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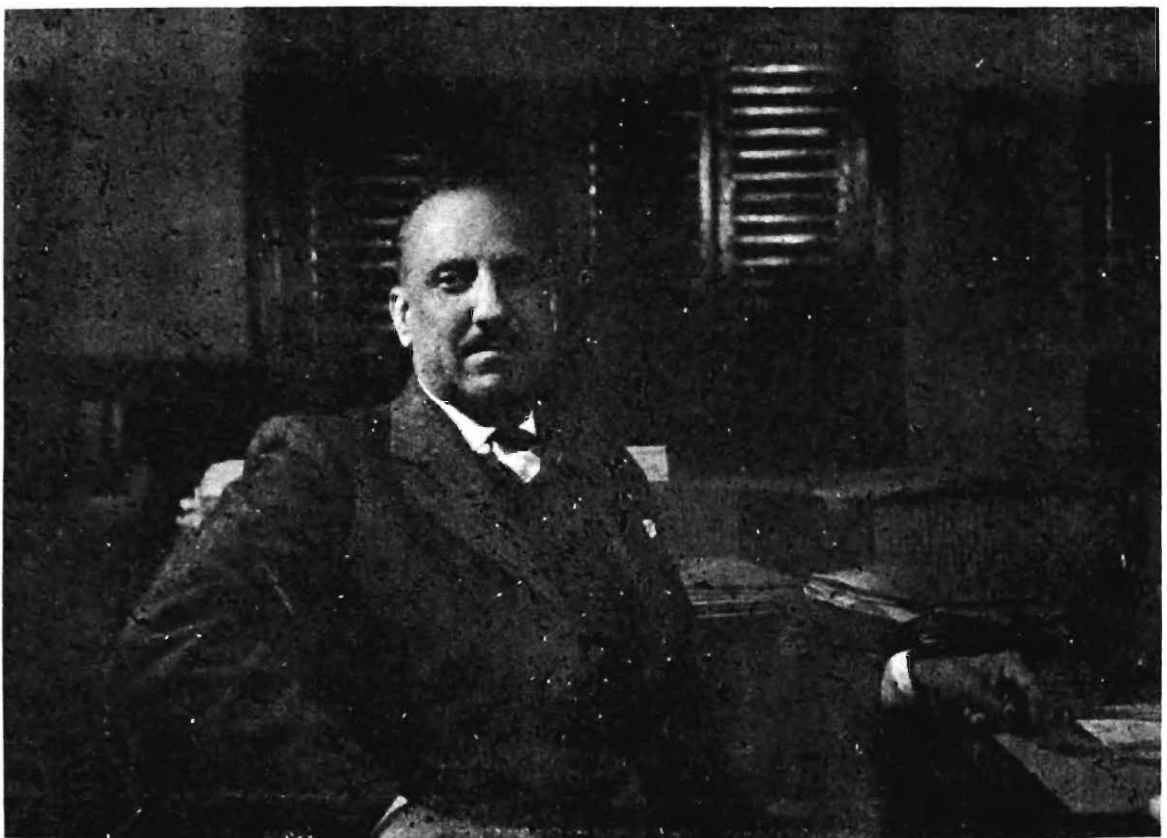
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MITHAN LAL ROONWAL

1908 — 1990



In Memoriam : The late Dr. M.L. Roonwal (1908-1990)

by R.K. VARSHNEY

Zoological Survey of India, Calcutta

(With an Appendix article by M.L. Roonwal)

Prof. Dr. Major M.L. Roonwal, M.Sc., Ph.D., Sc.D., F.N.A., F.E.S.I., F.Z.S.I., passed away on the 22nd July, 1990. He was 82. A renowned zoologist, entomologist and educationalist of India. Dr. Roonwal occupied many distinguished chairs during his career, including the Forest Entomologist of the Forest Research Institute, Dehra Dun; Director of the Zoological Survey of India, Calcutta; and the Professor of Zoology and later Vice-Chancellor of the University of Jodhpur.

LIFE

Mithan Lal Roonwal was born at Jodhpur (Rajasthan) on 18.09.1908. After getting early education at Jodhpur and Lucknow, he took M.Sc. (Hons.) degree from the University of Lucknow in 1930, and Ph.D. degree, on the **Studies on the embryology of the African migratory locust**, under the guidance of famous Dr. A.D. Imms, from the Cambridge University (U.K.) in 1935. Subsequently he got the Sc.D. degree of the later University, on his published works on the morphology and systematics of termites in 1962.

His service record started with a stint at the Locust Research Laboratory, Lyallpur (now in Pakistan) in January, 1931. On his return from Cambridge, he worked for a while as the Assistant Professor of Zoology at the Government College, Ajmer, but soon took up the post of Entomologist-in-Charge of the Locust Field Research Station at Pasni on the Baluchistan coast. Unravelling the migration routes of locusts, while riding on camel back day after day (the jeep had not yet been invented), he had unusual excitements, e.g. he hired a two-seater plane from Karachi to take his bride to Pasni, who once survived almost a mishap while boarding a boat in the Arabian ocean.

For ten years from 1939, Dr. Roonwal worked as the Officer-in-Charge of the Bird & Mammal Section of the Zoological Survey of India, Calcutta. In between, during the Second World War, he served as a Major in 5th Punjab Regiment, G.H.Q. of the Indian army, on the Assam-Burma border, in the South East Asia Theatre, where he acted as a mammalogist in the Field Typhus Research Team. For his meritorious services he was awarded with two military medals : the Burma Star and the War Medal. It was in 1946 that he started publishing a series of papers on the studies on intraspecific variations in the desert locust, which appeared for a long time in different journals and finally led to the '**Roonwal's Hypothesis on prediction of swarming**'.

As Chief Research Officer and Forest Entomologist at the Forest Research Institute, Dehra Dun, during 1949-1956, he initiated and guided the preparation of an exhaustive systematic catalogue of the main identified entomological collection, which was published in 38 parts, from 1950 to 1963 in the *Indian Forest Leaflets*. He also initiated and guided in the preparation of a thorough list of the insect pests of forest plants in India and the adjacent countries, arranged alphabetically according to the plant genera and species, which was published in several parts in the *Indian Forest Bulletin* from 1958 onwards, and the last parts of which were completed by his successor the late Dr. R.N. Mathur. During his stay in F.R.I., Dr. Roonwal got a F.A.O. foreign fellowship for four months in 1951-52, which he utilized with a visit to Prof. A.E. Emerson (U.S.A.) and brought from him large number of duplicate specimens of identified termites, to initiate a life long passion of studying the taxonomy of Indian termites. He was awarded the '**Sir Dorab Tata Gold Medal**' (second award) of the Zoological Society of India in 1956 for his contributions in Zoology.

Dr. Roonwal joined as the Director of Zoological Survey of India, in July 1956, succeeding renowned ichthyologist the late Dr. S.L. Hora. He held this chair with great distinction as an able administrator, planner, organizer and a first rate zoologist. He was responsible for the reorganization of the Survey, expanding it with several Regional Stations in different parts of the country. Due to his efforts, the Govt. of India declared its collections as the '**National Zoological Collections of India**', with a Gazette Notification in 1964. As the Chairman of the UNESCO Committee on Key Zoological Collections for South and South-East Asia, he brought a scheme for this purpose in Z.S.I. in 1960 and got the card catalogue prepared for all standard key zoological collections (type material) for this part of Asia. It was sad that he had to relinquish his charge of the Director, Z.S.I. post a bit prematurely, said to be due to his straight forward and unbending nature. His successor, Dr. M.S. Mani, then remembered him as 'not Roonwal, but a stone wall'!

He soon joined as the Professor and Head of the Department of Zoology in the Jodhpur University, and just after a year, the university appointed him as its Vice-Chancellor for a three year term of 1966-1969. During this period Dr. Roonwal organized a symposium and edited its proceedings in two volumes, entitled '**The Natural Resources of Rajasthan**' (1211 pp.) which were published by the University in 1977. On retirement from the active service, he was made an Emeritus Scientist of the Council of Scientific and Industrial Research for four years.

His last years passed working at the Desert Regional Station of the Zoological Survey of India, Jodhpur, in an honorary capacity, and here the author had the privilege of working with him. In this period he was actively engaged on two pet projects :

- (i) **Tail form and carriage in the Hanuman langur** and other primates, with field observations on their behaviour, group composition and evolutionary significance, showing the clinal variations and the geographical boundary between the Northern and Southern tail carriage styles (publishing over 18 papers from 1976) ; and
- (ii) **Micro-sculpturing on the wings of insects**, particularly of the termites (Isoptera), which he studied from 1967 with the light microscopy and later

extended with scanning electron microscopy, resulting in showing their value for taxonomic diagnosis of various families of Isoptera, and reporting their evolutionary and biological significance (publishing over 25 papers from 1973). This was the topic he selected for his **Har Swarup Memorial Award Lecture**, when invited by the Indian National Science Academy, at Jaipur in 1984.

Dr. Roonwal was Secretary-General of the Indian Board for Wild Life (1956-1962), President of the Zoology & Entomology Section of the Indian Science Congress (1945), a Fellow of the National Institute (now Indian National Science Academy) since 1945, the President of the First All-India Congress of Zoology (1959), and a member of the Advisory Council of the Bombay Natural History Society (1954-1965). A number of other societies nominated him as their Honorary Fellow.

Tall, soft spoken, straight forward and unemotional in deliberation, highly knowledgeable and well-read, meticulous and precise in language, prolific writer (still using the ink-pot), orthodox (somewhat British) in nature but a nonbeliever in rituals, a philosopher by disposition and above all a genius, that was Dr. Roonwal. He was suffering with prostrate and cataract ailments in old age, besides his coronary problem since childhood. His students and well wishers celebrated his 80th birthday at Jodhpur, in December 1988, holding a **National Seminar on the Advances in Economic Zoology**. When the author met him last, he showed the autobiography he was penning at leisure. He died due to a massive heart attack, at his residence 'Roonwal Bhawan' in Polo, Jodhpur.

PUBLICATIONS

He published more than 400 research papers including some books, besides more than a hundred reviews, forewords, articles, etc. The full list of his scientific contributions was published in his 80th Birthday Souvenir Volume in 1988. A brief selection of his works with abbreviated titles, is as follows :

On Insects :

- 1936-1937, Embryology of the African migratory locust *Locusta migratoria migratoroides* R. & F. [Multiphased Gastrulation Theory]. *Phil. Trans. R. Soc. Lond. (B)* **226** (538) : 391-421 ; **227** (543) : 174-244.
- 1936. On existence of two different types of striped eyes among the desert locust *Scistocerca gregaria* Forsk. *Current Sci.* **5**(1) : 24.
- 1939. Advances in insect embryology, with a complete bibliography. *J.R. Asiatic Soc. Beng. (Sci.) (N.S.)* **64** (1) : 17-105.
- 1947. Variation and structure of the eyes in the desert locust. *Proc. R. Soc. Lond. (B)* **134** (875) : 245-272.
- 1952-1953. The natural establishment and dispersal of imported lantana bug *Teleonemia scrupulosa* Stal. *J. zool. Soc. India* **4**(1) : 1-16; Further remarks. *Indian Forester* **79**(11) : 628-629.
- 1954. Progress of entomology in India with a bibliography. *Mem. Ent. Soc. India* **3** : 1-119.

1954. On a new evolutionary phenomenon : the sharp increase of intraspecific variation in minimum populations, as evidenced by desert locust. *Rec. Indian Mus.* **51** (4) (1953) : 481-525.
1956. Isoptera. In : *Taxonomist's Glossary of Genitalia in Insecta* (Ed. S.L. Tuxen), Copenhagen : 34-38; 2nd ed. 1970 : 41-46
1958. Population dynamics and evolutionary problems in the desert locust with a new theory on gregarization [The Tata Medal lecture]. *J. zool. Soc. India* **9**(1) (1957) : 72-96.
1958. Recent work on termite research in India. *Trans. Bose Res. Inst.* **22** : 77-100.
1958. *Descriptive account of the host-plants of the lac insect and the allied plants in the Indian region (Parts 1-2)*. Ranchi : 140 pp. (with M.B. Raizada, R.N. Chatterji and B. Singh).
1960. *Contributions to the Systematics of Oriental Termites*. I.C.A.R., New Delhi : 407 pp. (with P.K. Sen-Sarma).
1961. Bibliographia Acrididiorum. *Rec. Indian Mus.* **56** : 1-611.
1962. Recent developments in termite systematics. In : *Termites in the Humid Tropics*. UNESCO, Paris : 31-50.
1962. Termite fauna of Assam, Eastern India. *Proc. Natn. Inst. Sci. India (B)* **28**(4) : 281-406 (with O.B. Chhotani).
1964. Termite fauna of Rajasthan. *Zoologica* **40**(3) : 58 pp. (with G. Bose).
1966. Termites from Indonesia. *Treubia* **27**(1) : 63-140 (with P.K. Maiti).
1970. Taxonomy and zoogeography of the termite fauna of Andaman and Nicobar Is. *Rec. zool. Surv. India* **62**(1964) : 109-170 (with G. Bose).
1972. *Termite Problems in India*. C.S.I.R., New Delhi : 81 pp. (Editor).
1976. Ecology and biology of *Hieroglyphus nigrarepletus* Bolivar. *Z. angew. Ent.* **63** (2) : 171-185; **63**(3) : 309-332.
1976. Termites from Amazon basin, Brazil. *Rec. zool. Surv. India* **69** : 161-186 (with N.S. Rathore).
1978. Biology, ecology and control of the sal heartwood borer *Hoplocerambyx spinicornis*. *Indian J. Forestry* **1**(2) : 107-120.
- 1946-1978. Studies in intraspecific variation (15 parts). [with special reference to the desert locust and published in various journals] (many with R.K. Bhanotar).
1979. *Termite Life and Termite Control in Tropical South Asia*. Jodhpur : 177 pp.
1979. Field ecological studies on the sal defoliator *Lymantria mathura* in Sub-Himalayan forests. *Rec. zool. Surv. India* **75** : 209-236.
1980. Eye stripes and pigmentation in grasshoppers (Orthoptera : Acridoidea). *Rec. zool. Surv. India* **76** : 147-188.
1983. Fifty years of locust research : Reminiscences and contributions. *Plant Prot. Bull.* 33 (Special No. 1981) : 1-11.
1984. The abdomen, genitalia and accessory structures in termites (Isoptera). *Mem. ent. Soc. India* **9** : 69 pp.
1984. Wing micro-sculpturing in Embioptera. *Indian J. Ent.* **45**(4) (1983) : 323-334 (with N.S. Rathore).

1985. Recent researches on wing microsculpturing in termites (Isoptera) [Har Swarup Memorial lecture]. *Proc. Indian Natn. Sci. Acad. (B)* **51**(2) : 135-168.
1989. *Fauna of India, Isoptera (Termites)* Vol. 1. Z.S.I., Calcutta : 672 pp. (With O.B. Chhotani).

On Vertebrates :

1949. Systematics, ecology and bionomics of mammals studied in connection with scrub typhus disease. *Trans. Natn. Inst. Sci. India* **3**(2) : 67-122.
1949. Discontinuous distribution of certain Indo-Malayan mammals and its zoogeographical significance. *Proc. Natn. Inst. Sci. India*, **15**(8) : 375-377 (with B. Nath).
- 1949-1950. Fauna of Manipur State (Mammals with special reference to Muridae). *Rec. Indian Mus.* **46** : 123-181; **47** (1) : 1-64.
1949. Geographical and geological aspects of the migration of animals. *Bull. Natn. Geogr. Soc. India* **11** : 1-33.
1950. Preservation of wild-life in Indian forests — A plea for National Parks. *Indian Forester* **76**(2) : 63-66.
1961. Additions to J.R. Ellerman's volume on Mammalia (2nd ed.). *Fauna of India, Mammalia* Vol. 3 *Rodentia* (Part 2). Delhi : 853-867 (with B. Biswas).
1962. Ostrich breeding in Bikaner (Rajasthan, India). *Proc. 1st All-India Congr. Zool. (Jabalpur 1959)*, Pt. 2 : 24-29.
1962. An Indian zoologist in Brazil. *Proc. 1st All-India Congr. Zool. (Jabalpur 1959)*, Pt. 2 : 30-35.
1963. *Recent Advances in Zoology in India*. Delhi : 426 pp. (Ed. with K.S. Pradhan and A. Daniel).
1965. Fauna. In : *The Gazetteer of India, Vol. 1 Country and People*. New Delhi : 231-287 (with Salim Ali).
1966. A new frog from Assam, India with observations on metamorphosis and behaviour. *Rec. Indian Mus.* **59** (4) : 325-333 (with Mira B. Kripalani).
1966. Measurements of rodents, especially their skull, for taxonomic purposes. *Rec. Indian Mus.* **60** (1962) : 81-93 (with V.C. Agrawal).
1969. Fauna of Rajasthan — General Introduction. *Rec. zool. Surv. India* **61** (1963) 291-376.
1976. Dominance behaviour in South Asian primates. *J. Sci. Indus. Res.* **35** : 244-260.
1977. *Primates of South Asia. Ecology, Sociobiology, and Behavior*. Harvard Univ. Press, Cambridge (Mass.) : 421 pp. (with S.M. Mohnot).
1980. Quantification of tail loop characters for clinal variations in the langur *Presbytis entellus* in Peninsular India and Ceylon. *Zool. Anz., Jena* **204** : 177-185.
1982. Fauna of the Great Indian desert. In : *Desert Resources and Technology* (Ed. Alam Singh). Jodhpur : 1-86.

1984. Geographical boundary between the Northern and Southern tail styles in the common South Asian langur. *J. zool. Soc. India* **36** : 15-26 (with R.S. Pirta and S.S. Saha).
1984. *Current Primate Researches*. Zool. Deptt., Univ. of Jodhpur : 627 pp. (Ed. with S.M. Mohnot and N.S. Rathore).
1985. Primates affecting food production and environment in India. In : *Non-Insect Pests and Predators*. New Delhi : 151-158, 268-269.
1986. The langur (*Presbytis*). In : *Wildlife Wealth of India - Resources and Management* (Ed. T.C. Majupuria). Bangkok : 366-378.
1987. Recent advances in Rodentology in India. *Rec. zool. Surv. India (Occasional Paper)* **105** : 126 pp.

APPENDIX

In early 1989, it was decided by the Zoological Survey of India, to celebrate its Platinum Jubilee during the year 1st July 1990 – 30th June 1991. For this occasion, besides other publications, it was proposed to publish a special issue of the departmental hindi journal 'PRANI JAGAT', with articles from its some retired senior officers. The author, as coordinator of this publication, accordingly requested several retired colleagues, of whom Dr. Roonwal was the first to respond.

He sent in August 1989 an article (with a plate), entitled 'My association with the Zoological Survey of India, 1939-1965', to the author to get it translated and then publish. Unfortunately, the proposed issue of the 'PRANI JAGAT' with such articles could not be published. The author, thus, now takes the opportunity to append Dr. Roonwal's above mentioned article here.

My Association with the Zoological Survey of India, 1939 - 1965

By

M.L. ROONWAL

I. Introduction

My association with the Zoological Survey of India, as a member of its scientific staff, lasted for a total period of about nineteen years, during 1939-1965, in two phases with an interval of some seven years, 1949-1956, when I was posted at the Forest Research Institute, Dehra Dun.

The two phases, 1939-49 and 1956-65, are discussed below briefly.

II. The First Phase, 1939-1949

While I was still serving as the Assistant Locust Entomologist at the Locust Research Laboratory of the Imperial Council of Agricultural Research at Karachi, I was selected as a Trainee in Birds and Mammals at the Zoological Survey of India, and served in that capacity for three years, 1939 - 42. I was formally appointed, on the 28th of February, 1942, as the Assistant Suprintendant (Class I), in - Charge of

the newly formed Bird and Mammal Section. I served in that capacity until the 6th of November 1949, when I was relieved to join my new duties as the Forest Entomologist at the Forest Research Institute, Dehra Dun. During the absence of the Director, Dr. S.L. Hora, on deputation abroad, I served as the Officiating Director of the Survey for four months, 9th August to 7th November, 1949.

For about a year during the Second World War, I was on Active Service, as a Major in the 15th Punjab Regiment, being posted as Mammalogist to the G.H.Q. (India) Field Typhus Research Team in the Assam — Burma War Theatre under the South — East Asia Command.

The Zoological Survey of India then was a small organisation, with only nine scientific sections and eleven specialist officers (called Assistant Superintendents Class I, and a Director).

In May 1942 the Zoological Survey of India was transferred, complete with the Collections and the Library, to Banares Cant. (Varanasi) and was housed in a large building, the Kaisar Castle; it returned to Calcutta in January, 1949. Here, in September 1943, it suffered severely due to the floods of the river Varuna, a tributary of the Ganga. The flood waters entered the Kaisar Castle and the entire collection and library were under water for two days. For two whole years after the flood we were busy in repairing the damage. Fortunately, the type-specimens had been sent earlier to Dehra Dun to be housed in the Forest Research Institute, and escaped damage.

III. The Second Phase, 1956 - 1965

I returned to the Zoological Survey of India in July 1956, to take on the duties of the Director in the vacancy caused by the premature death of Dr. S.L. Hora. I held that post for about nine years, from the 24th of July 1956 until my retirement on the 27th of August 1965, and returned to Jodhpur to take on my new duties as the Professor and Head of the Department of Zoology, Jodhpur University, and a year later as its Vice-Chancellor.

Until the early fifties, the Survey was a small department, with nine scientific sections and eleven specialist officers. Expansion began with the implementation of the Five Year Development Plans of the government. Expansion during the First Plan was nominal because money sanction was received only in the fourth year of the Plan. Massive expansion and reorganisation took place in the Second and subsequent Plan periods, and it was my privilege to be associated with them. By the time I retired from the Directorship in the second half of 1965, the specialist staff had risen to 75 officers, with a total staff of 552 persons. At the headquarters, the Survey was grouped into 10 Divisions and 36 Sections. In addition, there were seven Regional Stations, based on ecological and geographical considerations, at Jabalpur, Pune, Madras, Dehra Dun, Jodhpur, Shillong and Patna. This massive expansion has inevitably resulted in the all - round development of the Survey activities and the discovery of hundreds of new species in the Indian fauna.

Through a Gazette of India notification, dated the 11th of July 1964 the collections of the Survey were declared as the National Zoological Collections of India. In the *Fauna of India* series, several volumes were brought out and new volumes assigned to recognised specialists.

On the recommendation of the UNESCO's Key Zoological Committee for South Asia, of which I was the Chairman, a Key Zoological Collection Centre was established in 1965 at the headquarters, Calcutta. The Centre maintains details of the "type" collections in India, Pakistan, Sri Lanka, Burma, Nepal and Bhutan.

For the safety and preservation of "type" specimens and uniques of the flora and fauna of India, the government appointed, in 1960 under my chairmanship, a Committee of Experts, with representatives from the Botanical, Geological and Anthropological Surveys of India and the Law and Customs departments. The Committee's Report, submitted in 1961, was accepted by the government.

During a part of my period of Directorship, I was closely associated with the Indian Board for Wild Life as its Secretary—General (1956-62), and assisted the board in the regulation of the export of prohibited animals and their skins. At the invitation of the Rajasthan Government, I inspected the Zoos of that State in 1959, and submitted recommendations for their improvement.

In 1960, the UNESCO held, under my Chairmanship, an international symposium on Termites in the Humid Tropics. The Proceedings of the Symposium were published by UNESCO in 1962.

As a member or chairman of a number of international committees, I had the welcome opportunity of visiting many parts of the world during which I also made zoological explorations on a modest scale, especially for termites. The countries visited included Brazil, Indonesia, Burma, Sri Lanka, Pakistan, and some parts of Africa, Great Britain and Europe. These visits also provided the opportunity of meeting distinguished foreign zoologists and to discuss problems of common interest with them.

IV Post — retirement Association

After retirement from the Directorship in 1965, I have been fortunate in being able to continue my close association with the Zoological Survey of India. For twenty years I have been continuing my research work in the laboratories of the Desert Regional Station of the Zoological Survey at Jodhpur, and I am grateful to the authorities and the staff of the Survey for their cooperation and assistance.

The Government of India appointed me, in 1967, as a Corresponding Member of the Zoological Survey of India ; as the Chairman of the Working Group (1968) for the Zoological Survey of India's Fourth Five — Year Plan ; and as a Member of the Programme Advisory Committee for the Botanical and Zoological Surveys of India (1989).

In 1988, on the occasion of my 80th birthday, the Zoological Survey of India brought out, jointly with the Entomological Society of India and the Jodhpur University, the following book which contains a short biographical sketch, a complete list of my scientific publications (numbering over 400) and the opinions of expert authorities on my published work :

Biography and Scientific Contributions of Professor M.L. Roonwal, Zoologist, Entomologist and Educationist, 80th Birthday Souvenir Volume. (Edited by R.C. Sharma, vi+95 pp., 6 pls. — Jodhpur, 1988).

INFANTICIDE IN ANIMALS AND MAN : COMPARATIVE ASSESSMENT IN EVOLUTIONARY CONTEXT, WITH A NEW THEORY.

M.L. ROONWAL

*Desert Regional Station,
Zoological Survey of India
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INTRODUCTION

Although infanticide in man and other animals has been known to exist for ages, it did not elicit much scientific interest until its discovery as a regular feature in a nonhuman primate, the Hanuman langur (*Presbytis entellus* : Cercopithecidae) in India in the sixties and seventies (Sugiyama 1964, 1965a, b, Mohnot 1971, Parthasarathy and Rahaman 1974, S.B. Hrdy 1974, 1977, Boggess 1979, Curtin and Dolhinow 1979, and Chapman and Hausfater 1979). Subsequently, the phenomenon has been reported in many other primates. Recently, a wealth of new data and analyses have been brought together (Hausfater and Hrdy 1984).

In the present account I have assessed infanticide comparatively in all animal groups and man in the evolutionary context. The various theories put forward to explain infanticide on the basis of the proximate as well the possible ultimate evolutionary causes have been discussed. As they were found to be inadequate, a new theory is provided.

In mammals the reproductive pattern puts certain constraints on the evolution of infanticide. The reproductive cycle can be broken up into an irreversible sequence of states (events) and stages, e.g., puberty, copulation, fertilisation (conception), implantation, parturition, lactation and weaning. These events and stages also provide the context for infanticidal behaviour which can occur at any stage of the reproductive cycle (Hayssen 1984).

WHAT IS INFANTICIDE ?

1. General Considerations

Infanticide is any behaviour that makes a direct and significant contribution to the immediate death of an embryo or newly hatched or born member of the performer's own species (Mock 1984). Two principal types of infanticides can be distinguished; viz., *nonkin infanticide* and *kin infanticide*. The latter type results in sacrificing shared genes for some presumed compensating benefits to the perpetrator's inclusive fitness. Kin infanticide can be further divided into two

categories, viz., *parental infanticide* (done by the parent) and *siblicide* (done by a sibling, and sometimes called *patricide* or *cainism*).

S.B. Hrdy (1979) has classified infanticide in animals into five categories, viz., exploitation (i.e., cannibalism), resource competition, parental manipulation, sexual selection and social pathology.

Direct contribution to infanticide indicates that either plain aggression or abusive neglect, or both, are involved. But the death need not be caused by any particular blows. Thus, aggressive intimidation of a nest-mate as an infanticidal act (i.e., siblicide) is included if, as a consequence, the victim starves to death, but the starvation would not be regarded as infanticide if it resulted from aggressive sibling competition. (For a more detailed discussion, vide Hrdy and Hausfater 1984, and Mock 1984.)

2. *Infanticide and Cannibalism*

Infanticide may or may not lead to cannibalism. Several cases are known in the animal world where cannibalism is the end and apparently the only purpose of infanticide, and it is not clearly distinguishable from predation ; here we also include 'ovicide', the killing (and eating) of eggs by conspecifics. Many fishes and insects eat their eggs and young ones. A recent example is that given by Roonwal and Rathore (1975) who observed dealated brooding termites, *Microtermes mycophagus* of the Indian Desert, eating young larvae in the colony : "alates often attack and eat up young larvae, a process which is finished in about 5 minutes. Sometimes the larvae are merely bitten and then left over in dead or dying condition" (p. 45) ; it was not possible to say whether the cannibals included the parents of the larvae. Similarly, I have seen the Old World Desert Locust (*Schistocerca gregaria*) attack and eat the older (fourth and fifth stage) hoppers while they were undergoing moulting ; it is possible that the hoppers were eaten not merely for the flesh but also for water. Steiner (1972) reported ground squirrels eating conspecific infants. I have seen a mother rat, *Rattus rattus*, eating young infants from her own litter, and a bitch eating a member of her own litter a few hours after giving birth, in both cases apparently due to hunger.

Cannibalism, however, is rare among the primates, and only a few cases are known, all among the higher apes. The early cases were reported by Suzuki (1971) and Bygott (1972) in the chimpanzee, *Pan troglodytes*, in Africa. In both cases, a group of adult males somehow acquired an infant and jointly tore it apart, limb by limb, and ate it alive. Since the infant could hardly have satisfied the appetite of a group of adults, it seems doubtful if the infant-eating was an immediate food-need. The act is even more surprising when we consider that chimpanzees in their natural habitat are largely vegetarians, and only much less commonly do they throw in animals as a part of their diet — mostly ants and termites, and occasionally the meat of monkeys and other medium-sized and mammals which they kill and eat. Also in the chimpanzee, Goodall (1977) reported two cases of individual females killing an infant of another disabled (polio-affected) and lower ranking female of her own group, and eating it. Fossey (1976) reported a suspected case of infant cannibalism by a dominant female in the mountain gorilla (*Gorilla gorilla beringei*).

Three categories of cannibalism can be recognised, viz., *filial cannibalism* (where the killer is the victim's parent), *heterocannibalism* (where the cannibal is not related to the victim), and *sibling cannibalism* (fratricide which ends up in cannibalism) (Dominey and Blumer 1984).

INFANTICIDE IN ANIMALS OTHER THAN PRIMATES

1. *Infanticide in the Invertebrates*

The invertebrates constitute a vast and varied assemblage of animal forms and include over 95 per cent of all the known animals. Intraspecific killings and cannibalism are widespread and have been recorded in nearly 1,000 species spread over 11 phyla from the Protozoa upward (Pollis 1984), and the phenomenon presents certain general characters which may be summarised as follows :—

- (i) Immature animals form the bulk of intraspecific prey.
- (ii) Predators may be adults, juveniles or even newborn animals, adults being the more common predators.
- (iii) Females are more cannibalistic than males.
- (iv) The rate of intraspecific predation increases with hunger and with a decrease in the availability of alternate foods.
- (v) Predation is often a direct function of density, the rate increasing with overcrowding.

The intraspecific predation of eggs and young ones significantly influences the population structure and dynamics. A large proportion of the entire population or the specific age-class (generally the young ones) may be killed and eaten, so that the population may be heavily skewed in favour of adults.

Cannibalism confers many advantages upon the predator, and the few existing studies suggest that there are genetic strains with different cannibalistic tendencies. In some cases, as in the corn earworm (*Heliothis* sp., Insecta, Lepidoptera) extremely voracious strains are over 20 times more cannibalistic than those that are least voracious.

Infanticide confers one advantage to some invertebrates that has no counterpart among the vertebrates. By killing conspecifics, some arthropods are able to decrease future intraspecific killing and predation on themselves. This is because some arthropods pass through a quiescent stage during larval moulting and pupation during which they are highly vulnerable to predation by the smaller conspecifics, e.g., in the treehole dwelling mosquito larvae (some members of the genus *Toxorhynchites*) whose older stages in the days immediately before pupation embark upon a "killing frenzy"

In some cases sexual selection may operate. Individuals may increase their own fitness by intraspecific predation specially by reducing the fitness of other individuals of the same sex. This may occur by direct cannibalism or killing of sexual competitors or by eating their offspring, as in termites and some social Hymenoptera where eggs and young larvae are eaten along with the defeated adults during territorial wars between rival colonies (Wilson 1971).

Some invertebrates practice sibling cannibalism by eating eggs, embryos and newborn young from within their own clutch.

2. *Infanticide in Fishes*

In fishes intraspecific predation of young stages (eggs, embryos, larvae and juveniles) is of common occurrence. Here, infanticide always results in cannibalism which is far more common than in the terrestrial vertebrates. Several factors have contributed to this situation. Among them, the more important ones are the following : (i) High fecundity, and the resulting smaller offspring ; (ii) the predominance of external fertilization, resulting in the deposition of helpless embryos in a potentially hostile environment ; and (iii) filial cannibalism, which is favoured by the frequent occurrence of parental care of offspring by males in contrast to the general prevalence of care by the mother in most other animal groups (Dominey and Blumer 1984).

3. *Infanticide in the Amphibia*

As in other animals, in the Amphibia too the highest mortality occurs in the younger stages (eggs and larvae), and the problem has been reviewed by Simon (1984). This is due to various causes, e.g., predation by the vertebrates and the invertebrates, fungal and other infections, competition, disease, starvation, hostile environment (extremes of temperature), etc. In some salamanders and frogs the father guarding the eggs is said to eat them occasionally (filial cannibalism).

Cannibalism by larvae of conspecific larvae is common in the Amphibia. Associated with this in some cases (e.g., in spadefoot toads of the genus *Scaphiopus*) a population may show polymorphism. Within a single population there may exist a noncannibalistic omnivorous morph, a cannibalistic carnivorous morph, and an intermediate morph.

Egg cannibalism by larval siblings has been reported in some tropical frogs that lay eggs in water-filled leaf axils or tree holes.

In most cases, conspecific egg-killing results in cannibalism, but noncannibalistic egg-killing may also occur, as in the frog *Hyla rosenbergi* of Central America and a few others.

In some Amphibia infanticide occurs by the mother deserting her laid eggs that she is guarding, thus exposing them to predation by enemies. This occurs in the salamander *Hemidactylum scutatum* where the desertion occurs when several clutches are clumped together but not when they are widely dispersed.

4. *Infanticide in Birds*

According to Mock (1984), infanticide in birds is most common in four broad contexts, viz., brood reduction, desertion, coloniality and communal nesting. He also points out that, contrary to S.B. Hrdy's assertion (1979) that infanticide is never common, field data on birds show that it is regularly the most important source of nestling mortality in some species and thus provides a major selection pressure to evolve various specific adaptations.

Brood reduction : In some species females consistently lay more eggs than are successfully hatched on an average. The regular loss of one or more members of the brood (brood reduction) is a density-dependent system for maximising parental reproductive success.

Desertion (parental infanticide) : This takes the form of outright killing of eggs (with or without cannibalism) or simple desertion ; outright killing is not common.

Coloniality : Infanticide commonly occurs in colonies when dense breeding colonies and unrelated adults are juxtaposed. The density of conspecifics intensifies competition of limited resources, e.g., nest sites, building materials and food. The rate of cannibalism (on eggs and young chick) is often quite high (ca. 23 per cent in herring gulls, one-half of which was performed by only four gulls in a colony of 900).

Communal nesting : Several cases of infanticide have been reported in the case of communal nesting. In the groovebilled anis, *Crotophaga sulcirostris*, the socially dominant female lays last after rolling out of the communal nest some of the eggs of the subordinate female. In the Mexican jays, a few group members pilfer eggs and eat them.

5. *Infanticide in Mammals other than Primates*

(a) *Carnivores*

Direct observations on infanticide in wild carnivores are far less numerous than in other groups of animals because of some inherent difficulties. Carnivores are dangerous and not easily approachable ; they are also mostly nocturnal and solitary and are wary of human approach. Consequently, much of the information available is either inferred or otherwise less direct. The results have been reviewed by Packer and Pusey (1983, 1984), and can be grouped into four categories as follows :—

Infanticide by males : The most extensive data are from the African lion, *Panthera leo*, in Tanzania. Outside males enter a pride of lions and kill one or more infants. In one case the killer male ate the viscera of one of the cubs. The killer male sometimes takes over the victimised pride, the females coming into oestrus within days or weeks of losing the infant (normally, they remain anoestrus until their cubs are one-and-a-half year old) and mate with the new male (cf. infra, a similar situation in the Hanuman langur, *Presbytis entellus*). The situation could be interpreted as a reproductive strategy by males in S.B. Hrdy's (1974) sense.

Extragroup infanticide : Several cases have been reported in which individuals of one breeding group kill the young of another (e.g., in the coyotes *Canis latrans* ; and the African lion).

Intragroup infanticide by females : Infanticide by the mother has been observed in the African lion, the mother abandoning healthy single surviving cubs less than three months old. A similar abandonment of a young cub has been reported in the grizzly bear, *Ursus horribilis arctos*. In an untamed pariah dog, near a human colony in India, I have witnessed a mother killing a six-day old infant (out of litter of five) and devour it entirely, the action being probably prompted by acute

hunger. Infanticide by females other than the mother have been recorded in captive wolves (*Canis lupus*), red foxes (*Vulpes vulpes*) and brown hyenas (*Hyaena brunnea*) ; in these cases there is at a time only one breeding female but more than one adult female is present in the group. This seems to be a female reproductive strategy by which a dominant female ensures that she alone can breed at that particular time and also that her offspring receive care from the subordinate female.

Intralitter infanticide : Examples are difficult to come by because of observational difficulties since most cubs are kept in dens. But a few cases have been recorded, e.g., in the Arctic fox, *Alopex lagopus*, in which six of the nine cubs had been killed by a bite at the base of the skull ; and in the spotted hyena (*Crocuta crocuta*) in which two three-fourths grown cubs of a den were each found strangling a 2-month old cub.

(b) *Rodents*

For a variety of reasons, such as small size, brief life-history, etc., rodents provide favourable material for the study of infanticide in the laboratory. Consequently, the phenomenon has been well documented and analysed in detail in the laboratory, but field studies on infanticide are scarce. Comprehensive reviews of our present knowledge of both the general and specific aspects have been provided recently by Labov (1984), Brooks (1984), Huck (1984), Elwood and Ostermeyer (1984), Svare et al. (1984) and vom Saal (1984).

As Brooks (1984, p. 334) points out, virtually all direct observations of infanticide in wild rodents are from ground squirrels (Sherman 1981) and marmots (family Sciuridae). In the Californian ground squirrel, *Spermophilus beldingi*, at least 8 per cent of the infants born are killed by conspecifics, mostly adult females, distantly related to the victims ; mothers thus bereft of their infants, abandoned these "unsafe" burrows, making them available to the killer female. Surprisingly, in the Muridae (voles, lemmings, mice, rats, gerbils, etc.), although several field studies on population dynamics have been made, few mention infanticide in the truly wild state. In view of the paucity, I give below my own observations (Roonwal 1949, p. 98) on freshly captured cases of the Manipur White-bellied Rat, *Rattus rattus bullocki*, in 1945 in Manipur (NE India). The litter size is 3-9 ; the young ones are born naked, with the eyes closed ; the eyes open on the 17th or 18th day ; young ones huddle close to the mother who suckles them for at least 25 days after birth ; she fiercely resents any intrusion. In one case when two 14-day old infants from another brood (after the mother's death) were placed in her nest, she instantly killed one of them and ate its head ; the other infant was quickly removed by me.

Huck (1984) has discussed the relationship between infanticide and the evolution of pregnancy block in rodents. Bruce (1959, 1960) had observed the occurrence of the pregnancy block (the Bruce Effect) in rodents. She noted that in the house mice exposure to a strange male (or to his odour) prevented implantation in recently inseminated females (a form of infanticide) and caused a return to oestrus 4 to 5 days later. This phenomenon has been confirmed in several rodent species. To what extent this form of male infanticide is adaptive, if at all, is not clear.

INFANTICIDE IN THE NONHUMAN PRIMATES

Infanticide in the nonhuman primates in the natural state was first reported in India on the Hanuman langur, *Presbytis entellus*, by Sugiyama (1964, 1965a, b), Mohnot (1971), and S.B. Hrdy (1974, 1977) ; later on by other workers in several species of both the Old World and New World monkeys and apes (vide supra, Introduction). Mitchell and Brandt (1977) reported it in several prosimians in captivity. Examples of infanticide are known in the following species, arranged in a classified way. This is followed by an account of the individual species.

Suborder 1. PROSIMII

(Tree shrews, lemurs, indris, lorises, tarsiers, etc.)

No field examples of infanticide are available.

Suborder II. SIMIAE (Anthropoidea of authors)

(Marmosets, monkeys, apes, man)

Infraorder (A) Platyrrhina

(New World Monkeys)

Family 1. CALLITHRICIDAE

No examples are available.

Family 2. CEBIDAE

1. *Alouatta seniculus* (Red howler monkey)

Infraorder (B) Catarrhina

(Old World Monkeys)

Family 3. CERCOPITHECIDAE

Subfamily : (1) Cercopithecinae (macaques, baboons, etc.)

- (2) *Macaca mulatta* (Rhesus macaque)
3. *Macaca sylvana* (Barbary macaque)
4. *Papio ursinus* (Chacma baboon)
5. *Papio cynocephalus* (Yellow baboon)
6. *Papio anubis* (Olive baboon)
7. *Papio hamadryas* (Hamadryas baboon)
8. *Cercopithecus ascanius schmidtii* (Red-tail monkey)
9. *Cercopithecus mitis stuhlmanni* (Blue monkey)
10. *Cercopithecus campbelli lowei* (Campbell's monkey)

Subfamily (ii) Colobinae

(Langurs, colobus, etc.)

11. *Presbytis cristatus* (Silvered leaf-monkey)
12. *Presbytis entellus* (Hanuman langur)
13. *Presbytis senex* (Purple-faced langur)
14. *Colobus badius tahproscalis* (Red colobus monkey)

Family 4. HYLOBATIDAE

No examples are known

Family 5. PONGIDAE

15. *Pongo pygmaeus* (Orangutan)
16. *Pan troglodytes schweinfurthi* (Common chimpanzee).
17. *Gorilla gorilla beringei* (Mountain gorilla)

1. *Red howler monkey, Alouatta seniculus*

Infanticide in the red howler monkey has been observed in Venezuela (South America) by Rudran (1979 a, b), Sekulic (1983) and Crockett and Sekulic (1984). One male (the "breeding" or dominant male) does most or all of the mating during a female's period of peak receptivity. Periodically, status changes occur among males, and it seems that infanticide occurs during the period of instability.

Rudran (1979 a, b) recorded (over a period of two years) one observed and three inferred cases of infanticide in three groups, following an invasion by outside males who were the killers. Sekulic (1983) reported one case of infanticide after an inferred status change of male, and 19 infant disappearances as possible cases of infanticide.

By analysing all the available data, Crockett and Sekulic (1984) concluded that most infant disappearances associated with male changes are infanticides, that the killers are new or newly dominant males, that young infants are more frequently killed than older ones, and that mothers and other members of the group attempt to defend the group against potentially infanticidal males.

2. *Rhesus macaque, Macaca mulatta*

In the rhesus macaque group size may vary from small to large (8 to 180 individuals) and the composition is mostly multimale-bisexual, with several adult males and females and a number of immatures (Roonwal and Mohnot 1977). Infanticide has been inferred in one group of 11 (1 adult male, 3 adult females, 4 juveniles and 3 infants) in the Asaroi forest in the Siwalik Hills, northern Uttar Pradesh, by Pirta and Singh (1981). When 10 of the group members were removed, leaving the male alone, he became aggressive. He started visiting 6 mother-infant pairs which were placed in the study area and forcibly snatched 5 infants from their mothers and probably killed them. But he resumed his normal behaviour after some new females were introduced in the area.

Earlier, Carpenter (1942) had recorded suspected cases of infanticide during the group formation process in *M. mulatta*.

3. *Barbary macaque, Macaca sylvana*

Infanticide by adult males in free-ranging population has been recorded by Burton (1972) in Gibraltar (Spain).

4. *Chacma baboon, Papio ursinus*

Infanticide in baboons has been reviewed in considerable detail by Collins, Busse and Goodall (1984). The phenomenon has been reported in four species which are discussed below.

In the chacma baboon groups are multimale. Infanticide in South Africa has been reported by several workers, e.g., Vincent and the South African Parks Board or SAPB, both quoted by Saayman (1971), Busse and Hamilton (1981) and Collins et al. (1984). Vincent observed an adult male killing two young males on the periphery of a group. The SAPB mentioned an adult male seizing an infant from its mother, running off with it and beginning to eat it. W.H. Buskirk (quoted by Collins et al. 1984) observed an adult male attack a 5-month old infant and drag it along the ground as a second male gave chase ; the infant died two days later.

Collins et al. (1984) have recorded three cases of direct observations of infanticide. In two cases the killer was a male ; in the third case, curiously, an adult female who somehow took a 2-day old infant from its mother (the lowest-ranking female of the group), resulting in the infants death two days later. The same authors have recorded circumstantial observations of two infanticides ; one of the dead infants, when abandoned, was partially eaten by a high-ranking female.

5. *Yellow baboon, Papio cynocephalus*

Groups are multimale. A few cases of infanticide in the yellow baboon have been provided by Altman (1980), Rhine et al. (1980), Shopland (1982) and Pereira (1983). Pereira noted, in addition to a case of infanticide, three cases of abortion following the immigration of an outside male into a group.

6. *Olive baboon, Papio anubis*

The olive baboon lives in multimale groups. In Tanzania Packer (1980) and Collins et al. (1984) have recorded several cases of infant killing by conspecifics in four groups (which had been kept under continuous observation for a period of over 10 years) in which infants died as a result of fatal injury or mishandling, including kidnapping. Non-fatal kidnapping by conspecifics is not uncommon ; but in these cases the kidnapper prevented the mother from retrieving the infant (usually by threat or avoidance) who died ; the kidnapper in one case was an adult female, in the other two cases adult or adolescent males. In four cases, an adult male attacked the mother and infant, inflicting fatal injuries, resulting in the death of the infants, and in one case of the mother as well. Packer (1980) and Smuts (1982) have also provided some evidence of infanticide in the olive baboon.

7. *Hamadryas baboon, Papio hamadryas*

Unlike the three baboon species discussed above, the hamadryas baboon generally lives in one-male groups. Infanticide has been reported both in captivity (Zuckerman 1932, Angst and Thommen 1977, Rijkson and Smit 1979, Rijkson

1981) and in the field (Kummer et al. 1974). The last mentioned authors recorded in the field that in two groups, when a breeding male was removed, the arrival of the replacement male was soon followed by the death of an infant in each group—one of the infants showed signs of deep wounds presumably inflicted by the canines of the replacement male.

In a 27-member group (comprising 2 adult and 2 subadult males, 20 adult females and 3 immatures), Rijksen and Smit (1979) removed 7 females (In contrast to the usual practice in zoos faced with infant killings where only the killer males are removed). Before this experimental change, of the over 21 infants born, all but 3 died within a few days of delivery. Post-experimentally, 9 of the 12 infants born survived. The killer male is the established leader of the group and the biological father of his victims. Observations established that mother carrying newborn infants attracted disproportionate attention from all group members, particularly from females in oestrus. The authors surmised that : (i) the male leader's status is seriously impaired by this deviation of attention ; and (ii) by removing the infants he gets rid of the cause of the deviation and restores his social position in group dynamics. The killing of his own offspring is only a side effect (cf. man where similar infant killings occur).

8. *Red-tail monkey, Cercopithecus ascanius schmidtii*

Struhsaker (1977, 1978 b) and Leland et al. (1984) have recorded infanticide in the red-tail monkey in the Kibale Forest, Uganda. This species lives in one-male harem groups of about 12-50 individuals. Groups at Ngogo contained one adult male and about 10 adult females with their offspring. During the study period after about four months, the original harem male was replaced by a new adult male who subsequently killed two newborn infants in the group within one to two-and-a-half months of his take over. After about a year this male was replaced by another one (Struhsaker 1977).

9. *Blue monkey, Cercopithecus mitis stuhlmanni*

Infanticide in the blue monkey has been recorded by Butynski (1982) and Leland et al. (1984) in the Kibale Forest, Uganda. Group size is 10-33, with one adult male, several adult females and their offspring. After several months of study, the original harem male was replaced by another male who killed one infant and suspected two others. After a brief tenure, he was replaced by a new male, and in a 11-month period five new males took over one after the other. The new males were often observed chasing and probably wounding infant-carrying females of the group, but no actual killing was observed.

10. *Campbell's monkey, Cercopithecus campbelli lowei*

In Campbell's monkey in the Ivory Coast (Africa), Galat-Luong and Galat (1979) recorded wounding of infants and their disappearances, believed to be infanticide. this monkey lives in predominantly one-male groups.

11. *Silvered leaf-monkey, Presbytis cristatus*

In a city park in Malaya (SE Asia), Wolf (1980) recorded suspected case of infanticide in the silvered leaf-monkey. It lives in predominantly one-male groups, but groups may sometimes contain up to 3 males and several adult females (Roonwal and Mohnot 1977).

12. *Hanuman langur, Presbytis entellus*

The Hanuman langur lives in two types of medium-sized groups, the bisexual (average size 15-35 individuals, sometimes reaching 80-90, or even 125) and all-male (average 4-15 individuals) (Roonwal and Mohnot 1977, Mohnot 1984 a, b). Bisexual groups again are of two types, viz., unimale (with only one adult male and several adult females), and multimale (with several adult males and females). In Jodhpur, groups are almost exclusively animale; in central and southern India both types may occur together in a place (Sugiyama 1964, 1965 a, b, Kankane 1980, Newton 1984, 1986, Kurup 1984), but the majority are still unimale.

Infanticide has been observed or inferred in several places in India and Sri Lanka. The first eye-witness account of actual infant killing is that of Mohnot (1971, three cases) in Jodhpur (northern India). The earlier mention of infanticide by Sugiyama (1964, 1965 a, b) was inferred, not eye-witnessed. Subsequently, several accounts of infanticide have been published, along with reviews and hypotheses to account for it, from Jodhpur, Mt. Abu, Dharwar (southern India), Kanha (central India), e.g., by S.B. Hrdy (1974, 1977 a, b, 1979, 1984), Sugiyama (1967, 1984), Makwana (1979), Makwana and Advani (1981), Schubert (1982), Boggess (1984), Hausfater (1984), Vogel and Loch (1984), Sommer and Mohnot (1985), Newton (1986), and Mohnot et al. (1987). Although about 70 cases of infanticide have been reported, the majority of them are inferred by indirect evidence (disappearance of infants, presumed killed). In only 12 cases has the event been eye-witnessed (9 at Jodhpur in Rajasthan, by Mohnot 1971 and Sommer and Mohnot 1985; and 3 in Kanha Park, Madhya Pradesh by Newton 1986). In many cases, the sequence of events is nearly similar. The attacker is usually a male (in only one case out of 12, the attack was by a female) belonging to one of the following 4 categories : a "new resident" who had been with the group for about a year ; an "established resident" who had lived in the group for over a year ; an "interim resident" who had been with a group for a few days to about 3 months ; and male (s) from an all-male band (Mohnot et al, 1987).

Infanticide is often connected with a change in the leadership of a group, but the change is not always accompanied by infanticide. An outside male from another group or an all-male band tries to wrest leadership or sexually possess a female (he is sometimes successfully repulsed by the resident male leader) and is often in a frenzy to do so and repeats his attacks. In this process he attacks and kills, usually by biting, the infant carried by the female. If he is successful, the killed infant's mother comes into oestrus prematurely, within few days or weeks, and mates with the killer male, who is now the new leader. Infanticide is not accompanied by cannibalism.

13. *Purple-faced langur, Presbytis senex senex*

This langur lives in predominantly one-male groups. Rudran (1973 a, b) observed that in Sri Lanka infants, and sometimes juveniles, disappeared in numbers from groups ; they were presumed to have been killed by conspecifics.

14. *Red Colobus monkey, Colobus badius taphrosceles and C.b. rufomitratu*

Infanticide in the red colobus monkey (of the Kabale Forest, Uganda, *C. b. taphrosceles*) has been recorded by Leland et al. (1984). This monkey lives in large, multimale, patrilineal groups of about 8-80 individuals. Males remain in their natal group for life or emigrate only as old juveniles, and rarely join other groups. Females join other groups as old juveniles or subadults, more rarely as adults. (For details, vide Struhsaker 1975, 1978a, 1980.) These groups had been under study for over 12 years. The "CW" group contained 33 individuals (3 adult males, 1 subadult male and 14 adult females and their offspring). No male had ever succeeded in immigrating into this group. In the 12th year of study, a subadult male (named "Whitey") was observed to kill an infant and presumably wounded another in an observed encounter, and probably killed two more which had disappeared. The period of infanticide coincided with the rapid physical and sexual maturation of this male.

In another subspecies, *C. b. rufomitratu* of the Tana river, Marsh (1979) recorded suspected cases of infanticide ; it lives in predominantly one-male groups.

15. *Orangutan, Pongo pygmaeus*

No clear case of infanticide has been recorded in the orangutans. But Galdikas (1980) reported that two young rehabilitant females might have been killed by a young rehabilitant male.

16. *Common chimpanzee, Pan troglodytes schweinfurthii*

This chimpanzee lives in multimale, multifemale "communities", and adolescent females frequently migrate from one community to another. Infanticide has been recorded by several authors in Africa, e.g., Suzuki (1971), Bygott (1972), Goodall (1977), Goodall et al. (1979), Nishida et al. (1979), Kawanaka (1981), and Fossey (1984). Both Suzuki and Bygott observed that in both instances a group of adult males somehow acquired an infant and ate it alive. Goodall et al. (1979) and Nishida et al. (1979) recorded observed cases of infanticide as well as inferred ones. Kawanaka (1981) reported that in the Mahali Mountains study between the years 1965 to 1979, infanticide accounted for 22 per cent of all infant deaths in a sample of 33 live-born infants. From the data of 12 cases summarised by Fossey (1984), it appears that the aggressor was an adult male in 8 cases and an adult female in four. The event happened within the community in 6 cases and outside it in 5 (one case was not clear). In all cases except two, the killed infant was cannibalised—in 6 cases by one or more adult males, and in 3 cases by an adult female and her offspring (in the remaining 3 there was no clear indication).

17. *Mountain gorilla, Gorilla gorilla beringei*

The mountain gorilla lives in relatively stable family groups of 2-20 individuals. Each group contains at least one dominant (silverback) male, 1 or 2 subordinate (blackback) males, 3-6 adult females and 4-6 immatures.

Infanticide has been reported by Fossey (1979, 1981, 1984) in groups in Rwanda (South Africa) which had been under observation for over 15 years. During this period, 9 cases of infanticide were recorded. Most of these cases occurred during violent intergroup interactions when one dominant (Silverback) male challenged another for the possession of females. The infanticidal silverbacks were often relatively young and were in the process of forming their own reproductive units. Infanticide often precipitated the emigration of the victims' mother to another group (in three such cases, the new group was in fact of the infanticidal male).

Of the cases of infanticide recorded by Fossey (1984), 3 were observed, and the remainder inferred ; the age of the infant killed varied from 1 day to about 5-11 months, in one case over 36 months.

INFANTICIDE IN MAN

1. *General*

Human infanticide can take many forms ranging from outright physical killing of the infant to its neglect, abuse, etc. It includes destroying the foetus by abortion, or by killing it outright by piercing the abdomen with a sharp instrument, etc. The infant may be drowned in water, placed in a basket and floated down the river; left alone in a jungle or the middle of a desert to die of starvation or be killed by predators. The subject has been reviewed by several authorities, notably Chandrasekhar (1959, India), Dickeman (1975, 1984), S.B. Hrdy (1979), Harris (1977), Williamson (1978), Scrimshaw (1984), Johansson (1984), Daly and Wilson (1984) and Bugos Jr. and McCarthy (1984).*

Infanticide is found in all societies, from the most primitive to the most civilised, throughout the world and over the centuries. Earliest man, in the hunter-gatherer, horticulturist and early agrarian societies, practised it for supposed purposes as diverse as population control and maintenance of the social structure (Dickeman 1975). In London in the 19th century, infants were commonly left abandoned in parks and ditches to die, and similar practices to kill infants were found in many parts of Europe (Scrimshaw 1984). Although infanticide seems to have disappeared from most parts of the world, it is said to be still practised in China.

* I have personally knew a man who had committed infanticide. He was a Non-Commissioned Officer from Garhwal (Uttar Pradesh) on the South-East Asia Front during the Second World War. In a moment of rare candour, under the influence of mild drink, he admitted having strangled to death, with the mother's consent, his newborn daughter, because he already had four daughters. He was quite unrepentant and did not regard this act as a heinous crime.

As stated in a large number of cases, human infanticide can be caused in a variety of ways, viz., deliberate killing (sometimes in rituals to propitiate a god or goddess, or to obtain kingship), placing the child in a dangerous situation, abandonment, "accidental" death, excessive physical punishment, and lowered biological support.

Whatever the immediate method or methods used for infanticide, the practice has certain limited biological consequences. Among the most obvious of these is population control, particularly where the infant killed is a female. On the whole, however, it may be pointed out that infanticide in man was on so small a scale compared to the total population in an area, that it probably did not have any large-scale biological consequences, and the various theories advanced to account for infanticide (particularly, comparisons with the nonhuman primates and other animals) are mostly idle speculations. Infanticide in man is simply a case of social pathology.

2. Some Theoretical Considerations

Man is remarkable among, and different from, all other primates (including its closest hominoid allies, the higher apes) in having lost the oestrous period in its menstrual cycle and its capacity for successful continuous annual reproduction, almost immediately after parturition and without the loss of the previous infant. This increase in reproductive capacity is to be balanced against a long span of life and slow maturation, the child being more or less dependent upon the parents for the first 17 or 18 years of its life, more so in modern societies with the need for higher education, the incidence of unemployment, etc.

As already stated, infanticide has been a common practice in many human societies, probably from the earliest times, and persists, though in a weak form, to modern times. The practice evidently arose because (inspite of man being ecologically a highly adaptable and successful 'generalist'), the need for some form of population control was present, and infanticide was an easily available means (Dickeman 1975, Ripley 1980). (Other available means of course are adult killings in warfare, abortions, the spread of pestilential diseases, etc., see Divale and Harris 1976, Hirschfield et al. 1978.) Ripley (1980), in fact has gone so far as to assert that "... the possibility of adaptive infanticide is an inevitable accompaniment of the status of an ecologically generalist species and is simply a price our species had to pay in the process of becoming, and remaining, human" (p. 383).

Infanticide in man is different from that in the nonhuman primates. In man it is most often practiced by females (with or without male parental concurrence) on their own progeny. Whether the motivation is 'biological benefit' is doubtful, the more likely motive being socio-economic (e.g., reduction in the number of daughters who are a social liability, as in India). The practice must be considered largely, if not wholly, an example of social pathology. It results in the *post hoc* correction of the following reproductive "errors" undersirable sex ratios or birth orders ; reduction of family size for optimal parental care ; the elimination of defectives ; etc. In the higher apes, both sexes commit infanticide though males seem to do it more often. In the langurs infanticide is almost always done by an outside male for the possession of a female who, after the infant's death, quickly comes into oestrus and mates with the killer male.

THEORIES OF INFANTICIDE (TOGETHER WITH A NEW THEORY)

1. *The Various Theories*

In recent years various theories have been advanced to account for the unusual and even bizarre phenomenon of infanticide by conspecifics, for, apart from man, the killing of conspecifics irrespective of age, is an uncommon feature. In man, on the contrary, killings of fellow humans on a large, even a vast scale, has been a regular feature of human society from the earliest to modern times.

To discuss these theories, it is necessary to separate the proximate from the supposedly ultimate or theoretical (evolutionary) causes. Most of these theories have been advanced largely on the basis of examples and incidents taken from primates, but we must take a broader view based on all classes of animals.

The theories so far advanced are as follows :—

- (a) Establishing social bonds (Sugiyama 1964, 1965 a,b, 1966, 1967).
- (b) Sexual excitement of males (Mohnot 1971).
- (c) Xenophobia (Carpenter 1942, and others).
- (d) Dominance assertion (Parthasarathy and Rahaman 1974).
- (e) Sexual selection (S.B. Hrdy 1974, 1977).
- (f) Social pathology (maladaptiveness and enforced proximity) (Curtin 1977, Dolhinow 1977, Curtin and Dolhinow 1978, 1979, Boggess 1979).
- (g) Resource competition (Rudran 1979 a,b).
- (h) Population control (density dependent infanticide) and prevention of inbreeding (Sugiyama 1967, Eisenberg et al. 1972, Ripley 1980).
- (i) Following response induction (Pirta 1981).
- (j) Parental manipulation (Alexander 1974, Dickeman 1975).
- (k) Genetic proneness to infanticide (a new theory) (Roonwal, present account).

These theories are discussed below briefly, with examples.

a) *Establishing social bonds*

This theory was advanced by Sugiyama (1964, 1965a, b, 1966, 1967) on the basis of his observations on the langurs (*Presbytis entellus*) in Dharwar, southern India. He noted that the loss of the infant stimulated the onset of oestrus in the infants's mother. This situation helped in establishing social bonds between the group females and the new male. (Also see infra : "Following Response Induction", Pirta 1981.)

(b) *Sexual excitement of males*

Mohnot (1971), who was the first author to eye-witness infant killing by males in the Hanuman langur, *Presbytis entellus*, in Jodhpur (India), stated that infanticide was induced by sexual excitement. He wrote (p. 196) :

"The aggressive attitude of the attackers, their sexual excitement (with the erection of the penis), their probable influence on the oestrus of the females, presentation by the oestrus females towards the invader, subsequent copulations

by them and their overstay with the sexually excited females indicates that the probable motive behind the attacks has some relationship with the sexual urge of the males."

All the infant deprived females came into oestrus quickly (within 6 days of the death of the infant), and mostly copulated with the killer males.

(c) *Xenophobia*

The killing of conspecific strangers is widespread among animals and has been reported to occur in several groups of animals, e.g., insects, fowl, geese, wolves, hyenas, primates and man. For example, in the Indian termite, *Anacanthotermes macrocephalus*, when two workers from different colonies are brought together, they often attack each other viciously, and within minutes one of them is seen lying fatally wounded or even cleanly decapitated (Roonwal, personal observations).

When infants are the victims, the phenomenon is called xenophobic infanticide. I have observed it in termites. Among primates it has been recorded by Carpenter (1942) in an introduced but free-ranging colony of the rhesus macaque, *Macaca mulatta*, in the Cayo Santiago Island in the West Indies ; in Sri Lanka in the Hanuman langur, *Presbytis entellus thersites*, by S.B. Hrdy (1979) ; and by others in mammals, including the northern subspecies of *P. entellus*, and the chimpanzee (vide supra, Introduction). It is sometimes accompanied by cannibalism, but food-need is only a partial explanation. Its causes remain problematic.

(d) *Dominance assertion*

From inferred cases in the Hanuman langur, *Presbytis entellus*, Parthasarathy and Rahaman (1974), postulated that infanticide was committed by the male to assert his dominant status. In the red howler monkey, *Aloutta seniculus*, Crockett and Sekulic (1984), who analysed several inferred cases of infanticide, concluded that the infant killers were new or newly dominant males (vide supra).

(e) *Sexual selection*

The sexual selection theory was proposed by S.B. Hrdy (1974, 1977) to account for infanticide in the Hanuman langur, *Presbytis entellus*, and postulated that it evolved as a result of male-male competition for gaining reproductive advantage. Following infanticide, the mother often comes into oestrus quickly and copulate with the killer male, a situation which provides support to the theory. On the other hand, the expectation that the attacking male attacks and kills only those infants who were not sired by him, is seldom proved for the simple reason that he cannot possibly recognise his own offspring (even man cannot do so).

The theory has been widely discussed, with arguments both for and against it, e.g., by Dolhinow (1977), Curtin (1977), Curtin and Dolhinow (1978, 1979), S.B. Hrdy (1977 a,b, 1979, 1984), Rudran (1979 a,b), Boggess (1979, 1984), Vogel (1979), Makwana (1979), Makwana and Advani (1981), Ripley (1980), Vogel and Loch (1984), Winkler et al. (1984), Hausfater (1984 a,b), Sugiyama (1984), Hrdy and Hausfater (1984), Sommer and Mohnot (1985), Newton (1986) and Mohnot et al. (1987).

Boggess (1979, 1984) in particular has stressed that there is no evidence to suggest that infanticide is the result of organised, goal-oriented behaviour in the long-term evolutionary sense. The contention of Mohnot et al. 1987, p. 23, that a male's repeated attack on the same infant until he succeeds in killing it, is "goal-oriented", is only in the immediate context, not in the long-term sense.

(f) *Social pathology (maladaptiveness) and enforce proximity:*

Infanticide by langur males (*Presbytis entellus*) is a maladaptive behaviour, even a case of social pathology, and occurs in areas where their population density is fairly high (Curtin 1977, Dolhinow 1977, Curtin and Dolhinow 1978, 1979, Boggess 1979, 1980, 1984, ripley 1980.)

It is pertinent to point out, for example, that while infanticide occurs regularly in areas which have a high density of langurs and are disturbed by human proximity and provisioning by man (Jodhpur, Mt. Abu, Dharwar), it is absent in Nepal (Boggess, 1976-1984) and in the Rajaji Wildlife Sanctuary in north-western Uttar Pradesh (Laws and Laws 1983) where langur population is not too high and the area is undisturbed. As Boggess (1984, pp. 307-308), points out, in this "enforced proximity hypothesis", inspite of the above points which may support it, it is difficult to prove that "enforced proximity results in infant killing"

(g) *Resource competition*

On the basis of observations in the New World howler monkey, *Allouta seniculus*, Rudran (1979 a,b) concluded that increasing male fitness through the reproductive strategy of infanticide (Hrды's Sexual Selection Theory, supra) is not the primary reason of infanticide but merely a secondary consequence. Infanticide is primarily an extension of the process of eliminating unrelated food competitors who do not benefit the invading male in any way. Regulation of population growth is another consequence of infanticide. According to Rudran, the differences in the ratios of benefits to cost of the process may explain the observed differences in this pattern of social change between the red howler monkey (*Alouatta seniculus*) and other primates (e.g., the langur, *Presbytis entellus*).

(h) *Population control (density-dependant infanticide) and prevention of inbreeding.*

On the basis of data from the Hanuman langur, *Presbytis entellus*, in Dharwar, Sugiyama (1967) suggested that infanticide is the product of high population densities and is a possible mechanism for population control ; Eisenberg et al. (1972) came to the same conclusion. In man, infanticide probably serves as a means of population control and prevents inbreeding (Dickman 1975, Ripley 1979, 1980). The device serves as a means of ensuring genetic polymorphism in the langurs also where the social structure and breeding pattern favour inbreeding (Seger 1977). Boggess (1984) has brought forward several factors which go against this theory. Density dependent infanticide has also been observed in birds (vide supra).

(i) *'Following response' induction.*

Pirta (1981) emphasised that a wide range of behaviour patterns are employed by males to induce a "following response" in females. A male's glance and movement are sometimes enough for this purpose during consort relations. At other times, a male may clasp, pull and bite a female, as in the hamadryas baboon, *Papio hamadryas* (Kummert and Kurt 1965). In the Olive baboon, *Papio anubis*, the male stole an infant from a female several times to induce a following response. In extreme cases, a male wounds (usually by biting) or even kills an infant, as in the Hanuman langur (*Presbytis entellus*) or in the Rhesus macaque (*Macaca mulatta*). (Also vide supra, "Establishing Social Bonds", Sugiyama 1964-1967.)

(j) *Parental manipulation*

Infanticide in traditional human societies, in contrast to other primates, appears to be primarily a sort of parental manipulation of their progeny to achieve various ends (Alexander 1974, Dickman 1975, Roonwal 1977). The death of an infant and the termination of parental investment will sometimes improve the chances of survival of either the mother or her older offspring, or will increase the reproductive fitness of both the parents (Hrdy and Hausfater 1984). (Also vide supra, "Infanticide in Man".)

(k) *Genetic proneness to infanticide (a new theory)*

The new theory presented below is based on happenings in the Hanuman langur.

The clearest details of infanticide by males in the Hanuman langur, *Presbytis entellus* (vide supra), are those provided by Mohnot (1971) and Sommer and Mohnot (1985). They show that only some males are infanticidal and repeatedly attack infants and kill them. In the example from Jodhpur (Mohnot 1971, pp. 187-194), all 3 infants of a group (p. 26) were killed by the *same* male leader (YA —1) after he had assumed leadership. Before each killing he was in an agitated mood and was sexually excited (with the penis erect). But sexual desire alone was not the motive. Earlier, several females had presented themselves to him and he had either copulated with them or ignored them. It was clear that he temporarily became 'abnormal' and prone to killing infants repeatedly, in much the same way as a criminally-minded man repeatedly commits murder.

In the other example from Jodhpur, provided by Sommer and Mohnot (1971), 5 adult males were replaced in three bisexual groups as a result of invasion by males from different neighbouring bands. Of the 5 new males only 3 proved to be infanticidal; the remaining 2 were harmless.

The simplest explanation of these events is that the killer males were genetically prone to killing. All other consequences which followed, or assumed to follow, the killings were secondary and incidental and no long-term evolutionary goal need be assigned to them.

The theory finds support from groups other than the primates. Thus, in the Corn earworm (*Heliothis* sp., Insecta : Lepidoptera), some infanticidal strains are

over 20 times more cannibalistic than others (vide supra, "Infanticide in the Invertebrates"). In the Amphibia (the spadefoot toads of the genus *Scaphiopus*), in a single population, there may be a noncannibalistic morph and a highly cannibalistic one (vide supra).

2. Discussion

It will be seen that the majority of the theories of infanticide, as discussed above, refer to the nonhuman primates, and indeed to a single species, the Hanuman langur (*Presbytis entellus*). The reason for this narrow approach evidently is that this species has provided the clearest examples of actually observed infanticide and has attracted the attention of a large number of primatologists both for field observations and for theorisation. The theories so far proposed have inevitably suffered from this restricted approach. I have attempted to correct the imbalance and have proposed a new theory which receives support not merely from mammals but also from various other groups of animals (Amphibia, insects).

Man, however, does not fall fully in line with the other animals, and infanticide here would seem to result from proximate causes (e.g., parental manipulation) rather than from long term evolutionary ones.

On the whole, it can be said that infanticide (though a bizarre phenomenon, of killing one's own conspecifics) is widespread throughout the animal kingdom and has a limited evolutionary purpose to serve. The reasons inducing it are a mixture of proximate and ultimate causes, and a clear-cut evolutionary picture fails to emerge.

SUMMARY

1. Although infanticide in man and other animals has been known to exist for ages, it is only in the last 25 years or so that it has been examined more scientifically, mainly because of the discovery of its regular occurrence in the nonhuman primates. A large body of information has thus become available, and numerous theories postulated to account for the phenomenon.

2. The object of the present account is to assess this comparative information critically in the evolutionary context. Other aspects such as infanticide and cannibalism, etc. are also discussed.

3. In the invertebrates, which cover a vast field and constitute nearly 95 per cent of all the known animals, infanticide is widespread and occurs in almost all groups from the Protozoa upward.

4. Infanticide in the vertebrate groups (fishes, amphibians, birds and mammals) is analysed. The most numerous and the best documented examples are from the nonhuman primates, and they have stimulated a considerable amount of theorisation about the possible evolutionary motives for committing infanticide.

5. Infanticide in man has occurred from the earliest times and continues to do so even today all over the world in the most primitive and the most sophisticated societies. In the evolutionary context, it does not fit in easily with the animals, and seems to have its own motivations.

6. Infanticide has been the subject of much theorisation. The numerous theories postulated to account for it in the evolutionary context are discussed in considerable detail. They were found to be inadequate as they cover a narrow field, sometimes only isolated cases in a single species. A new theory (of Genetic Proneness to Infanticide) is postulated to cover a wide field and cases of both vertebrates and invertebrates.

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**DIAMESA EDENTISTYLA, A NEW SPECIES OF DIAMESINAE
FROM INDIA (DIPTERA : CHIRONOMIDAE)**

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The present paper is the second account on Indian species of *Diamesa* Waltl of the subfamily diamesinae, the first being that of Chaudhuri and Ghosh (1981). This part deals with the description of one new species based on the adults collected during the faunistic survey of Indian chironomids at Darjeeling and its adjoining areas of West Bengal. With this, the representatives of the genus are accorded seven in India and nine from the oriental region.

The descriptions and terminology presented here follow saether (1980) and Chaudhuri and Ghosh (1981).

The types are retained with the authors for final disposal to the National Zoological Collections at the Zoological Survey of India, Calcutta.

***Diamesa edentistyla* sp. nov.**

Male : Body length 4.78 mm., wing length 2.1 mm. and wing breadth 1.20 mm.

Head : Dark brown in colour. Vertex with 18-19 setae on each side. Eyes pubescent, spherical without dorsal extension. Maxillary palp brown, palpomere III with a preapical sensory pit, palpomere bearing 5 apical setae length ratio of palpomeres I-V 9:25:46:55:74, L/W 2.27. Antenna brown, length ratio of flagellomeres I-XIII 8:7:10:10:10:11:10:12:12:15:15:210, AR 1.55. Pedicel ratio 1.8.

Thorax : Antepronotum collar like with 7 anteprenotals. Acrostichals 1-2 dorsocentrals 6-7 and prealars 3-4. Scutellum dark with several scattered setae, postscutellum dark brown.

Wing (fig. 1). Smoky with distinct veins. Brachiolum with 2 setae and 7 sensilla campaniformia ; R with 19, R₁, 10 and R₄ , with 4 setae. Costa extended a little, extension being 0.075 mm. long ; R₂ , meets C at a distance of 0.21 mm. away from R₁ ; r-m dark, m long and little bent ; m-cu faint and interrupted at the middle and short ; ratio of the distance between m-cu and r-m to f-cu and m-cu 1.75 ; Cu₂ bent at the apex. Sensilla campaniformia at the base of R₂ , and on r-m. Squama completely fringed with 24-25 state. Anal lobe rounded. Haltere pale. CR 0.96, VR 0.93.

