Nala nepalensis* (Burr) and *Forcipula quadrispinosa* (Dohrn) inhabiting under stones on the bank of a hill stream in Himachal Pradesh, India. The correlation between these fluctuations and rainfall, average minimum and maximum temperature and average relative humidity are tested statistically. Populations of both the species show two annual peaks and consist of more females than males.

INTRODUCTION

Though some information is available on the seasonal abundance, sex ratio and seasonal history of a few earwig species in Europe and U. S. A. (Brindley, 1912, 1914 ; Jones, 1917 ; Goe, 1925 ; Beall, 1932 ; Fox-Wilson, 1940 ; Crumb *et al.* 1941 ; Guppy, 1946 ; Behura, 1956 ; Walker and Newman, 1976), such studies on the Indian Dermaptera are known only through the recent work of Mishra and Dash (1980) on *Nala lividipes* (Dufour). An attempt has been made to study the seasonal abundance and sex ratio of *Nala nepalensis* (Burr) and *Forcipula quadrispinosa* (Dohrn) inhabiting under stones on the bank of a perennial hill stream in Himachal Pradesh, India. The possible relation of seasonal abundance of these species to climatic factors are also discussed.

STUDY AREA

The sampling was carried out on the right bank of a perennial hill stream in the vicinity of a road bridge at Sadhupul (alt. *ca.* 1100 m), about 35 km from Solan on way to Chail. The right bank of the stream is sandy with a number of stones, devoid of vegetation and with a gradual slope to the water-line. On the contrary, the left bank is a steep wall of rock with some grasses and shaded by tall trees.

MATERIALS AND METHODS

Except in October 1978, population estimates were made every month from June, 1978 to May, 1979. An area of 65 m length and 4 m width from the water-line on the right bank of the stream was selected for the present studies. It was established from

earlier intensive collecting that the earwigs were mostly found in this area. An effort was made to standardize the individual collection by visiting the same specified area each month and collecting intensively by upturning randomly selected 200 stones of 250-300 cm diameter. Though, admittedly, this method may not give precise quantitative analysis of absolute abundance, it is considered adequate for the present investigations.

The climatic (abiotic) factors such as temperature, rainfall and relative humidity were recorded with the help of the local College of Agriculture, Himachal Pradesh Krishi Vishva Vidhyalaya. Estimation of soil moisture under stones was made by oven-drying to a constant weight of soil at 105°C.

OBSERVATIONS

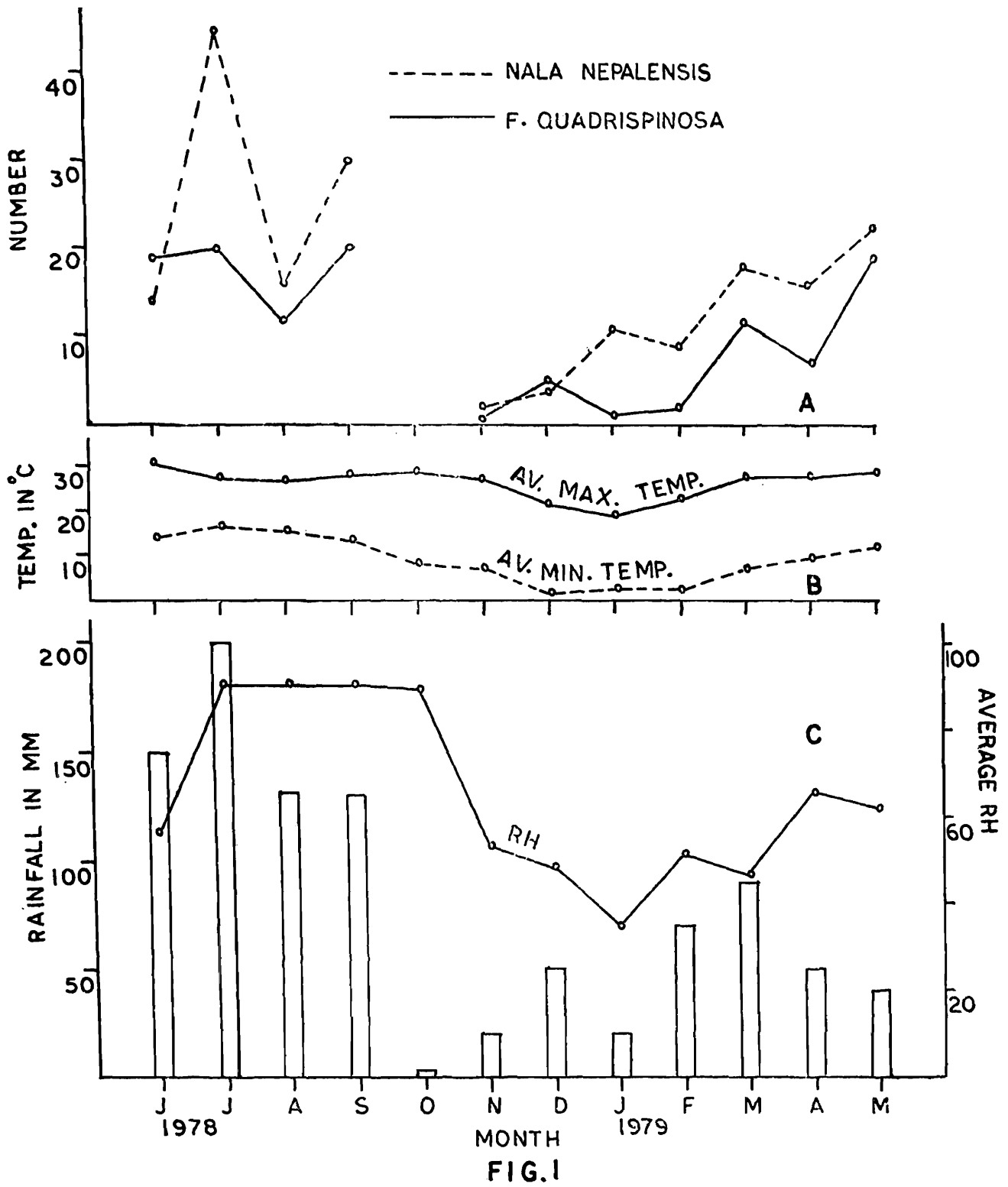
There are four distinct seasons viz., spring (late February to April), summer (May to August), autumn (September to middle of November) and winter (middle of November to middle of February). The seasonal fluctuations in the abiotic factors such as rainfall, average minimum and maximum temperature, and average relative humidity are depicted in Fig. 1. Temperature increased gradually from February till June, which was the hottest month of the year with an average maximum temperature of 30.9°C. From then onwards, it steadily decreased till November but with a slight rise in October. Thereafter, the decrease was very rapid. The coldest part of the year was from the end of December to January with minimum temperature occasionally falling below the freezing point of water. The monthly rainfall ranged from 3-200 mm. The chief amount of rainfall was received during the south-west monsoons from late June to the middle of September (130-200

mm). In association with western disturbances some rains occurred from the end of December to February (20-70 mm), often accompanied by hail and occasionally by snow flakes. Rainfall was moderate during spring (50-90 mm). The average relative humidity ranged from 35.5% in January to 91% in July-September. The average soil moisture under stones varied from 1.1 to 10.3.

Seasonal Abundance

Nala nepalensis (Burr).—The monthly changes in the numbers of *N. nepalensis* are shown in Fig. 1. Beginning in June, the number increased rapidly to a maximum in July, followed by a sharp decline in August. The population built up again in September, but did not reach the previous level. The number dropped to the lowest level in November. From December, the population rose gradually till May.

N. nepalensis probably possesses two annual generations—a first of summer (March to July) generation and a comparatively long, second or overwintering (August to February) generation with a diapause in the nymphal and adult stages. The over-wintered females lay the first generation eggs in March-April which hatch in late April to May. This is suggested by the fact that an appreciable increase in the total population of *N. nepalensis* in May is mainly due to a significant, rise in its nymphal population (Figs. 1 and 2). The nymphs become adults in July as indicated by a sharp increase in the adult population and a decrease in the nymphal population during this month. The second generation eggs are laid sometime in August. The hatching of these eggs in September corresponds to rise in the number of nymphs in that month,



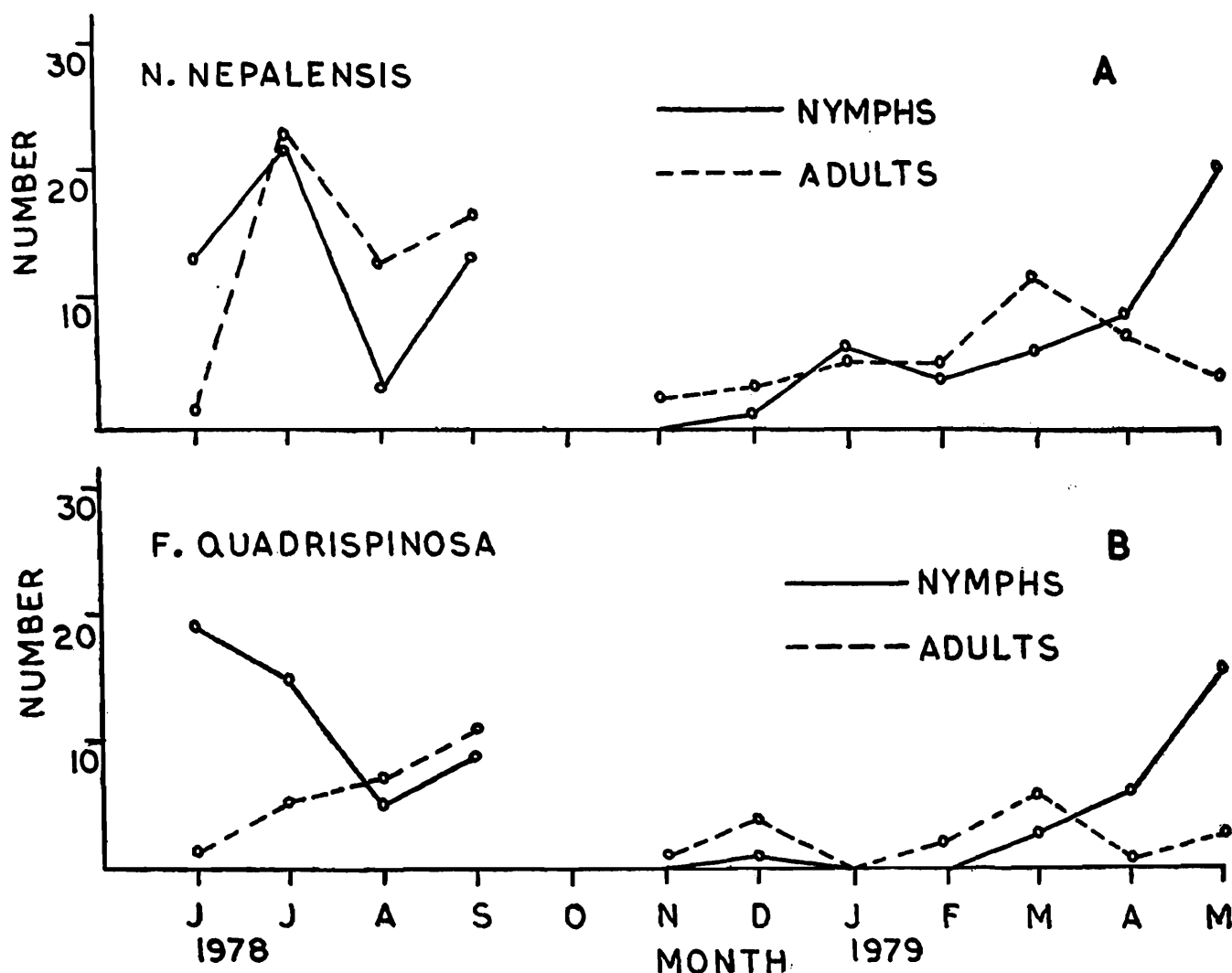


FIG. 2

Forcipula quadrispinosa (Dohrn).—The seasonal fluctuations in the population of *F. quadrispinosa* followed a pattern as in *N. nepalensis* but with some modifications (Fig. 1). The population was at a higher level in June and reached the peak in July. This level was maintained till September but with an appreciable decline in August. The number dropped to the lowest level in November and remained at about that level till February but with a slight increase in December. From March, the population rose steadily and followed a similar trend as in *N. nepalensis*.

Like *N. nepalensis*, *F. quadrispinosa* has also possibly two annual generations, but the duration of the first and second generations differ slightly from that of the former (Figs. 1 and 2).

Sex Ratio

The relative proportions of males and females in the populations of *N. nepalensis* and *F. quadrispinosa* are given in Table 1, a perusal of which shows that there is preponderance of females over males. The data were subjected to statistical treatment by means of 'Chisquare Test' under the hypothesis

TABLE 1. Sex ratio in the population of *Nala nepalensis* and *Forcipula quadrispinosa*.

Species	Total	Males	Females	Ratio	Chisquare value	Significance (p)
<i>N. nepalensis</i>	92	42	50	1 : 1.2	0.7	—
<i>F. quadrispinosa</i>	45	15	30	1 : 2	5	ca 0.05

that 1 : 1 ratio exists between the males and females. In *N. nepalensis*, a low chisquare value of 0.7 is obtained which is not of any significance at one degree of freedom. On the

contrary in *F. quadrispinosa*, a high chisquare value of 5 just reaches the 5% level of significance which suggests some difference from 1 : 1 ratio of males and females in its population.

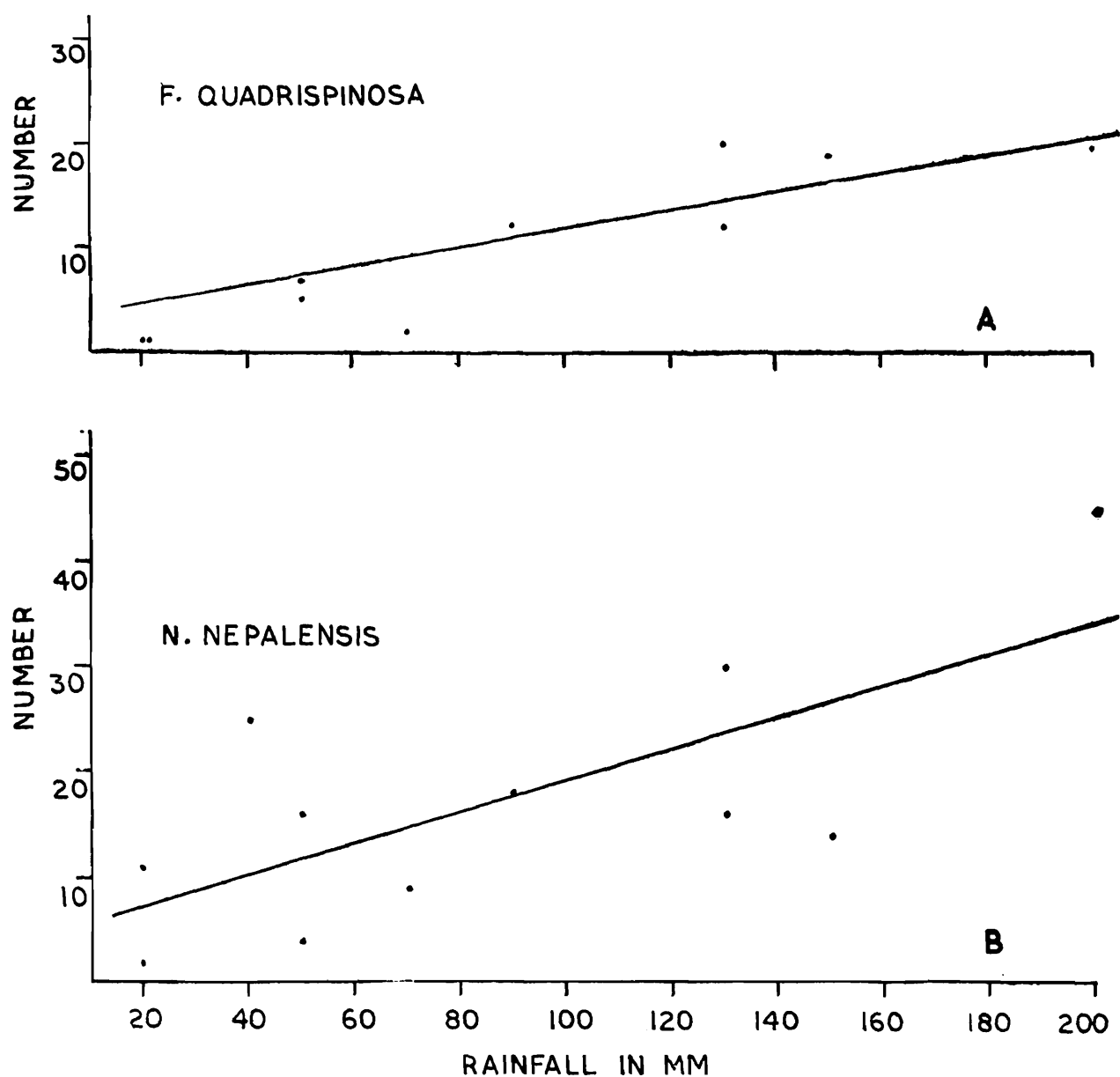


FIG. 3

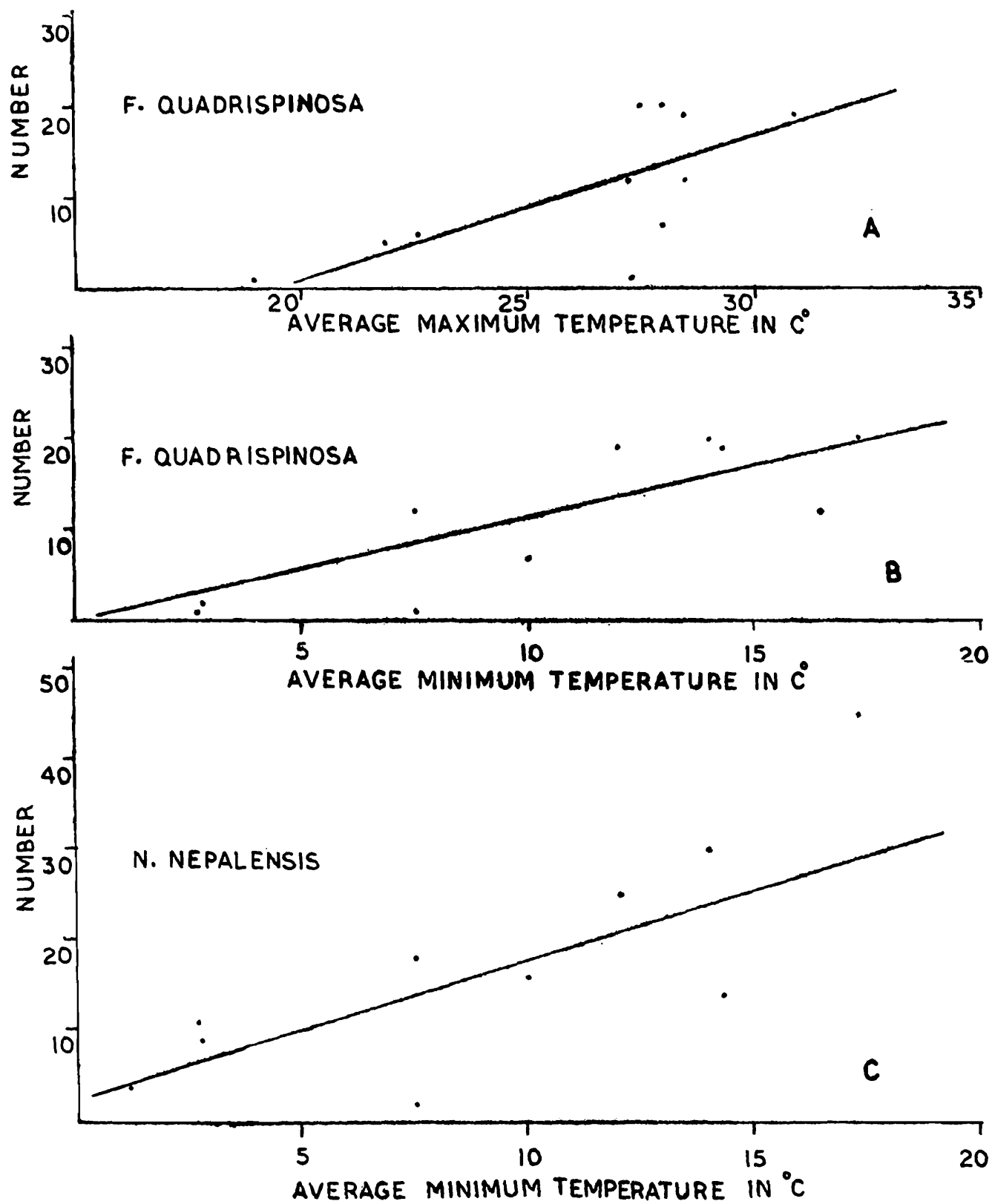


FIG. 4

DISCUSSION

In the complex of interdependent biotic and abiotic factors governing the seasonal abundance of earwigs, abiotic factors viz., rainfall, temperature and relative humidity appear to be important, since these insects are abundant during the months when the rainfall, temperature and relative humidity are maximum. Behura (1956) also states that

temperature is a limiting factor and the growth-rate in earwigs is directly proportional to fluctuation of temperature. The effect of abiotic factors viz., rainfall, average minimum and average maximum temperature, and average relative humidity on the seasonal fluctuations in the population of *N. nepalensis* and *F. quadrispinosa* was analysed statistically. Regression lines were obtained between the population density and four abiotic factors as

