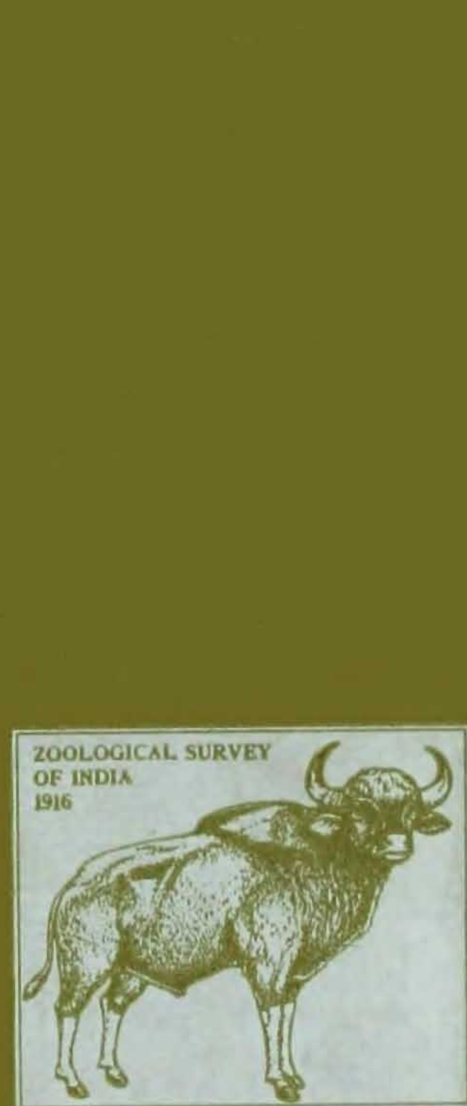
BULLETIN

OF THE

ZOOLOGICAL SURVEY OF INDIA



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BULLETIN OF THE ZOOLOGICAL SURVEY OF INDIA

CONTENTS

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OBSERVATION ON THE RELATIVE INTENSITY OF INFECTION ON THREE SPECIES OF CULTIVATED CITRUS PLANTS BY *PSYLLA MURRAYI* MATHUR (HOMOPTERA : PSYLLIDAE) AT SHILLONG, MEGHALAYA*

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ABSTRACT

Nature of infection on three species of cultivated Citrus plants caused by *Psylla murrayi* Mathur (Homoptera : Psyllidae : Psyllinae) at Shillong, Khasi hills, in relation to seasonal change, competition from other citrus pests, parasite and predator has been discussed in this paper.

INTRODUCTION

Citrus cultivation has immense economic importance in India considered from the point of medical utility as well as production of nutritious edible fruits. Psyllid flies are one of a number of pests that cause severe damage to cultivated citrus plan's resulting in a great national loss caused by depleted production.

The common Psyllid occurring almost exclusively on citrus plants all over South East Asia is *Diaphorina citri* Kuwayama (Psyllidae Psyllinae) and is more commonly known as Citrus Psylla. In India, it has been recorded on all species of Citrus plants besides a number of other plants of the family Rutaceae. However, while the Citrus Psylla has not yet been recorded from any part of Meghalaya so far, it was revealed in course of present investigation that a different species, *P. murrayi* Mathur, infects exclusively citrus plants in and around Shillong. First described from Dehradun, how *P. murrayi* Mathur turned out to be a citrus pest at Shillong replacing so to say the citrus Psylla has yet to be found out.

Infection of *P. murrayi* Mathur inflicts great loss to citrus cultivation in Shillong and around, since as much as 0% foliage of infected plants become deformed, resulting in a depleted photosynthetic activity over and above the loss caused by intake of plant sap by the growing larvae.

An investigation was carried out to ascertain the nature of injury caused by *P. murrayi* Mathur at Shillong in relation to host difference, seasonal change and outburst of other biological agents, either competitor, or even actual enemy of the Psyllid fly. Results of the investigation covering some basic informa-

*Part 13 of A preliminary study of the Insect fauna of Meghalaya.

tion for further investigation in future and suggestion for effective control of the pest have been incorporated in this paper.

MATERIAL AND METHODS

Three different species of cultivated citrus plants were selected for present investigation with an object to ascertain a comparative picture of nature of Psyllid infection on them. The three plants, henceforth referred to as "A", "B" and "C", in the text are *citrus medica* Linnaeus (SOHMAD in Khasi), *C. acida* Korel (SOHNAIRANG in Khasi) and *C. auranticum* Linnaeus (SOHMYNTRA in Khasi) respectively. Observation was carried out separately on three plants, (one each of A, B, and C) standing in a row within a stretch of 11.5 m at Risha colony, Shillong (Alt. 1625 m), regularly every week between July 1976 to June 1977. Presence or absence of adult as well as nymphs of Psyllid and other pests nature and intensity of infection on foliage and periodicity of development of new foliage were noted for each plant Rate of infection was ascertained through random counting of leaves. Some specimens were collected and preserved in spirit for identification. The plants under study were under natural condition throughout, free of any external interference, *e.g.* application of insecticides or otherwise.

OBSERVATIONS

Nature of infection of Psyllid larvae : The adult flies deposit their eggs on the inner surface of tender leaves just emerging and still within the bud, on the mid rib. The nymphs on emerging, keep on growing within the folded leaves, devouring the plant sap and moulting stage by stage. The leaves, thus infected by Psyllid nymphs become deformed and do not unfold or unfold only imperfectly for a prolonged period in comparison to normal, uninfected ones and still as long as they harbour the growing nymphs. The nymphs emerge into adult flies before the tender leaves turn old, thereby becoming thick and hardened. The leaves once infected by Psyllid nymphs remains variably curled ever afterwards, never being able to regain normal shape. Intensity of such deformed leaves is most noticeable in plant "B" which is having a single foliation in course of year, between February and April. Since the Psyllid infection also reach a peak period in this season on this plant (Fig. 1), throughout the rest of the year the plant "B" can be seen with 0% deformed foliage. Although, the Psyllid infection on plants "A" and "C" are at times as heavy as on "B" (Fig. 1) they are able to regain their loss to a considerable extent, each being credited with new foliation almost throughout the year, except in winter.

The infecting Psyllid nymphs are, however, forced to change their normal site of infection aud thus to move away from inner to outer surfaces of leaves in the face of severe competition from other citrus pests when it so happens.

Several factors influence the periodicity of infection of the Psyllid nymphs as discussed below.

A. Sequence of issue of new foliage correlated with seasonal change : As noted in the foregoing observation, the basic necessity for the substance of Psyllid nymphs is the availability of tender leaves. As a result, periodicity of infection of Psyllid nymphs depends primarily upon the sequence of issue of new foliage of citrus plants, which in turn is largely correlated with climatic factors or seasonal changes. In Shillong, optimum condition of available warmth comes in after the passing away of winter by the middle of February, when like most other plants. the citrus plants too take to a start for new folia-

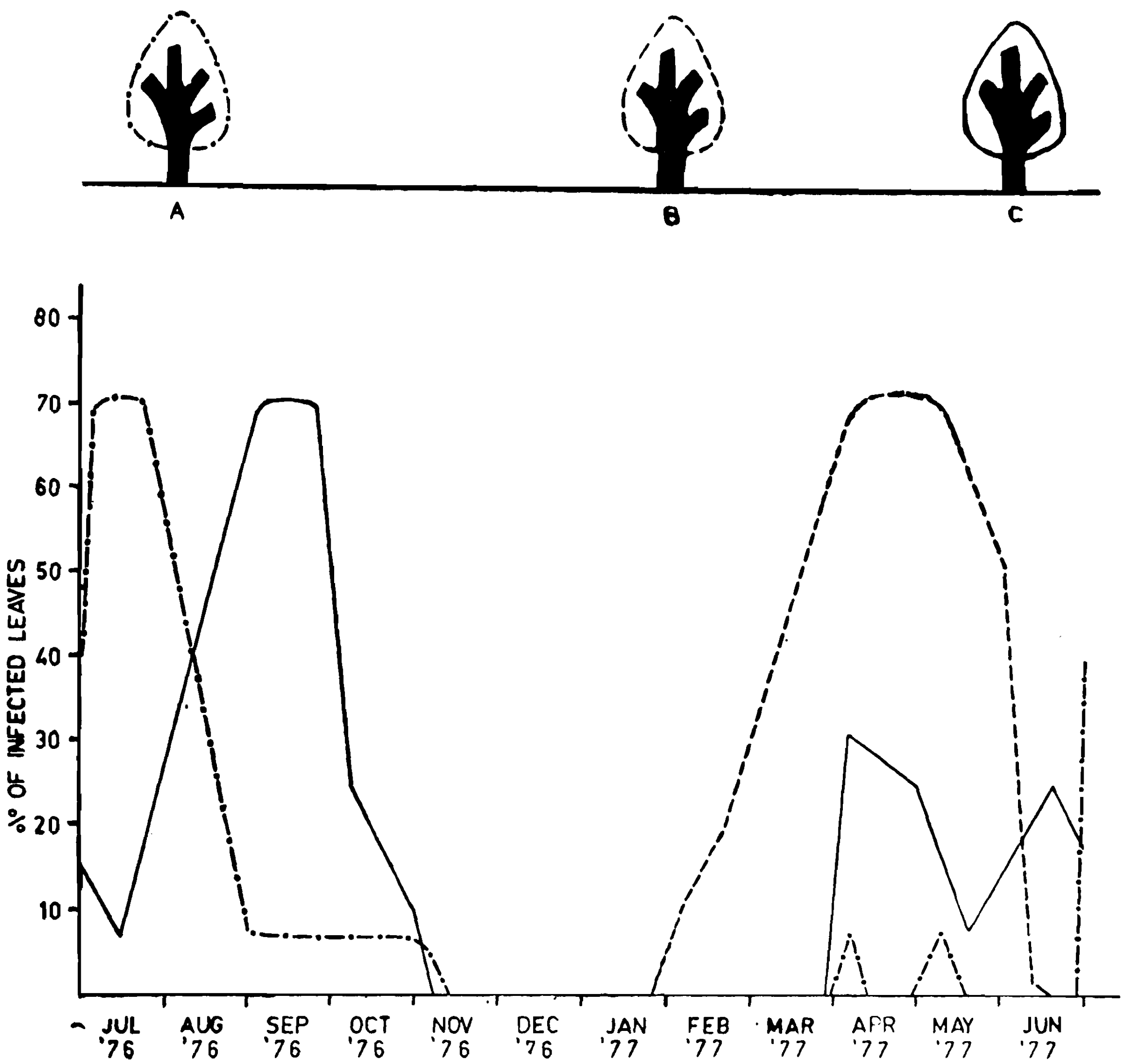


Fig. 1. Graphical representation of fluctuation in the intensity of infestation in course of investigation (from 1.7.'76 to 30.6.'77) caused by *P. murrayi* Mathur on different Citrus plants : A—*C. medica* L. B—*C. acida* Korel and C—*C. auranticum* L.

tion. The rate of issue of new foliage, however, take a luxurious shape with the availability of first few showers by the month of April. The rainy season, although heavy in the months of June and July is a prolonged one, sometimes lasting even beyond the month of October. This is followed by dry and severe winter, which is most predominant between November to middle of February. Issue of new foliage remains suppressed in all citrus plants in winter, is effective but for once in plant "B", between February and April, and continuous but of variable intensity for the rest of the year in plants "A" and "C" Keeping a sequence with the issue of new foliage the infection of *P. murrayi* Mathur also, remains suspended in winter, followed by a outburst in the month of April in all citrus plants and thereafter continuing on the plants "A" and "C" at variable intensity till the beginning of November.

Host preference : Periodicity of infection of Psyllid nymphs on different citrus plants is also correlated with different degree of choice for different *Citrus* spp. as host plant by the Psyllid fly. Plant "B" is apparently most choiced host plant (Pl. I, fig. A) for *P. murrayi* Mathur, followed by the plants "C" (Pl. I, fig. C) and "A" (Pl. I, fig. D) in sequence in this respect. This is evident from the differential intensiiy of infection caused by the Psyllid nymphs on the three different plants, (Fig. 1), most vividly exemplified in the month of April, when all the three *citrus* spp. took to issue of new foliage.

Competition from other citrus pests : *P. murrayi* Mathur is however, unable to monopolise the foliage of citrus plants due to competition from other citrus pests and also, the attack of a fungus, agents, which inflict more damage to citrus cultivation, over and above what is caused by the Psyllid fly. The effects of such agen's as noted during the present investigation are discussed below.

Psylloenistis citrella Stainton
(Lepidoptera : Gracilariidae)

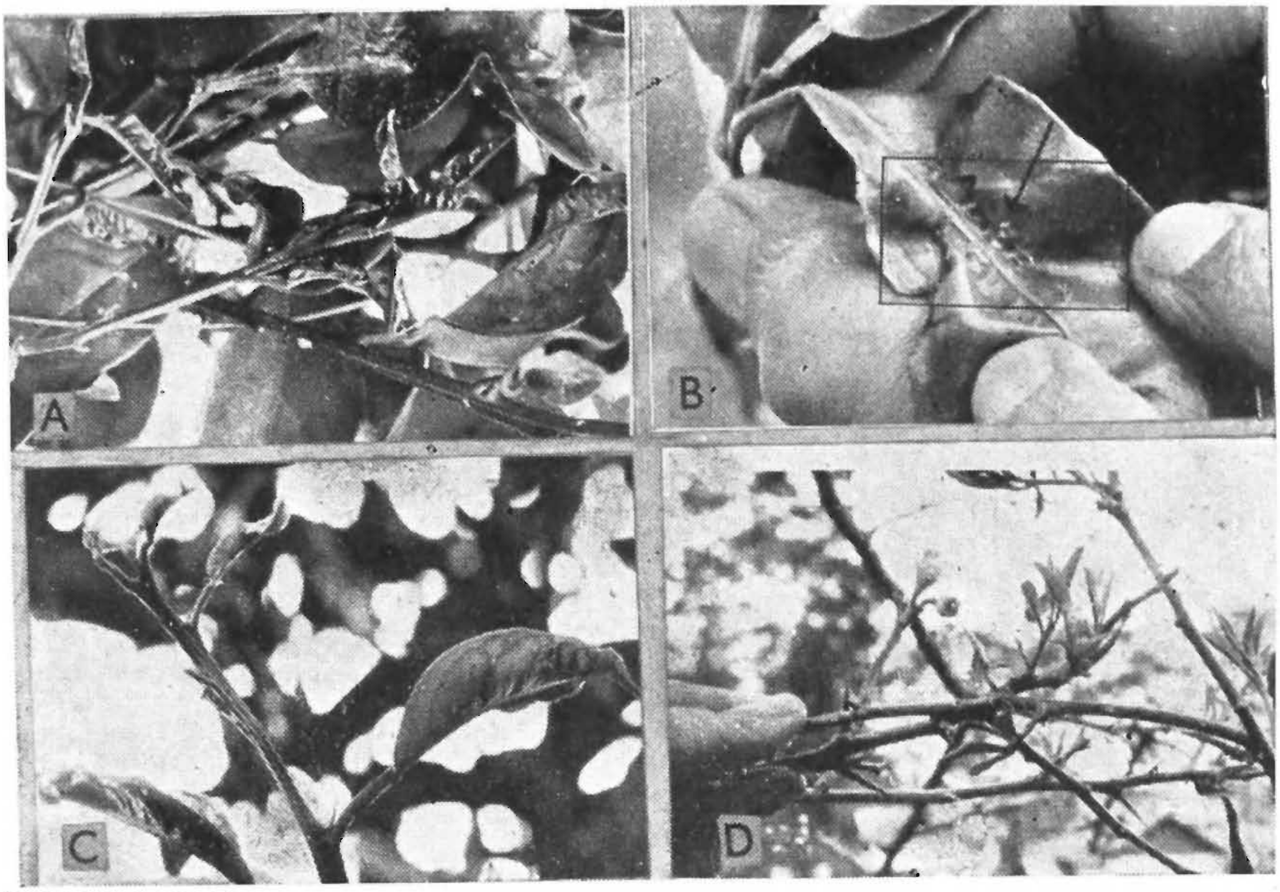
Tender foliage of the plants "A" and "C" were heavily infested in the months of July and August by the citrus leafminer, whose larvae would bore into the epidermis of citrus leaves, forming tunnels on their outer surfaces, these gradually growing into superimposed circles, till the emergence of the moth. The leafminer launched a serious competition for the Psyllid nymphs causing a lowered intensity of infection of the latter in either plant inspite of availability of tender foliage. Not uncommonly leaves were noticed, carrying either infection, the Psyllid nymphs on inner and those of leafminer on outer surface. An average of 50% psyllid nymphs succumbed to death due to competition from the leafminer larvae and in some of the doubly infected leaves the Psyllid nymphs were noticed wandering about on outer surface of leaves.

Plant "B" was, however not subjected to leafminer infection because of absence of tender foliage.

Dipteran larvae (unidentified) : Tender foliage of plant "A" was heavily infested in the month of April-May by one free living elliptical red larvae. These larvae at their early instars, were almost stationary while feeding the plant sap but, on maturity would become very agile and voluntarily fall into earth for pupation and subsequent emergence. A few of such larvai were also reared in the laboratory in petri dishes provided with moist soil. The small dipteran flies which emerged from these red larvae could not, however be identified. Comparatively low rate of intensity of infection of Psyllid nymphs on plant "A" in the months of April-May might have partly been caused due to competition from this Dipteran fly.

Citrus aphid : The common black aphid *Toxoptera citricidus* (Kirk) (Homoptera : Aphididae) infest citrus plants in winter months, when the infection of Psyllid nymphs remain suspended and therefore the two citrus pests do not normally render any competition to each other.

Other pests : The other pests were also noticed to infect the citrus plants, the citrus catterpillar, *Papilio demoleus* Linnaeus (Lepidoptera : Papilionidae), and two different Coccid (unidentified) species. However infection of either of these pests were only pericdic and of a very low intensity during the pericd of investigation, and normally noted to infect citrus leaves at bases, or on outer surfaces. Apparently, therefore, these pests also do not render any serious competion for the Psyllid nymphs.



Figs. A—Twigs of *C. acida* Corel infected by *P. murrayi* Mathur. B—A pair of *P. murrayi* Mathur, in copula on a spreaded leaf of *C. acida* Korel, carrying mite infection. C—Photograph showing A twig of *C. aurantiicum* L. infected by *P. murrayi* Mathur. D—Twigs of *C. medica* L. with just emerging new foliage, already infected by *P. murrayi* Mathur.

Fungal infestation : All citrus plants under present investigation were subject to fungal infestation from the middle of August, spreading all over the plants by the end of August and continuing upto the end of September. It affected all terminal parts of branches including tender leaves and terminal buds, which were gradually covered by the overgrowing ashy white fungal layer, subsequently to get dried and fallen. Plants "C", "A" and "B" stand in order of lowering rate of intensity of fungal infestation. By the beginning of October the fungal infection having been over, the citrus plants looked quite barren, holding only the subterminal hardened leaves which alone could withstand the attack of fungal infestation. Due to fungal attack Psyllid infection was very low in plant "A" during this period, while in plant "C" the same after attaining a peak period in the middle of September, rapidly depleted, and was terminated in either plant by the beginning of November. Fungal infection, however, did not effect Psyllids on Plant "B" where psyllid infection had terminated long before.

Predator : The small lady bird beetle *Telsimia* sp. (Coleoptera : Coccinellidae) a known predator of larvae of many insects including phytophagus insects *e.g.* scale insects, Coccids and Aphids were frequently noticed to harbour inside the folded citrus leaves carrying Psyllid nymphs. It was further noticed that leaves carrying the lady bird beetle invariably contained 50% or even less number of Psyllid nymphs in comparison to other Psyllid infected leaves. From this, the lady bird beetle appears to be a potential predator also of the Psyllid nymphs and thus act as a natural controlling agent for the same. However, for unknown reason, population of the lady bird beetle on the Citrus plants under study was never noticed to be a large one, in general appearing on not exceeding 10% of the Psyllid infected leaves.

Parasite : In the month of April, when there was a sudden outburst of Psyllid infection on all citrus plants, it was noticed that a red mite, *Bochartia* sp. (Acarina : Trombidiformis : Erythracidae) heavily parasitised externally the Psyllid population. Adults as well as nymphs of all stages of *P. murrayi* Mathur were subject to attack, but while the nymphs were attacked each by a single mite the adults (Pl. I, fig. B) were subject to attack by 1-3 mites each at a time The mites pierced into the body of their hosts generally on the thorax, but sometimes also on abdomen. The Psyllids attacked by 3 mites at a time become completely immobile, while the rest were partly so. Many adult Psyllids succumbed to death, the nymphs were also so before attaining maturity.

DISCUSSION

Attack of *P. murrayi* Mathur on Citrus plants initiates with the initiation of new foliage and therefore the pest can be effectively controlled by applying suitable insecticides at such stage. The same also applies for most other Citrus pests at Shillong. Cost of applying insecticides would evidently be less for plant "B" than in the other two plants, foliation period being restricted in the same. Further investigation is necessary to find out as to what extent biological control of *P. murrayi* Mathur is practicable by utilising the lady bird beetle and the red mite.

ACKNOWLEDGEMENTS

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PRIMARY PRODUCTIVITY AND TROPHIC STATUS OF TWO TROPICAL WATER BODIES OF CALCUTTA, INDIA

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ABSTRACT

The primary productivity of an artificial lake (Dhakuria lake) and a small polluted pond (Monohar Das pond) of Calcutta, India has been studied by classical light and dark bottle technique. With gross primary production rate 1800—(3733)—5600 mg C/m^2- day and annual production of 1364.544 mg C/m^2—year in Dhakuria lake and 7600—(9116)—12000 mg C/m^2—day with annual production of 3609 mg C/m^2—year in Monohar Das pond, both these water bodies have been classified as highly eutrophic. Respiration comprised 46.23% (24—83%) of the total gross production of Dhakuria lake while it was considerably high in the pond 75.15% (42—100%). Productivity was fairly uniform throughout the year with little oscilation except during monsoon months. Significant relationships were observed in case of transparency, pH, conductivity, phytoplankton and zooplankton density in both water bodies. However relationships with alkalinity and hardness were only significant in Dhakuria lake.

INTRODUCTION

Considerable work has been carried out during recent years on the primary productivity of freshwater ecosystems of temperate and arctic regions in order to assess the turnover rate at primary tropic level, community energetics, production capacity, trophic status and impact of human activities upon these water bodies, but such works on tropical waters, is comparatively lesser and scattered. In India Sreenivasan (1964 *a*, 1964 *b*, 1965, 1976), Ganapati and Sreenivasan (1970) and Vijayraghavan (1971) have studied the primary productivity of a number of ponds and reservoirs of Southern India but North Indian water bodies have received little attentions.

The present report, which is a part of the detailed investigations on the production ecology of some freshwater impoundments of this region of the country, deals with primary production, its seasonal variations and relationship with some of the physicochemical and biological factors of two impoundments, one being a large artificial lake (Dhakuria lake) and other a small polluted pond (Monohar Das pond) of Calcutta, India (Latitude 22°30′ N and longitude 88°30′ E).

DESCRIPTION OF THE STUDY AREA

Dhakuria lake is an artifical lake constructed by Calcutta Improvement Trust, 50 years ago. The main lake which is elongated in shape covers an aproximate area of 72 acres. The maximum length is about 1770 metres, while its width at the broadest point is 282 metres. The perimeter is about 18,000 Rft. Mean depth varies from 10.5 to 9.3 metres. The lake is mainly fed by rain water and is mainly used for recreational purposes. Monohar Das pond is small (*c.* 9050 sq. metre in area and 3.2 metre average depth) and situated in the densely populated area of the city. It is also connected with a sewage drain and used for a variety of purposes, making it highly polluted water body.

Materials And Methods

Plankton primary productivity and respiration were determined by the classical light and dark bottle technique (Garder and Gran 1927). The operation was carried out *in Situ* filling the bottle pairs with water and incubating for 6 hours (9 A.M. to 3 P.M.) at fortnightly or monthly intervals during the period October 1975 to September 1976 in Dhakuria lake and December 1976 to November 1977 in Monohar Das pond. Oxygen was determined by modified Winkler's method and gross photosynthesis was calculated from the differences in oxygen concentration in light and dark bottles while community respiration was calculated from decrease in the oxygen contents in dark bottle as compared to initial reading. Integrating oxygen production/m^3 at various depth, yield/m^2 was determined. Data obtained were converted to terms of carbon using conversion factor of 0.375 and values were expressed as mg C/m^2—day taking the photoperiod of the region (from sun rise to sun set for the respective months) as a day. Surface temperature, pH, Secchi disc transparency, alkalinity, hardness and electrical conductivity were also determined. Physical parameter were evaluated by the techniques of Welch (1948) and chemical analysis followed Standard Methods (APHA 1965). Phytoplankton samples were collected by concentrating 1 litre of water and were preserved by Lugol's solution and counting was done with the help of a Sedgwick Rafter counter under a microscope.

Zooplankton samples were collected with the help of a standard net of No. 21 cloth both by filtering 120 litres of water and by towing from a boat moving at a speed of 3 km. per hour in lake and from the shore in pond. The latter samples were collected only for relative distribution studies. Samples were preserved in 4% formalin. After suitably diluting, the identification and enumeration were done simultaneously by taking three 1 ml. sub-samples in a rectangular glass chamber under a binocular and a mean was obtained.

Results

The gross primary productivity of both the water bodies was considerably high and varied between 1800 and 5600 mg C/m^2 — day with a mean of 3733 mg C/m^2 — day in Dhakuria lake and between 7600 and 12000 mg C/m^2 — day with a mean of 3509.8 mg C/m^2 — day in Monohar Das pond, corresponding to annual yields of 1354.545 gm C/m^2 — year and 3509.840 gm C/m^2—year respectively. The magnitude of primary productivity was about 2.5 times higher in the pond as compared to Dhakuria lake (Table 1).

Definite trend of seasonal variations in gross primary productivity rate were observed in Dhakuria lake and a bimodal pattern of increased producitivity was noticed. The first peak appeared during March and second during November. Relatively low values were noticed during peak monsoon months (July—September) when production rate declined significantly (Fig. 1). Though the production rate in Monohar Das pond was fairly high and consistent during most of the months, a decline in productivity during monsoon months was noticed (Fig. 2). Except these months

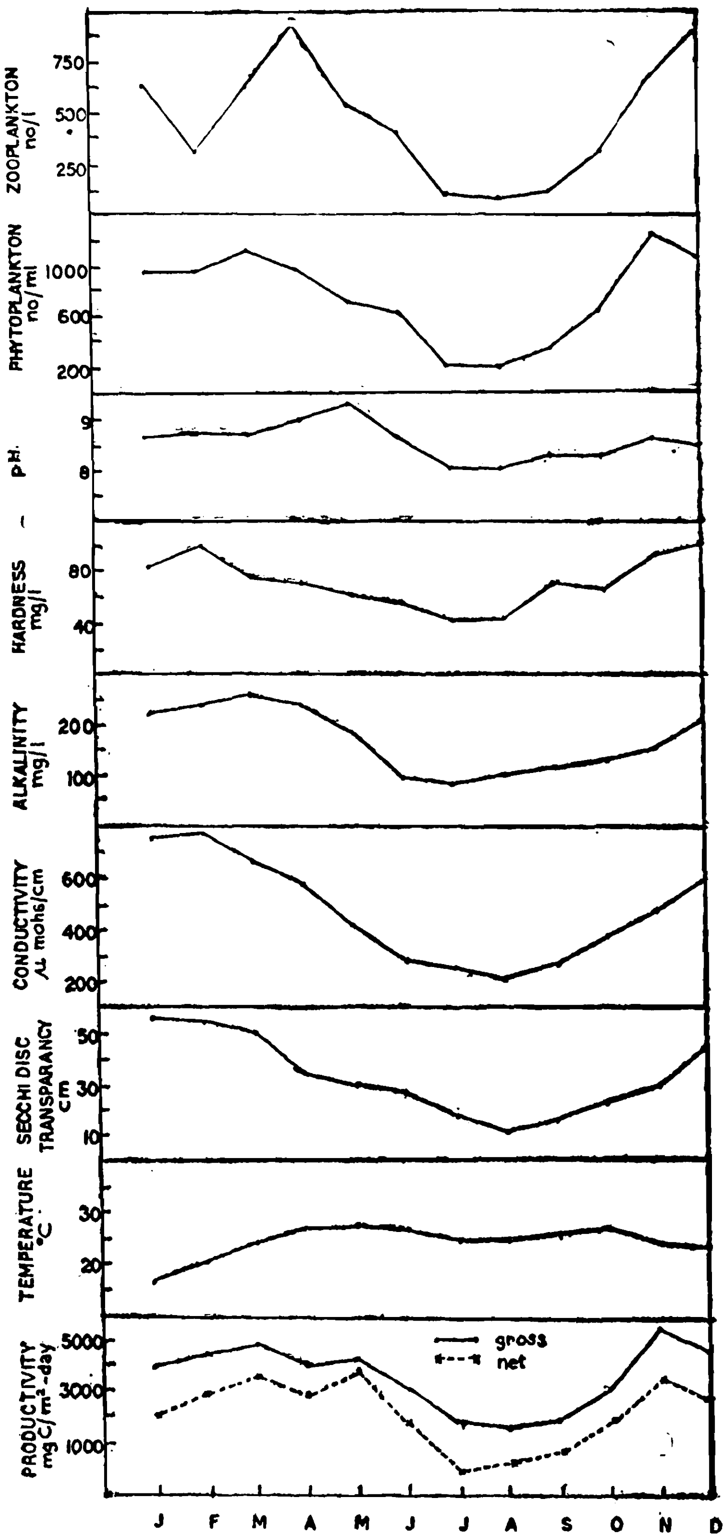

Fig. 1. Seasonal variations in primary productivity and various physicochemical and biological factors in Dhakuria lake.

the productivity was almost uniform throughout the year. Inspite of seasonal variation in the productivity the rate did not fluctuate too much in both the water bodies and maximum values were only 3 and 1.5 times higher than the minimum values in Dhakuria lake and the pond respectively (Table 1 & 2).

Respiration comprised about 46.23% of the gross production in Dhakuria lake and varied between 24% and 83%. The maximum respiration rate was noticed during peak monsoon months (August) and minimum during March when the gross production was relatively high. Consequently the ratio of net productivity to gross productivity ranged from 0.17 to 0.69. The average annual yield of the net productivity was found to be 568.607 gm C/m^2-year. In pond respiration rate was considerably high throughout the year and varied between 40.25% (December) to 100% (July-August). The ratio of the net productivity to the gross productivity ranged from 0.00 to 0.60 with a mean value of 0.24 and annual yield of net productivity was 1000.465 gm C/m^2-year.

The seasonal variations in various physicochemical factors in relation to productivity have been shown in Fig. 1. (Dhakuria lake) and Fig. 2 (Monohar Das pond). It is apparent that the Secchi disc transparancy was lower in the pond, total alkalinity, conductivity, hardness and pH were significantly higher as compared to Dhakuria lake. Each of the above-mentioned factors showed clear pattern of seasonal fluctuation in Dhakuria Lake. the values being low during monsoon months (June-September) and high during the period November-April. Almost similar pattern was also noticed in the pond in all the factors execpt in alkalinity and hardness which showed irregular trends. Fluctuations in water temperature in the both water bodies closely followed the air temperature which was governed by the season.

The marked seasonal fluctuations were noticed in the occurrence and density of phytoplankton and zooplankton of both the water bodies, the pattern of fluctuation being somewhat similar to most of the physicochemical factors. The phytoplankton and zooplankton concentration were considerably high in the pond as compared to Dhakuria Lake. The phytoplankton composition of Dhakuria Lake was dominated by green algae (40%) followed by diatoms (34%), while the share of blue green algae was only (20%). In pond the composition was dominated by blue green algae (55%) and a permanent bloom of *Microcystis aeruginosa* was observed. Green algae consituted only (20%) and diatoms 18%. The zooplankton concentration in the pond was fairly high and dominated by only few species of Cladocera and Copepoda. Two cladoceran speeies *Ceriodaphnia cornuta* and *Daphnia carinata* were found to be dominant species of zooplankton and a condition resembling to the swarming of these two species were observed during different periods of the year. In Dhakuria Lake the zooplankton were thinly distributed as compared to the pond.

The relationships between various physicochemical and biological factors and gross primary productivity (by computing the coefficient of correlation) (Table 1), was found to be significant in Dhakuria Lake in relation to Secchi dise transparency ($r=0.727$), pH $r=0.578$), conductivity ($r=0.765$), alkalinity ($r=0.887$), pH ($r=0.578$), phytoplankton ($r=0.972$) and zooplankton ($r=0.903$). The relationship between gross primary productivity and temperature was highly insignificant ($r=0.080$). In pond while the productivity was significantly related to transparency ($r=0.621$), conductivity ($r=0.980$), pH ($r=0.672$), phytoplankton ($r=0.846$) and zooplankton ($r=0.900$), the relationships with alkalinity ($r=0.377$) and hardness ($r=0.547$ were not significant. The relationship with temperature was also highly insignificant ($r=0.080$).

DISCUSSION

The classification of the trophic status of

TABLE 1. Seasonal variation in Primary Productivity of Dhakuria lake & Monohar Das pond.

