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ON THE BUTTERFLY FAUNA OF ANDAMAN AND NICOBAR ISLANDS (INDIA). II. PIERIDAE

By

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INTRODUCTION

The present account is a continuation of the first part which deals with family Papilionidae (*vide* Arora & Nandi, 1980), and based on the material collected by the various parties of Zoological Survey of India as well as on the material already present in the old National Zoological Collections in the Department (abbreviated in the text as N. Z. C), the details of which have been given in the above-mentioned paper.

The present paper incorporates 20 species with 27 subspecies distributed over 11 genera under two subfamilies, viz., Pierinae (*Leptosia*, 1 sp. ; *Cepora*, 2 spp. ; *Anapheis*, 1 sp. ; *Appias*, 4 spp. ; *Saletara*, 1 sp. ; *Ixias*, 1 sp. ; *Hebomoia*, 1 sp. ; and *Valeria*, 1 sp.) and Coliadinae (*Catopsilia*, 3 spp. ; *Gandaca*, 1 sp. ; and *Eurema*, 4 spp.). Of these, only three species viz., *Anapheis aurota aurota* (Fabr.), *Appias libythea olferna* Swinhoe and *Eurema brigitta rubella* (Wallace), all from Nicobars, have been reported as stragglers to these areas since these have neither been collected recently nor represented in N. Z. C. However, *Cepora nerissa dapha* (Moore) also reported as a straggler to Great Nicobar as been collected more often and is represented here by one example each of male and female.

The studies also throw light on the detailed distribution of the Pierid-fauna of these areas ; confirm the occurrence of *Appias paulina galathea* (Felder) in South Andamans, which was hitherto without any authenticated record of this species ; and record for the first time the distribution of *Ixias pyrene andamana* Moore and *Catopsilia florella gnoma* (Fabr.), from Car Nicobar.

The nomenclature and classification has been mainly followed after Talbot (1939).

SYSTEMATIC ACCOUNT

1. Subfamily PIERINAE

The subfamily Pierinae, represented by 12 species with 15 subspecies distributed over eight genera from Andaman and Nicobar Islands, is

characterised by the hind wing having a well developed precostal vein which is curved towards distal end and the labial palpi being always hairy.

The Andaman & Nicobar genera belonging to this subfamily can be differentiated by the following key (as adapted from Talbot, *loc. cit.*).

1. Fore wing with veins R_4 - R_6 coincident	...	2
— Fore wing with veins R_4 - R_6 separate; vein M_1 from upper angle of cell.	...	<i>Valeria</i> Horsfield
2. Fore wing with vein R_3 absent. Hind wing with veins M_1 - M_2 close at base.	...	<i>Leptosia</i> Hübner
— Fore wing with vein R_3 present, stalked with R_{4+5} .	...	3
3. Fore wing with vein R_1 anastomosing with Sc.	...	<i>Anapheis</i> Hübner
— Fore wing with vein R_1 free.	...	4
4. Fore wing with vein M_1 stalked with the stem of R_{4+5} and R_3 .	...	5
— Fore wing with vein M_1 below cell angle and arising at junction of discocellulars.	...	<i>Hebomoia</i> Hübner
5. Male with hair-pencils on abdomen.	...	6
— Male without hair pencils on Abdomen.	...	7
6. Male with a single tuft of hair arising between 7th-8th abdominal segment.	...	<i>Appias</i> Hübner
— Male with two hair-tufts.	...	<i>Saletara</i> Distant
7. Wings white. Fore wing with vein M_1 nearly from middle of the stem between cell angle and the fork.	...	<i>Cepora</i> Billberg
— Wings yellowish. Fore wing with vein M_1 close to cell angle than to fork.	...	<i>Ixias</i> Hübner

1. *Leptosia nina* (Fabricius)

Talbot (1939) reported only one subspecies in the Indian area, viz., *nina nina*, and occurring in areas of Andaman Islands besides other areas as given below.

Ferrar (1951), however, referred to another subspecies viz., *nina nicobarica* Moore.

1a. *Leptosia nina nina* (Fabricius)

1793. *Papilio nina* Fabricius, *Ent. Syst.*, 3 (1) : 194.

Material examined.—Andaman : 2 exs. (no date) (in *N. Z. C.*). N. Andaman : Rangat Jetty, 1 ♂, 1 ♀, 23. iv. 1970.

Wing expanse.—Male, 31-34 mm ; female, 32 mm.

Distribution.—India (Peninsular India to Mussoorie in North Western Himalayas ; Andaman Islands). Also Sri Lanka, Burma and China.

Remarks.—Although the subspecies is reported to be common throughout Peninsular India to Mussoorie (*vide* Talbot 1939), Ferrar (1951) reported it to be extremely local in Port Blair and adjoining areas.

1b. *Leptosia nina nicobarica* (Doherty)

1886. *Nychitona xiphia* var *nicobarica* Doherty, *J. Asiat. Soc. Beng.*, 55 : 262.

Material examined.—Great Nicobar, 2 ♂♂, 2 ♀♀, (no other data), Galathea Bay, 1 ♀ (no date) (in *N. Z. C.*).

Wing expanse.—Male and female, 33-43 mm.

Distribution.—South Nicobar.

Remarks.—This subspecies is close to *nina nina*, except in the sub-apical spot being smaller.

2. *Cepora nerissa* (Fabricius)

Talbot (1939) reported as many as four subspecies in the Indian area, including the two from Andaman & Nicobar Islands. Both these subspecies are dealt with here.

The species differs from *C. nadina* (Lucas) in the black spot in the middle of area above vein Cu_{1a} on underside of fore wing being separate from black border by a white spot.

2a. *Cepora nerissa dapha* (Moore)

1878. *Appias dapha* Moore, *Proc. zool. Soc. Lond.* : 838.

Material examined.—India : Gt. Nicobar, Cowrighat, 1 ♂, 1 ♀, 9. iv. 1966.

Wing expanse.—Male and female, 54-62 mm. (50-60 mm in literature).

Distribution.—India : Assam, Nicobars. Also Burma extending to Siam and Malaya.

Remarks.—The subspecies is stated to be a straggler in Nicobars from Burma, by Talbot (1939) as well as Ferrar (1951), but since a pair from Great Nicobar Island has been collected again in the recent surveys, it is quite probable the subspecies is normally available locally, though rare, as compared to the following from Andaman islands.

2b. *Cepora nerissa lichenosa* (Moore)

1877. *Pieris lichenosa* Moore, *Proc. zool. Soc. Lond.* : 591.

Material examined.—S. Andaman : Caddle gunj, 1 ♂, 16. xii. 1972 ; Manglutan, 1 ♂, 17. xii. 1972. N. Andaman : Durgapur, Diglipur, 1 ♂, 23. iv. 1971 ; Kishori Nagar, Mayabunder, 1 ♂, 3. v. 1971 ; Rest House Tugapur, 1 ♂, 11. v. 1971.

Wing expanse.—Male and female, 55-65 mm.

Distribution.—Andaman Islands.

Remarks.—The species is reported to be common in Andaman Islands.

3. *Cepora nadina andamana* (Swinhoe)

1889. *Huphina nama* var. *andamana*, Swinhoe, *Proc. zool. Soc. Lond.* : 398.

Material examined.—Andaman : 5 ♂♂, 7 ♀♀ (no other data) (in N. Z. C.).

Wing expanse.—Male, 54-67 mm ; female, 49-65 mm.

Distribution.—India : Andaman Islands.

Remarks.—This subspecies is not rare and is restricted to Andamans. The other two Indian subspecies, viz., *nadina remba* (Moore) and *nadina nadina* (Lucas) are reported from Peninsular India, and Sikkim to Burma, respectively.

It differs from the preceding species in the black spot in the area above vein Cu_{1a} on underside of fore wing not being separate from the black border.

4. *Anapheis aurota aurota* (Fabricius)

1793. *Papilio aurota* Fabricius, *Ent. Syst.*, iii, I : 197 (Coromandel)

Wing expanse.—Male and female, 40-55 mm. (*vide* Talbot, 1939).

Distribution.—Throughout India except Assam and Burma.

Remarks.—The authors have not seen any material of the species from Andaman and Nicobar Islands. Bingham (1907) reports a dry season form of the species from Great Nicobar and is of the opinion that the same is a straggler. Probably, the species does not occur in the area.

5. *Appias libythea olferna* Swinhoe

1890. *Appias olferna* Swinhoe, *Ann. Mag. nat. Hist.*, (6) 5 : 358.

Distribution.—India : W. Bengal to Assam ; Car Nicobar and extending to Burma and Malaya Peninsula.

Remarks.—The subspecies is extremely rare in Car Nicobar. The nominate subspecies is reported to be distributed in Peninsular India. Ferrar (1951) is of the opinion that in Nicobars the Dry Season Forms do not occur normally so that the collection of the males and females of both the forms by the collectors of Ferrar, is considered by the latter as being due to its migration from the mainland. The authors have not seen any material from these areas in *N. Z. C.*

The species *A. libythea* is close to *A. lyncida*, the hind wing being without a black spot at the end of cell and marginal dots between veins on the underside, but, however, differs in the character of the marginal border (see *A. lyncida*).

6. *Appias lyncida* (Cramer)

The species is represented by two subspecies viz., *nicobarica* and *galbana* from Nicobar Islands and is not reported to occur in Andaman Islands. Both these are dealt with here.

The species differs from *libythea* in the hind wing being yellow on underside and the marginal border being broad and dark chocolate, unlike *libythea* where it is without the above mentioned border.

6 a. *Appias lyncida nicobarica* Moore

1905. *Appias nicobarica* Moore, *Lep. Indica*, 6 : 198.

Material examined.—Car Nicobar, 2 ♂♂ (no other data) (in *N.Z.C.*) ; Arong 7 ♂♂, 27. xii. 1972.

Wing expanse.—Male and female, 48-66 mm.

Distribution.—Car Nicobar and Central Nicobar ; not rare.

Remarks.—Of the five subspecies which are available in the Indian region, *nicobarica* is restricted to the areas as mentioned above and is reported to vary considerably in size and colouration. The material before us also has a male, as small as 48 mm. in expanse as compared with the minimum recorded expanse of 55 mm. (*vide* Talbot, 1939 and Wynter Blyth, 1957).

6 b. *Appias lyncida galbana* Fruhstorfer

1910. *Appias lyncida nicobarica*, ♀ f. *galbana*, Fruhstorfer, In : Seitz, *Macrolepidoptera of the World*, 9 : 149.

Material examined.—Great Nicobar and Little Nicobar, 9 ♂♂, 5 ♀♀ (no other data) (in *N. Z. C.*).

Wing expanse.—Male, 48-63 mm ; female, 47-58 mm.

Distribution.—South Nicobar Islands.

Remarks.—The subspecies is restricted to South Nicobar Island, particularly the areas of Great Nicobar and Little Nicobar Island as recorded for the material present in *N. Z. C.* Both males as well as females are smaller in wing expanse than the earlier minimum record of '55 mm' (*vide*, Talbot, 1939).

7. *Appias albina darada* (C. & R. Felder)

1865. *Pieris darada* C. & R. Felder, *Reise Novara, Lep.*, 2 : 166.

Material examined.—S. Andaman : 5 ♂♂, 1 ♀, (no other data).

Wing expanse.—Male, 59-61 mm ; female, 56-58 mm.

Distribution.—India : Peninsular India to Sikkim and N. E. India ; S. Andaman ; Car Nicobar. Also Burma and Sri Lanka.

Remarks.—Ferrar (1951) was able to capture this rather rare species in hundreds only in the year 1927 in S. Andamans, but could get only a pair, or so, after that and has also recorded the subspecies as far as Car Nicobar Island. The material before us for study from *N. Z. C.*, however, show no other data except the date of registration as '21.4.84' which indicate that the material had been collected even earlier.

A. albina is close to *A. paulina*, particularly in the marginal black, in males, not being produced inwardly on upperside fore wing, which has the apex rather acute and with the outer margin curved as compared with the obtuse apex and the straight outer margin in *paulina*.

8. *Appias paulina galathea* (Felder)

1862. *Pieris galathea* C. Felder, *Verh. zool.-bot. Ges. Wien*, 12 : 485.

Material examined.—Little Nicobar, 2 ♂♂, 1 ♀ ; Nancowry, 1 ♂, 1 ♀ ; Camorta, 2 ♂♂ ; Great Nicobar, 6 ♂♂, 2 ♀♀, (all in *N. Z. C.*) ; Appiah Bay, 2 ♂♂, 14. iv. 1966 ; Forest around Campbell Bay, 4 ♀♀ (f. *principalis*), 1 ♀ (f. *semiflava*), 26. xii. 1975 ; Laksman Beach, 2 ♀♀ (f. *semiflava*), 28. xii. 1975 ; Champa Bay, 1 ♀ (f. *flava*), 31. xii. 1975. S. Andaman : Chiriatapu, 1 ♀, 28. v. 1971.

Wing expanse.—Male, 46-64 mm ; female, 55-61 mm.

Distribution.—Andaman and Nicobar Islands.

Remarks.—Talbot (1939) is of the view that there is no authenticated record of *galathea* from Andamans, and states it to be 'Not rare' in Nicobars. The material present here for study, however, includes a single female from Chiriatapu, which confirms its occurrence in Andamans, though undoubtedly rare as compared with its availability in the areas of Nicobars. Whereas Talbot (1939) reports four female forms of this subspecies, Ferrar (1951) is of the view that there may be as many as six female forms and all of them may occur together. The female forms available for study are mainly referable to f. *flava* (with upperside yellow, underside with the apical area of forewing yellow) ; f. *semiflava* (with upperside white and underside with the apical area of fore wing yellow) ; and *principalis* (with upperside white and underside with the apical area of fore wing stone white).

9. *Saletara panda chrysea* Fruhstorfer

1903. *Saletara panda chrysea* Fruhstorfer, *Soc. Ent.*, 18 : 124.

Material examined.—Great Nicobar, 9 ♂♂ ; Little Nicobar, 1 ♂ (no other data) (in *N. Z. C.*) ; Galathea Bay, 1 ♂, 23. iii. 1966.

Wing expanse.—Male, 49-60 mm.

Distribution.—South Nicobar Islands.

Remarks.—The species is rare and reported to be restricted to South Nicobar Is. only, particularly Gt. Nicobar and Little Nicobar Islands. The females seem to be quite rare and hitherto only three examples have been reportedly collected by Ferrar (1951).

10. *Ixias pyrene andamana* Moore

1877. *Ixias andamana* Moore, *Proc. zool. Soc. Lond.* : 590.

Material examined.—Andamans, 11 ♂♂, 6 ♀♀ (no other data) (in *N. Z. C.*). South Andaman : Humfraygunj, 1 ♂, 7. iii. 1964 ; Chiriatapu, 1 ♂, 28. v. 1971, 1 ♀, 20. xii. 1972, 1 ♀, 10. i. 1976. Middle Andaman : Colonighat, 1 ♀, 8. iv. 1964 ; East of Rangat jetty, 1 ♂, 23. iv. 1970. Car Nicobar : Malacca-Kakana Road, 1 ♂, 25. xii. 1972.

Wing expanse.—Male, 53-61 mm. ; female, 52-63 mm.

Distribution.—Andaman Islands extending from Gt. Cocos and Car Nicobar Islands (New record).

Remarks.—The subspecies reported to be restricted to Andaman Island (*vide* Talbot, 1939) was, later, recorded as very common at Gt. Cocos, an island 20 miles to the North of Gt. Andaman (*vide* Ferriar, 1951). Now, the single male, recorded from Car Nicobar, extends its distribution further southwards and is of zoogeographic interest.

11. *Hebomoia glaucippe roepstorffii* Wood-Mason

1880. *Hebomoia roepstorffii* Wood-Mason, *J. Asiat. Soc. Beng.*, **49**: 134.

Material examined.—Andaman, 2 ♂♂, 1 ♀. S. Andaman : 2 ♂♂, 2 ♀♀ ; Port Blair, 1 ♀ (no date) (in *N. Z. C.*).

Wing expanse.—Male, 85-91 mm. ; female, 84-86 mm.

Distribution.—Andaman Islands.

Remarks.—Popularly known as 'The Great Orange Tip', because of the characteristic orange patch in the forewing apical area, this subspecies is very common and more closely allied to the mainland subspecies *australis* than to the nominate one which extends from Nepal to Burma.

12. *Valeria ceylanica naraka* (Moore)

1877. *Eronia naraka* Moore, *Proc. zool. Soc. Lond.* : 591.

Material examined.—S. Andaman : 11 ♂♂, 1 ♀, Port Blair, 4 ♀♀ (no date) (in *N. Z. C.*) ; Caddlegunj, 1 ♂, 16. xii. 1972 ; Panighat, 1 ♂, 3. i. 1973 ; Ferrargunj, 1 ♂, 17. i. 1973 ; Manglutan, 1 ♂, 18. xii. 1975 ; Chiriatapu, Mundapahar, 1 ♂, 10. i. 1976 ; Kudyaghat, 1 ♀, 11. i. 1976. M. Andaman : Rangat jetty, 1 ♂, 23. iv. 1970 ; Rangat Forest, 1 ♂, 31. i. 1972 ; Rangat, 1 ♂, 7. i. 1973. N. Andaman : Durgapur, Diglipur, 2 ♂♂, 26. iv. 1971 ; Smith Island, Near Forest Dept. Camp, 2 ♂♂, 27. iv. 1971.

Wing expanse.—Male, 76-80 mm. ; female, 67-86 mm.

Distribution.—Andaman Islands.

Remarks.—This subspecies is close to *V. valeria* particularly in the fore wings being bluish-green in the males ; and without submarginal spots, or smaller if present. However, the females have the narrow submarginal bluish-green spots or streaks unlike those in *valeria* where these are bluish to white or yellow.

II. Subfamily COLIADINAE

The subfamily Coliadinae is represented by eight species with twelve subspecies distributed over 3 genera, from these areas, and is characterised by the precostal vein on hind wing either being absent or very short and directed basad if present.

The three genera are differentiated by the following key (as adapted from Talbot, 1939) :

- | | | | |
|--|-----|--------------------------|---|
| 1. Precostal vein on the hind wing short | ... | ... | 2 |
| — Precostal vein absent or obsolete. Fore wing with or without sex brand on upperside, and without tuft on inner area of underside | ... | <i>Eurema</i> Hübner | |
| 2. Precostal vein thick. Male with an oval sex patch on upperside at the base of vein Rs on hind wing ; fore wing with a tuft on inner area on underside | ... | <i>Catopsilia</i> Hübner | |
| — Precostal vein thin. Male without secondary sexual characters on wings | ... | <i>Gandaca</i> Moore | |

13. *Catopsilia crocale crocale* (Cramer)

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

Material examined.—Andaman : 2 ♂♂, (no other data) (in *N. Z. C.*). S. Andaman : Chiriatapu, 1 ♂, 1 ♀, 20. xii. 1972. N. Andaman : Kishorinagar, Mayabunder, 1 ♂, 3. v. 1971.

Wing expanse.—Male and female, 55-80 mm.

Distribution.—Andaman Islands.

Remarks.—The subspecies is rare and is without any markings on upper side unlike the following two species, viz., *pyranthe* and *florella*, where the wings are marked on the upperside.

Although Talbot (1939) records the subspecies from both Andamans and Nicobars, Ferrar (1951) reports that he had no material from Car Nicobar.

14. *Catopsilia pyranthe pyranthe* (Linnaeus)

1758. *Papilio pyranthe* Linnaeus, *Systema Naturae*, ed. 10th ; 469.

Material examined.—S. Andaman : Dockyard, 1 ♀, 25. ii. 1970 ; Chiriatapu, 1 ♂, 27. v. 1971, 1 ♂, 28. v. 1971, 1 ♀, 22. x. 1972 ; Aberdeen Bay, 1 ♀, 12. xii. 1972 (heavy dusting in the margin) ; Marine hill, 1 ♂, 4 ♀♀, 16. xii. 1975 ; South Point, Port Blair, 1 ♂, 1 ♀, 17. xii. 1975. Kamorta, 1 ♀, 30. iii. 1970. Car Nicobar : Sawai, 1 ♂, 1 ♀, 25. ix. 1972 ; Kakana, 4 ♂♂, 2 ♀♀, 27. xii. 1972,

Wing expanse.—Male and female, 50-70 mm.

Distribution.—India, including Andaman Islands, Sri Lanka, Burma extending to Hainan and Taiwan (China) in the South, and Philippines, Borneo, Sulawesi and Java in the East.

Remarks.—The subspecies, rare in Andamans, but common elsewhere, closely resembles *Catopsilia crocale* as well as *florella gnoma* except in the forewing marginal markings which are sometimes heavily dusted in Andaman specimens compared with those from Car and Great Nicobars where the marginal markings are comparatively narrow, almost as in the latter species, so that it becomes difficult to differentiate these from each other. Although Talbot (1939) reports the distribution of *crocale* in Nicobars, there seems to be no authenticated record of the latter there. Instead, following the characters given by Talbot (1939), the present material can be assigned only to *pyranthe* and *florella gnoma* both of which occur together.

Accordingly, the subspecies has a wide distribution through S. Andamans, Central and Car Nicobar to the South Nicobar, thus filling the gap in its distribution at least between the mainland and the Indonesian Islands.

15. *Catopsilia florella gnoma* (Fabricius)

1776. *Papilio gnoma* Fabricius, *Syst. Ent.* : 828.

Material examined.—Great Nicobar : Campell Bay, 1 ♀, 24. viii. 1882 (in. *N. Z. C.*). S. Andaman : Chiriatapu, Near Guest House, 1 ♀, 22. x. 1972. Car Nicobar : Horticulture garden, 2 ♂♂, 1 ♀, 8. iii, 2 ♂♂, 1 ♀, 9. iii, 3 ♂♂, 11. iii. 1970 ; Kakana, 2 ♂♂, 2 ♀♀, 27. xii. 1972 ; Agriculture garden, Malacca, 1 ♂, 2 ♀♀, 26, 29. xii. 1972.

Wing expanse.—Male, 50-64 mm ; female, 52-66 mm.

Distribution.—India : Andaman Islands and Nicobars (New) ; Burma.

Remarks.—The record of the subspecies from S. Andamans to Great Nicobar, similar to that of *pyranthe* is interesting in view of being the first authenticated record of the subspecies from areas other than of Andamans. The majority of the specimens, both males as well as females, are invariably with reddish brown markings, though specimens without such markings are not rare but they can be differentiated by the presence of the narrow marginal spots, which are often separate from each other.

16. *Gandaca harina* (Horsfield)

Two subspecies are known to occur in Andaman and Nicobar islands, besides one each from the Indian mainland, Burma and Tonkin. Both these subspecies are dealt with here.

16 a. *Gandaca harina andamana* Moore

1906. *Gandaca andamana* Moore, *Lep. Indica*, 7 : 35, pl. 563 figs. 4, a, b, c. (♂ ♀).

Material examined.—Andaman : 3 ♂ ♂ (no other data). S. Andaman, 3 ♂ ♂, 6. v. 80, Port Blair, 2 ♂ ♂, (April-May), 1 ♂, (in *N. Z. C.*) ; Manglutan, 1 ♀, 17. xii. 1972 ; Panighat, 1 ♂, 3. i. 1973. N. Andaman : Kishorinagar, Mayabunder, 1 ♀, 3. v. 1971.

Wing expanse.—Male, 48-50 mm ; female, 44 mm.

Distribution.—Andaman Islands.

Remarks.—The subspecies *Gandaca harina andamana* Moore, seems to be common on the Andaman group of islands, and differs from the mainland specimens in the marginal border extending up to vein Cu_1 , or rarely below it. *Gandaca harina* bears a close resemblance to the species of the genus *Eurema*, but can be easily distinguished by the presence of a well developed precostal spur, a character present only in *Dercas* and *Catopsilia*. The species, is however, differentiated by the forewing apical margin being rounded (*vs.* pointed in *Dercas*) and in the absence of any secondary sexual characters in the male (*vs.* present in *Catopsilia*).

16 b. *Gandaca harina nicobarica* Evans

1932. *Gandaca harina nicobarica* Evans, *Identification of Indian Butterflies*, 2nd ed. : 76.

Material examined.—Great Nicobar : 2 ♂ ♂, 2 ♀ ♀, (no other data) (in. *N. Z. C.*)

Wing expanse.—Male, 38-42 mm ; female 42-48 mm.

Distribution.—Nicobar Islands.

Remarks.—This differs from the preceding subspecies in being paler and having a reduced marginal border. The subspecies is rare as compared with the preceding one from the areas of the Andamans.

17. *Eurema brigitta rubella* (Wallace)

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

Material examined.—No material was available.

Wing expanse.—Male and female, 30-40 mm. (*vide* Talbot, 1939).

Distribution.—India including Nicobar Islands ; Sri Lanka, Burma and extending to South China.

Remarks.—Referable to the genus *Eurema*, the species *brigitta*, rare in Nicobar but very common elsewhere, is recognised by the complete absence of the discocellular ring spots on the underside of the fore wing ; the inner edge of apical black border on the upperside of fore wing being regular and not indented ; and the male fore wing being without a sex brand on upper side. There is only a single subspecies with the distribution as above, but it seems to be very rare in Nicobars since it has neither been reported by Ferrar (1951) nor represented in the *N. Z. C.*, either in old collections or in recent surveys.

18. *Eurema blanda* (Boisduval)

The species is easily distinguishable by the number of cell spots being three on the underside of fore wing, as compared with generally two in *hecabe*. However, in the latter one or both the spots may be absent. The species is represented throughout the Andaman & Nicobar Islands. The mainland subspecies *blanda silhetana* extends right up to Andaman Island ; the material viz., *blanda moorei* from Central & C. Nicobar Island is more closely allied to *silhetana* than to the southern Nicobar subspecies viz., *blanda grisea*. All the three subspecies are dealt with here.

18a. *Eurema blanda silhetana* (Wallace)

1867. *Terias silhetana* Wallace, *Trans. ent. Soc. Lond.*, (3) 4 (3) : 324.

Material examined.—S. Andaman, 3 ♂♂, 1 ♀, 1 ex. without abdomen (no other data) (in *N. Z. C.*) ; Bedanabad, 2 ♀♀, 21. xii. 1972 ; Panighat, 2 ♀♀, 3. i. 1973 ; Ferrargunj, 2 ♀♀, 15. i. 1973 ; 2 ♂♂, 17. i. 1973 ; Aniket, 1 ♂, 16. i. 1973 ; Marine hill, Port Blair, 1 ♀, 16. xii. 1975 ; Horticulture garden, 2 ♀♀, 21. xii. 1975 ; Kalapahar, Rutland Island, 1 ♀, 9. i. 1976. Mid. Andaman : Yereta, 2 ♂♂, 8. i. 1973 ; 1 Km. E. of Rangat, 1 ♂, 5. iii. 1975, 2 Km. W. of Rangat, 1 ♀, 6. iii. 1975, N. Andaman : Mayabunder, 1 ♂, 1 ♀, 10. i. 1973.

Wing expanse.—Male, 47-49 mm ; female, 49 mm.

Distribution.—Andaman Islands.

Remarks.—The subspecies is common and occurs in the company of *E. hecabe blairiana*, but is characterised by at least two well developed marks in the cell of fore wing and with a subapical bar in both sexes on underside ; the ground colour being lighter or sulphur yellow but not pale as compared with the latter.

18b. *Eurema blanda moorei* (Butler)

1886. *Terias moorei* Butler, *Ann. Mag. nat. Hist.*, (5) **17** : 216, pl. v, fig. 1 (imago) (Nicobars : Camorta).

Material examined.—Kamorta, 1 ♂, 1 ♀, 2 exs. without abdomen (in N. Z. C.).

Wing expanse.—Male, 45 mm ; female, 40 mm.

Distribution.—Car Nicobar ; Central Nicobar Islands.

Remarks.—Very similar to the preceding, except in being paler and occurring in the company of *E. hecabe nicobariensis*. However, the three spots, rarely two well developed spots, differentiate *moorei* to a certain extent ; *moorei* is rare compared with the two other subspecies.

18c. *Eurema blanda grisea* (Evans)

1932. *Terias blanda grisea* Evans, *Identification of Indian Butterflies*, 2nd ed. : 78 (South Nicobar).

Material examined.—Great Nicobar, 2 ♂ ♂, 1 ♀, 1 ex. without abdomen ; Forest around Campbell Bay, 2 ♂ ♂, 26. xii. 1975 ; Campbell Bay, 2 ♂ ♂, 1 ♀, 31. xii. 1975.

Wing expanse.—Male, 48-52 mm ; female, 54 mm.

Distribution.—South Nicobar Island.

Remarks.—This subspecies can very easily be distinguished from the preceding subspecies from Car and Central Nicobar by the marginal band on the upperside of the fore wing being very narrow and reduced, particularly in male. In all the above specimens the three spots in cell of fore wing on the underside are quite prominent which differentiate it from *E. hecabe*.

19. *Eurema hecabe* (Linn.)

This species is widely distributed in India and is represented by as many as five subspecies, of which two viz., *blairiana* and *nicobariensis* occur in these islands and are dealt with here.

19a. *Eurema hecabe blairiana* (Moore)

1907. *Terias blairiana* Moore, *Lep. Indica*, **7** : 75, pl. 575, figs. 1 (♂), 1a (♀) (Andamans).

Material examined.—S. Andaman : Horticulture cum Zoological Garden, 2 ♀ ♀, 28. iv. 1970, 2 ♂ ♂, 1 ♀, 21. xii. 1975 ; Aberdeen Bay, 2 ♀ ♀, 13. xii. 1972, 1 ♂, 15. xii. 1972 ; Caddlegunj, 2 ♀ ♀, 16. xii.

1972 ; Bedanabad, 1 ♀, 21. xii. 1972 ; Ferrargunj, 1 ♂, 17. i. 1973 ; Aniket, 1 ♀, 16. i. 1973 ; Marine hill, 1 ♀, 15. xii. 1972, 2 ♂♂, 1 ♀, 16. xii. 1975 ; South Point, 3 ♂♂, 2 ♀♀, 17. xii. 1975 ; Wandoor, 30 Km. S. W. of Port Blair, 1 ♂, 18. xii. 1975 ; Moujari, Chiriatapu, 1 ♂, 8. i. 1976 ; Kalapahar, Rutland Island, 1 ♀, 9. i. 1976. Mid. Andaman : Panchwati, 1 ♀, 6. i. 1973 ; 1 Km. South of Rangat, 1 ♀, 4. iii. 1975, 2 Kms. W. of Rangat, 1 ♂, 6. iii. 1975. N. Andaman : Mayabunder, 2 ♀♀, 10. i. 1973 ; Tugapur, 1 ♂, 10. i. 1973.

Wing expanse.—Male, 44-54 mm ; female, 46-52 mm.

Distribution.—Andaman Islands.

Remarks.—Very common in Andaman Island, the subspecies is not easily separable from *E. blanda silhetana* and the large number of examples which are available to us vary considerably. However, both males and females are paler, generally unmarked on the underside or at most with one or two very faint marks in the cell of fore wing. The subapical bar is poorly developed in the male, and obsolete in the female (*vs* well developed in *silhetana*).

19b. *Eurema hecabe nicobariensis* (Felder)

1862. *Terias nicobariensis* C. Felder, *Verh. zool. bot. Ges. Wien*, 12 : 480.

Material examined.—Car Nicobar : 1 Km. South of Circuit House, Malacca Village, 1 ♂, 4. iii. 1970 ; Horticulture Garden, 1 ♂, 8. iii. 1970 ; Keating Point, 1 ♀, 7. iii. 1970. Malacca Agriculture Garden, 1 ♀, 26. xii. 1972 ; Teetop, 1 ♂, 26. xii. 1972 ; Kachal, 1 ♂, 1 ♀ (in. *N. Z. C.*). Kamorta, 1 ♀, 19. iii. 1970, 2 Km. North East of Guest House, 1 ♂, 24. iii. 1970, 1 ♂, 8. x. 1972 ; Trainkate Is., 1 ♀, 20. iii. 1970 ; Malacca, Kakana Road, 1 ♂, 25. xii. 1972, 1 ♀, 27. xii. 1972 ; Nancowry, 7 ♂♂, 2 ♀♀ (in. *N. Z. C.*). Great Nicobar : 1 ♂, 1 ♀ 6 exs. without abdomen (in. *N. Z. C.*) ; Forest around Campbell Bay, 2 ♂♂, 26. xii. 1975 ; Laksman Beach, 1 ♂, 28. xii. 1975 ; Champa Bay, 3 ♂♂, 2 ♀♀, 31. xii. 1975.

Wing expanse.—Male, 37-45 mm ; female, 30-56 mm.

Distribution.—Nicobar Islands.

Remarks.—Both males and females are slightly paler compared with *silhetana*. For remarks see *E. blanda moorei*.

20. *Eurema andersoni evansi* Corbet & Pendlebury

1932. *Eurema andersoni evansi* Corbet & Pendlebury, *Bull. Raffles Mus. Sing.*, 7 : 179, pl. V.

Material examined.—S. Andaman : Bedanabad, 1 ♀, 21. xii. 1972 ;

Ferrargunj, 1 ♀, 15. i. 1973 ; Port Blair, Marine hill, 1 ♀, 16. xii. 1975. Gt. Nicobar, 5 ♂♂, 2 ♀♀ (no other data). (in *N. Z. C.*)

Wing expanse.—Male, 37-45 mm ; female, 36-56 mm.

Distribution.—Andaman Islands.

Remarks.—This is very closely allied to *E. hecabe blairiana* in the markings which are reported to be well developed, being dry-season in form as compared with *blairiana* which is supposed to be a wet-season form of *hecabe contubernalis*. As a matter of fact there are certain specimens of *blairiana* from Port Blair, which, although heavily marked, do not possess one zig-zag spot in the cell but more than one spot, a characteristic feature of *andersoni evansi* ; the latter is also characterised by the presence of a well developed spot in each area between Rs-M₁, and below Cu₁, unlike *blairiana* where these spots are poorly developed, and by a well developed subapical transverse stripe, with yellow spots on it on the underside of fore wing.

SUMMARY

The paper deals with 20 species with 27 subspecies distributed over eleven genera under two subfamilies viz., *Pierinae* and *Coliadinae*. The paper gives the detailed distribution of the Pieriid-fauna from these islands and confirms the occurrence of one species, in Andamans and reports two new records from Nicobars.

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REFERENCES

- ARORA, G. S. AND NANDI, D. N. 1980. On the butterfly fauna of Andaman and Nicobar Islands (INDIA). I. Papilionidae. —*Rec. zool. Surv. India*, 77 : 141-151.
- FERRAR, M. L. 1951. The butterflies of the Andaman and Nicobars.—*J. Bombay nat. Hist. Soc.*, 47 (3-4) : 470-491.
- TALBOT, G. 1939. *Fauna of British India, Butterflies*, 1 : XXIX+600 pp. (Taylor & Francis Ltd., London).
- WYNTER-BLYTH, M. A. 1957. *Butterflies of the Indian Region*, xx+523 pp. (B. N. H. S., Bombay).

OBSERVATIONS ON THE ZOANTHID, *SPHENOPUS MARSUPI-
ALIS* (GMELIN) (ANTHOZOA : ZOANTHIDEA : SPHENOPIDAE),
ALONG THE SOUTHEAST COAST OF INDIA, WITH NOTES
ON ITS BEHAVIOUR IN AQUARIA

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(With 1 Chart and 2 Text-figures)

INTRODUCTION

Sphenopus marsupialis (Gmelin) is a very common zoanthid found in the general sea-area between low-water mark and depths of at least 60 metres offshore, along the southeast coast of India from at least Ennur in the north to Nagapattinam in the south, being particularly common on sandy and muddysand sea-bottoms with a coarse substratum ; information on distribution, food and feeding, colouration, locomotion, growth and longevity are presented in this paper.

Practically nothing is known in the literature about this zoanthid, although our data indicate it to be a common form, and hence it was taken up for detailed study.

Gravely (1941) has recorded the occurrence of this species among the organisms cast up on Madras beaches. Menon (1927) has mentioned the absence of this species at Krusadai. Menon (1931) has found the Semper's larvae of *Sphenopus* in the plankton of the Madras area during the general period from November to February, with swarms in January and February.

MATERIAL AND METHODS

Data were collected on the occurrence of this species during the regular trawling and dredging operations carried out between Ennur in the north and Kalpakkam in the south, and down to a depth of over 60 metres offshore by the R. V. CHOTA INVESTIGATOR (see Chart I) from March 1975 to August 1979 inclusive. These specimens were brought back alive and put into the experimental tanks of the Station for detailed studies ; batches of the animals being used for the various experiments. Specimens were also collected during the 1976

and 1977 southeast coastal surveys during which it was found that this species was of common occurrence from Ennur in the north to Nagapattinam in the south.

A size-range between 5 mm and 45 mm was taken during hauls made by the R. V CHOTA INVESTIGATOR off Madras ; while a size-

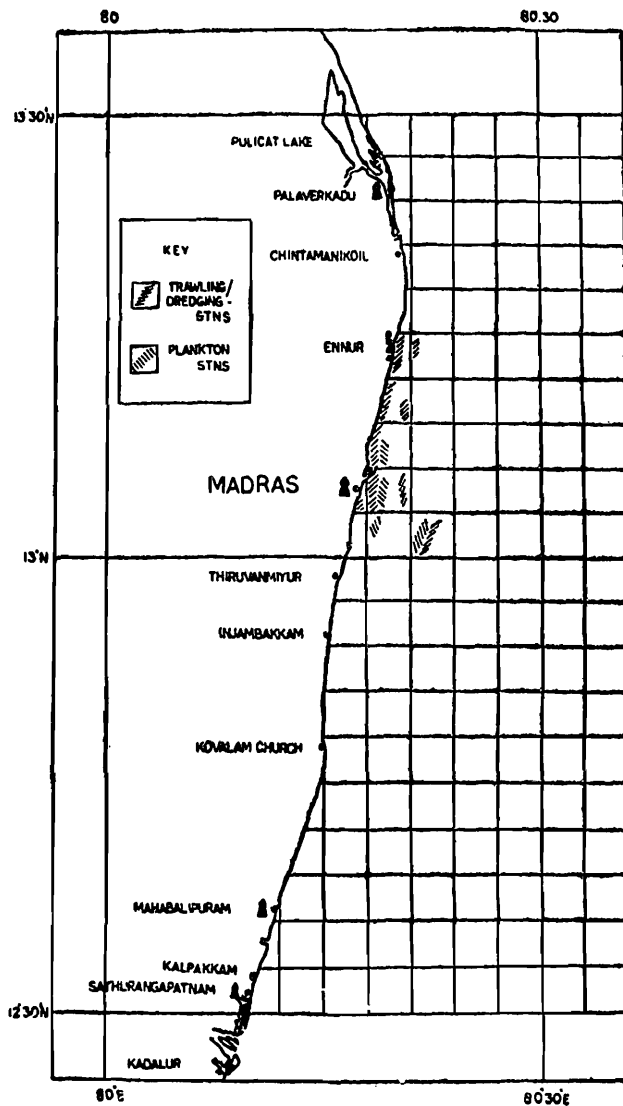


Chart 1. Operational area of R. V. "CHOTA INVESTIGATOR"

range between 20 mm and 75 mm was taken along the southeast coast during the general surveys.

FIELD OBSERVATIONS

This species is commonest on muddysand substrata with coarse sand grains ; it also occurred on coralline grounds in the deeper water—between 50 and 60 metres depths. This is the first time that this species is being recorded in such varying ecological habitats.

A Naturalist's dredge with a rectangular opening measuring 75 cms by 30 cms was used at a speed of approximately 2 knots over the grounds ; the dredge samples revealed that the species occurred

throughout the year and there did not appear to be any particular pattern in its distribution with increase in depth. A 10-minute operation of the dredge on muddysand substrata brought up 75-100 specimens, while a similar density of population was observed for coarse sand in depths ranging from 8-30 metres offshore ; a 10-minute dredge haul over coralline substrata landed 50-80 specimens. During the field surveys, the shore-seine hauls yielded large numbers of this species, when the inter-tidal and sub-tidal zones were sampled.

Thus, *Sphenopus marsupialis* is common on coarse sandy substrata, with or without an admixture of mud ; as well as on coralline substrata.

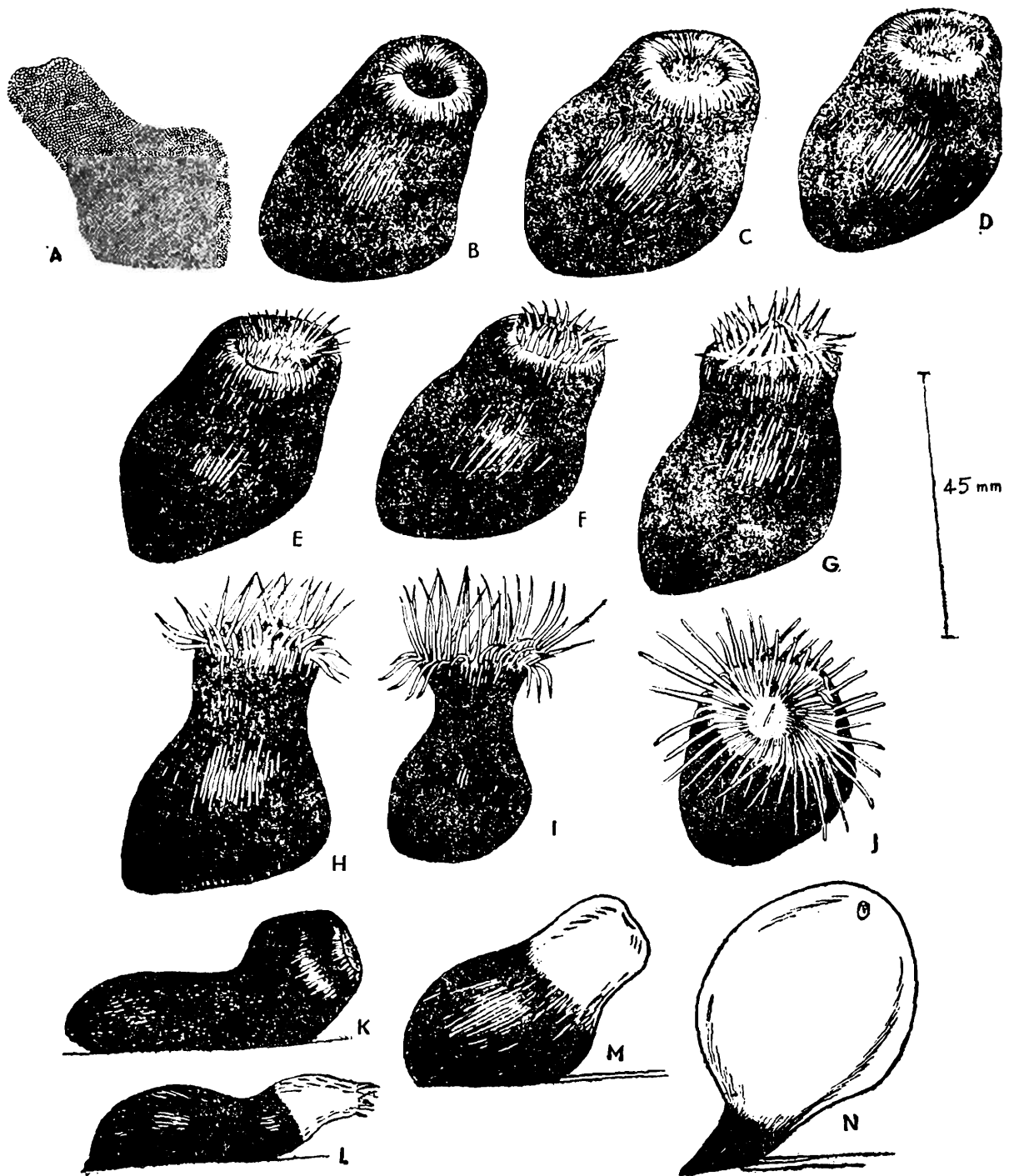
GENERAL DESCRIPTION

Sphenopus marsupialis has a laterally compressed, arrow-head shaped body in the resting, fully contracted condition, covered entirely with a 'coat' of sand particles when brought up from the seabed (Text-fig. 1-a) ; at first sight these blobs of sand do not even appear to contain an animal. When introduced into the aquarium, the animals throw off their sandy coat and unfold themselves into the typical zoanthid configuration, exhibiting muscular movements and a great range of body shape (Text-fig. 1 b-m).

When put on a sandy substratum in the aquarium, they burrow into the sand, exposing only the oral disc and tentacles above the surface ; indicating that this species forms a part of the infauna in the natural state. When disturbed, the animals moved from one location to another, using muscular contractions of the arrowhead shaped lower half of the body (see under : 'Locomotion').

Disturbance of the fully expanded animals results in immediate contraction, with invagination of the oral disc (Text-fig. 1-b). Approximately 30 minutes is taken by a fully contracted individual to fully expand itself (Text-fig. 1-c to j).

When fully expanded, the translucent inner row of oral tentacles are nearly half the length of the body while the outer row of tentacles fringing the oral disc are half the length of the inner row of tentacles. The tentacles usually hang down the sides of the columnar body (Text-fig. 1-i) which usually stands almost erect on the basal portion of the body. The two rows of oral tentacles surround the oral disc, which when fully expanded has a diameter nearly equal to the length of the animal for larger specimens (over 10 mm), and almost $\frac{3}{4}$ the length of the body for smaller specimens. There are 27 tentacles in the outer row and 24-26 tentacles in the inner row for a specimen measuring 10 mm.



Text-fig. 1 (a to n). *Sphenopus marsupialis* (Gmelin). a—freshly caught specimen with sandy 'coat', b—'coat' of sandy grains thrown off ; c to i—stages in the unfolding/evagination of oral disc and tentacles ; j—oral view of tentacular rings, note slit-like oral opening in the centre of the oral disc ; grooves lead to the oral opening from the circular edge of the oral disc ; k, l—nearly tubular shape adopted by *Sphenopus* for rapid gliding movement along substratum ; m—body held at an angle (variable) to substratum, for slower gliding movements, note pale creamy colouration of oral part of body ; n—body with small wedge-shaped basal part of body adopted for slow gliding movements, note rare bloating of the body due to inrush of water which larger prey, and pale creamy colouration of almost the whole body except for basal end.

OBSERVATIONS IN AQUARIA

The live specimens were introduced into a tank of 150 litre capacity, the contained seawater being aerated and the animals were 'conditioned' for a week during which time they were not fed. Different batches of *Sphenopus* were used for feeding studies and locomotion observations.

Food and feeding habits :

After each feeding experiment, the test-animals were dissected to confirm that complete digestion of the food material had occurred.

Plankton townetings containing chiefly copepods, copepodites, *Sagitta*, fish eggs and larvae, *Pleurobrachia*, and pteropods (*Limacina*, *Creseus*), with small numbers of mysids, *Acetes* and shrimp larvae were introduced into the tank containing *Sphenopus*. When any of these plankters touched the oral disc, the cilia on the oral disc appeared to seize and convey the now passive food-organism along the grooves on the oral disc (Text-fig. 1-j) towards one of the tentacle bases of the inner row of tentacles. The cilia on the base of the tentacle took over the food-item and conveyed it to the tip of the tentacle; the tentacular tip was then observed to bend over and drop the food organism into the slit-like mouth in the centre of the oral disc.

Sphenopus appeared to prefer the ciliary mode of feeding, to feeding on larger organisms. However, when bits of fish meat, etc., were dropped onto the disc of a *Sphenopus* while it was feeding on a rich plankton supply, the flesh ball was observed to be pushed away from the mouth by the ciliary mechanism of the oral disc, and ultimately it was toppled over the disc's edge to the aquarium floor. From this it would appear that *Sphenopus* prefers small living zooplankters to larger bits of dead organic material.

Table 1 gives details of observations made with different sizes of *Sphenopus*, food organisms taken, time for digestion, etc.; it was also observed that larger dying animals were attacked by 6-7 *Sphenopus* which attached themselves by their oral discs to the prey, and digestion had occurred deep into the musculature of the prey at the sites of attachment of the oral discs.

The above observations indicate that while *Sphenopus* is chiefly a plankton feeder using a ciliary mechanism, it is also capable of ingesting a variety of living and dead material when deprived of its normal planktonic food-supply. The mode of capture of the larger organisms which fall on the oral disc is as follows: The tentacles push the food item into the oral slit by sharply bending inwards, simultaneously

the coelenteron enlarges so that there is a quick inrush of water into the body carrying the food item further deeper into the coelenteron, the oral end of the animal invaginates firmly sealing the oral end ; after digestion is completed the anterior end evaginates unfolding the two rows of oral tentacles and oral disc, any indigestible matter is now voided.

Locomotion :

The animals showed great plasticity of body shape (Text-fig. 1-k to n) ; and only in the contracted or resting condition was the typical arrow-head configuration of the body to be seen.

When starved of a copious supply of plankton, *Sphenopus* was observed to exhibit characteristic modes of locomotion, these may be detailed as follows :

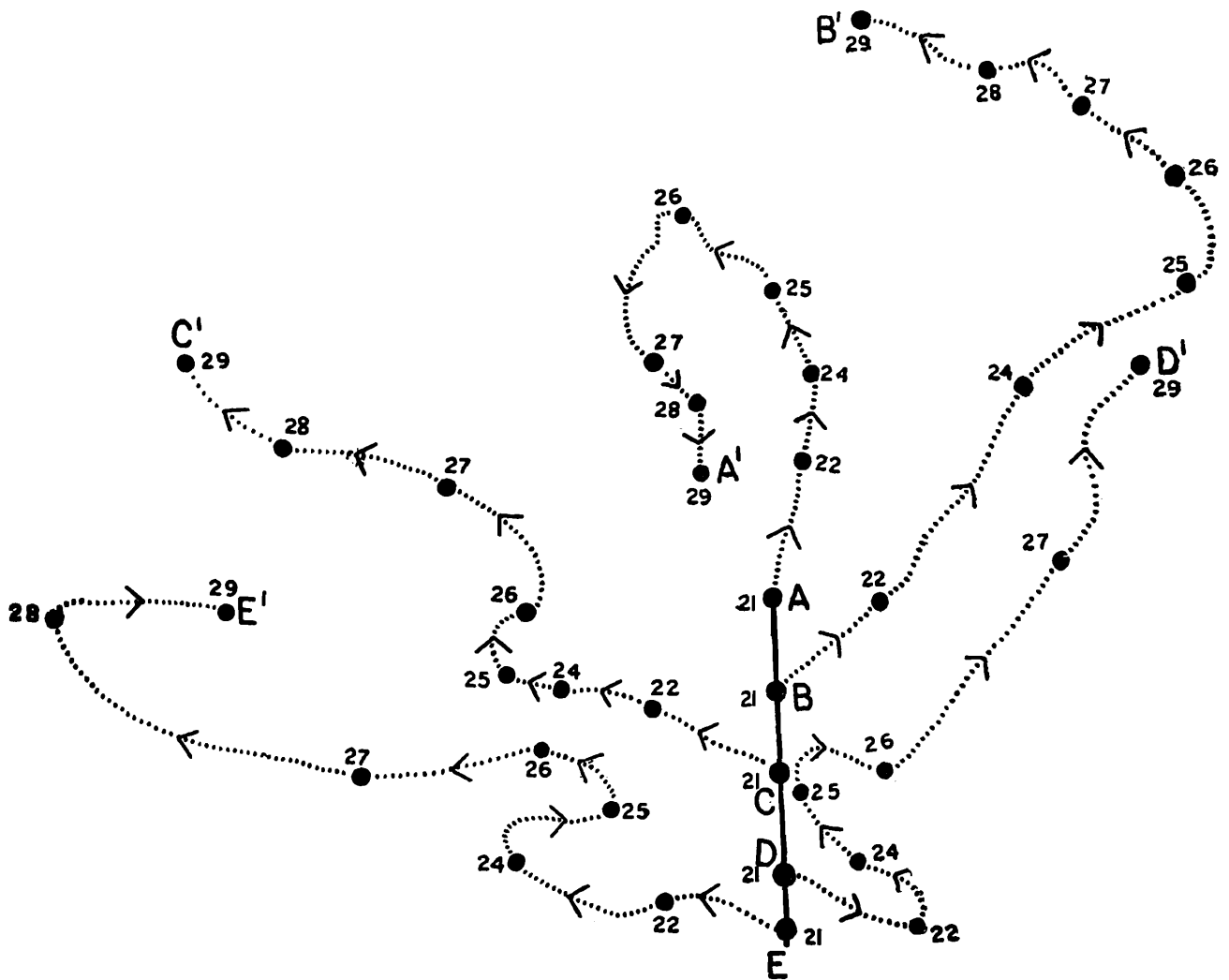
(i) From the near vertical position the animal falls over and becomes practically tubular (Text-fig. 1-k & l) ; usually, the body-wall is fairly hard to the touch, but when any area of the bodywall is in contact with the substratum, it first becomes soft to the touch and exhibits 'peristhalsis'. such that the animal moves forward with the oral end leading. During this type of locomotion the oral disc and tentacles may or may not be fully extended ; and is resorted to when the animal has to move quickly from point to point for feeding.

(ii) The animal does not fall over to the horizontal position, but leans over at an angle varying from near vertical to almost horizontal so that a varying area of the bodywall is apposed to the substratum ; and the animal moves at a slower speed from point to point (than that noted in (i) above) by peristhalsis (Text-fig. 1-m.)

(iii) The animal remains vertical, the basal end in contact with the substratum becomes broadened and exhibits peristhalsis in the direction of desired movement, usually with the oral disc and tentacles well expanded. The animal moves slowest by this mode of locomotion. (Text-fig. 1-n.)

The speed of locomotion is variable ; the maximum traversed in 24 hours was 115 mm, the minimum being 20 mm. Figure 2 shows the random movements exhibited by *Sphenopus* over several days from the 21st to 29th May, 1976. The 5 animals were arranged in a linear row, and a rich supply of plankton introduced more or less uniformly in the tank, throughout the period of observation. It was noted that the animals showed random movements from the initial position in

each case, in response to local concentrations of zooplankters. It would appear that even with a good supply of plankton, *Sphenopus* do move around to some degree and are not entirely static. However, sometimes the animals have been observed to remain more or less stationary for extended periods (24-48 hours) when the plankton in their immediate vicinity has been in copious supply, and the animals have remained steady in position. The movements of *Sphenopus* while primarily



Text-fig. 2. Random movements exhibited by *Sphenopus* between 21st and 29th of May, 1976 ; the maximum distance traversed was 115 mm, the minimum being 20 mm during a period of 24 hours.

motivated by food supply, being particularly pronounced while the animals were starved, could also be due to irritation. When objects are dropped on them, the animals tend to move away from the vicinity of such objects, particularly when such objects have no food value.

Other observations :

Sphenopus showed a variegated colouration ranging from an almost jet-black to a golden colour when taken from the sea, depending on the colour of the sandy 'coat' ; when this 'coat' of sand grains is cast

off in the aquarium, the body epidermis reveals itself to be darkly pigmented. The animals showed the capacity to change the colouration of the whole body save the basal portion, to a pale light creamy colour (Text-fig. 1-t to n). The exact stimuli which cause these changes in colouration have to be investigated, perhaps they are in response to different internal and external factors.

The smallest specimens collected during the present study measured 5 mm in body length, when fully expanded, and occurred during the months of March and December. Six specimens measuring 5 mm, during a period of study extending for 18 months, grew to a length of 35 mm when well fed and kept in a separate tank. No eggs and larvae were released by any of the *Sphenopus* kept in the aquaria.

DISCUSSION

Sphenopus marsupialis (Gmelin) is a common zoanthid in the Madras area, and present data showed it to occur commonly along the south-eastern coast from Ennur in the north to at least Nagapattinam in the south, and occupying a variety of substrates varying in depth from the low-water tide mark to depths of 60 metres at least, and sea-bottoms of a sandy nature to a mixture of muddysand and gravel and also coralline bottoms. Previously Menon (1927) has recorded its absence at Krusadai, stating however that it was common near Madras. Gravely (1941) has recorded that it has been cast up on Madras beaches. Gray (1867) has described *Sphenopus marsupialis* (Gmelin) and figured it along with other zoanthids. Menon (1931) while giving a general account of the Madras plankton, has found the Semper's larvae of *Sphenopus* to occur from November to February inclusive, with large swarms of the long larvae commonly present in the plankton during the months of January and February. Our data indicates that specimens of 5 mm occurred demersally during December and March, and we have not been able to take the larvae in the open sea plankton.

There are no data on the biology of *Sphenopus* in the literature. Our data shows that this species is primarily a plankton feeder, being also capable of feeding on a variety of living and dead macro-organisms ; this would indicate that *Sphenopus* could play a scavenging role in the ecological niche inhabited by it. It is also capable of great plasticity of body form and also it is capable of movement foraging actively on living and dead benthic, nektonic and planktonic organisms. The factors that enable control of its pigmentation are not clear, but the animal exhibits changes of colouration of particularly the oral end of the body.

The species has a life-expectancy of at least 18 months, possibly more, as in nature forms larger than 35 mm (the size attained under observation, from 5 mm to 35 mm) have been taken in the gears used.

TABLE 1 : Showing the size of *Sphenopus*, size of prey captured, time taken for digestion, and remarks on voiding of waste matter, etc.

<i>Sphenopus</i> Length (mm)	Food, size : mm	Time for digestion (hrs)	Remarks
30	Young fish, <i>Scatophagus argus</i> , 20 mm total length	6	Small pellet voided.
30	Fish meat-ball, 15 mm dia.	3 1/2	Very little matter voided
35	<i>Aequora</i> sp., 15 mm dia.	1 1/2	———
35	<i>Aequora</i> sp., 20 mm dia.	1 3/4	———
40	<i>Rhopilema</i> sp., terminal appendage 45 mm length	4	<i>Rhopilema</i> was able to escape only after it lost its terminal appendage

Gravely (1941) has mentioned that it is due to embedding of microscopic grains of dark sand that the animal looks blackish in colour. Our data show that this is not the case, the 'coat' of sand grains varies in hue depending on the niche occupied by the animal, and the animal is capable of casting off this coat revealing a darkly pigmented body, and it is capable of changing the pigmentation of the anterior (oral) part of its body. Further work is necessary to determine the nature of the adhesive produced by the body of the animals by which they coat themselves with sand grains under natural conditions, as also the significance of such a coat, perhaps it is for camouflage and/or protection against predators.

Hyman (1940) has described the movements of actinians (sea-anemones) in general, and our data indicate both the speed and moed of such movements for *Sphenopus*.

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REFERENCES

- GRAVELY, F. H., 1941 Shells and other animal remains found on the Madras beach : I—Groups other than Snails, etc. *Bull. Madras Govt. Mus., n. s., Nat. Hist. Sect.*, **5** (1) : 15-16.
- GRAY, J. E., 1867. On the Zoanthini. *Proc. zool. Soc., Lond.*, 1867 : 236, figs. 2-5.
- HYMAN, L. H., 1940. *The Invertebrata : Protozoa through Ctenophora*. McGraw-Hill Book Co., New York, pp. 566-599.
- MENON, K. R., 1927. Sub-Class Zoantharia (except Scleratiniae). *Bull. Madras Govt. Mus., n. s., Nat. Hist. Sect.*, **1** : 31-40.
- MENON, K. S., 1931. A preliminary account of the Madras plankton. *Rec. Indian Mus.*, **23** (1931) : 489-516, pl. ix-xv.

DETAILED STUDIES ON THE MORPHOLOGY AND INTRA-SPECIFIC VARIATIONS OF *PARAHADRONCHUS SHAKILI* (JAIRAJPURI, 1969) MULVEY, 1978 WITH SOME OBSERVATIONS ON ITS JUVENILE STAGES

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(With 7 Text-figures)

INTRODUCTION

The nematodes belonging to the Order Mononchida Jairajpuri, 1969, generally referred to as mononchs, constitute one of the most important groups among the soil nematodes because of their predatory feeding habits. Several workers have reported and described a large number of species of mononchs from different parts of the world (Cobb, 1916 & '17 ; Clark, 1960—'63 ; Mulvey, 1961—'78 ; Mulvey & Jensen, 1967 and Jairajpuri, 1969—'75). But only a few workers have worked exclusively on the morphology of mononchs (Coomans & Lima, 1965 and S. Z. Baqri & Jairajpuri, 1972). Since the detailed morphological and anatomical observations on a group or a species help in understanding the evolutionary trend in the nematodes, the present work was initiated on *Parahadronchus shakili* (Jairajpuri, 1969) Mulvey, 1978 which is a widely distributed species of mononchs in North and North-Eastern part of India.

In the present study an attempt has been made to describe in detail the intra-specific variations, the musculature, the digestive and the reproductive organs of *Parahadronchus shakili*. Besides, observations have also been made on different juvenile stages of this species. The specimens included in the present study were collected from soil around roots of *Litchi chinensis* Sonn. at Company gardens, Bareilly, Uttar Pradesh.

MATERIAL AND METHODS

The specimens of *Parahadronchus shakili* were fixed in hot 4% formalin, dehydrated slowly in a desiccator and mounted in dehydrated glycerine. The transverse sections of body at various levels were cut with the help of a sharp razor blade in glycerine-jelly and were mounted in the same medium.

GROSS MORPHOLOGY AND INTRA-SPECIFIC VARIATIONS OF *PARAHADRONCHUS SHAKILI* (JAIRAJPURI, 1969) MULVEY, 1978

Dimensions :

Females (140) : $L=2.40-3.35$ mm ; $a=40-52$; $b=3.8-6.0$;
 $c=6.4-11.8$; $c'=5.6-9.5$; $V=^{9-15}60-66^{9-15}$

Males (62) : $L=2.32-3.22$ mm ; $a=35-53$; $b=4.2-5.2$; $c=7.3-11.8$; $c'=4.5-7.0$; $T=39-45$.

Description :

Female : Lip region fairly expanded, marked off from body, 45-60 μ m wide, 15-25 μ m high, distinctly wider than the adjoining body. *En face* view (Text-fig. 4, A) shows the vestibulum bounded by six lips which are of same shape and size. There are two dorsolateral, two ventrolateral and two lateral lips. Each lip is provided with an outer and an inner papilla. Thus the two circlets have six papillae each. Near the middle of lips on either side of internal papillae are present prominent dots. Amphids are small cup-like, apertures 5-6 μ m wide, at 18-21 μ m from anterior end of body. The amphidial chamber is connected to an amphidial duct which leads to the sensillar pouch containing sensory neurons.

Stoma consists of a hexaradiate vestibulum and a barrel-shaped tri-radial buccal cavity 50-65 $\times$ 32-39 μ m. Apex of dorsal tooth at 21-30 μ m from the base of stoma. Walls of buccal cavity are formed by two sets of heavily cuticularized plates, the vertical and the oblique sets. The dorsal plate of the vertical set bears a large tooth in the posterior half of buccal cavity. The subventral walls bear 2-7 teeth and the oblique wall have two foramina each.

Oesophagus is roughly cylindrical and strongly muscular, with tri-radiate lumen, slightly expanded at its anterior end, narrowing a little at nerve ring and then widening towards base. The oesophago-intestinal junction is tuberculate with non-sclerotized tri-radiate lumen. Orifices of oesophageal glands are located as follows : dorsal 281-302 μ m from anterior end of body ; the first pair of subventrals 109-140 μ m from the orifice of dorsal one ; the second pair 168-196 μ m from the first pair. Nerve ring encircles the oesophagus at 148-197 μ m from anterior end of body. Intestine is sac-like, flattened dorsally in the region of gonads with 6-7 cells in circumference. Rectum 33-54 μ m or about one anal body-width long.

Vulva transverse, slit-like, post-equatorial in position with cuticularized lips. Pre-vulval papillae 0-3, post-vulval papillae 0-2. Vagina short, thick-walled. Gonads amphidelphic, ovaries reflexed. Each sexual

branch consists of an ovary with 10-25 oocytes, an oviduct with a narrow distal and an enlarged sac-like proximal part, well developed sphincter and a large flexible uterus. Uterine eggs measure $124-138 \times 51-56 \mu\text{m}$.

Tail $262-430 \mu\text{m}$ or about 6-10 anal body-widths long, elongate-conoid, tapering sharply. Caudal glands well developed, opening terminal. Caudal papillae 4 on either side.

Male : Body generally strongly curved in posterior half of its length, often 'C' shaped. Buccal cavity $49-60 \times 29-35 \mu\text{m}$. Apex of dorsal tooth $19-27 \mu\text{m}$ from base of stoma. Spermatozoa spindle-shaped measuring $6-10 \mu\text{m}$. Four ejaculatory glands generally visible from one side. Spicules $91-106 \mu\text{m}$ medially, gubernaculum $18-24 \mu\text{m}$ and lateral accessory pieces $12-18 \mu\text{m}$. Supplements 11-16. Rectum $38-56 \mu\text{m}$ or about one anal body-width long. Tail $223-354 \mu\text{m}$ or about 5-7 anal body-widths long.

ANATOMY OF *PARAHADRONCHUS SHAKILI*

MUSCULATURE

The musculature can broadly be divided into 'somatic or unspecialized musculature' which are arranged in the interchordal zones of the hypodermis and the 'specialized musculature' are those associated with a particular organ.

Somatic musculature (Text-fig. 3, I—K) :

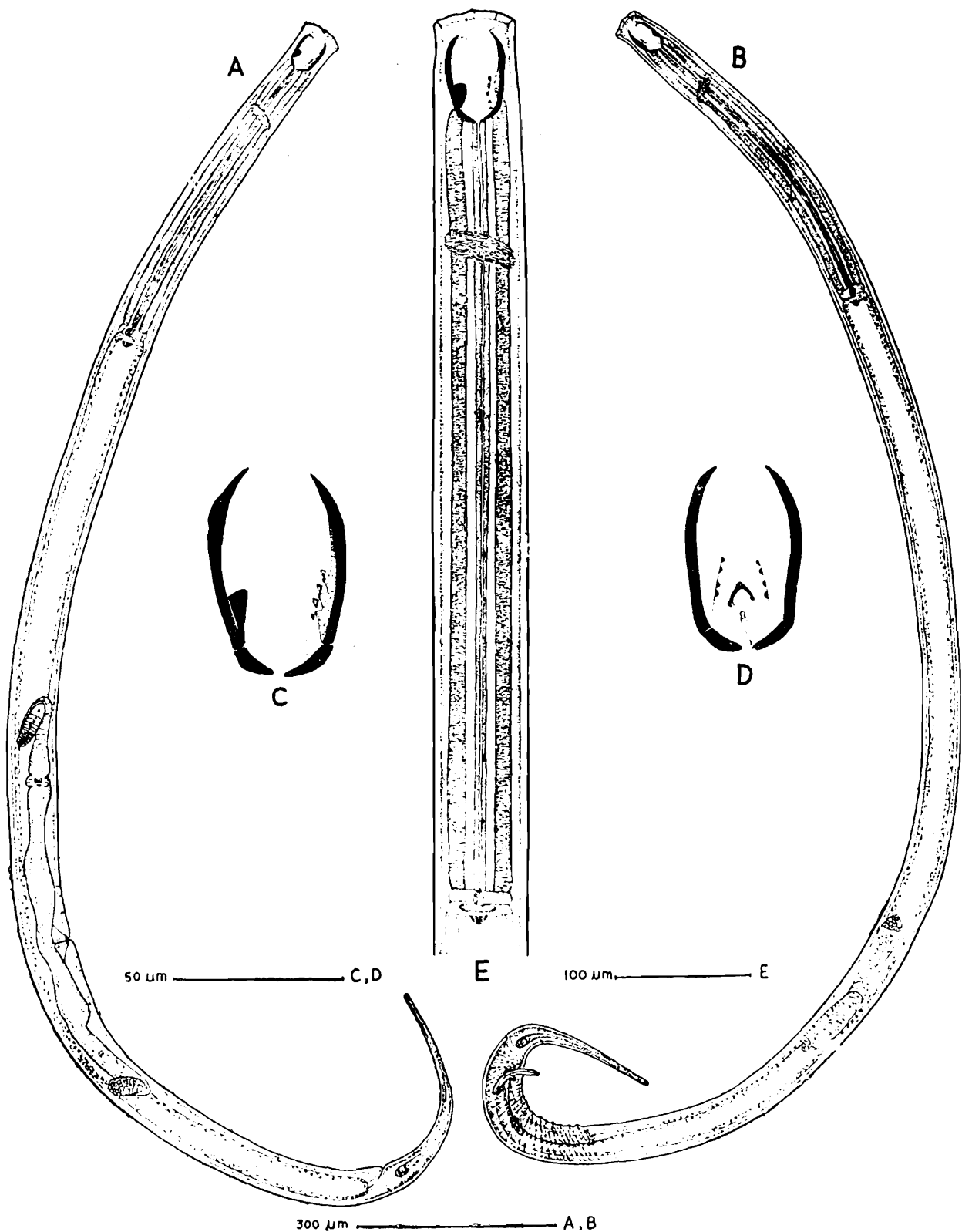
The somatic musculature consists of a single layer of cells situated beneath the hypodermis within the interchordal zones. In each quadrant four cells are present which shows that the nematodes are typically meromyarian. The cells are typically of platymyarian type. The shape and size of the muscle cells may be variable at the same or at different levels of body.

Specialized Musculature :

(i) *Cephalic muscles* : These are two sets of muscles. One set is attached to the lips and is known as labial muscles. The other set is attached to the walls of the stoma and is called stomatal muscles.

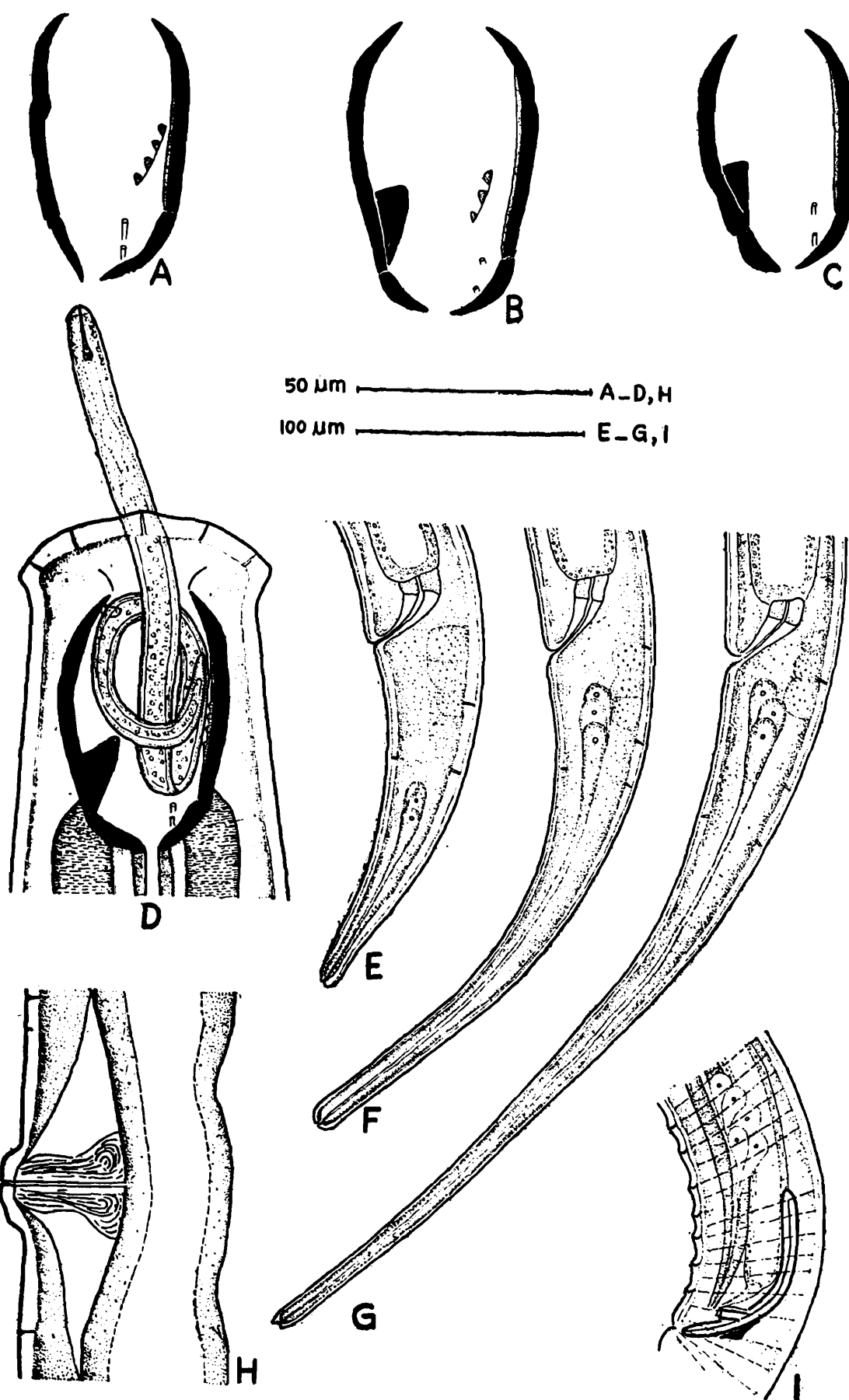
a. *Labial muscles* (Text-fig. 3, B and 4, D : 1) : These are six in number bifurcated at their anterior ends. The forked bands of labial muscles are attached to adjoining lips. Thus each lip is bounded by two different labial muscles. Most probably dots near the middle of lips on either side of the internal labial papillae are the points of attachment of these muscles.

b. *Stomatal muscles* (Text-fig. 3, B and 4, D : 2) : These are eight in number attached to the vertical walls of stoma. The point of their attachment is posterior to labial muscles. In cross section of body at level of stoma it becomes evident that two of these are subdorsal, two subventral and four sublateral in position. The contraction and relaxation of these muscles brings about the opening and closing of stoma.

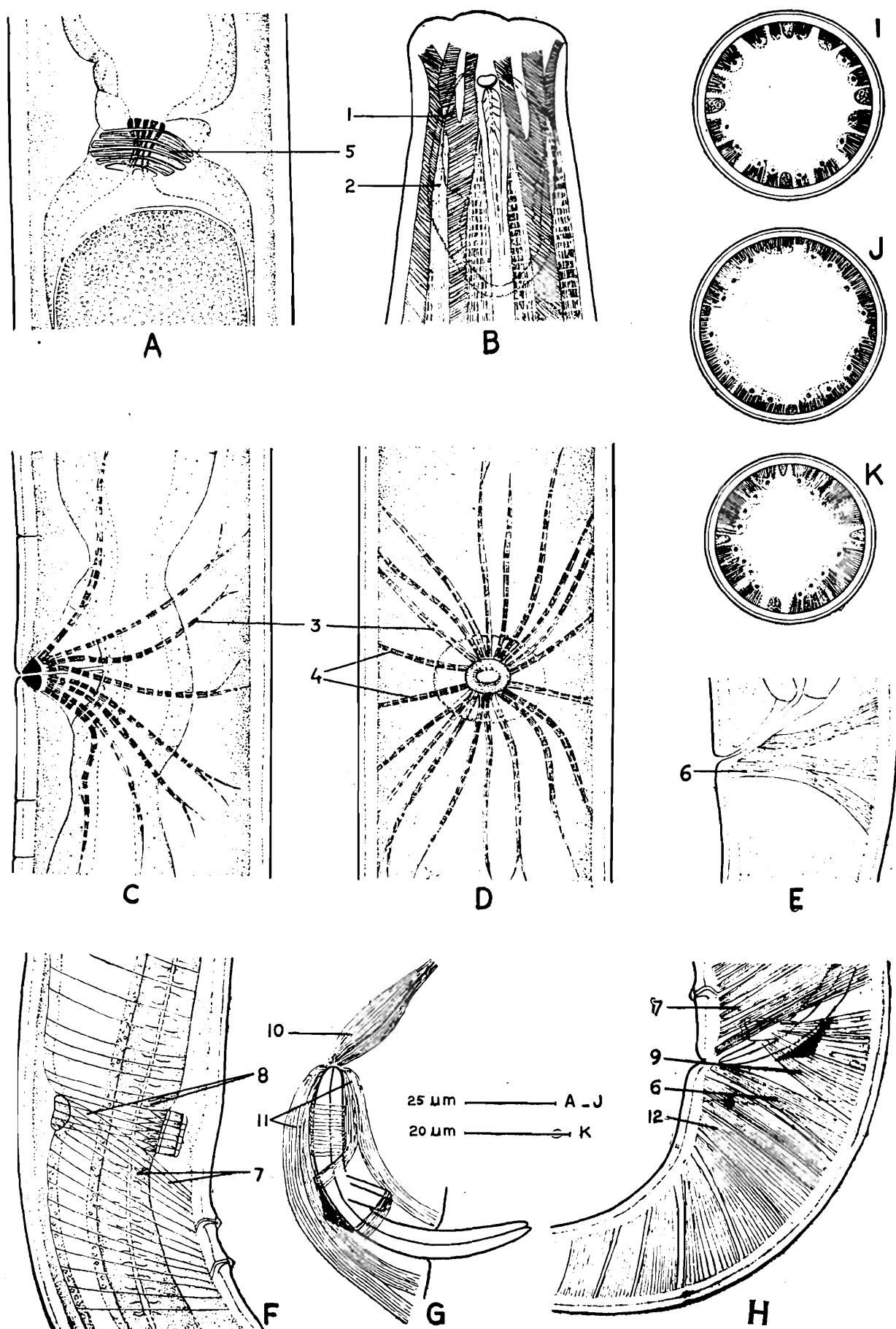


Text-fig. 1. A—Entire female ; B—Entire male ; C—Buccal cavity (Lateral view) ; D—Buccal cavity (Dorso-ventral view) ; E—Oesophagus.

(ii) *Vulval muscles* : The muscles associated with vulva bring about its dilation and contraction. Basically two sets of muscles are found associated with the vulva.



Text-fig. 2. A-C—Abnormal buccal cavities ; D—Anterior region of body showing a nematode (Prey) in the buccal cavity ; E-G—Abnormal tails ; H—Vagina without cuticularized pieces ; I—Posterior region of male showing abnormal number of ejaculatory glands (five).