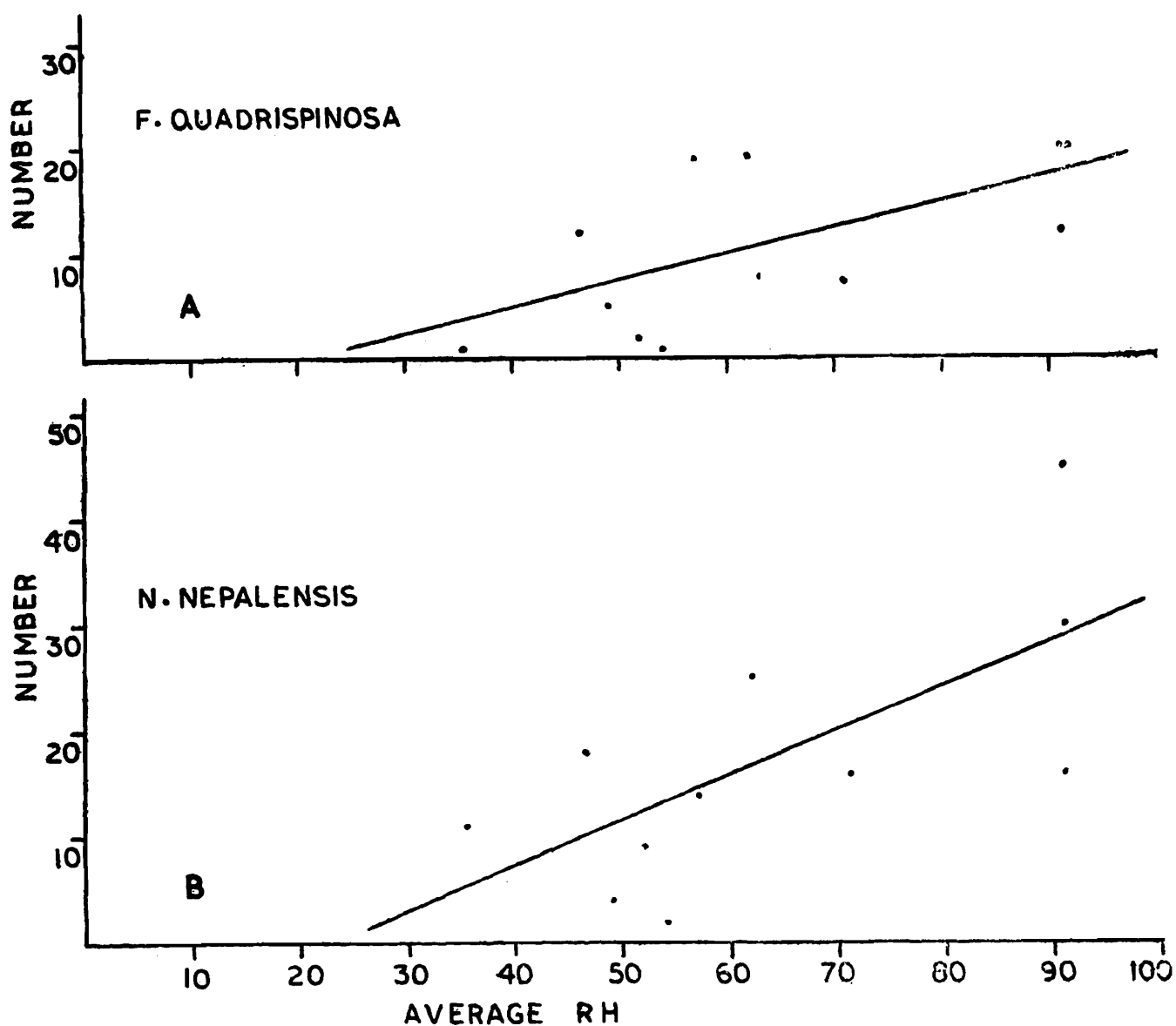


FIG.5

enumerated above (Figs. 3-5). A study of the coefficient of correlation shows that significant positive correlation exists between the population density and rainfall, average minimum temperature and average relative humidity in both *N. nepalensis* and *F. quadrispinosa* (Tables 2 and 3). Average maximum temperature has no significant effect on the population build-up of *N. nepalensis* but is quite significant in the case of *F. quadrispinosa*.

The results on the sex ratio point to a slight male deficiency in the population of

both *N. nepalensis* and *F. quadrispinosa* which agree with the observations made by Behura (1956) on *Forficula auricularia* Linnaeus.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for providing necessary facilities. They are also thankful to Dr. Asket Singh, Officer-in-Charge, High Altitude Zoology Field Station, Zoological Survey of India, Solan for encouragement.

TABLE 2. Relationship between *N. nepalensis* population and climatic factors.

	Correlation coefficient (r)	Significance with 10 d. f. (p)	Regression line of no. of <i>N. nepalensis</i> (y) on climatic factors (x). $y = a + bx$
Rainfall	0.7133	<0.01	$y = 4.361 + 1.495x$
Average minimum temperature	0.7169	<0.01	$y = 2.389 + 1.549x$
Average maximum temperature	0.3984	—	—
Average relative humidity	0.6891	<0.02	$y = -10.218 + 0.432x$

TABLE 3. Relationship between *F. quadrispinosa* population and climatic factors.

	Correlation coefficient (r)	Significance with 10 d. f. (p)	Regression line of no. of <i>F. quadrispinosa</i> (y) on climatic factors (x). $y = a + bx$
Rainfall	0.6815	<0.02	$y = 2.829 + 0.915x$
Average minimum temperature	0.8210	<0.01	$y = -0.129 + 1.136x$
Average maximum temperature	0.7105	<0.01	$y = -30.841 + 1.580x$
Average relative humidity	0.6285	<0.05	$y = -5.309 + 0.252x$

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A NEW SPECIES OF *LOBUS* MARTIN (DIPTERA : ASILIDAE)
FROM S. INDIA

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ABSTRACT

Lobus martini n. sp. is described from South India and its affinities are discussed. A key to the Indian species are also included.

Genus *Lobus* Martin

Lobus Martin, 1972, *J. Kans. ent. Soc.*, 45 (1) : 8.

Type-species *Leptogaster pallipes* Janssens 1953.

Lobus Martin can be easily distinguished from the remaining genera under Leptogastrinae by the long horizontal pod-like ventral organ of male terminalia called lobos (Martin, 1972) and the almost wholly fused aedeagal sheath with the lobos. It is a small genus represented by two species in India, *Lobus keralae* Martin and *L. himalayae* Martin, and the third one is described here.

Key to the Indian species of *Lobus* Martin

1. Anterior legs uniformly yellowish ...
Anterior legs pale yellow with dark brown apex, antennae black, mystax with a row of dense white bristles *martini* n. sp.
2. Hind femur with a dark spot both medially and basally, hind tibia without band, scutellum bears 8 short dark bristles on posterior margin. : *keralae* Martin

Hind femur with reddish-brown at apex, hind tibia with a brown band at apex, scutellum bears pale hairs on posterior margin

himalayae Martin

Lobus martini n. sp.

A slender black fly with pale and dark brown legs and brownish tinged wings. Male : length 7-9 mm, wing 4-5 mm ; female : length 7-10 mm, wing 4-6 mm.

Male : Head black with greyish-yellow scales on frons below antennae ; gibbosity weakly developed with dense white bristles, occiput medially and laterally grey tomentose leaving a large black area in between them or more or less uniformly grey tomentose, hairs on occiput white but become shorter and paler towards the middle. Antenna black, segment 1 subequal to 2, segment 3 elongate, style shorter than or nearly as long as segment 3 and suddenly narrowed at apex. Proboscis and palpi black with pale hairs.

Thorax black with grey tomentum ; pronotum densely grey tomentose ; mesono-

tum devoid of mediolongitudinal stripe, sides grey tomentose while the remaining black, covering hairs white or pale, postero-lateral sides with a pair of pale or dark brown bristles; scutellum thickly grey tomentose, hind border with 2 or 3 rows of pale or dark brown short bristles; pleura for greater part covered with grey tomentum, mesopleuron and sternopleuron anteriorly bearing dense, long white hairs. Halteres pale yellowish-brown with their stalks comparatively lighter coloured.

Legs pale and dark brown, the extension of colouration variable but shows the

following pattern: in foreleg femur pale yellow with its apex dark brown, tibia pale with its apex and sides dark brown, tarsus dark brown except the base of basitarsus being pale; in midleg femur basally pale while the remaining dark brown, tibia basally and dorsally pale while the rest dark brown, tarsus similar to the preceding; in hindleg femur and tibia less than half pale and the remaining dark brown, basitarsus almost wholly pale or apically dark brown, remaining segments dark brown; clothing hairs white or pale, bristles black with some pale ones also.

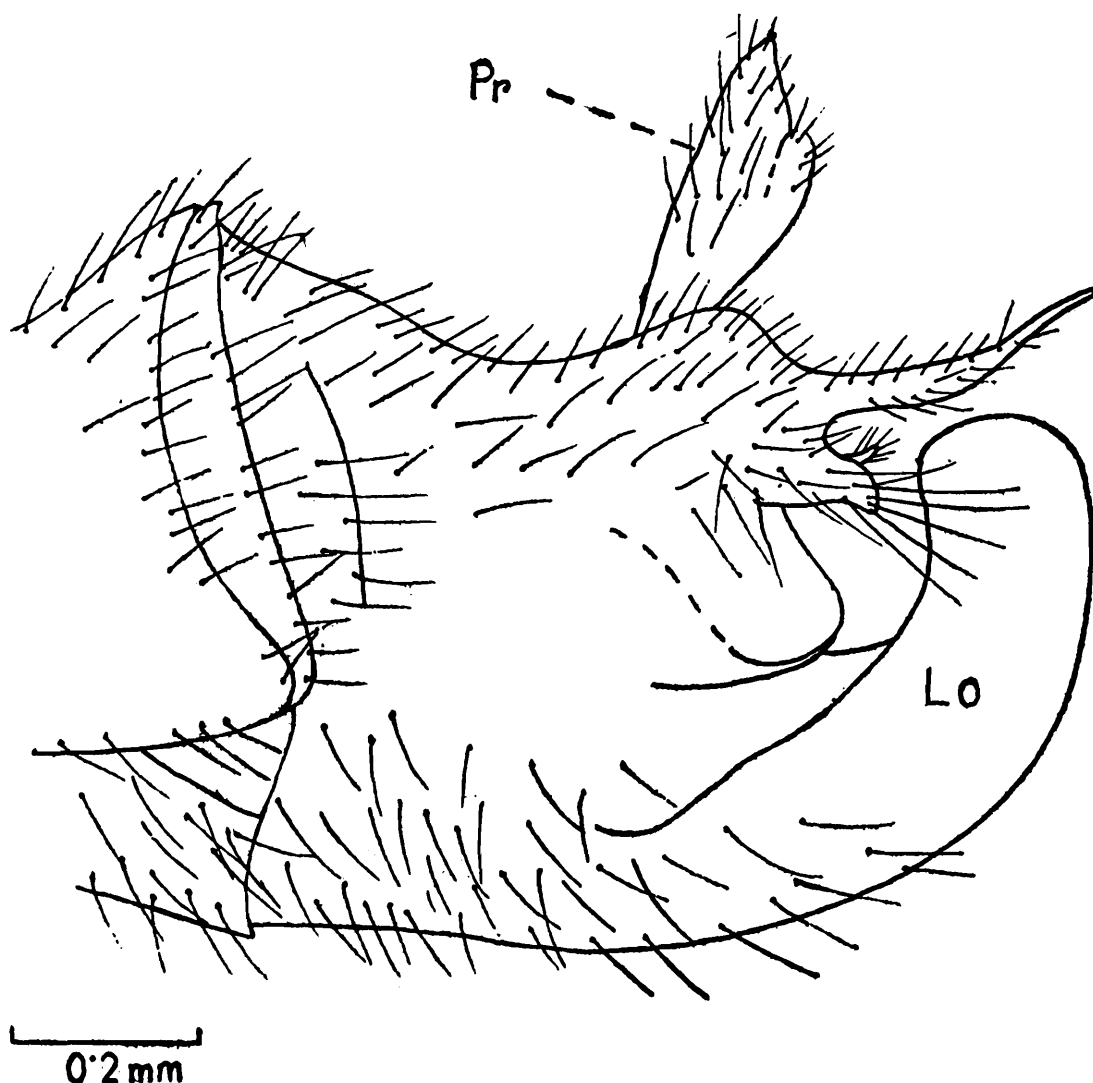


Fig. 1. Lateral view of male terminalia of *Lobus martini* n. sp. Lo, lobos; Pr, proctiger.

Wings brownish tinged, posterior half lighter than the anterior half.

Abdomen black with the tergites at the anterior and posterior borders marked grey, the area of grey marking gradually decreases in the posterior tergites, sides of tergites 1 and 2 with pale hairs. Male terminalia (Fig. 1) black with pale hairs.

Female : Similar to the males.

The only other known South Indian species is *Lobus keralae* Martin which is quite different. This species can be recognised at once from all the other species in the genus by the structural details of male terminalia, in which character the various species of the genus exhibit great variation. It is named in honour of late Dr. C. H. Martin, the author of the genus.

Holotype ♂, ZSI Reg. No. 6662/H6, INDIA : Kerala State : Trichur District : Chalakudy : Konnakuzhi, 22.xii. 1979, Coll. *Joseph and Parui*.

Paratypes. 1 ♂, 3 ♀♀, Reg. No. 6663/H6 to 6666/H6, details as in holotype. 1 ♂, Reg. No. 6667/H6, INDIA : Kerala State : Ernakulam District : Kannimangalam, 16.xii. 1979, Coll. *Joseph and Parui*. 1 ♀ Reg. No. 6668/H6, Malayattoor, rest of data as in preceding. 1 ♂, Reg. No. 6669/H6, Idamalaya, 18.xii. 1979, rest of details as in preceding.

ACKNOWLEDGMENTS

We are indebted to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta, for the keen interest in this work and to Dr. S. K. Bhattacharyya, Deputy Director of the same department for the encouragements.

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MECHANISM OF VACUUM FORMATION IN THE THORACIC DISC OF HILL-STREAM CATFISH, *PSEUDECHENEIS SALCATUS* (McCLELL.)

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ABSTRACT

The structure and function of thoracic disc of the hill-stream fish, *Pseudecheneis sulcatus*, have been described. The mechanism of vacuum formation in the disc has been explained by conducting an experiment with a model. The adaptive significance of the thoracic disc has been discussed.

INTRODUCTION

Pseudecheneis sulcatus (Sisoridae) occurs in the hill-streams of the Himalayas (Misra, 1976, Tilak and Hussain, 1977). It is known to live on stony bottom under the direct influence of fast current (Hora, 1923a, 1923b ; Shaw and Shebbeare, 1938) and adheres to rock surface by the help of a thoracic disc present on its ventral side (Hora, 1930). The thoracic disc consists of about 14 transverse, hollow ridges which are separated by narrow grooves. Since the ridges of the disc have no muscular arrangement for expanding or retracting the grooves it is believed that the fish is able to develop vacuum by some other mechanism. I have attempted in this paper to suggest the mechanism of vacuum formation inside grooves of the thoracic disc (Fig. 1).

OBSERVATIONS

In a resting *P. sulcatus*, the pectoral fins are fully expanded laterally in such a

way that the anterior rays of the fins are adpressed to the substratum. Consequently, a narrow gap is formed between the pectoral and substratum. This gap permits water to enter the underside of the body and flow as a channel along the lateral borders of the disc.

As water would flow constantly along the lateral borders of the disc, the water from transverse grooves would be drawn towards lateral sides of the disc to join the water channel. This happens because the channel becomes narrower at points of termination of transverse grooves and a partial vacuum is formed at such points according to Bernoulli's theorem (see Singh *et al.* 1973). The water from transverse grooves, therefore, flows into the channel and thus a complete vacuum is formed in the grooves. The hollow ridges would in turn expand and cause considerable narrowing of the grooves. As a result, the disc would be further pressed against the substratum and help the fish adhere more effectively (Fig. 1).

EXPERIMENT WITH A MODEL

Fig. 2A shows the apparatus which represents the model of water channels in and around the thoracic disc of a resting *P. sulcatus*. It consists of a 'U' shaped

glass tube with two outlets and a common inlet at the curve of the 'U', and rubber tubes, arranged transversely between its arms, inserted through the holes (provided in the glass tube) in such a way that their ends

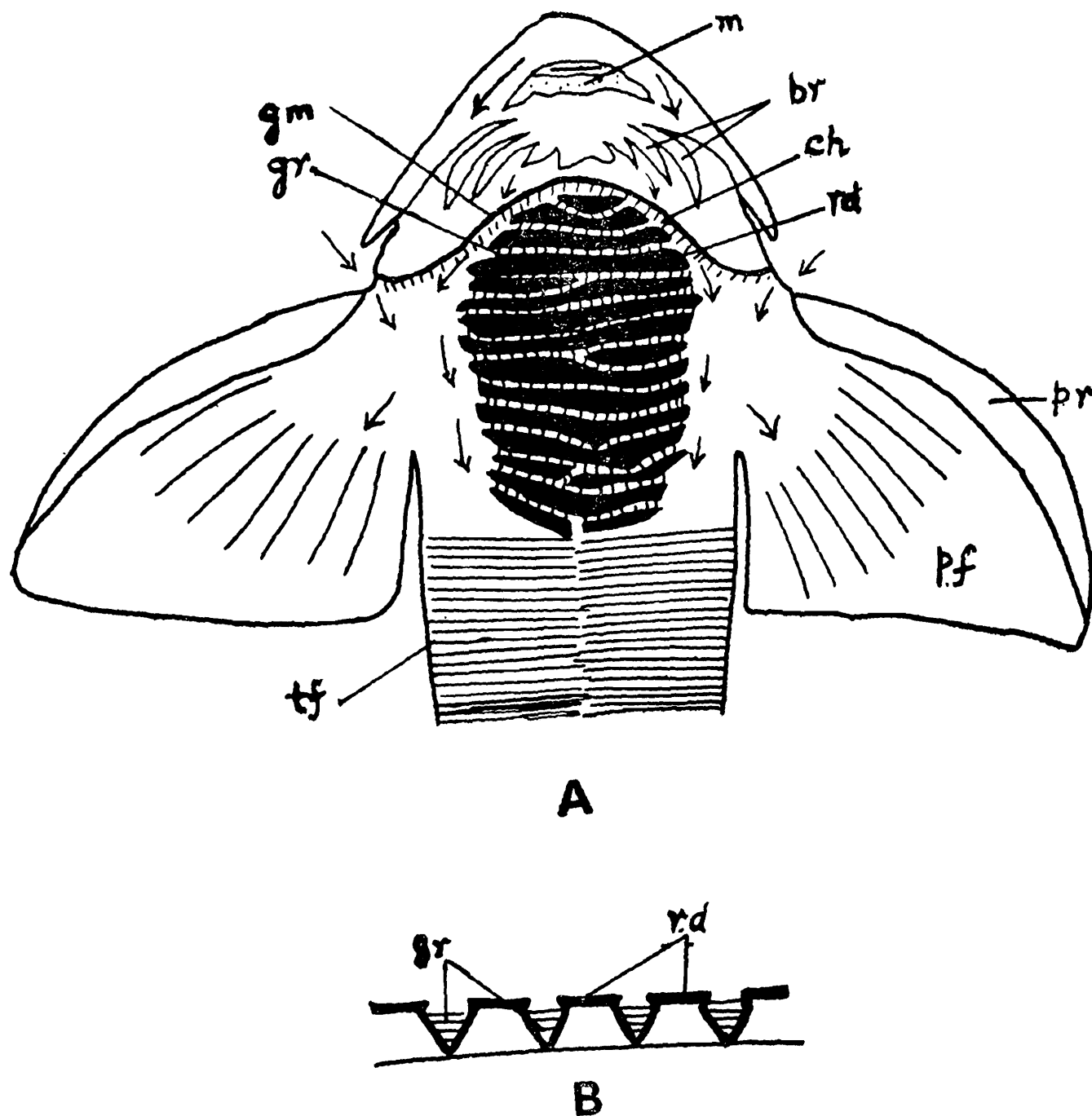


Fig. 1. A, Ventral view (semidiagrammatic) of anterior part of *P. sulcatus* showing the thoracic disc (arrows show the direction of water current), B, cross section of some ridges and grooves; br, barbel; ch, channel between the disc and gill-membrane; gm, gill-membrane; gr, groove; m, mouth; pf, pectoral fin; pr, first ray of pectoral; rd, ridge; tf, transverse folds.

extend a little inside. As a result, the space inside glass tube becomes narrower at points where rubber tubes are inserted (Fig. 2A). The arms of the 'U' and the rubber tubes, respectively, represent the water channel

(along the lateral borders of the disc) and the transverse grooves of the disc. Each rubber tube is further connected to an uninflated rubber balloon through a glass tube piece and all its connections are properly