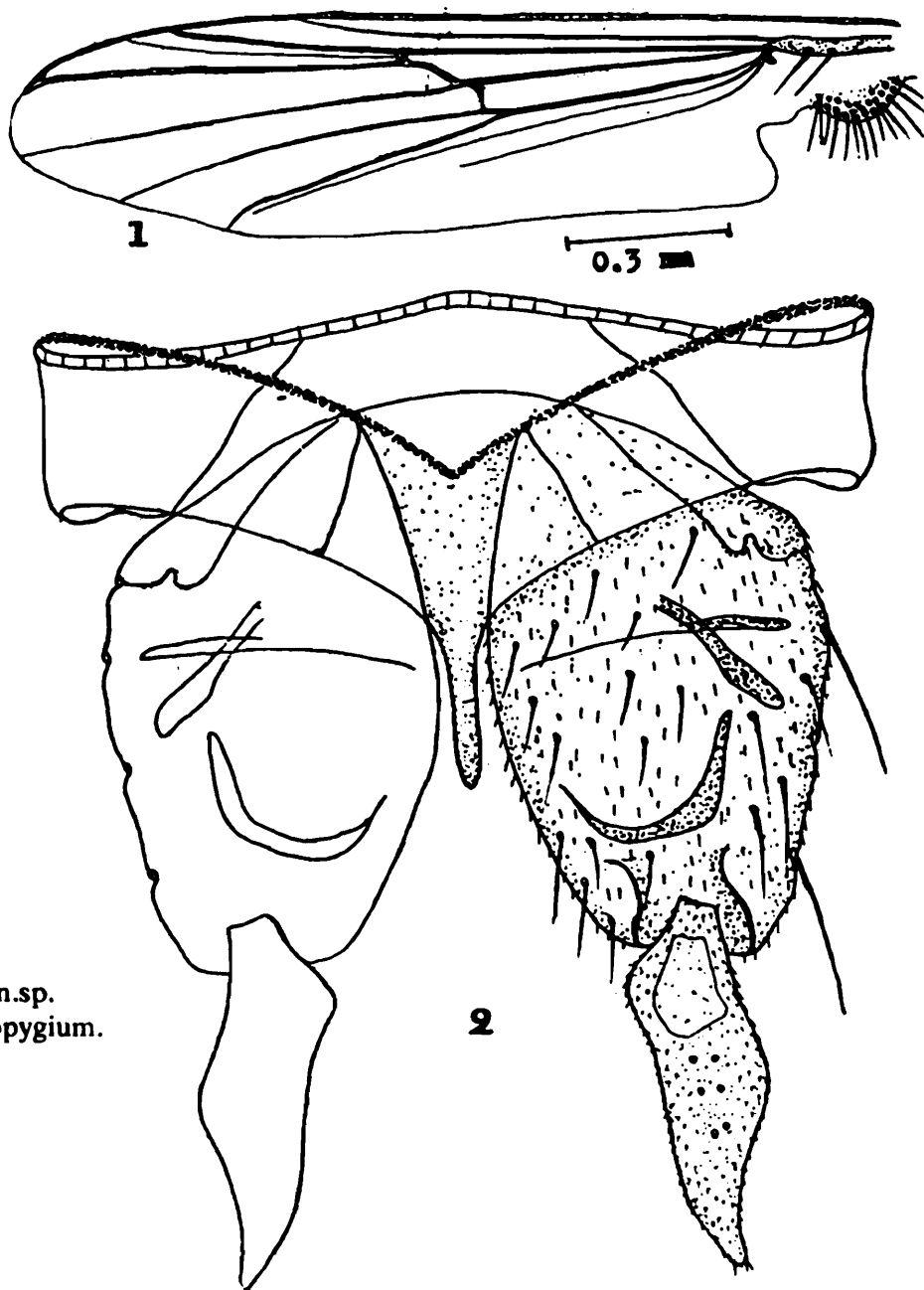
Legs : Dark brown in colour. Spur of fore tibia 0.057 mm. long, ratio of length of spur to the apical diameter of fore tibia 19:17 ; spur of mid tibia 0.081 mm. long,

ratio of length of spur to the apical diameter of mid tibia 27:20 ; spurs of hind tibia 0.078 and 0.036 mm. long, ratio of length of spurs to the apical diameter of hind tibia 26:24 and 12:24. Hind tibial comb with 13 setae. Tarsomeres of all legs broken.

Abdomen : Tergites brown. Tergum I with numerous setae. Hypopygium (fig. 2) with moderate tubular anal point. Gonocoxite robust with numerous strong long setae ; gonostylus stout with few punctures and narrowed towards apicad without tooth but with an apical seta. Transverse sternapodeme 0.15 mm. long, lateral sternapodeme 0.04 mm. long and phallapodeme 0.045 mm. long. HR 1.22, HV 2.85.

Holotype ♂ (Type no. 148, B.U. Ent.), India, West Bengal, Darjeeling, 6. iv. 1984, coll. Dr. D.K. Guha. **Paratype** ♂, data same as holotype.

Remarks : In view of absence of tooth at the apex of gonostylus the species is named as *Diamesa edentistyla*. *Diamesa edentistyla* sp. nov is closely related to *D. bicornipes* Chaudhuri and Ghosh (1981), *D. loffleri* Reiss (1968) and *D. banana* Saether (1969) differing in gonostylus, squama and thoracic chaetotoxy. But its identity as a new member of the genus *Diamesa* can be established by the following



Figs. : *Diamesa edentistyla* n.sp.
(1) wing and (2) hypopygium.

combination of characters ; (i) Anteprenotals 7 (ii) scutellum dark with several scattered setae (iii) squama with 24-25 setae and (iv) absence of tooth at the apex of gonostylus.

SUMMARY

A new species in Diamesinae, *Diamesa edentistyla* is described and illustrated from Darjeeling, India.

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DISTRIBUTIONAL AND BREEDING RECORDS OF SOME SPECIES OF MAMMALS FROM WEST BENGAL

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INTRODUCTION

In connection with the preparation of a document on the fauna of West Bengal, a programme of district-wise survey of the State was undertaken by the Zoological Survey of India in the year 1984. Since then, surveys were conducted in different districts of West Bengal, and a large number of mammal specimens were collected, along with their ecological data. During the course of identification of the material, it was observed that a number of species were yet unrecorded from this State and the distributional range of a few was noted to be more extensive than known through extant literature. A few of these species were subsequently recorded by some of the present authors (Mandal and Ghosh 1980, Mandal and Dey Sarkar 1984, Mandal 1986, Agrawal and Bhattacharyya 1987). Since the finalisation of detailed faunal account of mammals of West Bengal will take some more time, it was thought worthwhile to publish the remaining new distributional records hereunder. Many of the species of mammals collected from Koch Behar in April, 1986 were in breeding phases. Those breeding data have also been incorporated here.

All measurements are given in millimetres.

Following abbreviations have been used in the text

<i>apf</i>	=Length of palatal foraman
<i>bl</i>	=Length of bulla
<i>cb</i>	=Condylbasal length
<i>c-c</i>	=Canine width
<i>c-m</i>	=Maxillary tooth row
<i>cr</i>	=Cranial rostrum
<i>cw</i>	=Cranial width
<i>d</i>	=Diastema
<i>E</i>	=Ear
<i>F & Cl</i>	=Foot and Claw
<i>Fa</i>	=Forearm

<i>H & B</i>	=Head and Body
<i>Hf</i>	=Hindfoot
<i>iw</i>	=Interorbital width
<i>I</i>	=Greatest length of the skull
<i>m</i>	=Length of lower first molar
<i>m—m</i>	=Molar width
<i>mtr</i>	=Length of upper molar tooth row
<i>ml</i>	=Mandibular length
<i>mw</i>	=Maxillary width
<i>n</i>	=Length of nasal
<i>on</i>	=Occipitonasal length
<i>pl</i>	=Palatal length
<i>po</i>	=Post orbital width
<i>pm⁴</i>	=Length of upper fourth premolar
<i>Tb</i>	=Tibia
<i>Tl</i>	=Tail
<i>Tr</i>	=Tragus
<i>zw</i>	=Zygomatic width

SYSTEMATIC ACCOUNT

Order INSECTIVORA

Family SORICIDAE

Crocidura (pachyura) stoliczkana Anderson,

***Suncus stoliczkanus* (Anderson)**

1877. *J. Asiat. Soc. Beng.*, 46 : 270 (Bombay, Maharashtra, India).

Material examined : 1 ♂, 1 ♀ ; Raniband, Bankura district ; 10 & 11. i. 1985 ; coll. V. C. Agrawal.

Measurements : External : 1 ♂, 1 ♀ : *H & B* 59, 75 ; *Tl* 45, 54 ; *Hf* 12, 14 ; *E* 10, 10. Cranial : 1 ♂, 1 ♀ : *on* 17.5 18.5 ; *cb* 19.2, 20.4 ; *cw* 8.3, 10.5 ; *pl* 8.8. 9.6 ; *m—m* 5.5, *c—m* 8, 8.9 ; *ml* 10.4, 12.1

Remarks : As per extant literature (Anderson 1881, Blanford 1888, Lindsay 1929, Ellerman & Morrison-Scott 1951, Roberts 1977, Honacki 35 *al.*, 1982) this species occurs in Pakistan, India (Punjab, Rajasthan, Gujarat, Maharashtra and Madhya Pradesh), Nepal and Bangladesh. The present specimens, however, constitute the first record of this species from West Bengal as also fill the lacuna to some extent in its distribution between India and Bangladesh.

Order CHIROPTERA

Family PTEROPODIDAE

***Macroglossus minimus sobrinus* Andersen**

Macroglossus minimus sobrinus Andersen, 1911, *Ann. Mag. nat. Hist.*, 7 : 642. (Gunong Igari, Perak, Malaysia).

Material examined : 1 ♂, 1 ♀ ; Atiamochor, c 12 km. S.E. of Alipur Duar, Koch Behar district ; 3.iv. 1986 ; coll. S. Chakraborty.

Measurements : External : 1 ♂, 1 ♀ : *Fa* 37.7, 40 ; *E* 15, 15 ; *Tb* 17, 18 ; *F & Cl* 12, 13.3. Cranial : 1 ♂, 1 ♀ : *l* 30.3, 30.5 ; *cb* 26.6, 27.5 ; *Cr* 11.9, 11.6 ; *cw* 12.2, 11.7 ; *zw* 15.5, 15.3.

Remarks : This species, as per extant literature (Dobson 1876, Anderson 1881, Blanford 1891, Andersen 1912, Tate 1942, Ellerman & Morrison-Scott 1951, Hill and Thonglongya 1972, Lekagul and McNeely 1977), occurs in India (Darjeeling), Burma, Thailand, Indonesia, Malayasia and north Australia. However, its Indian range was based on a single young specimen collected from Darjeeling by F. Stoliczka. The specimen was donated by him to the Indian Museum in the year 1871, and subsequently recorded by Dobson (1876) and Anderson (1881). The same was finally incorporated in the National Zoological Collections of India. It is a dry skin (skull *in situ*) of a young specimen. The specimen was examined, but extraction and study of skull was not possible due to fragile condition of the skin. The present pair of specimens, however, constitute the second record of the species from India after the lapse of more than a century. Here, it is worthwhile to mention that recently Lekagul and McNeely (1977) regarded *sobrinus* as a distinct species.

Both the present specimens were netted at about 22.00 hours from the compound of Atiamochor Forest Rest House, located at the fringe of a secondary *Sal* forest.

Both testes of the male specimen were moderately enlarged ; female had two foetuses in an advanced stage of development, measuring 22.3 and 23 mm. in vertex-coccyx length.

Cynopterus sphinx sphinx (Vahl)

1797. *Vespertilio sphinx* Vahl., *Skr. Nat. Selsk Copenhagen*, 4, 1 : 123. (Transquebar, Tanjavur district, Tamil Nadu, India).

Material examined : 2 ♂, 8 ♀ ; Atiamochor, c 12 km. S.E. of Alipur Duar, Koch Behar district ; 3 & 5. iv. 1986 ; coll. S. Chakraborty. 1 ♂, 2 ♀ ; Sitalkhuchi, Koch Behar district ; 10. iv. 1986 ; coll. S. Chakraborty.

Measurements : External : 3 ♀ : *Fa* 65.5-69.8(67.4) ; *E* 15.3-18 (17.8). 10 ♀ : *Fa* 61.8-71.5(65.7) ; *E* 15.1-21.5(17.1). Cranial : 2 : *l* 32.0, 32.3 ; *cb* 30.4, 31.0 ; *cw* 13.3, 13.4 ; *m³-m³* 9.6, 10.0 ; *c¹-c¹* 6.5, 7.0 ; *c-m³* 10.1, 10.5 ; *zw* 19.9, 20.3 ; *ml* 24.2, 20.5.

Remarks : All the females were pregnant, each carrying one foetus. Foetuses were found to be in various stages of development, measuring 30-36 mm (mean 33.8 mm) in vertex-coccyx length. Testes in all the males were very prominent.

In the collected sample, ratio of female to male is very high (3 : 1).

Family MEGADERMATIDAE

Megaderma lyra lyra Geoffroy

1810. *Megadermalyra* Geoffroy, *Ann. Mus. Hist. nat., Paris*, 15 : 190 (India).

Material examined : 3 ♂, 6 ♀ ; Atiamochor, c 12 km. S.E. of Alipur Duar, Koch

Behar district ; 2 & 3, iv. 1986 ; coll. S. Chakraborty. 1 ♀ ; Mathabhanga, Koch Behar district ; 17.iv. 1986 ; coll. S. Chakraborty.

Measurements : External : 3 ♂ : Fa 64-65.5 (64.6) ; E 34.5-35.5 (34.9) ; Tb 33.7-34.0 (33.8) ; F & Cl 17.8-19.2 (18.6) ; tr 12.3-13.5 (12.4). 7 ♀ : Fa 65-69.3 (66.9) ; E 32.2-37.4 (34) ; Tb 32.9-34.7 (33.3) ; F & Cl 17.2-19.6 (18.2) ; Tr 13.0-17.4 (15.2). Cranial : 1 ♂ : l 27.6 ; cw 12.2 ; zw 16.5 ; m—m 10 ; c—m 11.2 ; ml 20.2. 1 ♀ : l 27.7 ; c2w 12.4 ; zw 16.8 ; m—m 10.1 ; c—m 11.1 ; ml 20.0.

Remarks : The specimen at Mathabhanga was netted at night, whereas the specimens from Atiamochor were bagged from a deserted room during the day time.

All the seven females were pregnant, each carrying one foetus. Except one, all the foetuses were in advanced stage of development, measuring 32-33 mm. (mena 35.4 mm.) in vertex-coccyx length. Testes were well developed in all the male specimens.

In the collected sample, ratio of female to male is high (2 : 1).

Family VESPERTILIONIDAE

Scotophilus heathi heathi (Horsfield)

1831. *Nycticejus heathii* Horsfield, *Proc. zool. Soc. Lond.*, 113 (Madras, Tamil Nadu, India).

Material examined : 1 ♂, 6 ♀ ; Sitalkhuchi, Koch Behar district ; 9. iv. 1986 ; coll. S. Chakraborty. 1 ♂, 1 ♀ ; Mathabhanga, Koch Behar district ; 17. & 18. iv. 1986 ; coll. S. Chakraborty.

Measurements : External : 7 ♀ : Fa 56.4-59.8 (58.1) ; E 12.9-14.4 (13.2) ; Tb 21.3-25.0 (23.1) ; tr 6.7-7.4 (6.9) ; F & Cl 9.7-11.3 (10.3). 2 ♂ : Fa 56.1, 59 ; E 12.3, 13.2 ; Tb 23.0, 23.8 ; Tr 6.5, 7.3 ; F & Cl 10, 11.2. Cranial : 2 ♀ : l 22.1, 22.2 ; c—m³ 7.7, 8.2 ; c—c¹ 7.4, 7.6 ; cw 10.3, 10.7 ; zw 15.7, — ; ml 15.7, 16.3. 1 ♂ : l 22.4 ; c—m³ 7.3 ; c¹—c¹ 7.6 ; cw 11.4 ; zw 16.0 ; ml 15.2.

Remarks : The bats were observed roosting on trees and in the false ceiling of a house. These were collected with the help of a mist net.

All the females were pregnant, carrying foetuses in various stages of development. However, out of seven females, two had single foetus and the rest two each. Vertex-coccyx length varied from 21 to 24 mm. (mean 22.8). Both the males had well developed testes.

The ratio of female and male in the collected sample is. 3.5 : 1.

Order CARNIVORA

Family VIVERRIDAE

Herpestes edwardsi nyula (Hodgson)

1836, *Mangusta (Herpestes) nyula* Hodgson, *J. Asiat. Soc. Beng.*, 5 : 236 (Nepal, Lowlands).

Material examined : 1 ♀ ; Mathabhanga, Koch Behar district ; 18. iv. 1986 ; coll. S. Chakraborty.

Measurements : External : 1 ♀ ; *H & B* 340 ; *TI* 342 ; *Hf* 69 ; *E* 15. Cranial : 1 ♀ : *l* 72.7 ; *cb* 71.4 ; *iw* 13.3 ; *po* 11.2 ; *zw* 38 ; *pm* 6.4 ; *m₁* 6.3 ; *mw* 13.7 ; *ml* 50.0.

Remarks : The mongoose had two foetuses in its uterus in an advanced stage of development, measuring 112 and 115 mm. The dorsum of the foetus was covered with fine pale brown hairs but venter was almost naked.

Order RODENTIA

Family MURIDAE

Nesokia indica indica (Gray)

1932, *Arvicola indica* Gray, 111. *Indian Zool.*, 1, pl. 11 (India).

Material examined : 2 ♂ ; Plassey, Nadia district ; 21. x. 1987 ; coll. S. Chakraborty.

Measurements : External : 2 ♂ : *H & B* 145, 177 ; *TI* 84, 98 ; *Hf* 30, 31 ; *E* 20, 19. Cranial : 2 ♂ : *on* 37.6, 39.8 ; *cb* 38.6, 40.2 ; *n* 11.7, 12 ; *pl* 24.5, 25 ; *mtr* 6.9, 7.2 ; *apf* 4.5, 5 ; *bl* 7, 8.5 ; *zw* 25.6, 26.3 ; *d* 14.9, 14.9.

Remarks : This species was reported from Punjab, Rajasthan, Haryana, Delhi and Uttar Pradesh in India (Blanford 1891, Ellerman & Morrison-Scott 1951, Ellerman 1961, Biswas & Tiwari 1969, Roberts 1977, Honacki *et al.* 1982). Recently, it has been reported from Nepal (Agrawal and Chakraborty 1971), Bihar (Sinha 1981) and Kushtia and Jessore in Bangladesh (Brooks 1987). Hence, the present report from Nadia district not only constitutes its first record from West Bengal but also makes its distribution continuous, practically throughout northern India including Nepal and Bangladesh.

Both the specimens were collected by digging the burrows located on 'bunds' adjacent to a sugarcane field on the bank of the river Ganga. A litter of six was found in one of the burrows.

DISCUSSION

Many of the species of mammals especially bats collected from Koch Behar in early April were pregnant. The foetuses were in advance stages of development. It shows that March and April (premonsoon period) are the breeding months of these mammals in northern West Bengal. Another feature to be marked is the uneven sex ratio of all the breeding bats collected, with the females outnumbering the males. Such a phenomenon has been reported in most of the Indian bats so far studied (Gopalkrishna and Madhavan 1970, Gopalkrishna *et al.* 1985, Madhavan 1971) except in *Taphozous melanopogon* and *Hipposideros lankadiva* (Abdulali 1949). Evidently, there is a preferential mortality of the males during the growth period and this is probably an adaptation to increase the potential reproductive population of the species (Gopalkrishna and Sakpal 1987).

On the basis of the past distributional records of *Nesokia indica* this species was understood to be mainly an inhabitant of arid region. Asia Minor, Egypt to Pakistan, Turkmenia, Uzbekistan, Tadzhikistan (USSR) and India Punjab, Haryana,

Rajasthan and Delhi in India. Now, it appears that it has established itself in relatively humid areas too, similar to another arid species, namely *Tatera indica* (vide Wroughton 1915, Parrack 1966, Mandal and Dey Sarkar, 1984).

SUMMARY

In this paper *Suncus stoliczkanus* (Anderson) and *Nesokia indica indica* (Gray) have been recorded for the first time from West Bengal. Further, the occurrence of *Macroglossus minimus sobrinus* Andersen in West Bengal is authenticated with the collection of two adult specimens from Koch Behar district. This paper also incorporates breeding data on four species of mammals, namely, *Cynopterus sphinx sphinx* (Vahl), *Megaderma lyra lyra* Geoffroy, *Scotophilus heathi heathi* (Horsfield) and *Herpestes edwardsi nyula* (Hodgson).

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**TAXONOMIC STATUS AND PHYLOGENETIC RELATIONSHIP
OF LITTLE KNOWN HILL STREAM FISH OF THE GENUS
PARAPSIORHYNCHUS (CYPRINIFORMES)***

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INTRODUCTION

The fish fauna of hill streams offer us an unique opportunity for studying some of the most remarkable adaptive designs amongst fishes. *Parapsilorhynchus* is one such fish, found in the fast flowing streams of the western ghats and the Satpuda hill ranges. This genus is remarkable in possessing a combination of characters which in turn form the family diagnostic characters of Cyprinidae, Psilorhynchidae, Homalopteridae and Gyrinocheilidae, besides having its own diagnostic characters. A callous pad present on the ventral side behind the lower lip is a very distinctive feature of this genus.

Annandale (1919) originally described the species *Psilorhynchus tentaculatus* from the hills of the Western ghats. Hora (1920) distinguished this species from other species of *Psilorhynchus* in the presence of a pair of barbels, lower lip bilobed and swim bladder being normal. Later Hora (1921) created a new genus *Parapsilorhynchus* with *Psilorhynchus tentaculatus* as the type species with distinguishing characters such as presence of two blunt cylindrical barbels on the snout, cyprinid type swim bladder and a characteristic upper lip with minute tubercles and with a rudimentary disc behind the lower lip. Later Hora (1925) elevated the genus *Psilorhynchus* into family Psilorhynchidae but the position of the genus *Parapsilorhynchus* was not discussed, obviously retaining it in the subfamily Cyprininae of family Cyprinidae. Yiyu (1981) considered it as a subfamily of Cyprinidae. The genus *Parapsilorhynchus* is known by three species viz., *P. tentaculatus* Annandale, *P. prateri* Hora & Misra and *P. discophorus*. Hora (1925) had considered *P. discophorus* as a synonym of *P. tentaculatus* but a close study of a series of *P. discophorus* specimens obtained from Koyna river (Western ghats) has shown that this species has its own specific characters distinct from *P. tentaculatus* (Yazdani & Rao 1977). The authors have obtained specimens of *P. tentaculatus* from around Pune, of *P. prateri* from Trimbak, Nasik and *P. discophorus* from Koyna river about 20 km. west of Mahabaleshwar. A study of these specimens made the authors realise the necessity to have a critical look into the taxonomic position of this genus vis-a-vis the related genera viz., *Psilorhynchus*, *Garra*, *Crossocheilus* and *Labeo*.

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As taxonomic studies are usually based on external morphological characters which are sometimes not sufficient enough (Regan 1911), osteological work has also been used to supplement the external characters.

MATERIAL AND METHODS

The present investigation is based on the comparative study of the following specimens :

Family CYPRINIDAE

Subfamily CYPRININAE

Labeo dero (Ham), *Parapsilorhynchus tentaculatus* Annandale—2 specimens

Subfamily GARRINAE

Crossocheilus latius (Ham)—2 specimens

Garra mullya (Sykes)—2 specimens

Subfamily PSILORHYNCHINAE

Psilorhynchus balitora (Ham)—1 specimen

Alizarin preparations were made of the above number of specimens for studying the osteological details. The figures were drawn with the help of a camera lucida. The osteological characters of subfamilies Rasborinae, Schizothoracinae and Cultrinae of the family Cyprinidae have not been taken into account as they do not come under the purview of this study.

OBSERVATIONS

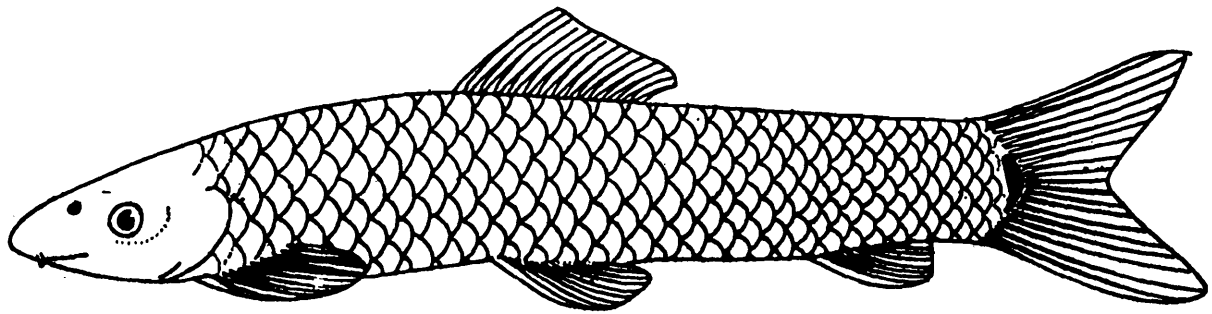
In *Parapsilorhynchus* the head is depressed, bearing a pair of rostral barbels. The snout is prominent. The mouth is small, ventral and horizontal (fig. 1). The upper lip is covered by a prominent rostral fold which is fringed. The lower lip is finely papillated. A groove is present round the corners of the mouth which is continued anteriorly round the outer margin of the rostral fold. Behind the lower lip is a callous area of skin. The ventral surface is flattened especially the anterior half of the body. Paired fins are horizontally placed, flattened and fan shaped. Four anterior rays of the pectoral are simple. The body is covered with small cycloid scales, except on the head and ventral surface. The gill openings are restricted to the sides. The gill rakers are absent. Only two pairs of pharyngeal teeth are present.

In all cyprinids the swim bladder lies immediately beneath the vertebral column and is an elongated structure consisting of anterior and posterior chambers (fig. 2). The two chambers are separated by a constriction in between them. In *Parapsilorhynchus* the swim bladder is reduced while in *Crossocheilus*, *Garra* and *Labeo* it is well developed. In *Psilorhynchus* it is generally very much reduced and the anterior chamber is partly or wholly covered with a thick fibrous coat.

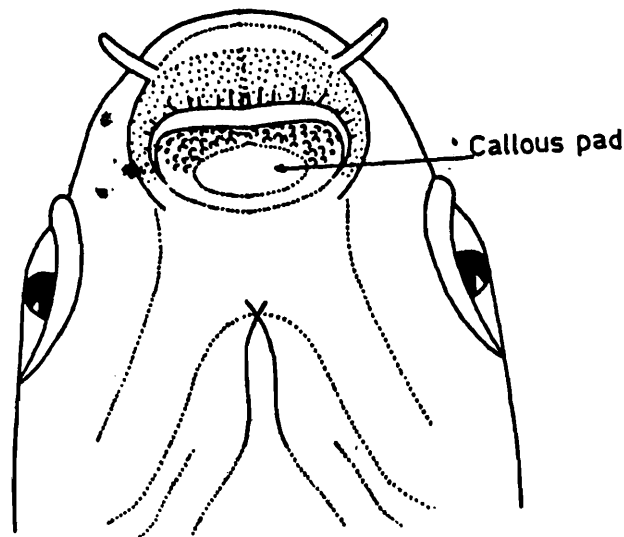
Some of the important osteological characters of *Parapsilorhynchus* are compared with those of related genera (Table 1, fig. 3 & 4).

Table 1

Osteological characters	Parapsilorhynchus	Subfamily : Garrinae <i>Crossocheilus Garra</i>		Subfamily : Psilorhynchinae <i>Psilorhynchus</i>	Subfamily : Cyprininae <i>Labeo</i>
Skull	Dorsoventrally flattened	Dorsoventrally flattened	Dorsoventrally flattened	Dorsoventrally flattened	not flattened
Supraethmoid notch	absent	absent	absent	absent	present
Ethmoid	Depressed	depressed	depressed	depressed	not depressed
Lateral process of ethmoid	Bifid	bifid	bifid	bifid	not distinctly bifid
Location of Preethmoid Prevomer	In anterior part	anterior part	anterior part	anterior part	posteriolateral part
Frontals	Broad with short posterior process	with blunt process	long process	long process	blunt process
Infraorbitals	long & narrow	long & narrow	long & narrow	long & narrow	not long & narrow
Parasphenoid	four	five	six	five	five
	Anterior broad posterior not forked	anterior slender posterior forked	anterior broad posterior not forked	anterior slender posterior forked	anterior slender posterior not forked
Interorbital septum					
Basioccipital	absent	present	absent	absent	present
	with very long post. process	very long post. process	very long post. process	short process	long with bifid tip
Urohyal					
Coracocleithral fenestra of Pectoral girdle	vertical wing extended much reduced	not extended much reduced	extended much reduced	not extended much reduced	extended not reduced
lateral fenestra of Pelvic girdle					
	short	long	short	short	long



A



B

Fig. 1. A. Lateral view of *P. tentaculatus* Hora
B. Anterior part of ventral surface of head.

The etkmoid region

The skull is dorsoventrally depressed in *Parapsilorhynchus*, *Psilorhynchus*, *Garra* and *Crossocheilus* while in *Labeo* it is not so. The premaxilla in all the five genera studied (*Parapsilorhynchus*, *Garra*, *Crossocheilus*, *Labeo* & *Psilorhynchus*), shows the characteristic *cyprinid* rostral process. In *Parapsilorhynchus* and *Psilorhynchus* the lateral limb of the premaxilla is long and bent at almost right angles. It shows an expanded posterior part. The lateral limb is short in *Crossocheilus* and *Labeo* while it is long in *Garra*. In *Parapsilorhynchus*, the supraethmoid part of the ethmoid possess two wing like extensions lying dorsally over the prominent prevomerine projection. In *Psilorhynchus* the supraethmoid is very broad and extends anteriorly in the form of a projection in the middle. In *Garra* and *Labeo* too the supraethmoid is wide with the prevomer extending considerably in front as a projection, while in *Crossocheilus* it is not so broad, leaving a small gap between the two prevomerine projections. The supraethmoid notch is absent in all except in *Labeo*, the preethmoid occupies a somewhat anterior portion of the prevomer while in *Labeo* it lies posterolateral to the prevomer.

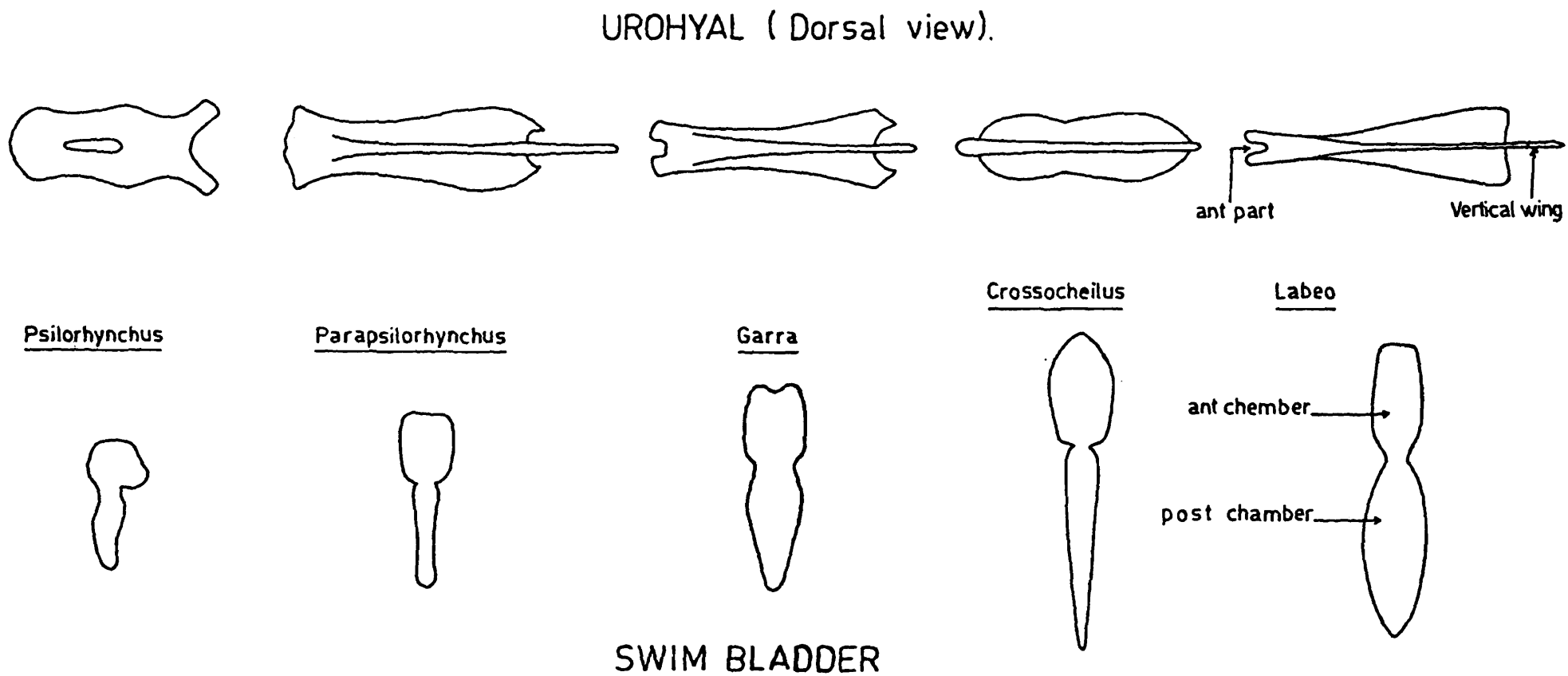


Fig. 2. Swim Bladder of *Parapsilorhynchus*, *Crossocheilus*, *Garra*, *Labeo* and *Psilorhynchus*.

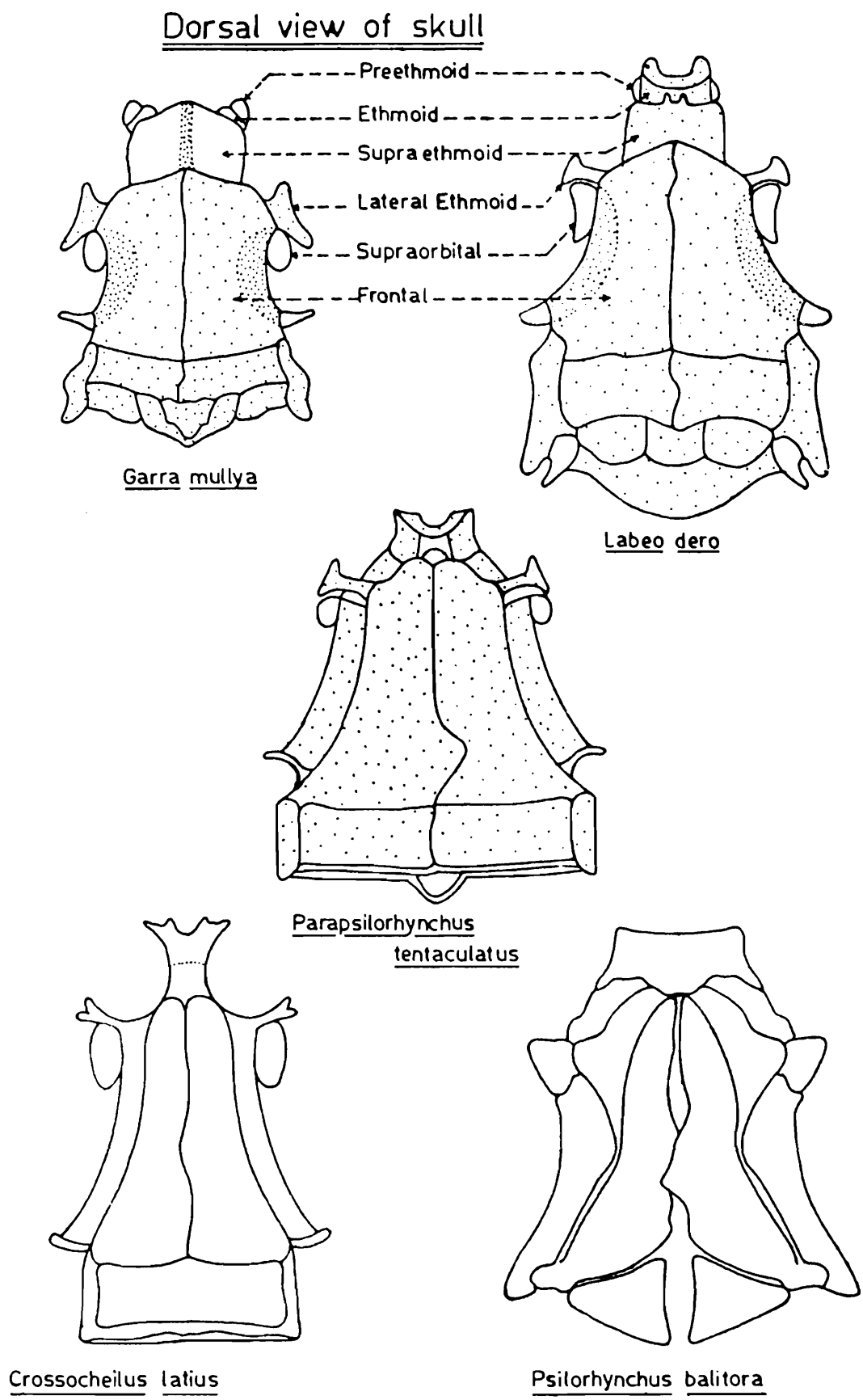


Fig. 3. Dorsal & ventral view of the skull of *Parapsilorhynchus*, *Crossocheilus*, *Garra*, *Labeo* and *Psilorhynchus*.

Dorsal Aspects of Pelvic girdle

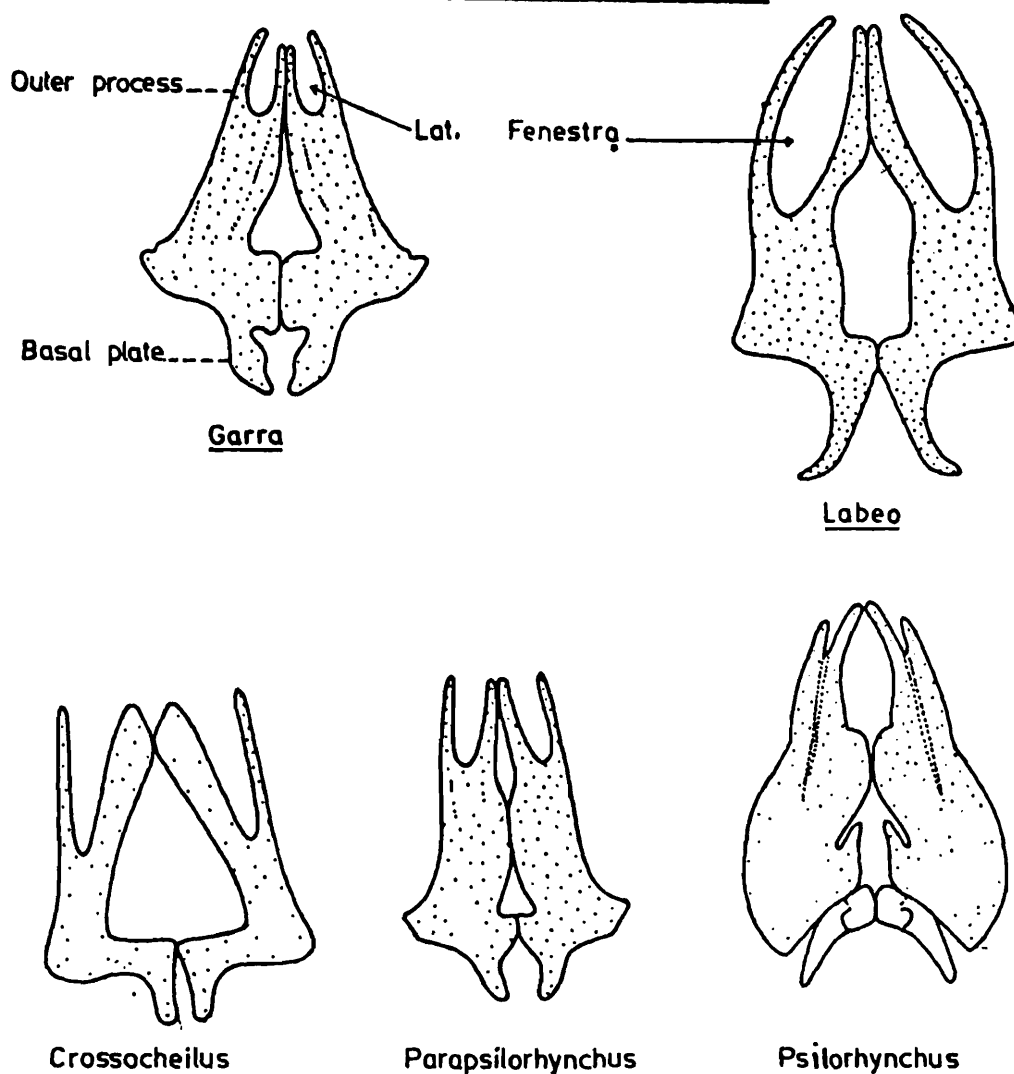


Fig. 4. Urohyal & Pelvic Girdle of *Parapsilorhynchus*, *Crossocheilus*, *Gara*, *Labeo* & *Psilorhynchus*
 pm, premaxilla ; max, maxilla ; mr, median rostral ; et, ethmoid ; pet, preethmoid ; pv, prevomer ; ppv, posterior process of vomer ; se, supraethmoid ; pal, palatine ; sor, supraorbital
 i, first infraorbital ; fr, frontal ; f, fontanel ; na, nasal ; pas, parasphenoid ; pt, pterotic, pro, prootic ; pa, parietal ; epi, epiotic ; eo, exoccipital ; so, supraoccipital ; bo, basioccipital ; So₂-So₆, infraorbitals (2-6) or suborbitals ; pt, post temporal ; php, pharyngeal process ; bp, bony plate.

The prevomer bone is very broad in *Parapsilorhynchus* with a short posterior process. In *Psilorhynchus* it is not as broad but shows a long posterior process. In *Garra* the anterior portion of the prevomer spreads out and there is a long posterior process. In *Crossocheilus* and *Labeo* the anterior portion is not so broad while the posterior portion is blunt.

The Orbital region

In all the genera excepting *Labeo* the frontals are long and narrow. In *Psilorhynchus* alone there is a median fontanel between the two frontals and the posterior edge of the supraethmoid. The orbit is large in *Parapsilorhynchus* and *Psilorhynchus*. Two small supraorbitals are noticed in all the genera studied excepting *Psilorhynchus* where they are completely absent.

In *Parapsilorhynchus*, on either side of the frontals are present 4 infraorbital (suborbitals) bones, while in others it varies from 5 (*Psilorhynchus*, *Crossocheilus*, *Labeo*) to 6 (*Garra*).

The interorbital septum, formed by the orbitosphenoids and the underlying parasphenoid, is present in *Labeo* and *Crossocheilus* while it is absent in the other genera under study. The parasphenoid is prominently forked in *Psilorhynchus* and *Crossocheilus* but it is not so in *Parapsilorhynchus* (and *Labeo* and *Garra*).

The Occipital region

In all the genera studied the exoccipitals form the roof of the foramen magnum, supraoccipital being excluded. The basioccipital shows a pharyngeal process which may be short (*Psilorhynchus*) or long (*Parapsilorhynchus*, *Garra*, *Crossocheilus* and *Labeo*). In *Labeo* the long pharyngeal process of the basioccipital tapers into a bifid tip.

The Urohyal

The shape of this bone differs in all the genera studied. The vertical wing of the urohyal extends posteriorly in *Parapsilorhynchus*, *Garra* and *Labeo* while in *Psilorhynchus* and *Crossocheilus* it is very much reduced (fig. 4).

The Pelvic Girdle

It comprises of two basipterygia, each consisting of a bony plate with two anterior processes (an outer & inner) and a horse shoe shaped posterior process. In *Parapsilorhynchus*, *Crossocheilus*, *Garra* and *Labeo* the two anterior processes of basipterygia are long and slender. Their anterior ends are wide apart. In *Psilorhynchus*, unlike others, the basipterygia are completely united with each other and the lateral & median fenestrae are reduced. In *Parapsilorhynchus* the median fenestra is reduced.

DISCUSSION

Fishes of the genus *Parapsilorhynchus* possess a peculiar combination of characters which they share with other Cyprinid subfamilies besides having their own distinctive characters. In order to assess the systematic position of *Parapsilorhynchus* it is, therefore, necessary to first find out the characters it shares with subfamilies Cyprininae, Garrinae & Psilorhynchinae and then its distinctive characters.

Parapsilorhynchus exhibits the following characters which is common to subfamily Cyprininae : premaxilla with a rostral process : median rostral with two dorsolateral processes ; the pre-ethmoid articulates with the palatine ; lateral ethmoid without prominent lateral processes ; supraoccipital does not roof the foramen magnum and exoccipitals cover it dorsally ; basioccipital with prominent pharyngeal process vertical wing of urohyal extended.

Parapsilorhynchus is distinguished from cyprininae in possessing more than one undivided pectoral ray ; presence of a callous thickening behind the lower lip ; typical body shape with paired fins horizontally placed ; gill openings restricted to

sides ; skull being dorsoventrally depressed ; supraethmoid notch absent ; pre-ethmoid anterior in position ; prevomer with short posterior process ; parasphenoid broad anteriorly ; interorbital septum absent ; frontals long and narrow ; lower number of infraorbital bones ; pharyngeal process of basioccipital without bifid tip coracocleithral fenestrae of pectoral girdle greatly reduced ; lateral and median fenestrae of the pelvic girdle reduced.

Parapsilorhynchus shows certain characters which are in common with subfamily Garrinae, viz., spatulate body shape ; paired fins horizontally placed pectorals possessing broader base ; skull dorsoventrally flattened ; supraethmoid notch absent ; basioccipital with long posterior process ; vertical wing of urohyal extended parasphenoid not forked.

Parapsilorhynchus differs from subfamily Garrinae in possessing a callous thickening behind the lower lip (regular muscular disc in *Garra*) ; gill openings extending upto pectoral fins ; prevomer with a short process ; parasphenoid not forked ; lower number of infraorbital bones ; absence of interorbital septum.

Parapsilorhynchus exhibits the following characters common in subfamily Psilorhynchinae ; large supraethmoid immovably articulated with the frontals ; pre-ethmoid articulates with the palatines ; premaxilla with a rostral process ; exoccipitals form the roof of foramen magnum ; basioccipital with bony plate and pharyngeal process.

From subfamily Psilorhynchinae it differs in possessing a pair of barbels ; two rows of pharyngeal teeth ; presence of callous thickening behind the lower lip ; under lip with fringed labial fold ; origin of dorsal fin almost opposite to that of the ventral fin ; short posterior process of prevomer ; absence of median ethmoid process ; absence of fontanel ; presence of supraorbital ; wing of urohyal extended ; elongated swim bladder not covered with a fibrous coat and in the number of infraorbital bones.

Parapsilorhynchus has its own distinctive characters not found in the related subfamilies : presence of a characteristic callous thickening on the ventral side, behind the lip ; presence of two blunt barbels on the snout ; gill openings restricted to sides (upto Petoral fin base) ; lesser number (4) of infraorbital bones ; absence of gill rakers.

The features mentioned above are sufficiently distinctive to warrant the separation of *Parapsilorhynchus* from subfamily cyprininae to a rank of a subfamily in itself.

DISTRIBUTION AND EVOLUTION

The genus *Parapsilorhynchus* has a restricted distribution mainly occurring in the Western ghats and the Satpuda hill ranges. It has also been recorded from the Balladila ranges of Bastar (M.P.) by Hora (1938). He also expressed the view that during the earlier geological period the Balladila ranges formed a part of the Satpudas and probably served as a highway for fish migration. The related genus *Psilorhynchus* occurs in the Himalayan region. Both are typical hill stream fishes. From their general similarities in morphology and habit it appears that both have a common origin and most likely as in the case of all earlier fishes, evolved in the South Chinese region and migrated to the eastern Himalayas and Westward to the Western ghats along the Garo hills-Rajmahal-Vindhya-Satpuda ranges during the

Pleistocene glaciation period when the Garo—Rajmahal gap was elevated and migration was possible for hill stream fishes. After migration the forms that reached the western side have specialised and developed their own characters evolving into a different group whereas those remaining back in the eastern himalayas have evolved into the present day Psilorhynchidae.

SUMMARY

Fishes of the genus *Parapsilorhynchus* Hora are found in the fast flowing streams of the Western ghats and Satpuda hill ranges. This genus is remarkable in possessing a combination of characters which in turn form the family diagnostic characters of Cyprinidae, Psilorhynchidae, Homalopteridae and Gyrinocheilidae, besides having its own diagnostic characters. A study was made on the taxonomic status of this genus vis-a-vis the related genera, viz., *Psilorhynchus*, *Garra*, *Crossocheilus* and *Labeo*. In the light of this study it was seen that its present inclusion in subfamily Cyprininae of the family Cyprinidae is not justified.

ACKNOWLEDGEMENT

We are thankful to Dr. B.S. lamba, Scientist-SF-Incharge, ZSI, Calcutta for allowing us to undertake this work.

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**NOTES ON A COLLECTION OF DERMAPTERA (INSECTA) FROM SABAH,
MALAYSIA PRESERVED IN THE NATIONAL MUSEUM OF NATURAL
HISTORY, WASHINGTON, D.C. (U.S.A.)**

G. K. SRIVASTAVA
Zoological Survey of India, Calcutta

The present study is based on a small collection of Dermaptera from Sabah, Malaysia brought by Mr. Garry F. Hevel and Mr. Warren E. Steiner which comprises 16 species (including 1 identified up to generic level, since represented by a only) and these include four species new to science, viz., *Cranopygia steineri*; *Displatys heveli*, *Chaetospania lamellata* and *Cordax cornutus*.

The fauna of Borneo appears not to have been adequately explored. Our knowledge is largely based on works of Burr (1900); Borelli (1932, 1932a) and Brindle (1980).

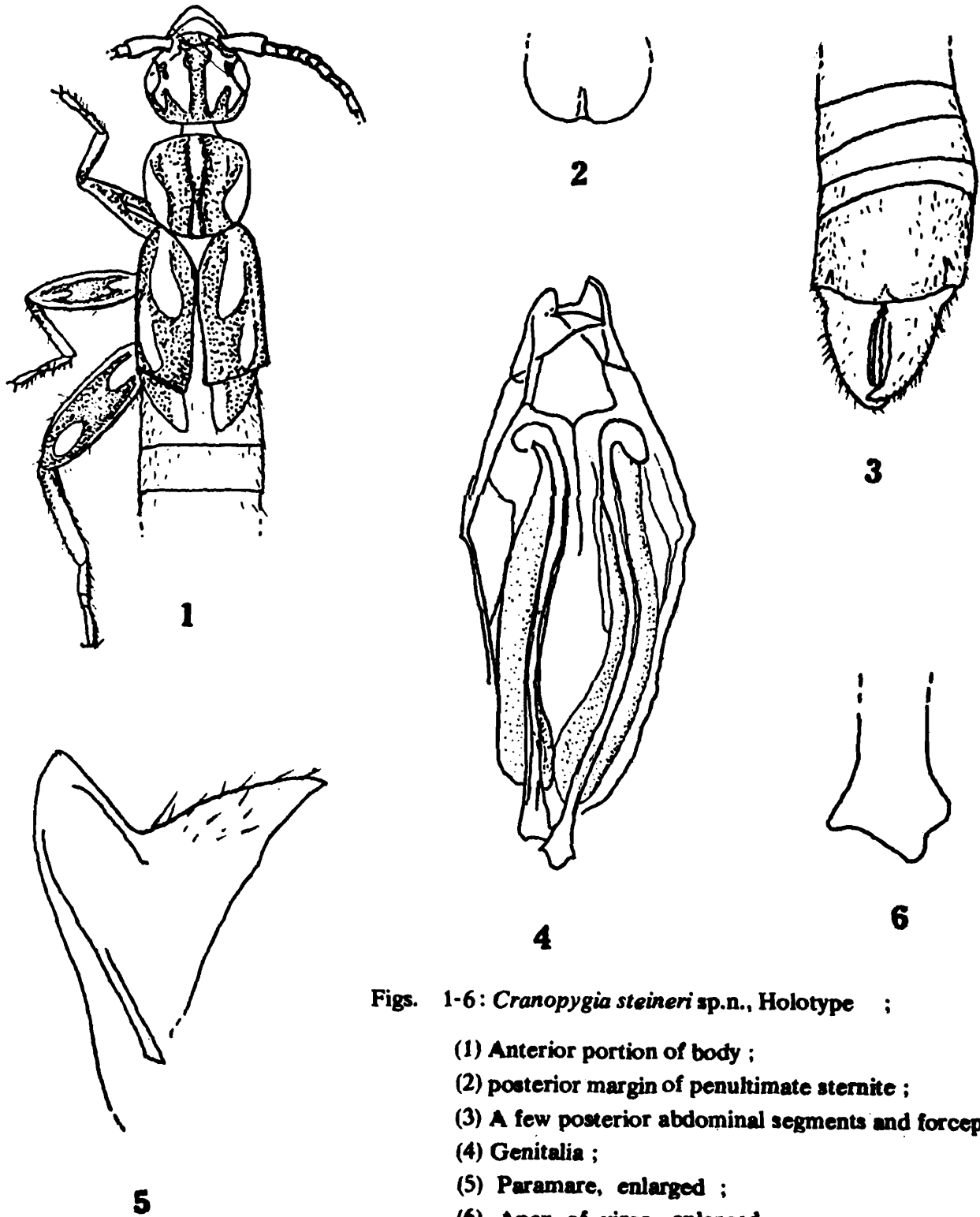
PYGIDICRANOIDEA
PYGIDICRANIDAE
PYGIDICRANINAE

***Cranopygia steineri* sp. n.**
(Figs. 1-6)

♂ : Yellowish, head dark brown on all sides and with a median stripe of some colour and another on post-ocular area; antennal segments except basal one light brown; pronotum with dark brown, broad longitudinal stripes, separated by a median yellow streak; elytra dark brown with an oblong spot extending from shoulder to middle and another smaller one in apical half; legs with femora dark brown with a yellow spot basally and apically, tibia in apical 2/3 and whole of tarsi yellow; abdomen and forceps dark blackish brown. Abdomen and forceps covered with fine yellow pubescence; head, pronotum elytra, wings and legs covered with short and long stiff hairs.

Head weakly convex, longer than broad, hind margin feebly emarginate. Eyes longer than the post-ocular length. Antennae partly broken (right side with 22 segments and left with 31 segments remaining), basal segment stout, about as long as the distance between bases of antennae; 2nd about as long as broad; 3rd long and slender, 1½ times longer than broad; 4th and 5th transverse; 6th slightly longer than broad, remaining gradually increasing in length and thinning. Pronotum slightly longer than broad, anteriorly and sides lightly convex, posterior margin truncate, median sulcus distinct, prozona raised and metazona weakly depressed. Elytra and wings well developed, former with inner basal angle rounded off to

show a triangular scutellum. Abdomen convex, smooth, gradually enlarging posteriorly. Penultimate sternite narrowed posteriorly, hind margin rounded with slight emargination in the middle, a fine, median groove in apical half present. Ultimate tergite slightly longer than broad, convex above, sloping backwards, in the middle posteriorly close to hind margin a glabrous, triangular area present, hind margin truncate, laterally oblique and emarginate, angles slightly projecting. laterally depressed. Forceps depressed, contiguous, tapering apically with tip



Figs. 1-6: *Cranopygia steineri* sp.n., Holotype ;

- (1) Anterior portion of body ;
- (2) posterior margin of penultimate sternite ;
- (3) A few posterior abdominal segments and forceps ;
- (4) Genitalia ;
- (5) Paramere, enlarged ;
- (6) Apex of virga, enlarged ;

gently hooked, inner margin ventrally at base dentate, afterwards dentation fine. Genitalia with parameres internally armed with a triangular tooth and apical external angle produced into a pointed lobe ; virga stout with tip trilobate, laterally furnished with membranous flange, almost throughout the entire length.

Measurements.—(in mm)

Holotype

♂

Length of body

18.5

Length of forceps

2.0

♀ : Unknown.

Material examined.—MALAYSIA : Sabah, 20 km E. Telupid, Holotype ♂ (genitalia mounted between two coverslips and pinned with the specimen), 14 August 1983, deposited at National Museum of Natural History, Washington, D.C., U.S.A.

Remarks.—This species resembles closely in external features with *Cranopygia curtula* Hincks, from Borneo but differs in being slightly shorter in size and having distinctive genitalia especially the shape of parameres with external apical angle pointed ; virga with membranous flange more pronounced, extending up to a little before the apex and tip tri-lobed.

DIPLATYINAE

Diplatys jacobsoni Burr

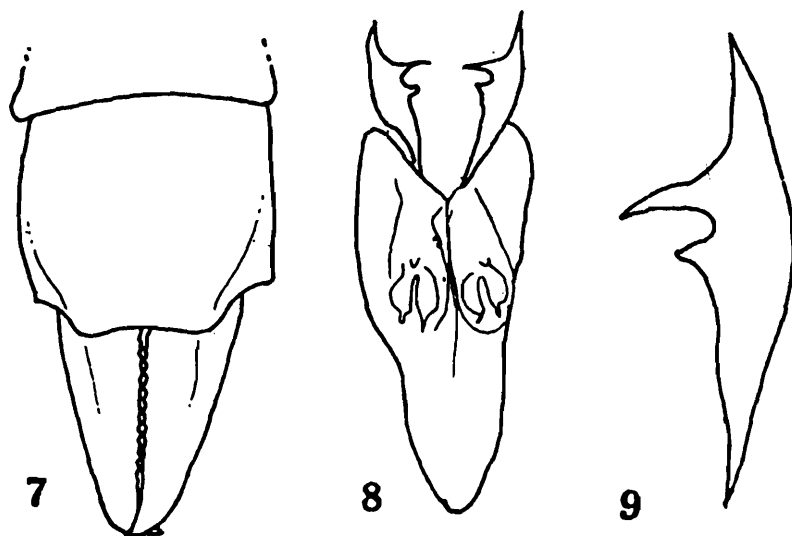
(Figs. 7-9)

1911. *Diplatys jacobsoni* Burr, *Trs.R.ent.Soc.Lond.*, 1911 28; 40, pl. 8, Fig. 23 a-b (♂ ; Java, Batavia).

Material examined.—MALAYSIA : Sabah ; Kinabalu National Park, Poring, el. 570 m. 1 ♂ (genitalia mounted between two coverslips and attached with the specimen), 8 sept 1983.

Distribution.—Java and Sabah (present record).

Remarks.—The forceps represent the microlabic phase.



Diplatys jacobsoni Burr,

(7) Ultimate tergite and forceps ;

(8) Genitalia ;

(9) Paramere, enlarged.

Diplaty heveli sp.n.

(Figs. 10-14)

♂ : General colour blackish brown ; antennae with 3rd, 4th and 5th in basal half only, pronotum laterally and posteriorly, elytra on shoulders, legs with knee joints, apical part of tibia and whole of tarsi and forceps yellowish brown. Finely pubescent ; a few stiff hairs present on legs and margins of pronotum.

Head slightly longer than broad, frons raised, occiput depressed, post-ocular carina extending from eye to hind margin, median suture marked by a fine groove, transverse suture obsolete, hind margin slightly thickened and broadly emarginate. Eyes whitish, prominent, about twice as long as the post-ocular distance. Antennae partly broken, only 14 segments remaining on both sides ; 1st stout, slightly shorter than the distance between antennal bases ; 2nd about as long as broad ; 3rd long and slender, 4th slightly shorter than the preceding and 5th almost equal to 3rd, remaining gradually increasing in length. Pronotum rounded, narrowed posteriorly, hind margin subtruncate, prozona convex and well differentiated from depressed metazona, median sulcus distinct. Elytra and wings well developed, former with inner basal angle rounded off to show a small scutellum. Leg typical for the genus. Abdomen convex, gradually enlarging posteriorly. Penultimate sternite with hind margin broadly emarginate, feebly depressed in posterior half with a fine median groove. Ultimate tergite about as long as broad, disc above convex, gently sloping backwards with a slight depression in middle, hind margin trisinate, laterally oblique. Forceps with branches contiguous, depressed, tapering apically with tip gently hooked, inner margin finely serrated. Genitalia with parameres narrowed apically to a fine point, internally armed with a hooked tooth at apical 1/3, followed by an emargination and with another minute tooth ; distal lobes with virga stout, median unpaired portion short, arms of bifurcated portion strongly narrowed apically, a chitinous, denticulated rod also present.

♀ : Agrees with males in most characters except that the general colour darker, forceps simple and straight.

Measurements. — (in mm)

	Holotype	
	♂	♀
Length of body	12.6	9.4
Length of forceps	0.9	1.1

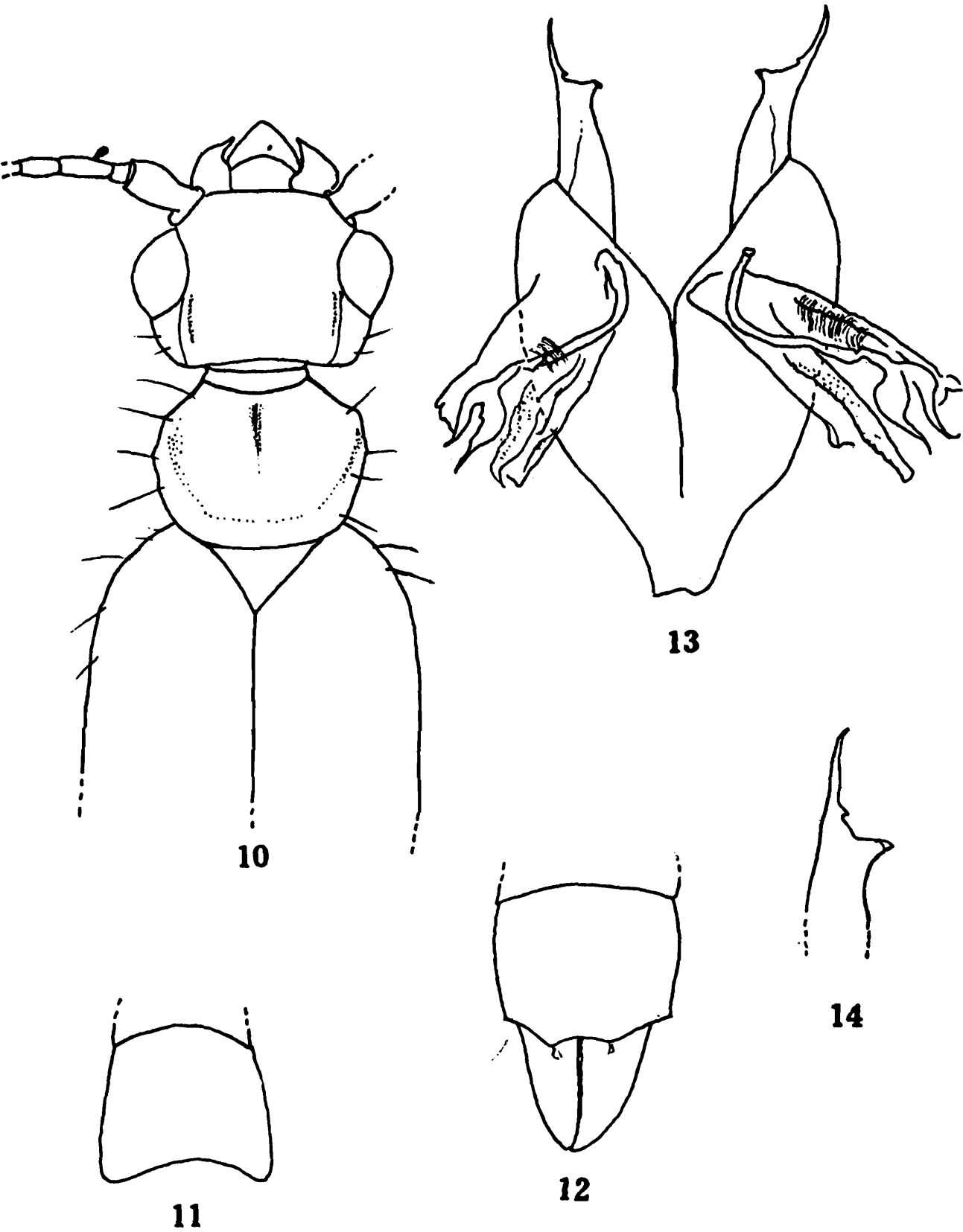
Material examined. — MALAYASIA : Sabah ; 1 km S. Kundasang, el. 1530 m, Holotype ♂ (genitalia mounted between two coverslips and pinned with the specimen), 28 Aug 1983, Malaise trap ; deposited at National Museum of Natural History, Washington, D.C., U.S.A.

1 ♀ and 1 nymph with same date as the Holotype except the date of collection, i.e., 24 Aug 1983 and 21 Aug, 1983, respectively.

Remarks. — This species comes very close *Diplatys nakasoni* Nishikawa, from South Vietnam but differs by the shape of penultimate sternite in having a depression in posterior half, with a median fine groove and posterior margin broadly concave ; parameres with two teeth internally, larger one at apical 1/3

and smaller minute one a little beyond it ; distal lobes with virga short and stout, apical protion of bifurcated protion strongly narrowed, and with a denticulated chitinous rod.

The 1 ♀ and 1 nymph are referred here since they were collected from the same locality as the Holotype but on different dates. Their identification should be treated with some reserve.



Figs. 10-14 : *Diplatys heveli* sp.n., Holotype ; (10) Anterior portion of body ; (11) Penultimate sternite ; (12) Ultimate tergite and forceps ; (13) Genitalia ; (14) Paramere enlarged ;

ECHINOSOMATINAE

Echinosoma horridum Dohrn

1863. *Echinosoma horridum* Dohrn, Stettin ent.Ztg., 24 : 66 (♂ Java).

Material examined. — MALAYASIA : Sabah ; 1 km S. Kundasang, el. 1530 m, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 22 August 1983.

Distribution. — Sumatra, Mentawai Is ; Java and Borneo.

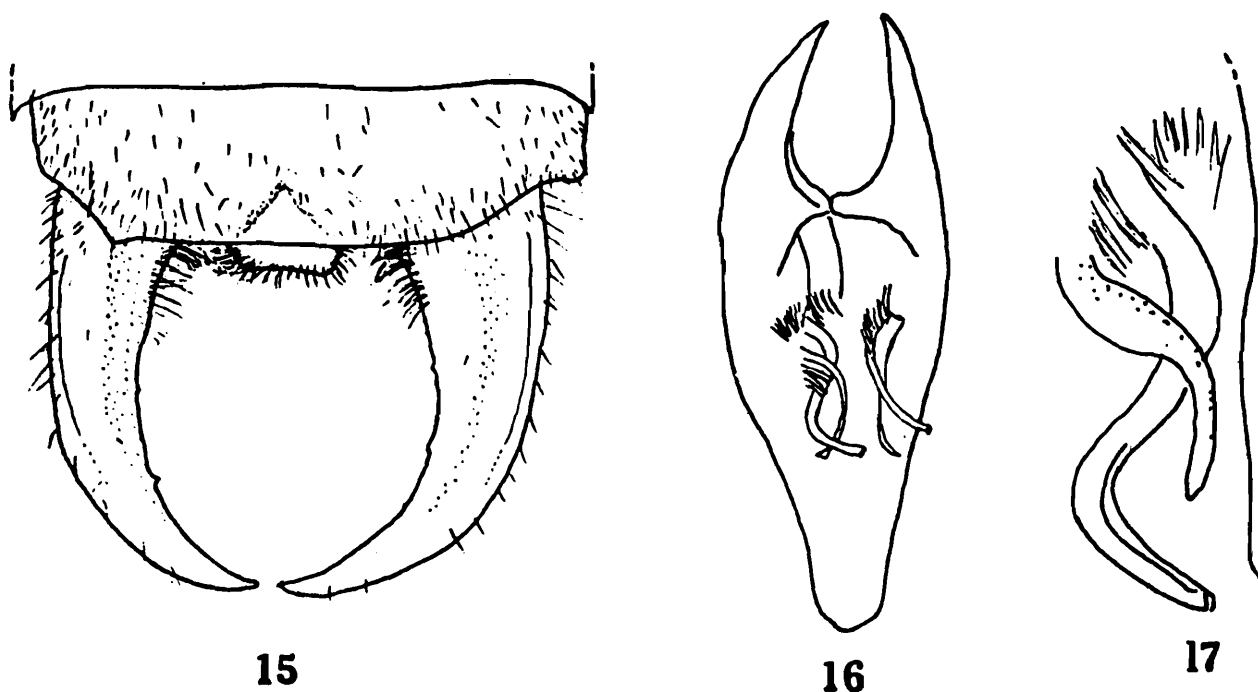
Echinosoma sumatranum (Haan)

(Figs. 15-17)

1842. *forficula* (*Echinosoma*) *sumatranum* Haan, Verh. nat. Gesch. Nér. Overz. Bezitt., 1842 : 241 (♂ ♀ ; Sumatra).

Material examined. — MALAYSIA : Sabah ; Telipok, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 12 August 1983.

Distribution. — China, Malay Peninsula, Vietnam, Sumatra, Java and Borneo.



Echinosoma sumatranum (Haan), ; 15) Ultimate tergite and forceps ; 16) Genitalia; 17) A, portion of distal lobe, enlarged.

Echinosoma sp.

Material examined. — MALAYSIA : Sabah ; Kula Penya, 1 ♀, 10 August 1983, at black light.

Remarks. — On the basis of size (Length ; body—5.3 ; forceps—0.8 mm) and general colouration it comes close to *E. parvalum* Dohrn, but in the absence of a ♂ it is not possible to identify with certainty up to specific level.

Euborellia plebeja (Dohrn)
(Fig. 18)

1863. *Labidura plebeja* Dohrn, *Stettin ent. Ztg.*, **24** : 322 (♀, Java).

Material examined. — MALAYSIA : Sabah : 25 km E. Telupid, 2 ♂♂ (1 ex with genitalia mounted between two coverslips and pinned with the specimen), 3 ♀♀, 17 August 1983, at blacklight.

Distribution. — Widely distributed in the Oriental Region.



Euborellia plebeja (Dohrn), ;

18) A portion of genitalia ;

LABIDURIDAE

NALINAE

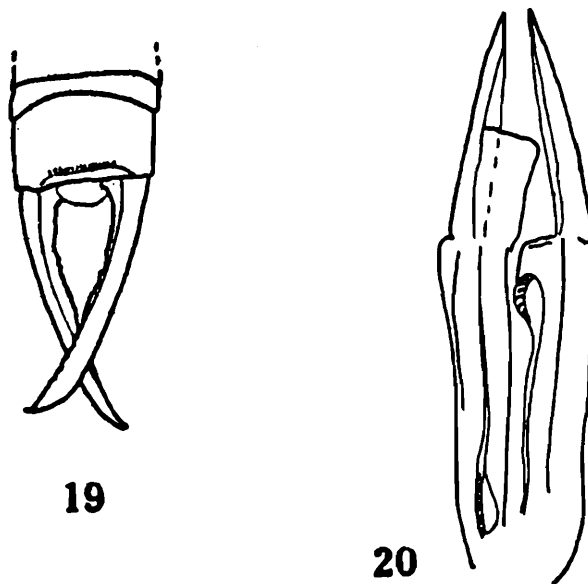
Nala ornata Borelli
(Figs. 19-20)

1932. *Nala ornata* Borelli, *J. fed. Malay St. Mus.*, **17** : 182, Figs. 1&2 (borneo : 1 ♂ Rock Ro, 1 ♀ Baran Riv.).

Material examined. — MALAYSIA : Sabah ; Ranau, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 13 Aug 1983, at blacklight.

Distribution. — Borneo.

Remarks. — This male specimen agrees with the original description of the species except for some minor variations in the inner dentation of forceps. The ♂ genitalia is figured here for the first time.



Nala ornata Borelli, (19) Ultimate tergite forceps ; (20) Genitalia :

LABIDURINAE

Labidura riparia (Pallas)

1773. *Forficula riparia* Pallas, *Reise Russ. Reichs*, 2 : 727 (sex ; Shores of Irtysh River, Western Siberia).

Material examined. — MALAYSIA : Sabah ; 1 km S Kundasang, el. 1503 m, 1 ♂ 6 Aug, 1983.

Distribution. — World wide.

Forcipula abbreviata Srivastava

Figs. 21-23

1986. *Forcipula abbreviata* Srivastava, *Rec.zool.Surv.India occ.pap.*, 89 : 10, Figs. 5 & 8 (♀, ♂ ; India : Arunachal Pradesh ; Sikkim and West Bengal (Darjeeling Dist.).

Material examined. — MALAYSIA : Sabah ; 17 km S. Keningau, 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 1 ♀ , 11 Aug. 1983.

Distribution. — India and Malaysia : Sabah (Present record).

Remarks. — The above material agrees with Indian material in most characters except that the sides of abdominal 3 to 5 provided with a hooked spine passing into the side below which is feebly developed, representing a vestige of ventral tubercle. In addition a very small tooth is also present on the sides of abdominal segments 2 and 6 also. On a closer examination of Indian material it has been found that such variation in the development of abdominal spines do exist and in males with minor development of forceps it is common.

FORFICULOIDEA SPONGIPHORIDAE SPONGIPHORINAE

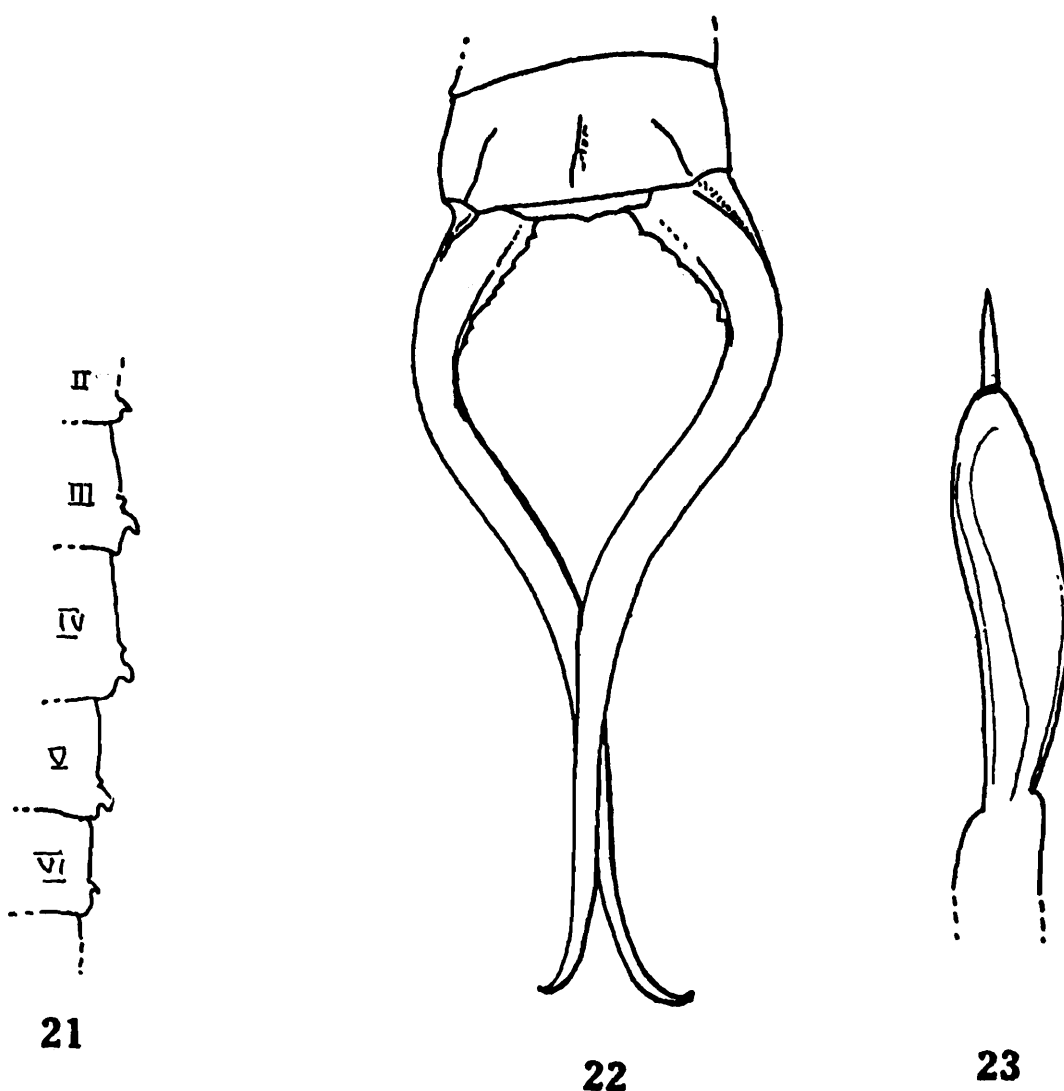
Spongovostox semiflavus (Bormans)

1894. *Spongophora semiflava* Bormans, *Annali Mus.civ.Stor.nat. Giacomo Doria*, (2) 14 : 385 (♂, ♀ ; Burma).