	Dhakuria lake					Monohar Das pond				
Months	Gross Primary productivity mg C/m^2-day	Community Respiration mg C/m^2-day (24 hrs.)	net productivity mg C/m^2-day	Respiration as % of gross	net gross ratio	Gross primary productivity mgC/m^2-day	Community Respiration mgC/m^2-day (24 hrs.)	net production mg C/m^2-day	Respiration as % of	net gross ratio
Jan.	4000	1900	2100	47.56	0.52	12000	7500	4500	62.50	0.37
Feb.	4600	1700	2900	37.00	0.63	12000	6200	5800	51.66	0.41
Mar.	5000	1300	3700	24.00	0.76	10300	7800	3000	70.87	0.29
Apr.	4200	1300	2900	31.00	3.69	9500	8000	1500	84.21	0.16
May,	4400	1600	3800	36.33	0.64	9000	7900	1200	80.66	0.19
Jun,	3200	1400	1800	43.75	0.56	8300	8300	0000	100.00	0.00
Jul.	2000	1500	500	75.00	0.25	8000	8000	0000	100.00	0.00
Aug.	1800	1500	300	83.30	0.17	7600	7600	0000	100.00	0.00
Sep.	2000	1200	800	60.00	0.40	8000	7600	400	95.00	0.05
Oct.	3200	1200	2000	37.50	0.63	9500	5500	6000	57.90	0.42
Nov.	5600	2000	3600	35.76	0.64	10200	4200	0000	58.82	0.41
Dec.	4800	2100	2700	43.60	0.56	11000	4500	6500	40.25	0.60
Annual mean	3733	1558	2175	46.23	0.537	9616	6875	2741	75.15	0.248

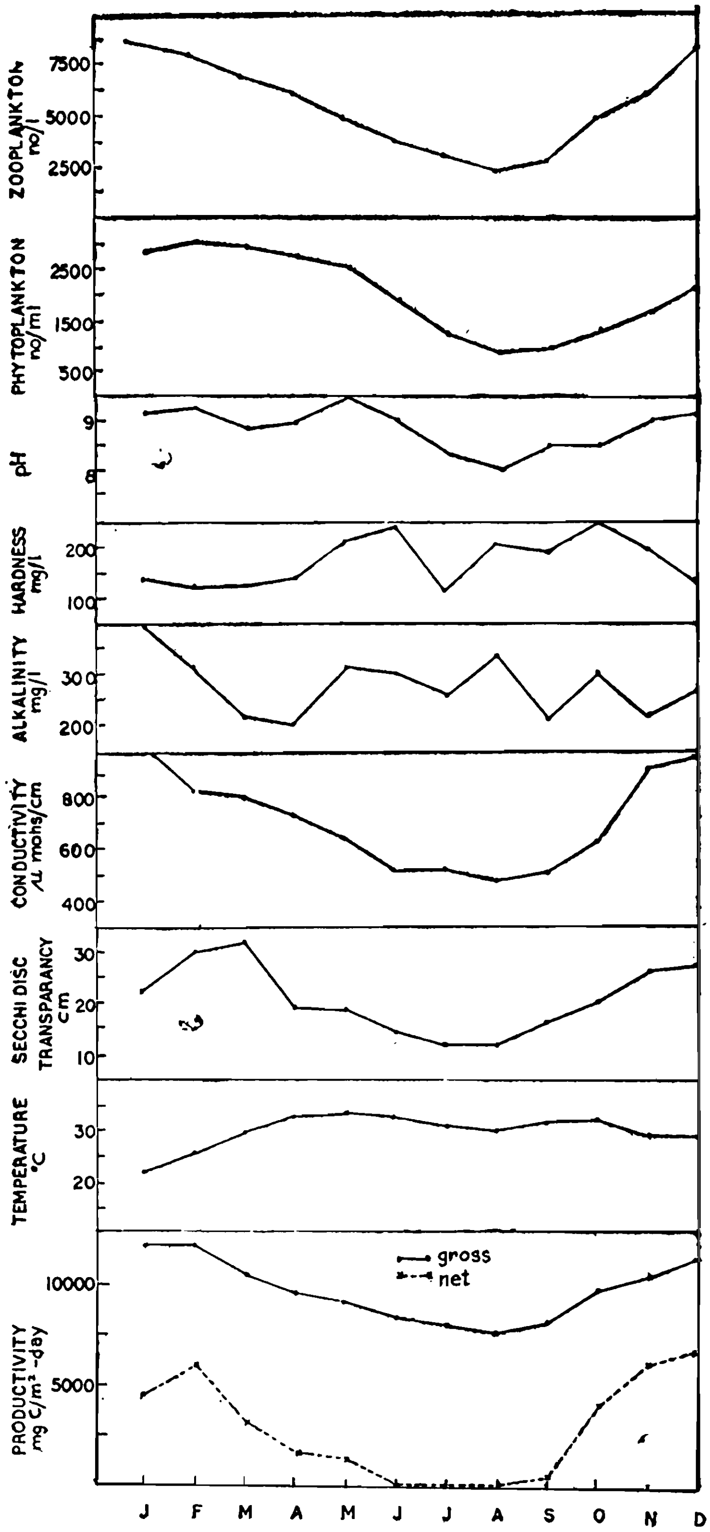

Fig. 2. Seasonal variation in primary productivity and various physicochemical and biological factors in Monohar Das pond.

European water bodies in relation to productivity has been given by Vallenweider (1968) and Rodhe (1969). According to former author, a lake having a primary productivity rate of 65—300 mg C/m^2-day is oligotrophic, 250-1000 mg C/m^2-day is mesotrophic and 1000-8000 mg C/m^2-day is eutrophic, while latter worker gives the values of 30-100 mg C/m^2 -day for oligotrophic 300-1000 mg C/m^2 --day for natural eutrophic and 1500-3000 mg C/m^2-day for polluted water bodies. Gessner (194) reported that the gross primary productivity of temperate eutrophic lakes varies between 500 and 5000 mg C/m^2-day. With gross primary productivity rate of 3733 (range 1800--5600) and 9116 (range 7600--12000) mg C/m^2-day, both Dhakuria lake and Monohar Das pond can be classified as highly eutrophic water bodies. Values are well above the limit fixed by above workers. Very high productivity rate of tropical water bodies have been reported by a number of workers. (Talling 1965, Falconer *et al.* 1970, Ganapati and Sreenivasan 1970, Vijayraghavan 1971 and Ganf 1972). It appears that in general extremely high productivity is an important feature of tropical eutrophic water bodies. These may be due to uniformly high temperatures, greater intensity of solar radiation and absence of a critical winter season. In fact, temperature and light are never a limiting factor under tropical conditions and the addition of small amount of nutrient will greatly increase the productivity (Marshall and Falconer 1973).

High production rates have been recorded both from temperate as well as tropical regions under specialized conditions, *e.g.* sewage ponds (Bartsch 1960), fertilized ponds (Hepler 1962) and refinery ponds (Copeland and Dorris 1962). The highly eutrophic nature and high productivity of Monohar Das pond can be attributed to its small size and high load of organic pollution caused by sewage as well as indiscriminate and intensive use made by the dense human population surrounding it. The presence of permanent bloom of blue-green algae in the pond also signifies its highly eutrophic nature. The effect of human activities is not as marked in Dhakuria lake as in the pond. This is due to the fact that Dhakuria lake covers a relatively larger area and is well managed. Human interference is very much restricted.

Contrary to the temperate waters where the seasonal variations in the primary productivity are considerably high, and maximum values, during summer being as high as fifty times ; in tropical water production remains moderate throughout the year with little oscillation (Hulbart *et al.* 1960, Prasad and Nair 1963 and Qasim *et al.* 1969). This is clearly evident from the present study also. Inspite of clear pattern of seasonal fluctuations in the two water bodies, production was fairly uniform throughout the year except during few monsoon months and the maximum values were not more than 3 and 1.5 times higher than minimum values in Dhakuria lake and Monohar Das Pond respectively. The low values during monsoon months were probably due to heavy rain which resulted in the increased turbidity and considerable dilution of the water. Similar effects of heavy rain on phytoplankton and zooplankton density have been reported by Ray *et al.* (1966).

In the absence of marked change in the temperature in tropical region different patterns of seasonal variations in productivity have been observed in different water bodies depending upon the local conditions and a generalization seems to be difficult. However Ganapati and Sreenivasam (1970) have tried to generalize the seasonal variations in the productivity of few south Indian water bodies and observed that the order of magnitude of production seasonwise was almost same in different water bodies, maximum during hot season and minimum

TABLE 2. Relationship between gross primary productivity and variation physicochemical and biological factors.

Factors	Dhakuria lake			Monohar Das Pond		
	Correlation coefficient	Degree freedom	Probability	Correlation coefficient 'r'	Degree of freedom	Probability
1. gross primary productivity and Zooplankton	0.080	10	more than 0.1*	0.009	10	more than 0.1*
2. gross primary productivity and Secchi disc transparancy	0.723	10	less than 0.01	0.621	10	less than 0.05
3. gross primary productivity and conductivity	0.765	10	less than 0.01	0.980	10	less than 0.001
4. gross primary productivity and total alkalinity	0.887	10	less than 0.001	0.377	10	more than 0.01*
5. gross primary productivity and hardness (Caco2)	0.786	10	less than 0.01	0.547	10	more than 0.05*
6. gross primary productivity and pH	0.578	10	less than 0.05	0.672	10	less than 0.05
7. gross primary productivity and phytoplankton	0.972	10	less than 0.001	0.846	10	less than 0.001
8. gross primary productivity and zooplankton	0.963	10	less than 0.001	0.900	10	less than 0.001

* Not significant

during cold season. This is in contrast to present observations where minimum values were recorded during monsoon months.

The annual net productivity and respiration of freshwaters have been found to vary considerably. While Ganapati and Sreenivasan (1970) found that the gross productivity was more in smaller water bodies as compared to large man made lakes, the order is found to be reverse in the present case, productivity being higher in Dhakuria lake than the pond. Similarly respiration rate in the pond was high throughout the year and during monsoon months, when dark clouds and heavy rains were common, it was cent percent of the gross production. Similar conditions have also being reported from other tropical water bodies (Prowse 1969, Ganapati and Sreenivasan 1970 and Vijayraghavan 1971). Ganapati and Sreenivasan (1970) suggested that such condition indicates a shift in photosynthetic oxygen production where respiration exceeds production.

Among the factors affecting productivity temperature has been reported to be the most important. This may be true in temperate waters, where it is detrimental, but in tropical waters, at least in this region of the country, it does not seem to play any important role. During present study it was found that rate of production increased and decreased irrespective of the fluctuations in temperature. A highly significant correlation coefficient between temperature and productivity in both the water bodies further supported the view.

Relationship between transparency, electricical conductivity and pH and primary productivity are well known Juday, *et al.* 1924, Philip (Rodhe 1949, Vallenweider 1963. 1927). Similarly during present study high productivity and direct significant correlations were observed in both ponds during the period when conductivity transparency and pH were high. Alkalinity was only significant in Dhakuria lake. Though considerably high alkalinity was observed in the pond throughout the year, it was not related to the productivity. It appears that alkalinity was always well above the required limit. Phytoplankton and zooplankton were also found to be significantly related to the productivity but a definite conclusion can not be drawn as the relationship was established between the number of plankton and productivity, not the biomass or chlorophyll content. This requires further investigations.

It is not easy to correlate the productivity with any single physical, chemical or biological factor as productivity of an ecosystem is governed by a complex of factors acting simultaneously. However, a gross idea can be obtained.

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I am thankful to the Director, Zoological Survey of India for providing necessary facilities and his keen interest in the work. Thanks are also due to the staff of Calcutta Improvement Trust at Dhakuria Lake for their help during the studies in the Lake.

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Bull. zool. Surv. India, 2 (2 & 3) : 139-143, 1980

TWO NEW SPECIES OF DORYLAIMIDAE (DORYLAIMIDA : NEMATODA) FROM TAMIL NADU, INDIA

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ABSTRACT

Two new species of nematodes belonging to the family Dorylaimidae de Man, 1876 have been described. One of these new species of the genus *Oriverutus* Siddiqi, 1971, described as *O. arcuatus*, is characterized by having subangular lips, 13-14 µm long odontostyle, 13-16 µm long odontophore and amphidelphic female reproductive system. The other new species belongs to the genus *Chitwoodius* Furstenberg & Heyns, 1966, named as *C. seshadrii*, which is distinguished by a set off lip region with centrally protruding portion, 25-29 µm long odontostyle, 22-26 µm long odontophore and the amphidelphic female reproductive system with less developed ovaries.

INTRODUCTION

While carrying out the faunistic survey of district Salem, Tamil Nadu in December, 1975, a tour party led by Dr. A. N. T. Joseph from the Zoological Survey of India collected few soil samples from around roots of coffee. These samples yielded a new species of the genus *Oriverutus* Siddiqi, 1971 and one new species of the genus *Chitwoodius* Furstenberg and Heyns, 1966. The genus *Chitwoodius* has been recorded for the first time from India.

MATERIAL AND METHODS

The nematodes were fixed in hot 4% formalin, dehydrated slowly in desiccator and mounted in anhydrous glycerine. The type specimens have been registered and deposited with the National Zoological Collection, Zoological Survey of India, Calcutta. *Oriverutus arcuatus* : Holotype female along with paratype male mounted on slide WN/308 ; *Chitwoodius seshadrii* : Holotype and 8 paratype females mounted on slides WN/309-310.

Oriverutus arcuatus n. sp.

(Fig. 1)

Dimensions : Holotype female : L= 0.79 mm ; a=33 ; b=3.7 ; c=15 ; V=$^{12}50^{12}$.

Paratype male : L=0.82 mm ; a=37 ; b=4.0 ; c=13 ; T=48.

Description : Body ventrally curved upon fixation, tapering gradually towards both ends. Cuticle transversely striated, 1—2 µm thick (thickest on tail). Lateral, ventral and

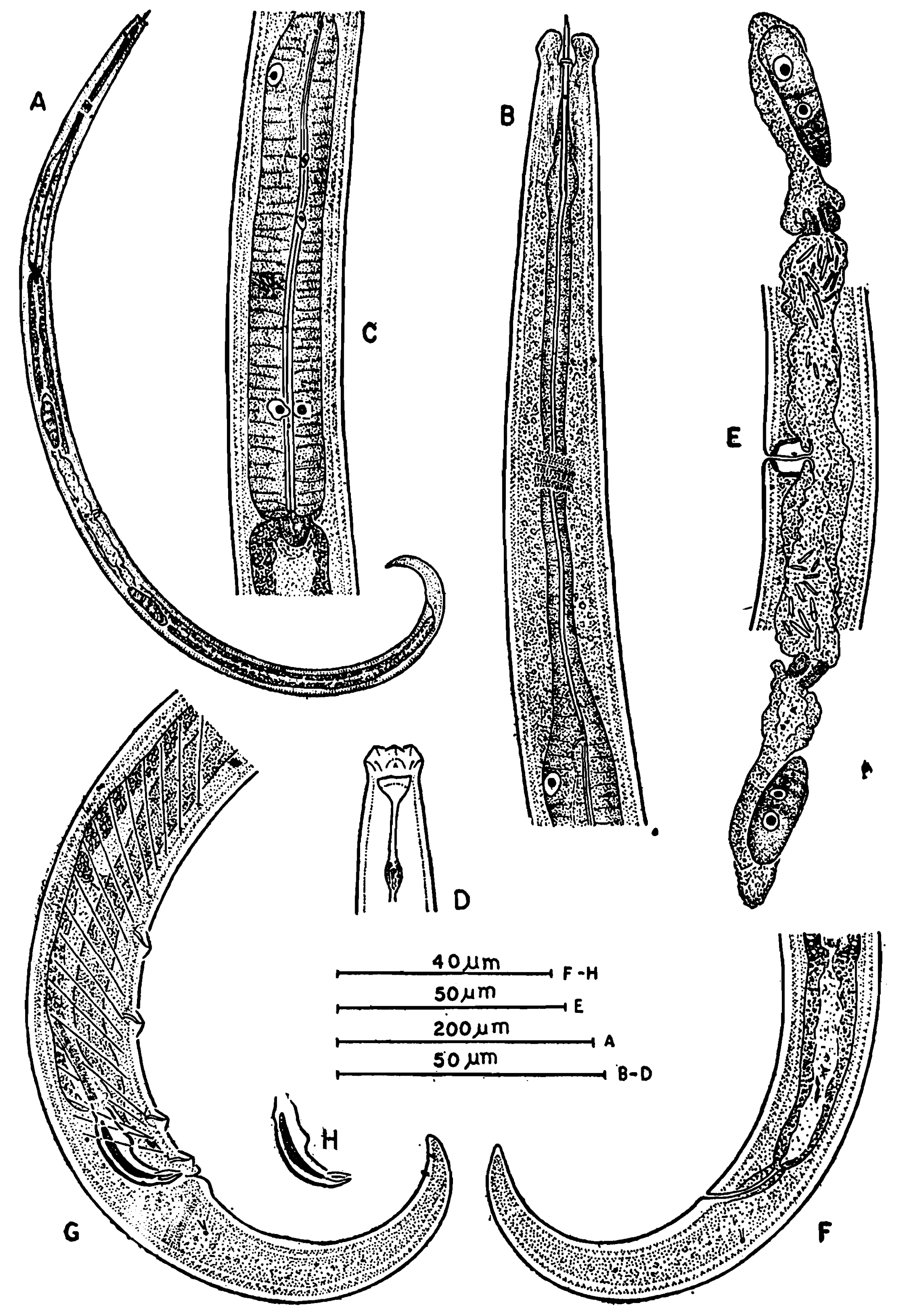

Fig. 1 *Oriverutus arcuatus* n. sp. A.—Entire ♀ B —Anterior region, C—Basal expanded part of oesophagus region, D—Surface view of anterior end, E—♀ reproductive system, F—Posterior region of ♀, G—Posterior region of ♂, H—Spicule and lateral guiding piece.

dorsal body pores not distinct. Lateral chords about $\frac{1}{3}$rd of body-width near middle. Lip region set off, wider than adjoining body, about $\frac{1}{3}$ of body-width at base of oesophagus ; lips subangular bearing the usual number of papillae. Amphids cup-shaped ; their apertures 5—6 μm from anterior extremity and 6 μm wide or occupying 65% of the corresponding body-width. Sensillar pouches 17—18 μm from amphidial slits.

Odontostyle narrow, 13—14 μm or about 1.2 head-width long ; aperture 2.5 μm or about 20% of odontostyle length. Odontophore 13—16 μm or 1.0—1.2 times the odontostyle length. Guiding ring 6—7 μm or about 60—65% of head-width from anterior end. Basal expanded part of oesophagus occupies 43—44% of the total oesophageal length. Nerve ring located at 77—80 μm or 37—38% of oesophageal length from anterior end. Cardia rounded, enveloped by intestinal tissue. Locations of oesophageal gland nuclei and their orifices in holotype as follows :

DO=59.7	S_1N_1=70	S_2N=91
DN=63.6	S_1N_2=75	S_2O=93
DO-DN=3.9		

Female : Vulva a transverse slit. Vagina extending inward 10 μm or less than $\frac{1}{2}$ of corresponding body-width, sclerotized distally. Reproductive system amphidelphic. Uterus and oviduct separated by a sphincter. Oocytes arranged in single row except at growth region. Sperms present in uteri. Prerectum 40 μm or about 3 anal body-widths long. Rectum 15 μm or about one anal body-width long. Tail ventrally arcuate conoid, 53 μm or about 4 anal body-widths long, with one caudal pore on each side.

Male : Spicules 22 μm medially. Lateral guiding pieces 5 μm long. In addition to the adanal pair, three ventromedian supplements present which are spaced nearly at regular intervals. Copulatory muscles 17, reaching anterior to the supplement region. Prerectum 42 μm or about 2.5 anal body-widths long. Tail ventrally arcuate conoid, 62 μm or about 3.5 anal body-widths long, with one caudal pore on each side.

Type habitat and locality : From soil around roots of coffee at Kumbakund, district Salem, Tamil Nadu.

Differential diagnosis : *Oriverutus arcuatus* n. sp. comes close to *O. hastatus* (Andrássy, 1963) Siddiqi, 1971 but differs from it in having more angular lips, differently shaped amphids (amphidial pouches more deeper in *O. hastatus*), shorter odontostyle (odontostyle 23—24 μm in *O. hastatus*), longer odontophore than odontostyle (odontophore shorter than odontostyle length in *O. hastatus*), distally sclerotized vagina and more arcuate tail.

Chitwoodius seshadrii* n. sp.

(Fig. 2)

Dimensions : Holotype female : L=1.65 mm ; a=27 ; b=4.6 ; c=61 ; V=^{14}56^{13}.

Paratype females (8) : L=1.21—1.71 mm ; a=28—31 ; b=4.0-4.6 ; c=50-68 ; V=$^{8-16}$53-56$^{9-13}$.

Description : Body slightly ventrally curved upon fixation, tapering slightly towards both ends. Outer cuticle smooth ; inner layer with transverse striae, irregularly wrinkled and loosened from outer layer ; 2-3 μm thick at mid-body and 5-7 μm thick on tail. Lateral chords $\frac{1}{4}$th-$\frac{1}{3}$rd of body-width near middle. Lateral body pores irregularly arranged on both the sides of lateral chords,

* The species is named after Dr. A. R. Seshadri, Joint Director and Dean, I. A. R. I., New Delhi.

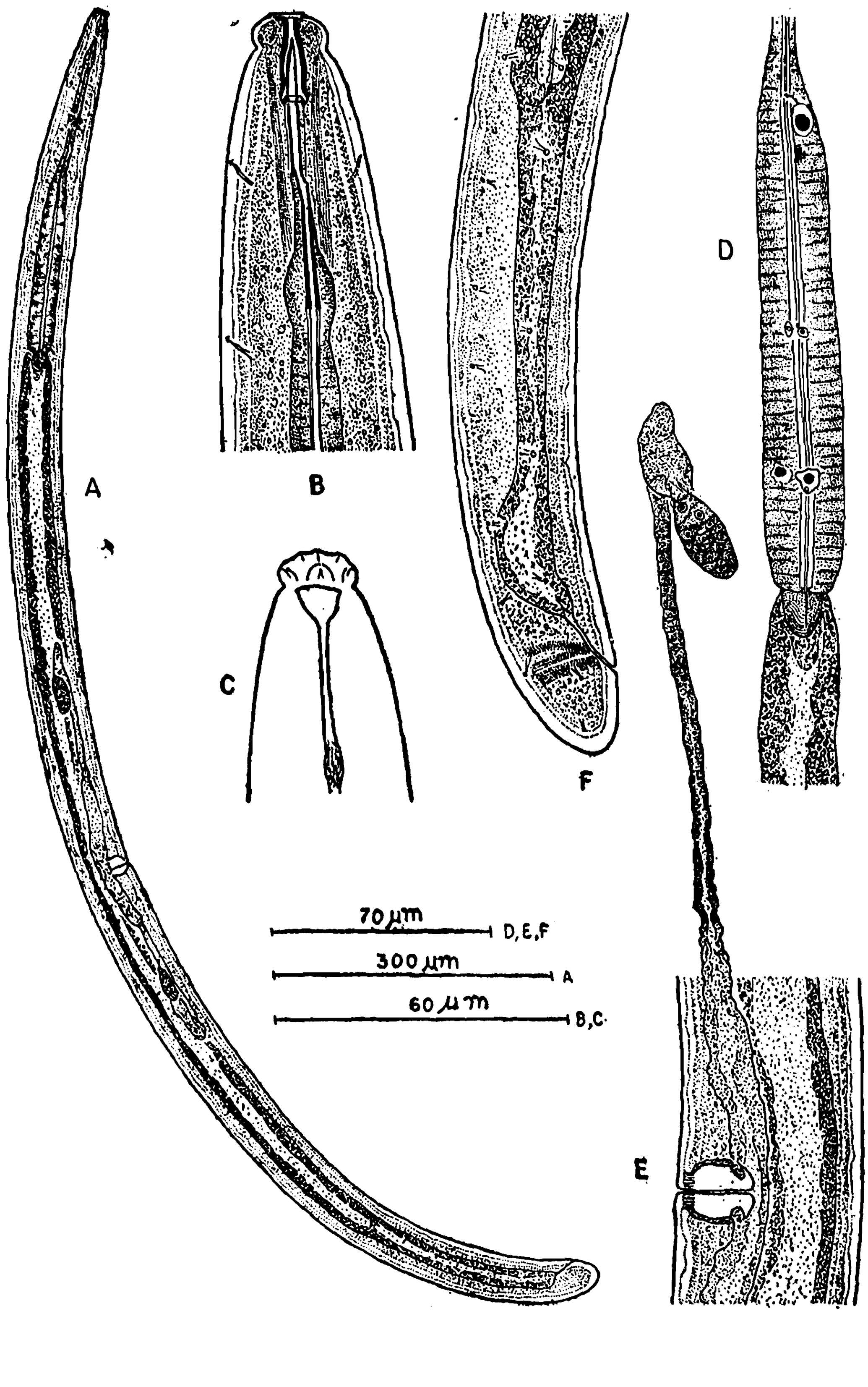

Fig. 2 *Chitwoodius seshadrii* n. sp., A—Entire ♀, B—Anterior region, C—Surface view of anterior end, D—Basal expanded part of oesophagus, E—Vulva region and anterior sexual branch, F—Posterior region.

83-102 in number; of which 19-21 in oesophageal region, 59-68 between cardia and prerectum, 11-15 in prerectum-rectum region, and 3 in caudal region. Ventral body pores 5-8 and dorsal body pores 3. Lip region set off by a deep constriction, cap-like, the central portion somewhat protruding and forming a labial disclike structure, about $\frac{1}{3}$rd of body-width at base of oesophagus. Amphids cup-shaped ; apertures occupying about 8 µm or 55-58% of the corresponding body-width and situated at 6-7 µm from anterior extremity. Sensillar pouches 31-33 µm from amphidial slits.

Odontostyle 25-29 µm or 1.8-2.1 lip region-width long ; aperture 3-4 µm or 10-14% of its own length. Odontophore 22-26 µm or 0.8-0.9 times the odontostyle length. Guiding ring 16-18 µm or 1.1-1.3 lip region-width from anterior end. Basal expanded part of oesophagus occupies 46-49% of the total neck length. Oesophageal gland nuclei and their orifices as follows :

$$DO=52.4\text{-}54.7 \quad S_1O=74\text{-}76 \quad S_2N=90\text{-}91$$
$$DN=54.4\text{-}57.7 \quad S_1N=75\text{-}77 \quad S_2O=91\text{-}92$$
$$DO\text{-}DN=2.2\text{-}3.1$$

Nerve ring 108-129 µm or 32-35% of the oesophageal length from anterior end. Cardia rounded, enveloped by intestinal tissue. Prerectum 126-193 µm or about 4-5 anal body-widths long. Rectum 22-27 µm or less than one anal body-width long.

Vulva a transverse slit. Vagina with a thick-walled muscular tube having a fringed appearance. ; 19-25 µm long or extending inward less than $\frac{1}{2}$ of the corresponding body-width. Reproductive system amphidelphic. Uterus and oviduct separated by a weak sphincter. Ovaries reflexed, less developed ; oocytes arranged in multiple rows.

Tail rounded, 23-27 µm or 0.7-0.8 anal body-width long, with 3 caudal pores on each side.

Male : Not found.

Type habitat and locality : From soil around roots of coffee at Kumbakund, district Salem, Tamil Nadu.

Differential diagnosis : *Chitwoodius seshadrii* n. sp. comes close to *C. transvaalensis* Furstenberg and Heyns, 1966 but differs from it in having more set off and differently shaped lip region having a disc-like structure in the centre (lip region without a disc-like structure in *C. transvaalensis*), more posteriorly situated guiding ring (guiding ring 15-16 µm from anterior end in *C. transvaalensis*), oesophagus with only a single ellipsoidal swelling in odontophore region before nerve ring (oesophagus with two swellings anterior to nerve ring in *C. transvaalensis*), transverse vulva (vulva longitudinal in *C. transvaalensis*), and 3 caudal pores (caudal pores absent in *C. transvaalensis*).

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Bull. zool. Surv. India, 2 (2 & 3) : 145-151, 1980

TWO DIGENETIC TREMATODES OF A MARINE FISH, *KYPHOSUS CINERASCENS* (FORSKAL), FROM THE GULF OF MANNAR WITH A NOTE ON THE SYSTEMATIC POSITIONS OF THE GENERA *ENENTERUM* LINTON, 1910, *CADENATELLA* DOLLFUS, 1946 AND *JEANCADENATIA* DOLLFUS, 1946

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ABSTRACT

Two new species, *Enenterum mannarense* and *Jeancadenatia dollusi*, collected from the marine fish, *Kyphosus cinerascens* (Forskål) from the Gulf of Mannar, are described. The genera *Enenterum* Linton, 1910 and *Jeancadenatia* Dollfus, 1946 are reported for the first time from India. Contrary to the opinion of Nahhas and Cable (1964) and concurrence of Overstreet (1969), the genera *Cadenatella* and *Jeancadenatia* are considered distinct from each other on the basis of structural pattern of the oral lobes, body form, and absence or presence of long esophagus. Thought has also been given to the much disputed problem regarding the family allocation of the genera *Enenterum*, *Cadenatella*, and *Jeancadenatia* in view of the new facts mentioned in the paper.

During the survey of the Gulf of Mannar, three specimens of digenetic trematodes were recovered from the intestine of the fish, *Kyphosus cinerascens* (Forskål), at Tuticorin. One of them belongs to the genus *Enenterum* Linton, 1910 and the remaining two (one immature and the other adult) to *Jeancadenatia* Dollfus, 1946. The two genera are reported for the first time from India. Specimens of *Kyphosus cinerascens* occur in the catches of shore seine and hook and line between October and March. This fish is a coral inhabitant and is not found in abundance.

All measurements are in micrometer unless otherwise stated. The drawings have been made with the aid of a camera lucida.

Family ENENTERIDAE Skrjabin and Koval, 1966
Subfamily ENENTERINAE Yamaguti, 1958

Enenterum mannarense n. sp.

(Fig. 1)

Host *Kyphosus cinerascens* (Forskål), (Pisces : Kyphosidae)
Location : Intestine
Locality : Tuticorin (Gulf of Mannar), India
Number of specimens : 1, collected on November 9, 1975
Specimen deposited : Z. S. I. Reg. No. W 7297/1

Description : Body 9.439 mm long measured from tip of oral lobes, 1.238 mm wide, elongate, slightly tapering anteriorly, posterior

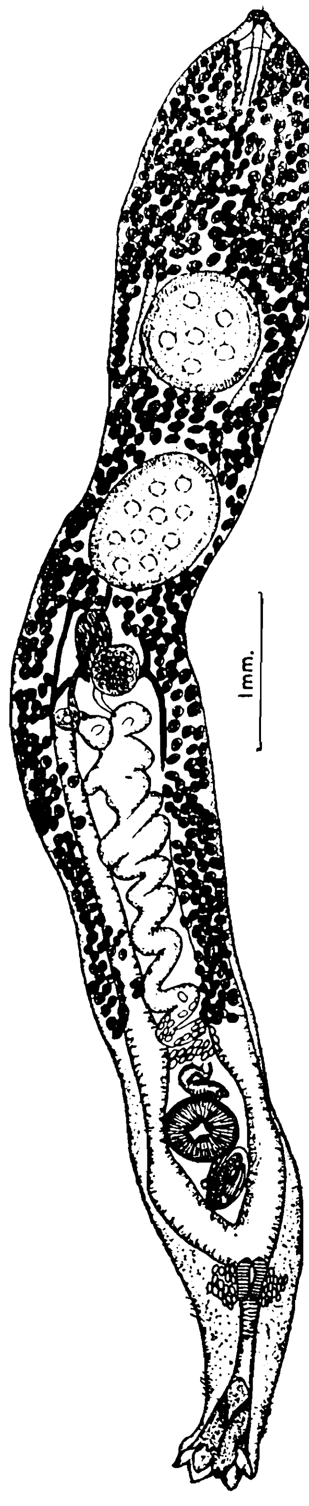

Fig. 1 *Enenterum mannarense* n. sp. Ventral View.

portion broad, end pointed. Tegument spinose, seen only in anterior region, probably lost during processing from rest of body. Acetabulum 413 long, 468 wide, spherical, situated at 2.145 mm from anterior end of body. Oral sucker funnel-shaped, terminal, directed anteriorly, 701 long, 481 wide, margin produced into five basic muscular conical broad-based lobes (one ventral, one on each side, two dorsal), ventral lobe notched into two to give a total of six lobes. Prepharynx 536 long, wide : pharynx 234 long, 193 wide, muscular, pear-shaped ; esophagus absent , intestinal bifurcation immediately behind pharynx ; ceca wide, extending laterally, united near posterior end of body ; anus opening near posterior end of body.

Testes two, entire, tandem, situated in posterior part of body, anterior testis 921 long, 688 wide, posterior testis 784 long, 756 wide, separated from each other. No external seminal vesicle. Cirrus sac thin-walled, ovate, intercecal and anterodorsal to acetabulum, reaching cecal bifurcation, containing saccular seminal vesicle becoming narrow and coiled anteriorly, pars prostatica surrounded by well developed prostate gland cells, and probably a protrusible cirrus rather than ejaculatory duct, Genital pore behind cecal bifurcation, submedian to left. Accessory sucker present behind genital pore.

Ovary globular, entire, almost in middle of body, pretesticular, median, 322 in diameter, separated from anterior testis. Seminal receptacle large, 413 long, 248 wide, posterodorsal to ovary. Mehlis' gland and Laurer's canal present. Vitellaria follicular, extensive, from posterior end of body nearly to posterior margin of acetabulum, follicles intruding between gonads. Uterus preovarian, winding anteriorly between ceca ; metraterm muscular, coiled behind acetabulum, straight dorsal to acetabulum. Eggs 56—63 μ ×42—45 μ.

Excretory vesicle tubular, traceable up to ovary ; pore terminal.

Discussion : The genus *Enenterum* Linton, 1910 has the following valid species : *E,* *aureum* Linton, 1910 ; *E. pimelepteri* Nagaty, 1942 (Syn, E. pseudaureum Dollfus, 1946) ; *E. elongatum* Yamaguti, 1970 ; and *E. kyphosi* Yamaguti, 1970. Manter (1947) indicated the synonymity of *E. pseudaureum* Dollfus. 1946 to *E. pimelepteri* Nagaty, 1942. Nagaty (1948) made it clear that Dollfus (1946) was not aware of his (1942) publication of the species, and considered Dollfus' species as synonym of his own. Fischthal and Thomas (1972) corrected the spelling of the name of Nagaty's species as *E. pimelepteri* instead of *E. pimelopteri* because the spelling of the host genus is *pimelepterus* Lacépède and not *Pimelopterus.*

The new species, *E. mannarense*, is characterised by the presence of five basic anteriorly directed conical oral lobes with broad bases, and only the ventral lobe is sub-divided into two by a deep notch making a total of six lobes. In this respect it differs from all the above listed known species. *E. aureum* has six basic oral lobes. Of these (2 dorsal, 2 ventral and 2 lateral), the two dorsal and two laterals are sub-divided to give ten lobes in total. The new species is also comparable to *E. pimelepteri* and *E. elongatum* in having unlobed gonads, but in *E. pimelepteri* an esophagus is present and vitellaria extend up to the posterior margin of acetabulum, whereas in *E. mannarense* an esophagus is absent and vitelline glands remain restricted short of the posterior margin of acetabulum. Even in these two characters, *E. mannarense* and *E. elongatum* are very close to each other. The differences between them may be found in the basic number of oral lobes and their notching pattern. In the latter the lobes are five, each of which is subdivided into two, making a total of ten lobes.

Jeancadenatia dollfusi n. sp.

(Fig. 2)

Host - *Kyphosus cinerascens* (Forskål), (Pisces : Kyphosidae)

Location : Intestine
Locality : Tuticorin (Gulf of Mannar), India
Number of specimens : 2, one adult and one immature ; collected on November 19, 1975
Specimens deposited : Z. S. I. Reg. No. W 7298/1

Description : (with measurements of mature specimen only) : Body long, filiform, posterior part tapering gradually, 7.665 mm long (excluding oral lobes), 0.343 mm wide. No ventral accessory suckers. Tegument spinose, not seen on posterior part of body. Eye-spot pigment present. Acetabulum 284 in diameter, situated in anterior region of body. Oral sucker 147 long, 123 wide, terminal with ten oral lobes (two pairs of long pointed antero-lateral and three pairs of short ones), of which, probably one pair dorsomedian and one pair each dorsolaterally ; shorter lobes contracted and pouch like with striations and incurved tips not discernible in all the three pairs, contracted in others ; some of them discernible with difficulty, completely retracted in immature specimen. Longer oral lobes 646-798 long, 247-285 wide at base. Prepharynx present, 348 long ; pharynx 261 long, 151 wide, elongated pear-shaped ; esophagus long (actual lengths preacetabular body, prepharynx and esophagus cannot be given because this part of body is contracted) ; bifurcation preacetabular ; ceca extending laterally, united posteriorly ; anus opening near posterior end of body.