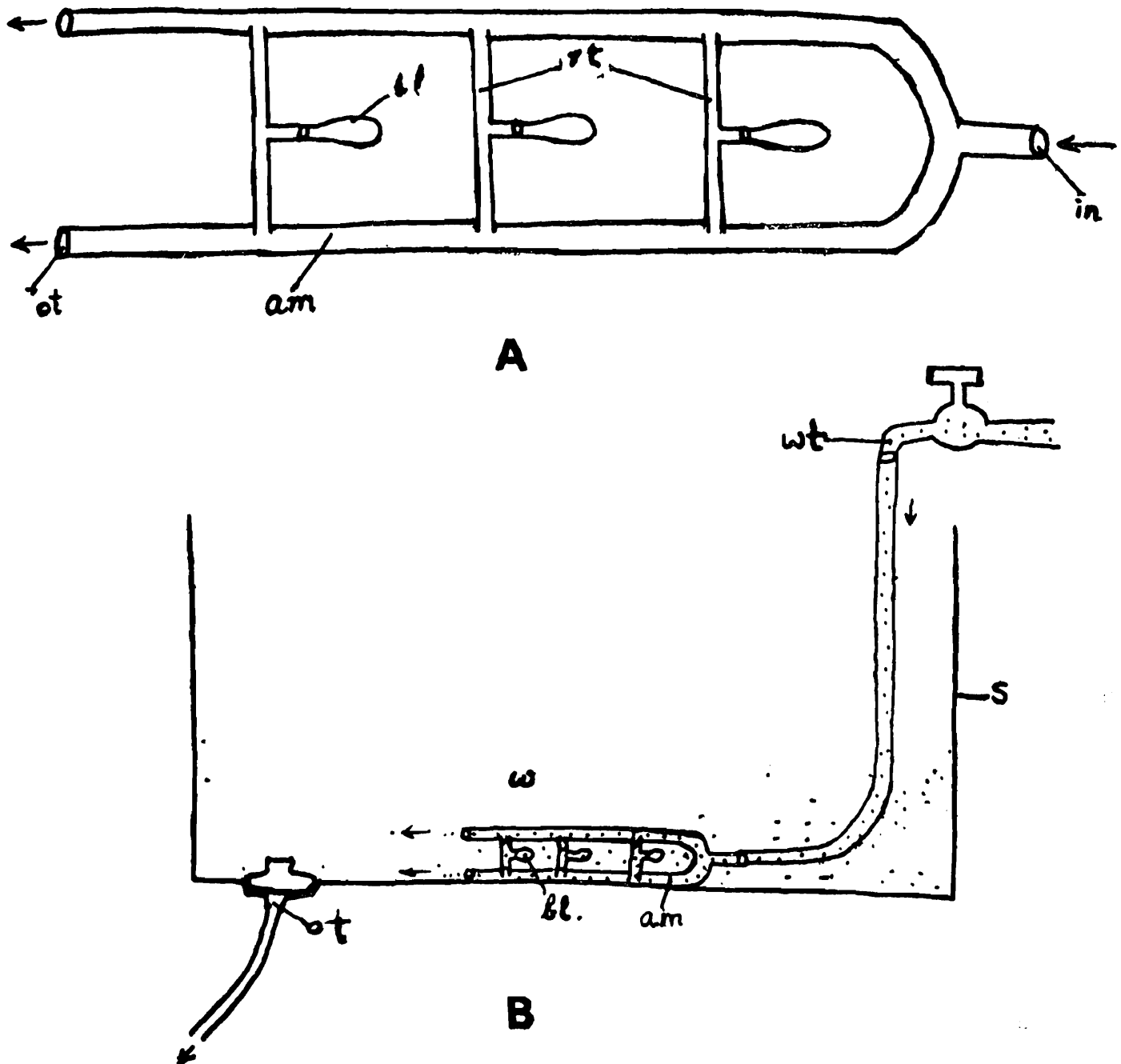


Fig. 2. A, Glass apparatus ; B, experiment with the apparatus described in the text : a, apparatus ; am, arm of the U-tube ; bl, balloon ; in, common inlet ; ot, outlet ; rt, rubber tube ; s, sink ; w, water ; wt, tap.

sealed with a suitable adhesive. The baloon is used to notice any difference of pressure inside the rubber tubes during the experiment.

The common inlet of the apparatus is connected to a water tap through a rubber tube and the whole apparatus is then placed horizontally at the bottom of the sink (Fig. 2B). The outlet of the sink is plugged in order to store sufficient quantity of water for keeping the apparatus fully submerged. The tap is opened slowly and the whole apparatus, including the balloons, is filled with water. This is done first by allowing the water to pass out of the apparatus and then filling it fully with water by closing the outlets temporarily. Adequate care is taken to ensure that no air bubble is left anywhere inside the apparatus. The tap is further opened and the water is allowed to flow at a fast speed. It is observed that as soon as the water flows out, the balloons start collapsing thereby suggesting that water from the rubber tubes is drawn towards the arms. This happens because a partial vacuum is formed inside arms at points of termination of rubber tubes and consequently the water from the rubber tubes (and balloons) is drawn towards the arms. Thus a vacuum is formed in the rubber tubes since no water supply towards them is possible from any side.

DISCUSSION

Unlike those of stationary or slow running waters, the fishes inhabiting hill-streams and mountain ranges have to live constantly against the pressure of fast current. Consequently, many of them have evolved mechanical devices to resist the force of current for adhering firmly to the substratum. In *P. sulcatus*, the thoracic disc appears to

serve dual purpose viz., it acts as a frictional device owing to the presence of transverse ridges which are so arranged that they would prevent backward sliding and it also functions as an automatic sucker without involving any special effort by the fish. It would be reasonable to believe that as soon as *P. sulcatus* settles down at the bottom of a fast stream the frictional device immediately provides a hold on the rock surface and thereafter vacuum is formed in the grooves to provide further adhesion between the disc and the substratum. In fishes of the genus *Garra* (Cyprinidae) the vacuum is believed to be produced by raising the central part of the sucker (Hora, 1930) which can resist pressure from all sides. But in *P. sulcatus*, where vacuum is formed in the grooves by utilising the strength of current, the disc can successfully oppose pressure from only front side. Hora (1930) suggested that the grooves on the thoracic disc of sisorid fishes serve as channels for the constant exit of water current from underneath and as a result a partial vacuum is created in the grooves which helps the fish to adhere firmly. He (op. cit.) explained with the aid of hydraulic principle that if water is allowed to flow through a pipe of varying diameter a partial vacuum would be formed in its narrower portion. Since the grooves on the thoracic disc of *P. sulcatus* are transverse in position it appears quite unlikely that water would constantly flow through them. Therefore, Hora's suggestion about the mechanism of vacuum formation in the thoracic disc of *P. sulcatus* does not hold good.

Among sisorid fishes only two species, *P. sulcatus* from India and *Parapseudecheneis*

paviei (Vaiillant) from Tonkin in the far east possess thoracic disc with transverse ridges and grooves (Hora and Chabanaud, 1930). Some members of *Glyptothorax* (Sisoridae) also possess thoracic disc but in them the ridges and grooves are arranged obliquely in a longitudinal direction (Misra, 1976). It seems probable that the disc in other sisorid fishes also serves the same dual function of friction and adhesion.

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POPULATION FLUCTUATIONS OF *LYMNAEA ACUMINATA* LAMARCK WITH NOTES ON ITS BIOLOGY

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ABSTRACT

Fluctuations in the natural population and breeding behaviour of *Lymnaea acuminata* Lamarck were studied in 1978-1979. High incidence of the species in October-January denotes its preference to low temperature. The species has no definite breeding season.

INTRODUCTION

Pillai and Koshy (1970) studied the population build-up of *Macrochlamys indica*; Agrawal (1976) and Raut (1979) made observations on *Bensonina monticola*, *Achatina fulica* and *Macrochlamys indica* respectively. Nothing is on record on freshwater gastropods except some preliminary observations on the breeding habits of *Lymnaea acuminata* (Agrawal, 1972). It appears that in the absence of density dependent factors, density independent factors such as vegetation, rainfall, temperature etc. might exert a control on snail population. In the present paper attempts have been made to gain knowledge on the factors influencing population density and also the breeding behaviour of *Lymnaea acuminata*.

MATERIAL AND METHODS

The snails were collected from Budagarh lake, Jabalpur (situated on Jabalpur-Katni road, 23° 20'N lat., 83°E long.) fortnightly in the years 1978-1979. In the lake five

sites were selected at random. From each site, snails and egg-masses present in half a square metre area were collected and counted. The mean of such five readings was considered as the actual snails and egg-masses present in the area. Only living snails above 5.4 mm were counted and measured with vernier callipers reading to 0.1 mm.

OBSERVATIONS

Hydrological conditions

The pH ranged from 7.1 to 7.8. The pH values were less in July-September period when the lake was flooded with rain water.

The water temperature of the lake ranged from 16.5°C to 29°C, with a minimum in December, 1978 and maximum in May, 1978. The minimum and maximum temperature values coincide with the seasonal changes.

Population trends

Lymnaea acuminata is found in the lake throughout the year, the population density

varied from place to place. The highest population density was 21 to 26 with an average 25 snails in the size-group 7.5-12.0 was recorded in November at a temperature

about 21°C (Fig. 1). The minimum was 3 to 7 with an average five snails in the size-group 6.1-8.2 was recorded in June at about 28°C temperature (Fig. 1).

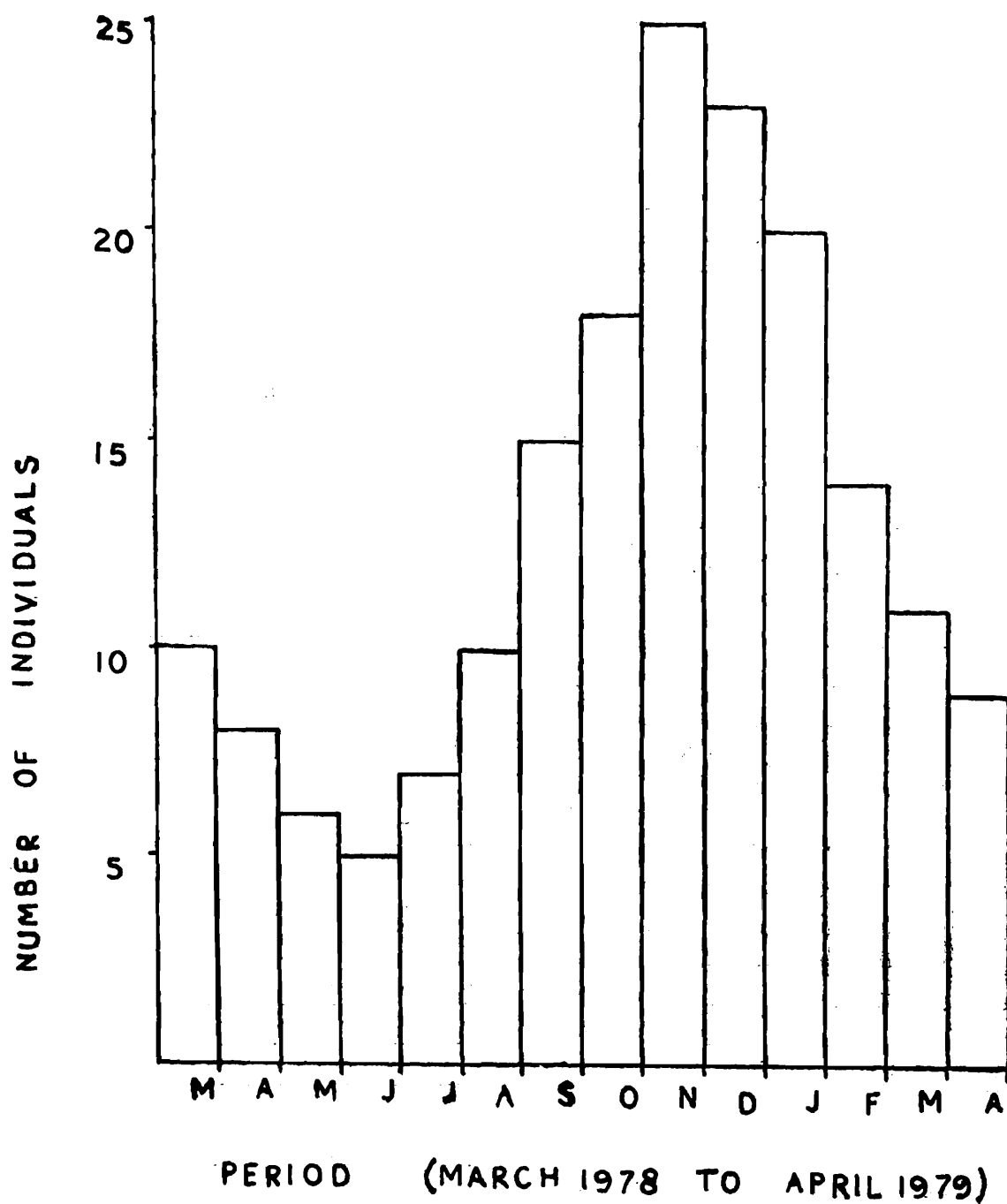


FIG 1

Fig. 1. Population fluctuations of *Lymnaea acuminata* from March, 1978 to April, 1979.

The numbers were low in other months. The higher incidence during October 1978 to January 1979 suggests their preference to low temperature (Fig. 2).

slowly. It takes about half an hour to lay a mass of about 120 eggs. The eggs could be collected round the year (Fig. 3) as different sets of individuals attain sexual maturity at

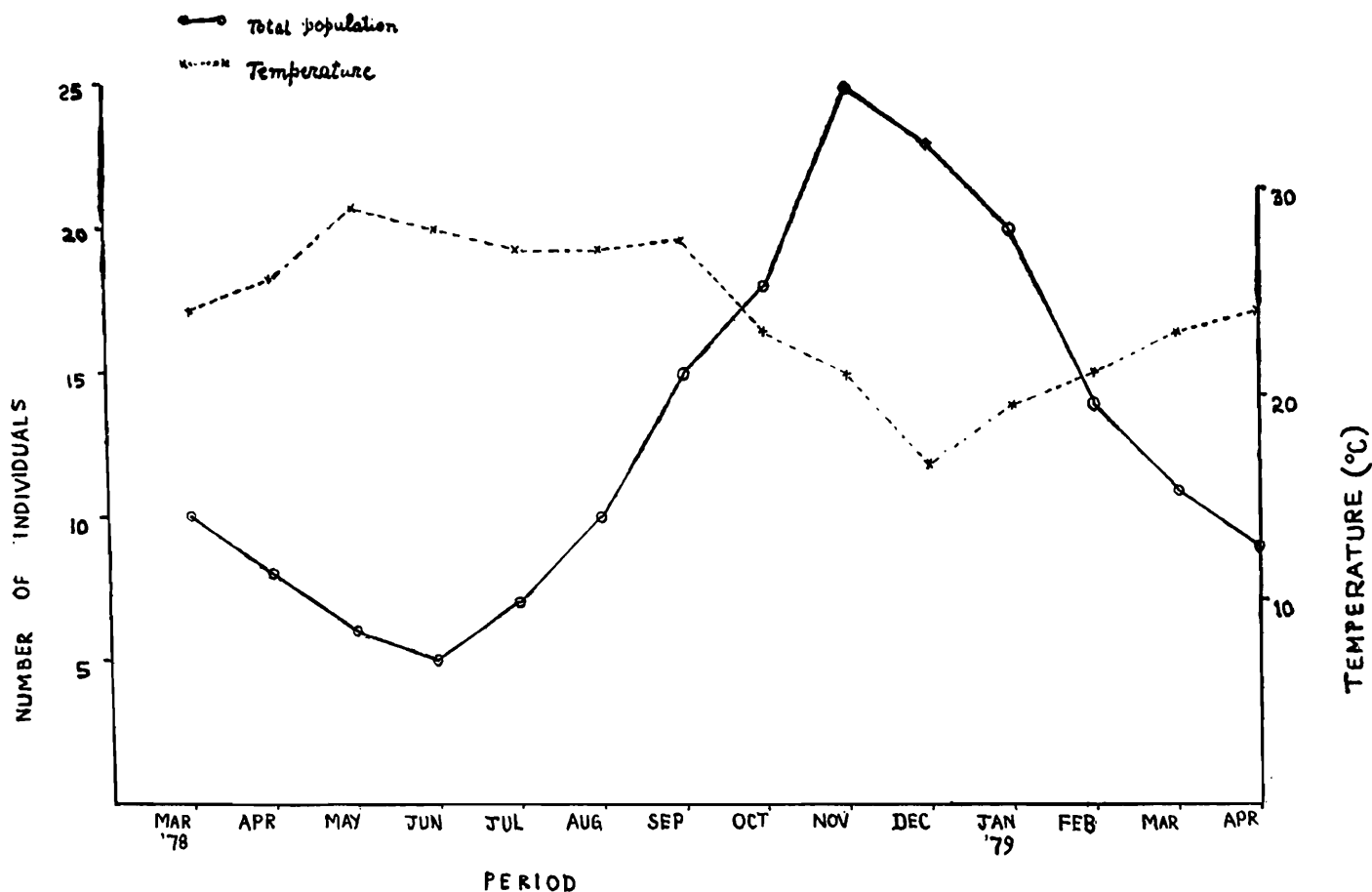


FIG. 2

Fig. 2. Graph showing the effect of temperature on the population of *Lymnaea acuminata*.

Biology

Lymnaea acuminata is hermaphrodite and oviparous. The copulation lasts for about fortyfive minutes and is not reciprocal. The individuals come to the surface for mating. The eggs are laid within two days. The individuals about to lay eggs, attaches itself by its foot to a leaf or to the walls of the aquarium in the laboratory. The eggs embedded in a jelly-like substance are laid on the support and the animal recedes very

different periods of the year. There seems to be no definite breeding season for the species.

An examination of the egg-mass under the microscope revealed that all the eggs were in the same stage of development. The number of the eggs laid in different egg-masses varies and the average number of eggs tends to fall with higher number of egg-masses laid by an individual.

The number of egg-masses laid by an individual varies from 1 to 28. The peak was

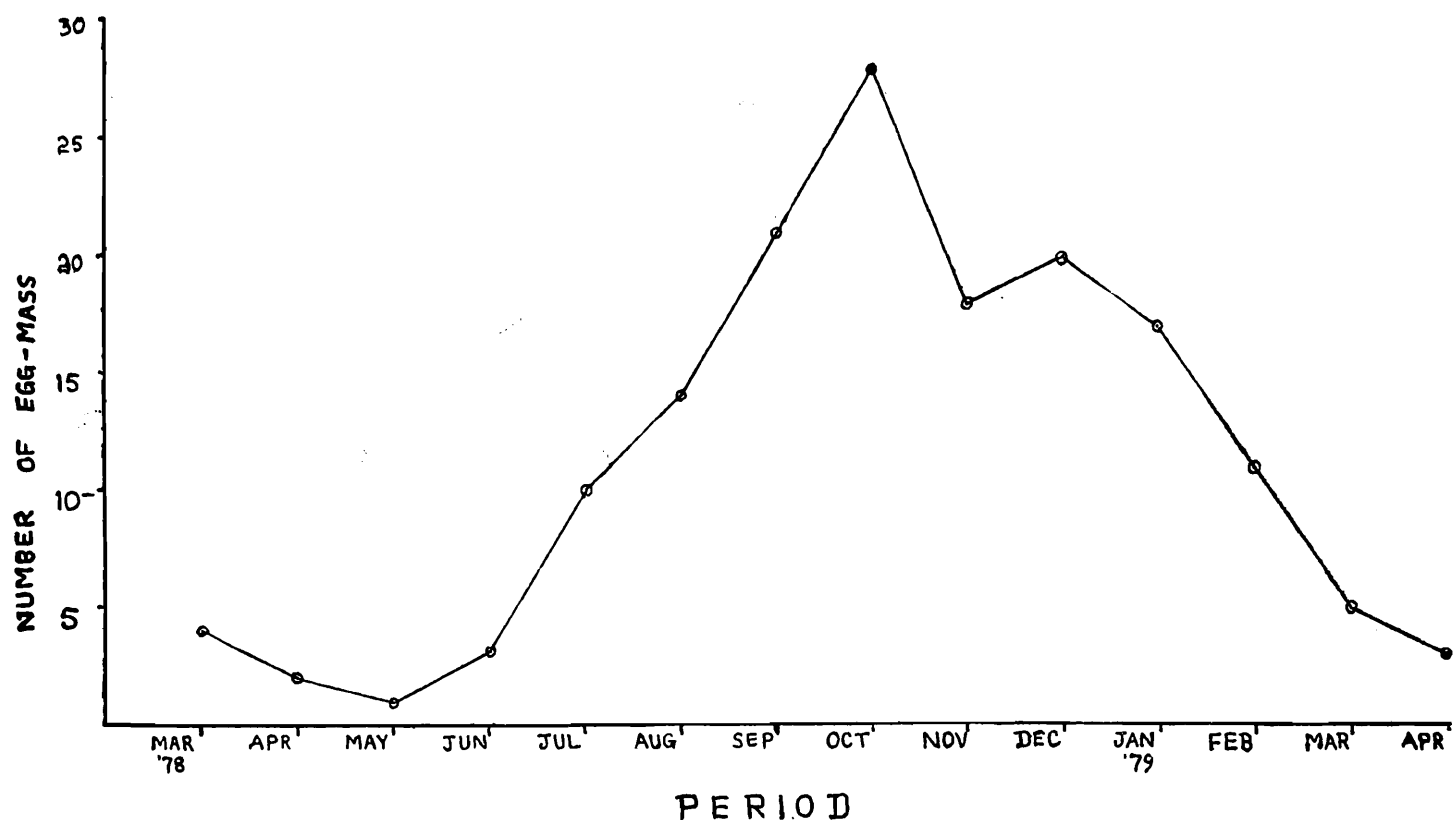


FIG. 3

Fig. 3. Fluctuations in the number of egg-masses of *Lymnaea acuminata*.

recorded in October during the period of investigation. The values were low in other months (Fig. 3).

DISCUSSION

Population density exhibits variations from place to place in the same lake. Biotic and abiotic factors of the lake were considered to ascertain their role on the survival and multiplication of the snails.

The vegetation is a significant factor in the multiplication of snails. Since the population was maximum from September to January, it appears that trapa vegetation (which is being cultivated during this period) is one of the vital factor for the propagation of this species.

Temperature plays an important role on

the snails population. It is inversely proportional to the temperature.