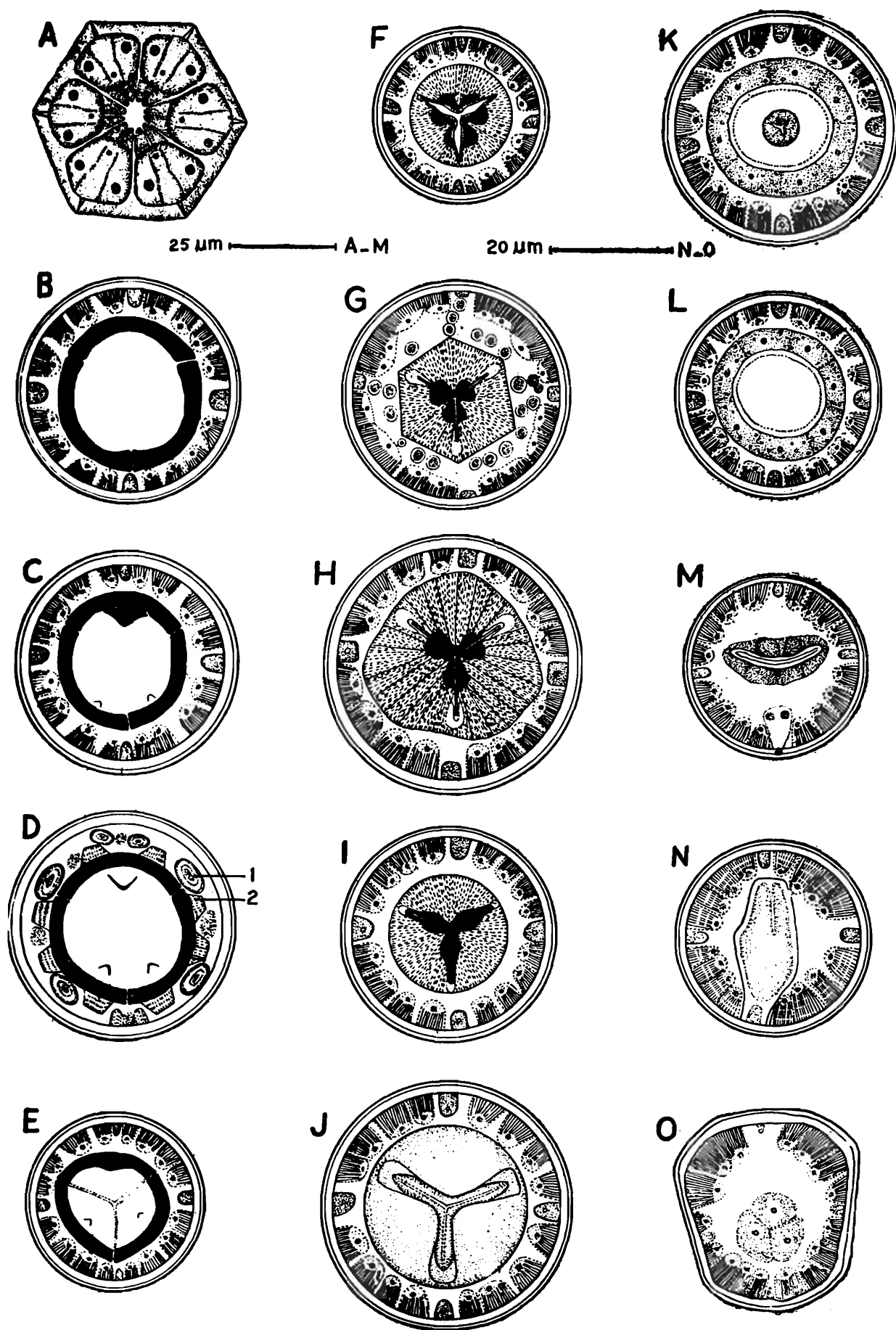


MUSCULATURE

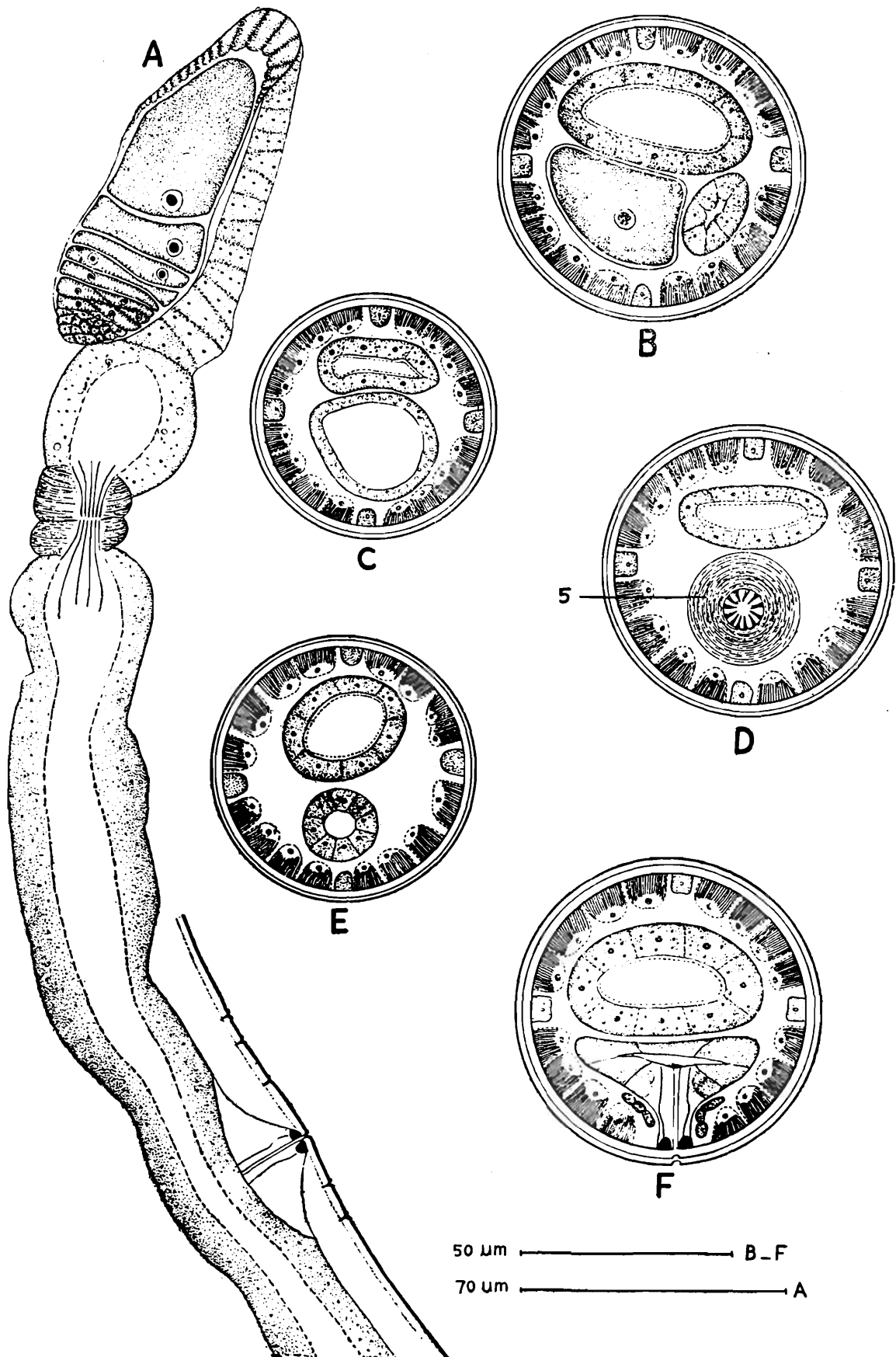
Text-fig. 3. *Specialized muscles* A—Sphincter muscles ; B—Cephalic muscles ; C & D—Vulval muscles ; E—Anal muscles (female) ; F—Accessory copulatory muscle ; G—Spicular muscles ; H—Anal, copulatory, gubernacular and caudal copulatory muscles (male).

Somatic muscles (Cross-sections) I—At base of buccal cavity ; J—At level of nerve ring ; K—At level of anus.

1. Labial muscles, 2. Stomatal muscles, 3. Dilator muscles, 4. Constrictor vulvae, 5. Sphincter muscles, 6. Anal muscles, 7. Copulatory muscles, 8. Accessory copulatory muscles, 9. Retractor gubernaculi, 10. Retractor spiculi, 11. Protractor spiculi, 12. Caudal copulatory muscles.

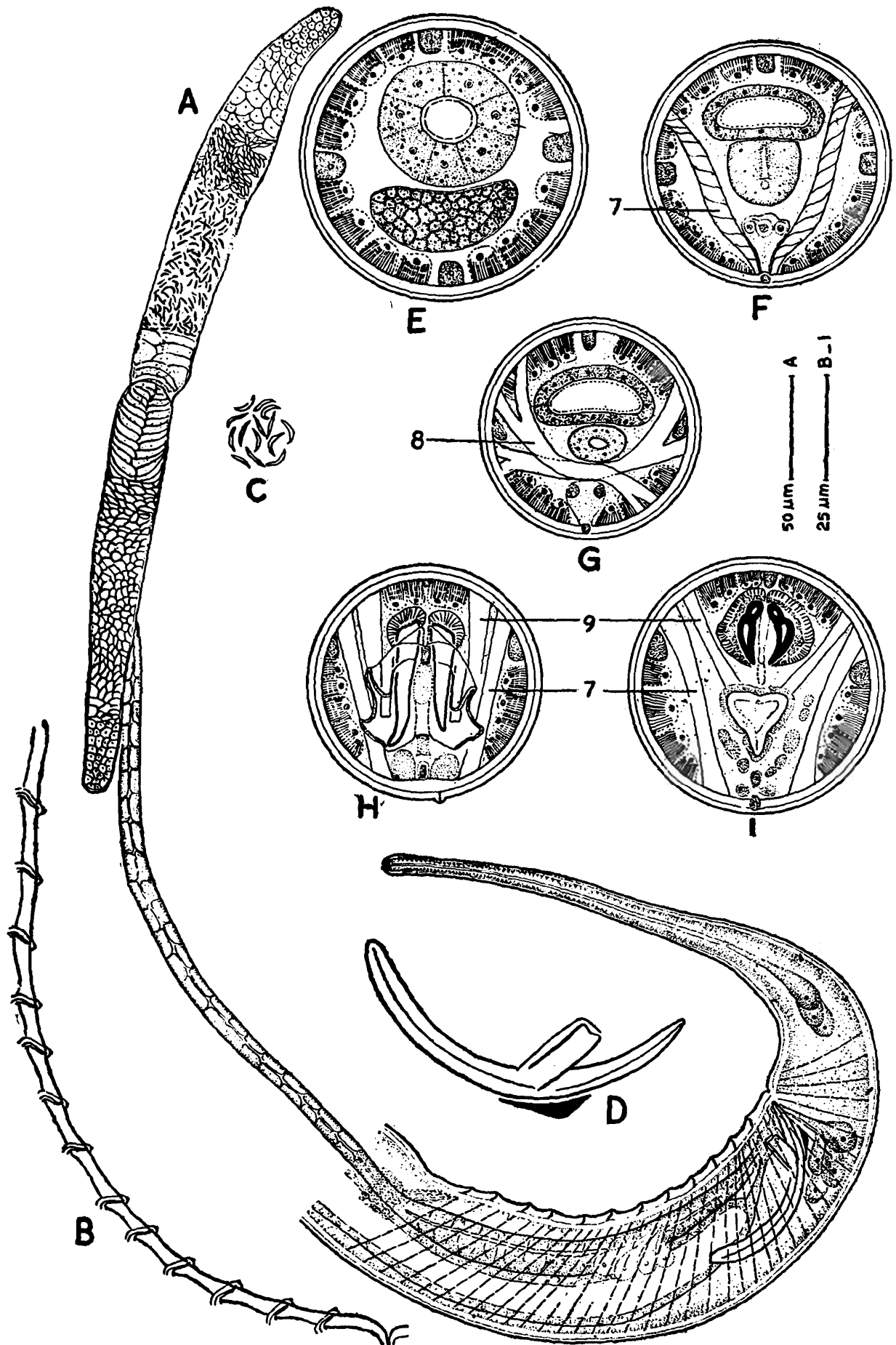
CROSS-SECTIONS OF BODY OF *P. SHAKILI*

Text-fig. 4. A—*En face* view ; B—Above dorsal tooth ; C—At level of dorsal tooth ; D—At basal level of dorsal tooth showing cephalic muscles ; E—At level of foramina ; F—At base of buccal cavity ; G—At level of nerve ring ; H—Through middle of oesophagus ; I—At base of oesophagus ; J—Through tubercles ; K—Through conical organ of oesophago-intestinal junction ; L—Through intestine ; M—Through rectum ; N—At level of anus ; O—At level of caudal glands.



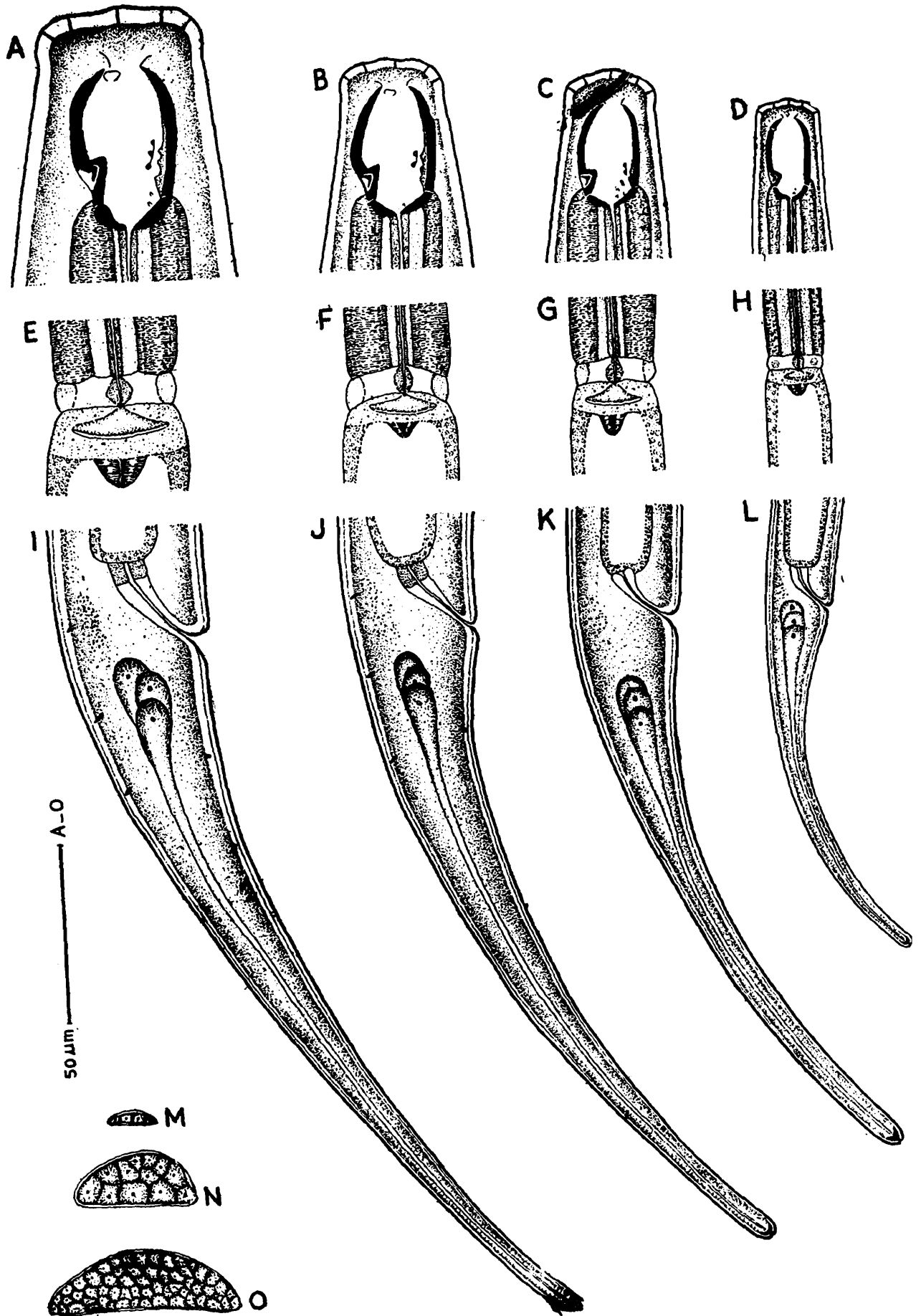
FEMALE GONAD

Text-fig. 5. A—Anterior gonad ; B—C. S. through ovary and distal part of oviduct, C—C. S. through proximal part of oviduct ; D—C. S. at level of sphincter; E—C. S. through uterus ; F. —C. S. at level of vulva.



MALE GONAD

Text-fig. 6. A—Entire gonad ; B—Supplements ; C—Sperms, D—Spicule, gubernaculum and accessory pieces ; E—C. S. through germinal zone of testis ; F—C. S. through vas deferens ; G—C. S. at level of transversely oriented accessory copulatory muscles ; H—C. S. through spicule ; I—C. S. through head of spicule.



JUVENILE STAGES

Text-fig. 7. A-D—Head ends of L_4 , L_3 , L_2 , L_1 respectively ; E-H—Oesophago-intestinal junction of L_4 , L_3 , L_2 , L_1 respectively ; I-L—Tails of L_4 , L_3 , L_2 , L_1 respectively ; M—Genital primordium of L_2 ; N—Genital primordium of L_3 ; O—Genital primordium of L_4 .

a. *Dilator vulvae* (Text-fig. 3, C-D : 3) : These are 16 in number appearing in 8 pairs, 4 of which are anterior to vulva and 4 posterior. Originating from vulva, they run ventrolaterally and some of them are bifurcated at their ends. The contraction of these muscles opens the vulva.

b. *Constrictor vulvae* (Text-fig. 3, D : 4) : The constrictor vulvae are 4 in number and occur in pairs. Each pair originates from base of vagina and is attached to ventrolateral body wall. The muscles function in direction opposite to the dilator muscles and bring about the closure of vulva.

(iii) *Sphincter muscles* (Text-fig. 3, A and V, D : 5) : The oviduct leads to uterus through a valve called as sphincter. The lumen of the valve is controlled by a set of circular muscles which are called as the sphincter muscles.

(iv) *Anal muscles* (Text-fig. 3, E & H : 6) : These muscles are associated with the anus. They originate below the anus, run laterally and ventrodorsally. The number of the anal muscle bands is 2 to 3 in females but single in males.

(v) *Copulatory muscles* (Text-fig. 3, F & H and 6, F, H & I : 7) : The copulatory muscles extend from the region where the vas deferens and intestine appear constricted and continue up to the upper margin of cloaca. Each copulatory muscle originates at the laterodorsal body wall, runs lateroventrally and is finally attached between the somatic muscles and ventral chord. The anterior most copulatory muscles are not attached to the dorsolateral body wall but surround the intestine from its dorsal side. In this region the intestine appears transparent. The number of these muscles varies from 30 to 35 on either side of the body wall.

(vi) *Accessory copulatory muscles* (Text-fig. 3, F and 6, G : 8) : These are 14 to 16 in number, lying in front of copulatory muscles, of these 8-10 are rather faint, oblique bands followed by 6-8 transversely oriented muscles. The latter run from the dorso-lateral body wall of one side to the lateroventral wall of the other side. They cross each other ventral to vas deferens and usually bifurcate before their latero-ventral attachment. These muscles along with the first copulatory muscles form a powerful constricting unit around the intestine and vas deferens.

(vii) *Gubernacular muscles* : These muscles are associated with gubernaculum and are basically of two types :

a. *Retractor gubernaculi* (Text-fig. 3, H and 6, H & I : 9) : They are 4 in number extending from the laterodorsal body wall to the gubernaculum. The anterior most originates dorsal to the copulatory muscles, curves on the inner side ventral to the spicules and is attached to the anterior end of the gubernaculum ventrally. The last muscle band runs laterodorsally and is attached to the gubernaculum on its laterodorsal side while the rest are attached laterally.

b. *Protractor gubernaculi* : The protractor gubernaculi are indistinct.

(viii) *Spicular muscles* : These are two sets of muscles attached to the spicules, one retractor spiculi and the other protractor spiculi.

a. *Retractor spiculi* (Text-fig. 3, G : 10) : A pair of muscle bands extending from the head of the spicules to the dorsolateral body wall.

b. *Protractor spiculi* (Text-fig. 3, G : 11) : A pair of muscle bands surrounding the spicules from dorsal, lateral and latero-ventral sides. These are attached to the spicular sheath which in turn envelops the spicules. One muscle band extends posteriorly from the head of the spicules beyond the gubernaculum and connects the dorsal and laterodorsal parts of the gubernaculum, then extends further posteriorly and gets bifurcated. The bifurcated bands are attached to the ventral body wall a short distance behind the anus. Another muscle band extends posteriorly from the head of the spicules runs lateroventrally and then bifurcates. A forked band extends laterally from the spicules and is attached to the laterodorsal parts of it. Another forked band passes laterally from the lateral accessory pieces and is attached with the ventral body wall near the upper lip of cloaca.

(ix) *Caudal copulatory muscles* (Text-fig. 3, H : 12) : Posterior to the anus there are about 5-9 bands of muscles arranged one behind the other. They extend from the laterodorsal body wall to the ventral body wall. The anterior most muscles band is attached to the lower lip of cloacal opening.

DIGESTIVE ORGANS

The digestive organs consist of stoma, oesophagus, oesophago-intestinal junction, intestine, rectum and anus. These organs have been described below in detail.

Stoma (Text-fig. 1, C-E and 4, A-E) : The stoma opens anteriorly through a hexaradiate oral aperture or vestibulum guarded by six lips. The vestibulum leads to a barrel-shaped buccal cavity formed by two sets : one vertical and another oblique set. Each set has three walls, one dorsal and the other two subventral in position. The dorsal wall of

vertical set bears a large dorsal tooth in the posterior half of buccal cavity pointing anteriorly. The subventral vertical walls are provided with denticles opposite the dorsal tooth. The subventral oblique walls bear two foramina each. Though the walls of both sets are almost similar in shape but those of the oblique set are smaller and less sclerotized. A cross section through vertical set shows the three walls to be similar anterior to dorsal tooth. The buccal cavity narrows posteriorly and joins the oesophageal lumen.

A few abnormal types of buccal cavities were also observed. In one specimen the buccal cavity lacked dorsal tooth (Text-fig. 2, A) in other subventral denticles were absent on one of the vertical wall (Text-fig. 2, B). In another case the subventral denticles were absent from both the walls (Text-fig. 2, C).

Oesophagus (Text-fig. 1, E and 4, F-K) : The buccal cavity is followed by a long cylindrical and highly muscular oesophagus. The oesophagus is slightly expanded at its anterior end surrounding the basal part of stoma, but slightly narrowing at level of nerve ring, then widening gradually towards the base. Various kinds of thickenings occur on the walls of the triradiate lumen. These serve as points of attachment for the radial muscles which originate from the walls of oesophagus. These muscles are strongly developed in the middle of oesophagus. The width of the lumen of oesophagus is uniform throughout its length except at the base of buccal cavity where it is wider.

Oesophago-intestinal junction (Text-fig. 1, E and 4, J-K) : The oesophago-intestinal junction or cardia connects the oesophagus with intestine and is tuberculate type. It consists of three tubercles, a filtration valve and a conical organ (Clark, 1960a). These tubercles open in the lumen of oesophagus which in turn opens into a funnel-shaped filtration valve situated in the somatic zone which lies below the transparent zone. The conical organ is heart-shaped projecting into the lumen of intestine. It also has triradiate lumen, but lacks cuticularized thickenings.

Intestine (Text-fig. 4, L) : The intestine is a long uniform tube with a wide lumen, narrowing posteriorly in the region where it joins the rectum. In a cross section it is single-layered with 6-8 cells in the circumference. The cells have distinct nucleus but are irregular in shape. The intestine on its dorsal walls where it is surrounded by anterior most copulatory muscles lacks granules and appears hyaline. The lumen of the intestine is also covered by a hyaline layer, but no cilia or rod-like structures are present.

Rectum (Text-fig. 3, E and 4, M) : The intestine is followed by the rectum which is a narrow, dorsoventrally flattened tube internally

lined with cuticle. The rectum leads to the exterior through anus. In males the rectum joins the genital duct to form the cloaca. The cloaca opens outside through the cloacal aperture.

Rectal glands (Text-fig. 6, A) : In males four rectal glands are present on each side dorsal and posterior to spicules. Their ducts run a short distance parallel to spicules turn upwards and open into the cloaca.

REPRODUCTIVE ORGANS

Female reproductive organs (Text-fig. 5, A-F) : The female reproductive system is amphidelphic. Each sexual branch consists of an ovary, oviduct, sphincter, uterus, vagina and vulva.

Ovary (Text-fig. 5, A) : The ovary is a thin-walled epithelial sac enclosing the germ cells and lying on ventral side of the body. The epithelium of the sac consists of long flattened cells which are clearly visible towards the proximal end. Typically the ovary may be divisible into two zones : the germinal zone and the growth zone (Text-fig. V, A & B). The oviduct is connected to the ovary subterminally which results in the formation of a blind sac in which the ripening oocytes or oogonia grow until they reach their full length. When the oocytes have reached maturity they leave the ovary and pass on to the oviduct.

Oviduct (Text-fig. 5, A-C) : The oviduct is at first a narrow tube and then enlarges proximally. The distal part differs from the proximal in having transverse markings (Coomans, 1964). In a cross section the distal part appears circular with a narrow lumen and made up of 6-7 high columnar cells. The proximal part also appears cellular in structure but the outlines of the individual cells are indistinguishable from one another and the whole region gives a rather granular vacuolated appearance.

Technically, the oviduct is followed by the uterus, but they are separated by a well developed structure which is called *sphincter* (Text-fig. 5, D). It is a truncated cone-like structure having longitudinal cuticularized linings of fine strands or fibers which arise from the inner walls of the uterus and converge at the centre of sphincter where they become slightly thickened and more refractive in nature. The fibers from the centre form the linings of the proximal end of the oviduct in the lumen of which narrow end of the sphincter is protruded.

Uterus (Text-fig. 5, E) : The uterus is a highly extensible tube with low columnar epithelial cells in circumference. The distal part of the uterus serves a fertilization chamber while the eggs are present in the proximal part and are provided with a visible shell. The maximum

number of eggs recorded at one time in the uterus was only 2, the sperms were also seen in the proximal part of uterus of some specimens.

Vagina (Text-fig. 5, F) : The uteri of both sides join to form a common short tube, the vagina. It is lined with cuticle and also adequately supported with muscles. It opens outside through vulva.

Vulva (Text-fig. 3, C, D and 5, F) : It is a ventral transverse slit, post-equatorial in position. It has cuticularized lips formed by the invagination of the cuticle. On either side of the vulva there are present vulval papillae which are variable in number. The prevulval vary from 0-3, and postvulval 0-2. In one female, the cuticularized pieces were absent (Text-fig. 2, H). A pair of vulval glands (Text-fig. 5, F) are situated ventrally which open into the vulva through their ducts.

Male reproductive organs (Text-fig. 6, A-I) : The male gonad consists of testes, vas deferens, ejaculatory duct and cloaca.

Testes (Text-fig. 6, A & E) : There are two testes, one directed anteriorly and the other posteriorly. Each testis is enclosed in a thin-walled sac made up of epithelial cells. Each testis is differentiated into a germinal zone and a zone of maturation. At the distal end of the maturation zone there are usually present several rows of spermatocytes. These are rectangular or hexagonal in shape and give rise to spindle-shaped spermatids which are present in clusters. The length of spermatids may be variable. These ultimately transform into spermatozoa or sperms (Aboul-Eid, 1969). The sperms (Text-fig. 6, A & C) are numerous and fill the entire proximal end of the growth zone.

Vas deferens (Text-fig. 6, F & G) : The proximal ends of the two testes join a single long thin-walled tube, the vas deferens. It runs posteriorly up to the constriction formed by the last accessory copulatory muscles and first copulatory muscles. The vas deferens at this point appears very much constricted.

Ejaculatory duct (Text-fig. 6, A) : Posterior to the horizontal accessory copulatory muscles, the vas deferens differentiates into a thin-walled tube, the ejaculatory duct. It narrows posteriorly to join the rectum to form a cloaca.

There are four ovoid or rounded ejaculatory glands lying over a part of the intestine or ejaculatory duct or both. Posteriorly each one narrows and joins a duct which opens into the lumen of the ejaculatory duct (Text-fig. 6, A). In one male the ejaculatory glands were five in number (Text-fig. 2, I).

Cloaca (Text-fig. 6, A & I) : The middorsal wall of the cloaca is first flattened, then compressed and finally folds backward where the spicules enter the cloaca. A bulging of the midventral wall also appears about halfway its length.

Spicules (Text-fig. 6, D, H & I) : These are a pair, equal in size and similar in shape. They are long and slender ventrally arcuate, sclerotized, narrowing towards their tips. Each spicule may be differentiated into two regions, a head region (capitulum) and a blade (Lamina). No region similar to shaft (calomus) was found to be present. Each spicule is covered by a spicular sheath. In a cross section at level of head of spicules, they appear flattened with two cavities and gradually inward curving flanges.

Gubernaculum & lateral accessory pieces (Text-fig. 6, D & H) : The gubernaculum lies dorsal to spicules from which a pair of lateral accessory pieces extend forward on either side of the spicules. In a cross section the gubernaculum appears trough-shaped with lateral parts first extending along the spicules and lateral accessory pieces (crura) then turned inwards in front of the crura and finally fused with the lateroventral walls of the cloaca as in *Anatonchus amiciae* by Coomans & Lima (1965) and *Cobbonchus pounamua* by Clark (1960b). The lateral accessory pieces are cuticularized and bifurcated at their distal end.

Supplements (Text-fig. 6, B) : Each supplement is an elevated structure supplied with a nerve ending.

TAIL (Text-fig. 6, A)

The tail is long filiform, tapering uniformly, with a ventral curvature and slightly clavate tip. The tail is provided with 4 prominent caudal papillae. The three caudal glands lead to a common duct which opens into an ampulla-like structure, the spinneret. The tuboid opening of the spinneret is provided with a cone-like structure which acts as a valve (Text-fig. 6, A & 4, O).

Apart from the normal type of tails, some abnormal tails were also recorded. In one specimen the tail is elongate conoid about half the normal tail length. The caudal glands are situated posteriorly and the spinneret absent (Text-fig. 2, E). In another specimen the tail is provided with a mucro (Text-fig. 2, G). Often the tail is broad especially in the hinder region (Text-fig. 2, F).

THE JUVENILE STAGES

First stage Juvenile (Text-fig. 7, D, H & L) :

Dimensions (16) : $L=0.61-0.93$ mm ; $a=22-31$; $b=2.5-3.7$;
 $c=6.0-7.9$; $c'=5.4-7.3$.

Description : Body almost straight upon fixation, tapering slightly anteriorly, but markedly posteriorly. Cuticle (inner and outer) smooth, $2\text{ }\mu\text{m}$ thick at various places on the body. Lip region marked off, $18-20\text{ }\mu\text{m}$ wide, $5-7\text{ }\mu\text{m}$ high, distinctly wider than the adjoining body. Amphids small cup-like, apertures $3-4\text{ }\mu\text{m}$ wide at $11\text{ }\mu\text{m}$ from anterior end of body.

Buccal cavity $21-23 \times 11\text{ }\mu\text{m}$. Apex of dorsal tooth at $5-8\text{ }\mu\text{m}$ from base of stoma. The dorsal wall of buccal cavity $18-20\text{ }\mu\text{m}$ in length. No tooth or teeth present on the vertical subventral walls. The oblique subventral walls have two foramina on each. Orifices of the oesophageal glands located as follows : dorsal $88-94\text{ }\mu\text{m}$ from anterior end of body ; the first pair of subventrals $30-39\text{ }\mu\text{m}$ from the orifices of dorsal one ; the second pair $44-60\text{ }\mu\text{m}$ from the orifices of the first pair. Oesophago-intestinal junction tuberculate. Nerve ring at $53-60\text{ }\mu\text{m}$ from anterior end of body. Rectum $14-16\text{ }\mu\text{m}$ or about one anal body-width long. Genital primordium not observed. Tail $82-126\text{ }\mu\text{m}$ or about 3-5 anal body-widths long. Caudal glands well developed, opening terminal, caudal papillae invisible.

Second Stage Juvenile (Text-fig. 7, C, G, K & M) :

Dimensions (10) : $L=1.06-1.26$ mm ; $a=30-31$; $b=3.4-4.5$;
 $c=6.3-7.2$; $c'=6.5-7.5$.

Description : Body arcuate upon fixation, tapering slightly anteriorly, but markedly posteriorly. Cuticle (inner and outer) smooth, $2\text{ }\mu\text{m}$ thick at midbody. Lip region marked off, $24-26\text{ }\mu\text{m}$ wide, $9-11\text{ }\mu\text{m}$ high, distinctly wider than adjoining body. Amphids small cup-like, apertures $3-4\text{ }\mu\text{m}$ wide at $11-13\text{ }\mu\text{m}$ from anterior end of body.

Buccal cavity $29-31 \times 15-17\text{ }\mu\text{m}$. Apex of dorsal tooth at $9-11\text{ }\mu\text{m}$ from base of stoma. Dorsal wall $24-28\text{ }\mu\text{m}$ high. The vertical subventral walls bear 1-2 teeth and the oblique walls have two foramina on each. Orifices of oesophageal glands located as follows : dorsal $102-156\text{ }\mu\text{m}$ from anterior end of body ; the first pair of sub-ventrals $46-53\text{ }\mu\text{m}$ from the orifices of dorsal one ; the second pair $68-95\text{ }\mu\text{m}$ from the orifice of the first pair. Oesophago-intestinal junction tuberculate. Nerve ring at $88-96\text{ }\mu\text{m}$ from anterior end of body. Rectum $20-24\text{ }\mu\text{m}$ or about 2-3 anal body-widths long. The genital primordium $14\text{ }\mu\text{m}$ long and consists of 4 serially arranged cells. Tail elongate-conoid, $156-195\text{ }\mu\text{m}$

or about 6-8 anal body-widths long. Caudal glands well developed, opening terminal. Caudal papillae invisible.

Third Stage Juvenile (Text-fig. 7, B, F, J & N) :

Dimensions (14) : $L=1.49-1.73$ mm ; $a=32-37$; $b=3.9-4.1$;
 $c=7.5-8.6$; $c'=5.6-6.9$

Description : Body almost straight upon fixation, tapering slightly anteriorly, but markedly posteriorly. Cuticle (inner and outer) smooth, $2-4\ \mu\text{m}$ thick at various places on the body. Lip region marked off, $29-33\ \mu\text{m}$ wide, $11-15\ \mu\text{m}$ high distinctly wider than the adjoining body. Amphids small cup-like, apertures $5-6\ \mu\text{m}$ wide at $12-15\ \mu\text{m}$ from the anterior end of body.

Buccal cavity $35-39 \times 18-20\ \mu\text{m}$. Apex of dorsal tooth at $13-17\ \mu\text{m}$ from base of stoma. The dorsal wall of buccal cavity $29-31\ \mu\text{m}$. Vertical subventral walls bear 3-4 teeth and the oblique walls have two foramina on each. Orifices of oesophageal glands located as follows : dorsal $170-194\ \mu\text{m}$ from anterior end of body ; the first pair of subventrals $56-63\ \mu\text{m}$ from orifice of the dorsal one ; the second pair $94-105\ \mu\text{m}$ from orifice of first pair. Oesophago-intestinal junction tuberculate. Nerve ring at $113-117\ \mu\text{m}$ from anterior end of body. Rectum $27-28\ \mu\text{m}$ or about 4-5 anal body-widths long. The genital primordium consists of 12 cells and measures $34\ \mu\text{m}$ in length. Tail elongate-conoid, $184-230\ \mu\text{m}$ or about 6-7 anal body-widths long. Caudal glands well developed, opening terminal. Caudal papillae 4.

Fourth Stage Juvenile (Text-fig. 7, A, E, I & O) :

Dimensions (22) : $L=1.81-2.31$ mm ; $a=40-42$; $b=4.0-4.5$;
 $c=6.6-8.8$; $c'=6.2-8.5$.

Description : Body almost straight upon fixation, tapering slightly anteriorly, but markedly posteriorly. Cuticle (inner and outer) smooth, $4-6\ \mu\text{m}$ thick at various places on the body. Lip region marked off, $35-40\ \mu\text{m}$ wide, $13-18\ \mu\text{m}$ high, distinctly wider than adjoining body. Amphids small cup-like, apertures $5-6\ \mu\text{m}$ wide at $16-18\ \mu\text{m}$ from anterior end of body.

Buccal cavity $42-48 \times 22-26\ \mu\text{m}$. Apex of dorsal tooth at $18-20\ \mu\text{m}$ from base of stoma. The dorsal wall of buccal cavity $37-40\ \mu\text{m}$ high. Vertical subventral walls bear 3-6 teeth and the oblique wall have two foramina on each. Orifices of the oesophageal glands are located as follows : dorsal $205-231\ \mu\text{m}$ from anterior end of body ; first pair of subventrals $65-95\ \mu\text{m}$ from orifice of dorsal one ; second pair $106-141\ \mu\text{m}$ from orifices of first pair. Oesophago-intestinal junction tuberculate. Nerve ring at $138-143\ \mu\text{m}$ from anterior end of body. Rectum $30-33\ \mu\text{m}$

or about 4-5 anal body-widths long. The genital primordium measuring 48-123 μm and consisting of 32-60 cells. Tail elongate-conoid, 226-314 μm or about 6-7 anal body-widths long. Caudal glands well developed, opening terminal, caudal papillae 4.

DISCUSSION AND CONCLUSION

The detailed morphological studies on *Parahadronchus shakili* (Jairajpuri, 1969) Mulvey, 1978 show many intra-specific variations which are important for the taxonomic study of the genus *Parahadronchus* and the related groups.

The shape of the body and the number of the labial papillae was found to be constant. The dot-like additional structures near the middle of lips on either side of internal labial papillae were observed which are supposed to be the points of attachment of six labial muscles which have been recorded for the first time for this species.

Important variations were observed in total body length, shape and size of buccal cavity, number of denticles on the subventral walls, number of ventromedian supplements etc. The size of the buccal cavity is to some extent related with the sex and body length. Larger specimens have larger buccal cavities and also the females usually have larger buccal cavities than males. The position and shape of the dorsal tooth are constant and is therefore of diagnostic value. The orifices of the oesophageal glands are variable and thus are not much significant.

The characters for the separation of different juvenile stages confirm with those given by Coomans & Lima (1965) with slight deviations. The first stage juveniles differ from all the other stages in the absence of denticles on the vertical subventral walls. These denticles are 1-2 in the second stage, 3-4 in the third stage and 3-6 in the fourth stage. The genital primordium was not observed in the first stage, in the second stage it is small having 4 serially arranged cells, in the third stage it is oval with 12 cells, while in the fourth stage it is elongate-oval with 32-60 cells. In the last juvenile stage usually a rectangular hyaline area also makes its appearance which indicates the place of formation of the future vulva.

The presence or absence and number of denticles on the subventral walls are helpful only up to the third stage. The tail length does not overlap between first and 2nd stages, yet it can not be taken as reliable character because it overlaps in the rest of the stages. The a, b, c and c' values are not useful distinguishing characters. The other features like amphids, tubercles, spare tooth etc., are unreliable in the

separation of juvenile stages. The presence of spare tooth clearly differentiates the juveniles from the adults.

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REFERENCES

- ABOUL-EID, H. Z. 1969. Histological anatomy of the excretory and reproductive systems of the *Longidorus macrosoma*, *Nematologica*, **15** : 437-450.
- BAQRI SAMER, Z. AND JAIRAJPURI, M. S. 1972. Studies on Mononchida of India V. Some observations on the morphology of *Mononchus aquaticus* Coetzee, 1968 with remarks on its status, *Indian J. Nematol.*, **2** : 105-116.
- CLARK, W. C. 1960a. The oesophago-intestinal junction in the mononchidae (Enoplida, Nematoda). *Nematologica*, **5** : 178-183.
- CLARK, W. C. 1960b. The Mononchidae (Enoplida, Nematoda) of New Zealand III. A review of the genus *Cobbonchus* Andr ssy, 1958 with descriptions of new species. *Nematologica*, **5** : 275-295.
- COBB, N. A. 1916. Notes on new genera and species of nematodes. 4. Subdivisions of *Mononchus*. *J. Parasit.*, **2** : 195-196.
- COOMANS, A. 1964. Structure of female gonads in member of Dorylaimina. *Nematologica*, **10** : 601-622.
- COOMANS, A. AND LIMA, M. B. 1965. Description of *Anatonchus amiciae* n. sp. (Nematoda : Mononchidae) with observations on its juvenile stages and anatomy. *Nematologica*, **11** : 413-431.
- JAIRAJPURI, M. S. 1969. Studies on mononchida of India I. The genera *Hadronchus*, *Iotonchus* and *Miconchus* and a revised classification of Mononchida, New order, *Nematologica*, **15** : 557-581.
- MULVEY, R. H. 1978. Predaceous nematodes of the family Mononchidae from Mackenzie and Porcupine river systems and Somerset Island, N. W. T., Canada. *Can. J. Zool.*, **56** : 1847-1860.
- MULVEY, R. H. AND JENSEN, H. J. 1967. The Mononchidae of Nigeria. *Can. J. Zool.*, **45** : 667-727.

BIOMETRIC STUDIES IN THREE TELEOST FISHES

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(With 5 Text-figures)

INTRODUCTION

Studies on biometry, length-weight relationship and condition factor of important fishes have been carried out in different countries. But Allometric observations on Indian fishes are very meagre. Allometry deals with the size relationships between the whole and its parts. Some of the important observations on allometry are by Banarjee and Venkateswarlu (1969), Venkateswarlu (1962a, 1962b and 1968), Venkateswarlu and Banarjee (1970, 1971 and 1975) and Ramaprasad (1968).

In the present paper some observations were made on the length-weight relationship, biometry, allometry and condition factor in three species of fresh water Cyprinids, *Puntius conchoni* (Ham.), *Puntius amphibius* (V.) and *Crossocheilus latius* (Ham.)

MATERIAL AND METHODS

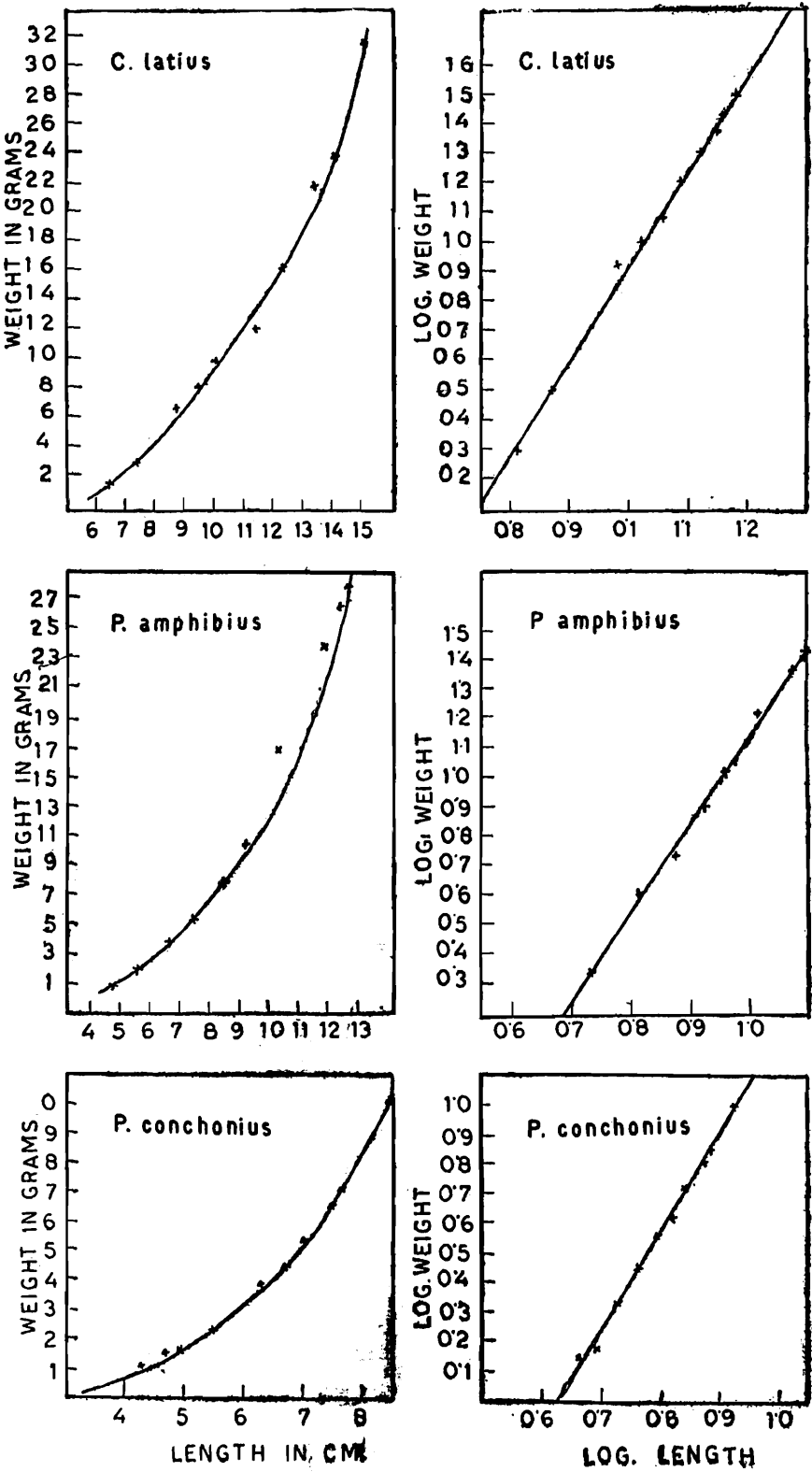
The present study is based on 293 specimens of *Puntius conchoni* (Ham.), 342 specimens of *Puntius amphibius* (V.) and 292 specimens of *Crossocheilus latius* (Ham.). The fishes were obtained locally at Patna (Bihar). As soon as the fishes are brought to the laboratory, weight was taken in fresh condition and preserved in 4% formaldehyde solution uniformly. Measurements of the different parts of the body were taken on a measuring board. Small measurements were taken with the help of a fine dividers. The length was measured to the nearest millimeter. The following measurements were taken : Total length, fork length, snout to dorsal, snout to ventral, snout to anal, snout to pectoral, greatest body height, height of caudal peduncle, head length, pectoral length and dorsal length.

The specimens are grouped, the class interval being 1.0 cm. in *P. amphibius* (V.) and *C. latius* (Ham.) and 0.3 cm. in *P. conchoni*.

The length weight relationship was studied by applying the equation $W=CL^n$. The growth of different body parts with relation to standard length was studied by regression analysis using Least Squares method. Allometry was studied following the method of Rensch (1959).

LENGTH WEIGHT RELATIONSHIP

The length weight relationship of most of the fishes can be expressed by a general equation $W=CL^n$, where 'W' is the weight in grams, 'L'



Text-fig. 1

is the length in centimeters, 'C' is the constant and 'n' is exponent. In practice, Le Cren (1951) indicates the length weight relationship would first be calculated as the logarithmic formula, $\text{Log } W = \text{Log } C + n \text{ Log } L$, where 'n' represents the slope of line and 'C' its position.

In the present study where the average values are plotted, an exponential curve was obtained in all the 3 species (Text-fig. 1). This shows that the weight of the fish increases as an exponential function of its length. The logarithmic relation of length and weight was found to be a straight line (Text-fig. 1). The formulae worked out are as follows :

$$P. \textit{conchonius} \quad W = 0.001347 L^{3.164}$$

$$P. \textit{amphibius} \quad W = 0.002461 L^{3.073}$$

$$C. \textit{latius} \quad W = 0.01746 L^{3.243}$$

According to Hile (1936) and Martin (1949), the value of the exponent 'n' usually lies between 2.5 and 4.0 and for an individual fish which maintains same shape it will be 3.0 (Allen, 1938). In the present study the values of 'n' are 3.164, 3.073 and 3.243 which are ideal and the three species maintain the same shape throughout their life. Hence it can be inferred that the weight increases in proportion to its length showing the normal pattern.

BIOMETRY

The mean values of various parameters in three species were given in Tables 1,2 and 3. The mean values of log. weight and log. total length were given in Table 4. The values of sums of different parameters were given in Table 5. The values of regression equation $Y = a + bx$, the angle of slope of regression line, the tangent of the angle and allometry were given in Tables 6,7 and 8. The regressions were shown in Text-figs. 2,3 and 4.

It is seen from the above Text-figures, that the fastest growing parameter is the total length in all the three species and slowest growing parameter is height of caudal peduncle. Next to total length, fork length is the fast growing parameter in all the three species and next to height of caudal peduncle, the slow growing parameters are dorsal length in *P. conchonius* and pectoral length in *P. amphibius* and *C. latius*. The rate of growth of other parameters are varied and can be seen from Text-figs. 2, 3 and 4.

TABLE 1. Showing mean values of *Puntius conchonius* (Ham.) in cm.

Sl. No.	Class interval	Weight	Total length	Standard length	Fork length	Snout to dorsal	Snout to anal	Snout to ventral	Snout to pectoral	Body height	Height of C. P.	Head length	Pecto- ral length	Dorsal length
1.	4.0 to 4.3	1.0	4.2	3.2	3.7	1.8	2.3	1.7	1.0	1.4	0.6	1.0	0.8	0.7
2.	4.4 to 4.7	1.4	4.6	3.5	4.0	2.0	2.6	1.9	1.0	1.5	0.6	1.0	0.9	0.8
3.	4.8 to 5.1	1.5	4.9	3.8	4.3	2.1	2.8	2.0	1.1	1.6	0.7	1.0	0.9	0.9
4.	5.2 to 5.5	2.2	5.4	4.2	4.8	2.2	3.1	2.2	1.2	1.8	0.7	1.2	1.0	1.0
5.	5.6 to 5.9	2.9	5.7	4.5	5.1	2.4	3.3	2.3	1.2	1.9	0.7	1.2	1.0	1.0
6.	6.0 to 6.3	3.7	6.2	4.8	5.4	2.6	3.6	2.5	1.3	2.1	0.8	1.3	1.1	1.1
7.	6.4 to 6.7	4.3	6.6	5.1	5.8	2.8	3.8	2.8	1.4	2.3	0.8	1.4	1.2	1.1
8.	6.8 to 7.1	5.2	6.9	5.3	6.1	3.0	4.0	2.8	1.4	2.5	0.9	1.4	1.2	1.1
9.	7.2 to 7.5	6.4	7.4	5.8	6.5	3.2	4.3	3.1	1.5	2.6	1.0	1.5	1.2	1.2
10.	7.6 to 7.9	7.0	7.6	5.9	6.6	3.4	4.4	3.1	1.6	2.8	1.1	1.6	1.3	1.3
11.	8.0 to 8.4	10.0	8.4	6.9	7.6	3.9	5.0	3.5	1.7	3.3	1.1	1.7	1.5	1.4

TABLE 2. Showing mean values of *Puntius amphibius* (V.) in cm.

Sl. No.	Class interval	Weight	Total length	Standard length	Fork length	Snout to dorsal	Snout to anal	Snout to ventral	Snout to pectoral	Body height	Height of C. P	Head length	Pectoral length	Dorsal length
1.	4.0 to 5.0	1.0	4.7	3.6	4.0	1.8	2.5	1.8	1.0	1.3	0.5	1.1	0.9	0.8
2.	5.0 to 6.0	2.2	5.4	4.3	4.8	2.3	3.2	2.2	1.3	1.6	0.7	1.3	1.0	0.9
3.	6.0 to 7.0	4.1	6.5	5.2	5.8	2.7	3.8	2.6	1.4	1.9	0.8	1.5	1.2	1.0
4.	7.0 to 8.0	5.5	7.4	5.9	6.5	3.0	4.3	2.9	1.6	2.1	0.9	1.6	1.3	1.1
5.	8.0 to 9.0	8.0	8.4	6.7	7.4	3.4	4.9	3.3	1.8	2.4	1.0	1.8	1.4	1.3
6.	9.0 to 10.0	10.4	9.1	7.4	8.1	3.7	5.4	3.6	1.9	2.8	1.1	1.9	1.5	1.4
7.	10.0 to 11.0	17.0	10.3	8.3	9.1	4.3	6.1	4.3	2.2	3.1	1.2	2.3	1.6	1.6
8.	11.0 to 12.0	24.0	11.8	9.5	10.3	4.8	7.0	4.6	2.4	3.8	1.4	2.5	1.8	2.0
9.	12.0 to 13.0	26.7	12.3	10.0	10.7	5.1	7.6	5.0	2.5	3.9	1.5	2.5	1.8	2.2
10.	13.0 to 14.0	28.0	12.5	10.2	10.8	5.2	7.8	5.1	2.6	4.0	1.6	2.7	1.9	2.3

TABLE 3. Showing mean values of *Crossocheilus latius* (Ham.) in cm.

Sl. No.	Class interval	Weight	Total length	Standard length	Fork length	Snout to dorsal	Snout to anal	Snout to ventral	Snout to pectoral	Body height	Height of C. P.	Head length	Pecto-ral length	Dorsal length
1.	6.0 to 7.0	2.0	6.4	5.0	5.7	2.2	3.7	2.5	1.2	1.0	0.6	1.1	1.1	1.0
2.	7.0 to 8.0	3.2	7.4	6.0	6.5	2.6	4.5	2.9	1.6	1.3	0.6	1.3	1.3	1.1
3.	8.0 to 9.0	7.0	8.7	7.2	7.7	3.5	5.5	3.7	2.0	1.9	0.9	1.9	1.4	1.7
4.	9.0 to 10.0	8.6	9.5	7.6	8.3	3.6	6.0	4.0	2.1	2.0	1.0	2.0	1.4	1.7
5.	10.0 to 11.0	10.2	10.5	8.3	9.0	4.0	6.5	4.4	2.2	2.2	1.0	2.2	1.6	1.8
6.	11.0 to 12.0	12.4	11.4	9.1	9.9	4.3	7.2	4.8	2.3	2.3	1.1	2.3	1.7	1.9
7.	12.0 to 13.0	16.6	12.3	9.9	10.6	4.6	7.8	5.2	2.5	2.7	1.2	2.5	1.8	2.1
8.	13.0 to 14.0	21.0	13.3	10.6	11.4	5.0	8.2	5.5	2.7	2.9	1.3	2.6	2.0	2.2
9.	14.0 to 15.0	24.0	14.0	11.3	12.3	5.3	9.0	6.0	2.7	3.1	1.3	2.7	2.1	2.3
10.	15.0 to 16.0	32.0	15.0	12.4	13.4	5.7	9.7	6.5	3.1	3.4	1.4	2.7	2.2	2.6

TABLE 4. Showing mean values of Log. length and Log. weight in three species.

<i>Puntius conchoni</i> (Ham.)		<i>Puntius amphibius</i> (V.)		<i>Crossocheilus latius</i> (Ham.)	
Log. Total Length	Log. Weight	Log. Total length	Log. Weight	Log. Total length	Log. Weight
0.6232	0.0000	0.6721	0.0000	0.8062	0.3010
0.6628	0.1461	0.7324	0.3424	0.8692	0.5051
0.6902	0.1761	0.8129	0.6128	0.9395	0.8451
0.7324	0.3424	0.8692	0.7404	0.9777	0.9345
0.7559	0.4624	0.9243	0.9031	1.0212	1.0086
0.7924	0.5682	0.9590	1.0170	1.0469	1.0934
0.8195	0.6335	1.0128	1.2304	1.0899	1.2201
0.8388	0.7160	1.07119	1.3802	1.1239	1.3222
0.8692	0.8062	1.0899	1.4265	1.1461	1.3802
0.8808	0.8451	1.0969	1.4472	1.1761	1.5051
0.9243	1.0000				

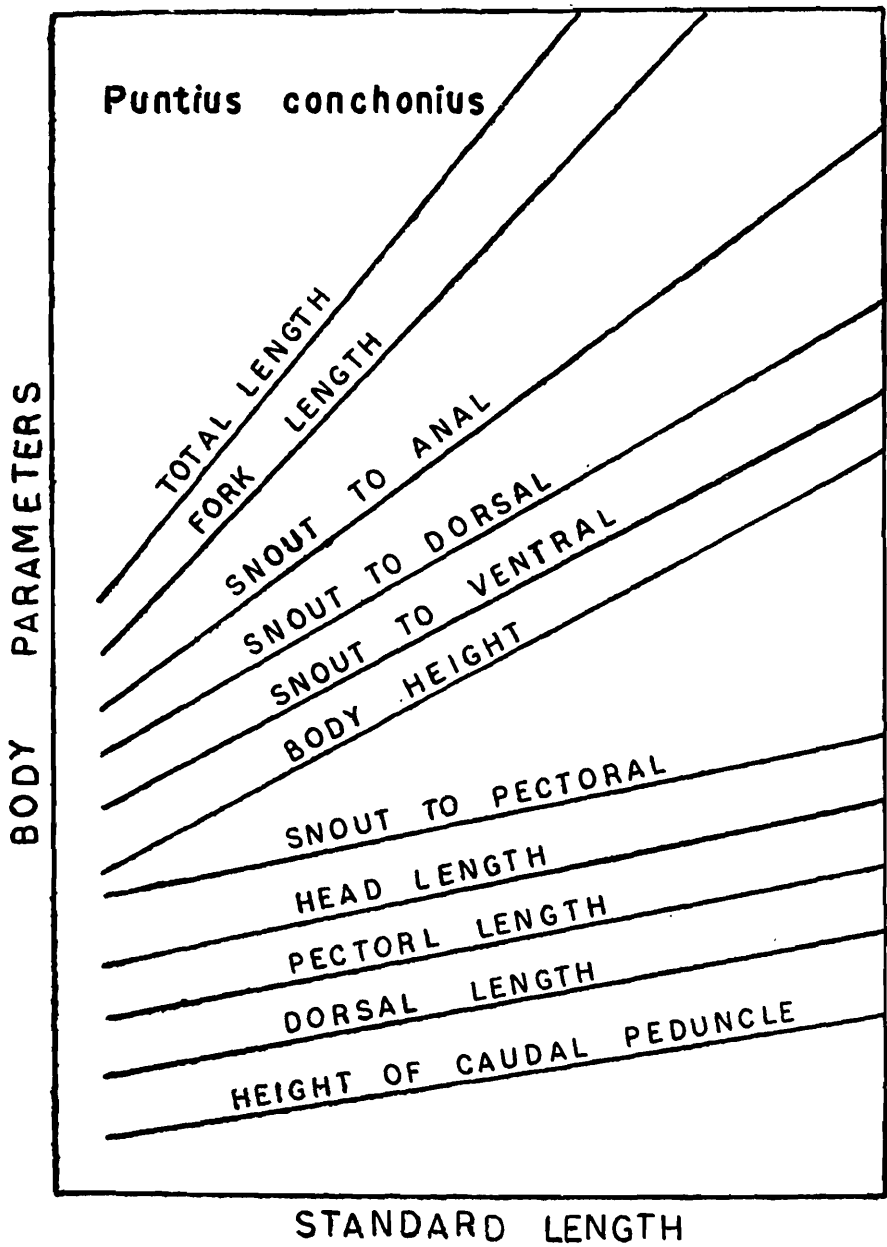
TABLE 5. Showing the values of sums in three species.

Parameter		<i>Puntius- conchonius</i>	<i>Puntius- amphibius</i>	<i>Crossocheilus- latus</i>
Standard-	X	53.0	71.1	87.4
length	X ²	272.02	556.13	814.12
Weight	Y	45.6	126.9	137.0
	XY	250.76	1119.09	1397.40
Total-	Y	67.9	88.4	108.5
length	XY	342.20	689.31	1009.58
Fork-	Y	59.9	77.5	94.8
length	XY	302.20	603.61	884.74
Snout to-	Y	29.4	36.3	40.8
dorsal	XY	148.97	283.60	380.60
Snout to-	Y	29.2	52.6	68.3
anal	XY	198.23	412.37	636.29
Snout to-	Y	27.9	35.4	45.5
ventral	XY	140.82	276.73	425.32
Snout to-	Y	14.4	18.7	22.4
pectoral	XY	71.99	144.61	207.47
Body-	Y	23.8	26.9	22.8
height	XY	121.35	212.26	215.53
Height of-	Y	9.0	10.7	10.4
C. P.	XY	45.34	83.70	96.70
Head-	Y	14.3	19.2	21.3
length	XY	71.61	148.29	197.67
Pectoral-	Y	12.1	14.4	16.6
length	XY	60.57	109.69	152.80
Dorsal-	Y	11.6	14.6	18.4
length	XY	58.17	115.05	171.33

ALLOMETRY

Rensch (1959) states that the process of allometric growth may be mathematically derived by a function formula $y = bx$ in which 'y' is the size of the organ under consideration and 'x' the body size. 'b' is the growth coefficient from which the size of the organ to a given body size can be calculated. It will be realized that the above formula may be written as $\text{Log } y = \text{log } b + \text{log } x$, from which it is evident that in system of logarithmic coordination this straight line indicates the degree of positive or negative allometry ($> 45^\circ = \text{positive}$, $< 45^\circ = \text{negative}$, $45^\circ = \text{isometry}$.)

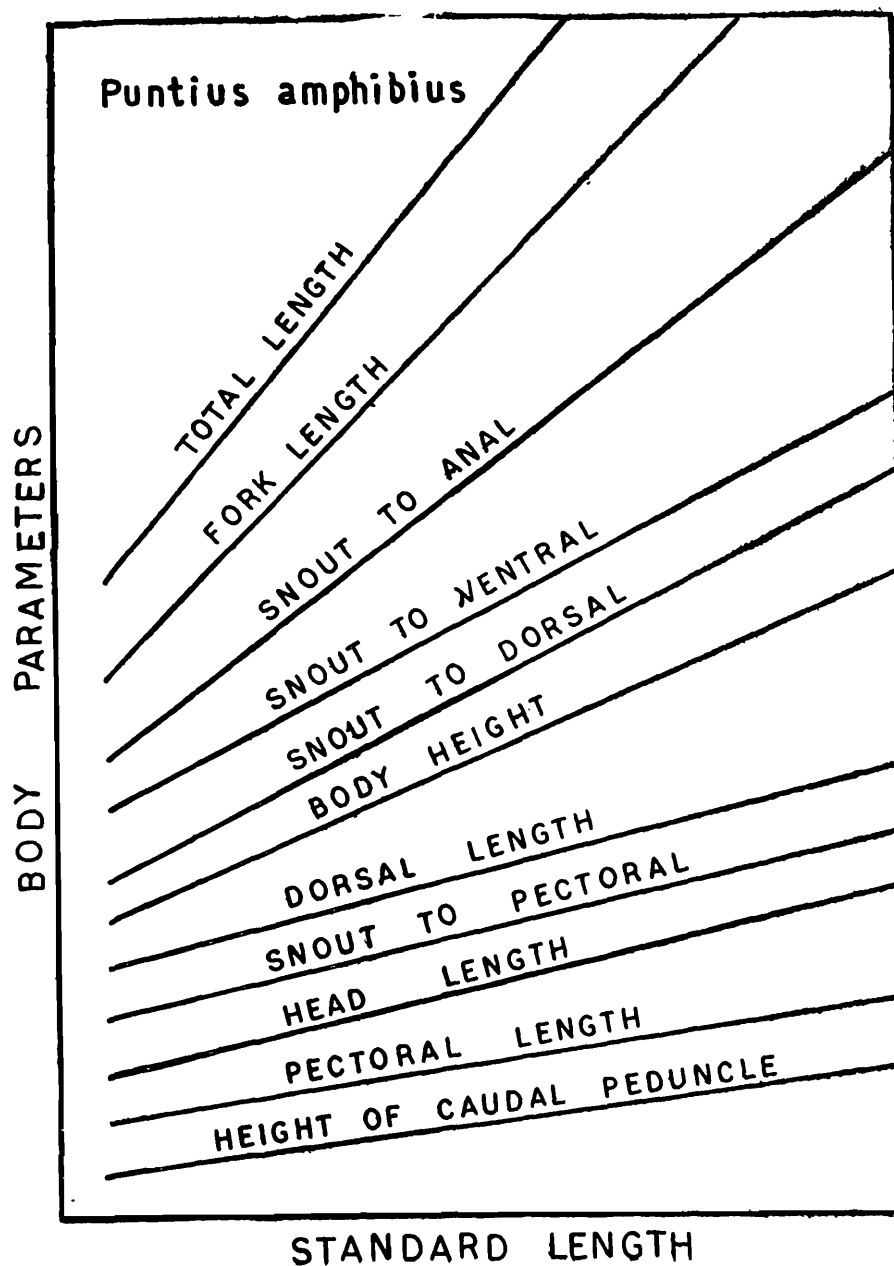
The measure of the slope of regression lines for different parameters and corresponding allometry in the three species are given in Tables 6, 7 and 8.



Text-fig. 2

TABLE 6. Showing Regression equations and Allometry in *Puntius conchoniuss* (Ham.)

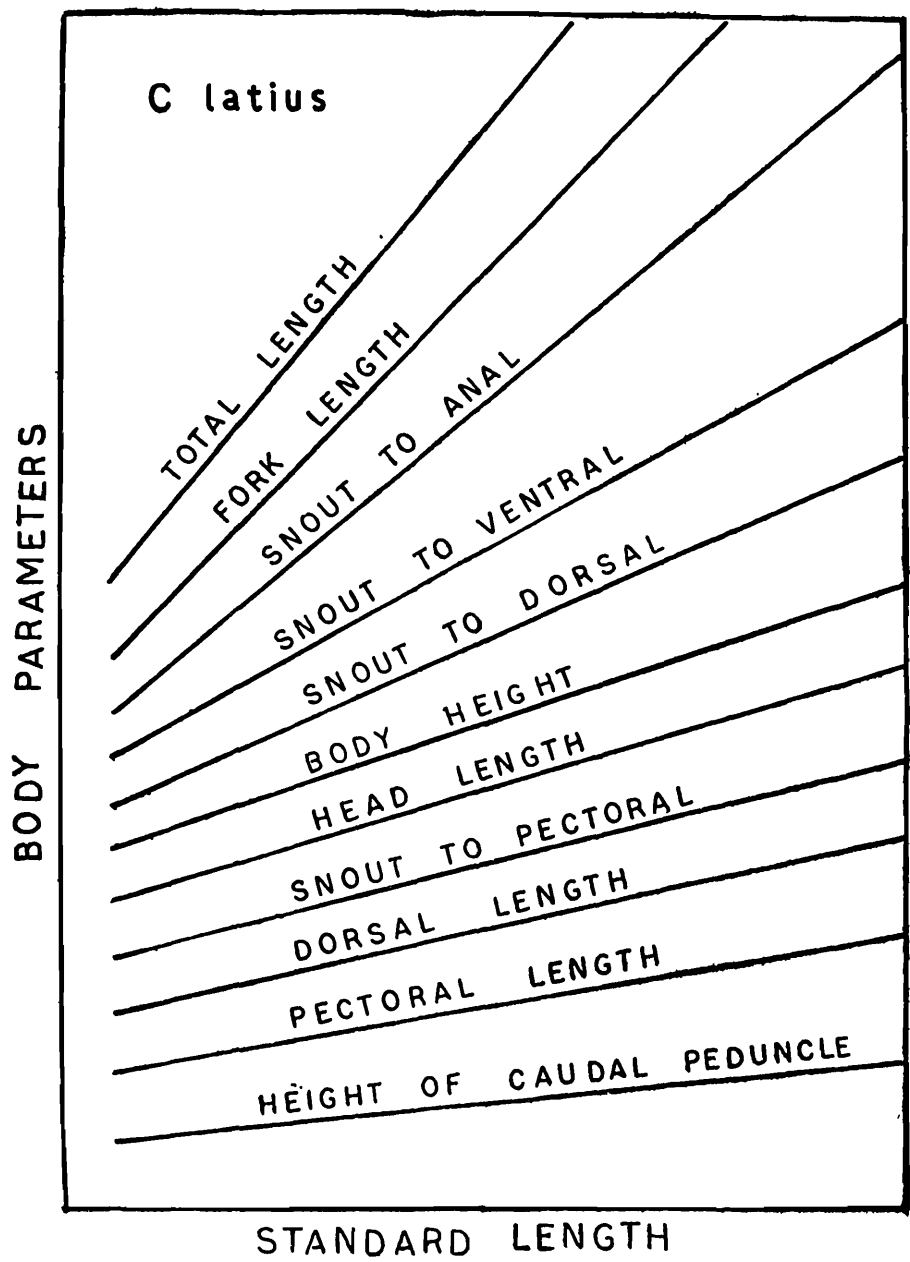
Parameter	Regression equation $Y=a+b\ x$	Angle	Tangent of the angle	Allometry + or -
Total length	$0.023+1.248\ x$	51°	1.2349	+
Fork length	$0.002+1.105\ x$	47°	1.0724	+
Snout to anal	$9.011+0.746\ x$	38°	0.7813	—
Snout to dorsal	$-0.066+0.584\ x$	30°	0.5774	—
Snout to ventral	$0.061+0.527\ x$	29°	0.5543	—
Body height	$0.046+0.539\ x$	29°	0.5543	—
Snout to pectoral	$0.106+0.232\ x$	12°	0.2126	—
Head length	$-0.034+0.224\ x$	12°	0.2126	—
Pectoral length	$0.011+0.221\ x$	12°	0.2126	—
Dorsal length	$-0.033+0.194\ x$	10°	0.1763	—
Height of caudal peduncle	$0.004+0.166\ x$	9°	0.1584	—



Text-fig. 3

TABLE 7. Showing Regression equations and Allometry in *Puntius amphibius* (V.)

Parameter	Regression equation $Y = a + b x$	Angle	Tangent of angle	Allometry + or -
Total length	$0.056 + 1.239 x$	$50^{\circ} 30'$	1.2131	+
Fork length	$0.004 + 1.084 x$	46°	1.0355	+
Snout to anal	$-0.002 + 0.749 x$	37°	0.7536	—
Snout to ventral	$-0.001 + 0.498 x$	27°	0.5095	—
Snout to dorsal	$-0.003 + 0.509 x$	27°	0.5095	—
Body height	$0.041 + 0.410 x$	$23^{\circ} 30'$	0.4348	—
Dorsal length	$0.164 + 0.213 x$	14°	0.2493	—
Snout to pectoral	$0.026 + 0.254 x$	13°	0.2309	—
Head length	$0.043 + 0.246 x$	13°	0.2309	—
Pectoral length	$-0.063 + 0.164 x$	8°	0.1405	—
Height of caudal-peduncle	$0.004 + 0.151 x$	7°	0.1228	—



Text-fig. 4

TABLE 8. Showing Regression equations and Allometry in *Crossocheilus latius* (Ham.)

Parameter	Regression equation $Y=a+bx$	Angle	Tangent of angle	Allometry
Total length	$0.005+1.241\ x$	$50^{\circ}\ 30'$	1.2131	+
Fork length	$-0.002+1.084\ x$	$46^{\circ}\ 30'$	1.0538	+
Snout to anal	$-0.012+0.810\ x$	40°	0.8391	—
Snout to ventral	$-0.009+0.524\ x$	29°	0.5543	—
Snout to dorsal	$0.084+0.801\ x$	24°	0.4245	—
Body height	$0.071+0.312\ x$	19°	0.3443	—
Head length	$0.043+0.301\ x$	17°	0.3057	—
Snout to pectoral	$0.004+0.243\ x$	13°	0.2309	—
Dorsal length	$0.002+0.210\ x$	12°	0.2126	—
Pectoral length	$-0.013+0.161\ x$	9°	0.1584	—
Height of caudal- peduncle	$0.001+0.118\ x$	5°	0.0875	—

From the tables it is evident that total length and fork length alone have positive allometry and all the rest negative allometry in all the three species. It is further proved by the fact that in the regression equations the value of 'b' (regression coefficient) for the total length and fork length are above 1.0 which shows positive allometry and for the rest it is below 1.0 showing negative allometry. So it can be concluded that total length and fork length are fast growing parameters and the rest are slow growing parameters.

CONDITION FACTOR

Le Cren (1951) observed that the condition factor forms an important part about feeding, spawning and other aspects related to the well being of the fish. Hart (1946) observed that, since the adolescent fishes have higher 'K' values than the older fishes, the increase and decrease in the 'K' values related to the increasing length can be employed to determine the size at first maturity. The formula applied is

$$K = \frac{W}{L^3 \times 100}$$

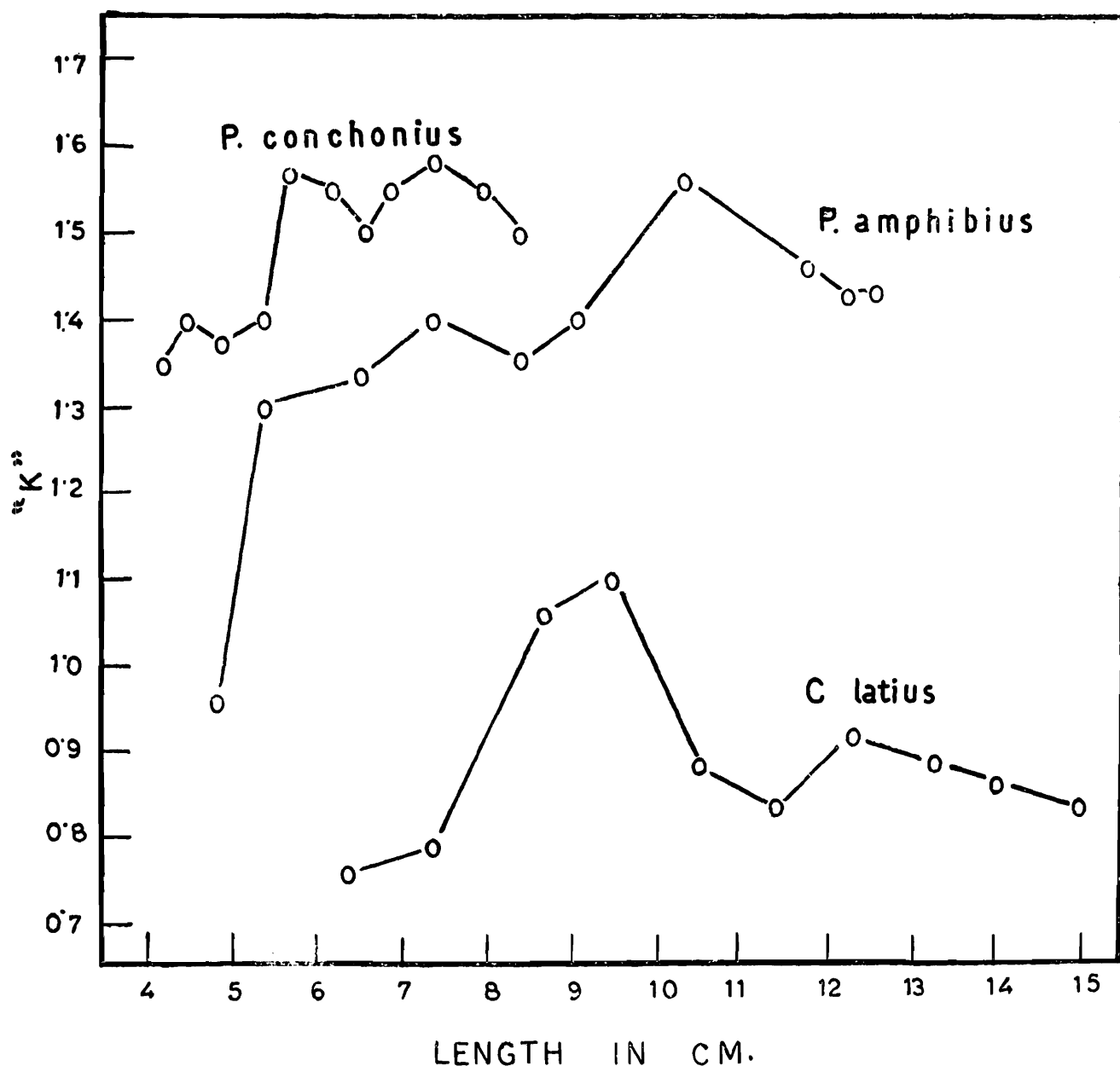
The average values of length and 'K' are given in Table No. 9.

It is observed from Text-fig. 5 that the first point of inflection in the curve is at 5.7 cm. for *P. conchoni*, 7.4 cm. for *P. amphibius* and 9.5 cm. for *C. latius*, which shows that the fish matures at that average length. But there is one more inflection in the curve at 7.4 cm. for *P. conchoni*, 10.3 cm. for *P. amphibius* and 12.3 cm. for *C. latius*. These secondary falls in the three species starting from 7.4 cm., 10.3 cm. and 12.3 cm. are probably because of increasing metabolic strain

TABLE 9. Showing total length and values of "K" in three species.

<i>Puntius conchoni</i> (Ham.)		<i>Puntius amphibius</i> (V.)		<i>Crossocheilus latius</i> (Ham.)	
Length	"K"	Length	"K"	Length	"K"
4.2	1.35	4.7	0.96	6.4	0.76
4.6	1.40	5.4	1.30	7.4	0.79
4.9	1.37	6.5	1.33	8.7	1.06
5.4	1.40	7.4	1.40	9.5	1.10
5.7	1.57	8.4	1.35	10.5	0.88
6.2	1.55	9.1	1.40	11.4	0.83
6.6	1.50	10.3	1.56	12.3	0.92
6.9	1.55	11.8	1.46	13.3	0.89
7.4	1.58	12.3	1.43	14.0	0.87
7.6	1.55	12.5	1.43	15.0	0.84
8.4	1.69				

due to spawning in older age groups as has been indicated in many other species (Hart, 1946 ; Menon, 1950 ; Qayyum and Qasim, 1964 and 1965.)



Text-fig. 5

ACKNOWLEDGEMENTS

My thanks are due to the Director, Zoological Survey of India, Calcutta ; O/C, S. R. S., Z. S. I., Madras ; O/C, G. P. R. S., Z. S. I., Patna for providing facilities and giving encouragement. I am also very thankful to Dr. G. H. R. Sarma, New Science College, Hyderabad for his kind help in calculations and Shri D. Sengupta, Z. S. I., Madras for the preparation of Text-figures.