Testis single, 1004 long, 193 wide, elongate, tapering towards ends, situated in posterior part of body. Vasa efferentia long, coiled at places. External seminal vesicle very long, extending from dorsal to acetabulum upto middle of space between acetabulum and testis, consisting of a posterior swollen and elongated part constricted at places, and a very long, narrow anterior part describing small coils at places on way, lying dorsal to broad uterus, surrounded by thick muscular wall,

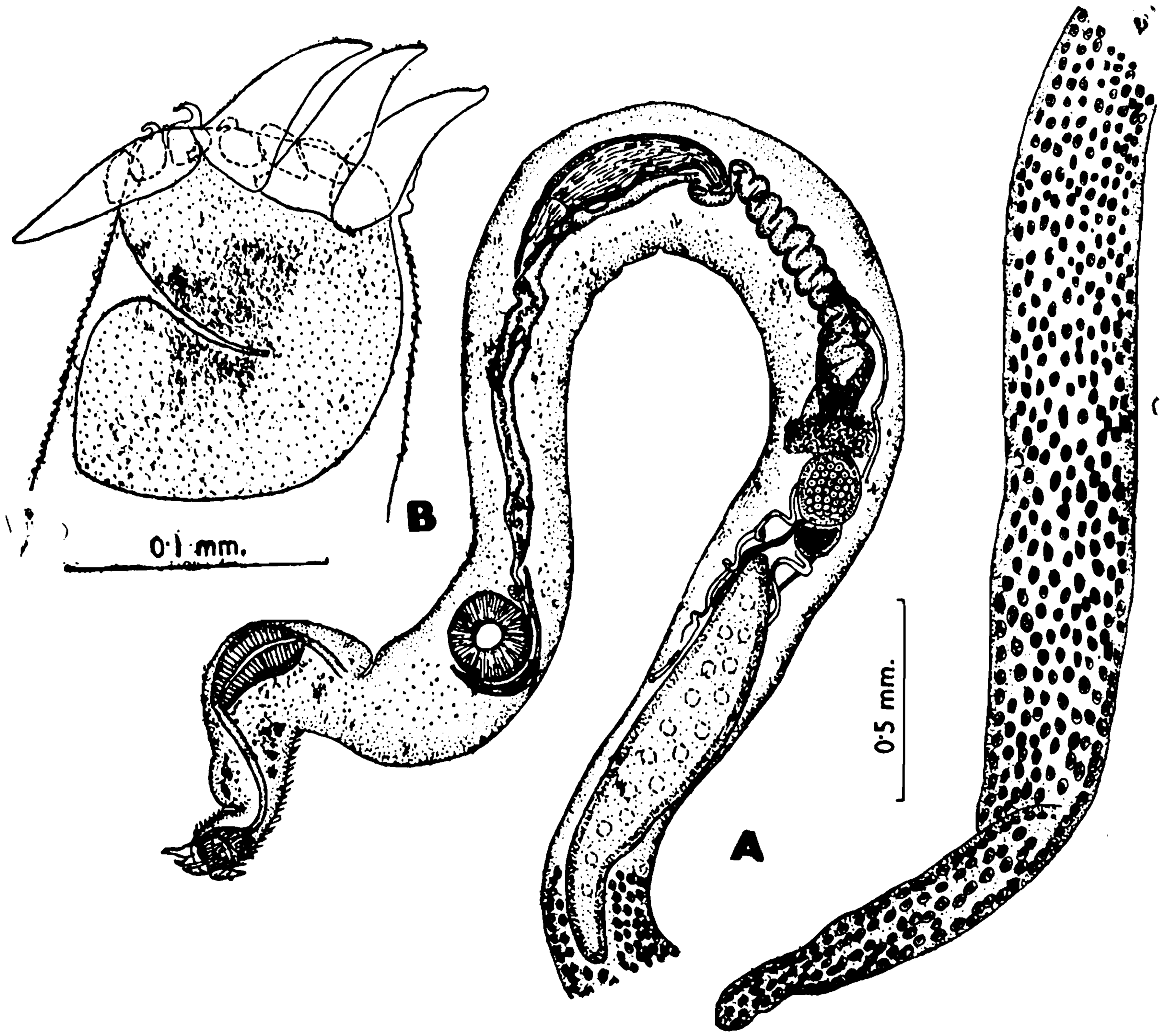

Fig. 2 A—B *Jeancadenatia dollfusi* n. sp., A—Ventral View, B—Ventral View of anterior end showing oral lobes.

Cirrus sac short, narrow, lying along antero-dextral margin of acetabulum, enclosing short tubular internal seminal vesicle. a pars prostatica surrounded by prostate gland cells, and an ejaculatory duct. Genital pore immediately preacetabular.

Ovary globular. 179 in diameter, pretesticular, separated from testis. Laurer's canal runs posteriorly, opening on dorsal surface of body at level of middle testis. Mehlis' gland anterior to ovary. Seminal receptacle large, anterior to Mehlis' gland. Uterus preovarian, posterior part wide describing close lateral coils up to posterior end of external seminal vesicle distal part narrow and rather straight ; running forward in middle field of body, filled with sperm cells throughout. Metraterm differentiated behind acetabulum. Vitellaria follicular, extensive, extending up to posterior part of testis. Vitelline reservoir globular, situated posterodorsal to ovary. Eggs collapsed. 59-63×35.

Excretory vesicle tubular, extending upto ovary ; pore terminal.

Discussion : *Jeancadenatia dollfusi* n. sp. is characterised by the presence of two pairs of long pointed, horn-like ventrolateral and three pairs of short (one pair mediodorsal and one pair each on dorsolateral sides) oral lobes which are pouch like with incurved pointed ends like hooks, and the absence of ventral accessory suckers. The pattern of oral lobes seems to be like that of *J. brumpti* with which the present species resembles closely. However, it differs from *J. brumpti* in much shorter body size, absence of ventral accessory suckers, and reverse sucker ratio as the Dollfus' description of his species states. There is no need of comparing the present species with *J. pacificus*. The differences between them are obvious.

Nahhas and Cable (1964) "believe that the presence of accessory suckers is a generic character whereas their number distinguishes species ; the same is concluded for the oral lobes some of which may be more or less distinctly subdivided in some species and not in others. *Jeancadenatia* is thus considered a synonym of *Cadenatella* which has page priority." Overstreet (1969) concurs with this. In *J. brumpti* Dollfus, 1946 accessory suckers number 14 to 17 (Sogandares-Beral, 1959) ; in *J. pacifica* they (number not given) are present in only one paratype, none in the others including the type. In *J. dollfusi* accessory suckers were absent in the immature and adult specimens. Thus, the deseriptions of *J. dollfusi* and *J. pacifica* show that the accessory suckers may be absent altogether in a species of *Jeancadenatia* while in other species some specimens of the population may or may not have them at all, *i. e.*, the number of accessory suckers may vary from nil to one or two or many in a single species. Therefore, in the light of the new facts, the presence of accessory suckers does not seem to form a generic character. The structural pattern of the oral lobes may be genus determining and their number and type may be species determining. The same should be true with *Cadenatella*. In contrast with Nahhas and Cable (1964) and Overstreet (1969), the author believes that *Jeancadenatia* Dollfus, 1946 is distinct from *Cadenetalla* Dollfus, 1946, at least in the filiform body, long esophagus and structural pattern of the oral lobes. As a matter of fact, all species with oral lobes of one type and uniform size should be grouped under *Cadenatella*, irrespective of their number.

Thus *Jeancadenatia* should have the following species ;

J. brumpti Dollfus, 1946 which has 10 conical oral lobes (3 pairs of short and 2 pairs of long ones), 14 to 17 ventral accessory suekers, long esophagus, and short cirrus sac in the acetabular region ;

J. pacifica Yamaguti, 1970 which has 6 oral lobes (one pair of short ones which are bifid at tips. and 2 pairs of long ones), accessory suckers may or may not be present in the specimens of the same population, long esophagus, and no cirrus sac ; and

J. dollfusi (present paper) which has 10 oral lobes (3 pairs of short ones which are pouch-like and curved inward at free ends like hooks, and 2 pairs of long ones), no ventral accessory suckers, long esophagus, and short cirrus sac in the acetabular region.

Jeancadenatia dohenyi Winter, 1957 does not have a filiform body, has 10 conical oral lobes of almost uniform size, has almost no esophagus and has vitelline follicles extending upto ovary as in the type species of *Cadenatella*, viz., *C. cadenatia* Dollfus, 1946 While giving the differential diagnosis of *J. pacifica*, Yamaguti (1970) also remarked, "No comparison is necessary with *J. dohenyi* Winter, 1957 from *K. elegans* from Isla Maria Magdalena, Nayarit of Mexico, because of great differences in general anatomy". The author, therefore, feels that Winter's species should be transferred to the genus *Cadenatella*, the new combination being *C. dohenyi.* (Winter, 1957).

The literature notes that a cirrus sac is present in *Enenteum* but the same may or may not be present in *Cadenatella* and *Jeaneadenatia*. The presence of a cirrus sac in *C. americana* Manter, 1949 was originally reported but on reexamination of the holotype by Nahhas and Cable (l. c.) it was found to be absent. Sogandares-Bernal (1959) reported the presence of a circus sac in *J. brumpti*. *Enenterum* has two testes whereas *Cadenatella* and *Jeancadenatia* have one. The structural pattern of the oral lobes is different in the three gefnera In *Enenterum* the oral lobes are simple extensions of the wall of the oral sucker, there being no joints at their bases. On the contrary, in *Cadenatella* and *Jeancadenatla* the oral lobes may be digitate or horn like or tentacle like with joints at their base. In *Cadenatella* the oral lobes or tentacles are all of one kind and size whereas in *Jeancadenaia* they are of two types and therein lies the basic difference between the latter two genera.

Yamaguti (1971) gave a key to the genera of the subfamily Enenterinae Yamaguti, 1958 which does not seem to be working well. However, basic differences separating the three genera are provided below :

Testes double ; oral loes simple extensions of oral sucker without joints at their base ...... *Enenterum* Linton, 1910

Testis single ; oral lobes of the same size with joints at their base ; esophagus either short or absent .... *Cadenatella* Dollfus, 1946

Testis single ; oral lobes of two sizes with joints at their base ; body filiform ; esophagus long .... *Jeancadenatia* Dollfus, 1946

Linton (1910) placed his papillose species *Enenterum aureum* Linton, 1910 in the subfamily Allocreadiinae, and Poche (1926)included it in the family Allocreadiiae. Hopkins (1934) has convincingly discussed that *Enenterum* materially differs from "the true Allocreadiinae in many respects and therefore it "certainly cannot properly be included in the subfamily (Allocreadiinae) of which *Allocreadium* is the type". The genus does not belong to the family Allocreadiidae. Hopkins further observed that "Perhaps it is more closely related to the Opecoelidae". Manter (1947) considered *E. aureum* in the Lepocreadiidae "inspite of the lack of eye-pigment even in young specimens. Perhaps it belongs in the Opecoelidae but it has a spiny cuticula, seminal receptacle and large pros atic glands", Manter (1954), Winter (1957), Sogandares-Bernal (1959) Nahhas and Cable (1964), and Overstreet (1969) included the three genera *Enenterum*, *Cadenatella* and *Jeancadenatia* in the family Lepocreadiidae Nicoll, 1934. Yamaguti (1958) placed his subfamily Enenterinae in the family Allocreadiidae but later (1970, 1971) placed it in the family Opecolidae Ozaki, 1925 because of lhe similarity of the internal anatomy to Opecoelinae. Preacetabular accessory suckers, a tubular excretory vesicle, and the formation of a cloaca are found in Opecoelinae as well as in Enenterinae. He (1970) stated that "the oral appendages in Enenterinae are analogous to the acetabular in Opecoelinae". Admittedly these genera form a group which share characters of both the Opecoelidae and Lepocreadiidae. In the present chaotic condition of the classification of the Digenea and particularly the fact that the life-history is not known for any species of the present group, it is safe and convenient to maintain the family Enenteridae Skrjabin and Koval, 1966. Yamaguti (1971) did not mention this family. Fischthal and Thomas (1972) have accepted Enenteridae, and the present author concurs.

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Bull. zool. Surv. India, 2 (2 & 3) : 153-158, 1980

BIOASSAY TRIALS WITH A FEW ORGANIC BIOCIDES ON FRESHWATER SNAIL, *LYMNAEA ACUMINATA* (MOLLUSCA : GASTROPODA)

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ABSTRACT

Biocides used for controlling the various pests ultimately enter into different water bodies and create problems for aquatic life therein. As the species of freshwater gastropod, *Lymnaea acuminata* is of much economic value, in the present work endrin and dimecron are used to know how they affect the snails when they are put in the toxic environment at different concentrations and at different time intervals, and also the relative toxicity of these biocides alongwith the susceptibility of the said species of the snail for these biocides. The values of lethal concentrations are 0.0075 and 0.009 ppm. The values of presumable harmless concentration can be considered for controlling the water pollution problem by these biocides. Metabolic changes in snails due to the effect of biocides are noted. The pH of the blood has changed to 4.3 and lactic acid accumulation increased to about 25 times as compared with that of normal snail. Due to the lowering of circulatory efficiency, the rate of heart beat dropped to seven beats per minute.

INTRODUCTION

Several biocides being effective in controlling insect pests, there has been rapid development of new ones. Ultimately these biocides find their way from different sources in the rivers, streams and ponds and create problems for aquatic life living therein. The wide use of biocides is unavoidable but the conservation of the natural water resources from pesticidal pollution is equally of utmost importance for the protection of aquatic life. Various methods have been devised to test the toxic reactions more accurately in the laboratory. Cope (1966) found that the toxic values of insecticides differ greatly from one animal to another.

A perusal of literature reveals that very little work has been done so far on the toxic effects of pesticides on molluscs. Hoffman *et al.* (1949) studied the effect of D. D. T. spray on some terrestrial snails and slugs. Loasanoff (1960) investigated the effects of pesticides on marine molluscs. Davis (1961) made observations on the effect of some pesticides on eggs and larvae of oysters (*Crassostrea virginica*) and clams (*Venus mercenaria*), but the freshwater molluscs have been left untouched so far. To fill up this lacuna, recently Agrawal (1977) studied the toxicity of nuvacron on some freshwater species of gastropods. As the species of freshwater gastropod such as *Lymnaea acuminata* is of considerable economic importance, in the present work the bioassays have been conducted with endrin and dimecron to know how the proposed pesticides affect the snails and what metabolic changes occur in the snails when they are put in the toxic environment at different concentrations and at different time intervals. This study will also evaluate the relative susceptibility for these biocides. The study will decidedly help in controlling the pollution problem caused by these biocides.

Material and Methods

The living specimens of this freshwater gastropod were collected from Budagar tank situated on Jabalpur-Katni road (23°.20′ N. latitude and 80° E. longitude). The shells were measured with vernier callipers reading to 0.1 millimetre. Specimens were kept in a glass trough containing three litres of tap water, which was dechlorinated by evaporation method. The experiments with dimecron

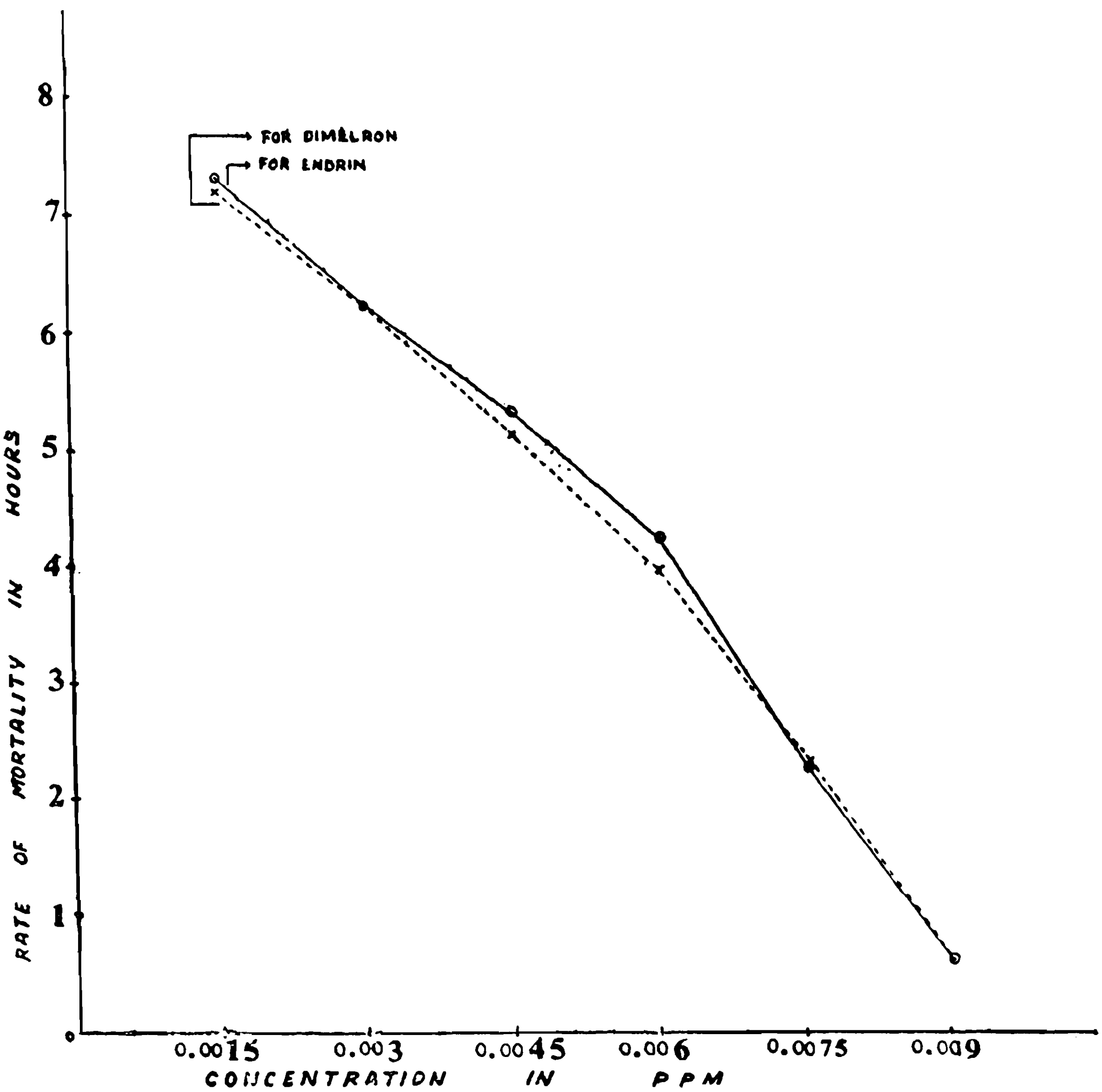

Fig. 1. Graph showing the rate of mortality in *Lymnaea acuminata* at varying concentrations of Endrin and Dimecron

were performed at room temperatures (18°C to 22.5°C) and with endrin at temperatures (22.5°C to 32°C) to which the test gastropods were acclimatized for two to three days. The test animals were not allowed to feed during the test period with an idea that such feeding might increase the rate of metabolism and the excretory substances may influence the toxicity of the test solution. These specimens of different sizes were exposed to various concentrations of endrin and dimecron and their responses were observed for 24 to 48 hours. Simultaneously control experiments were also undertaken with the same number of snails, but with no insecticide. The experimental media were not renewed and they were not aerated artificially during the investigation. Replicate experiments were also done. The biocide was thoroughly mixed with water and sprayed by syringe.

For the study of metabolic changes in the snail, the lactic acid content was determined by the method of Barker and Summerson (1941) and glycogen by the method recommended by Good *et al.* (1933). pH of the blood was seen on pH meter.

OBSERVATIONS

When varying concentrations of these chemicals were sprayed (see tables 1 and 2) they produced lethal effects. The snails respond immediately after their introduction into the water. The behavioural response to gastropods on contact with these insecticides is immediate at higher concentration and slow at lower concentration. The immediate reaction at higher concentration involves excitement and swimming becomes irregular. The respiration rate becomes much slower preceding death. The response to touch also decrease progressively. Animals showing the first sign of insecticide poisoning did not survive after it is transferred to freshwater. Before the spray, the snails show normal behaviour, protruding their organs such as foot, tentacles, visceral mass etc. Some of them got attached to the walls of the glass trough while some others were found sticking with other specimens. As soon as the insecticides were sprayed, there was a brisk reaction—some of the snails toppled down from the walls of the glass trough and got separated from each other. They started retracting inside the shell immediately. In all such cases the epithelial tissue of the gill lamellae becomes thicker.

It was observed that the animal lost the sense of equilibrium and orientation. The effect of toxicity is more marked in smaller specimens having thinner shells. In lower concentrations of both the biocides. all the above mentioned effects were visible but to lesser extent.

With dimecron (Table 1), it was observed, that animals excreted more faecal matter after the spray of chemical. Some of the specimens were seen floating with their expanded organs even after 1½ hours of the spray. The snails tried to crawl up the walls of the trough.

The behaviour of snails after the spray of endrin (Table 2) was different. All the specimens secreted slimy substance. Snails were seen floating with their expanded organs even after two hours of the spray.

However, in the control experiments, no mortality of the snail was observed. The snails showed normal behaviour.

The following metabolic or physiological changes were noted :

(i) the pH of the blood has changed to 4.3 ;

(ii) no change in the calcium and magne-

TABLE 1. Estimation of lethal doses of dimecron for *Lymnaea acuminata*

Experiment number	Length (in mm)	Diameter (in mm)	Volume of water in which the gastropods were treated (in litres)	TL m percentage concentration ppm	Rate of mortality Hours	Minutes
1.	17.0	8.5	3	0.0015	7	15
	13.5	6.0	,,	,,	6	45
	16.5	8.5	,,	,,	7	0
2.	13.5	7.0	,,	0.003	6	10
	16.0	8.0	,,	,,	6	15
	14.5	7.5	,,	,,	6	00
3.	20.5	10.0	,,	0.0045	5	10
	17.0	8.5	,,	,,	5	00
	11.5	5.0	,,	,,	4	45
4.	17.0	8.5	,,	0.006	4	00
	15.0	7.5	,,	,,	4	00
	12.5	6.0	,,	,,	3	55
5.	16.5	8.5	,,	0.0075	2	10
	14.0	6.5	,,	,,	2	00
	13.5	7.0	,,	,,	2	00
6.	15.0	8.0	,,	0.009	0	30
	17.5	8.5	,,	,,	0	35
	13.0	6.5	,,	,,	0	25

TABLE 2. Estimation of lethal doses of endrin for *Lymnaea acuminata*

Experiment number	Length (in mm)	Diameter (in mm)	Vol. of water in which the gastropods were treated (in ltrs).	TL m percentage concentration ppm	Rate of Hours	mortality Minutes
1.	13.5	8.0	3	0.0015	7	20
	16.5	8.5	,,	,,	7	25
	14.0	6.5	,,	,,	7	20
2.	15.5	8.0	,,	0.003	6	10
	17.0	8.5	,,	,,	6	15
	12.0	6.0	,,	,,	6	00
3.	17.0	9.0	,,	0.0045	5	20
	13.5	6.0	,,	,,	5	15
	16.0	7.5	,,	,,	5	20
4.	20.0	9.5	,,	0.006	4	10
	11.5	5.0	,,	,,	3	50
	16.5	8.0	,,	,,	4	00
5.	18.0	9.0	,,	0.0075	2	15
	15.5	7.5	,,	,,	2	05
	16.0	7.5	,,	,,	2	10
6.	17.0	8.5	,,	0.009	0	35
	14.5	7.5	,,	,,	0	30
	18.0	8.5	,,	,,	0	35

sium content of the blood as compared with that of normal snail ;

(iii) an increase in the lactic acid accumulation to about 25 times as compared with that of normal snail.

To see the effect of biocides on the circulatory system, the snails subjected to biocides were opened and kept in a petri dish containing pila ringer (Lal and Agrawal, 1968). The rate of heart beat was seven beats per minute while in the normal snail the rate is about 25 beats per minute. This shows decrease in the cardiac activity. Hence one of the significant changes of the toxic effect is the lowering of the circulatory efficiency of the body fluids. This indicates the non-utilization or non-availability of the energy-producing systems needed for the physiological activity of organs such as the heart.

DISCUSSION

Both the biocides are quite toxic to *Lymnaea acuminata* (Fig. 1). In all the cases, mortality was maximum at 0.0075 and 0.009 ppm concentrations. This does not support the view of Cope (1966) who compared the relative toxicities of some insecticides to other invertebrates and fish and found that the values differ greatly from one animal to another. It is really difficult to define particular factor responsible for mortality. According to Ellis (1937) the insecticides may affect the aquatic fauna in the following ways :

(i) by causing respiratory and circulatory interference ;

(ii) by specific toxic action , and

(iii) toxic action after absorption through the gastro-intestinal wall.

Mathur (1972) pointed out that fishes, subjected to insecticides, die owing to histopathological changes. It seems that the primary target is the circulatory system where an apparent stasis and congestion is followed by the appearance of precipitated material. This material probably represents a product from damaged erythrocytes. It, probably, severely compromised the circulatory function and potentially results in anoxia as well as deficiencies of other blood functions. It can be considered that in the present study also the metabolic changes occurred due to such anoxic condition developed and the gastropods mortality by dimecron and endrin may also have occurred due to such changes. The insecticides swallowed with water, might have damaged the intestinal mucosa, due to the free exchange of ions between gut and submucosal capillaries. The respiratory epithelium of these snails was also destroyed by acute exposure.

From the observations, it is clear that both the biocides affect the snail. It is felt that whole of the aquatic population needs a thorough study and their behavioural activities towards the different pollutants. However, the observations indicate that values of lesser than 0.0075 ppm concentration are not so dangerous for the snail population.

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ON TWO RARE SPECIES OF NERITIDAE (MOLLUSCA : GASTROPODA) FROM INDIA

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ABSTRACT

Nerita (*Theliostyla*) *textilis* Gmelin and *Nerita* (*Ritena*) *grayana* Recluz are redescribed. Their distribution was redefined. Both the species are rarely encountered in the collections. Their occurrence in Indian waters ia established beyond doubt.

Neritids are common in the intertidal zone along coasts of Indian mainland and Andaman and Nicobar Islands. Majority of the species belonging to the family Neritidae are truly marine, but some are found extending into estuarine regions and some into fresh water streams connected to the sea. About 42 species belonging to 8 genera are recorded from the Indian region (Subba Rao, 1975).

Two species belonging to the genus *Nerita*, namely *textilis* Gmelin and *grayana* Recluz are very infrequently met with in the collections. The former was reported only once and the occurrence of latter in Indian region was received with some doubt. In the present paper the two species are fully described and their occurrence in India is established beyond doubt.

Genus **Nerita** Linnaeus, 1957

Subgenus **Theliostyla** Mörch, 1852

Nerita (Theliostyla) textilis Gmelin, 1791

(Pl. II, figs. 1&2)

Nerita plexa Chemnitz, 1781, *Conch, Cab.*, 5 : 288, pl, 190, figs. 1944, 1945 ; Dillwyn, 1817. *Descriptive Catalogue of Recent Shells*. 2 : 998 ; Reeve, 1855, *Conch, Icon*, 9, *Nerita*, sp. no. 12, pl. 111, figs. 12 a, b; Von Martens, 1887—1889, in Martini & Chemnitz's *Syst. Conch. Cab.*, 2 (11) : 10, 107, pl. 4, figs. 1—3 : Tryon. 1888, *Man. Conch.*, 10, : 19, pl, 2, figs, 27—28 ; Melvill & Standen, 1901, *Proc. Zool, Soc. Lond.* 2 : 353 ; Dautzenberg, 1932, *J. Conch. Paris*, 74 ; Ray, 1948, *Rec. Indian Mus.*, 46 (1—4) : 93.

Nerita textilis Gmelin, 1791, *Syst. Nat.*, ed, 13 : 3683 no. 53 (Refers to *Rumph. Mus.*, t, 22. f. 3 (Type locality, Not mentioned) : Lamarck, 1822, *Hist, nat. Anim. sans Vert.*, 6 (2) : 190 : 8 (2) : 601 : Krauss. 1848, *Die Sudafri kanischen Mollusken*, p. 90.

Material : (1) 2 ex. Bombay ? Coll. *Prof. Awati*. (2) 1 ex., Sta. 23—Veraval beach, Gujarat, 26. viii. 1972. Coll. *K. V. Surya Rao & Party*.

Description : Shell ovately globose, thick, whorls 3, gradually expanding towards the aperture, spirally ribbed-ribs strong, rotundate, rugose or nearly nodose, alternately broad and narrow, rather irregular, spire flat, apex tinged with yellow, white, rather distantly tessellated with black.

Aperture yellowish, slightly thickened within and ridged, columellar area flatly excavated, callus tinged with yellow near the lower half of the outer margin, granular throughout, inner columellar margin, concave with two faintly marked teeth, outer margin of outer lip thickened, fimbriated, inner margin white, with 15—20 teeth.

Operculum thick and even, thickly granulated, gray with white nuclear area, internally reddish-gray, the rib short and white, peg broad and pointed.

Radula—central long and upper area more distinct. The first 28 marginals rounded, smooth and the following 7 marginals with serrations.

Measurements :

Length	Width	Height of aperture
35.15	27.20	17.10

Range : From East African Coast to West Coast of India.

Distribution : India : Bombay (Recluz) ; Tranquebar (Chemnitz). Elsewhere : Red Sea, Mekran coast, Natal Bay, Mocambique and Querimba island, Kendoa island, South of Zanzibar, Madagascar, Seychelles, Amirantes ; PAKISTAN : Karachi.

The localities "the Philippines" and "Nicobars" cited by Reeve (1855) and Chemnitz (1781) respectively are doubtful.

Habitat : Generally distributed on rocks at high water mark, but also found above high water mark, where they could only be reached by spray (Melvill & Standen, 1901, p. 333). It is usually restricted to exposed shores in the high eulittoral (Taylor, 1968. p. 149).

Remarks: Ray (1948) reported it from Madras, where its occurrence is doubtful, The material on which Ray based his report, was collected by Prof. Awati from various localities on the Coromandel Coast and also from Bombay, on the West Coast of India. From Ray's remarks it is clear that "records of exact localities from which the different species were obtained, the dates of collections and other data are not available". As such, possibly there was mix up of collections and the specimens of this species might have been collected from Bombay.

So far there is no authentic collection or report of this species from east coast of India. *Nerita textilis* is restricted to Indian Ocean not extending beyond west cost of India eastwards.

This is the first record from Gujarat coast. *Type-locality* : Gmelin (1791) didnot mention the type-locality. He however referred to Rumphius figures (pl. 22, fig. 3)

Subgenus Ritena Gray, 1858

Nerita (Ritena) grayana Recluz, 1843

(pl. II, figs. 3&4)

Nerita grayana Recluz, 1843, *Rev. Zool. Soc. Cuvier*, p. 200 (Type-locality : Port Curimao, Province of North Ilocos, Luzon Island, Philippines) ; Reeve, 1855, *Conch. Icon.*, **9**, *Nerita*, sp. no. 33, pl. VII, figs. 33 a, b.

Nerita (*Cymostyla*) *grayana* Recluz, Von Martens, 1887 in Martini & Chemnitz's *Syst. Conch. Cab.*, **2** (11) : 44, pl. 7 figs. 8, 10.

Nerita (*Pila*) *undata* var. *grayana* Recluz, Tryon, *Man. Conch.*, **10** : pl. 6, figs. 2, 3.

Material : (1) 2 ex., sta. 33—Nancowry, 2. iv. 1959—Coll. *K. K. Tiwari*. (2) 8 ex. Sta. 15—between Chota Inak village and Naval Garrison, Kamorta Island, 4. x. 1972 ; (3) 5 ex., Sta. 18—on mangroves in Nancowry bay, S. E. of Champion jetty, Nancowry Island, 6. x. 1972 ; (4) 34 ex. Sta. 23-on mangroves in front of Ramjao village, Kamorta Island, 8. x. 1972 : (5) 11 ex., Sta 31—on the mangroves, near the jetty, Barakhali, N. W. of Forest Dept. Rest House Chiriatapu, 27. x, 1972—coll. *K. Reddiah* & *N, V. Subba Rao.*

Description : Shell ovately globose and thick, colour greyish-black, flecked with white, whorls 3½, narrow, spire sharp but distinct and elevated, apex white and pointed, sculpture consists of 24 to 30 strong, exalted and crenulated ribs, spire and upper half of body-whorl with alternately thin and strong ribs : interstices generally larger than the actual ribs.

Aperture large, light yellow, columellar callus with a deep inward slope wlth strong aud uninterrupted wrinkles in the upper half but small and scanty in the lower half, inner columellar margin concave with 2 to 4 strong and blunt teeth, a ridge-like elevation runs on the superior side near the outer lip. Outer margin of latter straight on the superior side, moderately thick, tessellated and fringed with black, dipping straight inwards to the inner margin, the inner marginal callosity with 19 to 20 small teeth, the first superior tooth knob-shaped, the following longitudinally elongated, moderately weak, internal hinge tooth lacking.

Operculum externally flat, thickly granulated, gray with white nucleus, internal surface also grayish, rib strongly developed and furrowed.

Measurements (*in mm.*)

	Length	width	Height of aperture
Smallest (Ramjao, Kamorta)	11.15	8.65	5.00
Average (Between Chota Inak and Naval Garrison)	31.05	21.00	15.25
Largest (Nancowry Bay)	38.30	25.65	17.00

Range : Andamans to the Philippines.

Distribution : Andaman and Nicobar Island ; Philippines : Luzon Island. Tahiti ?. It is not found on the coast of the Indian mainland.

Frauenfeld's report of this species from Nicobars was doubted by Von Martens (1889). But the present author collected a good series of examples from the mangrove zones of Andaman and Nicobar Islands. The niches in the mangroves are not easily accessible and after reaching surmounting the difficulties, a careful scrutiny is needed to detect the snails in the crevices of the mangrove trees. Perhaps this is the major factor for the scanty collections and few reports of its occurrence in the Indo-Pacific region.

Habitat : Von Martens' (1887, p. 45) report of its occurrence on stones may not be correct. In Andaman and Nicobar Islands it was always found above the high tide level clinging to the roots and in the crevices of the branches of mangroves exhibiting a tendency for gregarious habit, often five or six in number. *Nerita planospira* Anton was also found occupying the same habitat.