It appears that pH has no impact on the snail population. This supports the view of Raut (1979).

Predators like birds (*Anastomus oscitans*) and trematode parasites have been recorded which affect the snail population.

Individuals of different size-groups were found throughout the year, probably due to the addition of new populations.

Definite breeding period could not be ascertained in *L. acuminata*. Ramanan (1900) has said that in case of *L. luteola* spawn was laid once in a fortnight. Thompson (1926), speaking of *L. stagnalis*, said that the eggs are laid through the summer. Annandale and

Rao (1925) stated that certain species of *Lymnaea* are functionally protandrous and pair when the male organs are ripe. The fecundity of *L. acuminata* seems to be susceptible to environmental influences.

ACKNOWLEDGEMENT

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POPULATION DYNAMICS, BIOLOGY AND PRODUCTION ECOLOGY
OF A LITTORAL ZOOPLANKTER, *CHYDORUS SPHAERICUS*
(O. F. MÜLLER) (CLADOCERA : CHYDORIDAE)

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ABSTRACT

The population dynamics, biology, biomass, production and turnover ratio of a littoral chydorid cladocera, *Chydorus sphaericus* (O. F. Müller) were studied in a large man made lake of Calcutta for 2 years (1978, 1979). The population density was high throughout the year with two peaks, during April-May and November-December, in both years. Minimum values were recorded in August which were related to heavy rain flooding of the lake resulting in the displacement of vegetation from the littoral zone. Reproduction took place by parthenogenetic females throughout the year and juveniles always dominated the population composition. In laboratory the total life span of 14.1 days was completed in 12 instars producing at an average 51.3 eggs/female.

Biomass and production values ranged respectively between 54-523 ($\bar{x}$ 271) mg dw/m² and 5.3-98.1 ($\bar{x}$ 57.83) mg dw/m²-day in 1978 and between 220-380 ($\bar{x}$ 276) mg dw/m² and 19.6-43.6 ($\bar{x}$ 60.79) mg dw/m²-day in 1979. The mean turnover ration for both years were very close (0.190 in 1978 and 0.205 in 1979).

INTRODUCTION

Whereas, among cladocera, daphnids have been the subject of numerous investigations during the last 3 decades and considerable work has been carried out on their population dynamics, life cycle, bioenergetics and impact of complex environmental factors both in field and laboratory (McArther and Baillie 1929, Berg 1934, Banta *et al.* 1939, Ingle *et al.* 1937, Brooks 1946, Edmondson 1955, Green 1956, Richman 1958, Regler 1961, Hall 1964, Schindler 1968, Beukema 1973, Vijverberg 1976, Murugan and Sivramakrishna 1976), not much attention has been given to other groups of cladocera, specially

to littoral Chydorids. Few accounts which are available deal with general taxonomy and ecology of chydorids in littoral zone (Smyly 1952, Smirnov 1963a, b, 1974, Goulden 1971).

Chydorids as a littoral taxocene are ecologically diverse and play an important role in the productivity of littoral zone of freshwater impoundments, which is the most productive zone. Because of abundance of submerged vegetation, reduced penetration of light and reduced temperature, the condition in littoral zone are different from open water.

The present study which is a part of a detailed investigation on population and

production ecology of tropical littoral fauna, describes the population dynamics, biology, biomass production and turnover, ratio of *Chydorus sphaericus* (O. F. Müller) in a large man made lake of Calcutta, India. Laboratory studies have also been carried out to determine instar duration, life span, growth rate and reproduction. *C. sphaericus* is the most common cladocera found all over the world (Brooks 1959).

MATERIALS AND METHODS

The study was carried out in Dhakuria lake, Calcutta, a large man made lake already described by Khan (1979, 1981). The samples were collected at fortnightly intervals from the littoral zone at 3 different centres of the lake. Hundred litres of water were filtered from the plant bed through a plankton net made of No. 21 cloth. In the laboratory, the chydorids were separated from detritus by settling the samples in a beaker and slightly heating the bottom. Chydorids swam up into the overlying water which was decanted from the beaker and concentrated with a net. Filtered samples were preserved in 4% formalin and adjusted to 100 ml. Identification and enumeration were done simultaneously under a binocular microscope with varying magnifications ($SM \times 20$) by taking several 1 ml subsamples. After general counting, each individual of *C. sphaericus* was separated and measured from the crown of the head to the posterior border of the carapace with the help of an ocular micrometer. Eggs (including embryos) in the brood pouch were counted after dissecting the brood pouch. Laboratory studies were carried out in December 1978-February 1979 when the conditions were most favourable and laboratory temperature fluctuated around

$25 \pm 3^\circ \text{C}$. Stock culture was maintained by keeping several parthenogenetic females collected from Dhakuria lake in a 3 litre Jar containing lakewater filtered through No. 25 net so as to remove all other zooplankton but include all phytoplankton, bacteria and detritus. All experiments were carried out in such water. Neonates, after their release, were taken out and cultured separately in small petridishes containing 80 ml water. Petridishes were examined daily and records of developmental duration, growth, number of youngones produced and total life span were made. Four successive generations of each original parent were studied.

For the determination of biomass and production, the animals were divided into 5 groups, viz. eggs, neonates, juveniles, adult I and II and biomass was determined by multiplying the number of each group present in the sample to the mean dry weight of the group and summing up. Mean dry weight of each group was determined only once in the beginning. About 500 animals of each group were dried at 65°C for 3 days and weighed on a microbalance and the mean individual weight was calculated.

Production was determined by the method of Petrovich *et al.* (1964) and Ivonova's given in Edmondson and Winberg (1971) as :—

$$P = \frac{N_i W_i}{t_i} + \frac{N_{ii} W_{ii}}{t_{ii}} + \frac{N_n W_n}{t_n}$$

where P is production in dry weight per day, N_i , N_{ii} and N_n are mean number of individuals in each group, W_i , W_{ii} and W_n are the mean dry weight of the group and t_i , t_{ii} and t_n are the development time of each group. The results obtained under

laboratory conditions on instar duration were used.

Daily production can be raised to production rates over longer times :—

$$\frac{P_1 + P_2}{2}(t_2 - t_1) + \frac{P_2 + P_3}{2}(t_3 - t_2) \\ + \frac{P_{n-1} + P_n}{2}(t_n - t_{n-1})$$

where P is summation of production from time $t - t_n$.

RESULTS

Population Cycle

Chydorus sphaericus was the most abundant chydorids of Dhakuria lake and occurred abundantly throughout the year. Except for a brief period of monsoon months (July and August), its density was always high. It surpassed in density to all other littoral cladoceran species and contributed at an average 38% and 42% of total littoral cladoceran population in 1978 and 1979 respectively (Fig. 1b). Its density fluctuated between 6/L (August) to 150/L (April) with an average of 80/L in 1978 and 25/L (August) 140/L (May) with an average of 85/L in 1979. Though several small and large peaks were visible, two peaks in each year (April and November in 1978 and May and December in 1979) were most conspicuous (Fig. 1a). The juveniles always dominated adults in both years and contributed about 71.5% and 76% in 1978 and 1979 respectively. In fact the population maxima of the total population were directly caused by the production of large number of juveniles in the population (Fig. 1c).

Reproduction

Only parthenogenetic reproduction occurred in Dhakuria lake and neither males nor ephippial females were observed. Reproductive activity was considerably high throughout the year, except during July and August, with two periods of heavy reproduction (Fig. 2a, b), resulting in high population density during both years as already mentioned.

The brood size expressed as egg number per brood varied between 3.5-6.6 ($\bar{x}$ 5.35) in 1978 and 3.3-7.0 ($\bar{x}$ 5.37) in 1979 (Fig. 2a). The size of breeding individuals was also not found to vary much between the two years and ranged between 3.8 to 5.0 ($\bar{x}$ 4.0) in 1978 and 3.6 to 5.2 ($\bar{x}$ 4.2) in 1979 (Fig. 2b).

Laboratory Studies

The parthenogenetic eggs were laid in brood pouches immediately after molting. Within a few hours, eggs swelled in brood pouches and became oval and started developing. The development took place in 3 major phases (1) egg phase (no segmentation), (2) first embryo stage (segmentation but no eye) and (3) second embryo stage (appearance of eye). The entire development was divided into six stages following Green (1956) with some modifications.

		Duration of Stage
Stage I	—Egg roundish or slightly flattened, transparent outer margin.	2 hours
Stage II	—Egg slightly enlarged and flattened with a creak.	3 hours

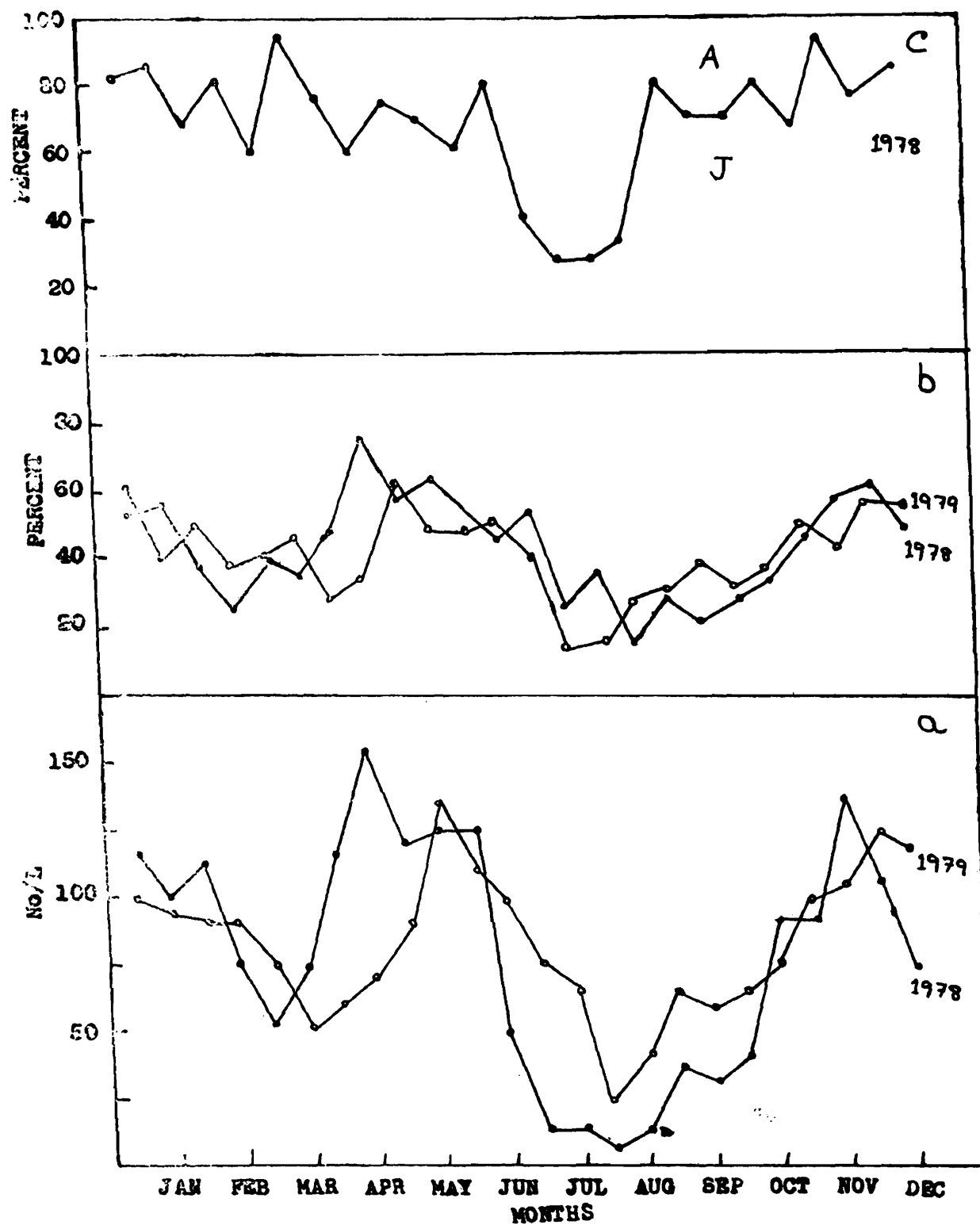


Fig. 1. Seasonal fluctuation (a) mean density (b) percentage of total littoral cladocera, (c) percentage of juveniles and adults of *C. sphaericus*.

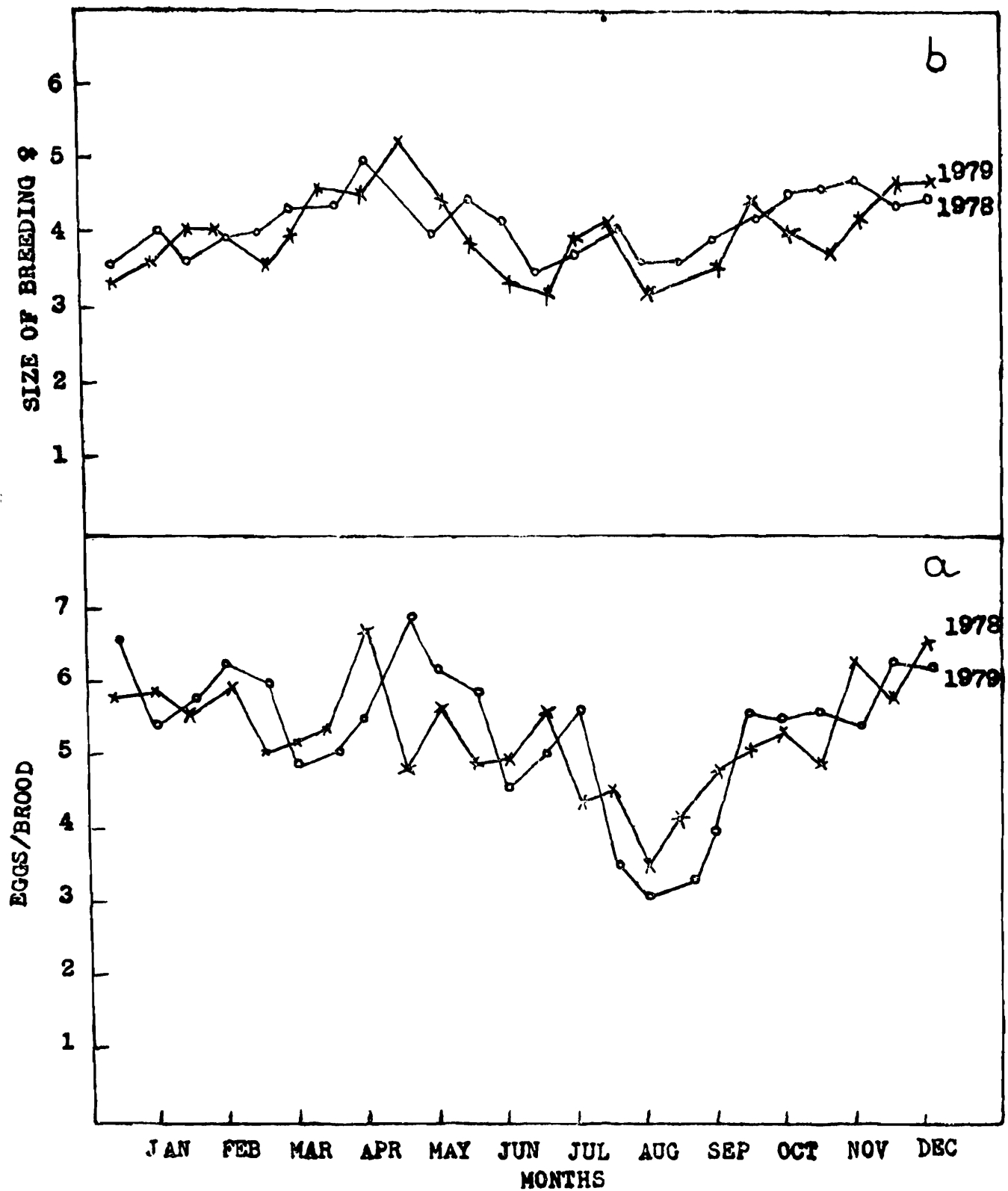


Fig. 2. (a) Eggs/brood of *C. sphaericus* in different months.
(b) Size of breeding females of *C. sphaericus* in different months.

		<i>Duration</i>	at an average 2 preadult and 10 adult instars
		<i>Stage</i>	(Table 1). The average size at the time of birth was 1.4 mm Growth took place after each molting Growth rate was rapid at earlier stages and gradually slowed down as age increased but continued throughout the life. The maximum size of the females observed was 0.51 mm. The durations of instars were small in preadults and early adults but increased afterwards and finally became almost constant. The mean total life span covering 12 instars (pre- and post-) was found to be 14.1 days. The duration of first adult instar was longer than any of the preadult instars.
Stage III	—Elongated with head rudiments, second antennae became separated.	4 hours	
Stage IV	—Head bulge distinct, antennae elongated.	5 hours.	
Stage V	—Antennae elongated, thoracic appendages developed, eye spot appeared.	6 hours.	
Stage VI	—Fully developed embryo with dark eye, like adults.	8 hours.	

Egg production, size and age

The first batch of eggs were laid into brood pouches immediately after the individuals molted into adult instar. The number of eggs per brood was few at the beginning and increased gradually during successive instars (Table 1). The Maximum number of egg/brood was found to be 6.8 produced by the

Instar duration, growth rate and life span

Neonates released from mother resemble in every respect to adults, except that their sizes were small and they did not possess eggs in egg sacs. Each individual passed through

TABLE 1. Instar duration, size, age, brood size and cumulative fecundity of *C. sphaericus*

Instar	size (mm)	Duration (hours)	Age (days)	No. of youngone produced	Cumulative fecundity
1	1.4	20	0.833	—	—
2	2.1	22	1.750	—	—
3	2.7	26	2.830	2.0	2.0
4	3.2	28	4.000	3.2	5.2
5	3.6	28	5.170	4.2	9.4
6	4.0	30	6.420	4.8	14.2
7	4.4	30	7.970	5.4	19.6
8	4.7	32	9.000	5.8	25.4
9	4.9	30	10.250	6.1	31.5
10	5.0	32	11.580	6.4	37.9
11	5.1	30	12.83	6.6	44.5
12	5.2	3.0	14.08	6.8	51.3

oldest female (12th instar). The total number of eggs produced by an individual female was 51.3. A gradual increase was observed, when cumulative egg production was plotted against instar number. When a log/log plot was made by converting into logarithms, a straight line relationship was observed.

Length weight relationship

Length weight relationship of individuals obtained from Dhakuria lake was determined. The relationship was exponential. Regression analysis of the Log weight on Log length gave a straight line relationship with 'b' value of 2.707, significant at 5% level. The length weight relationship equation was :—

$$\text{Log } W = -0.865 + 2.707 \text{ Log } L$$

where W and L are weight and length respectively.

Biomass, productivity and turnover ratio

Like density, the biomass was also high throughout the year, in both years, except in July and August when the values were minimum. While in 1978, the biomass fluctuated widely, in 1979 it was somewhat constant and fluctuated narrowly, except in June and November when small peaks were noticed (Fig 3). Biomass ranged between 54-523 ($\bar{x}$ 271.4) mg. dry weight/m³ in 1978 and between 220-380 ($\bar{x}$ 276) mg dry weight/m³ in 1979. It is very surprising to note that in spite of variations in the biomass patterns of the two years, the mean values were very similar.

Since the biomass pattern was chiefly influenced by the abundance of young ones in the population, the pattern of productivity

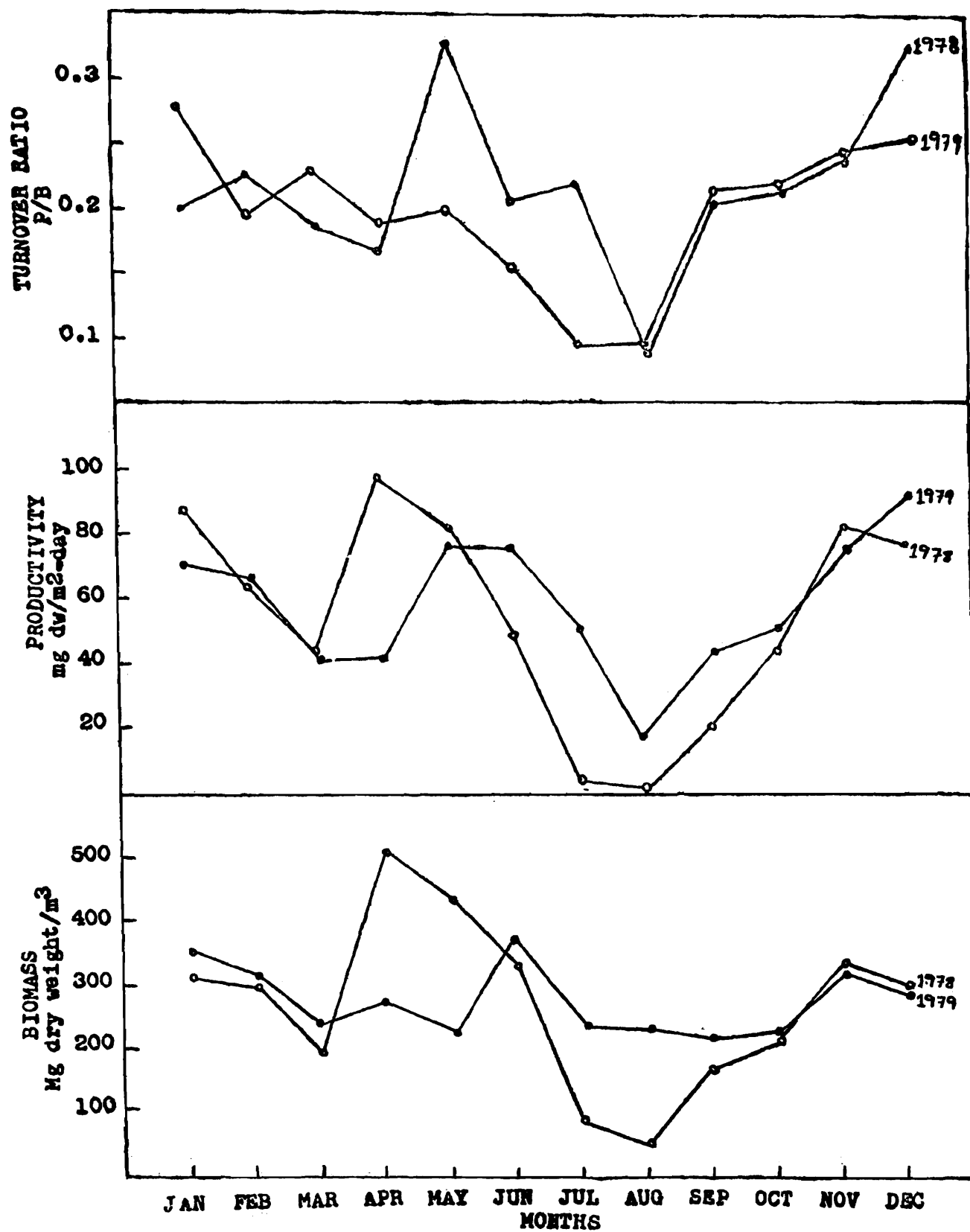
was almost similar. Mean daily productivity values ranged between 5.3-98.1 ($\bar{x}$ 57.83) mg dry weight/m³-day in 1978 and between 19.6-43.6 ($\bar{x}$ 60.79) mg dry weight/m³-day in 1979. While the contribution of juveniles in the biomass was only 30% in 1978 and 33% in 1979, they contributed to the bulk of production (72% and 79% in 1978 and 1979 respectively). The turnover ratio (P/B) varied between 0.098-0.276 ($\bar{x}$ 0.190) in 1978 and between 0.082-0.344 ($\bar{x}$ 0.205) in 1979.