REFERENCES

ALLEN, K. R. 1938. Some observations on the biology of the trout (*Salmo trutta*) in Windermere. *J. Anim. Ecol.*, 7 : 333-49.

- BANARJEE, V. AND VENKATESWARLU, T. 1968. A biometric study of *Gudusia chapra* (Ham.) *Patna Univ. J.*, **23** (4) : 39-42.
- HART, T. J. 1946. Report on trawling surveys of the Patagonian continental shelf. 'Discovery' Rep., **23** : 223-402.
- HILE, R. 1936. Age and growth of the *Leucichthys artedi* (Le Sueur) in the lakes of north eastern high lands, Wisconsin. *Bull. U. S. Bur. Fish.*, **48** : 211-317.
- LE CREN, E. K. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20** (2) : 201-19.
- MARTIN, W. R. 1949. The mechanics of environmental control of body form in fishes. *Univ. Toronto Stud. Biol.*, 58. *Publ. Ont. Fish. Res. Lab.*, **70** : 1-91.
- MENON, M. D. 1950. Bionomics of the poor Cod (*Gadus minutus* L.) in the Plymouth area. *J. mar. biol. Ass. U. K.*, **29** : 183-239.
- QAYYUM, A. AND QASIM, S. Z. 1964. Studies on the Biology of some fresh water fishes. Part I. *Ophicephalus punctatus* (Bloch). *J. Bombay Nat. Hist. Soc.*, **61** (1) : 74-98.
- QUYYUM, A. AND QASIM, S. Z. 1965. Part III. *Callichrous bimaculatus* (Bloch). *J. Bombay nat. Hist. Soc.*, **61** (3) : 627-650.
- RAMAPRASAD, T. N. C. 1968. Relative growth in *Opisthopterus tardoor* (Cuv.) *II All India Cong. Zool.*, Varanasi. Abstracts.
- RENSCH, B. 1959. *Evolution above species level*. Methuen & Co., Ltd., London, WC 2.
- VENKATESWARLU, T. 1962. Relative growth in *Hilsa kanagurta* (Blkr.) *II All India Cong. Zool.*, Varanasi. Abstracts.
- VENKATESWARLU, T. 1962b. Biometric comparison between *Johnius dussumieri* (Cuv.) and *Johnius axillaris* (Cuv. & Val.). *J. zool. Soc. India.*, **14** (2) : 170-75.
- VENKATESWARLU, T. 1968. Biometric studies in fishes. *Patna Univ. J.*, **23** (4) : 39-42.
- VENKATESWARLU, T. AND BANARJEE, V. 1970. Allometric growth in *Gudusia chapra* (Ham.). *Proc. 57th Indian. Sci. Congr.*, Pt. III, Sec. VII. Abstracts.
- VENKATESWARLU, T. 1971. Length-weight studies in *Gudusia chapra* (Ham.) *Proc. Nat. Acad. Sci. India*, **41** (B), **1** : 43-46.
- VENKATESWARLU, T. 1975. Allometric studies of growth in *Gudusia chapra* (Ham.) *Sci. & Cult.*, **41** (1) : 31-32.

ADDENDA & CORRIGENDA TO THE SYNOPTIC LIST OF
MALLOPHAGA *SENS. LAT.* (PHTHIRAPTERA : INSECTA)

By

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INTRODUCTION

Lakshminarayana (1979) provided the list of the chewing-lice (Mallophaga *sens. lat.*) reported from India and adjacent countries together with the host and regional indices. This list covers all the species reported up to the end of 1974. Omissions and commissions are inescapable in any such work partly due to non-availability of literature, and partly due to the results of later researches. It is felt desirable to up-to date the list covering the period from 1974-1979, and eliminate the omissions or commissions as far as practicable.

In the present paper, the newer reports are given in the Addenda following the same format as in Lakshminarayana (1979), and the corrections in the corrigenda.

ADDENDA

PART I (PARASITE INDEX)

4. *Alcedoecus* Clay & Meinertzhagen, 1939

Add under 4. 1 *A. annularis* Ansari Hosts :

Halcyon smyrnensis (Linne), [India : Imphal ; Manipur],
H. s. fusca (Boddaert), [India (Rajputana) Rajasthan],
Tendeiro, 1965. *Rev. estud. Gerais. Univ. Mocambique.*,
2 (4) : 35, photos 15-18. Erroneously reported as *Alcedoecus annulatus* Ansari (misspelt).

7. *Amyrsidea* Ewing, 1927

Add 7. 1 a. *A. elbeli* Emerson & Stojanovich, 1963. *Ent. News*, 74 : 263.

Hosts : *Arborophila t. torqueola* (Valenciennes), [India : Assam],
A. rufogularis (Blyth), *Ithaginis c. cruentus* (Hardwicke),
[Nepal], Scharf & Price, 1977. *Ann. ent. Soc. Am.*, 70 (5) : 819, figs. 7 & 8.

* Present Address : Southern Regional Station, Madras.

8. **Anaticola** Clay, 1936

Add under 8. 3. **A. crassicornis** (Scopoli) Hosts : (*Anas p. platyrhynchos*) **Anas p. platyrhynchos** (Linne), [India : Meghalaya (Shillong)], Rai, 1977. *Oriental Ins.*, 11 (4) : 587.

9. **Anatoecus** Cummings, 1916

Add under 9. 1. **A. dentatus** (Scopoli). Hosts : **Anas p. platyrhynchos** (Linne), [India : Meghalaya (Shillong)], Rai, 1977. *Oriental Ins.*, 11 (4) : 588.

Add under 9. 2. a. **A. icterodes** (Nitzsch), 1818 (*Philopterus*). *German's Mag. Ent.*, 3 : 290. *Nomen novum pro* "De Geer vii. t. 4f. 14".

Hosts : (*Murgus serrator*) **Mergus serrator** Linne, [India : Meghalaya (Shillong)] Rai, 1977, *Oriental Ins.*, 11 (4) : 588.

11. **Ardeicola** Clay, 1936

Add under 11. 7. **A. hardayali** Tandan & Kumar. Hosts : also on the same host, [India : Meghalaya (Shillong)] Rai, 1977. *Oriental Ins.*, 11 (4) : 587.

19. **Campanulotes** Kéler, 1939

Add under 19. 3. **C. heteroceros** Tendeiro.

Read after the publication (2) A : 399, figs 2, 4, 6 & 7, fotos 11, 14, 16 & 17 instead of (A) 2 : 399, figs.

Also add under Hosts : **C. leuconota gradaria** Hartert, [India : Sikkim].

24. **Ciconiphilus** Bedford, 1939

Add under 24. 5. **C. oquadripustulatus** (Burmeister). Hosts :

C. e. episcopus (Boddert), [India : Meghalaya (Shillong Zoo)], Rai 1977. *Oriental Ins.*, 11 (4) : 590.

Add under 24. 6. **C. temporalis** (Piaget). Hosts :

L. javanicus (Horsfield), [India : Meghalaya (Shillong Zoo)], Rai, 1977. *Oriental Ins.*, 11 (4) : 590.

25. **Coloceras** Taschenberg, 1882.

Add under 25. 2. **chinense** (Kellogg & Kuwana). Hosts :

S. chinensis ceylonensis (Reichenbach), [(Ceilao(Sri Lanka], **S. orientalis agricola** (Tickell), [India : Assam], Tendeiro, 1973. *Rev. Cienc. vet.*, 6 (A) : 353, figs 34-36, fotos 91-101, 188, 221 & 222.

Add under 25. 5. **piageti** (Johnston & Harrison) Hosts :

S. c. suratensis (Gmelin), [India : General ; Deccan, Indore ; Nepal], **S. d. decaocto** (Frivaldszky), [India (Rajputana) Rajasthan ; Pakistan : Sind], **S. t. tranquebarica** (Hermann), [India : (Rajputana) Rajasthan], Tendeiro, 1973. *Rev. Cienc. vet.*, 6 (A) : 322, figs 29, 33, 45, fotos 73-90, 185-197 & 211-220.

Add 25. 5 a. **setosum** (Piaget), 1880, (*Goniocotes*). *Pediculines* : 257.

Hosts : **Treron pompadora phayrei** (Blyth), [Nepal], (*Crocopus p. phoenicopterus*) **T. p. phoenicoptera** [Latham], [India : West Bengal (North) ; Nepal], **T. p. chlorigaster** (Blyth), [India : (Rajputana) Rajasthan specially Bharatpur], Tendeiro, 1973. *Rev. Cienc. vet.*, 6 (A) : 373, figs. 37-44, 46-48, & 50-53, fotos 106-122, 191, & 223-231].

26. **Colpocephalum** Nitzsch, 1818.

Add under 26. 7. **cooki** Price & Beer—Hosts :

L. javanicus (Horsfield), [India : Meghalaya (Shillong zoo)], Rai, 1977. *Oriental Ins.*, 11 (4) : 590.

Add under 26. 40. **uchidai** (Qadri). Hosts :

Same host, [India : Meghalaya (Shillong zoo)] Rai, 1977. *Oriental Ins.*, 11 (4) : 590.

27. **Columbicola** Ewing, 1929.

Add 27. 1 a. **bacillus** (Giebel), 1866, (*Lipeurus*). *Z. ges. Natwiss.*, 28 (11/12) : 379.

Hosts : **Streptopelia d. decaocto** (Frivaldszky), [India : Indore (U. P.), (Rajputana) Rajasthan], **S. t. tranquebarica** (Hermann), [India : (Rajputana) Rajasthan], **S. senegalensis cambayensis** (Gmelin), [India : Deccan], as *Columbicola c. bacillus* (Giebel), Tendeiro, 1965. *Jta. Invest. Ultramar*, (1962), (2) 32 : 101, figs. 13-16, fotos 7-12 & 191.

Add 27. 1 b. **cavifrons** (Taschenberg), 1882, (*Lipeurus*). *Nova Acta Leop.-Carol.*, 44 : 124.

Hosts : **Ducula aenea nicobarica** (Pelzeln), [India : Nicobar], **D. a. pusilla** (Blyth), [Sri Lanka], Tendeiro, 1965. *Jta Invest. Ultramar*, (1962), (2) 32 : 339, figs. 117-120, fotos 173-178 & 224.

Add under 27. 2. **columbae** (Linne). Hosts :

C. eversmanni Bonaparte, [Afghanistan], **Haliastur i. indus** (Boddaert) (Error. Straggler), [Burma : Mandalay], Tendeiro, 1965. *Jta Invest. Ultramar*, (1962), (2) 32 : 77, figs. 1-12, fotos 1-6 & 189-190.

Add under 27. 6. **fulmeki** Eichler. Hosts :

Streptopelia chinensis tigrina (Temminck), [Burma : Mandalay], Tendeiro, 1965. *Jta. Invest. Ultramar*, (1962), (2) 32 : 227, figs. 68-70, fotos 91-94 & 207.

Add under 27. 10. **C. orientalis** Tendeiro. Hosts :

[Afghanistan], and also **S. o. meena** (Sykes), [Afghanistan].

Add under 27. 11. **phoenicopterae** Tendeiro. Hosts :

[India : (Rajputana) Rajasthan], & **Treron phoenicoptera viridifrons** Blyth, [Burma], before, as *C. elbeli*.

Add under 27. 12. **theresae** Ansari. Hosts :

Streptopelia senegalensis cambayensis (Gmelin), [India : Deccan], **S. chinensis suratensis** (Gmelin), [India : Bihar, Maharashtra (Bombay)], **S. t. tranquebarica** (Hermann), [India : Manipur], Tendeiro, 1965. *Jta. Invest. Ultramar*, (2) 32 : 246, figs. 79-82, fotos 105-110, & 211.

Add 27. 13. **tschulyschman** Eichler, 1942, *Zool. Anz.*, 139 : 28.

Hosts : **Columba rupestris turkestanica** Buturlin, **C. leuconota leuconota** Vigors, [India : Sikkim], Tendeiro, 1965. *Jta. Invest. Ultramar*, (1962), (2) 32 : 131, figs. 27-29, fotos 27-90 & 195.

Add 27. 14. **turturis** (Uchida) 1917, (*Lipeurus*). *Annot. zool. Jap.*, 9 (3) : 212.

Hosts : **Streptopelia orientalis agricola** (Tickell), [India : Assam], Tendeiro, 1965. *Jta. Invest. Ultramar.*, (1962), (2) 32 : 121, figs. 22-24, fotos 19-22, & 193.

40. **Esthiopterum** Harrison, 1916

Add under 40. 2. **indicum** Tandan. Host :
Same host [India : Meghalaya (Shillong)] Rai, 1977.
Oriental Ins., 11 (4) : 588.

47. **Goniocotes** Burmeister, 1838

Add 47. 2 a. **diplogonus** Nitzsch, 1866. In Giebel, *Z. ges. Natwiss.*,
28 : 389.

Host : **Tragopan satyra** (Linne), [India : Meghalaya (Shillong zoo)],
Rai, 1977. *Oriental Ins.*, 11 (4) : 588.

Add under 47. 3. **gallinae** (de Geer), Hosts :
Same host, [India : Meghalaya (Jaintia Hills &
Shillong)], Rai, 1977. *Oriental Ins.*, 11 (4) : 588.

Add under 47. 8. Entry given in 47.10.

Add under (47.10) =no. 8.

48. **Goniodes** Nitzsch, 1818

Add under 48. 15. **dissimilis** Denny. Hosts :
Gallus gallus / domesticus / (Linne), [India : Megha-
laya (Jaintia Hills)], Rai, 1977. *Oriental Ins.*, 11 (4) :
588.

Add under lativentris Uchida, 1916. Read *Coloceras* as *Nitytschiella*.

Add under 48. 30. **pavonis** (Linne). Host :
[Bangla Desh ; Dacca ; India : General, Delhi, &
Lucknow], (Slides from the type host are available in
B. M. (Nat. Hist.), London).

Add under 48. 34. **spinicornis** Nitzsch. Host :
Tragopan satyra (Linne), [India : Meghalaya (Shillong
zoo)] , Rai, 1977. *Oriental Ins.*, 11 (4) : 589.

50. **Heleonomus** Ferris, 1916

Add under 50. 1. **elbeli** Price. Host :
Same host, [India : Meghalaya (Shillong zoo)] , Rai,
1977. *Oriental Ins.*, 11 (4) : 590.

56. **Kelerimenopon** Conci, 1942.

Add 56. 2. **tandani** Rai, 1977. *Oriental Ins.*, 11 (4) : 591, figs 1-7.
Error. Probably *Hohorstiella* Eichler.

Host : **Ducula badia insignis** Hodgson, [India : Meghalaya].

60. *Lipeurus* Nitzsch, 1818

bacillus Giebel, 1866. See *Columbicola*.

Add under 60. 2. *L. caponis* (Linne). Host :

Gallus gallus [domesticus] (Linne), [India : Meghalaya (Jaintia Hills & Shillong)], Rai, 1977. *Oriental Ins.*, 11 (4) : 589.

cavifrons Taschenberg, 1882. See *Columbicola lawrensis tropicalis* (Peters). Transfer entry to 74a.

turturis Uchida, 1917. See *Columbicola*.

63. *Menacanthus* Neumann, 1912

(63. 2.) *annulatus* (Giebel). Transfer entry to 63. 4a.

Add under 63. 3. *M. camelinus* (Nitzsch). Hosts :

Lanius cristatus Linne, *L. excubitor* Linne, *L. vittatus* Valenciennes [India], *L. schach* Linne, [India ; Nepal], Price, 1977. *J. Med. Ent.*, 14 (2) : 210, figs. 7-9.

Add 63. 4 a. *eurysternus* (Burmeister), 1838, (*Menopon*). *Handb. Ent.*, 2 : 439.

Host : *Passer* [domesticus] *indicus* Jardine et Selby, [India : Panjab], Ansari, 1956. *Indian J. Ent.*, 17 (3) : 400 & Ansari, 1957. *Indian J. Ent.*, 18 (4) : 434, as *M. annu'atus* (Giebel) (63. 2) ; (*Pastor roseus*) *Sturnus roseus* (Linne), [Pakistan [Lyallpur], Ansari, 1951. *Proc. nat. Inst. Sci. India*, 17 (2) : 139 as *M. gulabimaina* Ansari (63. 6) : (*Sturnus vulgaris humii*) *S. vulgaris indicus* Blyth, [Pakistan : Lyallpur], Ansari, 1951. *Proc. nat. Inst. Sci. India*, 17 (2) : 148, fig. 9 as *M. himalayicus* Ansari (63.8) (*Garrulus glandarius lanceolatus*) *Garrulus lanceolatus* Vigors, [India : Simla], Kellogg & Paine, 1914. *Rec. Indian Mus.*, 10 (4) : 240, fig. 5 as *Menopon monochromateus* Kellogg & Paine (63.13), (*Menopon gonophaeus* Burmeister (vide 63. 5), *M. himalayicus* Ansari (vide 63. 5) possibly conspecific with *M. mutabilis* Blag. (ct. Zlotorycka, 1965. *Arch. Parasit. Polon.*, 13 (6) : 50, fig. (19 & 3a) (63. 14) ; of which only the latter is considered as conspecific (vide infra Price, 1975) (*Molpastes l. leucogenys*) *Pycnonotus l. leucogenys* (Gray), [India : Kulu], Ansari, 1951. *Proc. nat. Inst. Sci. India*, 17 (2) : 141, fig. 6 as *M. safedgal* Ansari (63. 16) *Acridotheres t. tristis* (Linne), [Pakistan : Lyallpur], Ansari, 1951. *Proc. nat. Inst. Sci. India*, 17 (2) : 150, as *M. spiniferus* (Piaget) (63. 17) ; *A. t. tristis* (Linne), [India],

Qadri, 1935. *Z. Parasitenk.*, 8 : 226, fig. 1, as *M. tristisi* Qadri, and also [India : Panjab], Ansari, 1955. *Proc. 7th Pak. Sci. Conf. Sec. Agric.* : 54, Ansari, 1956. *Indian J. Ent.*, (1955), 17 (3) : 400, & Ansari, 1957. *Indian J. Ent.*, (1956), 18 (4) : 433, as *M. tristisi* Qadri (63.19) (*vide infra* Price, 1975); *Acridotheres gingianus* (Latham), [Nepal], *A. tristis* (Linne), [Burma; India], *Arachnothera magna* Hodgson, [India], *Brachypteryx major* (Jerdon), [India], *Dicrurus caerulescens* (Linne), [India], *D. hottentotus* (Linne), [Nepal], *D. / adsimilis / macrocercus* (Vieillot), [India : (Rajputana) Rajasthan], *D. paradiseus* (Linne), [Burma], *Garrulax cachinnans* Jerdon, [India], *G. erythrocephalus* Vigors, [India : Sikkim], *Oriolus xanthornus* (Linne), [Nepal], *Petronia xanthocollis* (Burton) [India], *P. l. leucogenys* (Gray), [India], *Sturnus pagodarum* (Gmelin), [India], *Turdus merula* (Gmelin), [India], Price, 1975. *Ann. ent. Soc. Am.*, 68 (4) : 618, figs. 1-9.

Add under 63. 5. *gonophaeus* (Burmeister). Host :

Corvus / s. / *splendens* Vieillot, [India], Qadri, 1935, *Z. parasitenk.*, 8 : 226, fig. 2. on the same host, [Pakistan : Lyallpur], Ansari, 1951. *Proc. nat. Inst. Sci. India*, 17 (2) : 13 as *M. masudi* Qadri (63. 12) (cf. Price, 1977. *J. Med. Ent.*, 14 (2) : 208, figs. 2-4).

Add under (63. 6.) *gulabimaina* Ansari. Transfer entry to 63. 4a.

Add under (63. 8.) *himalayicus* Ansari. Transfer entry to 63. 4a.

Add under (63. 11.) *mamola* Ansari after 53. (Doubtful species. *vide* Price, 1977. *J. Med. Ent.*, 14 (2) : 218).

(63. 12.) *masudi* Qadri. Transfer entry to 63. 5.

Add 63. 12a. *merisuoi* Eichler, 1953, *Beitr. Vogelk.*, 3 : 171.

Host : *Corvus* / s. / *splendens* Vieillot & (*Urocissa flavirostris*) *Kitta f. flavirostris* (Blyth), [Nepal], Price, 1975, *Ann. ent. Soc. Am.*, 68 (4) 621, fig. 10.

(63. 13.) *M. monochromateus* (K. & P.). Transfer entry to 63. 4a.

(63. 14.) *M. mutabilis* Blag. Transfer entry to 63. 4a.

Add 63. 15a. *M. pici* (Denny) 1842 (*Menopon*). *Mon. Anopl. Brit.*, : 200.

Hosts : **Megalaima zeylanica** (Gmelin), [Nepal] ,
Picus canus Gmelin, [Nepal], **P. flavinucha** Gould,
 [India], & **Zoothera dauma dauma** (Latham) (?),
 [Nepal], Price & Emerson, 1975. *Ann. ent. Soc.*
Am., 68 (5) : 779, figs. 1-5.

Add 63. 15b. **M. pusillus** (Nitzsch), 1866, (*Menopon*). *Z. ges. Natwiss.*,
 27 : 120.

Hosts : **Anthus hodgsoni** Richmond, [India],
 Price, 1977. *J. Med. Ent.*, 14 (2) : 213.

(63. 16.) **M. safedgal** Ansari. Transfer entry to 63. 4a.

(63. 17.) **M. spiniferus** (Piaget). Transfer entry to 63. 4a.

(63. 19.) **M. tristisi** Qadri. Transfer entry to 63. 4a.

64. **Menopon** Nitzsch, 1818.

Add eurysternus Burmeister, 1838. See *Menacanthus*.

Add incisum Giebel, 1866. See *Meromenopon*.

Add pici Denny, 1842. See *Menacanthus*.

Add pusillus Nitzsch, 1866. see *Menacanthus*.

65. **Meromenopon** Clay & Meinertzhagen, 1941.

Add 65. 1a. **M. incisum** (Giebel), 1866, (*Menopon*). *Z. ges.*
NatWiss., 28 : 391.

Host : **Coracias benghalensis** (Linne), [Burma], Price & Emerson,
 1977. *J. Kans. ent. Soc.*, 50 (2) : 219, figs. 8-10.

Add under 65. 1. **M. meropis** Clay & Meinertzhagen. Hosts :

Hosts : **Merops apiaster** Linne, [Afghanistan], **M. philippinus**
 Linne, [Burma ; India] , **M. orientalis** Latham (also as on
M. viridis Linne), **M. superciliosus** Linne. [India], Price &
 Emerson, 1977. *J. Kans. ent. Soc.*, 50 (20) : 216, fig. 7.

68. **Myrsidea** Waterston, 1915

Add 68. 1b. **ananthakrishnani**, Rai, 1978. *Entomon.*, 3 (2) : 281,
 figs. 1-6.

Host : **Garrulax phoeniceus bakeri** Hartert, [India : Meghalaya
 (Shillong)].

Add under 68. 3. **assamensis** Tandan. Host :

Same host, [India : Meghalaya (Umron forest, Khasi
 Hills)], Rai, 1977. *Oriental Ins.*, 11 (4) : 594.

Add under 68. 4. **bakttitar** (Ansari) Hosts.

Corvus s. splendens Vieillott, [Pakistan : Lyallpur]. Ansari, 1955. *Proc. 7th Pak. Sci. Conf., Sec. Agric.* : 53 ; Ansari, 1956. *Indian J. Ent.*, (1955) 17 (3) : 399, as *M. splendens* Ansari (68. 39) ; **C. s. zugmayeri** Laubmann, [India : Rajasthan (Bharatpur) ; Pakistan : Sind, & Kot Abdul Malik, Sheikpura Dist.] Klockenhoff, 1973. *Bonn. zool. Beitr.*, 24 (4) : 405 figs. 7-9 spelt as *Myrriidae bakttitar* (Ansari.) 68. 39 *splendens* Ansari. Transfer entry to 68. 4.

Add 68. 39a. **splendenticola** Klockenhoff, 1973. *Bonn. zool. Beitr.*, 24 (4) : 409 figs. 10-12.

Host : **Corvus s. splendens** Vieillot, [India : Bihar, (Mysore) Karnataka, Pt. Calimere ; Nepal].

Add 68. 40a. **subcoracis** Klockenhoff & Schirmers, 1976. *Bonn. zool. Beitr.*, 27 (3/4) : 315, figs. 4, 18 & 19.

Host : **Corvus corax subcorax** Severtzov, [Afghanistan : Dasht-e-Kushti, Kabul, B and e-Emir ; India : (Rajputana) Rajasthan ; Pakistan : Bahawalpur].

Add 68. 41a. **tibetana** Klockenhoff & Schirmers, 1976. *Bonn. zool. Beitr.* 27(3/4) : 323, figs. 6, 7 & 22-24.

Host : **Corvus corax tibetanus** Hodgson, [India : Khalatse, Ladak ; Nepal : Langtung valley].

71. **Neopsittaconirmus** Conci, 1942.

Add under item 1. **N. chandabani** (Ansari) Host :

also [Pakistan : Peshawar], Guimaraes, 1974. *Arq. Zool. S. Paulo*, 25 (3) : 155, figs. 67, 68, 70-72. (Guimaraes (*op. cit.*) stated that he examined the paratypes from the type host from Peshawar (Pakistan), collected by Dr R. Meinertzhagen. Ansari (1947) stated that his material was collected at Lyallpur (Pakistan). Since Peshawar was not mentioned by the author of the species, the so called 'paratype' material should be treated as general collection only and not the primary type material.....Lakshminarayana).

Add 1a. **N. difficilis** Guimaraes, 1974. *Arq. Zool. S. Paulo*, 25 (3) : 141, figs. 30-33.

Host : **Psittacula alexandri fasciata** (P. L. S. Mueller) [Burma : Myitkyina] as *N. lybartota difficilis* Guimaraes.

Add under 2. **N. lybartota** Ansari. Host :

Psittacula krameri borealis (Neumann), [India : Oating : Assam], Guimaraes, 1974. *Arq. Zool. S. Paulo*, 25 (3) : 139, figs. 26-29.

Add 3. **N. meinertzhageni** Guimaraes, 1974. *Arq. Zool. S. Paulo*, 25 (3) : 157, fig. 73.

Host : **Psittacula eupatria nipalensis** (Hodgson) [Nepal : (nr) Khatmandu].

Nirmus Nitzsch, 1818 (*nec* Hermann, 1804).

Add obscurus Burmeister, 1838. See *Quadriceps*.

Add similis Giebel, 1866. See *Quadriceps*.

73. **Nitzschiella** Kéler, 1939

Add 73. 1a. **N. doreyana** Eichler, 1950. *Doriana*, 1 (9) : 8. *Nom. nov. pro. N. menadensis* Kéler (*partim*).

Host : **Macropygia unchall tusalia** (Blyth), [India : Manipur]. Tendeiro, 1974. *Rev. Cienc. vet.*, 7 (A) : 158, fotos 4-5.

Add 73. 1b. **lativentris** (Uchida), 1916, (*Goniodes*). *Ann. zool. Jap.*, 9 (2) : 81.

Host : **Streptopelia chinensis suratensis** (Gmelin) [India : Punjab], Ansari, 1955. *Proc. 7th Pak. Sci. Conf. sec. Biol.* : 48 ; Ansari 1956. *Indian J. Ent.* (1955), 17 (3) : 398 as *Coloceras lativentris* (Uchida) ;

S. chinensis tigrina (Temminck), [Burma], & **S. c. suratensis** (Gmelin), [Himalaya], Tendeiro, 1974. *Rev. Cienc. vet.*, 7 (A) : 175, fotos 21-23.

Add 73. 1c. **N. liviae** Tendeiro, 1974. *Rev. Cienc. vet.*, 7 (A) : 184, fotos 31, 32 & 34.

Host : **Columba livia intermedia** Strickland, [India : Deccan].

(73. 1d.) *menadensis* (Piaget) sensu Kéler, 1939. *Nova Acta Leop. carol.* ; (n. f.) 8 (51) : 68 fig. 33. (*partim*)=73.1a.

Add under 73. 2. **N. orientalis** Tendeiro. Hosts :

Streptopelia o. meena (Sykes), [India : Uttar Pradesh] Tendeiro, 1974. *Rev. Cienc. vet.*, 7 (A) : 199, fotos 43-45.

74 a. *Numidilipeurus* Tendeiro, 1955.

Numidilipeurus Tendeiro, 1955. *Bol. Cult. Guine Port.*, 9 : 836. Type species. *Lipeurus lawrensis* Bedford, 1929.

Transfer the entire entry of item 7 from p. 120.

87. *Quadriceps* Clay & Meinertzhagen, 1939

Add under 87. 7. *Q. conformis* (Blag.) after photo 4. cf. Hopkins & Timmermann, 1954. *Trans. R. ent. Soc. Lond.*, 105 (8) : 144, fig. 10 pl. 2 figs. 13 & 14.

Add under 87. 11. *Q. furvus* (Burmeister), Hosts : after Ansari 1947... 201. *Tringa erythropus* (Pallas), [India : (Rajputana) Rajasthan], Hopkins & Timmermann, 1954. *Trans. R. ent. Soc. Lond.*, 105 (8) : 141, fig. 7 pl. 1 figs. 1 & 2.

Add 87. 20a. *Q. obscurus* (Burmeister), 1838, (*Nirmus*). *Handb. ent.*, 2 : 427 (*partim*).

Host : *Tringa stagnatilis* (Bechstein), [India], Hopkins & Timmermann, 1954. *Trans. R. ent. Soc. Lond.*, 105 (8) : 135, figs. 1-4, pl. 1 figs. 1 & 2.

Add under 87. 23. *Q. ravus* (Kellogg). Hosts :

(*Actitis hypoleucos*) *Tringa hypoleucos* Linne [Nepal], Hopkins & Timmermann, 1954. *Trans. R. ent. Soc. Lond.*, 105 (8) : 145, fig. 11, pl. 2 figs. 15 & 16.

Add under 87. 27. *Q. similis* (Giebel). Host :

after as *N. clypeatus* K. & P. also Hopkins & Timmermann, 1954. *Trans. R. ent. Soc. Lond.* 105 (8) : 139, fig. 6, pl. 1 figs. 5 & 6.

89. *Reticulipeures* Kéler, 1958

Add under 89. 4. *longus* (Piaget). Host :

Same host, [India : Meghalaya (Shillong zoo)], Rai, 1977. *Oriental Ins.*, 11 (4) : 589, as *Oxylipeurus longus* (Piaget).

94. *Strigiphilus* Mjoeberg, 1910

Add under 94. 1. *S. aitkeni* Clay. Hosts :

Tyto alba stertens Hartert, [India : Meghalaya Mawphlong, Khasi Hills], Rai, 1977. *Oriental Ins.*, 11 (4) : 589.

Add under 94. 4. **S. cursor** (Burmeister) : Hosts :

Asio f. flammeus (Pontoppidan), [India], Carriker, 1976, *Ann. Med. Naturalist*, 76 (3) : 85.

Add 94. 6a. **S. ketupae** Emerson & Elbel, 1957. *Proc. Biol. Soc. Wash.*, 70 : 196, figs. 2 & 7.

Host : **Strix leptogrammica newarensis** (Hodgson), [India], Rai, 1977. *Oriental Ins.*, 11 (4) : 589.

Add under 94. 7. **S. macrogenitalis** Emerson & Elbel. Host :

Same host, [India : Meghalaya (Tura, Garo Hills)], Rai, 1977. *Oriental Ins.*, 11 (4) : 590.

96. **Sturnidoecus** Eichler, 1944

Under 96. 1. **S. acutifrons** Ansari. Read pp. 8 & 30 instead of 8 & 31 ; add (Mysore) Karnataka.

Under 96. 2. **S. affinis** Piaget last line read 31 as 30.

Under 96. 6. **S. capensis** (Giebel)(Ansari 1967 wrongly stated (Giebel) 1847 as 1947).

Under 96. 10. **S. fragilis** Ansari. Enclose Ceylon in parentheses. Add Sri Lanka and also add *S. capensis fragilis* sp. nov.

99. **Trinoton** Nitzsch, 1818

Add under 99. 5. **T. querquedulae** (Linne) Hosts :

Anas c. crecca Linne, [India : (Rajputana) Rajasthan], **Sarkidornis melanota** (Pennant), [India : Bhopal], (transgressed parasite), Tendeiro, 1967. *Rev. estud. Gerais Univ. Mocambique*, 4 (4) : 48, fotos 7-8 & 11-18.

101. **Turturicola** Clay & Meinertzhagen, 1938

Add 101. 1. Publication as *Rev. estud. Gerais Univ. Mocambique*, 2 (4) : 25, photos 17, 21 & 27 instead of *Jta. Invest. Ultramar*, (2) 32 : 25, figs. 17, 21 & 27.

Add under 101. 2. **T. salimalii** Clay & Meinertzhagen Hosts :

also in Tendeiro, 1965. *Rev. estud. Gerais. Univ. Mocambique*, 2 (4) : 23, fig. 1b, photos 11, 16 & 24.

PART II—(HOST INDEX)

Order VII : ANSERIFORMES

- VII. (i) 12. *Anas p. platyrhynchos* Linne. Add (9.1).
 VII. (i) 15. *Mergus serrator* Linne. Add (9.2a.).
 VII. (i) (16). *Murgus serratus* (Error). See VII (i) 15.
 VII. (i) 18. *Sarkidornis melanotos* (Pennant). Add (99.5) (Straggler).

Order VIII : FALCONIFORMES

- VIII (i) 10. *Haliastur indus* (Boddaert). Add (27.2) (Error).

Order IX : GALLIFORMES

- IX (ii) 8. *Arborophila rufogularis* (Blyth), Add (7.1a).
 IX (ii) 13. *A. t. torqueola* (Valenciennes). Add (7. 1a).
 IX (ii) 45. *Ithaginis c. cruentus* (Hardwicke). Add (7. 1a).
 IX (ii) 83. *Tragopan satyra* (Linne), Add (47. 2a).

Order XI : CHARADRIIFORMES

- XI (iv) 1a. *Actitis hypoleucos* Linne. See XI (iv) : 6.
 XI (iv) 9. *Tringa stagnatilis* (Bechstein). Add (87. 20a).

Order XII : COLUMBIFORMES

- XII (ii) 3. *Treron phoenicoptera* (Latham), Add (25. 5a).
 XII (ii) 3a. *T. p. chlorigaster* (Blyth). Add (25. 5a).
 XII (ii) 3b. *T. p. viridifrons* Blyth. Add. (27. 11).
 XII (ii) 4a. *T. pompadora phayrei* (Blyth). Add (25. 5a).
 XII (ii) 6a. *Columba eversmanni* Bonaparte. Add (27. 2).
 XII (ii) 7a. *C. leuconota gradaria* Hartert. Add (19. 3).
 XII (ii) 8. *C. l. leuconota* Vigors. Add (27. 13).
 XII (ii) 10. *C. livia intermedia* Strickland Add (73. 1c.)
 XII (ii) 10a. *C. rupestris turkestanica* Buturlin. Add (27. 13)
 XII (ii) 11a. *Ducula aenea nicobarica* (Pelzeln). Add (27. 1b).
 XII (ii) 11b. *D. a pusilla* (Blyth). Add. (27. 1b).
 XII (ii) 11c. *D. badia insignis* Hodgson. Add (56.2) (Error).
 XII (ii) 12b. *Macropygia unchall tusalia* (Blyth) Add (73. 1a).
 XII (ii) 14. *Streptopelia chinensis ceylonensis* (Reichenbach). Add (25. 2).
 XII (ii) 15. *S. c. suratensis* (Gmelin), Add (27. 12 ; 73. 1b).
 XII (ii) 15a. *S. c. tigrina* (Temminck). Add (27. 6 ; 73. 1b.).
 XII (ii) 16. *S. decaocta* (Frisvaldsky), Add (27. 1a).
 XII (ii) 18. *S. orientalis agricola* (Tickell) Add (25. 2 ; 27. 14).

XII (ii) 18a. *S. o. meena* (Sykes) Add (27. 10 ; 73. 1).

XII (ii) 20. *S. senegalensis cambayensis* (Gmelin) Add (27. 1a).

XII (ii) 21. *S. t. tranquebarica* (Hermann). Add (25. 5 ; 27. 1a ; 27. 12)

Order XIII : PSITTACIFORMES

Add 1 a. *Psittacula alexandri fasciata* (P. L. S. Mueller). Add (71. 1a).

XII (i) 1. *P. eupatria nipalensis* (Hodgson). Add (71. 3).

Order XV : STRIGIFORMES

XV (i) 1. *Tyto alba stertens* Hartert. Add (94. 1).

XV (i) 8. *Strix leptogrammica newarensis* (Hodgson). Add (94. 6a).

XV (ii) under Striginae :

Add 7a. *Asio f. flammeus* (Pontoppidan), (94. 4.)

Order XVIII : CORACIIFORMES

XVIII (i) 4a. *Halcyon smyrnensis fusca* (Boddaert), Add (4. 1).

XVIII (ii) 3a. *Merops o. orientalis* Latham, Add (65. 1).

XVIII (ii) 3a. *M. philippinus* Linne. Add (65. 1).

XVIII (ii) (4). *M. viridis*. See XVIII (ii) 3.

XVIII (ii) 5. *M. superciliosus* Linne. Add (65. 1).

XVIII (iii) 1. *Coracias b. benghalensis* (Linne). Add (65. 1a).

Order XIX : PICIFORMES

XIX (i) 2. *Megalaima zeylanica* (Gmelin). Add (63. 15a).

XIX (ii) 5a. *Picus canus* Gmelin, Add (63. 15a).

XIX (ii) 5b. *P. flavinucha* Gould. Add (63. 15a).

Order XX : PASSERIFORMES

XX (iii) 1a. *Lanius cristatus* Linne. Add (63. 3).

XX (iii) 2a. *L. schach* Linne. Add (63. 3).

XX (iii) 3. *L. vittatus* Valenciennes. Add (63. 3).

XX (iv) 2. *Oriolus xanthornus* (Linne). Add (63. 4a).

XX (v) 2. *Dicrurus adsimilis macrocercus* Vieillot. Add (63. 4a).

XX (v) 2a. *D. caerulescens* (Linne). Add (63. 4a).

XX (v) 3. *D. h. hottentotus* (Linne). Add (63. 4a).

- XX (v) 6. *D. paradiseus* (Linne). Add (63. 4a).
 XX (vi) 3. *Acridotheres ginginianus* (Latham). Add (63. 4a).
 XX (vi) 5. *A. t. tristis* (Linne). Add (64. 4a). Delete (63. 17 & 63. 19).
 XX (vi) 9. *Sturnus pagodarum* (Gmelin). Add (63. 4a).
 XX (vi) 10. *S. roseus* (Linne). Add (63. 4). Delete (63. 6).
 XX (vi) 13. *S. vulgaris indicus* Blyth. Add (63. 4). Delete (63. 8).
 XX (vii) 4. *Corvus corax subcorax* Severtzov. Add (68. 40).
 XX (vii) 4a. *C. c. tibetanus* Hodgson. Add (68. 41a).
 XX (vii) 16. *C. splendens* Vieillot. Add (63. 5 ; 63. 12 a ; 68. 39a).
 Delete (68. 39).
 XX (vii) 18. *C. s. zugmayeri* Laubmann. Add (68. 4a).
 XX (vii) 25. *Garrulus lanceolatus* Vigors. Add (63. 4a). Delete (63. 13).
 XX (viii) 31. *Kitta f. flavirostris* (Blyth). Add (63. 12a).
 XX (viii) 10. *Pycnonotus l. leucogenys* (Gray). Add (63. 4a). Delete
 (63. 16).
 XX (ix) 6a. *Garrulax cachinnans* (Jerdon). Add (63. 4a).
 XX (ix) 10a. *G. phoeniceus bakeri* (Hartert). Add (68. 1b).
 XX (ix) . *Brachypteryx major* (Jerdon). Add (63. 4a).
 XX (ix) 44a. *Turdus merula* Linne, Add (63. 4a).
 XX (ix) 48. *Zoothera dauma* (Latham). Add (63. 15a (?))
 XX (xi) 1a. *Anthus hodgsoni* Richmond. Add (63. 15 b).
 XX (xii) 1a. *Arachnothera magna* (Hodgson). Add (63. 4a).
 XX (xiv) 1. *Passer domesticus indicus* Jardine & Selby. Delete (63. 2).
 Add (63. 4a).
 XX (xiv) 2. *Petronia x. xanthocollis* (Burton). Add (63. 4a).

PART III. (REGIONAL INDEX)

AFGHANISTAN

Add 27.2 ; 27.10 ; 65.1 ; 68.40a. (4 spp).

BURMA

Add 22.2 ; 27.6 ; 27.11 ; 63.4a ; 65.1a ; 65.1 ; 71.1a ; 73.1b. (8 spp).

INDIA

Add 4.1 ; 7.1a ; 9.1 ; 9.2a ; 11.7 ; 19.3 ; 25.5 ; 25.5a ; 27.1a ; 27.1b ;
 27.12 ; 27.13 ; 27.14 ; 47.2a ; 56.2 ; 63.3 ; 63.4a ; 63. 15a ; 63.15b ; 65.1 ;
 68.1b ; 68.4 ; 68.39a ; 68.40a ; 68.41a ; 71.2 ; 73.1a ; 73.1b ; 73.1c ; 87.11 ;
 87.20a ; 94.6a. (32 spp).

Delete 25.3 ; 63.2 ; 63.13 ; 63.14 ; 63.16 ; 63.19 (6 spp).

NEPAL

Add 7.1a ; 25.5 ; 25.5a ; 63.3 ; 63.4a ; 63.12a ; 63.15a ; 68.39a ; 68.41a ; 71.5 (10 spp).

PAKISTAN

Add 63.4a ; 68.40a. (2 spp.)

Delete 63.6 ; 63.8 ; 63.12 ; 63.14 ; 63.17 ; 68.39 (6 spp)

SRI LANKA

Add 25.2 ; 27.1b. (2 spp.)

CORRIGENDA

- P. 41. Foot note. Item 16, Add. (1973) after K. C.
- P. 45. Read Phicthyophaga as Philichthyophaga.
- P. 46. After the Table. Add—This table dose not include *Neomenopon* listed.
- P. 47. Line 4. Add—Price (1970), Emerson (1972) after 1967.
- P. 49. Line 7. Delete—Comma between School & Atlas.
Line 8. Delete—Comma between World & Atlas.
Item 6, Line 2. Read apprellations as appellations.
- P. 51. Item 3. Line 1. Read **himantopy** as **himantopi**. Read *it al.* as *Leningr.*
- P. 52. Item 7. Line 1. Read *Liotheums* as *Liotheum* s.
Line 2. Read *Mug.* as *Mag.*
Line 3. Read **Charaddius** as **Charadrius**.
- P. 53. Item 14. Line 1. Read **tettracicis** as **tetralicis**
Item 15. Host. Line 6. Read Pallus as Pallas.
- P. 54. Line 1. Read *Clopocephalum* as *Colpocephalum*.
Line 2. Under *Aegipiphilas*. Read Eichletr as Eichler.
- P. 55. **Alcedoecus**. Item 2. line 4. Read 26. 8. as 268.
- P. 56. Read always Zotorzycka or Ztorzycka as Zlоторzycka (to be pronounced as 'Zwotorhiska'. Likewise Wrocław as 'vroswa').
- PP. 56-57. **Amyrsidea**. Read Items 1 & 2 as 2 & 1.
- P. 60. Item 3. Read *castaneous* as **castaneus**.
Item 9. Line 1. Read *ges.* as *ges*.
- P. 62. Item 5. Line 1. Delete the interrogation mark after India.
- P. 65. Item 10. Line 3. Close the parentheses after *rufulus*.

- P. 67. Item 30. Host. Line 1. Read *sturnus* as **Sturnus**.
- P. 68. Item 34. Host. Line 1. Insert semicolon after Deccan.
Item 35. Host. Line 3. Read 39 as 394.
- P. 69. Item 42. Hosts. Line 3. Read (*Picasrustica*) as (*Pica rustica*).
Line 12. Put a bar after-Lyallpur.
Item 44. Host. Line 4. Close the parentheses after No. 6.
- P. 70. **Campanulotes**. Item 2. Read Eurmeister as Burmeister.
Item 3. Reverse position 2 &(A). Add figs. 2, 4, 6,
& 7, fotos 11, 14, 16, & 17 after 399.
- P. 71. Item 3. Host. Line 2. Delete *n* from *natn*.
Carrikericeps. Line 2. Read *quadriceps* as **Quadriceps**.
- P. 73. Item 5. Host. Line 2. Place a comma after **oscitans**.
- P. 74. Item 5. Line 1. Enclose *Goniodes* in parentheses.
- P. 75. Under 25a. Item 2. Host. line 1. Read **tubalia** as **tusalia**. Put a
hyphen after-Kan.
Under 26. Line 2. Read *Zebra* as *zebra*.
Line 5. Read *turhinetum* as *turbinatum*.
Item 1. Line 4. Bring affine...to the left margin as a
separate line.
Item 2. Host. Line 1. Place a semicolon after the
square bracket.
Line 2. Read *Canal* as *Canad*.
Item 3. Line 1. Read Anqola as Angola.
Host. Line 1. Read *apirovus ruficonis* as *apivorus rufi-*
collis
- P. 76. Item 10. Host. Line 5. Read **CORVUS CORAX SUBCORAX** as
Corvus corax subcorax.
- P. 77. **grandiceps**. Line 21. Delete *Corvus*.
Item 13. Host. Line 1. Read *rosens* as *roseus*.
Line 2. *pallas* as Pallas.
- P. 80. Item 32. Line 2. Place a hyphen before no.
Item 39. Line 1. Hosts. *Vultus* as *Vultur*.
- P. 82. Item 3. Line 3. Transfer parenthesis before pp. after 274.
Item 5. Host. Line 1. Insert—: Manipur after India.
- P. 83. Item 11. Host. Line 1. Read **phoenicopterae** as **phoenicoptera**
Under *Columbimenopon*. Line 3. Read *Chanabensis* as *chanabensis*.
- P. 84. Under 29. line 2. Read *piatystomus* as *Platystomus*.

- P. 85. Line 2. Read *philopterus* as *Philopterus*.
- P. 87. Last but one line. Read *marzai* as *mirzui*.
- P. 88. Item 8. Hosts. Line 1. Put a bar before India.
Line 12. Read *merulinurs* as *merulinus*.
- P. 89. Item 4. Host. Line 1. Place a—X after *caballus*.
- P. 90. Item 8. Host. Line 2. Read—Katmandu as Khatmandu.
Item 10. Line 4. Add-Nepal : before Langtung.
- P. 91. Under *conformis* line 6. Read Blagoverhschensky as Blagoveshtchensky or more precisely Blagoveschenskii.
Item 4. Host. Line 3. Read *spilornis* as **Spilornis**.
Item 5. Transfer parenthesis which is before **fusca** after *fusca*.
- P. 93. Add-(13a.) *splendens* Ansari, 1956, *Indian J. Ent.*, (1955), 17 (3) : 397.=no. 3.
- P. 94. Under 37. Item 1. Host. line 2. Place a comma after (A. P.).
Item 2. Host. Delete parentheses for Hume.
Item 5. Read *von arxi* as *vonarxi*.
Host. Line 1 Add Tschusi after *tunati*.
- P. 96. Under 39. Item 2. Host. Line 2. Place a parenthesis before *Haliaetor*. Read *Phalacrocoraz* as **Phalacrocorax**.
- P. 97. Under 42. Item 1. Host. Line 1. Read Rajpurana as Rajputana.
- P. 98. Item 4. Last line. Close the parentheses.
- P. 100. Add before the line 6.-*FERRISIA* Uchida, 1926 (nec Fullaway, 1923).
Under 46. line 2. Include the type species in inverted commas.
- P. 102. Item 7. Add after the last line. (Though, the authors followed Hopkins & Clay, 1952, in placing the species and the species given in item 8 under *Goniocotes* on the basis of the head and antennal characters, these two species are required to be transferred to the next genus, (i.e.) *Goniodes* (Nitzsch).
Item 8. (cf. Comments given against item 7.).
Item 9. Read *migriipennis* as *nigriipennis*
Item 10. Add after the last line. (Since sending this paper to press, the single female type has been examined and it agrees with the female of *parviceps* (item 8), rather than those females collected with males of *mayuri* (item 7). Therefore, this species is to be considered conspecific with species referred to in item 8.). Place=no. 8. in line 1. Transfer the entry to item 8.

- P. 103. Item 6. Host. Line 5. Read *cervicornis* as *Cervinicornis*.
- P. 105. Item 17. Hosts. Line 5. Read **Lophorus** as **Lophophorus**.
Line 9. Read *Margarirtenes* as *Margaritenes*.
- P. 106. Item 22. Host. Line 3. Read Humme as Hume.
- P. 107. Item 29. Hosts. Last but one line. Read **Bambustricola** as **Bambusicola**.
- P. 108. Item 30. Hosts. Last line. Insert a comma after General.
Item 33. Read *Excalfacioris* as *Excalfactoris*.
- P. 109. Item 49. Line 2. Read *Haemto, myzus* as *Haematomyzus*.
- P. 110. Under 50. Item 3. Hosts. Line 2. Change the position of parentheses after Hist.
- P. 111. Insert 1a. above Item 1.—(1a) *longitarsus* Piaget sensu Sen & Fletcher, 1962. = no. 1.
- P. 114. Item 57. Read **Kurodala** as **Kurodaia**.
- P. 116. Line 6. Read (Boddaesrt) as (Boddaert).
Item 10. Host. Close the parenthesis before =.
- P. 117. Under Liotheum. Line 5. Read *gigantieum* as *giganteum*.
- P. 118. Under 60. Item 2. Line 1. Read **Geunaeus** as **Gennaeus**.
- P. 119. Item 3. Host. Read **Clerysolophus amhersliae** as **Chrysolophus amherstiae**.
Item 6. Remove parentheses for 6.
- P. 120. Item 7. Transfer the item to the genus 74a. **Numidilipeurus** cf. *luridus*. Read **Fulicolfual** as **Fulicoffula**.
Item 9. Host. Line 6. Read *systematia* as *Systematic*.
Line 7. Agre as Agra.
Last line. Read pl. ? as Pl. M.
- P. 121. Items 13 & 14. Enclose in parentheses ; Bring unicolor to the margin of next line after (13).
turturis—see **Columbicola** cf.
Item 15. line 1. Transfer *zonatus* to the next line in the beginning.
- P. 123. Item 3. Host. Line 3. Read of as cf.
Item 6. Host. Read of as cf.
- P. 124. Line 3. *Camelinus* as *camelinus*.
Item 8. Host. Line 3. Read of as cf.
Item 14. Line 3. Read of as cf.

- P. 125. Item 18. Host. Line 1. Transfer square brackets to **domesticus**.
Item 19. Host. Line 2. A comma before Ansari.
- P. 127. Items 5. Host. Line 1. Put a hyphen after *erythrophtha*-.
Line 2. Enclose ♀sp. in parentheses.
- P. 127. stramineus. Read *Menacanthrus* as *Menacanthus*.
- P. 128. Under 66. Line 1. Delete comma after *Docophorus*.
- P. 129. Item 1. **Estrilde** as **Estrilda**.
- P. 130. Item 6. Host. Line 1. Read (Bhutan) as Bhutan :
- P. 131. Item 13. Host. Line 2. Place semicolon before Nepal. Read *Commen* as *Commem*.
- P. 132. Item 20. Read *Kulensis* as *kuluensis*.
- P. 133. Line 2. Read *nuristamensis* as *nuristaniensis*.
- P. 137. *Nirmus* Hermann. Line 1. Delete comma after De.
Nirmus Nitzsch. Last but one line from the bottom. Read *Sec.* as *Soc.*
- P. 138. Read *cllipticus* as *ellipticus*.
Under *melanophrys*. Read *Uppicola* as *Upupicola*.
- P. 139. Under 73. Line 2. Insert comma after Tendeiro and also 1969.
- P. 140. Under 75. Item 1. Host. Lines 3-4. Read Bhawalnagar as Bahawalnagar.
- P. 141. Under 76. Item 2. Line 4. Bring *crossoptilum* to the left margin and read it as *crossoptilon*.
- P. 142. Item 6. Host. Line 5. Remove square brackets after *millardi*
Under 77. Item 1. Host. in the end add (Hopkins & Clay, 1952, considered this species conspecific with *P. orthopleurus* (Nitzsch). The recent studies by the present author (Lakshminarayana, in press) indicated that it should be treated as a distinct species).
- P. 143. Line 4 from the bottom. Close parenthesis after *auct.*
- P. 147. Item. 10. Close parenthesis after the 3rd line.
- P. 150. Item 27. Read (*Emberiza brunniceps*) as (*Emberiza brunneiceps*).
- P. 154. Under *Cirroptithirius*. Line 2. Read synonyms as synonym and *Rhonbiceps* as *Rhombiceps*.
Under *Cistrellatrix*. Type species ; read *Cistellaxirt* as *Cistellatrix*.
Under *Chadriceps*. Line 1. Read *pol.* as *Pol*,
- P. 155. Line 4. Read *Anns* as *Ann*,

- P. 156. Item 14. Host. Line 3. Read of as cf.
- P. 157. Item 17. Host. Line 2. Read of as cf.
- P. 158. Item 22. Host. Last line Add : 721.
- P. 162. Item 9. Host. Last line. Read pl, 17 as Pl. M.
Item 11. Hosts. Line 2. Read Yunnon as Yunnan.
Under *Rhombiceps*. Line 1. Read **recurvirostrás** as **recurvirostrae**.
- P. 167. Under 96, Item 3. Host. Line 1. Read (*subcica*) as (*suecica*)
- P. 168. Item 10. Host. Line 2. Read [Ceylon / as (Ceylon) Srilanka]
- P. 169. Item 13. Host. Read *albocinctus* as *albicinctus*
- P. 171. Item 5. Host. Line 2. Read India as China.
- P. 174. Under 101. Item 2. Hosts. Line 1. Put a parenthesis before *Oeno*.
- P. 178. Phoenicopteriformes : Line 1. add r to conside,
Line 2. Delete r from 1961,
- P. 179. Item 6 under Anatinae. Line 3. Read 54. 4. as 53. 4.
- P. 182. Item 32. Delete 60. 7. Add 74a. 1.
- P. 183. Item 45. Read 89. 3a as 89. 4.
- P. 184. Item 77. Read **equilonifer** as **aquilonifer**.
Item 82. Read 89. 4 as 89. 3.
Item 83. Read 89. 4 as 89. 5.
- P. 182. Add 9a. **C. livia intermedia** Strickland (19.1 ; 19.2 ; 25.1 ; 27.1 ; 101.2).
- P. 192. Under Laniinae. Item 1. Read 82. 107. as 82. 10 ?
Under Sturninae. Item 3. Delete one 96. 5.
- P. 193. Item 5. Read 17. 4 as 17. 41.
Item 9. Read 62. 5 as 63. 5.
Item 34. Read **favirostris** as **flavirostris**.
- P. 194. Under Timaliinae. Item 16. Read 96. 6 as 96.9.
- P. 195. Item 36. Read 17. 29 as 17. 24.
Read (32) as (37) and *coerileus* as *coeruleus*.
- P. 199. Add in the end against ;
AFGHANISTAN (22 spp.) ; BANGLA DESH (6 spp.) ;
BHUTAN (4 spp.) ; BURMA (60 spp.) ; YUNNAN (7 spp.) ;
SZECHWAN (8 spp.) ; TIBET (9 spp.) ;
- P. 200. Under INDIA Add a semicolon after 24. 1 and 25a. 1 ; 25a. 2 ;
74a. 1 ; 89. 10. Delete 60. 7 ; 74. 1 ; 74. 2 ; 89. 7.
Read 48. 8 before 49. 9 as 47. 8 ; 69. 9 after 60. 7 as 60. 9 ;
89. 3a as 89. 4 ; 89. 4 as 89. 5 ; 89. 5 as 89. 6. Add in the end
(363 spp.).

P. 201. Under NEPAL ; Add 35. 10. In the end add (73 spp.).

Under PAKISTAN ,

Add 63. 6 ; 63. 7 ; 63. 8 ; 63. 17 ; 87. 9 ; 94. 2.

Delete 63. 4 ; 63. 5 ; 101. 1

Add in the end (182 spp.).

Under SRI LANKA :

Add in the end (41 spp.)

Read RUSSIA as CHINA and transfer the entry to p. 200 after TIBET.

In Table I, the additions or deletions of the genera *et* species to those listed in Lakshminarayana (1979) from 1974-1979 due to recent researches (excluding those species available in Z. S. I., but not yet been published) are summarised. Likewise, in Table II. countrywise split up of the reported species is given for information.

ACKNOWLEDGEMENT

The author expresses his grateful thanks to Drs T. N. Anantha-krishnan, K. K. Tiwari, B. K. Tikader, the successive Directors, B. Biswas, former Jt. Director, K. C. Jayaramakrishnan, Deputy Director, M. G. Siva Gurunathan, Publication Production Officer, Mr. K. N. Nair, Zoologist, for their interest in the publication of the synoptic list. The author is also indebted to Prof. J. A. Tendeiro, C'/ Centro de Zoologia Rua da Junqueira, 14 Lisboa—3, Portugal in addition to the other scientific colleagues referred to in the Synoptic list for several courtesies.

TABLE 1 : Number of Genera and species upto 1979

	1974 List		Present				Total	
	Genera	Species	Additions		Deletions		Genera	Species
			Genera	Species	Genera	Species		
<i>*AMBLYCEROPHTHIRINA</i>								
Family 1. Boopiidae	2	2	—	—	—	—	2	2
„ 2. Laemobothri- dae	2	5	—	—	—	—	2	5
„ 3. Menoponidae	26	173	—	9	—	10	26	172
„ 4. Ricinidae	1	7	—	—	—	—	1	7
„ 5. Trinotonidae	1	4	—	—	—	—	1	4
<i>*ISCHNOCEROPHTHIRINA</i>								
Family 6. Philopteridae	65	356	2	14	—	1	67	369
„ 7. Tricho- dectidae	3	16	—	—	—	—	3	16
<i>*RHYNCHOPHTHIRINA</i>								
Family 8. Haemato- myzidae	1	1	—	—	—	—	1	1
Total	101	564	2	23	—	11	103	576

*cf. LAKSHMINARAYANA, K. V.,

TABLE 2 : Country-wise figures of species

	1974	Present		Total
	List	Additions	Deletions	1979.
AFGHANISTAN	22	4	—	26
BANGLA DESH	6	—	—	6
BHUTAN	4	—	—	4
BURMA	60	8	—	68
CHINA				
Yunnan	7	—	—	7
Szechwan	8	—	—	8
Tibet	9	—	—	9
Kashgar	1	—	—	1
INDIA	363	32	6	389
NEPAL	73	10	—	83
PAKISTAN	182	2	6	178
SRI LANKA	41	2	—	43

REFERENCES

- LAKSHMINARAYANA, K. V. 1979. A Synoptic List of Mallophaga *Sens. Lat.* (Phthiraptera : Insecta) from India and adjacent countries together with Host and Regional Indices.—*Rec. zool. surv. India*, **75** : 39-201.

TAXONOMIC AND ECOLOGICAL STUDIES ON THE REPTILES OF GUJARAT

By

R. C. SHARMA

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(With 1 Plate and 5 Tables)

INTRODUCTION

The present work is based on the collection made from 60 localities in Gujarat by the Zoological Survey of India during 1964-1975. The material consists of 246 examples belonging to 29 species (2 testudines, 14 lizards and 13 snakes) distributed in 23 genera and 12 families. The variability and difference in means between the two sexes in scale characters of five species namely *Hemidactylus brooki* Gray, *Calotes versicolor* (Daudin), *Acanthodactylus cantoris cantoris* Günther, *Ophisops jerdoni* Blyth and *Ophisops microlepis* Blanford have been studied (Tables 1-5).

For related works on the subject references may be made to the publications of Stoliczka (1872), Murry (1884), Smith (1931, 1935 and 1945), McCann (1938), Daniel & Shull (1963), Minton (1966), Tiwari & Sharma (1970), Sharma (1971), Prakash (1973), Rao & Rajabai (1974), Indurkar & Sabnis (1976) and Sharma & Vazirani (1977). For each species, details of the material collected, some important measurements and the geographical distribution are given. Where necessary, taxonomic and ecological notes are given under each species.

SYSTEMATIC ACCOUNT

Class REPTILIA

Order TESTUDINES

Family TRIONYCHIDAE

***Lissemys punctata punctata* (Lacépède)**

(Indian flap—shell turtle)

Material : 3 ex., Bhuj (Kutch Dist.) and Viramgam (Viramgam Dist.), collected in February 1966 and October 1964 by V. C. Agrawal.

Measurements : Carapace : length 215-240 mm., width 150-175 mm., depth 64-95 mm.

Distribution : Gujarat : As above and from Kutch.

Elsewhere : Indus and Ganga river systems from the North-West Frontier Provinces of Pakistan to Sikkim in India and Bangladesh.

Trionyx gangeticus Cuvier

(Indian soft-shell turtle)

Material : 1 ex., Malegaon forest (The Dangs Dist.) collected in February 1975 by T. G. Vazirani, a few hundred metres from a nallah.

Measurements : Carapace : length 221 mm., width 172 mm. depth 68 mm.

Distribution : Gujarat : As above (first record).

Elsewhere : The Indus, Ganga, Mahanadi, Krishna and their tributaries, North West Frontier Provinces and Sind in Pakistan, Nepal and Bangladesh.

Order SQUAMATA

Suborder SAURIA

Family GEKKONIDAE

Hemidactylus brooki Gray

(Spotted Indian house gecko)

Material : 73 ex., Bhuj (Kutch Dist.), Himmatnagar (Sabarkantha Dist.), Halol (Broach Dist.), Rajpipla (Broach Dist.) Ahwa (The Dangs Dist.), Vijarkhe (Jamnagar Dist.), Jamnagar (Jamnagar Dist.) Ranavav (Junagadh Dist.), Porbandar (Junagadh Dist.), Jafrabad (Amreli Dist.), and Rajkot (Rajkot Dist.), collected between January and November by V. C. Agrawal, R. N. Bhargava, T. G. Vazirani and R. C. Sharma.

Measurements : Snout to vent length 23-52 mm., tail length 27-59 mm *Variability* in meristic characters : (Table 1).

Distribution : Gujarat : As above (new locality records), Surat and Dangs. *Elsewhere* : Widely distributed in India, Sri Lanka, Pakistan, Burma, South China, West Indies, tropical Asia and northern half of Africa.

Remarks : Their food in Gujarat as evidenced by the study of gut contents comprises grasshoppers and their nymphs ; beetles and their grubs (family Scarabaeidae) ; dipterous insects ; cockroaches ; termites ; spiders ; crickets and their nymphs ; earwigs ; arthropod eggs ; moths, butterflies and their caterpillars ; ants (*Camponotus compressus* Fbr.) ;

TABLE 1. *Hemidactylus brooki* Gray

Biometrical constants (Statistical parameters) of certain body parts.

S. No	Characters	Number of Samples		Range		Mean $\pm$		S. E.		C. V		't' value for Sex difference
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
1.	Number of dorsal rows of tubercles	36	39	16-20	16-20	17.02 $\pm$ 0.16	17.12 $\pm$ 0.20	5.52	7.24			0.39 ns
2.	Number of upper labials (Left)	36	40	8-11	8-11	9.33 $\pm$ 0.14	9.45 $\pm$ 0.13	8.87	8.62			0.64 ns
3.	Number of upper labials (Right)	36	40	8-11	8-11	9.33 $\pm$ 0.12	9.55 $\pm$ 0.13	7.68	8.85			1.22 ns
4.	Number of lower labials (Left)	36	40	7-10	7-10	7.89 $\pm$ 0.11	7.92 $\pm$ 0.13	8.45	10.03			0.18 ns
5.	Number of lower labials (Right)	36	40	7-9	7-10	7.75 $\pm$ 0.11	7.82 $\pm$ 0.10	8.92	8.13			0.46 ns
6.	Number of lamellae under first toe (Left)	36	40	4-6	4-6	4.86 $\pm$ 0.11	4.77 $\pm$ 0.11	14.04	15.37			0.55 ns
7.	Number of lamellae under first toe (Right)	36	40	4-6	4-6	4.94 $\pm$ 0.12	4.77 $\pm$ 0.11	14.47	15.37			1.02 ns
8.	Number of lamellae under fourth toe (Left)	36	40	6-10	6-10	7.83 $\pm$ 0.23	7.95 $\pm$ 0.20	17.76	15.59			0.39 ns
9.	Number of lamellae under fourth toe (Right)	36	40	6-10	6-10	7.78 $\pm$ 0.21	8.05 $\pm$ 0.20	16.29	15.94			0.91 ns
10.	Number of femoral pores (Left)	36	N.A	8-15	—	11.19 $\pm$ 0.29	—	15.38	—			—
11.	Number of femoral pores (Right)	36	N.A	8-15	—	11.25 $\pm$ 0.33	—	17.44	—			—
12.	Standard length (mm.)	36	38	34-53	29-50	43.08 $\pm$ 0.83	40.79 $\pm$ 0.94	11.50	14.25			1.82 ns
13.	Tail length (mm.)	25	25	34-60	28-58	48.24 $\pm$ 1.08	45.80 $\pm$ 1.76	13.44	19.24			1.03 ns

N. A : Femoral pores are not available in females

ns : Not significant.

Hymenopterous insects ; scutigerans ; solifugids, bugs and their nymphs ; isopods ; gastropods (*Zotecus* sp.) and seeds of wild plants.

Many lizards from Porbandar and Rajkot were having two large oviducal eggs.

***Hemidactylus leschenaulti* Dumeril & Bibron**

(Bark gecko)

Material : 2 exs., Malegaon forest rest house (The Dangs Dist.) collected in February 1975 by T. G. Vazirani.

Measurements : Snout to vent length 47-60 mm., tail length 43 mm.

Distribution : Gujarat : As above and Surat in southern Gujarat. *Elsewhere* : In India it has been recorded from Andhra Pradesh, Tamil Nadu, Kerala, Maharashtra, Rajasthan and West Bengal. Also available in Sri Lanka & Pakistan.

Remarks : The above lizards were hiding under the bark of a tree. The female had two large oviducal eggs. The male in the above collection differs from other Indian examples as it is having five lamellae under the first toe and 9 femoral pores (Vs. 10-17) on each side.

***Hemidactylus flaviviridis* Rüppell**

(Yellow bellied house gecko)

Material : 1 ex. (♀), Halol (Broach Dist.), collected in January 1975 by T. G. Vazirani ; 2 exs. (both ♀), Okha (Jamnagar Dist.) and 1 ex. (♂) ; Rajkot (Rajkot Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 54-75 mm., tail length 64-78 mm.

Distribution : Gujarat : As above, Bhuj, Kutch, Surat and Dangs. *Elsewhere* : Whole of India but widely distributed in North India above 20°N. Also available in Arabia, Pakistan, Iran & shores of the Red Sea.

Remarks : In Gujarat its food as evidenced by the study of gut contents comprises black mole crickets, beetles, maggots, spiders and moths.

Family AGAMIDAE

***Sitana ponticeriana* Cuvier**

(Sargota lizard)

Material : 21 exs., Junagadh (Junagadh Dist.), Godhra (Panchmahals Dist.), Ahwa (The Dangs Dist.), Somnath (Junagadh Dist.) and Rajkot

(Rajkot Dist.), collected between January, February, April and September 1969 and 1975 by D. S. Mathur, T. G. Vazirani, and R. C. Sharma.

Measurements : Snout to vent length 21-51 mm., tail length 34-97 mm.

Distribution : Gujarat : As above (new locality record), Kutch and Waghai. *Elsewhere* : Widely distributed in India, Sri Lanka and Thar-Parkar District of Pakistan.

Remarks : It is mainly a diurnal terrestrial lizard. At Junagadh a few examples were found inside a large termite mound at the depth of one metre, at Rajpipla one example was collected from the cracks in a wooden log, at Ahwa an example was collected from a nullah, at Somnath various lizards were hiding under a large stone surrounded by dense xerophytic vegetation, at Veraval many young ones were collected while they were chasing insects under the small green xerophytic bushes and at Rajkot these lizards prefer to live under the stones, surrounded by plenty of xerophytic vegetation.

The studies on its gut contents reveal that in Gujarat the species feeds on grasshopper nymphs, white ants, beetles, bugs, spiders, small red ants, arthropod eggs, dipterous maggots and fibres of wild plants. The presence of lizard skin and scales in the gut of various examples indicate that probably *Sitana ponticeriana* feeds on the lizards of its own or other kinds.

***Calotes versicolor* (Daudin)**

(Indian blood sucker, Indian garden lizard)

Material : 19 exs., Palanpur (Banaskantha Dist.) ; Mehsana (Mehsana Dist.) ; Himmatnagar (Sabarkantha Dist.) ; Godhra (Panchmahals Dist.) ; Halol (Broach Dist.) ; Rajpipla (Broach Dist.) ; Malegaon Forest, collected from a burrow (The Dangs Dist.) ; Vijarkhi, Collected under stones (Jamnagar Dist.) ; Porbandar, collected from a thorny bush (Junagadh Dist.) ; Somnath (Junagadh Dist.) ; Jafrabad (Amreli Dist.) ; Girnar Hills (Junagadh Dist.) ; Junagadh (Junagadh Dist.) and Rajkot (Rajkot Dist.) collected in January, February, September, October and November by V. C. Agrawal, R. N. Bhargava, T. G. Vazirani and R. C. Sharma.

Measurements : Snout to vent length ♂ 78-119 mm., ♀ 64-114 mm. ; tail length ♂ 222-275 mm., ♀ 146-204 mm.

Variability in meristic characters : (Table 2)

Distribution : Gujarat : As above, Kutch and Ahwa. *Elsewhere* : Whole of India and Andaman Islands. Also available in Sri Lanka, Afghanistan, South China, Malaya Peninsula, Sumatra and Pakistan.

TABLE 2. *Calotes versicolor* (Daudin) Biometrical constants (Statistical parameters) of certain body parts

S. No.	Characters	Number of Samples		Range		Mean $\pm$ S. E.		C. V.		't' value for sex difference
		Male	Female	Male	Female	Male	Female	Male	Female	
1.	Number of scales round the middle of body	8	10	38-44	35-46	40.88 $\pm$ 0.66	40.30 $\pm$ 1.00	4.61	7.85	0.42 ns
2.	Number of upper labials (Left)	8	10	12- 16	11-13	12.88 $\pm$ 0.48	11.70 $\pm$ 0.21	10.53	5.77	2.42 *
3.	Number of upper labials (Right)	8	10	11- 16	11-13	12.62 $\pm$ 0.53	11.50 $\pm$ 0.22	11.93	6.15	2.09 ns
4.	Number of lower labials (Left)	8	10	11- 13	10-13	12.00 $\pm$ 0.27	11.70 $\pm$ 0.33	6.30	9.05	0.67 ns
5.	Number of lower labials (Right)	8	10	10- 13	10-13	11.62 $\pm$ 0.37	11.40 $\pm$ 0.31	9.12	8.47	0.46 ns
6.	Standard length (mm.)	8	10	42-119	35-114	97.00 $\pm$ 9.20	66.10 $\pm$ 7.22	26.84	34.53	2.68 *
7.	Tail length (mm.)	7	9	108-275	82-204	220.71 $\pm$ 20.41	155.67 $\pm$ 12.68	24.46	24.43	2.79 *

ns—Not significant
 * Significant at 5% level of probability.

Remarks : The study of the gut contents confirm that the food of this most common garden lizard consists of grasshoppers and their nymphs (Acrididae, Blattidae) ; butterflies, moths and their caterpillars ; ants ; beetles ; earwigs ; spiders ; centipedes and vegetable matter like grass, leaves, twigs of delicate plants and seeds. The observations further add in its diet like arthropod eggs, honey bees, small crustaceans (Conchostraca), bugs and dipterous maggots. Numerous stone particles of variable size were found in the gut of many examples. Many examples were highly infested with nematodes. The presence of maggots in the gut suggests that the lizard is a carion feeder also.

In a gravid female from Vijarkhe, eight large eggs (7-8.5 mm. long and 6-6.5 mm. wide) were found in the oviduct.

Calotes rouxi Dumeril & Bibron

Material : 1 ex. (♂), Malegaon forest (The Dangs Dist.) collected in February 1974 by T. G. Vazirani.

Measurements : Snout to vent length 71 mm., tail length 137 mm.

Distribution : Gujarat : As above (first record). *Elsewhere :* Maharashtra (Western ghats), Goa (Molem, Valpoi, Ponda, Canacona), Kerala (Travancore), Karnataka (Chikmagalur and Karwar) and West Bengal (Kalimpong).

Agama minor Hardwicke & Gray

(Small tailed Indian Agama)

Material : 1 ex. ♀, Veraval (Junagadh Dist.) collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 53 mm., tail length 45 mm.

Distribution : Gujarat : As above, Kutch and Kathiawar. *Elsewhere :* Uttar Pradesh, Madhya Pradesh and Pakistan (Sind).

Remarks : The food as evidenced by the study of stomach contents consists of grasshoppers and their nymphs (abdomen, thorax and head portions), earwigs (crushed body parts like abdomen, genitalia, thorax, head etc.), beetles (crushed body parts like elytra, abdomen and antenna etc.), bugs (legs, scutulum, fore and hind limbs, head and other body parts), spider (crushed body parts like head, legs, abdomen), seven absolutely round arthropod eggs.

Family SCINCIDAE

Mabuya carinata (Schneider)

(Brahmini, Bronze spotted grass skink)

Material : 3 exs. (2 ♀ and 1 ♂). Ahwa (The Dangs Dist.), Vijarkhe (Jamnagar Dist.) and Girnar Hills (Junagadh Dist.), collected in February and September 1975 by T. G. Vazirani and R. C. Sharma.

Measurements : Snout to vent length 60, 100 and 102 mm., tail length broken, 155, 158 mm.

Distribution : Gujarat : As above (new locality record), North-west Kathiawar. *Elsewhere* : Widely distributed in India, Burma (Tenasserim), Sri Lanka and Bangladesh (Khulna).

Remarks : At Vijarkhe numerous abnormally large skinks were basking on rocks during the morning hours. At Girnar Hills these lizards were found even at an elevation of 1500 metres.

The seasonal food of *Mabuya carinata* in the above localities consists of black mole crickets, ordinary crickets (*Gryllus* sp.), lepidopterous caterpillars, beetles, arthropod eggs and fibres of wild plants.

In February six large oval eggs were found in the oviduct of a gravid female.

Mabuya macularia (Blyth)

(Smaller bronze grass skink)

Material : 4 exs. (2 ♀ and 2 ♂). Bhuj (Kutch Dist.), Rajpipla (Broach Dist.) and Ahwa (The Dangs Dist.), collected during January, February and October 1964 and 1975 by V. C. Agrawal and T. G. Vazirani.

Measurements : Snout to vent length 33-43 mm., tail length 59-69 mm.

Distribution : Gujarat : As above (first authentic record) and Kutch. *Elsewhere* : Widely distributed in India, Burma, Sri Lanka, Cambodia, Laos, Thailand, Malaya Peninsula, South Viet-nam and Pakistan (Baluchistan and lower Sind).

Remarks : In the vicinity of Bhuj these small agile skinks live under dry leaves and other similar places near rainwater tanks where soil is extremely saline and vegetation is absolutely xerophytic.

The study of the gut contents revealed that its food consists of grasshoppers, beetles, bugs, ants and spiders.

Family CHAMAELEONIDAE

Chamaeleo zeylanicus Laurenti

(Indian Chamaeleon)

Material : 1 ex. (♂), Palanpur (Banaskantha Dist.), collected in October 1964 by V. C. Agrawal.

Measurements : Snout to vent length 115 mm., tail length 144 mm.

Distribution : Gujarat : As above (new locality record) and Kutch.
Elsewhere : Peninsular India, Sri Lanka and Pakistan (The Desert).

Family LACERTIDAE

Acanthodactylus cantoris cantoris Günther

(Indian fringe toed sand lizards)

Material : 32 exs. (4 ♂, 8 ♀ and 20 Juvenile). Okha and Dwarka (Jamnagar Dist.), Porbandar, Somnath and Veraval (Junagadh Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 30-75 mm., tail length 55-144 mm.

Variability in meristic characters : (Table 3).

Distribution : Gujarat : As above (new record) and Bhuj. *Elsewhere* : Widely distributed in Rajasthan. Recorded from Uttar Pradesh, Haryana and Punjab. Also available in Pakistan, Eastern Iraq, Saudi Arabia, Southern Afghanistan and Iran.

Remarks : At Okha these lizards were in large numbers in sandy inland areas. The dense xerophytic bushes provide them an excellent shelter. At Dwarka they live in burrows dug by themselves under the dense bushes.

At Porbandar these lizards were observed while they were digging their burrows on the granular sand of the coast. In the process of digging generally the fore limbs were employed but occasionally the help was taken, also by the hindlimbs and tail in pushing the sand behind. The digging was most quick and the limb movements were extremely fast. The depth of the burrows varied from 11-65 centimetres and generally the each burrow was occupied by a single individual. The lizards were most abundant beneath the bushes and their activities were fast during the early hours of the day reaching at the optimum by 11-30 A. M.

TABLE 3. *Acanthodactylus cantoris cantoris* Günther

Biometrical constants (Statistical parameters) of certain body parts.

S. No.	Characters	No. of samples		Range		Mean ± S. E.		C. V.		't' value for sex difference
		Male	Female	Male	Female	Male	Female	Male	Female	
1.	Number of scales round the middle of body	13	8	31- 47	30- 40	38.00± 1.16	33.37± 1.08	11.02	9.12	2.69 *
2.	Number of longitudinal plates on the body	13	8	10- 16	12- 13	12.53± 0.42	12.25± 0.16	12.02	3.70	0.50 ns.
3.	Number of transverse rows of plates on the ventrum	13	8	28- 31	30- 33	30.23± 0.32	30.87± 0.40	3.86	3.65	1.23 ns.
4.	Number of femoral pores (Left)	13	8	18- 23	16- 21	19.53± 0.37	16.12± 0.67	6.81	11.84	4.48 ***
5.	Number of femoral pores (Right)	13	8	19- 23	16- 21	20.46± 0.35	18.00± 0.60	6.19	9.39	3.81 **
6.	Standard length (mm.)	12	3	30- 75	56- 72	42.25± 2.08	64.66± 4.67	17.05	12.50	4.95 ***
7.	Tail length (mm.)	8	3	55-144	63-110	88.00±12.64	87.66±13.62	40.61	26.91	0.01 ns

ns—Not significant
* Significant at 5% level of probability
** Significant at 1% level of probability
*** Significant at 0.1% level of probability

TABLE 4. *Ophisops jerdoni* Blyth

Biometrical constants (Statistical parameters) of certain body parts.