Remarks : *Nerita grayana* bears a striking resemblance to *Nertia lineata* Gmelin in its general colour, nature of ribs and in habitat. However, it can be easily distinguished from the latter by the more globose shell, elevated spire and strongly wrinkled columellar callus without conspicuous yellow colour.

Von Martens (1887) showed its resemblance to *Nerita undata*, a true marine form. Tryon (1888) considered it as a veriety of *N. undata*. But *N. grayana* differs from *N. undata* in occupying an entirely different habitat, in its more exalted ribs, and in slightly thinner outer margin of outer lip, which bears less number of teeth.

Reeve (1855) adopted the description of Recluz. Von Martens (1887) also followed the same, as he had only one specimen, from an unknown locality in the Berlin Museum.

A large collection from Andaman and Nicobar Islands does not exhibit any kind of variation and all conform to the description given above.

ACKNOWLEDGEMENTS

My thanks are due to the Director and Dr. S. Khera, formerly Joint Director-in-charge, Zoological Survey of India for the encouragement and necessary facilities; to Dr. K. C. Ghosh, Reader in Zoology, University of Calcutta and to Shri A.S. Rajagopal, Superintending Zoologist for their constant interest and guidance during the course of my studies on Indian neritids. My thanks are also due to Shri K. Dey, the photographer.

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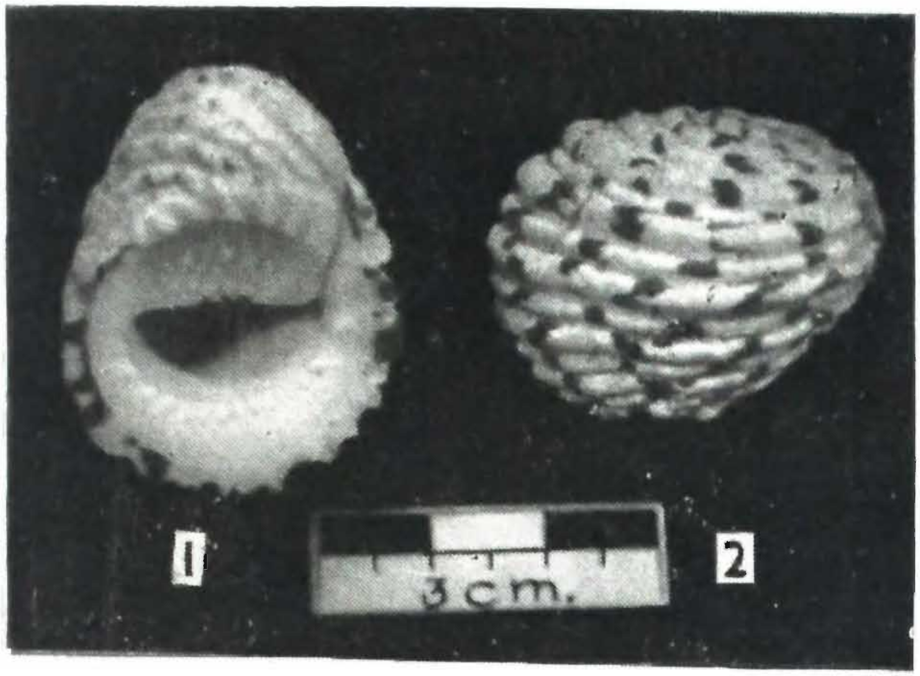

Figs. (1&2) ***Nerita (Theliostyla) textilis*****, 1—Apertural view, 2—Dorsal view.**

Figs. (3&4) ***Nerita grayana*****, 3—Apertural view, 4—Dorsal view.**

Bull. zool. Surv. India, 2 (2 & 3) : 163-166, 1980

PREDICTION OF HIND-FEMUR LENGTH FROM KNOWN ELYTRON/BODY LENGTH IN THE AAK GRASSHOPPER *POEKILOCERUS PICTUS* (FABR.) (ORTHOPTERA : PYRGOMORPHIDAE)

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ABSTRACT

Biometrical relationship in between elytron length and hind-femur length, and body length and hind-femur length, have been worked out in a population of aak grasshopper, *Poekilocerus pictus* (F.). The regression coefficient 11.241+0.3306 multiplied with elytron length in first case, and 20.5575+0.075 multiplied with body length in second case, gave estimated value of hind-femur length in mm. When compared with actual observed values, the estimated values varied from —2.8 to 2.2 mm. and the sum of differentiation was 0.0 mm. in the sample of 20 specimens. Data for construction of the prediction formulae have been provided.

INTRODUCTION

Among the orthopteran insects, the length of hind-femur is an important taxonomic character. It is used in segregating different taxa, as well as in distinguishing the different phases of locusts. The length of hind-femur is also used in conjunction with elytron length and width of head for these purposes. However, it is common experience that the pinned specimens are often found with broken hind-femora, as it get easily detached. In such specimens, thus, the length of hind-femur remains an unknown character.

With the biometrical principle of the regression coefficient, it has become possible to work out the relationship between two morphometric characters of a species distributed in the normal manner. In such cases, the estimated value of a missing character can be calculated from the known value of the other related character. During the present study, it has been applied in the case of the aak grasshopper, *Poekilocerus pictus.*

MATERIAL AND METHODS

Twenty adult unbroken specimens were selected at random from a population of the aak grasshopper, collected from Baikathpur, Fatwah, Distt. Patna (Bihar) (ZSI GPRS Regd. No. A—352 to A—355, dry material). These were grouped elytron length-wise, with accurate measurement (in mm.) taken of elytron, body and hind-femur in each case. The data obtained are given in the Table 1.

The data of sample given in Table I shows that

(1) $n=20$

(2) $\sum_{1}^{n} E=787$

Table 1. Data of sample for construction of the prediction formulae for the length of hind-femur in *Poekilocerus pictus*

Specimen No.	Length of elytron (E) in mm.	Length of body (B) in mm.	Length of Hind-Femur (F) in mm.	E x F	B x F
1.	37	49	23	851	1127
2.	37	54	24	888	1296
3.	37	48	24	888	1152
4.	38	44	21	798	924
5.	38	49	23	874	1127
6.	38	49	23	874	1127
7.	38	48	24	912	1152
8.	38	50	24	912	1200
9.	38	57	26	988	1482
10.	39	48	22	858	1056
11.	39	51	23	897	1173
12.	40	48	23	920	1104
13.	40	52	24	960	1248
14.	41	54	25	1025	1350
15.	41	58	26	1066	1508
16.	41	57	26	1066	1482
17.	41	53	27	1107	1431
18.	42	56	25	1050	1400
19.	42	56	25	1050	1400
20.	42	57	27	1134	1539
	787	1038	485	19118	25278

Observations And Results

To know the estimated value of the length of missing hind-femur ($\hat{F}$), its relationship with known value of elytron length (E) or length of the body (B) was worked out. This relationship is linear and fits into formulae $\hat{F}=a_1+b_1 E$, or $\hat{F}=a_2+b_2 B$, as the case may be, where a_1, b_1, and a_2 and b_2 are constants.

$\sum_{1}^{n} E^2=31069$

$\bar{E}=39.35$

(3) $\sum_{1}^{n} B=1038$

$$\sum_1^n B^2 = 55284$$

$$\overline{B} = 51.9$$

(4) $$\sum_1^n F = 485$$

$$\sum_1^n F^2 = 11811$$

$$\overline{F} = 42.25$$

In the regression analysis, the following three values, A—C, need to be calculated, to estimate the constants. When we take the case of known elytron length, a_1 and b_1 are calculated as follows :

(A) $e_1 = E - \overline{E}$

$$\sum_1^n e_1^2 = \sum_1^n (E-\overline{E})^2 = \sum_1^n E^2 - \frac{(\sum_1^n E)^2}{n}$$

$$= 31069 - \frac{(787)^2}{20} = 100.55\ldots \text{ (i)}$$

(B) $f_1 = F - \overline{F}$

$$\sum_1^n f_1^2 = \sum_1^n (F-\overline{F})^2 = \sum_1^n F^2 - \frac{(\sum_1^n F)^2}{n}$$

$$= 11811 - \frac{(485)^2}{20} = 49.75\ldots\text{(ii)}$$

Table 2. Data showing the estimated and observed values of length of the hind-femur in *Poekilocerus pictus*

Specimen No.	Length of elytron (E) in mm.	Observed length of hind femur (F) in mm.	Estimated length of hind femur ($\hat{F}$) in mm.	$F-\overline{F}$	$(F-\overline{F})^2$
1.	37	23	23.5	—0.5	0.25
2.	37	24	23.5	0.5	0.25
3.	37	24	23.5	0.5	0.25
4.	38	21	23.8	—2.8	7.84
5.	38	23	23.8	—0.8	0.64
6.	38	23	23.8	—0.8	0.64
7.	38	24	23.8	0.2	0.04
8.	38	24	23.8	0.2	0.04
9.	38	26	23.8	2.2	4.84
10.	39	22	24.1	—2.1	4.41
11.	39	23	24.1	—1.1	1.21
12.	40	23	24.5	—1.5	2.25
13.	40	24	24.5	—0.5	0.25
14.	41	25	24.8	0.2	0.04
15.	41	26	24.8	1.2	1.44
16.	41	26	24.8	1.2	1.44
17.	41	27	24.8	2.2	4.84
18.	42	25	25.1	—0.1	0.01
19.	42	25	25.1	—0.1	0.01
20.	42	27	25.1	1.9	3.61
		SUM : 485.0	485.0	0.0	

(C) $\sum_{1}^{n} e_1 f_1 = \sum_{1}^{n} (E-\bar{E})(F-\bar{F})$

$$= \sum_{1}^{n} EF - \frac{(\sum_{1}^{n} E)(\sum_{1}^{n} F)}{n}$$

$$= 19118 - \frac{787 \times 485}{20} = 33.25 \ldots \text{(iii)}$$

The regression coefficient becomes :

$$b_1 = \frac{\text{(iii)}}{\text{(i)}} = \frac{33.25}{100.55} = 0.3306$$

and, $a_1 = 24.25 - (b_1 \times 39.35)$

$$= 24.25 - (0.3306 \times 39.35) = 11.241$$

The equation for the regression line, in this case, thus becomes :

$\bar{F} = a_1 + b_1 \ E$

$= 11.241 + 0.3306 \times E$

It was further examined by the authors that how far the calculated values of the length of hind-femur compare with that's actual observed values. The data on the basis of above elytron : hind-femur case are given in the Table 2.

The estimate of the standard error for it was also calculated as follows :

$$\bar{\sigma} \ e = \sqrt{\frac{(F-\bar{F})^2}{n-2}}$$

$$= \sqrt{\frac{34.3}{18}} \qquad = 1.379$$

Therefore, for each value of known elytron length (E), an estimated value of the length of hind-femur $\hat{F}$ can be predicted by the above procedure.

Similarly, the authors surmised that for each value of known body length (B), an estimated value of hind-femur ($\bar{F}$) may also be predicted by the following equation :

$$\bar{F} = a_4 + b_2 \times B$$

$$= 20.5575 + 0.075 \times B.$$

It may be added that as the dependant variable F is almost always affected by variables other than E or B, hence, the prediction might be made more perfect by using these other concomitant variates.

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METHOD OF FEEDING BY HOLOMAS TIGID FLAGELLATES SYMBIOTIC IN XYLOPHAGOUS TERMITES

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ABSTRACT

The process of ingestion and digestion of the Holomastigid flagellates symbiotic in the digestive tract of xylophagous termites is hitherto unknown. In this paper the process studied in two species of flagellates, viz. *Holomastigotoides* sp. and *Spirotrichonympha* sp. from termites is presented.

INTRODUCTION

The symbiotic flagellates of the alimentary tract of xylophagous termites represent an interesting faunal association. In the feeding habit of these flagellates we find a great diversity as it is also found in other features of their life history. The flagellates abundant both in form and number filling the alimentary canal of the termites, ingest and digest the wood which is taken by the incumbent.

The total weight of all the protozoa present in a termite worker has been estimated to be from about 1/7—1/4 (Hungate, 1939) or 1/3 (Katzin and Kirby, 1939) to as much as 1/2 (Cleveland 1925) of the body weight of the termite. The method of food ingestion especially in Trichonymphid flagellates was studied by Swezy (1923) and Cleveland (1923*a*, 23*b*, 25). Nothing is known on feeding habit of Holomastigid flagellates, therefore the present work is brought forward.

MATERIAL AND METHODS

The specimens belonging to the genera *Holomastigotoides* and *Spirotrichonympha* were collected from Calcutta and its environs from *Coptotermes heimi* (Wasm.) and *Heterotermes indicola* (Wasm.) while dealing with the studies on symbionts of termites. For observation larger termites were selected in which the abdomens were somewhat swollen. The entire intestinal tract was removed and placed on a slide. The wall of the intestine was carefully opened and spread apart. The fresh smears of gut contents were mixed with very little quantity of 0.5% saline. The nature of food ingestion was observed under 10×40 magnification of the C. Z. microscope. The specimens were fixed in Schaudinn's fluid and stained in iron haematoxylin time to time. The figures were drawn with the help of camera lucida.

THE METHOD OF FEEDING

The pseudopodial method of feeding was

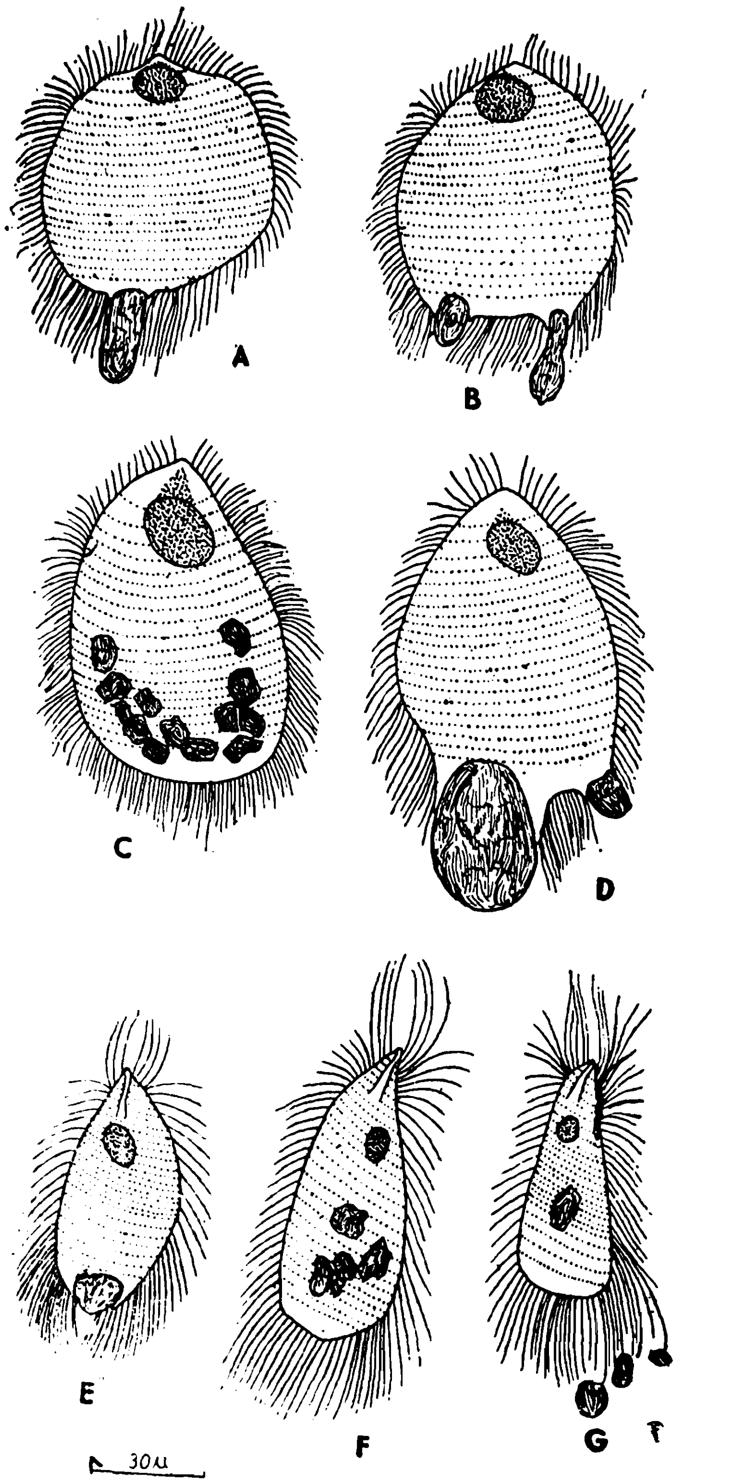

Fig. 1. A—The food particles adhering to the flagella at posterior end of the *Holomastigotoides* sp. B—Two small pseudopods approach on either side of the food particle and circling it, C—The individual shows fully engulfed food particles, D—The individual is showing ingestion of a large piece of wood, E—The food particles are entangled in the flagella at the posterior end in *Spirotrichonympha* sp. F—The two pseudopods forming a cup arround the food particle, G—The individual shows engulfed food particles at posterior end,

observed. *Holomastigotoides* sp. equipped with numerous flagella but the flagella do not take any part in the capture of food particles except when the food particles are entangled with them (Fig. 1A) are easily captured. The pseudopodia are generally formed from the posterior portion of the body where the flagella are absent. Two small pseudopodia of clear ectoplasm approach on either side of the wood particle (Fig. 1B). The pseudopodia continue further gradually forming a ring around the particle and draw it inside the body ultimately both ends of the pseudopodia come in contact with each and the food is completely ingested by the symbiont. The maximum size of the food particle measures 30.15×26.96 µ (Fig. 1D). In this way the entire body of the symbiont was almost filled up with the wooden particles (Fig. 1C). The act of engulfing one piece does not prevent in capturing a second simultaneously by other parts of the body. The particles in different degrees of digestion is indicated by the different grades of the food particles inside the body.

The process of feeding in *Spirotrichonympha* sp. is somewhat similar to that of *Holomastigotoides* sp. as described above. The posterior portion becoming wider almost ball-shaped and long flagella present over there extend backward with their tips interlocking (Fig. 1E). The food particles when come in contact to the body of that region from the under surface, one or more pseudopods are formed. The ectoplasm expands locally accompanied by flow of endoplasm. Immediately the marginal surface from this expanded cytoplasm become firmly attached to the food particle and the closed area arched upwards thercby the endoplasm between the upper and the lower surface of the pseudopodia recede forming a cuplike cavity (Fig. 1F). The rim or periphery of this concavity was slowly drawn from all direction reducing to an aperture first and later it completely closed. The food particle is now engulfed (Fig. 1G). The maximum size of wood chips measures 13.12×11.15μ.

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FLORAL ASSEMBLAGE AND FAUNAL DIVERSITY IN APHIDOIDEA (HOMOPTERA : INSECTA) IN EASTERN INDIA

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ABSTRACT

Aphids, perhaps form the most important group of crops pests on a world scale. A total of 653 species under 198 Genera of aphids have been recorded from India and its adjacent areas till 1975, of which at least 306 species and 37 genera are endemic in origin, a large percentage (more than 70%) of these aphid species could be found in Eastern India, especially in areas between *ca* 600 m to *ca* 3,000 m. A co-relation between floral assemblage in the region and the abundance and diversity of aphid fauna, has been discussed.

INTRODUCTION

Aphids have a long history which dates to 300 millon years as evidenced by records. The aphid-host plant relations has played an important role in their phylogeny and evolution and it has been considered that association with geologically old plant groups can be regarded as an plesiomorphic character and those with geologically young plant group as an apomorphic character (Heie, 1967).

Most aphid species are monohagous, feeding on plant species belonging to only one genus or oligophagous, feeding on plants of different genera of same family but several species are polyphagous and feed on plants belonging to different genera of non-related or distantly related plant families ; many aphid species of last two categories are heterecious. They exhbiit many interesting and curious phenomena in their pattern of infestation and complexities of life cycle. The seasonal cycle of temperate flora and great diversity of growth pattern perhaps necessiated the elaborate systems of polymorphism amongst aphid; the largest aphid family Aphididae, is also regarded to achieve evolutionary success and as agricultural pests through parasitic exploitation of temperate flora (Kennedy and Stroyan, 1959). However, in the tropical and subtropical vegetation and the moist temparate forests as evidenced in the region under study, a major change in the life cycle, involving anholocyclic parthenogenetic reproduction could be noticed

A total of 653 species under 198 genera of aphids have been recorded from India and its adjacent countries till 1975 of which at least 306 species and 37 genera are endemic in origin (Ghosh, 1977). A large percentage of these(more than 70%) aphid species could be found in Eastern India especially in areas between *c* 600 m to *c* 3,000 m. An analysis of vegetation type of India with special reference to Eastern India may help to co-relate the abundance of flora with unique assemblage of aphid fauna.

VEGETATION TYPES AND SPECIES DIVERSITY

Ths flora of India has been considered to be composed largely of relatively young intrusive elements but show marked evidence of influence of Himalayan uplift, both in composition and distributional pattern. A number of typical peninsular elements have also spread and infiltrated deep into the Himalaya (Mani, 1974). Floristic composition reveals that tropical Asiatic elements of Indo-Chinese and Malayan affinities represent the most dominant members of present day flora ; this can be evidenced most clearly in Eastern India where Assam-Meghalaya region has been considered as the gateway for influx of humid-tropical element from neighbouring areas. The floral composition of the region, show extremely rich assemblage of tropical elements along with temperate and alpine types, each composing numerous subtypes (Rao, 1974).

The tropical vegetation, which could be seen upto an altitude of ca 900 m, covers evergreen or semievergreen forests, deciduous forests and Grassland. Ferns and Orchids, representing rich epiphytic elements show a large number of interesting aphid-species (Ghosh, 1975) ; of the 11 species of aphids infesting Ferns in India, at least eight are only known from eastern India and of these four are endemic in crigin (Table—1) ; at

Table 1. Aphid species on ferns
(Species marked * are endemic in origin)

Aphid species	Host plants
*1. *Antracosiphoniella maculatum* Basu	*Asplenium esculentum* *Athyrium* sp. *Cheilanthus* sp. *Pteris acquilina* Indet. Fern
*2. *Amphorophora ampullata bengalensis* H. R. L. et Basu	
3. *Macromyzus polypodicola* (Tak.)	*Asplenium esculentum*
4. *Macromyzus woodwardiae* (Takahashi)	*Asplenium curioularium* *Asplenium esculentum*
5. *Micromyzodium dasi* Verma	Indet. Fern
6. *Micromyzodium filicum* David	*Asplenium trichomonas* *Adiantum tinctum* *Lastrea* sp. *Nephrolepis* sp. *Pitygramma peruviana* *Polypodium* sp. *Pteris critica* *Straptocarpus* sp.
7. *Micromyzus judenkoi* Carver	*Cheilanthes* sp.
*8. *Micromyzus mawphlangensis* Ghosh	*Polypodium* sp.
9. *Micromyzus nigrum* v. d. Goot	Indet. Fern
*10. *Myzus filicis* Basu	Indet. Fern
11. *Shinjia pteridifoliae* (Shinji)	*Pteris acquilina* *Polypodium* sp.

Table 2. Aphid species on orchids

Aphid species	Host plants
1. *Cerataphis orchidearum* (Westwood)	*Aerides fielidinqii* *Epidendron* sp.
*2. *Aulacorthum* (*Neomyzus*) *dendrobium* Basu	*Dendrobium* sp.
*3. *Macrosiphum* (*Sitobion*) *indicum* Basu	*Cymbidium eburneum* *Cymbidium elegans* *Cymbidium longifolium*
4. *Macrosiphum* (*Sitobion*) *luteum* Buckton	*Calanthae masuca* *Cymbidium insifolium* *Cymbidium lowianum* *Cymbidium monronianum* *Cymbidium tracyanum* *Cyperorchus elegans* *Dendrobium densiflorum* *Dendrobium longicornu* *Eria bambusifolia* *Otochilus porrecta* *Pamhiopedilum insigne* *Vanda caralea*
*5. *Macrosiphum* (*Sitobion*) *pseudoluteum* Ghosh	*Coelogyne ocpaci* *Cymbidium eburneum* *Cymbidium eleagns* *Mandenvallia sp.* *Cymbidium sinense*

least five orchid-infesting aphid species are restricted to the region, of which three are endemic (Table—2) ; similarly, the lush Bamboo vegetation reveals at least 15 species in India, all of which may be found in the region and five of these species have been described as new to science from localities of Eastern India (Table—3). *Castanopsis-Quercus* compex of tropical vegetation, exhibit an array of at least 30 endemic species besides some other species having a wider distribution in south east Asia, most of the species infesting Fagaceae being included under Greenideinae besides some belonging to Drepanosiphinae, Hormaphidinae and Lachninae of Aphidoidea ; a large number of interesting and some endemic aphid species mostly belonging to genera of Greenideinae have also been recorded from other conspicuous plant elements of tropical vegetation e. g. *Duabanga* (Lythraceae), *Engelhardtia* (Juglandaceae), *Eugenia* (Myrtaceae) *Ficus* (Moraceae), *Schima* (Ternstromiaceae) .etc. However, deciduous forests with dominating *Shorea rebusta* appears very poor in aphid-fauna. Tropical grassland of *Saccharum*, *Phragmites* and *Arundo* and other genera also offer an interesting group of species belonging to *Forda*, *Geoica*, *Ceratovacuna*, *Hyalopterus*, *Longiunguis*, *Schizaphis*, *Tetraneura*, many of which feed on the sub-aerial parts of the plants (Ghosh, 1975).

The temperate vegetation occurring at elevations from *ca* 1000 m to *ca* 3000 m may also exhibit an admixture of tropical or subtropical vegetation. Salient features of temperate vegetation include the assemblage of

Table 3. Aphid species on bamboo

Ahid species	Host plants
*1. *Astegopteryx bambusae* (Buckton) (=A. *lutecens* v. d. Goot)	*Bambusa arundinaria*
2. *Astegoptoryx minuta* (v. d. Goot)	Bamboo (unidentified)
*3. *Ceratoglyphina bambusae bengalensis* L. K. Ghosh	*Bambusa* sp.
*4. *Ceratovacuna indica* M. R. Ghosh, Pal, Raychaudhuri	Bamboo (Unidentified)
5. *Ceratovacuna silvestrii* (Takahashi)	*Bambusa* sp.
6. *Chaitoregma tattakana* (Takahashi)	*Arundinaria* sp.
*7. *Cranaphis bambusicola* David, Rajasingh, Narayanan	Bamboo (Unidentified)
8. *Glyphinaphis bambusae* v. d. Goot.	Bamboo (unidentified) Graminae *Physanolae maxima*
9. *Melanaphis arundinariae* (Takahashi)	*Arundinaria* sp.
10. *Melanaphis bambusae* (Fullaway)	*Arundinaria* sp. *Bambusa* sp. *Phyllostachys* sp.
11. *Paraoregma alexandrii* (Takahashi)	*Bambusa* sp.
*12. *Pseudoastegopteryx himalayensis* M. R. Ghosh, Pal, Raychaudhuri	Bamboo (Unidentified)
13. *Pseudoregma bambusicola* (Takahashi)	*Bambusa* sp.
*14. *Subtakecallis pilosa* (David, Rajasingh, Narayanan)	Bamboo (Unidentified)
15. *Takecallis arundinariae* (Essig.)	*Arundinaria Phyllostachys* sp.

Populus-Salix (Saliaceae), *Alnus-Betula* (Betulaceae), *Castanopsis-Quercus* (Fagaceae), *Polygonum-Rumex* (Polygonaceae), *Magonilia-Michelia* (Magnoliaceae), *Litsaea-Machilus* (Lauraceae), *Hydrangea-Saxifraga* (Saxifragaceae), *Eriobotrya-Photinia-Prunus-Pyrus-Rosa-Rubus-Spiraea* (Rosaceae), *Pieris-Rhododendron* (Ericaceae), *Artemisia-Erigeron* (Compositae) and each of these plant genera is known to harbour one or more aphid species which are rare in their distribution elsewhere or endemic in origin (Raychaudhuri, 1973 ; Ghosh, *op. cit.*) ; some examples may be cited to illustrate the point *viz.* Seven species of aphids **Chaetomyzus rhododendri*, Ghosh & Raychaudhuri, **Indiaphis crassicornis*. Basu, **Indiaphis rostrata*, A. K. Ghosh & Raychaudhuri, *Neoacyrthosiphon* (*P*) *holstii* (Takahashi),

**Neoacyrthosiphon* (*P*) *rhododendri*, M. R. Ghosh *et. al.*, **Vesiculaphis grandis*, Basu, **Vesiculaphis rhododendri*, A. K. Ghosh & Raychaudhuri are known to infest Rhododendron spp., of which six have been described from the region (*) : similarly out of eight species of aphids under four genera recorded from India on *Salix*, five species of *Cavariella* and one of *Tuberolachnus* are known from the region ; on *Prunus* and *Pyrus* group of hosts, at least nine species of aphids belonging to nine different aphid genera viz. *Betacallis, Brachycaudus, Dysaphis, Eriosoma. Hyalopterus, Nippolachnus, Pyroluchnus, Schizaphis, Tinocalloides* are known from India, of which all except one species could be largely seen in the region. Conifer forest in temperate vegetation type is mostly composed of Pine trees, on which three species **Cinara atrotibials* David & Narayanan ; *Eulachnus thunbergii* (Wilson) and *Schizoldchnus orientalis* (Takahashi), have been recorded of which one was described as new to science (*), from the region, On the whole, a curious and wide admixture of genera of almost all subfamilies of Aphididae and Adelgidae could be noticed in the temperate vegetation area viz. *Eulachnus, Cinara, Lachnus, Tuberolachnus* (Lachninae), *Chaitophorus, Periphyllus, Trichaitophorns* (Chaitophorinae) *Betacallis, Tinocallis, Tuberoculatus, Tinocalloides* (Drepanosiphinae), *Pterocomma* (Pterocommatinae) *Anomalophis Schoutedenia, Eutrichosiphum, Greenidea, Holotrichosiphon Paratrichosiphum* (Greenideinae) *Aiceoea* and *Anoecia* (Aiceoninae), *Cerataphis, Nipponaphis, Metanipponaphis, Astegopteryx, Ceratavacuna* (Hormaphidinae), *Pemphigus-Ericsoma Prociphilus* (Pemphiginae), *Pineus*, (Adelgidae), besides a host of genera under Aphidinae. The exploitation of temperate flora yielded an extremely rich aphid fauna but unlike in other temperate region, extent of polymorphism appear poor, involving mostly parthenogenetic apterae and alatae viviparae, leading largely anholocyclic life cycle ; sexual forms, both males and oviparae have however been recorded in only 12 species but no evidence has yet been obtained about successful completion of holocyclic life cycle amongst these species. Besides, origin of a large number of endemic aphid species on temperate flora, a wide spread polyphagism may be noticed in many species of aphids in the region, some infesting as many as 200 host plant species belonging to 50 plant families ; some aphid taxa have been described or recorded from host-plants (Like *Tinocalloides* a genus under Drepanosiphinae, described from Rosaceae in the region) which would have otherwise been considered incredible, had the flora of the region been not surveyed for aphid-pests.

The alpine vegetation which is known to be limited at altitudes of *c* 4500 m to 5500 m has been rather poorly surveyed for aphid pests. It is mostly composed of stunted *Rhododendron* species besides *Rheum, Sedum* and some other plant genera ; a more systematic and sustained study of alpine flora may pehaps reveal some more interesting aphid species as has been shown by studies of Ghosh et. al. (1971).

DISCUSSION

An analysis of aphid-fauna of the region clearly indicates that maximum potential for multiplition exists when nutritionally optimum condition in the host plants coincide with the climatically optimum condition of the pests. (Kennedy and Stroyan, *op. cit*). This can be illustrated taking a reference from the preceding text : it has been seen that a large number of aphid species feed on bamboos between *c* 300m and 2400 m in the Eastern Himalaya but in the valley of Brahmaputra and gangetic plains of West Bengal, bamboos are poorly infested by aphids. In the case of *Rhododendron* which is known to harbour at least seven species of aphids including six endemic species, in lower altitudes, has been hardly noted to be infested at higher altitudes in Alpine vegetation belt *i.e.* above *c* 4500m. These indicate that the presence of host plants alone does not provide the favourable habitat condition to form colonies and it is the interaction of biotic and abotic factors which determines the infestation pa.tern. Physical environment plays an important role through its effect of Plant phenelogy and growth habit on the reproductive behaviour and often, as in moist tropics, could lead to rapid population built up by con inous parthenogenesis. Acquisition of new hosts by many species in the region under review, indicate further advance towards polyphagy enabling the fauna to cover more completely the available ecological niches. As such the entire floral assemblage of Eastern India, offers an unique opportunity to study the effect of bio-climatic condition on a group of phytophagous insects involving their abundance, diversity and reproductive cycle.

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TWO NEW SPECIES OF APHIDS (HOMOPTERA ; APHIDIDAE) FROM MAHARASHTRA, INDIA

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ABSTRACT

Two new species of aphids viz. *Dactynotus orientalis* and *Dactynotus echinatus* from Maharashtra, India, are described and figured.

1. **Dactynotus orientalis** sp. nov.

Apterous viviparous ♀ : Body 3.40-3.81 mm. long, (Table 1) with maximum width being 1.91-2.04 mm. Head (Fig. 1A) brown, smooth, with well developed, diverging frontal tubercles ; dorsum of head with four long hairs with acute apices, longest one being 50 µ. Antennae 0.83-0.90x body ; segments I and II brown, darker than head, base of segment III paler than the rest of the dark brown flagellum. Antennal segment III (Fig. 1B) smooth, with 34-47 small slightly protuberant secondary rhinaria distributed over its basal 0.75 portion, segment IV smooth, V weakly wrinkled, rest of the flagellum feebly imbricated throughout ; processus terminalis (Fig. 1C) 6.00-6.90 x base of the segment ; flagellar hairs acute, longest hair on segment III about 0.75 x its basal diameter. Rostrum dark brown, reaches hind-coxae ; ultimate rostral segment (Fig. 1D) 1.10-1.20 x second segment of hind tarsi, with three pairs of secondary hairs. Mesothoracic furca (Fig. 1E) with a distinct stalk. Legs with coxae, very base and apical 0.66 portion of femora, apical 0.20 portion of tibiae dark brown, rest pale. First tarsal chaetotaxy 4, 4, 4 or 4, 5, 4.

Abdomen pale, post siphuncular sclerite well developed, antesiphuncular sclerite absent. Dorsal hairs (Fig. 1G) on small sclerotic bases, with acute apices, longest hair on anterior tergites about 1.00-1.40 x basal diameter of antennal segment III. Siphunculi (Fig. 1H) long, cylindrical, dark brown, imbricated throughout, with polygonal reticulations extending over its apical 0.30 portion ; 0.28-0.30 x body length and 2.00 x cauda. Cauda (Fig. 1F) brown, conical and pointed at apex, with 13-16 small, acute hairs.