DISCUSSION

The consistent occurrence of *C. sphaericus* in sufficient numbers throughout the year, with continuous active reproduction, revealed that the species is well adjusted to Dhakuria lake. The little variations in population fluctuation and mean density from year to year also indicated its stability. Among many factors governing the zooplankton cycle in littoral zone, the submerged vegetation has been reported to play an important role (Keen 1976). The dominant littoral vegetation of Dhakuria lake was the alga, *Chara fragilaris*, which was present abundantly throughout the year except during monsoon months (July-August) when heavy rain caused flooding of the lake and its removal from littoral zone. This has resulted in the reduced density of *C. sphaericus* in monsoon months of both years.

No indication of competition between *C. sphaericus* and other littoral chydorids was found as the occurrence of all other species followed their own course. Probably, as Fryer (1968) observed, because of greater diversity of habits of chydorids, the competitive interaction was reduced.

Temperature, the most important factor governing the cyclic occurrence and abundance

Fig. 3. Biomass, production and turnover ratio of *C. sphaericus*.

of zooplankton in temperate waters (McArther and Baillie 1929, Hall 1964), was of not much significance to *C. sphaericus* in Dhakuria lake. The population density and biomass increased and decreased irrespective of mean monthly temperature. As already discussed in case of primary and secondary productivity of Dhakuria lake (Khan 1979, 1981), the temperature in this region of country did not fluctuate much from season to season, so as to become limiting at any time of the year.

The fact that population density of *C. sphaericus* has never gone down considerably except during monsoon months, following the loss of suitable vegetation bed, suggests that sufficient food was available all the year round and the carrying capacity of the lake in term of food (of *C. sphaericus*) was never reached. This was quite expected. Being a highly eutrophic water body having rapid rate of primary production and continuous decay, the phytoplankton and detritus were available all the year round in abundance. The peak production of phytoplankton during April-May and November-December also resulted in increased density and biomass of *C. sphaericus* during the period suggesting its relationship with food. Most probably the predation pressure was the factor which kept the population of *C. sphaericus* in size and did not allow it to grow enormously.

The absence of either male or ephippial females also suggests that conditions were always favourable since only under unfavourable conditions like temperature above and below the optimum range, food shortage and overcrowding, the sexual reproduction and encystment occur in cladocera (Berg 1931).

The pattern of embryonic development

and instar duration was almost similar to general pattern as seen in cladocera. (Edmondson 1955, Green 1956, Murugan 1975). However, the duration of instars and total life span was considerably shorter than that of most of the temperate as well as tropical limnetic species of cladocera. The littoral chydorids have probably shorter life span. The pattern of growth rate was also basically similar to those in other species of cladocera in the respect that growth was rapid at early ages and decreased gradually as the age increased. (McArther and Baillie 1929, Anderson *et al.* 1937, Ingle *et al.* 1937, Banta *et al.* 1939, Green 1956, Richman 1958, Hall 1964, Vijverberg 1976, Murugan and Sivaramakrishna 1976) but it continued till death and no cessation of growth was found as reported in some species (Banta *et al.* 1939, Richman 1958).

The production and turnover ratio of *C. sphaericus* in Dhakuria lake was considerably higher than many of the species studied in temperate waters. The high production rate was due to rapid and continuous reproduction and availability of juveniles in the population throughout the year which accounted for 75% of the production rate.

ACKNOWLEDGEMENT

The author is thankful to Dr. B. K. Tikader, Director, Zoological Survey of India for providing necessary laboratory facilities. Thank are also due to Staff of Calcutta Improvement Trust at Dhakuria lake (Rabindra Sarobar) for their help in the collection of samples.

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A NEW *PTEROTRICA* SPIDER FROM INDIA
(ARANEAE : GNAPHOSIDAE)

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ABSTRACT

A new species of the genus *Pterotricha* Kulczynski, 1903, belonging to family Gnaphosidae, is described.

The genus *Pterotricha* was established by Kulczynski (1903) with *P. lentiginosa* Koch 1837 as the type species. Since then only thirty-two species have been reported from various parts of the world.

While studying the spiders of the family Gnaphosidae the author encountered a new species of *Pterotricha*. This genus is being recorded for the first time from India.

The type specimen will be deposited in the National Zoological Collections, Zoological Survey of India, Calcutta.

***Pterotricha tikaderi* sp. nov.**

(Fig. 1, A-H)

General : Cephalothorax and legs light brownish-green, Abdomen brown. Total length 6.90 mm. Carapace 3.00 mm long, 2.60 mm wide ; abdomen 3.70 mm. long, 2.00 mm wide.

Cephalothorax : Longer than wide, oval, convex, clothed with pubescence, posterior middle of cephalothorax provided with an

conspicuous long fovea. Radiating streaks diverge from fovea to lateral sides of cephalothorax. Eyes rows distinctly separated, pearly white except anterior medians which are black, posterior row of eyes slightly longer than the anterior row as in fig. B. Anterior row of eyes procurved (as seen from in front), medians smaller than laterals and closer to adjacent laterals than to each other. Posterior row of eyes straight, medians oval, smaller than laterals and slightly closer to adjacent laterals than to each other. Median ocular quadrangle longer than broad and slightly wider behind than in front. Clypeal height greater than diameter of anterior median eye. Sternum heart-shaped, pointed behind, clothed with hairs. Labium longer than wide, anterior end of labium and maxillae provided with scopulae, shape as in fig. H. Chelicerae moderately strong, vertical, inner margin provided with a chitinous serrated ridge and outer margin without tooth as in fig. G. Legs relatively long and thin, clothed with hairs and some spines. Leg formula 4123.

Abdomen : Longer than wide, nearly elliptical, clothed with pubescence and some hairs. Abdomen dorsally provided with three pairs of sigilla as in fig. A. Ventral side slightly lighter than the dorsal. Male palp as in figs. D, E, F. Spinnerets prominent, anterior spinnerets widely separated, posterior spinnerets much longer than the others as in fig. C.

Holotype : Male in spirit.

Type-locality : INDIA, Gujarat, Dwarki

Dist. Jamnagar, date 16. ii. 1975, coll. V D. Srivastava.

Remarks : This species resembles *Pterotricha kochi* (Cambridge) from Palestine but differs from it as follows : (i) Anterior eyes smaller than the laterals but in *P. tikaderi*, it is very slightly smaller. (ii) Posterior row of eyes strongly recurved but in *P. tikaderi* it is straight. (iii) Male palp also structurally different.

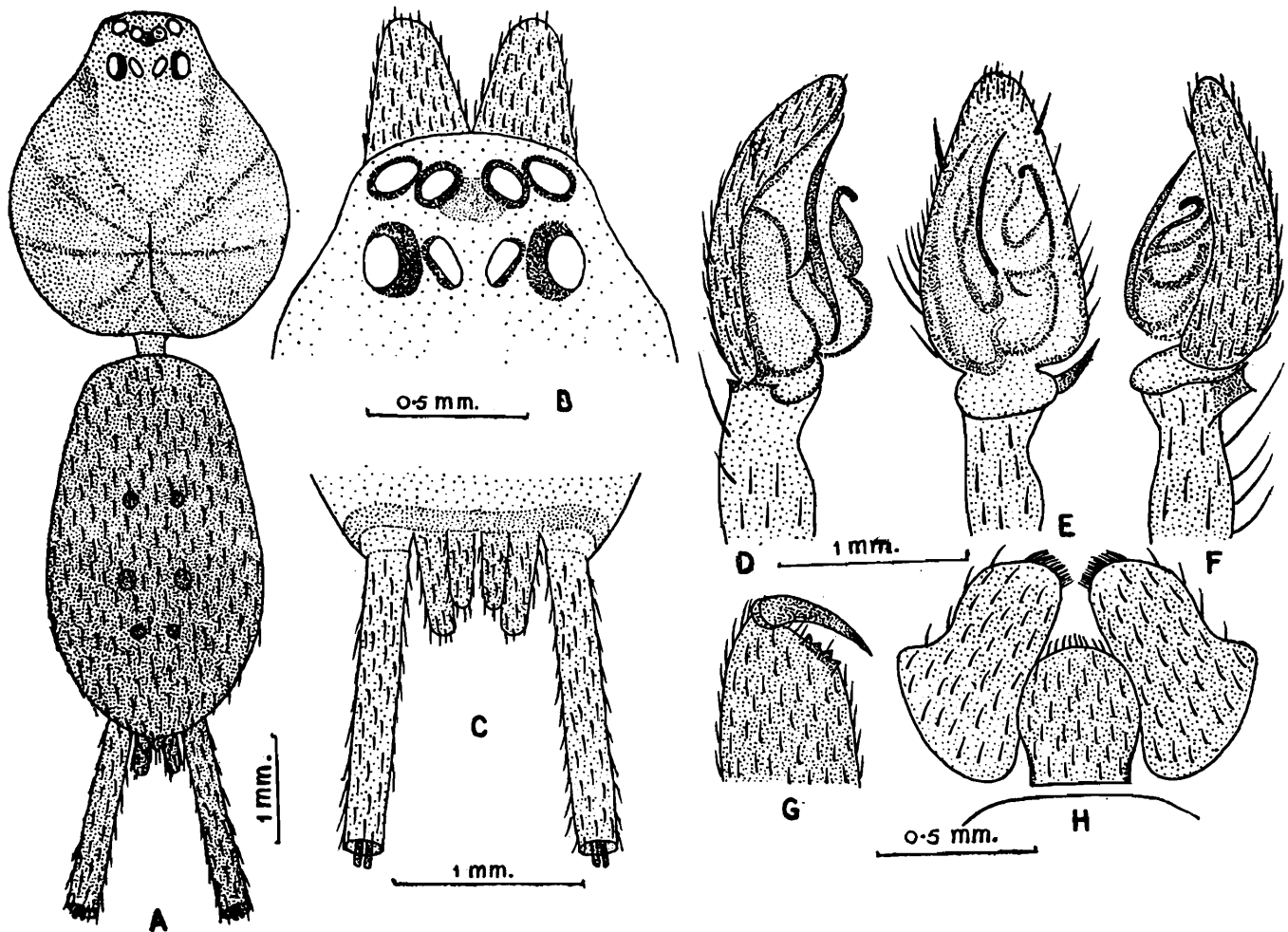


Fig. 1. A-H. *Pterotricha tikaderi* sp. nov. A. Dorsal view of male legs omitted. B. Eyes arrangement. C. Spinnerets. D. Left male palp, prolateral view. E. Left male palp, ventral view. F. Left male palp, retrolateral view. G. Chelicera. H. Labium and maxillae.

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THE EFFECTS OF FOOD ON GROWTH, LIFE SPAN AND REPRODUCTION OF A CLADOCERAN ZOOPLANKTER, *CERIODAPHNIA CORNUTA* (SARS).

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ABSTRACT

The effects of food concentration on the growth, brood size, fecundity and life span of a cladoceran zooplankter, *Ceriodaphnia cornuta* (Sars) have been studied under ordinary laboratory conditions (temperature $25 \pm 3^\circ \text{C}$). Six different food regimes ranging from distilled water to highly enriched medium were tested. Starvation affected considerably and animals could not survive for more than 24 hours. The molting, instar duration, growth and reproductive rates were lowered and life span shortened in diluted medium. The growth and reproductive rates were the highest in the medium containing moderate quantity of food and not much differences were noticed in these parameters with very high food level.

INTRODUCTION

Enormous amount of literature is available on the effects of food quality and quantity on various parameters affecting life and behaviour of daphnids both, in laboratory and under natural conditions from temperate regions (Ingle *et al.* 1937, Banta *et al.* 1939, Ryther 1954, Richman 1958, Regler 1961, Hall 1964, Hall *et al.* 1970, Buikema 1973, Vijverberg 1976). At the same time, there is an apparant lack of information on this subject from tropical regions, specially from India.

The present paper reports the results of laboratory studies carried out on the effects of food on instar duration, growth rate, survival, life span, reproductive rate and fecundity of an important cladoceran zooplankter, *Ceriodaphnia cornuta* (Sars). This

species occurs abundantly in the ponds of this region and contributes significantly to the total cladoceran population.

MATERIALS AND METHODS

All experiments were carried out under laboratory conditions (temperature $25 \pm 3^\circ \text{C}$). Stock culture of *C. cornuta* was maintained in laboratory in large enamel bowls. In order to avoid any genetic differences, the entire culture was raised gradually from a single parthenogenetic female obtained from nature, so that all animals belonged to the same clone. Details of culture procedure of cladocera have been described in a separate communication (Khan 1983). Culture was maintained in water collected from a near by pond (Monohar Das pond) and filtered through

No. 25 bolting cloth net so as to remove all zooplankton but allow all algae, protozoa, bacteria and detritus to pass through.

Water was changed thrice a week. Overcrowding was never allowed and when number of individuals increased in a bowl, they were removed and put in another bowl.

To study the effects of food quantity, the following 6 food regimes were tested, following Vijverberg (1976) with some modifications :

- | | |
|-------------|---|
| Food regime | I. Pond water filtered through No. 25 bolting cloth plankton net. Only zooplankton and larger particles were removed but protozoa, algae and detritus remained. This will be referred to as pond water. |
| Food regime | II. The water of food regime I filtered through 0.6 μ filter paper. |
| Food regime | III. Pond water (Food regime I) with additional 100 algal cell/ml. |
| Food regime | IV. Pond water with additional 1000 algal cell/ml. |
| Food regime | V. Pond water with additional 10,000 algal cell/ml. |
| Food regime | VI. Double distilled water. |

Since algal culture was not possible in the laboratory, algae were collected from Monohar Das pond in the following manner. Care was taken, while collecting, to avoid the bloom of blue green algae as far as possible. A large quantity of pond water was filtered through 0.6 μ filter paper (as for food regime II). The algae collected on

filter paper were washed in a small quantity of water and their concentration (cells/ml) was determined as for general phytoplankton counting. Then calculated volumes of algal concentration was added with the help of a wide mouth pipette to various petri dishes according to the quantity of water present and food level desired. Though this was a crude substitute of pure algal culture, for comparative effects of different food concentrations this gave satisfactory results.

Experiments were conducted by placing newly emerged neonates in small petri dishes containing 80 ml of test media. Examination of petri dishes was done daily and observations on molting, size increase, number of young ones produced etc. were recorded. Test medium was also changed at the time of examination. At least 10 replicates for each test medium were maintained at a time. The entire experiment was repeated three times and means were calculated. Statistical analysis was carried out following Bailey (1959).

RESULTS

Growth

The effects of food concentration on growth rate was assessed by comparing the size attained by animals grown in different food regimes. In ordinary pond water (Food regime I), the animals were found to pass through 18 instars (3 preadults and 15 adults) and attained a mean length of 0.70 mm in the total life span of 20 days (Table 1).

In food regime VI (distilled water), animals could not survive for more than 24 hours (mean 20.5 hours) and therefore no comparison could be made with others.

TABLE 1. Number of instars, mean size and life span of *C. cornuta* in different food regimes

Parameters	Food regime I	Food regime II	Food regime III	Food regime IV	Food regime V	Food regime VI
Mean maximum length (mm)	0.70	0.57	0.72	0.77	0.76	0.21
Mean life span (days)	20	14	20	22	23	1
Number of Instars						
a— preadult	3	5	3	3	3	—
b— adult	15	8	15	18	19	—

In food regime II (filtered through 0.6 μ filter paper), the growth and molting was considerably delayed than in food regime I or any other level studied. Though the animals were able to survive upto the age of 14 days, only 13 moltings (Table 1) took place and final length attained at the end of life was 0.57 mm, as compared to 0.70 mm in food regime I.

regime I and III. However, considerable differences were evident in the growth of animals in food regimes III and IV, but not much differences could be detected between regimes IV and V. In fact the mean growth rate and maximum size attained by the animals in food regime V were slightly lower than the animals in regime IV. The differences in the lengths of animals of same age

TABLE 2. Significance test of the differences in length and brood size of *C. cornuta* grown under different food regimes

Source	Length			Brood size		
	D.F.	't' value	Probability	D.F.	't' value	Probability
Food regimes I and II	19	9.11	less than 0.001	19	8.50	less than 0.001
Food regimes II and III	19	1.81	more than 0.005	19	1.70	more than 0.005
Food regimes III and IV	19	6.82	less than 0.001	19	6.50	less than 0.001
Food regimes IV and V	19	2.01	more than 0.005	19	1.89	more than 0.005

From Figure 1 it is evident that the size of individuals increased with increasing food concentrations. Whereas, the growth rate in food regime II was lower than food regime I, very little variation existed between food

but of different food regimes were statistically tested by 't' test (Table 2). Differences were significant at 1% level between food regimes I and II, III and IV, while values between I and III, IV and V were not significant.

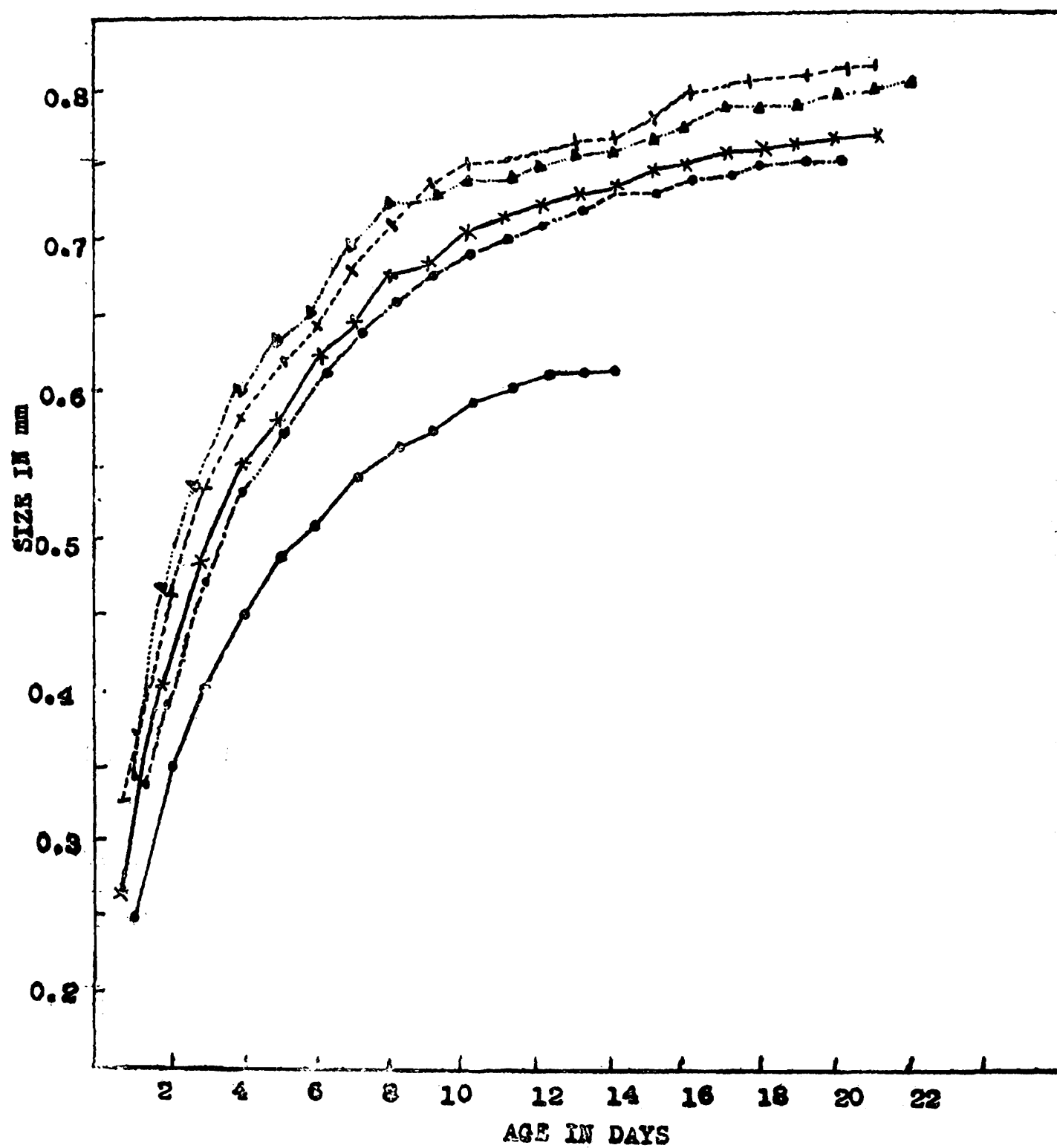


Fig. 1. Relationship between size and age at different food regimes.