S. No.	Characters	Number of Samples		Range		Mean ± S. E.		C. V.		't' value for sex difference
		Male	Female	Male	Female	Male	Female	Male	Female	
1.	Number of scales round middle of body	4	8	26-30	27-30	28.00±0.81	28.50±0.38	5.83	3.75	0.65 ns.
2.	Number of longitudinal plates on the belly	4	8	6- 6	6- 6	6.00±0.00	6.00±0.00	—	—	0
3.	Number of transverse plates on the ventrum	4	8	28-28	26-29	28.00±0.00	27.87±0.29	—	2.99	0.30 ns.
4.	Number of femoral pores (Left)	4	7	7- 8	6- 7	7.50±0.29	6.57±0.18	7.69	7.53	2.70 *
5.	Number of femoral pores (Right)	4	7	7- 8	6- 7	7.25±0.25	6.57±0.18	6.99	7.53	2.07 ns.
6.	Standard length (mm.)	4	6	19-36	24-40	30.50±3.88	35.33±2.37	2.54	16.47	1.13 ns.
7.	Tail length (mm.)	2	4	28-44	40-58	36.00±8.00	50.25±4.00	31.42	19.95	1.84 ns.

ns : Not significant
* Significant at 5% level of probability.

The food of *Acanthodactylus cantoris cantoris* in Gujarat as observed in the field and as evidenced by the study of gut contents consists of various insects like lepidopterous larvae, beetles, ants, bugs, nymphs and adults of orthopterous insects, flies, mole crickets, field crickets, earwigs, small cockroaches and the nymphs of various insects. Spiders and isopods (crustaceans) are also devoured.

The presence of large number of young ones in many areas denote a general post breeding season. But at Somnath and Veraval many gravid females were noticed with 3-5 large oval eggs (10-15 mm. long and 7-9 mm. wide) in their oviduct. The colour of peritoneum as noticed in numerous examples immediately after death was dark brown to black.

Ophisops jerdoni Blyth

(Golden striped lizard)

Material : 14 exs. (4 ♂, 8 ♀ and 2 Juvenile). Jamnagar, Dwarka, Bet Dwarka Island (Jamnagar Dist.), Ranavav, Porbandar, Somnath and Veraval (Junagadh Dist.), and Rajkot (Rajkot Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 19-40 mm., tail length 28-72 mm.

Distribution : Gujarat : As above (new locality record) and Kutch. *Elsewhere* : In India distributed in Andhra Pradesh, Maharashtra, Madhya Pradesh, Tamilnadu and Rajasthan. Outside India the species has been recorded from Pakistan.

Remarks : All the examples from Dwarka, Bet-Dwarka and Porbandar were collected from the coastal sandy areas during the day time by digging the small burrows under the xerophytic bushes. Noting was known about the food of this secretive and most agile tiny lacertid. The present findings on the basis of stomach contents establish that its diet in Gujarat during September consists of termites (*Odontotermes* sp.), lepidopterous caterpillars, ichneumonids (Hymenoptera), spiders, ants, orthopterans and their eggs.

Ophisops microlepis Blanford

(Snake eyed lizard)

Material : 31 exs. (13 ♂, and 18 Juvenile). Bhuj (Kutch Dist.) Okha, Dwarka, Bet Dwarka Island (Jamnagar Dist.) and Rajkot (Rajkot Dist.), collected in September and October 1964 & 1975 by V. C. Agrawal and R. C. Sharma,

Measurements : Snout to vent length 22-60 mm., tail length 38-132 mm.

Variability in meristic characters : (Table 5)

Distribution : Gujarat : As above (new locality record) and Kutch. **Elsewhere :** Widely distributed in western Rajasthan. The records are available from Bihar and Madhya Pradesh also.

Remarks : At Okha and Dwarka these diurnal, most agile lacertides, share the same ecological environment with *Acanthodactylus cantoris cantoris*. It is interesting to observe that not even a single female came across and the burrows were occupied either by the males or by the young ones, At Bet-Dwarka these lizards make their burrows under the dense bushes of *Acacia juliflora* and *Cactus* sp. The lizards are having an acute sense of homing behaviour and always choose to live in the burrows made by themselves. At Porbandar their population was observed to be the maximum and they live with a perfect harmony in the association of a tiny member of the family, *Ophisops jerdoni*, in the crevices on the railway tracs and other such places. At Rajkot numerous such lizards were found under a huge pile of loose, flat stones in the association of snakes (*Oligodon taeniolatus* and *Echis carinatus*), gekkonid lizards (*Hemidactylus brooki*), toads, (*Bufo melanostictus*), scorpions, centipedes and different kinds of spiders.

In Gujarat they feed on various Orthopterous insects, beetles of Staphylinidae and of other families, flies of family Muscidae, earwigs, bugs, grubs of beetles, spiders and isopods (crustaceans).

At Porbandar the presence of seven large oval eggs (8.5-10 mm. long and 5-6 mm. wide) in the oviduct of a gravid female indicate the continuation of breeding season of this species also through September.

The examples from Dwarka are darker in dorsal coloration. The peritoneum in all the examples is jet black. The hemipenis is bifid and is divide into two lobes at the tip. Scales across the middle of body 46-60, femoral pores on each side are 12-16 and the preanal plate is divided in few examples.

Family VARANIDAE

Varanus bengalensis (Daudin)

(Indian monitor)

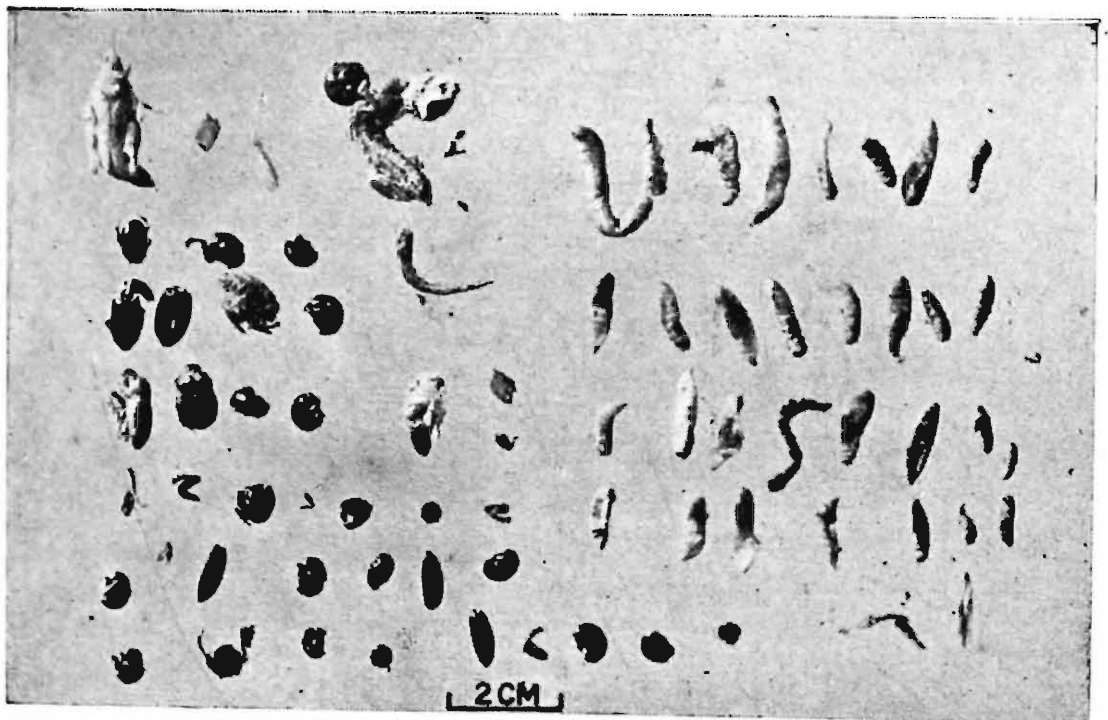
Material : 4 exs. (♀) Mehsana (Mehsana Dist.), Dwarka (Jamnagar Dist.), and Girnar Hills (Junagadh Dist.) collected in September and November 1964 and 1975 by R. N. Bhargava and R. C. Sharma.

TABLE 5. *Ophisops microlepis* Blanford

Biometrical constants (Statistical parameters) of certain body parts.

S. No.	Characters	Number of Samples		Range		Mean ± S. E.		C. V.		't' value for Sex difference
		Male	Female	Male	Female	Male	Female	Male	Female	
1.	No. of scales round the middle of body	15	4	53- 66	52- 59	57.86± 0.89	56.00± 1.47	5.98	5.25	0.98 ns.
2.	No. of longitudinal plates on belly	15	4	6- 6	6- 6	6.00± 0.00	6.00± 6.00	—	—	0
3.	Number of transverse plates on the ventrum	15	4	27- 32	28- 30	28.46± 0.36	29.00± 0.41	4.94	2.81	0.73 ns.
4.	Number of femoral pores (Left)	15	4	12- 14	12- 14	13.06± 0.12	13.00± 0.41	3.50	6.28	0.20 ns.
5.	Number of femoral pores (Right)	15	4	12- 16	12- 14	13.20± 0.24	13.00± 0.41	7.12	6.28	0.75 ns.
6.	Standard length (mm.)	15	4	25- 60	25- 63	46.26± 3.68	36.00± 9.03	30.83	50.20	1.38 ns.
7.	Tail length (mm.)	11	3	26-132	49-101	92.63± 11.24	66.67± 17.17	40.24	44.60	1.10 ns.

ns : Not significant



Various food items as evidenced by the stomach contents of *Varanus bengalensis* (Daudin).

Measurements : Snout to vent length 170-323 mm. tail length 249-448 mm.

Distribution : Gujarat : As above (new record) and Bhuj. *Elsewhere* : Whole of India, Burma, Sri Lanka, Iran, Waziristan, Western Himalayas, Nepal, Uzbekistan and Pakistan.

Remarks : At Dwarka a considerably large monitor was in a burrow (partly covered by a huge stone) in the company of toads, crabs, scorpions, spiders, centipedes, various insects and isopods (crustaceans). At Girnar foot hills one juvenile female monitor was on the trunk of a teak tree. Numerous monitor lizards came across in Girnar Hills up to 660 metres altitude.

Their food in Gujarat during September consists of beetles of families Scarabaeidae, Curculionidae, Carabidae etc. ; bugs ; grubs of various beetles ; orthopterous insects like *Chrotogonus* sp., nymphs of *Schizodactylus* sp. ; lepidopterous caterpillars and dipterous maggots. In addition to the above insect food its diet also includes scorpions, gekkonid lizards (*Hemidactylus brooki* Gray) and fibrous vegetable matter.

Though the records are available about its feeding on small mammals, snakes and lizards but its natural food in Gujarat and Rajasthan seems to be mainly the beetles and their grubs, lepidopterous and dipterous larvae and grasshoppers. In the full stomach with a capacity of 23 ml. of an example from Gujarat the following were the counts of food items. One entire lizard (*Hemidactylus brooki* Gray), 2 entire *Chrotogonus* sp. (Orthoptera), 2 entire nymphs of *Schizodactylus* sp. (Orthoptera), at least 50 beetles (5 entire and others evidenced by the body parts), 8 fairly large lepidopterous caterpillars, 40 dipterous maggots of quite a large size, 1 sting (with 5 segments) of a yellow scorpion and 8 fibrous pieces of vegetable matter (Plate I).

Fourteen large oval eggs (16-20 mm. long and 15-16 mm. wide) were found in the oviduct of a large gravid female at Dwarka.

Suborder SERPENTES

Family TYPHLOPIDAE

Typhlops braminus (Daudin)

(Brahminy snake, Common blind snake, worm snake)

Material : 4 exs., Rajpipla (Broach Dist.) and Vijarkhe (Jamnagar Dist.), collected in January and September 1975 by T. G. Vazirani and R. C. Sharma.

Measurements : Total length 62-125 mm., diameter at middle of body 2-2.5 mm. which is 29.2-31 times in the total length (Vs. 30-45 times, as recorded in other Indian examples) ; tail length 3-4 mm.

Distribution : Gujarat : As above (new record), Surat and Dangs districts. *Elsewhere* : Whole of India, Burma, Sri Lanka, East Indies, North Viet-nam, South Viet-nam, Malaya, Mexico, Pakistan, Bangladesh, Iran, Southern China, Arabia, South Africa, Islands of Indian Ocean, Hawai and other islands of Pacific ocean.

Remarks : Scales round the middle of body 20, transverse rows of scales 330-364 (vs. 290-320 rows in other Indian examples), caudal scales 9-12. The examples from Vijarkhe were buff to darkbrown in life.

***Typhlops porrectus* Stoliczka**

(Slender blind snake)

Material : 1 ex., Ranavav ca. 16 km. N. of Porbandar (Junagadh Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Total length 127 mm., diameter at middle of body 2 mm., which is 63.5 times in the total length of the snake.

Distribution : Gujarat : As above (first locality record). *Elsewhere* : Whole of India, Sri Lanka, Burma and Pakistan.

Remarks : Collected from the subterranean tunnel under a large black stone, where it was in the association of various small insects like earwigs, silverfish, and spiders. The vicinity around was rocky, with xerophytic vegetation.

***Typhlops acutus* (Dumeril & Bibron)**

(Beaked blind snake)

Material : 1 ex., Virandragarh ca. 14 km. from Dhrangadhra (Surendranagar Dist.), collected in February 1966 by V. C. Agrawal.

Measurements : Total length 289 mm., diameter at middle of body 5 mm., which is contained 57.8 times in the total length of the snake.

Distribution : Gujarat : As above (new locality record) and Baroda. *Elsewhere* : Peninsular India, Bihar, Orissa and West Bengal. The snake is absolutely an Indian.

Family BOIDAE

Eryx johni (Russell)

(John's sand boa)

Material : 1 ex., Veraval (Junagadh Dist.), collected in April 1969 by D. S. Mathur.

Distribution : Gujarat : As above (new locality record) and Kutch.

Elsewhere : Recorded from Andhra Pradesh, Maharashtra, Tamil Nadu, Punjab, Rajasthan and Uttar Pradesh. Also available in Pakistan, Afghanistan and Iran.

Family COLUBRIDAE

Oligodon taeniolatus (Jerdon)

(Streaked kuri snake)

Material : 1 ex., Aji River vicinity, Rajkot (Rajkot Dist.), collected in October 1975 by R. C. Sharma.

Measurements : Snout to vent length 315 mm., tail length 68 mm.

Distribution : Gujarat : As above (first locality record). *Elsewhere* : Peninsular India and Bihar. Also available in Sri Lanka and Pakistan.

Remarks : The snake was under a huge pile of stones in the association of various lacertid and gekkonid lizards, toads, scorpions, insects, centipedes and spiders but the examination of its gut revealed that it devoured nothing out of the above mentioned readily available animals and its stomach was completely empty.

Xenochrophis piscator (Schneider)

(Checkered keelback)

Material : 2 exs. (1 ♂ and 1 Juvenile), Gangasarovar tank, Viramgam (Viramgam Dist.). Ahwa (The Dangs Dist.), collected in February 1966 and 1975 by V. C. Agrawal and T. G. Vazirani.

Measurements : Snout to vent length 342-717 mm., tail length 60-305 mm.

Distribution : Gujarat : As above (new locality record), Surat and Dangs districts. *Elsewhere* : Widely distributed in India, Burma, Sri Lanka, China, Hongkong, Laos, Malaya, Nepal, Pakistan, Bangladesh, Thailand, Borneo and Taiwan.

Remarks : The Gangasarovar tank is inhabited by numerous such snakes where they were found in the association of large number of fishes, gastropods, bugs, dragon fly nymphs and decapod crustaceans.

Lycodon aulicus (Linnaeus)

(Common wolf snake)

Material : 1 ex. (Juvenile), Palanpur (Banaskantha Dist.), collected in October 1964 by V. C. Agrawal.

Distribution : Gujarat ; As above (first record). *Elsewhere* : Whole of India, Burma, Sri Lanka, Hongkong, Laos, Malaya, Mauritius, Nepal, North and South Viet-nam, Pakistan, Bangladesh, Phillippines, Sikkim, Timor and Thiland.

Psammophis leithi Günther

(Indian ribbon snake)

Material : 1 ex. (♂), Bet Dwarka Island (Jamnagar Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 447 mm., tail length 168 mm.

Distribution : Gujarat : As above, Kutch, Nirwand and Pachum Island, *Elsewhere* : In India the species has been recorded from Uttar Pradesh, Maharashtra and Kashmir, Also available in Waziristan and Pakistan.

Remarks : The colour of the head of this example varies from other Indian examples in having a tuning fork shaped dark brown marking from frontal shield to the tip of snout (passes through the prefrontals and internasals), a dark brown spot on the middle of the head at the junction of parietals and two rows of dark brown hatched lines on the throat. The snake possess large eyes with round pupil. Central portion of the eye is deep yellow which is encircled by a jet black ring (with yellow reticulations).

Family HYDROPHIIDAE

Enhydrina schistosa (Daudin)

(Beaked sea snake)

Material : 1 ex. (Juvenile), ca. 40 km. off shore, Veraval (Junagadh Dist.), collected in April 1969 by D. S. Mathur.

Measurements : Snont to vent length 462 mm., tail length 58 mm.

Distribution : Gujarat : As above (first locality record). *Elsewhere* : In India recorded from the coastal waters of Goa, Tamil Nadu, Orissa and West Bengal. Also available in Gulf of Oman, Seychelles, South Viet-nam coast, North coast of Australia, Rockhampton coast, coast of Burma and Sanday bay in Thailand.

Remarks : This deadly poisonous marine snake prefers to live generally in the shallow coastal waters but when the sea is calm it can go sufficiently advance in off shore waters also, in search of fishes and crustacean food.

According to Minton (1966) its food consists of large prawns and fishes like *Tetrodon coilia* and *Harpodon*.

In the above example from Veraval coast one small but entire *Gobid* sp. fish was found.

Microcephalophis cantoris (Günther)

Material : 1 ex., Old port ca. 4 km. N. of Bhaunagar (Bhaunagar Dist.), collected in April 1969 by D. S. Mathur.

Measurements : Snout to vent length 470 mm., tail length 53 mm.

Distribution : Gujarat : As above (first record). *Elsewhere :* On Western coast of India recorded from Cannanore, Orissa Coast, Sunderbans and Chittagong in Bangladesh. Also recorded from Pakistan coast near Karachi.

Hydrophis caeruleus (Shaw)

Material : 3 exs. (1 ♀ and 2 ♂) ca. 14 km. off shore Veraval (Veraval Dist.), collected in September 1975 by R. C. Sharma.

Measurements : Snout to vent length 608-700 mm., tail length 70-72 mm.

Distribution : Gujarat : As above (first record). *Elsewhere :* Coasts of Goa, Maharashtra, Karnataka, Tamil Nadu, West Bengal. Also recorded from Burma coast, Gulf of Thailand Malacca, Malaya archipelago.

Remarks : In the stomach of two individuals entire small fishes were found.

The female example was gravid and contained seven large oval eggs in the oviduct measuring 21-35 mm. in length and 16-18 mm. in width.

Lapemis curtus (Shaw)

(Short sea snake)

Material : 3 exs. Veraval coast and ca. 40 km. off shore (Veraval Dist.), collected in April 1969 and September 1975 by D. S. Mathur and R. C. Sharma.

Measurements : Snout to vent length 374-605 mm., tail length 42-84 mm.

Distribution : Gujarat : As above (first record). *Elsewhere* : Coasts of Goa, Maharashtra, Tamil Nadu, Orissa and West Bengal. Also recorded from the coastal waters of Burma, Arabia, Iran, Sri Lanka and Mekran.

Family VIPERIDAE

Echis carinatus (Schneider)

(Saw scaled viper)

Material : 3 exs. Rajkot (Rajkot Dist.), and Vijarkhe (Jamnagar Dist.), collected in February, September 1966 and October 1975 by V. C. Agrawal and R. C. Sharma.

Measurements : Snout to vent length 246-390 mm., tail length 33-41 mm.

Distribution : Gujarat : As above (new locality record), Kutch Nirw- and and Panchum Island, Bunny, Surat and Dangs. *Elsewhere* : Widely distributed in Andhra Pradesh, Goa, Maharashtra, Karnataka, Tamil Nadu, Rajasthan and Jammu & Kashmir. Outside India available in Arabia, Ghana, Kenya, Nigeria, Sri Lanka, Iran, Whole of middle east, south portion of Russian Asia, Pakistan and Iraq.

SUMMARY

This is the first comprehensive account of the taxonomy, habitats, food and other details of the ecology of 29 species of reptiles, so far collected from Gujarat by the various field parties of the Desert Regional Station, Zoological Survey of India, Jodhpur between the years 1964-1975.

The following species are recorded for the first time from the area : *Trionyx gangeticus* Cuvier, *Calotes rouxi* Dumeril and Bibron, *Mabuya macularia* (Blyth), *Acanthodactylus cantor's cantor's* Günther, *Varanus bengalensis* (Daudin), *Typhlops porrectus* Stoliczka, *Typhlops acutus* (Dumeril & Bibron), *Oligodon taeniolatus* (Jerdon), *Lycodon aulicus* (Linnaeus), *Enhydrina schistosa* (Daudin), *Microcephalopsis cantor's* (Günther), *Hydrophis caerulescens* (Shaw) and *Lepemis curtus* (Shaw). The species like *Lissemys punctata punctata* (Lacépède), *Hemidactylus brooki* Gray, *Hemidactylus flaviviridis* Rüppell, *Sitana ponticeriana* Cuvier, *Calotes versicolor* (Daudin), *Mabuya carinata* (Schneider), *Chamaeleo zeylanicus* Laurenti, *Ophisops jerdoni* Blyth, *Ophisops microlepis* Blanford, *Typhlops*

braminus (Daudin), *Eryx johani* (Russell), *Xenochrophis piscator* (Schneider) and *Echis carinatus* (Schneider) constitute the new locality records and extend the range in Gujarat.

The conventional characters of *Hemidactylus brooki* Gray, *Calotes versicolor* (Daudin), *Acanthodactylus cantoris cantoris* Günther, *Ophisops jerdoni* Blyth and *Ophisops microlepis* Blanford from different localities of Gujarat have been analysed statistically for showing the variability and difference between means in the two sexes.

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REFERENCES

- DANIEL, J. C. AND SHULL, B. M. 1963. A list of the Reptiles and Amphibians of the Surat Dangs, Southern Gujarat. *J. Bombay nat. Hist. Soc.*, **60** (3) : 737-743.
- INDURKAR, S. S. AND SABNIS, J. H. 1976. Observations on the dietary components of the Garden lizard, *Calotes versicolor* (Daudin) *Comp. Physiol. Ecol.*, **1** (1) : 9-12.
- MCCANN, C. 1938. The reptiles and amphibia of Cutch State. *J. Bombay nat. Hist. Soc.*, **40** : 425-427, pl. 1.
- MINTON, S. A. 1966. A contribution to the herpetology of West Pakistan, *Bull. Am. Mus. nat. Hist.*, **134** (2) : 27-184, text-figs., 1-12, plates 9-36, tables 1-7, maps 1-5.
- MURRY, J. A. 1884. *The vertebrate zoology of Sind*. A systematic account. xvi+424 pp., Illusts. London (Richurdson & Co.)
- PRAKASH, I. 1973. The ecology of vertebrates of Indian Desert. Ecology and Biogeography of India, 369-420 pp. Hague (Dr. W. Junk).
- RAO, M. V. S. AND RAJABAI, B. S. 1974. Food and feeding behaviour of the agamid lizards, *Sitana ponticeriana* Cuvier and *Calotes nemoricola* Jerdon. *Indian J. Ent.*, **36** (1) : 63-65,

- SHARMA, R. C. 1971. The Reptile fauna of the Nagarjunasagar Dam area (Andhra Pradesh, India). *Rec. zool. Surv. India*, **63** (1-4) : 77-93.
- SHARMA, R. C. AND VAZIRANI, T. G. 1977. Food and feeding habits of some Reptiles of Rajasthan. *Rec. zool. Surv. India*, **73** : 77-93.
- SMITH M. A. 1931. *The fauna of British India including Ceylon and Burma*. Reptilia and Amphibia, vol. 1 Loricata, Testudines xviii+185 pp., figs. 2 pls., map—London (Taylor and Francis).
- SMITH, M. A. 1935. *The fauna of British India including Ceylon and Burma*. Reptilia and Amphibia vol. II. Sauria. xiii+440 pp., figs., pl., map—London (Taylor & Francis).
- SMITH, M. A. 1943. *The fauna of British India including Ceylon and Burma*. Reptilia and Amphibia. Vol. III Serpentes, xii+583 pp., figs., map.
- STOLICZKA, F. 1872. Notes on the reptilian and amphibian fauna of Kuchh. *J. Proc. Asiat. Soc. Beng.*, pp. 71-85.
- TIWARI, K. K. AND SHARMA, R. C. 1970. Reptiles of Western Maharashtra. *J. zool. Soc. India*, **22** (1 & 2) : 101-115.

ON SOME PSEUDOCOCCIDS FROM THE ANDAMAN ISLANDS
(HOMOPTERA : PSEUDOCOCCIDAE)

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INTRODUCTION

Although the scale insects and mealy-bugs of the South India (Ayyar, 1930) and Sri Lanka (Green, 1896-1922) have been studied very extensively, there appears to be no previous report on these insects from the Andaman-Nicobar group of islands. While studying the registered collections present in the Zoological Survey of India, Calcutta, the author came across some examples of pseudococcids collected from the Andaman Islands. This paper deals with that small collection, which was brought by Dr. B. S. Lamba of the Zoological Survey of India, during 1964. It may be added that unfortunately no indication about the host-plants is available on accompanying labels and that the specimens are overstained and poorly mounted. However, on the basis of this preliminary study it is hoped that detailed studies would be very rewarding to know the coccid fauna of these islands.

SYSTEMATIC ACCOUNT

Superfamily COCCOIDEA

Family PSEUDOCOCCIDAE

1. *Maconellicoccus hirsutus* (Green)

1908. *Phenacoccus hirsutus* Green, *Mem. Dep. Agric. India*, **2** (2) : 25.

1930. *Pseudococcus hirsutus* Green : Ayyar, *Bull. Agric. Res. Inst. Pusa*, **197** : 68.

1970. *Maconellicoccus hirsutus* (Green) : Williams, *Bull. ent. Res.*, **60** : 149.

1970. *Maconellicoccus hirsutus* (Green) : Ali, *Indian Mus. Bull.*, **5** (2) : 86.

Material.—One ♀ mounted on a slide ; Andaman : Burmah Nallah (S. A.), 15. iv. 1964, coll. B. S. Lamba. ZSI Regd. No. 353/H 15.

Remarks.—This is a widely distributed species, reportedly occurring on numerous host-plants. In India it has earlier been collected from West Bengal and Bihar. However, Williams (1970) has shown that the record of this species on sugarcane in India is doubtful.

The other species of this genus occurring in the Indian region is *M. perforatus* (De Lotto), which is so far recorded from Bihar only.

2. *Rastrococcus iceryoides* (Green)

1908. *Phenacoccus iceryoides* Green, *Mem. Dep. Agric. India*, 2 (2) : 26.
 1922. *Phenacoccus iceryoides* Green : Green, *Coccidae of Ceylon*, 5 : 391.
 1930. *Phenacoccus iceryoides* Green : Ayyar, *Bull. Agric. Res. Inst. Pusa*, 197 : 62.
 1958. *Rastrococcus iceryoides* (Green) : Williams, *Bull. Br. Mus. nat. Hist. (Ent.)*, 6 (8) : 220.
 1970. *Rastrococcus iceryoides* (Green) : Ali, *Indan Mus. Bull.*, 5 (2) : 98.

Material.—Three ♀ ♀ mounted on 3 slides ; Andaman Is. : Cowri ghat, 11. iv. 1964, coll. B. S. Lamba. ZSI Regd. Nos. 354/H 15 to 356/H 15.

Remarks.—This species has been earlier recorded from a number of host-plants from India, Sri Lanka and other South East Asian countries. It is more widely distributed than its sister species *R. mangiferae* (Green) which is a pest of mangoes.

On the label of one slide received back from the Commonwealth Institute of Entomology, the author's name is wrongly shown as Cockerell. As pointed out above it should be Green.

3. *Cataenococcus* sp.

Material.—One ♀ on a slide ; Andaman Is. : Cowri ghat, 9. iv. 1964, coll. B. S. Lamba. ZSI Regd. No. 348/H 15.

Remarks.—This specimen could not be identified upto species level, because of the non recognition of the taxonomic characters due to poor mounting.

Genus *Cataenococcus* Ferris comprises some of those species which were earlier treated under Genus *Pseudococcus* Westwood. Presently two species are known from the Oriental limits (Ali, 1970), namely *C. hispidus* (Morrison) and *C. theaecola* (Green). Out of these, the former is recorded from South-East Asian countries like Malaysia and Indonesia etc., and the latter from Darjeeling and Assam in India. The latter species is known as a pest on roots of tea plants. In the light of above, the Andaman material may probably belong to *hispidus*, but can not be so placed at this stage without the study of more material from these Islands.

SUMMARY

Coccids from the Andaman-Nicobar Islands have not been recorded so far. In this paper three species of pseudococcids, viz., *Maconellicoccus hirsutus*, *Rastrococcus iceryoides* and *Cataenococcus* sp., have been reported from the Andaman Islands.

ACKNOWLEDGMENTS

The author is grateful to the Director, Zoological Survey of India, Calcutta, for providing facilities and for encouragement, and to Dr. B. S. Lamba, Joint Director, for collection of these interesting insects. Thanks are recorded to Dr. D. J. Williams, Commonwealth Institute of Entomology, London, also with regard to this study.

REFERENCES

- ALI, S. MOHAMMAD, 1970. A Catalogue of the Oriental Coccoidea. Part-IV. *Indian Mus. Bull.*, 5 (2) : 71-150.
- AYYAR, T. V. RAMAKRISHNA, 1930. A Contribution to our knowledge of South Indian Coccidae (Scales and mealy-bugs). *Bull. agric. Res. Inst. Pusa*, No. 197 : 73 pp.
- GREEN, E. ERNST, 1896-1922. *The Coccidae of Ceylon*. Dulau & Co., London, Parts 1-5.
- WILLIAMS, D. J., 1970. The mealy bugs (Homoptera, Coccoidea, Pseudococcidae) of sugar-cane, rice and sorghum. *Bull. ent. Res.*, 60 (1) : 109-188.

STUDIES ON THE LARVAL TREMATODES OF WEST BENGAL.
PART I. *CERCARIA ESPLANADENSIS* MUKHERJEE AND
GHOSH, 1975, A FURCOCERCOUS CERCARIA.

By

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Zoological Survey of India, Calcutta.

(With 3 Text-figures)

Since publication of Sewell's (1922) monographic work on the larval trematodes of India, which included a number of cercariae from West Bengal, drastic ecological transformation has occurred in the urban and rural areas. This has necessitated a reappraisal of the cercarial fauna of this area. With this end in view a project has been undertaken to assess the present position of larval trematodes in and around Calcutta which aims at intensive investigation of these forms in the study area. The present paper includes the description in detail of the cercaria which has been briefly reported by the authors in 1975. The second part of this series dealing with a new echinostome cercaria has already been published (1977).

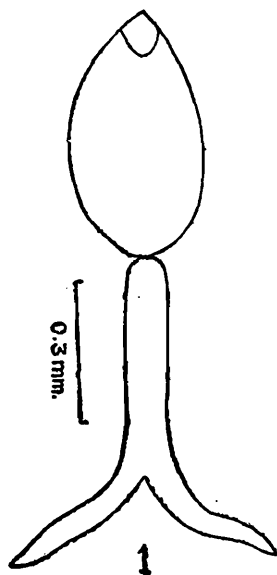
***Cercaria esplanadensis* Mukherjee and Ghosh 1975**

(Text-figs. 1—3).

Out of seven *Vivipara bengalensis* collected from Manohar Das tank situated at Esplanade, Calcutta, one snail was found to discharge distome, pharyngeate, non-ocellate and longifurcate cercariae. The white coloured cercariae remained suspended and uniformly distributed in water. They hang in water with up side down and slightly bend tail pointing upward with stretched out furcal rami. The cercariae in hanging position did not remain stationary at a place for long but slowly drifted with feeble current of water and gradually losing the height when they began to swim actively and regain height. The movement was vertically upwards. At times they sank to bottom of the container and remained there sometime before regaining their normal activity. They crawled rapidly on surface of a slide with help of oral and ventral suckers. Under laboratory conditions majority of cercariae died within 24 hours of emergence from the snail.

Spoon-shaped body of cercaria in fixed condition measures 0.369-0.414(0.405)* in length and 0.225-0.279(0.245) in breadth. Tail measures 0.378-0.450 (0.418) in length and 0.072-0.099 (0.081) in breadth and ramus measures 0.261-0.315 (0.295) in length and 0.054-0.063 (0.61) in breadth. The muscular and well developed oral sucker measures 0.084-0.120 (0.096) in length and 0.048-0.089 (0.069) in breadth. Ventral sucker measures 0.031-0.034 (0.032) in length and 0.024-0.031 (0.028) in breadth. Pharynx measures 0.031-0.048 (0.035) in length and 0.022-0.034 (0.031) in width.

The anterior end forms a conical, protrusible and retractile snout which in turns provided with 7 to 8 rows of anteriorly directed small piercing spines. The rest of the posteriorly directed small spines are arranged in transverse rows. The body is covered with minute backwardly directed spines but the sensory hairs and papillae are absent.



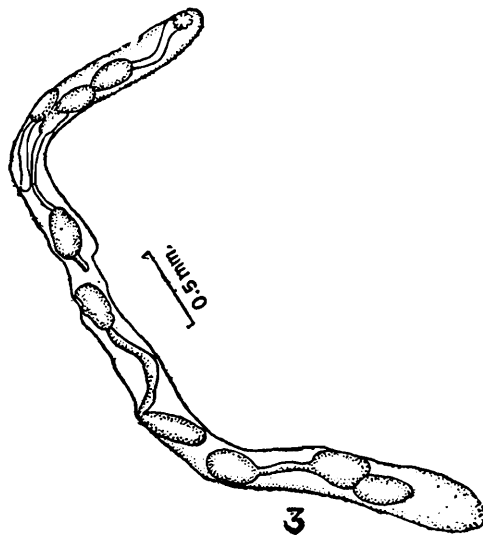
Text-fig. 1. *cercaria*

Oral sucker is furnished with uninucleated gland cells. The mouth is located terminally and leads into a muscular pharynx. The prepharynx forms a triangular non-muscular structure. The long oesophagus forms a loop before bifurcating into two caeca. Two well developed, broad, muscular and sinuous caeca extend upto the posterior part of body and terminate just anterior to excretory vesicle. Ventral sucker is small in size, less muscular than oral sucker, oval in shape and situated anterior to excretory vesicle. Holdfast organ is located anterior to ventral sucker, slightly smaller in size than ventral sucker and unarmed.

Tail is strong, muscular organ and is provided with large number of uninucleate cells arranged laterally along length of tail stem. The stout

* All measurements are in millimeters. Average measurements are in parenthesis. Measurements are based on twenty specimens.

as sinuous tubes along length of ascending ducts. Descending canals soon after leaving the ascending ducts divide into anterior and posterior collecting ducts. Anterior duct runs forward to short distance and gives off a small lateral duct which finally ends in three flame cells in the region of oesophageal bifurcation, while the other long duct of anterior collecting duct runs forward and ends in three flame cells in region of pharynx. The posterior collecting duct runs back and gives off small duct which ends in three flame cells in mid region of body. Posterior collecting duct runs further downward and gives off another small duct which ends in three flame cells in posterior part of body. Finally the posterior collecting duct enters in stem of tail by passing close to lateral side of excretory bladder. Each duct after entering into tail stem gives



Text-fig. 3. *Sporocyst*.

off three flame cells in each side. First pair of caudal flame cells is situated near base of tail and directed anteriorly. Second and third pairs of posteriorly directed caudal flame cells are situated in middle and near the end of tail stem respectively. Caudal flame cells of two sides are not located at the same level. Caudal excretory canal originates from posterior end of excretory bladder and runs through the entire length of stem and divides distally into two ducts passing through each furcal ramus of its side to open at the tip. Flame cell formula of this cercaria is $2 [(3+3)+(3+3)+(3)]=30$. Out of these 30 flame cells 12 pairs are located in body proper and 3 pairs in stem of tail.

Dorsally placed genital rudiments are represented by a mass of cells and situated between ventral sucker and excretory bladder. Nerve mass consists of a pair of ganglia placed on either side of pharynx and is connected by transverse band of nerve tissue. Each ganglion gives off nerve bands anteriorly and posteriorly.

Thin walled, transparent, elastic, long and cylindrical sporocysts

contain 8 to 14 cercariae in various stages of development. Birth pore is situated near one end of body and is encircled by two rows of minute anteriorly directed spines. Posterior end of body is also provided with one row of posteriorly directed spines. Sporocyst measures 1.098—4.095 (2.982) in length and 0.153—0.207 (0.189) in breadth. They are so firmly attached by the posteriorly directed spines with tissue of the digestive gland of host that it is difficult to separate them out of it.

Host : *Vivipara bengalensis*

Locality : Manohar Das tank, Esplanade, Calcutta.

Discussion : The present cercaria comes close to *Cercaria kumaunensis* Singh and Malaki, 1963, *Cercaria shikarii* Singh, 1966 and *Cercaria kukrailensis* Thapar, 1969 in the general arrangement of various body organs but it differs from *C. kumaunensis* in the absence of sensory hairs and papillae on the body and absence of hairs, papillae and spines on the caudal stem, absence of spines on the hold-fast organ, absence of antero-lateral ducts of the median duct, number and arrangement of the flame cells in body and caudal stem of cercaria and presence of spines around birth pore and at the posterior end of body of sporocyst. It differs from *C. shikarii* in the absence of long hairs on body and caudal stem, absence of spines on the caudal stem, size and structure of prepharynx and oesophagus, number and arrangement of penetrating glands, presence of hold-fast organ and in the morphology of the sporocyst. It differs from *C. kukrailensis* in the presence of spines on the body, absence of fin folds on the furcal rami, presence of hold-fast organ, structure of prepharynx, oesophagus and excretory system, number and arrangement of flame cells in cercaria and in the morphology of sporocyst.

Summary : This paper includes the description of a pharyngeate, non-ocellate and longifurcate cercaria, discharged by *Vivipara bengalensis*. Main features of this cercaria are presence of spines at anterior end, presence of small spines on the body, oesophagus forms a loop before it bifurcates into two caeca and presence of hold-fast organ. Sporocyst is provided with spines round the birth pore as well as in the posterior end of body.

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Thanks are due to the Director, Zoological Survey of India, Calcutta for providing laboratory facilities. We are grateful to Dr. K. K. Tiwari for going through the manuscript.

REFERENCES

- MUKHERJEE, R. P. AND GHOSH, R. K. 1975. Studies on the Larval trematodes of West Bengal Part I. *Cercaria esplanadesis* n. sp. a Furcocercous cercaria. *3rd All India Cong. Zool.*, 53-54.
- MUKHERJEE, R. P. AND GHOSH, R. K. 1977. Studies on the larval trematodes of West Bengal. Part II. On a new Echinostome cercaria. *Rec. zool. Surv. India*, **72** : 277-280.
- SEWELL, R. B. S. 1922. *Cercariae indicae*. *Indian J. med. Res., Suppl.* 1-370.
- SINGH, K. S. AND MALAKI, A. 1963. Parasitological Survey of Kumaun region. Part XVIII. One known and two new cercariae from fresh-water snails. *Indian J. Helminth.*, **15** (1) : 54-69.
- SINGH, R. N. 1966. Studies on a new species of cyathocotylid cercaria with a remark on cythocotylid cercariae. *2nd. All India Cong. Zool.*, **2** : 382-391.
- THAPAR, G. S. 1969. Studies on the life history of trematode parasites. II—Some new and little known cercariae from Lucknow and its environments. *Indian J. Helminth.*, **21** (2) : 119-146.
- YAMAGUTI, S. 1975. A synoptical review of the life histories of digenetic trematodes of vertebrates, Keigaku Publishing Co., Japan, 1-590.

SARCOPHAGID FLIES FROM ASSAM AND ARUNACHAL
PRADESH, INDIA. (DIPTERA : SARCOPHAGIDAE)

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(With 4 Text-figures)

INTRODUCTION

This paper is dealing with fifteen species of Sarcophagid flies under eight genera, collected by the authors during the years 1977-1978 from different parts of Assam and Arunachal Pradesh under the financial assistance of University Grants Commission, New Delhi. All the specimens are placed in a proper systematic position and the distributional records and bionomics of the species are mentioned in case if these are not mentioned in earlier papers of senior author (Nandi, 1977a, 1977b, 1978, 1979a, 1979b, 1979c). All the materials along with the type will be deposited in the National Collection of Zoological Survey of India, Calcutta in due course.

ABBREVIATIONS USED IN THE TEXT

ac—acrostichal bristles, *dc*—dorsocentral bristles. *ia*—intra-alar bristles, *h*—humeral bristles, *ph*—posthumeral bristles, *np*—notopleural bristles, *sa*—supra-alar bristles, *pa*—postalar bristles, *st*—sternopleural bristles, *mpl*—mesopleural bristles, *hpl*—hypo-pleural bristles.

SYSTEMATIC ACCOUNT

Subfamily : SARCOPHAGINAE

Tribe : Sarcophagini

Subtribe : Parasarcophagina

***Bercaea haemorrhoidalis* (Fallèn)**

1816. *Musca haemorrhoidalis* Fallèn, *Sevensk. Vet. Akad. Handl.*, p. 236.

1978. *Bercaea haemorrhoidalis* (Fallèn) : Nandi, *Oriental Ins.*, 12 (3) : 377.

Material.—1 ♂, Arunachal Pradesh : Subansiri, Likhali, 7. 1. 1978 ;
1 ♂, Bomdila, 23. 12. 1977.

***Boettcherisca* (s. str.) *peregrina* (Robineau—Desvoidy)**

1830. *Myophora peregrina* Robineau-Desvoidy, *Essai Myodaires*, 1 : 356.

1977. *Boettcherisca* (s. str.) *peregrina* (Robineau—Desvoidy) : Nandi, *Rec. zool. Surv. India*, 73 : 211.

Material.—4 ♂ ♂, Assam : Tinsukia, Barpathar, 15. 1. 1978 ; 2 ♂ ♂,

Tinsukia, Tengapani Tea Estate, 16. 1. 1978 ; 2 ♂♂, Nowgang Circuit House Campus, 26. 1. 1978 ; 1 ♂, Tezpur, 21. 1. 1978.

Subtribe : **Hapragophallina**

Hapragophalla kempi (Senior—White)

1924. *Sarcophaga kempi* Senior—White, *Rec. Indian Mus.*, **26** (3) : 247.

1965. *Hapragophalla kempi* (Senior—White) : Fan, *Key to the common synanthropic flies in China*, p. 261.

Material.—2 ♂♂, Assam : Dibrugarh University Campus, 14.1.1978 ; 2 ♂♂, Jorhat, 21. 1. 1978 ; 1 ♂, Tinsukia, Barpathar, 15. 1. 1978.

Distribution.—India : West Bengal, Kerala ; Trivancore ; Sri Lanka ; China. It is reported for the first time from Assam.

Bionomics.—According to Senior—White *et al.* (1940) this species has been bred from dead *Achatina fulica* and dead Sphingid larva. The female is known to attract to *Aristolochia ridicula*.

Iranihindia futilis (Senior—White)

1924. *Sarcophaga futilis* (Senior—White), *Rec. Indian Mus.*, **26** (3) : 246.

1979. *Iranihindia futilis* (Senior—White) : Nandi, *Oriental Ins.*, **13** (1-2) : 206.

Material.—1 ♂, Assam : Nowgang, 26. 1. 1978 ; 1 ♂, Kaziranga, 24. 1. 1978.

Subtribe : **Parasarcophagina**

Parasarcophaga (s. str.) albiceps (Meigen)

1825. *Sarcophaga albiceps* Meigen, *System. Besch.*, **5** : 22.

1979. *Parasarcophaga (s. str.) albiceps* (Meigen) : Nandi, *Oriental Ins.*, **13** (1-2) : 190.

Material.—3 ♂♂, Assam : Dibrugarh, 13-14. 1. 1978 ; 1 ♂, Jorhat, 21. 1. 1978 ; 3 ♂♂, Kaziranga, 24.1.1978 ; 5 ♂♂, Nowgang, 26, 1. 1978 ; 1 ♂, North Lakhimpur Circuit House Campus, 1. 1. 1978 ; 4 ♂♂, Tinsukia, 15. 1. 1978 ; 2 ♂♂, Tezpur, 21. 12. 1977 ; 4 ♂♂, Subansiri, Likhali, 7. 1. 1978 ; 1 ♂, Nowgang College Campus, 25. 1. 1978.

Parasarcophaga (s. str.) knabi (Parker)

1917. *Sarcophaga knabi* Parker, *Proc. U. S. natn. Mus.*, **54** : 96.

1979. *Parasarcophaga (s. str.) knabi* (Parker) : Nandi, *Oriental Ins.*, **13** (1-2) : 190.

Material.—2 ♂♂, Assam : Gauhati, 29. 1. 1978 ; 2 ♂♂, Jorhat, 21. 1. 1978 ; 3 ♂♂, Koziranga, 24. 1. 1978 ; 4 ♂♂, Dibrugarh, 14-15. 1. 1978 ; 6 ♂♂, Nowgang, 26. 1. 1978 ; 1 ♂, North Lakhimpur, 1. 1. 1978.

Parasarcophaga (s. str.) orchidea (Böettcher)

1918. *Sarcophaga orchidea* Böettcher, *Annl. hist. nat. Mus. natn. Hung.*, **11** : 375.

1979. *Parasarcophaga* (s. str.) *orchidea* (Böettcher) : Nandi, *Oriental Ins.*, **13** (1-2) : 190.

Material.—2 ♂♂, Assam : Dibrugarh, 13-14. 1. 1978 ; 2 ♂♂, Jorhat, 21. 1. 1978 ; 3 ♂♂, Kaziranga, 24.1.1978 ; 4 ♂♂, Nowgang, 26. 1. 1978 ; 3 ♂♂, Tezpur, 21. 12. 1977 ; 1 ♂, Arunachal Pradesh ; Subansiri, Likhali, 7. 1. 1978. This species is recorded for the first time from Assam.

Parasarcophaga (Liopygia) ruficornis (Fabricius)

1794. *Musca ruficornis* Fabricius, *Ent. Syst.*, **4** : 314.

1978. *Parasarcophaga* (*Liopygia*) *ruficornis* (Fabricius) : Nandi, *Oriental Ins.*, **12** (3) : 382.

Material.—1 ♂, Assam : Jorhat, 21. 1. 1978.

Parasarcophaga (Liosarcophaga) dux (Thomson)

1868. *Sarcophaga dux* Thomson, *Kongl. Seven. Freg. Eugen. Resa.*, p. 534.

1979. *Parasarcophaga* (*Liosarcophaga*) *dux* (Thomson) : Nandi, *Oriental Ins.*, **13** (1-2) : 190.

Material.—2 ♂♂, Assam : Dibrugarh University Campus, 14. 1. 1978. This is the first record of this species from Assam.

Parasarcophaga (Liosarcophaga) brevicornis (Ho)

1934. *Sarcophaga brevicornis* Ho, *Bull. Fan. meml. Inst. Biol.*, **5** : 23.

1977. *Parasarcophaga* (*Liosarcophaga*) *brevicornis* (Ho) : Nandi, *Rec. zool. Surv. India*, **73** : 213.

Material.—6 ♂♂, Assam : Dibrugarh University Campus, 14. 1. 1978 ; 1 ♂, Nowgang College Campus, 26. 1. 1978.

Bionomics.—This species has been bred in dead fish, meat and animal carcasses.

Distribution.—India : West Bengal, Orissa, Tamil Nadu. It is recorded for the first time from Assam.

Parasarcophaga (Curranea) scopariformis (Senior-White)

1927. *Sarcophaga scopariformis* Senior-White, *Spolia zeylan*, **14** (2) : 82.

1979. *Parasarcophaga* (*Curranea*) *scopariformis* (Senior-White) : Nandi, *Rev. Brasil Biol.*, **39** (2) : 459.

Material.—1 ♂, Assam : Dibrugarh University Campus, 14. 1. 1978 ; 1 ♂, Nowgang College Campus, 26. 1. 1978.

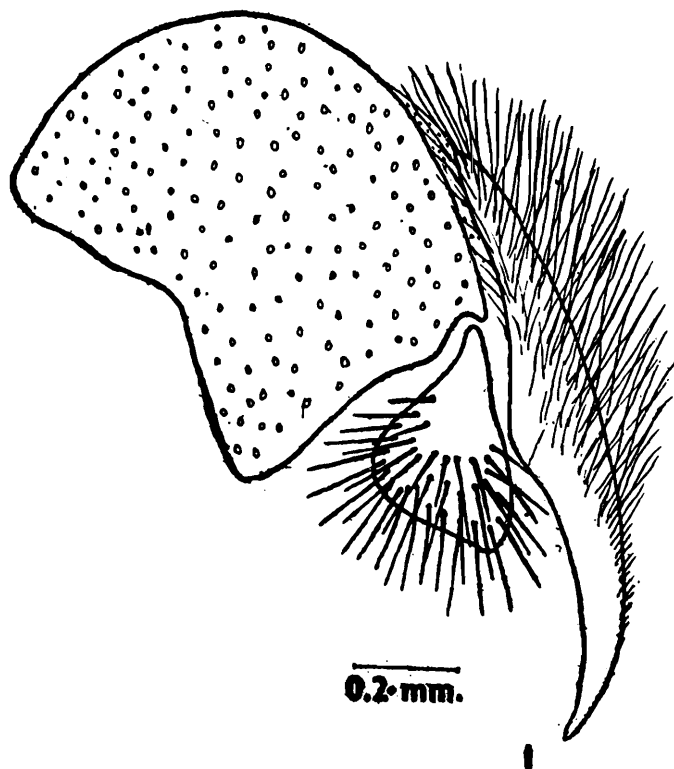
This species is recorded for the first time from Assam.

Parasarcophaga (Pandelleisca) assamensis sp. nov.

(Text-figs. 1-4)

Male.—Body length 8 mm.

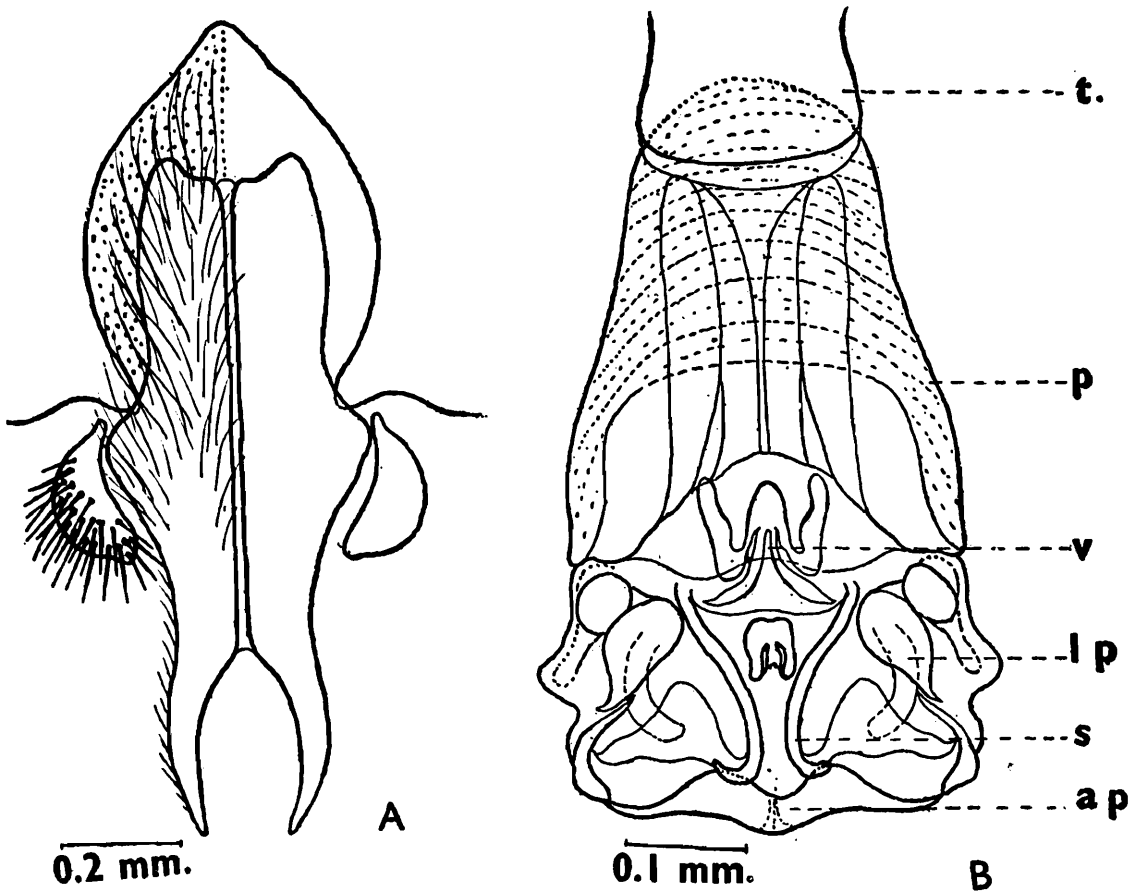
Head.—Width of frons about two-fifths that of one eye; frontal vitta black, its width at narrowest point of frons about double the width of each frontal; parafrontal and parafacial black with silvery to golden pollen, the latter with short hairs near the eye margin. Antennae blackish; 1st segment slightly brown, 2nd black, 3rd blackish with silvery pollen, about two times the length of 2nd antennal segment and reaching to about 0.85 distance to vibrissae; arista long plumose on basal two-thirds; vibrissae long, crossed, distance between vibrissae about parafacial width; facial ridge black with silvery pollen and with short hairs near the vibrissal base; gena brownish black with silvery

Text-fig. 1. *Parasarcophaga (Pandelleisca) assamensis*, sp. nov. cercus, lateral view

pollen; post gena black with black hairs; frontal bristles 11, arranged in a row on parafrontal, upper 2 reclinate, lower 4 below base of antennae and reaching to about two-thirds the distance of 2nd antennal segment; ocellar triangle black with black hairs; outer vertical short and equal to post vertical; inner vertical long about two and a half times that of the post vertical; ocellar and post ocellar short; only one row of post ocular setae beside post ocular cilia, rest of the area with black and white hairs; palpi slender, black; proboscis black.

Thorax.—Blackish-grey with three black longitudinal stripes ; *ac* 0+1 ; *dc* 5+6 ; *ia* 1+2 ; *ps* 1 ; *h* 3 ; *ph* 2 ; *np* 4 ; *sa* 3 ; *pa* 2 ; *st* 1+1+1 ; *mpl* 6 ; *hpl* 9 ; upper part of propleura brownish black ; prostigmatic and propleural bristles well developed and accompanied with short hairs ; apicoscutellar and discoscutellar bristles 1 pair each ; lateroscutellar bristle 1 pair ; pro- and meso-thoracic spiracles brown.

Wings.—Hyaline with brown veins ; R_1 bare ; R_{4+5} with 7-8 short setae located dorsally and extending to about half the way of basal node to r-m and several short setae on ventral surface of basal node of



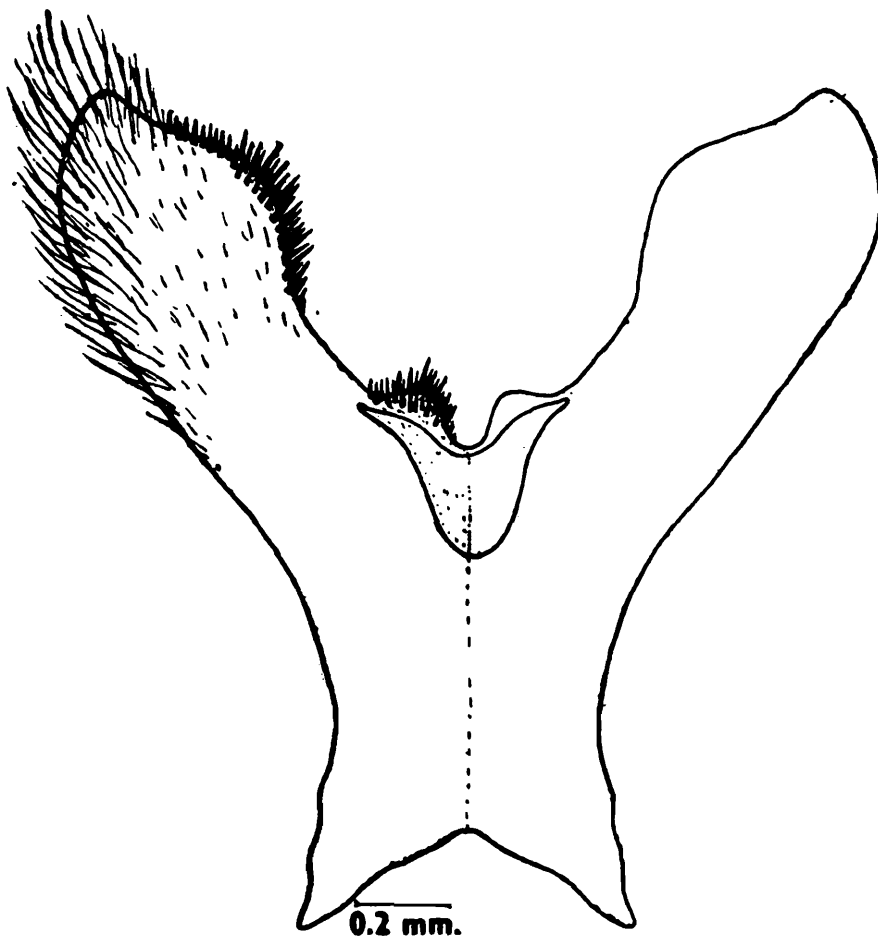
Text-fig. 2. *Parasarcophaga (Pandelleisca) assamensis*, sp. nov.

A. cercus, dorsal view B. penis, ventral view

R_{4+5} ; 3rd sector of costa a little longer than the 5th ; basicostal scale yellowish ; costal spine stout ; epaulet black with many short spines ; squama white ; haltere brown.

Legs.—Black ; fore femur with a row of bristles on each of postero-dorsal and posterolateral surfaces and a row of bristles on posterior margin of ventral surface ; fore tibia with 3 bristles about basal one-third of anterodorsal surface and 1 bristle on posterodorsal surface at about one-third the distance from the distal end ; mid femur with a row of several short setae on anterolateral surface, 1 bristle each on postero-dorsal and posterolateral surfaces distally, a row of long hairs on basal

half and a row of short bristles on distal half of posterolateral, a row of bristles on anteroventral, 3 bristles on posterodorsal, 1 bristle on posteroventral surfaces at about one-third the distance from the distal end, 2 bristles on anterolateral surface medially and 1 bristle on anteroventral surface at about one-fifth the distance from the distal end ; hind femur with 2 rows of bristles on anterodorsal surface, 1 bristle each on anterodorsal and posterodorsal surfaces at one-fourth the distance from the distal end, a row of hairs on ventral surface ; hind tibia with a row of bristles on distal surface, 2 bristles on posterodorsal surface distally,

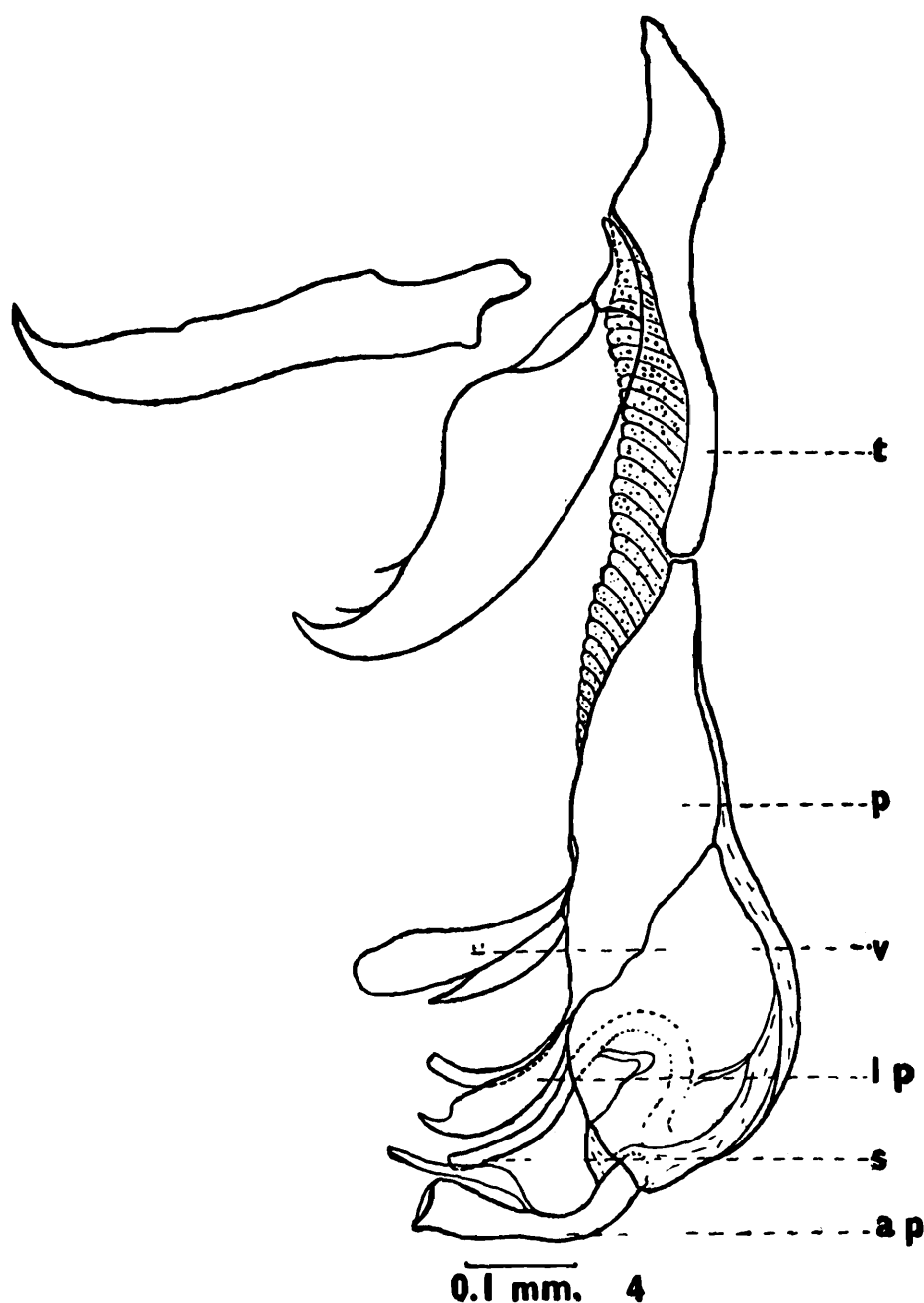


Text-fig. 3. *Parasarcophaga (Pandelleisca) assamensis*, sp. nov.
5th sternite

1 bristle on anteroventral surface at about one-fifth the distance from the distal end and without hairs on anterior and posterior margins of ventral surface distally.

Abdomen.—Black with silvery checkered pattern ; median marginal bristles on 2nd tergite absent, but each with 4 lateral marginal bristles ; 3rd with two median and 1 lateral marginal bristles ; 4th with 2-3 lateral marginal bristles ; 5th with a row of prominent bristles ; 1st genital tergite blackish with short hairs, 2nd shiny black with short hairs and without marginal bristles ; 5th sternite v-shaped bearing short hairs terminally and spines on lateral sides of each arm ; inner forcep slightly

curved forwards terminally, pointed and without notch at apex and bearing hairs on basal three-fifth ; outer forcep triangular with hairs ; anterior paramere long, almost straight and slightly curved and pointed at apex ; posterior paramere curved terminally and with single hair anteriorly ; theca shorter than paraphallus ; apical plate of paraphallus sclerotised, slightly curved and blunt at apex with two slender subbasal membranous processes ; lateral plate of paraphallus short, slightly chitinised and hook-like terminally ; styli of glans short, pointed and without serration ; ventralia almost membranous and lobulated terminally.



Text-fig. 4. *Parasarcophaga (Pandelleisca) assamensis*, sp. nov. penis, lateral view

Female.—Unknown.

Holotype.—♂, Assam : Jorhat station area, 22. 1. 1978.

Discussion.—This species is quite similar to *Parasarcophaga* (*Pandelleisca*) *similis* (Meade) but quite differs from it by the structure of apical plate of paraphallus, the subbasal membranous process of apical plate of paraphallus in *assamensis* is shorter than *similis*. Moreover, the detailed structures of lateral plate of paraphallus and ventralia are quite distinguishable from the above species.

Bionomics.—This species has been collected by bush-sweeping near human excrement which shows that it is attracted to human excrement.

***Robineauella* (*Jantiella*) *coei* Rohdendorf**

1966. *Robineauella* (*Jantiella*) *coei* Rohdendorf, *Bull. Br. Mus. nat. Hist. (Ent.)*, **17** (10) : 458 ; 1976, Nandi, *Rev. Brasil Biol.*, **36** (4) : 920.

Material.—1 ♂, Arunachal Pradesh ; Pasighat, 12. 1. 1978.

This is the first record of this species from Arunachal Pradesh.

***Sinonipponia* *bengalensis* Nandi**

1977 : *Sinonipponia bengalensis* Nandi, *Rev. Brasil Biol.*, **37** (1) : 79.

Material.—1 ♂, Assam : Jorhat College Campus, 21. 1. 1978.

This is the first record from Assam.

Subtribe : *Seniorwhiteina*

***Seniorwhitea* *krameri* (Böettcher)**

1912. *Sarcophaga krameri* Böettcher, *Ent. Mitt.*, **1** : 166.

1978. *Seniorwhitea krameri* (Böettcher) : Nandi, *Oriental Ins.*, **13** (1-2) : 194.

Material.—2 ♂ ♂, Arunachal Pradesh : Subansiri, Likhali, 7. 1. 1978 ; 5 ♂ ♂, Assam : Tinsukia, Barpathar, 15-17. 1. 1978 ; 4 ♂ ♂, Tezpur Circuit House Campus, 21. 12. 1977 ; 1 ♂, Kaziranga, 25. 1. 1978 : 1 ♂, Nowgang College Campus.

SUMMARY

This paper records the systematic account of fifteen species of Sarcophagid flies from Assam and Arunachal Pradesh. Among them *Harpagophalla kempfi* (Senior-White), *Parasarcophaga* (*s. str.*) *orchidea* (Böettcher), *P. (Liosarcophaga) dux* (Thomson), *P. (Liosarcophaga) brevicornis* (Ho), *P. (Curaanea) scopariformis* (Senior-White) and *Sinonipponia bengalensis* Nandi are recorded for the first time from Assam. *Robineauella* (*Jantiella*) *coei* Rohdendorf is recorded for the first from Arunachal Pradesh. *Parasarcophaga* (*Pandelleisca*) *assamensis* is new to science from Assam.

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REFERENCES

- FAN, T. 1965. *Key to the common synanthropic flies in China, Peking, Academy of Science* : p. 1-330.
- HO, C. 1934. Four new species of the genus *Sarcophaga* from Peiping, China, *Bull. Fan meml. Inst. Biol.*, **5** : 19-29.
- MEADE, R. H. 1876. Monograph upon the British species of *Sarcophaga* or flesh fly. *Entomologist's mon. Mag.*, **12** : 260-268.
- NANDI, B. C. 1976. *Robineauella* Enderlein from India with description of a new species (Diptera : Sarcophagidae). *Rev. Brasil Biol.*, **36** (4) : 919-922.
- NANDI, B. C. 1977a. A new species of *Sinonipponia* Rohdendorf from West Bengal, India (Diptera : Sarcophagidae). *Rev. Brasil Biol.*, **37** (1) : 79-81.
- NANDI, B. C. 1977b. Sarcophagid flies (Diptera : Sarcophagidae) from Orissa, India. *Rec. zool. Surv. India*, **73** : 211-216.
- NANDI, B. C. 1978. Flesh flies (Diptera : Sarcophagidae) in the collection of Forest Research Institute, Dehra Dun, India. *Oriental Ins.*, **12** (3) : 377-386.
- NANDI, B. C. 1979a. Flesh flies (Diptera : Sarcophagidae) in the collection of Indian Agricultural Research Institute, New Delhi, India. *Oriental Ins.*, **13** (1-2) : 189-200.
- NANDI, B. C. 1979b. Genus *Iranihindia* Rohdendorf from India with description of two new species (Diptera : Sarcophagidae). *Oriental Ins.*, **13** (1-2) : 201-217.
- NANDI, B. C. 1979c. Subgenus *Curranea* Rohdendorf from India with description of a new species (Diptera : Sarcophagidae). *Rev. Brasil Biol.*, **39** (2) : 457-461.
- PARKER, R. R. 1917. New flies of the genus *Sarcophaga* from Guam and the Phillipines. *Proc. U. S. natn. Mus.*, **54** : 89-97.

SENIOR-WHITE, R. 1924. A revision of the subfamily Sarcophaginae in the Oriental Region. *Rec. Indian Mus.*, **26** (3) : 193-283.

SENIOR-WHITE, R. 1927. Notes on the Oriental species of the genus *Sarcophaga*, *Spolia zeylan*, **14** (2) : 77-83.

SENIOR-WHITE, R., AUBERTIN, D. AND SMART, J. 1940. *The fauna of British India, including the remainder of the Oriental Region*, Diptera : Calliphoridae, p. 1-288.

EARTHWORM FAUNA OF THE ANDAMAN AND NICOBAR ISLANDS, INDIA

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INTRODUCTION

The first records of earthworms from the Andaman and Nicobar Islands were provided by Rosa (1891). He reported two species, *viz.*, *Lumbricus rubellus* Hoffmeister and *Eisenia foetida* (Savigny) from the Nicobars. Both the species are now believed to have been transported to the Nicobars from Europe by man alongwith the soil around the roots of the introduced plants. Michaelsen (1907) discovered the first endemic earthworms, *viz.*, *Metaphire* (*Pheretima* s. l.) *andamanensis*, *Amyntas* (*Pheretima* s. l.) *osmastoni* and *Amyntas* (*Pheretima* s. l.) *suctorius* from the Andamans. Subsequently, more endemics belonging to *Metaphire* and *Amyntas* were discovered by Stephenson (1925) and Gates (1932, 1936). The other reports on the earthworms of the Andaman and Nicobar Islands are limited to incidental records in the literature (Michaelsen, 1909 ; Stephenson, 1916 ; Gates, 1933, 1954, 1958, 1960, 1962a ; Julka & Halder, 1975). Recently, Soota & Julka (1970) recorded fourteen species from these islands, all of which probably have been introduced there.

This article deals with a comprehensive account of twenty seven megadrile species so far reported from the Andaman and Nicobar Islands. For a detailed account on the world distribution and synonymies of the species Gates (1972) may be consulted. The classification followed is that proposed by Gates (1959). For explanation of latest technical terms and conventions necessary for earthworm description, the articles by Ljungström (1970), Gates (1972) and Reynolds (1977) may be referred.

ZOOGEOGRAPHY

Of the twenty seven species (Table I) known from the Andaman and Nicobar Islands, twenty are exotic and are best excluded from zoogeographical discussions. The endemics belong to the former genus *Pheretima* s. l. (Michaelsen, 1900) and now transferred to *Amyntas* and *Metaphire* by Sims and Easton (1972). Relationships of the endemics

are to be found with presently unknown Sumatran species (Gates, 1972). Geologically also, the Andaman and Nicobar Islands are believed to have once formed the part of the land mass of South East Asia. There was a continuous mountain range along the whole length of these islands connected to the Arakans of Burma at one end and to Sumatra at the other end. About 150 million years ago, due to geological activity, the land near about these islands was submerged and the summits of the mountain range standing out of the sea became the present day islands. According to Gates (1972), the separation of the islands from Burma must have been prior to that from Sumatra and before *Eutypophoeus* (endemic in Burma) could have reached so far south.

Among the twenty exotic species, 2 are of European, 7 of South or South East Asian, 2 of South American, 1 of Central American, 3 of African and 5 of Indian origin. All the exotics are suspected to have been introduced alongwith the soil around the roots of the plants brought by man to the islands. It is of course not definite that they have been introduced from their original homes directly to the Andaman and Nicobar group of islands but might have arrived via other continent. Gates (1976) records instances of interceptions of peregrine earthworms (transported by man) in soil around roots of ornamental plants arriving in U. S. A. by ships or aeroplanes. The European species, viz., *Eisenia foetida* and *Lumbricus rubellus* were not found in recent collections from the Andaman and Nicobar Islands (Gates, 1972). Possibly they have failed to establish themselves on these islands because of climatic reasons.

SYSTEMATIC ACCOUNT

KEY TO FAMILIES

1.	Testes and male funnels intraseptal.	...	MONILIGASTRIDAE
	Testes and male funnels not intraseptal.	...	2
2.	Prostates with muscular ducts present.	...	3
	Prostates generally absent.	...	6
3.	Last pair of hearts in XI.	...	OCNERODRILIDAE
	Last pair of hearts behind XI.	...	4
4.	Prostates racemose.	...	MEGASCOLECIDAE
	Prostates tubular.	...	5
5.	Nephridia holoic.	...	ACANTHODRILIDAE
	Nephridia meroic	...	OCTOCHAETIDAE
6.	Dorsal pores present.	...	LUMBRICIDAE
	Dorsal pores absent.	...	GLOSSOSCOLECIDAE

TABLE—I. List of earthworms known from the Andaman & Nicobar Islands.

Species	Introduced/endemic	Original Home
Fam. ACANTHODRILIDAE		
<i>Pontodrilus bermudensis</i>	Introduced	? S. Asia
Fam. GLOSSOSCOLECIDAE		
<i>Pontoscolex corethrurus</i>	Introduced	S. America
Fam. LUMBRICIDAE		
<i>Eisenia foetida</i>	Introduced	Europe
<i>Lumbricus rubellus</i>	Introduced	Europe
Fam. MEGASCOLECIDAE		
<i>Amyntas aculeatus</i>	Endemic	
<i>Amyntas alexandri</i>	Introduced	S. E. Asia
<i>Amyntas facetus</i>	Endemic	
<i>Amyntas malacus</i>	? Introduced	? S. E. Asia
<i>Amyntas osmastonii</i>	Endemic	
<i>Amyntas sutorius</i>	Endemic	
<i>Lampito mauritii</i>	Introduced	Peninsular India
<i>Metapheretima elongata</i>	Introduced	Region incl. Indonesia & Philippines
<i>Metaphire andamanensis</i>	Endemic	
<i>Metaphire harrietensis</i>	Endemic	
<i>Metaphire houlleti</i>	Introduced	S. E. Asia
<i>Metaphire planata</i>	? Introduced	? S. E. Asia
<i>Metaphire posthuma</i>	Introduced	S. E. Asia
<i>Metaphire scitula</i>	Endemic	
<i>Perionyx excavatus</i>	Introduced	Himalayas, India
Fam. MONILIGASTRIDAE		
<i>Drawida nepalensis</i>	Introduced	Himalayas, India
Fam. OCNERODRILIDAE		
<i>Eukerria kukenthali</i>	Introduced	S. America
<i>Gordiodrilus elegans</i>		
<i>morph paski</i>	Introduced	Tropical Africa
<i>Ocnerodrilus occidentalis</i>	Introduced	Central America
<i>Thaonia gracilis</i>	Introduced	? India
Fam. OCTOCHAETIDAE		
<i>Dichogaster bolauii</i>	Introduced	W. Africa
<i>Dichogaster modiglianii</i>	Introduced	? W. Africa
<i>Ramiella bishambari</i>	Introduced	Sub-Himalayan India

Family ACANTHODRILIDAE

Genus *Pontodrilus* Perrier, 1874*Pontodrilus bermudensis* Beddard

1891. *Pontodrilus bermudensis* Beddard, *Ann. Mag. nat. Hist., Ser. 6*, 7 : 96. (Type loc.—Bermuda ; Type in Musée Royal de l 'Afrique Centrale, Bruxelles).
1970. *Pontodrilus bermudensis*, Soota & Julka, *Proc. zool. Soc., Calcutta*, 23 : 202.
1972. *Pontodrilus bermudensis*, Gates, *Trans. Am. phil. Soc.*, 62 : 47.

Diagnosis.—Length 32-120 mm ; diameter 2-4 mm. Segments 78-125. Prostomium epilobic, tongue open. Dorsal pores absent. Setae lumbricin, ornamented ectally, *a*, *b* of XVIII lacking, $AB < CD$, $AA \approx ca. = CD$, $DD < \frac{1}{2}C$. Clitellum saddle-shaped, XIII—XVII, XVIII. Nephropores minute, in $\frac{1}{2}BC$. Spermathecal pores 2 pairs, at $7/8-8/9$, in line with or just lateral to *B*. Male pores minute on XVIII, at *B* ; each pore surrounded by a small porophore on lateral wall of a longitudinal depression. Genital markings unpaired, median, transversely oval, in *AA*, across $19/20$ but sometimes on $12/13$, $13/14$.

Unpigmented. Septa $5/6-12/13$ muscular. Gizzard absent ; gut somewhat thickened in V but apparently not muscular ; intestinal origin may be in the region of XIV—XVII ; calciferous glands lacking. Last pair of hearts in XIII. Nephridia holoic ; ducts slightly thickened before entering parietes ; nephridia lacking on preclitellar segments. Testes holandric, free in X, XI ; seminal vesicles small, racemose, in XI and XII. Prostates tubular. Spermathecae diverticulate ; duct shorter than ampulla ; diverticulum digitiform to club-shaped, arising from ectal end of duct. Genital marking glands lacking.

Distribution.—Andaman & Nicobar Islands : Port Blair ? (Gates, 1936) ; Car Nicobar (Soota & Julka, 1970).