1911. *Spongovostox semiflavus* ; Burr, *Genera Insect*, 122 : 52.

Distribution. — Widely distributed in the Oriental Region and Bismark Is.

Material examined. — MALAYSIA : Sabah ; Telipok, 3 , 12 Aug. 1983.



Forcipula abbreviata Srivastava. 21) Sides of abdominal tergites 2nd to 6th showing the lateral spines ; (22) Ultimate tergite and forceps ; (23) Paramere, enlarged.

Remarks. — Although only females are represented these are referred here without any hesitation since they agree well with a large series from India, present in the collections of the Zoological Survey of India, Calcutta.

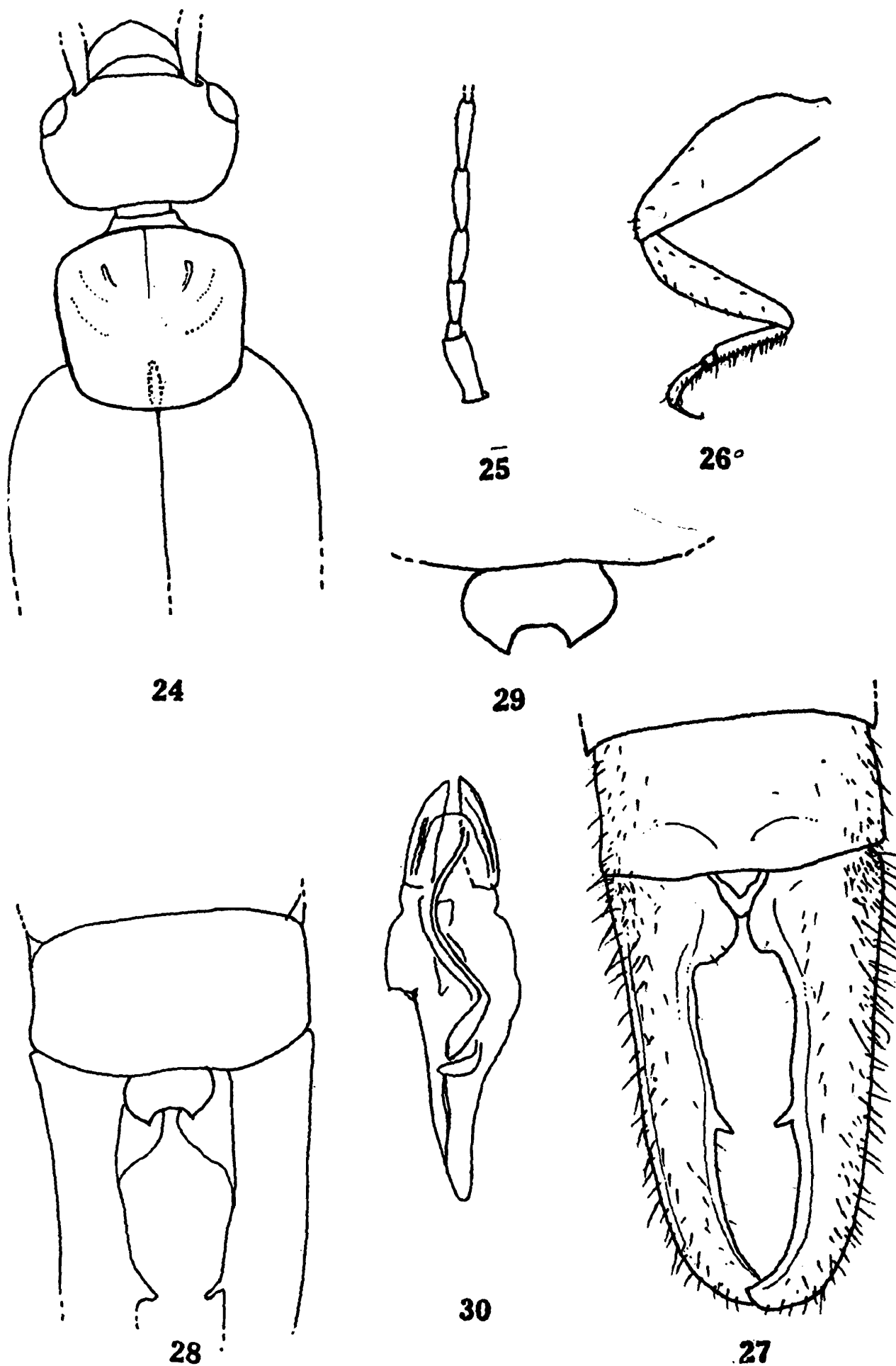
LABIINAE

***Chaetospania lamellata* sp.n.**

(Figs. 24-30)

♂ : General colour dark brownish black ; a few apical antennal segments, knee joint, apical 1/3 of tibia and whole tarsi of fore—leg yellowish brown. Finely pubescent, large pubescence present on certain body parts and forceps.

Head cordiform, slightly longer than broad, smooth, frons feebly depressed, sutures obsolete, hind margin emarginate in middle. Eyes reddish brown, about half as long as the post-ocular length. Antennae partly broken, 9 segments on the left side and 12 on the right present, basal segment narrowed at base, about as long as the distance between antennal bases ; 2nd short, about as long as broad ; 3rd



Figs. 24-30 : *Chaetospania lamellata* sp.n., Holotype ; 24) Anterior portion of body ; 25) A few antennal segments ; (26) Hind leg ; (27) Ultimate tergite and forceps ; (28) Penultimate sternite, pygidium and a portion of forceps ; (29) Pygidium, enlarged, in ventral view ; (30) Genitalia.

segments, slender ; 4th slightly longer and stouter than preceding ; 5th onwards gradually increasing in length except a few apical ones shorter, each segment narrowed basally. Pronotum quadrate, about as long as broad, sides parallel and deplanate, anteriorly convex, posterior margin and angles rounded, prozona raised and well differentiated from flat metazona, median sulcus distinct. Legs typical for the genus. Elytra and wings well developed, finely punctulate, former with hind margin obliquely truncate. Abdomen narrowed basally, convex, micro-reticulated. Penultimate sternite transverse, hind margin broadly convex with slight emargination in middle. Ultimate tergite transverse, micro-reticulated, moderately depressed, hind margin faintly trisinate, oblique laterally. Pygidium in dorsal view mostly covered by basal lamellation of forceps, in ventral view transverse, sides convex and hind margin distinctly concave, postero-lateral angles with a minute point. Forceps stout, depressed, straight, tapering apically with tips hooked and pointed, internally at base with a rounded lamellation, at about middle a ventral tooth directed downwards and backwards present, margin wavy, poorly differentiated in dorsal and ventral borders. Male genitalia with parameres narrowed apically, inner margin straight and external margin convex, virga tubular, boardly S-shaped, gently dilated at base, an accessory chitinous structure present.

Measurements. — (in mm) Holotype

	♂
Length of body	9.0
Length of forceps	2.8

♀ : Unknown.

Material examined. — MALAYSIA : Sabah ; 1 km S. Kundasang, el. 1530 m, Holotype ♂ (genitalia mounted between two coverslips and pinned with the specimen), 25 Aug. 1983, deposited at National Museum of Natural History, Washington D.C., U.S.A.

Remarks. — This species comes close to *Chaetospania feuerborni* Gunther, from Sunda Islands and Sumatra but differs in ♂ by the shape of pygidium being convex laterally and with a deep emargination in middle posteriorly (vs Pygidium transverse with posterior margin wavy or slightly longer than broad, narrowed posteriorly with a narrow emargination in middle posteriorly in *C. feuerborni* Gunther) and forceps at base with an inner lamellation converging the pygidium, followed by a sharp, small tooth at about middle (vs forceps without any basal lamellation internally, armed internally with minute tooth at basal 1/3 followed by another similar tooth at apical 1/3).

The described species can also be compared with *Chaetospania borneensis* (Dubrony) from Sarawak and Sumatra but differs a by the shape of pygidium and forceps.

CHELISOCHIDAE

CHELISOCHINAE

Adiathetus shelfordi (Burr)

1900. *Chelisoche shelfordi* Burr, *Ann. Mag. nat. Hist.*, (7) 6 : 96, pl. 4, Fig. 4 (♀ not ♂ ; Sarawak).

1900. *Chelisoche hercules* Burr, *Ann. Meg. nat. Hist.*, (7) 6 : 96, pl. 4, Fig. 2 (♂ ; Sarawak).

Material examined. — MALAYSIA : Sabah ; 1 km S. Kundasang, el. 1530m, 1

♀, 26 Aug. 1983.

Distribution. — India (Sikkim), Sumatra and Borneo.

FORFICULIDAE
OPISTHOCOSMIINAE

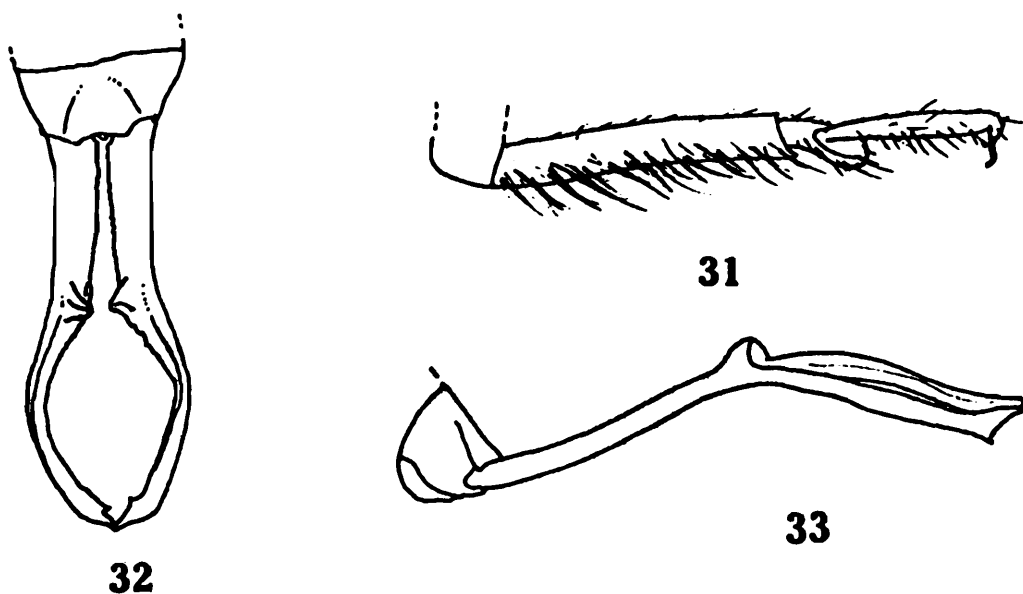
***Eparchus forcipatus* (Haan)**

(Figs. 31-33)

1842. *Forficula (Opisthocasmia) forcipata* Haan, *verh.nat.Gesch.Nederl.Overz.Bezitt*, 1842 : 243 (♀, ♂; Batang, Singalang, Sumatra).

Material examined. — MALAYSIA : Sabah ; 1 km. S. Kundasang, el. 1530m, 1 ♂, 5 ♀♀, 7 Aug 1983 ; 1 ♀ (genitalia mounted between two coverslips and pinned with the specimen), 28 Aug 1983.

Distribution. — Widely distributed in the Oriental Region.



Figs. 31-33 : *Eparchus forcipatus* (Haan) ; (31) Hind tarsi ; (32) Ultimate tergite and forceps ; (33) Forceps, in profile.

***Eparchus dux* (Bormans)**

(Figs. 34-39)

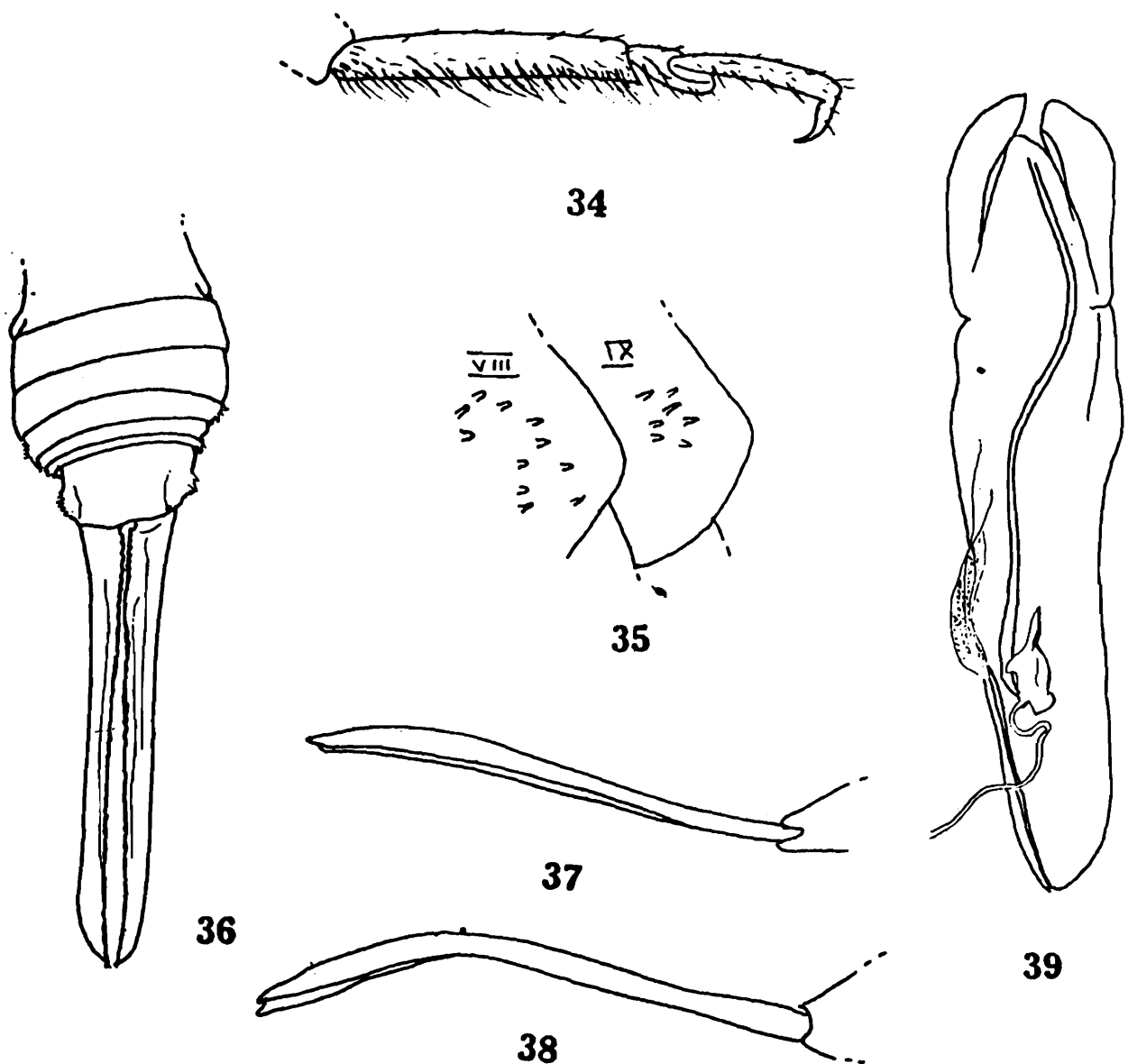
1894. *Opisthocasmia dux* Bormans, *Annali.Mus.Civ.Stor.nat.Giacomo Doria*, (2) 14 : 395 (2 ♂♂; Burma).

1981. *Eparchus dux* ; Srivastava, *Annali.Mus.Civ.Stor.nat.Giacomo Doria*, 83 : 300 (Lectotype and Paralectotypes designated).

Material examined. — MALAYSIA : Sabah ; Kinabalu National Park, headquarters area, el. 1560 m, 1 ♀, 5 Aug, 1983 ; 1 ♂, 8 Aug, 1983 ; 1 km S. Kundasang, el. 1530 m, 1 ♀, 7 Aug 1983 ; 1 ♀, 24 Aug 1983 ; 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 26 Aug 1983 ; 1 ♂ 28 Aug 1983.

Distribution. — Burma and Sabah (present record).

Remarks. — The present material agrees with the original description of the species and subsequent notes by Srivastava (1981). Sides of abdominal segments 6th to 9th and ultimate tergite are provided with several spiniform tubercles and forceps are straight in basal half, afterwards bent downwards.



Eparchus dux (Bormans), : (34) Hind tarsi ; (35) Sides of abdominal segments VIII and IX showing sipiniform tubercles ; (36) A portion of abdomen and forceps ; (37) and (38) Forceps, in profile ; (39) Genitalia.

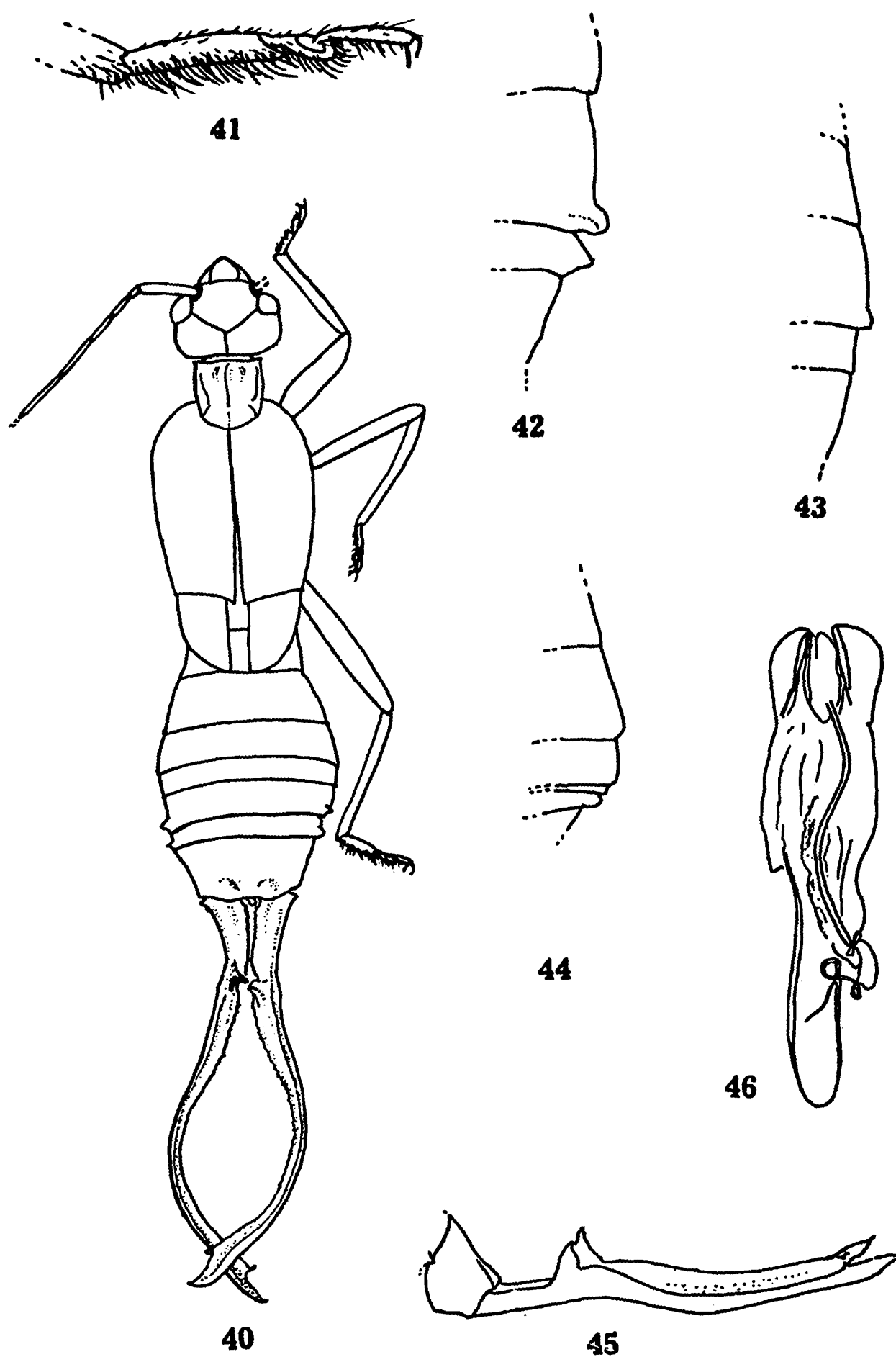
The present record of the species is new to the area

It may be pointed out here that *Narberia tuberculata* Borelli (1921), originally described from Kouy Tch'ou, China and subsequently recorded from Borneo (Borelli, 1932) by three varieties together with typical form comes very close to this species and may prove to be a synonym.

***Cordax cornutus* sp.n.**

Figs. 40-46

♂ : General colour blackish brown ; legs slightly lighter in colour or brownish yellow especially tarsi ; antennae with whole of 7th or part of 6th and 7th yellowish, sides of pronotum yellowish, elytra and blackish brown, latter with a yellow spot at base close to external margin and inner tip ; abdominal tergites with a black patch medially and laterally with a pair of smooth oblong areas also black or dark brown ; forceps reddish brown, yellow for a short distance at apex.



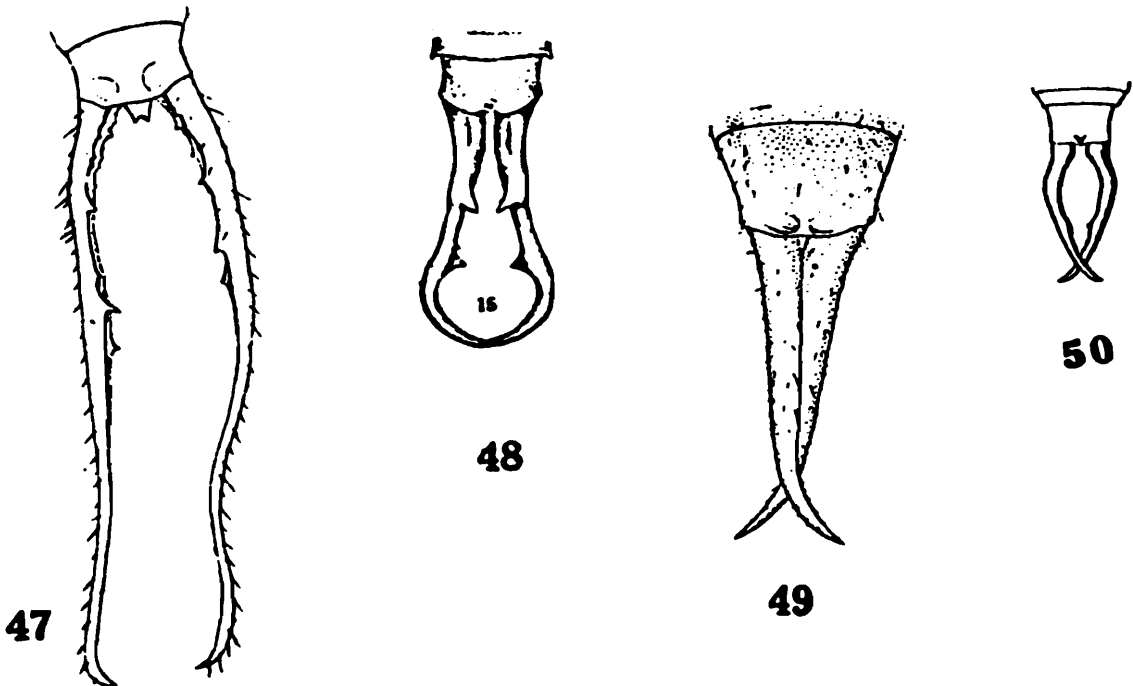
Figs. 40-46 : *Cordax cornutus* sp.n., Holotype ♂ ; (40) Dorsal view, (41) Hind tarsi, enlarged ; (42) to (44) Sides of certain abdominal segments showing the development of spines ; (45) Forceps in profile ; (46) Genitalia ;

Head convex, smooth, sutures distinct, hind margin feebly emarginate in middle. Eyes small, distinctly shorter than the post-ocular length. Antennae 12-segmented, 1st segment longer than the distance between antennal bases ; long, thin and cylindrical. Pronotum longer than broad, anteriorly narrower than head, lateral angle, a little projecting, sides straight, depressed, gently contracted posteriorly, hind margin rounded, median sulcus distinct. Elytra and wings well developed. Legs long and slender, hind tarsi with 1st segment distinctly longer than 3rd segment ; 2nd enlarged ; fore and middle legs with 1st tarsal segment almost equal to 3rd. Abdomen convex, finely punctulate, gradually enlarging posteriorly, laterally above with a pair of smooth oblong patches on each tergite, lateral tubercles on 3rd tergite weakly and on 4th strongly developed, sides of 8th and 9th abdominal segments posteriorly produced into a triangular lobe, often weakly developed or absent. Penultimate sternite transverse, hind margin rounded with slight emargination in middle. Foreceps contiguous in basal 1/3, cylindrical, provided with a small vertical tooth, often weakly developed, afterwards compressed, gradually separating and broadly incurved to leave an elongated oblong space, narrowed apically with tip pointed and gently hooked, internally armed with numerous small tubercles and a little before apex with a small tooth directed posteriorly and ventrally, in profile gently undulate. Genitalia as seen in fig. 46.

♀ : Agrees with ♂ in most characters but differs in having head less convex. sutures obsolete ; often general body colour darker with pronotum uniformly coloured ; ultimate tergite more strongly narrowed posteriorly and foreceps simple and straight.

Measurements — (in mm)

	Halotype	Paratypes	
	♂	♂♂	♀♀
Length of body	12.5	12.0-13.0	12.0-16.0
Length of forceps	8.0	7.0- 7.5	7.0- 7.5



C. politus Burr, ♂ ; (47) Ultimate tergite and forceps ; *C. armatus* (Haan), ♂ ; (48) Ultimate tergite and forceps ; *C. ceylonicus* (Motschulsky), ♂ (49) Ultimate tergite and forceps ; *C. vandermeermohri* Menozzi, ♂ , (50) Ultimate tergite and forceps (after Menozzi, 1933).

Material examined. - MALAYSIA : Sabah, 1 km S. Kundasng, el. 1530 m, Holotype ♂ (genitalia mounted between two coverslips and pinned with the specimen), 28 Aug 1983, Paratypes 1 ♂ (genitalia mounted between two coverslips and pinned with the specimen), 23 Aug 1983 ; 1 ♂ (genitalia mounted between two coverslips and pinned with the the specimen), 4 ♀♀, 28 Aug 1983 ; 1 ♂ 10 Sept 1983 and 1 nymph, 7 Aug 1983.

Remarks.—The inclusion of this species under *Cordax Burr*, appears to be justified on account of its slender build ; head with sutures distinct, frons and occiput raised ; pronotum longer than broad, anteriorly narrower than head and hind tarsi with 1st segment only slightly longer than the 3rd.

At present four species viz., *C. armatus* (Haan), *C. ceylonicus* (Motschulsky), *C. politus* Burr and *C. vandermeermohri* Menozzi, are known from the Oriental

Region and can be differentiated by the following key :

- (2). Forceps with branches remote at base ; pygidium projecting, with a triangular incision in middle posteriorly and lateral angle produced into a spine (fig. 47) *C. politus* Burr
- 1 (2). Forceps with branches contiguous or subcontiguous in basal 1/3, pygidium small, not as above.
- 3 (6). Forceps armed with a vertical tooth above and another tooth internally
- 4 (5). Head with frons weakly convex, sutures obsolete ; forceps stout, armed with a strong, posteriorly directed, vertical tooth at middle and another horizontal tooth internally at 2/3 of the length (fig. 48) *C. armatus* (Haan)
- 5 (4). Head with frons and occiput raised, sutures distinct ; forceps long and slender, armed with a vertical tooth, directed internally at basal 1/3, often weakly developed ; and another small tubercle, directed posteriorly a little before apex *C. cornutus* sp.n.
- 6 (3). Forceps serrated internally, otherwise unarmed
- 7 (8). Forceps contiguous, almost straight, tapering apically with tips gently hooked (fig. 49) *C. ceylonicus* (Motschulsky)
- 8 (7). Forceps subcontiguous and feebly dilated at base for some distance, afterwards incurved, internally with convexity at about 2/3 of the length (Fig. 50) *C. Vandermeermohri* Menozzi

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LIMNOLOGICAL STUDIES OF THE TANK IN VEDANTHANGAL WATER-BIRD SANCTUARY, WITH SPECIAL REFERENCE TO IMPACT OF GUANO ON WATER AND SOIL QUALITY

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INTRODUCTION

Vedanthangal water-bird Sanctuary in Tamil Nadu has been a subject of study for various workers to investigate either the avian fauna (Spillett, 1968) or to record Vascular plants (Henry & Swaminathan, 1981). Recently one of us (Kumar, in press) has enlisted the Odonata fauna of the sanctuary. The sanctuary in question has been a winter home of a large number of migratory water birds, which arrive at Sanctuary in October and stay here till March. Needless to mention that here the birds find here an easy and protected sites in the form of big or small trees (particularly *Barringtonia*) growing in the midst of Vedanthangal tank. During their stay, apart from other activities, the most striking one has been their excretal droppings on the trees as well as in the tank. Spillett (1968) has rightly said that the droppings of birds nesting in the middle of tank fall into the water, most of which eventually reaches to the farmers field as there is regular practise of using the water as well as the silt from the tank for irrigation and fertilizing the adjacent fields.

The continuous addition of bird 'Guano' should definitely have its impact on the water and quality of the soil of the tank, thereby rendering the water unsuitable to a great extent, for the well being of aquatic fauna, specially the fishes, which during the preliminary observations were found to be scanty. Considering these and other related aspects it was felt desirable to investigate the tank in question from limnological point of view. Simultaneously another fresh water body, situated about 20 km N.E. of Vedanthangal tank, but not at all exploited by migratory birds, was also selected for similar studies, just to compare the water and soil quality with special reference to impact, if any, of guano.

PHYSIOGRAPHY AND CLIMATE OF THE AREA OF STUDY

1. *Vedanthangal Bird Sanctuary Tank* (VT) (12°N ; 79°E ; 120 mt msl) is about 80 km south of Madras city and 48 km inland from Bay of Bengal. The average rainfall is about 1150 mm/annum during the months of October to January under the influence of retreating NE monsoon. The Sanctuary includes a ca 30 hectare Vedanthangal tank. April to June (30° to 38°C) are the hottest

months, whereas December and January are regarded as the coolest months (mean temp. 18° to 26° C). The area around Vedanthangal is flat with rocky plains and scattered bushes and trees. The tank is dotted with about 500 *Barringtonia acutangula* trees, which withstand the seasonal water-logging quite well. The trees form a compact grove with almost a contiguous canopy (4 to 6 mt. high) occupying half of the area of the tank and offering a suitable nesting site for water birds (Spillett, 1968). The tanks retains water mostly during rainy months (ca. depth 5 mt.) but thereafter shrink gradually reaching to its minimum (ca depth 1 mt.) and assuming the shape of a small muddy pond during summers. The substratum is generally sandy and greyish. Aquatic weeds are generally scarce but phytoplankton blooms are of common occurrence.

2. *Chengalpattu water tank* (CT) (12° N, 79° E, ca 120 msl), is situated about 55 km south of Madras and about 20 km NE of Vedanthangal tank. The total area of the tank is about 50 hectare with average depth of about 3 mt. Rocky hillocks surround the tank on its western bank, the other sides have agricultural fields with very few trees on the bank. The pond is different from Vedanthangal in the sense that it has both inlet as well as outlet and thus water quantity does not change appreciably round the year. Human settlements are within $\frac{1}{2}$ km and thus human activities in the form of washing, bathing, cattle washing and fishing are common. The bottom mud is dark and clayish, water is generally clear supporting a noxious growth of *Eichhornia*. The striking feature to note about this tank is that no migratory water birds visit this tank during winters, hence free from any fertilizing effect of bird guano whatsoever, though the addition of organic debris from human and other activities cannot be ruled out.

MATERIAL AND METHODS

Water : Monthly water sampling were conducted from both the tanks at fixed points (between 9 and 11 hrs.) with the help of a water sampler. Water temperature was measured by a mercury thermometer fitted in the Sampler. pH was determined by Universal indicator solution and Lovibond pH meter. Field estimations were made for dissolved oxygen (DO), free CO_2 , total alkalinity and calcium. Estimation of chlorine, sulphate, various forms of nitrogen, phosphate, silicate and electrical conductivity were made in the laboratory. All above parameters were analysed with the help of DREL-5 water analysis kit supplied by HACH & Co., Europe. Plankton samples were collected by filtering 10 litre water through a plankton net made up of bolting silk (No. 25). Samples thus collected were preserved in 4% formaldehyde for subsequent quantitative and qualitative analysis using a inverted plankton microscope. The quantitative and qualitative data regarding planktons shall be discussed separately elsewhere.

Soil : Sampling was done every month from both the tanks by collecting about 2 kg of wet soil from surface layers. The soil samples were dried under shady conditions in laboratory and then sieved sufficiently to have fine powdery soil. The total soluble salts, soluble cations, viz., calcium, magnesium, sodium ; soluble anions namely CO_3 , HCO_3 , chloride and sulphate were analysed by leaching method as described in Soil Analysis kit supplied by HACH & CO., Europe. pH electrical conductivity, potassium, nitrite and phosphate contents

were estimated by soil analysis Laboratory of Tamil Nadu State Government, Kanchipuram. The estimation of trace elements in soil, viz., Zn, Mn, Cu and Fe was also conducted in the same Laboratory using AAS.

PHYSIO—CHEMICAL CHARACTERISTICS OF WATER (Table 1&2, Figs. 1 to 4)

Water temperature : At VT water temperature fluctuated between 25° to 33°C, whereas at CT the range of variation was between 22° and 32°C. Normally both the tanks recorded lowest water temperature during December (CT) and January (VT). A perusal of the trend of fluctuation indicates gradual rise from January onwards at both the tanks but VT as compared to CT registered slightly higher values in the respective months. The lower values at CT may be attributed to more open and larger area and great turbulence of water by strong winds prevalent throughout the day.

pH : Of water varied within a narrow range at both the tanks, but as compared to CT (7.9 to 9.0), the range values were quite low at VT (6.5 to 8.0). At VT the pH value goes as low as 6.5 (acidic) during September, when the water level is at the lowest and there is high decomposition activity under higher temperature. The higher pH value at CT generally coincide with overall higher alkanity values of as much as 240 mg/l.

DO : Content was fairly higher (8.8 to 22.3 mg/l) at CT than at VT (8.2 to 15.4 mg/l). Generally the concentration of DO was higher during winter in both the tanks. The maximum values are recorded during winter months of November and January. The higher values in general at CT are correlated with lower values of CO₂, which was generally higher at VT indicating high decomposition activity at the latter due to heavy induction of organic matter in the form of dead planktons and guano. Further the increase in DO value during winter monsoons and then onwards may be due to rainfall and prolific growth of phytoplanktons and macrophytes.

Free CO₂ : Was detected almost in all the months at VT except December and January, whereas its presence from March to October was noticed at CT but to a lesser extent than VT. The higher CO₂ values at VT are inversely correlated with low alkanity (18.4 to 97 mg/l) at VT. Simultaneously lower CO₂ values at CT coincide with comparatively higher alkanity (17 to 240 mg/l) at CT.

Total alkanity : It's generally lower at VT (18.4 to 97 mg/l), which show that water is generally softer in nature and not conducive for fish and other aquatic biota. At CT the mean values of total alkanity are generally higher above 86 mg/l, varying from 86 to 240 mg/l. This shows that water body is hard water type and such waters are often the best fish producers (Barett, 1953). The latter fact is correlated with regular fishing activity at CT. The highest values of total alkanity are recorded in the pre-monsoon months and with the advent of rains at water bodies dilution of alkanity occurs.

Table 1 · Range of fluctuations in physico-chemical characteristics of water in Vedanthangal tank (VT) in different months of the year.

Character	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Water temperature (°C)</i>	25.0	28.0	33.0	30.0	32.0	32.0	32.0	30.0	32.0	29.0	28.0	26.0
<i>pH</i>	7.5	8.0	7.5	8.0	7.9	7.5	8.0	7.5	6.5	7.0	7.0	7.05
<i>EC mmhos/cm</i>	5.80	6.00	6.80	5.60	11.00	13.40	6.00	6.00	7.60	6.20	4.20	5.00
<i>Free CO₂ (mg/l)</i>	0.0	0.2	1.2	2.3	4.2	5.5	3.0	1.4	2.5	1.9	2.2	0.0
<i>Total alkanity (mg/l)</i>	30.0	24.0	26.0	97.0	38	87	61	42	18.4	45	54	40
<i>Dissolved oxygen (mg/l)</i>	18.0	11.4	8.2	10.6	9.9	9.9	10.0	12.4	10.5	15.4	12.5	14.5
<i>Calcium (mg/l)</i>	18.0	22.0	20.0	62.0	74.0	82.0	96.0	54.0	75.0	45.0	38.0	32.0
<i>Chlorine (mg/l)</i>	0.03	0.03	0.28	0.05	0.11	0.07	0.19	0.12	0.75	0.35	0.04	0.05
<i>SO₄ (mg/l)</i>	10.0	8.0	10.0	11.5	60.0	39.0	40.0	22.0	38.0	55.0	22.0	13.0
<i>Nutrients</i>												
<i>NH₃—N (mg/l)</i>	0.80	0.70	0.63	0.70	0.82	0.87	0.95	1.03	2.19	1.4	1.8	1.1
<i>NO₃—N (mg/l)</i>	2.0	2.3	4.0	4.2	6.9	8.2	8.0	7.8	8.5	9.68	4.40	1.02
<i>NO₂—N (mg/l)</i>	0.01	0.02	0.05	0.09	0.022	0.030	0.050	0.030	0.150	0.060	0.035	0.00
<i>PO₄ (mg/l)</i>	0.8	0.6	1.4	1.6	1.8	3.4	3.2	3.2	3.0	3.2	1.0	0.9
<i>SiO₂ (mg/l)</i>	9.60	7.40	6.84	5.04	6.60	4.80	5.20	3.80	4.80	8.00	4.50	6.60

Table 2 : Range of fluctuations in physico-chemical characteristics of water in Chengalpattu tank (CT) in different months of the year.

Characters	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Water temperature (°C)	24.0	26.0	26.0	28.0	30.0	31.0	32.0	32.0	30.0	30.0	25.5	22.0
pH	8.0	8.0	7.9	7.9	8.0	9.0	8.5	8.5	8.0	8.0	8.5	8.0
EC (mmhos/cm)	6.00	7.20	8.80	8.80	13.40	21.00	16.00	20.00	14.40	6.00	6.00	6.00
Free CO ₂ (mg/l)	0.0	0.0	2.3	4.6	3.6	1.4	1.2	1.4	1.2	0.2	0.0	0.0
Total alkalinity (mg/l)	86	89	67	115	150	178	227	240	156	117	86	93
Dissolved oxygen (mg/l)	19.5	14.3	15.7	10.5	9.9	8.8	11.5	11.0	15.0	18.2	21.0	22.3
Calcium (mg/l)	22.0	35.0	39.0	54.0	63.0	70.0	71.0	132.0	124.0	128.0	53.0	9.0
Chlorine (mg/l)	0.04	0.05	0.05	0.07	0.06	0.07	0.04	0.05	0.08	0.03	0.25	0.01
SO ₄ (mg/l)	2.0	2.0	2.0	35.0	7.0	4.0	6.0	20.0	0.0	0.0	18.5	2.0
<i>Nutrients</i>												
NH ₃ -N (mg/l)	0.30	0.41	0.00	0.52	0.65	0.72	0.82	1.22	0.50	0.60	0.00	0.20
NO ₃ -N (mg/l)	1.00	0.09	1.00	0.80	2.20	5.60	6.36	4.80	5.60	5.90	4.40	3.00
NO ₂ -N (mg/l)	0.004	0.009	0.012	0.012	0.010	0.010	0.015	0.010	0.025	0.020	0.010	0.010
PO ₄ (mg/l)	0.40	0.52	0.70	1.30	1.70	2.00	2.30	1.90	1.60	1.60	0.80	0.70
SiO ₂ (mg/l)	5.50	4.88	6.60	7.20	7.00	5.40	7.20	5.60	7.20	6.40	6.40	7.20

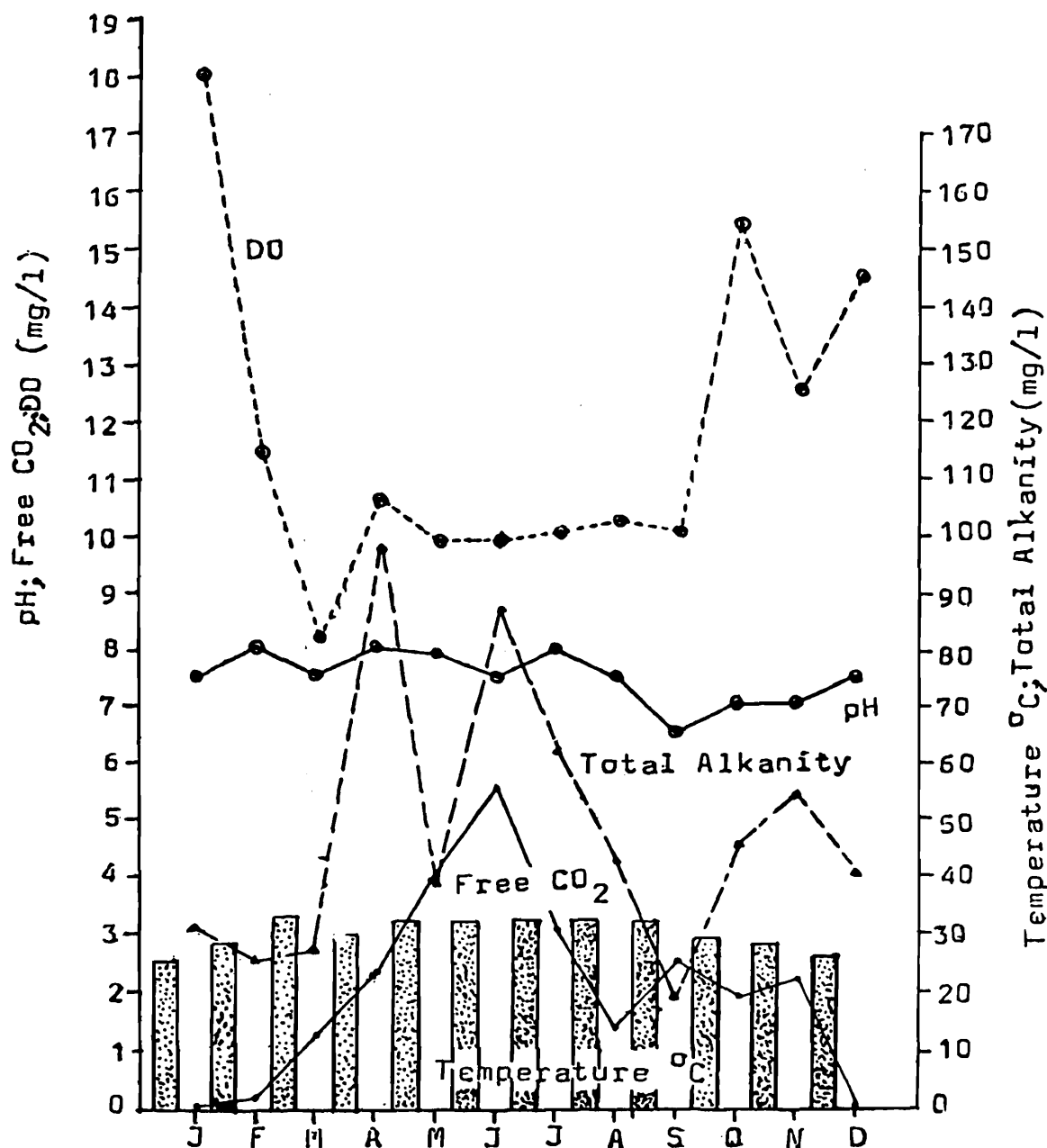


Fig. 1. Monthly fluctuations in water at VT : pH, temperature, free CO₂, DO and total alkanity.

Calcium (Ca⁺) : Contents in CT exhibited fairly higher values and fluctuated within a range of 90 to 132.0 mg/l. The value at VT ranged between 18.0 to 96.0 mg/l. The rise and fall in values of Ca contents was more or less similar at both the tanks. The values gradually rise in summer months due to rapid oxidation of the organic matter in the substrate. The decline in values from September onwards may be due to dilution by rain water and/or its utilization by phyto and zooplanktons (at VT) and macrophytes (at CT).

Total chlorine (Cl) : Content in VT was fairly higher than at CT ; in the former it ranged between 0.03 to 0.75 mg/l whereas in the latter from 0.01 to 0.08 mg/l. No definite pattern of seasonal fluctuation could be deduced from the data but as stated by Thresh, *et. al* (1944), higher chloride content of the water is an index of pollution of animal origin (either by guano or by death and decay of zooplanktons which, it is assessed in the preliminary findings, exhibit population explosion in the warmer months. The low chlorine values at CT are because of insignificant animal pollution (guano or death decay) and also due to its large size.

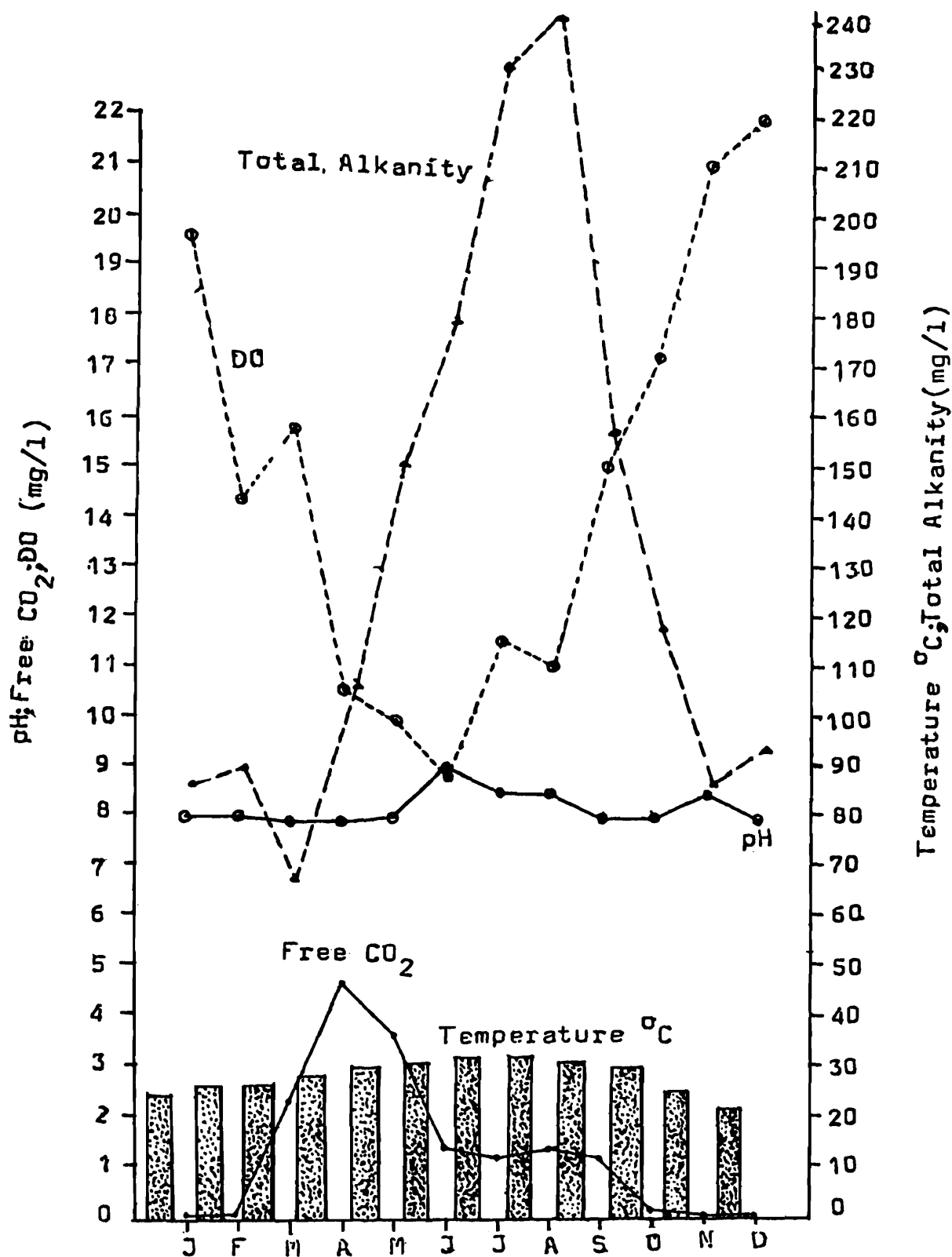


Fig. 2. Monthly fluctuations in water at CT : pH, temperature, Free CO₂, DO and total alranyity.

Sulphate (SO₄) : Strikingly the sulphate appeared higher at VT (8.0 to 60.0 mg/1) than at CT (Nil to 35.0 mg/1). The highest concentration of sulphate at VT is recorded during summers. This coincides with higher suspended solids imparting turbidity to the water. It is indispensable to mention here that due to high nutrient status (in term of nitrate and phosphate) VT exhibit lower transparency values due to round the year presence of planktonic dispersions as against the CT, where the water remains mostly transparent due to heavy growth of *Eichhornia* and other macrophytes.

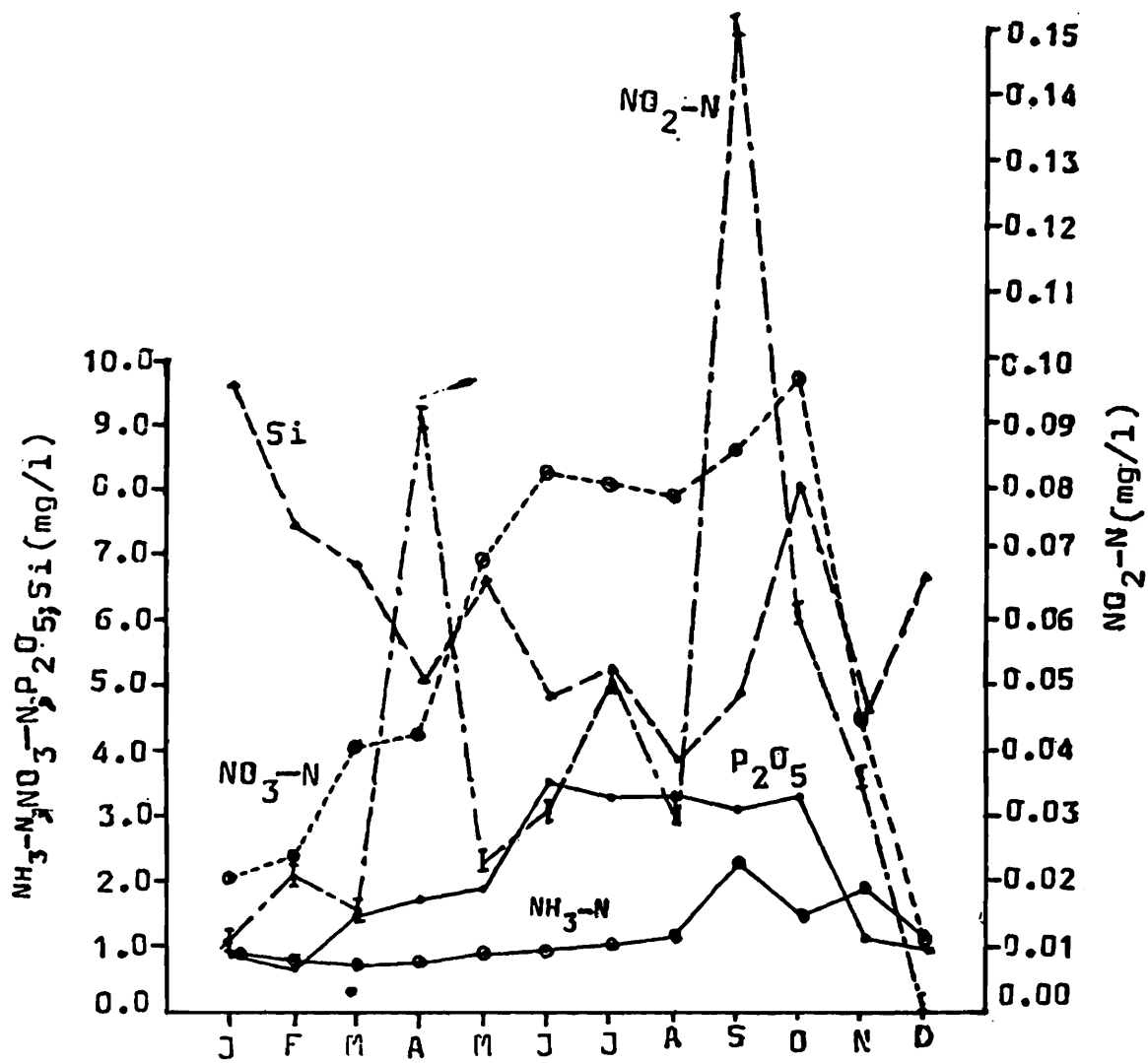


Fig. 3. Monthly fluntuations in nutrients in water at VT : NH₃ – N, NO₃ – N, NO₂ – N, PO₄ and Si.

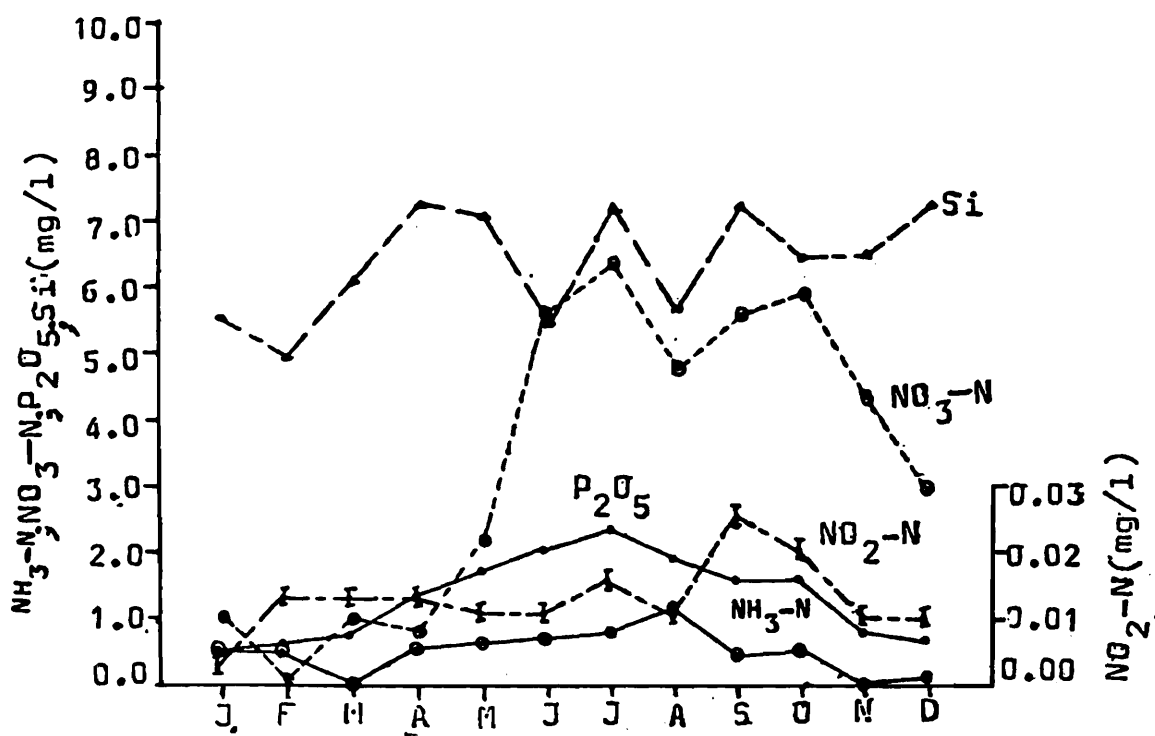


Fig. 4. Monthly fluctuations in nutrients in water at CT : NH₃ – N, NO₃ – N, NO₂ – N, PO₄ and Si.

Phosphate : With regard to its mode of fluctuation, the phosphate contents show more or less close relationship with nitrate and nitrite contents. On the whole, the mean value of Phosphates were higher in VT (0.6 to 3.4 mg/1), while these varied from 0.4 to 2.3 mg/1 in CT. Higher values at both the tanks were obtained during summer months and a declining trend was apparent from November onwards till February. The higher contents of phosphate at VT may safely be attributed to excessive addition of guano and decomposition of dead organic matter.

Nitrate ($\text{NO}_3\text{-N}$) : As stated above with reference to phosphate, nitrate showed similar trend of fluctuation in both the tanks. Higher values were recorded at VT (1.0 to 8.68 mg/1) than at CT (0.80 to 5.90 mg/1). The value of nitrate start rising appreciably from October which coincide with the arrival of migratory birds at the tank. Generally, the values of nitrate are higher during summer months both at VT and CT. The decline in nitrate contents is possibly due to their utilization by phytoplanktons.

Nitrite ($\text{NO}_2\text{-N}$) : Contents of VT are strikingly more : (nil to 0.15 mg/1) than CT (0.004 to 0.025 mg/1). Like nitrate the nitrite contents in VT show two well defined peaks in the year, but at CT the nitrite show only one peak of lower magnitude in the month of September.

Ammonia nitrogen ($\text{NH}_3\text{-N}$) : Contents are quite high in VT (0.63 to 2.19 mg/1) than in CT (nil to 1.22 mg/1). At VT the highest value of ammonia nitrogen is recorded during the month of September, it rises again from October onwards. No set pattern of fluctuation was recorded at CT except that it showed only one peak in the month of August.

A perusal of the foregoing account of different forms of nitrogen contents ($\text{NO}_3\text{-N}$, $\text{NO}_2\text{-N}$, $\text{NH}_3\text{-N}$) indicates overall nitrogen richness at VT than at CT. This nitrogen richness at VT can be safely attributed to the organic pollution of animal origin (bird guano or death and decay of tank biota). Thresh, *et al.* (1944) ; Swarup & Singh (1979) have also expressed the same views. Zaffar (1964) emphasized that when the dead organic matter decomposes in water, it forms complex proteins which get converted into nitrogenous organic matter and finally into nitrates by the bacterial activity. This condition seems to be prevalent at VT. The CT, which is not polluted by bird droppings, the presence of different forms of nitrogen can be on account of decomposition activity only. The other possible reason of lower nitrogen values than VT can be due to rapid consumption and storage by macrophytic vegetation.

Silica (Si—) : The silicate contents though slightly lower at Ct (4.88 to 7.2 mg/1) do not show a regular trend of distribution possibly due to the fact that submerged vegetation (which aids quick settlement of silt) is altogether wiped out by the surface growth of *Eichhormia*. At VT the silica contents varied between 4.8 and 9.6 mg/1. It showed the peak during winter monsoon, which is due to freshets and affluents from surroundings.

PHYSICO—CHEMICAL CHARACTERS OF THE SOIL

(Tables 3 & 4 ; Figs. 5 to 10)

pH : Of the soil in both the tanks ranged from acidic to alkaline, the range being 5.6 to 8.0 at VT and 6.0 to 8.0 at CT. A comparison of the pH values clearly indicates acidic nature of the soil in six months at VT than at CT where the high acidic reaction was evident in September and October (6.1 & 6.0 respectively). Besides nearly neutral (6.8 & 6.9) reaction was noticed in the months of March and April at CT. Conclusively it is apparent that the soil pH registers below neutral values in four months at CT as against six months at VT. The possible explanation of lower pH values in most of the months at VT can be given on the basis of the fact that the addition of guano besides affecting the pH of water also affects the pH of soil.

Soluble cations (Ca^{++} , Mg^{++} , Na^{+} , K^{+}) : The cationic composition of the soil of both the tanks indicates K^{+} as the predominant cation. The other cations to follow can be represented in the following order $\text{K}^{+} > \text{Na}^{+} > \text{Ca}^{++} > \text{Mg}^{++}$. In general, the fluctuation pattern of cations is more or less uniform exhibiting higher values during summer months (February to September). In monsoon a general decline is observed which is obviously due to dilution effect. At both the tanks the K^{+} values are appreciably high, in VT the single peak is during the month of June while at CT the value is recorded during the month of January with sharp decline, than onwards upto October.

Soluble anions (HCO_3^{-} , Cl^{-} , SO_4^{-2}) : The concentration of anions show the following order $\text{Cl}^{-} > \text{SO}_4^{-} > \text{HCO}_3^{-}$ at CT but the changes to $\text{Cl}^{-} > \text{HCO}_3^{-} > \text{SO}_4$ at VT

The value of it in general was distinctly higher throughout the year (15 to 50 mg/l) at VT than at CT (15 to 30 mg/l). The higher values at VT can be attributed to the higher pollutional status imparted by dead settled organic matter of animal origin. Concurrently the Cl^{-} values of water are also significantly higher at Vt. The average values of soil SO_4^{-2} are higher at Ct than at VT, a feature opposite to that of water. Higher values at CT can be attributed to their settling down in soil due to quick settlement of aquatic angiospermic vegetation. On the other hand, there are less chances for the SO_4^{-2} to settle down at VT because the water remains mostly turbid due to suspended solids. As is evident from the total alkanity status of water of CT, the HCO_3 are mostly in soluble state and are not expected to settle in quantities on the bottom soil, hence the HCO_3 values at CT are found to be lesser. Another reason for less HCO_3 in the CT soil is that most of the HCO_3 settle in the form of marl on the vegetation thriving in the tank. The high HCO_3 concentration in VT soil is explainable on the basis of the process just reverse to that of CT as there is no appreciable aquatic vegetation at VT. Additionally the purification of guano at VT is also responsible for formation of HCO_3 .

Sodium Adsorption Ratio (SAR) : SAR values varied from 16.66 to 50.35 at VT and 7.56 to 22.99 at CT. The higher values of SAR at VT are correlated with the higher values of Na^{+} and Cl^{-} at VT.

Table 3 : Range of fluctuations in physico-chemical characteristics of soil in Vedanthangal Tank (VT) in different months of the year.

Character	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
pH	7.5	6.4	6.4	8.0	7.2	7.4	5.6	5.6	7.3	6.8	7.8	6.7
EC (mmhos/cm)	0.1	0.1	0.36	0.70	0.73	0.11	0.10	0.15	0.20	0.10	0.10	0.10
Total soluble salts (meq/l)	55	45	60	130	75	50	60	70	75	75	40	40
<i>Soluble cations (meq/l)</i>												
Ca	5	4	8	32	15	2	3	3	2	2	4	4
Mg	2	5	5	5	6	8	2	3	3	2	0	2
Na	48	39	47	93	54	40	55	64	70	71	36	34
K	34	38	67	85	118	125	65	27	36	29	10	11
<i>Soluble anions (meq/l)</i>												
CO ₃ ²⁻	00	00	00	00	00	090	00	00	00	00	00	00
HCO ₃	20	20	20	40	15	20	10	10	10	10	00	10
Cl ⁻	20	15	30	50	35	20	30	40	45	50	20	15
SO ₄ ²⁻	15	10	10	40	25	10	20	20	20	15	20	15
SAR	28.20	18.39	18.50	21.62	16.16	17.93	34.81	36.99	44.30	50.35	25.53	19.65
<i>Nutrients (mg/100 gm)</i>												
N	84	118	115	64	101	137	105	50	59	95	53	54
P ₂ O ₅	30	15	55	3	Tr.	105	68	5	10	47	45	45
<i>Trace elements (ppm)</i>												
Zn	1.00	0.82	1.52	0.50	5.22	1.32	1.02	0.56	0.40	0.84	0.36	1.24
Mn	5.28	1.80	7.10	4.38	8.32	9.80	7.32	2.94	2.30	3.10	1.10	3.32
Cu	1.60	1.70	1.64	0.86	4.40	2.06	1.75	1.42	1.14	1.78	1.16	1.54
Fe	35.00	40.00	40.00	12.72	40.00	40.00	32.00	30.60	20.22	21.36	10.00	30.70

Table 4 : Range of fluctuations in physico-chemical characteristics of soil in Chenglepattu Tank (CT) in different months of the year.

Characters	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
pH	7.0	7.9	6.8	6.9	7.5	7.7	8.0	7.2	6.1	6.0	8.0	7.9
EC (mmhos/cm)	0.15	0.10	0.12	0.17	0.40	0.56	0.40	0.18	0.05	0.15	0.10	0.10
Total soluble salts (meq/l)	50	35	40	50	70	140	70	80	40	50	60	45
<i>Soluble cations (meq/l)</i>												
Ca	4	4	3	4	8	31	21	24	12	4	6	7
Mg	4	5	2	5	10	22	13	14	5	3	4	4
Na	42	26	35	41	52	87	36	42	22	43	50	34
K	147	143	137	67	84	78	65	52	6	10	16	22
<i>Soluble anions (meq/l)</i>												
CO ₃ ²⁻	00	00	00	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HCO ₃	20	10	10	20	10	30	10	10	10	10	20	20
Cl	20	15	20	20	25	30	25	30	20	30	20	15
SO ₄	10	10	10	10	20	50	30	30	10	10	20	20
SAR	21.00	12.26	22.15	19.33	17.33	16.92	8.73	9.65	7.56	22.99	22.42	15.24
<i>Nutrients (mg/100 gm)</i>												
N	61	53	48	98	64	76	72	70	64	50	42	28
P ₂ O ₅	10	15	100	Tr.	Tr.	10	12	17	36	10	30	5
<i>Trace elements (ppm)</i>												
Zn	2.56	3.34	2.26	2.26	3.46	5.76	4.32	2.34	0.92	0.85	0.80	0.96
Mn	12.00	8.50	13.00	3.50	5.20	10.40	13.52	15.02	17.72	7.52	2.36	9.34
Cu	1.50	1.62	1.94	1.44	1.82	4.06	3.25	2.62	1.96	2.02	2.12	1.34
Fe	26.00	30.00	40.00	40.00	40.00	40.00	38.00	35.00	32.52	25.25	19.92	21.54

Nutrients (P_2O_5 , N) : The mean monthly values of N vary from 50 to 137 at VT, while from 28 to 98 at CT. The mean monthly value of P_2O_5 vary from (T to 105) at VT and from (T to 100) at CT. The nutrients of the soil of both the tanks clearly illustrate that it is of higher order at VT corresponding with the high nutrient status of the water as well. Needless to emphasize that the high nutrient status of the water and soil of VT is as a result of high guano dropping during winter.

Trace elements : The mean monthly values of the concentration of trace elements, i.e. Zn, Mn, Fe and Cu are also given in Tables 3 & 4, Figs. 9 & 10.

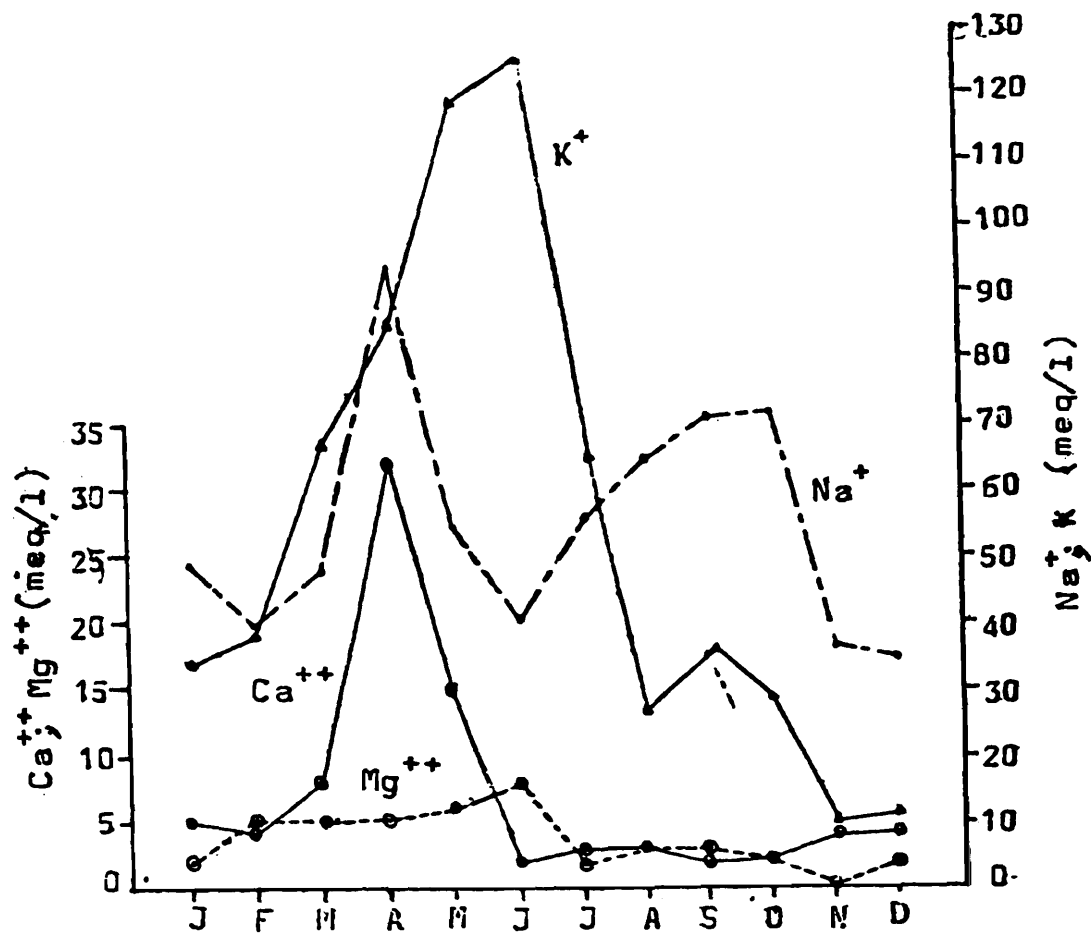


Fig. 5. Monthly fluctuations in cations in soil at VT : Ca^{++} , Mg^{++} , Na^{+} and K^{+} .

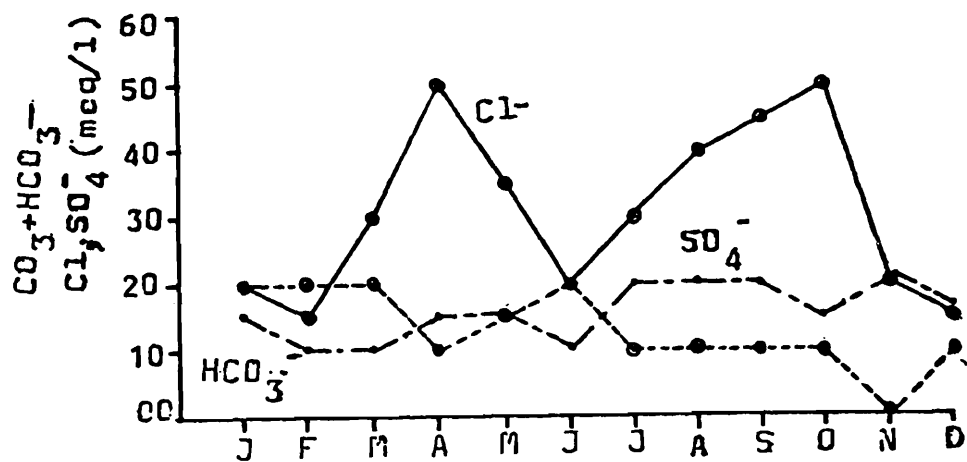


Fig. 6. Monthly fluctuations in anions in soil at VT : HCO_3^- , Cl^- and SO_4^- .