Reproduction

The effects of food quantity on brood size (egg/brood) in relation to length is shown in Figure 2. In all the sets of experiments, the brood size increased gradually with increasing size upto certain point after which it either decreased or remained constant. In normal pond water (Food regime I), the brood size varied between 2.2, produced by

the 4th instar females, to 10.0 produced by the 16th instar females (Table 1).

In food regime II, the egg production was low and the maximum brood size observed was 4 in the largest (0.57 mm) and the oldest (14 days) female. The tests of significance in different food regimes gave similar results as for the effects on growth (Table 2).

The differences were more striking,

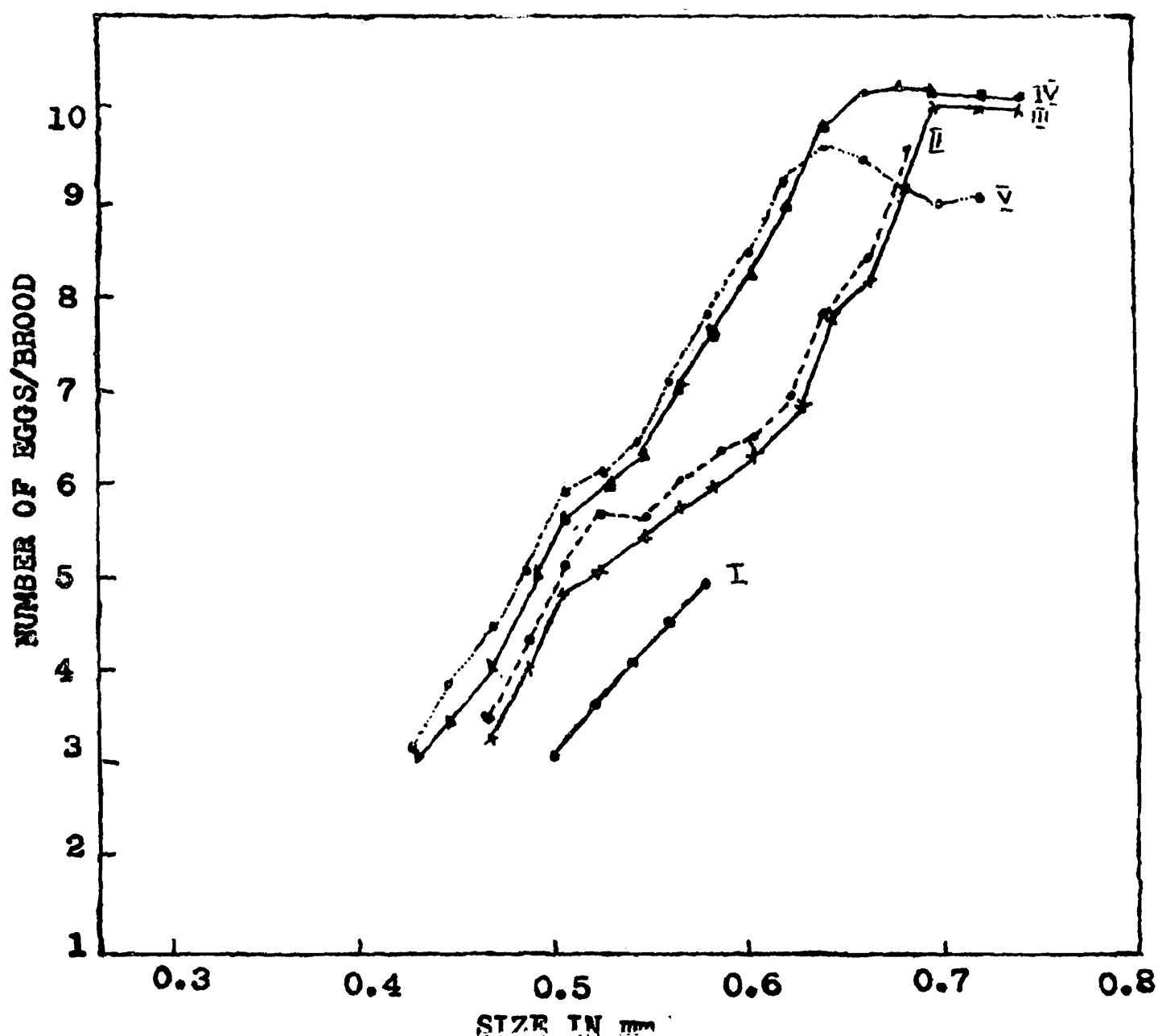


Fig. 2. Relationship between size and brood size at different food regimes.

when the total egg produced by a female in the life span was compared. Fecundity increased with increasing food concentrations. The fecundity of animals in food regime II was very low as compared to other food regimes (Figure 3).

Physiological Longevity

The mean total life span of individuals grown in different food regimes differed (Table 1). Like all other parameters, the total life span of the animals in food regime

II was only 14 days as compared to 20 days in food regime I. Highest life span was observed in the animals of food regimes V.

DISCUSSION

The effect of food on size, reproductive rate and life span was essentially similar to those reported by other workers (Brooks 1946, Ingle *et al.* 1937, Ryther 1954, Green 1956, Vijverberg 1976) in the respect that these increased with increasing food levels. Complete starvation was fatal to animals and

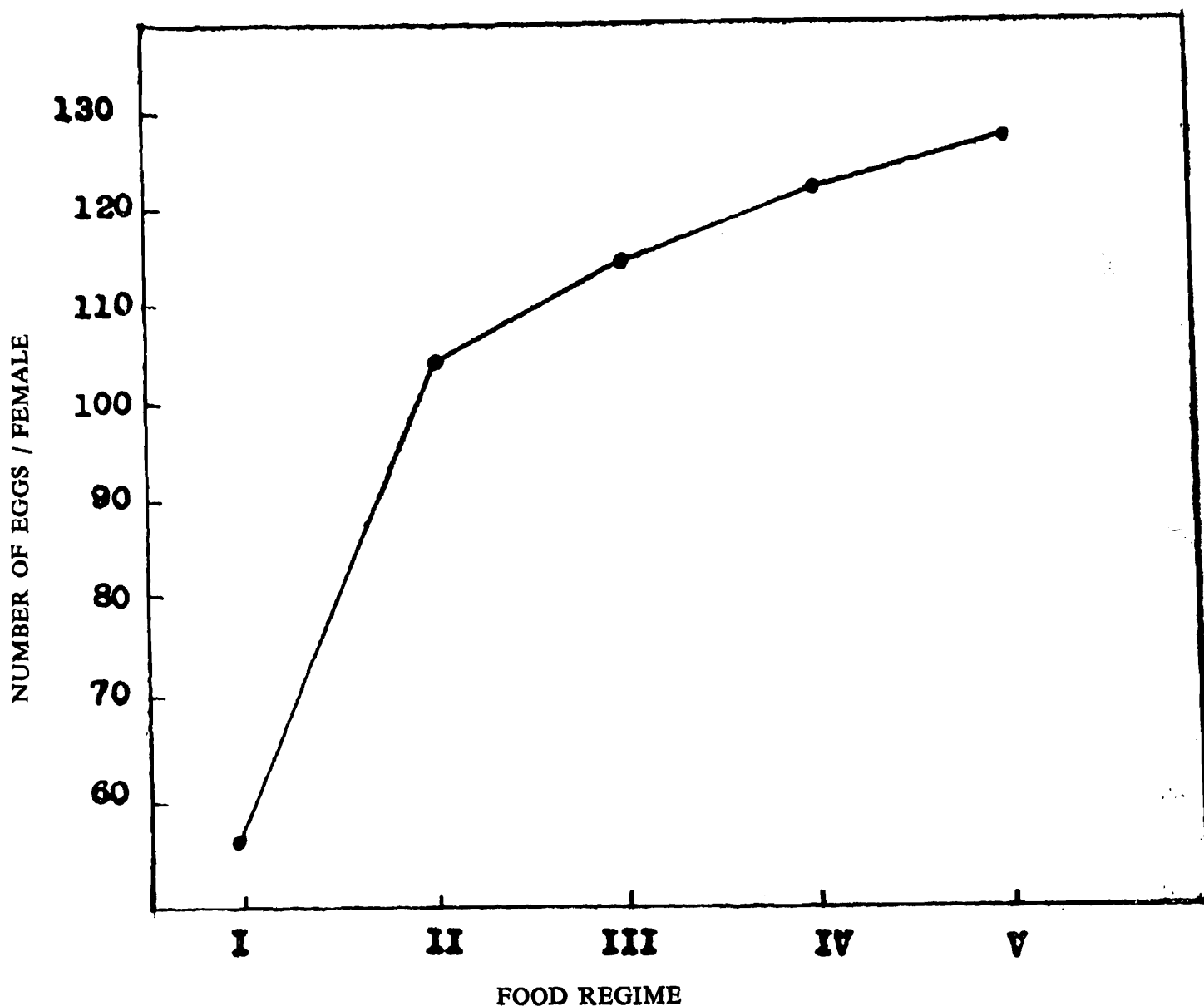


Fig. 3. Total number of eggs produced by a female at different food regimes.

they could not survive after 24 hours. These results support the observations of Dehn (1930) who found that *Daphnia magna* could not survive for more than 12 hours in bacteriologically filtered water. However this is contrary to the observations reported by Staurt *et al.* (1931) in case of *Moina macropa* which could survive for four days in distilled water.

The conditions in food regime II, which was filtered through 0.6 μ filter paper were unique, neither completely devoid of food nor with sufficient food and probably represented a dilute medium. Many smaller organic particles can pass through filter paper. Some species of daphnids have been found to grow and reproduce, though in a restricted way, in such media (Gellis and Clarke 1935, Vijverberg 1976).

The insignificant differences between growth and reproductive rates of animals in food regime I and III, where the difference was only additional 100 cells/ml, was probably due to the very little amount of extra food.

The significant difference in life parameters of the animals in food regime III and IV, where the quantity of extra food added was 10 times, revealed that a moderate supply of food could be favourable. However, the insignificant differences in the growth and reproductive rates and life span of animals in food regime IV and V showed that very high concentrations of food did not necessarily result in the enormous increase in the growth or reproductive potential of the animals. Hall (1964) also found no effect on the longevity of *Daphnia galeata mendotae* when the food was over 64 fold range. Vijverberg (1976) also found insignificant differences in the growth rate

of *Daphnia hyalina* at very high food concentrations.

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COMPARATIVE MORPHOLOGY OF THE CRANIAL MUSCLES IN
SOME SPECIES OF THE GENUS *ARIUS*, WITH A NOTE ON
THEIR UTILITY IN TAXONOMY (ARIIDAE : SILURIFORMES)

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ABSTRACT

The cranial musculature of three species of the genus *Arius* (*A. arius*, *A. caelatus* and *A. thalassinus*) was studied. The mandibular and hyoid muscle complexes and the constituent muscular elements in each one of these have been described.

A comparison of the three species based on their myological attributes indicates that they exhibit a common pattern in respect of the origin, insertion, disposition and the morphology of nine muscles of the total 18 muscles studied. Moreover, the magnitude of interspecific differences in the rest nine muscles are also slight which has been discussed in relation to the habitat and the systematic status of each species.

The nomenclature of some muscles confused by earlier workers has also been clarified.

INTRODUCTION

One of the recent trends in Ichthyotaxonomy has been the increasing awareness of utilising body structure and associated parts for classification and derivation of phylogenetic relationships. Winterbottom (1974) has demonstrated that there is a good deal of interrelationships and diversity among the fishes belonging to the order Tetraodontiformes based on their myology. Fishes in general are well known for their adaptive radiations since they inhabit diverse aquatic ecosystems and are consequently put under different ecological stresses.

The Siluroid fishes are also no exception to this phenomenon though most are generally confined to fresh water ecosystem only. However, the family Ariidae is known

from all the three kinds of aquatic habitats viz. fresh water, estuarine and marine. Considering that these diverse habitats may have some modifications in the basic structural patterns, the cranial myology of three species (*A. arius*, *A. caelatus*, and *A. thalassinus*) of the genus *Arius* has been carried out.

The cranial and more particularly, the jaw muscles of teleosts attracted the attention of several authors in the past. The pioneer workers in this field are Vetter (1878), Alis (1897, 1903) and Juge (1899). Among those who have studied cranial muscles of siluroid fishes include : Mc Murrich (1884), Takahasi (1925), Edgeworth (1935), Dubale (1952), Nawar (1955), Munshi (1960), Dubale and Vidyasagar (1960), Dubale and Saha (1962), Singh and Munshi (1969), Mahajan (1971) and Liem (1979).

The knowledge of teleostean myology is still fragmentary. Romer (1962), Klaauw (1963) and Winterbottom (1974a) were aware of this "incompleteness". Winterbottom (*op. cit.*) made a logic comment that lack of reliable published information on the myology of the majority of fish groups prevents any statement pertaining to phylogeny. In recent years investigations of the functional morphology of the skeletal muscles of teleostean fishes have become a fascinating study. A large number of workers (Klaauw, 1950, 1963; Günther and Deckert, 1953, 1955, 1959, 1960; Alexander, 1966, 1967a, b; Field, 1966; Millard, 1966; Branch, 1966; Karrer, 1967; Dutta, 1968; Osse, 1969) studied the functional morphology of the cranial muscles of various groups of teleostean fishes. While Greenwood *et al.* (1966), Rosen (1962, 1964), Nelson (1967a, b), Rosen and Patterson (1969) and Winterbottom (1974a, b), studied the myology of the teleosts from morphological stand point and its utility in phylogenetic as well as taxonomic interpretations.

From the aforecited review of the literature, it is clear that no attempt has been made so far to study the muscles of the fishes belonging to the family Ariidae, in any respect. In order to correlate the myology exhibited by the three species inhabiting different ecological niche, with their inter-specific relationship, this investigation was undertaken.

MATERIAL AND METHODS

The study is based on the dissection of freshly collected specimens preserved in 10% formalin solution. 20 specimens of each species: *A. arius* from Chilka Lake, *A. caelatus* from Hooghly estuary and Orissa Coast,

A. thalassinus from the seas near Cochin and Mandapam, were dissected. After thoroughly washing the formalin preserved specimens, the skin was carefully removed without injuring and disturbing the natural disposition of muscular pattern. Dissection of different muscles except the branchial and eye muscles of the cranium were made under the stereoscopic binocular microscope. The structure and the nature of origin, insertion and the course of the muscle fibres were noted with utmost care. Free hand drawings of the outer sketch of the cranium were drawn and then individual muscle components as seen under the stereoscopic Binocular microscope in the dissected specimens have been produced.

The nomenclature adopted by various workers for different cranial muscles is not uniform. Single muscle has been described under an incredible variety of names in the published literature. Winterbottom (1974a) published a descriptive synonymy of the striated muscles of the teleostei which have been followed here.

OBSERVATIONS

The cranial muscles, as the name itself implies, are very much associated, morphologically, functionally, and embryologically, with the cranium. They are also known as branchiomeric muscles from embryological stand point and develop from the embryonic hypomere. They are quite distinct from the body muscles which develop from the myomeres (Eaton, 1951).

For the purpose of this study two complexes have been investigated: (1) Mandibular muscle complex, (2) Hyoid muscle complex. Further division and subdivision

of these complexes, primarily based on the disposition, origin, insertion and function of each muscle are as follows.

1. Mandibular muscle complex :

The mandibular muscle complex is enormously developed in case of all the three species of the genus *Arius* studied and it is composed of three groups namely : (1) Adductor mandibulae, (2) Constrictor dorsalis and (3) Intermandibularis.

1.1. Adductor mandibulae group :

This group of cranial muscles is massive and complex, having several components which connect the lower jaw with the palatopterygoid arch and also with the neurocranium. Based on the location, origin and insertion of its various components, in relation to the respective bones, the Adductor mandibulae group, in ariid fishes can be divided into two components : (1) Mandibularis and (2) Intramandibularis. Whereas in case of other teleosts, this group of muscles is supposed to have another component called : Maxillaries, in addition to the above mentioned two components.

1.1.1. Adductor mandibularis :

In *Arius arius* this component is enormously developed and comprises six elements viz. *Adductor mandibularis*_{1,2,3,4,5,6}. Whereas in *A. caelatus* only five elements are observed but *A. thalassinus* resembles with *A. arius* in having six elements. The gross function of this component is to move the lower jaw upwards resulting the closing of the mouth.

1.1.1.1. Adductor mandibularis₁ (*Add. mand.*₁) :

It is a thick, elongated, prominent muscular

element covering underneath itself the other elements of *Add. mand.* In all the three species, this muscle originates musculously as well as aponeurotically from the preopercular, hyomandibular and the quadrate. The muscle fibres are arranged in two layers. The first superficial one is thick, long and runs downwards and forwards in a convergent manner which finally inserts musculously on the anterodorsal surface of the angular. Along the upper free margin of this muscular layer a thin somewhat broad aponeurosis provides attachment to some of the fibres which ultimately are attached to the angular below the muscular insertion. This aponeurosis is very prominent in *A. arius* and *A. thalassinus* while indistinct in *A. caelatus*.

The second, deeper layer of this muscle originates from the lower surface of the hyomandibular and the quadrate and runs antero-downwards to get inserted musculously on the lower surface of the angular. Unlike that of superficial layer, it is overlapped partially by the *Add. mand.*₂ in *A. arius* and *A. thalassinus* while in *A. caelatus* this element is overlapped by the *Add. mand.*₃ (Fig. 1 : Ia, Ib, Ic)

1.1.1.2. Adductor mandibularis₂ (*Add. mand.*₂) :

It is a narrow and elongated moderately developed muscle, originating from the pre-percular and hyomandibular. The origin of most of the fibres is muscular in all the three species with some exception in case of *A. caelatus* where sometime a few fibres are attached aponeurotically. The muscle runs in forward direction in a convergent fashion and finally gets inserted on the ventral ridged surface of the angular through an elongated

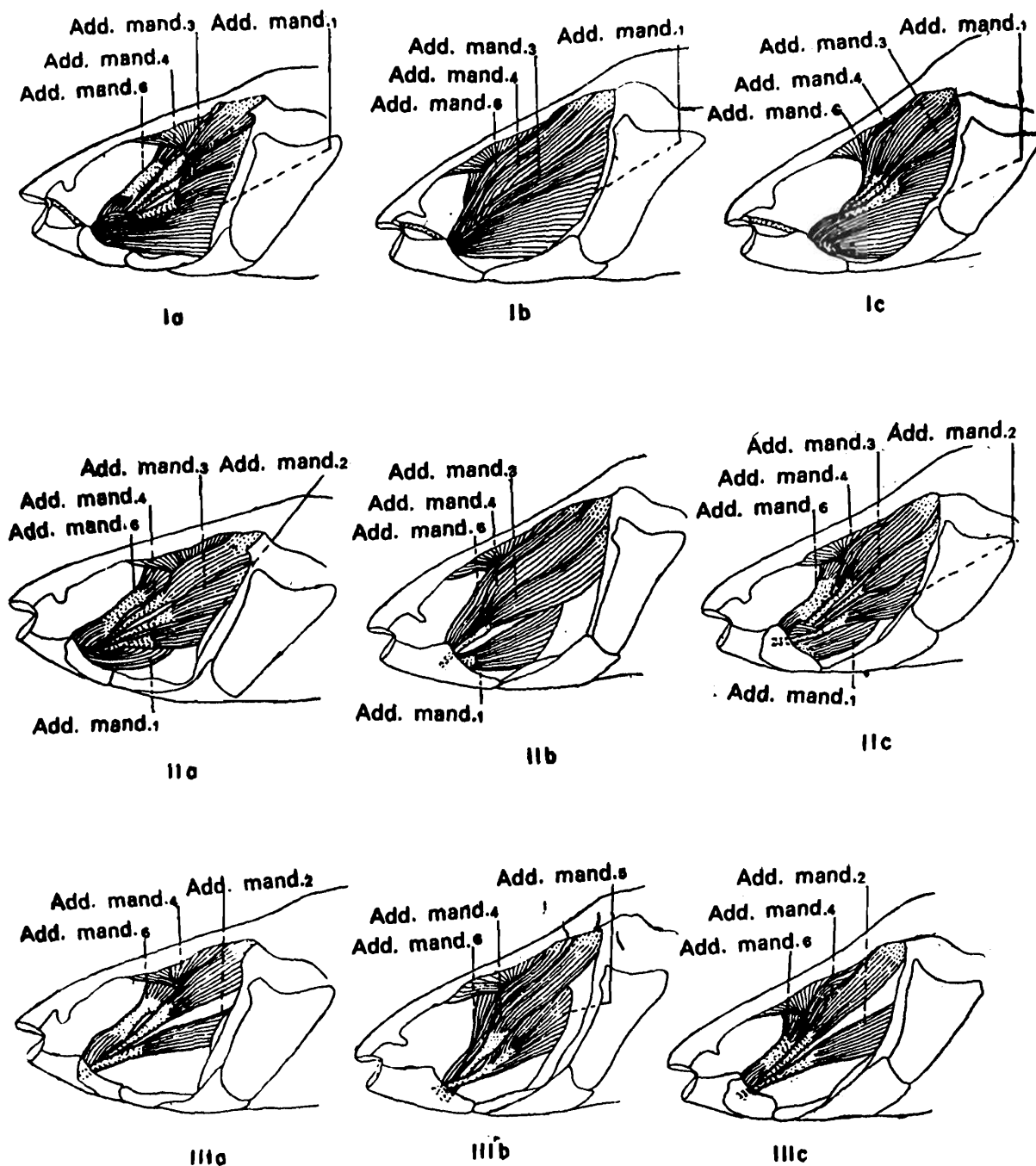


Fig. 1. I. Left lateral view of the head region showing the disposition of *Adductor mandibularis* components. a- *Arius arius*, b- *A. caelatus*, c- *A. thalassinus*. II. Left lateral view of the head region showing the disposition of *Adductor mandibularis* components after removing the superficial layer of *Adductor mandibularis*₁. III. Left lateral view of the head region showing the disposition of *Adductor mandibularis* components after removing the muscle *Add. mand.* 1, 3, 5.

aponeurosis. It is overlapped partially by *Add. mand.*₁ and *Add. mand.*₃.