Range.—Mainland India, Laccadive and Maldiv Islands, Sri Lanka, Vietnam, Indonesia, Australia, some islands in the middle of Pacific Ocean, U. S. A., West Indies, South America, Africa, Madagascar.

Family GLOSSOSCOLECIDAE

Genus *Pontoscolex* Schmarda, 1861*Pontoscolex corethrurus* (Müller)

1856. *Lumbricus corethrurus* Müller, *Abhandl. Naturgesch. Ges. Halle*, 4 : 26. (Type loc.—Itajahy, Brazil ; typus amissus)
1972. *Pontoscolex corethrurus*, Gates, *Trans. Am. phil. Soc.*, 67 : 54.

Diagnosis.—Length 48-120 mm ; diameter 2-6 mm. Segments 60-232. Prostomium lacking. Dorsal pores lacking. Clitellum saddle-shaped,

XV, XVI—XXI, XXII or XXIII ; tubercula pubertatis narrow, slightly elevated, longitudinal bands, between *BC* on XVIII, XIX—XX, XXI, XXII. Setae lumbricin, on I—II very closely paired, from III widely paired, at hinder end of body usually arranged in “quincunx” ; setae on posterior segments enlarged and ornamented. Nephropores obvious, at *C* on anterior segments and about at *mL* on postclitellar segments. Spermathecal pores 3 pairs, minute (often unrecognizable), at *C*, on 6/7—8/9. Male pores minute (often unrecognizable), probably at 20/21. Female pore minute, on left side, at *AB*, slightly in front of 14/15. Genital tumescences around *a*, *b*, or *a* or *b* of XIX—XXI, sometimes of XIV, XVI, XVIII, XXII.

Unpigmented. Septa 5/6 thin, 6/7—13/14 funnel-shaped, 6/7—9/10 thickly muscular and displaced posteriorly. Gizzard in VI ; calciferous glands in VII, VIII and IX ; intestinal origin probably in XIV or XVI. Last pair of hearts in XI. Nephridia vesiculate ; bladders ocarina-shaped. Testes probably metandric ; seminal vesicles present or absent, if present, only one pair in XII, rudimentary or small or large, extending back through 8-10 segments. Spermathecae adiverticulate, somewhat club-shaped. Tubercula pubertatis glands tripartite, in XVIII bigger in size, then diminishing posteriorly.

Distribution.—Andaman & Nicobar Islands : Ross Island (Stephenson, 1916) ; Aberdeen (Stephenson, 1925) ; Port Blair, Mount Harriet (Gates, 1933, 1954) ; Minnie Bay (Gates, 1933) ; Wrightmyo (Soota & Julka, 1970).

Range.—Indian sub-continent, S. E. Asia, Hong Kong, Malay Peninsula, Indonesia, Philippines, Australia with adjacent islands, some islands in Pacific Ocean, West Indies, U. S.A., Mexico, South America, Africa, Madagascar with adjacent islands, Iran.

Family LUMBRICIDAE

KEY TO GENERA

- | | | |
|--|-----|------------------|
| 1. Spermathecal pores near mid-dorsal line ;
prostomium epilobic. | ... | Eisenia |
| Spermathecal pores in <i>CD</i> ; prostomium
tanylobic. | ... | Lumbricus |

Genus **Eisenia** Malm, 1877**Eisenia foetida** (Savigny)

1826. *Enterion fetidum* (corr. *foetidum*) Savigny, *Mém. Acad. Sci. Inst. Fr.*, 5 : 182. (Type loc. —Paris ; types in Museum National d'Histoire Naturelle, Paris).

1972. *Eisenia foetida*, Gates, *Trans. Am. phil. Soc.*, 62 : 97.

Diagnosis.—Length 27-130 mm ; diameter 3-5 mm. Segments 80-131. Colour purple or red or brown, usually in transverse mid-segmental bands dorsally. Prostomium epilobic, tongue open. First dorsal pore at 4/5 or 5/6. Clitellum saddle-shaped ; XXVI—XXXII, sometimes extending to XXIV and XXXIV ; tubercula pubertatis on XXVIII—XXX, sometimes extending to XXVII and XXXII. Setae lumbricin, closely paired, present on clitellar segments, $AB=CD$, $BC<AA$, anteriorly $DD=\frac{1}{2}C$ but posteriorly $DD<\frac{1}{2}C$. Spermathecal pores 2 pairs, near mid-dorsal line, in 9/10, 10/11. Male pores with large glandular papillae on XV, in BC . Female pores paired, just lateral to B , at eq/XIV. Genital tumescences around any of the setae on VIII-XII, usually around setae a and b of XXIV—XXXIII.

Pigmented, pigment red. Gizzard mainly in XVII ; intestinal origin in XV ; calciferous sacs absent. Extra-oesophageals passing to dorsal trunk along 9/10 ; last pair of hearts in XI. Nephridia vesiculate ; bladders transversely placed and sausage-shaped. Testes holandric ; in X, XI ; seminal vesicles in IX—XII. Spermathecae adiverticulate ; ducts short.

Distribution.—Andaman & Nicobar Islands : Nicobar Island (Rosa, 1891).

Range.—Mainland India, Australia, New Zealand, North America, South America, West Indies, Europe, some of the islands in Atlantic Ocean, U. S. S. R., Korea, Japan, Afghanistan, Turkey, Lebanon.

Genus **Lumbricus** Linnaeus, 1758**Lumbricus rubellus** Hoffmeister

1843. *Lumbricus rubellus* Hoffmeister, *Arch. Naturgesch.*, 9 : 187. (Type Loc.—unknown ; types in Museum National d'Histoire Naturelle, Paris).

1972. *Lumbricus rubellus* Gates, *Trans. Am. phil. Soc.*, 67 : 115.

1978. *Lumbricus rubellus* Gates, *Megadrilogica*, 3 (6) : 100.

Diagnosis.—Length 41-150 mm ; diameter 3-6 mm. Segments 70-126. Prostomium tanylobic. Colour ruddy brown or red-violet dorsally. First dorsal pore in region of 5/6-8/9. Clitellum saddle-shaped, XXVII—XXXII, rarely extending to XXVI or XXXIII ; tubercula

pubertatis on XXVIII-XXXI. Setae lumbricin, closely paired, present on clitellar segments, $AA > BC$, $AB > CD$, $DD = \text{or} < \frac{1}{2}C$. Spermathecal pores 2 pairs, at CD , in 9/10, 10/11. Male pores inconspicuous, without glandular tumescences on XV, in median half of BC . Female pores paired, above B , on XIV. Genital tumescences in VIII—XII (less frequently on X), XX—XXIII, XXVI—XXXVI.

Pigmented, pigment red. Gizzard mainly in XVII; intestinal origin in XV; calciferous sacs digitiform, opening into gut posteriorly and ventrally near 10/11. Extra-oesophageals joining dorsal trunk along 9/10; last pair of hearts in XI. Nephridia vesiculate; bladders J-shaped. Testes holandric, contained in unpaired sacs, in X, XI: seminal vesicles in IX, XI, XII. Spermathecae adiverticulate; ducts short.

Distribution.—Andaman & Nicobar Islands: Nicobar Island (Rosa, 1891).

Range.—New Zealand, North America, Mexico, Europe, Iceland, some of the islands in Atlantic Ocean, South Africa, Turkey, Iran, Afghanistan, U.S.S. R., Far East.

Family MEGASCOLECIDAE

Nomenclature and taxonomy of the pheretimoid earthworms is that of Sims and Easton (1972). All the endemics so far known from the Andaman and Nicobar Islands belong to this family.

KEY TO GENERA

1. Nephridia stomate, and with preseptal funnels.	...	Perionyx
Nephridia astomate, at least in some part of body.	...	... 2
2. Gizzard in front of 7/8.	...	Lampito
Gizzard behind 7/8.	...	... 3
3. Intestinal caeca absent.	...	Metapheretima
Intestinal caeca present.	...	... 4
4. Copulatory pouches absent.	...	Amyntas
Copulatory pouches present.	...	Metaphire

Genus *Amyntas* Kinberg, 1867

KEY TO SPECIES OF GENUS AMYNTHAS

1. Spermathecal pores intrasegmental.	...	<i>A. facetus</i>
Spermathecal pores intersegmental.	...	... 2

2.	First spermathecal pores at 5/6 ; pores 4 pairs.	...	3
	First spermathecal pores behind 5/6 ; pores less than 4 pairs.	...	5
3.	Genital markings lacking.	...	<i>A. alexandri</i>
	Genital markings present.	...	4
4.	Genital marking glands sessile.	...	<i>A. suctorius</i>
	Genital marking glands stalked.	...	<i>A. aculeatus</i>
5.	Spermathecal pores one pair, at 6/7.	...	<i>A. malacus</i>
	Spermathecal pores three pairs, at 6/7-8/9.	...	<i>A. osmastonii</i>

***Amyntas aculeatus* (Gates)**

1936. *Pheretima aculeata* Gates, *Rec. Indian Mus.*, **38** : 390. (Type loc.—Port Blair ; types in Zoological Survey of India, Calcutta).
1972. *Pheretima aculeata*, Gates, *Trans. Am. phil. Soc.*, **62** : 154.
1972. *Amyntas aculeatus*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 234.

Diagnosis.—Length 128 mm ; diameter 4 mm. Segments (?). Prostomium epilobic (?). First dorsal pore at 12/13 (?). Clitellum annular, XIV—XVI. Setae perichaetin, present ventrally on clitellar segments, 36 on VIII, 61 on XX, 9-13 between spermathecal pores, 3-4 between male pores. Spermathecal pores 4 pairs, superficial, on tiny circular discs, in 5/6-8/9. Male pores in XVIII, minute, superficial, each at the centre of a small circular disc. Female pore single, mid-ventral, on XIV. Genital markings small, paired, on XVIII, slightly medially to male porophores.

Pigmented, pigment red. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV ; intestinal caeca simple, paired, origin in XXVII, extending forward to (?). Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs, in X, XI. Prostates racemose, large, extending from XVII to XX ; ducts spindle-shaped. Penial setae 0.58-0.6 mm long, 85 μ thick entally, straight ; ornamentation of short, transverse rows of fine spines ectally, tip slightly concave on one side. Spermathecae unidiverticulate ; duct bulbous, shorter than ampulla ; diverticulum may be longer than combined lengths of duct and ampulla, stalked, with a looped middle portion and an ovoidal to ellipsoidal seminal chamber at ectal end, arises from ectal end of duct. Genital marking glands stalked.

Distribution.—Andaman & Nicobar Islands : Port Blair (Gates, 1936).

Amyntas alexandri Beddard

1900. *Amyntas alexandri* Beddard, *Proc. zool. Soc. Lond.*, 1900 ; 988. (Type loc.—supposedly Calcutta ; type in Brit. Mus. (Nat. Hist.), London).
1972. *Pheretima alexandri*, Gates, *Trans. Am. phil. Soc.*, 62 : 155.
1972. *Amyntas alexandri alexandri*, a. *gracilor*, Sims & Easton, *Biol. J. Linn. Soc.*, 4 (3) : 234.

Diagnosis.—Length 105-290 mm ; diameter 4-9 mm. Segments 90-141. Prostomium rudimentary. First dorsal pore at 12/13. Clitellum annular, XIV—XVI, occasionally reaching to XVII. Setae perichaetin, apparently lacking on clitellar segments, 44 (?) on IX, 58-76 on XX, 9-22 between spermathecal pores, 9-28 between male pores. Spermathecal pores 4 pairs, minute, in 5/6-8/9, about 0.33 circumference apart. Male pores in XVIII, minute, each in a rather circular disc. Female pore single, mid-ventral, on XIV. Genital markings absent.

Pigmented, pigment reddish brown. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV or sometimes in XVI (?) ; intestinal caeca paired, simple, origin in XXVII, extending forward to XX. Last pair of hearts in XIII. Testes holandric, contained in paired and vertical or unpaired and horseshoe-shaped testis sacs, in X, XI, hearts and seminal vesicles of XI included ; seminal vesicles in XI, XII. Prostates racemose, extending from XVI to XXII ; duct variously looped. Spermathecae unidiverticulate ; duct markedly narrowed in parietes ; diverticulum longer than combined lengths of duct and ampulla, arises from median face and ectal end of duct, with a slender stalk and a variously looped wider portion (seminal chamber) entally.

Distribution.—Andaman & Nicobar Islands : Wimberleygunj (Stephenson, 1925) ; Minnie Bay, Mount Harriet (Gates, 1932).

Range.—Indian mainland, Burma, Thailand.

Amyntas facetus (Gates)

1932. *Pheretima faceta* Gates, *Rec. Indian Mus.*, 34 : 422. (Type loc.—John Lawrence Island ; types in Zoological Survey of India, Calcutta).
1972. *Pheretima faceta*, Gates, *Trans. Am. phil. Soc.*, 62 : 185.
1972. *Amyntas facetus*, Sims & Easton, *Biol. J. Linn. Soc.*, 4 (3) : 235.

Diagnosis.—Length 75-113 mm ; diameter 4 mm. Segments 93-114. Prostomium epilobic, tongue open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, apparently lacking on clitellar segments, 48 on XII, 52-56 on XX, 16-22 between spermathecal pores,

10-15 between male pores. Spermathecal pores 2 pairs, minute, segmental, on anterior portions of VIII, IX. Male pores in XVIII, minute, each at centre of a small, transversely elliptical disc. Female pores closely paired (?), on XIV. Genital markings absent.

Pigmented, pigment red. Septum 8/9 absent. Gizzard between septa 7/8 and 9/10; intestinal origin in XV; intestinal caeca paired, simple, originating in XXVII, extending forward to XXIII. Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs, in X, XI; seminal vesicles in XI, XII. Prostates racemose, extending from XVII to XIX; ducts nearly straight. Spermathecae unidiverticulate; duct shorter than ampulla; diverticulum longer than combined lengths of duct and ampulla, with a sinuous or zigzag-looped stalk and a slightly thicker seminal chamber, arises from anterior face and ectal end of duct.

Distribution.—Andaman & Nicobar Islands: John Lawrence Island (Gates, 1932); vicinity of Port Bonington, N. Andaman Island (Gates, 1960).

Amynthas malacus (Gates)

1933. *Pheretima maculosa* (non *P. "maculosus"* Hatai 1930) Gates, *Rec. Indian Mus.*, **35**: 534. (Type loc.—Between Kyaukmedaung and Kameik; types in Zoological Survey of India, Calcutta)

1936. *Pheretima malaca*, Gates, *Rec. Indian Mus.*, **38**: 429. (Nom. nov. pro *maculosa* Gates, 1933).

1972. *Pheretima malaca*, Gates, *Trans. Am. phil. Soc.*, **62**: 199.

1972. *Amynthas malacus*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3): 237.

1975. *Pheretima malaca*, Julka & Halder, *Newsl. zool. Surv. India*, **1** (4): 65.

Diagnosis.—Length 46-82 mm; diameter 2-4 mm. Segments 109-119. Prostomium epilobic. First dorsal pore in region of 10/11-12/13. Clitellum annular, XIV—XVI. Setae perichaetin, ventrally present on clitellar segments, 77 on VIII, 55-77 on XX, 26-31 between spermathecal pores, 4-10 between male pores. Spermathecal pores one pair, minute, in 6/7. Male pores in XVIII, minute, each on a circular disc. Female pore single, mid-ventral, on XIV. Genital markings small and circular discs, in transverse rows on or near 17/18, 18/19; paired and presetal, median to spermathecal pore lines on VII or VIII or XV or XVI: unpaired, median and postsetal on some of IX—XVI; paired on anterior faces of male porophores.

Pigmented, pigment red. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11; intestinal origin in XV; intestinal caeca paired, simple, origin in XXVII, extending forward to XXII. Hearts of X, XI

lacking, last pair of hearts in XIII. Testes holandric, contained in paired and vertical or unpaired and U-shaped or annular testis sacs, in X, XI ; seminal vesicles in XI, XII, of XI included in testis sac. Prostates racemose, small, confined to XVIII ; duct straight or in a hairpin loop. Spermathecae unidiverticulate ; duct shorter than ampulla ; diverticulum shorter than combined lengths of duct and ampulla, middle portion looped, with an ovoidal seminal chamber at ental end, arises from anterior face and ectal end of duct.

Distribution.—Andaman & Nicobar Islands : Bara Balu village, nr. Cheria Tapu, S. Andaman (Julka & Halder, 1975).

Range.—Burma.

***Amyntas osmastoni* (Michaelsen)**

1907. *Pheretima osmastoni* Michaelsen, *Jb. hamb. wiss. Anst.*, 24 : 163. (Type loc.—Port Blair ; types in Zoologisches Institut und Zoologisches Museum Universität, Hamburg, Zoological Survey of India, Calcutta and Museum für Naturkunde der Humboldt Universität, Berlin).

1972. *Pheretima osmastoni*, Gates, *Trans. Am. phil. Soc.*, 62 : 204.

1972. *Amyntas osmastoni*, Sims & Easton, *Biol. J. Linn. Soc.*, 4 (3) : 237.

Diagnosis.—Length 185-320 mm ; diameter 8-11 mm. Segments 126-153. Prostomium epilobic, tongue open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin ; 50 on IX, 65-84 on XX, 8-17 between spermathecal pores, 10-20 between male pores. Spermathecal pores 3 pairs, minute, at centres of small porophores, in 6/7-8/9, ca. 0.28 circumference apart. Male pores in XVIII, minute, each towards the lateral margin of a transversely elliptical disc. Female pores closely paired (?), on XIV. Genital markings small, circular, postsetal, closely crowded in a median or paired patches, on VIII, X, XII, occasionally on XIII.

Pigmented, pigment red (?). Septum 8/9 absent. Gizzard between septa 7/8 and 9/10 ; intestinal origin in XV ; intestinal caeca paired, simple, origin in XXVII, extending forward to XXIV. Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs, in X, XI ; seminal vesicles in XI, XII ; pseudovesicles in XIII, XIV. Prostates racemose, large, extending from XVII to XXII ; ducts looped. Penial setae 1.13-1.25 mm long and 0.20-0.28 mm thick ; ornamentation, circles of fine teeth towards ectal end. Spermathecae unidiverticulate ; duct shorter than ampulla ; diverticulum longer than combined lengths of duct and ampulla, stalked, seminal chamber short and small, arises from anterior face and ectal end of duct. Gland to

male porophore in XV—XXV, bilobed, composed of numerous stalked glands, each passing to a common T-shaped duct with thick and straight horizontal limbs and a slender, vertical leg especially narrowed in parietes. Genital marking glands stalked.

Distribution.—Andaman & Nicobar Islands : Wimberleyganj—Port Blair (Michaelsen, 1907, 1909 ; Stephenson, 1925) ; Mount Harriet (Stephenson, 1925 ; Gates, 1932) ; Minnie Bay (Gates, 1932) ; Port Bonington, N. Andaman Island (Gates, 1960).

***Amynthas sutorius* (Michaelsen)**

1907. *Pheretima sutoria* Michaelsen, *Jb. hamb. wiss. Anst.*, **24** : 165. (Type loc.—Andaman Islands ; types in Zoological Survey of India, Calcutta and Zoologisches Institut und Zoologisches Museum Universität Hamburg.)

1972. *Pheretima sutoria*, Gates, *Trans. Am. phil. Soc.*, **62** : 220.

1972. *Amynthas sutorius*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 235.

Diagnosis.—Length 70-140 mm ; diameter 4-7 mm. Segments 103-123. Prostomium epilobic, tongue closed. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, apparently lacking on clitellar segments, 35-38 on X, 66 on XX, 10-16 between spermathecal pores, 4-8 between male pores. Spermathecal pores 4 pairs, minute, superficial, in 5/6-8/9, *ca.* 0.25 circumference apart. Male pores in XVIII, minute, each on the central portion of a small disc. Female pores closely paired, on XIV. Genital markings paired, just median to male porophores, in XVIII.

Pigmented, pigment red (?). Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV (?) ; intestinal caeca paired, simple, origin in XXVII, extending forward to XXII. Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs ; seminal vesicles in XI, XII. Prostates racemose, in XVII—XIX ; ducts straight or looped. Spermathecae unidiverticulate ; duct shorter than ampulla ; diverticulum longer than combined lengths of duct and ampulla, with a short stalk and a more or less regularly zigzagged seminal chamber, arises from anterior face and ectal end of duct. Genital marking glands sessile.

Distribution.—Andaman & Nicobar Islands : Andaman Islands : (Michaelsen, 1907, 1909) ; Camorta (Gates, 1936).

Genus **Lampito** Kinberg, 1866**Lampito mauritii** Kinberg

1866. *Lampito mauritii* Kinberg, *Ofvers. K. Vetens. Akad. Föreläs. Stockholm*, **23** : 103. (Type loc.—Mauritius ; types in Naturhistoriska Riksmuseet, Stockholm).

1972. *Lampito mauritii*, Gates, *Trans. Am. phil. Soc.*, **62** : 133.

Diagnosis.—Length 95-155 mm ; diameter 3-6 mm. Segments 157-201. Prostomium apparently prolobic, often retracted into buccal cavity. First dorsal pore in region of 10/11-12/13. Clitellum annular, XIV—17/18. Setae perichaetin, present on clitellar segments, circles interrupted mid-ventrally, 40-51 on VIII, 30-43 on XX, 11-16 between spermathecal pores, none between male pores. Spermathecal pores 3 pairs, large, in EG, at 6/7, 7/8, 8/9. Male pores on XVIII, at or lateral to B, in paired, circular, slightly raised porophores that extend from A into CE. Genital markings absent.

Pigmented, pigment brown. Septa all present from 4/5. Gizzard in V ; oesophagus on its inner wall with longitudinal calciferous lamellae in X—XIII ; intestinal origin in XV. Last pair of hearts in XIII. Prostates racemose ; ducts straight. Testes holandric, free, in X, XI ; seminal vesicles in IX and XII. Penial setae with horseshoe-shaped or scoop-shaped tips, ornamentation of closely set circles of triangular teeth. Spermathecae bidiverticulate ; ducts barrel-shaped ; diverticula digitiform, from lateral and median faces of duct.

Distribution.—Andaman & Nicobar Islands : Ross Island (Stephenson, 1916) ; Middle Point, Mount Harriet, Jinghighat (Gates, 1932) ; Haddo, Pahargaon, Aberdeen (Gates, 1960) ; Port Blair (Gates, 1960 ; Soota & Julka, 1970) ; Rajatgarh, Maya Bundar (Soota & Julka 1970).

Range.—Mainland India, Sri Lanka, Maldives & Laccadive Islands, Minicoy, Burma, Thailand, Malay Peninsula, Indonesia, Philippines, Hong Kong, China, New Caledonia, Mauritius, Seychelles, Comoro Island, Madagascar, Zanzibar.

Genus **Metapheretima** Michaelsen, 1928**Metapheretima elongata** (Perrier)

1872. *Perichaeta elongata* Perrier, *Nouv. Arch. Mus. Hist. nat. Paris*, **8** : 124. (Type loc.—Peru ; types in Museum National d'Histoire Naturelle, Paris).

1972. *Pheretima elongata*, Gates, *Trans. Am. phil. Soc.*, **62** : 182.

1972. *Metapheretima elongata*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 233.

1976. *Metapheretima elongata*, Easton, *Bull. Br. Mus. nat. Hist. (Zool.)*, **30** (20) : 40.

Diagnosis.—Length 75-300 mm ; diameter 3-6 mm. Segments 136-297.

Prostomium rudimentary or lacking. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, may be present on clitellar segments, 67-140 on VIII, 55-75 on XX, 13-17 between spermathecal pores, 7-15 between male pores. Spermathecal pores lacking or numerous, minute, in paired groups of 2-5, in 5/6-6/7 or 5/6 or 6/7 only. Male pores in XVIII, minute, each in a small disc on median wall entally of a deep copulatory pouch. Female pore single, mid-ventral, on XIV. Genital markings transversely elliptical, presetal, on XIX and successive segments in line with or slightly ventral to male pores.

Unpigmented (?). Septum 9/10 absent. Gizzard between septa 7/8 and 8/9; intestinal origin in XV; intestinal caeca lacking. Last pair of hearts in XIII. Testes holandric, contained in unpaired and annular testis sacs, in X, XI; seminal vesicles in XI, XII, of XI along with hearts of X and XI included in testis sacs; pseudovesicles well-developed in XIII, rudimentary or lacking in XIV. Prostates racemose, extending from XVI to XXI; ducts looped. Spermathecae unidiverticulate, in paired batteries of 2-5; duct shorter than ampulla; diverticulum arises from ectal end of duct, with a long stalk and an ovoidal seminal chamber. Genital marking glands sessile.

Distribution.—Andaman & Nicobar Islands : Mount Harriet (Gates, 1932); Minnie Bay (Gates, 1932, 1933); Wrightmyo, Rajatgarh (Soota & Julka 1970).

Range.—Mainland India, Pakistan, Burma, Sri Lanka, Thailand, Malay Peninsula, Indonesia, Formosa, Philippines, some Islands in Pacific Ocean, South America, Egypt, Madagascar, Comores.

Genus *Metaphire* Sims & Easton, 1972

KEY TO SPECIES OF *METAPHIRE*

- | | | | |
|---|-----|--------------------|---|
| 1. First spermathecal pores at 5/6; pores 4 pairs. | ... | <i>M. posthuma</i> | |
| First spermathecal pores behind 5/6; pores less than 4 pairs. | ... | ... | 2 |
| 2. First spermathecal pores at 6/7; pores 3 pairs. | ... | ... | 3 |
| First spermathecal pores behind 6/7; pores 2 pairs. | ... | ... | 5 |
| 8. Genital markings lacking. | ... | <i>M. scitula</i> | |
| Genital markings present. | ... | ... | 4 |

- | | |
|--|------------------------|
| 4. Genital markings in two median patches of
ca. 9 irregular transverse rows each, on
XVIII. ... | <i>M. harrietensis</i> |
| Genital markings. when present, in the
vicinity of spermathecal pores. ... | <i>M. houlleti</i> |
| 5. Spermathecal pores intrasegmental, on VII,
VIII. ... | <i>M. planata</i> |
| Spermathecal pores intersegmental, on 7/8,
8/9. ... | <i>M. andamanensis</i> |

Metaphire andamanensis (Michaelsen)

1907. *Pheretima andamanensis* Michaelsen, *Jb. hamb. wiss. Anst.*, **24** : 164. (Type loc.—N. Cinque Island ; types in Zoologisches Institut und Zoologisches Museum Universität Hamburg and Zoological Survey of India, Calcutta.)
1972. *Pheretima andamanensis*, Gates, *Trans. Am. phil. Soc.*, **62** : 157.
1972. *Metaphire andamanensis*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (6) : 237.

Diagnosis.—Length 108-120 mm ; diameter 6-6.5 mm. Segments 110. Prostomium epilobic, tongue open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, present on clitellar segments ventrally at least, 52 on XII, 54 on XXVI, 11-12 between spermathecal pores, 10-15 between male pores. Spermathecal pores 2 pairs, small, in 7/8, 8/9, ca. 0.28 circumference apart. Male pores in XVIII, minute, on lateral walls of copulatory pouches, ca. 0.25 circumference apart. Female pores closely paired (?). Genital markings paired, on XVIII, median to copulatory pouches.

Pigmented, pigment red. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV (?) ; intestinal caeca paired, simple, origin in XXVII, extending forward to XXIII. Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs, in X, XI ; seminal vesicles in XI, XII. Prostates racemose, extending from XIX to XXIII ; ducts S-shaped. Spermathecae unidiverticulate ; duct shorter than ampulla ; diverticulum longer than combined lengths of duct and ampulla, arises from median face and ectal end of duct, with a thread-like stalk and ovoidal seminal chamber ; a lobed annular gland on parietes around base of each spermatheca. Genital marking glands stalked.

Distribution.—Andaman & Nicobar Islands : North Cinque Island (Michaelsen, 1907, 1909).

Metaphire harrietensis (Stephenson)

1925. *Pheretima harrietensis* Stephenson, *Rec. Indian Mus.*, 27 : 59. (Type loc.—Mount Harriet ; types in Zoological Survey of India, Calcutta).
 1972. *Pheretima harrietensis*, Gates, *Trans. Am. phil. Soc.*, 62 : 188.
 1972. *Metaphire harrietensis*, Sims & Easton, *Biol. J. Linn. Soc.*, 4 (6) : 238.

Diagnosis.—Length 200 mm ; diameter 11.5 mm. Segments 123. Prostomium epilobic, tongue open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, present ventrally on clitellar segments, 75 on IX, 91 on XIX, 24-25 between spermathecal pores, 30 between male pores. Spermathecal pores 3 pairs, transverse slits, in 6/7-8/9, *ca.* 0.33 circumference apart. Male pores in XVIII ; each pore minute, at the tip of a conical papilla protrusible from a copulatory pouch. Female pore median (?), on XIV. Genital markings small circular discs, in two median patches of *ca.* 9 irregular transverse rows each, presetal and postsetal in XVIII.

Pigmented ; pigment red (?). Septa 8/9 and 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV ; intestinal caeca single, origin in XXVII, extending forward to (?). Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral (?) testis sacs, in X, XI ; seminal vesicles in XI, XII ; pseudovesicles well-developed, in XIV. Prostates racemose, extending from XVII to XXI ; ducts short and curved. Penial setae *ca.* 1 mm long, ornamented ectally with transverse rows of five spines. Spermathecae unidiverticulate ; duct shorter than ampulla ; diverticulum much longer than combined lengths of duct and ampulla, arises from anterior face and ectal end of duct, slightly dilated entally. Genital marking glands stalked.

Distribution.—Andaman & Nicobar Islands : Mount Harriet (Stephenson, 1925).

Metaphire houlleti (Perrier)

1872. *Perichaeta houlleti* Perrier, *Nouv. Archs. Mus. Hist. nat. Paris*, 8 : 99. (Type loc.—Calcutta ; types in Museum National d'Histoire Naturelle, Paris).
 1972. *Pheretima houlleti*, Gates, *Trans. Am. phil. Soc.*, 62 : 190.
 1972. *Metaphire houlleti*, *h. rugosa*, *h. tortuosa* ; *campanulata campanulata*, *c. meridiana*, *c. penetralis* ; *wimberlayana*, Sims & Easton, *Biol. J. Linn. Soc.*, 4 (3) : 238.

Diagnosis.—Length 40-200 mm ; diameter 3-8 mm. Segments 90-140. Prostomium epilobic, tongue open. First dorsal pore in the region of 7/8-11/12. Clitellum annular, XIV—XVI. Setae perichaetin, often

present on clitellar segments, 30-55 on VIII, 48-62 on XX, 11-26 between spermathecal pores, 4-16 between male pores. Spermathecal pores 3 pairs, minute, within parietal invaginations, in 6/7-8/9, *ca.* 0.5 circumference apart. Male pores in XVIII, minute, each pore on a penial body within a copulatory pouch. Female pore single, mid-ventral, on XIV. Genital markings either present or lacking externally.

Pigmented, pigment reddish brown. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV ; intestinal caeca paired, simple, origin in XXVII, extending forward to XXII. Last pair of hearts in XIII. Testes holandric contained in unpaired and ventral testis sacs, in X, XI ; seminal vesicles in XI, XII ; pseudovesicles rudimentary, in XIII, XIV. Prostates racemose. Spermathecae unidiverticulate ; diverticulum arises from ectal end of duct, with a short stalk and an elongate, variously looped seminal chamber. Genital marking glands when present stalked.

Remarks.—Gates (1972) recognizes seven morphs within the *houletti*-complex. The specimens of *houletti* hitherto recorded from the Andaman & Nicobar Islands belong to H morph and smaller Hp morph.

(i) *Metaphire houletti* H morph (Gates)

1970. *Pheretima houletti*, Soota & Julka, *Proc. zool. Soc., Calcutta*, **23** : 204.

1972. *Pheretima houletti* H morph, Gates, *Trans. Am. phil. Soc.*, **62** : 191.

Diagnosis.—Genital markings, when present externally, in the vicinity of spermathecal pores and near 6/7-8/9. Prostates extending from XVI to XXI. Seminal vesicles well-developed. Penial body columnar with trilobed tip, male pore on middle lobe. Penial setae present, 1-3 in copulatory pouches, 0.47-0.9 mm long, tip bifid, sparsely ornamented ectally with small teeth. Internal genital markings, one on each of two lateral lobes at tip of penial body, others at or near base of penial body or elsewhere on wall of copulatory pouch, one on anterior and one on posterior wall of each spermathecal invagination.

Distribution.—Andaman & Nicobar Islands : Wimberleyganj (Stephenson, 1925) ; Minnie Bay (Gates, 1932, 1933) ; Mount Harriet (Gates, 1933) ; Viper Island (Gates, 1936) ; Port Blair (Gates, 1936 ; Soota & Julka, 1970).

Range.—Mainland India, Burma, Indonesia.

(ii) *Metaphire houletti* smaller Hp morph (Gates)

1972. *Pheretima houletti* smaller Hp morph, Gates, *Trans. Am. phil. Soc.*, **62** : 194.

Diagnosis.—Genital markings none externally. Prostates extending from XVI to XXIII. Seminal vesicles juvenile. Penial body slenderly

conical with a male pore at distal end. Penial setae lacking. Internal genital markings, one on median wall of each copulatory pouch, 1-3 on or near base of penial body, one on anterior wall of each spermathecal invagination.

Distribution.—Andaman & Nicobar Islands : Minnie Bay (Gates, 1932) ; Mount Harriet (Gates, 1932, 1933) ; Andaman Islands (Gates, 1960).

Range.—Mainland India, Burma, Thailand, Malay Peninsula, Java, Philippines, Fiji Island, South America, U. S. A.

Metaphire planata (Gates)

1926. *Pheretima planata* Gates, *Ann. Mag. nat. Hist. (ser. 9)*, **17** : 411. (Type loc.—Rangoon ; types in U. S. National Museum, Washington ; Brit. Mus. (Nat. Hist.), London ; Zoological Survey of India, Calcutta).

1972. *Pheretima planata*, Gates, *Trans. Am. phil. Soc.*, **62** : 211.

1972. *Metaphire planata*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 239.

Diagnosis.—Length 64-176 mm ; diameter 4-7 mm. Segments 115-142. Prostomium lacking or rudimentary (?). First dorsal pore at 10/11 or 11/12. Clitellum annular, XIV—XVI. Setae perichaetin, present on clitellar segments, 75-87 on VIII, 56-65 on XX, 35-42 between spermathecal pores, 8-14 between male pores. Spermathecal pores 2 pairs, minute, segmental, on anterior margins of VII, VIII. Male pores in XVIII, minute, each in a circular area on roof of a copulatory pouch. Female pore single, mid-ventral, on XIV. Genital markings small, circular, 1-4 slightly median to each spermathecal pore, 8-13 on roof and walls of each copulatory pouch.

Pigmented ; pigment brownish red. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XV ; intestinal caeca paired, simple, origin in XXVII, extending forward to XX. Last pair of hearts in XIII. Testes holandric, contained in paired testis sacs, of X ventral, of XI vertical and including seminal vesicles of XI ; seminal vesicles in XI, XII. Prostates racemose, in XVI—XXI ; duct U-shaped. Spermathecae unidiverticulate ; duct elongate ; diverticulum longer than combined lengths of duct and ampulla, with a short stalk and an elongately ellipsoidal seminal chamber. Genital marking glands stalked.

Distribution.—Andaman & Nicobar Islands : Garai-Berana, Corbyn's Cove, Navy Bay (Gates, 1933) ; Port Blair (Soota & Julka, 1970).

Range.—Mainland India, Burma, Bangla Desh, Thailand, Malay Peninsula,

Metaphire posthuma (Vaillant)

1868. *Perichaeta posthuma* Vaillant, *Annls Sci. nat. (ser. 5)*, **10** : 228. (Type loc.—Java ; types in Museum National d'Histoire Naturelle, Paris).
 1972. *Pheretima posthuma*, Gates, *Trans. Am. phil. Soc.*, **62** : 212.
 1972. *Metaphire posthuma*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 239.

Diagnosis.—Length 60-140 mm ; diameter 3-8 mm. Segments 91-124. Prostomium epilobic, tongue usually open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, present on clitellar segments ventrally, 106-129 on VIII, 60-95 on XX, 36-44 between spermathecal pores, 16-22 between male pores. Spermathecal pores 4 pairs, minute, in 5/6-8-9, *ca.* 0.33 circumference apart. Male pores in XVIII, minute, each in a small disc on median wall near roof of a copulatory pouch. Female pore single, mid-ventral, on XIV. Genital markings paired, equatorial, slightly median to male pore line, on XIV—XXX, but usually on XVII and XIX.

Pigmented ; pigment brown. Septum 8/9 present, 9/10 absent. Gizzard between septa 7/8 and 8/9 ; intestinal origin in XV ; intestinal caeca simple, origin in XXVII, extending forward to XXIV. Last pair of hearts in XIII. Testes holandric, contained in unpaired testis sacs, of X ventral, of XI vertically U-shaped and including seminal vesicles of that segment ; seminal vesicles in XI, XII ; pseudovesicles small, in XIII. Prostates racemose, in XV—XXI ; ducts U-shaped. Spermathecae unidiverticulate ; duct shorter than ampulla, diverticulum of variable length, with a short stalk and an ellipsoidal seminal chamber, arises from median face and near ental end of duct. Genital marking glands sessile.

Distribution.—Andaman & Nicobar Islands : Jhinghat (Gates, 1932) ; Minnie Bay (Gates, 1933) ; Ross Island (Soota & Julka, 1970).

Range.—Mainland India, Bangla Desh, Burma, Malay Peninsula, South East Asia, Formosa, Indonesia, Philippines, U. S. A.

Metaphire scitula (Gates)

1936. *Pheretima scitula* Gates, *Rec. Indian Mus.*, **38** : 457. (Type loc.—Port Blair ; types in Zoological Survey of India, Calcutta).
 1972. *Pheretima scitula*, Gates, *Trans. Am. phil. Soc.*, **62** : 219.
 1972. *Metaphire scitula*, Sims & Easton, *Biol. J. Linn. Soc.*, **4** (3) : 238.

Diagnosis.—Length 100-200 mm ; diameter 5 mm. Segments (?). Prostomium epilobic, tongue open. First dorsal pore at 12/13. Clitellum annular, XIV—XVI. Setae perichaetin, apparently absent on clitellar

segments, 37-44 on VIII, 44-46 on XX, 12-25 between spermathecal pores, 12-14 between male pores. Spermathecal pores 3 pairs, minute, each at centre of a small circular porophore, in 6/7, 7/8, 8/9, *ca.* 0.5 circumference apart. Male pores in XVIII, minute, each on a thick circular disc on roof of a deep copulatory pouch. Female pore single, mid-ventral, on XIV. Genital markings absent.

Pigmented ; pigment red. Septa 8/9, 9/10 absent. Gizzard between septa 7/8 and 10/11 ; intestinal origin in XVI ; intestinal caeca paired, simple, origin in XXVII, extending forward to (?). Last pair of hearts in XIII. Testes holandric, contained in unpaired and ventral testis sacs, in X, XI ; seminal vesicles in XI, XII. Prostates racemose, in XVII—XIX ; duct A-, U- or C-shaped. Spermathecae unidiverticulate ; duct almost confined to parietes ; diverticulum much longer than combined lengths of duct and ampulla, arises from anterior face of duct in parietes, with stalk partly looped in a zigzag manner and a short spheroidal to ellipsoidal seminal chamber.

Distribution.—Andaman & Nicobar Islands : Port Blair (Gates, 1936).

Genus *Perionyx* Perrier, 1872

Perionyx excavatus Perrier

1872. *Perionyx excavatus* Perrier, *Nouv. Arch. Mus. Hist. Nat. Paris*, 8 : 126. (Type loc.—Saigon ; types in Museum National d'Histoire Naturelle, Paris).

1972. *Perionyx excavatus*, Gates, *Trans. Am. phil. Soc.*, 62 : 142.

Diagnosis.—Length 30-180 mm ; diameter 3-7 mm. Segments 123-178. Prostomium epilobic, tongue open. First dorsal pore in region of 2/3-5/6. Clitellum annular, XIII-XVII. Setae perichaetin, present on clitellar segments, 56 on IX, 46-52 on XX, 4-6 between spermathecal pores. Nephropores inconspicuous, in one rather irregular longitudinal rank on each side near mL. Spermathecal pores 2 pairs, near mid-ventral line, in 7/8, 8/9. Male pores in small transverse protuberances within a single male field, each protuberance with a slightly irregular transverse groove containing apertures of 4-9 penisetal follicles. Female pore, single, mid-ventral, on XIV.

Pigmented ; pigment red. Septa all present from 4/5. Gizzard absent or rudimentary in V ; oesophagus widened and moniliform in XIII, with longitudinal calciferous ridges on its inner wall in IX—XIV ; intestinal origin in XV or XVI. Last pair of hearts in XIII. Testes holandric, free, in X, XI ; seminal vesicles in XI, XII. Prostates racemose, in XVIII ; ducts straight. Penial setae 0.60-0.69 mm long, 15-25 μ thick, ornamentation of 6-16 circles of triangular spines ectally, tip

bluntly rounded or finely pointed or flattened and truncate. Spermathecae large, duct short and stout, often with intramural seminal chambers located near ental end of duct.

Distribution.—Andaman & Nicobar Islands : Little Andaman (Michaelsen, 1909) ; John Lawrence Island (?) (Gates, 1933) ; Parnashala (Soota & Julka, 1970).

Range.—Mainland India, Burma, Sri Lanka, South East Asia, Indonesia, Philippines, Formosa, Hawaii, West Indies, Madagascar and adjacent islands.

Family MONILIGASTRIDAE

Genus *Drawida* Michaelsen, 1900

Drawida nepalensis Michaelsen

1907. *Drawida nepalensis* Michaelsen, *Jb. hamb. wiss. Anst.*, **24** : 146. (Type loc.—Gowchar, Nepal ; types in Zoologisches Institut und Zoologisches Museum, Hamburg and Zoological Survey of India, Calcutta).

1972. *Drawida nepalensis*, Gates, *Trans. Am. phil. Soc.*, **62** : 256.

Diagnosis.—Length 78-130 mm ; diameter 4-5 mm. Segments 129-180. Clitellum IX/n-XIV/n. Setae lumbricin, present on clitellar segments, $AA = \text{or slightly} > < BC$, $DD ca. = \text{or slightly} > \frac{1}{2}C$. Nephropores at D, somewhat more dorsal in VIII or VII—VIII, lacking in X (and XII ?) of adults. Spermathecal pores one pair, transverse slits, just median to C, in 7/8. Male pores at or median to m BC, in 10/11 each usually on or near end of a protuberant ventrally directed porophore, apparently independent of both X and XI. Female pores paired, at 11/12. Genital markings, one small, circular translucent area on lateral or anterior face of each male porophore, a similar area in VII just anterior to each spermathecal pore.

Unpigmented. Gizzards 2-4, in XII-XX (XXIII ?) ; intestinal origin in XXVII (± 1). Connectives from extra-oesophageals on anterior face of 8/9. Nephridia of X lacking in adults. Sperm duct in a cluster of loops that may be larger than testis sac, passing into ental end of prostate directly. Prostates glandular ; prostatic capsule, 2-4 mm long, club-shaped. Spermathecae diverticulate ; diverticulum saccular, 3-5 mm long, in VII. Genital marking glands solid, spheroidal.

Distribution.—Andaman & Nicobar Islands : Mount Harriet (Michaelsen, 1909 ; Stephenson, 1925 ; Gates, 1933) ; Port Blair (Gates, 1962 a, Soota & Julka, 1970).

Range.—Mainland India, Pakistan, Bangla Desh, Burma, Indonesia.

Family OCNERODRILIDAE

KEY TO GENERA

1.	Extramural calciferous glands lacking.	...	Thatonia
	Extramural calciferous glands present.	...	2
2.	Calciferous glands unpaired and ventral.	...	Gordiodrilus
	Calciferous glands paired and lateral.	...	3
3.	Gizzard lacking.	...	Ocnerodrilus
	Gizzard present, in VII.	...	Eukerria

Genus **Eukerria** Michaelsen, 1935**Eukerria kukenthali** (Michaelsen)

1908. *Kerria kukenthali* Michaelsen, *Zool. Jb. (Supp.)*, **11** : 24. (Type loc.—St. Thomas Island, West Indies ; types in Museum für Naturkunde der Humboldt Universität, Berlin and Zoologisches Institut und Zoologisches Museum Universität Hamburg).

1970. *Eukerria peguana* Soota & Julka, *Proc. zool. Soc., Calcutta*, **23** : 204.

1970. *Eukerria kukenthali* Jamieson, *Bull. Br. Mus. nat. Hist. (Zool.)*, **20** : 144.

1972. *Eukerria kukenthali* Gates, *Trans. Am. phil. Soc.*, **62** : 269.

Diagnosis.—Length 20-70 mm ; diameter 0.75-1.0 mm. Segments 105-142. Prostomium prolobic. Dorsal pores lacking. Clitellum annular, XIII-XIX, XX. Setae lumbricin ; $AB=CD$, $AA=BC$, $DD=\frac{1}{2}C$. Spermathecal pores 2 pairs, at AB , in $7/8-8/9$. Prostatic pores 2 pairs, at AB , minute, on roofs of transversely slit-like parietal invaginations with transversely placed apertures, on protuberant anterior and posterior ends of paired, longitudinal, dumbbell-shaped porophores, in XVII and XIX ; a solid 'clear gland' with a short stalk protrusible from each prostatic pore invagination. Male pores one pair, minute, at equator of XVIII, slightly lateral to B . Female pores paired, on XIV. Genital marking, a transversely placed area of epidermal thickening in XXI, with a pair of minute pores, each pore just lateral to B .

Unpigmented. Septa all present from $4/5$. Gizzard in VII ; calciferous glands paired, in IX ; intestinal origin in XII. Last pair of hearts in XI. Testes proandric, free, in X ; seminal vesicles in IX, XI. Prostates tubular, long. Spermathecae adiverticulate ; duct about as long as ampulla, moniliform and bound to parietes. Genital marking glands tubular, stalked, prostate-like.

Distribution.—Andaman & Nicobar Islands : Maya Bundar, Port Blair, Car Nicobar (Soota & Julka, 1970).

Range.—Burma, Malay Peninsula, Indonesia, South America.

Genus *Gordiodrilus* Beddard, 1892*Gordiodrilus elegans* morph *paski* Stephenson

1928. *Gordiodrilus paski* Stephenson, *Ann. Mag. nat. Hist. (ser. 10)*, 1 : 1. (Type loc.—Kigoma Harbour, Lake Tanganyika ; types in Brit. Mus. (Nat. Hist.). London).
1963. *Gordiodrilus paski*, Jamieson, *Bull. Br. Mus. nat. Hist. Zool.*, 9 : 312.
1970. *Gordiodrilus paski*, Soota & Julka, *Proc. zool. Soc., Calcutta*, 23 : 205.
1972. *Gordiodrilus elegans* (?), Gates, *Trans. Am. phil. Soc.*, 62 : 271.

Diagnosis.—Length 35-47 mm ; diameter 1-1.5 mm. Segments (?). Prostomium epilobic. Clitellum annular, XIII-XIX, XX. Setae lumbricin ; $AB=CD$, $AA<BC$, $DD=\frac{1}{2}C$; a , b , of XVII and XVIII absent or some of them present. Spermathecal pores 2 pairs, in or near B , on 7/8, 8/9. Prostatic pores 2 pairs, on setal arcs of XVII and XVIII, in AB , at anterior and posterior ends of straight or slightly outwardly curved seminal grooves ; male pores one pair, apparently at 17/18 in seminal grooves. Male shield a squarish or dumbbell-shaped area. Female pores paired, just lateral to B , on XIV.

Unpigmented. Septa all present from 4/5. Gizzard absent ; intestinal origin in XII. Calciferous glands unpaired and ventral in IX. Last pair of hearts in XI. Testes holandric, probably contained in testis sacs, in X, XI ; seminal vesicles in XII, sometimes in XI also. Spermathecae adiverticulate ; duct slightly spindle-shaped, longer than ampulla, the walls of the swollen region possess 2-8 small chambers.

Distribution.—Andaman & Nicobar Islands : Maya Bundar (Soota & Julka, 1970).

Range.—Mainland India, Burma, South America, Africa.

Remarks.—Jamieson (1963) included *G. paski* alongwith another 15 species in the *elegans* group. Further, he considers possibly that *G. niloticus*, *G. bonacanus*, *G. travancorensis*, *G. worthingtoni*, *G. madagascariensis* and *G. paski* (including *G. unicus* and *G. peguanus*) as all synonyms of *G. dominicensis*. However, Gates (1962 b) lists *G. dominicensis*, *G. ditheca*, *G. zanzibaricus*, *G. travancorensis*, *G. habessinus*, *G. paski*, *G. unicus*, *G. wemanus*, *G. bonacanus* and *G. peguanus* as synonyms of *G. elegans*. The synonymy proposed by Gates is due to the frequent reduction of certain genital organs in parthenogenetic morphs of a Burmese species and the presumption that most of the other 'species' in the *elegans* group are also parthenogenetic morphs derived from a sexprostatic H morph.

Genus *Ocnerodrilus* Eisen, 1878*Ocnerodrilus occidentalis* Eisen

1878. *Ocnerodrilus occidentalis* Eisen, *Nova Acta R. Soc. Sci. upsaliensis* (ser. 3), **10** (4) : 10 (Type loc.—Fresno, California ; types in Brit. Mus. (Nat. Hist.), London).
1972. *Ocnerodrilus occidentalis*, Gates, *Trans. Am. phil. Soc.*; **62** : 273.
1973. *Ocnerodrilus occidentalis*, Gates, *Bull. Tall Timbers Res. Stn.*, no. 14 : 14.

Diagnosis.—Length 12-46 mm ; diameter 1-2 mm. Segments 70-84. Prostomium epilobic, tongue open. Dorsal pores absent. Clitellum annular, XIV—XIX, sometimes covering XIII and XX. Setae lumbricin ; $AA=BC$, $DD=\frac{1}{2}C$. Spermathecal pores absent. Male pores at centres of whitish, low, porophores ; each porophore lateral to *B*, in XVII, Female pores paired, on XIV, at or slightly lateral to *B*. Genital markings lacking.

Unpigmented. Septa all present from 4/5. Gizzard lacking ; calciferous glands paired, in IX ; intestinal origin in XII. Last pair of hearts in XI. Testes holandric, in X, XI ; seminal vesicles lacking. Prostates tubular, of variable length, either confined to XVII or passing back into region of XVIII—XXX.

Distribution.—Andaman & Nicobar Islands : Ross Island (Stephenson, 1916) : Car Nicobar, Maya Bundar, Port Blair (Soota & Julka, 1970).

Range.—Mainland India, Burma, Pakistan, Sri Lanka, Singapore, China, Japan, Philippines, some islands in Pacific Ocean, U. S. A., Mexico, St. Thomas, Europe, Africa, Cape Verde Islands, Great Comoro, Israel, Lebanon, Central Asia Basin (SSSR).

Genus *Thatonia* Gates, 1942*Thatonia gracilis* Gates

1942. *Thatonia gracilis* Gates, *Bull. Mus. comp. Zool. Harv.*, **89** : 101. (Type loc.—Thongwa, Burma ; typus amissus).
1972. *Thatonia gracilis*, Gates, *Trans. Am. phil. Soc.*, **62** : 266.

Diagnosis.—Length 63-87 mm ; diameter 1 mm. Segments (?). Prostomium epilobic. Dorsal pores absent. Clitellum saddle-shaped, XIII—XXII, XXIII. Setae lumbricin ; $AB=CD$, $AA>BC$, $DD ca.=\frac{1}{2}C$; setae *a*, *b* of II—XV or XVI enlarged. Spermathecal pores 2 pairs, at *B*, in 7/8, 8/9. Prostatic pores 2 pairs, on setal arcs of XVII and XIX, at anterior and posterior ends of seminal grooves ; male pores one pair, in XVIII, a little in front of setae *a* ; seminal grooves H-shaped. Female pores paired, at *B*, on XIV. Genital markings lacking.

Unpigmented. Septa all present from 4/5. Gizzard in VII ; calciferous glands lacking ; intestinal origin in XII. Last pair of hearts in XI. Testes holandric, free, in X, XI ; seminal vesicles in XI, XII. Prostates tubular. Spermathecae adiverticulate ; ampulla tubular, coiled ; duct short.

Distribution.—Andaman & Nicobar Islands : Port Blair (Soota & Julka, 1970).

Range.—Mainland India, Burma.

Family OCTOCHAETIDAE

KEY TO GENERA

- | | |
|---|--------------------|
| 1. Gizzard single ; discrete calciferous glands absent. ... | Ramiella |
| Gizzard doubled ; one pair of trilobed discrete calciferous glands present, in XV-XVII. ... | Dichogaster |

Genus **Dichogaster** Beddard, 1888

KEY TO SPECIES OF DICHOGASTER

- | | |
|--|-----------------------|
| 1. Female pore single, at mid-ventral. ... | D. bolau |
| Female pores paired ; ... | D. modiglianii |

Dichogaster bolau (Michaelsen)

1891. *Benhamia bolavi* Michaelsen, *Jb. hamb. wiss. Anst.*, 8 (2) : 9. (Type loc.—Bergedorf, Hamburg ; types in Zoologisches Institut und Zoologisches Museum Universität, Hamburg).

1972. *Dichogaster bolau*, Gates, *Trans. Am. phil. Soc.*, 62 : 279.

Diagnosis.—Length 20-40 mm ; diameter 1-3 mm. Segments 70-98. Prostomium epilobic, tongue narrowing posteriorly ; intersegmental furrow 1/2 often lacking or indistinct. First dorsal pore in 5/6 or 6/7. Clitellum annular, XIV-XVIII, sometimes extending to XIII, XIX, XX, XXI. Setae lumbricin, present on clitellar segments, $AA=BC$, $DD>\frac{1}{2}C$. Spermathecal pores 2 pairs, at A, in 7/8, 8/9. Prostatic pores 2 pairs, at A, on XVII and XIX, at anterior and posterior ends of seminal grooves ; male pores one pair, in seminal grooves, on XVIII. Female pore single, mid-ventral, on XIV.

Unpigmented (?). Septa all present from 7/8. Gizzards in VI and VII ; one pair of trilobed calciferous glands in XV-XVII ; intestinal origin in XIX. Last pair of hearts in XII. Testes holandric, contained in testis sacs (?), in X, XI ; seminal vesicles in XI, XII. Prostates tubular,

confined to XVII and XIX ; ducts straight. Spermathecae unidiverticulate ; duct barrel-shaped, as long as ampulla ; diverticulum digitiform, arises from ental end of duct. Penial setae 0.27-0.4 mm long, 3.5-7.5 μ thick at midshaft ; tip hooked or widened and then scalpel—, spatula—, oar—, spoon-shaped ; ornamentation of several triangular teeth.

Distribution.—Andaman & Nicobar Islands : Car Nicobar (Soota & Julka, 1970).

Range.—Indian subcontinent, Malay Peninsula, Indonesia, Philippines, some islands in Pacific Ocean, Australia, Hawaii, U. S. A., Mexico, South America, West Indies, Africa, Madagascar and adjacent islands.

***Dichogaster modiglianii* (Rosa)**

1896. *Benhamia modiglianii* Rosa, *Ann. Mus. Sto. Nat. Genova*, **36** : 510. (Type loc.—Padang, Sumatra ; types in Museo Civico di Storia Naturale, Genova).

1972. *Dichogaster modiglianii*, Gates, *Trans. Am. phil. Soc.*, **62** : 280.

Diagnosis.—Length 22-60 mm ; diameter 1-2 mm. Segments 76-120. Prostomium epilobic, tongue narrowed posteriorly and reaching 1/2. First dorsal pore in 4/5 or 5/6. Clitellum annular, XIII-XX. Setae lumbricin, present on clitellar segments, $AA=BC$, $DD>\frac{1}{2}C$. Spermathecal pores 2 pairs, in 7/8, 8/9, at or close to *A*. Prostatic pores 2 pairs, at anterior and posterior ends of seminal grooves, at *A*, on XVII and XIX ; male pores one pair, in seminal grooves, on XVIII. Female pores paired, on XIV, just median or posteromedian to *A* setae.

Unpigmented (?). Septa 7/8 as well as 5/6 and 6/7 lacking (?). Gizzards in VII, VIII (?) ; calciferous glands one pair, trilobed, in XV-XVII ; intestinal origin in XIX. Last pair of hearts in XII. Testes holandric, contained in unpaired testis sacs, in X, XI ; seminal vesicles lacking or vestigial in XII. Prostates tubular, confined to XVII and XIX ; ducts straight. Spermathecae unidiverticulate ; duct bulbous and longer than ampulla ; diverticulum stalked with a small spheroidal to ellipsoidal seminal chamber, arises from middle region of duct ; Penial setae 0.31-0.42 mm long, 5-9 μ thick entally, straight or slightly bowed ; tip slightly thickened or recurved ; ornamentation of scale-like markings.

Distribution.—Andaman & Nicobar Islands : Port Blair, Haddo, Pahargaon (Gates, 1958).

Range.—Mainland India, Burma, Pakistan, Malay Peninsula, Indonesia, Philippines, some of the islands in Pacific Ocean, South America,

Genus *Ramiella* Stephenson, 1921*Ramiella bishambari* (Stephenson)

1914. *Octochaetus bishambari* Stephenson, *Rec. Indian Mus.*, 10 : 347. (Type loc.—Saharanpur ; types in Brit. Mus. (Nat. Hist.), London).

1972. *Ramiella bishambari*, Gates, *Trans. Am. phil. Soc.*, 62 : 312.

Diagnosis.—Length 20-35 mm ; diameter 1-1.2 mm. Segments 82-87. Prostomium epilobic, tongue open. First dorsal pore in region of 6/7-10/11. Clitellum annular, XIII-XVII. Setae lumbricin, present on clitellar segments, $AB=CD$, $AA=BC$. Spermathecal pores 2 pairs, at *B*, just behind intersegmental furrows 7/8, 8/9. Prostatic pores 2 pairs, in *AB*, at anterior and posterior ends of seminal grooves, on XVII and XIX ; male pores one pair, in seminal grooves, on XVIII. Female pores paired ; anteromedian to *A*, on XIV. Genital markings small, circular to shortly elliptical, paired, in or near *AB*, presetal on VII, VIII, IX, XVII and XX, postsetal on VII, VIII, X, XI ; unpaired and median, postsetal in XIX or at 19/20.

Unpigmented. Septa all present from 4/5. Gizzard in VI ; intestinal origin in XIV. Nephridia in postclitellate segments arranged in 2 or 3 longitudinal ranks on each side. Last pair of hearts in XII. Testes holandric, free, in X, XI ; seminal vesicles in (XI), XII. Prostates tubular ; ducts S-shaped. Penial setae ribbon-like, rolled so as to appear solid, 0.50-0.95 mm long ; 0.020-0.036 mm thick, tip narrowed and hooked ; ornamentation of 7-15 transverse rows of triangular teeth. Spermathecae diverticulate ; duct slender, longer than ampulla ; diverticulum single, spheroidal to ellipsoidal, sessile, arises from ental end of duct. Genital marking glands (?).

Distribution.—Andaman & Nicobar Islands : Aberdeen, Port Blair (Gates, 1958).

Range.—Mainland India, Burma, Indonesia, Philippines.

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SUMMARY

This paper presents a comprehensive account of twenty seven earthworm species so far reported from the Andaman and Nicobar

Islands. For each of these is presented a synonymy, diagnosis, distribution in Andaman and Nicobar Islands and range of distribution in the world. Of the 27 species, 20 are exotic and probably have been transported to these islands by man alongwith the soil around the roots of plants. The zoogeographical relations of the earthworm fauna of these islands have also been discussed.

REFERENCES

- GATES, G. E. 1932. The earthworms of Burma. III. *Rec. Indian Mus.*, **34** : 357-549.
- GATES, G. E. 1933. The earthworms of Burma. IV. *Rec. Indian Mus.*, **35** : 413-606.
- GATES, G. E. 1936. The earthworms of Burma. V. *Rec. Indian Mus.*, **38** : 377-468.
- GATES, G. E. 1954. The earthworms of Burma. VI. *Rec. Indian Mus.*, **52** : 55-93.
- GATES, G. E. 1958. On Burmese earthworms of the megascolecid subfamily Octochaetinae. *Ann. Mag. nat. Hist. (ser. 13)*, **1** : 609-624.
- GATES, G. E. 1959. On a taxonomic puzzle and the classification of the earthworms. *Bull. Mus. comp. Zool. Harv.*, **121** : 229-261.
- GATES, G. E. 1960. On Burmese earthworms of the family Megascolicidae. *Bull. Mus. comp. Zool. Harv.*, **123** : 203-282.
- GATES, G. E. 1962a. On some Burmese earthworms of the moniligastrid genus *Drawida*. *Bull. Mus. comp. Zool. Harv.*, **127** : 297-373.
- GATES, G. E. 1962b. Contributions to revision of the earthworm family Ocnerodrilidae. IV. On a species of the African genus *Gordiodrilus*. *Revue Zool. Bot. afr.*, **66** : 344-352.
- GATES, G. E. 1972. Burmese earthworms, an introduction to the systematics of megadrile oligochaetes with special reference to south-east Asia. *Trans. Am. phil. Soc.*, **62** (7) : 1-326.
- GATES, G. E. 1976. More on oligochaete distribution in North America. *Megadrilogica*, **2** (11) : 1-6.
- JAMIESON, B. G. M. 1963. A revision of the genus *Gordiodrilus* (Oligochaeta, Megascolicidae). *Bull. Br. Mus. nat. Hist. (Zool.)*, **9** : 297-323.

- JULKA, J. M. AND HALDER, K. R. 1975. Record of *Pheretima malaca* Gates (Oligochaeta-Megascolecidae) from Andaman Islands. *Newsl. zool. Surv. India*, **1** (4) : 65-66.
- LJUNGSTRÖM, P. O. 1970. Introduction to the study of earthworm taxonomy. *Pedobiologia*, **10** : 265-285.
- MICHAELSEN, W. 1907. Neue Oligochäten von Vorder-Indien, Ceylon, Birma und den Andaman-Inseln. *Jb. hamb. wiss. Anst.*, **24** : 143-188.
- MICHAELSEN, W. 1909. The Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. *Mem. Indian Mus.*, **1** : 103-253.
- REYNOLDS, J. W. 1977. The earthworms (Lumbricidae and Sparganophilidae) of Ontario. *Life Sci. Misc. Pub., R. Ont. Mus.*, 1-141.
- ROSA, D. 1891. Die exotischen Terricolen des k. k. naturhistorischen Hofmuseums. *Annln naturh. Mus. Wien*, **6** : 379-406.
- SIMS, R. W. AND EASTON, E. G. 1972. A numerical revision of the earthworm genus *Pheretima* auct. (Megascolecidae : Oligochaeta) with the recognition of new genera and appendix on the earthworms collected by the Royal Society North Borneo Expedition. *Biol. J. Linn. Soc.*, **4** (3) : 169-268.
- SOOTA, T. D. AND JULKA, J. M. 1970. Notes on earthworms of the Andaman and Nicobar Islands, India. *Proc. zool. Soc., Calcutta*, **23** : 201-206.
- STEPHENSON, J. 1916. On a collection of Oligochaeta belonging to the Indian Museum. *Rec. Indian Mus.*, **12** : 294-354.
- STEPHENSON, J. 1925. On some Oligochaeta mainly from Assam, South India and the Andaman Islands. *Rec. Indian Mus.*, **27** : 43-73.

ON THE VALIDITY OF THE SPECIES OF THE GENUS
PALLISENTIS VAN CLEAVE, 1928 (ACANTHOCEP-
HALA : PALLISENTIDAE) FROM THE INDIAN
SUBCONTINENT

By

T. D. SOOTA AND S. B. BHATTACHARYA

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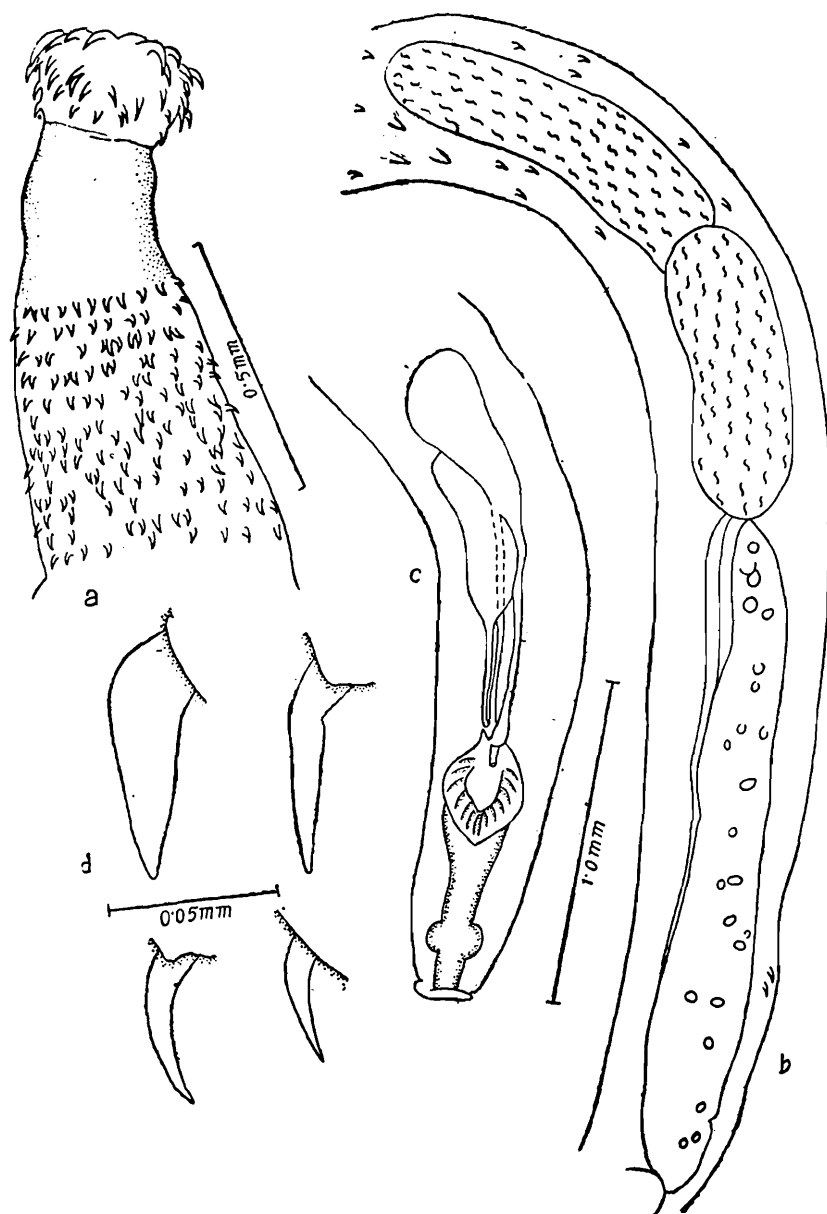
(With 3 Text-figures)

Van Cleave (1928) created the genus *Pallisentis* with *P. umbellatus* as its type species and also transferred *Echinorhynchus gaboes* McCallum, 1918, under the aforesaid genus. Thapar (1930) described *Farzandia* as a new genus with *F. ophiocephali* as its type species and shortly afterwards Bhalerao (1931) added another species, viz. *F. nagpurensis* from the same host. Baylis (1933), however, regarding *Farzandia* a direct synonym of the genus *Pallisentis*, assigned the two above mentioned species to it. Subsequently the following eight more species were added to the genus *Pallisentis*, viz. *P. nandai* Sarkar, 1953, *P. colisai* Sarkar, 1954, *P. allahabadii* Agarwal, 1958, *P. basiri* Farooqi, 1958, *P. buckleyi* Tadros, 1966, *P. guntei* Sahay, Nath & Sinha, 1967, *P. pandei* Rai, 1971 and *P. magnum* Saeed & Bilqees, 1971, mostly from ophiocephalid hosts. In the meanwhile Golvan (1959), on the basis of number of proboscis hooks in each circle, sub-divided the genus *Pallisentis* into three sub-genera, viz. *Pallisentis* (the nominal s. g.), *Neosentis* and *Farzandia*, but Tadros (1966) found this subdivision unsatisfactory as some of the species could not be properly accommodated. A careful study of the present material which comprises collection from various hosts from different parts of the country lead us to conclude that the number of proboscis hooks, size of proboscis, number of both collar and body spines, and shape and size of testes etc. are variable characters and much reliance cannot be placed on the same. Also, we have found that all the members of the genus from the above region comprise only two species, viz. *P. ophiocephali* (Thapar, 1930) and *P. colisai* Sarkar, 1954, differentiated from each other mainly by the shape of proboscis hooks. Further, in all the species of the genus the males lack the Saefftigen's pouch. It may also be noted that the present forms show much proximity to the rather inadequately described species, *P. gaboes* (McCallum, 1918) where the shape of the hooks, however, is not recorded. As such nothing definite can be said regarding their relationship for the present.

Pallisentis ophiocephali (Thapar, 1930) Baylis, 1933

(Text-fig. 1, a-d)

1930. *Farzandia ophiocephali* Thapar, *Ann. Mag. nat. Hist.*, (10) 6 : 77.
 1931. *Farzandia nagpurensis* Bhalerao, *Ann. Mag. nat. Hist.*, (10), 7 : 569.
 1933. *Pallisentis nagpurensis* Baylis, *Ann. Mag. nat. Hist.*, (10), 12 : 444.
 1935. *Pallisentis nagpurensis* : Datta and Poddar, *Rec. Indian Mus.*, 37 : 234.
 1936. *Pallisentis nagpurensis* : Subrahmanian, *Rec. Indian Mus.*, 38 : 331.

Text-fig. 1. *Pallisentis ophiocephali* (Thapar, 1930) Baylis, 1933

a. male anterior end ; b. male middle portion showing testes and cement gland ; c. male posterior end showing seminal vesicle and cement reservoir ; d. proboscis hooks (enlarged).

1937. *Pallisentis nagpurensis* : Subrahmanian, *Zool. Anz.*, 119 (3/4) : 111.
 1953. *Pallisentis nandai* Sarkar, *Proc. zool. Soc. Beng.* 6 (2) : 139.
 1958. *Pallisentis allahabadii* Agarwal, *Curr. Sci.*, 27 : 107.
 1963. *Pallisentis nagpurensis* : Fernando and Furtado, *Z. Parasitenk.*, 23 : 151.
 1968. *Pallisentis ophiocephali* : Gupta and Lata, *Res. Bull. Panjab Univ. Sci. (N. S.)*, 18 : 340.

1971. *Pallisentis magnum* Saeed and Bilqees, *Pakist. J. Zool.*, **3** (2) : 221.
 1972. *Pallisentis ophioccephali*. Saeed and Bilqees, *Agric. Res. Council Govt. Pakistan* : 82.
 1973. *Pallisentis nagpurensis* : George and Nadakal, *Hydrobiologia*, **42** (1) : 31.
 1973. *Pallisentis nandai* : Bashirullah, *Bangladesh J. Zool.*, **1** (1) : 79.
 1973. *Pallisentis nagpurensis* : Bashirullah, *Bangladesh J. Zool.*, **1** (1) : 74, 79.
 1976. *Pallisentis ophioccephali* : Bilqees, *Proc. Pakistan Acad. Sci.*, **13** (2) : 110.
 1976. *Pallisentis magnum* : Bilqees, *Proc. Pakistan Acad. Sci.*, **13** (2) : 110.
 1979. *Pallisentis nagpurensis* : Jain and Gupta, *Helminthologia*, **16** (3) : 173.
 1979. *Pallisentis allahabadi* : Jain and Gupta, *Helminthologia*, **16** (3) : 174.

Material : 1 ♂ ; Z. S. I. Reg. No. WN 420/1 ; host—*Nandus nandus* ; location—intestine ; locality—Diamond harbour (W. B.) ; collector—M. Hafeezullah, 13. ii. 1977. 1 ♂ ; Z. S. I. Reg. No. WN 421/1 ; host—*Channa* sp. ; location—intestine ; locality—Kidderpore fish market (Calcutta) ; collector—M. Hafeezullah, 2. iii. 1979. 1 ♂ ; Z. S. I. Reg. No. WN 422/1 ; host—*Channa punctatus* ; location—intestine ; locality—Siliguri (W. B.) ; collector—T. D. Soota, 13. vi. 1975. 1 ♂ and 1 ♀ ; Z. S. I. Reg. No. WN 423/1 ; host—*Channa punctatus* ; location—intestine ; locality—Siliguri (W. B.) ; collector—T. D. Soota, 14. vii. 1974. 2 ♂ ♂ & 4 ♀ ♀ ; Z. S. I. Reg. No. WN 424/1 ; host—*Channa* sp. ; location—intestine ; locality—Kurseong (W. B.) ; collector—T. D. Soota, 10. v. 1975. 4 ♂ ♂ & 3 ♀ ♀ ; Z. S. I. Reg. No. WN 425/1 ; host—*Channa* sp. ; location—intestine ; locality—Kurseong (W. B.) ; collector—T. D. Soota, 10. v. 1975. 1 ♀ ; Z. S. I. Reg. No. WN 426/1 ; host—*Channa* sp. ; location—intestine ; locality—Darjeeling (W. B.) ; collector—T. D. Soota, 22. v. 1975. 2 ♂ ♂ ; Z. S. I. Reg. No. WN 427/1 ; host—*Channa* sp. ; location—intestine ; locality—Bishnupur (W. B.) ; collector & date of collection—? 1 ♂ ; Z. S. I. Reg. No. WN 428/1 ; host—*Glossogobius giuris* ; location—intestine ; locality—Karaikal (Pondicherry) ; collector—M. Hafeezullah, 25. xi. 1975. 3 ♂ ♂ & 1 ♀ ; Z. S. I. Reg. No. WN 429/1 ; host—*Channa punctatus* ; location—intestine ; locality—Karaikal (Pondicherry) ; collector—M. Hafeezullah, 25. xi. 1975. 1 ♀ ; Z. S. I. Reg. No. WN 430/1 ; host—*Channa punctatus* ; location—intestine ; locality—Konarak (Orissa) ; collector—M. Hafeezullah, 13. xii. 1973. 1 ♀ ; Z. S. I. Reg. No. WN 431/1 ; host—*Channa gachua* ; location—intestine ; locality—Chandbeli (Orissa) ; collector—M. Hafeezullah, 22. xii. 1974. 2 ♂ ♂ ; Z. S. I. Reg. No. WN 432/1 ; host—*Channa* sp. ; location—intestine ; locality—Cochin (Kerala) ; collector—T. D. Soota ; 21. i. 1976. 3 ♀ ♀ ; Z. S. I. Reg. No. WN 433/1 ; host—*Channa* sp. ; location—intestine ; locality—Cochin (Kerala) ; collector—T. D. Soota ; 21. i. 1976.

Description : Males. All measurements are in mm unless otherwise mentioned. Body $5.06-11.88 \times 0.44-0.55$; proboscis $0.176-0.22 \times 0.22-0.25$; neck $0.22-0.33 \times 0.22-0.24$; proboscis hooks in 4 circles of

8 or 10 each ; hooks in 1st circle 0.068-0.085, in 2nd 0.068-0.0735, in 3rd 0.051-0.06, and in 4th 0.0255-0.0425 long ; proboscis sheath $0.55-0.8 \times 0.198-0.275$; collar spines in 13-15 rows with 14-24 in each ; trunk spines in 25-35 rows with 10-20 in each ; testis, anterior 0.335-1.1 and posterior 0.33-1.04 long ; cement gland $0.55-2.09 \times 0.05-0.242$ and with 12-30 nuclei ; cement reservoir $0.253-0.66 \times 0.132-0.33$; seminal vesicle $0.275-0.55 \times 0.055-0.198$.

Female : Body $8.03-24.86 \times 0.475-0.715$; proboscis $0.22-0.275 \times 0.22-0.3$; neck $0.165-0.33 \times 0.22-0.27$; proboscis hooks as in male ; proboscis sheath $0.77-0.88 \times 0.165-0.22$; lemnisci 1.04-2.36 and 0.99-2.42 long ; trunk spines in 30-72 rows with 10-24 in each ; eggs $0.051-0.085 \times 0.034-0.042$.

Host : *Nandus nandus*, *Channa gachua*, *C. punctatus*, *C. sp.*, and *Glossogobius giuris*

Location : Intestine

Locality : West Bengal, Orissa, Pondicherry, and Kerala

Remarks : This species was originally described by Thapar (1930) as *Farzandia ophiocephali* from *Channa marulius*, but later transferred by Baylis (1933) under the genus *Pallisentis*. Four out of the ten species described from the Indian subcontinent, viz. *P. allahabadii* Agrawal, 1958, *P. nagpurensis* Bhalerao, 1931, *P. nandai* Sarkar, 1954, and *P. magnum* Saeed and Bilquees, 1971, share the following characters with this valid species :

1. Shape of the proboscis.
2. Number and arrangement of proboscis hooks (4 circles of 8 or 10 each).
3. Gradual reduction in the size of the hooks in each circle (H_1 0.068-0.085 ; H_2 0.068-0.073 ; H_3 0.051-0.059 ; and H_4 0.025-0.042).
4. Stronger and stouter hooks of first circle in comparison to others (*vide* figure and type specimens *Farzandia ophiocephali* and *P. nandai* in National Collection, Z.S.I. No. W 6432-5/1 & W 3797/1).

Regarding other characters shown as differentiating the above five species from one another, examination of a number of specimens from different parts of the country indicate that these are variable. Hence, the above four species are conspecific with *P. ophiocephali* though *P. allahabadi* has been upheld by Jain and Gupta (1979). New host and locality records are also included as well as certain interesting

TABLE 1 : (All measurements are in millimeters).