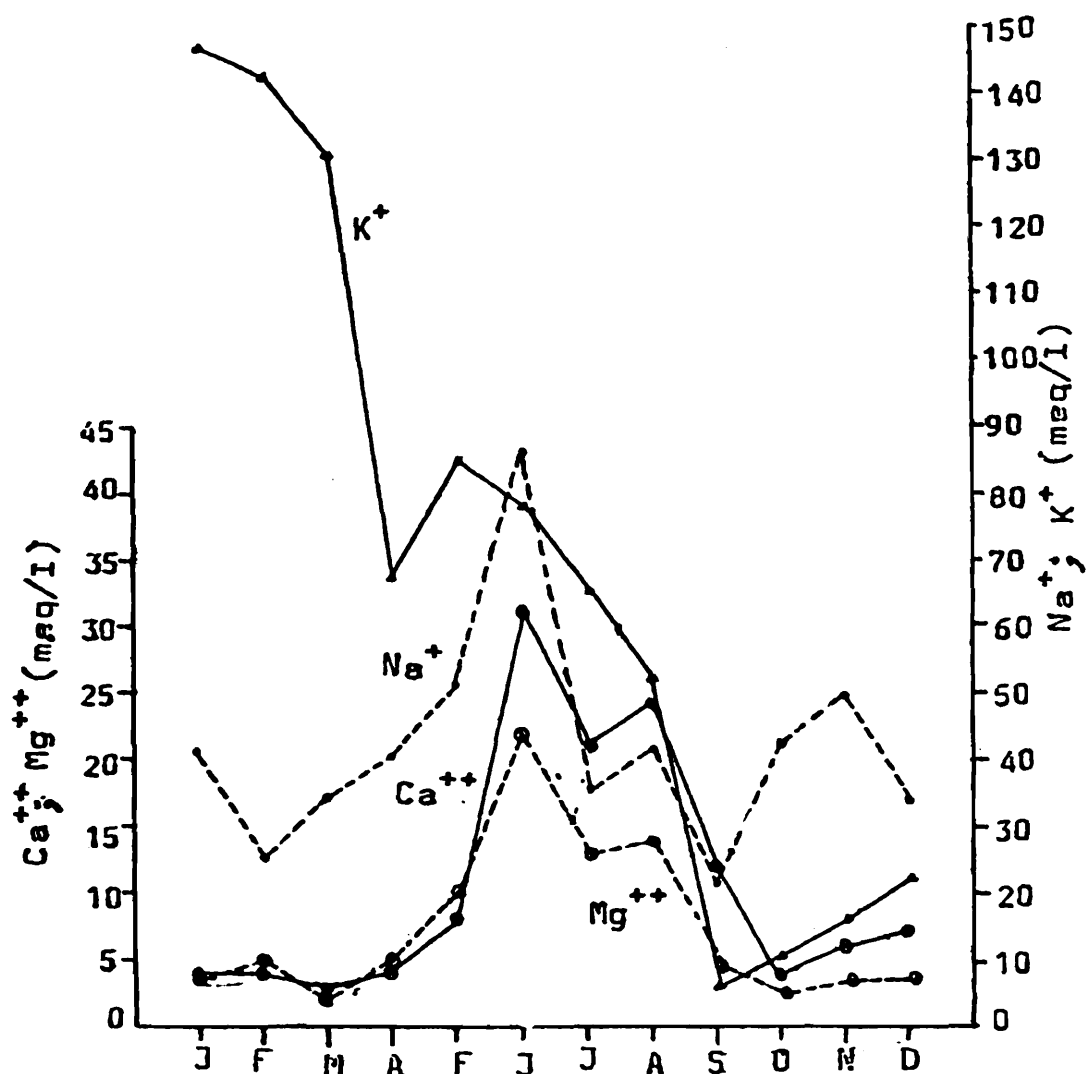


Fig. 7. Monthly fluctuations in cations in Soil at CT : Ca⁺⁺, Mg⁺⁺, Na⁺ and K⁺.

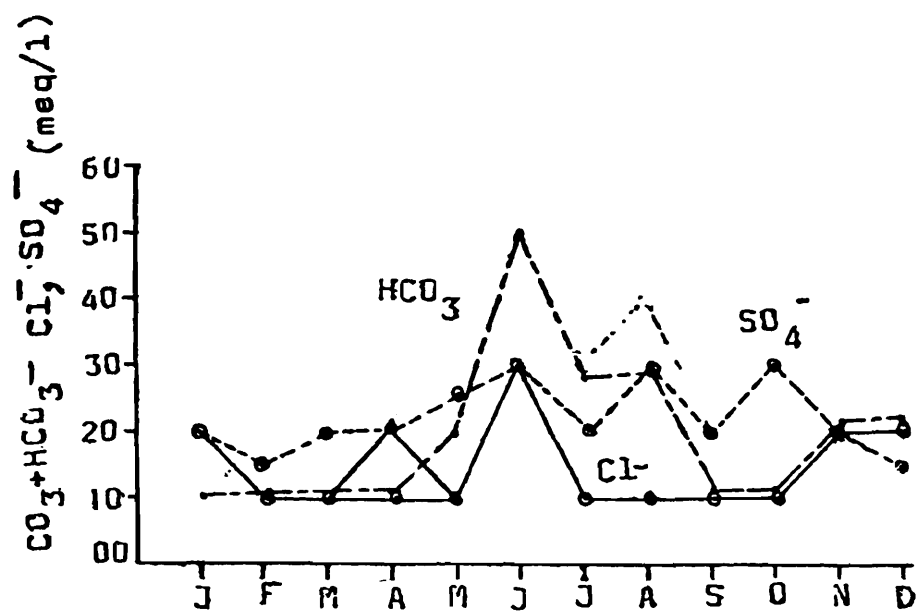


Fig. 8. Monthly fluctuations in anions in soil at CT : HCO₃⁻, Cl⁻ and SO₄⁻.

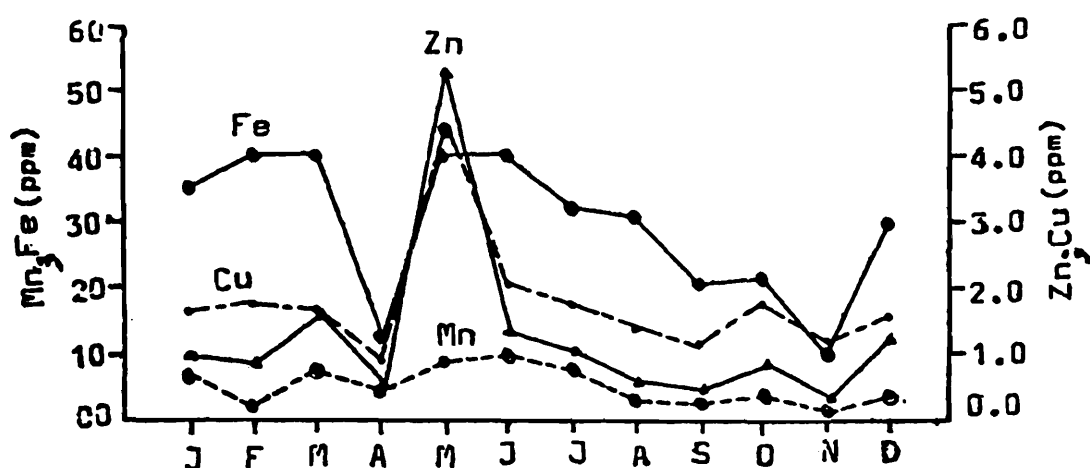


Fig. 9. Monthly fluctuations in trace elements in soil at VT : Zn, Mn, Fe and Cu.

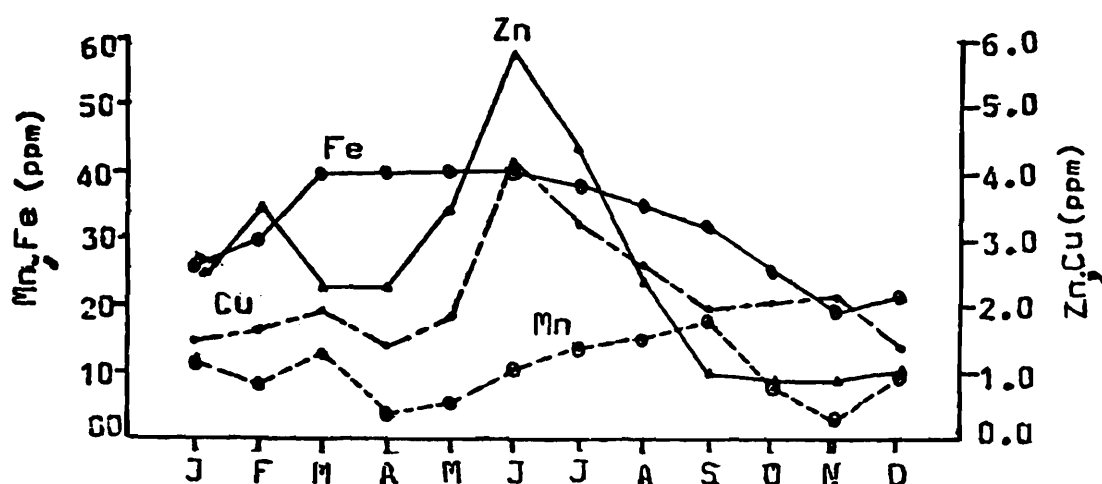


Fig. 10. Monthly fluctuations in trace elements in soil at CT : Zn, Mn, Fe and Cu.

GENERAL CONCLUSIONS

The present Investigations demonstrate that the water and soil characteristics of two selected tanks have striking differences. The overall assessment of the conditions prevalent at VT has clearly shown that water and soil characteristics are to a great extent affected by the bird droppings. Simultaneously it is worthwhile to classify the two tanks on the basis of water and soil characteristics. Though the biological analysis is under process, it has apparently exhibited striking difference in the two tanks, at VT in the form of chiefly planktons and at CT in the form of macrophytes. It is an established fact that the enhanced growth of either planktons or weeds is the outcome of high nutrient status of a water body. Therefore, on the basis of the soil and water data computed herein and the biological data being processed, the two tanks can be safely put into the category of Eutrophic nature.

The eutrophication criteria at both the tanks is strikingly different, at VT the high nutrients supply being utilized by planktonic blooms and swarms and at CT by macrophytes.

SUMMARY

Seasonal variations of the physico-chemical conditions of water and soil in relation to bird guano were carried out in 30 hectare Vedanthangal water-bird Sanctuary tank, Tamil Nadu, during the years 1986 and 1987. This tank is visited by a large number of migratory birds during NE monsoon period of mild winter. The physico-chemical conditions prevalent here were compared With the seasonal variations of these conditions in a nearby 50 hectare Chengalpattu tank, which is not at all exploited by the birds.

The water quality of Vedanthangal tank differed appreciably in the values of total alkalinity, chlorine, sulphate, phosphate and various nitrogen contents, which showed higher values due to organic wastes of animal origin. Similarly the soil quality also varied in reference to nutrients, i.e. P_2O_5 and N. The SAR was much higher in Vedanthangal tank soil. The trace elements, namely, Zn, Mn, Fe and Cu were also analyzed from the soil of both the tanks. Both the tanks are of eutrophic nature.

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The authors are grateful to the Director, Zoological Survey of India, Calcutta and the Joint Director, Environmental Monitoring Wing, Zoological Survey of India, Madras, for permission to undertake the present study, necessary facilities and the encouragement. Thanks are also due to the In-charge, Soil Laboratory, Tamil Nadu Govt., Kanchipuram, for having analysed the soil samples. We are also grateful to our other friends, specially Dr. Ravichandran and Dr. S.K. Gupta for many helpful suggestions. First author is also grateful to Dr. Pratap Narain, Scientist S-3, Central Soil & Water Conservation Research & Training Institute, Dehradun, for critically going through the manuscript. Grateful thanks are also due to the Officer Incharge, Z.S.I., N.R.S., Dehradun, for various facilities.

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INTERESTING SPECIES OF NEUROPTERA FROM HIMACHAL PRADESH

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The present contribution is based on a fairly good collection of neuroptera belonging to the families Chrysopidae and Myrmeleontidae from Himachal Pradesh received by the author for identification from High Altitude Field Zoology Station, Solan. Amongst a total of ten species examined, four species and the female of a species are for the first time recorded from India. All the species, except two, constitute new locality records for Himachal Pradesh. Besides, the Keys to taxa of the examined material, geographical distribution, remarks, wherever necessary, and suitable references have been provided.

Family CHRYSOPIDAE

Key to genera of the family Chrysopidae

1. Gradate veins distributed in two regular series in wing disc.	2
- Gradate veins distributed irregularly over wing disc.	<i>Tumeochrysa</i> Needham
2. With tignum but without gonapsis in males.	<i>Chrysperla</i> Steinmann
- Without tignum and gonapsis in males.	<i>Chrysopa</i> Leach

***Tumeochrysa indica* Needham**

1909. *Tumeochrysa indica* Needham, *Rec. Indian Mus.* 3 : 24.

Material examined : 1♂ : India, Himachal Pradesh, Kinnaur, 17. vii. 1988 (Coll. J. M. Julka).

Distribution : India (Manipur and Western Himalayas including Himachal Pradesh).

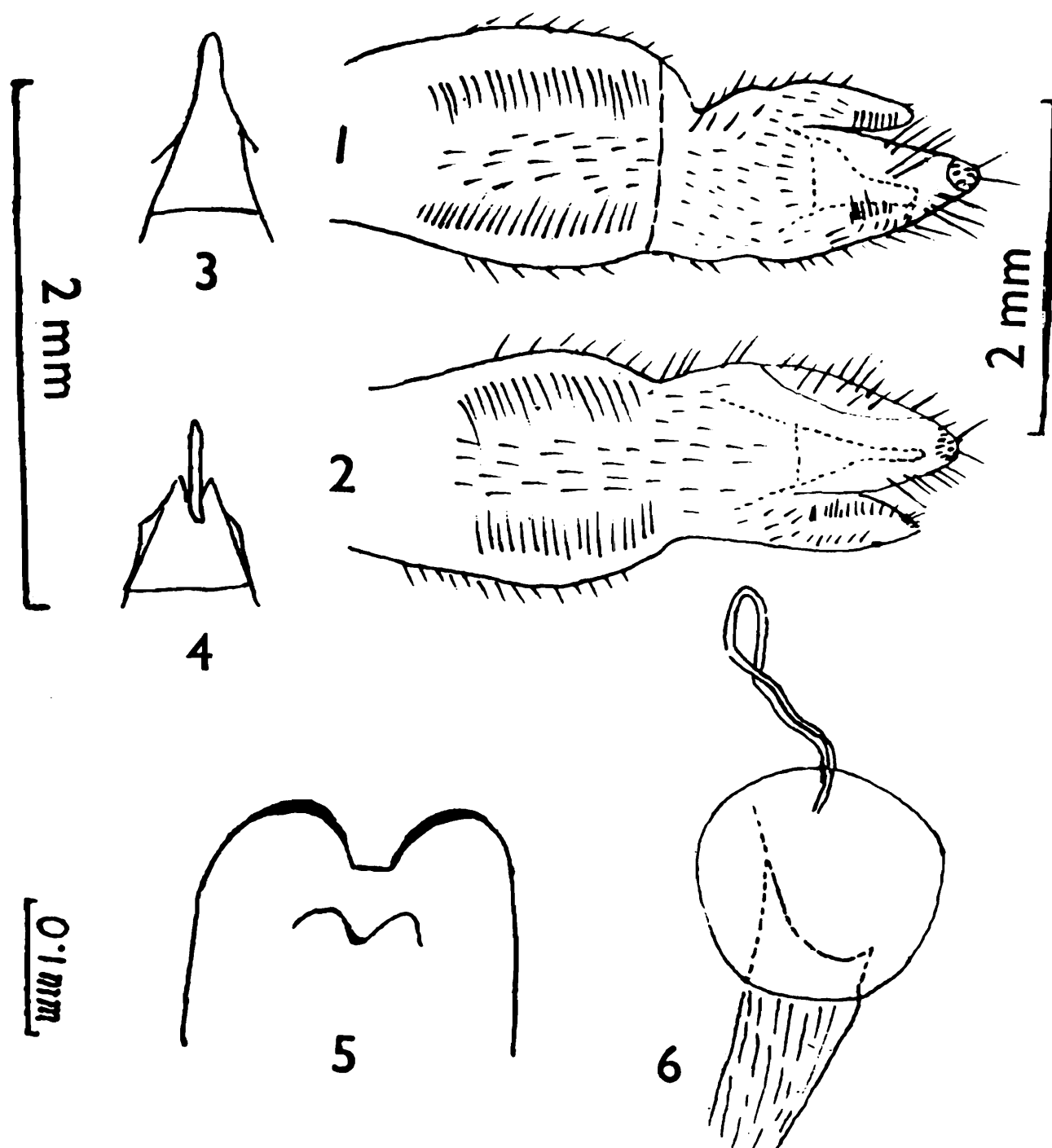
Remarks : Illustrations of the abdominal tips and genital armature (Figs. 1-4) in male are given.

***Chrysoperla gujaratensis* Ghosh**

1976. *Chrysopa (Chrysoperla) gujaratensis* Ghosh, *Ent. scand.*, 7 : 74.

Female : Vertex, frons and clypeus : yellow ; palpi : pale brownish ; antenna : first two basal segments yellow but other flagellar segments pale brownish ; thorax : pronotum yellow at middle and brownish laterally ; sides parallel, anterior angles rounded ; a raised transverse ridge across middle ; meso—and metanotum : yellowish ; wings : transparent, veins pale yellowish ; fore wing ; elongate, oval, apex sub-

acute, pterostigma distinct ; first intra-median cell distinct, ovate and basal cross vein between $R_s + M_2$ beyond apex of median loop ; hairs on margin not long ; 5-6 crossveins in outer gradates and 6-8 crossveins in the inner ; hindwings : similar to forewing, 4-5 crossveins in the inner and 6-7 in the outer gradates ; legs : pale yellowish with short black hairs, tarsi brown and claws dark brown ; abdomen : dorsally yellow ; tergite 9 + ectoproct oblique structures with subacute upper angle, gonapophysis lateralis not very broad, subgenital plate with apical lobes separated and rounded in ventral view (fig. 6) ; spermatheca not large (fig. 7).



Figs. 1-4. *Tumeochrysa indica* Needham, (1) Apex of male abdomen (dorsal), (2) Same (ventral) (3) Genitalia in male (dorsal), (4) Same (Ventral), Figs. 6-7. *Chrysoperla gujaratensis* Ghosh, (6) Subgenital plate (Ventral), (7) Spermatheca (dorsal).

Measurement : Length of forewing, 12-13 mm ; hindwing, 11-12 mm.

Material examined : 12 exs. ♂ ♀ : India, Himachal Pradesh, Kinnaur, Pooh, 11.vii.88, 6 exs ; Rogi, 8 kms. of Kalpa, 8.vii.88, 6 exs. (Coll. J.M. Julka & party).

Distribution : India (Himachal Pradesh and Gujarat).

Remarks : Ghosh (1976) described the species from Gujarat on the basis of males. The female, hitherto unreported, is described from Himachal Pradesh for the first time. It constitutes a new locality record for Himachal Pradesh.

Key to species of the Genus **Chrysopa**

A black spot on head between antenna.....*septempunctata* Wesmael
No black spot on head between antenna.....*albolineata* Killington

Chrysopa albolineata Killington

1935. *Chrysopa albolineata* Killington, *Jour Soc. Brit. Ent.*, 1(3) : 87.

1967. *Chrysopa albolineata*, Holzel, *Beitr. naturk. Forsch. Sw-Deutschl.*, 26(1) : 43.

Material examined : 24 exs. ♂ ♀ : India, Himachal Pradesh, Kinnaur, Pooh, 11.vii, 13.vii.1988, 10 exs. ; Rogi, 8 kms. of Kalpa, 9.vii.1988, 14 exs. (Coll. J.M. Julka).

Distribution : India (Himachal Pradesh) ; Anatolia, Afghanistan, Europe, North Africa and Japan.

Remarks : Killington (1935) reported the species from Europe, Holzel (1967) recorded the species from Anatolia, Afghanistan and indicated the distribution of species in Japan. However, with the first record of species from India, it is now known to be distributed in both the Palaearctic and Oriental regions of the globe.

Chrysopa septempunctata Wesmael

1841. *Chrysopa septempunctata* Wesmael, *Bull. I Acad. Brux.* 8 : 210.

1967. *Chrysopa septempunctata*, Holzel, *Beitr. naturk. Forsch. Sw-Deutschl.*, 26(1) : 43.

Material examined : 30 exs. ♂ ♀ : India, Himachal Pradesh, Kinnaur, Pooh, 10.vii.1988 & 13-15.vii.88 (Coll. J.M. Julka).

Distribution : India (Himachal Pradesh) ; Europe, North Africa, Afghanistan, Pakistan, Iran, Irak, Lebanon, Mauritius, Turkey, Eastern Siberia, China, Cambodia, and Japan.

Remarks : The species is for the first time recorded from Himachal Pradesh.

Key to subfamilies of the family Myrmeleontidae

Cup in forewing long, free and terminating at posterior margin of wing
Palparinae Banks
Cup in forewing short or sometimes long and fused with 1A in its course
Myrmeleontinae Banks

Subfamily PALPARINAE

Tribe Palparini

Palpares pardus Rambur

1842. *Myrmeleon pardus* Rambur, *Hist. nat. Ins. Néur*, p. 375.

1983. *Palpares pardus*, Ghosh, *Rec. Zool. Surv. India*, **81** : 79.

Material examined : 1 ♂ : India, Himachal Pradesh, Kinnaur, 11.vii.88 (Coll. J.M. Julka).

Distribution : India (Sikkim, "North India", West Bengal, Orissa, South India, Maharashtra, Goa, Rajasthan and Himachal Pradesh).

Subfamily MYRMELEONTINAE

Key to tribes of subfamily Myrmeleontinae

1. Inner radial field of hindwing with three or more crossveins	2
Inner radial field of hindwing with only one crossvein	<i>Distoleonini</i> Navas
2. 1A in hindwing fused with lower branch of Cu	<i>Acanthaclisini</i> Navas
1A in hindwing not fused with Cu	<i>Myrmeleonini</i> Banks

Key to genera of tribe Distoleonini

1. Cup in forewing well developed	2
Cup in forewing shorter than a crossvein	<i>Pignatellus</i> Navas
2. Wing heavily spotted and legs strongly hairy	<i>Distoleon</i> Banks
Wing less spotted and legs without special hairs.	<i>Neuroleon</i> Navas

Tribe Distoleonini

Pignatellus intricatus Holzel

1972. *Pignatellus intricatus* Holzel, *Beitr. naturk. Forsch. Sw-Deutschl.*, **1** : 47.

Material examined : 13 exs. ♂ ♀ : India : Himachal Pradesh, Kinnaur, Pooh, 11.viii. 1988 and 13-14.vii.1988 ; Bhuiro, 4.ix.1988 (Coll. J.M. Julka).

Distribution : India (Himachal Pradesh) ; Afghanistan and Iran.

Remarks : The species is for the first time recorded from India including Himachal Pradesh after the discovery of species from Afghanistan and Iran by Holzel (1972). The species may be readily recognised by more or less strongly developed markings in forewing, abdomen in males shorter than wings and legs with short spurs.

Distoleon verendus (Walker)

1853. *Myrmeleon verendus* (Walker), *Cat. Brit. Mus. Néur.*, p 342.

1984. *Distoleon verendus*, Ghosh, *Rec. zool. India, Occ. paper*, no. **52** : 49.

Material examined : 3 exs. ♂ ♀ : India : Himachal Pradesh, Bhuiro, 4.ix.1988 (Coll. M. Singh).

Distribution : India (Himachal Pradesh, "North India ; Orissa and Maharashtra).

Neuroleon diana Holzel

1972. *Neuroleon diana* Holzel, *Beitr. naturk. Forsch. Sw-Deutschl.* 1 : 51.

Material examined : 4 exs. ♂ ♀ ; India : Himachal Pradesh, Kinnaur, Pooh, 10-11.vii.1988 (Coll. J.M. Julka).

Distribution : India (Himachal Pradesh) ; Iran and Afghanistan.

Remarks : Holzel (1972) described the species from Iran and Afghanistan. It is for the first time recorded from India including Himachal Pradesh. The species may be recognised by the two longitudinal middle stripes in the pronotum, shadings in forewing, abdomen with well developed dorso-lateral yellow spots and also by genitalia in males.

Tribe Acanthaclisini

Acanthaclisis occitanica (Villers)

1789. *Myrmeleon occitanicum* Villers, *Linn. Ent.*, p. 63.

1972. *Acanthaclisis occitanica*, Holzel, *Beitr. naturk. Forsch. Sw-Deutschl.*, 1 : 12.

Material examined : 2 exs., ♂ ♀ : India, Himachal Pradesh, Kinnaur, Rogi, 8 kms. of Kalpa, 8. vii.1988 (Coll. J.M. Julka).

Distribution : India (Himachal Pradesh) ; Afghanistan, Iran, Pakistan, and Israel.

Remarks : The species is for the first time recorded from India including Himachal Pradesh. The species may be easily recognised by the division of the costal field by divisory veinlets near costa resulting the smaller cells in upper row. Besides, segment six of abdomen is hairy and the ectoproct long and dilated laterally in males.

Tribe Myrmeleonini

Myrmeleon montanus Navas

1914. *Myrmeleon montanus* Navas, *Ann. Soc. Sci.*, 38 : 234.

1980. *Myrmeleon montanus*, Ghosh, *Rec. Zool. Surv. India, Occ. paper*, no. 52 : 24.

Material examined : 10 exs. ♂ ♀ : India, Himachal Pradesh, Kinnaur, Rogi, 8 kms. of Kalpa, 9. vii. 1988, 8 exs. ; Sanala, 17. vii. 1988, 1 ex. ; Rukti, near Sangta, 18.vii.1988, 1 ex. (Coll. J.M. Julka).

Distribution : India (Darjeeling and Himachal Pradesh).

Remarks : The species constitutes a new locality record for Himachal Pradesh.

SUMMARY

The paper deals with altogether ten species from Himachal Pradesh out of which four species and the female of a species are for the first time reported from

India. All the species, except two, constitute new locality records for Himachal Pradesh.

ACKNOWLEDGEMENT

The author is grateful to the Director, Zoological Survey of India for providing laboratory facilities for the aforesaid work.

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ON THE STATUS AND DISTRIBUTION OF SOME NEW RECORDS OF FRESHWATER ROTIFERS (ROTIFERA : EUROTATORIA) FROM INDIA.

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INTRODUCTION

Sarma (1988) examined twenty seven species of freshwater rotifers, including twenty five new to India, in his samples from Dal Lake (Kashmir), in and around Calcutta (West Bengal) and Delhi (Union territory). The status and distribution of a number of these records are commented in this paper particularly with reference to the present author's observations based on the collections from various states in Eastern and North-Eastern India.

REMARKS ON STATUS AND BIOGEOGRAPHY

Family LECANIDAE

Lecane (Lecane) doryssa is not new to India ; it had previously been documented by this author (Sharma, 1987a) as a rare and an acidophilic species from Meghalaya State (Fig. 1). The report from Calcutta (Sarma, 1988), therefore, extended its distributional range ; this lecanid was, however, not observed in my earlier extensive collections (Sharma, 1978, 79) from West Bengal.

Lecane (Lecane) althausi is apparently incorrectly identified ; Delhi specimens (Fig. 2) are presently assigned to *L. (L.) inermis* because of their close similarity with the same. The later is a cosmopolitan and variable species (Koste, 1978) that had been reported in India (Fig. 3) only from Meghalaya State (Sharma, 1987a).

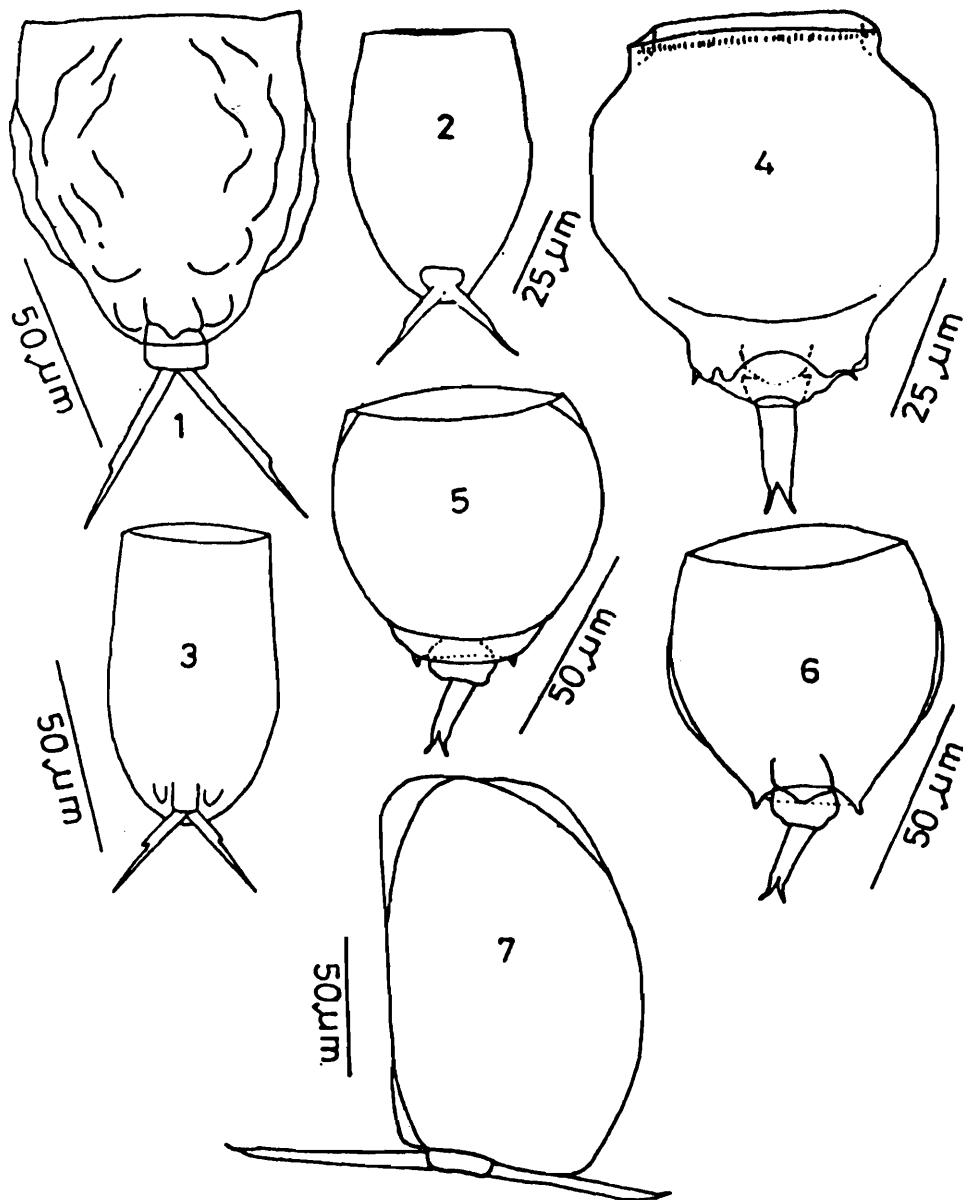
Lecane (Lecane) elongata is a biogeographically important element which occurred in Northern, Eastern and Southern Europe. The material from Delhi (Sarma, 1988), however, differed from that described by Haring & Myers (1926) in the absence of well defined claws. One specimen of *L. elongata* is also observed in my recent collections from Assam State in North-Eastern India.

Lecane (Hemimonostyla) blachei was described from Cambodia (Berzins, 1973) and represented an exclusive South-East Asian element ; it was not so far documented from the Indian subcontinent. Its report from Calcutta (Sarma, *loc. cit.*) is, hence, of regional distributional interest.

Lecane (Monostyla) bifurca is a little known species in this subcontinent ; this cosmopolitan lecanid had been so far reported from Nepal (Turner, 1987) and Delhi (Sarma, *loc. cit.*). Hexagonal shape of lorica of Delhi material (Fig. 4) was probably due to contraction. *L. (M.) bifurca* is also examined recently by me from

a paddy-field in Puri, Orissa State (Figs. 5 & 6) ; these specimens are broadly identical with that of Pax & Voigt (1941/42).

Lecane (Monostyla) thalera is not new to India and had previously been reported from Madras (Hauer, 1936 as *Monostyla conspicua* n.sp.) and West Bengal (Sharma, 1978). In addition, Nayar (1968) described *Monostyla paradeciapiens* n.sp. from Pilani in Rajasthan which is presently treated as a junior synonym of *L. (M.) thalera*. This lecanid has been identified as a subspecies of *L. (M.) lamellata* by Sarma (1988) but is retained as a distinct species in this account.



Lecane (Lacane) doryssa Harring : Fig. 1, Ventral view (after Sharma, 1987a) ; *Lecane (Lecane) inermis* (Buyce) : Fig. 2, Ventral view (after Sarma, 1988), identified as *L. (L.) althausi*, Fig. 3, Ventral view (after Sharma 1987a). *Lecane (Monostyla) bifurca* (Bryce) : Fig. 4, dorsal view (after) Sarma, 1988), Fig 5. & 6, dorsal and ventral view from Orissa State. *Mylilina lisulcata* (Luckes). Fig. 7. Lateral view from Orissa State.

Family BRACHIONIDAE

Brachionus dimidiatus is a little known member of Indian brachionids. Its earlier report from Rajasthan (Nayar, 1968) could not be confirmed (cf. Sharma, 1983). However, the specimens from Delhi (Sarma, 1988) certainly belong to this species.

Platytias leloupi was believed to be an exclusive 'Ethiopian element' (Pejler, 1977) but is now stated to exhibit pantropical distribution (de Ridder, 1981 ; Sharma, 1987b). Arora (1966) described *Platytias longispinosus* n.sp. from Nagpur which was designated (Sharma, *loc. cit.*) as a synonym of *P. leloupi*. The report from Delhi (Sarma, 1988), therefore, extended its distributional range northwards in India.

Keratella ticinensis is a biogeographically significant addition not only to Indian Rotifera but also to Asian fauna because it was so far restricted to North America, Europe and Africa. The material from Dal Lake (Sarma, *loc. cit.*), however, differed from typical *ticinensis* particularly in the shape of the posterior end of lorica. The present author did not notice this interesting species in the examined extensive samples (collected by Dr. Balkhi) from Kashmir valley.

Notholca labis is yet another important member of the Brachionidae examined from Yamuna River at Wazirabad near Delhi (Sarma, 1988) ; this occurrence may be attributed to the drift of this species from higher latitudes of Kumaon Hills in the Western Himalayas.

Family EUCHLANIDAE

Euchlanis incisa is a rare and interesting euchlanid documented from this country. Besides its report from Delhi (Sarma, *loc. cit.*) it is also observed in one of my collections from Mizoram State in North-Eastern India.

Family MYTILINIDAE

Mytilina bisulcata, primarily an inhabitant of peat-bogs (Koste, 1978), was also reported from a gem-pit from Sri Lanka (Chengalath *et.al.*, 1974). This interesting species of *Mytilina* (Fig. 7) is observed in my collection from a domestic well in West Bengal, a paddy-field in Puri (Orissa) and in a number of samples from a variety of habitats in Brahmaputra valley of Assam State. Further, my observations ascertain acidophilic nature of this species.

Family EPIPHANIDAE

Epiphanes macrourus is not new to this country and had been reported previously from Meghalaya (Patil, 1978). In addition, it is observed in my recent collections from Darbhanga city in Bihar State.

Other reported species of this family (Sarma, 1988) i.e., *Cyrtonia tuba*, *Liliferotrocha subtilis* and *Microcodiles chelana* are rare and biogeographically interesting additions to the rotifer fauna of India.

Family TRICHOCERCIDAE

The cosmopolitan *Trichocerca pusilla* reported from Delhi (Sarma, 1988) was believed to be a rare species as also noticed in my recent collections from Darbhanga (Bihar State). On the contrary, the present author noticed it to be fairly widely

distributed amongst planktonic and periphytic rotifer communities in North-Eastern region and also in some samples from Orissa.

Family TRICHOTRIDAE

Wolga spinifera is a little known and interesting element documented (Sarma, *loc. cit.*) from India. Till now it was known to be distributed only in Eurasia between 37°N - 52°N. The report from river Yamuna (Sarma, 1988) near Delhi considerably extended its latitudinal distributional range. *W. spinifera*, like *N. labis* is also presently believed to have drifted from higher altitudes in Western Himalayas.

Family NOTOMMATIDAE

Genus *Monommata* is not new in India ; it had been reported earlier from Meghalaya State (Sharma & Sharma, 1986) and was represented by only one species i.e., *M. longiseta* (Müller). *M. arndti* from Delhi (Sarma, *loc. cit.*) is the second species known to occur in Indian waters.

Family TESTUDINELLIDAE

Testudinella species had been poorly documented in this country till the recent contribution by this author (Sharma, in press). Of these, *T. emarginula* was so far reported only from Delhi (Sarma, 1988) apparently indicating restricted occurrence. My collections from Orissa State in Eastern India and that from various states in North-Eastern region reflected wider distribution of this species which occurred primarily in slightly alkaline to slightly acidic waters (pH 6.5-7.2).

SUMMARY

This communication comments on the status and distribution of various rotifer taxa, belonging to nine eurotatorian families, recently reported (Sarma, 1988) from India. *Lecane* (*Lecane*) *doryssa*, *Lecane* (*Monostyla*) *thalera*, *Epiphanes macrourus* and genus *Monommata* are known from this country. The specimens of *Lecane* (*Lecane*) *althausi* are assigned to *Lecane* (*Lecane*) *inermis*. *Monostyla pardecipiens* Nayar, 1968 is proposed to be a junior synonym of *Lecane* (*Monostyla*) *thalera*. The latitudinal distributional range of *Wolga spinifera* is considerably extended. Various other species are stated to be of regional distributional interest. *Lecane* (*Lecane*) *doryssa* and *Mytilina bisulcata* represent acidophilic elements.

ACKNOWLEDGEMENTS

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**GROUSE LOCUSTS (INSECTA : ORTHOPTERA : TETRIGIDAE)
OF THE KANHA NATIONAL PARK, DISTRICT MANDLA,
MADHYA PRADESH, INDIA**

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INTRODUCTION

Tandon *et. al.* 1976 have reported 23 species of Orthoptera, belonging to families Pyrgomorphidae, Acrididae, Gryllidae and Oecanthidae, from the Kanha National Park, District Mandla, Madhya Pradesh. The present study deals with the grouse locusts (Family : Tetrigidae) of that area. Eight species under six genera are recorded. Distributional ranges have been given for each of these species. A consolidated list of species of grouse locusts reported from Madhya Pradesh, along with a key is appended in the end. This study is based on the material collected during the Kanha National Park Survey, 1974.

SYSTEMATIC ACCOUNT
Order ORTHOPTERA
Family TETRIGIDAE
Subfamily SCELIMENINAE

1. *Thoradonta pruthii* Gunther, 1938

1938. *Thoradonta pruthii* Gunther, *Stettin. ent. Ztg.*, **99** : 129-30.

Material examined : 1 ♂, Forest near Rest House, Kanha, 28. ii. 1974, coll. H. Khajuria; 2 ♂♂, 2 Km. north of Mukki forest, Kanha, 1. iii. 1974, coll. H. Khajuria.

Distribution : India (Madhya Pradesh, Karnataka).

2. *Criotettix bispinosus* (Dalman)

1818. *Acrydium bispinosum* Dalman, *Kongl. Vet. Akad. Handl.*, : 77.

1887. *Criotettix bispinosus*, Bolivar, *Annls Soc. ent. Belg.*, **31** : 185.

1938. *Criotettix bispinosus*, Gunther, *Stettin. ent. Ztg.*, **99** : 134.

Material examined : 1 ♀, Forest meadow and a nala close to Rest House, Kanha, 20. ii. 1974, coll. N. K. Sinha.

Distribution : India (Assam, Bihar) ; Burma ; Java ; Sumatra ; Borneo ; Taiwan ; Hainan ; China ; Sulawesi ; Malaya ; Thailand and Luzon.

Subfamily TETRIGINAE

3. *Euparatettix personatus* (Bolivar)

1887. *Paratettix personatus* Bolivar, *Anns Soc. ent. Belg.*, **31** : 128.

1904. *Euparatettix personatus*, Hancock, *Spolia zeylan.*, **2** : 145-146.

Material examined : 1 ♀, Forest near Rest House, Kanha, 28. ii. 1974, coll. H. Khajuria.

Distribution : India (Throughout India) ; Bangladesh ; Pakistan ; Burma ; Sri Lanka ; Java ; Philippines ; Taiwan and Celebes.

4. *Euparatettix histricus* (Stål)

1860. *Tetrix histrica* Stål, *Freq. Euganes Resa Orth.*, : 347.

1941. *Euparatettix histricus*, Günther, *Stettin. ent. Ztg.*, **102** : 150.

Material examined : 8 ♂♂, 6 ♀♀ Fallow paddy fields, about 2 km. north of Mukki forest, 1. iii. 1974, coll. H. Khajuria ; 1 ♂, 1 ♀, 2 km. south of Kisli market road, 18. ii. 1974, coll. N. K. Sinha ; 1 ♀, Forest meadow and a nala, close to Rest House, 20. ii. 1974, coll. N. K. Sinha ; 1 ♂, 2 ♀♀ Forest around Forest Rest House, 28. ii. 1974. coll. H. Khajuri ;

Distribution : India (Tamilnadu, Orissa, Bihar, West Bengal, Meghalaya) ; Pakistan ; Nepal ; Burma ; Sri Lanka ; Java ; Philippines ; Bornaeo ; Sumatra ; Malaya Islands ; South China ; Taiwan ; Queensland ; N. Austrilia ; Holand ; N. Calendonia and Mindanao.

5. *Hedotettix gracilis* (De Haan)

1842. *Acridium (Tetrix) gracile* De Haan, *Temminck, Verhandel. Orth.*, : 167-169.

1914. *Hedotettix gracilis*, Kirby, *Fauna Brit. India Orth. (Acridiidae)* : 72.

Material examined : 1 ♀, Periphery of forest meadow, close of nala, 2 km. south east of Kisli. 17. ii. 1974, coll. N. K. Sinha ; 1 ♂ 2 km. south west of Kisli market road, 18. ii. 1974, coll. N. K. Sinha ; 2 ♂♂, 1 ♀. Forest meadow and a nala, near to Rest house, 20. ii. 1974, coll. N. K. Sinha ; 2 ♂♂, Forest around Rest House, 28. ii. 1974, coll. H. Khajuria ; 9 ♂♂, 4 ♀♀, Fallow paddy field about 2 km. north of Mukki forest, 1. iii. 1974, coll. H. Khajuria.

Distribution : India (Throughout India) ; Pakistan ; Bangladesh ; Sri Lanka ; Burma ; Thailand ; Java ; Sumatra ; Celebes ; Vietnam and Taiwan.

6. *Hedotettix punctatus* Hancock

1908. *Hedotettix punctatus* Hancock, *Trans. R. ent. Soc. Lond.*, 1909 : 422.

1970. *Hedotettix punctatus*, Steinmann, *Acta zool. hung.*, **16** : 234.

Material examined : 1 ♂, 1 ♀, Fallow paddy field, 2 km. north of Mukki forest, 1. iii. 1974, coll. H. Khajuria.

Distribution : India (Madhya Pradesh, Rajasthan and Himalayan Region) and Borneo.

7. *Coptotettix conspersus* Hancock

1915. *Coptotettix conspersus* Hancock, *Rec. Indian Mus.*, **11** : 119-120.

Material examined : 1 ♂, Forest meadow and a nala close to Rest House, Kanha, 20. ii. 1974, coll. N. K. Sinha.

Distribution : India (West Bengal, Assam, Uttar Pradesh) and Sri Lanka.

8. *Ergatettix dorsifera* (Walker)

1871. *Tettix dorsifera* Walker, *Cat. Derm. Salt. Brit. Mus.*, **5** : 825.

1929. *Ergatettix dorsifera*, Hebard, *Revue suisse Zool.*, **36** : 588.

Material examined : 1 ♂, Periphery of forest meadow, close to nala, 2 km. south east of Kisli, 17. ii. 1974, coll. N. K. Sinha ; 1 ♂, 2 km. South west of Kisli market road, 18. ii. 1974, coll. N. K. Sinha ; 1 ♂, Forest meadow and a nala, close to Rest House, 20. ii. 1974, coll. N. K. Sinha ; 5 ♂♂, 2 ♀♀, Fallow paddy field, 2 km. north of Mukki forest, 1. iii. 1974, coll. H. Khajuria.

Distribution : India (Uttar Pradesh, Bihar, Orissa, West Bengal, Madhya Pradesh, Maharashtra, Kerala and Assam) ; Nepal ; Bangladesh ; Burma ; Sri Lanka and Sumatra.

Key to the species known from Madhya Pradesh

1. Posterior angles of lateral lobes of pronotum acutely produced outwards and spined. 2
- Posterior angles of lateral lobes of pronotum neither produced nor spined. ... 4
2. Margin of tibiae and first tarsal segment of hind leg very wide and subhyaline ; hind femora spined beneath. *Euscelimena harpago* (Serville)
- Margin of tibiae and first tarsal segment not expanded, but normal; hind femora without spine beneath. 3
3. Lateral margin of the pronotum behind the shoulders, in profile, distinctly angular upwards and from the top view bent inwards ; dorsum strongly sculptured; lateral lobes of pronotum with spine which is directed transversely. *Thoradonta pruthii* Gunther
- Lateral margin of the pronotum behind the shoulders neither outwards nor inwards distinctly angularly bent ; dorsum without sculptures ; lateral lobes of pronotum with spines which are directed posteriorly. *Criotettix bispinosus* (Dalman)
4. Vertex and eyes obviously raised above the level of pronotum ; antennae placed between the lower border of eyes. 5
- Vertex and eyes very little or not at all raised above the level of pronotum ; antennae scarcely placed between the middle of eyes. 7
5. Vertex narrower than an eye ; antennae inserted below the middle of eyes ; median carina of pronotum not undulated ; posterior femora with less conspicuous nodosities on the externo—medial area. 6

Vertex still narrower than an eye ; antennae inserted distinctly below the inferior margin of eyes ; median carina of pronotum undulated ; posterior femora with distinct nodosities on the externo—medial area.

Ergatettix dorsifera (Walker)

6. Stature slender ; hind tibiae dense black with white annulation just behind the knees ; frontal costa, generally narrowly sulcate.

Euparatettix personatus (Bolivar)

Stature more robust and larger ; hind tibiae subunicoloured or obscurely marked but never dense black ; frontal costa, generally, moderately sulcate.

Euparatettix Histricus (Stal)

7. Dorsum of pronotum bearing lineate tubercles ; vertex narrower and more narrower in front, not expanded in front ; abbreviated carinae indistinctly present ; median carina of pronotum very fine and interrupted.

Coptotettix conspersus Hancock

Dorsum of pronotum smooth or a little granulose ; vertex equal to or a little narrower than an eye ; subtransversely or triangularly carinated in front ; median carina of pronotum percurrent, not at all interrupted. 8

8. Frontal costa widely sulcated, the rami more or less abruptly widened between the antennae ; pronotum convex, anterior margin transverse ; median carina of pronotum compresso—arcuate forward before the shoulders, highest at the sulci.

Hedotettix gracilis (De Haan)

Frontal costa narrowly sulcated, the rami subparallel ; pronotum strongly compresso—cristate, anterior margin angulate ; median carina of pronotum arcuately-cristate, thin and translucent.

Hedotettix punctatus Hancock

SUMMARY

Eight species of grouse locusts are recorded from the Kanha National Park. Distributional ranges are provided for these species. A list, along with a key to all species recorded from the whole Madhya Pradesh is also appended.

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**BURROW SYSTEM OF THE LARGE BANDICOOT RAT,
BANDICOTA INDICA (BECHSTEIN)
RODENTIA : MURIDAE IN WEST BENGAL**

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INTRODUCTION

Like majority of murid rodents, *Bandicota Indica* spends much of its time in extensive burrow system dug by it. Damages to buildings and mud houses by its tunnelling in the walls and beneath the floors are well known (Hutton 1949, Prakash 1976). However, except for the works of Urs *et al.* (1969) at the villages near Mysore, Arjunwadkar and Gadgil (1974) at Poona, Tien and Cu (1965) in Vietnam and Marshall (1977) in Thailand, practically nothing is known about the pattern of its burrow systems, their diversity and microclimate. The present study involves the identification and excavation of its burrow systems in different habitats and data collecting of the microclimatic features of the same.

METHODOLOGY

Burrow systems at different habitats and at different times of the years 1981, 1982 and 1983 were excavated. Using a spade, the earth above the burrow was carefully removed and the course of the burrow was determined by introducing a long flexible rod. Number and diameter of burrow openings of each burrow system were noted. The measurements of the extension and depth were noted with a tape. Whenever nesting material were found, they were collected in a polythene bag and later analysed. Flora and fauna of the burrow systems were also collected, preserved and identified. To study the climatic condition of the burrow system, temperature and Relative Humidity near the burrow openings and at various depths were noted with the help of a Japanese made dial type hygrometer and a steelcased soil thermometer (Plate 1a).

STUDY AREA

The study was mainly conducted at Sagar Island (21.56° to 21.88° N and 88.08° to 88.16° E), the largest delta in the western sector of the Sundarbans. It is situated nearly 85 km. south of Calcutta. It is surrounded by large water bodies, namely the river Hugli in the northern and western sides and the river Mooriganga in the eastern side. The southern part of the Island faces the open area, the Bay of Bengal. Reclamation of the Sagar Island by deforestation was started early in nineteenth

century, but the southern part of the Island was covered with jungle till the first quarter of the present century. Gradual deforestation, cordoning of the island with high embankments and repeated monsoon wash the salinity of the soil and made the entire area cultivable. Several tanks were dug out which subsequently filled up with rain water to meet man's requirement.

Additional study was also made at Thakurpukur and Behala (South 24 Parganas District) regions of West Calcutta. Only few decades ago these regions were mostly under cultivation of paddy with much marshy areas. But in recent years most of the land have been reclaimed for construction of buildings, factories and roads. However, there are still a number of ponds, open drains and stretches of green land which are left over relics of the original topography of the area.

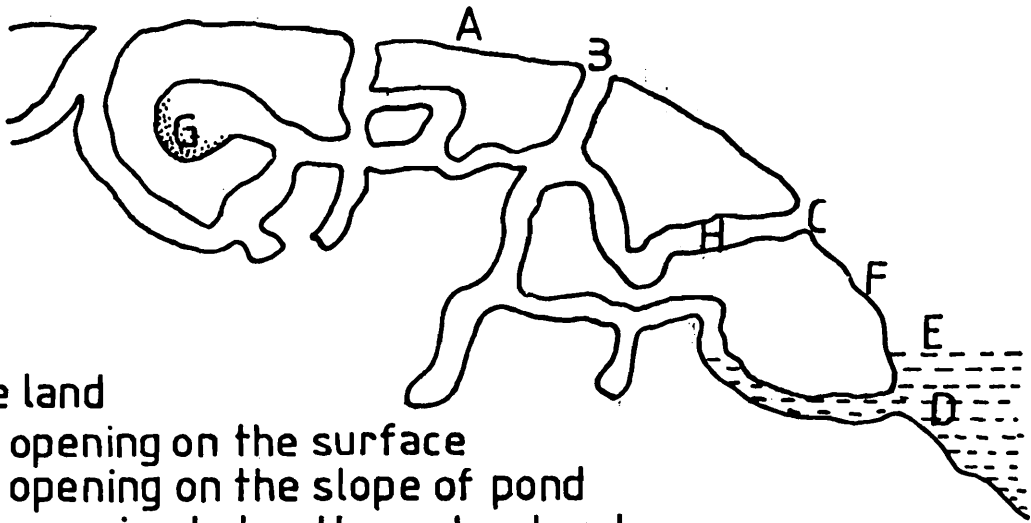
BURROW LOCATION AND IDENTIFICATION

Burrows of *B. indica* were observed in paddy fields, 'bunds', vegetable gardens, mud houses having a stock of food grains, along the ponds or other marshy areas as well as by the sides of open drains. Live burrow system can be recognised by the fresh wet globules of earth at the burrow openings and presence of foot prints, tail marks, soft faecal matter and sometimes fresh broken shells of crabs and molluscs (Plate 1b). Such burrows were observed throughout the year along the ponds, open drains or other water resources having some aquatic weeds, fish and molluscan population. In the paddy fields, live burrows were noticed only during late November to next May, and in the 'bunds' from June to December. Occurrence of live burrows along the boundary of vegetable gardens were observed only when there was standing vegetables in the garden, irrespective of season. Live burrows in or adjacent to the mud houses containing stored grains were only occasionally noticed, but in a fallow land with thick bush adjacent to a mud house, burrows were observed almost throughout the year. Month—wise occurrence of live burrows in different habitats of the Sagar Island and suburbs of Calcutta based on two years observations is summarised in table 1.

Burrow Pattern : Pattern and nature of burrow systems vary from habitat to habitat. The same has been described below :

Ponds and marshy areas : Along the ponds and marshy areas, as already stated, burrows are found throughout the year. Adjacent areas of twelve ponds each measuring 400 sq. m to 2500 sq. m of Sagar Island have been surveyed. Number of burrow systems varied from 3 to 17 and simple burrows 2 to 14 around each pond. However, are a of the pond has no relation with the number of burrow systems or simple burrows. Number is somewhat directly proportional to the thickness of the surrounding vegetation and richness of the molluscan population in the pond. Burrows are mostly located on the side having dense bush, bamboo thickets or trees like coconut, datepalm, *etc.* Sometimes burrows are located adjacent to the 'ghat' (a cemented or wooden structure which facilitates the landing in the pond) used for cleaning the household utensils. A total of 24 burrow systems along the ponds were excavated for detail study. From the pattern, it appears that burrows were initially started on the sloping edge of the pond and then extension and ramification took place with the age of the occupant, and except the first opening others were made from inside the earth, forming tunnel. Each burrow system (Fig. 1a, Plate 2 a, b) had

a number of openings—one to three on the slope of the pond and zero to eleven on the adjacent surface land. Sometimes one of the openings on the slope might lie below the level of water. From the first opening above the level of water on the slope, a tunnel is traceable, which runs away from the pond for 30 to 64 cm. and then bifurcates. These two tunnels may run in the same or different directions, giving a number of branching tunnels mostly in linear fashion in all directions. Branches of one tunnel often communicate with that of other forming a net work below the ground. Some branches turned back towards the pond and opened on the slope or even below the level of water. Tunnels and its branches are tortuous and tortulous in nature. Most of the tunnels and their branches ended blindly below the surface with occasional enlargement, while others opened on the surface land adjacent to the pond. Entire burrow system is extended to at least two or more strata of the soil and depth varied from 30 cm. to 103 cm. Burrow openings on the surface land might be found even at about 3 meter away from the edge of the pond. However, it will not be out of point to mention about a particular burrow system observed at Santoshpur (South 24 Parganas) which extended from the slope of a pond to a mud house (containing stored grains at about 9 meters away from the pond), forming almost a straight tunnel at a depth of 40 to 60 cm. Mostly the extension of the burrow system and number of openings are some what directly proportional to the diameter of the original opening on the slope. The original opening on the slope is more or less elliptical in shape, 9 to 24 cm. in diameter and smooth in outline. Other openings are mostly roundish, 6-19 cm. in diameter with irregular or smooth outline. It appears that openings with irregular outlines are new ones. Diameter of the tunnel and its branches varies widely within the same burrow system ranging from 6-24 cm., except at the point of enlargement where it is more. Boundary wall of the older tunnels and branches are very smooth but not so in the freshly constructed regions. Tunnels or branches are not sealed with soil except at the points where they accidentally opened on the tunnels of neighbouring burrow system. A detail statistics of the twenty four burrow systems dug out along the ponds are given in table 2.



- A. Surface land
- B. Burrow opening on the surface
- C. Burrow opening on the slope of pond
- D. Burrow opening below the water level
- E. Water
- F. Slope of pond
- G. Brood chamber
- H. Tunnel

Fig1a. Pattern of a complete burrow system near pond.

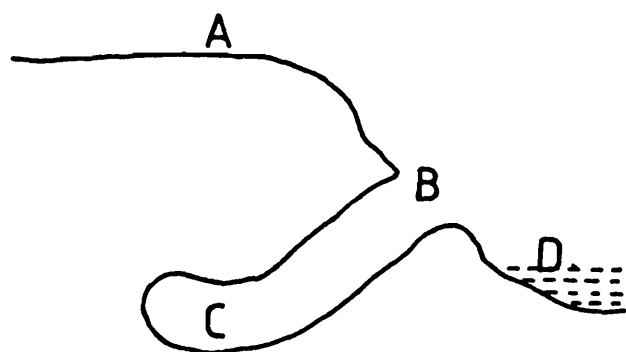
Table 1. Monthwise occurrence of live burrow systems of *Bandicota indica* in different habitats of Sagar island and sububs of Calcutta.

Habitat	January	February	March	April	May	June	July	August	Septem-ber	October	Novem-ber	Decem-ber
1. Along the ponds or other marshy areas	+	+	+	+	+	+	+	+	+	+	+	+
2. Along the open drains	+	+	+	+	+	+	+	+	+	+	+	+
3. Paddy fields	+	+	+	+	+	-	-	-	-	-	+	+
4. 'Bunds'	-	-	-	-	-	+	+	+	+	+	+	+
5. Vegetable garden	+	+	-	-	-	+	+	-	-	+	+	+
6. Mud houses and neighbouring land	+	+	+	+	+	+	+	+	-	-	+	-

All the burrow openings on the surface land as well as on the slope as observed remain permanently open. Globules of earth measuring 3 to 8 mm. in diameter are found particularly below the opening in the slope in case of fresh burrow system, but not in old ones. It appears that, after attaining a certain age, the animal stops the further extension of the burrow system. The presence of small whitish soft faecal pellets in the accumulated globules of earth indicates the existence of suckling youngs in the burrow system.

In seven out of 24 burrow systems, a brood chamber was found, which is nothing but a dilated blind end of a little upwardly directed tunnel, padded with some soft material like dry grasses, leaves and roots of aquatic weeds, *etc.* It is located at a depth of 40 to 90 cm. in somewhat central position of the burrow system. Shells of molluscs and crabs were often found inside the tunnel near the brood chamber.

In addition to the burrow system, some simple burrows were also found along the slope of ponds and marshy areas. The opening of which leads into a short, unbranched, curving tunnel extending into the same or two strata of the soil (Fig. 1b). Excavation of thirteen such burrows revealed that maximum length of the tunnel is about 72 cm. with diameter ranging from 6 to 14 cm. Animal was not found in any such burrows, but in six, floor of the tunnel was wet with fresh markings of foot and tail indicating that these were used by the animal for temporary shelter during the night. In five, broken shells were found inside the tunnel or just outside the opening. Thus, it appears that these burrows are also often used as feeding place.

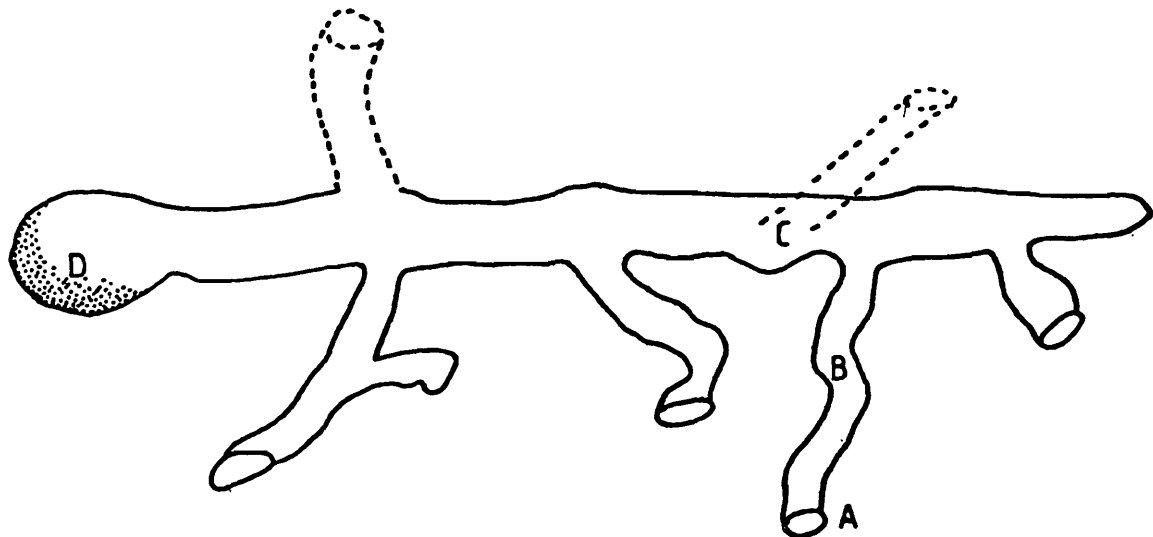


- A. Surface land
- B. Burrow opening
- C Tunnel
- D Water

Fig. 1b. Pattern of a simple burrow near pond

Bunds' : Live burrow systems were observed in the 'bunds' or highlands adjacent to the cultivated fields from April to December but the frequency was minimum. In about 9 km. of 'bunds' around paddy fields of four villages, *viz.*, Kachuberia, Kashtala, Phulbari and Sapkhali surveyed during the year 1981-82, only 14 live burrow systems could be found. Seven of them were excavated. A typical burrow system (Plate 3a, Fig. 2) consists of a series of openings on one side of the 'bund', some of which might remain under water during rainy season, a few on the upper surface and occasionally one or two on the other side of the 'bund'. From each opening a small tunnel leads into the 'bund' to meet with a central tunnel lying at a depth of 30 to 60 cm. The central tunnel runs almost horizontal to the surface of the 'bund' and ends blindly on either sides. Number of burrow openings varied from

three to ten. Diameter of the burrow openings ranged from 4 to 13 cm, and the largest one always found on the side. Central tunnel is almost uniform in diameter but varies from one burrow system to other being 7 to 13 cm. Small tunnels are always narrower than the central. Maximum extension of the burrow system was found to be 232 cm. Burrow openings were clean, but when the fields became dry, globules of earth were often found on the ground below the openings.



- A. Burrow opening
- B. Tunnel
- C. Central tunnel
- D. Brood chamber

Fig 2. Pattern of a burrow system in the 'bund'

Out of seven burrow systems only in one (dug out in October) brood chamber was found, which was nothing but one end of the central tunnel padded with finely cut roots and leaves of paddy and some grasses. Statistical features of the seven dug out burrow systems are given in table 3.

Paddy fields : Live burrow systems in the paddy field were observed only from late November to early May of the next year depending on the time of ripening and harvesting of the paddy as well as the nature of land *i.e.* high or low. However, frequency of the occurrence of burrow system in the field was minimum and only 17 were observed during 1981-82 in 59 plots each having an average area of 860 sq. m. Burrows are initiated with the drying up of the field and maturing of the crop probably by the animals living in the adjacent 'bunds' or marshy areas. Altogether twelve burrow systems were excavated in different months. During November—December, burrow system is very simple consisting of one or two openings (Plate 3b). From each opening a tunnel runs obliquely downwards for 30 to 60 cm. In case of two tunnels, they communicate directly forming somewhat 'U' shaped structure or they are connected by a simple branch. Diameter of the same tunnel varies widely from 5 to 13 cm. Walls of the tunnels are very rough. Diameter of the burrow openings ranged from 5 to 13 cm. Heap of soft, wet globules of earth of about 4 to 12 mm in diameter are found outside, which partially covers the burrow opening. A few scattered grains are found in the tunnel but without any sign of hoarding. From January onwards complicated burrow systems were observed, with increasing number of burrow openings, tunnels and their branches, which communicate with each other to form the usual network below the ground (Plate 4a, Fig. 3). Walls of

Table 2. Statistics of excavated twenty four live burrow systems of *Bandicota indica* along the ponds. Figures in parenthesis indicate the number of burrow systems.

No. of openings	Diameter of largest opening (cm.)	Maximum depth of the burrow system (cm.)	Maximum diameter of the tunnel (cm.)	Minimum diameter of the tunnel (cm.)	Maximum* extension of the burrow system (cm.)
1-3(4)	9-13(3)	30-55(5)	3-12(3)	6-8(9)	100-150(5)
4-7(15)	14-17(14)	56-76(14)	13-16(7)	9-11(10)	151-200(6)
8-10(3)	18-21(4)	76-95(3)	17-20(11)	12-14(5)	201-250(9)
11-13(2)	22-24(3)	95-103(2)	21-24(3)	—	251-302(4)

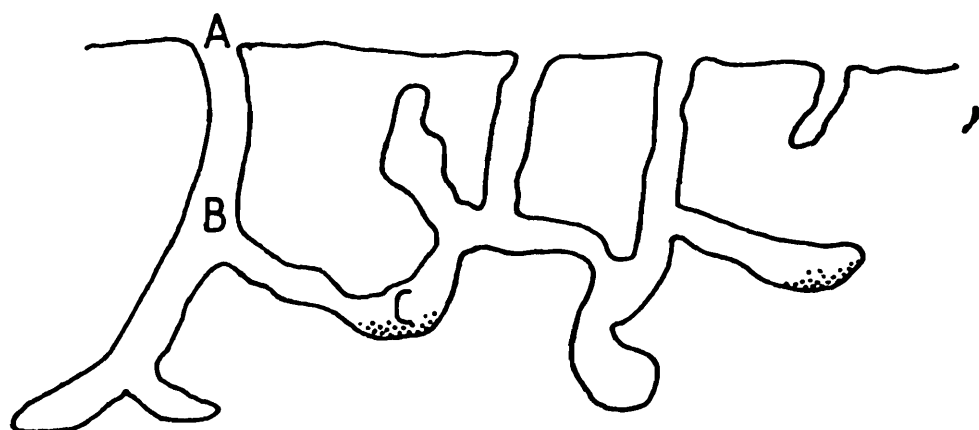
* Straight line distance between the two most distantly located burrow openings.

Table 3. Statistics of excavated seven live burrow systems of *Bandicota indica* on the 'bunds'

Burrow number	No. of opening	Maximum diameter of the largest opening (cm.)n	Maximum depth of the burrow system (cm.)	Maximum diameter of the tunnel (cm.)	Maximum diameter of the burrow tunnel (cm.)	Maximum* extension of the burrow system (cm.)
1	3	8	30	9	7	98
2	5	8.5	49	12	10.5	113
3	4	10	78	11	9	145
4	8	13	114	12	10	180
5	9	13	98	13	11	165
6	8	12	111	13	11	232
7	10	9.5	106	12.5	10.5	170

* Straight line distance between the two most distantly located burrow openings.

the tunnel and their branches became smooth with occasional dilation particularly at the blind ends. A maximum of 6 burrow openings were observed, diameter of which ranged from 5 to 11 cm. Some of the openings were partially covered with globules of earth and rest were clean. Extension and depth of the burrow system did not exceed 198 cm. and 72 cm. respectively and extended in two to three strata of soil. In none of the excavated burrow system brood chamber was found. Ears of paddy, individual grains and also some straw were often noticed in the tunnel and dilated portion (plate 4b), but the total weight of all these material never exceeded 258 gm. Thus, it appears that the animal depends only partially on these hoarded grains during the period from February to May when little grains remain in the field.



- A. Burrow opening
- B. Tunnel
- C. Hoarded grains

Fig.3 Pattern of a burrow system in the paddy field in March

Vegetable Garden : When there is a standing crop particularly sweet gourd, potato, pumpkin, *calocasia*, etc., live burrows or burrow systems are observed along the boundary of the vegetable garden. Usually most of the vegetable gardens of South 24 Parganas District have a boundary of thick bushes and the burrows are located inside the bushes (Plate 5a). Altogether 39 gardens of the Sagar Island, Behala and Thakurpukur were surveyed in which 16 live burrow systems distributed in 13 gardens have been observed at different times of the year. Being unable to get the permission from owners of the gardens, only two of them could be excavated. One of which consisted of a single burrow opening from which a tunnel of 48 cm. lead towards the garden without any branching. Tunnel wall was very smooth and its blind end was slightly dilated. Another burrow system had three openings within a small area of about 2600 sq. cm. inside the bush. From each opening, an obliquely directed tunnel went towards the garden at a depth of 30 to 40 cm. These tunnels were connected by simple branches. Two tunnels extended for 90 and 112 cm., and ended blindly with a little dilation, but the third one after extending for about 133 cm. below the ground, directed upwards and opened on the surface of the garden. The burrow system was almost restricted to one stratum of soil. Interestingly enough, burrow openings inside the bushes were free, but that on the garden was completely covered with loose soil. diameter of the tunnels varied from 6 to 13 cm. No brood chamber was found. There was no sign of hoarding but a few partly eaten potatoes were observed at different parts of the tunnel.

Mudhouses and adjacent land : Live burrow systems were found almost throughout the year in or adjacent to the mudhouses having some stored grains. As many as 27 such burrow systems were observed at the Sagar Island of which 6 were excavated. However, due to practical difficulties proper excavation of the portion inside the house could not be done. Each burrow system had 3 to 19 openings, distributed inside as well as outside the house. These openings are connected by underground tunnels and their branches, depth of which went up to 65 cm. It is extended to three strata of the soil. Sometimes, tunnels go up through the wall of the mudhouse and open at a height of even 1.2 m. (Plate 5b). Extension inside the wall sometimes lead to the total collapse of the wall, as it is reported by the local people. Diameter of the burrow openings widely vary from 4 to 13 cm., and that of the tunnels from 5 to 14 cm. Huge piles of the earth were found at the edge of the openings lying outside the house but not in those of inside. Some simple holes are also made at the base of the mud wall and used as ready passage for in and out. Though there was no definite storing chamber, but up to 500 gm. grains were found stored irregularly at different parts of the tunnels and their branches. In addition to the grains, other articles of daily household, viz., soap, candle, spoon (steel), pieces of cloth etc., have been recovered from the burrow systems. Brood chamber which is a slightly upwardly directed dilated blind end of a tunnel, padded with variety of material like husk, cotton, jute, paper, etc., was found in three burrow systems.

Open drains : Along the sloping edge of the open drains at Behala and Thakurpukur a series of live burrow systems were observed throughout the year. Each burrow system (Plate 6) consisted of a number of openings on the slope of the drain almost in a linear fashion. From each opening a short tunnel of 30 to 40 cm. went slightly downwards and then upwards. These tunnels met with a central tunnel. Central tunnel ran almost parallel to the slope of the drain even up to 410 cm. Central tunnel gave rise one to four short, blind, upwardly directed branches opposite to the direction of slope. Diameter of the tunnels varied from 5 to 10 cm., and that of burrow openings from 4 to 7 cm. Accumulation of very fine globules of earth could be marked below each opening particularly during dry period of the year. Most of the dug-out burrow systems had a brood chamber, which was again nothing but a blind, upwardly directed branch, padded with fine dust of soil, pieces of paper, cloth, dry leaves and roots.

FLORAL COMPOSITION IN ASSOCIATION WITH THE BURROW SYSTEM

A number of plant species were found neighbouring the burrow system. The most of the burrow openings are not covered by the globules of earth, but often they are concealed by the growth of different plants. Different species of plants associated with the burrow systems in different habitats are listed in table 4. Variety and richness of the plant species are most pronounced near the ponds and marshy areas and minimum around vegetable gardens. Some of the plant species associated with the burrow system served as items of food of *B. indica*, which is advantageous for the youngs. In addition to the green plants number of fungi, viz., *Mucor*, *Aspergillus*, *Rhizopus* were also found in an around the burrow systems of all habitats.

Table 4. Floral composition in association with the burrow systems of *Bandicota indica* at different habitats.

HABITATS			
Ponds and marshy areas	Along the drains	Vegetable gardens	'Bunds' and paddy fields
<i>Imperata arundinacea</i>	<i>Peperomia pillucida</i>	<i>Opuntia dillanii</i>	<i>Cynodon dactylon</i>
<i>Calocasia antiquorum</i>	<i>Alternanthera sessilis</i>	<i>Calotropis</i> sp.	<i>Amaranthus gracilis</i>
<i>Alocasia indica</i>	<i>Amaranthus viridis</i>	<i>Croton</i> sp.	<i>A. spinosus</i>
<i>Masilea quadrifoliata</i>	<i>A. spinosus</i>	<i>Convolvulus</i> sp.	<i>Cammelina bengalensis</i>
<i>Ipomea</i> sp.	<i>Chrosophora peicata</i>	<i>Jatropha</i> <i>gossypifolia</i>	<i>Andropogon scuarrosus</i>
F <i>Sphegalea</i> sp.	<i>Oxalis corniculata</i>		
<i>Sesleania</i> sp.	<i>Xanthium strumarium</i>		
L <i>Trapa bispinosa</i>	<i>Croton</i> sp.		
<i>Vallieneria</i> sp.	<i>Haliotropium indioum</i>		
<i>Atternanthera</i> sp.	<i>Eclipta prostrata</i>		
O <i>Chrosophora plicata</i>	<i>Glycosmis arborea</i>		
<i>Onalis corniculata</i>	<i>Tagetes</i> sp.		
R <i>Xanthium stromarium</i>	<i>Vernonia</i> sp.		
<i>Glycosmis arborea</i>	<i>Acalypha indica</i>		
A <i>Sporonlus fertilis</i>			
<i>Lippia nodiflora</i>			
<i>Tagetes</i> sp.			
<i>Typha</i> sp.			
<i>Cocos nucifera</i> .			
<i>Borassus flabellifer</i>			
<i>Phoenix sylvestris</i>			
<i>Cyperus kyllingia</i>			

FAUNAL ASSOCIATION WITH THE BURROW SYSTEM

Faunal composition of six live burrow systems of five different habitats were studied. Protozoan and nematode species were studied by culture and seiving of the burrow soil respectively. As many as 36 species belonging to four different phyla were revealed. A burrow-wise detail analysis of the fauna is given in table 5. It appears that fauna of the burrow system located near a water source is comparatively richer than that of other habitats. Three species, viz., *Colpoda cucullus*, *Pheretima posthuma* and *Cyphoderus* sp. are the most common species living in the burrow system and found in four out of six burrow samples studied. Though Arjunwadkar and Gadgil (1974) reported lizards as a commensal species in the burrows of *B. indica* at Poona, but no vertebrate commensal was found in the live burrow systems excavated during the present study. However, several amphibian and reptilian species use the deserted burrow systems at the Sagar Island as their shelter particularly during winter.

MICROCLIMATE

Soil : Soil of the Sagar Island may be classified into four categories, viz., *Matial*, *Baliara*, *Dhap*. Burrows were found in all the types, but more frequently in the *Baliara* and *Matial* type, Moisture-content of the soil lining the tunnels was very high in all the habitats. During the year 1981-82, it varied from 15 to 32 per cent at

the deepest position and 7 to 28 per cent at the upper region. Some whitish efflorescences of sodium chloride were found in the soils of the burrow systems of the Sagar Island, while soils from the burrows of Thakurpukur and Behala were often impregnated with 'Kanhari' and laterite debris.

Temperature : Temperature inside the burrow system at a depth between 70 and 100 cm. was measured by vertical drilling and inserting the thermometer there. For comparison, air temperature as well as temperature of the soil surface were also noted. Temperature was recorded at different hours of the day from 6.00 to 17.00 hrs. This study was conducted only during 1981-82.

Average hourly air temperature varied from 19.3° C to 34.2° C during premonsoon, 24° C to 33.6° C during monsoon and 14.4° C to 28.6° C during post monsoon period. Peak in temperature was attained at about 14.00 hours during monsoon and premonsoon period while at about 15.00 hours during post monsoon (Table 6). Average hourly temperature inside the burrow at a depth of 70 to 100 cm. varied from 18.4° C to 28.3° C, 19.0° C to 26.8° C and 16.4° C to 26.6° C during premonsoon, monsoon and post-monsoon months respectively. Peak in temperature inside the burrow was attained about an hour later than that of outside in all the three seasons (Table 5). Average hourly soil surface temperature exhibited much variation during premonsoon and post-monsoon periods, but not so in the monsoon. During premonsoon and post-monsoon, average hourly soil surface temperature varied from 17° C to 35.2° C and 12.8° C to 28.5° C respectively, while it ranged from 20° C to 29° C during monsoon. Peak in the temperature of soil surface was usually attained a little before the peak of air temperature (Table 6).