Holotype : Apterous viviparous ♀, India, Maharashtra, Dist. Aurangabad, Vill. Satara ; 31. x. 1971, from *Carthamus tinctorium* L. Coll. *P. P. Kulkarni.*

Paratypes : Three apterous viviparous ♀♀ data as in holotype.

Remarks : This species resembles *Dactynotus compositae* Theobald, but differs from it in having i. fewer number of secondary rhinaria and shorter hairs on antennal segment III ; ii. longer siphunculi with

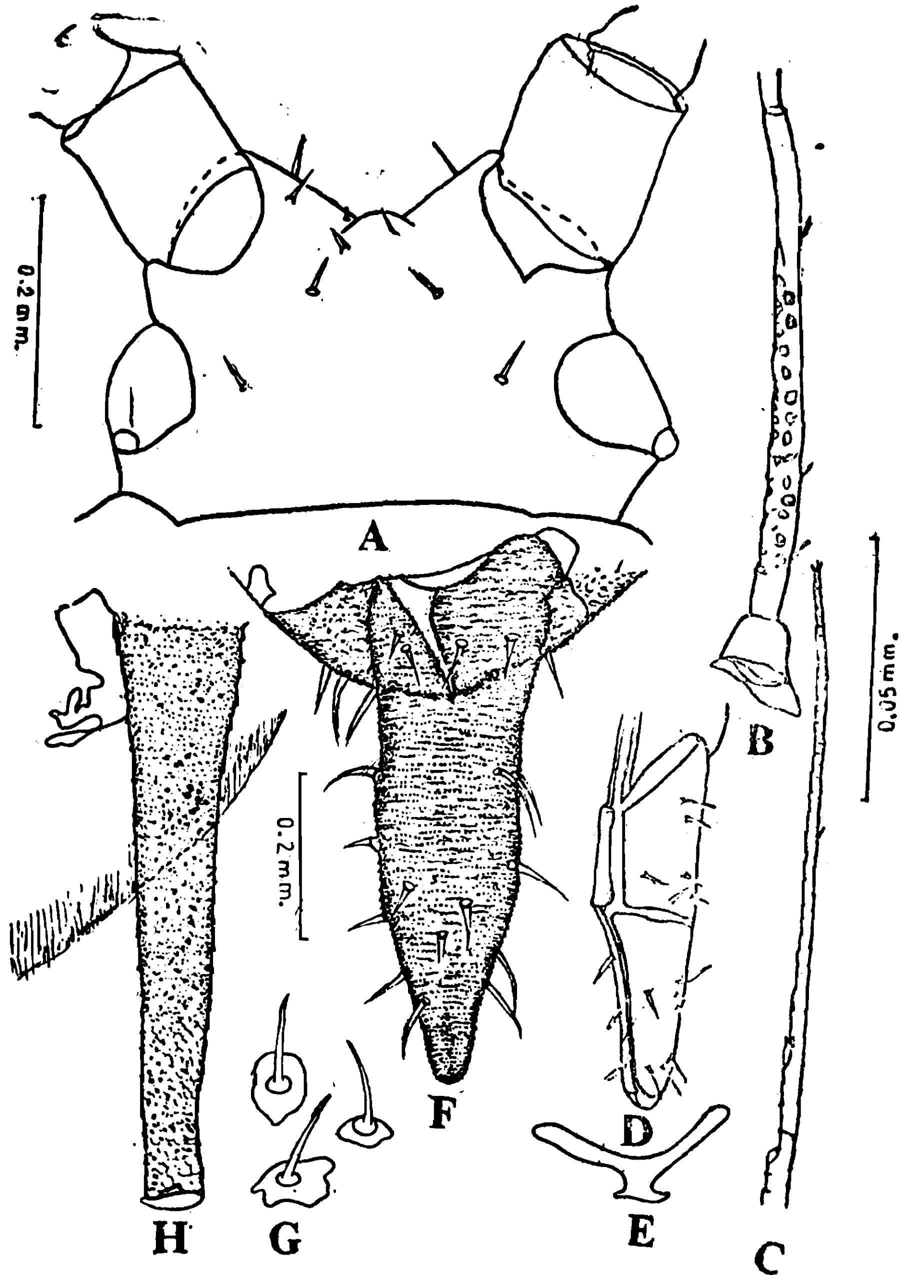

Fig. 1. *Dactynotus orientalis* sp. nov. Apterous viviparous ♀, A—Head, B—Antennal segment III, C—Processus terminalis, D—Ultimate rostral segment, E—Mesothoracic furca, F—Cauda, G—Dorsal abdominal hairs, H—Siphunculus.

Table 1. Measurements (in mm.) of the specimens worked out in detail.

Name of the species	Morph	Body Length	Body Width	antennal segments III	IV	V	VI	U.R.S.	Second Joint of hind tarsus	Siphunculus	cauda
Dactynotus orientalis Sp. nov.	Apterous viviparous ♀	3.40	1.95	0.92	0.45	0.50	(0.13+ 0.82)	0.16	0.14	1.11	0.56
Dactynotus echinatus sp. nov.	Apterous viviparous ♀	2.97	1.39	0.85	0.41	0.36	(0.14+ 0.93)	0.16	0.12	0.83	0.45
,,	Alate viviparous ♀	2.42	0.93	0.72	0.39	0.33	(0.12+ 0.89)	0.16	0.12	0.65	0.33

apical 0.33 portion reticulated. This species also shows close resemblance to *Dactynotus similis* Hille Ris Lambers (1938, 1939) but differs from the same in having shorter antennae, longer processus terminalis and having shorter hairs on dorsum of abdomen.

2. **Dactynotos echinatus** sp. nov.

Apterous viviparous ♀ : Body 2.30-2.97 mm. long (Table 1), with its maximum width being 1.20-1.39 mm. Head (Fig. 2A), brown, smooth, with well developed diverging frontal tubercles. Dorsum of head with eight long hairs having blunt to furcated apices, longest one being 72 μ. Antennae 0.95-1.20 x body ; segments I and II dark brown, darker than

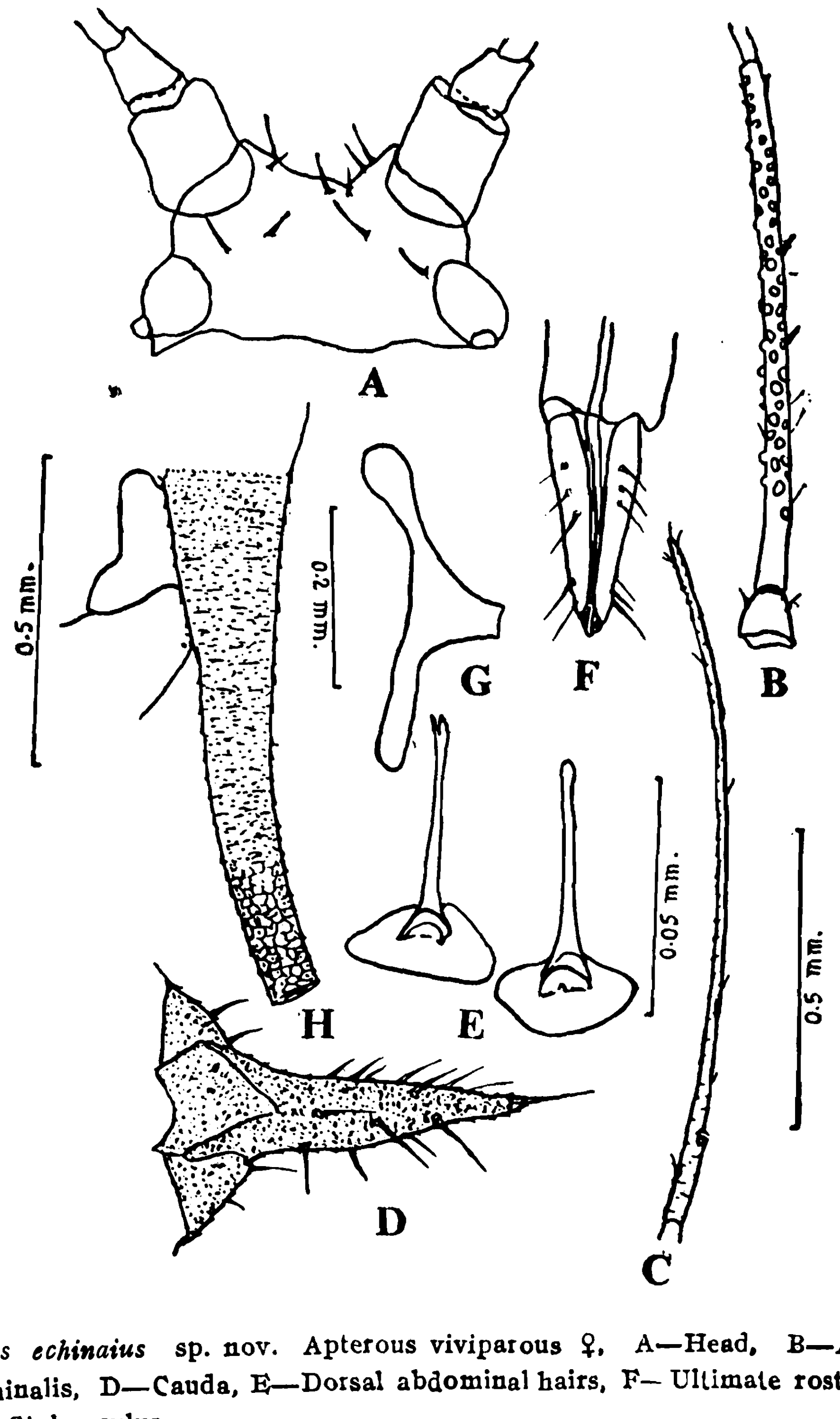

Fig. 2. *Dactynotus echinatus* sp. nov. Apterous viviparous ♀, A—Head, B—Antennal segment III, C—Processus terminalis, D—Cauda, E—Dorsal abdominal hairs, F— Ultimate rostral segment, G—Mesothoracic furca, H—Siphunculus.

head, base of segment III slightly paler than rest of the dark brown flagellum. Antennal segment III (fig. 2B) smooth, with 65-70 slightly protuberrent secondary rhinaria of minalis (Fig. 2C), 6.00-6.30 x base of the segment ; flagellar hairs thick, with furcated or blunt and expanded apices, longest hair on segment III about 1.00 x its basal dia-

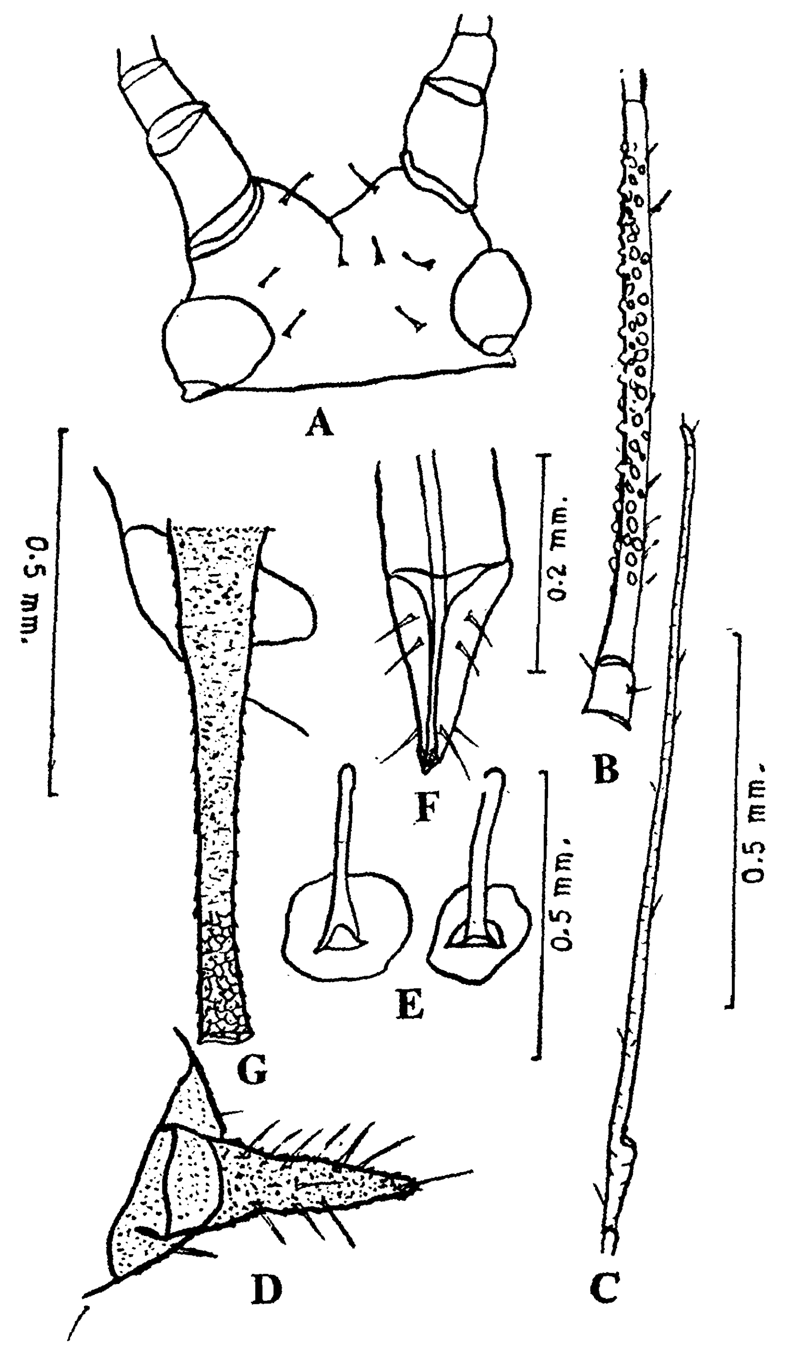

Fig. 3. *Dactynotus echintius* sp. nov. Alate viviparous ♀, A—Head, B—Antennal segment III, C—Processus terminalis, D—Cauda, E—Dorsal abdominal hairs, F—Ultimate rostral segment, G—Siphunculus.

varying size having distributed throughout the segment except basal 0.20 portion ; segment IV smooth weakly wrinkled, V smooth and deeply wrinkled, processus terminalis meter. Rostrum dark brown, long, extending beyond hind-coxae, ultimate rostral segment (Fig. 2F) 1.10-1.20 x second segment of the hind tarsus, with four pairs of secondary hairs. Mesothoracic furca (Fig. 2G), with a distinct stalk. Legs with coxae, apical 0.75 portion of femora, extreme base and apical 0.25 portion of tibiae dark brown, rest pale. Hairs on femora and tibiae thick, short, with blunt to slightly furcated apices. First tarsal chaetotaxy 5, 5, 5.

Abdomen pale; post siphuncular sclerite well developed, antesiphuncular sclerite absent. Dorsal hairs (Fig. 2E), on small sclerotic bases. Hairs arranged in a line, twelve on each of the first five abdominal segments. Marginal two hairs of both the sides of the segments form small composit sclerotic plates. The dark sclerites of the VI and VII hair of each segment fuse together to form a distinct spinal row of plates. Rest of the hairs with their independent sclerites. Abdominal segments VI and VII with eight and six hairs respectively. segment VIII with four hairs, longest of these being 72 μ. Longest hair on anterior abdominal tergites being about 1.60-2.40 x basal diameter of antennal segment III. Siphunculi long (Fig. 2H), cylindrical, dark brown, imbricated throughout, with polygonal reticulations extending over apical 0.30 portion ; 0.29-0.31 x body length and 1.90-2.00 x cauda. Cauda (Fig. 2D), brown, conical, pointed at apex, without any constriction, with 13-15 long acute hairs.

Alate viviparous ♀ ; (Fig. 3A-G) Resembles apterous viviparous female except i. number of secondary rhinaria on antennal segment III 100-115 ; those absent on antennal segment IV and V ; ii. processus terminalis 7.60 x base of the segment ; iii. presence of distinct marginal sclerites on abdominal segments 1-7.

Holotype : Apterous viviparous ♀, India, Maharashtra, Aurangabad, Marathwada University campus : 9. i. 197?, Ex. *Echinus echinatus* Raf. Coll. *P. P. Kulkarni.*

Paratypes : Ten apterous and five alate viviparous ♀♀, data as in Holotype.

Remarks : This species can easily be distinguished from all other species of *Dactynotus* Raf. (Olive, 1963 a, b, 1964 ; Miyazaki, 1971 ; Banerjee and Basu, 1969) by i. the presence of blunt to forked apices of the body hairs and their definite pattern of distribution on the dorsum of the abdomen ; ii. longer processus terminalis ; iii. more secondary rhinaria on antennal segment III in alate and their absence on antennal segments IV and V of alate.

All the type specimens are in the collection of the author.

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TRYPANOSOMA TANDONI SP. NOV. (PROTOZOA) FROM FRESHWATER SHARK *WALLAGO ATTU* (SCHN.)

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ABSTRACT

Trypanosoma tandoni sp. nov. is described from a freshwater shark, *Wallago attu* (Schn.) from Champahati, West Bengal, India. It is monomorphic, measuring 38.00 µm in total length. Volutin granules present in the cytoplasm. Nucleus sansage-shaped situated almost at the middle. Flagellum very long and sharp, distinctly visible with Leishman's stain. Its affinities with the allied species are incorporated in this paper.

INTRODUCTION

The present communication is the fourth instalment of the series and deals with the haematozoa of some fishes of commercial importance. A new species of trypanosome has been described herein after obtaining the specimens from two examples of a freshwater shark, *Wallago attu* out of 80 examined during the year 1975-1977.

The type specimens are deposited in the National Collection of the Zoological Survey of India, Calcutta.

MATERIAL AND METHODS

The fishes were procured from different fish markets of Calcutta and brought to the Laboratory for examination. The blood smears are generally taken by puncturing the bronchial blood vessels. Wright, Leishman and Giemsa's stain were used for staining. Some organ smears from the infected hosts were made and examined after necessary staining. Except in the peripheral blood nowhere the trypanosomes were possible to detect. The figures were drawn with the help of camera lucida and the measurements were taken by placing a thread along the middle of the parasite. About 10 to 50 trypanosomes were counted in a film positive for the parasite.

Trypanosoma tandoni sp. nov.

(Fig. 1A-G)

Description : The trypanosomes are monomorphic, elongated and attenuated at both ends. The configuration generally restricted to an 'S'. Length of the cell body 23.5 µm (range 20.5 µm) ; length of the free-flagellum 14.5 µm (range 11.5-18.5 µm). distance from anterior end of the body to the anterior end of the nucleus 10.0 µm (range 9.00-11.00 µm) ; length of the nucleus 2.5 µm (range

2.25-3.00 µm) ; width of the nucleus 0.75 µm (range .5-1.00 µm) ; distance from posterior end of the nucleus to the kinetoplast 7.00 µm (range 6.00-8.5 µm) ; length of the kinetoplast 1.5 µm (range 1.00-1.75) ; width of the kinetoplast 0.76 (range 0.5-1.00 µm) ; distance from kinetoplast to the posterior tip 1.5µm (range .5-2.00 µm) ; width of the undulating membrane 0.6 µm (range 0.3-95 µm) ; maximum width of the cell body 1.5 µm (range 1.3-1.8 µm). No polymorphism was noted and no divisional stages were found in the blood or any organ smear preparations.

Cytoplasm : The cytoplasm stains faint blue with Giemsa. Numerous granules are localized in the cytoplasm, deeply concentrated at the border opposite to the undulating membrane in a linear fashion. Sometimes few small vacuoles (2.5 in numbers) are found in the cytoplasmic area anterior to the nucleus.

Nucleus : The nucleus is sausage-shaped, placed almost at the middle of the body. Sometimes shifted a little towards the posterior end. It stains deep blue but does not occupy the entire width of the body. The nucleun materials lie in a uniform manner and do not form a karyhsomal mass in side.

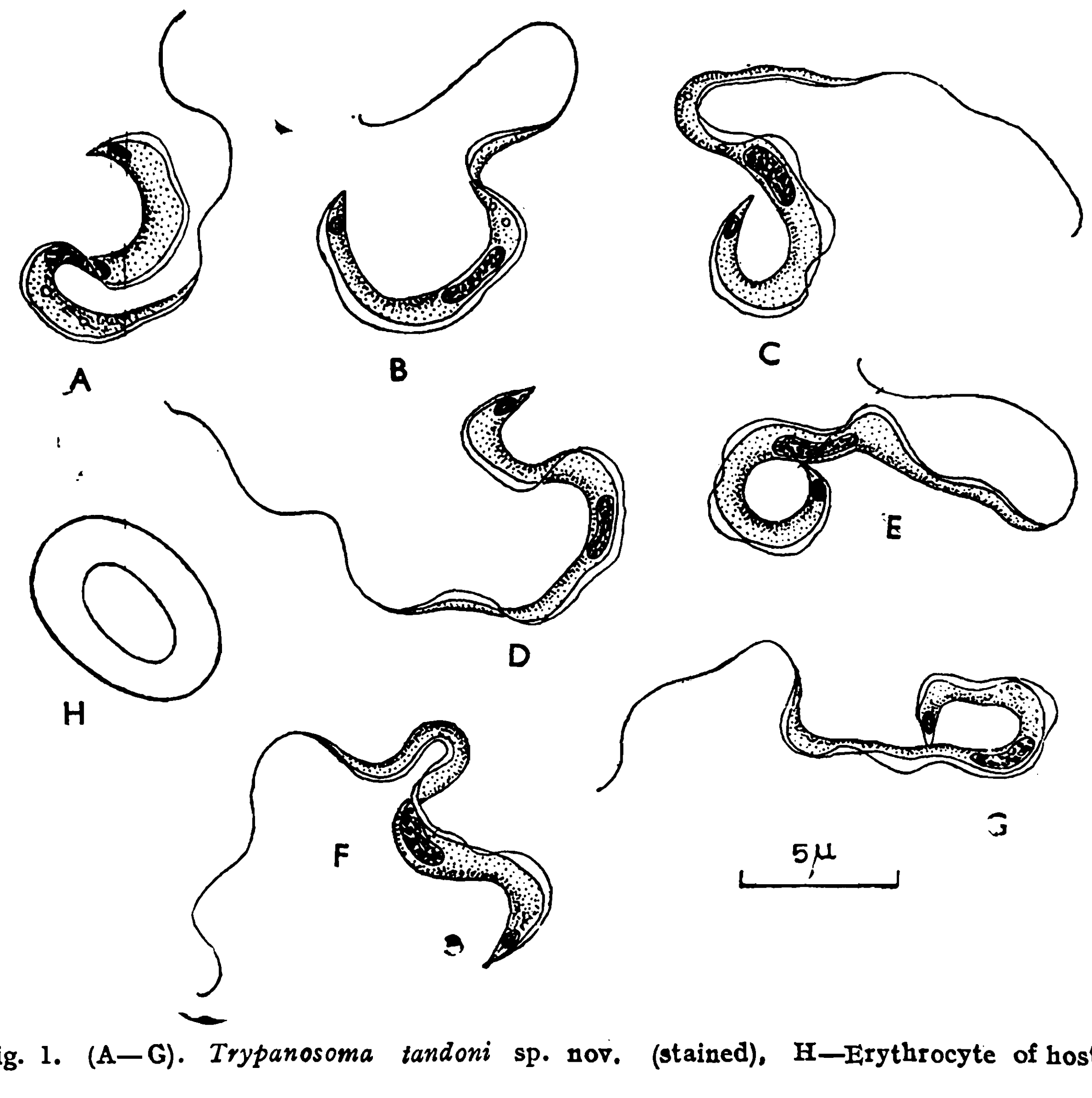

Fig. 1. (A—G). *Trypanosoma tandoni* sp. nov. (stained), H—Erythrocyte of host.

Kinetoplast : The Kinetoplast is almost naviculoid in shape, sometimes oval forms have also been encountered in the preparation. It stains very deep with any stain and does not exceed the width of the cytoplasonic mass of the posterior end of the body where it is situated.

Flagellum and undulating membranet The flagellum appears from the Kinetoplast and trails anteriorly bordering the undulating membrane. It extends beyond the body as a distinct large free flagellum and perform a clear lashing, movement when the organism is alive in citrate preparation. The undulating membrane stains very faint, having 5—9 folds and can easily be seperated from the body cytoplasm by its light colour bordered by thick flagellum.

Type host : Freshwater shark, *Wallago attu* (Schn.)

Site of infection : Blood.

Type specimens : Holotype Regd. No. 1937 paratype Regd. No. 1938
Locality : Champahati, 24-Parganas, West Bengal (India).

Vector and life cycle : Unknown.

Diagnosis of *Trypanosoma tandoni* sp. nov.

The trypanosome is monomorphic, measuring 38.00 µm in total length, with volutin granules in the cytoplasm, nucleus sausage-shaped situated almost at the middle but sometimes shifted a little towards the posterior end with uniform nucleolar mass. Kinetoplast naviculoid does not exceed the width of the body where it is situated. Undulating membrane prominent having 5-9 folds bordered by a distinct, elongated and thick flagellum.

REMARKS

The present species resembles *T. punctati* Hasan and Qasim (1962) *T. batrachi* Qadri (1962) *T. danilenskyi saccobranchi* Qadri (1962), *T. panchali* Mandal (1975) *T. anabasi* Mandal (1978), *J. cancili* Mandal (1978) and *T. chaudhury* Mandal (1976) due to monomorphic nature but differs from them for its enormous length of the free flagellum (14.5 µm) bordering the prominent undulating membrane of 5-9 folds. It also comes close to *T. chaudhuryi* Mandal in respect of the distribution of granules towards the border opposite to undulating membrane. But here the granules are uniformly distributed whereas in the *T. chaudhuryi* the granules are more towards portion anterior to the nucleus.

Therefore it is evident that due to the prominent and elongated flagellum with lashing movement when alive, and thicker concentration of granules towards the border opposite to undulating membrane are sufficient to seperate the present one from any of the known trypanosome described so far and designate as *Trypanosoma tandoni* sp. nov. The specific name is given after Dr. R. S. Tandon University of Lucknow, U. P. who reported the occurrence of trypanosome in *Wallago attu* for the first time. (*Vide* Tandon, 1977).

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Bull. zool. Surv. India, 2 (2 & 3) : 187-191, 1980

ON A NEW SPECIES OF STYLIFERA (LEPISMATIDAE : THYSANURA INSECTA) FROM INDIA

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ABSTRACT

A new species of Thysanura, *Stylifera wygodzinskyi*, from India is described and illustrated.

INTRODUCTION

Wygodzinsky (1959) elevated Stylifera to generic rank, it was Stach (1932) who introduced the new subgenus *Acrotelsa* (*Stylifera*) for *Lepisma galapagoensis* Banks, 1901. Thereafter *Silvestri* (1934) probably not knowing the Stach's paper clearly subdivides *Acrotelsa,* erecting *Allacrotelsa* gen. n. for *Lepisma spinulata* Pack., 1872 and *Acrotelsella* gen. n. as the type of which he named *Acrotelsa producta* Esch., 1905. So far the genus is represented by 15 species and 2 subspecies from Europe, America, Australia, Seychelles, China and Madagascar. This new species is the first species of the genus *Stylifera* from India.

Stylifera wygodzinskyi sp. nov.

Male and Female : Maximum length of the body 12 mm. shape of the body more or less parallel-sided, thorax very slightly wider than abdomen. Dorsally scales are darker, ventrally light yellowish, hypodermal pigments distinct on the antennae, on the labial palp, apex of tibia, tarsus also on the caudal appendages and on the tip of the trochanter.

Chaetotaxy of head as in fig. 1A, mandibles normal, palp as usual. Labial palp as in fig. 1B, apical segment distinctly broader and bears 10 normal sized sensory papillae arranged in a single row. Antennae more or less as long as body, base of the antennae as in fig. 1C. Lateral borders of the nota with 8-9 bristle combs each composed of 1-2 macrochaete, hind border of the nota with 1+1 bristle combs, each composed of 5-7 setae (fig. 1D).

Prosternum triangular posteriorly not narrow (fig. 1E) lateral borders with 3+3 bristle combs each composed of setae ; mesosternum (fig. 1F) somewhat more wider than prosternum lateral border with 2+2 bristle combs each comb consisting of 4-5 setae ; metasternum (fig. 1G) wider and apically rounded with 1+1 bristle combs each comb consisting of 7-9 setae.

Shape and chaetotaxy of hind leg as in fig. 2A, B, C, abdominal terga 2-7 each with 3+3 bristle combs consisting of 5-7 setae, tergum I with 1+1 bristle combs, tergum VIII with 2+2 bristle combs, tergum IX devoid of any bristle combs ; terga VIII, IX with

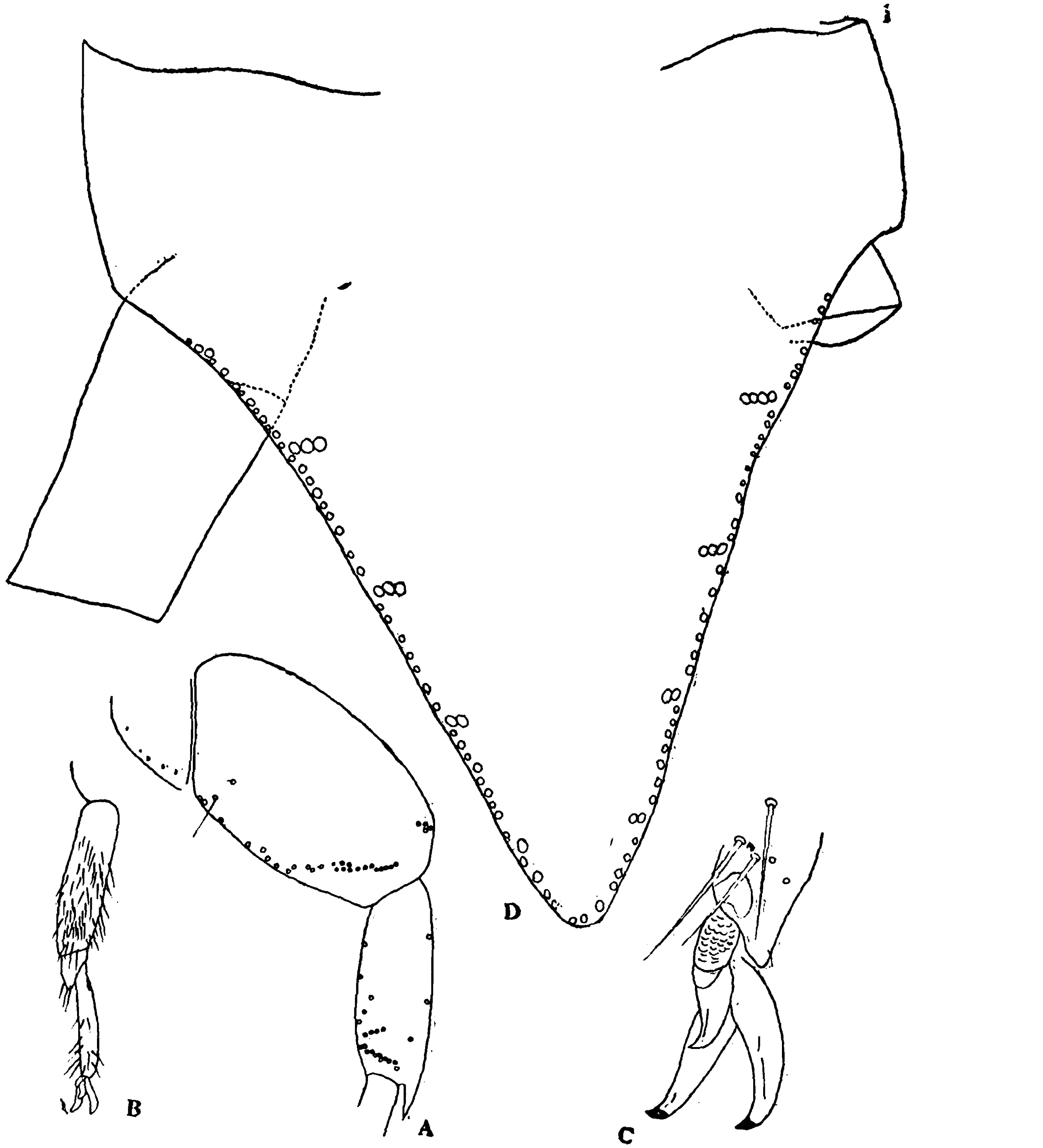

Fig. 1. *Stylifera wygodzinskyi* sp. n. ♀, A—head dorsally with insertion of macrochaetae ; B—labial palp ; C—basal segments of antena ; D—part of pronotum ; E—Prosternum ; F—mesosternum ; G—metasternum.

stylets, Xth tergum long, triangular. Pointed with 4+4 bristle combs of which consists of 1-4 setae (fig. 2D). Urosternum 3-8 with 1+1 sublateral bristle combs consisting of 7-11 setae.