In case of *A. arius* and *A. thalassinus* the muscle is distinctly separated from *Add. mand.*₃ and its aponeurosis provides attachment to some of the fibres of *Intramandibularis* in the latter species. Whereas in *A. caelatus* this muscle has blended with the fibres of *Add. mandibularis*₃; (Fig. 1 : IIa, IIc ; IIIa, IIIc).

1.1.1.3. *Adductor mandibularis*₃ (*Add. mand.*₃) :

It is comparatively a less developed element of the *Add. mand.* component. In all the three species the muscle originates musculously and partly aponeurotically from the upper portion of the preopercular and the hyomandibular. The muscle fibres run forwards and downwards in a convergent manner through an elongated aponeurosis which finally insert on the inner ventral surface of the angular. In *A. arius* and *A. thalassinus*, the muscle covers the *Add. mand.*₂ partially and itself is overlapped by the *Add. mand.*₁ as well as *Add. mand.*₄ in all the three species (Fig. 1 : Ia, Ib, Ic ; IIa, IIb, IIc).

1.1.1.4. *Adductor mandibularis*₄ (*Add. mand.*₄) :

This muscle is quite massive and well developed as compared to *Add. mand.*₃. In *A. arius*, it originates aponeurotically as well as musculously from the dorsal surface of the preopercular, and lateral surface of the sphenotic and pterotic. While in *A. thalassinus*, the origin is completely tendinous, though the place of attachment is same as in *A. arius*. In *A. caelatus* the muscle originates from the dorsal surface of the hyomandibular, lateral surface of the sphenotic and pterotic.

The nature of origin is more or less similar to that of *A. arius*.

In all the three species, the muscle lies along the dorsal aspect of *Add. mand.*₃. The fibres of this muscle run obliquely downwards, converging at the fairly long proximal end of an aponeurosis which provides attachment to the *Intramandibularis* and finally gets inserted on the inner ventral ridged surface of the angular just below the insertion of the *Add. mand.*₃. Partially, it overlaps the *Add. mand.*₄ and *Add. mand.*₅ (Fig. 1 : IIa, IIb, IIc).

1.1.1.5. *Adductor mandibularis*₅ (*Add. mand.*₅) :

A well developed muscle which can be viewed after removing the *Add. mand.*₁₋₄. In all the three species, it originates musculously from the ventral grooved surface of the hyomandibular and slightly from the junction of the quadrate and hyomandibular. The lower fibres are longer than the upper and run obliquely in a convergent fashion to the proximal end of an elongated aponeurosis which finally insert on the inner ventral grooved surface of the angular. The aponeurosis of this muscle overlaps the aponeurosis of the *Add. mand.*₂₋₄ in case of *A. arius* and *A. thalassinus*, whereas *Add. mand.*₃₋₄ in *A. caelatus* (Fig. 1 : IIb ; Fig. 2 : IIa, IIc).

1.1.1.6. *Adductor mandibularis*₆ (*Add. mand.*₆) :

This muscle is the largest and deepest among the other elements of the mandibularis group. In *A. arius* the whole muscle originates musculously from the entire anterodorsal and anteroventral surface of the hyomandibular. While in *A. caelatus* and *A. thalassinus* the muscle is cleft into two layers,

The fibres of upper layer originate aponeurotically from the sphenotic and overlap the *Lev. arc. pal.* The lower layer of the muscle originates musculously from the hyomandibular and ventral surface of sphenotic and itself is overlapped by the *Lev. arc. pal.* and the *Dil. op.* It runs anterodown-wardly in a convergent manner to get inserted on the inner ventral surface of the angular by an elongated and strong aponeurosis which provides attachment to some fibres of the *Intramandibularis*. In *A. arius* and *A. thalassinus*, the aponeurosis is very prominent and the fibres of *Intramandibularis* muscle are attached along its distal anterior margin, while in *A. caelatus* the aforesaid aponeurosis is poorly developed and the *Intramandibularis* muscle fibres are attached along the distal posterior margin of it (Fig. 2 : Ia, Ib, Ic ; IIa, IIb, IIc).

1.1.2. *Intramandibularis* (*Int. mand.*) :

The magnitude of development of this muscle varies from species to species, in the sequence of well, moderately, and poorly developed in *A. arius*, *A. thalassinus* and *A. caelatus* respectively. It arises from the aponeurosis of *Add. mand.*₂ *Add. mand.*₆ in case of *A. arius* and *A. thalassinus*, while only the *Add. mand.*₆ in *A. caelatus*. The muscle fibres run in a divergent fashion and directly attached on the inner surface of the dentary and angular in all the three species (Fig. 2 : IIa, IIb, IIc, IIIa).

1.2. *Constrictor dorsalis* group :

This group of muscles provides suspensory support to the hyomandibular and the opercular from the cranium. In the present species it comprises two components :

(1) *Levator arcus palatini*, (2) *Dilator operculi*.

1.2.1. *Levator arcus palatini* (*Lev. arc. pal.*) :

In all the three species, this muscle is well developed which can be viewed after removing the *Add. mand.* muscle complex. It originates from the ventral surface of the sphenotic and frontal. The origin of the fibres from the frontal is musculous, while from the sphenotic partly musculous and partly aponeurotic. The anterior fibres run downwards at right angle to the median longitudinal axis while the posterior fibres run slightly backwards and downwards finally all the fibres get inserted on the mesial ridged surface of the hyomandibular. It overlaps the *Add. mand.*₆ and *Dil. op.* partially. The contraction of this muscle moves the hyomandibular upwards and thus increasing the capacity of pharyngeal cavity (Fig. 2 : Ib, IIa, IIc).

1.2.2. *Dilator operculi* (*Dil. op.*) :

This component of constrictor dorsalis group is well developed, lying underneath the *Add. mand.* complex and the *Lev. arc. pal.* It connects the opercular to the neurocranium. The whole muscle is divisible into two distinct parts based on the nature of origin and insertion of the fibres : 1) *Dilator operculi superioris* and 2) *Dilator operculi inferioris*.

1.2.2.1. *Dilator operculi superioris* (*Dil. op. sup.*) :

In all the three species, this muscle is somewhat conical in shape and lies underneath the *Lev. arc. pal.* It originates directly from the ventral surface of the sphenotic and the frontal. From the place of origin the muscle fibres run downwards and backwards

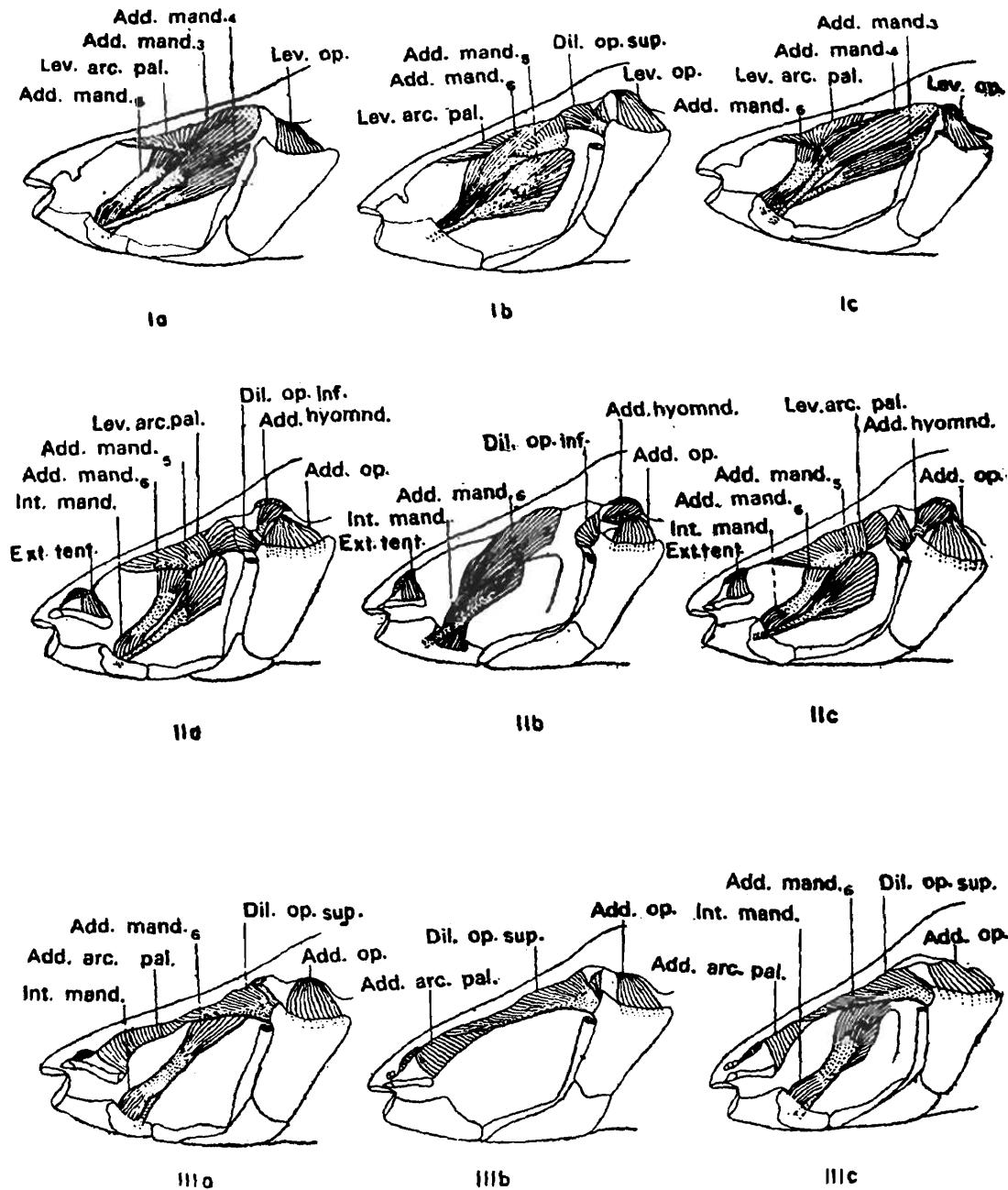


Fig. 2. I. Left lateral view of the head region showing the disposition of some *Add. mand.* components and *Levator arcus palatini*, *Levator operculi* and *Dilator operculi*. a- *Arius arius*, b- *A. caelatus*, c- *A. thalassinus*. II. Left lateral view of the head region showing the disposition of *Extensor tentaculi*, *Levator arcus palatini*, *Dilator operculi inferioris*, *Adductor operculi*, *Adductor hyomandibulae* and *Intramandibularis*. III. Left lateral view of the head region showing the disposition of the *Adductor arcus palatini*, *Dilator operculi superioris* and *Adductor operculi*.

in a convergent manner to get inserted through an aponeurosis on the dorsolateral cornu of the opercular. The muscle overlaps the anterior fibres of the *Dil. op. inf.* (Fig. 2 : IIIa, IIIb, IIIc).

1.2.2.2. *Dilator operculi inferioris* (*Dil. op. inf.*) :

It is a small poorly developed element situated just behind and slightly underneath the *Dil. op. sup.* The fibres of this muscle originate from the dorso-posterior surface of the hyomandibular and the ventral surface of the pterotic in *A. arius* and *A. thalassinus* while only from hyomandibular in *A. caelatus*. From the place of origin the muscle fibres run downwards at right angle to the longitudinal axis to get inserted on the opercular just below the insertion of *Dil. op. sup.* (Fig. 2 : IIa, IIb, IIc).

1.3. *Intermandibularis* (*In. mand.*) :

In the present three species of the genus *Arius*, the muscle is moderately developed and stretched transversely between the dentaries of either side just behind the symphysis. The attachment of the fibres is mainly muscular but for some of the posterior fibres which are aponeurotically attached. The whole muscle is sandwiched between the two silvers of the *Protractor hyoidei* (Fig. 3 : IIa, IIb, IIc).

2. *Hyoid muscle complex* :

The muscles of this complex can be grouped into two main divisions : (1) Constrictor hyoideus dorsalis and (2) Constrictor hyoideus ventralis (Edgeworth, 1935).

2.1. *Constrictor hyoideus dorsalis* :

This dorsal group of the hyoid muscle

complex suspend the hyomandibular and the palato-pterygoid arch from the cranium. It comprises 5 components : (1) *Adductor arcus palatini*, (2) *Extensor tentaculi*, (3) *Levator operculi*, (4) *Adductor operculi* and (5) *Adductor hyomandibulae*.

2.1.1. *Adductor arcus palatini* (*Add. arc. pal.*) :

It is a massively developed muscle filling the entire space present between the neurocranium and pterygo-hyomandibular arches. The muscle lies directly underneath the membrane in the roof of the mouth and the anterior part of the pharyngeal cavity on either side of the parasphenoid. The muscle fibres originate from the lateral surface of the parasphenoid in case of *A. arius* and *A. thalassinus* while in *A. caelatus* the origin of some of the fibres extend anteriorly upto the orbitosphenoid. From the site of origin the fibres run horizontally at a right angle to the longitudinal axis of the head in a divergent fashion and finally get inserted on the hyomandibular and the metapterygoid. The origin and insertion of the fibres are mainly muscular but in some specimens the fibres are also seen attached through tendon. Anteriorly the muscle overlaps the *Extensor tentaculi* partially, in all the three species (Fig. 3 : IIIa, IIIb, IIIc).

2.1.2. *Extensor tentaculi* (*Ext. tent.*) :

The development of this muscle varies significantly among the three species, that is poorly, moderately and well developed in *A. arius*, *A. thalassinus* and *A. caelatus* respectively. Otherwise there is no difference in respect of origin and insertion. In all the three species the muscle originate from the ventral aspect of the lateral ethmoid and

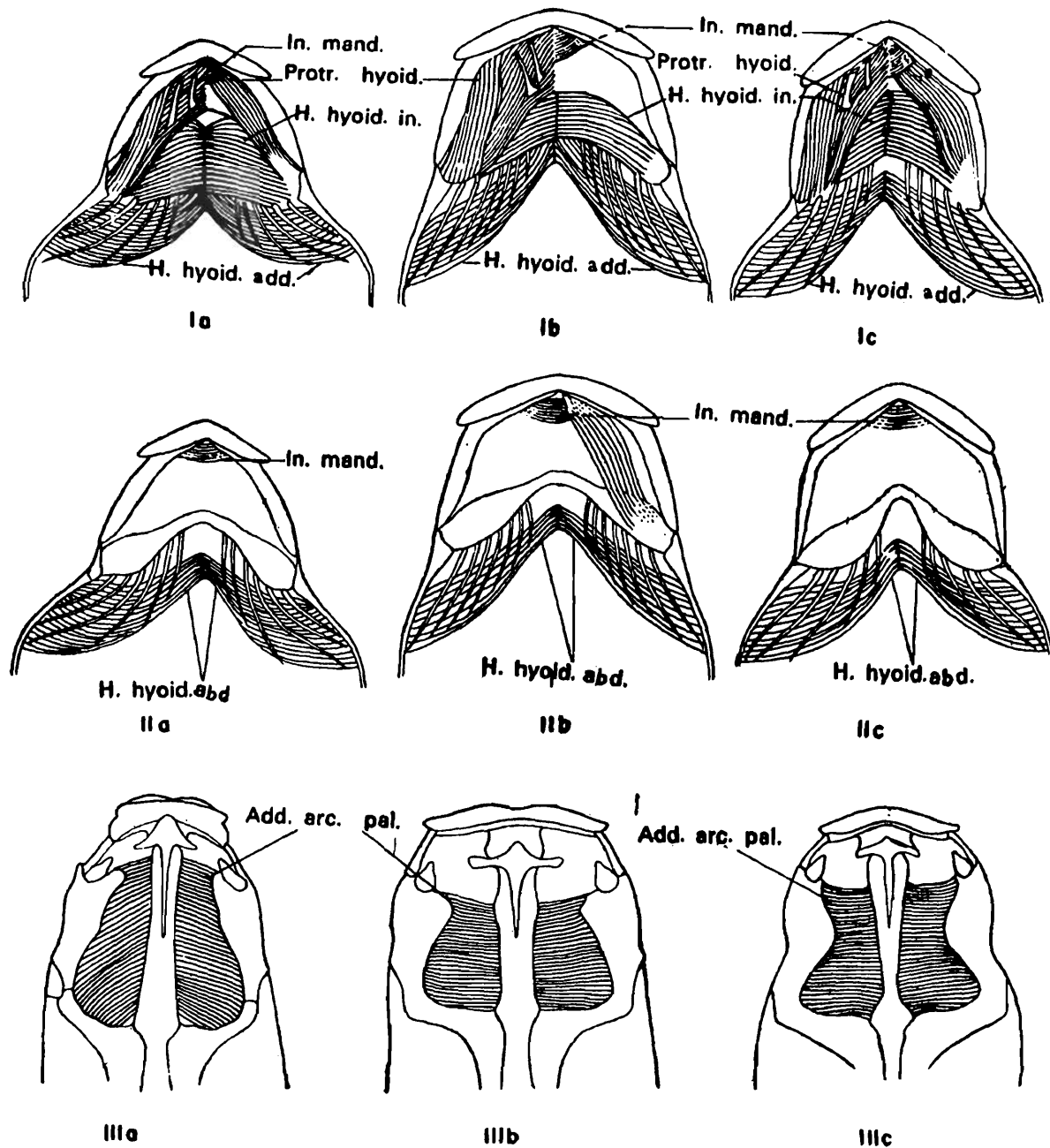


Fig. 3. I. Ventral view of the head region showing the disposition of *Protractor hyoidei*, *Hyohyoidei inferioris* and *Hyohyoidei adductores*. a- *Arius arius*, b- *A. caelatus*, c- *A. thalassinus*. II. Ventral view of the head region showing the disposition of *Intermandibularis* and *Hyohyoidei abductores*. III. Ventral view of the head region showing the disposition of *Adductor arcus palatini*.

orbitosphenoid. The insertion is mainly muscular except some posterior fibres which are attached through aponeurosis on the distal end of the autopalatine and the endopterygoid. This muscle helps in the movement of the maxillary barbel (Fig. 2 : IIa, IIb, IIc).

2.1.3. *Levator operculi* (Lev. op.) :

This muscle is moderately developed just lying underneath the skin behind the *Dialator operculi*. It originates directly from the ventrolateral surface of the pterotic and the post temporal in *A. arius* and *A. caelatus*, while in *A. thalassinus* some of the fibres are also attached through tendon. The muscle fibres run downwards to get inserted on the dorsomesial surface of the opercular. It partially overlaps the *Add. hyomand.* and *Add. op.* (Fig. 2 : Ia, Ib, Ic).

2.1.4. *Adductor operculi* (Add. op.) :

It lies beneath the *Lev. op.* clearly separated by a connective membrane from the latter. In all the three species the muscle originates from the ventro-lateral surface of the pterotic and runs downwards in a divergent manner, to get its insertion on the inner-dorsal surface of the opercular. The origin and insertion is mainly muscular but in case of *A. thalassinus* some of the fibres are attached aponeurotically on the pterotic (Fig. 2 : IIIa, IIIb, IIIc).

2.1.5. *Adductor hyomandibulae* (Add. hyomnd.) :

It is a moderately developed muscle, situated underneath the *Lev. op.* In all the three species, the muscle originates from the ventral surface of the pterotic, and runs forwardly directing downwards to get its insertion on the posterodorsal projection of

the hyomandibular. The insertion is partly aponeurotic and partly muscular. It partially overlaps the *Add. op.* and itself overlapped by the *Lev. op.* (Fig. 2 : IIa, IIb, IIc).