	<i>P. ophiocephalis</i> [*] Host : <i>Channa merulius</i> Loc. India	<i>P. naggurensis</i> Host : <i>Channa striatus</i> Loc. Nagpur (Maharashtra) Calcutta, Uttarbhag (W. B.), Rangoon (Burma)	<i>P. nandai</i> [*] Host : <i>Nandus nandus</i> Loc. Calcutta (W. B.)	<i>P. allahabadi</i> Host : <i>Channa punctatus</i> Loc. Allahabad (U.P.)	<i>P. magnum</i> Host : <i>Wallago attu</i> Loc. Kalri Lake, Sind (Pakistan)	<i>Present specimens</i> Host : <i>Nandus nandus</i> , <i>Channa</i> sp. <i>Channa</i> <i>punctatus</i> C. <i>gachua</i> , and <i>Glossogobius giuris</i> Loc. Diamond Harbour, Calcutta, Siliguri, Kurseong, Darjeeling, Vishnupur (W. B.), Karaikal (Pondicherry), Cochin, Konark and Chandbeli (Orissa)
Size of body	♂ 5.99 × 0.34 ♀ 14.3 × 0.495	2.4-14 × 0.45 2.4-19.0 × 0.56-0.9	5.6-9 × 0.37-0.63 6.3-10.4 × 0.35-0.56	2.85-5.7 × 0.285-0.323 5.79-16.34 × 0.42-0.95	6.40-19.00 × 0.36-0.70 6.40-40.00 × 0.36-1.10	5.06-11.88 × 0.44-0.53 8.03-24.86 × 0.49-0.715
Size of proboscis	♂ 0.14 × 0.22 ♀ 0.175 × 0.242	0.2 × 0.23	0.17-0.48 × 0.19- 0.32	0.1-0.288 × 0.1-0.342	0.28-0.32 × 0.16-0.20	0.176-0.22 × 0.22-0.25 0.22-0.275 × 0.22-0.3
Neck	♂ 0.198 × 0.22 ♀ 0.308 × 0.22	—	0.98 × 0.165	—	—	0.22-0.33 × 0.22-0.24 0.165-0.33 × 0.22-0.27
No. of proboscis, hooks.	4 × 8 or 10	4 × 8 or 10	4 × 8 or 10	4 × 8-10	28-30	4 × 8 or 10
Length of proboscis hooks.	H ₁ 0.076-0.085 H ₂ 0.068-0.076 H ₃ 0.051 H ₄ 0.034-0.0425	0.076-0.083 0.068-0.07 0.047-0.059 0.03-0.034	0.093 0.08 0.06 0.033	each hook measuring 0.02-0.1 in length	0.028 × 0.054 1.20	0.068-0.085 0.068-0.073 0.051-0.059 0.0255-0.0425
Proboscis sheath	♂ 0.66 × 0.22 ♀ 0.935 × 0.22	0.47-0.88 × 0.28	0.46-0.84 × 0.12- 0.25	0.437-1.6 × 0.095-0.48	1.20	0.55-0.80 × 0.198-0.275 0.77-0.88 × 0.165-0.22
Lemnisci	(1) 1.925 (2) 2.20	2.43 × 0.09	(1) 1.1-1.9 × 0.04 (2) 0.72-1.3 × 0.04	(1) 0.57-2.75 × 0.028-0.18 (2) 0.418-1.805 × 0.028-0.064		(1) 1.04-2.36 (2) 0.99-2.42
No. of collar spines	♂ 11-13 × 14-16 ♀ 13-14 × 14-16	12-14 × 20-24	13-16 × 18-20	15-18 × 8-12 15-18 × 20-25	16 × 10	13-15 × 14-24
No. of trunk spines	♂ 28-34 ♀ 60-65	30-63 × 8-14	28-55 × 16-20	21-25 × 1-12 32-36 × 1-18	in anterior third	25-35 × 10-20 30-72 × 10.24
Testis	(1) 0.605-0.66 (2) 0.352-0.66	0.64-1.82 × 0.16-0.37 0.49-1.28 × 0.17-0.36	0.605 × 0.165 0.55 × 0.16	0.247-0.475 × 0.114- 0.128 0.342-0.437 × 0.128- 0.133	0.40-0.80 × 0.10-0.14	0.385-1.1 0.33-1.04
Cement gland	0.99-1.32 × 0.132	1.15-2.65 × 0.20	0.77-1.4 × 0.14- 0.22	0.323-0.57 × 0.08- 0.171	0.40-1.20 × 0.12-0.14	0.55-2.09 × 0.05-0.242
No. of nuclei in cement gland	14-16 or more	15-30	23-25	8-16	—	12-30
Cement reservoir	0.44-0.495	—	0.29-0.48 × 0.12- 0.21	0.228-0.456 × 0.064- 0.18 with two ducts	0.40-0.80 × 0.16-0.21	0.253-0.66 × 0.132-0.33
Seminal vesicle	0.44 × 0.143	0.85 × 0.18	0.24-0.89 × 0.13- 0.9	0.34-0.9 × 0.08-0.133	0.60-0.14 × 0.11-0.12	0.275-0.55 × 0.055-0.198
Egg	0.068 × 0.025	0.09-0.214 × 0.04- 0.115	—	0.02-0.072 × 0.012- 0.028	0.018-0.042 × 0.021- 0.025	0.051-0.085 × 0.034-0.042

* Fresh measurements of material in the National collection of Z. S. I. No. W 6432-5/1 & W 3797/1.

variations. Table 1 furnishes details of the measurements, etc. of the five concerned species alongwith the present specimens.

***Pallisentis colisai* Sarkar, 1954**

(Text-fig. 2, a-e ; & Text-fig. 3 a-c)

1954. *Pallisentis colisai* Sarkar *Rec. Indian Mus.*, **52** : 349.
 1958. *Pallisentis basiri* Farooqi, *Z. f. Parasitenkunde*, **18** : 457.
 1966. *Pallisentis buckleyi* Tadros, *J. Helminth.*, **4** (1/2) : 155.
 1967. *Pallisentis pandei* Rai, *Indian J. Helminth.*, **19** (1) : 39.
 1967. *Pallisentis guntei* Sahay, Nath and Sinha, *Zool. Anz.*, **178** (5/6) : 348.
 1971. *Pallisentis pandei* : Rai, *Agra Univ. J. Res.*, **20** (1) : 127.

Material : 1 ♀ (juv.) ; Z. S. I. Reg. No. WN 434/1 ; host-Eel ; location—intestine ; locality—Rajgir (Bihar) ; collector—T. D. Soota, 6. ix. 1973. 2 ♂♂ & 1 ♀ ; Z. S. I. Reg. No. WN 435/1 ; host—*Channa* sp. ; 3 ♀♀ ; Z. S. I. Reg. No. WN 436/1 ; host—*Channa* sp. ; 2 ♀♀ ; Z. S. I. Reg. No. WN 437/1 ; host—*Channa* sp. 1 ♀ ; Z. S. I. Reg. No. WN 438/1 ; host—*Channa* sp. ; location, locality, collector & date of collection—same as above. 2 ♀♀ ; Z. S. I. Reg. No. WN 439/1 ; host—*Channa* sp. ; location—intestine ; locality—Patna ; collector—T. D. Soota ; 19. ix. 1973. 1 ♂ ; Z. S. I. Reg. No. WN 440/1 ; host—*Channa punctatus* ; location—intestine ; locality—Ankhola (W. B.) ; collector—I. B. Datta, 7. xi. 1974.

Description : *Males*.—Body $3.24-4.18 \times 0.27-0.28$; proboscis 0.13×0.14 ; neck $0.22 \times 0.11-0.13$; proboscis hooks in 4 circles of 8 or 10 each ; hooks in 1st circle 0.076, in 2nd 0.068-0.07, in 3rd 0.03-0.034, and in 4th 0.025 long ; proboscis sheath 0.495×0.132 ; lemnisci 1.738×0.044 ; collar spines in 15-17 rows with 12-14 in each ; trunk spines in 15-17 rows with 14-15 in each ; testis, anterior 0.495×0.132 , and posterior 0.405×0.132 ; cement gland 0.22-0.605 and with 12 nuclei ; cement reservoir 0.33×0.165 ; seminal vesicle 0.374×0.066 .

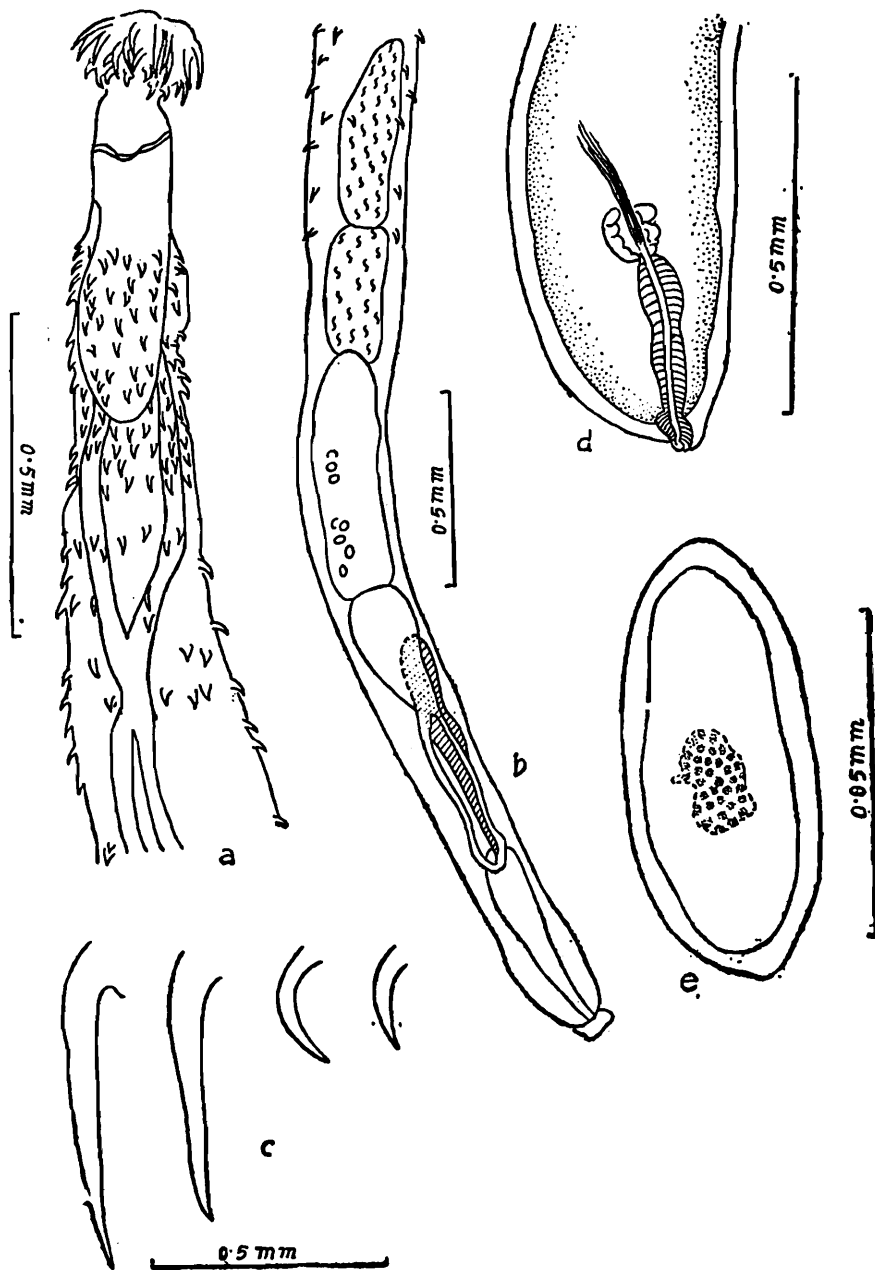
Females : Body 2.86 (in juv.) $9.35 \times 0.605-0.715$; proboscis 0.13-0.16 $\times 0.176-0.22$; neck $0.38-0.44 \times 0.22-0.24$; proboscis hooks in 4 circles of 8 or 10 each ; hooks in 1st circle 0.093-0.102, in 2nd 0.076-0.093, in 3rd 0.034-0.037, and in 4th 0.025-0.03 long ; proboscis sheath $0.495-0.77 \times 0.132-0.22$; lemnisci 1.98×0.055 ; collar spines 15-17 $\times 12-16$; trunk spines 33-35 rows with 15-18 in each ; eggs $0.051-0.068 \times 0.025-0.03$.

Host : Eel, *Channa punctatus*, and *C. sp.*

Location : Intestine

Locality : West Bengal, and Bihar

Remarks : Sarkar (1954) described the new species *P. colisai* from *Colisa fasciatus*. Four of the remaining five species from the Indian subcontinent under the genus *Pallisentis*, viz. *P. basiri* Farooqi, 1958,



Text-fig. 2. *Pallisentis colisai* Sarkar, 1954

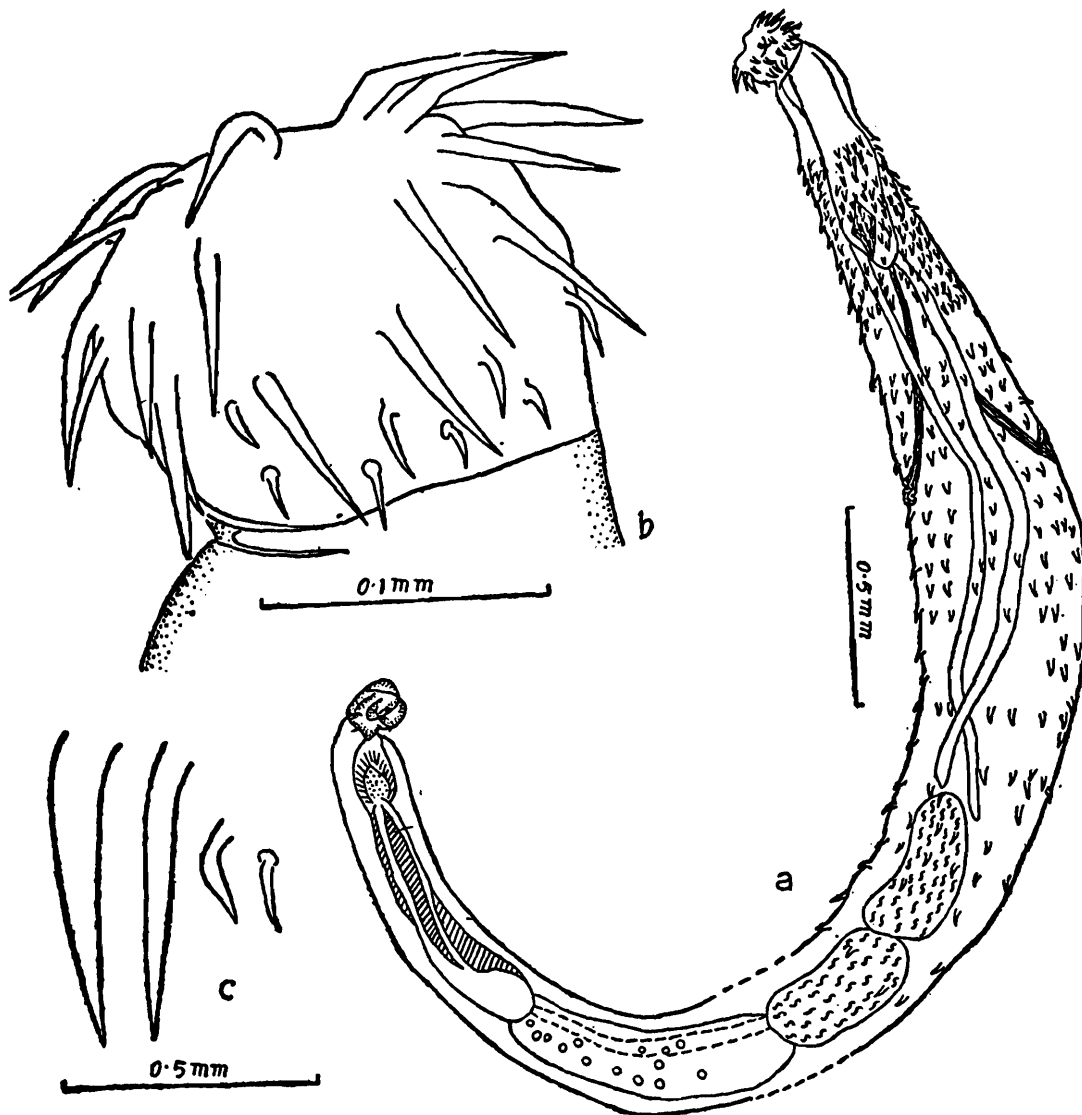
a. male anterior end ; b. male showing genitalia ; c. proboscis hooks (enlarged) ; d. female posterior end ; e. egg.

P. pandei Rai, 1971, *P. guntei* Sahay, Nath & Sinha, 1967, and *P. buckleyi* Tadros, 1966 [which last synonymised with *P. allahabadii* by Jain and Gupta (*op. cit.*)] share the following characters with this valid species.

1. Number and arrangement of proboscis hooks (4 circles of 8 or 10 each).
2. Much longer hooks in first two circles ; difference in hooks size between 1st and 2nd circle almost same as that in same between 3rd and 4th.

3. Cement gland small, with smaller number of nuclei ranging from 8-12.

As regards Saeftigen's pouch, Farooqi (1958) first reported its presence in the genus *Pallisentis* ; Fernando and Furtado (1963) reported it for the first time in *P. nagpurensis* alongwith the seminal vesicle but



Text-fig. 3. *Pallisentis colisai* Sarkar, 1954
(redrawn from male type)

a. entire male ; b. proboscis ; c. proboscis hooks (enlarged).

did not give its measurements ; Tadros (1966) too reported the Saeftigen's pouch in other specimens and also mistook cement duct for sperm duct in *P. basiri* ; and Jain and Gupta (1979) also reported it with definite emphasis in *P. allahabadii* in which not reported earlier. From these circumstances, therefore, the present authors cannot help concluding that no Saeftigen's pouch is present in the members of the genus *Pallisentis* so far described from the Indian subcontinent and the structure described is nothing but seminal vesicle.

Though Rai (1967), in his species, *P. pandei* recorded the presence of Saeftigen's pouch, seminal vesicle, and cement reservoir, he only included measurements of the first two structures. Jain and Gupta (*op. cit.*) too reported simultaneous presence of these three structures in a single specimen, but omitted to show Saeftigen's pouch in their figure stating that the figure was based on whole mounts where such structure could not be clearly discerned, though present. However, they gave its measurements as $0.309-0.456 \times 0.049-0.065$. Further, Rai (*op. cit.*) is also reported to have observed eggs with filaments. But, their above observations need confirmation. However, on the basis of shape and size of proboscis hooks as well as of the cement gland and the number of its nuclei, as given by Rai (*op. cit.*), the present authors are of the opinion that his species is conspecific with *P. colisai* Sarkar, 1954.

Sahay *et al.*, (1967) while inadequately describing the species *P. guntei* from *Lepidocephalichthys guntea* reported the joining of prostatic ducts with the bursa, but making no note of cement reservoir from which arise the ducts mentioned by them. They further reported a bilobed cement gland without cement reservoir and with obscure number of nuclei. From these circumstances it is obvious that the authors were not able to observe cement reservoir due to the specimens being juvenile. On the basis of the shape of male genitalia as well as of the pattern of proboscis hooks, in the opinion of the present authors *P. guntei* is also conspecific with *P. colisai*. The range in measurements of present material (Table 2) almost covers those of the above 4 species.

The differentiating characters between the two valid species, viz. *P. colisai* and *P. ophioccephali* can be summed up as follows :

1. Body length in former species in both sexes shorter than in latter.
2. First two circles of proboscis hooks in former thinner and narrower than the 1st circle of the same in latter which being stouter and broader.
3. Proboscis hooks in 1st and 2nd circle in former showing almost same difference in size as in 3rd and 4th, while in latter, hooks gradually decrease in size posteriorly.
4. Sexual dimorphism in former in regard to conspicuousness of body spines more pronounced than in latter.
5. Male genitalia of former agreeing with that of latter in arrangement of organs but differ in size of cement gland and in its number of nuclei ; cement gland being smaller in former than in latter and also its number of nuclei varying from 8-12 while in latter from 12-30.

TABLE 2 : (All measurements are in millimeters)

	<i>P. colisai</i> * Host : <i>Colisa fasciatus</i> Loc. : Delhi	<i>P. basiri</i> Host : <i>Rhyncobdella aculeata</i> Loc. : Aligarh (U.P.)	<i>P. pandei</i> Host : <i>Channa punctatus</i> Loc. : Raya (U.P.)	<i>P. guntei</i> Host : <i>Lepidocephali- thys guntea</i> Loc. : Ranchi (Bihar)	<i>P. buckleyi</i> Host : Fish (?) Loc. : Aligarh (U. P.)	<i>Present specimen</i> Host : Eel, <i>Channa punctatus</i> Loc. : Rajgir, Patna, (Bihar), Ankholā (W. B.)
Size of body	♂ 4.125 × 0.385 ♀ 5.4-12.9 × 0.610.62	8.28 × 0.24 10 × 0.04-0.05	5.07-6.00 × 0.30- 0.35 6.1-13.24 × 0.61-0.76	1.75-1.95 4.15-4.5	3.5-6.4 × 0.24-38	3.24-4.18 × 0.27-0.28 2.86-9.35 × 0.605- (juv.) 0.715
Size of proboscis	♂ 0.132 × 0.154 ♀	1.1 × 0.3	0.14-0.16 × 0.14-0.17	0.135-0.15 0.17-0.19	0.112-0.127 × 0.159-0.163	0.13 × 0.13-0.14 0.13-0.16 × 0.176- 0.22
Neck	♂ 0.264 × 0.165 ♀	0.27 × 0.14		0.33-0.35		0.22 × 0.11-0.13 0.38-0.44 × 0.22- 0.24
No. of Proboscis hooks	4 × 10	4 × 9	4 × 10	4 × 8-10	4 × 10	4 × 8 or 10
Length of Proboscis hooks	H ₁ 0.076 × 0.0068 H ₂ 0.068 H ₃ 0.0306 H ₄ 0.0255	H ₁ 0.1 H ₂ 0.058 H ₃ 0.03 H ₄ 0.02	H ₁ 0.07-0.03 H ₂ 0.031-0.039 H ₃ 0.02-0.031 H ₄ 0.02-0.03	H ₁ 0.085 H ₂ 0.085 H ₃ 0.03-0.045 H ₄ 0.025-0.03	H ₁ 0.07-0.077 H ₂ 0.06-0.034 H ₃ 0.02-0.028 H ₄ 0.016-0.02	♂ H ₁ 0.076 × 0.0068 H ₂ 0.068-0.07 H ₃ 0.03-0.034 H ₄ 0.025 ♀ H ₁ 0.093-0.102 H ₂ 0.076-0.093 H ₃ 0.034-0.037 H ₄ 0.025-0.03
Proboscis sheath	♂ 0.605 × 0.11-0.165 ♀	0.4 × 0.17 1.28 × 0.45	0.35-0.46 × 0.13-0.15	— —	0.52-0.58 × 0.125-0.154	0.495 × 0.132 0.495-0.77 × 0.132- 0.22
Lemnisci	2.2 × 0.05	(1) 0.76 (2) 0.66		—	(1) 1.0-1.82 (2) 0.85-1.42	1.738-1.98 × 0.044- 0.055
No. of collar spines	♂ 16 × 14-16 ♀ —	15 × 14 —	14-16 × 16	16-17 —	16-18 × 12-14 —	15-17 × 12-14 15-17 × 12-16
No. of trunk spines.	♂ 22 × 12-16 ♀ 67	26 —	20-28	— —	26-28 × 10-12 —	15-17 × 14-16 33-35 × 14-18
Testis	(1) 0.335 × 0.165 (2) 0.352 × 0.165	0.95 × 0.35 0.7 × 0.35	0.58-0.62 × 0.13-0.15 0.51-0.56 × 0.13-0.14	0.2-0.3 × 0.10-0.11 0.175-0.25 × 0.10- 0.11	0.35-0.64 × 0.15-0.18 0.36-0.46 × 0.15-0.2	0.495 × 0.135 0.405 × 0.132
Cement gland	0.44 × 0.187	0.9 × 0.34	0.47-0.63 × 0.12-0.14	0.125-0.18	0.3-0.73 × 0.088-0.227	0.22-0.605 × 0.165
No. of nuclei in cemeng gland	8-15	9	8	—	12	8-12
Cement reservoir	0.20-0.42 × 0.12-0.13	1.05 × 0.18	Present but mesure- ment not given.	—	0.175-0.59 × 0.085-0.236	0.374 × 0.066
Seminal vesicle	0.27-0.38 × 0.11-0.13	—	0.32-0.39	0.35-0.475 × 0.075- 0.09	—	0.33 × 0.165
Egg	—	0.036 × 0.021	0.08-0.10 × 0.04-0.049	—	—	0.051-0.068 × 0.025-0.03

* Fresh measurements of male only in the National collection of Z. S. I. No. W 3955/1.

SUMMARY

The paper deals with the validity of the ten species of the acanthocephalan genus *Pallisentis* Van Cleave, 1928, from the Indian subcontinent, and accepts only *P. ophiocephali* (Thapar, 1930) and *P. colisai* Sarkar, 1954, as valid. Fresh measurements taken from original specimens of both these species are also included as well as new host and locality records.

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REFERENCES

- AGARWAL, S. C. 1958. A new species of the genus *Pallisentis* (Acanthocephala). *Curr. Sci.*, **27** : 107.
- BASHIRULLAH, A. K. M. 1973. A brief survey of the helminth fauna of certain marine and freshwater fishes of Bangladesh. *Bangladesh J. Zool.*, **1** (1) : 63-85.
- BAYLIS, H. A. 1933. On some parasitic worms from Java, with remarks on the acanthocephalan genus *Pallisentis*. *Ann. Mag. nat. Hist.*, (10), **12** : 443-449.
- BHALERAO, G. D. 1931. On a new species of acanthocephala from *Ophiocephalus striatus*. *Ann. Mag. nat. Hist.*, (10), **7** : 569-573.
- BILQES, F. M. 1976. A list of parasites of fishes of Kinjar lake, Sind. *Proc. Pakistan Acad. Sci.*, **13** (2) : 109-111.
- DATTA, M. N. AND PODDAR, T. N. 1935. Acanthocephalan parasites of certain fishes from Calcutta. *Rec. Indian Mus.*, **37** : 231-236.
- FAROOQI, H. U. 1958. A new species of the genus *Pallisentis* from a fresh water eel. *Z. f. Parasitenkunde*, **18** : 457-464.
- FERNANDO, C. H. AND FURTADO, J. I. 1963. A study of some helminth parasites of freshwater fishes in Ceylon. *Z. f. Parasitenkunde*, **23** : 141-163.
- GEORGE, P. V. AND NADAKAL, A. M. 1973. Studies on the life cycle of *Pallisentis nagpurensis* Bhalerao, 1931 (Pallisentidae : Acanthocephala) parasitic in the fish *Ophiocephalus striatus* (Bloch). *Hydrobiologia*, **42** (1) : 31-43.

- GOLVAN, Y. J. 1959. Le Phylum des Acanthocephala (2. note). La Classe des Eoacanthocephala (Van Cleave, 1936). *Annl. Parasit. hum. comp.*, **34** (1) : 5-52.
- GUPTA, N. K. AND LATA, V. 1968. Observations on eight already known acanthocephalan parasites from vertebrate hosts. *Res. Bull. Panjab Univ. Sci.*, (n. s.), **18** (3/4) : 325-341.
- JAIN, M. AND GUPTA, N. K. 1979. On two already known species of the genus *Pallisentis* Van Cleave, 1928 (Acanthocephala) and discussion on the validity of *Pallisentis buckleyi* Tadros, 1966 and genus *Devendrosentis* Sahay, Sinha et. Ghosh, 1971. *Helminthologia*, **16** (3) : 173-183.
- MEYER, A. 1932. Acanthocephala. Dr. H. G. Bronns Klassen und Ordnungen d. Tierreichs. 4 Bd., 2te. Buch : 1-332.
- RAI, P. 1967. On four acanthocephalan genera parasitic in fresh water fishes with description of three new species. *Indian J. Helminth.*, **19** (1) : 27-44.
- RAI, P. 1971. Studies on the pathogenic helminths of freshwater fishes with special reference to Uttar Pradesh. [Abstract of thesis] *Agra Univ. J. Res. (Sci.)*, **20** (1) : 121-127.
- SAEED, R. AND BILQEES, F. M. 1971. *Pallisentis magnum* new species (Acanthocephala, Quadrigyridae) from the fish *Wallago attu* of Kalri lake, West Pakistan. *Pakist. J. Zool.*, **3** (2) : 221-223.
- SAEED, R. AND BILQEES, F. M. 1972. Acanthocephala of same fishes from the vicinity of Kalri lake (Sind), West Pakistan. *Agric. Res. Council Govt. of Pakistan* : 82-86.
- SAHAY, U., NATH, S. AND SINHA, A. 1967. On an acanthocephala from a hill stream fish—*Lepidocephalichthys guntea* (Hamilton). *Zool. Anz.*, **178** (5/6) : 348-353.
- SARKAR, H. L. 1953. On a new acanthocephala, *Pallisentis nandai*, from the fish *Nandus nandus* (Hamilton), with notes on the other species of the genus. *Proc. zool. Soc. Beng.*, **6** (2) : 139-147.
- SARKAR, H. L. 1954. On a new acanthocephala *Pallisentis colisai*, from the fish *Colisa fasciatus* (Bloch & Schn.) with a note on *Acanthogyrus acanthogyrus* Thapar, from the fish *Labeo rohita* (Hamilton). *Rec. Indian Mus.*, **52** : 349-362.
- SUBRAHMANIAN, K. 1936. Studies on the acanthocephalan fauna of Burma. *Rec. Indian Mus.*, **38** (3) : 311-315.

- SUBRAHMANIAN, K. 1937. *Pallisentis nagpurensis* (Acanthocephala) (Bhalerao, 1931). *Zool. Anz.*, **119** (3/4) : 111-112.
- TADROS, G. 1966. On three new Acanthocephala of the genera *Pallisentis* Van Cleave, *Saceosentis* gen. n. and *Acanthocephalus* Kuelreuther, from fish. *J. Helminth.*, **40** (1/2) : 155-180.
- THAPAR, G. S. 1931. On *Farzandia*, a new genus of acanthocephalid worms from the intestine of *Ophiocephalus marulius*. *Ann. Mag. nat. Hist.*, (10), **6** : 76-86.
- VAN CLEAVE, H. J. 1928. Acanthocephala from China. I. New species and new genera from China fishes. *Parasitology*, **20** (1) : 1-9.
- YAMAGUTI, S. 1963. Acanthocephala. *Systema Helminthum*, V. Acanthocephala. N Y & London : John Wiley & Sons.

ODONATA (INSECTA) FAUNA OF CALCUTTA AND SURROUNDINGS

By

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(With 6 Text-figures)

No comprehensive work is available so far on the Odonata fauna of Calcutta and surroundings, except a few by Laidlaw (1916, 1919 & 1922), Fraser (1933, 1934 & 1936), Bhasin (1953), Lahiri & Mitra (1972) and Mitra and Lahiri (1974 & 1975). Recently Mitra *et al.* (1976) have published a list of twenty two species of Libelluloid Odonates from Calcutta. Keeping this in view a detailed survey of this area (Text-fig. 1) was made by one of the authors (Raja Ram). As a result of this a large number of specimens of Zygoptera and Anisoptera have been accumulated in addition to collection present in the Zoological Survey of India. The present study reveals the occurrence of 50 species of Odonata belonging to two suborders, spread over 8 families and 34 genera. Of these, 9 species have shown extended distribution, and been recorded for the first time from Calcutta and environs and one species is a new record from India. Besides above 9 other species recorded from Calcutta are also included.

SYSTEMATIC ACCOUNT

Order : ODONATA

Suborder : ZYGOPTERA

Family : PLATYCNEMIDIDAE

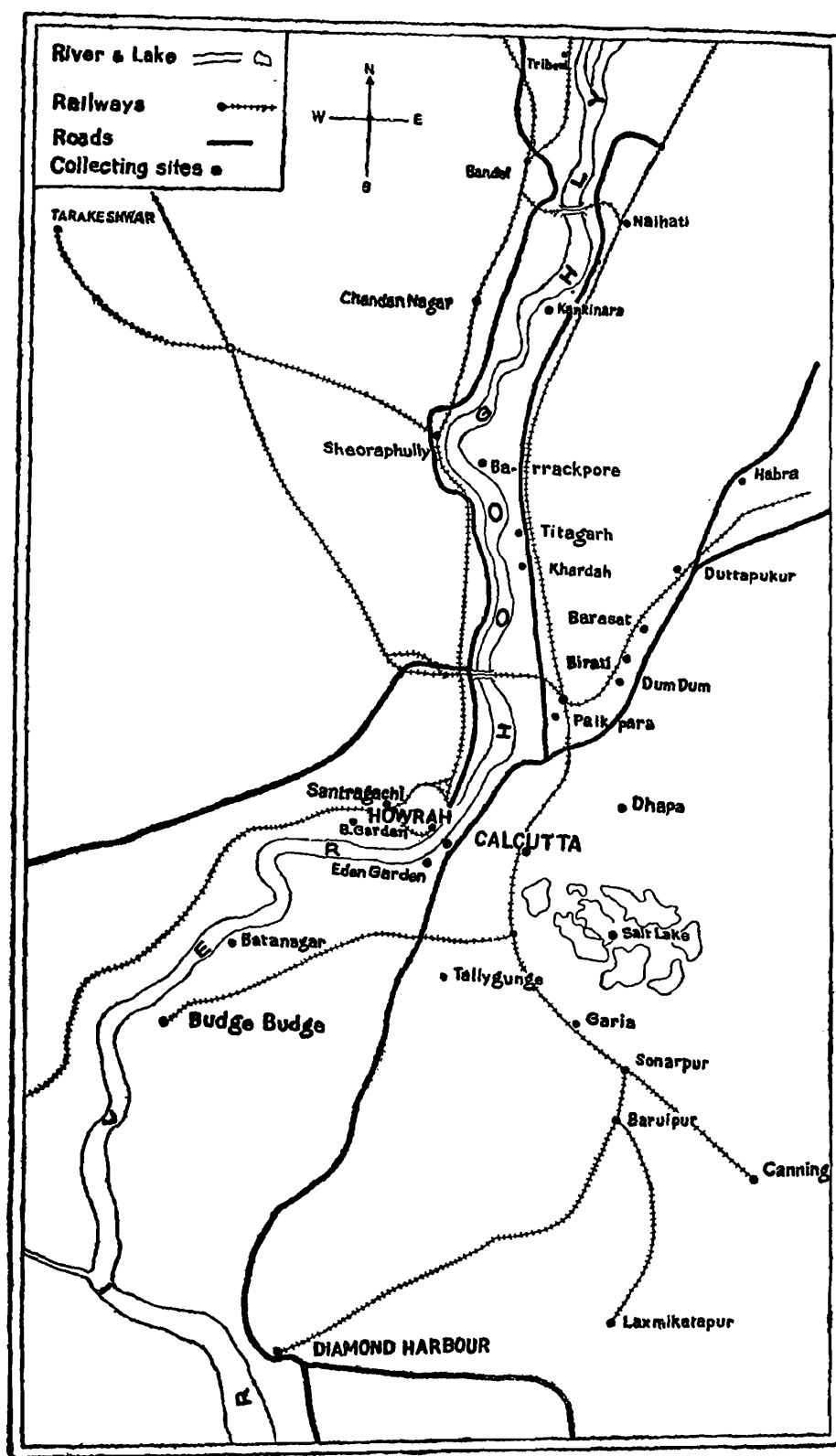
1. *Copera marginipes* (Rambur)

1842. *Platycnemis marginipes* Rambur, *Ins. Neurop.*, : 240 ; 1933. *Copera marginipes*, Fraser, *Fauna Brit. India*, 1 : 192-197.

Material : 1 ♂, Banglagram, Batanagar, 24 Parganas, 30. x. 1974, Raja Ram coll. and 1 ♀, Dum Dum, 24 Parganas, 18. x. 1975, D. R. Maulick coll.

Distribution : India [Himachal Pradesh, Madhya Pradesh, Uttar Pradesh, West Bengal (Jalpaiguri)], widely distributed throughout

Southern Asia, Sondoic Islands, Lower Burma, Sri Lanka, Java and Siam.



Text-fig. 1. Map of the area showing collection sites.

Remarks : Specimens were collected under dense shadow of Bamboo and Banana plantation near small temporary monsoon ponds, alongwith *Copera annulata*. It is first time recorded from Calcutta and its surroundings,

2. *Copera annulata* (Selys)

1863. *Psilocnemis annulata* Selys, *Bull. Acad. Belg.*, (2) 16 : 172.; 1933. *Copera annulata*, Fraser, *Fauna Brit. India*, 1 : 203-206.

Distribution : India [Assam, Himachal Pradesh, Manipur, South India, West Bengal (Botanical Garden, Howrah)] and extended from Eastern India to Malaysia. Present recorded from Hooghly and 24 Parganas (West Bengal).

Remarks : Specimens agree fairly well with the published description of the species, except for the following : Postnodal nervures varies from 10-16 in the fore wings and 9-14 in the hind wings. This species also prefers shadow near permanent or temporary water bodies.

Family : COENAGRIONIDAE

3. *Pseudagrion microcephalum* (Rambur)

(Text-fig. 2 A-I)

1842. *Agrion microcephalum* Rambur, *Ins. Neurop.*, 259 ; 1916. *Pseudagrion microcephalum*, Laidlaw, *Rec. Indian Mus.*, 12 : 23-24 ; 1933. Fraser, *Fauna Brit. India*, 1 : 278-280.

Distribution : Throughout the plains of India, Burma, Sri Lanka and extending to Australia. Material of this species studied from Hooghly, Howrah, and 24 Parganas (West Bengal).

Remarks : A common species near permanent and temporary monsoon ponds in and around Calcutta. The male specimens of this species exhibit a wide range of variation in the markings of head, thorax and on 2nd abdominal segment.

4. *Pseudagrion australasiae* Selys

(Text-fig. 3 A-C)

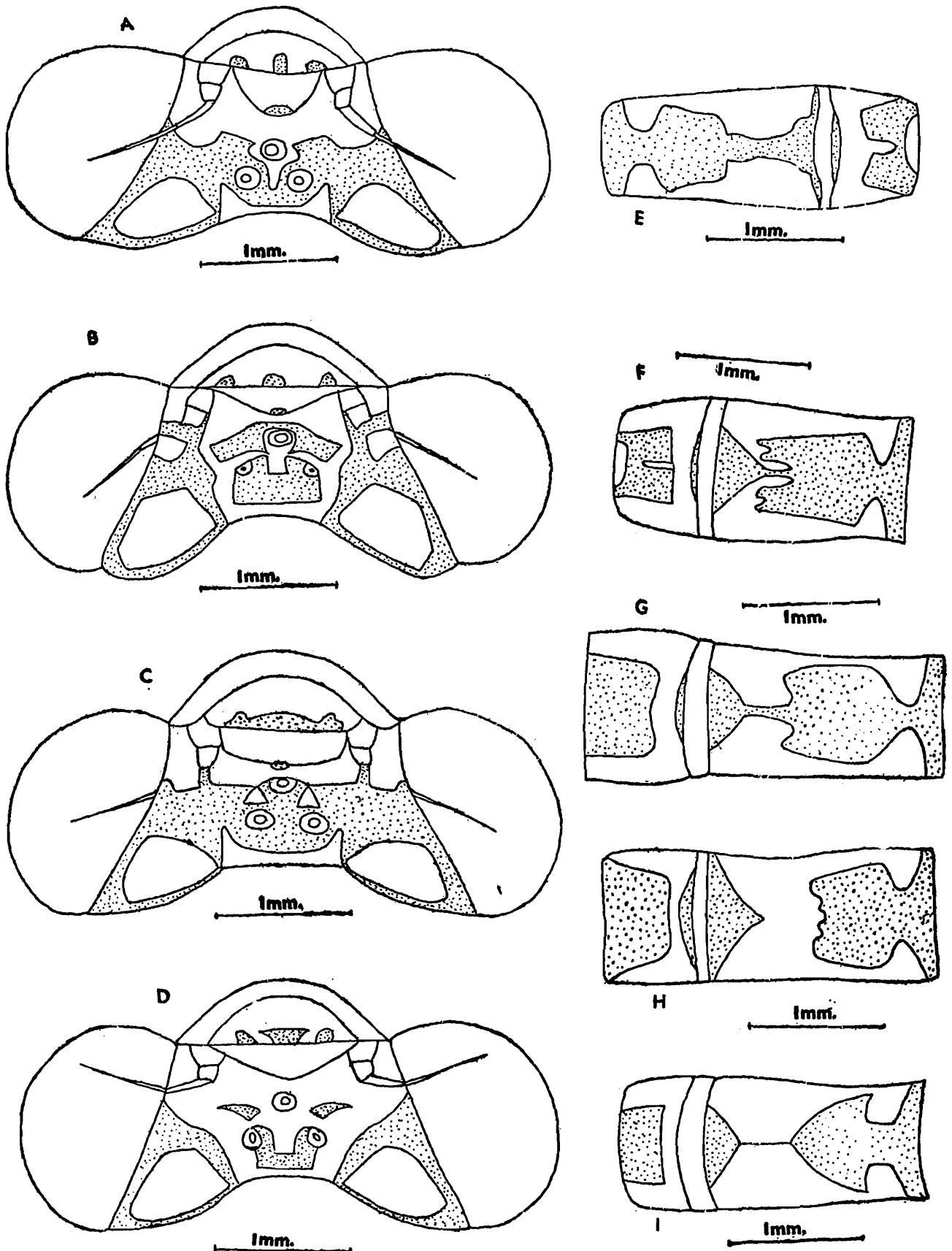
1916. *Pseudagrion australasiae*, Laidlaw, *Rec. Indian Mus.*, 12 : 21-23 ; 1919. Laidlaw, *Rec. Indian Mus.*, 16 : 192 ; 1933. *Pseudagrion bengalense* Fraser, *Fauna Brit. India*, 1 : 282-284 ; 1954. *Pseudagrion australasiae*, Lieftinck, *Treubia*, 22 : 1-202.

Distribution : India [Assam, West Bengal (Calcutta)], Burma and extending into Malaysia. Material of this species presently studied from Howrah (West Bengal).

Remarks : Head markings similar to Java specimens (Fraser, 1933). Postclypeus with comparatively larger black spots. Small black spot in the middle of the vertex is replaced by crown shaped marking

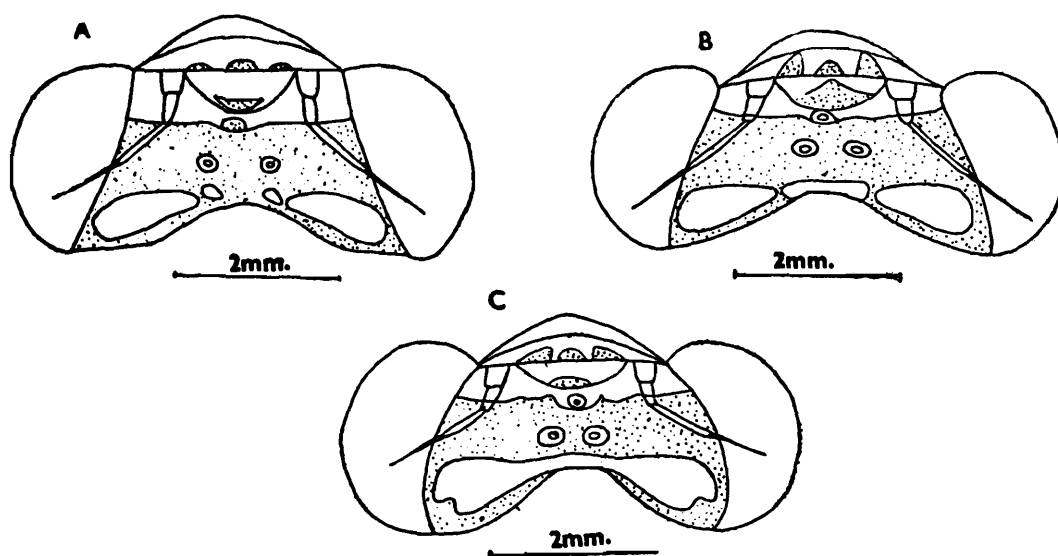
In a male specimen postnodal nervures varies 11-12 in the fore wing and 9-10 in the hind wing. It commonly occurs at its breeding places during the month of November and December.

A study of the type material present in Zoological Survey of India revealed some differences with descriptions in Fraser (1933) namely,



Text-fig. 2. (A-I) *Pseudagrion microcephalum* (Rambur); (A-D) Head markings; (E-I) Abdominal markings.

3 small basal black spots on postclypeus and a spot on the middle of the vertex.



Text-fig. 3. (A-C) Head markings of *Pseudagrion australasiae* Selys

5. *Pseudagrion decorum* (Rambur)

1842. *Agrion decorum* Rambur, *Ins. Neurop.* : 258 ; 1916. ¹*Pseudagrion decorum*, Laidlaw, *Rec. Indian Mus.*, 12 : 24 ; 1933. Fraser, *Fauna Brit. India*, 1 ; 286-289.

Distribution. : India [Coorg, Himachal Pradesh, Nilgiris, (Ootacamund) Uttar Pradesh, West Bengal (Darjeeling and Jalpaiguri)], Burma and Sri Lanka. Material of this species presently studied from Howrah and 24 Parganas (West Bengal).

Remarks : Markings on head, thorax and 2nd and 10th abdominal segments are very much variable even in the specimens collected from the same locality. Detailed intraspecific variation of the species will be published separately. This is one of the most common species and frequents near permanent water bodies during August to November.

6. *Pseudagrion spencei* Fraser

1922. *Pseudagrion spencei* Fraser, *Mem. Dep. Agric. India ent. Ser.*, 7 (7) : 47-48 ; 1933. Fraser, *Fauna Brit. India*, 1 : 292-294.

Material : 1 ♂, Santragachi, Howrah, 26. xii. 1976, Raja Ram coll.

Distribution : India [Bihar, Madhya Pradesh, West Bengal (Jalpaiguri)] and Pakistan (Lower Sind).

Remarks : It is an extremely rare species in this area and was collected while it was perching on the vegetation within water body. It is recorded for the first time from Calcutta and environs.

7. *Pseudagrion rubriceps* Selys

1876. *Pseudagrion rubriceps* Selys, *Bull. Acad. Belg.*, (2) 42 : 510 ; 1933. Fraser, *Fauna Brit. India*, 1 : 296-299.

Distribution : Widely distributed in the plains and submontane area of continental India [Himachal Pradesh, Madhya Pradesh, Uttar Pradesh and West Bengal (Calcutta)] except desert tract and Burma. Material of this species presently studied also from Hooghly, Howrah and 24 Parganas (West Bengal).

Remarks : Males exhibit wide range of variation in markings on head, thorax and abdominal segments. A male specimen collected from Sheoraphully (Hooghly) bears identical marking on 2nd abdominal segment as in Coorg specimen (Fraser, 1933).

8. *Ceriagrion coromandelianum* (Fabricius)

1798. *Agrion coromandelianum* Fabricius, *Ent. Syst. Suppl.* : 287 ; 1916. *Ceriagrion coromandelianum*, Laidlaw, *Rec. Indian Mus.*, 12 : 132 ; 1919, Laidlaw, *Rec. Indian Mus.*, 16 : 190 ; 1933. Fraser, *Fauna Brit. India*, 1 : 315-316.

Distribution : Throughout India, Sri Lanka, Burma, Malaysia, Indo-China and South China. Material of this species presently studied from Calcutta, Howrah and 24 Parganas (West Bengal).

Remarks : Large number of males and females are very common at permanent and temporary monsoon ponds. It is also attracted towards electric light during night.

9. *Ceriagrion cerinorubellum* (Brauer)

1865. *Pyrrhosoma cerinorubellum* Brauer *Verh. zool. bot. Ges. Wien.*, 15 : 511 ; 1933. *Ceriagrion cerinorubellum*, Fraser, *Fauna Brit. India.*, 1 : 326-328.

Distribution : India [Assam, Himachal Pradesh, South India (Coorg), Uttar Pradesh, West Bengal], Borneo, Burma, Sri Lanka, Java, Malaysia and Sumatra. Material of this species presently studied from Hooghly, Howrah and 24 Parganas (West Bengal).

Remarks : It is very colourful and always confined only to temporary as well as permanent water bodies.

10. *Coenagrion dyeri* (Fraser)

1919. *Agriocnemis dyeri* Fraser, *Rec. Indian Mus.*, 16 : 451-52 ; 1933. *Coenagrion dyeri* Fraser, *Fauna Brit. India*, 1 : 413-415.

Material : 1 ♀, 9. viii. 1975, 1 ♂, 1 ♀, 28. ix. 1975, 1 ♀, 22. xi. 1976, 2 ♂ ♂, 1 ♀, 12. xii. 1976, 6 ♂ ♂, 1 ♀, 28. xii. 1976 and 6 ♂ ♂, 2 ♀ ♀, 29. xii. 1976, Santragachi, Howrah, *Raja Ram* coll.

Distribution : India [Himachal Pradesh, Madhya Pradesh throughout Peninsular India, Uttar Pradesh and Western Ghat].

Remarks : It is first time recorded from West Bengal. During the month of November and December, it is very common at Santragachi and can be seen in the green grass and bushes and sometimes far away from the water bodies. The male specimens of the species differ from the published description in the following. They are smaller in body length as well as in wing expanse. Postnodal nervures vary from 7-8 in the fore wing and 5-6 in the hind wings. Thorax, femora and abdomen in some of the fully mature specimens are heavily pruinose.

11. *Ischnura senegalensis* (Rambur)

1842. *Agriion senegalensis* Rambur, *Ins. Neurop.*, 276 ; 1916. *Ischnura senegalensis*, Laidlaw, *Rec. Indian Mus.*, 12 : 129 ; 1933. Fraser, *Fauna Brit. India*, 1 : 348-351.

Distribution : India [Himachal Pradesh, Manipur, Maharashtra, Rajasthan, Uttar Pradesh, West Bengal], Burma, Sri Lanka and extends eastwards as far as Malaysia. Philippines, Japan and westwards throughout the African continent. Material of this species presently studied from Hooghly, Howrah and 24 Parganas (West Bengal).

Remarks : This is one of the most common species on both, permanent and temporary water bodies. Emergence was recorded in the morning hours in a large scale, gradually increasing with the rise of temperature during winter (November and December). Specimens have been observed to remain in copula for hours together.

12. *Ischnura forcipata* Morton

1907. *Ischnura forcipata* Morton, *Trans. ent. Soc. Lond.*, : 306 ; 1933. Fraser, *Fauna Brit. India*, 1 : 354-357.

Distribution : Baluchistan, Quetta, and Northern India. Material of this species presently studied from Calcutta (West Bengal).

Remarks : It is rare species in this area,

13. *Ischnura rufostigma rufostigma* Selys

1876. *Ischnura rufostigma* Selys, *Bull. Acad. Belg.*, (2) **41** : 283 ; 1916. Laidlaw, *Rec. Indian Mus.*, **12** : 130 ; 1919. Laidlaw, *Rec. Indian Mus.*, **16** : 175 ; 1933. Fraser, *Fauna Brit. India*, **1** : 362-364. 1977 ; *Ischnura rufostigma rufostigma*, Lahiri, *Rec. zool. Surv. India*, **72** : 413.

Distribution : India [Assam, Bihar, Himachal Pradesh, Kashmir, Madhya Pradesh, Manipur, Uttar Pradesh, West Bengal (Calcutta)] and Burma. Material of this species presently studied from Howrah and 24 Parganas (West Bengal).

Remarks : This species is commonly found near temporary and permanent monsoon ponds. It was also observed at electric light during night.

14. *Ischnura aurora aurora* (Brauer)

1858. *Agrion delicatum* Hagen. *Verh. Zool.-bot. Ges. Wien*, **8** : 479 ; 1865. *Agrion aurora*, Brauer, *Verh. zool.-bot. Ges. Wien*, **15** : 510 ; 1915. *Ischnura aurora*, Ris, *Nova caledonia*, *Zool.*, **2** : 4, 67 ; 1931. Fraser, *Rec. Indian Mus.*, **33** : 448 ; 1954. *Ischnura aurora aurora* Lieftinck, *Treubia*, **22** : 74.

Distribution : India [Himachal Pradesh, Punjab, South India, Uttar Pradesh], Australia, Borneo, Burma, Sri Lanka, Malaysia, New Guinea, Philippines, Samoa and Sondaic Archipelago. Material of this species presently studied from Howrah (West Bengal).

Remarks : Differs from published description by having 6 postnodal nervures in fore wing and 5 in the hind wing.

15. *Enallagma parvum* Selys

1876. *Enallagma parvum* Selys, *Bull. Acad. Belg.*, (2) **41** : 537 ; 1919. Laidlaw, *Rec. Indian Mus.*, **16** : 184 ; 1933. Fraser, *Fauna Brit. India*, **1** : 376-378.

Material : 2 ♂♂, 1 ♀, Banglagram, Batanagar, 24 Parganas., 30. x. 1974, Raja Ram coll. and 2 ♂♂ Santragachi, Howrah, 31. vii. 1975, Raja Ram coll.

Distribution : India [West Bengal (Darjeeling), Gujarat, Madhya Pradesh, Manipur, Uttar Pradesh], Burma and Ceylon.

Remarks : It is recorded for the first time from Calcutta and surroundings.

16. *Agriocnemis lacteola* Selys

1877. *Agriocnemis lacteola* Selys, *Bull. Acad. Belg.*, (2) **43** : 144 ; 1933. Fraser, *Fauna Brit. India*, **1** : 381-383.

Material : 3 ♂♂, Kumra, Habra, 24 Parganas, 10. x. 1974, D. R. Maulick coll. and 5 ♂♂, Langalpara, Sonarpur, 24 Parganas, 15. x. 1975, Raja Ram and D. R. Maulick coll.

Distribution : India [Assam, Bihar, Sikkim and West Bengal (Hasi-mara and Jalpaiguri)].

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

17. *Agriocnemis splendidissima* Laidlaw

1919. *Agriocnemis splendidissima* Laidlaw, *Rec. Indian Mus.*, **16** : 180-82 ; 1933. Fraser, *Fauna Brit. India*, **1** : 392-94.

Material : 1 ♀, Devendrapur, Hooghly, 24. iii. 1976, K. K. Ray coll. and 1 ♀, Santragachi, Howrah, 26. xii. 1976, Raja Ram coll.

Distribution : India [Madhya Pradesh, Maharashtra and Western Ghat].

Remarks : It is first time recorded from West Bengal. Specimen differs from published description in respect of its longer size (abdomen 21 mm.) and having 8 postnodal nervures in fore wing and 6 in the hind wing.

18. *Agriocnemis pygmaea* (Rambur)

1842. *Agrion pygmaea*, Rambur. *Ins. Neurop.* : 278 ; 1933. *Agriocnemis pygmaea*, Fraser, *Fauna Brit. India*, **1** : 398-401.

Distribution : India [Assam, Himachal Pradesh, Madras, Malabar, Manipur, Nicobar, Punjab, Rajasthan, Uttar Pradesh, West Bengal (Calcutta)], Australia, Burma, Sri Lanka, China, Formosa, Java, Malaysia, Manila, North Guina, Philippines, Singapore and Seychelles. Material of this species presently studied from Howrah and 24 Parganas (West Bengal).

Remarks : It is one of the most commonly distributed damselfly in the area near water-bodies. Though, sometimes it is also observed away from the water bodies. Specimens of this species are commonly seen attracted towards electric light during night.

19. *Onychargia atrocyana* Selys

1865. *Onychargia atrocyana* Selys, *Bull. Acad. Belg.* (2) **20** : 416 ; 1933. Fraser, *Fauna Brit. India*, **1** : 417-418.

Distribution : Throughout the wet and montane areas of India [Assam, North Coorg, Malabar, Paralai, Anaimalai Hills, West Bengal]. Material of this species presently studied from Hooghly and Howrah (West Bengal).

Remarks : On few occasions specimens of this species were observed to follow trains for some distance,

Family : LESTIDAE

20. *Platylestes platystyla* (Rambur)

1842. *Lestes platystyla* Rambur, *Ins. Neurop.*, : 254 ; 1933. *Platylestes platystyla*, Fraser, *Fauna Brit. India*, 1 : 59-62.

Distribution : India [West Bengal (Calcutta)], Burma and Iraq.

Remarks : Postnodal nervures varies 11-12 in the fore wing and 10-11 in the hind wing. Three spots present on postclypeus.

Suborder : ANISOPTERA

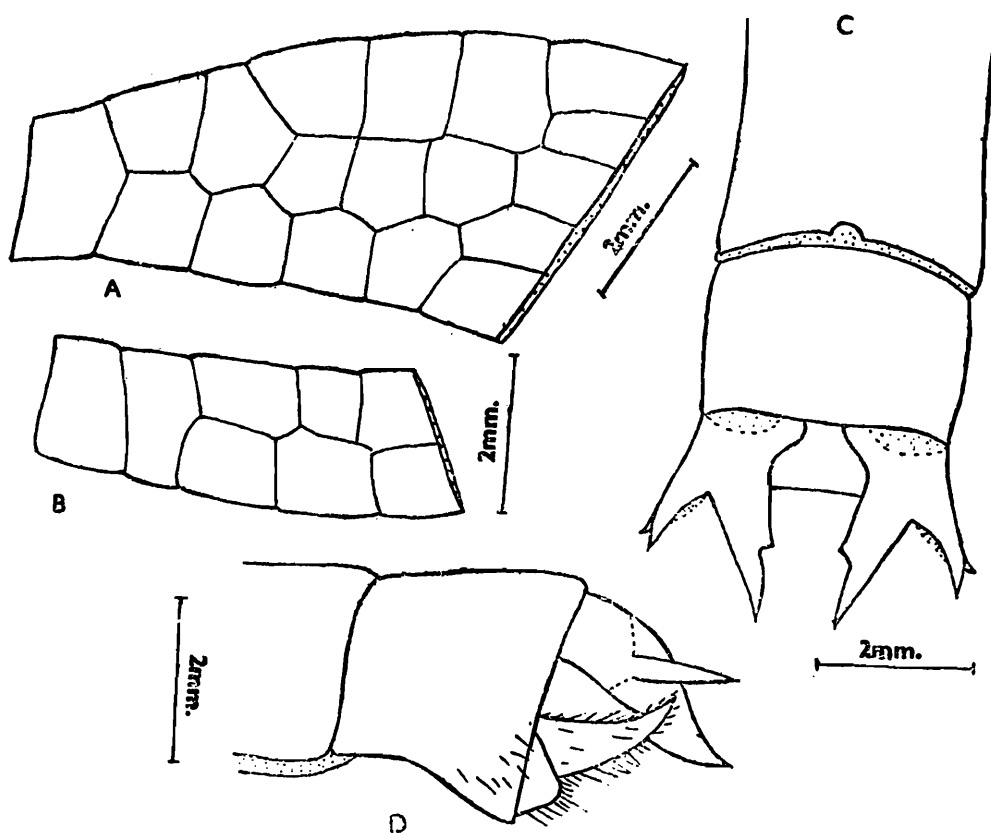
FAMILY : GOMPHIDAE

21. *Macrogomphus montanus* Selys

(Text-fig. 4 A-D)

1869. *Macrogomphus montanus* Selys, *Bull. Acad. Belg.*, (2) 28 : 171 ; 1922. Laidlaw, *Rec. Indian Mus.*, 24 : 377-378 ; 1934. Fraser, *Fauna Brit. India*, 2 : 345-346.

Distribution : India [West Bengal (Calcutta)] and Bangladesh (Sylhet). Material of this species presently studied from 24 Parganas (West Bengal).



Text-fig. 4. (A-D) *Macrogomphus montanus* Selys : (A-B) Right and left hind wings showing cells in between nervures Cuii and 1A ; (C) Anal appendages—dorsal view ; (D) Anal appendages—lateral view.

Remarks : Specimen agrees well with the Fraser (1934) description, except as follows : labrum yellow at sides, lateral sides of prothorax

and middle of posterior lobe yellow, 2 cubital nervures present in the left hind wing. Cuii and IA parallel in the left hind wing, whereas much divergent in the right wing (5 celled) (Text-fig. 4 A-B).

22. *Ictinogomphus rapax* (Rambur)

1842. *Diastatomma rapax* Rambur, *Ins. Neurop.*, : 169 ; 1922. *Ictinus rapax*, Laidlaw, *Rec. Indian Mus.*, 24 : 373-374 ; 1934. Fraser, *Fauna Brit. India*, 2 : 373-376.

Distribution : Throughout India, Burma, Sri Lanka and Malaysia, except in desert area. Material of this species presently studied from Calcutta and Howrah (West Bengal).

Remarks : This species was observed to return to the same perching place, over the water body on being disturbed for several times. On one occasion a male was observed to repeat this behaviour for five times, and ultimately on the sixth attempt the specimen itself got struck by the stone.

Study of a large series of specimens reveal venational variation as follows : anal triangle 5-7 celled, discoidal cell in hind wing 2-4 celled, hypertrigone 1-3 celled, anal loop varies from 3-5 cells, discoidal field starts with 3-4 cells in the fore wing and 3-5 in the hind wing.

23. *Ictinogomphus pertinax* Selys

1854. *Ictinus pertinax* Selys, *Bull. Acad. Belg.*, 21 (2) : 88 ; 1934. Fraser, *Fauna Brit. India*, 2 : 377-378.

Material : 1 ♂, Santragachi, Howrah, 10. viii. 1975, *Raja Ram* coll.

Distribution : Burma, China, Indochina, and Malaysia.

Remarks : Specimen agrees with Fraser's description (1934) but differs in the followings : Anal triangle 5 celled, lanceolate stripe on the dorsum of 2nd abdominal segment is reaching upto the apex of the segment and touching the suture. This is the first record of this species from India.

24. *Ictinogomphus angulosus* Selys

1854. *Ictinus angulosus* Selys, *Bull. Acad. Belg.*, 21 : 92 ; 1934. Fraser, *Fauna Brit. India*, 2 : 378-379.

Distribution : India (Calcutta).

Family : AESHNIDAE

25. *Anax imperator* Leach

1815. *Anax imperator* Leach, *Edinb. Encycl.*, 9 : 137 ; 1936. Fraser, *Fauna Brit. India*, 3 : 136-138 ; 1974. Mitra & Lahiri, *Entomologist's Rec. J. Var.*, 86 : 74.

Distribution : India [West Bengal (Calcutta) N. W. Provinces, Mussoorie] extending from the British Isles across Europe to Central Asia and South-wards to central and North Africa.

26. *Anax guttatus* (Burmeister)

1839. *Aeshna guttata* Burmeister, *Handb. Ent.*, 2 : 840 ; 1936. *Anax guttatus*, Fraser, *Fauna Brit. India*, 3 : 140-142 ; 1942, Lieftinck, *Treubia*, 18 (3) : 591-592.

Distribution : Extends from Seychelles to Samoa in the Pacific, common throughout the plains of India except in desert areas [Coorg, Nilgiris, Malabar, Annaimallai Hills, Madras, Waltair, Assam, West Bengal (Calcutta)].

27. *Hemianax ephippiger* (Burmeister)

1839. *Aeshna ephippiger* Burmeister, *Handb. Ent.*, 2 : 840 ; 1936. *Hemianax ephippiger*, Fraser. *Fauna Brit. India*, 3 : 147-149 ; 1974. Mitra & Lahiri, *Entomologist's Rec., J. Var.* 86 : 74.

Distribution : India [Maharashtra, Rajasthan, South India, Uttar Pradesh, West Bengal (Calcutta)], South Europe to North Asia. Material of this species presently studied from Howrah and 24 Parganas (West Bengal).

28. *Anaciaeschna jaspidea* (Burmeister)

1839. *Aeshna jaspidea* Burmeister, *Handb. Ent.*, 2 : 840 ; 1936. *Anaciaeschna jaspidea*, Fraser, *Fauna Brit. India*, 3 : 152-154.

Distribution : India [Coorg, Nilgiris and West Bengal (Hasimara, Duars, Calcutta)], extending to Pacific Islands.

Remarks : Specimens examined exhibit certain differences with Fraser (1936), such as yellow tinge present in the subcostal region of the hind wing instead of costal region and absent in centre. One specimen collected from Horticulture Garden, Calcutta further differs in vesicle and occiput being deep brown instead of yellow.

29. *Gynacantha rammohni* Mitra & Lahiri

1975. *Gynacantha rammohni* Mitra & Lahiri, *Entomologist's Rec. J. Var.*, 87 : 148-149.

Distribution : India [West Bengal (Calcutta)].

30. *Acanthagyna dravida* (Lieftinck)

1960. *Gynacantha dravida* Lieftinck, *Mem. Soc. Ent. Ital.*, **38** : 252-253 ; 1972. *Acanthagyna dravida* Lahiri & Mitra, *J. Bombay nat. Hist. Soc.*, **69** (2) : 438-439.

Distribution : India [Bihar, Coimbatore, Coorg, Malabar, Meghalaya, Nilgiris, Orissa and West Bengal (Calcutta, Darjeeling, Singla, Mangpo)].

Family : CORDULIIDAE

31. *Epophthalmia vittata vittata* Burmeister

1839. *Epophthalmia vittata* Burmeister, *Handb. Ent.*, **2** : 845 ; 1936. *Epophthalmia vittata vittata*, Fraser, *Fauna Brit. India*, **3** : 194-196.

Material : 1♂, Indian Museum, Calcutta, 8. iv. 1941.

Distribution : Widely distributed throughout Peninsular India and Uttar Pradesh.

Remarks : This is the first record of the species from West Bengal. Differs from the available published descriptions in the following : Inner costal margin is yellow ; anal loop made up of 9 cells. In addition to this, three more specimens of this species present in earlier collection, without any locality labels were also studied. Their cubital nervures varies from 4-6 and anal loop 9-11 in numbers.

Family : MACRODIPLACTIDAE

32. *Macrodiplax cora* (Brauer)

1867. *Diplax cora* Brauer, *Verh. zool.-bot. Ges. Wien.* **17** : 20, 289 ; 1936. *Macrodiplax cora*, Fraser, *Fauna Brit. India*, **3** : 448-450 ; 1974. Mitra & Lahiri, *Entomologist's Rec. J. Var.*, **86** : 74 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Coimbatore Plateau, Western Ghat, West Bengal (Calcutta)], widely distributed from the east coast of Africa Oceania and Australia, throughout Southern Asia. Material of this species presently recorded from Howrah and 24 Parganas (West Bengal).

33. *Aethriamanta brevipennis brevipennis* (Rambur)

1842. *Libellula brevipennis* Rambur, *Ins. Neurop.*, : 114 ; 1936. *Aethriamanta brevipennis brevipennis*, Fraser, *Fauna Brit. India*, **3** : 445-447 ; 1976. Mitra *et al.*, *Third all India, Congr. Zool.*, 64.

Distribution : India [Assam, South India (Coorg and Malabar), West Bengal (Calcutta)], Sri Lanka and Burma. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal).

Remarks : This species is always found in the gardens with multi-coloured flowers.

34. *Urothemis signata signata* (Rambur)

1842. *Libellula signata* Rambur, *Ins. Naurop.*, : 117 ; 1839. *Libellula sanguinea*, Burm., *Handb. Ent.*, 2 : 858 ; 1936. *Urothemis signata signata*, Fraser, *Fauna Brit. India*, 3 : 442-444 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Peninsular India, Eastern Uttar Pradesh, West Bengal (Calcutta)], Burma and Sri Lanka. Material of this species presently studied also from Hooghly and 24 Parganas (West Bengal).

Remarks : It is one of the commonest species in this area from June to October and found resting on the top of the twigs of the bushes. In few cases male specimens have blackish brown spots in the anal area of the hind wings, well separated as in the case of females forming distinct separate areas.

Family : LIBELLULIDAE

35. *Orthetrum sabina sabina* (Drury)

1770. *Libellula sabina* Drury, *Ill. Exot. Ins.*, 1 : 114-115 ; 1936. *Orthetrum sabina* Fraser, *Fauna Brit. India*, 3 : 300-302 ; 1974. Mitra & Lahiri, *Entomologist's Rec. J. Var.*, 86 : 74 ; 1976. *Orthetrum s. sabina*, Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, Bihar, Himachal Pradesh, Manipur, Punjab, Uttar Pradesh, West Bengal (Calcutta)], North East Africa, Eastward across Asia to Australia, Nepal and Pacific Islands. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal).

Remarks : Very commonly occurring in the area.

36. *Orthetrum glaucum* (Brauer)

1865. *Libellula glauca* Brauer, *Verh. zool.-bot. Ges. Wien.* 15 : 1012 ; 1936. *Orthetrum glaucum*, Fraser, *Fauna Brit. India*, 3 : 307-309 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : Throughout India, Java, Philippines.

37. *Orthetrum triangulare triangulare* (Selys)

1878. *Libellula triangularis* Selys, *Mitth. Mus. Dresden*, : 314 ; 1936. *Orthetrum triangulare triangulare*, Fraser, *Fauna Brit. India*, 3 : 305-307 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [S. India, all along the Himalayas, West Bengal (Calcutta)], Burma.

38. *Lathrecista asiatica asiatica* (Fabricius)

1798. *Libellula asiatica* Fabricius, *Ent. Syst. Suppl.*, : 283 ; 1936. *Lathrecista asiatica asiatica*, Fraser, *Fauna Brit. India*, 3 : 281-284 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

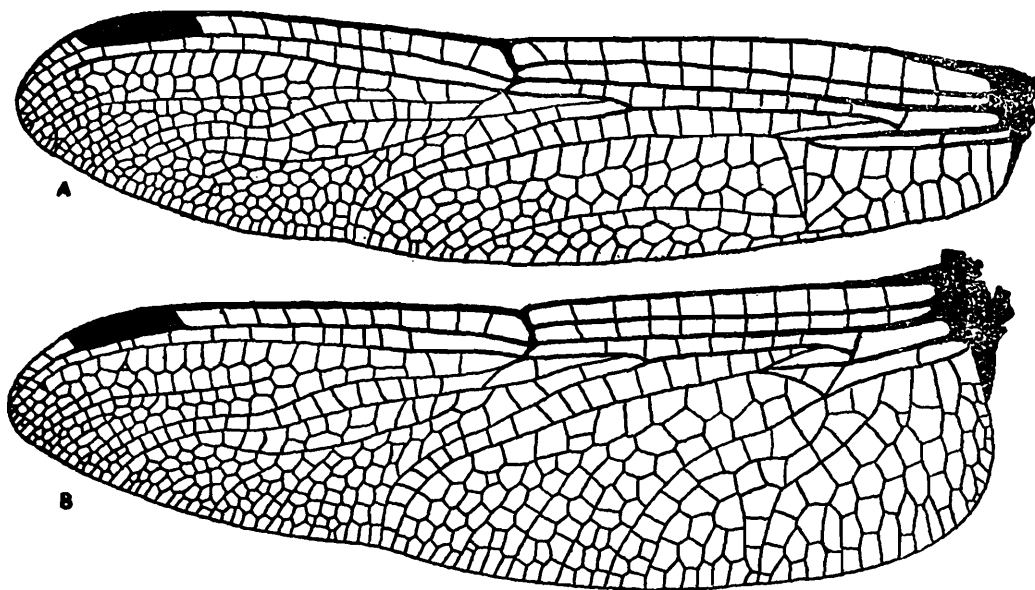
Distribution : India [Malabar, West Bengal (Calcutta)], Samoa, Sondaic Archipelago, Borneo, New Guinea, Philippines.

39. *Potamarcha obscura* (Rambur)

(Text-fig. 5 A-B)

1842. *Libellula obscura* Rambur, *Ins. Neurop.*, : 64 ; 1936. *Potamarcha obscura*, Fraser, *Fauna Brit. India*, 3 : 289-291.

Distribution : India [Himachal Pradesh, Madhya Pradesh, Uttar Pradesh, West Bengal (Calcutta)], widely distributed from Sri Lanka to Tibet and from west coast of India to Philippines and Formosa except



Text-fig. 5 (A-B) Fore and hind wings of *Potamarcha obscura* (Rambur).

desert areas. Material of this species presently also studied from Hooghly and 24 Parganas (West Bengal).

Remarks : Agrees fairly well with the description of the species. This species commonly occurs near residential area.

40. *Brachydiplax sobrina* (Rambur)

1842. *Libellula sobrina* Rambur, *Ins. Neurop.*, : 114 ; 1936. *Brachydiplax sobrina*, Fraser, *Fauna Brit. India*, 3 : 325-327 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, Himachal Pradesh, Maharashtra, Punjab, Uttar Pradesh, Western coast of India, Travancore, West Bengal (Calcutta)], Burma and Sri Lanka. Material of the species presently studied also from Hooghly, Howrah and 24 Parganas (West Bengal),

41. *Brachydiplax farinosa* Kruger

1902. *Brachydiplax farinosa* Kruger, *Stettin, ent. Ztg.*, **63** : 135 ; 1936. Fraser, *Fauna Brit. India*, **3** : 327.

Material : 1 ♂, Dattapukur, 24 Parganas, 8. ii. 1967, K. K. Ray coll. ; 2 ♂♂, Botanical Garden, Howrah, 18. ix. 1974, Raja Ram and S. Das coll. and 2 ♂♂, Batanagar, 30. x. 1974, Raja Ram coll.

Distribution : India [Assam, West Bengal (Jalpaiguri)], Burma, Malaysia and Sumatra. It is first time recorded from Calcutta and its environs.

42. *Brachydiplax chalybea chalybea* Brauer

1868. *Brachydiplax chalybea*, Brauer, *Verh. zool.-bot. Ges. Wien*, **18** : 173, 725 ; 1936. Fraser, *Fauna Brit. India*, **3** : 328-329 ; 1976. *Brachydiplax chalybea chalybea*, Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, West Bengal (Calcutta)], Burma, Java, Malaysia, Siam and Sumatra. Material of this species presently studied from 24 Parganas (West Bengal).

43. *Brachythemis contaminata* (Fabricius)

1793. *Libellula contaminata* Fabricius, *Ent. Syst.*, **2** : 382 ; 1936. *Brachythemis contaminata*, Fraser, *Fauna Brit. India*, **3** : 365-366 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, Bihar, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh and West Bengal (Calcutta)], Burma, Sri Lanka and extending east of China, Java, Formosa Philippines and Sumatra. Material of this species presently studied also from 24 Parganas (West Bengal).

Remarks : Very commonly observed fluttering over aquatic vegetation at permanent and temporary water bodies. It has also been observed and collected at electric light during night.

44. *Sympetrum hypomelas* (Selys)

1884. *Diplax hypomelas* Selys, *Annls. Soc. ent. Belg.*, **28** : 37 ; 1936. *Sympetrum hypomelas*, Fraser, *Fauna Brit. India*, **3** : 373-374.

Distribution : India [West Bengal (Calcutta), Assam, Sikkim], Burma, Tibet,

45. *Acisoma panorpoides panorpoides* Rambur

1842. *Acisoma panorpoides* Rambur, *Ins. Neurop.*, : 28 ; 1936. *Acisoma panorpoides panorpoides*, Fraser, *Fauna Brit. India*, 3 : 330-331 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, Himachal Pradesh, Madhya Pradesh, Manipur, Punjab, Uttar Pradesh, Western India, West Bengal (Calcutta)], Sri Lanka, Celebes, China, Japan, Java, Moluccan Islands, Sumatra and Taiwan. Material of the species presently studied from Howrah and 24 Parganas (West Bengal).

Remarks : It is very common and found near water bodies.

46. *Diplacodes trivialis* (Rambur)

1842. *Libellula trivialis* Rambur, *Ins. Neurop.*, : 115 ; 1936. *Diplacodes trivialis* Fraser, *Fauna Brit. India*, 3 : 336-338 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Himachal Pradesh, Madhya Pradesh, Madras, Punjab, Manipur, Uttar Pradesh, West Bengal (Calcutta)], Australia, Burma, Sri Lanka, Nepal, and Seychelles. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal.)

Remarks : Specimens of this species are common in this area during July to November. This can be seen near waterbodies as well as far away from the waterbodies at green vegetation.

47. *Diplacodes nebulosa* (Fabricius)

1793. *Libellula nebulosa* Fabricius *Ent. Syst.*, 2 : 379 ; 1936. *Diplacodes nebulosa*, Fraser, *Fauna Brit. India*, 3 : 335-336 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Himachal Pradesh, Madhya Pradesh, Madras, Uttar Pradesh, West Bengal (Calcutta)], extended from western India. Sri Lanka to Australia and Southwards to Java. Material of this species presently studied from 24 Parganas (West Bengal).

Remarks : Specimens of this species are common in and around paddy fields, but sometimes they can be seen near water bodies with weeds and aquatic plants.

48. *Crocothemis servilia servilia* (Drury)

1770. *Libellula servilia* Drury, *Ill. Ex. Ins.*, 1 : 112-113 ; 1936. *Crocothemis servilia servilia* Fraser, *Fauna Brit. India*, 3 : 345-347 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Bihar, Himachal Pradesh, Madhya Pradesh, Manipur, Punjab, Rajasthan, Uttar Pradesh, West Bengal (Calcutta)],

Australia, Nepal, Philippines and Sondaic Archipelago. Material of this species presently studied from 24 Parganas (West Bengal).

Remarks : Most commonly and easily available species. It is also attracted to electric light during night.

49. *Crocothemis indica* Sahní

1965. *Crocothemis indica* Sahní, *Indian J. Ent.*, **27** (3) : 284-287 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Uttar Pradesh and West Bengal (Calcutta)].

50. *Bradinopyga geminata* (Rambur)

1842. *Libellula geminata* Rambur, *Ins. Neurop.*, : 90 ; 1936. *Bradinopyga geminata*, Fraser, *Fauna Brit. India*, **3** : 349-350 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Madhya Pradesh, Uttar Pradesh, peninsular India and West Bengal (Calcutta)]. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal).

Remarks : It is a garden species and always observed near the small cemented water tanks, cemented surface of walls, nallah, asbestos sheets, etc.

51. *Neurothemis tullia tullia* (Drury)

1773. *Libellula tullia* Drury, *Ill. Exot. Ins.* **2** : 85 ; 1936. *Neurothemis tullia tullia*, Fraser, *Fauna Brit. India*, **3** : 360-362 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Bihar, Bombay, Himachal Pradesh, Madhya Pradesh, Peninsular India, Punjab, Uttar Pradesh, West coast of India, West Bengal (Calcutta)]. Burma, Sri Lanka, Hongkong, Indo-china and Malacca. Material of this species presently studied also from Hooghly, Howrah and 24 Parganas (West Bengal).