Relative Humidity : Relative Humidity outside the burrow and at about 30 cm. inside the burrow system was noted at 8.30 hours and 17.30 hours. Relative Humidity inside and outside the burrow was maintained at a very high level throughout the year, particularly during premonsoon and monsoon (Table 7). Range of variation of Relative Humidity outside the burrow was practically negligible during premonsoon and monsoon, but about 8 per cent during post monsoon. Relative Humidity inside the burrow was always slightly more than that of outside and range of variation was further less, maximum being 3 per cent during post monsoon (Table 7).

ORGANISATION OF THE BURROW SYSTEMS

No particular organisation of the burrow system could be marked in the paddy fields, 'bunds' or vegetable gardens, but found scattered here and there. Near ponds and marshy areas, though scattered burrow systems were found, but groups of two to five were also observed below some thick bush adjacent to the water. Similarly, series of two to four burrow systems with linear arrangement were found in some part of the open drain adjacent to a fallow land. Groups of two to three burrow systems were also observed in the fallow land adjacent to a mud house. From outside no line of demarcation among the burrow systems of a particular group could be found, the openings of one burrow system might lie within the extension of another. Distance of one group of burrow systems from another depends on the availability of next suitable site.

Table 5. Faunal association of six live burrow systems of *Bandicota indica* at five different habitats.

Fauna	Burrow No. Habitat	1 Marshy area	2 Marshy area	3 Paddy field	4 'Bunds'	5 Open drain	6 Vegetable garden	Frequency
Protozoa :								
<i>Acanthamoeba palisalensis</i>		+	+	—	—	—	+	3
<i>A. glebae</i>		+	+	—	—	—	—	2
<i>A. culbertsoni</i>		—	+	—	—	—	—	1
<i>A. astronyxis</i>		—	—	+	+	—	—	2
<i>Colpoda cucullus</i>		+	+	+	+	—	—	4
<i>Hartmannella crumpae</i>		—	—	—	—	+	—	1
<i>Oxytricha fallax</i>		—	+	—	—	+	—	2
Nemathelminthes :								
<i>Eudorylaimus</i> sp.		+	—	+	—	—	—	2
<i>Thornenema</i> sp.		+	—	—	—	+	—	2
<i>Sicaguttur</i> sp.		—	—	+	—	—	+	2
<i>Aporcelaimellus</i> sp.		—	+	—	—	—	—	1
<i>Oxydirus</i> sp.		—	—	—	+	—	—	1
<i>Axonchium</i> sp.		—	+	—	—	+	—	2
Annelida :								
<i>Pheretima posthuma</i>		+	—	+	—	+	+	4
<i>Lampito mauritti</i>		—	+	—	—	—	—	1

Insecta :

<i>Lepidocyrtus</i> sp.	-	-	-	-	+	-	1
<i>Isotomurus</i> sp.	+	+	-	-	+	-	3
<i>Cryptopygus</i> sp.	-	-	-	+	-	-	1
<i>Cyphoderus</i> sp.	+	+	-	-	+	+	4
<i>Grylotalpa</i> sp.	-	-	+	+	-	-	2
<i>Odontotermis</i> sp.	-	+	-	+	-	-	2
<i>Philoscia lodnensis</i>	-	-	-	-	+	-	1
<i>Solonopsia geminata</i>	-	-	-	+	-	+	2
<i>Monomorium latinoda</i>	+	+	-	-	-	-	2
<i>M. floricola</i>	-	-	-	+	-	-	1
<i>Camponotus compressus</i>	-	-	-	-	+	-	1
<i>Pronolopsis longicornis</i>	+	-	-	-	-	-	1
<i>Pheropsophus catorei</i>	-	-	+	-	-	+	2
<i>Abacetus guttaela</i>	-	-	-	+	-	-	1
<i>Onthrophagus</i> sp.	+	+	-	-	-	+	3
<i>Nonolepta nigobilineata</i>	+	+	-	-	-	-	2

Arachnoidea :

<i>Lycosa</i> sp.	-	+	-	-	+	-	2
<i>Pisaurina</i> sp. <i>indi</i>	+	-	+	-	-	-	1
<i>Pardosa mukundi</i>	+	-	-	-	-	-	1
Myriapoda :							
<i>Rhysida</i> sp.	+	-	-	-	+	-	2

Table 6. Average hourly temperature of air, soil surface and at 70 to 100 cm. depths of the live burrow systems of *Bandicota indica* at Sagar Island during three different seasons of 1981-82.

Area	Temperature (°C) at different hours of the day											
	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00
<i>Premonsoon</i>												
Air	19.3	20	21.8	23	26.2	28.3	30.3	32.6	34.2	33	31.2	28.2
Soil surface	17	18.2	20.6	24.3	27	30.4	32.8	35.2	34.4	30.4	28.3	26.5
At 70-100 cm. depth	18.4	18.8	19.7	21.2	23.5	25.4	26.8	27.5	28.1	28.3	27.6	27
<i>Monsoon</i>												
Air	24.7	24.7	24.8	25	24.8	25.6	27.2	29.2	33.6	31.6	31	29.1
Soil surface '	20	22.1	22.87	23.7	24.4	26.1	29	28.6	27.4	27	26.4	26
At 70-100 cm. depth	19	19.1	20.5	21.7	22.6	23.1	23.9	24.4	25.7	26.8	26.6	26.2
<i>Post monsoon</i>												
Air	14.4	14.6	16.9	10.2	19.3	21.1	23.4	26.1	28.6	28.3	26.2	20.1
Soil surface	12.8	12.9	13.4	15.7	19.3	22.9	26.1	28.5	28.3	27	23.2	20.1
At 70-100 cm. depth	16.4	16.6	17.5	18.1	18.4	19.3	20.3	21.4	22.9	24.6	24.4	23

Table 7. Average Relative Humidity of outside and at about 30 cm. inside the live burrow systems of *Bandicota indica* at Sagar Island during different seasons of the year 1981-82.

Area	Relative Humidity	
	At 8-30 hrs.	At 17-30 hrs.
<i>Premonsoon</i>		
Outside burrow	80.4%	81%
At about 30 cm. inside the burrow	82%	84%
<i>Monsoon</i>		
Outside burrow	85.4%	84%
At about 30 cm. inside the burrow	85.8%	84.2%
<i>Post monsoon</i>		
Outside burrow	74%	67%
At about 30 cm. inside the burrow	75%	72%

DISCUSSION

In some habitats, live burrow systems of *B. indica* are found only at certain period of the year, while in other habitats throughout the year. This indicates a sort of local migration of a part of population but not the entire. This migration is related partly to food, partly to shelter. With the maturing of the paddy ('Amon' variety) and drying up of the field, a part of population from the neighbouring 'bunds' and marsy areas migrate to the field and settle there. They remain in the field till there is crop or onset of monsoon. With the beginning of rain, ploughing activity starts resulting the destruction of burrow systems. Thus, the rats of the field migrate at that time to the neighbouring 'bunds' or other suitable sites. Similarly, vegetable gardens also attract some of the rats at different periods. Such local migration have also been reported in *Bandicota bengalensis* population of lower Bengal (Chakraborty 1977).

Study revealed that extension, depth, number of openings, *etc.*, of burrow system vary widely in different habitats as well as within the same habitat. Tien and Cu (1965) also found the similar variation at Vietnam. Such variations are mainly related to the nature of the soil and age of the animal.

Burrow system adjacent to the pond or marshy areas usually have an opening below the surface of water. Such opening facilitates entry as well as exit of the animal in secret during the time of emergency.

Brood chamber was found in some of the burrow systems and its occurrence was in no way related to the extension or location of the burrow system or seasons. Probably brood chambers was made only in the burrow which was occupied by an adult female. Location of the brood chamber in a somewhat upwardly directed tunnel is advantageous to protect the young ones against inundation during monsoon.

Sign of hoarding in the burrow systems was not much obvious. In fact, burrows were mostly constructed in the areas having some perennial source of food. Thus, hoarding was not required. Arjunwadkar and Gadgil (1974) also found that burrows of *B. indica* at Poona are not used for the storage of food grains. However, at Vietnam, dilated chambers of the burrow system are filled with stored grains like paddy, etc., (Tien and Cu 1965). Similar geographical variation of habit is evident in *B. bengalensis*, which is famous for its hoarding habit (Jerdon 1874, Blanford 1891, Wagle 1927, Kamath 1961, Chakraborty 1977). However, George *et. al.* (1981) reported non hoarding habit of *B. bengalensis* population at Kerala and they attributed this habit to the easy accessibility to crops and other food material throughout the year. Thus, it appears that hoarding habit is not a species specific character, but an adaptation to a habitat having a period of food scarcity.

Moisture content of the burrow soil samples at Sagar Island was very high. This is in accordance with the somewhat amphibious habit of *B. indica*. Studies of Urs *et. al.* (1969) revealed that moisture content of burrow soils of different species of rodent is different. Barnett and Prakash (1975) found that some species of rodent live in dry soil others in wet soil. Thus, it may be concluded that moisture content of the soil has a definite role in the survival and distribution of different species of rodent specially of fossorial ones.

Mean temperature and Relative Humidity inside the burrows were slightly lower and higher respectively than those of outside. Moreover, range of variation was further less inside the burrow than outside. Thus, a microclimate is formed inside the burrow system. This microclimate protects the animal from the climatic extremities of outside during the period of rest.

From the above discussion it may be concluded that the large bandicoot rats use their burrow system for rest, protection, parturition, developing the young ones and to avail a most congenial microclimatic condition during the period of rest.

SUMMARY

Burrow systems of *B. indica* have been studied in different habitats. Live burrow system could be recognised by the presence of fresh globules of earth at the burrow openings, foot prints, tail marks, soft faecal matter and fresh broken shells of molluscs, crabs, etc. Most of the burrow systems have a number of openings leading in to branching tunnels. Brood chambers were found in many of the burrow systems. There was not much sign of hoarding in burrow system. Floral and faunal composition in association with the burrow systems were very rich. Range of variations of temperature and Relative Humidity inside the burrow were much less than outside. Burrows are mainly used for the shelter, protection and developing the youngs. Extensive tunnels are often responsible for the damage of mud houses and other structures.

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a



b

- a. Using a Dial Hygrometer to measure Relative Humidity.
- b. Fresh, wet globules of earth and shells of molluscs near the burrow opening of a live burrow system.

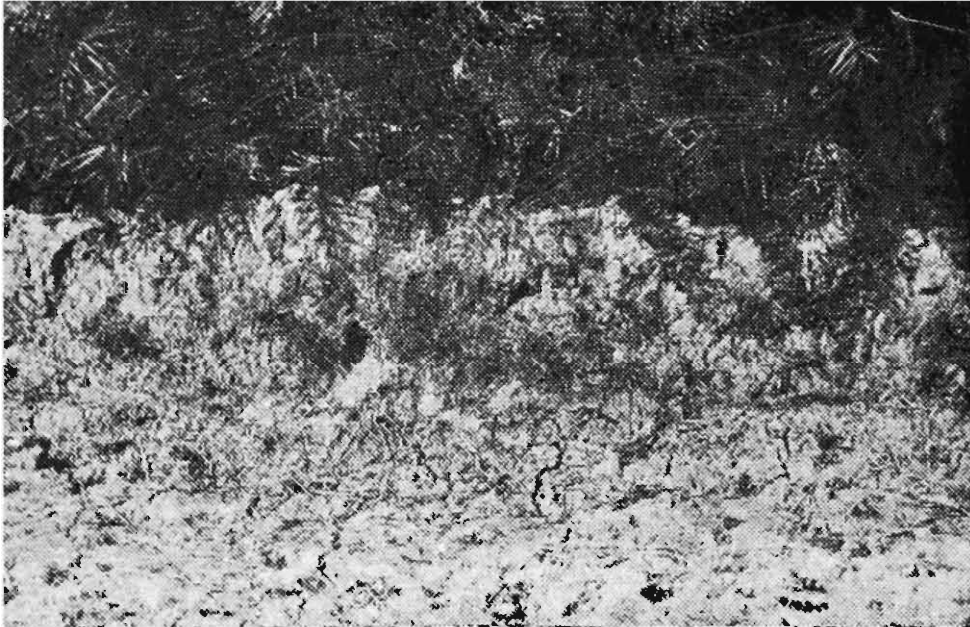


a



b

- a. An excavated burrow system near pond.
- b. Another excavated burrow system near pond.

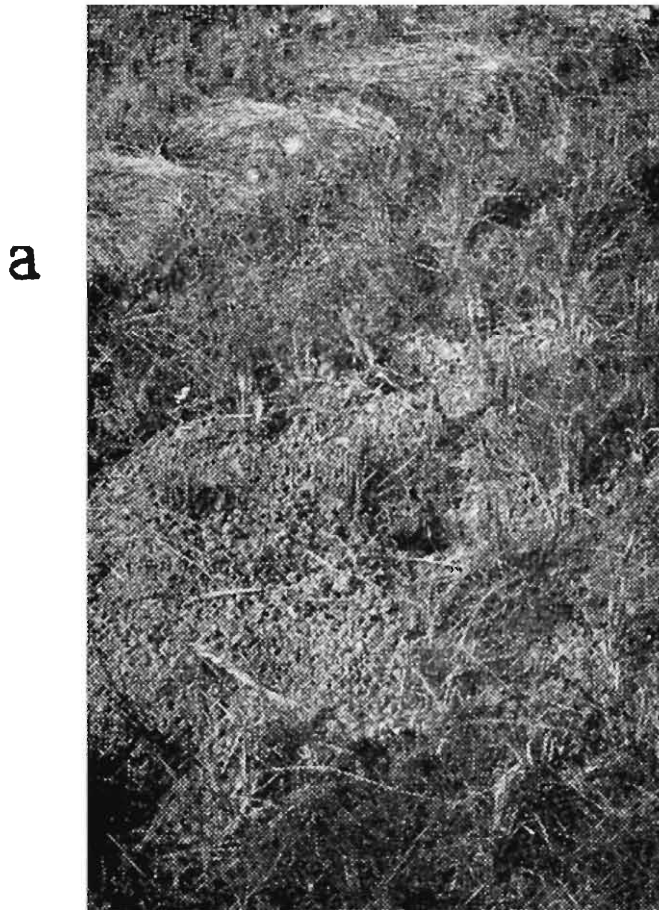


a



b

- a. Openings of the burrow system in the 'bund'.
- b. Burrow openings in the paddy fields during November-December.



- a. Burrow openings in the paddy fields during February.
b. Stored grains in the burrow system of paddy field.



a



b

- a. Openings of the burrow system in the bushes adjacent to vegetables garden.
- b. Openisngof the burrow system in the wall of mud house.

CHAKRABORTY & CHAKRABORTY

PLATE VI



Burrow opening along the open drain.

**THE INDIAN SPECIES OF THE GENUS *ASIORESTIA* JACOBSON
(COLEOPTERA : CHRYSOMELIDAE : ALTICINAE) WITH
DESCRIPTIONS OF THREE NEW SPECIES**

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Jacobson (1925) described the Genus *Asiorestia* (Type : *A. kozhantshikovi* Jacobson) from Jukutskningrad. Scherer (1969) described a new species from India and transferred another one species from the genus *Crepidodera* to *Asiorestia* from India. So far, thus two species have been reported from India. In the present paper three more species are described as new to science. Number of Indian species of *Asiorestia* Jacobson now comes to five. All the specimens included in this paper are deposited in the Zoological Survey of India, Calcutta.

Key to the Indian species of *Asiorestia*

1. Species apterous ; Red-brown to dark chest nut brown with elypeus and labrum dark ; clypeal carina broad ; antennal calli feeble ; elytral punctation strong and bold, ante-basal transverse impression on pronotum feeble only with one or two rows of fine puncturen *danahina* n.sp.
Species winged 2
2. Species metallic blue-black, parallel-sided, elytra almost equal with or very slightly broader than prothorax ; elytral punctures strong and arranged in regular rows. *arunachalensis* n.sp.
Species not metallic. 3
3. Elytral punctures extremely fine, each puncture surrounded by a dark ring ; red-brown with the legs, lebrum, elypous and seven to eight apical antennal segments black ; size 4-5 mm. *schenklingi* (Csiki)
Elytral punctures fine but strongly impressed ; red-brown with labrum, apical part of clypes and hind femora black ; size 3.00 mm. *manipurensis* n.sp.

(*Asiorestia naini* Scherer is not included in the key as the material was not seen).

**1. *Asiorestia schenklingi* (Csiki)
(Figs. 1—4)**

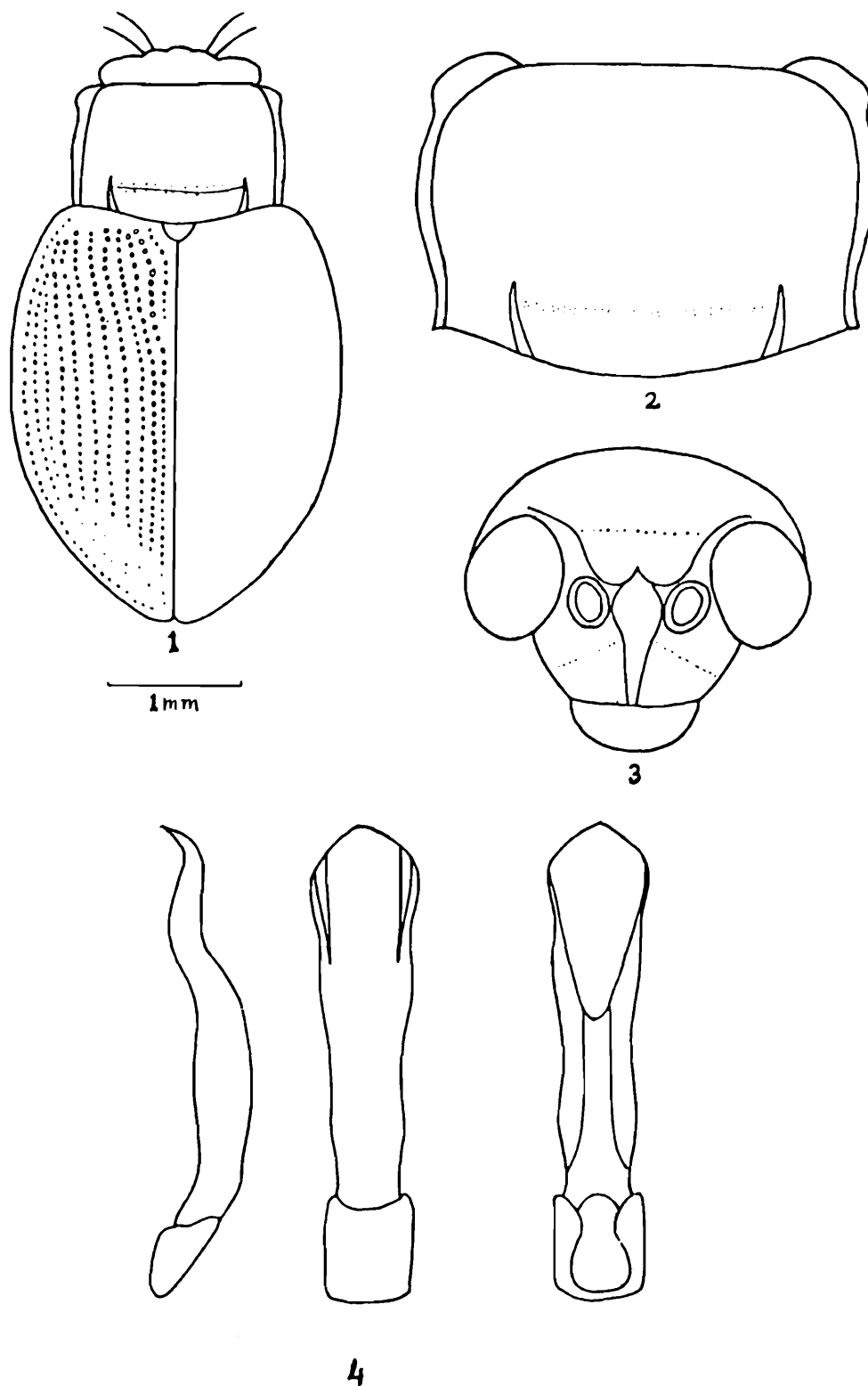
1935. *Crepidodera sublaevis* Chen, *Bull. Soc. Ent. France* 40 : 76.

1940. *Crepidodera schenklingi* Csiki, In Junk, *Col. Cat.* 166 : 298 (nom. nov. pro *C. sublaevis* Motsch.).

1969. *Asiorestia schenklingi* : Scherer, *Pacif. Ins. Monogr.* 22 : 134.

Specimens examined : 4 ex., Sukia Pokri, Darjeeling Dist., West Bengal, 3.x.1974, H.K. Bhowmik & A.R. Bhaumik coll. ; 1 ex, Jorpokri, 2210 m., Darjeeling dist., West Bengal, 23.v.1971, A.R. Bhaumik coll.

Distribution : India : West Bengal and Sikkim.



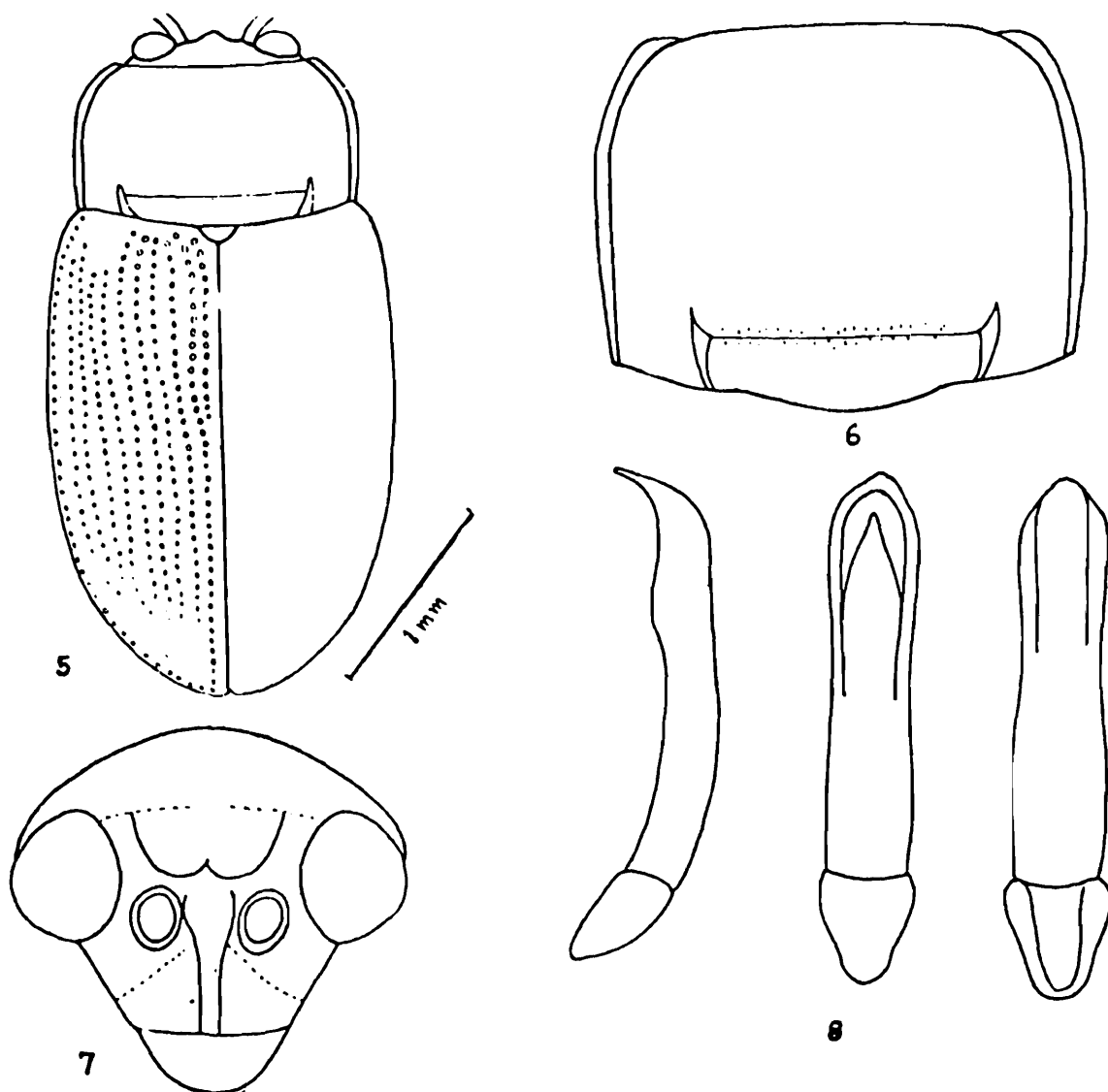
Figs. 1-4. *Asiorestia schenklinsi* (Csiki), 1. Dorsal view, 2. Prothorax, 3. Front view of head, 4. Ventral-Dorsal and Lateral view of Aedeagus.

2. *Asiorestia arunachalensis* n.sp.

(Figs. 5-8)

Oblong, parallel, metallic blue-black with violaceous tinge, antennae pitch brown, ventral side darker with the basal part of femora and coxae red brown.

Head (fig. 7) impunctate with a few strong punctures on frons, antennal calli prominent, contiguous and distinctly separated in front by a deep impression, clypeal carina raised, convex and gradually narrowed towards front margin. Antennae reaching beyond the middle of the body, segment 1 long and thick, segment 2 small, segment 3 longer than segment 2, segment 4 longer than segment 3, segment 5-10 subequal and each longer than segment 4, segment 11 longest. **Prothorax** (fig. 6) broader than long, anterior margin straight, posterior margin sinuated and lateral margins rounded, anterior angles thickened, posterior angles obtuse, surface strongly convex in front, finely punctate, punctation dense at the middle and sparse at sides, ante-basal transverse impression distinct and strong and with sparse punctures. **Scutellum** black, triangular with its apex rounded, surface smooth and impunctate. **Elytra** with eleven regular rows of strong punctures including scutellar and marginal ones, interstices flat, slightly convex at sides and with minute punctures. **Aedeagus** as figured (fig. 8).



Figs. 5-8. *Asiorestia arunachalensis* n.sp.. 5. Dorsal view, 6. Prothorax 7. front view of head, 8. Ventral, Dorsal and lateral views of Aedeagus.

Measurements of holotype : Length 3.60 mm. length of antennae 2.50 mm. width of head across eyes 0.90 mm., length of prothorax 1.00 mm., width of prothorax across middle 1.25 mm., length of elytra 2.75 mm. and width of elytra across middle 1.70 mm.

Holotype ♂, INDIA : ARUNACHAL PRADESH : Subansiri Dist., Hopoli, 1585 m, 15.v. 1966, A.N.T. Joseph coll. ; *Paratypes* 26 ♂♂ ♀♀, same as holotype, 8 ♂♂ ♀♀, Kameng Dist., Tawang, 3200 m., 27.v. 1966, A.N.T. Joseph coll.

Remarks : This species is near *A. tonkinensis* (Chen) but can be easily separated in having the following characters : Elytral punctures distinctly arranged in rows ; antennae pitch brown with its segment 2 shorter than segment 3, segment 3 shorter than segment 4 ; dorsal surface metallic blue-black with violaceous tinge ; basal part of femora and coxae red brown.

3. *Asiolestia manipurensis* n.sp.

(Figs. 9-12)

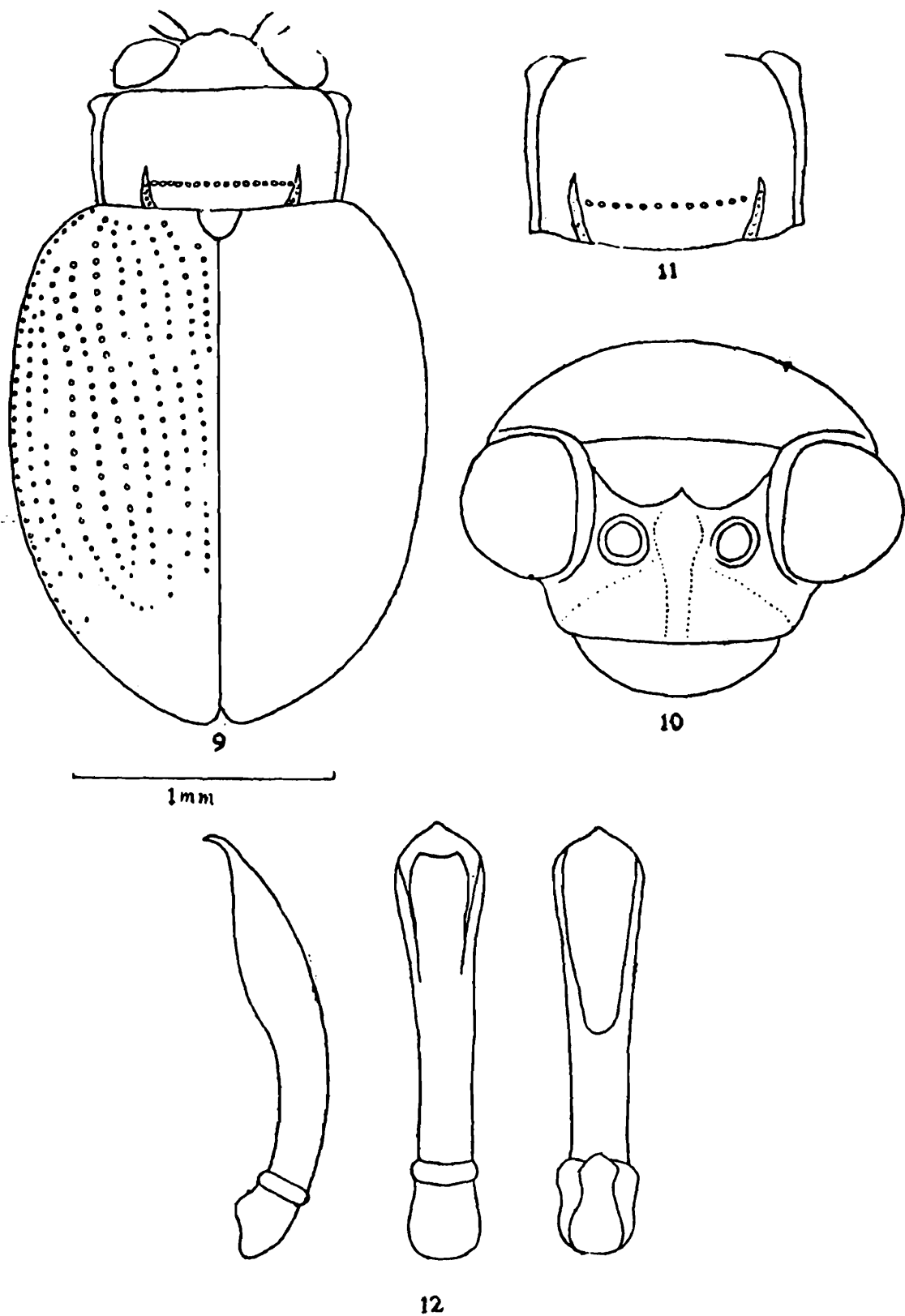
Ovate, red brown with apical part of clypeus and hind femora black.

Head (fig. 10) impunctate, antennal calli distinct, contiguous and separated from vertex by a distinct transverse impression, clypeal carina raised and continued to front margin. Antennae reaching beyond middle of elytra, segment 1 long and thick, segment 2 small, rounded and half as long as segment 1, segment 3 longer than segment 2 and equal to segment 4, segments 5-11 subequal, each longer than segment 4. *Prothorax* (fig. 11) one and half times broader than long, front margin straight, basal margin sinuated, lateral margins rounded at middle, front angles produced, posterior angles obtuse ; pronotum smooth and impunctate except for a row of fine punctures along antebasal transverse impression, latter distinct and curved. *Scutellum* triangular, rounded apically, smooth and impunctate. *Elytra* broader at base than prothorax, each elytron with eleven rows of punctures including scutellar and marginal ones, punctation fine, interstices flat and finely punctate. First tarsal segments of anterior two legs strongly dilated in male. Female unknown *Aedeagus* (fig. 12) as figured.

Measurements of holotype : Length 3.00 mm., length of antennae 2.30 mm., width of head across eyes 0.80 mm., length of prothorax 0.85 mm., width of prothorax across middle 1.15 mm., length of elytra 2.25 mm. and width of elytra across middle 1.75 mm.

Holotype ♂, INDIA : MANIPUR : Ukhrul, Horticultural Farm, 30.ix. 1975, M.S. Shishodea coll.

Remarks : This species to close is *A. naini* Scherer but can be easily separated in having the following characters : Red brown colour with its labrum and hind femora black ; antennae completely redbrown and long, reaching beyond the middle of elytra ; interstices between the rows of punctures flat and minutely punctate ; size smaller (3.00 mm.).



Figs. 9-12. *Asiolestia tanipurensis* n.sp., 9. Dorsal view, 10. Front view of head, 11. Prothorax, 12. Ventral, Dorsal and Lateral view of Aedeagus.

4. ***Asiolestia danahina* n.sp.**
(figs. 13-16)

Ovate, redbrown to dark chest nut brown, antennae, legs and ventral side light brown to dark brown.

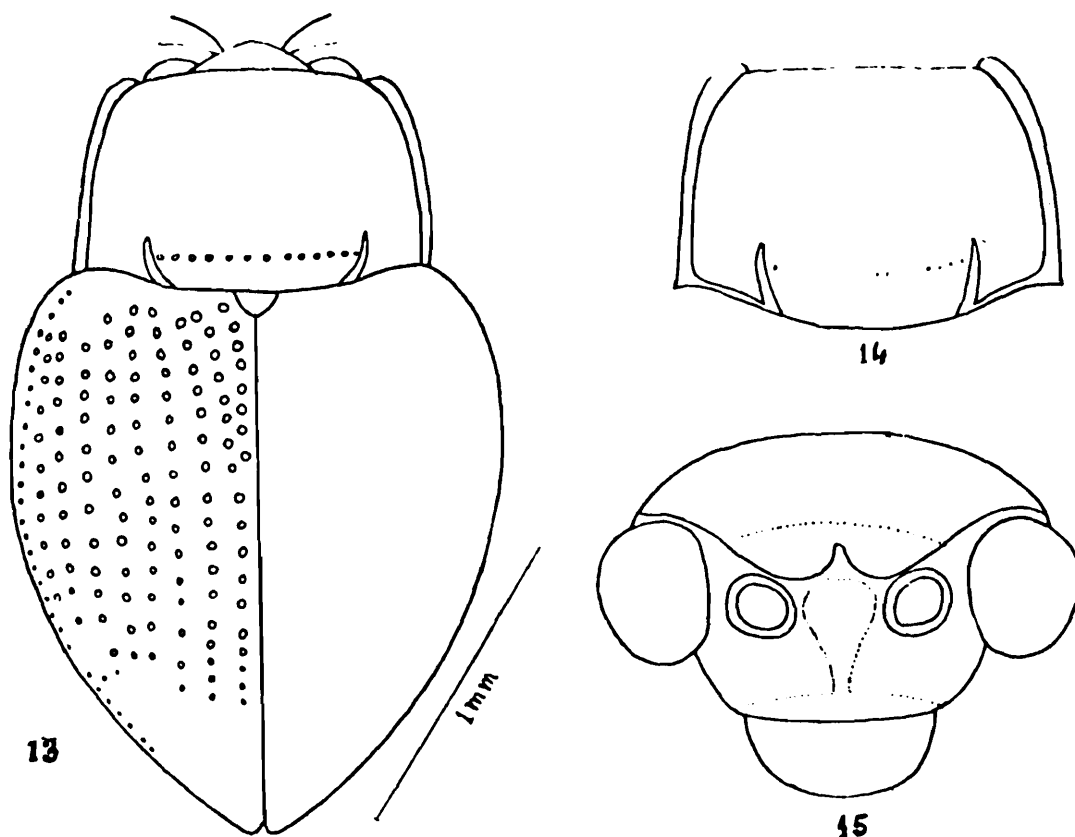
Head (fig. 14) impunctate, antennal calli distinct, contiguous and separated

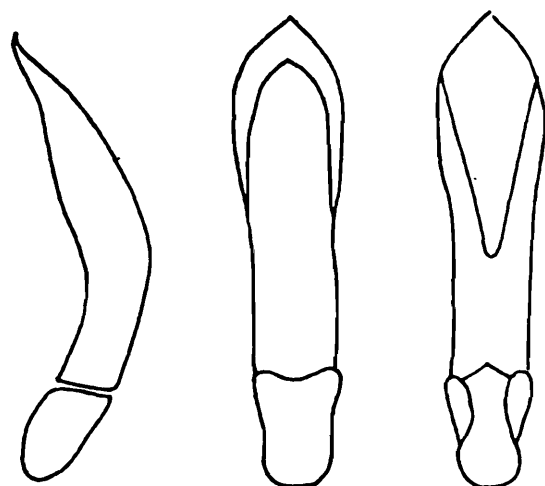
behind by an indistinct transverse depression, clypeal carina broad, raised, convex and gradually narrowed towards front margin. Antennae reaching beyond the shoulder, segment 1 long and thick, segment 2 small and rounded, segment 3 longer than segment 2, segment 4 equal to segment 3, segments 5-11 gradually thickened, subequal and each longer than segment 4. *Prothorax* (fig. 15) one and half times broader than long, narrowed anteriorly, front margin straight, basal margin rounded, sides gently rounded, anterior angles rounded, posteriors obtuse, pronotum almost impunctate, under high magnification very finely punctate, ante-basal transverse impression indistinct and with a row of punctures. *Scutellum* triangular, apex broadly rounded and impunctate. *Elytra* broad at base and pointed apically, each elytron with eleven rows of punctures including scutellar and marginal ones, interstices flat, impunctate and slightly convex at sides. *Wings* absent in both sexes. First tarsal segments of anterior two pairs of legs strongly dilated in male. *Aedeagus* as figured (fig. 16).

Measurements of holotype : Length 2.25 mm., length of antennae 1.60 mm., width of head across eyes 0.65 mm., length of prothorax 0.90 mm., width of prothorax across middle 1.10 mm., length of elytra 2.10 mm. and width of elytra across middle 1.50 mm.

Holotype ♂, INDIA : HIMACHAL PRADESH : Mashobra, 26.vi. 1975, T. Sengupta coll. ; *Paratypes* 2 ♂♂ 8 ♀♀, locality same as holotype.

Remarks : This species is perhaps the unique apterous representative of the genus *Asiorestia* from India. Considering the size and colour of the species, it may resemble *A. naini* Scherer. But it can be easily separated by the following characters Apterous form, elytra apically pointed and its punctation stronger ; prothorax narrowed anteriorly with its sides gently rounded, ante-basal transverse impression straight and indistinct.





Figs. 13-16. *Asiolestia danahina* n.sp.,
 13. Dorsal view,
 14. Front view of head,
 15. Prothorax,
 16. Ventral, Dorsal and Lateral view
 of Aedeagus.

16

5. *Asiolestia naini* Scherer

1969. *Asiolestia naini* Scherer, *Pacif. Ins. Monogr.*, **22** : 134-135.

Material : Not seen

Distribution : India : Uttar Pradesh.

SUMMARY

The present paper deals with five species of the genus *Asiolestia* Jacobson from India. Of these, three species namely *A. arunachalensis*, *A. manipurensis* and *A. danahina* are described as new to science. A key to the four Indian species of the genus is also provided.

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NEMATODE FAUNA OF LIVESTOCK AND POULTRY OF MEGHALAYA

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INTRODUCTION

An examination of literature on the helminth fauna of India shows that no major work so far has been done on the systematics of nematodes of livestock and poultry in Meghalaya. The region pertaining to present studies being of its own kind in India, i.e., super-humid climatic type, has an added importance in context of the kind and nature of parasitic infections among various hosts under these climatic conditions. Hence a survey was undertaken to establish the nematode parasite spectrum of livestock and poultry of the region. The present paper embodies the results of a two-years' survey work and incorporates the systematics of nematode parasites of livestock and poultry collected from various hosts of three districts of Meghalaya State.

A total of 26 species belonging to 19 genera and 13 families are recorded in the present communication. Barring a few, all other species are new records from the State ; the species marked with an asterisk (*) refer to those that have been just mentioned in the various Annual Reports of Indian Council of Agricultural Research, NEH Region, Shillong to occur in the State. Three species, namely, *Capillaria annuata*, *C. contorta* and *Setaria bernardi*, are being recorded here for the first time from India.

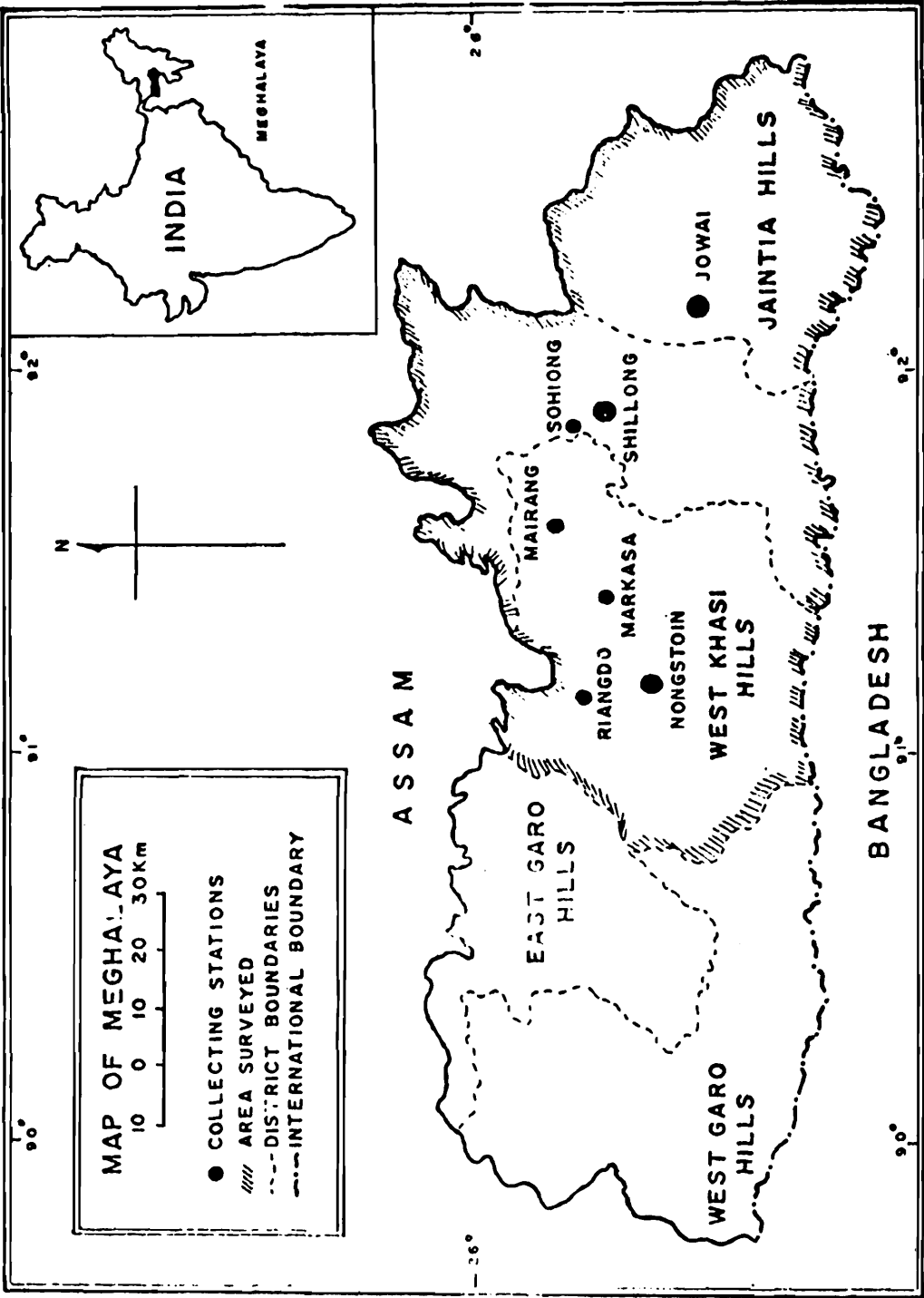
Standard methods were followed in fixing and processing the parasites for examination. Identifications of specimens were accomplished following Yamaguti (1961), Baylis (1936, 1939) and CIH keys to the Nematode parasites of Vertebrates Nos. 1-10 (1974-1983). The number of specimens examined of a species, unless otherwise indicated, is more than ten. All measurements are in millimeters.

LIST OF COLLECTING STATIONS

The materials described herein was collected mainly from eastern and central parts of Meghalays, represented by East and West Khasi Hills and Jaintia Hills Districts. This region lies at an altitude range of 400-1900 mASL. Detailed informations about collecting stations is given in Table 1 (also see text-Fig.1).

Table 1. List of collecting stations for Nematodes of livestock and poultry of Meghalaya

Locality	District	Appro. Latitude and Longitude	
		Lat. N	Long. E
1. Shillong	East Khasi Hills	25°34'	91°45'
2. Sohiong	East Khasi Hills	25°38'	91°40'
3. Mairang	West Khasi Hills	25°46'	91°32'
4. Markasa	West Khasi Hills	25°33'	91°20'
5. Nongstoin	West Khasi Hills	25°32'	90°15'
6. Riango	West Khasi Hills	25°43'	90°10'
7. Jowai	Jaintia Hills	25°25'	92°10'



TEXT - Fig. 1 - Map of Meghalaya, showing the collecting Stations for Nematodes.

LIST OF NEMATODES RECOVERED FROM LIVESTOCK AND POULTRY OF MEGHALAYA

The following is the list of nematodes recovered from livestock and poultry of Meghalaya and discussed in this paper ; all of them are based on the present study ; species marked with an asterisk (*) are also mentioned in the Annual Reports of Indian Council of Agricultural Research, NEH Region, Shillong.

Family I. ASCARIDIDAE Baird, 1853

Subfamily ASCARIDINAE (Baird, 1853) Hartwich, 1974

Genus **Ascaris** Linnaeus, 1758

1. *A. Suum** Goeze, 1782

Host : Pig

Family II. ASCARIDIIDAE Travassos, 1919

Genus **Ascaridia** Dujardin, 1845

2. *A. Galli** (Schrunk, 1788) Freeborn, 1923

Host : Fowl

Family III. HATERAKIDAE Railliet et Henry, 1912

Subfamily HETERAKINAE Railliet et Henry, 1912

Genus **Heterakis** Dujardin, 1945

3. *H. gallinae** (Gmelin, 1790) Freeborn, 1923

Host : Fowl

Family IV KATHLANIIDAE (Lane, 1914) Travassos, 1918

Subfamily CRUZIINAE (Travassos, 1917) Ortlepp, 1924

Genus **Pseudocruzia** Wolfgang, 1953

4. *P. orientalis* (Maplestone, 1930) Wolfgang, 1953

Host : Pig

Family V STRONGYLOIDIDAE Chitwood et McIntosh, 1934

Genus **Strongyloides** Grassi, 1879

5. *S. papillosus* (Weld, 1856) Ransom, 1911

Host : Goat

Family VI. CHABERTIIDAE (Popova, 1952) Lichtenfels, 1980

Subfamily OESOPHAGOSTOMINAE Railliet, 1916

Genus **Bourgelatia** Railliet, Henry et Baushe, 1919

6. *B. diducta* Railliet, Henry et Bauche, 1919

Host : Pig

Genus **Oesophagostomum** Molin, 1861

Subgenus **Bosicola** Sandground, 1929

7. *O. (B.) radiatum* (Rudolphi, 1803) Travassos et Vogelsang, 1932

Host : Cow

Subgenus **Oesophagostomum** Molin, 1861

8. *O. (O) dentatum* (Rudolphi, 1803) Molin, 1861

Host : Pig

Subgenus **Proteracaecum** Railliet et Henry, 1913

9. *O. (P) columbianum* (Curtice, 1890) Railliet et Henry, 1913
Host : Goat
Subgenus **Hysteracrum** Railliet et Henry, 1913
10. *O. (H) aspersum* Railliet et Henry, 1913
Host : Goat
Family VII. SYNGAMIDAE Leiper, 1912
Subfamily STEPHANURINAE Railliet, Henry et Bache, 1919
Genus **Stephanurus** Diesing, 1839
11. *S. dentatus** Diesing, 1839
Host : Pig
Family VIII. ANCYLOSTOMATIDAE (Looss, 1905) Lichtenfels, 1980
Subfamily ANCYLOSTOMATINAE Looss, 1905
Genus **Globocephalus** Molin, 1861
12. *G. connorfilli* Lane, 1922
Host : Pig
Subfamily BUNOSTOMINAE (Railliet et Henry, 1990) Looss, 1911
Genus **Bunostomum** Railliet, 1902
13. *B. trigonocephalum* (Rudolphi, 1808) Railliet, 1902
Host : Goat
Family IX. TRICHOSTRONGYLIDAE (Leiper, 1908) Leiper, 1912
Subfamily HAEMONCHINAE (Skrijabin et Schulz, 1937)
Skrijabin et Schulz, 1952
Genus **Haemonchus** Cobb, 1898
14. *H. contortus* (Rudolphi, 1803) Cobb, 1898
Host : Goat
Genus **Mecistocirrus** Railliet et Henry, 1912
15. *M. digitatus* (Linstow, 1906) Railliet et Henry, 1912
Host : Cow
Family X. ONCHOCERCIDAE (Leiper, 1911) Anderson et Bain, 1976
Subfamily SETARIINAE Yorke et Maplestone, 1926
Genus **Setaria** Viborg, 1795
16. *S. cervi* (Rudolphi, 1819) Baylis, 1936
17. *S. digitata* (Linstow, 1906) Railliet et Henry, 1911
Host : Cow
18. *S. bernardi* Railliet et Henry, 1911
Host : Pig
Family XI. SPIROCERCIDAE (Chitwood et Wehr, 1932) Chabaud, 1975
Subfamily ASCAROPSINAE Alicata et McIntosh, 1933
Genus **Ascarops** Beneden, 1873
19. *A. strongylina* (Rudolphi, 1809) Alicata et McIntosh, 1933.
20. *A. dentata* (Linstow, 1904) Alicata et McIntosh, 1933.
Host : Pig/

21. *P. sexalatus** (Molin, 1860) Diesing, 1861
Host : Pig
Family XII. GNATHOSTOMATIDAE Railliet, 1895
Subfamily GNATHOSTOMATINAE (Railliet, 1895) Baylis et Lane, 1920
Genus **Gnathostoma** Owen, 1836
22. *G. doloresi* Tubanguui, 1925
Host : Pig
Family XIII. Trichuridae (Ransom, 1911) Railliet, 1915
Subfamily TRICHURINAE Ransom, 1911
Genus **Trichuris** Roederer, 1761
23. *T. globulosa* (Linstow, 1901) Ransom, 1911
24. *T. ovis* (Abildgard, 1795) Smith, 1908
Host : Goat
Subfamily CAPILLARIINAE Railliet, 1915
Genus **Capillaria** Zeder, 1800
25. *C. annulata* (Molin, 1858) Cram, 1926
26. *C. contorta* (Creplin, 1839) Travassos, 1915

SYSTEMATIC ACCOUNT OF NEMATODES OF LIVESTOCK AND POULTRY OF MEGHALAYA

Following is the detailed account of various nematode species recorded in this study from their respective host(s) :

Host : Pig. (*Sus scrofa domestica* L.)

1. **Ascaris summ** Goeze, 1782

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/1 ; location - small intestine ; Coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : cosmopolitan.

Remarks : The species is of very common occurrence in this region and is one of the most widely occurring nematode parasites of the pig.

2. **Pseudocruzia orientalis** (Maplestone, 1930)

(Text-Fig. 2) Wolfgang, 1953

Material : 2 ♂♂ & 4 ♀♀ ; NEHU/Z-NM/4 ; location - small intestine ; coll. A.K. Yadav.

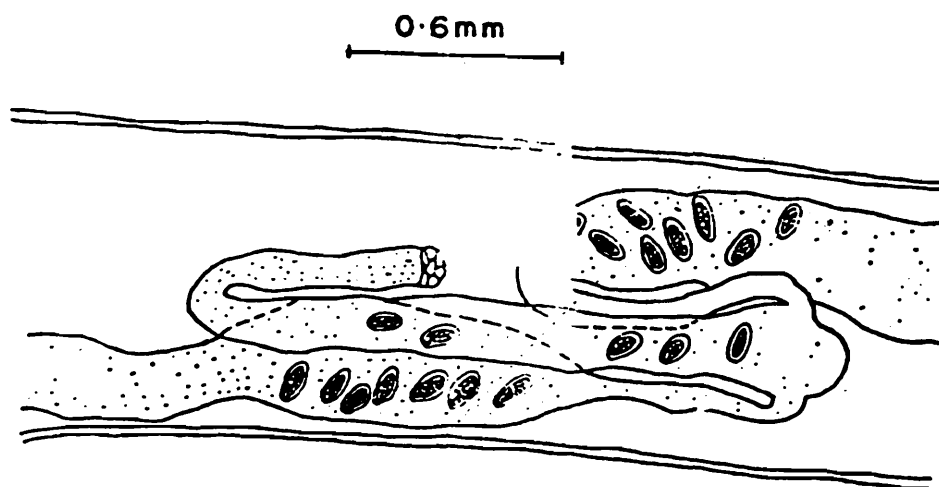
Distribution : Meghalaya : Shillong. Elsewhere : India (Calcutta).

Remarks : Originally described as *Cruzia orientalis* by Maplestone (1930) from pigs in Calcutta, the species was placed in a new genus *Pseudocruzia* erected by Wolfgang (1953) for its reception. Following Maplestone's record (1930) there has been hitherto no report of the occurrence of *P. orientalis* in suids elsewhere in India or abroad.

The original description given by Maplestone (1930) has been supplemented herein.

The position of vulva, not recorded earlier, was found to be at a distance of 6.48 - 7.92 from the anterior end. The male measures 0.70 - 0.72 and female, 0.73-0.76 in maximum thickness.

This species seems to be of very rare occurrence in pigs of India.



TEXT - Fig. 2 *Pseudocruzia orientalis* (Maplestone) Wolfgang - Vulvar region..

3. *Bourgelatia diducta* Railliet, Henry et Bauche, 1919

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/11 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya ; all the three districts. Elsewhere : India (Bengal), Annam, Indonesia and Japan.

Remarks : Of the various localities surveyed, Nongstoin showed a higher prevalence of infection, probably because it lies at a relatively low altitude.

4. *Oesophagostomum* (*Oesophagostomum*) *dentatum* (Rudolphi, 1803) Molin, 1861

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/10 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : India (Chandigarh, Calcutta) ; cosmopolitan.

Remarks : The species closely resembles in general appearance *O. quaddrispinulatum* (Marcone, 1901) Alicata, 1935 also parasitizing the same host. Only the shape of the oesophagus (oval) and the tail length (comparatively short) enable us to differentiate the present species from the latter species, in which oesophagus has a small but distinct swelling at its anterior end.

The infection is very common in the hosts and the species is quite widely distributed.

5. *Stephanurus dentatus* Diesing, 1893

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/5 ; location - renal and perirenal tissue ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin, Mairang and Jowai. Elsewhere : India (Calcutta), Annam, Sumatra, Java and West Indies.

Remarks : According to Baylis (1936) the Indian origin of the specimens recorded as *S. dentatus* in the collection of the Zoological survey of India by Baylis and Daubney (1935) is doubtful as this material was supposed to have come from the West Indies.

The species occurs rather less commonly in domestic pigs of the State.

6. *Globocephalus connorfilli* Lane, 1922

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/9 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin ; Riangdo and Sohiong. Elsewhere : India (Calcutta), Europe, Samoa, Canton, Luzon, Porto Rico and U.S.A.

Remarks : Yamaguti (1961) considered this species a synonym of *G. urosubulatus* (Allessandrini, 1909). However, Maplestone (1930) and Popova (1955) recognized the two as distinct species. The present authors are of the opinion that due to the character, i.e., bases of teeth in the buccal capsule not reaching its posterior end, it is worth regarding *G. connorfilli* as a valid species.

The species occurs commonly in the pigs of the State. The specimens are of very small size (4 - 5 long) and hence may be overlooked in a visual examination of the alimentary canal.

The species has been rather rarely reported.

7. *Setaria bernardi* Railliet et Henry, 1911

(Text-Fig. 3)

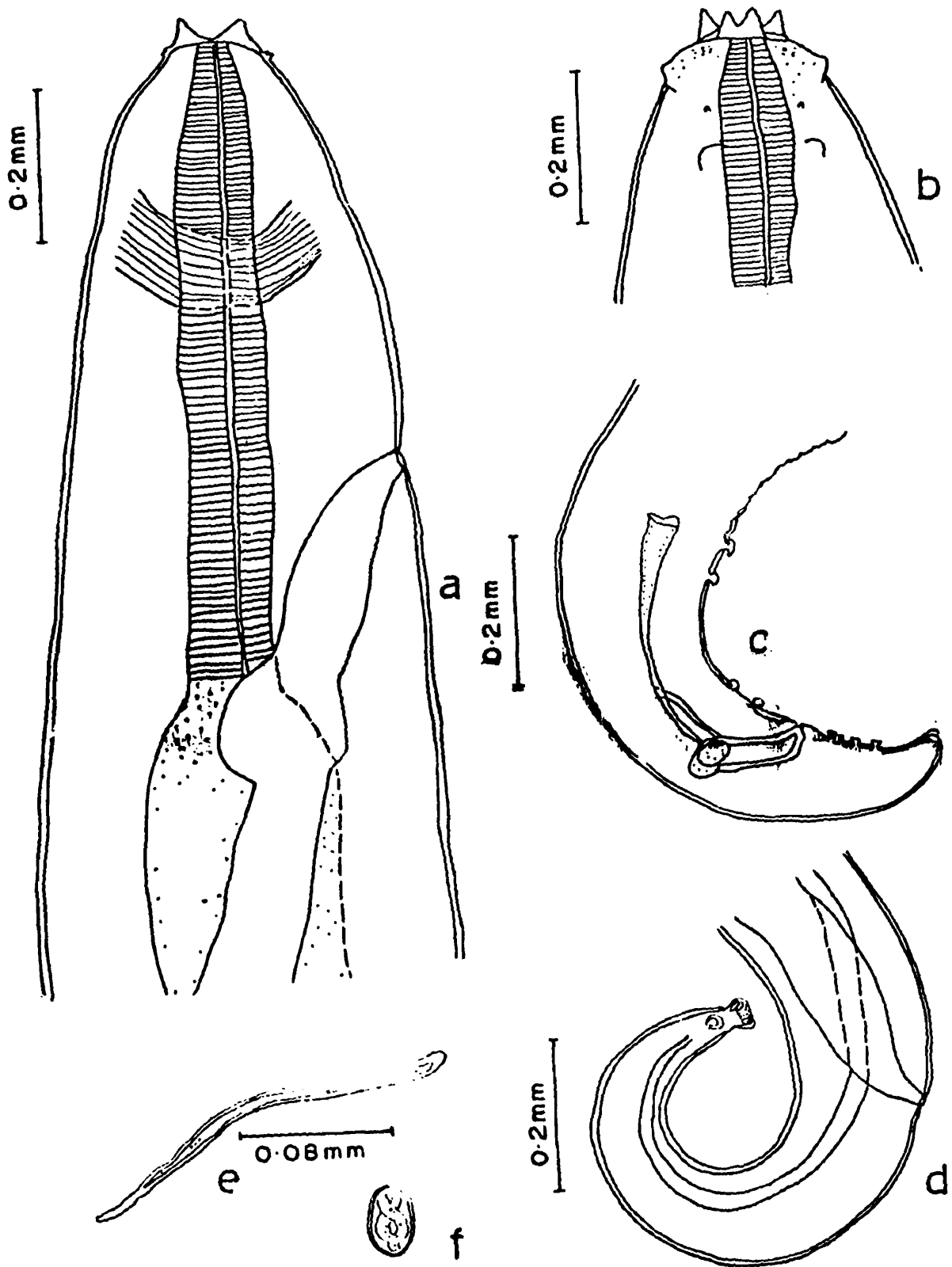
Material : 1 ♂ & 5 ♀♀ ; NEHU/Z-NM/3 ; location - peritoneal cavity ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong and Nongstoin. Elsewhere : Japan and Burma.

Male : Body 95 long, 0.63 wide ; oesophagus 10.89 long, anterior portion 0.77 long and 0.09 wide, posterior portion 10.12 long 0.21 wide ; tail 0.18 long ; lateral appendages and postdeirid lie at a distance of $50\ \mu$ and 0.78, respectively from posterior end ; spicules unequal and dissimilar, smaller 0.18 and longer 0.34 long.

Female : 105-220 long, 0.57-0.99 wide, Oesophagus 9.1-10.2 long, anterior portion 0.96-1.16 long and 0.10 wide, posterior portion 8.20-9.04 long and 0.32 wide ; tail 0.54-0.79 long ; lateral appendages and postdeirid lie at a distance of 29-45 μ and 1.98-2.40, respectively from posterior end ; vulva 0.40-0.64 from anterior end.

Remarks : Besides *S. bernardi* three more species of the genus have been reported from Suidae of the world viz , *S. congolensis* Railliet et Henry, 1911 ; *S. thomasi* Sandosham, 1954 and *S. castroi* Ortlepp, 1964. The present form can be distinguished from these in possessing an oblong peribuccal crown and also in the general appearance of the tail end. The morphometric measurements of the



TEXT - Fig. 3

Setaria bernardi Railliet et Henry (a) ♀ anterior end (dorsal view), (b) ♂ anterior end (lateral view), (c) ♂ posterior end showing caudal papillae, (d) ♀ posterior end, (e) egg, (f) larvae.

present specimens also tally with those described by Shoho and Machida, 1979 from Japan except for minor variations in the length of the body, i.e., male 95 and female 105-220.

The species is being reported for the first time from pigs of India and seems to be of very rare occurrence in these hosts.

8. *Ascarops strongylina* (Rudolphi, 1809) Alicata et McIntosh, 1933

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/17 ; location - stomach ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin and Jowai. Elsewhere : India (Chandigarh), Europe, Africa, Australia, Formosa, Ceylon, U.S.A. and China.

Remarks : This genus comprises only two known species so far represented in the suids of the world, and the body length alone, i.e., 12-21.2, enables us to differentiate *A. strongylina* from *A. dentata* ; in the latter the body is 20-46 long.

Of the various localities surveyed, Nongstoin showed a higher prevalence of infection.

9. *Ascarops dentata* (Linstow, 1904) Alicata et McIntosh, 1933

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/8 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin, Markasa and Sohiong. Elsewhere : India (Chandigarh), China, Indonesia, Malaya, Chailaw, Ceylon and Borneo.

Remarks : For this species also, the prevalence was found to be more in the hosts from Nongstoin, for the probable reason already stated.

10. *Physocephalus sexalatus* (Molin, 1860) Diesing, 1861

Material : 1 ♂ & 5 ♀♀ ; NEHU/Z-NM/6 ; location - stomach and small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong and Nongstoin ; Elsewhere : India (Chandigarh), South America, Colombia, Europe, Africa and Ceylon.

Remarks : The presence of a small sharp papilla on each side in front of the tip of the tail as mentioned by Maplestone (1930) could not be traced out in the specimens studied.

The species is of very rare occurrence and the intensity of infection is also very low.

11. *Gnathostoma doloresi* Tubanguui, 1925

Material : 1 ♂ & 4 ♀♀ ; NEHU/Z-NM/2 ; location - gastric wall ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong and Nongstoin. Elsewhere : India (Calcutta), Philippines, Malaya and Japan.

Remarks : Maplestone (1930) described this species from pigs in Calcutta. Except for the number of rows of hooks on the head, which was observed as 8 in the present specimens, the other observations tally with the earlier description.

The species has been rather rarely reported.

Host : goat (*Capra hircus* L.)

1. **Strongyloides papillosus** (Wedl, 1856) Ransom, 1911

Material : 1 ♀ ; NEHU/Z-NM/22 ; location - duodenum ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong. Elsewhere : cosmopolitan.

Remarks : The species occurs rarely in the hosts of the State as only a single specimen was recovered during present exploration.

2. **Oesophagostomum (Proteracaecum) columbianum** (Curtice, 1890) Railliet et Henry, 1913

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/19 ; location large intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong; Nongstoin, Markasa and Sohiong. Elsewhere : cosmopolitan.

Remarks : Except for the gubernaculum which could not be traced out in the present specimens, all other observations tally with the description of Baylis (1936).

The species occurs commonly in the goats of the State. As a general observation female specimens outnumbered the males in the majority of the samples.

3. **Oesophagostomum (Hysteracrum) aspersum** Railliet et Henry, 1913

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/20 ; location-large intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : cosmopolitan.

Remarks : In a few specimens cervical papillae could not be seen, while in some others the gubernaculum was absent.

The incidence of infection tends to be very high in the hosts.

4. **Bunostomum trigonocephalum** (Rudolphi, 1808) Railliet, 1902

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/21 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : India (Bengal, Punjab), cosmopolitan.

Remarks : The species is quite widely distributed.

5. *Haemonchus contortus* (Rudolphi, 1808) Cobb, 1898

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/18 ; location - stomach ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : cosmopolitan.

Remarks : Variations in the form of vulvar flaps were noted in a few specimens. They were bilobed in some and in others not as conspicuous as noted in the majority of the cases.

This species seems to be highly prevalent in the goats.

6. *Trichuris globulosa* (Linstow, 1901) Ransom, 1911

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/16 ; location - caecum ; coll. A.L. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin and Jowai. Elsewhere : India (Calcutta, Punjab), Europe, Africa, China, Australia and Argentina.

Remarks : The cuticle near the head end is slightly inflated a feature not mentioned by Baylis (1936).

The species is common in goats and infection was observed to occur all the year round.

7. *Trichuris ovis* (Ablidgard, 1795) Smith, 1908

Material : 8 ♂♂ & 2 ♀♀ ; NEHU/Z-NM/17 ; location - caecum ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin, Jowai and Shillong. Elsewhere : India (Chandigarh, Punjab, Bombay, Madras), Europe, Africa, Cyprus, Australia, New Zealand, Mongolia, China and Indonesia.

Remarks : The number of females was invariably more than the males. Here also the infection was observed to occur all the year round.

Host : Cow (*Bos Indicus* L.)

1. *Oesophagostomum (Bosicola) radiatum* (Rudolphi 1803) Travassos et Vogelsand, 1932

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/25 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin and Markasa. Elsewhere : cosmopolitan.

Remarks : Agreeing with the subgeneric divisions of the genus by Railliet et Henry (1913) Travassos and Vogelsang (1932) added *Bosicola* Sandground, 1929 as another subgenus under *Oesophagostomum*. However, Baylis (1936) described this species as *Bosicola radiatus* (Rudolphi, 1803).

The present observations tally with those of Baylis (1936) in all major aspects excepting the cervical groove which was found to be more prominent herein.

2 *Mecistocirrus digitatus* (Linstow) 1906 Railliet et Henry, 1912

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/26 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin and Riango. Elsewhere : India (Calcutta, Punjab), China, Taiwan, Indonesia, Philippines, Japan and USSR.

Remarks : The infection is not very common in the hosts.

3. *Setaria cervi* (Rudolphi, 1809) Baylis, 1936

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/23 ; location - peritoneal cavity ; coll. A.K. Yadav.

Distribution : Meghalaya : all the districts. Elsewhere : India (U.P., Punjab), Ceylon and Burma.

Remarks : The circlet of spikes at the posterior extremity of the body was not found to be so prominent in few female specimens as observed by Gupta and Kalia (1978).

The species is very common in the hosts.

4. *Setaria digitata* (Linstow, 1906) Railliet et Henry, 1911

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NM/24 ; location - peritoneal cavity ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong and Nongstoin. Elsewhere : India (Madras, Punjab), Ceylon, Burma, East Asia and Dahomey.

Remarks : Bhalerao (1933) regarded *S. digitata* as a synonym of *S. labiato-papillosa* (Alessandrini, 1838). Baylis (1936) considered it a synonym of *S. cervi*. In agreement with Yamaguti (1961) the present authors consider *S. digitata* a valid species because of the number of pre-and post-anal papillae and the presence of prominent cephalic papillae.

The species occurs very commonly in the hosts.

Host : Fowl (*Gallus gallus domesticus* L.)

1. *Ascaridia galli* (Schrank, 1788) Freeborn, 1923

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NB/12 ; location - small intestine ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : India (Behrampore, Calcutta, Madras), Europe, Japan and Colombo.

Remarks : Of the three pairs of subterminal papillae, the last pair is the smallest and not the first pair as reported by Deo (1964).

The species is very common in the poultry of the State. The infection was observed to occur throughout the year.

2. *Heterakis gallinae* (Gmelin, 1790) Freeborn, 1923

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NB/13 ; location caecum ; coll. A.K. Yadav.

Distribution : Meghalaya : all the three districts. Elsewhere : India (Chandigarh, Punjab, Himachal Pradesh, Calcutta) and Europe.

Remarks : In a few specimens, instead of twelve pairs of caudal papillae as reported by Deo (1964), 13 pairs were observed with one additional pair of papillae just at the base of the first pair of caudal papillae.

The species occurs commonly in the poultry of the State.

3. *Capillaria annulata* (Molin, 1858) Cram, 1926

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NB/14 ; location caecum ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong and Nongstoin. Elsewhere : Europe, Asia, South and North America.

Remarks : This is the first record of the occurrence of *C. annulata* from India. The specimens are very thin and may be overlooked in a visual examination of the organ.

The specimens in the present study lacked the anterior cuticular swelling and the folds, probably due to shrinkage during preservation (Deo, 1964).

4. *Capillaria contorta* (Creplin, 1939) Travassos, 1915

Material : Several ♂♂ & ♀♀ ; NEHU/Z-NB/15 ; location caecum ; coll. A.K. Yadav.

Distribution : Meghalaya : Shillong, Nongstoin and Riango. Elsewhere : South And North America, Europe and Asia.

Remarks : The species is being reported for the first time from India and seems to be of very rare occurrence in these hosts. The worms are filiform, thread-like and hence may be overlooked in a visual examination of the organ.

The hair-like processes on the spicule sheath were not found to be prominent; all other observations tally with the description provided by Deo (1964).

SUMMARY

1. This paper presents the spectrum of nematodes of livestock and poultry of Meghalaya. Twenty-six species of nematodes belonging to 19 genera and 13 families are reported herein.

2. Except a few, most species are first records from Meghalaya. Three species, namely, *Setaria bernardi*, *Cupillaria annuata* and *C. contorta* constitute new records from India.

3. A systematic account of the nematodes of livestock and poultry of Meghalaya is included in the paper.

4. Interesting variations are noted in the case of some species, while the description is supplemented for others.

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* References to authors of the various taxa included in the text are cited in bibliographies in Yamaguti (1961) and CIH keys.

** Not seen in original.

**STUDIES ON CRUSTACEA (OSTRACODA) OF BIHAR, INDIA.
II. CENTROCYPRIS INDICUS SP NOV.**

LAKSHMAN PRASAD GUPTA
Zoological Survey of India, Patna - 20

INTRODUCTION.

The genus *Centrocypris* Vavra was recorded (*C. horrida*) from Palni hills, India by Hartmann (1964). Victor & Fernando (1979) transferred *Eurycypris mathai* Arora to this genus as *C. matha*. Battish (1981) described two new species as *C. bhagirathiae* and *C. madani* from Ludhiana, Punjab. *Centrocypris indicus* sp. nov. is clearly distinguishable from other known species and is described here.

Family CYPRIDIDAE Baird 1845
Subfamily CENTROCYPRIDINAE Hartmann & Puri 1974
Genus. *Centrocypris* Vavra 1895
Centrocypris indicus sp. nov.

Diagnosis : Shell pitcher like in dorsal view, Posterior broader than anterior, outer surface profusely tuberculated throughout, tubercles pointed, anterior ones sharp and longer than posteriors, fine hairs in between the tubercles, ventral margin without plate, height more than half and width $\frac{3}{4}$ of the length ; right and left maxillary palps symmetrical in male ; Zenker's organ with 22 whorls of spicules.

Description. Female (Figs. 1-13).

Colour dirty green, ventral black : shell in dorsal view pitcher like, posterior broader than anterior, neck with distinct depression in anterior half, lateral margins partly straight in posterior, surface profusely tuberculate throughout with fine hairs in between, tubercles pointed, anterior ones sharp and longer than posteriors, ventral margin without plate. Left valve extends slightly beyond right valve anteriorly.

Antennule (Fig. 5):

Length ratio of segments 3 to 7 : 18 : 7 : 5 : 3 : 4.5, small aesthetasc on 7th natatory setae well developed.

Antenna (Fig. 6)

Prominent, first protopod with 2 scale bearing stout spines, length ratio of endopod segments 30:13:12:6, inner margin of endopod-1 and outer margin of endopod-2 with rows of microtrichs and inner margin of segment 2 with a bunch of setae, natatory setae long reaching beyond claws and sparsely setose in distal half, Y seta long, proximal and distal parts equal, segment 2 and 3 fused, setae t_1 and t_4

small and simple while t_2 and t_3 finely setulate, Z_1 , Z_2 and Z_3 setulate reaching tip of claws, Y_2 a small aesthetasc, claws G_1 , G_2 , G_3 serrated terminally ; segment 4 narrow and small, seta Y_3 with a simple seta (or setule) and common stalk, GM long and prominent claw, Gm small and slender seta.

Rake like organ (Fig. 8).

15 teeth.

Mandible (Fig. 7).

Seven rows of multidentate chitinous teeth, palp well developed and four segmented, first segment with 3 plumose and one α seta, second segment with 4 long plumose and one β seta, third segment with plumose thick Y seta, one simple seta on inner side and 7 smooth long setae on outer side, fourth segment with 2 smooth and 2 distally serrated long setae.

Maxillule (Fig. 9).

Third lobe with 5 denticulate and 1 smooth spine, distal segment of palp cylindrical and length twice the least width.

Maxilla (Fig. 10).

Palp in female with 3 unequal terminal setae and epipodite with 6 plumose setae.

Thoracopod- I (Fig. 11).

Segment 1 to 4 with one seta each on its inner side, segment 4 with one strong long terminally denticulate claw and one outer small seta, all the setae pilose with that of segment 1 curved, terminal claw curved, length ratio of segments and claw 62:28:25:12:100 in distal direction.

Thoracopod - II (Fig. 12).

Terminal segment with a complex pincer organ, with a beak like claw, a long denticulate (2 rows) curved claw, a narrow seta PZ_2 in between, a spoon like lobe (Lo) on the interodistal side of the third segment. Segment 4 not distinct from 3rd segment.

Furca (Fig. 13).