Ovipositor of female as long as the inner processes of coxite IX and covered by it, outer process outwardly curved (fig. 3A) Coxite VIII not long shape as in (fig. 3B). Anterior gonapophyses composed of 19-21 segments,

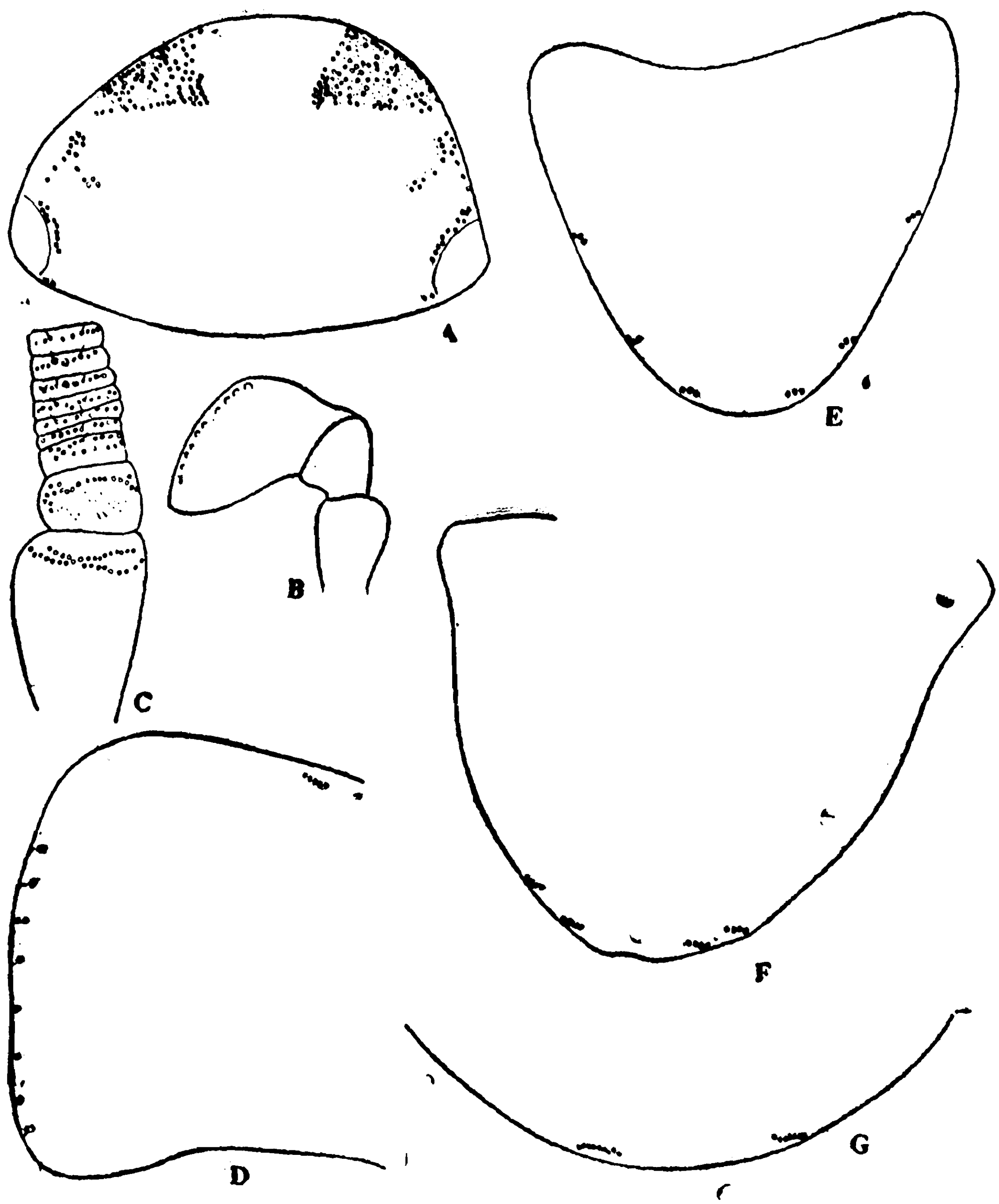

Fig. 2. *Stylifera wygodzinskyi* sp. n. ♀, (A—C) hind leg, with insertion of macrochaetae shown on femur and tibia ; C—tergite X.

apex of the anterior gonopophyses with 6-7 pointed fossorial spines and also 4-5 long setae 6-7 setae also present in the segment (fig. 3C). Posterior gonapophyses extended upto IX coxite and the apex bears 3 pointed fossorial spines, and also with two long setae and numerous short setae scattered in this segment (fig. 3D). Caudal appendages as long as body.

The species is named in honour of Dr. P. Wygodzinsky, of the American Museum of Natural History, New York, whose contribution in the field of Thysanura is well known.

Distribution : INDIA West Bengal.

Type locality : Holotype ♀ India : West Bengal, Bundwan Forest, Purulia Dist. 700 ft.

11.ii.1974, coll. *A. K. Hazra*, 59 examples, Holotype Regd. No. deposited to Zoological Survey of India, Calcutta.

Comparison : This species shows affinities with the species *annamita* Silv., 1948 but can be distinguished by the presence of sublateral bristle combs on urosternites 3-8.

ACKNOWLEDGEMENTS

I am indebted to Dr. P. Wygodzinsky of the American Museum of Natural History, New York, for constructive criticisms and constant suggestions. Thanks are also due to the Director, Zoological Survey of India, Calcutta for laboratory facilities.

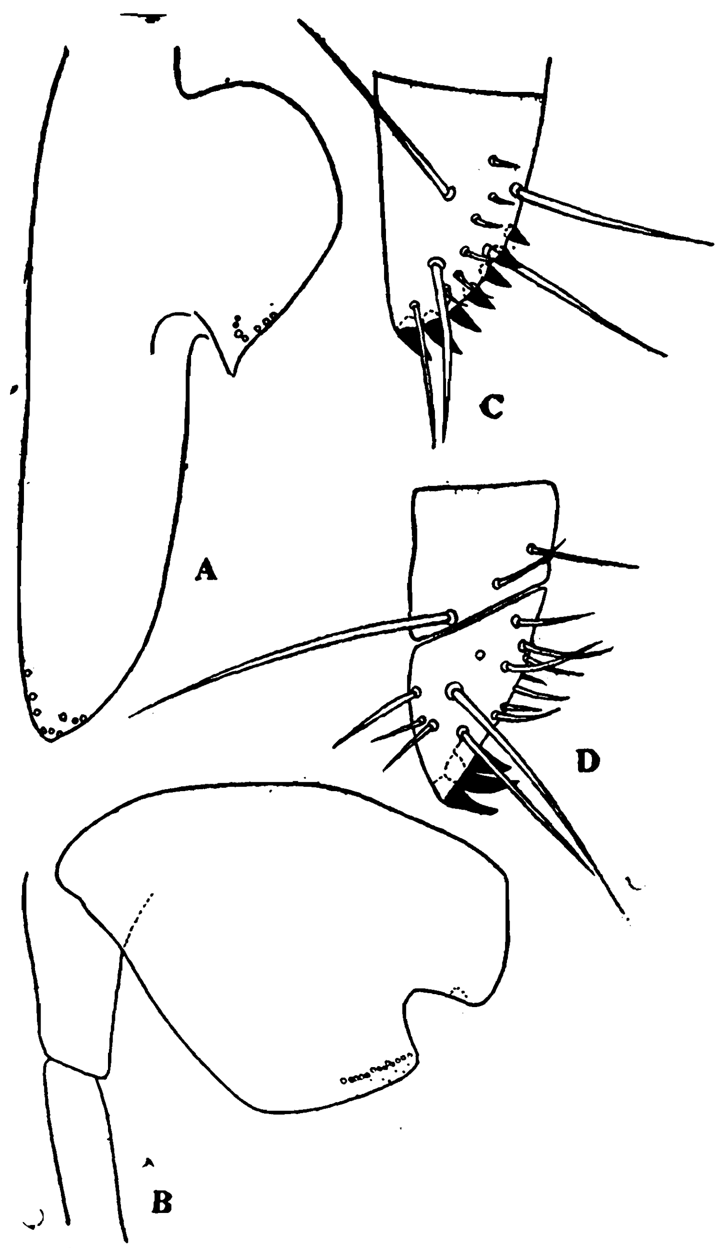

Fig. 3. *Stylifera wygodzinskyi* sp. n. ♀, A— coxite IX ; B—coxite VIII with portion of anterior gonapophysis ; C—apex of anterior gonapophysis ; D—apex of Posterior gonapophysis.

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Bull. zool. Surv. India, 2 (2 & 3) : 193-1.6, 19:0

CLUPISOMA BASTARI SP. NOV. (PISCES : SCHILBEIDAE) FROM BASTAR, MADHYA PRADESH, INDIA

A. K. DATTA AND A. K. KARMAKAR

Zoological Survey of India, Calcutta.

ABSTRACT

A new species of schilbeid fish, *Clupisoma bastari,* from Indravati river at Lohandigura, Bastar District, Madhya Pradesh, India, is described and illustrated. A key to the species of *Clupisoma* Swainson is also included in the paper.

Order SILURIFORMES

Suborder *SILUROIDEI*

Super Family SILUROIDAE

Family SCHILBEIDAE

Genus Clupisoma Swainson

Clupisoma bastari sp. nov.

(Figs. 1 and 2)

Material : 2 exs., Indravati River (a tributary of Godavari River) at Lohandigura, 33 kms west of Jagdalpur, Bastar District, Madhya Pradesh.

Diagonastic Characters : A Clupisoma with abdominal edge keeled from vent to thorax. Maxillary barbels extend upto anal base. Anal fin with 52-54 rays.

Description : B 6 ; D-1/7-8 ; P-1/10-12 ; V-6 ; A 52-54. Body elongate, compressed, abdominal edge keeled from vent to thorax, Head short, buntly pointed, width 1.4 to 1.7 in its length, head length 4.4-4.7, depth 6.4 to 6.7 in standard length ; covered with soft skin. Snout bluntly pointed, 2.5 to 3 in head 1.0 to 1.4 in eye. Eyes large, visible from ventral surface, ventrolateral, with adipose lids, in the middle of head, above angle of mouth, 3.0 to 3.5 in head, 1.0 to 1.5 in interorbital width ; mouth subterminal, cresentric, gape of mouth 1.9 to 2.3 in width of head, upper jaw slightly longer ; maxillary barbels extending to anal fin base, outer and inner mandibular barbels longer than head, nasal barbels extend upto middle of eye. Teeth villiform in bands in both jaws ; vomaropalatine band interrupted in middle. Median longitudinal groove on the head extend to hind border of eye. Occipital process long, pointed, extending to basal bone of dorsal, 4.0 to 4.8 times as long as wide at its base. Dorsal fin 1.2 to 1.3 in head with a strong spine serrated internally and finely serrated externally, 1.3 to 1.4 in head, insertion 1.0 to 1.8 eye diameter behind head, adipose dorsal above the last quarter of anal base, 1.4 to 1.6 eye diameter before last anal ray. Pectoral fins 1.1 to 1.2 in head, not reching pelvic insertion with a spine serrated internally and finely serrated externally. Pelvic fins 2.2 to 2.4 in head, nearly reaching anal insertion, 2.6 to 3.4 eye diameter from pectoral base, insertion 0.5 to 0.55 deeply forked, lobes equal, 1.2 to 1.4 in head, 4.4 to 4.7 in total length, least height of caudal peduncle 1.4 to 1.7 its length. Lateral line extending to caudal base. Skin smooth, dark above lighter below.

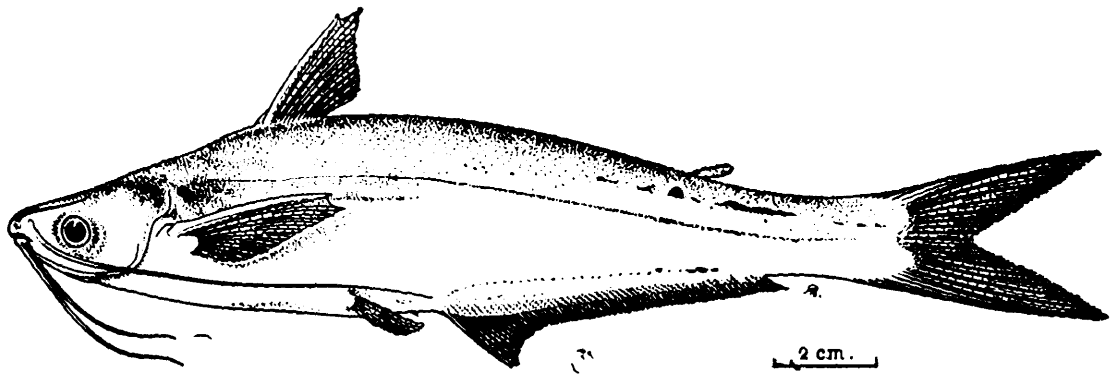

Fig. 1. *Clupisoma bastari* sp. nov.

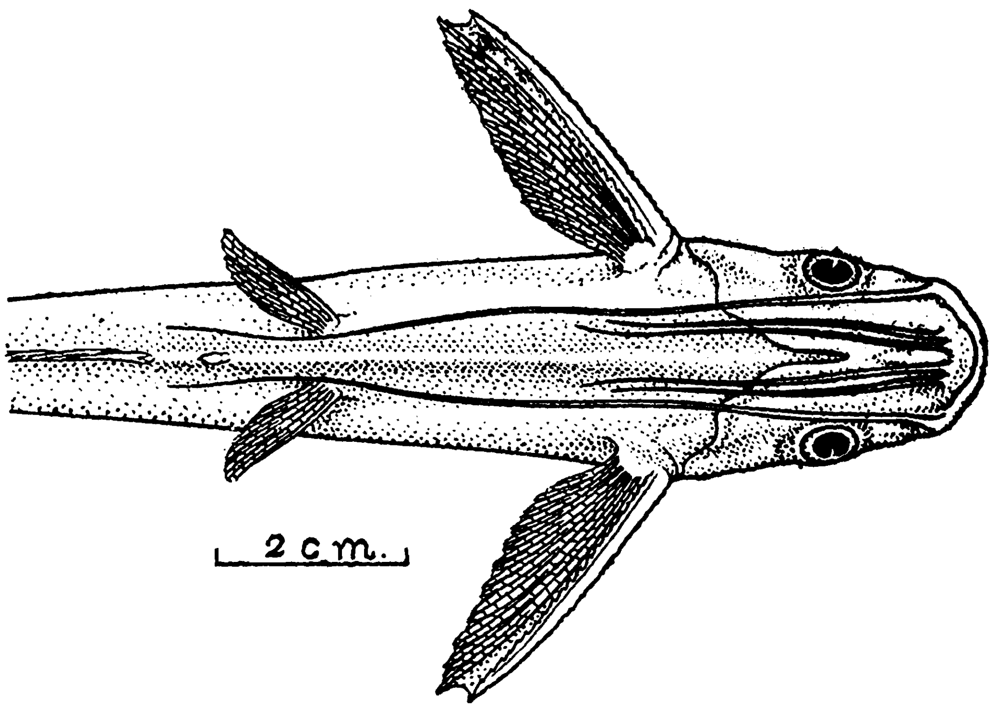

Fig. 2. Ventral view of *Clupisoma bastari* sp. nov. showing the abdominal keel.

in eye diameter behind last dorsal ray, nearer to anal origin than to pectoral base. Anal fin long with 52 to 54 rays, its base 2.55 to 2.65 in standard length, insertion 1.3 to 1.8 eye diameter behind pelvic origin. Caudal fin

Type specimens : Deposited in the Zoological Survey of India, Calcutta. *Holotype* : Reg. No. FF. 1324, 175 mm in standard length ; from Indravati River (a tributary of Godavari River) at Lohandigura, 33 km West

Table 1. Comparison of *C. bastari* with related species

Sl. No.	*Characters*	*C. garua*	*C. montana*	*C. prateri*	*C. naziri*	*C. bastari*
1.	Length of head contained	5.50-6.00, length of caudal 4.50 and height of body 5.50-7.00 times in total length.	6.01, length of caudal 5.91 and height of body 5.45 in total length.	7.10, length of caudal 6.92 and height of body 5.51 in total length.	5.65-6.34 length of caudal 4.71-5.35 and height of body 5.76-6.34 in total length.	4.46-6.34 length, of caudal 4.38-4.72 and height of body 5.61 to 6.58 in total length.
2.	Diameter of eye contained	3.50-4.00 in length of head. 1.00-1.50 in length of snout and 2.50 in interorbital space.	4.70-4.80 in length of head, 1.80 in length of snout and 2.00 in interorbital space.	3.10 to 3.50 in length of head, 1.10-1.50 in length of snout and 1.20 to 1.40 in interorbital space.	4.80-6.00 in length of head 2.00-2.64 in length of snout and 2.36-2.75 in interorbital space.	3.00-3.50 in length of head, 1.00-1.50 in length snout and 1.00-1.50 in interorbital space
3.	Nasal barbel	not reaching eye, maxillary barbel reach to the end of pelvic, mandibular barbels as long as head.	extending middle of eye, maxillary barbel extend beyond pectoral base, mandibular barbel not reaching pectoral base.	extending middle of eye, maxillary barbel exteiding middle of pelvic mandibular barbel reaching pect·ral base.	extending behind the eye, maxillary barbel extend upto base of pelvic or little beyond mandibular barbel slightly short of head, reaching pectoral base.	extending middle of eye, maxillary barbel extend upto anal base, mandibular barbel extend beyond pectoral base.
4.	Gape of mouth	4.00 in length of head.	3.21 in length of head.	3.23 in length of head.	2.00 to 3.11 in length of head.	2.71 to 4.00 in length of head.
5.	Abdominal edge	keeled between pelvic and vent.	rounded.	keeled throughout.	rounded.	keeled from vent to thorax.
6.	Anal fin with	29-36 rays.	41-43 rays.	40.-44 rays.	40-47 rays	52-54 rays
7.	Length of pelvic in head	1.8.	1.8-1.9.	1.4.	2.0-1 45	2.2-2.4
8.	Anal insertion	2.4 in eye diameter behind pelvic fin.	3 in eye diameter behind pelvic fin.	2 8 in eye diameter behind pelvic fin.		1.3-1.8 in eye diamater behind pelvic fin.
9.	Caudal peduncle	2 in its length·	1.8-1.9 in its length.	2 in its length.	1.2 in its length.	1.4-1.7 in its length.

of Jagdalpur, Bastar District, Madhya Pradesh 7.vii.1978. *A. K. Karmakar* Coll., *Paratypes* : Reg. No. FF 1325, 1 ex, 180 mm in standard length ; taken along with Holotype in the same date.

Affinity : *Clupisoma bastari,* in having 52–54 anal rays, significantly differs from *C. montana, C. garua, C. prateri* and *C. naziri,* in which there are 41-43 rays, 29-36 rays, 40·44 rays and 40-47 rays respectively. This new species also differs in having the maxillary barbels extending up to anal fin insersion. The maxillary barbels extending upto middle of pelvic in *C. prateri,* in *C. montana* it extends beyond pectoral base, in *C. naziri* the maxillary barbels extend upto base of pelvic or little beyond and in *C. garua* the maxillary barbel reaches the outer margin of pelvic fin. In having the abdominal edge keeled from vent to thorax, it differs from *C. montana* and *C. naziri* where abdominal edges are rounded. It comes in betweeni *C. garua* and *C. prateri* where the abdominal edge is keeled between pelvic and vent and abdominal edge keeled throughout.

Key to the species of *Clupisoma*

1. Abdominal edge keeled either throughout or between pelvic and vent, or between vent and thorax, maxillary barbel extending beyond pectoral base or to the base of anal ; pectoral reaching or not reaching pelvic origin........ 3

— Abdominal edge rounded 2

2. maxillary barbel not extending beyond base of pectoral, pectoral reaching pelvic. Anal rays 41-43. .. .. *C. montana* Hora

— Maxillary barbel extending upto or behind the base of pelvic fin. Pectoral may or may not reach pelvic. Anal rays 40-47. .... *C. naziri* Mirza & Awan

3. Abdominal edge keeled throughout, pectoral reaching pelvic origin, maxillary barbel not reaching ventral, anal 40·44 .... *C. prateri* Hora

— Abdominal edge keeled from vent to thorax ; pectoral not reaching pelvic origin, maxillary barbel reaching anal base, anal 52-54 .... *C. bastari* sp. nov.

— Abdominal edge keeled between pelvic and ventral, pectoral not reaching pelvic origin, maxillary barbel reaching ventral, anal 29·36 ...... *C. garua* (Ham.)

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FIRST RECORD OF *TRIGONOMIMA* ENDERLEIN (DIPTERA : ASILIDAE) FROM INDIA WITH DESCRIPTION OF A NEW SPECIES

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ABSTRACT

Trigonomima Enderlein is reported here for the first time from India. *T anamaliensis* sp. nov. is described from South India and its affinities are discussed.

INTRODUCTION

Trigonomima Enderlein is a small Oriental genus represented by four species ; it is for the first time this genus is recorded from the Indian sub-continent.

Genus Trigonomima Enderlein

Trigonomima Enderlein 1914 *Wien Ent. Z.* 33, : 164.
Type-species *Trigonomima apipes* Enderlein by original designation.

Small flies closely related to *Damalina* Doleschall from which it can be distinguished by the four posterior cells of wings together with the strongly humped mesonotum.

Types are deposited in the California University, California.

Trigonomima anamaliensis sp. nov.
(Fig. 1A & B)

A medium sized black and grey species with black and yellow legs and infuscated large wings. Male : length 6.0-6.5 mm, wing 6.5-7.0 mm ; female : 5.5-6.0 m, wing 6.5-7.0 mm.

♂ : Head broader than thorax. Head black with greyish-yellow tomentum, mystax sparse, yellow coloured ; bristles of ocellarium yellow and black, occiput mixed grey and yellow tomentose with concolourous bristles. Antenna black, segments 1 and 2 with black bristles, segment 1 short, subequal to the following globular segment, combined 1 and 2 segments about one-third of segment 3, the terminal segment bearing double bristle like the other members of the genus. Palpi and proboscis black with yellow hairs.

Thorax black with greyish-yellow tomentum ; pronotum black anteriorly and greyish-yellow posteriorly, hairs sparse, pale and restricted to the sides ; mesonotum with the extension of greyish-yellow and black colouration variable, in some cases almost wholly greyish-yellow with a spot on each side posterior to the middle while in extreme cases with three mediolongitudinal black bands extending from the anterior border to a little beyond the middle, the median band in its turn divided by a median grey line, bristles of mesonotum yellow but a few in the middle black ; pleura yellow haired ; scutellum with a few yellow bristly hairs on the disc ; mesopleuron, sternopleuron and metanotal callosity with yellow hairs. Halteres pale yellow.

Legs black and yellow with yellow hairs, coxa, trochanter and femur black, tibia and tarsus yellow, but the apical tarsal segment or segments brown to dark brown ; legs conspicuously hairy on the dorsal and ventral sides of femora and hind tibia, hairs longer and denser on hind femur and hind tibia.

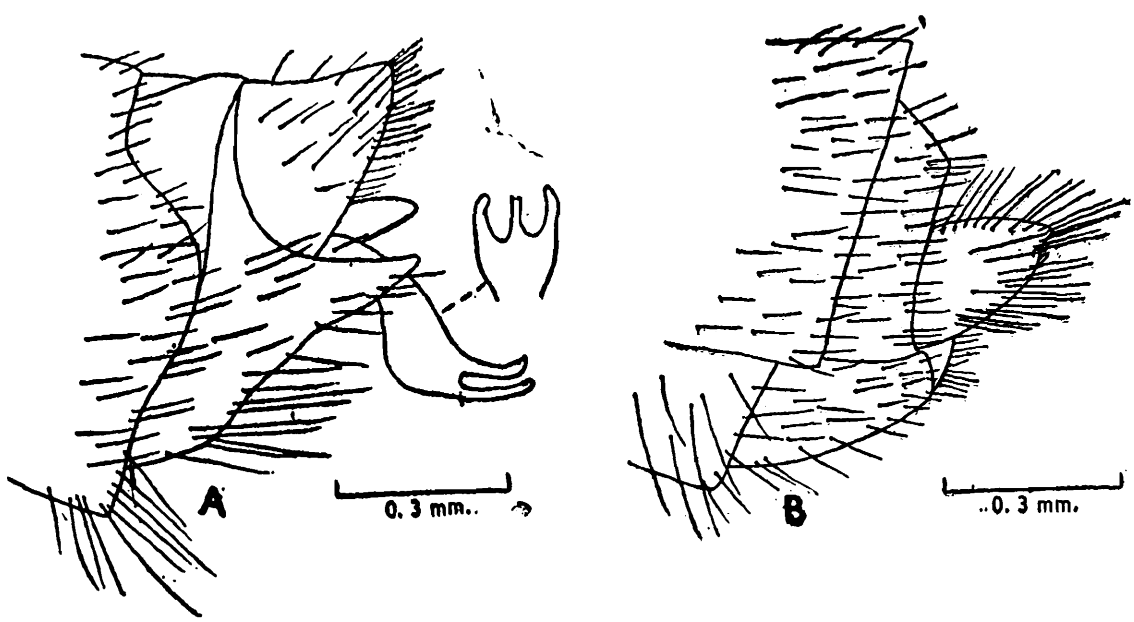

Fig. 1. *Trigonomima anamaliensis* sp. nov. A— ♂ terminalia lateral view ; B—♀ terminalia, lateral view.

Wings black basally and light brownish distally ; venation typical of the genus with only four posterior cells. Some of the flies have supernumerary veins : in one paratype a cross-vein is present at the base of the 2nd submarginal cell in one of the wings ; in one paratype one and in another two cross-veins are present between R and discal cell in one of their wings ; and in one paratype a vein is present in the 3rd posterior cell towards its apex in one of the wings.

Abdomen black with yellow tomentum, the area of tomentum varying from a narrow hind border to the entire dorsum, fringe of yellow hairs present on sides which become gradually shorter in length on posterior tergites. Male genitalia (Fig. 1A) yellow.

♀ : Exactly similar to the male : female terminalia figured (Fig. 1B).

Trigonomima Enderlein is represented by four species, viz. *T. apipes* Enderlen from Sumatra, *T. canifrons* Enderlein from iSumatra, *T cyanella* Osten Sacken from Philippines and *T. pennipes* (Hermann) from Formosa. Of these *T anamaliensis* sp. nov. is most similar to *T. pennipes* (Hermann) from which it differs in the colouration of tibia and in the differences in the shape of male terminalia. Dr. Hull (1962) has figured (Figs. 1875, 1958) the terminalia of *T. pennipes* (Hermann).

Holotype : ♂, S. India : Tamil Nadu : Anamali Hills : Kadampara, 1067 m, iv.1963, Coll. *P. S. Nathan.*

Paratypes : 32♂♂ and 37♀♀, rest of data as in holotype.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India, for encouragements and facilities of work.

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Bull. zool. Surv. India, 2 (2 & 3) : 201-206, 1980

SYSTEMATIC POSITION OF *LABEO DEVDEVI* HORA WITH A DESCRIPTION OF THE SPECIES (PISCES : CYPRINIFORMES)

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ABSTRACT

A full description of *Labeo devdevi* Hora is given in this paper with illustrations of the juvenile and adult forms.

Introduction

Mukerji (1934) reporting upon the fish collections made by Lt. Col. R. W. Burton from the tributary streams of the Mali Hka river, Myitkyina district, Burma stated that *Labeo dyocheilus* (McClelland) is a very variable species and that it may be subdivided into three geographical groups based on their distribution. Besides the Burmese material, Mukerji also examined three specimens labelled as *Labeo dyocheilus* already present in the Z. S. I. Two out of these three examples were purchased from Day collected from Hardwar (ZSI No. 1522) and Simla (ZSI No. 1533) respectively. The third example (ZSI No. F 7932/1) is a skin of a medium sized specimen procured by Dr. S. W. Kemp from Yembung, Abor hills, Arunachal Pradesh. Mukerji thought that Day's two specimens did not represent *Labeo dyocheilus* (*sens. str.*) but considered the Abor example only as the typical form. He further stated that the Western Himalayan form of the speices is distinct from the Eastern Himalayan one. He gave a good description of the *forma typica* of *L. dyocheilus* based on the single specimen of Kemp referred to above and also on additional material collected by Shaw and Shebbeare from Siliguri, Eastern Himalaya. He made only a brief note of the Western Himalayan and Burmese and Thai forms.

Hora (1936) while dealing with the fishes of the Naga Hills re-examined all the above cited material reported by Mukerji and stated that the two specimens of Day (ZSI Nos. 1522 and 1533) do represent *L. dyocheilus* and the single specimen of Kemp from Abor hills and the examples collected by Shaw and Shebbeare from Siliguri, Darjeeling Himalaya are referable to *Labeo dero* (Hamilton). He also considered the five examples of Burton's collections from Mali Hka, Burma initially as *L. dero* and not as *L. dyocheilus* as reported by Mukerji. Later Hora separated the Burmese and Thai forms which differ from the typical *L. dero* in several characters as a new species *L. devdevi*. However, he did not give any description or figures of this fish.

The specific identity of the different material is clarified in Table 1.

Affinities of *L. devdevi* Hora

Before a description of *L. devdevi* is attemp-

Table 1

Sl. No.	Material	No. of exs.	Identification by Mukerji 1934	Identification by Hora, 1936	Present position	Remarks
1.	ZSI No. 1522, Hardwar Purchased F. Day.	One	Not referable to *L. dyocheilus*	*L. dyocheilus*	*L. dyocheilus*	
2.	ZSI No. 1533, Simla, Purchased F. day.	One	Not referable to *L. dyocheilus*	*L. dyocheilus*	*L. dyocheilus*	
3.	ZSI No. F 7932/1. Yembung (1100 ft.) Abor hills, Arunachal Pradesh, S. W. Kemp coll.	One	*L dyocheilus*	*L. dero*	*L. dero*	
4.	ZSI Nos, F 11406/1 and F 11409/1, rivers near Siliguri, Darjeeling Himalaya, Shaw and Shebbeare coll.	Six	*L. dyochelius*	*L. dero*	*L. dero*	
5.	ZSI No. F 11457/1, Phungiu Hka, tributary o Mali Hka river system Burma, R.W. Burton coll.	Three	*L. dyocheilus*	*L. devdevi*	*L. devdevi*	
6.	ZSI No. F 11458/1, Sinan Hka, tributary of Mali Hka river system Burma, R. W. Burton coll.	Two	*L. dyocheilus*	*L. devdevi*		Not readily available
7.	A stream at Meh Sord on Burmese boarder, N. W. Thailand, H. M. Smith coll.	One	*L. dyocheilus*	*L. devdevi*		Not readily available.
8.	ZSI No. F 12456/1, Namya river at Kongan Thana, Burma. S. J. Duncan coll.	Four				Hora (1937) referred this material to *L. devdevi* ; material not readily available.
9.	ZSI No. F 13458/1, Dalu, Upper Burma, Vernay-Hopwood Upper Chindwin Expedition coll.	Four			*L. devdevi*	Hora & Misra (1941) referred this material to *L. devdevi*.

ted it seems necessary to discuss the precise systematic position of *L dyocheilus* and *L. dero* with which *L. devdevi* is undoubtedly related.

McClelland (1839) described *L. dyocheilus* from "clear active currents of the Brahmaputra from Middle Assam." He named the fish as "*dyocheilus*" because of the "pendulous structure of the snout descending so as to form the appearance of second lip". Hamilton (1822) described *L. dero* from Brahmaputra river in Assam, where it is found at the sides of torrential streams in shallow waters. Hora (1936) studied in detail the two species and gave a number of characters to differentiate them andopined that probably on account of the differences in the habitats of these two species, *L. dero* is well represented in Museum collections unlike *L. dyocheilus.*

Besides their habitat, *L. dero* and *L. dyocheilus* are principally differentiated by the nature of the dorsal surface of the free portion of the lower lip and the number of scales below the lateral line to pelvic fin base.

L. devdevi is more closely related to *L. dero* than to *L. dyocheilus*. It is separable from *L. dero* by its shorter head, bluntly rounded snout with the depression across it less pronounced and number of scales (Table 2).

DESCRIPTION

Labeo devdevi Hora

(Fig. 1)

Labeo devdevi Hora, 1936, *Rec. Indian Mus.*, **38**(3) : 323, 324 (type locality, Mali Hka river, Burma, type specimens not designated originally).— Hora, 1937, *Rec. Indian Mus*, 39. (4) : 333 (Namya river, Burma).— Hora & Misra, 1941, *J. Bombay nat. Hist. Soc.*, **42** (3) : 479 (Dalu, Burma).

Specimens studied : Seven examples in total as below—

ZSI F 11457/1, three exs. (one juvenile specimen very much damaged, hence examination not possible), Phungin Hka, tributary of Mali Hka river system, Burma, *R. W. Burton* coll., 19:0.

ZSI F 13458/1, four exs., Dalu, Upper Burma, *Vernay-Hopwood Upper Chindwin Expedition* coll., 1935.*

Besides these, *L. devdevi* is also known by the following six examples which are not readily traceable.

ZSI F 114581/, two exs., Sinan Hka, tributary of Mali Hka river system, Burma, *R. W. Burton* coll, 1930.

ZSI F 12456/1, four exs., Namya river at Kongan Thana, a Kabo or Shan village, Upper Chindwin Drainage, Burma, *S. J. Duncan* coll., 1937.

D. iii/11 ; P. i/15 ; V. 9 ; A. iii/5 ; C. 19 ; LL. 40-41.

Table 2. Characters differentiating *L. devdevi* Hora from its allied species.

S. No.	Characters	*L. devdevi*	*L. dero*	*L. dyocheilus*
1.	Width of gape of mouth	3.85 in head length.	3.28 in head length.	2.78 in head length.
2.	Eyes	3.86 in head length, 1.28 in inter-orbital space width and 1.19 in snout length.	4.71 in head length, 1.57 in inter-orbital space width and 1.72 in snout length.	4.93 in head length, 1.9 in inter-orbital space width and 2.29 in snout length.
3.	Snout	3.36 in head length, with a slight depression and without lateral lobe.	2.8 in head length, with a groove and without lateral lobe.	2.15 in head length, usually without a groove and with distinct lateral lobes.
4.	Tubercles on snout	Inconspicuous and very few in number.	Spiny tubercles, when present, relatively few in number.	Spiny tubercles prominently present, on dorsal lateral and ventral surface of snout.
5.	Scales round caudal peduncle.	19 to 21	22 to 24	21 to 23
6.	Rows of scales below lateral line to pelvic fin base.	5½	7 to 8	5 to 6

* Hora & Misra (1941, p. 479) have stated that 22 examples were collected in this lot. Unfortunately only four are available.

Head moderately large, compressed. Snout bluntly rounded anteriorly, with a slight depression across. Mouth inferior, large and crescentic. Lips thick, fleshy, continuous at the angle of mouth, lower lip papillated, labial fold discontinuous. Lower jaw with a cartilaginous covering on inner sides. Eyes large, situated in anterior half of head, visible from below ventral surface. Nostrils wide, prominent, situated nearer eye than to tip of snout. One pair of small maxillary barbels present at angle of mouth.

fin and pelvic fins do not reach anal fin. Caudal fin deeply forked.

Scales moderate sized, 13 in a transverse series, 7½ rows between base of dorsal fin and lateral line and 5½ rows between lateral line and base of pelvic fin, 18 pre-dorsal scales and 19-21 round the caudal peduncle.