2.2. *Constrictor hyoideus ventralis* group :

This group of muscle consists of 5 distinct muscular components which are responsible for the movement of lower jaw in relation to the hyoid arch. These are as follows :

1. Protractor hyoidei, 2. Hyohyoidei inferioris, 3. Hyohyoidei abductores, 4. Hyohyoidei adductores.

2.2.1. *Protractor hyoidei* (Protr. hyoid.) :

This is an enormously developed compound component formed by the fusion of the *Intermandibularis posterioris* (anteriorly) and the *interhyoideus* (posteriorly) (Edgeworth, 1935 ; Winterbottom, 1974). The antero-lateral segment of the muscle originates from the epihyal and the junction of the ceratohyal and epihyal muscoulously in case of *A. caelatus*, partly muscoulously and aponeurotically in *A. arius* and *A. thalassinus*. Finally the fibres of this segment get inserted on the mesial surface of the dentary through an aponeurosis as well as directly. The posteroinner portion of this muscle is quite massive and broad covering almost entire, anterior-ventral surface of the head. The fibres of this muscle originate directly from the ceratohyal in *A. arius* and *A. thalassinus* but in *A. caelatus* some of the fibres are also originating tendinously from the junction of the epihyal and the ceratohyal. The muscle fibres run forwards and inwards in a divergent fashion to get fused with its fellow of the other side along the mid ventral line. Anteriorly the muscle bifurcates into two slips (superior and inferior), which finally get inserted on the

mesial surface of the dentary near the symphysis. The lower (inferior) slip runs below the *intermandibularis*, while the upper (superior) one overlaps the *intermandibularis*. This muscle provides support to the mandibular barbels. The insertion on the dentary is partly muscous and partly aponeurotic. The muscle overlaps the *H. hyoid. inf.* (Fig. 3 : Ia, Ib, Ic).

2.2.2. *Hyohyoide inferioris* (*H. hyoid. inf.*) :

It is a massive and enormously developed muscle situated behind and slightly underneath the *Protractor hpoidei*. The muscle fibres arise from the ceratohyal and hypohyal in all the three species, besides from the fourth branchiostegal ray in *A. thalassinus*, the fifth ray in *A. arius* and the sixth ray in *A. caelatus*. After the muscous origin the fibres run transversely at right angle to the median longitudinal axis which finally get fused with its fellow of the other side along the mid ventral line. The muscle partly overlaps the *Abd. hyoid.* and the *Add. hyoid* (Fig. 3 : Ia, Ib, Ic).

2.2.3. *Hyohyoidei abductores* (*H. hyoid. abd.*) :

It is also a well developed muscle, lying underneath and behind the *H. hyoid. inf.* In all the three species the muscle fibres from either side get fused with each other through a raphae along the mid ventral line above the urohyal. The fibres are stretched in a divergent fashion transversely, which finally get attached on the entire first branchiostegal ray in all the species in addition to the distal end of the other branchiostegals (Fig. 3 : IIa, IIb, IIc).

2.2.4. *Hyohyoidei adductores* (*H. hyoid. add.*) :

This muscle is stretched in between the

branchiostegal rays and the opercular in various bands. The number of muscle bands vary specifically in the three species. There are 6 bands in *A. arius*, 6-7 in *A. caelatus*, and 5 in *A. thalassinus*. In the distal portion of all the branchiostegals the muscle fibres are well developed but gradually get thinner towards the proximal portion and finally vanish at the end (Fig. 3 : Ia, Ib, Ic).

DISCUSSION

While comparing the various muscular elements of the mandibular and hyoid muscle complexes, it is seen that the three species (*Arius arius*, *A. caelatus* and *A. thalassinus*) exhibit a common pattern in respect of the origin, insertion, disposition and the morphology of the following muscles : *Adductor mandibularis*_{3,4} ; *Levator arcus palatini*, *Dilator operculi* ; *Intermandibularis* ; *Adductor operculi* ; *Adductor hyomandibulae* and *Hyohyoidei abductores*. However, from table 1 it may be observed that in the gross morphology of the *Adductor mandibular* muscle complex, certain specific differences do exist such as the absence of *Adductor mandibularis*₂ in *A. caelatus* unlike that of the other two species where it is present. Similarly the three species also vary in respect of the magnitude of the development of the *Intra-mandibularis* and the *Extensor tentaculi*.

The *Constrictor dorsalis* and *Intermandibularis* group of the *Mandibular* complex do not differ much in the three species. Moreover the nomenclature of the muscle *Levator arcus palatini* itself (and adopted here) needs some clarification since the earlier workers (Munshi, 1960 ; Singh and Munshi, 1969) reported this muscle under two different names i.e., *Abductor hyomandibularis* and

Protractor hyomandibularis. Winterbottom (1974a) considered these two names as synonymous with the *Levator arcus palatini*, which seems to be apt since there is no cleavage in this muscle at least in the three species studied.

In respect of the *Hyoid* muscle complex, the *Adductor hyomandibulae* originates from the pterotic in all the three species we have

studied. Singh and Munshi (1969) on the other hand reported this muscle as originating from the hyomandibur (named by them as *Retractor hyomandibularis*) in *Rita rita*, *Wallago attu* and *Aoriichthys aor*. Jayaram and Singh (1982) have, however, found that this muscle (*Adductor hyomandibulae* = *Retractor hyomandibularis* as per Winterbottom, 1974a) originating from the pterotic only in *Rita*

TABLE. 1. Comparison of various muscles in the three species of the genus *Arius*.

	<i>A. arius</i>	<i>A. thalassinus</i>	<i>A. caelatus</i>
1. Adductor mandibularis ₁	This muscle is inserted through a very prominent aponeurosis. The inner part of this muscle is overlapped by <i>Add. mand.</i> ₂ .	Similar to that of <i>A. arius</i> .	The aponeurosis is indistinct and inner part of this muscle is overlapped by <i>Add. mand.</i> ₃ .
2. Adductor mandibularis ₂	Present	Present	Absent
3. Adductor mandibularis ₃	The aponeurosis of this muscle overlaps the aponeurosis of <i>Add. mand.</i> _{2,4} .	Similar to that of <i>A. arius</i> .	The aponeurosis of this muscle overlaps the aponeurosis of <i>Add. mand.</i> _{3,4} .
4. Intramandibularis	Well developed, attached on the aponeurosis of <i>Add. mand.</i> _{2,6} .	Moderately developed, attached on the aponeurosis of <i>Add. mand.</i> _{2,6} .	Poorly developed, attached on the aponeurosis of <i>Add. mand.</i> ₆ only.
5. Adductor arcus palatini	Originates only from the parasphenoid.	Similar to that of <i>A. arius</i> .	The origin also extends up to the orbitosphenoid.
6. Extensor tentaculi	Poorly developed.	Moderately developed.	Well developed.
7. Levator operculi	Originates musculously.	Originates musculously as well as aponeurotically.	Similar to that of <i>A. arius</i> .
8. Adductor operculi	Originates musculously.	Originates musculously as well as aponeurotically.	Similar to that of <i>A. arius</i> .
9. Protractor hyoidei	Originates musculously from ceratohyal only.	Similar to that of <i>A. arius</i> .	Originates musculously and aponeurotically from ceratohyal as well as from the junction of cerato-and epihyal.
10. Hyohyoidei adductores	Present in 6 bands.	5 bands.	6-7 bands.

rita, *Mystus gulio*, *Horabagrus brachysoma* and *Aoriichthys aor*. The *Protractor hyoidei* originates musculously from the ceratohyal in *A. arius* and *A. thalassinus* but in *A. caelatus* it extends to the junction of epihyal as well. The comparative table indicates *A. arius* and *A. thalassinus* to be sharing many common features unlike *A. caelatus*. The origin of *Adductor arcus palatini* extends up to the orbitosphanoid in case of *A. caelatus* while in the other two species it is restricted to the parasphenoid only. The *Hyohyoidei adductores* has greater number (6 or 7 bands) of supporting bands in *A. arius* and *A. caelatus* unlike *A. thalassinus* which has only five bands. *Extensor tentaculi* is also well developed in *A. caelatus* than in the other two species.

It appears from the above structural pattern that amongst the three species, *A. caelatus* is better developed than the other two. However, *A. thalassinus* grows to considerably larger size (1 meter or more) than *A. arius* (400 cm) and *A. caelatus* (not more than 600 cm) and is also more widely distributed and abundant in terms of catches. *A. arius* is the smaller of the three in size wise and is also restricted in its distribution.

A. arius is dominant in the Chilka Lake while *A. caelatus* is an inhabitant of estuaries and sea shores. *A. thalassinus* is a denizen of the open seas. Whether these habitat preferences have any relationship with their structure is hard to postulate at this juncture. It may however be stated that these differences in the muscle pattern are of limited taxonomic utility.

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Bull. zool. Surv. India, 5 (1) : 123-124, 1983

NEW RECORD OF TWO SPECIES OF THE GENUS *ANISOPS* SPINOLAE
(HEMIPTERA : INSECTA) FROM THE LOWER WESTERN
GHATS, KERALA

The genus *Anisops* Spinolae, an old world genus of the family Notonectidae, enjoys its distribution from the Fiji Island in the Pacific across Australia to Africa and Canary Islands (Hungerford, 1958). It has 95 species in the old world of which only 18 species are represented in India. The present note deals with the occurrence of two species of *Anisops*, namely, *Anisops batillifrons* Lundbald and *Anisops debilis* Gerstaecker from the lower Western Ghats of Kerala.

Of the two, *Anisops batillifrons* was first reported from China (Lundbald, 1933) and subsequently recorded from Formosa, Hainan, Burma, Philippines, Okinawa, India (Brooks, 1951) and Sri Lanka (Fernando, 1959 ; Leong & Fernando, 1962). In India, *Anisops batillifrons* was reported above 4000'-4700' in Eastern Himalaya (Brooks, 1951). During a recent expedition by the Southern Regional Station, Madras to Mullaperiyar Wildlife sanctuary, Thekkady, Kerala (February, 1981), 2 males and a female of *Anisops batillifrons* were collected from a jungle stream near Mullayaru (980 m. s. l.). Fernando (1959), however, recorded it in isolated habitats and stated that it inhabits the Paddy fields.

The second species, *Anisops debilis*, an ethiopian species, recorded from various places of Africa (Brooks, 1951) was also collected (16 males and 12 females) from a jungle pool from the Karadikavala, off Mullaperiyar Wildlife sanctuary, Thekkady, Kerala. A perusal of literature (Brooks, 1951 ; Leong and Fernando, 1962) on the distribution of the genus *Anisops* revealed that this species has not been reported so far from Oriental region so the present report is the first record of this species from Oriental region. The general colour of *Anisops debilis* reported in the present study is very similar to the ethiopian species as given by Brooks (1951), but lacks the two triangular hyaline areas on each side of the anterior half of scutellum. The size of the male varies from 6.5 mm. to 7.0 mm. in length and 2.0 mm. to 2.3 mm. in width (greatest body width), while the female varies from 7.2 mm. to 7.8 mm. in length and 2.1 mm. to 2.4 mm. in width (greatest body width). The stridulatory comb is exactly identical with that figured by Brooks (1951) wherein the comb decreases slightly in length from base to apex but the number of teeth being 23 instead of 21.

It is interesting to note that *Anisops batillifrons* an Indo-Chinese, and Indo-Malayan, and Palaearctic, and Pacific species, and *Anisops debilis*, an Ethiopian form, from lower Western Ghats which perhaps providing an ideal habitat to many other species in the like manner compared with the rest of the peninsular India. The study of Notonectidae is important, since water bugs in general among insects are less likely to be transported by the agencies of man (Hungerford, 1958) and hence valuable for the study of zoogeographic relationship.

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Southern Regional Station,
Madras—600 028 (India).*

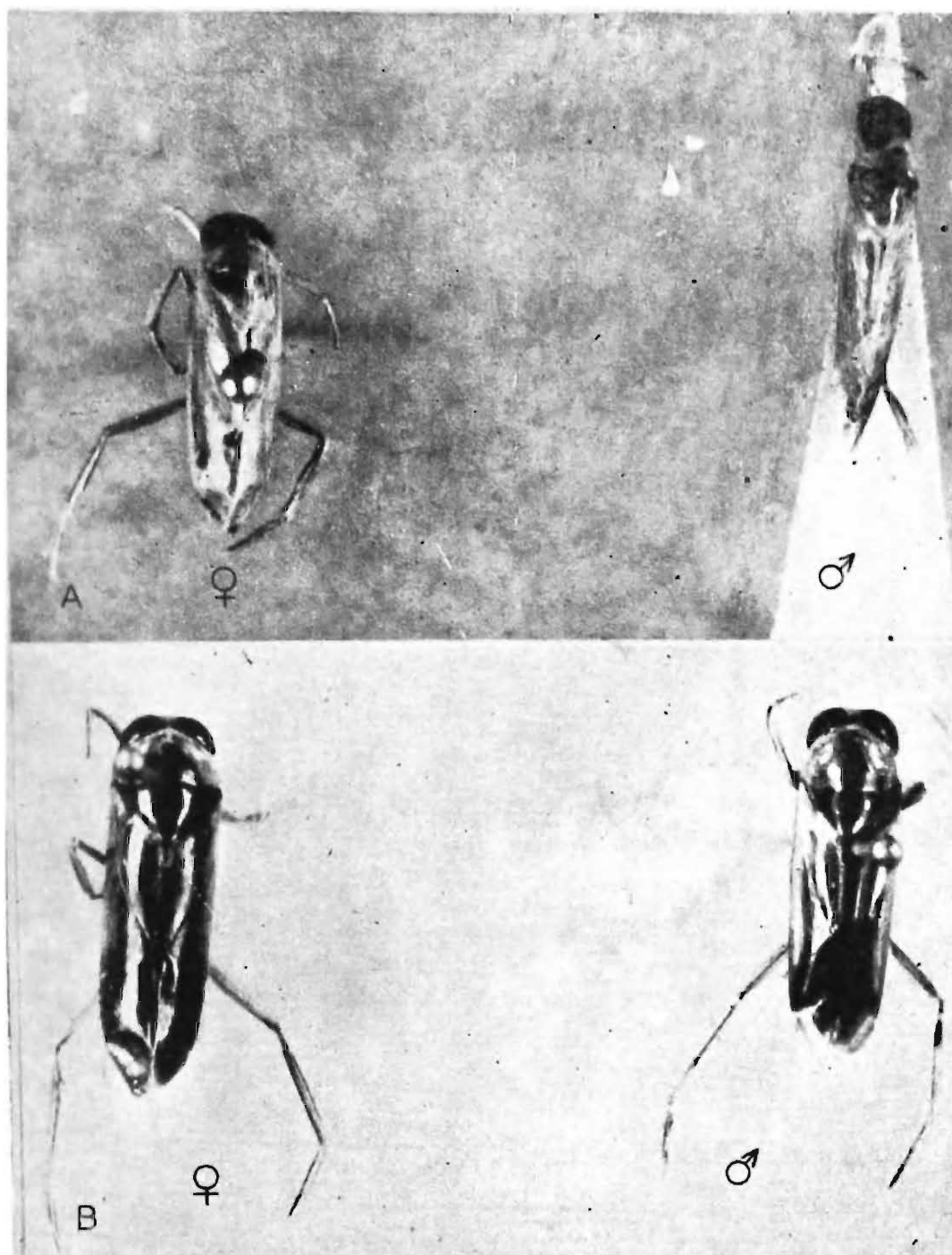
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G. THIRUMALAI

THIRUMALAI

PLATE V



A. *Anisops batillifrons* x 8
B. *Anisops debilis* x 10

Bull. zool. Surv. India, 5 (1) : 125-127, 1983

STUDIES ON HOUSE-HOLD INSECT-PESTS (HYMENOPTERA : FORMICIDAE) OF SHILLONG

During a survey made to study the house-infesting ants of Shillong, the author came across 15 species of ants belonging to 12 genera under 5 sub-families. Certain species are found to be more abundant and annoying than others.

Sub-family : 1. DORYLINAE

1. *Dorylus orientalis* Westwood

The blind workers of this nomadic species, while on their onward march, sometimes invade houses. During these trips they clear away everything off their way. The damage these ants cause to the plants is already reported by Roonwal (1972). The males of this species are wasp like insects and are attracted towards the light. They are often seen coming to the houses during the months of June and July. They make their temporary nests in the soil.

Sub-family : 2. PONERINAE

2. *Odontomachus monticola* Emery

Workers of this species are often seen wandering inside the toilet rooms, especially at night. I have come across their well protected and sheltered nests in the soil near wet surroundings.

3. *Pachycondyla luteipes* (Mayr)

Workers of this species roam around the kitchen and carry away any food particles that they come across. They make their nests in the soil, often under stones or any such sheltered place.

Sub-family : 3. MYRMICINAE

4. *Aphaenogaster schurri* Forel

On rare occasions this species is seen inside the house. It makes its nests in the soil.

5. *Crematogaster biroi* Mayr

Members of this species are fond of sugary food and can easily be baited with sugar crystals. They make their nests in the soil.

6. *Crematogaster* sp.

The workers of this small, black ant are often encountered inside the kitchen and store rooms. They sap up any liquid food they get like milk, tea, starch solution and even chilly juice. It is really cute to see them lining around a drop of milk spilt on the table, with their abdomens raised up above the head-level. At such times even a mild touch on their body may not drive them away. They make their nests in the hollows of trees. Their bite is irritating.

7. *Ceratopheidole smythiesi* Forel

This species sometimes makes its nests in the lawn or under the steps of the houses, unearthing large amount of soil and disfiguring the area. At times the workers invade the kitchen and carry away grains of rice and other cooked food particles. I have observed them taking insect food of various kinds like caterpillars, beetles, bugs, grasshoppers, etc. They also feed on earthworms. They tend aphids and are real nuisance to the kitchen garden.

8. *Pheidole constanciae* Forel

This species seems to be fond of fatty and oily food. A large number of workers and the soldier forms collect over a piece of cooked meat or fish dropped on the ground. They also take bread, butter, etc. They build their nests in the soil often under stones or among the roots of the creepy grass.

9. *Tetramorium barryi* Mathew

This species is rarely seen wandering inside the house. Its food consists mainly of collembolans, dipteran larvae, aphids etc. and makes its nests in the soil, in the hollows of tree trunks and in the crevices of concrete buildings.

Sub-family : 4. FORMICINAE

10. *Camponotus compressus* (Fabricius)

The minor workers of this species wander hither and thither inside the houses. They forage on the shrubs of *Solanum* sp. taking honey from their flowers. I have come across their nests in the soil under stones or in between the roots of trees, etc.

11. *Camponotus selene* (Emery)

I have observed the workers of this ant inside the house, often at night, holding themselves firmly to the window sill of the

bathroom. They forage for honey on the flowers of *Lantana camera* and *Solanum* sp. The species makes its nests in the hollows of trees.

12. *Paratrechina* sp.

This is the species that one encounters most often inside the houses in Shillong. Like most of the other members of this sub-family, the workers of this species are also fond of sugary food. They take sugary food of any kind, and one has to take good care to keep them away from sweets. In Shillong, I have come across their nests in the soil, and in the hollows of trees. They tend aphids, but are not as mischievous as *Ceratopheidole smythiesi*.

13. *Prenolepis* sp.

Members of this species are fond of sugarcane, ripe-fruits and other sweet food. In Shillong, this species comes next to *Paratrechina* sp., in frequenting the houses. It makes its nests in the soil.

Sub-family : 5. DOLICHODERINAE

14. *Tapinoma melanocephalum* (Fabricius)

This black ant makes its nest in the hollows of trees and rarely invades the houses. It tends aphids on broad beans, but its workers are not found in so large a number as in the case of *Ceratopheidole smythiesi*.

15. *Liometopum lindgreeni* Forel

Though a forest ant, members of this species sometimes invade houses. They keep aphids.

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ALAIMUS RAFIQI NOM. NOV. FOR *ALAIMUS*
SIDDIQII CHATURVEDI & KHERA, 1979

While working on nematodes associated with jute crop Chaturvedi & Khera (1979) described a species under the genus *Alaimus* de Man, 1880. Later on it was found that Andrassy (1970) has already described a species by this name from Vietnam. Thus the name was preoccupied and *Alaimus siddiqii* Chaturvedi & Khera, 1979 being a primary junior homonym needed a new replacement name. Therefore, a new name *Alaimus rafiqi* is proposed.

The detail description, diagrams and all other particulars of the species remain same as given in the original description.

The new name too is after Dr. M. R. Siddiqi, as proposed originally.

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REVIEWS

REVIEW ON THE FAUNA OF INDIA : SPIDERS, VOL. 2

THE FAUNA OF INDIA. SPIDERS : ARANAE. Vol. 2, Part 1. Family Araneidae (=Argiopidae), Typical Orb-weavers. Part 2. Family Gnaphosidae.—By B. K. TIKADER. xiv + 536 pp., 504 figs., 3 col. pls. 1982. Calcutta (Zoological Survey of India). Price : In India : Rs. 200.00 : Foreign : £ 20.00 or U. S. : \$ 75.00

This is the second volume of the *Fauna of India* on spiders, (for the first volume by the same author, published in 1980, see the *Journal, Bombay nat. Hist. Soc.*, 77, p. 310, 1980), and is like the first equally well written and well produced, for which both the author and the printers deserve congratulations.

Part 1 (pp. 1-293) deals with the orb-weavers of family Araneidae and includes 21 genera and 101 species. The introductory part contains an account of the orb-weaving mechanism, the general taxonomic characters of spiders, a list of all the spider families of the world of which 43 are stated to occur in India, keys to families and genera of Indian spiders and, finally, keys to the subfamilies and genera of the Indian Araneidae. This is followed by an illustrated account of the various genera and species. Then follows a bibliography and a short index.

Part 2 (pp. 295-536) deals with the family Gnaphosidae and follows the same pattern as Part 1, except that it includes a useful glossary of anatomical terms for spiders. The account includes 21 genera and 89 species. Altogether, therefore, the volume covers 42 genera and 190 species.

The generic and species descriptions are brief but clear and succinct, and synonymies with references are provided in each case.

The book forms a very welcome addition to the understanding of our large spider fauna and we shall look forward to many more volumes by the same author which will be required to cover the entire group. For the families covered, the present volume will remain a standard work of reference for many years to come, and we hope that all zoological libraries will acquire it.

A small suggestion may be offered for the index. It should include the synonymies as well in a distinguishable type besides the valid species. At present the italicised type includes only those for which detailed descriptions are given.

M. L. ROONWAL