Remarks : Medium sized beautiful species commonly available throughout this area during June to November.

52. *Neurothemis intermedia intermedia* (Rambur)

1842. *Libellula intermedia* Rambur, *Ins. Neurop.*, : 91 ; 1936. *Neurothemis intermedia intermedia*, Fraser, *Fauna Brit. India* **3** : 357-358.

Material : 1 ♂, Baruipur, 24 Parganas, 18. ix. 1965, G. N. Saha coll.

Distribution : India [Bihar, Madhya Pradesh, Peninsular India, Punjab, Uttar Pradesh], Burma, Sri Lanka, Indo-China and Malacca.

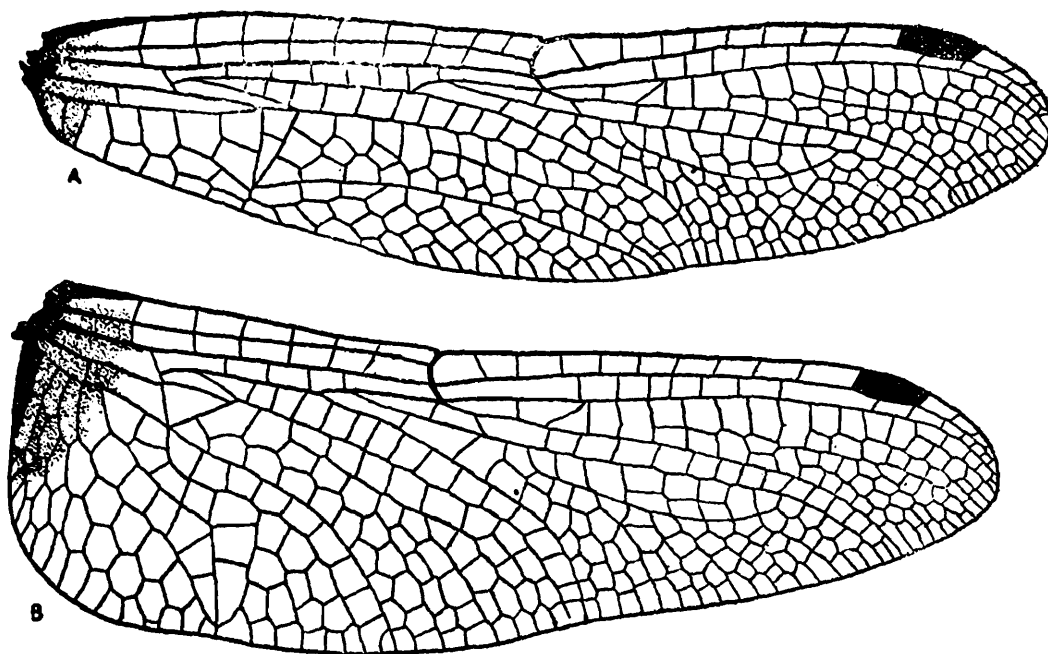
Remarks : It is first time recorded from West Bengal.

53. *Trithemis pallidinervis* (Kirby)

(Text-fig. 6 A-B)

1889. *Sympetrum pallidinervis* Kirby, *Trans. zool. Soc. Lond.*, **12** : 327 ; 1936. *Trithemis pallidinervis*, Fraser, *Fauna Brit. India*, **3** : 389-391 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Assam, Bihar, Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal (Calcutta)], Burma, Sri Lanka, Formosa and Philippine. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal).



Text-fig. 6 (A-B) Fore and hind wings of *Trithemis pallidinervis* (Kirby).

Remarks : Very commonly occurs during May to September, either at permanent or temporary monsoon ponds. Sometimes it was also observed far away from the water bodies resting on the top of small vegetation or on the twigs of the bushes.

54. *Trithemis aurora* (Burmeister)

1839. *Libellula aurora* Burmeister, *Handb. Ent.*, **2** : 859 ; 1936. *Trithemis aurora*, Fraser, *Fauna Brit. India*, **3** : 386-385.

Distribution : Throughout India, Sri Lanka, Burma, Java and Philippines. Material of this species presently studied from Calcutta, Howrah and 24 Parganas.

55. *Rhyothemis variegata variegata* (Linnaeus)

1763. *Libellula variegata* Linnaeus, *Amoenitates. Acad.*, **6** : 412 ; 1936. *Rhyothemis variegata variegata*, Fraser, *Fauna Brit. India*, **3** : 423-424 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.* : 64.

Distribution : India [Assam, Bihar, Himachal Pradesh, West Bengal (Calcutta)], Burma, Sri Lanka, Malaysia and Philippines. Material of

this species presently studied also from Hooghly, Howrah and 24 Parganas (West Bengal).

Remarks : It is also most commonly available in this area. A large number of specimens were observed fluttering about 6-7 metres above the ground near a permanent pond.

56. *Zyxomma petiolatum* Rambur

1842. *Zyxomma petiolatum* Rambur, *Ins. Neurop.*, : 30 ; 1936. *Zyxomma petiolatum*, Fraser, *Fauna Brit. India*, 3 : 409-410.

Distribution : Throughout India, Burma and Sri Lanka Material of this species presently studied from Calcutta (West Bengal).

57. *Tholymis tillarga* (Fabricius)

1798. *Libellula tillarga* Fabricius, *Ent. Syst. Suppl.*, : 285 ; 1936. *Tholymis tillarga*, Fraser, *Fauna Brit. India*, 3 : 411-413 ; 1974. Mitra and Lahiri, *Entomologist's Rec. J. Var.* 86 : 74 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Himachal Pradesh, Madhya Pradesh, Punjab, Uttar Pradesh, West Bengal (Calcutta)], Australia, Burma, Sri Lanka, Madagascar and tropical Africa. Presently recorded from Hooghly, Calcutta and 24 Parganas (West Bengal).

Remarks : Commonly available at temporary and permanent water bodies. Specimens of this species were also observed at electric light during night.

58. *Pantala flavescens* (Fabricius)

1798. *Libellula flavescens* Fabricius, *Ent. Syst. Suppl.*, 285 ; 1936. *Pantala flavescens*, Fraser, *Fauna Brit. India*, 3 : 414 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : Circumtropical and subtropical in distribution, India [Assam, Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal (Calcutta)], Burma, Sri Lanka and Tibet. Material of this species presently studied also from Howrah and 24 Parganas (West Bengal).

59. *Tramea basilaris burmeisteri* Kirby

1889. *Tramea burmeisteri* Kirby, *Trans. Zool. Soc. Lond.*, 12 : 316 ; 18.9. *Libellula chinensis*, Burmeister, *Handb. Ent.*, 2 : 852 ; 1936. *Tramea basilaris burmeisteri*, Fraser, *Fauna Brit. India*, 3 : 432-434 ; 1976. Mitra *et al.*, *Third All India Congr. Zool.*, : 64.

Distribution : India [Himachal Pradesh, Punjab, Rajasthan, Uttar Pradesh, West Bengal (Calcutta)], Burma, Sri Lanka and Malaysia. Material of this species presently studied from Hooghly (West Bengal).

SUMMARY

A total of 50 species of Odonata belonging to two suborders, 8 families and 34 genera have been recorded from Calcutta (West Bengal, India) and surroundings which includes nine species recorded for the first time from this area and one (*Ictinogomphus pertinax*) is a new record from India. Synonymy and distribution of another 9 species recorded from Calcutta are included. Some field notes and variations from the published description, have also been recorded. A key to the species and subspecies of adult dragonflies has also been provided.

Key to the Odonates of Calcutta and its environs

A key to 59 species of Odonates under 37 genera and 8 families known to occur in and around Calcutta is given below. Fraser (1933, '34, '36, '57) has been adopted with slight modification.

1. Head transversely elongated ; eyes well separated ; fore and hind wing more or less similar in shape and breadth. ...

Head not prominently elongated transversely, eyes not well separated, meeting only at a point or broadly confluent. ...

2. Veins IRiii+v arising nearer node than arc, no intercalated sectors at apical end of wing....

Veins IRiii+v arising nearer arc than node ; variable number of intercalated sectors at the apical end of wing. ...

3. Discoidal cell short ; anal vein separating from wing border either proximal to Ac or distal to Ac ; MA and IRiii zigzagged for greater part of their length. ...

Discoidal cell elongate ; anal vein separating from wing border proximal to Ac ; MA and Rliii mostly straight only zigzagged apically or not at all. ...

4. Cuii at its origin only slightly arched towards the costa. Pterostigma nearly as broad as long, nearly squared. ...

5. Arc situated distal to the level of distal antenodal nervure, the junction of ab and IA markedly angulated. ...

Arc situated at the level of distal antenodal nervure. ...

6. Labrum non-metallic. ...

Labrum metallic blue. ...
- 2

23

3

4

5

21

Platylestes Selys

[*Platylestes platystyla* (Rambur)]

Agriocnemis Selys....

8

7

A. pygmaea (Rambur)

7.	Abdomen whitish in colour.	...	<i>A. lacteola</i> Selys	
	Abdomen with heavy black marking.	...	<i>A. splendidissima</i> Laidlaw	
8.	ab arising from the hind border of the wing at the point where ac meets it.	...	...	9
	ab arising from the hind border of the wing more or less proximal to the point where ac meets it.	...	...	15
9.	A prominent ridge on the frons ; postocular coloured spots absent.	...	Ceragrion Selys...	10
	Ridge absent on the frons ; Pterostigma longer than broad.	...	Pseudagrion Selys...	11
10.	Abdomen bright red at base.	...	<i>C. cerinorubellum</i> (Brauer)	
	Abdomen citron yellow.	...	<i>C. coromandelianum</i> (Fabricius)	
11.	Face, frons and vertex blue or green and marked with black.	...	...	12
	Face, frons and vertex bright reddish-orange...	...	<i>P. rubriceps</i> Selys	
12.	Thorax pale blue on dorsal side.	...	<i>P. decorum</i> (Rambur)	
	Thorax blue on dorsal side.	...	...	13
13.	Superior anal appendages shorter than segment 10.	...	<i>P. australasiae</i> Selys	
	Superior anal appendages as long as segment 10.	...	...	14
14.	Superior anal appendages expanded on the inner side ; with 2 to 3 small spines near the base.	...	<i>P. microcephalum</i> (Rambur)	
	Superior anal appendages not expanded in the inner side, with a single robust spine near the base.	...	<i>P. spencei</i> Fraser	
15.	Pterostigma of the same colour and shape in fore and hind wings of male ; dorsal apical tubercle on segment 10 of male absent.	...	...	16
	Pterostigma differing in shape and size in fore and hind wings of male ; dorsal apical tubercle on segment 10 of male present.	...	Ischnura Charp.	18
16.	Female with a robust ventral apical spine on segment 8.	...	Enallagma Charp. (<i>Enallagma parvum</i> Selys)	
	Female without a ventral apical spine on segment 8.	...	...	17
17.	Tarsal claw-hooks of equal length ; post ocular coloured spots absent.	...	Onychargia Selys (<i>Onychargia atrocyana</i> Selys)	
	Tarsal claw-hooks unequal in length ; postocular coloured spots present ; only 8 to 10 post-nodal nervures in forewing.	...	Coenagrion Kirby [<i>Coenagrion dyeri</i> (Fraser)]	

18.	Body colour of male bright orange red ; abdominal segments 8 to 10 only black. ...	<i>I. rufostigma rufostigma</i> Selys	
	Body colour of males and Isochrome females blue or pale grass green. ...	...	19
19.	Abdominal segments 3 to 6 citron. ...	<i>I. aurora aurora</i> (Brauer)	
	Abdominal segments 3 to 6 black on dorsum....	...	20
20.	Segment 10 with blue spot on dorsum. ...	<i>I. forcipata</i> Morton	
	Segment 10 unmarked with blue ; abdominal segment 2 steely metallic blue on dorsal side. ...	<i>I. senegalensis</i> (Rambur)	
21.	Costal and posterior sides of discoidal cell equal or nearly so ; second segment of antennae as long as third. ...	Copera Selys...	22
22.	Legs bright orange to dull reddish in colour. ...	<i>C. marginipes</i> (Rambur)	
	Legs white in colour. ...	<i>C. annulata</i> (Selys)	
23.	Eyes meeting at a point or broadly confluent or zygoterous ovipositor lacking. ...	...	24
	Eyes confluent above. ...	...	29
24.	Discoidal cell, hypertrigone and subtrigone of fore wing traversed or reticulated. ...	...	25
	Discoidal cell, hypertrigone and subtrigone of fore wing entire. ...	...	28
25.	Superior anal appendage acute at apex. ...	Ictinogomphus Rambur...	26
26.	Face and femora yellow. ...	<i>I. angulosus</i> Selys	
	Face and femora black. ...	...	27
27.	Yellow ring on the 8th abdominal segment present. ...	<i>I. rapax</i> (Rambur)	
	Yellow ring on the 8th abdominal segment absent. ...	<i>I. pertinax</i> Selys	
28.	Discoidal cell of fore wing shorter than hind wing ; not more than 4 cells in anal triangle ; incomplete basal antenodal nervure ; 3 or more cells between IA and posterior margin of wings ; superior anal appendages of male with inner medial branch. ...	Macrogomphus Selys (<i>Macrogomphus montanus</i> Selys)	
29.	Discoidal cells closely similar in fore and hind wings and traversed. ...	...	30
	Discoidal cells differing in fore and hind wings, not traversed. ...	...	34
30.	Base of hind wing without a notch, tornous of hind wing rounded in both sexes, anal triangle absent. ...	...	31
	Base of wing more or less deeply notched, tornous of hind wing angulated in male, anal triangle always present. ...	...	33

31. Segments 4-8 of abdomen with longitudinal supplementary ridge on the sides, only 2 rows of cells between origin of cuia and IA of hind wing, superior anal appendage of male obtuse at apex. ... **Anax** Leach 32
- Segments 4-8 of abdomen without ridge, 3 rows of cells between origin of Cuia and IA of hind wing, superior anal appendages acuminate at apex. ... **Hemianax** Selys
[*Hemianax ephippiger* (Burmeister)]
32. Abdomen with orange coloured markings. ... *A. guttatus* (Burmeister)
Abdomen with blue coloured markings. ... *A. imperator* Leach
33. Nervure Riii making an abrupt curve towards and beneath outer end of Pterostigma, MA fusing with Riv+v well before posterior border of wing, Rspl forked shortly after its origin, superior anal appendage with apex prolonged and curved downwards abruptly ... **Anacischna** Selys.
[*Anacischna jaspidea* (Burm.)]
- Pterostigma long and narrow, dentigerous plate of female ending in 2 long curved divaricate spines, segment 3 of abdomen nearly always constricted. ... **Acanthagyna** Rambur
[*Acanthagyna dravida* (Lieftinck)]
- Pterostigma long and narrow, dentigerous plate of female provided with two long, straight styles with hairs at tip. ... **Gynacantha** Rambur
(*Gynacantha rammohni* Mitra & Lahiri)
34. Base of hindwing in male more or less angulated or notched; orilllets present, tibiae of male with elongate lamina shaped keel on flexor surface. ... 35
Base of hindwing not angulated or notched but rounded in both sexes tibiae of male without keel. ... 36
35. Base of wings of female alone with dark brown costal rays; superior anal appendages poorly angulated on the outer side near the middle; frons with a single medial yellow spot in the notch. ... **Epophthalmia** Burmeister
[*Epophthalmia v. vittata* (Burm.)]
36. Sectors of arc separate from origin; feebly developed primary:antenodal present. ... 37
Sectors of arc fused at their origin; Primary antenodal absent. ... 39
37. Subtrigone in fore wing entire. ... **Aethriamanta** Kirby
[*Aethriamanta b. brevipennis* (Rambur)]
- Subtrigone in fore wing 3 celled. ... 38

88.	Abdomen blood red.	...	Urothemis Brauer [<i>Urothemis s. signata</i> (Rambur)]	
	Abdomen bright pale yellow.	...	Macrodiplax Brauer [<i>Macrodiplax cora</i> (Brauer)]	
89.	Apex of loop in the wings open.	...	...	40
	Apex of loop in the wings closed.	...	...	41
40.	An opalescent white spot in the middle of the hind wings present.	...	Tholymis Hagen [<i>Tholymis tillarga</i> (Fabr.)]	
	An opalescent white spot in the middle of the hind wings absent.	...	Zyxomma Rambur (<i>Zyxomma petiolatum</i> Rambur)	
41.	Distal antenodal nervure in forewings complete.	...	...	42
	Distal antenodal nervure in forewings incomplete.	...	...	48
42.	Frons metallic above.	...	Brachydiplax Brauer	43
	Frons non-metallic above.	...	...	45
43.	Bases of both fore and hindwings darkbrown.	...	<i>B. chalybea chalybea</i> Brauer	
	Bases of both fore and hindwings uncoloured or rarely light pale yellow.	...	...	44
44.	8 to 9 antenodal nervures in forewings.	...	<i>B. farinosa</i> Kruger	
	only 7 antenodal nervures in forewings.	...	<i>B. sobrina</i> (Rambur)	
45.	Small sized species ; only 6 antenodal nervures in forewings.	...	Acisoma Rambur (<i>Acisoma p. panorpoides</i> Rambur)	
	Medium sized species, not less than 12 antenodal nervures in forewings		Orthetrum Newman....	46
46.	Abdomen enormously swollen at base and then abruptly slimmed ; thorax and abdomen not pruinosed.	...	<i>O. sabina sabina</i> (Drury)	
	Abdomen variable, never very slimmed ; thorax and abdomen pruinosed.	...	...	47
47.	Large black triangular spots present at the base of hind wings.	...	<i>O. triangulare triangulare</i> (Selys)	
	Large black triangular spot absent at the base of hindwings.	...	<i>O. glaucum</i> (Brauer)	
48.	Lobes of prothorax with long hairs.	...	...	49
	Lobes of prothorax without long hairs.	...	...	51

49. Borders of discoidal field converging at the wingb order ; black marking on thorax present. ... **Sympetrum Newman**
[*Sympetrum hypomelas* (Selys)]
- Borders of discoidal field diverging at wing border and begin with 2 row of cells. ... **Diplacodes Kirby... 50**
50. Apices of fore and hind wings tipped with black. ... *D. nebulosa* [Fabr.]
- Apices of fore and hindwings not tipped with black ; anal appendages yellow. ... *D. trivialis* (Rambur)
51. Sectors of arc in forewings separated and divergent at the origin ; black and golden yellow markings present on the wings. ... **Rhyothemis Hagen**
[*Rhyothemis v. variegata* (Linnaeus)]
- Sectors of arc in forewings arising from common long stalk. ... 52
52. Discoidal field converging at wing border. ... 53
- Discoidal field parallel or divergent at wing border. ... 55
53. Nervure IRii present in between Rii and Riii. ... **Pantala Hagen**
[*Pantala flavescens* (Fabr.)]
- Nervure IRii absent in between Rii and Riii. ... **Trithemis Brauer... 54**
54. Legs very long and spidery ; pterostigma bicolourous. ... *T. pallidinervis* (Kirby)
- Legs normal length ; pterostigma unicolourous ; neuration crimson. ... *T. aurora* (Burmeister)
55. Pterostigma unequal in fore and hindwings ; two large black spot surrounded by golden yellow markings present at the base of wings. ... **Tramea Hagen**
(*Tramea basilaris burmeisteri* Kirby)
- Pterostigma equal in size in fore and hindwings. ... 56
56. Pterostigma bicolours (Black with white end). ... **Bradinopyga Kirby**
[*Bradinopyga geminata* (Rambur)]
- Pterostigma unicolourous. ... 57
57. More than one cubital nervure present in all wings. ... **Neurothemis Brauer 58**
- only one cubital nervure present in all the wings. ... 59
58. Base of wings golden yellow ; an opalescent white bands in the wings absent. ... *N. intermedia intermedia* (Rambur)
- Base of wings broadly black ; an opalescent white band in the wings present. ... *N. tullia tullia* (Drury)

59. Red or pale yellow species ; basal or medial yellow marking present on wings. ... 60
variable coloured species ; base of wings rarely marked with red or pale yellow. ... 62
60. Broad reddish yellow medial marking present on the wings. ... **Brachythemis** Brauer.
[*Brachythemis contaminata* (Fabricius)]
Small basal yellow marking present at the base of wings. ... **Crocothemis** Brauer... 61
61. Anal appendages blood red. ... *C. servilia servilia* (Drury)
Anal appendages reddish brown with black base. ... *C. indica* Sahni
62. Only one row of cells present inbetween IRii and Rspl. ... **Lathrecista** Kirby
[*Lathrecista asiatica asiatica* (Fabricius)]
Two rows of cells present inbetween IRiii and Rspl. ... **Potamarcha** Karsch
[*Potamarcha obscura* (Rambur)]

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REFERENCES

- BHASIN, G. D. 1953. Odonata, In Roonwal *et. al.* A systematic catalogue of the main identified collection of the Forest Research Institute, Dehra Dun, Part 9-21. *Indian Forest Leaflet*, **121** (3) : 63-69.
- FRASER, F. C. 1933. *The Fauna of British India, Odonata*, (London) **1** : 1-423.
- FRASER, F. C. 1934. *The Fauna of British India, Odonata* (London) **2** : 1-398.
- FRASER, F. C. 1936. *The Fauna of British India, Odonata* (London) **3** : 1-461.
- FRASER, F. C. 1957. A reclassification of order Odonata, based on some new interpretation of the venation of the dragonfly wing. *Royal Zoological Society N. S. W. Sydney*, : 133.
- LAIDLAW, F. F. 1916. Notes on Indian Odonates, *Rec. Indian Mus.*, **12** : 129-136.

- LAIDLAW, F. F. 1916. Notes on Oriental dragonflies in the Indian Museum. *Rec. Indian Mus.*, **12** : 21-25.
- LAIDLAW, F. F. 1919. A list of the dragonflies recorded from the Indian Empire with special reference to the collection of the Indian Museum. *Rec. Indian Mus.*, **16** Part II : 169-195.
- LAIDLAW, F. F. 1922. A list of the dragonflies recorded from the Indian Empire with special reference to the collection of the Indian Museum, Part V. *Rec. Indian Mus.*, **24** : 367-414.
- LIEFTINCK, M. A. 1942. Dragonflies (Odonata) of New Guinea and Neighbouring Islands. *Treubia*, **18** (3) : 441-608.
- LAHIRI, A. R. AND MITRA, T. R. 1972. A note on *Acanthagyna dravida* (Lieftinck) (Insecta : Odonata : Aeshnidae). *J. Bombay nat. Hist. Soc.*, **69** (2) : 438-439.
- MITRA, T. R. AND LAHIRI, A. R. 1974. Notes on distribution of some dragonfly species (Odonata : Anisoptera) of Bengal. *Entomologist's Rec. J. Var.*, **86** (3) : 73-74.
- MITRA, T. R. AND LAHIRI, A. R. 1975. A new species of *Gynacantha* Rambur (1842) (Odonata) from India. *Entomologist's Rec. J. Var.*, **87** (5) : 148-149.
- MITRA, T. R., LAHIRI, A. R. AND RAYCHAUDHURY, D. N. 1976. Remarks on dragonflies (Odonata : Anisoptera) of Calcutta. *Third All India Congr. Zool.* : 64.

TERMITE FAUNA OF ORISSA STATE, EASTERN INDIA

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(With 3 Text-figures and 2 Tables)

INTRODUCTION

Silvestri (1923) reported 10 species of termites from a small island of Barkuda in the Chilka lake, Orissa, while Annandale in the same year gave a detailed account of the nesting habits of these insects from this island. There was no further addition to our knowledge of the termites of Orissa state till the publication of the catalogue by Snyder (1949) wherein ten species were reported from this state. Subsequently Roonwal and Sen-Sarma (1955), Mathur and Chhotani (1969), and Thakur (1976) have reported ten more species.

This present work deals with the termite material, collected over the past few years, by various survey parties of the Zoological Survey of India, from Orissa state, India. The entire material consists of 20 species distributed over 10 genera and 2 families. Of these eight species are new records for the state and one is new to science. In all, 31 species are now known from this state, a list of which and the keys for their identification are provided here.

Abbreviations used

The following abbreviations are used : coll., Collected by ; Im., Imago ; K., King ; Q., Queen ; S., Soldier ; W., Worker.

LIST OF SPECIES AND KEY FOR IDENTIFICATION

(A) LIST OF SPECIES KNOWN FROM ORISSA STATE

Family KALOTERMITIDAE

1. *Bifiditermes pintoï* (Kemner)
2. *Cryptotermes dudleyi* Banks

Family RHINOTERMITIDAE

3. *Heterotermes balwanti* Mathur & Chhotani
4. *Coptotermes heimi* (Wasmann)
5. *Coptotermes travians* Haviland

Family TERMITIDAE

6. *Speculitermes cyclops* Wasmann
7. *Speculitermes sinhalensis* Roonwal & Sen-Sarma
8. *Eurytermes assmuthi assmuthi* Wasmann
9. *Eurytermes assmuthi modestior* Silvestri
10. *Angulitermes ramanii* sp. nov.
11. *Dicuspitermes obtusus* (Silvestri)
12. *Microcerotermes annandalei* Silvestri
13. *Microcerotermes beelsoni* Snyder
14. *Macrotermes estherae* (Desneux)
15. *Odontotermes assmuthi* Holmgren
16. *Odontotermes bellahunisensis* Holmgren & Holmgren
17. *Odontotermes brunneus* (Hagen)
18. *Odontotermes ceylonicus* (Wasmann)
19. *Odontotermes feae* (Wasmann)
20. *Odontotermes guptai* Roonwal & Bose
21. *Odontotermes horni* (Wasmann)
22. *Odontotermes indicus* Thakur
23. *Odontotermes microdentatus* Roonwal & Sen-Sarma
24. *Odontotermes obesus* (Rambur)
25. *Odontotermes orissae* (Snyder)
26. *Odontotermes redemanni* (Wasmann)
27. *Odontotermes wallonensis* (Wasmann)
28. *Euscaiotermes primus* Silvestri, Silvestri (1923) described this species as *Odontotermes (Euscaiotermes) primus* Silvestri
29. *Microtermes obesi* Holmgren
30. *Nasutitermes fletcheri* (Holmgren & Holmgren)
31. *Trinervitermes biformis* (Wasmann)

**(B) KEY FOR THE IDENTIFICATION OF TERMITES OF
ORISSA BASED ON SOLDIER CASTE**

- | | | | |
|---------|--|-----|--|
| 1 (4) | Head without fontanelle and frontal gland | ... | Family KALOTERMITIDAE |
| 2 (8) | Head capsule long and not phragmotic ;
mandibles comparatively long | ... | Genus <i>Bifiditermes</i> Krishna |
| | [Anterior broader part of postmentum bilobed
and covering about half its total length] | ... | <i>B. pintoï</i> (Kemner) |
| 3 (2) | Head capsule short and phragmotic ; man-
dibles comparatively short | ... | Genus <i>Cryptotermes</i> Banks |
| | [Head-length to base of mandibles 1.60-1.80
mm, width of head 0.90-1.35 mm ; mandi-
bles with prominent dentition] | ... | <i>C. dudleyi</i> Banks |
| 4 (1) | Head with fontanelle and frontal gland | | |
| 5 (10) | Pronotum flat | ... | Family RHINOTERMITIDAE |
| 6 (7) | Head-capsule rectangular, fontanelle small,
situated on dorsum of head | ... | Genus <i>Heterotermes</i> Froggatt |
| | [Small species ; head-length 1.03-1.25 mm,
head-width 0.66-0.88 mm] | ... | <i>H. balwanti</i> Mathur & Chhotani |
| 7 (6) | Head oval, fontanelle large, situated just
behind clypeus | ... | Genus <i>Coptotermes</i> Wasmann |
| 8 (9) | Minimum width of postmentum greater
(0.25-0.34 mm), contraction index 0.63-0.76 | ... | <i>C. heimi</i> (Wasmann) |
| 9 (8) | Minimum width of postmentum smaller
(0.20-0.29 mm), contraction index 0.57-0.69 | | <i>C. travians</i> Haviland |
| 10 (5) | Pronotum saddle-shaped | ... | Family TERMITIDAE |
| 11 (14) | Mandibles degenerate, head produced into
rostrum | | |
| 12 (13) | Soldiers dimorphic | ... | Genus <i>Trinervitermes</i>
Holmgren |
| | [Head width 1.30-1.36 mm ; number of
antennal segments 13] | ... | <i>T. biformis</i> Wasmann |
| 13 (12) | Soldiers monomorphic | ... | Genus <i>Nasutitermes</i> Dudley |
| | [Head-length with rostrum 1.25-1.36 mm,
head-width 0.78-0.83 mm ; number of anten-
nal segments 12] | ... | <i>N. fletcheri</i> (Holmgren &
Holmgren) |
| 14 (11) | Mandibles well developed ; head not pro-
duced into rostrum | | |
| 15 (48) | Mandibles symmetrical | | |
| 16 (19) | Mandibles serrated, without any prominent
teeth | ... | Genus <i>Microcerotermes</i>
Silvestri |

- 17 (18) Pronotum with well developed notch at anterior margin. Head-length 1.63-1.66 mm, head-width 0.95-1.00 mm ... *M. annandalei* Silvestri
- 18 (17) Pronotum without or with a weak median notch at anterior margin
Head-length 1.25-1.30 mm, head-width 0.80-0.82 mm, head-index (width/length) 0.58-0.61 ... *M. beelsoni* Snyder
- 19 (16) Mandibles not serrated, with or without teeth or crenulations
- 20 (21) Left mandible with a prominent notch at middle ... *Euscaiotermes primus* Silvestri
- 21 (20) Left mandible without any notch
- 22 (23) Mandibles thin, without any teeth or crenulations. Soldiers smaller than workers ... Genus *Microtermes* Wasmann
[Mandibles weakly hooked ; labrum lanceolate, broader at tip] ... *M. obesi* Holmgren
- 23 (22) Mandibles thick and stout ; left with teeth or crenulations
- 24 (27) Left mandible with two widely separated teeth ; labrum triangular. ... Genus *Eurytermes* Wasmann
- 25 (26) Larger species (head 2.0 mm long and 1.30 mm wide) ; mandibles 0.83-0.87 mm long ... *E. assmuthi assmuthi* Wasmann
- 26 (25) Smaller species (head 1.70 mm long and 1.08 mm wide) ; mandibles 0.78 mm long ... *E. assmuthi modestior* Silvestri
- 27 (24) Left mandible with a single variably placed tooth or crenulations in basal half
- 28 (29) Labrum with a hyaline tip ; left mandible with crenulations in basal half ... Genus *Macrotermes* Holmgren
[Soldier major : head-length 4.15-4.20 mm, head-width 4.10-4.25 mm] ... *M. estherae* (Desneux)
- 29 (28) Labrum without a hyaline tip ; left mandible with a variably placed tooth ... Genus *Odontotermes* Holmgren
- 30 (31) Mandibles very straight, tooth on left mandible minute ... *O. microdentatus* Roonwal & Sen-Sarma
- 31 (30) Mandibles curved or sabre-shaped, tooth on left mandible prominent
- 32 (41) Head oval to subrectangularly oval ; antennae darker distally
- 33 (36) Mandibles short, index left mandible-length/head-length 0.52-0.57
- 34 (35) Anterior margin of pronotum rounded and posterior margin with a weak median depression ... *O. guptai* Roonwal & Bose

- 85 (34) Anterior margin of pronotum triangular and posterior margin straight ... *O. bellahunisensis* Holmgren & Holmgren
- 86 (33) Mandibles long, index left mandible-length/head-length 0.60-0.70
- 87 (38) Left mandibular tooth forwardly placed, index tooth distance from tip/mandible length 0.30-0.37 ... *O. redemanni*/ *O. obesus* (Wasmann) (Rambur)
- 88 (37) Left mandibular tooth backwardly placed, index tooth distance from tip/mandible length 0.39-0.46
- 89 (40) Mandibles strongly incurved in front from middle ; left mandibular tooth index 0.39-0.42 ; larger species ... *O. brunneus* (Hagen)
- 40 (39) Mandibles comparatively less so incurved from distal third ; left mandibular tooth index 0.41-0.46 ; smaller species ... *O. wallonensis* (Wasmann)
- 41 (32) Head capsule subrectangular ; antennae uniformly coloured
- 42 (43) Tooth on left mandible distinctly acute, making an angle of 60° ... *O. indicus* Thakur
- 43 (42) Tboth on left mandible laterally directed, making an angle of 90°
- 44 (45) Smaller species. Head-length 1.55-2.20 mm ; head sides subparallel. ... *O. ceylonicus* (Wasmann)
- 45 (44) Larger species. Head-length 2.30-2.60 mm ; head sides weakly convex, or converging in front
- 46 (47) Head-capsule parallel sided, somewhat convex medially ... *O. horni* (Wasmann)
- 47 (46) Head capsule converging anteriorly ... *O. feae* (Wasmann)
- 48 (15) Mandibles asymmetrical or rod-like
- 49 (50) Head with frontal protuberance ; mandibles rod-like ... Genus *Angulitermes* Sjöstedt
- [Frontal gland large ; head-length 1.18-1.20 mm, mandible-length 1.18-1.25 mm ; labrum anteriorly deeply incurved] ... *A. ramanii* sp. nov.
- 50 (49) Head without frontal protuberance ; mandibles strongly asymmetrical, left mandible strongly twisted in the middle. ... Genus *Dicuspiditermes* Krishna
- [Labrum deeply concave with two antero-lateral processes ; head 2.00 mm long ; antero-lateral corners of head rounded] ... *D. obtusus* Silvestri

SYSTEMATIC ACCOUNT

Family RHINOTERMITIDAE

Genus *Coptotermes* Wasmann1. *Coptotermes heimi* (Wasmann)

Material (S., W.) and distribution : Rambha, coll. *O. B. Chhotani*, July, 1961 ; Puri and Gopalpur, coll. *G. Ramakrishna*, Feb. 1962 ; Champajuhra forest, Rairakkol, Hathisalpara, coll. *P. K. Maiti*, Dec. 1971 ; Jharsuguda, coll. *P. K. Maiti*, Jan. 1972 ; Chandbali, coll. *S. Biswas*, Feb. 1972 ; Champagarh, coll. *J. K. Sen*, Feb. 1972. Earlier records : India : Barkuda Island, Chilka Lake and almost throughout India.

Remarks : This species is noted for its destruction of wood and wooden articles and is reported from all over India. From Orissa this species has been collected from the dead trunk of *Casuarina equisetifolia*, cocoanut and banyan trees.

Genus *Heterotermes* Froggatt2. *Heterotermes balwanti* Mathur & Chhotani

Material (S., W.) and distribution : Barkuda Island, Puri and Rambha ; coll. *O. B. Chhotani*, July, 1961. Earlier records : India : Balukhand Forest Range near Puri ; Goa.

Remarks : This is not a very common species. It is recorded from dead trunk of *Casuarina* and banyan trees and twigs lying on ground.

Family TERMITIDAE

Genus *Speculitermes* Wasmann3. *Speculitermes cyclops* Wasmann

Material (W.) and distribution : Joshipur, coll. *J. K. Sen*, Nov. 1972. Earlier records : India : Assam ; Madhya Pradesh ; Maharashtra ; Rajasthan ; Uttar Pradesh.

Remarks : This species dwells in soil and is a non-wood-destroying termite. In Orissa, it has been collected from loose soil. This constitutes a new record of this species from Orissa state.

4. *Speculitermes sinhalensis* Roonwal & Sen-Sarma

Material (W.) and distribution : Kathpal, coll. *R. L. Chowdhury*, Nov. 1976. Earlier records : Sri Lanka. India : Madhya Pradesh ; Tamil Nadu.

Remarks : This is also a soil inhabiting termite from Orissa. It has been collected from loose soil. This is a new record for this state.

Genus *Microcerotermes* Silvestri5. *Microcerotermes annandalei* Silvestri

Material (S., W.) and distribution : Chahala, coll. *S. Ali*, Feb., 1951 ; Barkuda Island, coll. *O. B. Chhotani*, July, 1961 ; Chhatrapur, coll. *G. Ramakrishna*, Nov. 1962. Earlier records : Barkuda Island.

Remarks : This termite is very much restricted in distribution. It nests in wooden stumps, logs, etc. but does not pose a serious problem. From Orissa it has been collected from the dead trunk of *Casuarina equisetifolia*, stumps of felled trees and twigs.

6. *Microcerotermes beelsoni* Snyder

Material (S., W.) and distribution : Champajuran Forest, Haldi nulla, Bonaigarh and Rairakhol, coll. *P. K. Maiti*, Dec. 1971. Earlier records : India : Haryana ; Madhya Pradesh : Punjab and Uttar Pradesh. Pakistan.

Remarks : This species attacks wood in the open and builds nests therein. In Orissa it has also been collected from dead trunk of *Casuarina equisetifolia*. This is a new record for the state.

7. *Angulitermes ramanii* sp. nov.

(Text-fig. 1 ; Table 1)

Material : (S.) Barkuda Island, Chilka Lake, Orissa ; coll. *O. B. Chhotani*, 8. vii. 1961 ex. mound (mixed with *Microtermes obesi* Holmg.)

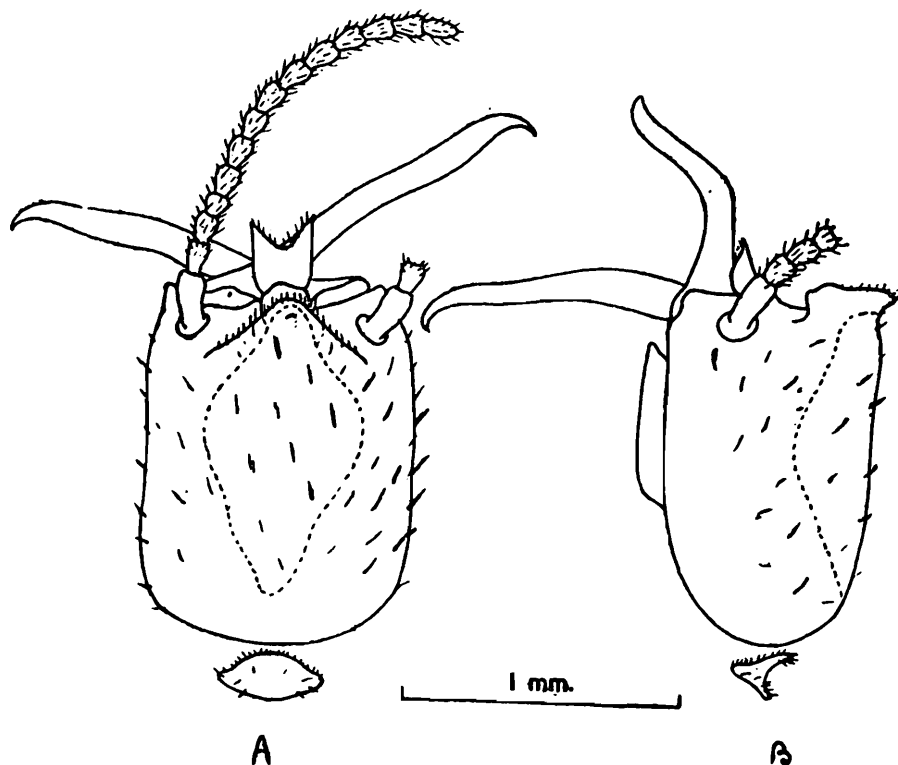
Description : 1. *Imago*.—Unknown

2. *Soldier* (Text-fig. 1 : Table 1).—Head light brown, mandibles dark reddish brown, antennae, labrum, legs and body pale yellow. Head and body moderately pilose. Total body-length 4.21-4.75 mm.

Head-capsule subrectangular, a little wider anteriorly ; longer than wide (head-length to base of mandibles 1.18-1.20 mm, head-width 0.88—0.91 mm) ; frontal projection bluntly conical, extends beyond base of mandibles. Fontanelle lying just below frontal projection and covered with hairs ; frontal gland large extending to about three fourths of head. Eyes and ocelli absent. Antennae 14-segmented, pilose ; segment 1 largest, cylindrical ; 2 less than half of 1, subequal to 3 ; 4 shortest ; from 5 gradually increasing in length and club-shaped, last (14th) oval, subequal to penultimate. Anteclypeus medially protruding, subsquarish.

Postclypeus reduced, notched. Mandibles long, slender, rod-like, bow-shaped in profile ; a little longer than head-length to mandible.

base ; left mandible broad near apex on inner margin, apex drawn out to a beak ; right mandible thin, with apex drawn out to a short beak. Labrum : subrectangular (length 0.23—0.26 mm ; width 0.23 mm) ; anterior margin deeply concave ; lateral processes pointed. Postmentum subrectangular, with slight constriction near base. Pronotum saddle-shaped, much broader than long, narrower than head ; anterior lobe



Text-fig. 1. *ulitermes* sp. nov. Soldier. (A) Head and pronotum dorsal view, (B) Head and pronotum, side view.

upturned, with weak median notch. Legs thin, pilose ; apical tibial spurs 3 : 2 : 2. Abdomen oval, pilose ; cerci 2-jointed, 0.09 mm long ; styli absent.

3. Worker : Unknown

Type-specimens : Holotype S. (Z. S. I., Reg. No. 2370/H11) and one paratype S. (Z. S. I. Reg. No. 2371/H11) in two vials, vide material above, deposited in National Zoological Collections, Zoological Survey of India, Calcutta.

Type-locality and Distribution : India : Orissa, Barkuda Island, Chilka lake (Type-locality), known only from the type-locality.

Affinities : The soldier of *Angulitermes ramanii* sp. nov. is close to that of *Angulitermes obtusus* Holmgren & Holmgren but is separable

by the following characters :—(i) Size larger (head length 1.18-1.20 mm. vs. 1.12-1.14 mm in *obtusus*). (ii) Mandibles shorter, length 1.25 mm, stouter and curved on outer margin vs. longer, length 1.27-1.30 mm and not so curved. (iii) Frontal gland large, covering three fourth of head vs. smaller, covering only about half of head. (iv) Frontal protuberance more acute. (v) Labrum deeply incurved anteriorly vs. shallowly incurved in *obtusus*.

TABLE 1. Measurements (in mm) etc. of soldier of *Angulitermes ramani* sp. nov.

Body parts	Range (2 exs)	Holotype
1. Total body-length (excluding antennae) ...	4.20-4.75	4.20
2. Length of head to lateral base of mandibles ...	1.18-1.20	1.20
3. Length of head to frontal projection ...	1.28-1.33	1.33
4. Length of protuberance ...	0.13-0.15	0.15
5. Maximum width of head ...	0.88-0.91	0.88
6. Maximum height of head ...	0.70-0.73	0.70
7. Head Index (Width/Length) ...	0.74-0.75	0.74
8. Head Index (Height/Width) ...	0.79-0.80	0.79
9. Head Index (Height/Length) ...	0.58-0.60	0.58
10. Maximum length of labrum ...	0.23-0.26	0.26
11. Maximum width of labrum ...	0.23	0.23
12. Length of mandibles (from upper base of condyle to tip)		
(a) Left mandible ...	1.25	1.25
(b) Right mandible ...	1.18-1.23	1.18
13. Head-mandibular length Index (left-mandible-length/Head-Length) ...	1.04-1.05	1.04
14. Minimum median length of postmentum ...	0.50	0.50
15. Maximum width of postmentum ...	0.31-0.32	0.32
16. Width of postmentum at waist ...	0.26-0.28	0.26
17. Maximum length of pronotum ...	0.19-0.20	0.20
18. Maximum width of pronotum ...	0.48-0.50	0.48

Genus *Macrotermes* Holmgren

8. *Macrotermes estherae* (Desneux)

Material (*Im, S., W.*) and **distribution** : Barkuda Island and Rambha, coll. O. B. Chhotani, July, 1961. Earlier records : India : Peninsular India.

Remarks : This species attacks wood in the open but generally it is subterranean in habit. In Orissa, it was collected from small heaps of loose soil while returning from foraging expeditions to the nest in the evening. This is a new record for the state.

Genus **Odontotermes** Holmgren9. **Odontotermes assmuthi** Holmgren

Material (S., W.) and distribution : Barkuda Island, coll. O. B. Chhotani, July 1961 ; Ghatgaon, coll. J. K. Sen, Nov. 1972 ; Biso, coll. S. K. Gupta, March, 1973 ; Lulung, coll. D. P. Sanyal, Dec. 1975. Earlier records : Recorded from all over India. Also Pakistan and Bangla Desh.

Remarks : It is generally a non-mound building subterranean termite. It attacks logs in the open and is a pest of sugarcane. In Orissa this species was collected from rotten logs of unidentified plants.

10. **Odontotermes bellahunisensis** Holmgren & Holmgren

Material (S., W.) and distribution : Chahala, coll. A. K. Mondal, Jan. 1971 ; Lulung, Ghatgaon, coll. D. P. Sanyal & A. K. Sarkar, Dec. 1975. Earlier records : India : Karnataka, Rajasthan and Tamil Nadu.

Remarks : This is also a non-mound building termite and attacks dead woods. In Orissa the species has been collected from the rotten logs of unidentified trees.

11. **Odontotermes brunneus** (Hagen)

Material (S., W.) and distribution : Biswanathpur, coll. A. K. Mondal, July, 1974. Earlier records : Andhra Pradesh, Bihar, Karnataka, Maharashtra, Rajasthan, Tamil Nadu and West Bengal.

Remarks : This species usually builds mounds and attacks wood lying in the open. Here this species was collected from rotten logs of unidentified plants. This species is a new record for the state.

12. **Odontotermes ceylonicus** (Wasmann)

Material (S., W.) and distribution : Rairakhol, coll. P. K. Maiti, Dec. 1971 ; Kotabangi, coll. K. V. Surya Rao, Jan. 1972 ; Lathore, coll. D. P. Sanyal, Nov. 1972 ; Ghatgaon, coll. D. P. Sanyal & A. K. Sarkar, Dec. 1975. Earlier records : India : Southern India.

Remarks : This species is very much restricted in distribution. In Orissa it has been collected from soil and forms first record of this species from the state.

13. *Odontotermes feae* (Wasmann)

Material (Q., K. S. W.) **and distribution** : Barkuda Island, coll. N. Annandale, June, 1920, and O. B. Chhotani, July, 1961 ; Badrama, coll. D. P. Sanyal, June, 1972. Earlier records : India : Andhra Pradesh, Kerala, Rajasthan, Tamil Nadu, Tripura, West Bengal.

Remarks : This is a serious pest of timbers. It attacks woods of different trees. In Orissa also this species was collected from rotten logs.

14. *Odontotermes horni* (Wasmann)

Material (S., W.) **and distribution** : Sambalpur, Bolangir, Rairakhol, and Sundergarh, coll. P. K. Maiti, Dec. 1971-Jan. 1972 ; Badrama, coll. K. Rai, Sept. 1972 ; Ghatgaon, Joshipur and Tikripara, coll. J. K. Sen ; Nov. 1972 ; Posighat, Baiganpal, coll. S. K. Gupta, March 1973 ; Sonapur, coll. S. Biswas, Jan. 1975 ; Dhenkikote and Lulung, coll. D. P. Sanyal & A. K. Sarkar, Dec. 1975. Earlier records : Southern and Eastern India.

Remarks : This is a subterranean species, builds nests underground, attacks wood and does a lot of damage. In Orissa the species has been collected mainly from rotten logs. This species also forms a new record for the state.

15. *Odontotermes microdentatus* Roonwal & Sen-Sarma

Material (S., W.) **and distribution** : Chahala, coll. A. K. Mondal, Jan. 1971. Earlier record : India : Bihar ; Himachal Pradesh ; Madhya Pradesh ; Uttar Pradesh.

Remarks : This termite builds mounds but also attacks wood when comes in contact with it. In Orissa it has been collected from a mound.

16. *Odontotermes obesus* (Rambur)

Material (K., Q., S., W.,) **and distribution** : Satpura, coll. B. S. Lamba, Dec. 1960 ; Rambha, coll. O. B. Chhotani, July, 1961 ; Mahanadi estuary, coll. N. V. Subba Rao, March, 1964 ; Barkuda Island, coll. K. N. Nair, Feb. 1969 ; Chandipur, and Puri, coll. V. K. Premkumar, Jan.-Feb. 1972 ; Sonapalli, Subālia Kangra, Balijuri and Grandarail, coll., P. K. Maiti, Dec. 1971-Jan. 1972 ; Attgarh, coll. S. K. Mitra, August, 1972 ; Badrama, Deogarh, Panposh, Harishankar Hill and Lathore, coll. D. P. Sanyal, May-June, 1972 ; Tikrapara, Nimapatha and Balugaon,

coll. Y. Chaturvedi, Sept.-Oct. 1972 ; Padmapore, Joshipur, coll. J. K. Sen, Nov. 1972 ; Angul, coll. K. Rai, Sept. 1972 ; Khantapara, coll. B. C. Saha, Sept. 1974 ; Puranokot, Denkanol and Denkikote, coll. D. P. Sanyal & A. K. Sarkar, Dec. 1975-Jan. 1976 ; Pudamani, Kathpal, Rangamati, Taptipuri, Dighapahandi, and Lulung, coll. R. L. Chowdhury, Feb.-March, 1976. Earlier records : Throughout India, Pakistan and Bangla Desh.

Remarks : This is the most widely distributed and abundant species of termites. It builds mounds and is a serious pest of crops and forestry. From Orissa it has been collected from both mounds and from dead woods.

17. *Odontotermes wallonensis* (Wasmann)

Material (S., W.) and distribution : Sambalpur, and Rourkela, coll. P. K. Maiti, Dec. 1971 ; Bandigarh, coll. S. Biswas, Jan. 1975. Earlier records : India : Madhya Pradesh ; Maharashtra ; Gujarat ; Rajasthan ; Karnataka ; Tamil Nadu ; Uttar Pradesh.

Remarks : This is a mound-building termite and often attacks wood. From Orissa the species has been collected from woods and mounds.

Genus *Microtermes* Wasmann

18. *Microtermes obesi* Holmgren

Material (S., W.) and distribution : Rambha and Barkuda Island, coll. O. B. Chhotani, July, 1961 ; Panposh, Graundarail and Sambalpur, coll. P. K. Maiti, Dec. 1971-Jan. 1972. Earlier records : Throughout India. Also Pakistan, Bangla Desh, Burma and Thailand.

Remarks : Usually this species forms subterranean nests but sometimes attacks wood and crop plants also and causes heavy damages. From Orissa it was collected from dead wood and nesting in mounds of *O. feae* and *O. obesus*.

Genus *Nasutitermes* Dudley

19. *Nasutitermes fletcheri* (Holmgren & Holmgren)

Material (S., W.) and distribution : Puri, coll. A. K. Mondal, July, 1973. Earlier records : India : Peninsular India.

Remarks : This species generally builds nests in dead wood in the open area. From Orissa also this species has been collected from dead wood. This species is a new record for the state,

Genus *Trinervitermes* Holmgren20. *Trinervitermes biformis* (Wasmann)

Material (S., W.) and distribution : Barkuda island, coll. O. B. Chhotani, July, 1961. Earlier records : India : Andhra Pradesh ; Karnataka ; Madhya Pradesh ; Maharashtra ; Rajasthan ; Tamil Nadu.

Remarks : This species generally forms subterranean nests but sometimes also builds small mounds. In Orissa it has been collected from diffuse soil under stones. This species also forms a new record for the state.

DISTRIBUTION OF TERMITES IN ORISSA

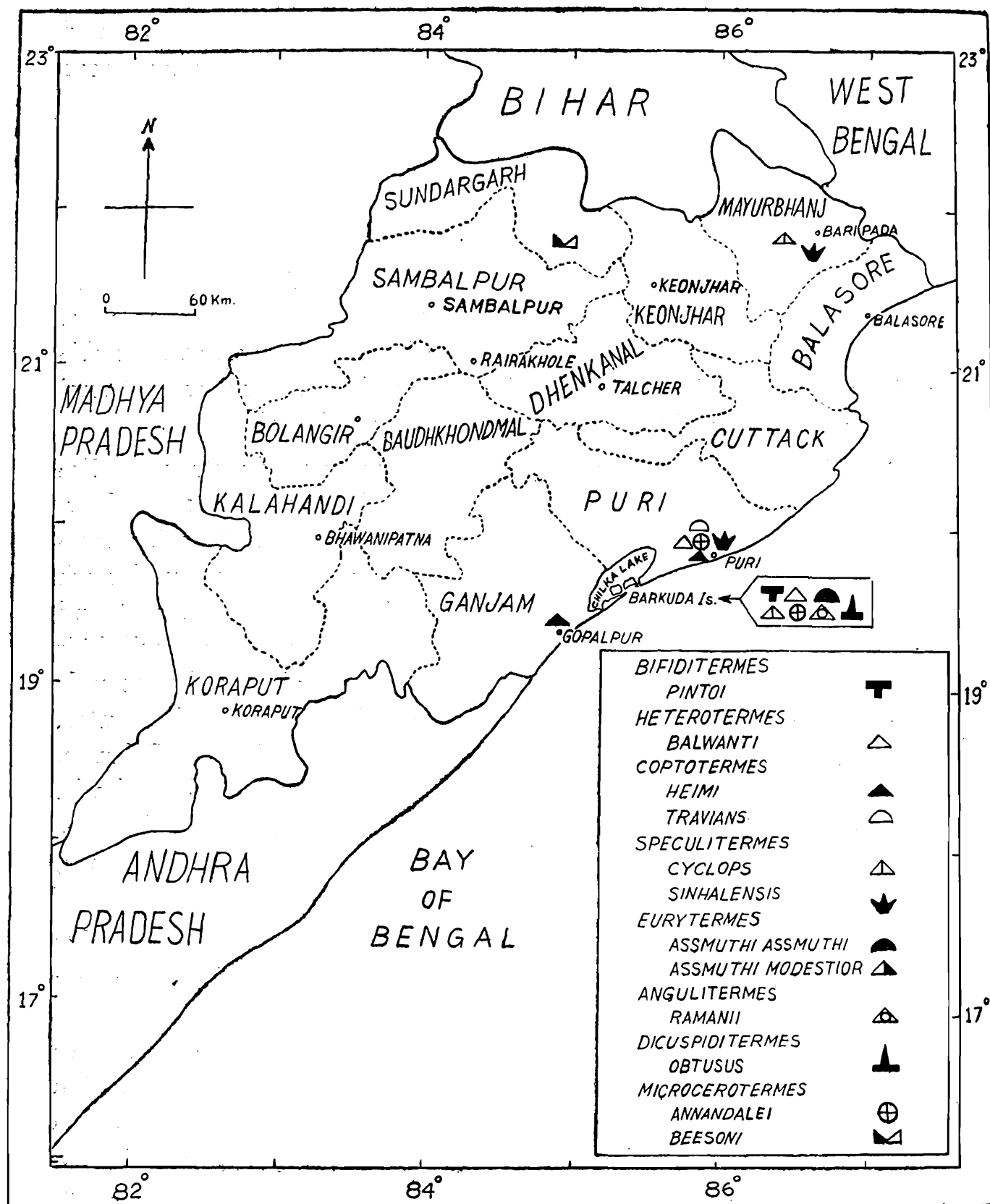
(Text-figs. 2 and 3 ; Table 2)

The state of Orissa has an area of about 1,55,782 sq km and physiographically it is of heterogenous character. It's geological formations vary from the oldest rocks of the earth crust in the stable land-mass of the Indian peninsula to the deltaic alluvium or littoral deposits and ridges of wind blown sand on the seaboard.

Broadly the state can be divided into four natural divisions, (i) The Northern plateau ; (ii) the Eastern ghat ; (iii) the central tract ; and (iv) the coastal plains. The Northern plateau is an extension of the Chotanagpur plateau covering the Mayurbhanj, Keonjhar and Eastern Sundergarh areas. The upper parts of the rivers Subarnarekha, Baitarini and Brahmani lie in this area and its central portion has many small hills and forests. The Eastern ghat forms an uneven plateau that extends over Koraput, parts of Kalahandi, Baudhkhondmals and Ganjam districts. The Central tract covers the districts of Sambalpur, Bolangir, Dhenkanol and parts of Kalahandi, Sundergarh and Baudhkhondmals. The rivers Mahanadi, Brahmani and Baitarini and their tributaries flow through the area. The landscape consists of succession of plateau, hills, uplands and valleys. The coastal plains cover the districts of Balasore, Cuttack, Puri and parts of Ganjam. This fertile area runs parallel to the coast and contains the river deltas formed of alluvium and silt.

The pattern of distribution of termite species from these areas also varies according to the topography of the area. From the distribution pattern of the various species in different natural divisions, we find that the Kalotermitidae is restricted to the coastal tract. The Rhinotermitidae is represented by only one species i. e., *Coptotermes heimi* (Wasmann) in the Northern plateau and Eastern ghat and by three species viz., *Coptotermes heimi* (Wasmann), *Coptotermes travians* Haviland

and *Heterotermes balwanti* Mathur & Chhotani in the coastal plains. In the Eastern ghat and central tract, the subfamily Apicotermittinae is absent and is represented in the Northern plateau by two species viz., *Speculitermes cyclops* Wasmann and *Speculitermes sinhalensis* Roonwal & Sen-Sarma and in the coastal plains by two subspecies i.e.,

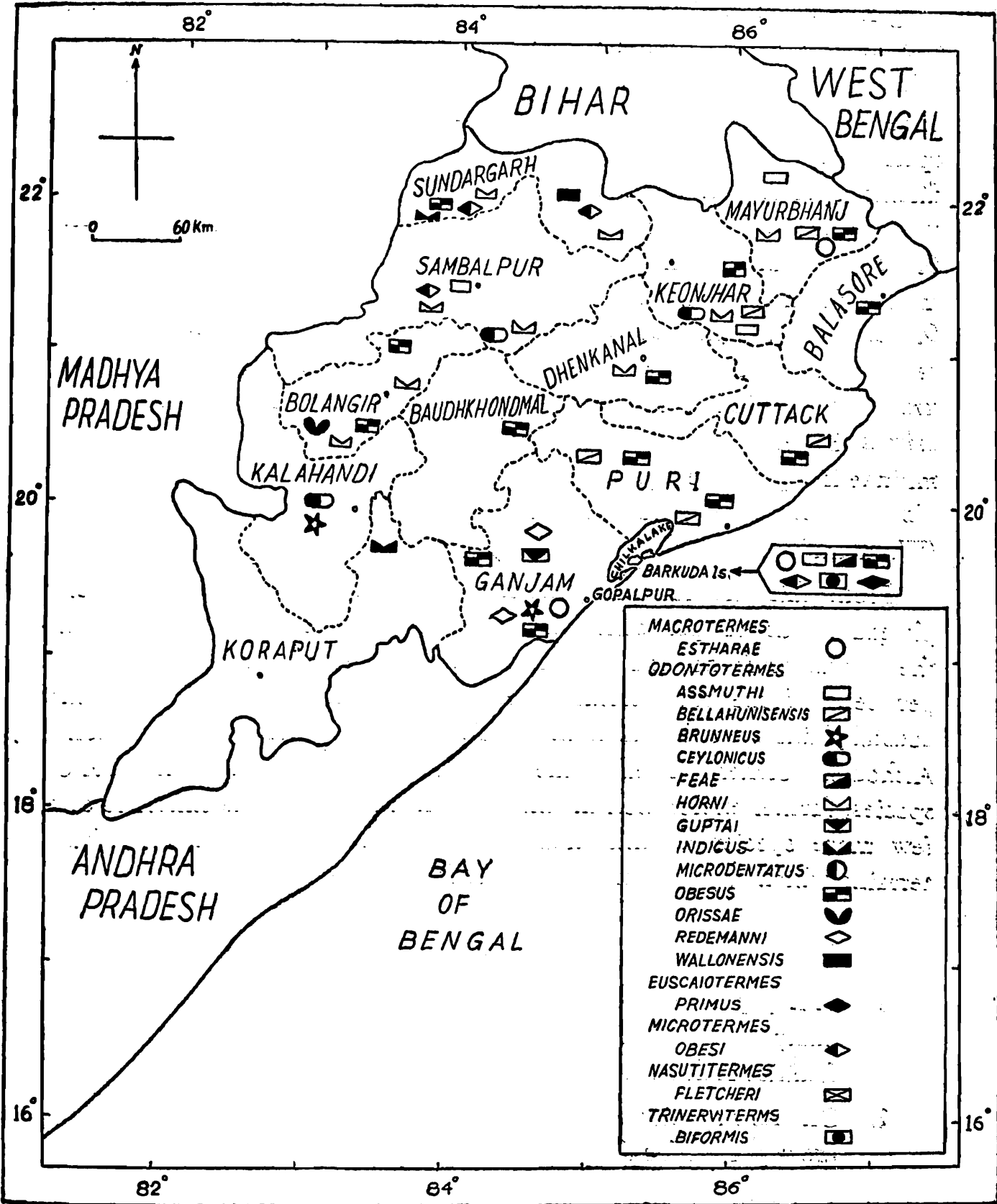


Text-fig. 2. Map showing the distribution of termites in Orissa.

TABLE 2. Distribution of termites in the four natural divisions of the state of Orissa.

Northern plateau	Eastern ghat	Central tract	Coastal plains
Family KALOTERMITIDAE Nil	Family KALOTERMITIDAE Nil	Family KALOTERMITIDAE Nil	Family KALOTERMITIDAE <i>Bifiditermes pinto</i> (Kemner) <i>Cryptotermes dudleyi</i> Banks
Family RHINOTERMITIDAE <i>Coptotermes heimi</i> (Wasmann)	Family RHINOTERMITIDAE <i>Coptotermes heimi</i> (Wasmann)	Family RHINOTERMITIDAE Nil	Family RHINOTERMITIDAE <i>Heterotermes balwanti</i> Mathur & Chhotani <i>Coptotermes heimi</i> (Wasmann) <i>Coptotermes travians</i> Haviland
Family TERMITIDAE <i>Speculitermes cyclops</i> Wasmann	Family TERMITIDAE <i>Macrotermes estherae</i> (Desneux)	Family TERMITIDAE <i>Odontotermes feae</i> (Wasmann)	Family TERMITIDAE <i>Eurytermes assmuthi assmuthi</i> Wasmann
<i>Speculitermes sinhalensis</i> Roonwal	<i>Odontotermes brunneus</i> (Desneux)	<i>Odontotermes horni</i> (Wasmann)	<i>Eurytermes assmuthi modestior</i> Silvestri <i>Angulitermes ramanii</i> sp. nov.
<i>Microcerotermes beasoni</i> Snyder <i>Odontotermes assmuthi</i> Holmgren	<i>Odontotermes ceylonicus</i> (Wasmann) <i>Odontotermes indicus</i> Thakur	<i>Odontotermes obesus</i> (Rambur) <i>Odontotermes wallonensis</i> (Wasmann)	<i>Dicuspitermes obtusus</i> (Silvestri) <i>Microcerotermes annandalei</i> Silvestri
<i>Odontotermes bellahunisensis</i> Holmgren & Holmgren <i>Odontotermes ceylonicus</i> (Wasmann)	<i>Odontotermes obesus</i> (Rambur) <i>Odontotermes orissae</i> Snyder	<i>Microtermes obesi</i> Holmgren	<i>Microcerotermes beasoni</i> Snyder <i>Macrotermes estharae</i> (Desneux) <i>Odontotermes assmuthi</i> Holmgren <i>Odontotermes bellahunisensis</i> Holmgren & Holmgren
<i>Odontotermes microdentatus</i> Roonwal & Sen-Sarma <i>Odontotermes obesus</i> (Rambur) <i>Odontotermes walloniensis</i> (Wasmann)	<i>Odontotermes redemanni</i> (Wasmann) <i>Microtermes obesi</i> Holmgren		<i>Odontotermes feae</i> (Wasmann) <i>Odontotermes guptai</i> Roonwal & Bose <i>Odontotermes obesus</i> (Rambur) <i>Odontotermes redemanni</i> (Wasmann)
<i>Odontotermes indicus</i> Thakur <i>Microtermes obesi</i> Holmgren			<i>Euscaiotermes primus</i> Silvestri <i>Microtermes obesi</i> Holmgren <i>Nasutitermes fletcheri</i> (Holmgren & Holmgren) <i>Trinervitermes biformis</i> (Wasmann)

Eurytermes assmuthi assmuthi Wasmann and *Eurytermes assmuthi modestior* Silvestri. The subfamily Termitinae is absent in the Eastern ghat and central tract, in the Northern plateau it is known by only one species, *Microcerotermes beelsoni* Snyder but in the coastal plain by four species i. e., *Microcerotermes annandalei* Silvestri, *Microcerotermes*



Text-fig. 3. Map showing the distribution of termites in Orissa.

beesoni Snyder, *Dicuspiditermes obtusus* (Silvestri) and *Angulitermes ramanii* sp. nov. The Macrotermitinae is less prominent in the central tract, being represented by *Odontotermes feae* (Wasmann), *Odontotermes horni* (Wasmann), *Odontotermes obesus* (Rambur), *Odontotermes wallonensis* (Wasmann) and *Microtermes obesi* Holmgren. In the Eastern ghat it is represented by *Macrotermes estharae* (Desneux), *Odontotermes brunneus* (Hagen), *Odontotermes ceylonicus* (Wasmann), *Odontotermes indicus* Thakur, *Odontotermes obesus* (Rambur), *Odontotermes orissae* Snyder, *Odontotermes redemanni* (Wasmann) and *Microtermes obesi* Holmgren. In Northern plateau and coastal plain, this subfamily is well represented by several species of common occurrence in both regions besides a few other distinct species. The common species to both these regions are *Odontotermes assmuthi* Holmgren, *O. bellahunisensis* Holmgren & Holmgren, *O. obesus* (Rambur) and *Microtermes obesi* Holmgren. Besides these, in the Northern plateau the species *Odontotermes ceylonicus* (Wasmann), *O. horni* (Wasmann), *O. microdentatus* Roonwal & Sen-Sarma, *O. wallonensis* (Wasmann), *O. indicus* Thakur and in the coastal plains *Macrotermes estherae* (Desneux), *Odontotermes feae* (Wasmann), *Euscaiotermes primus* Silvestri, *O. redemanni* are present. The subfamily Nasutitermitinae is represented in the coastal plains by only two species i. e., *Nasutitermes fletcheri* (Holmgren & Holmgren) and *Trinervitermes biformis* (Wasmann).

From this distribution pattern it is seen that in the Northern plateau about 42 per cent, in the Eastern ghat about 29 per cent, in the central tract about 16 per cent and in the coastal plains about 68 per cent of the total termite species are represented. As such, the coastal plains are richer in termite fauna than the other natural divisions. Although Northern plateau comes next to coastal plains in number of species, further exploration in this region may reveal the existence of a few more species as this area is covered by forests and low hilly terrains which suggests an ideal abode for termites.

SUMMARY

1. This paper deals with the termite fauna of the Orissa state. As many as 31 species are now known and these belong to the families Kalotermitidae, Rhinotermitidae and Termitidae.
2. One new species, *Angulitermes ramanii* is described and eight are reported for the first time from the state.
3. The distribution of termites in the various natural divisions of the state is discussed. The species *Odontotermes obesus* (Rambur) has been found to be very extensively distributed throughout.

4. A key to the identification of all the species has been provided ; it is based on soldier's characters.

ACKNOWLEDGEMENTS

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REFERENCES

- ANNANDALE, N. 1923. The fauna of an island in the Chilka lake. The habits of the termites of Barkuda island. *Rec. Indian Mus.*, **25** (2) : 233-251.
- CHHOTANI, O. B. 1977. Termites of Kanha National Park (Madhya Pradesh), India. *Rec. zool. Surv. India*, **72** : 367-388.
- MATHUR, R. N. AND CHHOTANI, O. B. 1969. Two new termites of the genera *Coptotermes* Wasmann and *Heterotermes* Froggatt (Rhinotermitidae) from India. *J. Timb. Dev. India*, **15** (4) : 1-10.
- ROONWAL, M. L. 1970. Termites of the Oriental region. In : *Biology of Termites*, vol. II (Ed. by K. Krishna & F. M. Weesner) : 315-391.
- ROONWAL, M. L. AND CHHOTANI, O. B. 1962. *Indian Species of the Genus Coptotermes*. 1-15. (Ent. monograph 2. ICAR).
- ROONWAL, M. L. AND SEN-SARMA, P. K. 1960. *Contribution to the Systematics of Oriental Termites*. 1-407 (Ent. monograph 1. ICAR).
- SEN-SARMA, P. K., THAKUR, M. L., MISRA, S. C. AND GUPTA, B. K. 1975. Wood Destroying Termites of India. pp. 1-187. (Final report PL 480 Project No. A7-FS-58).
- SNYDER, T. E. 1949. Catalog of the termites (Isoptera) of the World, *Smithson. misc. Coll.* **112** : 1-410.
- SILVESTRI, F. 1923 The termites of Barkuda island. The fauna of an island in the Chilka Lake. *Rec. Indian Mus.*, **25** (2) : 221-232.
- THAKUR, M. L. 1976. Zoogeography of termite genus *Odontotermes* Holmgren in the Indian region (Isoptera : Termitidae : Macrotermitinae). *Indian Forester*, **102** (8) : 498-505.

ON SOME FRESHWATER SPONGES FROM THE UNNAMED
COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

By

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(With 3 Text-figures)

The study of freshwater sponges in India has made practically no headway since the pioneering works of Annandale (1906-1919). Recently, Penney and Racek (1968) in their outstanding work covering the then known species of the world, also included a praiseworthy survey of Indian forms. In fact it forms the main basis of a checklist of Indian fresh-water species attempted by Khera and Chaturvedi (1976).

The present paper deals with freshwater sponges from the unnamed collection of the Zoological Survey of India and these comprise nine species belonging to six genera, most of which species forming new locality records. Synonymies have been deliberately omitted, not only to avoid redundancy but especially as they have been very elaborately and exhaustively dealt with by Penney and Racek (*op. cit.*).

A key to the Indian genera of Spongillidae, as well as keys of species of three genera not represented in the unnamed collection of the Survey, have also been appended.

SYSTEMATIC ACCOUNT

Phylum PORIFERA

Class DEMOSPONGIAE

Order HAPLOSCLERINA

Family SPONGILLIDAE

Genus **Corvospongilla** Annandale, 1911

Generic characters :

Megascleres—amphistrongyles, robust, inflated at their extremities, smooth to granulated, slightly curved ; occasionally amphioxea.

Microscleres—microbirotulates, almost straight to slightly curved with smooth or spined shaft having a small number of terminally recurved spines of varying length ; also, though only exceptionally spined amphioxea, which are possibly adventitious.

Gemmoscleres—amphistrongyla, invariably spined and distinctly curved.

Gemmules—spherical, large, oval in outline with flattened base found in groups at base of sponge; pneumatic coat ill-defined or absent; gemmoscleres embedded in inner gemmular membrane, lying close together to form a mosaic cover; foramen tubular and lateral; occasionally free gemmules also present, usually different in form and structure of pneumatic coat.

KEY TO INDIAN SPECIES

1. Megascleres amphioxea.	...	...	2
Megascleres amphistrongyla.	...	...	3
2. Gemmules adhering to substratum.	...	<i>C. ultima</i>	
Gemmules not so.	...	<i>C. caunteri</i>	
3. Gemmoscleres in concentric layer or layers on inner gemmular membrane.	...	<i>C. burmanica</i>	
Gemmoscleres in one or two layers, arranged in mosaic-like covering on inner gemmular membrane.	...	<i>C. lapidosa</i>	

Corvospongilla caunteri Annandale, 1911

(Text-fig. 1, A—D)

Material: One lot; Z. S. I. Reg. No. P. 3092/1; locality—Santhal Parganas; coll. *H. A. Hafiz*; 2. xii. 1938. One lot; Z. S. I. Reg. No. P. 3032/1; locality—Medha (Maharashtra); coll. *S. P. Aghaskar*; 23. vi. 1913.

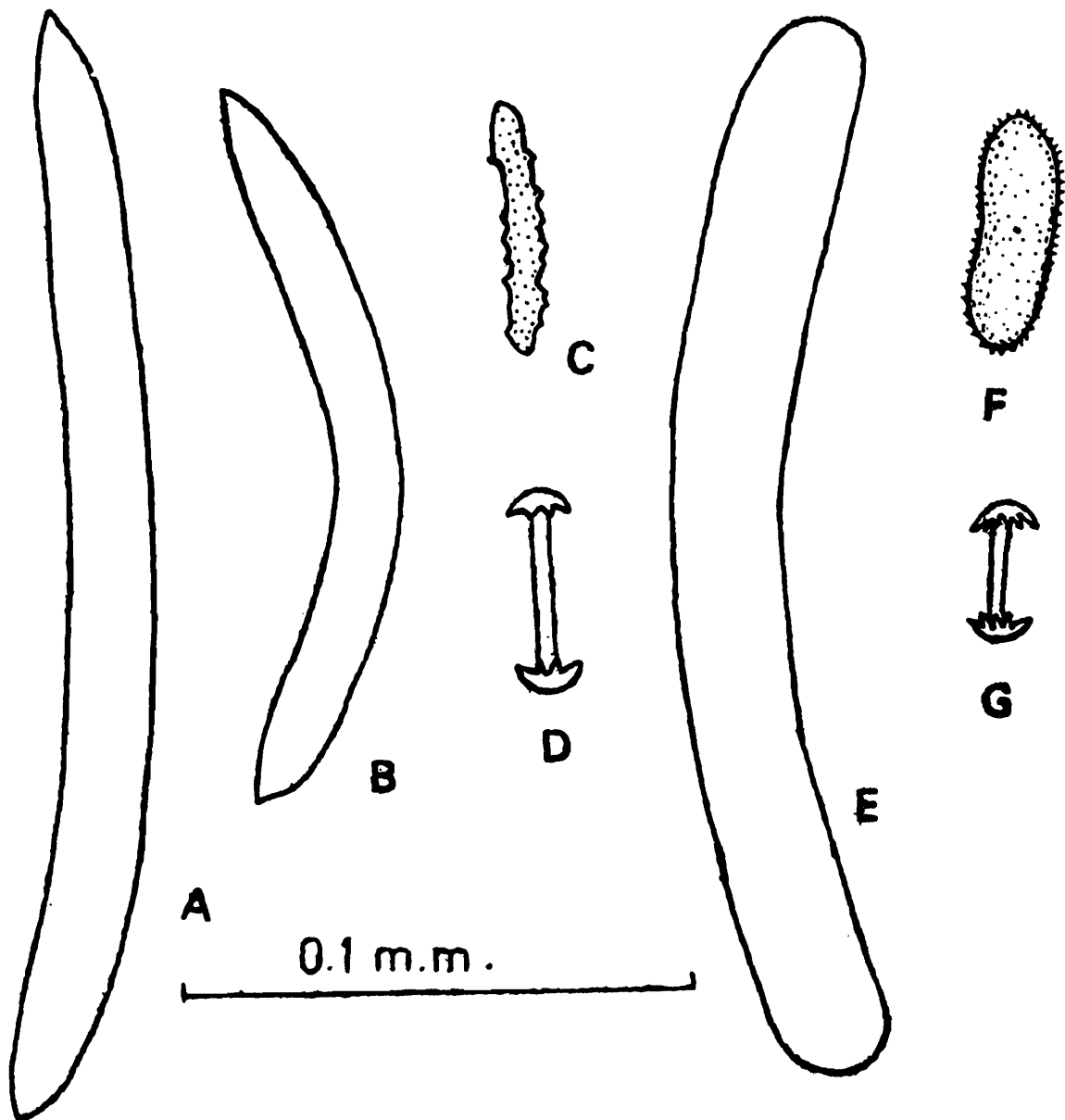
Description: Form moderately delicate with smooth surface. Megascleres—amphioxea, smooth, generally straight, bluntly or abruptly pointed; occasionally granulated or spiny at their extremities, often sharply pointed; length range 172-270 μ , width range 15-25 μ .

Microscleres—microbirotulæ, with smooth shaft, never strongly curved, terminal spines relatively short, not strongly incurved; length range 25-35 μ , diameter of rotules 8-10 μ .

Gemmoscleres—amphistrongyla, slightly curved, rarely blunt, irregularly spiny, length range 43-51 μ , width range 10-12 μ .

Gemmules—present freely in lower parts of inner symplasm, spherical to somewhat depressed, pneumatic coat rather thick, apparently consisting of very minute air spaces, under which gemmoscleres arranged in tangential mosaic-like covering on inner gemmular membrane; diameter 550-600 μ .

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



Text-fig. 1. A—D. *Corvospongilla caunteri* Annandale, 1911,
E—G. *C. lapidosa* (Annandale, 1908).

A, B—Megascleres ; C—gemmosclere ; D—microsclere ; E—Megasclere ; F—gemmosclere ; G—microsclere.

***Corvospongilla lapidosa* (Annandale, 1908)**

(Text-fig. 1, E—G)

Material : One lot ; Z. S. I. Reg. No. P. 1471/1 ; locality—Pulta water tank, 24-Parganas (West Bengal) ; coll. *Pulta survey party* ; 14. v. 1937. One lot ; Z. S. I. Reg. No. P. 3036/1 ; locality—Igatpuri (Maharashtra) ; collector & date of collection—?.

Description.—Form irregular, hard and brittle, with rough surface.

Megascleres—amphistrongyla, feebly curved, smooth, length range 220-230 μ , width range 17-21 μ .

Microscleres—microbirotulates, shaft smooth and terminally with smaller number of recurved hooks, length range 30-34 μ , diameter of rotules 8-11 μ .

Gemmoscleres—amphistrongyla, slightly curved with blunt spines except at their extremities ; length range 50-60 μ , width range 12-15 μ .

Gemmules—subspherical, not very abundant, firmly adhering to substratum ; pneumatic coat feebly developed, without discernible air spaces ; gemmoscleres in one or two layers arranged in mosaic-like covering on inner gemmular membrane ; foramen produced into small and straight tubule, usually situated laterally ; average diameter 650 μ .

Genus **Dosilia** Gray, 1867

Generic characters ;

Megascleres—amphioxea, slender, fusiform, either smooth or covered with minute spines, excepting at their tips.

Microscleres—asters usually with rays arising from a central spherical nodule, or rough amphioxea bearing centrally several long perpendicular radiating rays, or a combination of both of these types ; abundant.

Gemmoscleres—birotulates with strongly spined shafts, terminally with distinctly umbonate rotules of equal diameter.

Gemmules—subspherical, abundant, large ; pneumatic layer consisting of minute spherical air spaces ; foramen produced into short, straight tubule.