Colour :

In spirit preserved specimens the colour is dark brown above and pale below. A large

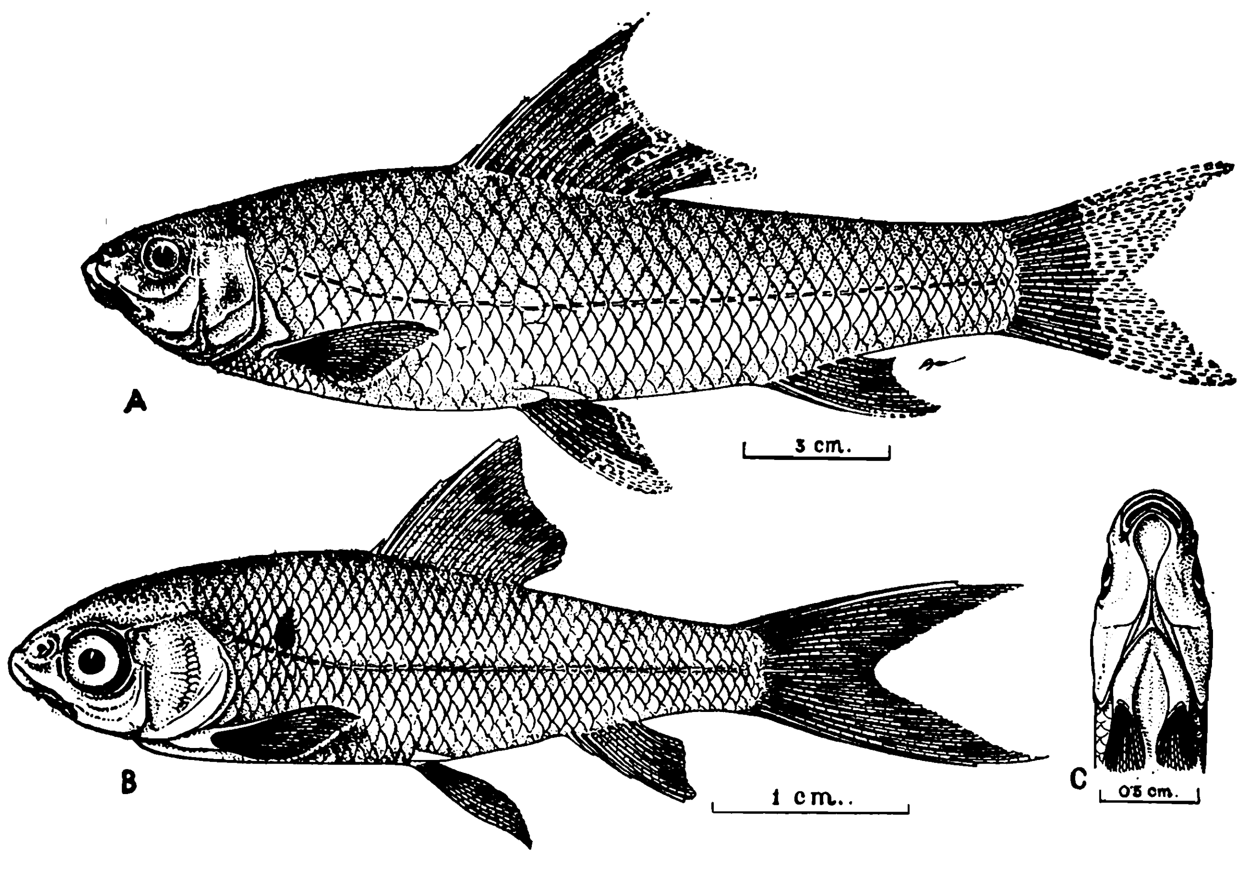

Fig. 1. *Labeo devdevi* Hora, A—Lateral view fo the adult (ZSI F 1442, Standard length : 187.0 mm), B—Lateral view of the juvenile (ZSI F 13458/1, Standard length : 37.0 mm), C—Ventral view of the head region of the juvenile.

Dorsal fin inserted just after tip of pectoral fin, nearer tip of snout than caudal fin base (clearly observed in adults) with the outer margin concave. Pectoral, pelvic and anal fins long ; pectoral fin does not reach pelvic

faint black blotch present above mid pectoral fin and just above the lateral line on the sixth and seventh scales. Mukerji mentioned the presence of a blackish pre-caudal blotch which is now not discernible in any of the specimens examined. The central caudal fin-rays are blackish. The Thailand examples are reported to have a fine series of dusky longitudinal lines on each scale and a faint reddish dot in centre.

According to S. J. Duncan who collected four young specimens from Namya river at Kongan Thana, Burma (ZSI, No. F 12456/1) the colouration of the species is as follows :

"Dark green dorsal surface and white ventral. The scales are small and have a coppery tint. Opercular region with a golden tint. Fins pinkish" (Hora, 1937).

*Body proportions :**

Length of head 3.28—4.68 (M=3.75), body depth 3.42—4.23 (M=3.82), pre-dorsal length 1.94—2.34 (M=2.11), post-dorsal length 1.55—1.81 (M=1.69), pre-pelvic length 1.75—2.13 (M=1.89), all in standard length. Diameter of eye 3.00—5.33 (M=3.86), head width 1.65—2.1 (M=1.94), snout length 2.85—3.8 (M=3.36), width of gape of mouth 2.68—4.75 (M=3.85), post-orbital length 2.0—2.33 (M=2.17), inter-orbital space width 2.85—3.16 (M=3.04), dorsal fin base 1.02—1.61 (M=1.39), length of caudal peduncle 1.13—1.69 (M—1.42), least depth of caudal peduncle 1.7—3.8 (M=2.73), all in head length. Diameter of eye 1.0—1.86 (M=1.28) in inter-orbital space width and 0.83—1.86 (M=1.19) in snout length. Least depth of caudal peduncle 1.49—2.4 (M=1.88) in its length.

Frequency distribution of fin-rays in specimens of *L. devdevi* examined :

Dorsal fin rays		*Pectoral fin rays*
iii/11	iii/12	i/15
5	1	6

Pelvic fin rays	*Anal fin rays*	*Caudal fin rays*
9	iii/5	19
6	6	6

Distribution : Burma : Phungin Hka and Sinan Hka, tributaries of Mali Hka river system, Namya river and Dalu.

Thailand : Stream at Meh Sord, N. W. Thailand.

Lectotype designation : Hora (1936) did not designate any type specimen for *L. devdevi*. The five examples, collected by R. W. Burton which formed the basis of his discussion, becomes *ipso facto* the original type material (syntypes). Of these five, three are at present available in the National Zoological Collection and one 187.0 mm in standard length from this lot is hereby designated as the lectotype.

Lectotype : ZSI No. FF 1442 from Phungin Hka, tributary of Mali Hka river system, Burma, collected by R. W. Burton, 1930.

ACKNOWLEDGEMENTS

We are thankful to the Director, Zoological Survey of India for facilities provided. Shri Parimal Biswas, Senior Artist, ZSI executed the drawings under our supervision and we are thankful to him. One of us (M. K. Das) is thankful to the D. S. T. for the award of a Junior Research Fellowship.

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* Data is only of six specimens.

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Bull. zool. Surv. India, 2 (2 & 3) : 207-211, 1980

A NEW GENUS AND TWO NEW SPECIES OF THRIPS INHABITING *EUGENIA* GALLS (THYSANOPTERA : PHLAEOTHRIPIDAE)

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ABSTRACT

Mutothrips validus a new genus and species and a new species *Arrhenothrips brevis* are described from the leaf galls of *Eugenia*.

Three species of *Arrhenothrips* Hood, viz., *A. ramakrishnae* Hood, *A. dhumrapaksha* Ramk., and *A. acuminatus* Ananthakrishnan are on record from South India (Ananthakrishnan and Jagadish, 1969 ; Ananthakrishnan 1969 a, b, and 1978). Recently Sen (1977) described another new species *A. longisetis* from North Eastern India with a key to the Indian species of *Arrhenothrips.* The present paper includes the description of a new inquilinous genus *Mutothrips validus* gen. *et* sp. n., occurring along side with a new gall making species *Arrhenothrips brevis* sp. n., from the galls of *Eugenia* sp. (Myrtaceae) (Plate III) collected in Mercara (Coorg District, Karnataka), at elevation of 1,500 metres.

Mutothrips gen. n.

Head about as long as wide, weakly transversely reticulate, slightly longer than prothorax, with interocellar region strongly reticulate. Antenna 8 segmented, segment 3 a little asymmetrical, more elongate and narrower with one sensecone. Mouth cone narrowly rounded, maxillary stylets oculad, not meeting at middle. Postocular and prothoracic setae well developed, long and pointed. Forefemora moderately enlarged and foretarsal tooth well developed. Macropterous and apterous conditions distinct, with double fringes when macropterous. B_2 of abdominal segment IX short in both sexes. Tube shorter than head.

Type-species : *Mutothrips validus* gen. et sp. n.

This genus appears to come near the genus *Liophlaeothrips* Priesner, differing from it in having B_1 and B_2 of IX abdominal segment not expanded, but pointed, and B_2 short in both sexes.

1. Mutothrips validus sp. n. (Fig. 1)

Macropterous female (male) : Body bicolourous, abdominal segments II and III yellow with slightly brownish anterior margins, segment IV yellowish brown with posterior half more yellowish than brown. Antennal segments 1-4 yellowish, segment 5 brownish, with a slightly yellowish basal portion, segments 6, 7 and 8 brownish. Forefemora mostly yellow, slightly brownish at

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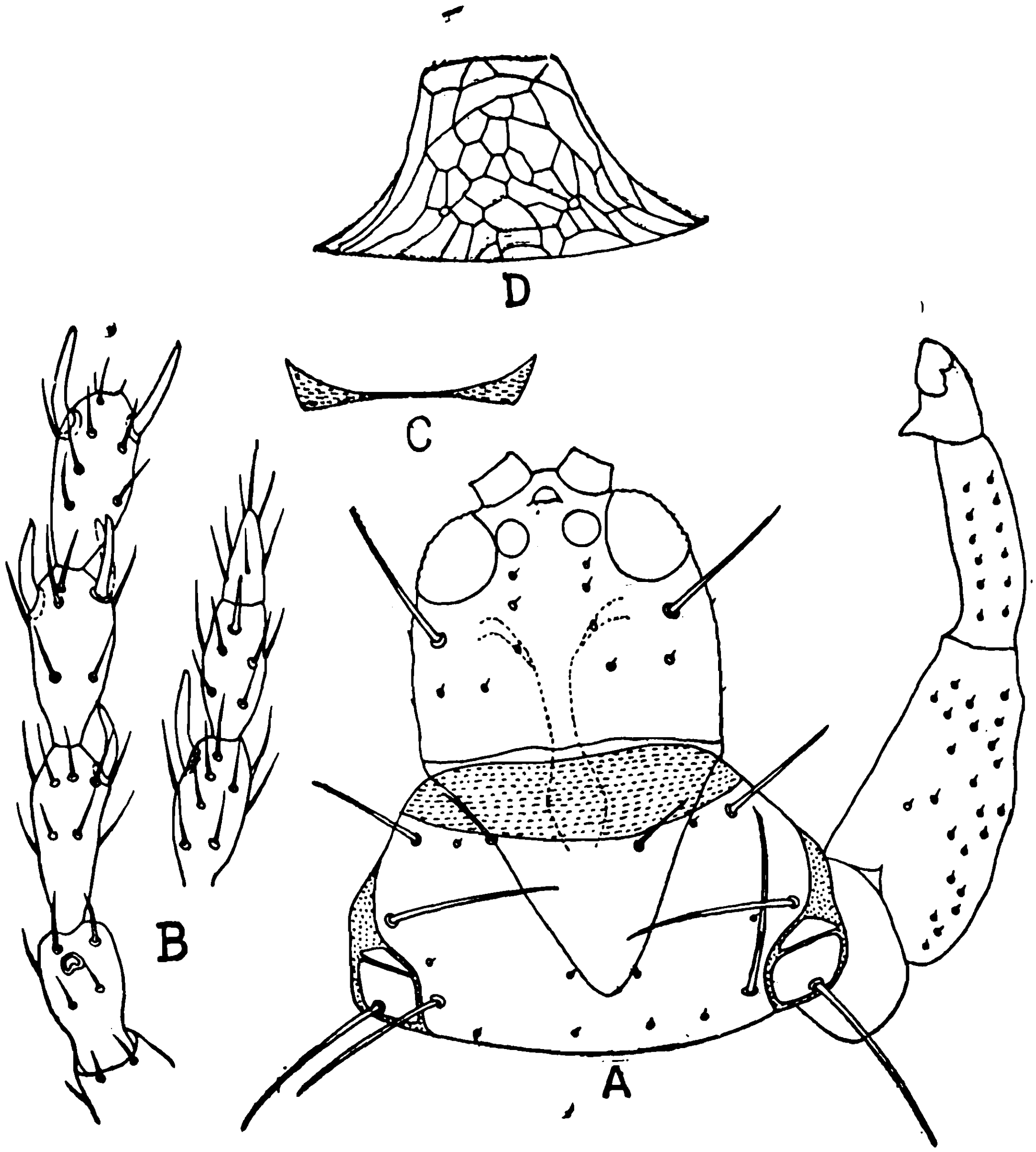


Fig. 1. *Mutothrips validus* (macropterous female) : A—Head and Prothorax, B—Antenna, C—Mesopraesternum, D—Pelta.

extreme base and along outer margin ; mid-femora yellowish with slightly brownish distal areas along both margins ; hind femora bicoloured, mostly yellow, brownish at apex and along distal outer margins ; all tibiae and tarsi yellow. Wings uniformly clouded greyish brown. All setae brown.

Head 184—194 (173)* long, 163—173 (153) wide across eyes, 178—194 (163) across cheeks, and 173—184 (168) at base. Eyes 63—67 (55) long, and 41—43 (45) wide, with mediun ocellus 20 (20) wide placed 20 (20) from paired ocelli 20 (20) wide and 25-36 (36) apart. Postoculars 82—97 (82) long. Antennal segments, length (width) :

Female : 41(30-33) ; 46-51(31-32) ; 61 (26) ; 56(31) ; 51(26) ; 51(20) ; 41(15) ; 31(10).

Male : 41(31) ; 51(31) ; 61(26) ; 51(31) ; 51(28) ; 51(25) ; 41(20) ; 31(10).

* all measurements in microns unless otherwise specified.

Sensecones 12-32 (18-28) long. Mouth cone 173 (163) long, 173-182 (163) wide at base and 35-45 (35) at apex.

Prothorax 168-173 (148) long, 183-204 (114) wide across anterior margin, and 347-357 (357) across posterior margin ; anteroangulars 74-82 (82), anteromarginals 51-55 (41), midlaterals 98-101 (82), postangulars 124-130 (92) and epimerals 133-138 (102). Pterothorax 357 (357) long, 367-395 (387) wide across mesothorax and 337-347 (347) wide across metathorax. Forefemora 204-214 (224) long and 82-102 (92) wide ; foretarsal tooth 17-25 (31) long. Forewings 745-765 (785) long, 66-92 (61) wide at base, 45-60 (51) at middle and 26-41 (36) at apex ; basal wing setae 61-71) (71), 75-82 (82) and 82-92 (92) long respectively, with 7-8 (8) double fringes.

Abdomen 367-418 (377) wide at base, 362-398 (337) at middle, 255-275 (214) across segment VIII and 173 (133) across segment IX. B_1-B_3 of IX segment 142 (132), 76-82 (61) and 132-142 (132) long respectively. Tube 133 (133) long, 61-71 (66) wide at base, 40-45 at middle and 31-35 (31) at apex.

Total body length : 2.020-2.040 mm. (2.020 mm.).

Apterous female (male) : Colour as that of macropterous forms. Head 173-184 (153-163) long, 153-163 (138-153) wide across eyes, 1 4- 94 (163-173) across cheeks and 184-194 (163-173) at base. Eyes 46-51 (46) long and 36-41 (36-41) wide with median ocellus 10-15 (10) wide placed 21-25 (21-26) from paired ocelli 10-15 (10) wide, 36 (31-36) apart. Postoculars 87-97 (56-75) long. Antennal segments length (width) :

Female : 31(36) ; 41(36) ; 56-61(31) ; 51-56(31) ; 51(31) ; 51(26) ; 36-41(20) ; 25-31 (12-16).

Male : 36-41(31-36) ; 40-46(26) ; 55-56 (31) ; 51(31) ; 46-51(31) ; 46-51(26) ; 31-36 (25-26) ; 25(12).

Sensecones 16-20 (18-20) long. Mouth cone 179-194 (163-173) long, 173-184 (153-158) wide at base and 25-28 (25-26) at apex.

Prothorax 178-184 (153-184) long, 20 -265 (094-230) wide at anterior margin, 385-434 (325-428) at posterior margin ; anteroangulars 82-92 (66-78), anteromarginals 61-71 (45-61), midlaterals 122-133 (91-102), postangulars 132-148 (96-115) and epimerals 143-153 (115-138). Pterothorax 316-377 (345-367) long, 377-433 (316-418) wide across mesothorax and 357-418 (306-398) across metathorax. Forefemora 234-245 (214-265) long, and 86-92 (92-125) wide ; foretarsal tooth 21-26 (31-46) long.

Abdomen 423-459 (337-418) wide at base, 398-423 (286-375) wide at middle, 281-286 (194-224) across VIII segment and 173-184 (133-143) across segment IX. B_1-B_3 of IX segment 132 (122-163), 82 (51-75) and 132 (122-163) long respectively. Tube 143 (112-133) long, 71 (66) wide at base, 41 (39-41) at middle and 36 (31-36) apex.

Total body length : 1.877-2.254 mm. (1.571-1.979 mm.).

Material : Holotype macropterous ♀, allotype macropterous ♂, paratypes 9♀♀ (2 macropterous and 7 apterous) and 4♂♂ (4 apterous), within leaf galls of *Eugenia* sp. (Myrtaceae), INDIA : KARNATAKA : Mercara, 31.12.1977. Types in the collections, (TNA) of the Entomology Research Unit, Loyala College, Madras.

2. Arrhenothrips brevis sp. n. (Fig. 2)

Macropterous female : Body brown, including mid and hind tibiae. Antennal segments 1, 7 and 8 brown, 2-6 with increasing shades of yellowish brown. Pronotum with distinct polygonal reticulations. Fore-tibia except along outer margin and to little extent on inner margin more yellowish, all tarsi yellowish to yellowish brown. Wings uniformly shaded brown. All setae brown and pointed.

Head 204-214 long, 153-173 wide across eyes, 163-184 across cheeks and 163-184 at base. Eyes 71-82 long, and 41-51 wide, with median ocellus 20 wide, placed 31 from paired ocelli 20 wide, 31 apart. Postoculars 92-102

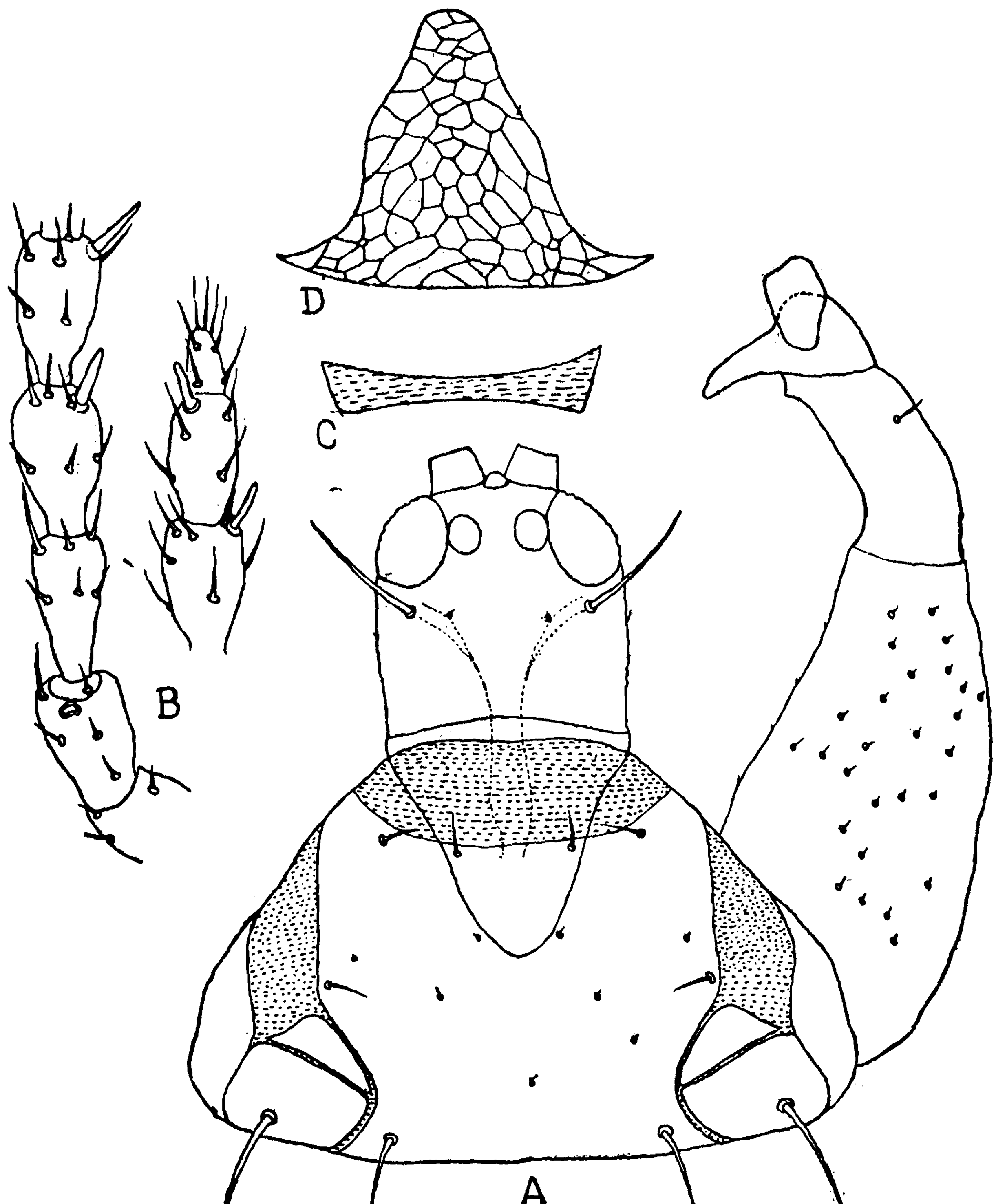
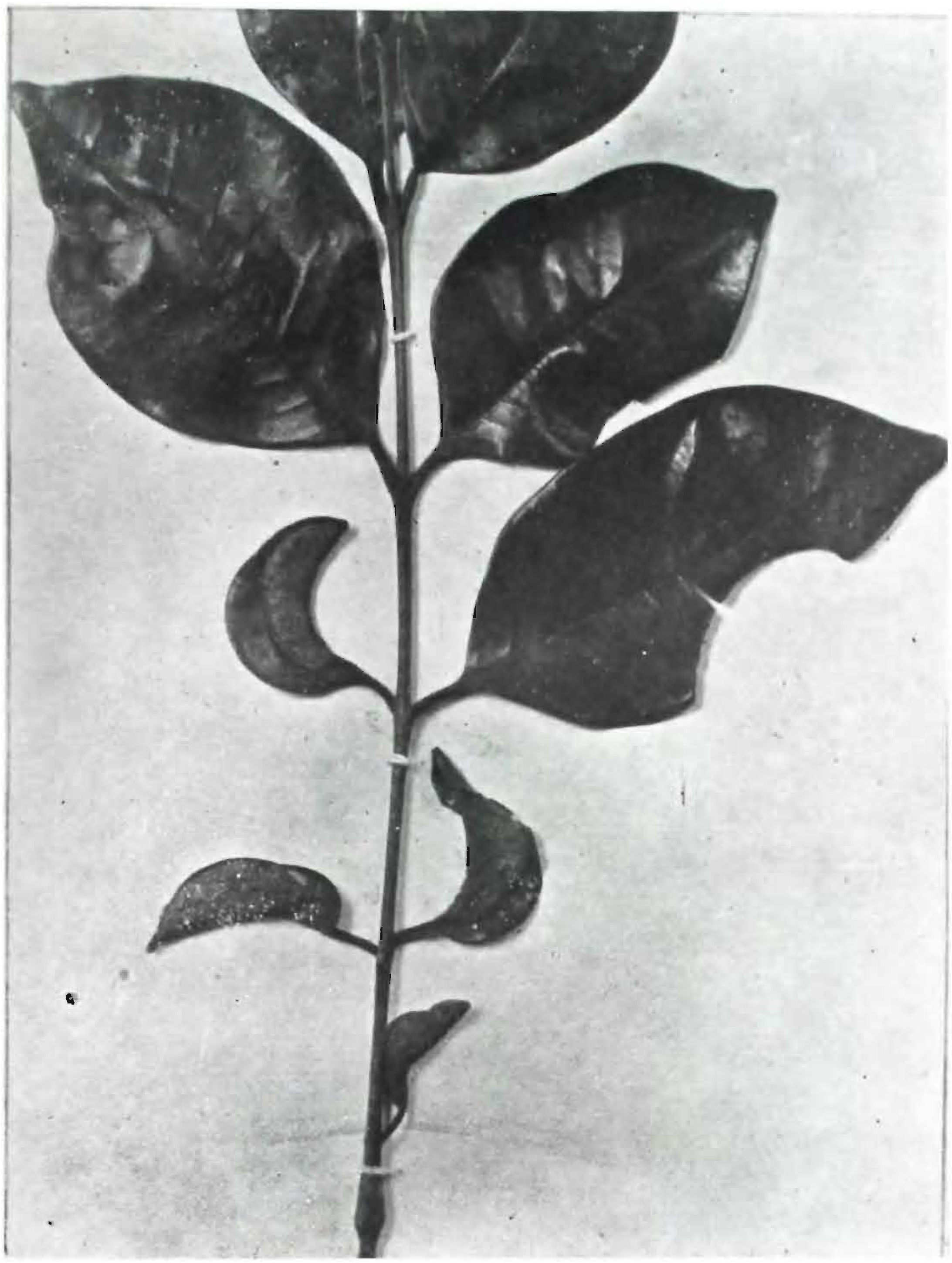


Fig. 2. *Arrhenothrips brevis* : A—Head and Prothorax, B—Antenna, C—Mesopraesternum, D—Pelta.



Eugenia sp. leaf gall

long. Antennal segments length (width) : 41(31-36) ; 46-51(31-36) ; 56-61(31 ; 51-56 (36) ; 51(36) ; 46-51(31) ; 41-46(26) ; 26 (10) ; sensecones 16-20 long. Mouth cone 163-183 long and pointed, 153-168 wide at base and 26-31 at apex.

Prothorax 240-255 long, 219-234 wide across anterior margin, and 418-439 across posterior margin ; anteroangulars 35-37, anteromarginals 32-35, midlaterals 37-39, postangulars 80-90 and epimerals 112-126. Pterothorax 408-439 long, 393-459 wide across mesothorax and 377-428 wide across metathorax. Fore femora 349-398 long and 122-153 wide ; fore tarsal tooth 6 -82 long. Forewings 918-969 long, 92-102 wide at base, 76-82 wide at middle and 51-61 wide at apex ; basal wing setae 61-65, 66-70 and 77-82 long respectively. No double fringes.

Abdomen 388-439 wide at base 367-408 at middle, 286-306 across VIII segment and 163-204 across IX segment. B_1-B_3 of IX segment 152-154, 85-94 and 129-043 long respectively. Tube 184-194 long, 70-82 wide at base 55 at middle and 36 at apex.

Total body length : 2.101-2.519 mm.

Material : Holotypes ♀, paratypes 11♀♀, within leaf galls of *Eugenia* sp. (Myrtaceae), INDIA : KARNATAKA : Mercara, 31.12.1977. Types in the TNA collections, Entomology Research Unit, Loyala College, Madras.

This species differs from the other Indian species of *Arrhenothrips* in the absence of double fringes.

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Bull. zool. Surv. India, 2 (2 & 3) : 213-215, 1980

ON A NEW SPECIES OF *PARADASYS* (GASTROTRICHA : LEPIDODASYIDAE) FROM ANDHRA COAST, INDIA

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ABSTRACT

A new interstitial species of the macrodasyid gastrotrich genus *Paradasys* collected from the intertidal sands on Andhra coast (Bay of Bengal), is described under the name *P. lineatus*. Of the species hitherto known, the new species approaches *P. hexadactylus* in general organization, but clearly differs from the latter in morphological details.

INTRODUCTION

While surveying the interstitial meiofauna inhabiting the intertidal sands of Andhra coast, specimens of a new macrodasyid gastrotrich belonging to the genus *Paradasys* Remane were encountered in the collections. The description of the new species will form the subject matter of the present paper. Hitherto, *P. littoralis* Rao and Ganapati is the only species of the genus known to occur on the Indian coast.

SYSTEMATIC ACCOUNT

Order MACRODASYIDA

Family LEPIDODASYIDAE Ramane, 1927

[Genus **Paradasys** Remane, 1934

Paradasys lineatus sp. nov. (Fig. 1, A-D)

Description : Adult specimens attain 650-800 μ in length and 70-80 μ in maximum width, depending on the state of contraction. Body transparent, elongated, dorsoventrally flattened and slightly tapering towards both the ends. Head is not delineated from the rest of the body and the posterior end rounded. Cuticle thin, finely granular and without epidermal glands, papillae, scales, spines, etc. Numerous cephalic sensory cilia about 5 μ long occur on anterior border. Trunk bears several lateral sensory hairs 10-20 μ long. Ventral surface flat, with sparse ciliation more or less uniform.

Two pairs of anterior adhesive tubes about 10 μ in length occur behind the buccal cavity and are directly borne on ventral body surface. Lateral and dorsal adhesive tubes absent. Six posterior adhesive tubes about 8 μ in length occur on posterior border of posterior end, three of them being located on either side of midline.

Mouth is about 20 μ wide, terminal but slightly inclined to ventral surface and surrounded by short sensory bristles 4-5 μ in length. Buccal cavity small and cup-shaped. Pharynx is 240 μ long, contains numerous round refringent granules and forms slightly more than one-third of total gut length. Pharyngeal pores well developed and occur at the posterior end of pharynx. Intestine is about 440 µ long, granular and divisible into a broad anterior region and a narrower posterior region. Anus subterminal and opens on the ventral surface about 25 µ from the posterior border.

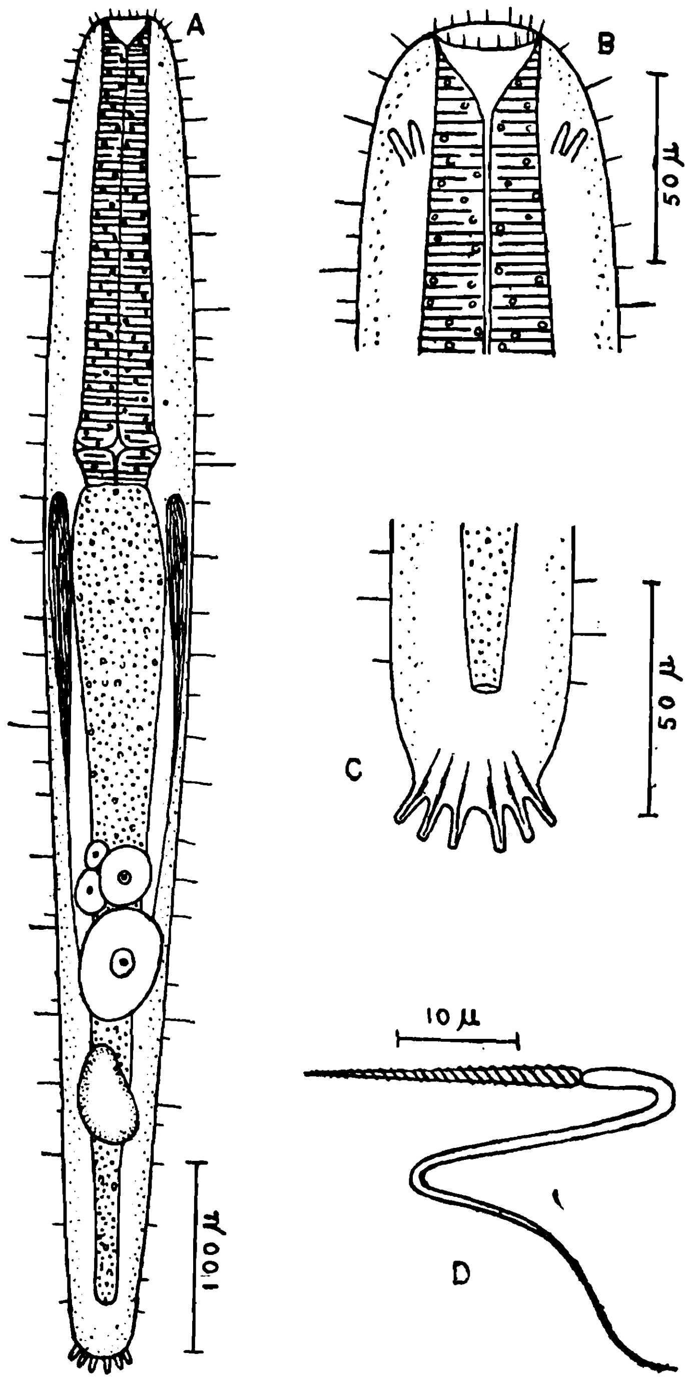

Fig. 1. *Paradasys lineatus* sp. nov., A—adult, dorsal view ; B—anterior region, ventral view ; C—posterior region, ventral view ; D—spermatozoon.

Testes paired, located lateral to the anterior part of intestine and extend anteriorly up to the posterior end of pharynx. Vasa deferentia converge behind the egg cells and the actual male pore not seen. Structure of spermatid is shown in fig. 1. It reaches about 90 µ in length. Sperm head is about 25 µ long, tapers anteriorly to a fine point and shows complete spiral thickening. The tail occupies about 65 µ or slightly more than two thirds of its total length. Ovary is solitary and dorsal, with 3-5 eggs situated in the posterior third part of body. The egg attains about 60 µ in maximum diameter. A dorsal oblong seminal receptacle about 55 µ in length occurs behind the ovary.

Holotype : Specimen 720 µ long, with gonads, coll. *G. C. Rao*, 3.iii.1978. Deposited with the Zoological Survey of India, Calcutta. Regd. No. P 3028/1.

Type locality Medium sand 10 cm below surface, intertidal zone, Krishnapatnam Beach (Lat. 14°17'28" N and Long. 80°08'12" E), Andhra Pradesh, India.

Remarks : Four species of the genus *Paradasys* Remane are hitherto known (see Hummon, 1974). They are *P. subterraneus* Remane (1934), *P. hexadactylus* Karling (1954), *P. littoralis* Rao and Ganapati (1968) and ? *P. pacificus* Schmidt (1974). Of these species, *P. lineatus* sp. nov. approaches *P. hexadactylus* in the general organization, but clearly differs from the latter in the size and shape of body, number of adhesive tubes and the structure of genital apparatus.

The specific name of the new species refers to the linear shape of its body.

Diagnostic features : Body up to 800 µ long, 80 µ wide and dorsoventrally flattened. Head not delineated. Hind end rounded, Two pairs of anterior adhesive tubes. Three pairs of posterior adhessive tubes. Lateral adhesive tubes absent. Cuticle thin and granular. Ventral ciliation sparse and uniform. Mouth terminal. Buccal cavity cupshaped. Pharynx slightly more than ⅓ of the total gut length. Pharyngeal pores at posterior end of pharynx. Anus subterminal. Testes paired. Penis absent. Seminal receptacle oblong. Solitary dorsal ovary.

Ecology : The specimens of *Paradasys lineatus* were collected in medium sands with a grain size of 300-500 µ in mean diameter and at a depth of 10-20 cm below surface between the low and half—tide levels of the intertidal zone. The sands are mostly silicious, angular and rich in organic detritus. At the time of collection, temperature in the habitat was read 28°C, while the salinity of interestitial water showed 32‰. The gastrotrich is agile, negatively phototactic and moves through the interestices of sand with considerable ease.