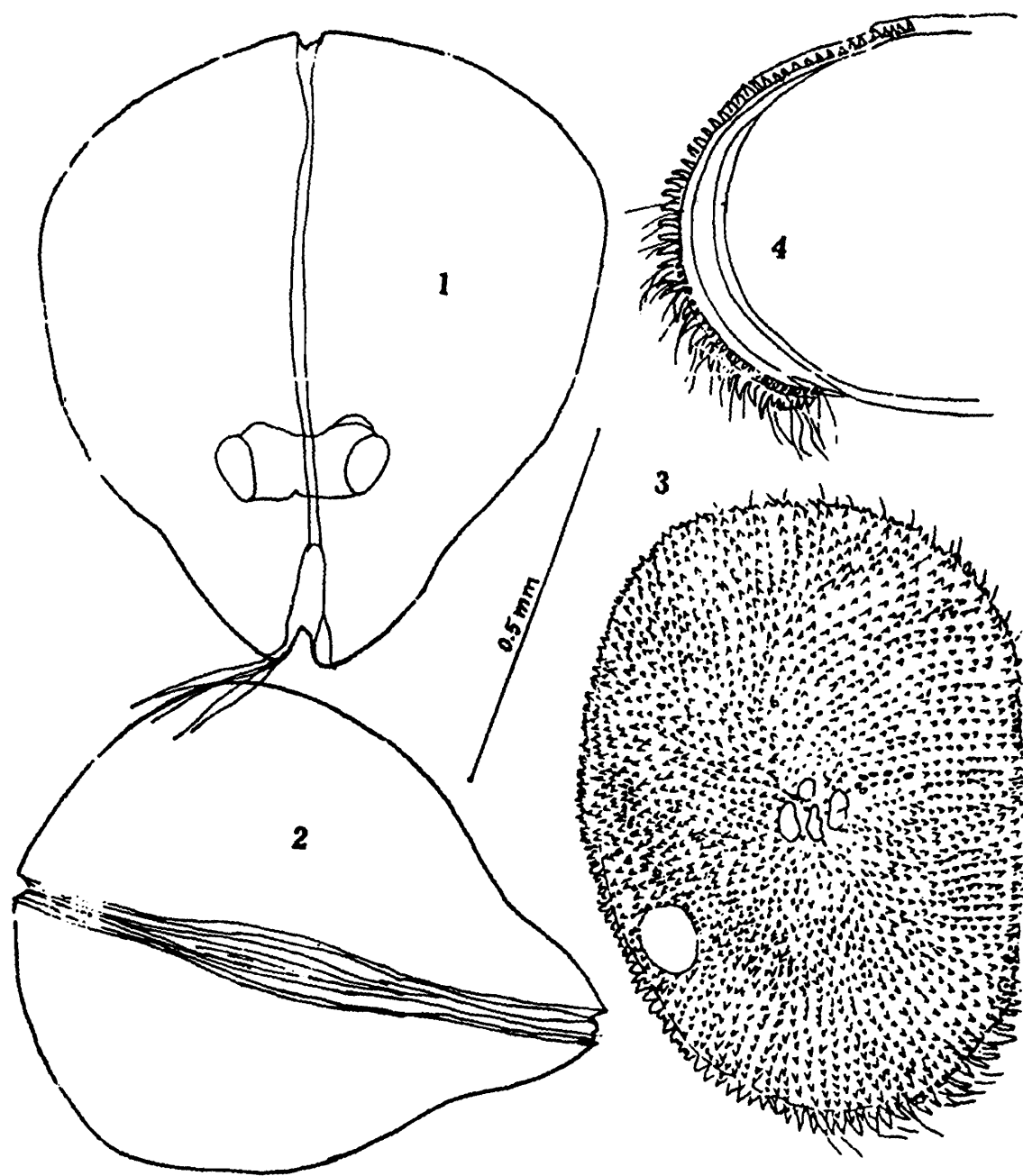
Asymmetrical in female, ramus length 14 times least width, dorsal margin serrate distally, terminal seta (Sa) small and nearly half of the dorsal seta (Sp) furcal support simple arch like.

Male (Figs. 14-19).

Smaller in size but difficult to distinguish from outside, maxillary palp symmetrical, Zenker's organ with 22 whorls of spicules, setae on thoracopod-I (on segments 1 & 3) smaller than females, endopod segments 2 and 3 of antenna fused in both.

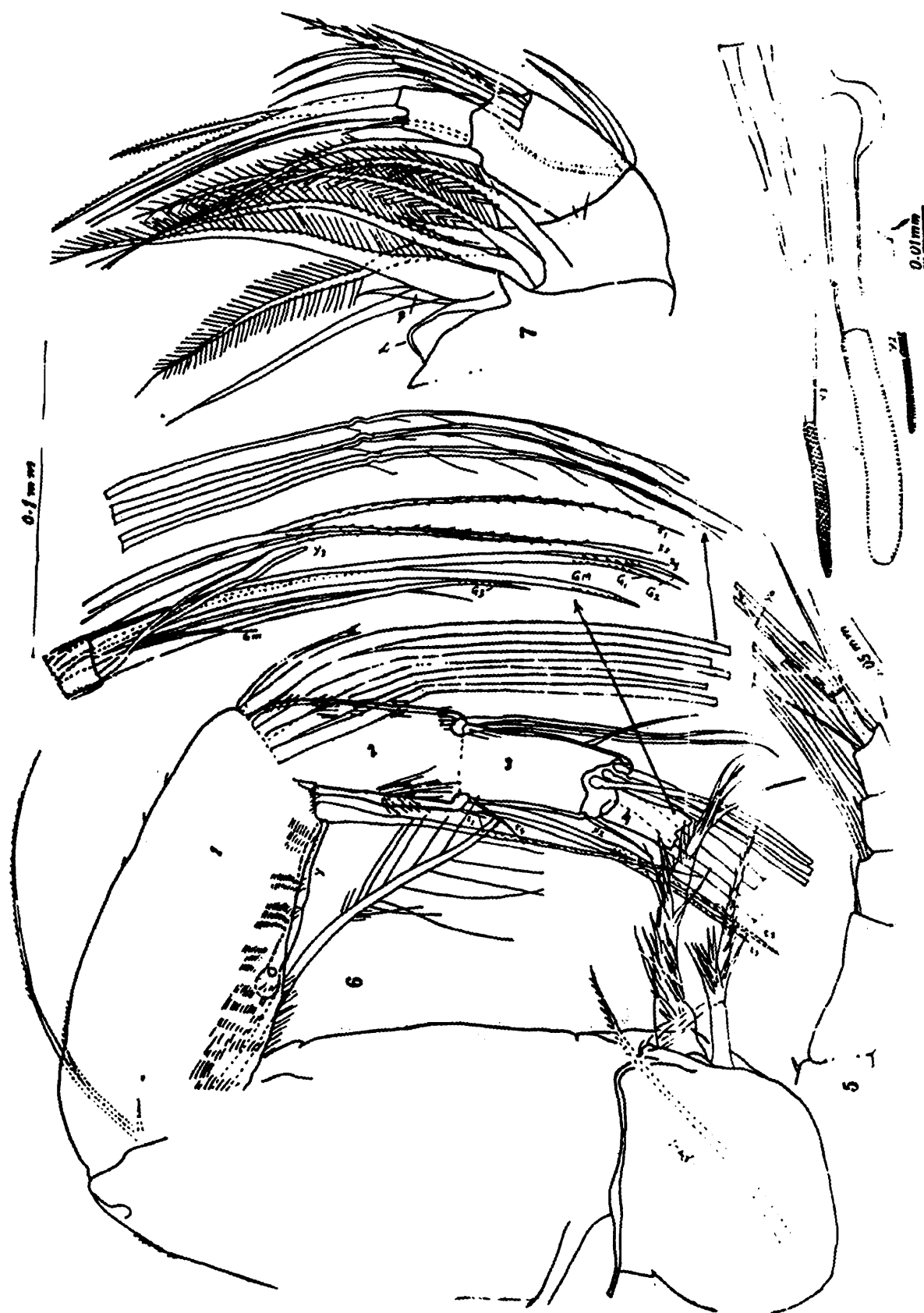
Holotype : ♀ (Slide No 5a, 5b) Reg. No A1052 Zoological Survey of India, Gangetic plains Regional Station, Patna ; Loc. Pond, Sadikpur Mathia, Siwan, Bihar, India, Coll. Lakshman Prasad Gupta, 10-X-1985.

Paratypes : ♂♂ The males will be Allotyped (Slide No 1a, 1b and 3), ♀♀ (Slide No 2, 4, 6 and unsorted 200 specimens in Spirit, Reg. No. A1053, details same as for Holotype.



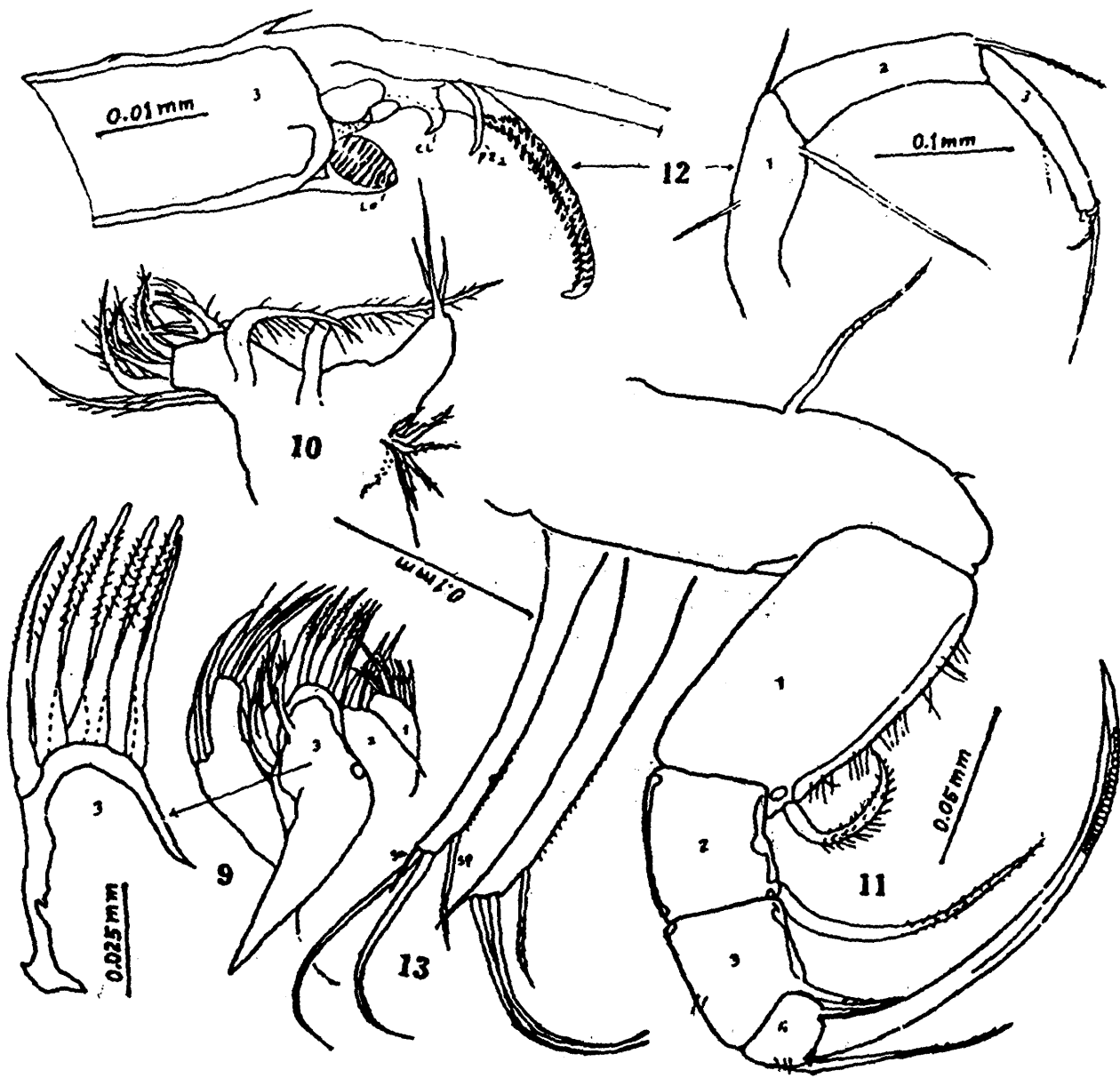
Centrocypsis indicus (Female)

Figs. 1-4. 1. Dorsal view of shell outlines. 2. Ventral view of shell outline. 3. Lateral view of shell tubercles. 4. Side view of shell anterior margin.



Centrocypris indicus (Female)

Fig. 5-7. 5. Antennule, 6. Antenna, 7. Mandible.



Centrocypris indicus (Female)

Fig. 9-13. 9. Maxillule ; 10. Maxilla ; 11. Thoracopod-I ; 12. Thoracopod-II ; 13. Furca.



Centrocypris indicus (Male)

Figs. : 8, 14-19. 8. Rake like organ ; 14. Antenna ; 15. Mascilla ; 16. thorocopod-I ; 17. Furca and furcal support ; 18. Zenker's organ ; 19. Hemipenis.

Measurement : Length 0.75 - 0.94 mm, height 0.52 - 0.57 mm ; breadth 0.6 - 0.72 mm.

DISCUSSION

There is some controversy regarding characters and status of the genus *Centrocypris* for inclusion at family level. Hartmann and Puri (1974) stated that *Centrocypris* Vavra 1895 has 4 toothed spines on third lobe of maxillule and hence established a new subfamily centrocypridinae separating it from Notodromatinae which has 6 toothed spines. McKenzie (1971) noted that there are 5 zohnbursten (toothed spines) on third lobe of maxillule and 6 strahlen on epipodite of maxillae in both male and female of *Centrocypris*, which is absent in Notodromatinae. The terminal joint of cleaning limb (Thoracopod-II) is not separated from penultimate (3rd) segment in case of centrocypridinae while in case of Notodromatinae, though small, but clearly separated.

My observations are in agreement with the description given for the genus by McKenzie. It is probable that in case of *C. bhagirathiae* and *C. madani* (Battish 1981), dentate nature of 5th spine which is outermost has escaped his notice as he fails to give this character. In *C. indicus* this is clear and distinct.

Therefore, the present species is close to *C. madani* battish (1981) but differs in outline in dorsal view and being smaller in size, having 15 number of teeth on rake like organs distal segment of maxillular palp which is twice in length to the width, maxillary palp symmetrical, Zenker's organ with 22 whorls of spicules and furcal ramus 14 times longer as its least width. It also differs from *C. mathai* (Arora 1931) which is larger in size and has asymmetrical maxillary palp in males. Thus *C. indicus* is the smallest species known so far.

ACKNOWLEDGEMENT

I am thankful to the Director, Zoological Survey of India, Calcutta and Officer-in-Charge, Z.S.I., G.P.R.S. Patna for their help. I am also thankful to Dr. S.K. Battish for sending his reprints on the subject.

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OBSERVATION ON THE EPICRANIO-ORBITAL COMPLEX OF SOME INDIAN AESHNINAE (ODONATA : AESHNIDAE)

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INTRODUCTION

Diversity of the epicranium resulting from the extent of isolation or contiguity of the compound eyes gained, till date, comparatively little attention in generic or subgeneric classification of Odonates, although such characteristics are of recognised importance in supergeneric classification of the group. Fraser (1936, 1957) mentioned about the presence of extensive variability in the extent of fusion of eyes in the families Aeshnidae and Libellulidae. Lieftinck (1968) made use of the nature of inter-orbital suture to distinguish various species of *Oligoaeschna* Selys.

In the present paper, the nature of the epicranio-orbital complex of some Indian Aeshnid dragonflies (division Aeshninae) has been discussed with an attempt to analyse their possible taxonomic significance.

MATERIAL AND METHOD

12 Aeshnid species, representing all but one of the seven known genera and approximately half of the total known species of Indian Aeshninae were studied from either or both sexes as represented in the named odonate collection of the Zoological Survey of India. Observation was made by placing the specimens under light binocular microscope with objective 1.8 X and eye piece 6.0 X respectively. The specimens were so placed as to produce best clear view of the interorbital suture. Figures were drawn with the help of camera-lucida drawing apparatus. Attempt has been made to formulate running keys to various genera and species based on the nature of the epicranio-orbital complex.

TREND OF VARIATION OF THE EPICRANIO-ORBITAL COMPLEX OF AESHNINAE DRAGONFLIES AS OBSERVED DURING THE PRESENT STUDY

The compound eyes exhibit considerable variation in their shape in different genera and species, varying from being oval, rounded, oblong or subtriangular, their lateral margin being occasionally deflected variably. Further, the compound eyes are broadly contiguous with each other over the epicranium along the length of the inter-orbital suture that isolates the occiput from other elements of the epicranium like the vertex, vesicle etc. The interorbital suture varies in extent with a reciprocal variation of the extent of the occiput. The apex of the occiput

fails, when the occiput is too small, to reach the point of maximum width of the head. The anteromedian margin of the orbit just in front of the interorbital suture also varies from being substraight to deeply arquate in nature. These, are in short, the major trend of variation noticed in course of the present study in respect of the epicranio-orbital complex.

LIST OF SPECIES STUDIED

Family AESHNIDAE Division Aeshninae

1. <i>Polycanthagyna erythromelas</i> (MacLachlan)	... ♂ ♀
2. <i>Aeshna mixta</i> (Latreille)	... ♂ ♀
3. <i>Anax guttatus</i> (Burmeister)	... ♂ ♀
4. <i>Anax immaculifrons</i> Rambur	... ♂
5. <i>Anax imperator</i> Leach	... ♀
6. <i>Anax nigrolineatus</i> Fraser	... ♀
7. <i>Hemianax ephippiger</i> (Burmeister)	... ♂ ♀
8. <i>Anaciaeschna jaspidea</i> (Burmeister)	... ♂
9. <i>Gynacantha bainbriggei</i> Fraser	... ♂
10. <i>Gynacantha dravida</i> Lieftinck	... ♂
11. <i>Gynacantha millardi</i> Fraser	... ♀
12. <i>Gynacantha basiguttata</i> Selys	... ♂

Key to the genera of AESHNINAE

1. Occiput very small, interorbital suture 3.5 to 5.5 times as long as occiput _____ 2
 - Occiput large, interorbital suture 1.10 to 2.75 times as long as occiput _____ 3
2. Outer margin of eyes rounded _____ *Anaciaeschna* Selys (Fig. 12)
 - Outer margin of eyes oval _____ *Gynacantha* Rambur (Figs. 13 to 16)
3. Occiput very large, interorbital suture less than 1.15 times as long as occiput ; anteromedian margin of orbit substraight ; vesicle protruding beyond the level of anterior margin of orbit _____ *Hemiana* Selys (Figs. 10 and 11)
 Occiput moderately large, interorbital suture 1.30 to 2.75 times as long as occiput ; anteromedian margin of orbit usually arquate ; vesicle sunk behind or anteriorly just reaching the anteriormost margin of orbit _____ 4
4. Vesicle thick and large in comparison to frons (Figs. 1 and 2) ; anteromedian margin of orbit deeply arquate _____ *Polycanthagyna* Fraser (Figs. 1 and 2)
 - Vesicle, in comparison to frons, small and narrow or moderately large (Figs. 3 to 9) ; anteromedian margin of orbit substraight or moderately arquate _____ 5

5. Eyes shorter than frons in width ; outer margin of eyes rounded and without any deflection ; apex of occiput falling behind the level of maximum width of head — *Aeshna* Fabricius (Figs. 3 and 4)
- Eyes usually broader than frons in width ; outer margin of eyes suboval and/or with posterolateral deflection ; apex of occiput extending beyond the point of maximum width of head — *Anax* Leach (Figs. 5 to 9)

SALIENT FEATURES OF THE EPICRANIO-ORBITAL COMPLEX IN DIFFERENT GENERA AND SPECIES STUDIED

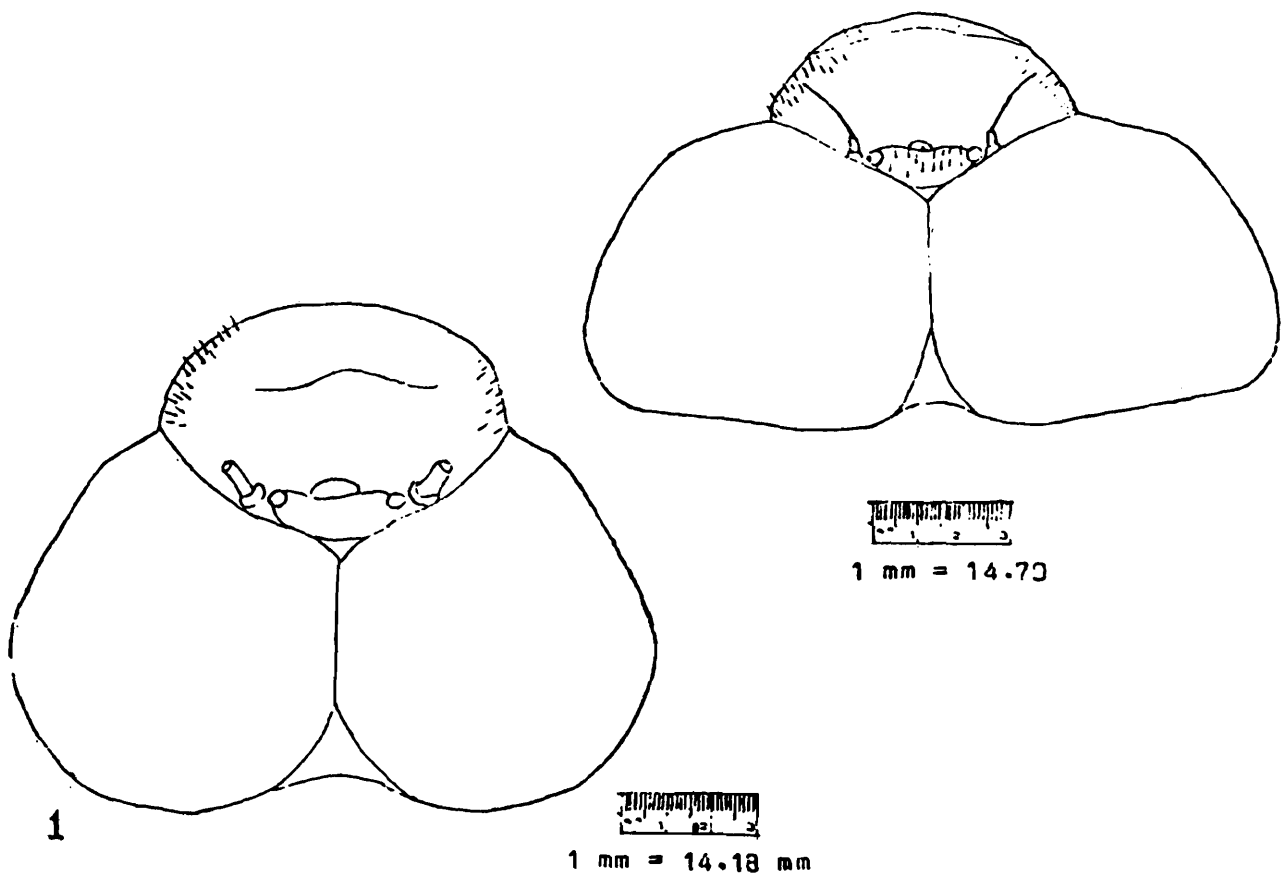
Genus *Polycanthagyna* Fraser 1933 (Figs. 1 and 2)

Vesicle rather thick and large in comparison to frons. Anteromedian margin of orbit deeply arquate, shape of eyes variable. Occiput large. Interorbital suture 1.58-1.60 times the length of occiput.

Polycanthagyna erythromelas (MacLachlan 1896) (Figs. 1 and 2)

Material studied : 1♂, INDIA : JAMMU AND KASHMIR, Poonch, 10.x.1972, coll B.D. Sharma ; 1 ♀, INDIA : JAMMU AND KASHMIR, Balli Nala, 11.ix.1964, coll Raj Tilak.

Male : Eyes subtriangular, broader than long, outer margin of eyes suboval with subsquare posterolateral angle.



Figs. 1 & 2 : *Polycanthagyna erythromelas* (MacLachlan) 1. Female, 2. Male.

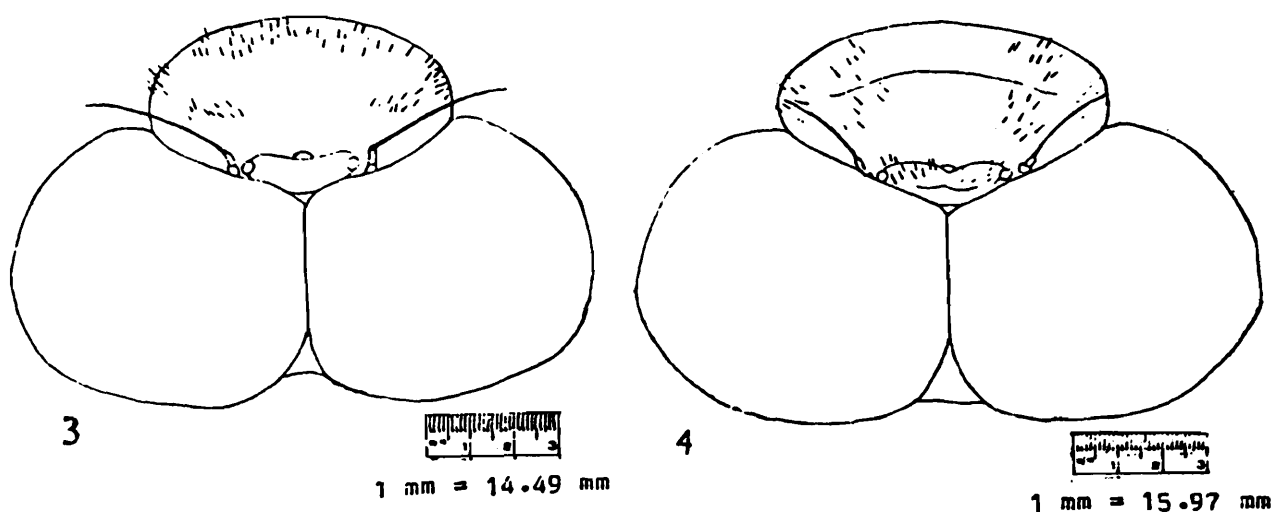
Female : Eyes globular, longer than broad, outer margin subrounded with feeble median deflection.

Note : The species is recorded here for the first time from Jammu and Kashmir.

Genus *Aeshna* Fabricius 1775

(Figs. 3 and 4)

Vesicle moderately large in comparison to frons, Anteromedian margin of orbit arquate. Occiput rather large, interorbital suture nearly twice the length of occiput. Eyes oblong, subequal to or shorter than frons in width with subrounded outer margin. Apex of occiput falling behind the level of maximum width of head.



Figs. 3&4 : *Aeshna mirta* Latreille 3. Male, 4. Female.

Aeshna mixta Latreille 1805

(Figs. 3 and 4)

Material studied : 8 exs, JAMMU AND KASHMIR, coll S.K. Gupta and party ; 2 ♂♂, Shalimar, Srinagar, 19.x.1976 ; 2 ♂♂, Anantanag, 2.xi.1976 ; 2 ♂♂, 2 ♀♀, Achabal, Jogigund, 7.xi.1976.

Eyes equal to and slightly shorter than the frons in width in male and female respectively. Other details as for the genus.

Genus *Anax* Leach 1815

(Figs. 5 to 9)

Usually vesicle narrow in comparison to frons and anteromedian margin of orbit arquate. Occiput large, interorbital suture 1.29 to 3.20 times the length of occiput. Eyes oval, oblong or subtriangular, subequal to or broader than frons in width. Outer margin of eyes variably suboval and posterolateral angle of the same variably rounded or subsquare. Apex of occiput extending to the level of maximum width of head.

Key to the species of genus **Anax** Leach*Male*

Occiput small, interorbital suture about 3.2 times as long as occiput (Fig. 5) —
 _____ *A. guttatus* (Burmeister)

Occiput large, interorbital suture about 2.09 times as long as occiput (Fig. 7) —
 _____ *A. immaculifrons* Rambur

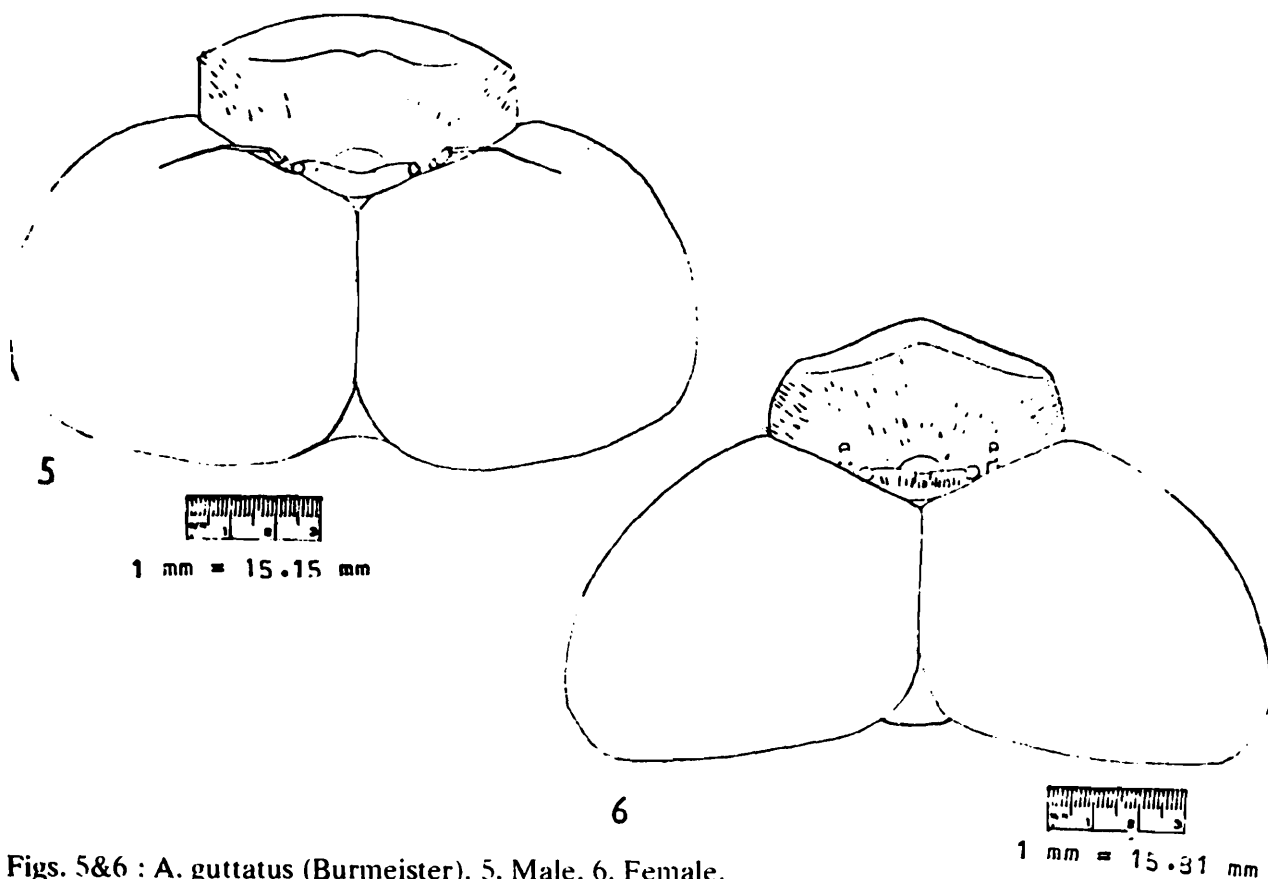
Female

1. Anteromedian margin of orbit substraight (Fig. 8) _____
 _____ *A. imperator* Leach

- Anteromedian margin of orbit arcuate (Figs 6 and 9) _____ 2

2. Occiput small, interorbital suture 2.75 times the length or occiput (Fig. 6) ;
 posterior margin of occiput convex _____
 _____ *A. guttatus* (Burmeister)

- Occiput comparatively larger, interorbital suture 1.29 times the length of
 occiput (Fig. 9) ; posterior margin of occiput concave *A. nigrolineatus* Fraser



Figs. 5&6 : *A. guttatus* (Burmeister). 5. Male, 6. Female.

***Anax guttatus* (Burmeister 1839)**
 (Figs. 5 and 6)

Material studied : 5 exs ; 1 ♀, INDIA : WEST BENGAL : Jaipur Forest, Purulia, 9.x.1983, coll A.K. Hazra and party ; 3 exs, ORISSA : 1 ♂, Barkuda, 28.viii.1919, coll S.L. Hora ; 2 ♀♀, Barsasan, Keonjhar, 27.ix.1972, coll K. Rai and party ; 1 ♂, TAMIL NADU : on board the ship "City of Karachi", 18 miles off Cape Comorin, 25.xi.1927, coll J.A.R. Gockerell.

Male : Eyes subsquare, nearly as long as broad (Figs. 5) with weakly subsquare posterolateral angle ; occiput with concave posterior margin ; interorbital suture 3.2 times the length of occiput. Anteromedian margin of eyes arquate.

Female : Eyes subtriangular, visibly broader than long (Fig. 6), with subsquare posterolateral angle ; occiput small with concave posterior margin ; interorbital suture 2.75 times as long as occiput.

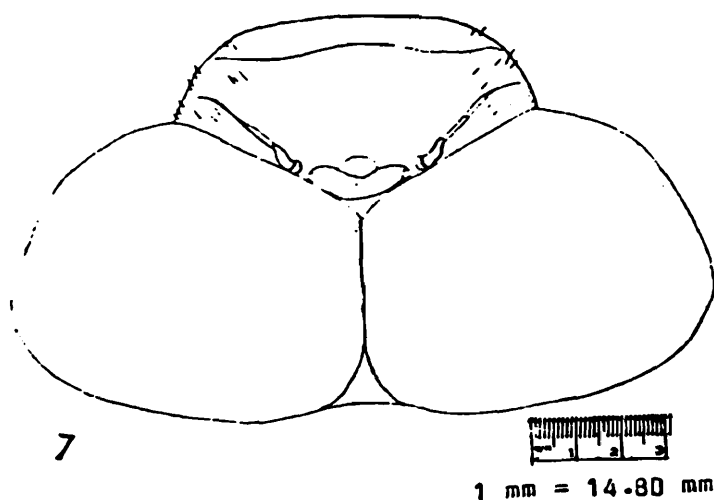


Fig. 7 : *A. immaculifrons* Rambur, Male.

***Anax immaculifrons* Rambur 1842**
(Fig. 7)

Material Studied : 4♂♂, INDIA ; 1 ex, MAHARASHTRA : Panchgani, ? date, coll E. Blatter and J. Fernandez ; 1 ex, UTTAR PRADESH : Rishikesh, 5.x.1976, coll R. K. Vershney ; 1 ex, PUNJAB : Choa, 15-21.x.1930, coll S.L. Hora and party ; 1 ex, ? : Bhimsankar forest bungalow, 3.v.1965, coll B.S. Lamba and party.

Male : Eyes suboval, longer than broad (Fig. 7), with lateral margin smoothly oval ; occiput small with substraight posterior margin ; interorbital suture 2.09 times the length of occiput. Anteromedian margin of eyes arquate.

Note : The species is recorded here for the first time from Punjab and Uttar Pradesh.

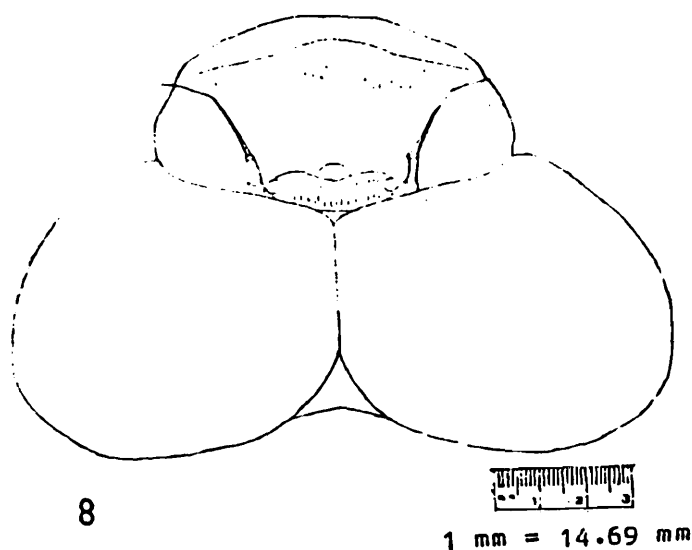


Fig. 8 : *A. imperator* Leach, Female.

Anax imperator Leach 1815
(Fig. 8)

Material studied : 1 ♀ INDIA : PUNJAB : Dalhousie, May, 1927, coll. S.L. Hora.

Female : Eyes suboval, broader than long (Fig. 8), with lateral margin smoothly oval. Occiput moderately large with concave posterior margin ; interorbital suture about twice as long as occiput.

Note : The species has been recorded for the first time from Punjab.

Anax nigrolineatus Fraser 1935
(Fig. 9)

Material studied : 1 ♀, INDIA : SIKKIM : Lachan, 4.vi.1959, coll A.G.K. Menon.

Female : Eyes subtriangular, broader than long (Fig. 9), with posteriorly deflected outer margin. Occiput large with concave posterior margin. Interorbital suture 1.29 times as long as occiput.

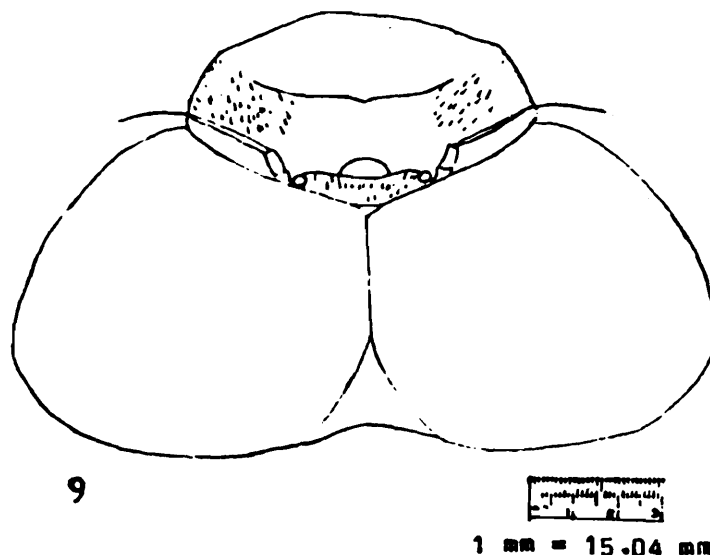


Fig. 9 : *A. nigrolineatus* Fraser, Female.

Genus Hemianax Selys 1883
(Figs. 10 and 11)

Vesicle moderately large in comparison to frons. Anteromedian margin of eyes substraight. Occiput large and almost as long as the interorbital suture. Eyes oblong, a little longer than frons in width with posteriorly deflected outer margin. Apex of occiput extending to the level of maximum width of head.

Hemianax ephippiger (Burmeister 1839)
(Figs. 10 and 11)

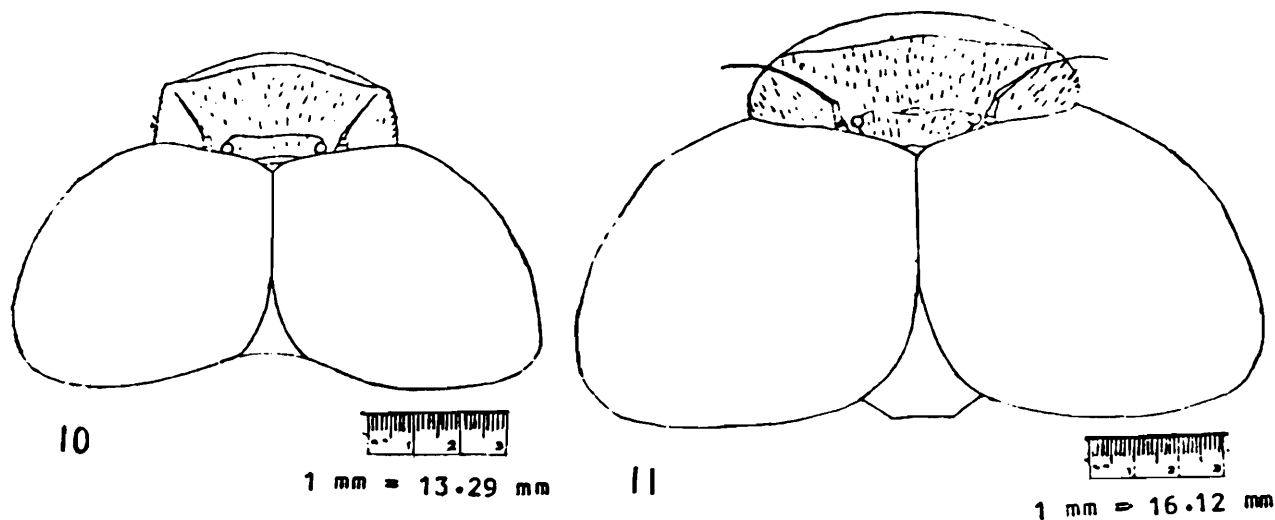
Material studied : 4 exs, INDIA ; 1 ♂, RAJASTHAN, Pali, 4.xii.1956, coll B. Biswas ; 2 exs, BIHAR ; 1 ♂, Patna, 5.viii.1967, coll K.K. Mukherjee ; 1 ♀, Ranchi

collector and date of collection unknown ; 1 ♀, MAHARASHTRA, Tarapora village, ? date, coll Kewetramani.

Male : Occiput narrower than vesicle in width and a little shorter than the interorbital suture in length with sinuous posterior margin (Fig. 10).

Female : Occiput subequal to vesicle in width also subequal to the interorbital suture in length ; posterior margin of occiput squarely produced backwards (Fig. 11).

Note : The species has here been recorded for the first time from the states of Bihar and Rajasthan in India.



Figs. 10&11 : *Hamianax ephippiger* (Burmeister) 10. Male, 11. Female.

Genus *Anaciaeschna* Selys 1878

(Fig. 12)

Vesicle moderately large in comparison to frons. Anteromedian margin of eyes deeply arquate. Occiput very small, interorbital suture more than five times the length of occiput. Eyes globular, broader than frons in width with nearly rounded outer margin. Apex of occiput falling behind the level of maximum width of head.

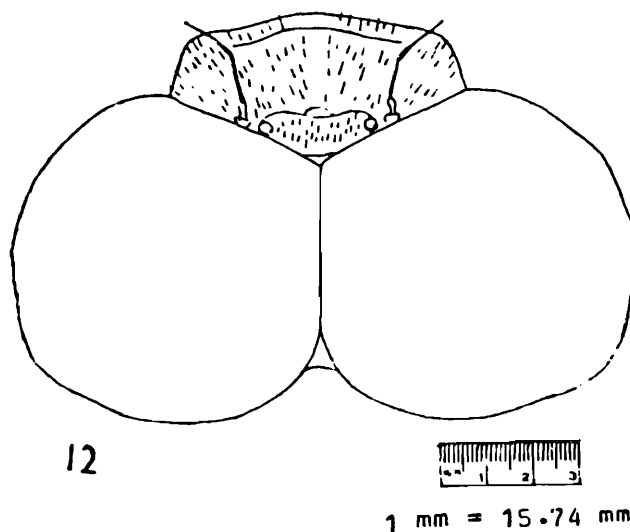


Fig. 12 : *Anaciaeschna jaspidea* (Burmeister), Male.

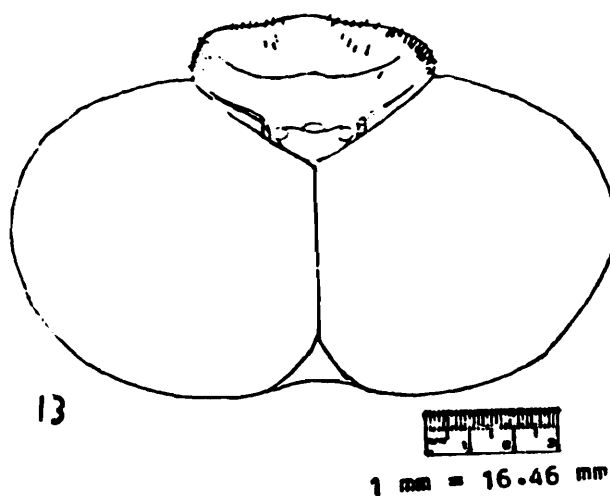


Fig. 13 : *Gynacantha bainbriggei* Fraser, Male.

***Gynacantha basiguttata* Selys 1882**
(Fig. 16)

Material studied : 2 ♀♀, INDIA ; 1 ex, MEGHALAYA, Songook, 1g. 1x-1975, coll N. Muralidharan ; 1 ex., ARUNACHAL PRADESH, Tirap district, Deban, 11.xii.1982, coll S. Biswas.

Female : Occiput very small, shaped as an isolateral triangle. Interorbital suture more than five times as long as the occiput.

Note : The species has been recorded here for the first time from Arunachal Pradesh and Meghalaya states of the Indian Union.

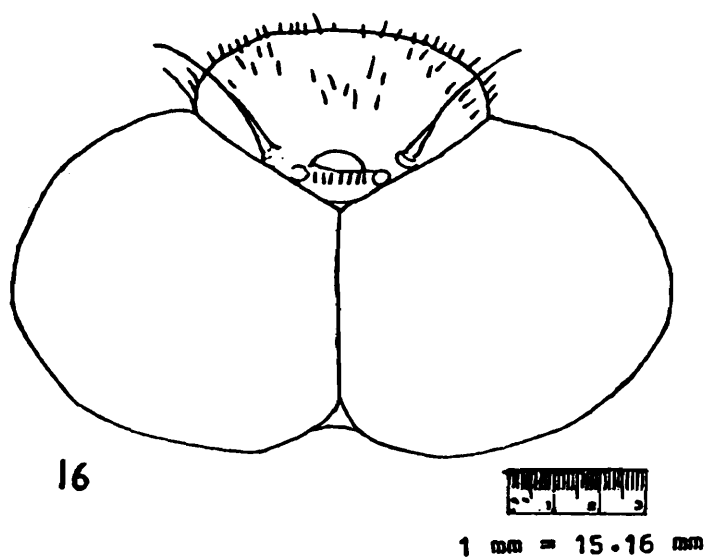


Fig. 16. *G. basiguttata* Selys, Female.

***Gynacantha dravida* Lieftinck 1960**
(Fig. 14)

Material studied : 1 ♂, INDIA : WEST BENGAL, Calcutta, -ix.1928, coll R.B.S. Swell.

Anaciaeschna jaspidea (Burmeister 1839)
(Fig. 12)

Material studied : 3♂♂, INDIA ; 1 ex, MEGHALAYA, Garo hills, Rongram, 25.iv.1976, coll N. Muralidharan ; 2 exs. WEST BENGAL, Calcutta ; 1 ex, Jabakusum House building, 21.iii.1965, coll S. Manjhi ; 1 ex. Horticulture garden, 11.x.1973, coll J. Ram.

Male : Eyes as long as wide with outer margin very weakly deflected posteriorly. Occiput with sinuous posterior margin.

Note : The species is recorded here for the first time from Meghalaya and the plains of West Bengal.

Genus Gynacantha Rambur 1842
(Figs. 13 to 16)

Vesicle rather small in comparison to frons. Anteromedian margin of eyes deeply arquate. Occiput small, interorbital suture 3.5 to 5.5 times as long as occiput. Eyes oval, broader than frons in width. Apex of occiput falling behind the point of maximum width of head.

Key to the species of Genus Gynacantha Rambur

Male

Eyes broader than long and widest at a point a little below the middle of their length (Fig. 14) _____ *G. dravida* Lieftinck

Eyes as long as wide and widest at a point a little above the middle of their length (Fig. 13) _____ *G. bainbriggei* Fraser

Female

Occiput very small, interorbital suture more than five times as long as occiput (Fig. 16) _____ *G. basiguttata* Selys

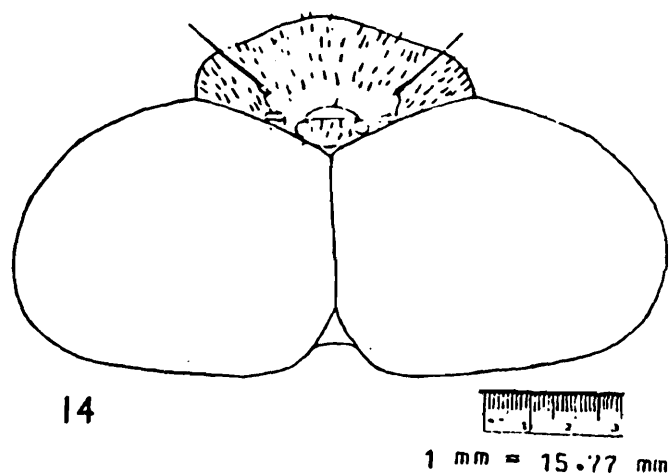
Occiput larger, interorbital suture less than four times as long as occiput (Fig. 15) _____ *G. millardi* Fraser

Gynacantha bainbriggei Fraser 1922
(Fig. 13)

Material studied : 1 ♂, INDIA : WEST BENGAL, Calcutta, 27.vii. 1972, coll unrecorded.

Male : Eyes as long as wide and widest at a point a little above the middle of their own length. Occiput as wide as the vesicle.

Note : The species has been recorded here for the first time from West Bengal.

Fig. 14. *G. dravida* Lieftinek, Male.

Male : Eyes broader than long and widest at a point a little below the middle of their own length ; occiput narrower than vesicle in width.

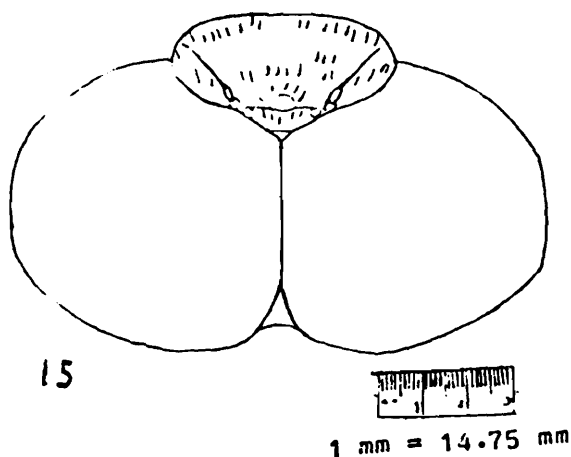
Note : The species has been recorded here for the first time from Northern India.

***Gynacantha millardi* Fraser 1920**
(Fig. 15)

Material studied : 2 ♀♀, INDIA ; 1 ex. ORISSA, Balangir, Harisankar road, 17.xii.1972, coll A.K. Mondal and party ; 1 ex, MAHARASHTRA, Poona, N.C.L. compound, -.1962, coll B.K. Halder.

Female : Occiput small with sides a little longer than the hind margin. Interorbital suture less than four times the length of occiput.

Note : The species has been recorded here for the first time from Orissa.

Fig. 15. *G. millardi* Fraser, Female.

SUMMARY

Nature of the epicranio-orbital complex has been discussed for twelve Indian Aeshninae dragonflies viz. *Polycanthagyna erythromelas* (MacLachlan), *Aeshna mixta* (Latreille), *Anax. guttatus* (Burmeister), *A. immaculifrons* Rambur, *A.*

imperator Leach, *A. nigrolineatus* Fraser, *Hemianax ephippiger* (Burmeister), *Anaciaeschna jaspidea* (Burmeister), *Gynacantha bainbriggei* Fraser, *G. dravida* Lieftinck, *G. millardi* Fraser and *G. basiguttata* Selys. The trend of variation has been discussed and tentative generic and species keys based on such studies have been provided.

ACKNOWLEDGEMENT

The authors are thankful to Dr. B.K. Tikader, Director Zoological Survey of India, Calcutta, for providing an opportunity to carry out the present study.

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ON SOME ANOMALIES IN DENTITION OF PREHISTORIC CANIDS

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INTRODUCTION

The dentition in the genus *Canis*, that includes the dog, jackal, wold, covote and allied species, is typically 3142/3143. But occasionally supernumerary or subnumerary teeth are also encountered during odontological investigation. While studying some osteological material in the Prehistoric Zoology Laboratory of the department, the author came across such anomalies in the dentition of a few Canid specimens. The details of the study is the subject matter of the present communication.

MATERIAL

- Sp. No. 1 - Intact skull, *Canis familiaris* ; Loc, Lalpahar, South Andaman, 1980 (Kitchen Midden), Coll. S. Banerjee.
- Sp. No. 2 - Complete mandible, *Canis lupus* ; Reg. No. 3293, Loc. Burzahom Kashmir ; BZH - 3, A11 ; SEQD ; Pit 1 (Neolithic) ; Coll. Archaeological Survey of India.
- Sp. No. 3 - Complete mandible, *Canis familiaris* ; Reg. No. 3136, Loc. Burzahom Kashmir, BZH - 3, B11 ; SEQD ; Pit 1 (Megalithic) ; Coll. Archaeological Survey of India.
- Sp. No. 4 - Damaged mandible, *Canis familiaris* ; Reg. No. 3280, Loc. Burzahom, Kashmir, (Early Neolithic) ; Coll. Archaeological Survey of India.
- Sp. No. 5 - Damaged mandible, *Canis familiaris* ; Reg. No. 3036, Loc. Burzahom, Kashmir ; xxx' - xxivx', Pit 7 cut into 9 sealed by 8, (Early Neolithic), Coll. Archaeological Survey of India.

OBSERVATION

All the specimens were of un-sexed, adult subjects. In the skull of dog from South Andaman (Sp. No. 1, Fig. A) the formation of M₃ in the left maxilla is an interesting anomaly. The molar is normal in its constitution, having tuberculated cusps and three roots, which are well embeded in the alveoli. The mandibular specimens are all from Burzahom, Kashmir. The presence of one extra anterior premolar, structurally resembling the P₁ is seen on the left ramus of a wold's jaw (Sp. No. 2, Figs. B&D). Likewise, another jaw of a dog also shows the presence of such extra premolar, anterior to P₁ on its right ramus (Sp. No. 3, Fig. C). Both the premolars have a single root, protoconid cusp and a cingulum behind, and as such deserve the ordinal number P₁. The specimen No. 3, of course lacks the last molar

M₃ on right ramus. Specimen No. 4, (Fig. E) damaged mandible of a dog does not show the anterior premolar P₁ on the right ramus and likewise the specimen No. 5, (Fig. F), another damaged lower jaw lacks it on the left. The last three examples are cases of subnumerary dentition. The supernumerary upper molar (M₃) and lower premolars (P₁) quoted above were morphologically perfect, having distinct crown, neck and root regions, composed of the essential elements *viz.*, enamel, dentine and a little root-cement.

DISCUSSION

The canids belong to the fissiped carnivores. In present day carnivores as well as the extinct Paleocene Creodonts, the maximal monodelphous dental formula $3143/3143=44$ never exceeds and most of the placental mammals, which have been derived from early tertiary forms, had similar dentition (Peyer 1968). Barring the pig and mole, majority of the recent mammals have acquired a reduced dentition during evolution. The genus *Canis* is also not an exception to it and lacks two upper third molars (M₃) and has species-specific dentition $3142/3143=42$. Excepting the case of African wild dog *Otocyon*, in which minor increase in the cheek teeth i.e. $314(3-4)/3144$ is observed, most of the recent species of carnivores have much reduced dentition, e.g. Dole $3142/3142$, Felids $3121/3121$, Hyenids $3141/3131$. Therefore, when a progressive reduction in the number of cheek teeth are met with in the much evolved later forms, sudden re-appearance of a pristine molar or development of additional premolars, is interesting. Though the dentition in the wild species is rather uniform and follows rigidly the species-typical dentition, anomalies are also found to occur in them. Nellis (1972) observed a number of dental abnormalities involving both supernumerary and subnumerary dentition in wild Coyotes (*Canis lutrans*) from central Alberta. He also found the presence of such extra premolars (P₁) in two specimens and third upper molar (M₃) in one specimen of Coyotes.

In domestic dog, the upper cheek teeth are generally six and the lower cheek teeth are seven. But in extreme brachycephalic breeds, these numbers may be further reduced to 5/7 or even less (Sisson & Grossman 1953). So, the breed-oriented reduction of teeth or individual loss of certain tooth are not very uncommon in the recent dogs. But the re-appearance of a vestigial molar or formation of additional premolars in some prehistoric dogs, including one that belongs to a wolf are noteworthy. The remains from Burzahom, Kashmir are dated to 2500 B.C., but the skull from Kitchen midden of South Andaman is not much old and is assumed to be 200 - 500 years B.P.

The development of the upper third molar M³, in the skull of a dog (Fig. A) from South Andaman (Kitchen Midden) may be accounted as a sudden recapitulation of the paligenetic dentition (i.e. 3143) in the left maxilla against the cenogenetic (i.e. 3142) retained by the opposite side. It is morphologically reciprocal to the lower M³, and from the ground condition of the (tri-) tuberculated cusps, it is evident that the tooth received regular resistance from the lower M₃ when the beast was alive. The additional M³ in Coyote studied by Nellis (1972) also had three roots,

skull is rather roundish like the lower M_3 in shape. The upper and lower cheek teeth in *Canis* do not correspond but rather dovetail. Normally, the rudimentary, single rooted lower last molar is not occlusal to the upper last molar (M^2) and practically in the absence of M^3 , remains un-opposed and thus functionally becomes less important. Probably this is the reason for occasional loss or complete non-formation of the tooth as is testified by one of the present material also (Sp. No. 3). Nellis (1972) also mentioned that the most common dental anomaly involved is in the loss of M_3 and he accounted for its rudimentary structure and remote situation. The present author assumes that like the vestigial upper M^3 , the lower M_3 in dog may also become degenerate someday. However, due to the presence of M^3 , the length of the cheek teeth series in Sp. No. 1, becomes 3.50 mm longer and reaches the periphery of the palatine plane.

The existence of five functional premolars in the lower ramus in specimen Nos. 2 & 3 are also example of supernumerary dentition. Nellis (1972) observed such premolars anterior to P_1 in both the jaws of one Coyote and on the left jaw of another. Generally, in *Canis*, the first cheek tooth appears only once at the age of 4-5 months and does not have any descendant thereafter. So, it is difficult to consider that a milk P_1 and a secondary P_1 simultaneously occupy two different alveolus without replacing one another and continue to grow and function. the occupation of more anterior portion of the jaw by the additional P_1 diminishes the C- P_1 gap, meant for the accomodation of upper canine by 3-5 mm. The presence of the five premolars in alinement (3153) poses difficulty in assessing their seniority and in assigning the ordinal numbers. If the premordial premolar is put with ordinal number P_1 , then the last premolar, mesial to M_1 is to be ordinated P_5 .

The non-formation of M_3 in specimen No. 3 and P_1 in specimen Nos. 4 & 5 are examples of subnumerary dentition. Presumably these teeth were not developed at all as is evident from the absence of any alveolar scar and no special dental cells (odontoblast/ameloblast) could be differentiated in the area. The absence of P_1 increases the alveolar gap between C- P_2 by 5 mm. and renders the portion of the ramus more diastema like. The absence of lower M_3 in specimen No. 3, decreases the length of cheek teeth series by 3 mm. Generally from carnassial, the teeth diminish in size and in number of roots both forward and backward. Therefore, missing of anterior premolar or posterior molar in the dog are not surprising. But development of unusual tooth is interesting from the point of genetics and odontology.

SUMMARY

One extra upper molar (M^3) and two additional premolars (P_1), examples of supernumerary dentition and missing of lower third molar (M_3) and anterior premolars (P_1) example of subnumerary dentition have been observed in some prehistoric remains of Canids from Burzahom, Kashmir and South Andaman. Loss or non-formation of anterior or posterior cheek teeth are more common in *Canis* as these teeth are rudimentary in structure, but supernumerary teeth in *Canis*, that too in prehistoric forms is noteworthy from the point of dental anatomy. It has probably resulted from genetical or developmental disorder. It appears that in

absence of the upper last molar (M) in dog, the lower one (M₃) becomes non-functional and therefore may become completely degenerated someday.

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**RECORDS OF MOSQUITOES (DIPTERA : CULICIDAE) FROM
MANIPUR : GENERA MIMOMYIA, COQUILLETIDIA, MANSONIA,
TRIPTEROIDES, AND URANOTAENIA.**

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INTRODUCTION

The so far known mosquito-records from the state of Manipur (Barraud, 1934 ; Christophers, 1933 ; Covell, 1927, 1931 ; Puri, 1936 ; Mortimer, 1946 and Malhotra *et al.*, 1983) did not include genera *Mimomyia*, *Tripteroides*, and *Uranotaenia*, while the genera *Mansonia* and *Coquillettidia* are represented each by single species (Malhotra *et al.*, 1983).

The present communication includes the distribution records for these genera in the State of Manipur. The surveys for the present distribution records were made during 1983 to 1985. The collection procedure, rearing and identification technique, description of area & climate, have already been described earlier (Rajput and Singh, 1986).

COLLECTION RECORDS

1. *Mimomyia luzonensis* (Ludlow)

O'Reillia luzonensis Ludlow, 1905, *Can. Ent.* **37** : 101 ; Barraud, 1934 : 113-115 ; Knight and Stone, 1977 : 248.

This species is Oriental in distribution. It has been recorded from Manipur, Tamil Nadu, Uttar Pradesh and West Bengal.

Present records : Manipur : *Chingmeirong* (785 m.) — 18♂♂, 6♀♀ (18 Sept. '83 — 29 Nov. '83), 14♂♂, 4♀♀ (27 Jul. '84 — 14 Oct. '84) were collected from *Quercus acutissima* plantation. *Khongampat* (785 m.) — 12♂♂, 4♀♀ (27 Nov. '83), 2♂♂ (12 Aug. '84 — 16 Dec. '84) from herb vegetation. *Mantripukhri* (785 m.) — 2♂♂ (13 Nov. '83 — 19 Nov. '83) from bulb-light.

Present address : Central Tasar Research & Training Institute, Basic Seed Multiplication & Training Centre, Kumarganj, Faizabad (U.P.) 224229 INDIA..

2. *Mimomyia chamberlaini* Ludlow

Mimomyia chamberlaini Ludlow, 1904, *Can. Ent.* **36** : 297 ; Barraud, 1934 : 108-111 ; Knight and Stone, 1977 : 285.

The species is known from Oriental region and recorded from all over India.

Present records : Manipur : Chingmeirong (785 m.) : 2 ♂♂, 1 ♀ (17 Oct. '83) larvae reared from a pond, 5 ♂♂, 13 ♀♀ (29 Nov. '83 — 25 Dec. '83), 10 ♀♀ (22 Jan. '84) from *Quercus acutissima* plantation, 6 ♀♀ (7 Jan. '84) from herb vegetation. Associated breeder was *Anopheles gigas*.

3. *Mimomyia hybrida* (Leicester)

Conopomyia hybrida Leicester, 1908, *Cul. Malaya* : 115 ; Barraud, 1934 : 111-113 ; Knight and Stone, 1977 : 286.

This is an Oriental species recorded from Assam, Bihar, Manipur and West Bengal in India.

Present records : Manipur : Chingmeirong (785 m.) — 3 ♂♂, 1 ♀ (2 Oct. '83 — 14 Oct. '83), 3 ♂♂ (13 Jul. '84 — 14 Oct. '84) from *Quercus acutissima* plantation. Jiribam (150 m.) — 1 ♀ (7 Oct. '84) from Banana (*Musa balbisiana*) groves. Mantripukhri (785 m.) — 1 ♀ (20 Nov. '83) from bulb — light.

4. *Coquillettidia crassipes* (van der Wulp)

Culex crassipes Van der Wulp, 1881, *Nat. Hist.* : 9 ; Knight and Stone, 1977 : 290.

The species is known to be distributed in Oriental, Palaearctic and Australian region. Recorded from all over India.

Present records : Manipur : Beru-Khudom (1,200 m.) — 4 ♂♂, 1 ♀ (23 Oct. '85) from shrubby vegetation. Chandel (1,500 m.) — 7 ♂♂, 11 ♀♀ (22 Oct. '85) from mixed vegetation in forest. Chingmeirong (785 m.) — 1 ♀ (14 Oct. '83) from shrubby vegetation, 1 ♀ (14 Apr. '84) from herb vegetation, 41 ♂♂, 10 ♀♀ (27 Jun. '84 — 14 Oct. '84) were collected from shrubby vegetation of *Quercus acutissima*. Geljang (820 m.) — 1 ♀ (27 Nov. '84) from shrubby forest of *Lithocarpus dealbata*. Khongampat (785 m.) — 1 ♂ (12 Aug. '84), from herb vegetation. Kwakta (760 m.) — 4 ♂♂, 1 ♀ (8 Oct. '83) from shrubby plantation of mulberry. Langol-hill (785 m.) — 1 ♂ (29 Jul. '84) from pit-shelter. Mantripukhri (785 m.) — 1 ♂ (11 Oct. '83), 1 ♂, 6 ♀♀ (27 Jul. '84 — 21 Oct. '84) from bulb — light. Modikhul (1,150 m.) — 2 ♂♂, 1 ♀ (23 Oct. '85) from herb vegetation. Moltam-hill (820 m.) — 1 ♂ (1 Nov. '84) from shrubby forest. Moreh (150 m.) — 1 ♂ (19 Aug. '84) from shrub vegetation. Pheidinga (900 m.) — 1 ♂ (12 Aug. '84) from shrubby vegetation. Zaphou (1,000 m.) — 1 ♀ (21 Oct. '85) from herb vegetation, 36 ♀♀ (21 Oct. '85 — 22 Oct. '85) from human-bait.

5. *Mansonia annulifera* (Theobald)

Panoplitus annulifera Theobald, 1901, *Monogr. Cul.* **2** : 183, Barraud, 1934 : 127-128 ; Knight and Stone, 1977 : 297.

The distribution of the species is known from Oriental region extending upto New Guinea in Australian region. Recorded from all over India except some

western states viz., Gujarat, Rajasthan, Punjab, Harayana, Himachal Pradesh and Jammu & Kashmir.

Present records : Manipur : *Mantripukhri* (785 m.) — 1 ♀ (21 Nov. '83) from cattle-shed ; 4 ♀♀ (9 Aug. '84 — 13 Oct. '84) from bovine-baits.

6. *Mansonia indiana* Edwards

Mansonia indiana Edwards, 1930, *Bull. Ent. Res.* 21 : 541. Barraud, 1934 : 130-131 ; Knight and Stone, 1977 : 297.

Distributed in Oriental region and New Guinea. In India recorded from Assam, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Tamil Nadu and West Bengal.

Present records : Manipur : *Chingmeirong* (785 m.) — 12 ♀♀ (11 Sept. '83 — 6 Nov. '83), 17 ♀♀ (27 Jun. '84 — 13 Sept. '84) were collected from day-biting, 9 ♂♂, 13 ♀♀ (18 Sept. '83 — 4 Dec. '83), 1 ♀ (9 Jun. '84), 1 ♀ (28 Jul. '84), 2 ♀♀ (8 Aug. '84), 4 ♂♂, 16 ♀♀ (9 Aug. '84 — 14 Oct. '84) from shrubby vegetation. *Khongampat* (785 m.) — 1 (27 Nov. '83) from herb vegetation. *Langol-hill* (785 m.) — 5 ♂♂ (29 Jul. '84) from pit — shelter. *Mantripukhri* (785 m.) — 6 ♀♀ (2 Oct. '83 — 21 Nov. '83), 2 ♀♀ (10 Jul. '84 — 15 Sept. '84) from cattle-sheds, 1 ♀ (21 Oct. '83) from shrubby vegetation, 1 ♂, 25 ♀♀ (23 Oct. '83 — 15 Nov. '83) 2 ♂♂, 134 ♀♀ (8 Apr. '84 — 14 Oct. '84) from human-bait, 4 ♀♀ (14 Nov. '83 — 26 Nov. '83), 25 ♂♂, 116 ♀♀ (24 Apr. '84 — 29 Oct. '84) from bovine-baits, 5 ♀♀ (27 Jun. '84 — 14 Oct. '84) from bulb-light.

7. *Mansonia uniformis* (Theobald)

Panoplitis uniformis Theobald, 1901, *Monogr. Cul.* 2 : 180; Barraud, 1934 : 129-130; Knight and Stone, 1977 : 297.

This has been recorded from Ethiopian, Oriental and Australian regions, last to Bismarks, Japan and Ryukyu-Retto. Recorded from all over India.

Present records : Manipur : *Bungmul* (850 m.) — 2 ♀♀ (27 Nov. '84) from herb-vegetation. *Chandel* (1,500 m.) — 1 ♀ (22 Oct. '85) from shrubby vegetation. *Chingmeirong* (785 m.) — 1 ♂, 4 ♀♀ (11 Sept. '83), 15 ♀♀ (13 Jul. '84 — 14 Oct. '84) from human-bait during day in *Quercus acutissima* plantation, 9 ♂♂, 6 ♀♀ (18 Sept. '83 — 4 Dec. '83), 9 ♂♂, 14 ♀♀ (9 Jun. '84 — 14 Oct. '84) from shrubby vegetation. *Jiribam* (1,500 m.) — 2 ♀♀ (7 Oct. '84) from bovine-bait, *Kanglatongbi* (1,000 m.) — 1 ♀ (12 Aug. '84) from herb vegetation. *Khongampat* (785 m.) — 1 ♀ (27 Nov. '83), 1 ♂ (12 Aug. '84) from herb vegetation. *Kwakta* (760 m.) — 4 ♂♂, 2 ♀♀ (8 Oct. '83), from shrubby vegetation. *Langol-hill* (785 m.) — 18 ♂♂, 3 ♀♀ (29 Jul. '84) from pit-shelters. *Mantripukhri* (785 m.) — 18 ♀♀ (19 Sept. '83 — 23 Nov. '83), 5 ♀♀ (26 Jul. '84 — 22 Aug. '84) from cattle-sheds, 3 ♀♀ (21 Oct. '83) from shrubby vegetation, 1 ♂, 28 ♀♀ (23 Oct. '83 — 15 Nov. '83), 1 ♂, 38 ♀♀ (25 Apr. '84 — 14 Oct. '84) from human-bait, 4 ♂♂, 9 ♀♀ (14 Nov. '83 — 26 Nov. '83), 2 ♂♂, 154 ♀♀ (4 Apr. '84 — 28 Oct. '84) from bovine-bait, 1 ♀ (7 Nov. '83), 3 ♂♂, 4 ♀♀ (27 Jun. '84 — 15 Aug. '84) from bulb-light. *Moltam-hill* (820 m.) — 1 ♀ (1 Nov. '84) from day-biting. *Phedinga* (900 m.) — 1 ♂, 1 ♀ (12 Aug. '84) from shrubby vegetation. *Zaphou* (1,000 m.) — 8 ♀♀ (21 Oct. '85 — 22 Oct. '85) from human-bait.

8. *Tripteroides indicus* (Barraud)

Rachionotomyia indicus Barraud, 1929, *Indian J. med. Res.* 16 : 1061.

The species has been recorded from Burma, Celebes, India and Thailand. It is known from Assam, Manipur, Meghalaya and West Bengal in India.

Present records : Manipur : Nungba (750 m.) — 1 ♀ (8 Oct. '84) from day-biting.

9. *Uranotaenia bicolor* Leicester

Uranotaenia bicolor Leicester, 1908, *Cul. Malaya* : 225 ; Barraud, 1934 : 83; Stone *et al.* 1959 : 110; Knight and Stone, 1977 : 339.

The species is known from Hainan Islands, India and Malaysia. In India, recorded from Karnataka and Manipur.

Present records : Manipur : Mantripukhri (785 m.) — 1 ♀, 1 ♂ (12 Nov. '83) from light during night.

10. *Uranotaenia bimaculata* Leicester

Uranotaenia bimaculata Leicester, 1908, *Cul. Malaya* : 226 ; Barraud, 1934 : 78-79 Knight and Stone, 1977 : 340.

The species is known from India and Malaysia. Recorded from Manipur and West Bengal in the country.

Present records : Manipur : Mao (1,850 m.) — 1 ♂ (8 Sept. '85) larva was reared from a discarded motor-tyre. Associated breeders were *Culex harrisoni* and *C. pallidothorax*.

11. *Uranotaenia recondita* Edwards

Uranotaenia recondita Edwards, 1922, *Bull. Ent. Res.* 13 : 91 ; Barraud, 1934 : 83-84; Knight and Stone, 1977 : 344.

The species has its distribution in Hainan Island, India, Sri Lanka and Thailand. In India, it has been recorded from Andhra Pradesh, Bihar, Karnataka, Madhya Pradesh, Manipur and Tamil Nadu.

Present records : Manipur : Khongampat (785 m.) — 1 ♀ (27 Nov. '83) from herbs below trees.

12. *Uranotaenia edwardsi* Barraud

Uranotaenia edwardsi Barraud, 1926, *Ind. Journ. Med. Res.* 14 : 337 ; Barraud, 1934 : 65-66; Knight and Stone 1977 : 348.

This species has its distribution in Hainan Islands, India, Malaya and Thailand. Recorded from Assam, and Manipur in the country.

Present records : Manipur : Mantripukhri (785 m.) — 2 ♂♂, 4 ♀♀ (11 Oct. '83 19 Nov. '83), 2 ♀♀ (15 Aug. '84 — 20 Oct. '84) collected from bulb-light.

13. *Uranotaenia campestris* Leicester

Uranotaenia campestris Leicester, 1908, *Cul. Malaya* : 213 ; Barraud, 1934 : 68 ; Stone *et al.* 1959 : 111; Knight and Stone, 1977 : 347.

This is an Oriental species recorded from Assam, Bihar, Delhi, Manipur and

Uttar Pradesh in India.

Present records : Manipur : *Chingmeirong* (785 m.) — 1 ♂, 1 ♀ (14 Oct. '84 — 30 Oct. '85) from shrubby vegetation of *Querus acutissima*. *Jiribam* (150 m.) — 1 ♀ (7 Oct. '84) from shrubby vegetation.

14. *Uranotaenia macfarlanei* Edwards

Uranotaenia macfarlanei Edwards, 1914, *Bull. Ent. Res.* 5 : 127 ; Barraud, 1934 : 70-71; Knight and Stone, 1977 : 350.

The species has its distribution range in Oriental, south western and southern Palaearctic region. In India, it is known from Assam and Manipur only.

Present records : Manipur : *Geljang* (850 m.) — 1 ♂, 1 ♀ (27 Nov. '84) from shrubby forest of *Lithocarpus dealbata*.

SUMMARY

The present paper includes distribution record for *Mimomyia luzonensis*, *M. chamberlaini*, *M. hybrida*, *Coquillettidia crassipes*, *Mansonia annulifera*, *M. indiana*, *M. unitormis*, *Tripteroides indicus*, *Uranotaenia bicolor*, *U. bimaculata*, *U. recondita*, *U. edwardsi*, *U. campestris*, and *U. mactarlanei* in the Manipur. Except *Coquillettidia crassipes* and *Mansonia uniformis* all other species are recorded for the first time from the State. The larval associates were also noted for the species which were reared from larval collection.