Dosilia plumosa (Carter, 1849)

(Text-fig. 2, A—D)

Material : One lot ; Z. S. I. Reg. No. P. 1793/1 ; locality—Sarupurai village, Sardar Samand, dist. Pali (Rajasthan) ; coll. *K. K. Mahajan* ; 20. xi. 1963. One lot ; Z. S. I. Reg. No. P. 3100/1 ; locality—Pulta water tank, 24-Parganas, (West Bengal) ; coll. *Pulta survey party* ; 22. ix. 1936. One lot ; Z. S. I. Reg. No. P. 3040/1 ; locality—Ramgarh, dist. Jaipur (Rajasthan). One lot ; Z. S. I. Reg. No. P. 3035/1 ; locality—Lily pond, half a mile north of Silwary Hill on Hazaribagh-Bogodar Rd. ; 30. xi. 1938. One lot ; Z. S. I. Reg. No. P. 3094/1 ; locality—Hazaribagh, 9. x. 1938 ; collector—?.

Description : Form bulbous, compact and flattened with rough surface.

Megascleres—amphioxea, slightly curved, fusiform, smooth, length range 490-540 μ , width range 17-20 μ .

Microscleres—stellate spicules consisting of 8-12 smooth rays projecting from a central globular nodule, radius of rays 15-18 μ , abundant.

Gemmoscleres—birotulates, shaft strongly spined, cylindrical, rotules distinctly umbonate, equal, similar, their margins incised into numerous blunt recurved teeth, length range 80-85 μ , thickness of shaft 4 μ , diameter of rotules 21-25 μ .

Gemmules—subspherical, scattered throughout skeletal meshwork ; foramen a short and straight tubule, pneumatic layer well developed and granular, consisting of minute spherical air spaces ; gemmoscleres regularly embedded in this coat, their rotules rarely protruding through its outer surface ; average diameter 600 μ .

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

Genus *Eunapius* Gray, 1867

Generic characters :

Megascleres—amphioxea or amphistrongyla, stout, smooth, rarely spined.

Microscleres—absent.

Gemmoscleres—amphioxea or amphistrongyla, slender to robust, usually strongly spined and only slightly curved.

Gemmules—moderately abundant, comparatively small, often somewhat flattened, and having well-developed pneumatic layer with conspicuously polygonal air-spaces ; foramen tube straight or strongly curved.

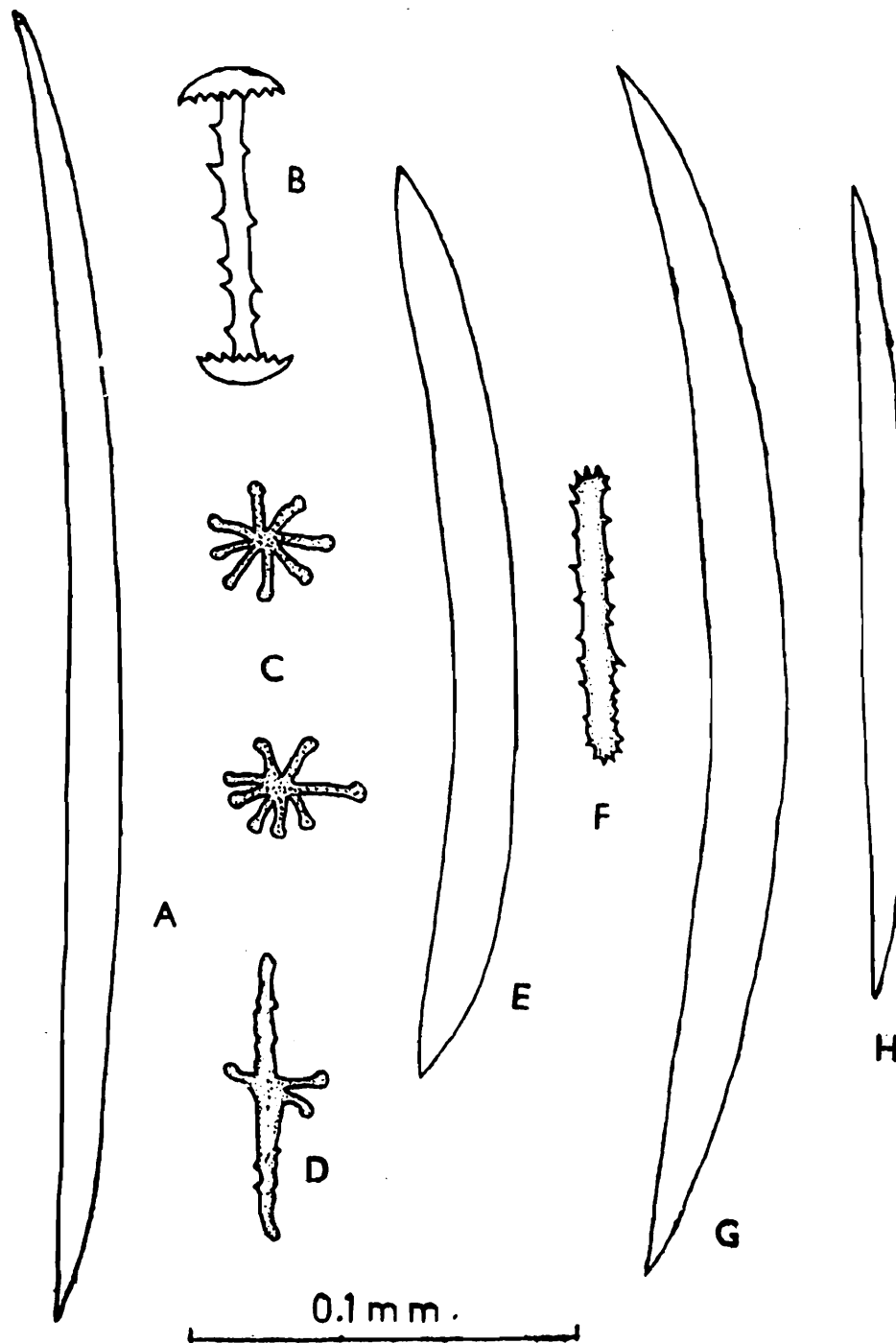
KEY TO INDIAN SPECIES

- | | | | |
|--|-----|------------------------|---|
| 1. Megascleres amphistrongyla. | ... | <i>E. crassissimus</i> | |
| Megascleres amphioxea. | ... | ... | 2 |
| 2. Gemmoscleres similar in shape and structure to megascleres but smaller in size. | ... | <i>E. carteri</i> | |
| Gemmoscleres not so. | ... | ... | 3 |
| 3. Gemmules bound together in pairs, irrespective of their location. | ... | <i>E. geminus</i> | |
| Gemmules bound together in free groups of more than two. | ... | <i>E. calcuttanus</i> | |

Eunapius calcuttanus (Annandale, 1911)

(Text-fig. 2, E, F)

Material : One lot ; Z. S. I. Reg. No. P. 3033/1 ; locality—Ray Dighi, 24-Parganas (West Bengal) ; coll. *K. R. Haldar* ; 3. i. 1965.



Text-fig. 2. A—D. *Dosilia plumosa* (Carter, 1849) ; E & F. *Eunapius calcuttanus* (Annandale, 1911) ; G & H. *E. carteri* (Bowerbank, 1863).

A—Megasclere ; B—gemmosclere ; C—stellate microscleres ; D—acerate microsclere ; E—Megasclere ; F—gemmosclere ; G—Megasclere ; H—gemmosclere.

Description : Form elongated, finger-like, and with smooth surface.

Megascleres—amphioxea, slender, fusiform, smooth, with abruptly pointed and peculiar tips invariably forming lanceolate apical projections ; length range 200-225 μ , width range 9-10 μ .

Microscleres—absent.

Gemmoscleres—amphistrongyla, very slender, cylindrical, curved, and with spines, length range 80-100 μ , width range 2-4 μ .

Gemmules—abundant, present in inner symplasm, spherical, with smooth outer covering ; pneumatic layer well developed and thick, consisting of large polygonal air spaces ; foramen invariably tubular, porus tube conspicuously bent and long, well projecting beyond surface of pneumatic layer ; diameter of inner gemmular membrane 200-225 μ .

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

***Eunapius carteri* (Bowerbank, 1863)**

(Text-fig. 2, G, H)

Material : One lot ; Z. S. I. Reg. No. P. 3039/1 ; locality—Hazari-bagh lake, Hazaribagh ; coll. *Raj Tilak and party* ; 26. xi. 1969. One lot ; Z. S. I. Reg. No. P. 3101/1 ; locality—Gotuma village, 3 Km. S of Khariāl Road, Orissa ; coll.—*K. V. S. Rao and party* ; 8. ii. 1972. One lot ; Z. S. I. Reg. No. P. 3096/1 ; locality—Indian Museum tank, Calcutta ; coll. *M. N. Datta* ; Nov., 1930. One lot ; Z. S. I. Reg. No. P. 3103/1 ; locality—Pulta water tank, 24-Parganas (West Bengal) ; coll. *Pulta Survey party* ; 11. v. 1937.

Description : Form irregular with varying dimensions and greatly roughened surface.

Megascleres—amphioxea, stout, fusiform, slightly curved, smooth, length range 300-350 μ , width range 15-25 μ .

Microscleres—absent.

Gemmoscleres—in shape and structure very similar to megascleres but considerably smaller, length range 150-200 μ , width range 5-8 μ .

Gemmules—spherical, comparatively large, abundant, scattered throughout the body ; pneumatic layer well developed and thick, consisting of several layers of regularly arranged polygonal air spaces ; gemmoscleres embedded in this layer tangentially or in an irregular manner ; foramen tubular ; diameter 500-600 μ .

Remarks : This species is recorded for the first time from Hazari-bagh and Gotuma.

Genus **Radiospongilla** Penney and Racek, 1968*Generic characters :*

Megascleres—amphioxea, moderately stout to slender, smooth or covered with spines.

Microscleres—true microscleres absent, in the growing phases of some species immature gemmoscleres abundantly present in dermal membrane and inner symplasm, previously recorded as microscleres.

Gemmoscleres—amphioxea or amphistrongyla, slender, spined, spines often conspicuously aggregated and larger in the vicinity of the tips of the scleres forming club-or scepter-like terminal structure.

Gemmules—spherical, scattered throughout the sponge, abundant, with a large, strong and thick pneumatic layer consisting of air spaces of small size and gemmoscleres embedded in this layer more or less radially ; foramen tubule delicate, straight or slightly curved, rarely projecting beyond outer gemmular membrane.

KEY TO INDIAN SPECIES

1. Megascleres smooth. ...	<i>R. cerebellata</i>
Megascleres incipiently to strongly spined. ...	... 2
2. Immature gemmoscleres abundant in symplasm and dermal membrane. ...	<i>R. hemephydatia</i>
Immature gemmoscleres not abundant. ...	... 3
3. Gemmoscleres embedded radially in pneumatic coat rarely crossing each other. ...	<i>R. indica</i>
Gemmoscleres embedded irregularly, often crossing each other. ...	... 4
4. Gemmoscleres extremities not penetrating outer gemmular membrane. ...	<i>R. crateriformis</i>
Gemmoscleres extremities penetrating outer gemmular membrane apparently making gemmular surface distinctly hispid. ...	<i>R. cinerea</i>

Radiospongilla cerebellata (Bowerbank, 1863)

(Text-fig. 3, A—C)

Material : One lot ; Z. S. I. Reg. No. P. 1554/1 ; locality—Paikpara tank, Calcutta ; coll. *N. S. Kumar* ; date of collection—?. One lot ; Z. S. I. Reg. No. P. 3098/1 ; locality—bank of Piali river, Uttarbhag ; 8. ii. 1938 ; collector—?.

Description : Form like shallow cushions, and with surface prominently irregular.

Megascleres—amphioxea, feebly curved to almost straight, fusiform, sharply pointed at their tips and entirely smooth, length range 250-300 μ , width range 10-12 μ .

Microscleres—absent.

Gemmoscleres—amphistrongyla, curved, cylindrical, shaft abundantly spined, length range 65-85 μ , width range 2-3 μ .

Gemmules—spherical, numerous ; pneumatic coat well developed and usually thick, consisting of minute spherical air spaces ; gemmoscleres embedded in this coat in two distinct layers i. e. (1) more or less radially arranged, arising from inner gemmular membrane, often crossing each other at various angles, and not reaching outer gemmular membrane, and (2) lying on top of the first, more or less tangentially arranged, embedded with their proximal portions in the pneumatic coat, their distal ends protruding through outer gemmular membrane ; foramen distinctly tubular, tube slender and straight, always at least reaching level of pneumatic coat ; diameter 450-500 μ .

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

Genus *Spongilla* Lamarck, 1816

Generic characters :

Megascleres—amphioxea, slender to stout, smooth.

Microscleres—amphioxea, slender, spined and different from gemmoscleres.

Gemmoscleres—amphioxea, stout, strongly spined, with varying curvature.

Gemmules—spherical, abundant, large, scattered throughout body, usually with a moderately strong granular pneumatic layer with very small nonpolygnal air spaces and having gemmoscleres embedded in it tangentially ; foramen simple to slightly cup-shaped, not tubular.

KEY TO INDIAN SPECIES

- | | |
|--|---------------------|
| 1. Microscleres with small spines or granules of almost equal size and distribution. ... | <i>S. lacustris</i> |
| Microscleres with spines of unequal size and distribution. ... | ... |
| 2. Spines invariably much longer and more prominent in central part of microscleres. ... | <i>S. alba</i> |

Spongilla alba Carter, 1849

(Text-fig. 3, D—F)

Material : One lot ; Z. S. I. Reg. No. P. 3034/1 ; locality—Minto Square, Calcutta ; coll. *N. Santhakumar* ; 17. vii. 1962. One lot ; Z. S. I. Reg. No. P. 3097/1 ; locality—Nalbari, North Salt Lake, 24-Parganas (West Bengal) ; coll. *B. Biswas* ; 14. vi. 1967.

Description : Form with irregular projections and rough surface.

Megascleres—amphioxea, fusiform, smooth, length range 270-330 μ , width range 12-14 μ .

Microscleres—amphioxea, numerous, slender, slightly curved, covered with erect spines, which being more prominent and longer in central region, often with knoblike inflation at their tips, length range 95-125 μ , width range 2-3 μ .

Gemmoscleres—amphistrongyla, slender, cylindrical, feebly curved and covered with large and recurved spines, length range 86-100 μ , width range 5-7 μ .

Gemmules—spherical, large, abundant, and scattered throughout the body, pneumatic layer only moderately thick, distinctly granular ; gemmoscleres embedded in this layer rather sparsely at irregular angles with their tips usually projecting beyond outer surface of layer ; diameter range 500-600 μ .

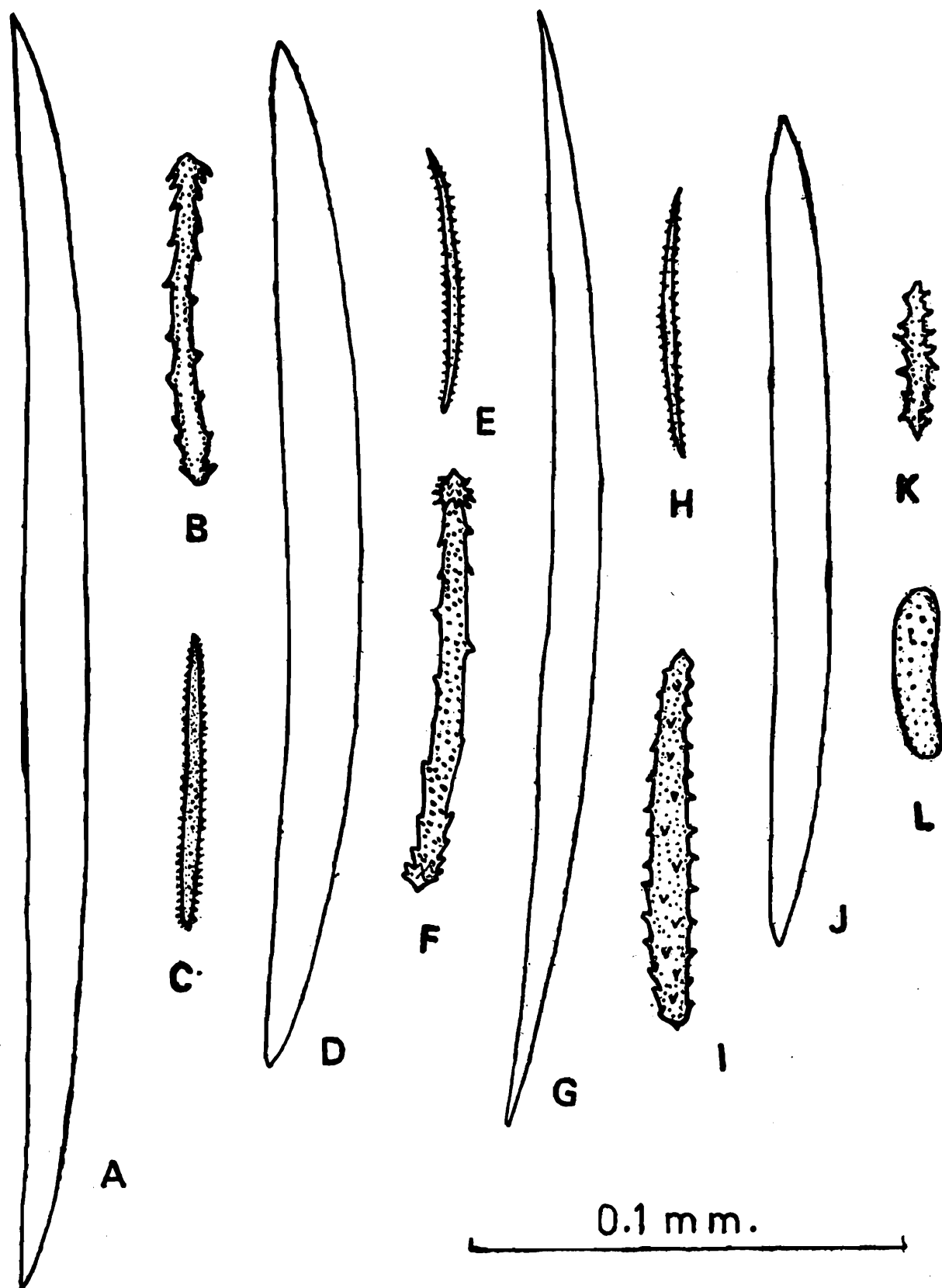
Spongilla lacustris (Linnaeus, 1758)

(Text-fig. 3, G—I)

Material : One lot ; Z. S. I. Reg. No. P. 3099/1 : locality—near Race course, Mysore (Karnataka) ; coll. *B. L. Chaudhuri* ; 15. i. 1917. One lot ; Z. S. I. Reg. No. P. 3093/1 ; locality—Dhyrampur Kooa, Patiala Estate, base of Simla Hills (Himachal Pradesh) ; coll.—? ; 21. vii. 1911. Two lots ; Z. S. I. Reg. No. P. 3037/1 & P. 3041/1 ; locality—Ranchi (Bihar) ; collector & date of collection—?. One lot ; Z. S. I. Reg. No. P. 3104/1 ; locality—Kacha pond, opp. Kotli P. O., Jhajjar, dist. Udhampur, Jammu ; 7. x. 1964. One lot ; Z. S. I. Reg. No. P. 3105/1 ; locality—Puthi Khad Nala, about 12 kms. NE of Jhajjar, dist. Udhampur ; coll. *Raj Tilak* ; 12. x. 1964.

Description : Form soft, firm, and with cylindrical branches arising from irregular base.

Megascleres—amphioxea, straight, fusiform, and smooth, length range 225-300 μ , width range 6-8 μ ,



Text-fig. 3. A—C. *Radiospongilla cerebellata* (Bowerbank, 1863) ; D—F. *Spongilla alba* Carter, 1849 ; G—I. *Spongilla lacustris* (Linnaeus, 1758) ; J—L. *Stratospongilla indica* (Annandale, 1908).

A—Megasclere ; B—gemmosclere ; C—immature gemmosclere. D—Megasclere ; E—microscelere ; F—gemmosclere. G—Megasclere ; H—microscelere ; I—gemmosclere ; J—Megasclere ; K—microscelere ; L—gemmosclere.

Microscleres—amphioxea, abundant, and covered with small spines, length range 80-90 μ , width range 4-5 μ .

Gemmoscleres—amphioxea, covered with strong and curved spines, length range 85-95 μ , width range 4-5 μ .

Gemmules—spherical, abundant, and present throughout body, pneumatic layer either well developed, ill-defined, or altogether absent generally when gemmoscleres lacking : these latter irregularly embedded where layer present, diameter average 600 μ .

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

Genus *Stratospongilla* Annandale, 1909

Generic characters :

Megascleres—amphioxea or amphistrongyla, stout, smooth or roughened.

Microscleres—amphioxea, short and slender, almost straight, covered with relatively long and irregular spines.

Gemmoscleres—amphistrongyla, strongly bent, covered with minute spines of unequal size, or amphioxea, slightly curved, spined, or combination of both.

Gemmules—spherical, large, firmly adherent to substratum : pneumatic layer without noticeable air spaces, often poorly developed or absent ; foraminal tubule either short and straight, or long and recurved.

KEY TO INDIAN SPECIES

1. Megascleres amphistrongyla.	...	<i>S. indica</i>
Megascleres amphioxea.	...	... 2
2. Gemmoscleres strongly curved often forming wide arc.	...	<i>S. gravelyi</i>
Gemmoscleres straight to feebly curved.	...	... 3
3. Gemmoscleres embedded in pneumatic coat in two layers, separated by empty space.	...	<i>S. bombayensis</i>
Gemmoscleres closely crowded in pneumatic coat, embedded strictly tangentially and forming mosaic layer.	...	<i>S. sumatrana</i>

Stratospongilla indica (Annandale, 1908)

(Text-fig. 3, J—L)

Material : One lot ; Z. S. I. Reg. No. P. 3042/1 ; locality—Pulta water tank, 24-Parganas (West Bengal) ; coll. *Pulta survey party* ;

21. xi. 1937. One lot ; Z. S. I. Reg. No. P. 3091/1 ; locality—Gonewara tank, Nagpur ; coll. *F. H. Gravely* ; 1. iii. 1919. One lot ; Z. S. I. Reg. No. P. 3095/1 ; locality—Igatpuri ; collector & date of collection—?. One lot ; Z. S. I. Reg. No. P. 3102/1 ; locality—Pulta water tank, 24-Parganas (West Bengal) ; coll. *Pulta survey party* ; 26. vi. 1937.

Description : Form shallow, cushion-like, hard and brittle.

Megascleres—amphistrongyla, straight, cylindrical, covered with short and minute spines, arising from a rather broad base ; tips of scleres often surrounded by “rings” of smaller spines ; length range 200-215 μ , width range 12-14 μ .

Microscleres—amphioxea, straight, covered with irregular spines, length range 40-47 μ , width range 3-4 μ .

Gemmoscleres—amphistrongyla, slightly curved to straight, stout, covered with minute granules, length range 35-43 μ , width range 7-8 μ .

Gemmules—less numerous, subspherical, with flattened base ; pneumatic coat feebly and irregularly developed, without discernible air spaces, usually forming a basal membrane by which the gemmule is fastened ; gemmoscleres forming a dense, tangentially arranged mosaic layer over inner gemmular membrane ; foramen with a short and straight porus tube ; diameter ranging from 470-500 μ .

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

KEY TO THE INDIAN GENERA OF SPONGILLIDAE

- | | | | |
|--|-----|--|---|
| 1. Microscleres absent. | ... | ... | 2 |
| — Microscleres present. | ... | ... | 5 |
| 2. Gemmoscleres birotulates. | ... | ... | 3 |
| — Gemmoscleres amphioxea or amphistrongyla.... | ... | ... | 4 |
| 3. Rotules flat in lateral view. | ... | <i>Ephydatia</i> Lamouroux, 1816 | |
| — Rotules circular, with entire margins. | ... | <i>Trochospongilla</i> Vejdovsky, 1883 | |
| 4. Gemmoscleres with characteristic arrangement of terminal spines. | ... | <i>Radiospongilla</i> Penney and Racek, 1968 | |
| — Gemmoscleres with spines more or less uniformly distributed. | ... | <i>Eunapius</i> Gray, 1867 | |
| 5. Microscleres microbirotulates. | ... | <i>Corvospongilla</i> Annandale, 1911 | |
| — Microscleres either distinct aster or rough amphioxea which in their central portion with long perpendicular radiating rays, or combination of both. | ... | <i>Dosilia</i> Gray, 1867 | |
| — Microscleres amphioxea or amphistrongyla. | ... | ... | 6 |

- | | | | |
|----|--|-----|--|
| 6. | Foramen simple to slightly cup-shaped, never distinctly tubular. | ... | <i>Spongilla</i> Lamarck, 1816 |
| — | Foramen tubular. | ... | 7 |
| 7. | Gemmoscleres terminally a unilateral arrangement of spines in shape of hair brush. | ... | <i>Pectispongilla</i> Annandale, 1909 |
| — | Gemmoscleres spiny amphistrongyles or amphioxea. | .. | <i>Stratospongilla</i> Annandale, 1909 |

KEY TO INDIAN SPECIES OF THE GENUS *Trochospongilla*

- | | | | |
|----|--|-----|-------------------------|
| 1. | Megascleres entirely smooth. | ... | <i>T. latouchiana</i> |
| — | Megascleres covered with small conical spines. | ... | 2 |
| 2. | Megascleres amphioxea. | ... | <i>T. pennsylvanica</i> |
| — | Megascleres amphistrongyla. | ... | <i>T. philottiana</i> |

KEY TO INDIAN SPECIES OF THE GENUS *Ephydatia*

- | | | | |
|----|--|-----|-----------------------|
| 1. | Gemmoscleres embedded in pneumatic coat in one layer ; distal rotules of gemmoscleres just reaching outer gemmular membrane. | ... | <i>E. fluviatilis</i> |
| — | Gemmoscleres embedded in pneumatic coat in one or two layers ; distal rotules of gemmoscleres of outer layer invariably penetrating outer gemmular membrane. | ... | <i>E. meyeri</i> |

KEY TO INDIAN SPECIES OF THE GENUS *Pectispongilla*

- | | | | |
|----|--|-----|----------------------|
| 1. | Megascleres entirely smooth. | ... | <i>P. aurea</i> |
| — | Megascleres covered with minute rounded spines or tubercles excepting at tips. | ... | 2 |
| 2. | Spherasters present. | ... | <i>P. stellifera</i> |
| | Spherasters absent. | ... | <i>P. subspinosa</i> |

SUMMARY

The paper deals with nine species of freshwater sponges, most of which from new locality records. Diagnostic keys for all the Indian genera of Spongillidae and keys to their species have also been furnished.

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REFERENCES

- ANNANDALE, N. 1911. Freshwater sponges and Polyzoa. *Fauna British India, including Ceylon and Burma*, pp. 27-126, 241-245.
- ANNANDALE, N. 1912. Notes on freshwater sponges. XIV. The generic position of *Spongilla ultima*. *Rec. Indian Mus.*, 7 : 99.
- ANNANDALE, N. 1912. Observation of the invertebrate fauna of the Kumaon Lakes, with special reference to the sponges and Polyzoa. III. Systematic and geographical notes on the sponges and Polyzoa. *Rec. Indian Mus.*, 7 : 137-139.
- ANNANDALE, N. 1912. The freshwater sponges of the Malabar zone. *Rec. Indian Mus.*, 7 : 383-397.
- ANNANDALE, N. 1915. Notes on freshwater sponges of the genus *Pectispongilla* and its allies. *Rec. Indian Mus.*, 11 : 171-178.
- ANNANDALE, N. 1915. Fauna of the Chilka Lake. Sponges. *Mem. Indian Mus.*, 5 pt. I, : 21-54.
- ANNANDALE, N. 1919. The fauna of certain small streams in the Bombay Presidency VIII. Sponges from the Satara and Poona districts and from Chota (Chutia) Nagpur. *Rec. Indian Mus.*, 16 : 156-161.
- DALAL, Y. M. AND RAWAL, U. M. 1980. Occurrence of freshwater sponge *Eunapius carteri* Bowerbank from Junagarh (Saurashtra). *Vidya*, 23 (2), B—Sciences : 73-74.
- GEE, N. G. 1932. *Spongilla carteri* and its varieties. *Rec. Indian Mus.*, 34 : 185-194.
- KHERA, S. AND CHATURVEDI, Y. 1976. Check-list of Indian freshwater sponges. Miscellaneous publication occasional paper No. 4, *Rec. zool. Surv. India*, pp. 1-29.
- PENNEY, J. T. AND RACEK, A. A. 1968. Comprehensive revision of a worldwide collection of freshwater sponges (Porifera : Spongillidae). *Bull. U. S. natn. Mus.*, No. 272 : 184 pp.
- SOOTA, T. D., BASKARAN, S. AND SAXENA, M. M. 1981. Sponges of Lake Kailana (Jodhpur), their ecology, with a note on role of sponges as the indicators of water quality *Nat. Symp. Eval. our Environ., Jodhpur*. Abst. 41, p. 26.
- SOOTA, T. D. AND SAXENA, M. M. (in press). Sponge fauna of some waters of Rajasthan and its ecology.
- TONAPI, G. T. 1964. A note on the freshwater sponges of Poona. *Curr. Sci.*, 33 (12) : 372-373.

CONTRIBUTIONS TO THE STUDY OF BAGRID FISHES. 15.
A COMPARATIVE ACCOUNT OF THE CRANIAL
MUSCULATURE IN FOUR BAGRID GENERA
WITH A NOTE ON THEIR PHYLOGENY

By

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(With 3 Text-figures)

INTRODUCTION

The family Bagridae of the order Siluriformes contains 27 genera with about 200 species, distributed from Africa through the Middle east, India, Pakistan, Bangladesh, Sri Lanka, Burma, Malaya Archipelago, China and Japan. They are mostly freshwater fishes with a few species entering estuaries and brackish water. Such vast assemblage of species in so wide geographic range would naturally involve different structural patterns but these fishes are remarkably akin in their morphological facies. Jayaram (1966, 1966a and 1968) in a series of papers attempted to classify the genera of this family based on certain osteological features. He divided the family into five subfamilies : Ritinae, Chrysichthyinae, Bagrinae, Bagroidinae and Auchenoglanidinae.

The cranial muscles of siluroid fishes attracted the attention of several workers in the past, either from anatomical or functional morphology standpoint of view. The work of Mc Murrich (1884) and Juge (1899) relates to the myology of *Amiurus catus* and *Silurus glanis* respectively. Takahasi (1925) studied the cranial musculature of a number of siluroid fishes. Nawar (1955) described various muscular elements of *Clarias lazera*. Dubale and Vidyasagar (1960) and Munshi (1960) endeavoured to study the cranial musculature pattern of *Heteropneustes fossilis* and *Mystus* (= *Aorichthys*) *aor* respectively. Singh and Munshi (1969) investigated the functional morphology of *Rita rita* and *Wallago attu*. Mahajan (1971) while dealing with the adaptive radiation in *Sisor rhabdophorus*, studied the cranial muscles in relation to the morphology of the skull.

From the aforecited review of literature, it is apparent that no effort has been made so far to study the cranial muscles of any particular family or subfamily in its entirety. An attempt has been made in this

paper to compare the cranial musculature of selected members of three subfamilies of Bagridae as proposed by Jayaram (1966), and derive their interrelationships. The genera studied are as under :—

1. Subfamily Ritinae—Genus *Rita* Bleeker
Rita rita (Ham.)
2. Subfamily Chrysichthyinae
Tribe Pelbeobagrini
Genus *Horabagrus* Jayaram
H. brachysoma Günther
3. Subfamily Bagrinae
Genus *Mystus* Scopoli
M. gulio (Hamilton)
Genus *Aorichthys* Wu
A. aor (Hamilton)

Relevant published data from literature on *Rita rita* by Singh and Munshi (1969) and on *A. aor* by Munshi (1960) have been taken for comparison purposes. In respect of *Horabagrus brachysoma* and *Mystus gulio*, fresh specimens were dissected out, stained and the data obtained first hand.

MATERIAL AND METHODS

The fishes for this study were collected from the back waters of Cochin and Vellar estuary (South India). Dissections were made on the specimens preserved in 10% formalin, after washing them thoroughly and under stereoscopic binocular for meticulous examination. The drawings were made by free hand.

The nomenclature adopted by various workers giving names to the different cranial muscles is not uniform and differs with different investigators. The terminology adopted here is of Winterbottom (1974) with some changes to facilitate better understanding.

OBSERVATIONS

For the purpose of this study only two complexes of the cranial muscles have been investigated: (1) Mandibular and (2) Hyoid. Further division and subdivision of these are primarily based on the disposition, origin, insertion and functions of each muscle. The pattern is given in the next page :—

I. Mandibular muscle complex	Abbreviation
1. Constrictor dorsalis group	
a. Levator arcus palatini	Lev. arc. pal.
b. Abductor hyomandibularis	Abd. hyom.
c. Dilator operculi	Dil. op.
(i) Dilator operculi superioris	Dil. op. sup.
(ii) Dilator operculi inferioris	Dil. op. inf.
2. Adductor mandibulae group	
a. Adductor mandibularis	Add. mand.
(i) Adductor mandibularis ₁	
(ii) Adductor mandibularis ₂	
(iii) Adductor mandibularis ₃	
(iv) Adductor mandibularis ₄	
(v) Adductor mandibularis ₅	
b. Intramandibularis	Int. mand.
3. Intermandibularis group	
a. Intermandibularis	In. mand.
b. Protractorhyoidei	Protr. hyoid.
II. Hyoid muscle complex	
1. Constrictor hyoideus dorsalis group	
a. Adductor arcus palatini	Add. arc. pal.
b. Extensor tentaculi	Ext. tent.
c. Levator operculi	Lev. op.
d. Adductor operculi	Add. op.
e. Adductor hyomandibulae	Add. hyom.
2. Constrictor hyoideus ventralis group	
a. Hyohyoides inferioris	H. hyoid. in.
b. Hyohyoidei abductores	H. hyoid. abd.
c. Hyohyoidei adductores	H. hyoid. add.

I. Mandibular muscle complex :

This is a well developed complex in both *Mystus gulio* and *Horabagrus brachysoma*. It is composed of three group of muscles.

1. Constrictor dorsalis group.

This group of muscles provides suspensary support to the suspensorium and comprises three main components,

a. *Levator arcus palatini*

This muscle is situated between the neurocranium and the hyomandibula and may be viewed after dissecting out the muscular elements of the Adductor mandibularis group (*Add. mand.*).

M. gulio : This muscle (Text-fig. 4 B) is moderately developed and originates mainly musculously from the ventrolateral surface of the frontal and the sphenotic though a few posterior fibres are also aponeurotically attached to the shphenotic. The muscular fibres run downwards in a convergent fashion to get inserted on the anterior surface of the hyomandibula through an aponeurosis. The free anterior margin of this muscle is bordered by a prominent narrow aponeurosis. It is comparatively longer than wide and partly overlaps the *Add. mand.*₄ and *Add. mand.*₅.

H. brachysoma : On the other hand this muscle (Text-fig. 4A) is well developed and extends its origin to the ventral surface of the lateral ethmoid in addition to frontal and sphenotic unlike *M. gulio*. Further, the muscle is broader than long and does not overlap any element of Adductor mandibularis complex.

b. *Abductor hyomandibularis* :

In general this muscle is situated posterior to the *Lev. arc. pal.* by which it is partly overlapped also. It is quite distinct in *Rita* than in other genera of the family Bagridae.

H. brachysoma : It originates from the ventrolateral surface of the sphenotic through a broad aponeurosis and then runs downwards in a divergent fashion to get inserted on the anterior surface of the hyomandibula. The posterior and the inner muscular fibres are comparatively shorter than the anterior and outer fibres (Text-fig. 4A).

M. gulio : This muscle seems to be fused with the fibres of *Lev. arc. pal.*

c. *Dilator operculi* :

This muscle lies below the *Lev. arc. pal.* It runs from the opercular to the neurocranium and is divisible into two distinct parts based on the nature of its origin and insertion : (i) Dilator operculi superioris and (ii) Dilator operculi inferioris.

(i) *Dilator operculi superioris* :

This muscle is developed moderately in both *Mystus* and *Horabagrus*. It originates from the ventral surface of the frontal, lateral ethmoid and lateral surface of the sphenotic and the orbitosphenoid. The muscle fibres run backwards and downwards in a convergent fashion

to get inserted aponeurotically on the dorsolateral cornu of the opercular. The aforesaid aponeurosis is elongated and very prominent along the ventral free margin of the anterior fibres of this muscle. The muscle overlaps the *Dil. op. inf.* and its anterior fibres are longer (Text-figs. 5A and B).

(ii) *Dilator operculi inferioris* :

In the present two genera of the family Bagridae, this muscle is poorly developed and is situated underneath the *Dil. op. sup.* The muscular fibres originate from the posterodorsal grooved surface of the hyomandibula and run downwards in a somewhat convergent fashion to get inserted on the opercular just below the insertion of *Dil. op. sup.* (Text-figs. 6A & B).

2. Adductor mandibulae group :

This group of muscles is well developed, having several muscular components which help in the closing of the mouth. These components run from the lower jaw to the branchiocranium and neurocranium. Each is very distinct and this group comprises only two components in *M. gulio* and *H. brachysoma*, whereas in *Rita rita* and *Aorichthys aor.*, this group of muscles is having one additional component called. Maxillaris (Admx.) or Retractor tentaculi.

a. Adductor mandibularis :

This is well developed in both fishes of the present study but the number of elements constituting this muscle is variable. In *M. gulio*, it comprises five muscular elements whereas in *H. brachysoma*, only three elements are observed.

(i) *Adductor mandibularis*₁ :

This element is very well developed in comparison to other elements of Adductor mandibularis group. It lies adjacent to the lower border of the *Add. mand.*₂. In the fishes studied, it originates from the preopercular, hyomandibula 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 fashion to get inserted by means of an aponeurosis to the posterodorsal aspect of the angular. This connecting aponeurosis is comparatively smaller in *M. gulio* (Text-fig. 1B).

The position and nature of origin of this muscle is somewhat different in both the genera. In *M. gulio*, it originates only from preopercular, hyomandibula and the quadrate but in *H. brachysoma* (Text-fig. 1 A),

it does not originate from the quadrate and also some of its muscle fibres originate aponeurotically.

The second, deeper layer of this muscle is thin, lying underneath the superficial layer and originates from the hyomandibula and the quadrate as well. The muscular fibres run anterodownwards which are finally inserted aponeurotically as well as musculously on the angular just underneath the insertion of the superficial layer. No difference is observed in either genera *Mystus* or *Horabagrus*. (Text-figs. 2 A & B).

(ii) *Adductor mandibularis*₂ :

In *M. gulio*, this muscle is narrow and developed moderately whereas in *H. brachysoma*, it is well developed and thick. In the former (Text-fig. 2B) it originates musculously from the preopercular and the hyomandibula but in latter (Text-fig. 2A) it originates partly musculously and partly aponeurotically from the preopercular, hyomandibula, sphenotic and the pterotic. From the place of origin the muscle fibres run forwards and downwards in a convergent fashion and are finally inserted on the ventral surface of the dentary through an elongated aponeurosis in *M. gulio*. In *H. brachysoma*, on the other hand these fibres are inserted on the ventral median surface of the angular and the aforesaid aponeurosis provides the attachment to the muscular fibres of *Intramandibularis* unlike that of *M. gulio* (see Text-fig. 2A).

(iii) *Adductor mandibularis*₃ :

This is a moderately developed element situated adjacent to *Add. mand.*₂ and originating musculously as well as aponeurotically from the preopercular, hyomandibula, sphenotic and the pterotic. Then it runs downwards and forwards in a convergent manner and is finally inserted on the angular through an elongated aponeurosis. This aponeurosis passes below (see Text-fig. 3) that of the *Add. mand.*₂ and provides the attachment to the fibres of *Intramandibularis*.

In *H. brachysoma*, this component is absent and it seems that the muscle fibres have become blended with the *Add. mand.*₂ as the latter one is comparatively thick and wide in this species unlike that of *M. gulio*.

(iv) *Adductor mandibularis*₄ :

In both the genera, this muscle is developed moderately and lies deeply. It takes its origin from the median surface of the hyomandibula and the dorsal surface of the quadrate and then runs downwards and forwards in a convergent fashion. Finally, the muscular fibres are

inserted aponeurotically on the ventral median surface of the angular. The dorsal fibers are longer than the ventral fibres.

In *M. gulio* (Text-figs. 4B & 5B), this muscle is partly overlapped by the *Add. mand.*₂ and *Lev. arc. pal.* whereas in *H. brachysoma*, it is overlapped by the *Add. mand.*₁ and₂ and not by *Lev. arc. pal.* (Text-fig. 4A). In the former, the aponeurosis of this element distally passes over the aponeurosis of *Add. mand.*₃ and is inserted just below the latter while in *H. brachysoma*, this passes over that of *Add. mand.*₂ and is inserted ahead of the latter.

(v) *Adductor mandibularis*₅ :

This muscle is present only in *M. gulio* where it lies adjacent to the *Add. mand.*₄. The muscular fibres are elongated and originate from the dorsoanterior surface of the hyomandibula. The muscular fibres run downwards and forwards in convergent manner to get inserted on the angular through an elongated aponeurosis. This aponeurosis runs distally along side of the aponeurosis of *Add. mand.*₄ and is inserted on the angular. Distally, this aponeurosis is comparatively wider than that of other elements of this group (Text-fig. 5b).

b. *Intramandibularis* :

In both the genera, this muscle is developed moderately and is present on the inner side of the lower jaw. This is the only element of this group which does not connect the lower jaw directly with the neurocranium. In *M. gulio* (Text-fig. 3) and *H. brachysoma* (Text-fig. 2A), it originates from the dentary and angular. From the place of origin the muscle fibres run upwards and backwards in a convergent fashion to get inserted on the aponeurosis of the *Add. mand.*₃ and₂ respectively.

3. Intermandibularis group :

This group of muscle is situated on the ventral surface of the jaw and comprises of two components. These components help in opening of the mouth.

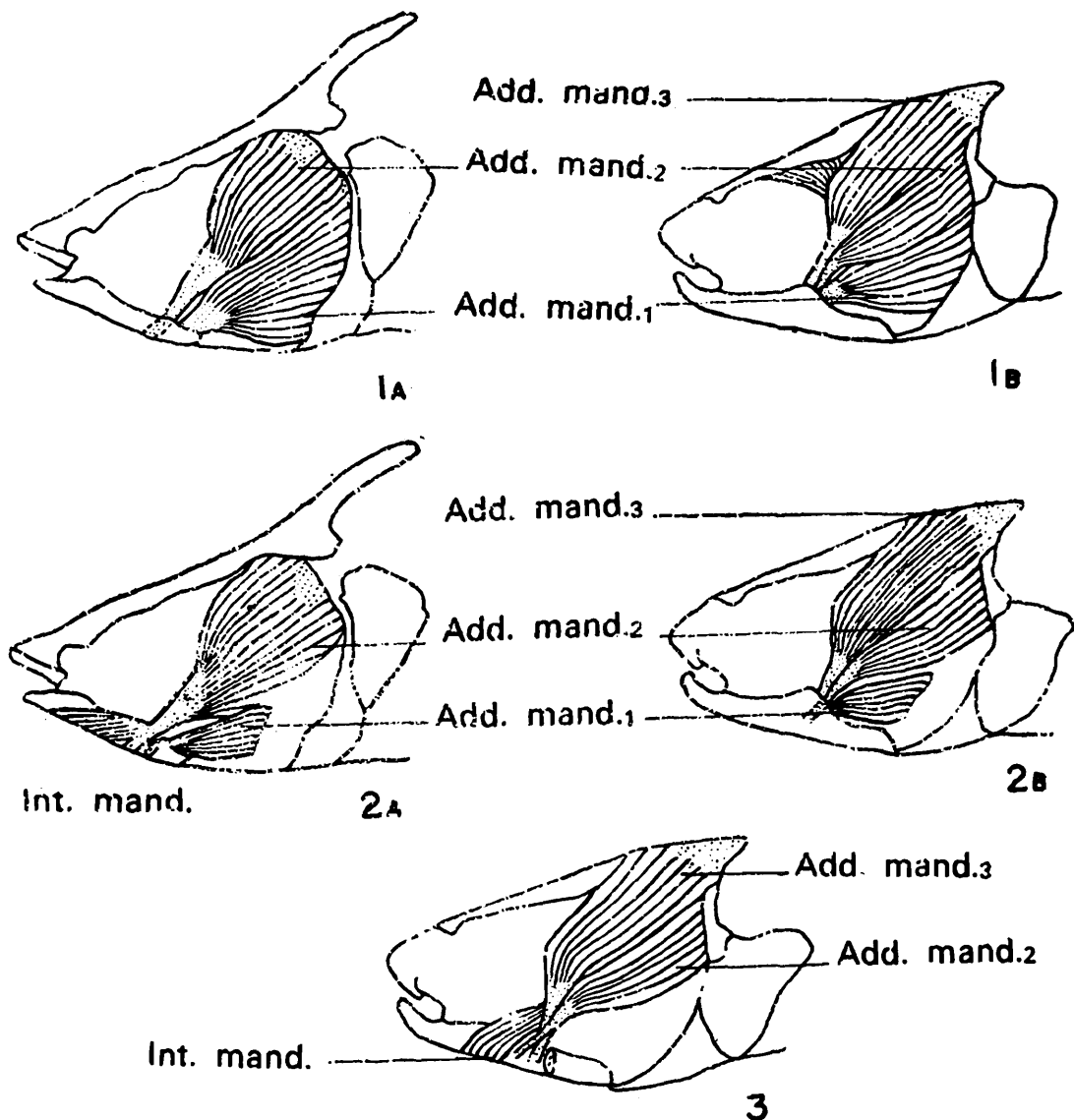
a. *Intermandibularis* :

In *H. brachysoma* (Text-fig. 8A) and *M. gulio* (Text-fig. 8B), this muscle is moderately developed and is arranged transversely inbetween the dentaries just below the symphysis. The muscular fibres are provided with an aponeurosis at deeper level. The whole muscle is sandwiched between the two halves of the *Protractorhyoidei*.

b. *Protactorhyoidei* :

This muscle is very well developed and connects the lower jaw with the hyoid cornu. It is in the form of two segments, one antero-

lateral and another postero inner portions. The anterolateral segment of this muscle is narrow and originates musculously as well as aponeurotically from the epihyal in case of *M. gulio* while only musculously



Text-fig. 1A. Left lateral view of the head region of *Horabagrus brachysoma*, showing the disposition of Adductor mandibularis components.

1B. Left lateral view of the head region of *Mystus gulio*, showing disposition of Adductor mandibularis components.

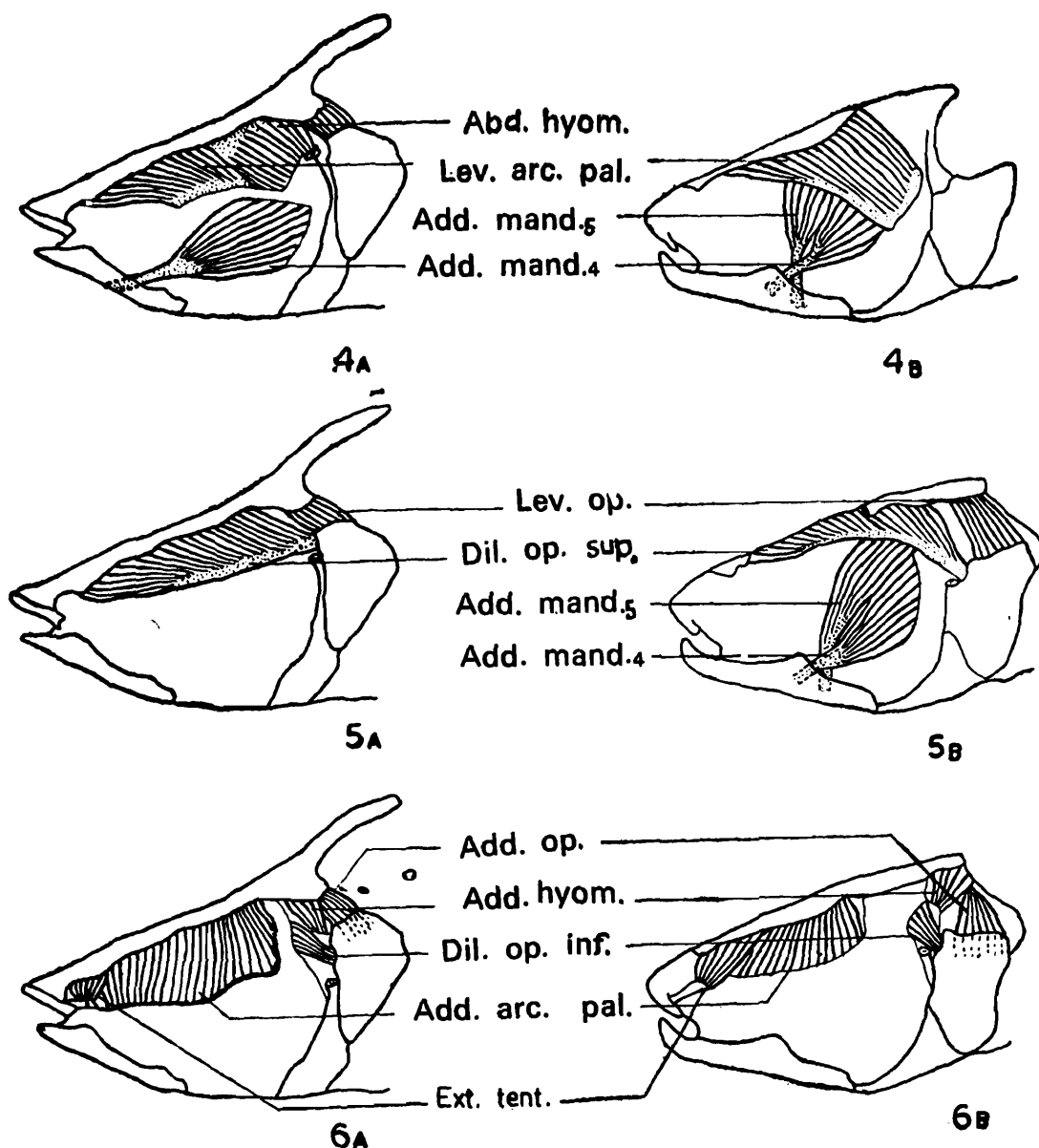
Text-fig. 2A. Left lateral view of the head region of *Horabagrus brachysoma*, showing the disposition of Adductor mandibularis components.

2B. Left lateral view of the head region of *Mystus gulio*, showing the disposition of the Adductor mandibularis components.

Text-fig. 3. Left lateral view of the head region of *Mystus gulio*, showing the disposition of the Adductor mandibularis components.

in case of *H. brachysoma*. Finally the fibres of this segment are inserted on the mesial surface of the dentary through an aponeurosis in *M. gulio* whereas in *H. brachysoma*, the insertion is partly musculous and partly aponeurotic. The posteroinner portion of this muscle is thick,

wide and covering almost the entire anteroventral surface of the head. Its fibres originate partly aponeurotically and partly musculously from the ceratohyal and epihyal in *M. gulio* but only from ceratohyal



Text-fig. 4A. Left lateral view of the head region of *Horabagrus brachysoma*, showing the disposition of the components of Adductor mandibularis and Constrictor dorsalis groups.

4B. Left lateral view of the head region of *Mystus gulio*, showing the disposition of Levator arcus palatini.

Text-fig. 5A. Left lateral view of the head region of *Horabagrus brachysoma*, showing the disposition of Dilator operculi superioris and Levator operculi.

5B. Left lateral view of the head region of *Mystus gulio*, showing the disposition of the components of Adductor mandibularis, Constrictor dorsalis and Constrictor hyoideus dorsalis groups.

Text-fig. 6A. Left lateral view of the head region of *Horabagrus brachysoma*, showing the disposition of the components of Constrictor hyoideus dorsalis and Constrictor dorsalis groups.

6B. Left lateral view of the head region of *Mystus gulio*, showing the disposition of the components of Constrictor hyoideus dorsalis and Constrictor dorsalis groups.

in *H. brachysoma*. The muscle fibres run forwards and inwards in a divergent fashion to get inserted on the dentary. Before insertion the muscle is bifurcated into two parts (superior and inferior) which fuses with the fellow of other side along a mid ventral line. The superior part provides the support to the mandibular barbles and passes over the *Intermandibularis*, while the inferior part passes below the *Intermandibularis*. In *M. gulio*, the insertion is partly aponeurotic and partly muscular. (Text-figs. 7A & B).

II. Hyoid Muscle Complex :

The muscles of this complex are divisible into two main divisions

1. Constrictor hyoideus dorsalis group :

This group of muscles is situated in the interspace between the suspensorium and the neurocranium and comprises of five components.

a. *Adductor arcus palatini* :

This muscle is well developed and occupies the entire space between the neurocranium and the pterygo-hyomandibular arch. The muscle fibres take their muscular origin from the parasphenoid except few posterior fibres which originate aponeurotically. The muscle fibres run downwards at a right angle to the longitudinal axis of the skull and in a somewhat divergent fashion to get inserted on the anterolateral surface of the hyomandibula, dorsolateral surface of the metapterygoid and ectopterygoid. The insertion of the fibres are partly muscular and partly aponeurotic. Anteriorly the muscle is partly overlapped by the *Extensor tentaculi* in both the genera (Text-fig. 6A & B).

b. *Extensor tentaculi* :

This muscle is situated anterior to the *Add. arc. pal.* and overlaps the latter partially. The development of this muscle varies among the two genera. In *M. gulio* (Text-fig. 6B) it is well developed and is having longer muscle fibres but in *H. brachysoma* (Text-fig. 6A) the muscle fibres are shorter and the muscle is moderately developed. The muscular fibres originate from the ventral surface of the lateral ethmoid and anterolateral surface of the parasphenoid and then run downwards in a convergent manner to get their insertion on the distal end of the autopalatine. The nature of insertion differs in both the genera. In *M. gulio*, the posterior fibres are inserted through an aponeurosis and the anterior fibres are inserted muscularly ; in *H. brachysoma*, on the other hand all the fibres of this muscle are inserted muscularly. Contraction of this muscle moves the autopalatine thereby causing the head of the autopalatine to move, which in turn abducts the maxillary barbels,

c. *Levator operculi* :

This muscle is moderately developed lying underneath the skin and just behind the *Dil. op.* In both the genera, it originates musculously from the pterotic except few fibres which originate from the posterodorsal surface of the hyomandibula. The muscle fibres run downwards in a divergent fashion to get inserted on the dorsal surface of the opercular. It overlaps the *Add. hyom.* (Text-figs. 5A & B).

d. *Adductor operculi* :

It is present beneath the *Lev. op.* and is well developed in *M. gulio* while it is moderately developed in *H. brachysoma*. In both the genera (Text-figs. 6A & B), the muscle originates from the prootic and then runs downwards in a divergent fashion after which the fibres are inserted on the dorsoinner surface of the opercular.

e. *Adductor hyomandibulae* :

This muscle is moderately developed, situated beneath the *Lev. op.* In *M. gulio* (Text-fig. 6B) as well as in *H. brachysoma* (Text-fig. 6A), the muscle originates from the ventral surface of the pterotic and then runs downwards in an anterior direction. It is inserted on the posterodorsal surface of the hyomandibula. The insertion is partly aponeurotic and partly muscular. It partly overlaps the *Add. op.* and is itself overlapped by the *Lev. op.*

2. Constrictor ventralis group :

This group comprises three main muscular elements which are lying on the ventral side of the head and connects the hyoid bones of one side with the other side. It may be viewed after removing of *Protractorhyoidei*.

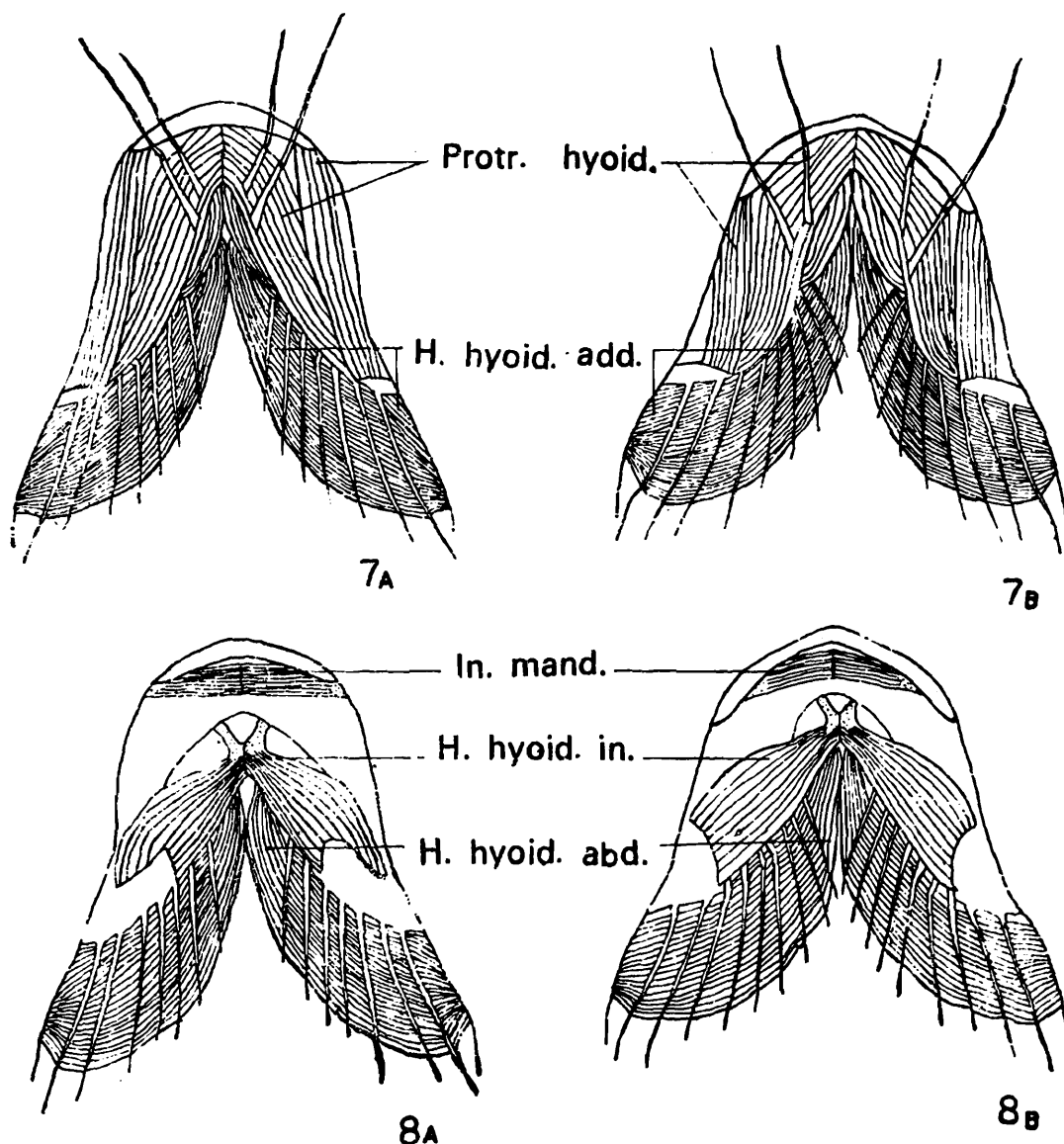
a. *Hyohyoide inferioris* :

This muscle is well developed, lying beneath the *Protr. hyoid.* and arising from the ceratohyal in *M. gulio* (Text-fig. 8B) and *H. brachysoma* (Text-fig. 8A) as well. It is seen that some smaller fibres also arise from the hypohyal in *M. gulio*. The muscle fibres of each side run forwards in a convergent fashion, fused with its fellow of the other side anteriorly along a mid ventral line. Finally, the fibres are attached on the anterodorsal surface of the hypohyal through a V-shaped aponeurosis. It partly overlaps the *Hyohyoidei abductores*.

b. *Hyohyoidei abductores* :

It is a well developed muscle, situated beneath and behind the *Hyohyoide inferioris*. In both the genera (Text-figs. 8 A & B), the muscle

fibres originate aponeurotically from the hypohyal. In *M. gulio*, the aforesaid aponeurosis is attached with its fellow of the other side before its attachment on the hypohyal. It also provides the attachment to



Text-fig. 7A. Ventral view of the head region of *Horabagrus brachysoma*, showing the disposition of Protractorhyoidei and Hyohyoidei adductores.

7B. Ventral view of the head region of *Mystus gulio*, showing the disposition of Protractorhyoidei and Hyohyoidei adductores.

Text-fig. 8A. Ventral view of the head of *Horabagrus brachysoma*, showing the disposition of Intermandibularis, Hyohyoidei inferioris and Hyohyoidei abductores.

8B. Ventral view of the head of *Mystus gulio*, showing the disposition of Intermandibularis, Hyohyoidei inferioris and Hyohyoidei abductores.

some inner fibres of *Hyohyoidei inferioris* unlike that of *H. brachysoma*. This aponeurosis lies just below that of *Hyohyoidei inferioris*. In *H. brachysoma* on the other hand the muscular fibres are closely applied to the ventral surface of the aponeurosis of *Hyohyoidei inferioris*. After their aponeurotic origin, the muscle fibres run downwards in a divergent fashion and get attached on the first branchiostegal ray in both the genera.

c. *Hyohyoidei adductores* :

This is a moderately developed muscle, present in between the branchiostegal rays in various bands and finally inserted on the inner surface of the opercular. There is variation in the number of muscle bands in each one of the genus. In *M. gulio* (Text-fig. 78), it is present in nine bands while only seven bands in *H. brachysoma* (Text-fig. 7A). It is very thick between the 2nd, 3rd, 4th and 5th branchiostegal rays.

DISCUSSION

The fishes of the family Bagridae has been considered as a base for the derivation of other siluroid families such as Amblycipitidae, Amphiliidae, Akysidae etc. Regan (1911) and Gosline (1944) postulated that the phylogeny of many Asiatic siluroids are interlinked with that of the Bagridae. Tilak (1961 ; 1963 a, b, & c ; 1964 ; 1965 a & b ; 1966 and 1967) in a series of papers demonstrated that such a hypothesis is more or less true at least in regard to the Indian siluroid families. Jayaram (1966 a) after a world revision of the fishes of family Bagridae, divided the family into five subfamilies : Ritinae, Chrysichthyinae, Bagrinae, Bagroidinae, Auchinoglanidinae. *Rita* was included under the subfamily Ritinae while *Mystus*, *Aorichthys* were included under Bagrinae and *Horabagrus* under Chrysichthyinae. Ritinae was considered more primitive than the other subfamilies.

While comparing the four genera myologically it is seen that these genera show uniformly a pattern in respect of the nature of origin, insertion and disposition of the following muscles viz. *Extensor tentaculi*, *Adductor operculi*, *Adductor arcus palatini*, *Intermandibularis* and *Dilator operculi inferioris*.

The features which are unique in respect of *Rita* are as below :

1. *Retractor tentaculi* :

This muscle is present in the form of muscular fibres in *Rita*, in the form of a ligament in *Aorichthys*, and is completely absent in *Mystus* and *Horabagrus*. It is known that *Retractor tentaculi* helps mainly in the movement of the maxillary barbels. It appears that in the case of *Mystus* and *Horabagrus* this function is taken over by the *Adductor mandibularis* muscle. Considering the fact that *Mystus gulio* and *Horabagrus brachysoma* are found in stagnant back waters where the visibility is less than as compared to the habitats of *Rita* and *Aorichthys* which are found in clear fast flowing streams this modification seems justified. The effective function of the maxillary barbel is more advanced in *Rita* and *Aorichthys* than in *Mystus* and *Horabagrus*.

2. *Adductor mandibularis* :

The origin of *Adductor mandibularis*₁ extends upto supraoccipital in *Rita* whereas in the other three genera it originates only from the branchiocranium. The number of muscular elements of *Adductor mandibularis* component is also significant. There are five elements in *Mystus*, four in *Rita* and *Aorichthys* and three in *Horabagrus*. In respect of the constituent elements of *Adductor mandibularis* component as stated above, it may be that the habitat of these fishes and also the large size of their head may have a bearing on the disposition of these muscles.

3. *Intramandibularis* :

In the case of *Mystus* and *Horabagrus*, this muscle is inserted on the aponeurosis of *Adductor mandibularis*₃ and₂ respectively. On the other hand in *Rita* this muscle is inserted only on the quadrate. In *Aorichthys* besides the quadrate, the insertion is on the aponeurosis of *Adductor mandibularis*₂ also. Additional difference in respect of *Aorichthys* is that this muscle is present in two parts unlike the other three genera where it is present as a single part.

The peculiar insertion of the *Intramandibularis* muscle only on the quadrate in *Rita* is a primitive feature indicating lack of support for the movement of the dentary bone. It may be due to the feeding habits as well as the dentition pattern in *Rita*. It may be noted that the dentition in the lower jaw of *Rita* is an elliptical patch with large molariform teeth towards the inner side and small villiform teeth towards the outer side of the jaw (See Jayaram, 1966, p. 441 and fig. 4).

4. *Levator operculi* :

Here also as in the case of *Intramandibularis* discussed above, this muscle originates from the pterotic by means of a tendon instead of a muscular origin as in the case of the other three genera. This also indicates the primitive feature of *Rita* showing the less efficient mechanism in the movement of the opercular bone.

5. *Hyohyoides inferioris* :

Rita is unique in having this muscle arranged in the form of 8 transverse muscular bands unlike other genera where it is present in the form of a single muscle. These bands are not inserted on the hypohyal but are fused with its antimere along the midventral line unlike the other genera.

The modification in *Hyohyoides inferioris* in the form of muscular bands, appears to be a progressive character considering the fact

that *Rita* generally prefers bottom areas and that its requirement of oxygen are comparatively less than those of other genera. This modification of *Hyohyooides inferioris* is a significant feature.

6. *Hyohyoidei abductores* :

This muscle generally assists in the movement of the branchiostegal membrane. It shows a somewhat progressive feature in the case of *Rita* unlike the other genera. The tendon of this muscle is criss-crossed whereas in other genera they are arranged in a simple manner. Reasons adduced above relating to the habitat of the fish would seem to apply here also.

It may thus be seen from the above discussion that *Rita* has the following features which are indicative of its primitive nature.

1. Presence of *Retractor tentaculi*.
2. The origin of the element of *Adductor mandibularis* component extending upto supraoccipital bone.
3. The insertion of the *Intramandibularis* muscle only on the quadrate.
4. Origin of *Levator operculi* from the pterotic by means of a tendon instead of a musculous origin.

The characters which may be stated as progressive are

1. Modification in *Hyohyooides inferioris* in the form of muscular bands.
2. The tendons of *Hyohyoidei abductores* in the form of a criss-cross.

Comparing the overall features of *Rita* with other genera it is seen that *Horabagrus* resembles a greater extent to *Rita* than *Mystus* and *Aorichthys*. As for instance out of 15 myological features (Tab. 1) listed for the four genera it is seen that only in respect of three main characters the two genera differ. The *Retractor tentaculi* and *Adductor mandibularis*₃ are absent in *Horabagrus* vs. present in *Rita* and the *Hyohyoidei adductores* have 7 bands vs. 8 bands in *Rita*.

Mystus and *Aorichthys* are naturally expected to resemble each other since taxonomically both of them are almost akin. However *Aorichthys* appears to be more specialised in possessing the *Abductor hyomandibularis*, in having a larger *Levator arcus palatini* and in the absence of *Adductor mandibularis*₃. The number of bands of *Hyohyoidei adductores* is maximum (eleven) in *Aorichthys* which also supports the view that *Aorichthys* is more specialised than the other three genera.

TABLE—I

	<i>M. gulio</i>	<i>H. brachysoma</i>	<i>R. rita</i>	<i>A. aor</i>
1. <i>M. abductor hyomandibularis</i>	Absent	Present	Present	Present
2. <i>M. levator arcus palatini</i>	It is longer than broad, originates from frontal and sphenotic.	Broader than long, originates from frontal, sphenotic and lateral ethmoid.	Similar to that of <i>H. brachysoma</i>	Broader than long, originates from sphenotic and frontal only.
3. <i>M. dilator operculi superioris</i>	Originates from frontal, sphenotic, lateral ethmoid and the orbitosphenoid.	From frontal, sphenotic, lateral ethmoid and orbitosphenoid.	From sphenotic, pterotic and hyomandibula.	From sphenotic, pterotic and frontal.
4. <i>M. retractor tentaculi</i>	Absent	Absent	Present in the form of muscular fibres.	Present in the form of ligament.
5. <i>M. adductor mandibularis</i> ₁	Originates from preopercular, hyomandibula and quadrate.	Similar to that of <i>M. gulio</i> .	From the preopercular hyomandibula, supraoccipital and the frontal.	From preopercular and the quadrate.
6. <i>M. adductor mandibularis</i> ₂	Originates from branchiocranium and is inserted on the dentary. Present in one part.	Originates from branchiocranium and neurocranium. Inserted on the angular. Present in one parts.	Originates from branchiocranium and neurocranium excluding preopercular. Inserted on the dentary. Present in two parts.	Similar to that of <i>H. brachysoma</i>
7. <i>M. adductor mandibularis</i> ₃	Originates from branchiocranium and neurocranium and present in one part.	Absent	Originates from branchiocranium only and present in two parts.	Similar to that of <i>R. rita</i> .
8. <i>M. adductor mandibularis</i> ₄	Originates from branchiocranium and present in one part and is partly overlapped by the <i>M. lev. arc. pal.</i>	Originates from branchiocranium, present in one part and is not overlapped by the <i>M. lev. arc. pal.</i>	From neurocranium, present in two parts and is partly overlapped by the <i>M. lev. arc. pal.</i>	From neurocranium and branchiocranium, present in one part and is partly overlapped by the <i>M. lev. arc. pal.</i>

	<i>M. gulio</i>	<i>H. brachysoma</i>	<i>R. rita</i>	<i>A. aor</i>
9. <i>M. adductor mandibularis</i> ₁	Present	Absent	Absent	Absent
10. <i>M. intramandibularis</i>	Insertion on the aponeurosis of <i>M. add. mand.</i> ₁ . Present in one part.	Insertion on the aponeurosis of <i>M. add. mand.</i> ₂ . Present in one part.	Insertion on the quadrate, present in one part.	Insertion on the quadrate as well as on the aponeurosis of <i>M. add. mand.</i> ₂ . Present into two parts.
11. <i>M. levator operculi</i>	Originates musculously from the pterotic.	Similar to that of <i>M. gulio</i> .	Originates from the pterotic through a tendon.	Similar to that of <i>M. gulio</i> .
12. <i>M. protractorhyoidei</i>	Originates from epihyal and ceratohyal.	Similar to that of <i>M. gulio</i>	From ceratohyal only.	Similar to that of <i>R. rita</i> .
13. <i>M. hyohyoidei inferioris</i>	Not present in the form of different bands. Inserted aponeurotically on the hypohyal.	Similar to that of <i>M. gulio</i> ,	Present in the form of eight muscular bands. Not inserted on the hypohyal but is fused with its fellow of otherside in the middle.	Similar to that <i>M. gulio</i> .
14. <i>M. hyohyoidei abductores</i>	The tendon of this muscle is not arranged in a criss-cross fashion with that of its fellow of other side.	Similar to that of <i>M. gulio</i> .	The tendon of this muscle of one side is criss-crossed to that of otherside.	Similar to that of <i>M. gulio</i> .
15. <i>M. hyohyoidei adductores</i>	Present in 9 bands.	Present in 7 bands.	Present in 8 bands.	Present in 11 bands.

As stated earlier Jayaram (1966) in his classification placed *Rita* under the subfamily Ritinae, *Mystus* and *Aorichthys* under Bagrinae and *Horabagrus* under Chrysichthyinae. Of these *Rita* was considered more primitive as already stated.

From the evidence of myology and considering the ecology of these fishes the above conclusions seem to be aptly justified. Osteologically it is known that *Aorichthys* and *Mystus* are derivatives from *Porcus* like ancestors. *Rita* appears to have evolved independently and may have given rise to *Chrysichthys* like fishes found in Africa which in turn may have given rise to *Horabagrus* like forms. The unique myological features of *Rita* justifies the above conclusion.

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SUMMARY

The mandibular and hyoid musculature in the osteocranium of four bagrid genera *Rita* Bleeker, *Horabagrus* Jayaram, *Mystus* Scopoli and *Aorichthys* Wu belonging to subfamilies Ritinae, Chrysichthyinae and Bagrinae of the family Bagridae was investigated. Published data on these muscular complexes on *Rita rita* by Singh and Munshi (1969) and *Aorichthys aor* by Munshi (1960) were utilised for comparing with the patterns obtained in *Horabagrus brachysoma* and *Mystus gulio* of which dissections were made and data retrieved first hand. The muscles in these latter two fishes are described in detail.

A comparison of the four genera myologically indicates that *Rita* is primitive in possession of *Retractor tentaculi* and in having the origin of *Adductor mandibularis* component extending up to the supraoccipital bone. Further in *Rita* the *Intramandibularis* muscle is inserted only on the quadrate. The origin of *Levator operculi* from the pterotic is by means of a tendon instead of a muscle. In respect of *Hyohyoideus inferioris* and *Hyohyoidei abductores* *Rita* exhibits some specialised features. Comparing the overall features of *Rita* with other three genera it becomes apparent that *Rita* is primitive than others. *Aorichthys* and *Mystus* are interrelated, *Rita* appears to have evolved independently and may have given rise to *Chrysichthys* like fishes which in turn may have given rise to *Horabagrus* like forms. The classification of Jayaram (1966) is justified.

REFERENCES

- DUBALE, M. S. AND VIDYASAGAR, J. 1960. Cranial musculature of a siluroid fish, *Heteropneustes fossilis* (Muller). *Vidya*, 3 : 148-156.
- EDGEWORTH, F. H. 1935. *The cranial muscles of vertebrates*. Cambridge University Press. ix, 1-493pp.
- GOSLINE, W. A. 1944. The problem of the derivation of the south American freshwater fish fauna. *Anais Acad. bras. Ciene.*, 16 : 211-223.
- JAYARAM, K. C. 1966. Contributions to the study of Bagrid Fishes (Siluroidea : Bagridae). 1. A systematic account of the Genera *Rita* Bleeker, *Rama* Bleeker, *Mystus* Scopoli, and *Horobagrus* Jayaram. *Int. Revue ges. Hydrobiol.*, 51 (3) : 433-450.
- JAYARAM, K. C. 1966a. Contributions to the study of the Fishes of the family Bagridae. 2. A systematic account of the African genera with a new classification of the family. *Bull. de l' Institut Fondamental d'Afrique Noire.*, (A) 28 : 1064-1139.
- JAYARAM, K. C. 1968. Contributions to the study of Bagrid fishes (Siluroidea : Bagridae). 3. A systematic account of the Japanese, Chinese, Malayan and Indonesian genera. *Treubia*, 27 (2-3) : 287-386.
- JUGE, M. 1899. Recherches sur les nerfs cérébraux et la musculature céphalique de *Silurus glanis*. *Rev. suisse Zool.*, 6 : 1-171.
- Mc MURRICH, J. P. 1884. The myology of *Amiurus catus* (Linn) Gill., *Proc. Canadian Inst. Toronto*, N. S., 2 : 311-351.
- MAHAJAN, C. L. 1971. *Sisor raddophorus*—A study in adaptation and natural relationship. 4. The head and pectoral musculature. *J. Zool. Lond.*, 165 (2) : 163-182.
- MUNSHI, J. S. D. 1960. The cranial muscles of some freshwater teleosts. *Ind. Jour. Zoot.*, 1 : 59-134.
- NAWAR, G. 1955. On the anatomy of *Clarias lazera*. II. The muscles of the head and pectoral girdle. *J. Morph.*, 97 : 23-38.
- REGAN, C. T. 1911. The classification of the teleostean fishes of the order Ostariophysi. 2. Siluroidea. *Ann. Mag. nat. Hist.*, (8) 8 : 553-577.
- SINGH, B. R. AND MUNSHI, J. S. D. 1969. The Jaw muscles and their mode of working in two Indian siluroid fishes. *Zool. Anz.*, 181 : 356-370.

- TAKAHASI, N. 1925. On the homology of the cranial muscles of the cypriniform fishes. *J. Morph.*, **40** : 1-109.
- TILAK, R. 1961. The osteocranium and the Weberian apparatus of *Eutropiichthys vacha* (Ham.) and *Eutropiichthys murius* (Ham.). A study of interrelationship. *Zool. Anz.*, **167** : 443-430.
- TILAK, R. 1963a. Studies on the Nematognathins pectoral girdle in relation to taxonomy. *Ann. Mag. nat. Hist.*, (13) **6** : 145-155.
- TILAK, R. 1963b. The osteocranium and the Weberian apparatus of the fishes of the family Sisoridae (Siluroidea) : A study in adaptation and taxonomy. *Z. wiss. Zool.*, **168** : 281-320.
- TILAK, R. 1963c. The osteocranium and the Weberian apparatus of a few representatives of the families Siluridae and Plotosidae (Siluroidea). A study of interrelationship. *Zool. Anz.*, **171** : 424-439.
- TILAK, R. 1964. The osteocranium and the Weberian apparatus of the fishes of the family Schilbeidae (Pisces : Siluroidea). *Proc. zool. Soc. Lond.*, **143** (1) : 1-36.
- TILAK, R. 1965a. The comparative morphology of the osteocranium and Weberian apparatus of Tachysuridae (Pisces : Siluroidei). *J. Zool. Lond.*, **146** : 150-174.
- TILAK, R. 1965b. The osteocranium and the Weberian apparatus of the fish of family Bagridae (Pisces : Siluroidei). *Morph. Jb.*, **107** : 415-443.
- TILAK, R. 1966. The osteocranium and the Weberian apparatus of *Amblyceps mangois* (Hamilton) (Pisces : Siluroidei) in relation to taxonomy. *Zool. Anz.* **174** : 61-74.
- WINTERBOTTOM, R. 1974. A descriptive synonymy of the striated muscles in the teleostei. *Proc. Acad. nat. Sci. Philad.*, **125** (12) : 225-317.