Other interstitial species collected in association with the gastrotrich included, the turbellarian *Otoplana* sp., the nematodes *Enoploides* sp., *Platycoma africana* Gerlach, *Metepsilonema* sp., *Desmodora* sp., the gastrotrichs *Xenotrichula velox* Remane, *Chaetonotus* sp., *Pseudostomella indica* Rao, *Paraturbanella* sp., the polychaetes *Sphaerosyllis bengalensis* Rao and Ganapati, *Hesionides gohari* Hartmann-Schroder, *Petitia amphophthalma* Siewing, *Eusyllis homocirrata* Hartmann-Schroder, *Protodrilus indicus* Aiyar and Alikunhi, *Saccocirrus minor* Aiyar and Alikunhi, the copepods *Ameira* sp., *Kliopsyllus wilsoni* (Krishnaswamy), *Arenopontia indica* Rao, *Sewellina reductus* Krishnaswamy, *Paramesochra* sp., the isopod *Microcerberus predatoris* (Gnanamuthu) and the halacarid *Halacarus anomalus* Trouessart.

ACKNOWLEDGEMENTS

The author is grateful to the Director, Zoological Survey of India, for the facilities provided to carry out this work.

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SHORT COMMUNICATION

Bull. zool. Surv. India, 2 (2&3) : 217-218, 1980

FURTHER OBSERVATIONS ON *PSILOCOLLARIS INDICUS* SINGH, 1954, WITH A NOTE ON ITS SYSTEMATIC POSITION (TREMATODA : PSILOSTOMATIDAE)

The genus *Psilocollaris* was proposed by Singh (1954) with *P. indicus* as its type species collected from *Dissoura episcopus episcopus* (= *Ciconia e. episcopus*) in Lucknow. While assigning the genus *Psilocollaris* to the famliy Psilostomatidae, Singh mentioned the presence of a collar at the anterior end of the body and remarked that if spines were present this form would be regarded as typical echinostome. This author had the privilege to re-examine the type specimens which have been deposited in the Zoological Survey of India, Calcutta.

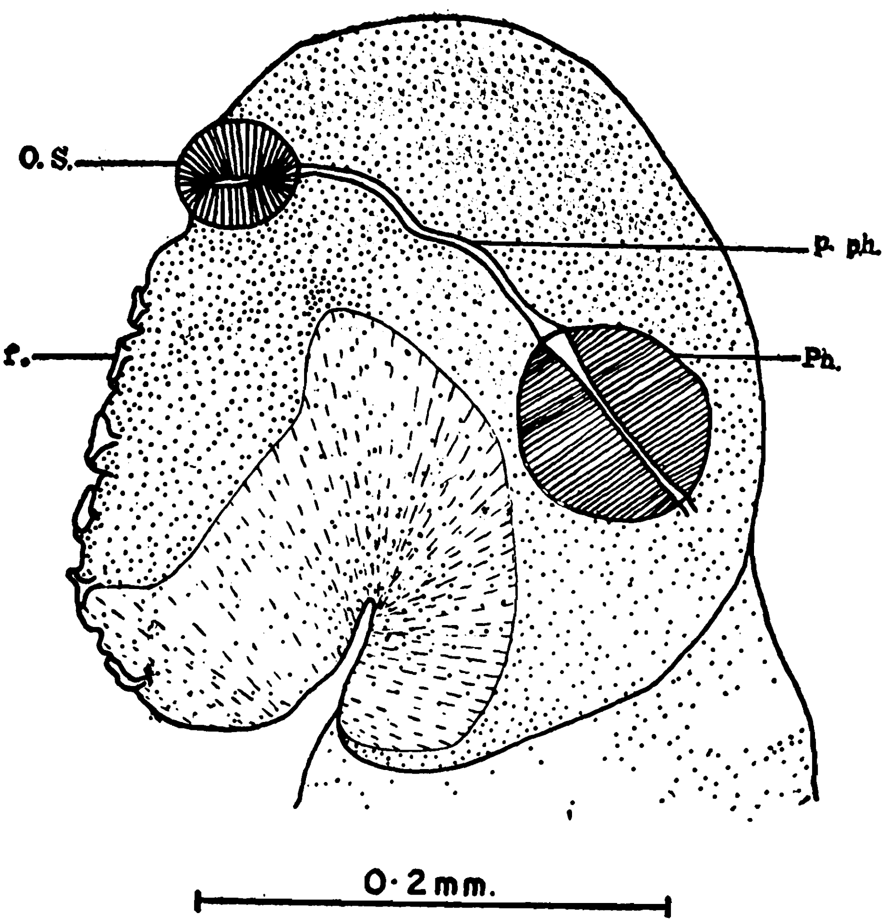

Fig. 1. Head collar of *Psilocollaris indicus* Singh, 1954 showing follicles of collar spines.

There are three slides of *Psilocollaris indicus*, bearing the number W 3893/1, W 3894/1 and W 3895/1.

The holotype specimen on slide No. W 3893/1, the figure of which has been given by Singh, has a distinct collar but the collar spines are not visible as stated by Singh.

The slide No. W 3894/1 has two specimens, one straight and the other somewhat U-shaped. The right part of the head collar in the straight specimen has some collar spines, their exact number could not be counted. The U-shaped specimen also bears about 11 spines in the collar region.

The trematode on slide No. W 389 /1 has small cup-like depressions (Fig. 1) at the margin of the collar. These depressions have a cavity, the edges of which are projecting beyond the outline of the collar. There are six such depressions to be clearly seen on the left side and a few towards the right side of the collar are not so clear as those on the left side. It is difficult to make an accurate count of such depressions. These depressions are considered to be follicles of collar spines which have fallen off during processing of the specimen.

The presence of collar spines in these specimens indicate that they are typical echinostomes. The general morphology of *Psilocollaris indicus* agrees with *Dissurus farrukhabadi* Verma, 1936 collected from the same host, as redescribed and figured by Srivastava (19.4) in his critical restudy of the specimens of Verma (1936). On the basis of close resemblance between *Psilocollaris indicus* and *Dissurus farukhabadi* the genus *Psilocollaris* is dropped as a synonym of *Dissurus*, treating *Psilocollaris indicus* Singh, 19 4 as synonym of *D. farukhabadi* Verma, 1936.

The author is grateful to the Director, Zoological Surveyof India, Calcutta, for these facilities.

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Gangetic Plains Regional Station,
Zoological Survey of India, Patna

P. D. GUPTA

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SHORT COMMUNICATION

Bull. zool. Surv. India, 2 (2 & 3) : 219, 1980

ON A RARE NUDIBRANCH, *THORDISA CROSSLANDI* ELIOT (MOLLUSCA : DORIDIDAE) FROM THE WEST COAST OF INDIA

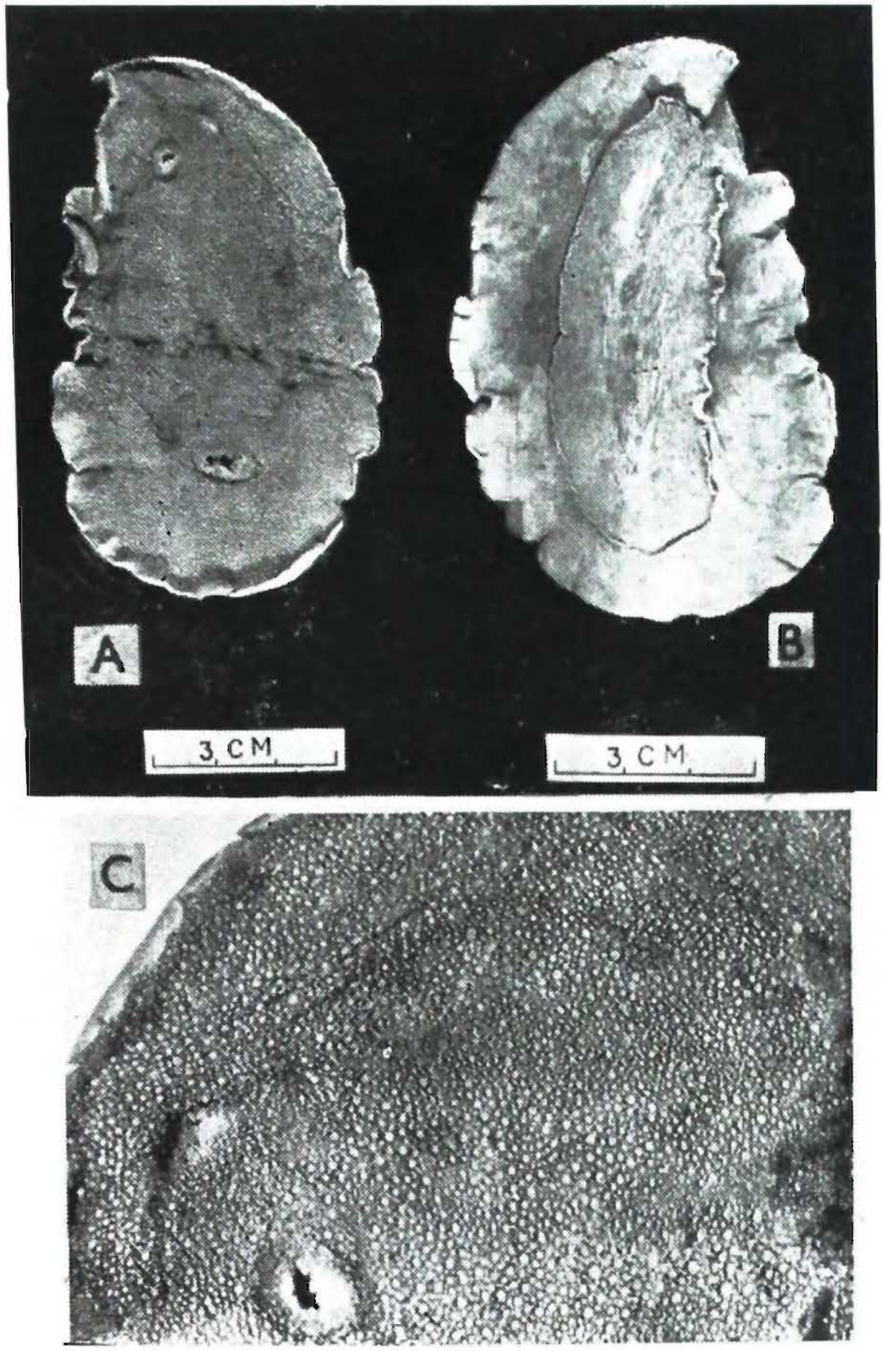
While studying the molluscs of Gujarat Coast, the authors came across with a rare nudibranch, *Thordisa crosslandi* Eliot collected in 1953 from Porbandar beach. There was no previous report of this species from west coast of India. Hence it is thought worthwhile to present the distribution and other details of this rare nudibranch.

The genus *Thordisa* Bergh 1877 includes about 15 species recorded from different localities in the Indo-Pacific region. However, in Indian waters the genus is represented by two species viz. *T. villosa* (Alder & Hancock 1866) and *T. crosslandi* Eliot 1903 which hitherto were known only from Gulf of Mannar on the east coast of India. The present record fills the gap in the distribution of this species in the Indo/West Pacific.

Thordisa crosslandi (Pl. IV) can be easily distinguished from *T. villosa* by its relatively enormous size, deeper and brighter colouration, and by its more strongly developed and elongately conical dorsal tentacles. The presence of a labial armature also distinguishes it from *T. villosa*. (Satyamurti, 1952)

Zoological Survey of India,
Calcutta

N. V. SUBBA RAO AND
K. V. SURYA RAO



(A—C) *Thordisa crosslandi* Eliot : A—Dorsal view ; B—Ventral view ; C—Anterior part

SHORT COMMUNICATION

Bull. zool. Surv. India, 2 (2 & 3) : 221-222, 1980

THE RELATIONSHIP OF EURYPYGIDAE (GRUIFORMES : AVES) ON THE BASIS OF THE CHEWING-LICE (PHTHIRAPTERA : INSECTA)

Recently, while going through a paper of Hendrickson (1969) on the egg white proteins of the Order Gruiformes, it was found that certain remarks made by that author are quite interesting in the light of the present authors' work. Hendrickson (1969) stated that "It is surprising that no one has ever proposed a close relationship between the Eurypygidae and Rallidae in view of the large number of characters shared in common. Garrod (1876) thought *Eurypyga* not distant from *Aramus*". He further added "Thus, with the possible exception of the Eurypygidae, we find a reasonable amount of support from 'classical' sources for a close relationship among the families of the 'rail-like complex' as defined by the egg white proteins". He concludes "I believe that the Eurypygidae, Heliornithidae, Rallidae, Turnicidae, and Psophiidae form a natural group with common ancestry. The Gruidae are a divergent family having ancestors from the same stock as the rail-like complex. These two groups appear to be linked by the Aramidae. The Cariamidae and Rhynochetidae may or may not have arisen from the same ancestral stock. Their present characters make it impossible to be certain of their origin. The Otididae are most probably of independent origin and their closest relatives are unknown'.

It is well known that parasites serve as good biological indicators of their host relationships. Hendrickson (1969) was aware of the papers of Hopkins (1942) and Clay (1950) and quoted their observations of the inter-family relationships of Gruiformes on the basis of their chewing-lice. The present author unaware of Hendrickson's paper, while discussing the trends in evolution of *Laemobothrion*-complex (Lakshminarayana, 1970 *a*) remarked that "The discovery of *E. eurypygae* by Carriker (1963) is very important. It clearly indicates the relationship of Eurypygidae with Gruiformes contrary to the view of Chandler (1916). Clay (1950) suggested that Lowe's Ralloidea should include Aramidae, Psophiidae, Heliornithidae, Rhynochetidae, Jacanidae, and Rallidae ; they appear more nearly related to each other on the basis of Mallophagan relationship. To this Eurypygidae should also be added".

Lakshminarayana (1970 *b*) further stated that "*Rallicola sens. str.*, occurs chiefly on Rallidae, and on the monogenic families Aramidae, Psophiidae, Rhynochaetidae and possibly Eurypygidae suggesting that perhaps these families acquired the species from a common ancestor". While discussing the inter-family relationships of the order Gruiformes, Lakshminarayana (1970 *b*) stated with reference to Eurypygidae "that this family possesses three genera, *Rallicola* (Eichler, 1943), *Eulaemobothrion*, (Carriker, 1963) characteristic of Rallidae and *Quadraceps* (Timmermann, 1955) found on Charadriiformes. The last named genus has been reported besides the latter, on Heliornithidae amongst Gruiformes and on Ciconiiformes. *Eulaemobothrion* reported from *Eurypyga* undoubtedly belongs to the group present on Rallidae, Aramidae and Psophiidae, but not to *Ciconiicola* group present on Ciconiiformes".

Lakshminarayana (1970 *b*) concluded that "Applying the *Hopkins' principle* to the families it is evident that the families Rallidae, Heliornithidae, Aramidae, Psophiidae, Eurypygidae, also Jacanidae, and Rostratulidae are more closely related than Gruidae, Otididae, Turnicidae, Mesonaetidae, and Cariamidae. The Jacanidae and Rostratulidae though included under Charadriiformes possess only a single parasite genus usually occurring on Charadriiformes and so is the case with Gruidae. The genera found on Otididae, Mesonaetidae, Turnicidae, and Cariamidae do not show any affinities to those on Gruiformes or Charadriiformes". On the inter family relationships of Gruiformes and Charadriformes, attention is also invited to a recent paper on another genus of chewing-lice, viz., *Pseudomenopon* (Lakshminarayna, 1977).

Thus, the chewing-lice also support the contentions drawn by Hendrickson (1969) on the basis of the egg-white proteins that Eurypygidae, Heliorni hidae, Rallidae, Psophiidae (except Turnicidae) are closely related, connected to Gruidae through the Aramidae, while Cariamidae, and Rhynochaetidae may or may not be related to the common stock, and Otididae is probably of an independent origin. Lakshminarayana (1977) and Clay (1950) considered Jacanidae also closely related to Rallidae, although Sibley *et al.* (1974) quoting from Gysels, contend that Jacanidae belongs to Charadriiformes on the basis of protein biochemistry.

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The author is indebted to Prof. M. S. Mani, Emeritus Professor of Entomology, St. John's College, Agra, Drs. T. N. Ananntha-krishnan, Director, and B. Biswas, Deputy Director, Z. S. I., for all encouragement in the author's work.

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Zoological Survey of India, Calcutta K. V. LAKSHMINARAYANA

SHORT COMMUNICATION

Bull. zool. Surv. India, 2 (2 & 3) : 223-224, 1980

OBSERVATIONS ON THE PREDATORY BEHAVIOUR OF A FRESHWATER LEECH *GLOSSIPHONIA WEBERI* (BLANCHARD) [ANNELIDA : GLOSSIPHONIDAE]

While studying the breeding biology of some freshwater leeches, the authors observed the predatory behaviour of *Glossiphonia weberi* (Blanchard) on a species of freshwater snail, *Lymnaea luteola*, which forms the basis of this communication.

Observations on the predatory behaviour of *G. weberi* have been made on several occasions in the laboratory and in their natural habitat. Small museum jars measuring 20× 10 cm and two aquaria measuring 35×20 ×20 cm were used for observing the same in the laboratory. Both juvenile and adult leeches, single or in batches, were offered prey snail, one to several each time, of different size groups, for the purpose of study. It has been observed that the freshly hatched and juvenile leeches were incapable of preying upon this snail. Adult leeches (over 15 mm in length) were found to attack and overpower prey snails, preferably below 12 mm shell size. Normally, the adult leeches "eat out" or/and suck up the whole prey, while in case of larger prey, only a portion of the foot is left. But, the remaining portion of the foot may be seen to devour by other leeches present thereupon. Larger snails are sometimes attacked by 2-3 leeches whereas for the smaller ones, "one predator one prey" is the usual phenomenon. Furthermore, the leeches are also attracted to snails supplied after removing the shell or freshly killed, and start eating "flesh" from somewhere except foot. However, no part of the body other than foot is left unconsumed. The leeches are never found feeding on decomposed prey-matters.

The prey-catching behaviour of leeches involved intricate mechanisms and instinctive movements. It proved impossible to interpret the coordination and sequence of prey-catching actions in exact details. The leeches are apparently able to 'feel' the presence of prey animals even from a distance. Normally, a leech swims greedily towards the prey and attaches itself on the shell of the prey or sometimes to the substratum nearby wifh the help of posterior sucker. Then it pulls and glides its head up and down, to and fro, in every possible ways, pointing its oral sucker towards the prey's head. It tries repeatedly to have a bite on the soft part of the exposed oral end, but not to muscular foot. As soon as it takes a bite, the snail reacts violently to sever the leech from biting. The snail gives the leech a swift shake by making the shell rotates to nearly 360°, clockwise and anticlockwise, alternately and uninterruptedly. The speed of the rotation sometimes helps the snail to sever the leeches but swinging of the shell continues for a little while, even after severing the leech. But the larger leeches are rarely observed to be severed while they are on the shell of smaller preys.

The predation is mostly restricted to feeding hours (between 6.00 pm to 10.00 pm) only while the snails are actively moving with foot and buccal mass stretched open outside the shell. Generally, a leech attacks a snail at a particular point, keeping the pulmonary opening a target, through which the oral sucker is being inserted deep inside the pulmonary chamber. It gives the prey a "precise penetrating bite" somewhere inside the pulmonary chamber or otherwise in the visceral mass, in some cases, which probably paralyzes the prey partially, and thus, the snail looses its hold with the substratum. The snail now floats in water with "shell down and foot up" posture with the leech attached to the body. In this posture the snail rotates its foot instead of rotating the shell. This lasts so long the prey ceases all escaping movements. After a while, the snail is finally calmed down and gets dropped at the bottom along with the leech, retracting its foot and the buccal mass deep inside the shell cavity. Sometimes the prey snails are held float by the leech attached to a substratum with the help of its posterior sucker. In this case, the leech tries to raise and adjust the prey animal to rest on the substratum so that it can push its oral sucker further inside and relish eating "flesh" or sucking fluids until the whole prey (or except the foot) is consumed. It takes about 2-4 hours to complete the whole preying-feeding operation.

The Glossiphoniid leeches are known to prey on freshwater snails, reaching into the retracted animal and sucking it out (Elliot, 1917 ; Dorier, 1951 ; Michaelson, 1957). However. nothing is known about the mechanism and sequence of prey—catching action by the leech and the pattern of resistance it gives to the predator. According to Harding (1910), *Glossiphonia complanata*, common in British Islands, is parasitic chiefly upon *Lymnaea* and *Planorbis* but preys upon a variety of other hosts including other freshwater molluscs, the larvae of *Chironomus* ("blood worms") and probably aquatic annelids. Elliot (1917) reported that a leech (probably a species of *Glossiphonia*) was observed by him to prey on a small *Lymnaea pereger* attacking it near the collumellar muscle.

A number of species of the genera *Lymnaea* and *Planorbis* act as vectors for various helminth diseases in India and abroad including schistosomiasis (Rees, 1932 ; Khaw, 1947 , McCullough, 1951 ; Ghosh and Chauhan, 1975). In view of this fact, it may be suggested that the predatory leeches can be utilized in the biological control of the vector snails. Further studies on this aspect would expectedly uncover their control potential.

ACKNOWLEDGEMENTS

The authors are thankful to the Director, Zoological Survey of India, Calcutta, for facilities provided and for encouragement.

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Zoological Survey of India, Calcutta

S. K. RAUT AND N. C. NANDI

Short Communication

Bull. zool. Surv. India, 2 (2 & 3) : 225, 1980

OCCURRENCE OF *ILYOCRYPTUS SPINIFER* HERRICK 1884 (CRUSTACEA ; CLADOCERA ; MACROTHRICIDAE) IN BIHAR

Sewell (1935) and Biswas (1971) recorded *Ilyocryptus spinifer* Herrick 1884 (=*halyi* Brady 1886) from Bengal and Rajasthan. There is no record of its occurrence in Bihar. Here *I. spinifer* is reported for the first time from Bihar.

Material : 4 ex. from well at Rishikund, Dist. Monghyr, 26.xi.76. (Reg. No. A 791, Z.S.I., G.P.R.S., Patna)

Measurement : Length 0.5—0.55 mm.

Remarks : The water in the well from which these specimens were collected, had temperature 25.5°C and pH 6.4. The height of the water column was approximately 2 metres at the depth of 1 metre from ground level. Collections from a nearby well with temperature 28.5°C and pH 6.4 did not have any Cladocera.

In both the wells the water was acidic with pH 6.4, but the one with higher temperature did not have any Cladocera. Probably the higher temperature acts here as a limiting factor for this species. It is observed that the Cladocera are found in abundance in alkaline waters with pH upto 7.6 but in all such cases the temperature of the water was 25—27°C.

The known distribution of *Ilyocryptus spinifer* indicates that it may also be occurring in other parts of India.

The author is thankful to the Director, Zoological Survey of India, and Dr. P. D. Gupta, Deputy Director, Gangetic Plains Regional Station, Patna, for encouragement and facilities.

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Gangetic Plains Regional Station, Zoological Survey of India, Patna

Lakshman Ram

SHORT COMMUNICATION

Bull. zool. Surv. India, 2 (2 & 3) : 227, 1980

RECORD OF A LIVE SPECIMEN OF SUNSET SHELL, *SILIQUA RADIATA* (LINNAEUS) FROM THIRUCHENDUR, GULF OF MANNAR, INDIA

Recently, the authors who were on a faunistic survey tour to South India, had the opportunity to make a survey of the coastal areas of the Gulf of Mannar. During this period they came across a live specimen of the sunset shell, *Siliqua radiata* (Linnaeus) on Thiruchendur sea coast on 25-i-1978. The specimen was collected while it was burrowing into the sand when it had just been exposed by a receding wave at the lowest phase of the low-tide. The bivalve appears to be a dweller of the tidal flat in this area.

The specimen which is not of a large size is in an excellent condition. It responded well to a treatment of Menthol for narcotisation. In the preserved state now, it has both the valves wide open, the foot and the siphons in well extended condition (Pl. V).

This probably is the first live specimen of this species to be recorded.

Ghosh (1920) who has made an excellent study of the soft parts of many genera and species of members of the family Solenidae, did not work out the anatomy of this species probably because suitable material of the animal was not available to him.

This communication is intended to stimulate further efforts among collectors for collecting more live specimens of the species so as to facilitate studies on the soft parts, because scarcely any information seems to be available in literature about this animal. The authors offer their sincere thanks to the Director, Zoological Survey of India, Calcutta, for the facilities and encouragement.

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Zoological Survey of India,
Calcutta.

A. S. RAJAGOPAL,
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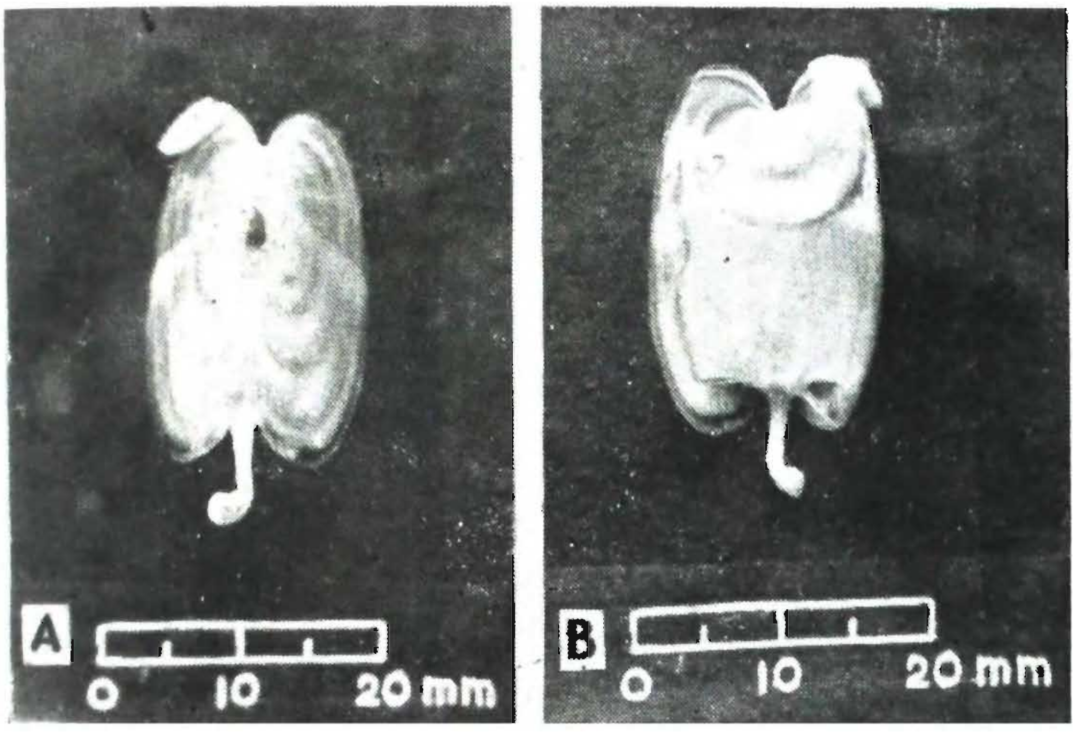

Siliqua radiata (L.). A—Dorsal view, B—Ventral view

Bull. zool. Surv. India, 2 (2&3) : 229-231, 1980

RECORD OF *STIGMATOGOBIUS HOEVENII* (BLEEKER) FROM THE GANGETIC DELTA, WEST BENGAL, WITH A KEY TO THE INDIAN SPECIES OF *STIGMATOGOBIUS* (PISCES : GOBIIDAE)

Stigmatogobius hoevenii (Bleeker, 1851) is known so far from long Island, Middle Andamans (Herre, 1939 : 348). A recent collection of gobiid fishes from the Gangetic delta in West Bengal contained three well preserved female specimens of *S. hoevenii*. The present record of this species from West Bengal thus extends it distributional range to the Indian mainland.

Eight species of the genus *Stigmatogobius** Bleeker, 1874 are known from Indian waters : *S. sadanundio* (Hamilton, 1822), *S. poicilosoma* (Bleeker, 1849), *S. hoevenii* (Bleeker, 1851), *S. oligactis* (Bleeker, 1875), *S. römeri* Weber, 1913, *S. minima* (Hora, 1923), *S. yanamensis* Visweswara Rao, 1971 and *S. micrognathus* Visweswara Rao, 1971.

A brief description of *S. hoevenii* with a revised key to the Indian species of *Stigmatogobius* is given.

Stigmatogobius hoevenii (Bleeker, 1851)
(Fig. 1)

Gobius hoevenii Bleeker, 1851, *Natuurk. Tijdschr. Ned. Indië*, 2 : 426 [type locality : Sambas river, Borneo ; holotype in Rijksmuseum van Natuurlijke Historie, Leiden].

Stigmatogobius hoevenii (Bleeker) : Koumans, 1941, *Mem. Indian Mus.*, 13 (3) : 260 (revis.).

Material : Three ♀ specimens, 15.8-20.0 mm standard length ; Edward's creek, Fraserganj (West Bengal) in the Gangetic delta ; Sept. 8, 1974 ; coll. *T, K. Chatterjee* ; Z. S. I. Regd. No. F 7256/2.

Description : D_1 VI, D_2 I, 7 ; V I, 5 ; A I, 7 ; P 16 ; C 15 ; scale rows in lateral series 31-32, in transverse series 9-10, predorsal scales 10-11. Body elongated, somewhat compressed, head depressed. Depth of body 21.9-22.9, length of head 25.6-3 .2 ; both in percentage of standard length. Eye diameter 25.3-28.4 percent head length. Pit organs in three longitudinal lines on the pre-opercular region and two transverse and one longitudinal lines on the operculum (fig. 1B). Four nasal sensory canal-pores (fig. 1B). Scales ctenoid, of head, nape and breast cycloid. Pre-operculum naked, operculum scaled. Tip of tongue rounded. Teeth in jaws multiserial, close-set, inner row in lower jaw slightly enlarged ; prevomer and palatine toothless.

Colour in alcohol : Yellowish brown, head and body with nine deep brown transverse

**Gobius javanicus* Bleeker, 1856, heretofore treated under genus *Stigmatogobius* is placed under genus *Pseudogobius* (Bleeker) Popta, 1922 (Akihito and Meguro, 1975).

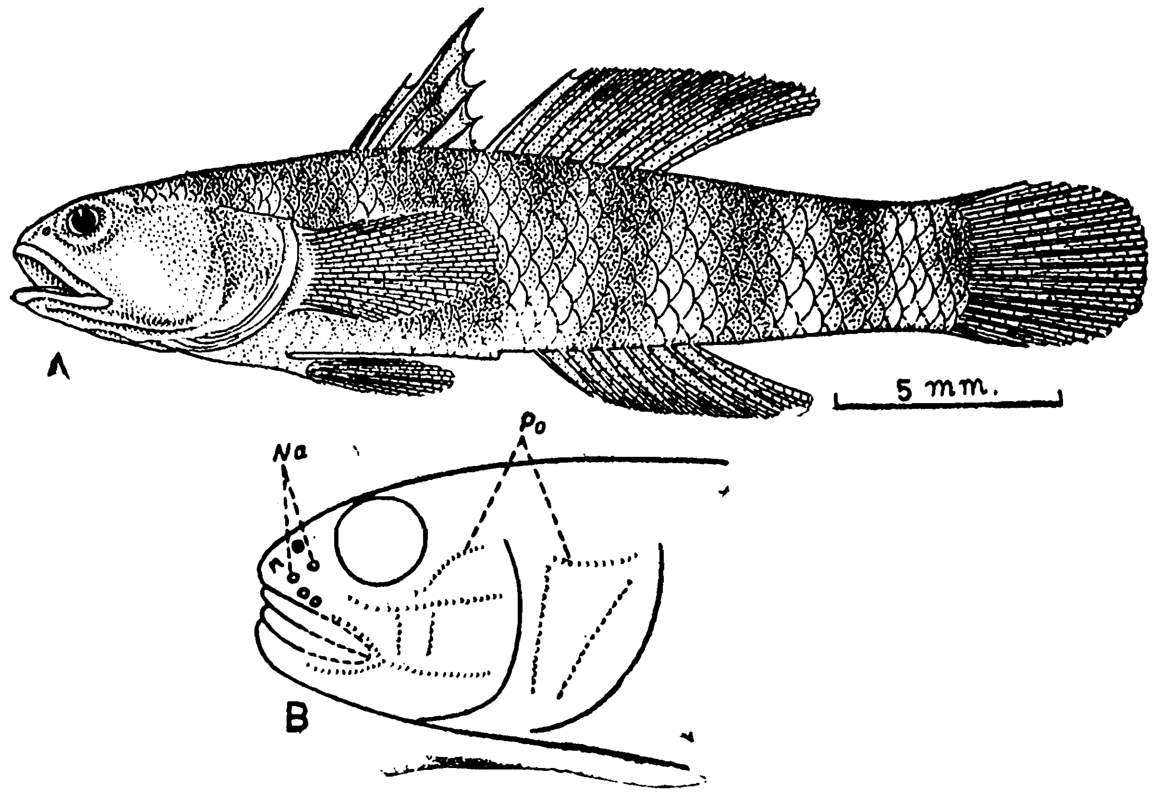

Fig. 1. *Stigmatogobius hoevenii* : A—lateral view ; B—schematic figure showing nasal sensory canal-pores (Na) and pit organs (Po).

bands, first on interorbital region, second and third on predorsum, fourth below first dorsal fin, fifth to seventh below second dorsal fin, eighth at caudal peduncle and the ninth at caudal fin base. First dorsal fin with a dark blotch, margin diaphanous.

Distribution : Long Island, Middle Andamans ; Thailand, Hongkong, Samoa, Indo-Australian archipelago, ? the Philippines (Koumans, 1953) ; in seas, estuaries and freshwaters. The present record of this species from West Bengal extends its distributional range to the mainland of India.

Key to Indian species of *Stigmatogobius*

1.	Predorsal scales 6-9 ; sides of body without transverse bands.	
—	Predorsal scales 11-13 ; body with distinct transverse bands along sides..	*S. hoevenii*
2.	Head depressed ; jaws subequal	*S. oligactis*
—	Head subcylindrical or compressed ; jaws not subequal.	
3.	Lower jaw prominent.	
—	Upper jaw prominent.	
4.	Inner row of teeth in lower jaw enlarged ; anal fin-rays eight	*S. sadanundio*
—	Inner row of teeth in lower jaw not enlarged ; anal fin-rays six	*S. romeri*
5.	Pectoral fin-rays 14-15 ..	*S. poicilosoma*
—	Pectoral fin-rays 16-19.	
6.	Mouth oblique, maxilary reaches upto middle of eye	*S. minima*
—	Mouth horizontal, maxillary does not reach middle of eye.	
7.	Nasal sensony canal-pore present ; anal fin-rays seven	*S. micrognathus*

GG. Nasal sensory canal-pore absent ; anal fin-rays eight — *S. yanamensis*

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Zoological Survey of India, Calcutta

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