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FISH FAUNA OF DISTRICT SAHARANPUR (UTTAR PRADESH) WITH NOTES ON ECOLOGY AND ZOOGEOGRAPHY

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INTRODUCTION

Saharanpur district is an important geographical area which presents a variety of topographical realms, comprising nontane, submontane and plain areas. The area is contained within the parallels of 29°34' and 30°24' north latitude and of 77°7' and 78°12' east longitude. Ganga and Yamuna reivers form the east and west boundaries of the district, while it is surrounded by Siwalik hills on its northern side, extending in south east direction upto Hardwar, a distance of about 62 kms. Muzaffarnagar district is situated on its southern side. The length and width of the district are nearly 104 and 90 kilometres respectively. On either side of two main rivers of the district, there is a broad and low lying valley full of swamps, in addition to grassy plains and forests. The hills are abrupt and rugged on its southern side, but has a small slope towards north. Sal, Sain, Chir, Sheesham, Eucalyptus, Zizyphus trees are mostly found in the hills. The important peaks in the district are Mohund Pass 2916 feet, Doiwala peak 2947, Sahansra 3011, Bahansia 3059 and Amsot 3140 feet.

The fish fauna of this district has considered ecological and zoogeographically very important. The various varieties of ecological niches contribute to the great variety of fish fauna. Hugh Falconer (1868) named a small fish from the district as *Esox hindustanicus* which was later on identified as *Xenentodon cancila*. This reference was forgotten for almost a centurey when Myer's (1960) pointed out the existence of this reference about a fresh water belonid fish. So far, 39 species have been recorded from the district by Day (1875-78), Fowler (1924) and Husain (1975). Tilak and Husain (1974, 1980) have described new species from the district such as *Laguvia riberiroi kapuri*, and *Psilorhynchus sucatio nudithoracisus* and discovered the distribution of eastern Indian forms in the streams of this area and confirmed their taxonomic status. The present authors have collected, studied and identified 86 species from the district, thus adding 47 species to the fish fauna already known through literature. These species belong to 48 genera, 18 families and 7 orders, which are categorised according to the most recent classification available in the literature.

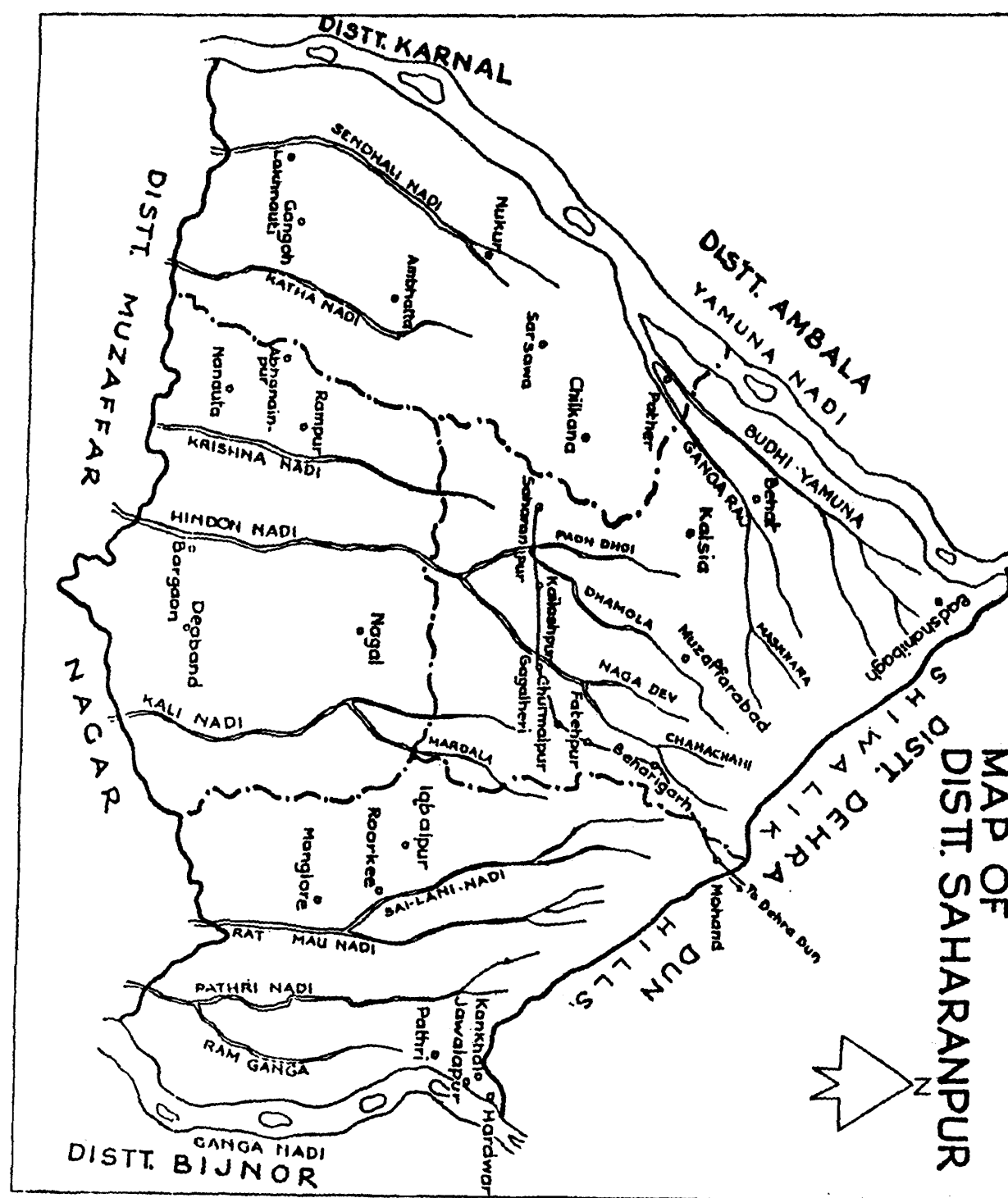


Fig. 1. Map of Distt. Saharanpur (Uttar Pradesh).

MATERIAL COLLECTED.

The collection was made from the Ganga and the Yamuna rivers bordering the eastern and western boundary of the district besides rivers, streams such as Ram Ganga, Ganga Rao, Pathri, Ratmau, Sailani, Kali Hindon, Krishna, Katha, Sendhali, Budhi Yamuana, Maskhara, Dhamola, Paondhoi, Chahachahi and Nagadev as depicted in the Map (Fig. 1). Besides this, collection has also been made from the various ponds, seasonal streams and ditches in the district during the last four years duration in all seasons. The fishes were collected with the help of cast net, hand net, drag net, sweep net etc.

SYSTEMATIC LIST OF FISHES

Class	PISCES
Sub class	Teleostomi
Cohort	ARCHAEOPHYLACES
Superorder	OSTEOGLOSSOMORPHA
Order	OSTEOGLOSSIFORMES
Family	NOTOPTERIDAE
Genus	Notopterus Lacepede

1. *Notopterus chitala* (Hamilton)
2. *Notopterus notopterus* (Pallas)

Cohort	EUTELEOSTEI
Superorder	OSTARIOPHYSI
Order	CYPRINIFORMES
Subfamily	SCHIZOTHORACINAE
Genus	Schizothorax Heckel

3. *Schizothorax richardsonii* (Gray)

Genus	Schizothoraichthys Misra

4. *Schizothoraichthys (Racoma) progastus* (McClelland)

Subfamily	RASBORINAE
Genus	Amblypharyngodon Bleeker

5. *Amblypharyngodon mola* (Hamilton)

Genus	Aspidoparia Heckel

6. *Aspidoparia jaya* (Hamilton)
7. *Aspidoparia morar* (Hamilton)

Genus **Barilius** Hamilton

- 8. *Barilius barila* Hamilton
- 9. *Barilius barna* Hamilton
- 10. *Barilius bendelisis* Hamilton
- 11. *Barilius shacra* Hamilton
- 12. *Barilius vagra* Hamilton

Genus **Raiamas** Jordan

- 13. *Raiamas bola* Hamilton

Genus **Brachydanio** Weber and Beaufort

- 14. *Brachydanio rerio* (Hamilton)

Genus **Danio** Hamilton

- 15. *Danio devario* Hamilton

Genus **Esomus** Swainson

- 16. *Esomus danricus* (Hamilton)

Genus **Parluciosoma** Howes

- 17. *Parluciosoma daniconius daniconius* (Hamilton)

Subfamily **CULTRINAE**

Genus **Chela** Hamilton

- 18. *Chela (Chela) cashius* Hamilton
- 19. *Chela (Chela) laubuca* Hamilton

Genus **Salmostoma** Swainson

- 20. *Salmostoma bacaila* (Hamilton)

Subfamily **CYPRININAE**

Genus **Catla** Valenciennes

- 21. *Catla catla* (Hamilton)

Genus **Chagunius** Smith

22. *Chagunius chagunio* (Hamilton)Genus **Cirrhinus** (Oken) Cuvier23. *Cirrhinus mrigala* (Hamilton)24. *Cirrhinus reba* (Hamilton)Genus **Labeo** Cuvier25. *Labeo calbasu* (Hamilton)26. *Labeo dero* (Hamilton)27. *Labeo dyocheilus* McClelland28. *Labeo gonius* (Hamilton)29. *Labeo pangusia* (Hamilton)30. *Labeo rohita* (Hamilton)Genus **Osteobrama** Hecrel31. *Osteobrama cotio* (Hamilton)Genus **Oriechthys** Smith32. *Oriechthys cosuatis* (Hamilton)Genus **Puntius** Hamilton33. *Puntius carletone* Fowler34. *Puntius chola* Hamilton35. *Puntius conchonus* Hamilton36. *Puntius sarana sarana* Hamilton37. *Puntius sophore* Hamilton38. *Puntius terio* Hamilton39. *Puntius ticto* HamiltonGenus **Tor** Gray40. *Tor putitora* (Hamilton)41. *Tor tor* (Hamilton)Subfamily **GARRINAE**Genus **Crossocheilus** Van Hasselt

42. *Crossocheilus latius* (Hamilton)Genus **Garra** Hamilton43. *Garra gotyla gotyla* (Gray)Family PSILORHYNCHIDAE
Genus **Psilorhynchus** McClelland44. *Psilorhynchus sucatio nudithoracicus* Tilak and HusainFamily HOMALOPTERIDAE
Subfamily NOEMACHEILINAE
Genus **Noemacheilus** Van Hasselt45. *Noemacheilus denisoni denisoni* Day46. *Noemacheilus botia* (Hamilton)47. *Noemacheilus corica* (Hamilton)48. *Noemacheilus montanus* (McClelland)49. *Noemacheilus rupecula* (McClelland)Family COBITIDAE
Subfamily BOTIINAE
Genus **Botia** Gray50. *Botia lohachata* ChaudhuriSubfamily COBITINAE
Genus **Lepidocephalus** Bleeker51. *Lepidocephalus (Lepidocephalichthys) annandalie* Chaudhuri52. *Lepidocephalus (Lepidocephalichthys) caudofurcatus* Tilak and Husain53. *Lepidocephalus (Lepidocephalichthys) guntea* (Hamilton)Order SILURIFORMES
Family BAGRIDAE
Genus **Mystus** Scopoli54. *Mystus bleekeri* (Day)55. *Mystus cavassius* (Hamilton)56. *Mystus vittatus* (Bloch)Genus **Pseudeutropius** Bleeker

57. *Pseudeutropius atherinoides* (Bloch)Genus **Aorichthys** Wu58. *Aorichthys seenohala* (Sykes)Genus **Rita** Bleeker59. *Rita rita* (Hamilton)Family **SILURIDAE**Genus **Ompok** Lacépède60. *Ompok bimaculatus* (Bloch)Genus **Wallago** Bleeker61. *Wallago attu* (Schneider)Family **SISORIDAE**Genus **Bagarius** Bleeker62. *Bagarius yerrellii* SykesGenus **Gagata** Bleeker63. *Gagata cenia* (Hamilton)Genus **Glyptothorax** Blyth64. *Glyptothorax pectinopterus* (McClelland)65. *Glyptothorax saisii* (Jenkins)66. *Glyptothorax telchitta* (Hamilton)Genus **Laguvia** Hora67. *Laguvia ribeiroi kapuri* Tilak and HusainFamily **SCHILBEIDAE**Subfamily **SCHILBEINAE**Genus **Clupisoma** Swainson68. *Clupisoma garua* (Hamilton)Family **AMBLYCIPITIDAE**Genus **Amblyceps** Blyth

69. *Amblyceps mangois* (Hamilton)

Family	CLARIIDAE
Genus	Clarias Scopoli

70. *Clarias batrachus* (Linnaeus)

Family	HETEROPNEUSTIDAE
Genus	Heteropneustes Mueller

71. *Heteropneustes fossilis* (Bloch)

Super order	ATHERINOMORPHA
Order	ATHERINIFORMES
Family	BELONIDAE
Genus	Xenentodon Regan

72. *Xenentodon cancila* (Hamilton)

Order	CHANNIFORMES
Family	CHANNIDAE
Genus	Ophiocephalus Bloch

73. *Ophiocephalus gachua* Hamilton74. *Ophiocephalus marulius* Hamilton75. *Ophiocephalus punctatus* (Bloch)76. *Ophiocephalus striatus* (Bloch)

Order	PERCIFORMES
Family	NANDIDAE
Genus	Nandus Valenciennes

77. *Nandus nandus* (Hamilton)

Subfamily	BADINAE
Genus	Badis Bleeker

78. *Badis badis* (Hamilton)

Family	BELONTIDAE
Subfamily	TRICHOGASTRINAE
Genus	Colisa Cuvier

79. *Colisa fasciatus* (Schneider)80. *Colisa lalius* (Hamilton)

Family CHANDIDAE
Genus **Chanda** Hamilton

- 81. *Chanda ranga* Hamilton
- 82. *Chanda nama* Hamilton

Family GOBIIDAE
Subfamily GOBINAE
Genus **Glossogobius** Gill

- 83. *Glossogobius qutum* (Hamilton)

Order MASTACEMBELIFORMES
Family MASTACEMBELIDAE
Genus **Mastacembelus** Scopoli

- 84. *Mastacembelus armatus* (Lacépède)
- 85. *Mastacembelus pancalus* (Hamilton)

Genus **Macrogathus** Lacépède

- 86. *Macrogathus aculeatus* (Bloch)

Note :- Besides, those species which are recorded in this paper, there are two species i.e. *Pseudogaster gora* (Hamilton) and *Salmostama phulo* (Hamilton) which are also likely to occur in the district according to local information but could not be collected for study hence included in the key to the identification of the fishes.

KEY FOR THE IDENTIFICATION OF THE FISHES OF SAHARANPUR DISTRICT (U.P.)

- 1. The maxilla forms the gape of the mouth ; the pterygoid teeth developed ; swim bladder connected to otic region (Otophysic connection) without intercalation of bony elements ; hypurals supported on 1-5 centra (Taeniopaedia and Archaeophylaces) (2)
The maxilla completely or partially excluded from the gape of the mouth by the pre-maxilla ; pterygoid teeth absent ; swim bladder connected to otic region (Otophysic connection) involving in many cases the intercalation of bony elements ; hypurals supported on a half centrum . . . (Euteleostei) (3)
- 2. Opercular scales much larger than those on body ; maxille not extending beyond the hind edge of the orbit ; no black spot at the tail ; dorsal part of body less humped ; 28-33 scutes along the abdominal edge (Notopterus notopterus (Pallas)

Opercular scales not larger than those on the body ; maxilla extending far beyond the hind edge of the orbit ; a few black spots at the tail end ; dorsal part of body much humped ; 50-51 scutes along abdominal edge

Notopterus chitala (Hamilton)

3. The anterior vertebrae modified to form the weberian apparatus. . . .
Ostariophyceae (4)

The anterior vertebrae not modified to form the weberian apparatus
(82)

4. Body with scales (Cycloid) Cypriniformes (5)

Scales usually absent except in some forms, where they are modified to form bony plates Siluriformes (63)

5. Pectoral with more than one or two unbrached rays ; mouth always ventral *Psilorhynchus sucatio nudithoracicus* Tilak & Husain

Pectoral with one or rarely a second rudimentary unbranched ray ; mouth dorsal, terminal or ventral (6)

6. Barbels one to two pairs or absent ; No sub-ocular spine ; mouth terminal or inferior ; gill openings wide ; scales generally large ; eyes never covered with skin Cyprinidae (7)

Barbels 3-4 pairs ; sometimes with a simple or bifid movable spine present in a groove before or below the eye ; mouth inferior ; gill openings small or moderate ; scales small or rudimentary ; eyes sometimes covered with skin Cobitidae

7. Scales always small in size or absent ; anal sheath covered with enlarged tile like scales Schizothoracinae (54)

Scales may be small or big but always present ; anal without enlarged scales (8)

8. Abdomen round or flat ; dorsal fin not in the posterior half of body Rasborinae (13)

Abdomen or part of it keeled but not serrated ; dorsal fin always in the posterior half of the body Cultrinae (9)

9. Pelvic fins originate nearer to pectoral base than to anal base ; outer pelvic rays produced ; predorsal scales do not extend to the inter-orbital space ; lateral line abruptly curved downwards above the pectoral fin

Chela Hamilton. (10)

Pelvic fins originate nearer to anal base than to pectoral base ; outer pelvic rays not produced ; predorsal scales extend to the inter-orbital space ; lateral line gently curves down above the pectoral ; a knob at the symphysis of lower jaw fitting into a corresponding depression in the upper jaw present (11)

10. Lateral line scales 51-56 ; predorsal scales 23-29 ; no shoulder spot present *Chela (chela) cachi* Hamilton

Lateral line scales 34-37 ; predorsal scales 15-20 ; a dark shoulder spot

- present *Chela (Chela) laubuca* Hamilton
11. Bones of pectoral girdle support the edge of the hardened and muscular thorax ; lateral line scales more than 100 ... *Pseudogaster gora* (Hamilton)
Bones of pectoral girdle do not support the edge of the thorax ; lateral line scales less than 100 *Salmostoma* Swainson (12)
12. 16-18 branched rays in the anal fin ; lateral line scales 80-87
..... *Salmostoma phulo* (Hamilton)
11-13 branched rays in the anal fin ; lateral line scales more than 85
..... *Salmostoma bacaila* (Hamilton)
13. Origin of dorsal fin nearly opposite the ventral fin or a little before ... (27)
Origin of dorsal fin clearly behind the ventral fin (14)
14. Lateral line incomplete *Amblypharyngodon mola* (Hamilton)
Lateral line complete (15)
15. Dorsal fin does not extend to above the anal fin ; anal fin with 5-11 branched rays (16)
Dorsal fin generally extending over the anal ; anal fin with 7-33 branched rays (19)
16. A symphysial knob present in the lower jaw fitting into the upper jaw ; mouth oblique ; both lips present (18)
Abdomen or part of it keeled but not serrated ; dorsal fin always in posterior half of the body (17)
17. 8-10 branched rays in the anal fin ; lateral line scales 38-42
..... *Aspidoparia morar* (Hamilton)
7 branched rays in the anal fin ; lateral line scales 52-60
..... *Aspidoparia jaya* (Hamilton)
18. Barbels absent *Parluciosoma daniconius daniconius* (Hamilton)
Maxillary barbels very long *Esomus danricus* (Hamilton)
19. Anal fin long (25-38) rays ; body laterally much compressed
..... *Osteobrama cotio* (Hamilton)
Anal fin short (7-15 rays) ; body not so much laterally compressed ... (20)
20. Sub-orbital ring of bones distinctly broad and prominent ; cleft of the mouth often extending beyond anterior margin of eye ; mandibles rather broad (21)
Sub-orbital ring of bones not broad ; cleft of mouth extending beyond anterior margin of eye ; Jaws compressed *Barilius* Hamilton (22)
21. Dorsal fin with 7 branched rays ; anal with 11-13 rays
..... *Brachydanio rerio* (Hamilton)
Dorsal fin with more than 7 branched rays ; anal fin with 14-19 rays

- *Danio devario* Hamilton
22. Cleft of the mouth extending beyond the post-orbital margin *Raiamas hola* (Hamilton)
Cleft of the mouth not extending beyond the post-orbital margin (23)
23. Cleft of the mouth extending upto below the middle of the orbit *Barilius vagra* Hamilton
Cleft of the mouth extending upto below the anterior third of the orbit ... (24)
24. Anal fin with 7-8 branched rays (25)
Anal fin with 10-13 branched rays (26)
25. Lateral line with 60-70 scales ; lateral transverse 10-11/9 ; sexual dimorphism not well marked *Barilius shacra* Hamilton
Lateral line with 40-43 scales ; lateral transverse 7-8/5 ; sexual dimorphism well marked (male with prominent pectoral fins and colour) *Barilius bendelisis* Hamilton
26. 16 rows of scales before the dorsal fin ; no barbels present *Barilius berna* Hamilton
18 rows of scales before the dorsal fin ; only a small rostral pair of barbels present *Barilius barila* Hamilton
27. Upper lip separated from the skin of the snout by a deep groove ; lower lip without a suctorial disc (29)
Upper lip continuous with the skin of the snout ; lower lip with or without a suctorial disc (28)
28. Upper and lower lips continuous at the angles of the jaws ; lower lip with a suctorial disc *Garra gotyla gotyla* (Gray)
Upper and lower lips not continuous ; lower lip without a suctorial disc *Crossocheilus latius* (Hamilton)
29. The last undivided ray of the anal fin posteriorly serrated (30)
The last undivided ray of the anal fin unserrated (33)
30. Dorsal fin long (with more than 15 rays) (31)
Dorsal fin short (with less than 15 rays) (32)
31. Head with four barbels *Cyprinus carpio* Linnaeus
- 31.a Scales on the body irregular, large and fewer in number *Cyprinus carpiospecularis* Lacépède
- 31.b Body uniformly scaled ; scales of normal size and more in number *Cyprinus carpio commurs* Linnaeus
- 31.c Body partly or wholly devoid of scales *Cyprinus carpio nudus* Bloch
Head without barbels *Carassius carassius* (Linnaeus)

32. Body deep ; anal fin long ; dorsal fin slightly behind that of the pelvic fin
Hypophthalmichthys molitrix (Valenciennes)
 Body less deep ; anal fin short ; origin of dorsal fin before pelvic
Ctenopharyngodon idella (Valenciennes)
33. Upper lip absent *Catla catla* (Hamilton)
 Upper lip present (34)
34. A symphysial knob in the lower jaw present (35)
 No symphysial knob in the lower jaw (36)
35. Lateral line scales 35-38 ; dorsal fin rays 10-12 *Cirrhinus reba* (Hamilton)
 Lateral line scales 40-45 ; dorsal fin rays 15-16
Cirrhinus mrigala (Hamilton)
36. Lower lip with an inner transverse fold ; mouth inferior (37)
 Lower lip without an inner transverse fold ; mouth terminal (43)
37. Branched dorsal rays 11-18 (38)
 Branched dorsal rays 8-10 (42)
38. Head with four barbels (39)
 Head with two barbels (40)
39. Diameter of eye contained 4.5-5.5 times in the length of head
Labeo pangusia (Hamilton)
 Diameter of eye contained 6-9 times in the length of head
Labeo dyocheilus McClelland
40. A cartilaginous or horny covering over jaws present
Labeo gonius (Hamilton)
 A cartilaginous or horny covering over jaws absent (41)
41. Branched dorsal rays 13-15 ; colour uniformly dark
Labeo calbasu (Hamilton)
 Branched dorsal rays 12-13 ; colour brownish on back and silvery on sides
Labeo rohita (Hamilton)
42. A tubercle inside lower jaw present above the symphysis ; no horny covering on jaws
Labeo bata (Hamilton)
 No tubercles inside lower jaw above the symphysis ; both jaws covered with a horny layer
Labeo dero (Hamilton)
43. Lower lip with an uninterrupted posterior groove continuous around corners of mouth (44)
 Lower lip with posterior groove interrupted (46)
44. Lateral line complete; last undivided ray of dorsal fin ossified and simple barbels present (45)
 Lateral line incomplete, piercing only 6-7 anterior scales ; last undivided ray of

- dorsal fin simple and nonosseous ; barbels absent ; head with numerous pores mostly parallel in groups *Orieichthys cosuatis* (Hamilton)
45. Head length greater than the depth of the body ; fins yellow *Tor putitora* (Hamilton)
- Head length shorter than the depth of the body ; fins reddish *Tor tor* (Hamilton)
46. Snout with median and lateral lobes ; snout and cheeks beset with horny tubercles ; gill rakers a few, triangular ; branched dorsal rays 6 ; last anal ray elongated in male, normal in female ; barbels rostral and maxillary *Chagunius chagunio* (Hamilton)
- Snout entire ; snout and cheeks without horny tubercles ; gill rakers numerous, usually lanceolate ; branched dorsal rays 7-9 ; branched anal rays not elongated in males ; barbels four two or none *Puntius* Hamilton (47)
47. Barbels present (48)
- Barbels absent (49)
48. Four barbels ; last undivided ray of dorsal fin serrated, dorsal without colour markins *Puntius sarana sarana* Hamilton
- Two maxillary barbels ; last undivided ray of dorsal fin bony and smooth ; dorsal with colour spot *Puntius chola* Hamilton
49. Last undividual ray of drosal fin bony (50)
- Last undivided ray of dorsal fin articulated and weak (55)
50. The bony last undividual ray of dorsal fin smooth (51)
- The bony last undivided ray of dorsal fin posteriorly serrated (52)
51. Lateral line complete and with 23-36 scales a dark mark at the base of middle dordal rays ; a black spot at the end of lateral line *Puntius sophore* Hamilton
- Lateral line incomplete and with 21-23 scales ; dorsal rays without a mark ; a large black blotch above anal fin *Puntius terio* Hamilton
52. The dorsal spine dark stained ; a few dark spots at the base of anal fin present *Puntius carletoni* Fowler
- Neither dorsal spine stained nor anal base bears spots (53)
53. Depth of body 2.7-2.9 times in total length ; a spot on lateral side of the body near the base of caudal *Puntius conchoniis* Hamilton
54. Mouth ventral with a sharp edge ; a horny plate covers the lower jaw and a transverse labial papillated plate at the chin present *Schizothorax richardsonii* (Gray)
- Mouth terminal ; no horny plate or a papillated plate on the lower jaw or the chin ; lower labial groove continuous *Schizothoraichthys* (Racoma) *progastus* (McClelland)
55. An erectile spine present near the orbit *Botiinae* (56)
- Without any erectile spine near the orbit *Noemacheilus* Van Hasselt (59)
56. BOdy oblong ; eyes not covered with skin head without scales ; dorsal fin with 10-15 rays *Botia lohachatta* Chaudhuri

- Body elongated ; eyes covered with skin ; head with scales ; dorsal fin with 8-9 rays
Lepidocephalus (Lepidocephalichthys) (57)
57. Caudal forked or deeply emarginate whole of the lateral and ventral sides of head scaled
Lepidocephalus (Lepidocephalichthys) caudofurcatus Tilak & Husain
 Caudal convex cut square ; slightly emarginate or notched ; lateral and ventral sides of head naked (58)
58. Caudal fin notched or concavely lunate ; caudal fin obliquely banded with three faint grey bands on each side of the middle line ; two intensely dark spots encircled in white rims, one slightly above the middle of the base of caudal fin and the other at the notch present
Lepidocephalus (Lepidocephalichthys) annandalei Chaudhuri
 Caudal convex, cut square or slightly emarginate ; bands on caudal not oblique ; only one dark spot slightly above the middle of the base of caudal fin present
Lepidocephalus (Lepidocephalichthys) guntea (Hamilton)
59. Dorsal fin with 10-12 branched rays
Noemacheilus botia (Hamilton)
 Dorsal fin with 7-8 branched rays (60)
60. Third and fourth rays of pectoral fin produced and reach upto the ventrals
Noemacheilus corica (Hamilton)
 None of the rays of pectoral fin produced (61)
61. Scales absent on the anterior part of body ; head and anterior part of body somewhat depressed
Noemacheilus denisonii Day
62. 11-12 dark verticle bands on the body ; bands nearly three times as broad as the buff interspace
Noemacheilus montanus (McClelland)
 12-17 brown verticle bands, narrower than the intermediate ground space
Noemacheilus rupecula (McClelland)
63. Anal fin long (64)
 Anal fin short or of moderate length (67)
64. Dorsal fin spineless and long, has more than 30 rays
Clariidae ; Clarias batrachus (Linnaeus)
 Dorsal fin with or without a spine but short (65)
65. Dorsal fin with a spine ; either a second dorsal or an adipose fin present
Schilbeidae ; Clupisoma garua (Hamilton)
 Dorsal fin spineless ; neither a second dorsal nor an adipose dorsal fin present (66)
66. Two pairs of barbels present ; nasal barbels absent
Siluridae (69)
 Four pairs of barbels present ; nasal barbels present
Heteropneustidae ; Heteropneustes fossilis (Bloch)
67. Nostrils widely separated
Bagridae (70)
 Nostrils close together (68)
68. Lower surface of the head and body flat ; paired fins horizontal
Sisoridae (76)
 Lower surface of the head and body not greatly flattened ; paired fine

subhorizontal ; dorsal fin lies between bases of pectorals and ventrals ...
 Amblycipitidae ; *Amblyceps mangots* (Hamilton)

69. Eyes with a free orbital margin and lie above the level of the corner of the mouth and not visible from underside of head ; gape of mouth oblique, wide and very long reaching to or beyond anterior border of eye ; pectoral not reaching beyond origin of anal ... *Wallago attu* (Schneider)
 Eyes sub-cutaneous, lie posterior to the level of corner of mouth and visible from underside of head ; pectoral usually surpassing the origin of anal fin ; pectoral spine pectinate or smooth *Ompok bimaculatus* (Bloch)
70. Anal fin long *Pseudeutropius atherinoides* (Bloch)
 Anal fin short (71)
71. Six barbels ; eyes sub-cutaneous *Rita rita* (Hamilton)
 Eight barbels ; eyes with free orbital margins (72)
72. Interneural shield in between the occipital process and the basal bone of dorsal fin absetn *Mystus Scopoli* (73)
 Internueral shield present *Aorichthys seenghala* (Sykes)
73. Occipital process 1.5-2.0 times as long as wide at the base *Mytus bleekeri* (Day)
 Occipital process 3-5 times as long as wide at the base (74)
74. Maxillary barbels extend beyond pelvic fins (75)
 Maxillary barbels do not extend beyond pelvic fins ; lateral side of body with three longitudinal dark stripes *Mystus vittatus* (Bloch)
75. Occipital process 3.5-4.0 times as long as wide at the base. Maxillary barbels extend even beyond caudal base ; inter-orbital width 1.0-1.5 times in eye diameter *Mystus mendo* (Hamilton)
76. Head somewhat compressed and elevated (77)
 Head depressed (78)
77. Gill opening wide and gill membranes not or only slightly adherent in the skin of the isthmus ; dorsal rays 6-8 ... *Nangra viridescens* (Hamilton)
 Gill opening narrow and gill membranes confluent with the skin of the isthmus ; dorsal rays 6 *Gagata cenia* (Hamilton)
78. In the caudal region, the upper lobe or its rays significantly prolonged *Bagarius yarrellii* Sykes
 Caudal lobes not prolonged (79)
79. Humero-cubital and scapular process and bony tubercles on sides of the body present ; the adhesive apparatus on the chest not well developed *Laguvia ribeiroi kapuri* Tilak and Husain
 Humero-cubital and scapular process and bony tubercles on sides of the body absent ; the adhesive thoracic apparatus well marked ... *Glyptothorax* Blyth (80)
80. Skin coarsely tuberculated or denticulated adhesive thoracic aparatus prominent, elongated and without a central pit ; occipital process distinctly separated from the basal bone of the dorsal fin *Glyptothorax telchitta* (Hamilton)

- Skin granulated ; adhesive thoracic apparatus not very long (81)
81. Occipital process touching basal bone of dorsal ; adhesive thoracic apparatus broader than long or the breadth equal to its length
Glyptothorax pectinopterus (McClelland)
- Occipital process distinctly separated from basal bone of dorsal ; adhesive thoracic apparatus longer than broad *Glyptothorax saisii* (Jenkins)
82. Fishes of usually small size ; secondary sexual dimorphism pronounced ; branchiostegal rays 4-15 ; opercular bones unarmed ; or thoracic ; commonly viviparous ; ctenoid scales only in a few species
Atherinomorpha ; Atheriniformes ; *Xenentodon cancila* Hamilton
- Fishes of normal or large size ; secondary, sexual dimorphism not such pronounced ; branchiostegal rays 4 and the anterior hair, like branchiostegal rays may be present on ceratohyal ; opercular bones armed in many species ; pelvic fins, if present, thoracic or jugular ; vivipary, uncommon ; ctenoid scales common *Acanthopterygii* (83)
83. Head snake like ; supra branchial organs always present ; only one elongated dorsal fin present *Channiformes* (84)
- Head not snake like ; supra branchial organs absent except in anabantoidei ; dorsal fin normally short and second dorsal fin usually present
Perciformes (87)
84. 15-20 scales between the snout and the origin of dorsal fin ; 9-10 scales between the orbit and the angle of the preoperculum ; dorsal rays 37-55.
(85)
- 12-13 scales between the snout and the origin the dorsal fin ; 4-5 scales between the orbit and the angle of the preoperculum ; 37-45 rays in the dorsal fin
Ophiocephalus striatus (Bloch)
85. 18-20 scales between the snout and the origin of dorsal fin; 9 scales between the orbit and the angle of preoperculum; 37-45 rays in the dorsal fin
Ophiocephalus striatus (Bloch)
- 15-16 scales between the snout and the origin of dorsal fin; 10 scales between the orbit and the angle of preoperculum; 45-55 rays in the dorsal fin
Ophiocephalus riarulius Hamilton
86. Ventral fin 2/5th the length of pectoral ; dorsal fin with 32-37 rays ; pectoral fin with alternating orange and blue transverse bands in fresh specimens ; no bands on the body
Ophiocephalus gachua Hamilton
- Ventral fin 2/3rd-3/4th of the length of pectoral ; dorsal fin with 29-32 rays; pectoral without transverse bands and with uniform colouration; several bands or patches from back pass down the abdomen
Ophiocephalus punctatus (Bloch)
87. Body cylindrical and elongated *Mastacembelidae* (88)
- Body neither cylindrical nor much elongated (90)
88. Snout oblong, fleshy, concave beneath and transversely striated ; no preorbital spine ; a few white bordered black ocelli along the base of soft dorsal present
Macrognathus aculeatus (Bloch)

- Snout not transversely striated beneath ; a distinct preorbital spine present ;
no black ocellii along the soft dorsal (89)
89. Anal and dorsal fins confluent with the caudal
..... *Mastacembeus armatus* (Lacépède)
Anal and dorsal fins distinct from the caudal
..... *Mastacembelus pancalus* (Hamilton)
90. Pelvics united to form a sucking disc *Glossogobius gutum* (Hamilton)
Pelvics not united to form a sucking disc (91)
91. Accessory respiratory organs absent Percoidei (92)
Accessory respiratory organs present Anabantoidei : Belontiidei (95)
92. Spinous and soft dorsals connected at base (or separated) ; procumbent
spine before dorsal fin present ; caudal fin furcate ; scales cycloid ; dorsal
with 7 spines Centropomidae ; *Chanda* Hamilton (93)
Spinous and soft dorsal continuous ; no procumbent spine before dorsal fin ;
caudal fin entire ; dorsal with more than 7 spines (94)
93. Lower jaw with two pairs of large crooked caniniform teeth
..... *Chanda nama* Hamilton
No such teeth on the lower jaw, all teeth small and normal
..... *Chanda ranga* Hamilton
94. Hyomandibular does not articulate with the metapterygoid ; prevomer bears
teeth ; parietal and frontal crests are absent ; an ascending process of
premaxillary not reaching the frontal Badidae : *Badis badis* (Hamilton)
Hyomandibular articulates with the metapterygoids ; prevomer bears no
teeth ; parietal and frontal crests present ; a process of pre-maxillary reaches
the frontal Nandidae *Nandus nandus* (Hamilton)
95. Dorsal fin with 7-8 soft rays (96)
Dorsal fin with 9-13 soft rays *Colisa fasciatus* (Schneider)
96. A dark band from eye to the caudal base present .. *Colisa sota* (Hamilton)
Body vertically banded with scarlet and azure blue bands ; sexual dimorphism
very prominent *Colisa lalius* (Hamilton)

DISCUSSION

Zoogeographical Remarks :

The fish fauna of the district Saharanpur is of great zoogeographical importance. The species collected from the area can be categorised into three for zoogeographical studies.

I. Species endemic to district Saharanpur

- a) *Laguvia ribeiroi-kapuri* Tilak and Hussain
- b) *Psilorhynchus sucatio nudithoracicus* Tilak and Hussain

II. Species earlier recorded from Eastern India but now found in district Saharanpur

- a) *Glyptothorax saisii* (Jenkins)
- b) *Lepidocephalus (Lepidocephalichthys) annandalei* Chaudhuri

III. Species recorded from other parts of India

The remaining 82 species are widely distributed in many other States of India.

The presence of the species falling under category I and II above in Saharanpur district at the base of Western Himalayas in Uttar Pradesh indicates that the species got dispersed from east to west India during and earlier geological eras, most probably during pliocene or Pliocene. Due to differences in the ecological conditions of the habitat of the species i.e. *Laguvia ribeiroi kapuri* Tilak and Husain and *Psilorhynchus sucatio nudithoracicus* Tilak and Husain, in eastern India on one hand, and western part of India on the other and long separation from the parent stock, the species in district Saharanpur developed into different taxa.

Species Recorded from other parts of India

Among the species of this district, which are distributed in other parts of India also, *Schizothorax richardsonii* and *Schizothoraichthys (Racoma) progastus* are also important schizothoracids, which are governed by a different principal of fish distribution in India. Tilak (in press) while writing the fauna of India on schizothoracinae has remarked that the fishes of the subfamily schizothoracinae have infiltrated into the Indian sub continent from the adjoining Palaearctic region through Ladakh, Kashmir valley and further west across the Pir Panjal ranges to southern face of Himalaya. The distribution of *S. richardsonii* is interesting in this respect because the same species exist at an altitude of 4,000 metres in Jammu & Kashmir while on the south face of Himalaya, it is not recorded from above an altitude of 1,500 metres, suggesting that the existence of *S. richardsonii* in the streams on southern face of Himalaya is a subsequent introduction. This suggests that the route of migration of schizothoracids is from north (in the Palaearctic region) to the south (along the base of Himalaya in Oriental region). During the course of migration of Schizothoracids, the two species *Schizothorax richardsonii* and *Schizothoraichthys (Racoma) progastus* entered streams along Siwaliks in Saharanpur district.

From the foregoing discussion, it is clear that Saharanpur district appears to be the meeting point of the fish fauna from two directions, one from the eastern India and other from the Palaearctic region in the north. The fauna of district Saharanpur, therefore, has a great significance in the zoogeography of fish fauna of India as a whole and has been responsible for strongly supporting the modified hypothesis on the introduction of fish fauna into India.

Correlation of fish species with their Ecological conditions

District Saharanpur is clearly divisible into three ecological zones, viz., montanus,

submontanus and plains.

1. Montanus area :

The montanus area in Saharanpur district comprises the hills in Siwalik ranges, where the streams gather water from the springs and cascade down through the submontane region to plains. Because of the fast current and boulders, rooted and submerged or floating vegetation in the streams is absent. The pH of the water ranges between 7.35 — 7.90. The water has higher dissolved oxygen which ranges between 11.2 — 11.6 ppm and the water is clear and the turbidity is almost nil. The species such as *Glyptothorax pectinopterus* (McClelland), *Glyptothorax saisii* (Jenkins), *Barilius benedictis* Hamilton and *Barilius vagra* Hamilton, need higher dissolved oxygen to inhabit hill streams. These feed on food occurring in fast streams in between the boulders.

2. Submontanus area :

In the submontanus region along Siwalik ranges in district Saharanpur, the streams flow over stony bed which has a vast stretch and the soil is highly porous. As a result, the little amount of water in the streams normally seeps down into the earth and the streams in majority of the cases are dry throughout the year except during monsoon season, when some of the species which can enter regions of higher dissolved oxygen contents are also found. Such species are the following :

1. *Barilius benedictis* Hamilton
2. *Aspidoparia jaya* (Hamilton)
3. *Aspidoparia morar* (Hamilton)
4. *Glyptothorax telchitta* (Hamilton)
5. *Garra gotyla gotyla* (Gray)
6. *Crossocheilus latius* (Hamilton)
7. *Labeo dero* (Hamilton)
8. *Labeo dyocheilus* McClelland
9. *Amblyceps mangois* (Hamilton)
10. *Heteropneustes fossilis* (Bloch)

3. Plain Area :

The streams in the plains become slow and gradually harbour rooted, submerged and floating vegetation in addition to algae. The water in the streams has a pH range between 7.0 — 7.55, the temperature 20.9°C — 36.5°C and the dissolved oxygen 8.9 — 11.6 ppm.

In this region, there are a large number of ponds of various dimensions in which rooted and submerged, rooted and floating and floating type of vegetation are commonly found. Majority of the species in the plains find this habitat very convenient for living and breeding. All those species mentioned in the systematic list other than those mentioned above, are found in the plains.

The categorisation of the ecological niches in district Saharanpur such as the montanus, the submontanus and the plain areas are only roughly demarcated from one another. The ecological conditions of the two contiguous ecological niches merge and accordingly, there is a certain amount of intermingling of fish species of the two contiguous ecological niches. The species existing in the two

ends of the series i.e. the montanus on the one hand and the plains on the other differ greatly from each other because of the vast amount of differences in the ecological conditions of the two niches. The submontanus region on the other hand acts as a buffer zone between the montanus and the plain areas and this region is frequented by the species of both the montanus and the plain areas.

The ecological conditions, depicting three types of ecological zones, as remarked above, distinguish district Saharanpur from majority of the other areas, where such a ecological diversity does not exist. The study of the fish fauna of Saharanpur district is, therefore, very important from ecological point of view and should serve as a base for study of the fish fauna in relation to various ecological conditions elsewhere in the country.

The species of the montane and submontane region of the district represent 4.6% and 13.9% respectively, while the species inhabiting the plain area are represented by 81.5%.

SUMMARY

The Saharanpur district has been surveyed in montane, submontane and plain areas for four years, covering all seasons. More than 10,000 examples belonging to 86 species, 48 genera, 18 families and 7 orders have been collected. The species occurring in different zones have been analysed. A dichotomous key to the identification of species of the district is also given. The zoogeographical importance of fish taxa has been mentioned.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Zoological Survey of India, Calcutta for providing facilities to work and for encouragement.

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TAIL CARRIAGE IN THE HANUMAN LANGUR, *PRESBYTIS ENTELLUS*, IN SOUTHERN RAJASTHAN, INDIA

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INTRODUCTION

Tail carriage in primates has behavioural and evolutionary significance and also shows a considerable degree of geographical and subspecific variation (Roonwal 1984). The Hanuman langur, *Presbytis entellus* (Dufresne) (Cercopithecidae : Colobinae) is found all over south Asia (Pakistan, India, Nepal, Bangladesh and Sri Lanka), and has several subspecies. Its tail is long and rope-like, with a tassel of hair at the tip, it is usually a little longer than head-and-body together. Its mode of carriage has been studied in considerable detail by Roonwal (1979-1984), Roonwal and Makwana (1981), Roonwal and Pirta (missprint Prita) (1984), and Roonwal, Pirta and Saha (1984). Two main styles of tail carriage occur (Roonwal 1979a, 1981), viz., a northern (Type I, tail looped forward above the body) and a southern (Type II, tail away from the body). Two styles are geographically separated by a diagonal line (NW to SE) running approximately from 21°-22° N latitudes in the west (somewhere between Vadodara and Surat in Gujarat) to about 16°43' N latitude in the east (Roonwal 1984a, b ; Roonwal, Pirta and Saha 1984).

In the northern style again, two types occur, viz., (i) the tail tip reaching the back or even going well below the belly and forming a complete closed loop (Type IA) ; and (ii) the tail tip remaining well above the back (Type IB) in which case no closed loop is formed. Type IA is widespread, occurring all over the plains of northern India and Pakistan, while Type IB is mainly confined to Himalayan and sub-Himalayan regions but also found in Vadodara (Baroda) in Gujarat.

The object of the present paper is to determine the nature of the style in the districts of southern Rajasthan which lie only a little north of Vadodara. Further north, in Jodhpur and Ajmer Type IA prevails.

MATERIAL AND MATHODS

The four southern districts of Rajasthan, viz, Banswara, Dungarpur, Udaipur and Sirohi (latitudes 23°-26° N) were surveyed during May-June, 1987. A total of 46 groups of *Presbytis entellus entellus* were observed (for details of group-size, composition etc., see Tak, 1989). Field observations were made on individuals:

lateral photographs of tail carriage were utilised for calculating the loop index, position of tail tip, etc.

RESULTS AND DISCUSSION

(Table 1, Figure 1 and Plates 1,2)

Tail carriage :

Adults and subadults carry the tail in different situations as follows :— (i) In the relaxed state (standing or slow walk) the tail is looped forward (Type IA). (ii) Under stress (fast running or fighting), the tail loop partly or wholly unwounds and the tail acquires a bow shape and (iii) During rest (sitting on a tree branch or on the ground) either the tail hangs down limp or lies on the ground without any pattern.

Position of tail tip :

Out of 31 individuals (6 males, 25 females) observed in the relaxed state, in 65% of the cases the tail tip trails along the body-sides, either to the left or right, in 19% it remains above the back and in remaining 16% it reaches below the belly. Sex-wise, in majority of the males (66.6%) the tail-tip reaches below the belly, while in majority of females (72%) it remains on the belly.

Tail loop shape and index :

In the majority of the cases (94%), the loop shape observed is of the normal upright, forwardly directed, 'open' type (i.e. the tail does not cross at any point, as elucidates by Roonwal and Makawana, 1961) (Plate 2, Figs. 1&4). Only in two individuals (6%), a 'crossed' loop is recorded (Plate 2, Figs. 3). In the 31 cases analysed from photographs, the Loop Index (width/height of inside the loop) varies from 0.43-1.15, the majority (90%) being between 0.6 and 0.9 ; the loop thus tends to be rounded oval. In males, the mean loop index (0.71) is slightly higher than in females (0.63) (Table 1).

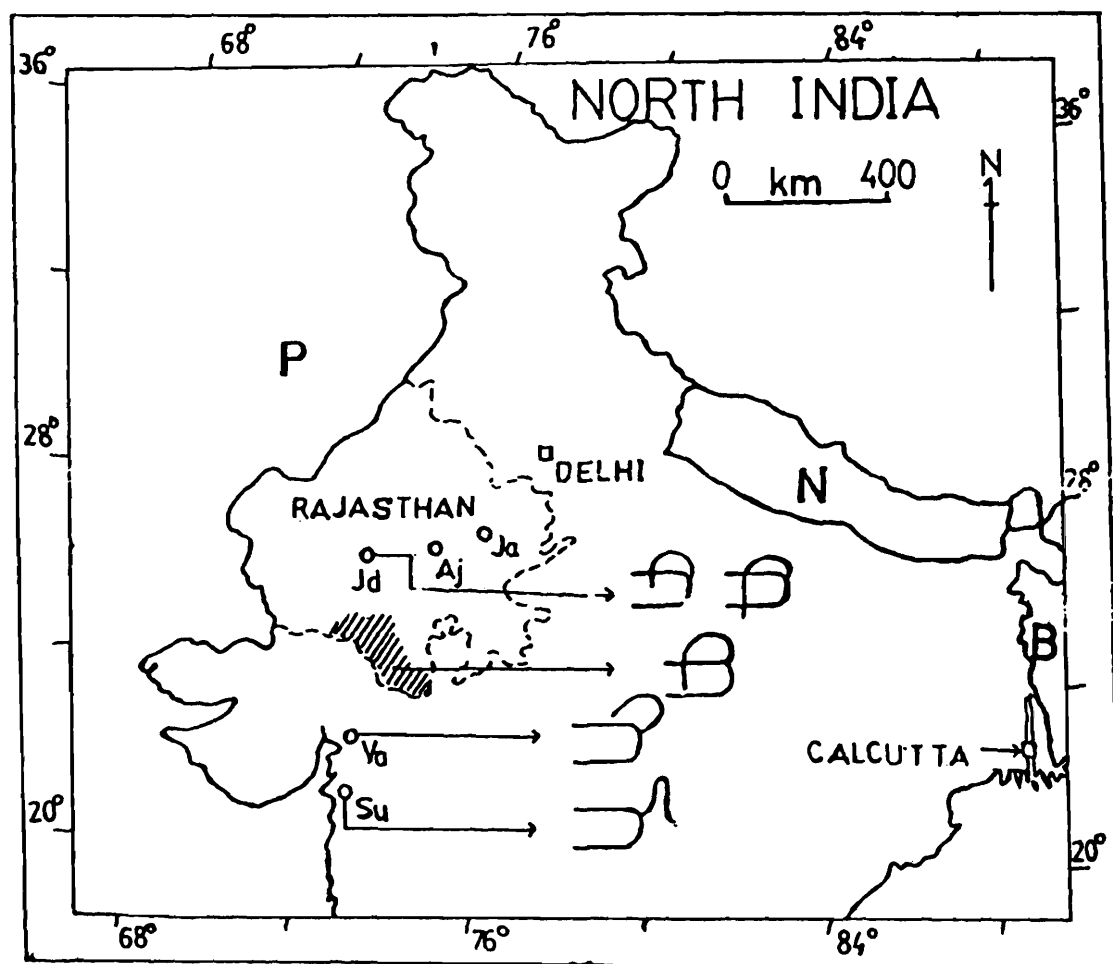
Handedness in tail loop :

In the 31 individuals studied from lateral photographs, the position regarding handedness of the tail loop is as follows :— In males, the tail is right-handed in 66.6%, and the remaining left-handed ; in none the tip lies in the middle. In females, the stance is more evenly distributed (right-handed 36%, left-handed 36% and middle stance 28%).

Handedness in Jodhpur and Peninsular Indian populations (of the places such as : Orissa : 1. Chandikhole. 2. Chandaka. 3. Khandagiri. 4. Bhubaneswar. 5. Tikapada. 6. Baida. 7. Senkarkhole. 8. Phringis. 9. Narayane. 10. Nirmaljar. 11. Bagra. Maharashtra : 12. Near Arni (5 km. SE). 13. Same (15 km SE). 14. Hewari. Andhra Pradesh : 15. Rajahmundry. 16. Eluru), is nearly similar in males with a slight preference for the left, but in southern Rajasthan (present study) it is the reverse, where preference is for the right (66.6%). The situation is different in females. Overwhelmingly left stance (90.4%) is found in Jodhpur and a largely right stance (67.3%) in Peninsular Indian forms (Roonwal and Pirta 1984). But in southern Rajasthan it is more evenly distributed, as stated above.

Table 1. *Presbytis entellus entellus*, southern Rajasthan. Frequency (%) in individuals, of tail handedness, position of tail tip, and loop index.

Individuals	Tail Handedness			Position of tail tip in relation to belly			Loop index	
	LEFT	RIGHT	MIDDLE	ABOVE	ON	BELOW	RANGE	MEAN
Males (n=6)	33.3	66.6	Nil	Nil	33.3	66.6	0.43-1.07	0.71
Females (n=25)	36.0	36.0	28.0	24.0	72.0	4.0	0.45-1.15	0.63
Total (n=31)	35.0	42.0	23.0	19.0	65.0	16.0	0.43-1.15	0.65



Text figure 1. — Map of North India showing mode of the tail carriage in southern Rajasthan and Gujarat in *Presbytis entellus*. Shaded area : Four districts of southern Rajasthan (Banswara, Dungarpur, Udaipur and Sirohi). Aj, Ajmer ; B, Bangladesh ; Ja, Jaipur ; Jd, Jodhpur ; N, Nepal ; P, Pakistan ; Su, Surat ; Va, Vadodara.

SUMMARY

The mode of tail carriage was studied, by field observations and with the aid of lateral photographs, in adults and subadults of *Presbytis entellus entellus* (Dufresne) (Cercopithecidae : Colobinae) in four southern districts of Rajasthan, viz., Banswara, Dungarpur, Udaipur, and Sirohi. Several aspects were examined, viz., left, right-handedness of tail loop (directed forwardly), the position of tail tip in relation to the body, the loop index (width/height) and sexual dimorphism.

ACKNOWLEDGEMENTS

The author is deeply indebted to the Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Desert Regional Station, ZSI, Jodhpur for providing working facilities to the author while he was posted at Jodhpur ; to Prof. M.L. Roonwal for guidance throughout ; and to Shri A. Basit, ZSI, Jodhpur for assistance in taking some valuable photographs. Thanks are also to the Officer-in-Charge, NRS, ZSI, Dehra Dun for various courtesies.

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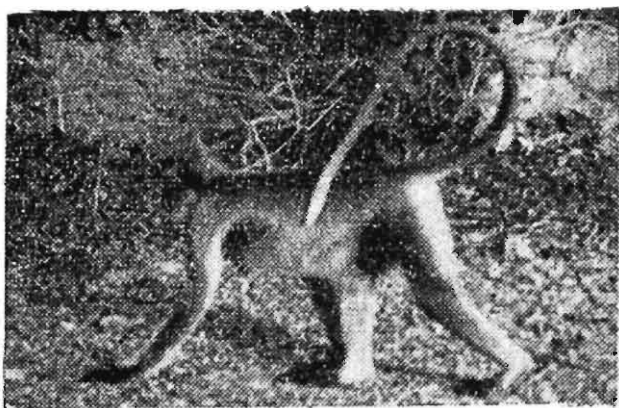
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P. C. TAK

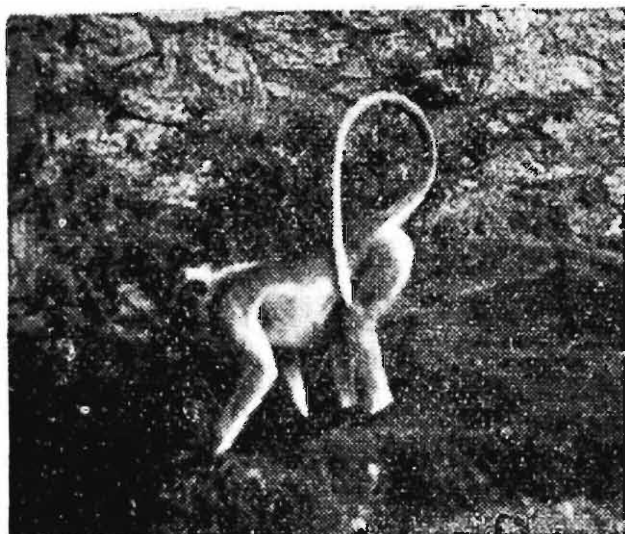
PLATE I



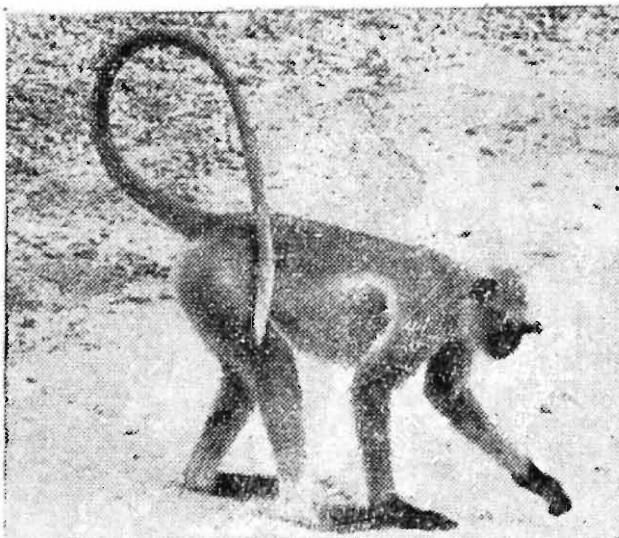
1



2



3



4



5



6

Presbytis entellus entellus in Mt. Abu, Rajasthan

1. Adult sitting on a tree branch, tail hangs down limp.
2. Adult male during slow walking, tail loop left-handed.
3. Adult male standing, tail loop left-handed.
4. Adult male standing, tail loop right-handed.
5. Adult female during slow walking, tail loop right-handed.
6. Subadult female during fast walking, tail loop right-handed.

P. C. TAK

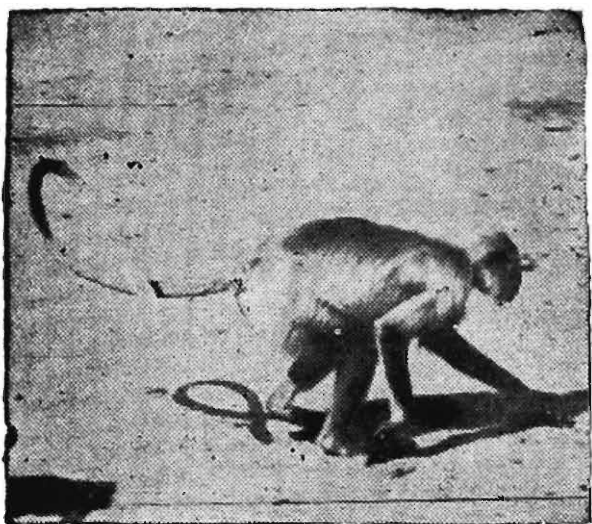
PLATE II



1



2



3



4

Presbytis entellus entellus in Southern Rajasthan.

1. Two subadults running, tail loop right-handed in the foreground one and left-handed in the background one.
2. Subadult running, tail loop open.
3. Adult female running, with terminal loop right-handed.
4. Subadult female in fast walk, tail loop right-handed.

**A RARE NEW SPECIES OF HOMALONYCHUS MARX (ARANEAE :
HOMALONYCHIDAE) FROM COASTAL
ANDHRA PRADESH, INDIA.**

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INTRODUCTION

The earlier works of Stoliczka (1869), Pocock (1900), Sherriffs (1927) and Gravely (1931) do not contain any reference to the rare spiders of the family Homalonychidae. Tikader (1970) reported the occurrence of the genus *Homalonychus* Marx for the first time from West Sikkim describing a new species. While examining the spider collections made from Coastal Andhra Pradesh, we came across a new species of this genus which is described here. Both the family and genus are being recorded for the first time from Coastal Andhra Pradesh and second time from Indian sub-continent.

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

***Homalonychus raghavai* sp. nov.**

(Fig. 1, a-d)

General : Cephalothorax and abdomen black, legs brownish green. Total length 13.65 mm. Carapace 6.16 mm long, 4.33 mm wide ; abdomen 8.00 mm long, 5.50 mm wide.

Cephalothorax : Longer than wide, convex, narrowing in front, mid-dorsally provided with a broad longitudinal brown patch and this portion of patch clothed with fine grey hairs. Lateral margins of thorax also provided with brown longitudinal patches. Centre of thorax provided with a depression and fovea. Clypeus high. Eyes black, in two rows. Anterior row short and procurved, posterior row strongly recurved and much longer than the anterior row. Anterior medians are slightly larger than the anterior laterals. Eyes of anterior row are placed equidistant from each other. Posterior medians are much closer to each other than to the laterals and equal in size. Ocular quad as long as wide, slightly narrowing behind as in Fig. 1 a. Chelicerae with small fange and without teeth on the margins. Sternum broad, clothed with hairs and posterior coxae widely separated. Sternum, labium and maxillae as in Fig. 1 b. Legs strong and robust, clothed with thick hairs. Legs I and II longer than III and IV. Metatarsi I and II with five and four pairs of ventral short and blunt spines resp., metatarsi III and IV with one pair of ventral spines

each at the distal end. The distal ends of metatarsi and tarsi of all legs provided with a brush of terminal tenent hairs. Tarsal claws two, equal in size. Leg formula 1 2 4 3.

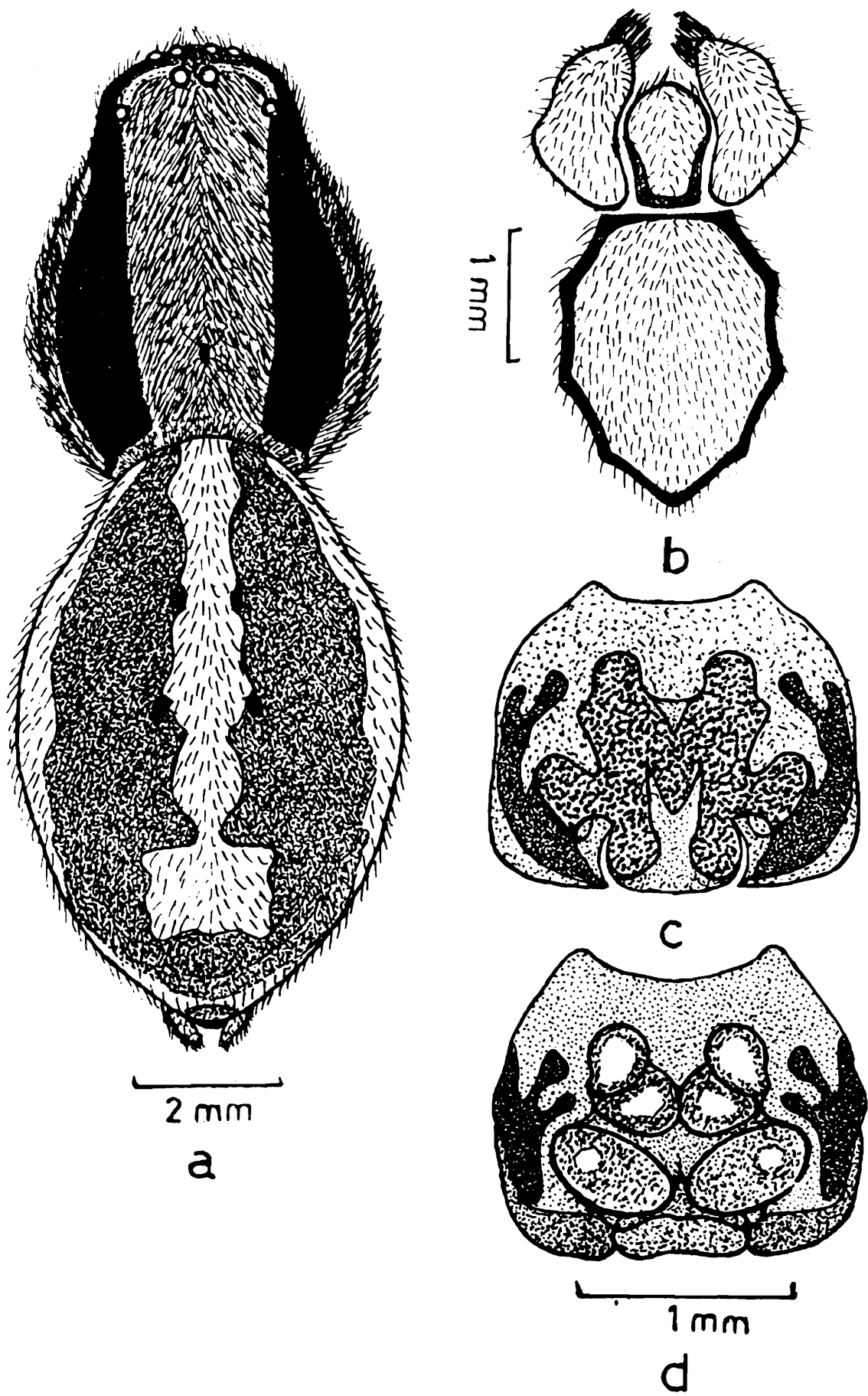


Fig. 1. *Homalonychus raghavai* sp. nov. : a. Dorsal view of female ; b. Sternum, labium and maxillae; c. Epigyne ; d. Internal genitalia.

Abdomen : Oval, longer than wide, clothed with thick black hairs. Mid-dorsally provided with a continuous white longitudinal band extending from the base to end and clothed with thick grey hairs as in Fig. 1 a. Lateral margins also provided with similar white longitudinal bands. Ventral side black but lateral sides provided with white longitudinal strips. Epigyne and internal genitalia are as in Fig. 1 c and d respectively.

Holotype : One female, **Paratype** : One sub-adult female in spirit.

Type-locality : Araku valley, Dist. Visakhapatnam, 13.x.1986. Coll. T. S. Reddy.

Diagnosis : This species resembles to *Homalonychus joyaus* Tikader but it is separated as follows : (1) Abdomen mid-dorsally provided with a broad continuous white longitudinal band extending from base to end with a rectangle and clothed with thick grey hairs but in *H. joyaus* abdomen mid-dorsally provided with a discontinuous broad white longitudinal band, the posterior end of which forms a separate white rectangular patch. (2) Epigyne and internal genitalia are also structurally different.

This species also differs from *H. selenopoides* Marx in having the differences in (1) the size and shape of longitudinal bands on the cephalothorax and abdomen (*H. selenopoides* provided also with two chevrons on the posterior end of abdomen) and (2) the structure of sternum, labium, maxillae and epigyne. (3) Posterior eyes are equal but in *H. selenopoides* posterior lateral eyes are larger than the posterior medians.

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THE AMPHIBIANS OF CHOTA NAGPUR (BIHAR), INDIA

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INTRODUCTION

Chota Nagpur hills in the State of Bihar are not very high in altitude (614-1366 m.) but are noted for their natural beauty, thick evergreen and moist deciduous forests. These hills are situated between latitudes 22° - 25° N and longitudes $83^{\circ} 30'$ - 87° E. The area comprises eight administrative districts namely, Ranchi, Gumla, Lohardaga, Singhbhum, Hazaribagh, Giridih, Palamau and Dhanbad. Rivers Koel (a large branch of the River 'Son'), Subarnarekha, Sankh, Barakar, etc. traverse the area. The mean annual rainfall of Ranchi and its surroundings is about 1513 mm., and its daily mean temperature is about $23^{\circ} 7$ C. The area is also important for its rich resources like coal, iron, bauxite and mica. Hazaribagh National Park, Palamau Tiger Reserve, Netarhat touring spot, Hundru and Zohna Water-falls, Maithon and Tilaiya Water-Reservoirs fall within this area.

Boulenger (1890 & 1920), Annandale and Rao (1918), Daniel (1963 & 1975) and Parker (1934) have recorded amphibians from different parts of India and adjoining Countries, but there is no mention of any amphibian from Chota Nagpur Hills in these works. Venkateswarlu and Murthy (1972) have published a list of amphibians occurring in Bihar, but they also do not mention of any species from this area.

This is the first account of the amphibians of Chota Nagpur (Bihar), and is based on 2000 examples available in the Zoological Survey of India and collections made by author during a field trip to Ranchi district in November-December, 1967. Eleven species belonging to seven genera and four families of Order Anura have been determined and reported for the first time from the area. Tadpoles of three species namely, *Rana cyanophlyctis*, *Rana limnocharis* and *Microhyla ornata* have also been recorded from the area. The Order Apoda and Caudata are not reported in these collections.

Where the collections are large, only localities with dates are given under "Material"

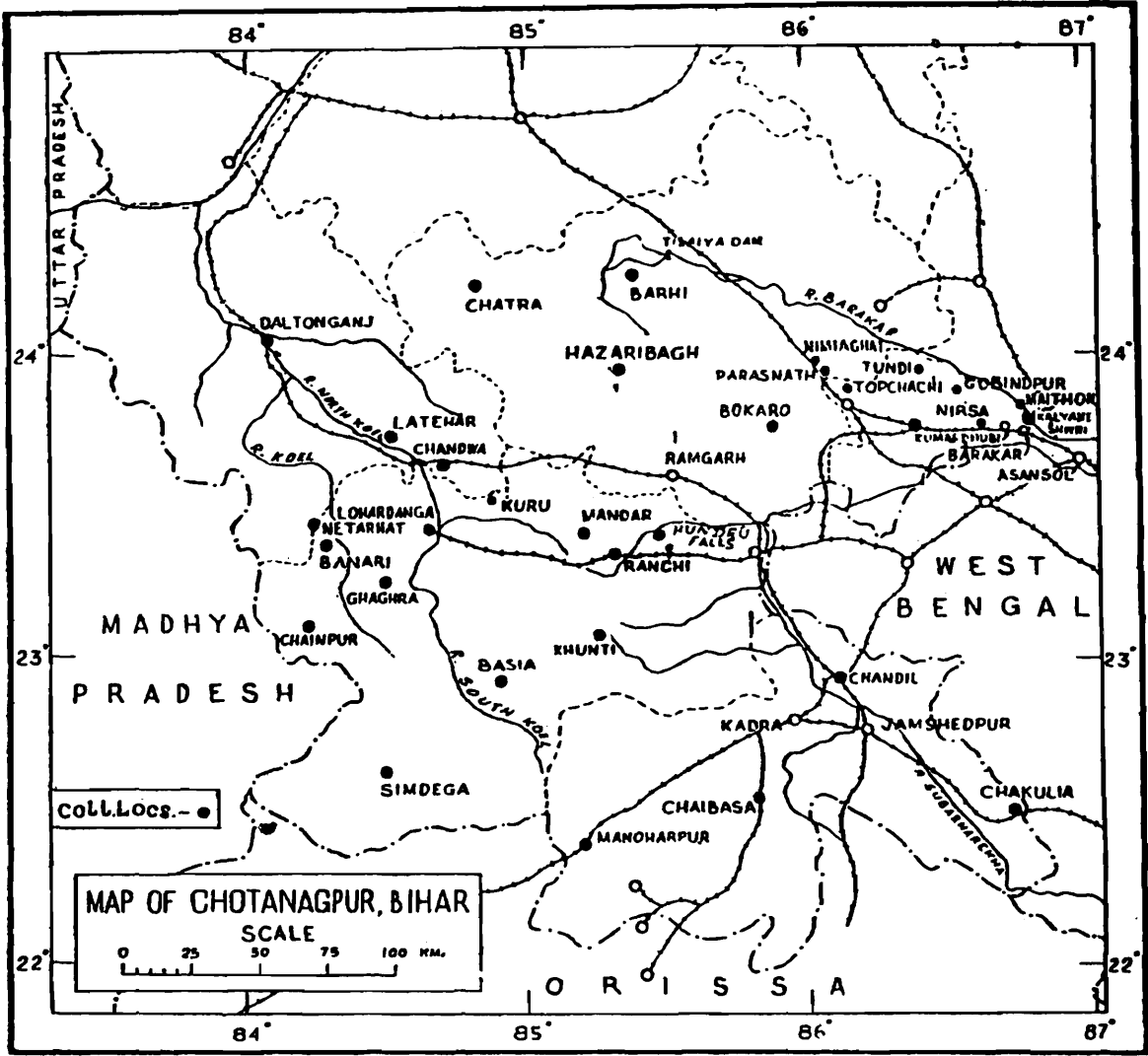
SYSTEMATIC ACCOUNT

Class AMPHIBIA

Order ANURA

Key to the families

1. Upper jaw toothless	2
Upper jaw toothed	3



2. Skin rough with spiny warts, parotoids present

.. BUFONIDAE
- Skin more or less smooth, parotoids absent

MICROHYLIDAE
3. No intercalary cartilage between the distal and penultimate phalanges

.. RANIDAE
- An intercalary cartilage present between the distal and penultimate phalanges

RHACOPHORIDAE

Family 1. BUFONIDAE

This family is represented in Chota Nagpur by two species of the genus *Bufo* which can be distinguished by the following key.

Genus 1. **Bufo** Laurenti

- Head with bony ridges

melanostictus
- Head without bony ridges

stomaticus

1. **Bufo melanostictus** Schneider
(Common Indian Toad)

1799. *Bufo melanostictus* Schneider, *Hist. Amph.*, 1:216

Material : Total 54 examples (toads). Dhanbad district : Maithon Dam site, 15.xi.1948 (under stone); Kalyaneshwari, 16.xi.1948; Maithon pahar, 16.xi.1948;

Inanpur, Nov.-Dec., 1948; base of Panchet Hill at Inanpur, 25-26.xi.1948; Panchet Hill at Inanpur, Nov.-Dec., 1948 (under stone). All coll. B. Nath. Barakar river bank at Maithon, 15 & 20. viii. 1969; Tundi, 11.ix.1969 (under stone); nala at Topchachi, 16.ix.1969; pond at Topchachi, 20.ix.1969. All coll. Raj Tilak. Ranchi district : Tikoo river side near Kuru town, 12.xii.1967 (under stone), coll. Raj Tilak and A.K. Sarkar. Singhbhum district : B.D.O.'s Office campus at Chakulia, 28.x.1968, coll. Raj Tilak.

Measurements : Length (snout to vent) 19-133 mm.

Distribution : Chota Nagpur : As above. It is common throughout the plains of India; Sri Lanka; Burma, and extends to Southern China, Malay Peninsula and Archipelago.

Remarks : It is nocturnal in habit and has been collected from inside burrows and dark corners of dwellings during the day. Barring the winter months they are commonly seen in the area and can be used for dissection in educational institutions.

2. **Bufo stomaticus** Lutken
(Marbled Toad)

1863. *Bufo stomaticus* Lutken, *Vidensk. Meddr dansk naturh - Foren*, 14 : 305.

Material : Dhanbad district : 2 ex., Chirkunda, 7.xi.1948; 16 ex., paddy-field at Mugma, 9.xi.1948; 20 ex., Maithon Dam site (under stone), 12, 13 & 15.xi.1948; 1 ex., Maithan, 16.xi.1948; 1 ex., Kanja Pahar, 20.xi.1948; 2 ex., Inanpur, 25.xi.1948; 1 ex., Inanpur, 26.xi.1948. All coll. B. Nath. Ranchi district : 2 ex., Horhap, 3.ii.1954, coll A.P. Kapur and T.G. Vazirani. 4 ex., Simdega, 14.xi.1966; 10 ex., Kuru, Chainpur, 18.ix.1966; 1 ex., under wooden logs at Banari, 22.ix.1966; 10 ex., Kuru, 13.xii.1967; 1 ex., Basia, 25.xii.1967. All coll. Raj Tilak and A.K. Sarkar.

Measurements : Length (snout to vent) 27-79 mm.

Distribution : Chota Nagpur : As above. *Elsewhere* : Assam, West Bengal, Uttar Pradesh, Himachal Pradesh, Andhra Pradesh, Rajasthan, Gujarat and Maharastra in India. Also Nepal, Sri Lanka, Pakistan and Arabia. This species is also fairly common.

Family II. MICROHYLIDAE

This family is represented by two genera, each represented by a single species.

Key to the genera :

1. Two normal metatarsal tubercles present 2
- Two large, shovel-shaped metatarsal tubercles (inner larger) present *Uperodon*
2. Tips of fingers with triangular dilatations *Ramanella*
- Tips of fingers without dilatations *Microhyla*

Genus 2. **Uperodon** Dumeril & Bibron.3. **Uperodon globulosus** (Gunther)
(Balloon Frog)

1864. *Cacopus globulosus* Gunther, *Rept. Br. India*, p. 416.

Material : Dhanbad district : 1 ex., (under stone) inside I.B. Compound at Tundi, 11.ix.1969, coll. Raj Tilak.

Measurements : Length (snout to vent) 68 mm.

Distribution : Chota Nagpur : As above. *Elsewhere* : Karnataka, Andhra Pradesh, Madhya Pradesh and Orissa in India. Also Sri Lanka.

Remarks : This is a rare microhylid found in the area. It leads a secretive subterranean life and surfaces only during breeding season (Monsoon months).

Genus 3. **Ramanella** Rao and Ramanna4. **Ramanella variegata** (Stoliczka)

1872. *Callula variegata* Stoliczka, *Proc. Asiat. Soc. Bengal*, : 111.

Material : Singhbhum district : 1 ex., Chakradharpur, 29.ix.1911, coll. F.H. Gravely.

Measurements : Length (snout to vent) 14 mm.

Distribution : Chota Nagpur : As above. *Elsewhere* : Assam, West Bengal, Orissa, Madhya Pradesh, Maharashtra, Gujarat and Karnataka in India.

Genus 4. **Microhyla** Tschudi5. **Microhyla ornata** (Dumeril & Bibron)
(Ornate Microhylid)

1841. *Engyston ornata* Dumeril and Bibron, *Erpet. Gen.*, 8 : 745.

Material : Total : 139 examples (67 frogs and 72 tadpoles). Dhanbad district : Chirkunda, 7.xi.1948; 5 ex., Mugma, 9.xi.1948; Nirsa, 10.xi.1948; near Maithan Dam, 12-13.xi.1948; Maithan Dam site (under stone), 15.xi.1948; forest near Kalyaneshwari, 16.xi.1948; Gobindpur, 22 miles west of Barakar, 18.xi.1948; Inanpur, 24.xi.1948; base of Panchet Hills, 2.4 km. west of Inanpur, 25.xi.1948; Chaurasi, 4 km. west of Inanpur, 26.xi.1948; stream near Panchet Hill, 3 km. west of Inanpur, 4.xii.1948; ponds on the east of Inanpur, 9.xii.1948. All coll. B. Nath. Chas, Bokaro, 21.xi.1968; stream about 1.5 km. north of Maithan Dam, 19.vii.1969; Khudia nala, 1 km. north of Gobindpur, 6.ix.1969; rain water pond, 1 km. north of Gobindpur, 7.ix.1969. All coll. Raj. Tilak. Ranchi district : Simdega, 12.ix.1966; union of Sankh and Palmara rivers, 10 km. north-west of Simdega, 13.ix.1966; Chainpur, 19.ix.1966; under logs inside I.B. Compound at Lohardaga, 19.xii.1967; grassy soil, 8 km. south-east of Basia town, 25.xii.1967; Basia, 27.xii.1967. All coll. Raj Tilak and A.K. Sarkar.

Measurements : Length (Snout to vent) 13-21 mm.

Distribution : Chota Nagpur : As above. **Elsewhere** : It is a widely distributed species found all over the plains of India upto an altitude of 1524 meters. Also Nepal, Sri Lanka, Bangladesh, Burma, South China, South-east Asia and Taiwan.

Remarks : This is an active toad-like tiny frog mostly found in grass and under dry leaves in moist soil. In contrast to its tiny size, it can cover considerable distance by jumping. It is attracted to night light and occasionally enters houses during monsoon days.

Family, III. RANIDAE

This family is represented in Chota Nagpur by four species of genus *Rana*, and one of genus *Tomopterna*.

Key to the genera of family Ranidae

Outer metatarsals seperated by web at least in the distal half	<i>Rana</i>
Outer metatarsals united or separated only in their distal extremity	<i>Tomopterna</i>

Genus 5. *Rana* Linnaeus

Key to the species of genus *Rana*

1. Toes webbed upto the tips, inner metatarsal tubercle digitiform (toe-like) *cyanophlyctis*
- Toes not webbed upto the tips, inner metatarsal tubercle not digitiform 2
2. Both inner and outer oval-shaped metatarsal tubercles present *limnocharis*
- Inner metatarsal tubercle present, Outer metatarsal tubercle absent 3
3. Inner metatarsal tubercle blunt and not shovel-shaped *tigerina*
- Inner metatarsal tubercle crescentic and shovel-shaped *crassa*

6. *Rana cyanophlyctis* Schneider (Skipping Frog)

1799. *Rana cyanophlyctis* Schneider, *Hist. Amph.* 1 : 137

Material : Total 1316 examples (1275 frogs and 41 tadpoles). Dhanbad district : Chirkunda, Barakar, Nirsa, Kumar Dhubi, Mithon Dam site, Kalyaneshwari, Inanpur, Panchet Hill site, Raghunathpur; Collected during November, 1948; all coll. B. Nath. Chas (Bokaro), Ganga Dam site (Bokaro), Damodar river, Barakar river near Mithon Dam, Bamhor river near Mithon Dam, Gobindpur, Topchachi Lake; collected during November, 1968 and Aug. Sept., 1969; all coll Raj Tilak. Hazaribagh district : Chatra, Hazaribagh lake, Suraj Kund (Cold sulphur spring), Ramgarh; collected during February, 1954; all coll. A.P. Kapur and T.G. Vazirani. Hazaribagh Lake, Hazaribagh National Park, Chherva Dam and Konar river near Hazaribagh town, Burhi, Barakar river, Jamni river at Nimiaghat, Parasnath hill base; collected during November-December, 1968; all coll. Raj Tilak. Palamau

district : Amanat river and North Koel river near Daltangunj, Latehar, Mugaldaha river near Chandwa; collected during Sept.-Oct., 1966; all coll. Raj Tilak. Ranchi district : Koel river at Netarhat, Mandar, Bala Nadi near OPA, Ranchi town, Namkun, Subarnrekha river at Ranchi, Khatnahi Dah at Horhap, Khunti; collected during January-February, 1954; all coll. A.P. Kapur and T.C. Vazirani. Simdega, Chainpur, Banari, Subarnrekha river, Hinoo river, Bundu Bund, Kanke Bund, Hatia Dam, Hundru Falls, South Koel river near Mandar, Tikko river near Kuru town, Lohardaga, Bagru Hills, Ghaghra town, Basia town; collected during November-December, 1967; all coll. Raj Tilak and A.K. Sarkar. Singhbhum district : Hirani Falls near Chaibasa, Chiria Coal mines, Monoharpur, Tholkabad Reserve Forest, Karampada, Old Angua, Koel river at Monoharpur; collected during Feb., 1954 and Feb., 1955; all coll. A.P. Kapur. South Koel river and Koena river near Manoharpur, Chakulia, Barkunda river and Kojo river near Chaibasa, Chandil; collected during December, 1967 and Oct.-Nov., 1968; all coll. Raj Tilak.

Measurements : Length (Snout to Vent) 26-71 mm.

Distribution : Chota Nagpur : As above. *Elsewhere* : Throughout the plains of India, upto 1846 m. in the Himalayas. Also Pakistan, Afghanistan, Iran, South Arabia, Nepal, Thailand and Sri Lanka.

Remarks : It is a very common species and are found to float in ponds, ditches, canals and rivers.

7. ***Rana limnocharis* Wiegmann** (Indian Cricket frog)

1835. *Rana limnocharis* (Boie) Wiegmann, *N. Acta. Ac. Leop. - Carol.*, 17 (i) : 255.

Material : Total 319 examples (289 frogs and 30 tadpoles). Dhanbad district : Chirkunda, Kumar Dhubi, Mugma, Maithon Dam site, Inanpur, Panchet Hill-base, Chaurasi; collected during November, 1948; all coll. B. Nath. Chas (Bokaro), Mithon Dam site, Gobindpur, Topchachi; collected during August-September, 1969; all coll. Raj Tilak. Hazaribagh district : Hazaribagh National Park, Chherva Dam, Parasnath Hill-base near Nimiaghat; collected during November-December, 1968; all coll. Raj Tilak. Palamau district : Chandwa, 5-6.x.1966, Raj Tilak. Ranchi district : Bala Nadi, Horhap, Khunti; collected during February, 1954; all coll. A.P. Kapur and T.G. Vazirani. Simdega, Chainpur, Banari, in and around Ranchi town, Hatia Dam, Mandar, Kuru, Lohardaga, Ghaghara, Basia; collected during September, 1966 and November-December, 1967; all coll. Raj Tilak and A.K. Sarkar. Singhbhum district : Chaibasa, Chiria Coal Mines, Manoharpur, Tholkabad, Old Angua; collected during February, 1954 and February, 1955; all coll. A.P. Kapur. Mahoharpur, Chaibasa, Chakulia; collected during December, 1967 and November, 1968; all coll. Raj Tilak.

Measurements : Length (Snout to Vent) 13-61 mm.

Distribution : Chota Nagpur : As above. The species is recorded for the first time from the area. *Elsewhere* : It is a widely distributed species in India, found in almost all biotopes. Also Eastern Asia from Pakistan, Nepal, Sri Lanka and China to Japan.

Remarks : This is also a common species mostly found on bunds in paddy-

fields, burrows on moist soil, and under stones near water. it is terrestrial in habit and jumps into water when disturbed only to return to the bank soon being a poor swimmer. In Ranchi district these frogs are frequently seen inside the bushes grown on the banks of rivers like Subarnarekha, Hinoo, Tikoo, Mukri, South Koel etc.

8. ***Rana tigerina*** Daudin (Indian Bull Frog)

1803. *Rana tigerina* Daudin, *Hist. Rain. Gren. Crap.*, p. 64.

Material : Ranchi district : 1 ex., Jungle, 3.5 Km. west of Chainpur, 17.ix.1966; 1 ex., Bundu Bund, 4.8 km. south-east of Ranchi town, 1.xii.1967. All coll. Raj Tilak and A.K. Sarkar.

Measurements : Length (Snout to Vent) 89-137 mm.

Distribution : Chota Nagpur : As above. The species is recorded for the first time from the area. *Elsewhere* : It is common throughout India, from the base of the Himalaya to South India. Also Nepal, Sri Lanka, Burma, Thailand, South China and Taiwan.

Remarks : Bhattacharya (1936) reports its tadpoles feeding on mosquito larvae. The frogs have been collected from Ranchi district only.

9. ***Rana crassa*** Jerdon (Jerdon's Bull Frog)

1853. *Rana crassa* Jerdon, *J. Asiat. Soc. Bengal*, 22 : 531.

Material : Dhanbad district : 3 ex., Mugma, 5.5 km. from Barakar, 9.xi.1948; coll. B. Nath. 1 ex., Khudia nala, 1.5 km. north of Gobindpur, 5.ix.1969; coll. Raj Tilak.

Measurements : Length (Snout to Vent) 57-73 mm.

Distribution : Chota Nagpur : As above. The species is recorded for the first time from the area. *Elsewhere* : Uttar Pradesh, Bihar, Orissa, West Bengal, Tamil Nadu and Kerala in India. Also Sri Lanka.

Remarks : This is an uncommon form and has been collected only from Dhanbad district from burrows on the elevated banks of ponds and ditches. The species is allied to *Rana tigerina* and can be distinguished by its toad-like form and the shovel-shaped metatarsal tubercles.

Genus 6. ***Tomopterna*** Dumeril and Bibron

10. ***Tomopterna breviceps*** (Schneider) (Burrowing Frog)

1799. *Rana breviceps* Schneider, *Hist. Amph.*, 1 : 140

Material : Dhanbad district : 1 ex., Inanpur, 24.xi.1948, coll. B. Nath. 1 ex., Chas, Bokaro, 20.xi.1968, coll. Raj Tilak.

Measurements : Length (Snout to Vent) 34-41 mm.

Distribution : Chota Nagpur : As above. The species is recorded for the first time from the area. *Elsewhere* : Himachal Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Madhya Pradesh, Orissa, West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu and Kerala. Also Sri Lanka, Nepal and upper Burma.

Remarks : This frog is rarely seen. The tibiotarsal tubercle seen by Bhaduri and Kripalani (1954) has not been observed in the present examples.

Family IV RHACOPHORIDAE

This family is represented in Chota Nagpur by one species of the genus *Polypedates*.

Genus 7. *Polypedates* Tschudi

11. *Polypedates maculatus* (Gray) (Tree Frog)

1832. *Hyla maculata* Gray, *Ill. Indian Zool.*, 1, pl. 82, Fig. 1

Material : Dhanbad district : 1 ex., Nirsa, 10.xi.1948; 1 ex., Maithon Dam site, 13.xi.1948; 1 ex., Chaurasi, 4 km. west of Inanpur, 26.xi.1948; 1 ex., Inanpur, 26.xi.1948. All coll. B. Nath. Palamau district : 4 ex., around Chandwa, 6-8.x.1966 coll. Raj Tilak, Ranchi district : 1 ex., Kanka Bandh, 8.5 km. north of Ranchi town, 3.xii.1967; Coll. Raj Tilak and A.K. Sarkar. Singhbhum district : 1 ex., under decaying and wetlog of Sal at Tholkabad, 9.ii.1955; coll. A.P. Kapur. 2 ex., Chaibasa, 1-2.xi.1968 ; 1 ex., at light at Chandil, 11.xi.1968. All coll. Raj Tilak.

Measurements : Length (Snout to Vent) 11-62 mm.

Distribution : Chota Nagpur : As above. The species is more or less common in the area. *Elsewhere* : South India and Plains of North India in general. Also Sri Lanka.

Remarks : It is the only species of tree-frog found in the area. It is nocturnal in habit. During day-time frogs are collected from holes on tree-trunks, burrows on the walls of old houses and roofs of thatched village huts.

SUMMARY

This paper deals with the amphibians collected from Chota Nagpur (Bihar). Eleven species of Anura (frogs and toads) belonging to four families and seven genera are recorded for the first time from the area with notes wherever available. Keys for determination of the species, and a map showing localities of collection have also been provided.

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**STUDIES IN SEPTATE GREGARINES (APICOMPLEXA : SPOROZOEAE)
FROM INSECTS OF WEST BENGAL : SIX NEW SPECIES OF
HIRMOCYSTIS, GREGARINA, STENOPHORA AND HYALOSPORINA**

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INTRODUCTION

During the course of our investigation on the protozoan parasites of insects we have obtained six new species of septate gregarines (Apicomplexa : Sporozoea) belonging to the genera *Hirmocystis*, *Gregarina*, *Stenophora* and *Hyalosporina*. The structures, life histories and affinities of these gregarines have been elaborately described in this communication. It may be mentioned here that the genera *Gregarina*, *Hirmocystis*, *Stenophora* and *Hyalosporina* were established by Dufour (1828), Labbe (1899), Labbe (1899) and Chakravarty (1935) respectively. Subsequently, many new species were added to all these genera. Haldar et al. (1985a, b) compiled a list of Indian species from various arthropods.

MATERIALS AND METHODS

The different insect hosts were collected from various places in West Bengal (TABLE 1) and were brought alive to the laboratory for microscopic examination of protozoan parasites. These were dissected out, smeared on slides, fixed and stained by the usual Heidenhain's haematoxylin method. Development of gregarines was studied by staining sections of host gut. For details, please see Ghose et al. (1986). The type materials are deposited in the National Collection, Z.S.I. (Calcutta).

OBSERVATIONS

Genus *Hirmocystis* Labbe, 1899

Sporadins in association of 2 to 12 ; epimerite conical or cylindrical knob ; cysts spherical and ovoidal spores.

***Hirmocystis alphitobiusi* n. sp.**

(Text Figs. 1-5)

Host : *Alphitobius piceus* Oliver (Coleoptera : Tenebrionidae).

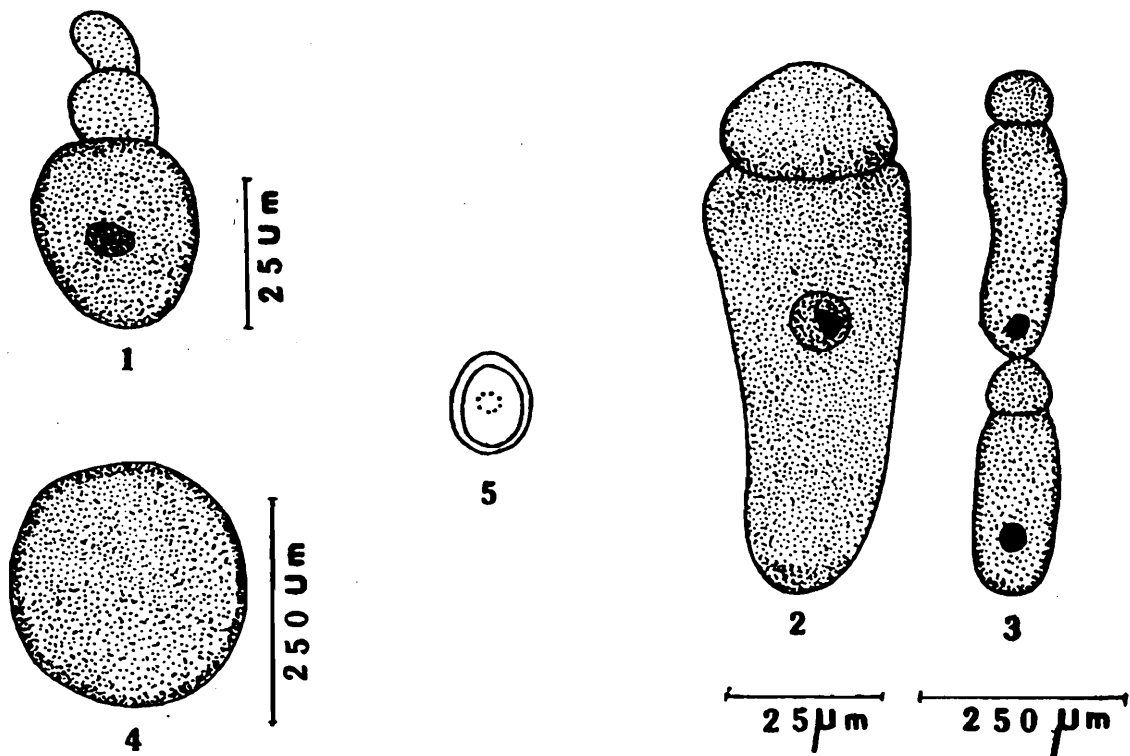
Développement : Extracellular.

TABLE I

Showing names of the hosts, names of the parasites, places of collection, number of hosts examined, number of hosts parasitized and percentages of infection of six new species of gregarines from insects.

Sl. No.	Name of the hosts	Name of the parasites	Place of collection	No. of hosts examined	No. of hosts parasitized	% of infection
1.	<i>Alphitobius piceus</i> Oliver	<i>Hirmocystis alphitobiusi</i>	Naihati, W.B., India	75	55	73.3
2.	<i>Coccinella transversalis</i> (Fabr.)	<i>Hirmocystis coccinelli</i>	Kalyani, W.B., India	500	75	15.0
3.	Larva of <i>Tribolium Castaneum</i> (Herbst)	<i>Gregarina amojii</i>	Chandannagar, W.B., India	191	37	17.3
4.	<i>Verania discolor</i> (Fabr.)	<i>Gregarina veraniae</i>	Kalyani, W.B., India	65	19	29.2
5.	An unidentified harpagophorid Millipede	<i>Stenophora harpagophora</i>	Kalyani, W.B., India	50	40	80.0
6.	An unidentified harpagophorid Millipede	<i>Hyalasporina mukundi</i>	Kalyani, W.B., India	40	30	75.0

Trophozoite : Solitary, elongated ; knob-like epimerite and ovoidal protomerite. The deutomerite is cylindro-conical in shape with rounded end. Spherical nucleus situated at the centre of the deutomerite.



Text Figs. 1-5. Camera lucida drawings of different life-cycle stages of *Hirmocystis alphitobiusi* n. sp. — 1. Fully grown trophozoite ; 2. Sporadin ; 3. Association ; 4. Gametocyst ; 5. Spore.

Sporadin and association : Cylindro-conical in shape with hemispherical protomerite which is broader than long. Elongated cylindrical deutomerite broadest at the protomerite-deutomerite junction with a rounded posterior end. Cytoplasm is densely granulated in protomerite than the deutomerite. Epicyteal striations are absent. Spherical nucleus with an endosome present centrally.

Syzygy caudo-frontal. Primita is larger than satellite.

Gametocyst and spore : Gametocyst spherical in shape measuring $133.3\ \mu\text{m}$ in diameter. After 120 hrs. cyst dehisces by simple rupture liberating double walled, oval spore. Each spore measures $5.0\ \mu\text{m} \times 3.3\ \mu\text{m}$. Formation of eight sporozoites is completed after 30 hrs. of development.

Measurements (in microns) :

Trophozoite

TL = 50.0-66.6 (55.5) ;

LE = 8.3 (8.3) ;

LP = 16.7 (16.7) ;

LD = 25.0-41.7 (30.6) ;

LN = 8.3 (8.3) ;

WE = 8.3 (8.3) ;

WP = 8.3-16.7 (11.1) ;

WD = 8.3-16.7 (11.1) ;

WN = 8.3 (8.3) ;

Sporadin

TL = 58.3-166.6 (118.0) ;

LP = 8.3- 41.7 (21.6) ;

LD = 42.7-141.6 (98.6) ;

LN = 8.3-25.0 (10.8) ;

WP = 8.3-50.0 (33.2) ;

WD = 8.3-58.3 (37.7) ;

WN = 8.3-16.7 (9.3) ;

LP:TL = 1:3.0-16.0 (6.13) ;

WP:WD = 1:0.04-1.5 (0.92).

Material : Holotype ; Coll. No. X 6/1 S.C. Datta Coll. dated 9.10.1979. Type locality ; Naihati, W.B., Paratype ; Coll No. X 6/2 and 3.

Affinities : The gregarine possesses close resemblances with *H. ovalis* Crawley, 1903 and *H. bengalensis* haldar and Chakraborty, 1979 in the LP : TL and WP : WD values. But in *H. ovalis* the cyst and spores are unknown while in *H. bengalensis* the development is intracellular and spores possess four knob-like projections which are lacking here. In view of these differences the parasite is assigned a new taxonomic status and is named *Hirmocystis alphitobiusi* n.sp., after the generic name of its host.

***Hirmocystis coccinelli* n. sp.**

(Test Figs. 6-11)

Host : *Coccinella transversalis* (Fabr.) (Coleoptera : Coccinellidae)

Development : Extracellular.

Trophozoite : Solitary, opaque white in colour ; simple hyaline papilla-like epimerite. The protomerite is hemispherical and the deutomerite is spherical in shape. Nucleus is oval with distinct nuclear membrane.

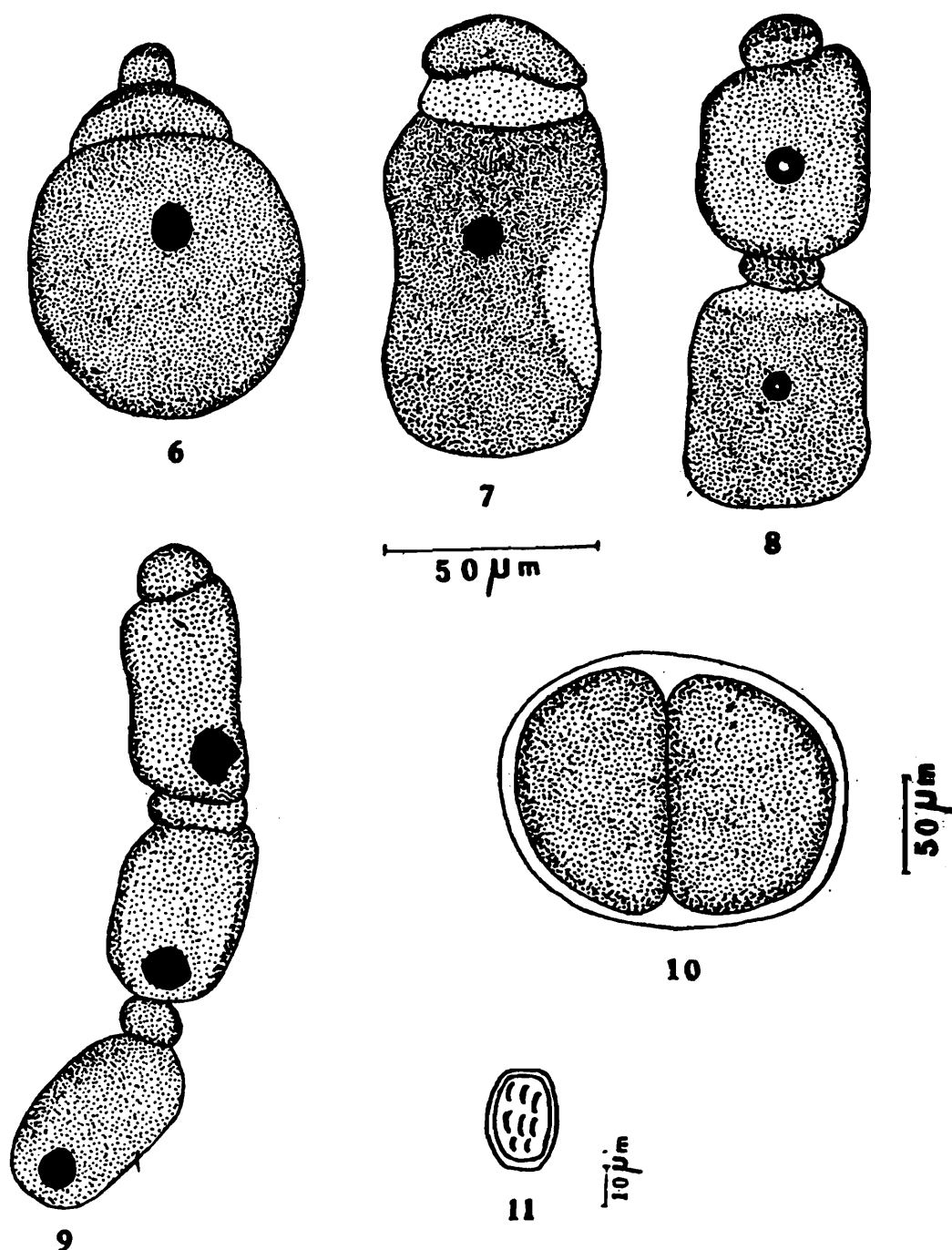
Sporadin and association : Barrel-shaped sporadin. Protomerite is hemispherical

with a convex free end and the deutomerite is cylindrical with a rounded posterior end. Cytoplasm is uniformly granulated. The pellicle is thin and epicyteal striations are not observable.

Caudo-frontal syzygy, 2-4 in number ; primitive is larger than the satellite.

Gametocyst and spore : Gametocyst spherical measuring $150.0\ \mu\text{m}$ — $155.0\ \mu\text{m} \times 130.0\ \mu\text{m}$ — $140.0\ \mu\text{m}$. Cyst wall is thin and transparent enclosing two unequal gametocytes. After 24 hrs. of development the partition wall between the gametocytes disappears. The cyst dehisces by simple rupture after 120 hrs. of development.

Barrel-shaped, double-walled spores measure $10.0\ \mu\text{m} \times 5.0\ \mu\text{m}$ with eight sickle-shaped sporozoites arranged irregularly in each spore.



Text Figs. 6-11. Camera lucida drawings of different stages of life-cycle of *Hirmocystis coccinelli* n.sp. — 6. Trophozoite ; 7. Sporadin ; 8 and 9. Associations ; 10. Gametocyst ; 11. Spore.

*Measurements (in microns) :***Trophozoite**

TL = 31.9-38.3 (35.1) ;

LE = 4.3-10.6 (7.5) ;

LP = 6.4 (6.4) ;

LD = 21.3 (21.3) ;

LN = 4.3-6.4 (5.4) ;

WE = 6.4-8.5 (7.4) ;

WP = 8.5-12.8 (10.7) ;

WD = 12.8-21.3 (17.1) ;

WN = 4.3 (4.3) ;

Sporadin

TL = 42.5-110.5 (73.9) ;

LP = 8.5- 17.0 (13.0) ;

LD = 34.0-97.8 (60.9) ;

LN = 4.3- 6.4 (5.8) ;

WP = 17.0-55.3 (23.4) ;

WD = 25.5-76.5 (43.0) ;

WN = 4.3- 6.4 (5.8) ;

LP:TL = 1:3.0-12.5 (6.0) ;

WP:WD = 1:0.3-0.8 (0.6).

Material : Holotype : Coll. No. C₅ S.C. datta. Coll. dated 1.3.1979. Type locality; Kalyani University campus, West Bengal. Paratype ; Coll. No. C₆ and C₇.

Affinities : Possession of simple-papilla like epimerite, association of two's to four's and simple dehiscence of cyst place the parasite under the genus *Hirmocystis* Labbé. The gregarine bears close affinity with *H. dharwarensis* Uttangi and Desai, 1962 in LP:TL value but differs in all other respects. The parasite also shows some similarities with *H. alphetobiusi* n. sp. in the development, shape of the gametocyst and WP:WD values but differs in the shape of epimerite, protomerite, deutomerite, spore and LP:TL values. As such, the gregarine is designated as a new species and named *Hirmocystis coccinelli* n.sp. after the generic name of its host.

Genus Gregarina Dufour, 1828

Biassociative, Epimerite small, globular or cylindrical spores dolioform to cylindrical. Cyst dehisces by sporoducts.

***Gregarina amojii* n. sp.**

(Text Figs. 12-17)

Host : Larva of *Tribolium castaneum* (Herbst) (Coleoptera : Curculionidae).

Development : Intracellular.

Trophozoite : Small globular or cylindrical. The epimerite is globular or knob-like with very less amount of cytoplasm. The protomerite is hemispherical, bell-shaped or dome-shaped. A concave septum separates the epimerite from the protomerite. The deutomerite is also variously shaped e.g., conical, cylindrical or globular. A rounded or spherical nucleus with nuclear membrane and an endosome is present at the posterior portion of the deutomerite.

Sporadin and association : Sporadins are solitary as well as biassociative. Globular to cylindrical in shape with subspherical or flat protomerite and obese to elongated deutomerite. The pellicle is thick and cytoplasm is finely granulated.

Caudo-frontal association is very firm. The protomerite of the primitive is egg-shaped while that of the satellite is more or less rectangular.

Gametocyst and spore : Gametocysts are egg shaped, double-walled with a gelatinous outer membrane. The cyst measures $69.7 \mu\text{m} \times 54.0 \mu\text{m}$ in diameter. After 72 hrs. of development six sporoducts are developed from the cyst surface. Eight hrs after the formation of sporoducts the spores are released in short chains.

Ellipsoidal spores measure $4.4 \mu\text{m} \times 2.3 \mu\text{m}$. Each spore contains eight pea-shaped sporozoites arranged irregularly.

Measurements (in microns) :

Trophozoite

TL = 18.36-31.05 (26.1) ;

LE = 5.4- 6.75 (5.7) ;

LP = 5.4 - 8.1 (6.8) ;

LD = 6.48-17.55 (13.4) ;

LN = 3.0 - 4.85 (3.8) ;

WE = 5.4 - 7.0 (5.7) ;

WP = 8.1 - 9.45 (8.7) ;

WD = 8.1-13.0 (10.8) ;

WN = 3.24- 5.4 (4.1) ;

Sporadin

TL = 17.55-68.04 (42.5) ;

LP = 6.75-18.9 (13.3) ;

LD = 7.45-53.46 (28.3) ;

LN = 3.24-6.75 (5.5) ;

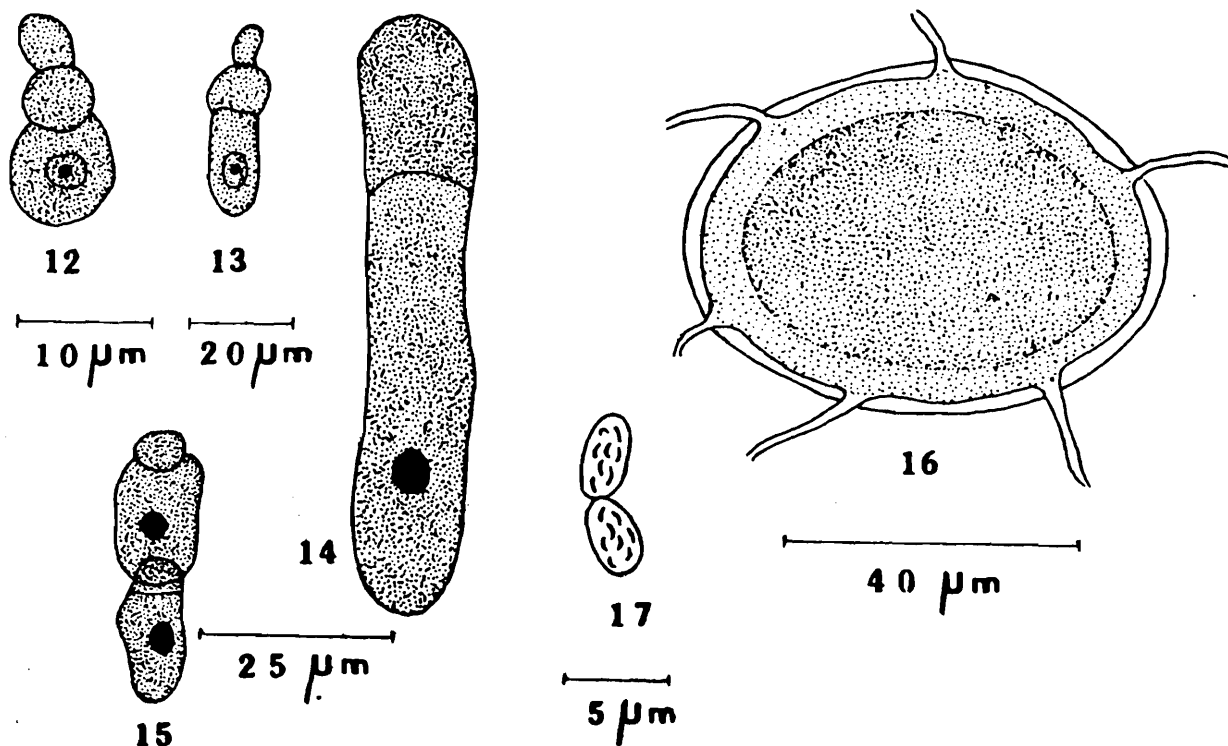
WP = 7.57-18.9 (13.4) ;

WD = 8.1 -22.95 (14.1) ;

WN = 4.59-6.75 (5.4) ;

LP:TL = 1:2.2-5.2 (3.3) ;

WP:WD = 1:0.7-1.5 (1.0).



Text Figs. 12-17. Camera lucida drawings of different stages of life-cycle of *Gregarina a.nojii* n. sp. — 12 and 13. Trophozoites ; 14. Sporadin ; 15. Syzygy ; 16. Gametocyst with six sporoducts ; 17. Spores ;

Material : Holotype ; Coll. No. BLT/4 S Ghose Coll. dated 2.4.1984. Type locality ; Chandonnagore, W.B., Paratype ; Coll. No. BLT/5 and BLT/6.

Affinities : Four species of the genus *Gregarina* have so far been recorded from *Tribolium* spp. (Sokoloff, 1972 ; Ghose et al., 1986). These are *G. minuta*, *G. cuneata*, *G. crassa* and *G. basiconstrictonea*. The species under report shows close similarities with *G. cuneata* Stein, 1848 in LP:TL and WP:WD ratios and formation of sporoducts but differs from it in the shape of epimerite, sporadin, gametocyst and spore. The gregarine exhibits close resemblances in the shape of association with *G. minuta* Ishii, 1914 but differs from it in all other characters. The gregarine also resembles *G. basiconstrictonea* in the general shape of the sporadin and WP:WD values, but markedly differs from it in other respects. The gregarine possesses characters like knob-like or globular epimerite and egg-shaped gametocyst, dehisces through six sporoducts liberating ellipsoidal spores. These characters are sufficient to erect a new species for it and the name *Gregarina amojii* n. sp. is proposed, after the Indian gregarinologist, Dr. S.D. Amoji of Gulbarga.

***Gregarina veraniae* n. sp.**

(Test Figs. 18-22)

Host : *Verania discolour* (Fabr.) (Coleoptera ; Coccinellidae).

Development : Extracellular.

Trophozoite : Elongated ; knob-like epimerite, hemispherical protomerite and cylindrical deutomerite. Cytoplasm is uniformly granulated and epicyteal striations are not discernable.

Sporadin and association : Sporadins are elongated, cylindrical with dome-shaped protomerite and ovoidal or barrel-shaped deutomerite. A straight septum separates the protomerite from the deutomerite. Spherical nucleus is present posteriorly in the deutomerite.

Association is caudo-frontal ; protomerite of the satellite becomes concave for receiving the primite and thus reveals firm attachment between the two.

Gametocyst and spore : Gametocyst spherical, measuring $91.6 \mu\text{m} \times 108.3 \mu\text{m}$ in diameter. After 24 hrs. of development four sporoducts appear from the cyst surface. Each duct measures $41.7 \mu\text{m}$ in length. At about 48 hours of development spores are liberated in chains through these sporoducts.

The spores are ovoidal measuring $8.3 \mu\text{m} \times 4.2 \mu\text{m}$ with eight sporozoites arranged in a circular fashion in each spore. Formation of sporozoites is completed at 48 hrs. of development.

Measurements (in microns) :

Trophozoite

TL = 40.7-51.0 (45.9) ;

LE = 1.7- 8.5 (5.1) ; WE = 1.7- 8.5 (5.1) ;

LP = 8.3- 8.5 (8.4) ; WP = 10.0-12.8 (11.4) ;

LD = 32.4-34.0 (33.2) ; WD = 16.6-17.0 (16.8) ;

LN = 4.2- 6.0 (5.2) ; WN = 4.0- 6.0 (5.2) ;

Sporadin

TL = 29.8-82.9 (48.9) ;

LP = 4.3-17.0 (8.5) ; WP = 8.5-21.3 (13.3) ;

LD = 25.5-65.9 (25.6) ; WD = 14.9-46.8 (23.1) ;

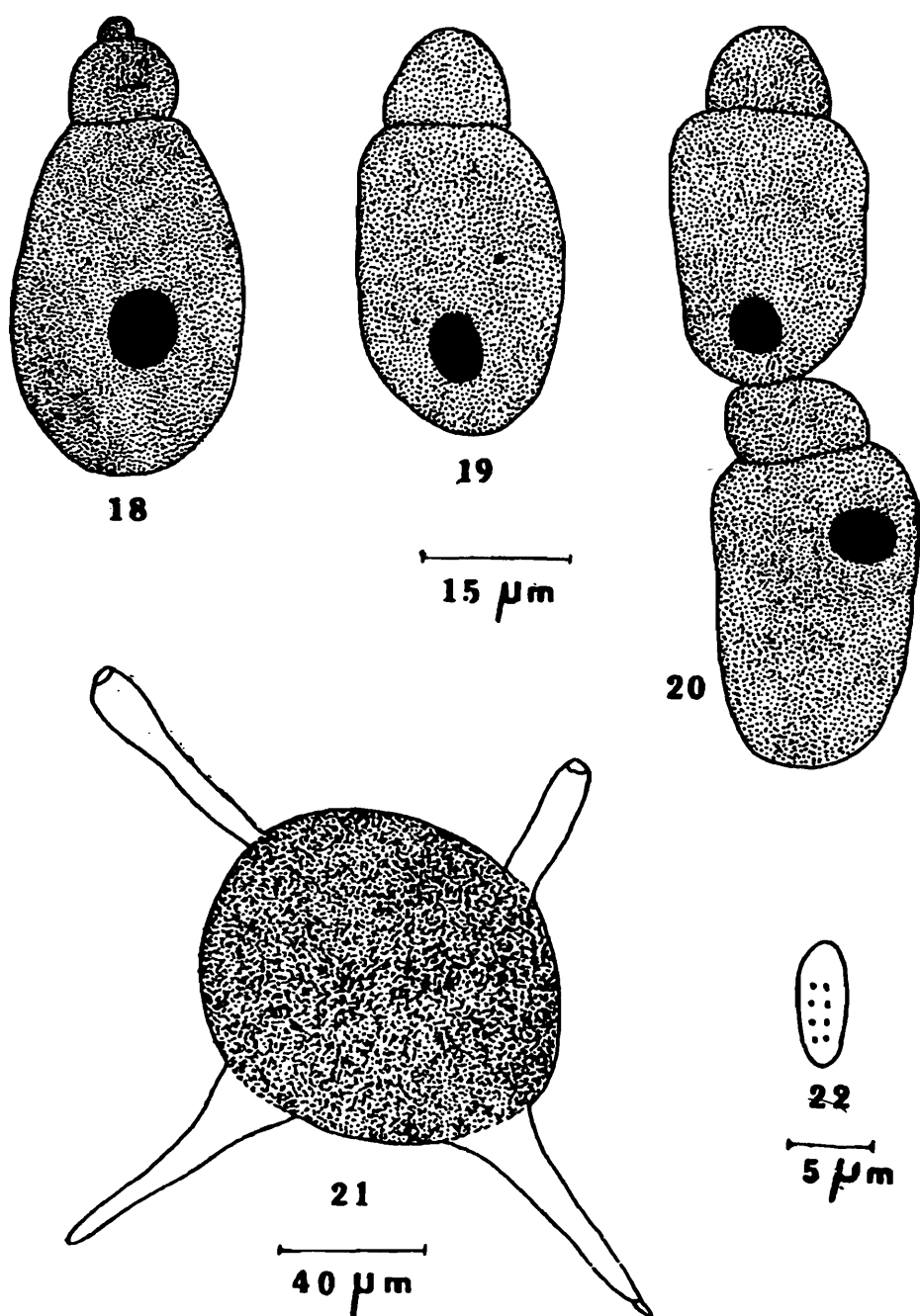
LN = 4.3- 6.4 (5.8) ; WN = 4.3- 6.4 (5.8) ;

LP:TL = 1:5.6 ;

WP:WD = 1:1.6.

Material : Holotype ; Coll. No. X5/1 S.C. Datta Coll. dated 8.10.1979. Type locality ; Kalyani University campus, W.B., paratype ; Coll. No. X5/3 and others.

Affinities : Presence of knob-like epimerite, biassociative sporadins and dehiscence through sporoducts are sufficient to place this parasite under the genus *Gregarina*.



Text Figs. 18-22. Camera lucida drawings of different stages of life-cycle of *Gregarina veraniae* n. sp. — 18. Trophozoite ; 19. Sporadin ; 20. Association ; 21. Gametocyst with four sporoducts ; 22. Spore.

The under report gregarine possesses close similarities in the shape of the epimerite with *G. alcidesii* Halder and Chakraborty, 1978 and *G. spraguei* Halder and Chakraborty, 1978 ; however, it differs from these two species in other respects. Its ovoidal spores and the ratios of LP:TL and WP:WD are distinctly separate from previously described species of the genus *Gregarina*. A new species *Gregarina veraniae* n.sp. is proposed here to accommodate the gregarine.

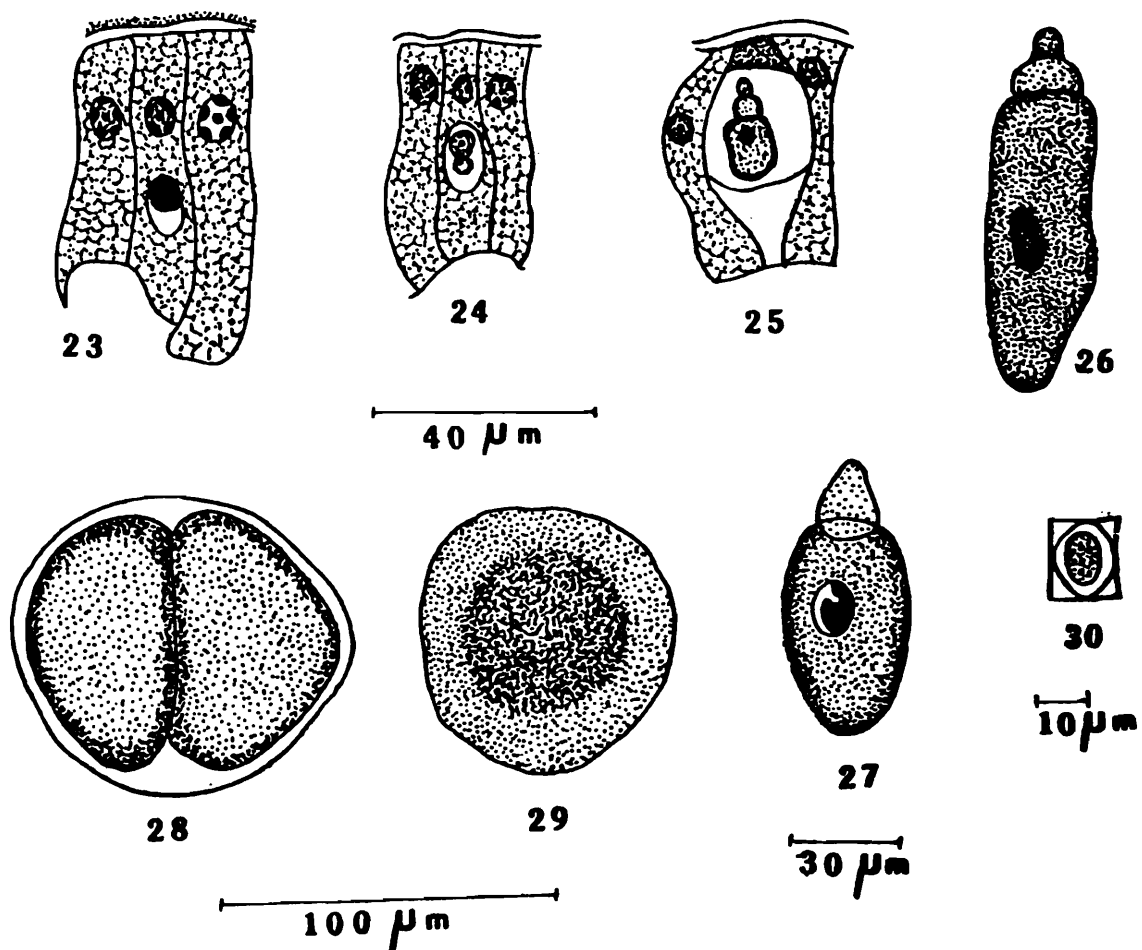
Genus *Stenophora* Labbe, 1899

Intracellular development. Sporonts solitary. Epimerite absent or simple. Cysts dehisce by simple rupture. Spores ovoidal with equatorial line, not extruded in chains.

Stenophora harpagophora n. sp.
(Text Figs. 23-30)

Host : An unidentified millipede (Spirosteptida : Harpagophoridae)

Development : Intracellular.



Text figs. 23-30. Camera lucida drawings of different stages of life-cycle of *Stenophora harpagophora* n. sp. — 23. Section of the host midgut showing the first intracellular stage of development of the parasite ; 24. Second intracellular stage of development of the parasite ; 25. A fully grown trophozoite within the epithelial cell of the midgut of the host ; 26. Trophozoite ; 27. Sporadin ; 28. An early gametocyst ; 29. Gametocyst before dehiscence ; 30. A spore with rectangular episporium ;

Trophozoite : Elongated. Epimerite is small, hyaline papilla like. The protomerite is dome-shaped while deutomerite is elongated with rounded end. The elliptical nucleus is situated anywhere in the deutomerite.

Sporadin : Solitary, cylindro-conical in shape. The protomerite is hemispherical and tapering towards the distal end. Cylindro-conical deutomerite with moderate amount of cytoplasm while the protomerite is almost free of granules. Nucleus with distinct nuclear membrane and a deeply stained endosome located at any place in the deutomerite.

Gametocyst and spore : Gametocyst rounded in shape measuring 133.3 μm in diameter. The gametocytes are equal in size. After 144 hrs. of development the gametocyst dehisces by simple rupture releasing the spores in mass.

Ovoidal spores with two walls surrounded by a rectangular coat. Tuzet, Manier and Jolivet (1957) have called this as 'episore'. Each spore measures $4.4 \mu\text{m} \times 3.9 \mu\text{m}$. 24 hrs. after the dehiscence of cyst, sporozoites are formed and are arranged irregularly.

Measurements (In microns) :

Trophozoite

TL = 85.9-110.8 (94.7) ;
 LE = 2.8 (2.8) ; WE = 2.8- 5.5 (3.3) ;
 LP = 11.1- 13.9 (11.7) ; WP = 16.4-19.4 (17.2) ;
 LD = 69.3- 83.1 (74.8) ; WD = 24.9-30.5 (27.1) ;
 LN = 11.9- 16.6 (14.6) ; WN = 2.8- 5.5 (4.96) ;

Sporadin

TL = 69.7-152.4 (93.8) ;
 LP = 8.3- 19.4 (13.6) ; WP = 13.9-27.7 (17.5) ;
 LD = 58.2-135.7 (81.4) ; WD = 22.2-55.4 (28.4) ;
 LN = 8.3-19.4 (12.4) ; LP:TL = 1:5.7-10.0 (7.3)
 WN = 5.5 (5.5) ; WP:WD = 1:1.3- 2.0 (1.7)

Material : Holotype ; Coll. No. M 6/1 S.C. Datta Coll. dated 3.4.1980. Type locality ; Kalyani, W.B., Paratype ; Coll. No. M 6/2 and others.

Affinities : Possession of solitary sporadin, dehiscence of cyst by simple rupture, spore possessing an episore and intracellular development are sufficient for the inclusion of the gregarine under the genus *Stenophora* Labbe. The parasite bears similarities in shape of protomerite and cyst with *S. conjugata* Rodgi and Ball, 1961 and *S. haplothysani* Tuzet, Manier and Jolivet, 1957 but differs in all other respect. It has also some resemblances with *S. mahabaleshwari* Amoji and Rodgi, 1972 and *S. haplothysani* Tuzet, Manier and Jolivet, 1957 in the shape of nucleus while it differs in all other characters. Therefore, the parasite described here as a new species, for which the name *Stenophora harpagophora* n. sp. is proposed after the name of the family to which the millipede belongs.

Genus Hyalaspiorina Chakravarty, 1935

Sporonts solitary ; epimerite small, tongue-like ; anisogametes ; cysts with

ducts ; spores oval with a hyaline membrane.

***Hyalosporina mukundi* n. sp.**
(Text Figs. 31-36)

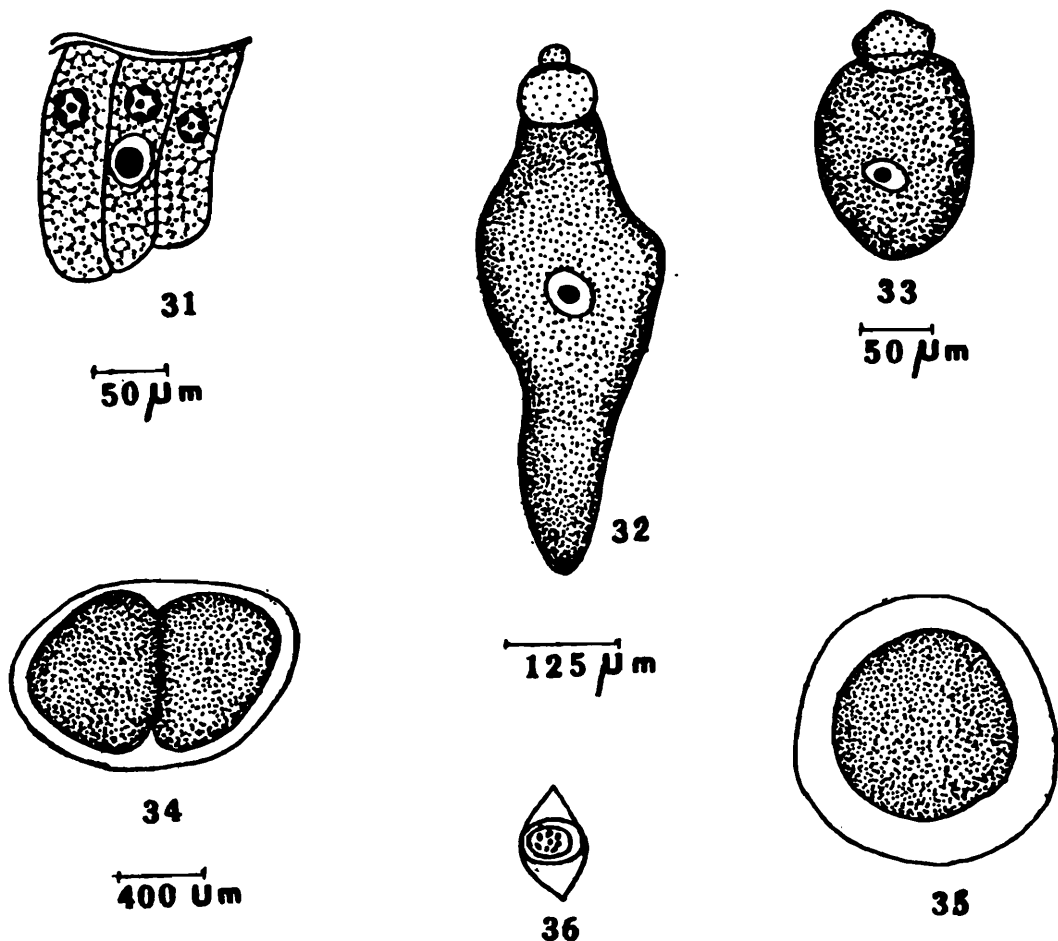
Host : An unidentified millipede (Spirosteptida : Harpagophoridae)

Development : Intracellular.

Trophozoite : Elongated with tongue-like epimerite which is always broader than long. The protomerite is hemispherical while the deutomerite is saucer-shaped. Cytoplasm is uniformly granulated. Spherical nucleus with distinct nuclear membrane.

Sporadin : Cylindro-conical with ovoidal protomerite and conical deutomerite. Spherical nucleus. Cytoplasm is uniformly granulated.

Gametocyst and spore : Gametocyst opaque-white in colour, spherical in shape measuring 312.0 μm in diameter. The gametocytes are equal in size. An ectocyst is present encircling the cyst measuring 62.4 μm . After 216 hrs. the cyst dehiscence by simple rupture liberating oval spore with two coats. A hyaline spindle-shaped membrane encircles the spores. Each spore measures 7.8 μm $\times$ 5.0 μm .



Text Figs. 31-36. Camera lucida drawings of different stages of life-cycle of *Hyalosporina mukundi* n. sp. — 31. Earliest intracellular stage with the epithelial cell of the host proventriculus; 32. Trophozoite ; 33. Sporadin ; 34. Early gametocyst ; 35. Gametocyst ; advanced stage ; 36. Spore with a hyaline coat.

Formation of sporozoites is completed after 24 hrs. of dehiscence whice lie scattered irregularly within the spore.

Measurements (in microns) :

Trophozoite

TL = 299.9 ;
LE = 8.3 ; WE = 16.7 ;
LP = 16.7 ; WP = 33.3 ;
LD = 274.9 ; WD = 83.3 ;
LN = 25.0 ; WN = 8.3 ;

Sporadin

TL = 83.3-266.6 (193.7) ;
LP = 16.7- 33.3 (19.6) ; WP = 16.7- 50.0 (27.9) ;
LD = 66.6-249.9 (165.8) ; WD = 33.3-133.3 (90.6) ;
LN = 16.7- 25.0 (20.8) ; WN = 16.7-25.0 (17.2) ;
LP:TL = 1:5.0 -14.0 (10.8) ;
WP:WD = 1:0.16- 0.75 (0.3).

Material : Holotype ; Coll. No. M7/1 S. C. Datta Coll. dated 8.10.1979. Type locality ; Kalyani University campus. Paratype ; Coll No. M7/3 and others.

Affinities : In having tongue-shaped epimerite, solitary sporadin, dehiscence of cyst by simple rupture, spores with hyaline membranes. The parasite satisfies its inclusion in the genus *Hyalosporina* Chakravarty, 1935. The presently described species has some resemblances with *H. Cambolopsisae* Chakravarty, 1935 in having tongue-like epimerite and ovoidal spores, but differs from the latter in other features. The parasite under report also shows some relationships with *H. rayi* Chakravarty, 1936 in having spherical gametocyst and general elongated shaps of the body but differs in all other characters. Thus in having some distinct features of its own the parasite designated as a new species and named *Hyalosporina mukundi* n. sp. after the Late Dr. Mukunda Murari Chakravarty who established the genus.

SUMMARY

The present paper deals with six new species of septate gregarines (Apicomplexa : Sporozoea) from insects.

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REPORT ON THE ICHTHYO FAUNA OF ANNA AND MADURAI DISTRICTS, TAMIL NADU

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Zoological Survey of India, Madras

INTRODUCTION

During the years 1986-1987, Zoological Survey of India, Southern Regional Station, carried out two extensive surveys of Anna and Madurai Districts, in Tamil Nadu, under the Mopping Survey Scheme. Madurai District is traversed by the river Vaigai and its tributaries such as Theni, Surali and Moolar. These are seasonal rivers. Apart from these water ways there are few lakes i.e. Kodaikanal Lake and Berijam Lake in Anna District. Some water falls and hillstreams were also surveyed for their Ichthyo fauna. The Vaigai Dam across Vaigai river near Madurai and Sathiar Dam also near Madurai were also surveyed.

No comprehensive account on the fish fauna of Anna and Madurai Districts is available and therefore, a list of fishes from these districts is worth reporting. The data under each species includes its first reference, number of examples, their size range in mm. in standard length, area of collection, date of collection, geographical distribution and remarks (wherever variations are observed).

In all there are 34 species in the present collection of 560 examples (503 adults and 57 juveniles) belonging to 9 families. *Puntius arenatus* (Day) is being reported for the first time from Vaigai Dam. *Puntius filamentosus* (Valenciennes) and *Puntius mahecola* (Val.) were treated as two distinct species in accordance with the findings of Selvaraj, Mathew and Abraham (1986-87). Jayaram (1981) was followed for the identification and distribution of fishes.

LIST OF SPECIES

Super Order	Ostariophysi
Order	Cypriniformes
Family	Cyprinidae
Sub Family	Cultrinae

1. *Salmostoma clupeoides* (Bloch)

.. 11 exs.

Subfamily	Rasborinae

4.	<i>Rasbora</i> (R) <i>caverii</i> (Jerdon)	.. 4 exs.
5.	<i>Rasbora</i> (R) <i>daniconius</i> (Hamilton)	.. 6 exs. 8 juv.

Subfamily Cyprininae

6.	<i>Catla catla</i> (Hamilton)	.. 2 exs.
7.	<i>Cirrhinus mrigala</i> (Hamilton)	.. 1 ex.
8.	<i>Cyprinus carpio communis</i> Linnaeus	.. 6 exs.
9.	<i>Labeo rohita</i> (Hamilton)	.. 3 exs.
10.	<i>Puntius arenatus</i> (Day)	.. 5 exs.
11.	<i>Puntius chola</i> (Hamilton)	.. 4 exs.
12.	<i>Puntius dorsalis</i> (Jerdon)	.. 5 exs. 45 juv.
13.	<i>Puntius filamentosus</i> (Valenciennes)	.. 21 exs.
14.	<i>Puntius mahecola</i> (Valenciennes)	.. 4 exs.
15.	<i>Punthus melanampyx</i> (Day)	.. 133 exs.
16.	<i>Puntius sarana sarana</i> (Hamilton)	.. 1 ex.
17.	<i>Puntius sophore</i> (Hamilton)	.. 11 exs.
18.	<i>Puntius ticto ticto</i> (Hamilton)	.. 39 exs.

Subfamily Garrinae

19.	<i>Garra mullya</i> (Sykes)	.. 12 exs.

Family Cobitidae
Subfamily Noemacheilinae

20.	<i>Noemacheilus denisonii denisonii</i> Day	.. 9 exs.
21.	<i>Noemachilus semiarmatus</i> Day	.. 5 exs.

Subfamily Cobitinae

22.	<i>Lepidocephalus thermalis</i> (Valenciennes)	.. 17 exs.

Order Siluriformes
Family Bagridae

23.	<i>Mystus cavasius</i> (Hamilton)	.. 2 exs.
24.	<i>Mystus montanus</i> (Jerdon)	.. 1 ex.
25.	<i>Mystus vittatus</i> (Bloch)	.. 3 exs.

Family Siluridae

26.	<i>Ompok bimaculatus</i> (Bloch)	.. 2 exs.
27.	<i>Wallago attu</i> (Schneider)	.. 4 exs.

Super Order Atherinomorpha
Order Atheriniformes
Family Poecilidae

28. *Gambusia affinis patrulis* (Baird & Girard) .. 54 ♀
.. 30 ♂

Super Order Acanthopterygii
Order Channiformes
Family Channidae

29. *Channa orientalis* (Schneider) .. 1 ex.
30. *Channa striatus* (Bloch) .. 1 ex.

Order Perciformes
Family Cichlidae

31. *Eetroplus maculatus* (Bloch) .. 2 exs.
32. *Sarotherodon mossambica* (Peters) .. 47 exs.

Family Mugilidae

33. *Rhinomugil corsula* (Hamilton) .. 5 exs.

Family Gobiidae

34. *Glossogobius giuris* (Hamilton) .. 14 exs.

SYSTEMATIC ACCOUNT

Salmostoma clupeioides (Bloch)

1795. *Cyprinus clupeioides* Bloch, *Naturg. Ausland. Fische*, 12 p. 49, pt. 408. fig. 2. (Type locality : Tranquebar).

Material : 6 exs., 87-107 mm. SL., Vaigai Dam., 9.11.86; 3 exs., 117-155 mm. SL., Vaigai Dam., 13.11.86; 2 exs., 68-75 mm. SL., Vaigai Dam., 14.3.87.

Distribution : India : Narmada, Tapi, Krishna, Godavery and Cauvery river systems. Recorded from Nasik, Deolali and Jabalpur.

Amblypharyngodon microlepis (Bleeker)

1853. *Leuciscus microlepis* Bleeker, *Verh. batav. Genoot. Kunst. wet.* 25, p.r. (Type locality : River Hooghly).

Material : 15 exs., 62-82 mm. SL., Vaigai Dam., 9.11.86; 11 exs., 71-85 mm. SL., Vaigai Dam., 13.11.86.

Distribution : India : Eastern and Southern India.

Danio aequipinnatus Mc Clelland

1839. *Perilampus aequipinnatus* Mc Clelland, *Asiatic Researchers*, 19, p. 393. (Type locality : Assam).

Material : 4 exs. (juv.) 19-24 mm. SL., Veerapandi., 10.11.86; 1 ex. 57 mm. SL., Pick up site, Vaigai Dam., 11.11.86; 11 exs., 68-74 mm. SL., Suruli falls., 15.3.87.

Distribution : India : Eastern Himalaya, Meghalaya and Decan. Nepal, Bangladesh, Burma, Thailand and Sri Lanka.

Remarks : Specimens collected from Suruli fall agreed with *Danio aequipinnatus* in colour pattern, presence of barbels and in number of lateral line scales but differ from it in having 9-10 branched rays in dorsal fin and 15-16 branched rays in anal fin. A critical analysis of various morphometric characters of specimens collected from various localities was taken up for the study. The results will be published elsewhere.

Rasbora (Rasbora) caverii (Jerdon)

1849. *Leuciscus caverii* Jerdon, *Madras J. Lit. & Sci.*, 15, p. 320. (Type locality : Cauvery river, Coorg State)

Material : 1 ex., 84.0 mm. SL., Vaigai Dam., 9.11.86; 3 exs., 52-87 mm., SL., Kodavanaru, near Ramayyan Patti., 23.11.86.

Distribution : India : Southern India, notably Karnataka, especially in Cauvery Basin. Sri Lanka.

Rasbora (Rasbora) daniconius (Hamilton)

1822. *Cyprinus daniconius* Hamilton, *Fish Ganges*, p. 327, pl. 15. fig. 89 (Type locality : Rivers of Southern Bengal).

Material : 1 ex., 37.0 mm. SL., Chinnamanur., 10.11.86; 4 exs., (juv.) 18-23 mm. SL., Veerapandi, 10.11.86; 4 exs., 30-42 mm. SL., Madhavan Kulam (Madurai), 7.3.87; 4 exs., (juv.) 20-24 mm. SL., Sathiar Dam., 18.3.87; 1 ex. 22.0 mm. SL., Berijam Lake, 22.3.87.

Distribution : India : Throughout India. Pakistan, Nepal, Bangladesh, Sri Lanka, Burma, Malapis and Thailand, Zanzibar.

Catla catla (Hamilton)

1822. *Cyprinus catla* Hamilton, *Fish Ganges*, p. 287, 387, pl. 13, Fig. 18. (Type locality : In the rivers and tanks of Bengal).

Material : 1 ex., 183.0 mm. SL., Theni river, 9.11.86; 1 ex., 204.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India. Pakistan, Bangladesh, Burma. Introduced into South Indian rivers.

Remarks : Natarajan *et. al.*, (1977) have recognised three subspecies of *Catla catla* in Rihand Dam, based on the relative length of pectoral fin (P_s) (P_m) and (P_l). In the present collections both the specimens fall into (P_m) category i.e. Medium sized Pectoral fin.

Cirrhinus mrigala (Hamilton)

1822. *Cyprinus mrigala* Hamilton, *Fish Ganges*, p. 279, 386, pl. 6, fig. 78. (Type locality : Ponds and freshwater rivers of the Gangetic Provinces).

Material : 1 ex., 294.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India, Pakistan, Bangladesh, Burma.

Cyprinus carpio communis Linnaeus

1758. *Cyprinus carpio* Linnaeus, *Syst. Nat. Ed.*, 10, 1, p. 525. (Type locality : Europe).

Material : 1 ex., 163.0 mm. SL., Sathiar Dam, 6.11.86; 1 ex., 165.0 mm. SL., Parapalar Dam, 12.11.86; 1 ex., 56.0 mm. SL., Berijam Lake, 15.11.86; 2 exs., 149-207 mm, SL., Lakshmipuram, 13.3.87; 1 ex., 47.0 mm. SL., Berijam Lake, 22.3.87.

Distribution : Naturally found all over China, Japan, Taiwan, Europe, America. Introduced into Indian waters.

Labeo rohita (Hamilton)

1822. *Cyprinus rohita* Hamilton, *Fish Ganges*, p. 301, 388, pl. 1, Fig. 85. (Type locality : Freshwaters of the Gangetic Province).

Material : 2 exs., 154-190 mm. SL., Vaigai Dam, 13.11.86; 1 ex., 168.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India. Pakistan, Bangladesh, Burma. Introduced into South Indian rivers and reservoirs.

Puntius arenatus (Day)

(Plate I, Fig. 1)

1878. *Barbus arenatus* Day, *Fish India*, p. 574, pl. cxlii, Fig. 7 (Type locality : Madras).

Material : 5 exs., 62-89 mm. SL., Vaigai Dam, 9.11.86.

Distribution : Madras.

Remarks : This is the first record of this species from Vaigai Dam. As it shows some differences in bio-metric characters, a detail description of the species is given:

D. iv/8, P. 1/14-16, V. 1/7/1, A. 3/5, C. 19, Ll. 24-27, L. tr. 4½/3½.

Length of head 4.30-4.69 (4.58) in TL and 3.28-3.75 (3.53) in SL; body depth 3.67-4.70 (4.34) in TL and 2.91-5.59 (3.35) in SL. Eye 3.40-3.92 (3.68) in head length; 0.75-0.96 (0.67) from snout; 1.25-1.67 (1.45) apart. Dorsal more convex than the abdomen. A pair of barbel reaches the first third of the eye. Dorsal fin

Characters	Day's Present	Species collection
1. Dorsal	2/8	4/8
2. Pectoral	15	1/14-1/16 (15-17)
3. Predorsal scales	11	9-10
4. Total length/Head length	4.75	4.30-4.79 (4.58)
5. SL/Head length	—	3.28-3.75 (3.53)
6. Total length/Body depth	4.0	4.35-4.70 (4.34)
7. Head length/Eye diameter	4.5-5.0	3.40-3.92 (3.68)
8. Snout/Eye	1.5	0.75-0.96 (0.67)
9. Inter orbital width/Eye	2	1.25-1.67 (1.45)

commences slightly nearer to the caudal end than to the snout. The last undivided dorsal ray smooth, osseous inferiorly, becoming articulated superiorly. The first two spines hidden beneath the predorsal rows of scales.

Colour : Upper half of body steel blue becoming golden on sides. In the upper half of body each scale has black dots along the outer margin. On the scales on the lateral line, the dots ceases with the upper half of the scale. Dorsal fin with black, closely packed dots on the first two soft rays and scatterly arranged dots on the other soft rays, which forms a band thicker in the beginning and lighter in the end. First two rays of the anal fin too, black tipped with dots. Caudal fin black edged.

In general it resembles *Puntius arenatus* (Day) but it differs from Day's description in the following characters.

***Puntius dorsalis* (Jerdon)**

1849. *Systonus dorsalis* Jerdon, *Madras J. Lit. & Sci.*, p. 314, 316. (Type locality : Tanks and rivers in the neighbourhood of Madras).

Material : 6 exs., (juv.) 27-38 mm. SL., Chinnamanur, 10.11.86; 36 exs., (juv.) 20-33 mm. SL., Veerapandi, 10.11.86; 1 ex., (juv.) 33.0 mm. SL., Periakulam, 11.11.86; 3 exs., 113-124 mm. SL., Pick up site Vaigai Dam, 11.11.86; 2 exs., (juv.) 29-33 mm. SL., Forest Training College pond, 13.11.86; 1 ex., 114.0 mm. SL., Vaigai Dam, 13.11.86; 1 ex., 68.0 mm. SL., Sathiar Dam, 8.3.87.

Distribution : India : Krishna, Cauvery, Coleroon river systems in South India.

Remarks : The juveniles resemble *Puntius puckelli* (Day) in all the characters.

***Puntius filamentosus* (Valenciennes)**

1844. *Leuciscus filamentosus* Valenciennes, *Hist. Nat. Poiss.*, 17, p. 96, pl. 492. (Type locality Alleppey, Kerala).

Material : 1 ex., 93.0 mm. SL., Vaigai Dam, 9.11.86; 14 exs., 62-85 mm. SL., Vaigai Dam, 11.11.86; 6 exs., 78-129 mm. SL., Vaigai Dam, 13.11.86.

Distribution : India : Freshwaters of Kerala, Southern karnataka, Tamil Nadu and Sri Lanka.

***Puntius mahecola* (Valenciennes)**

1844. *Leuciscus mahecola* Valenciennes, *Hist. Nat. Poiss.*, 17, p. 305, pl. 502. (Type locality : Canara).

Material : 4 exs., 59-101 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : From Canara down the Western Coast and along the base of the Nilgiris and Travancore Hills. Sri Lanka.

***Puntius malanampyx* (Day)**

1865. *Labeo malanampyx* Day, *Proc. zool. Soc. London*, p. 298. (Type locality : Wynaad).

Material : 106 exs., 27-48 mm. SL., Berijam Lake, 15.11.86; 26 exs., 26-55 mm. SL., Kodaikanal Lake, 17.11.87; 1 ex., 30.0 mm. SL., Berijam Lake, 22.3.87.

Distribution : India : Cauvery river and its head water streams at base of Wynaad, Nilgiri and Travancore Hills. Also known from Nallamalai Hills, Eastern Ghats.

Puntius sarana sarana (Hamilton)

1822. *Cyprinus sarana* Hamilton, *Fish Ganges*, p. 307. (Type locality : Gangetic Systems, Bengal).

Material : 1 ex., 84.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India. Thailand, China, Bangladesh, Burma.

Puntius sophore (Hamilton)

1822. *Cyprinus sophore* Hamilton, *Fish Ganges*, p. 310, 319, pl 19. Fig. 86. (Type locality : Ponds of Bengal).

Material : 2 exs., 62-71 mm. SL., Vaigai Dam, 9.11.86; 7 exs., 57-71 mm. SL., Vaigai Dam, 13.11.86; 2 exs., 37-40 mm. SL., Madhavankulam, 7.3.87.

Distribution : India : Throughout India. Pakistan, Bangladesh, Sri Lanka.

Puntius ticto ticto (Hamilton)

1822. *Cyprinus ticto* Hamilton, *Fish Ganges*, p. 314, 389, pl. 8, Fig. 87. (Type locality : Southeastern parts of Bengal).

Material : 39 exs., 20-51 mm. SL., Kodaikanal lake, 17.11.86.

Distribution : India : Throughout India. Pakistan, Bangladesh, Burma, Sri Lanka, Thailand.

Remarks : Hora and Law (1941) stated that the Peninsular forms has complete lateral line. In the present collection it was observed taht the lateral lineé was complete in large sized forms (above 50 mm, TL) the lateral line is visible only upto 16 to 18 scale. Frequence distribution of lateral line scales and extension of posterior spot on the lateral line is given below.

Lateral Line Scales				
Ll. Scales	24	25	26	27
No. of Exs.	4	8	20	7

Extension of posterior colour spot on lateral line									
Ll. Scales	16-18	17-18	17-19	18-19	18-20	18-21	19-20	19-21	19-22
No. of exs.	1	1	4	3	15	2	3	9	1

Garra mullya (Sykes)

1841. *Chondrostoma mullya* Sykes, *Trans. zool. Soc. London*, 2 : p. 359, pl. 62, fig. 3. (Type locality : Poona waters).

Material : 12 exs., 67-98 mm. SL., Suruli fall, 15.3.87.

Distribution : India : Throughout India except Assam and Himalaya.

Noemacheilus denisonii denisonii Day

1867. *Noemacheilus denisonii* Day, *Proc. zool. Soc. Lond.*, p. 287. (Type locality : Nilgiri and Coorg Hills).

Material : 7 exs., 25-47 mm. SL., Suruli fall, 15.3.87; 2 exs., 32-38 mm. SL., Moolar river, 21.3.87.

Distribution : India : Rivers in the base of Nilgiris and Coorg Hills.

Noemacheilus semiarmatus Day

1867. *Noemacheilus semiarmatus* Day, *Proc. zool. Soc. Lond.*, p. 286. (Type locality : Bhavani and Siger rivers at base of Nilgiri Hills).

Material : 3 exs., 36-40 mm. SL., Moolar river, 21.3.87; 2 exs., 24-27 mm. SL., Myladumparai, 20.3.87.

Distribution : India : Bhavani and Siger rivers at base of Nilgiri Hills . Also known from Karnataka, likely to be obtained from the headwaters of Cauvery.

Lepidocephalus thermalis (Valenciennes)

1846. *Cobitis thermalis* Valenciennes, *Hist. nat. Poiss.*, 17, p. 78. (Type locality : Ceylon).

Material : 2 exs., 17-23 mm. SL., Veerapandi, 10.11.86 ; 12 exs., 19-31 mm. SL., Chinnamanur, 10.11.86; 1 ex., 35.0 mm. SL., Periyakulam, 11.11.86; 1 ex., 38.0 mm. SL., Thankkachiyanman patti, 20.11.86; 1 ex., 21.0 mm. SL., Madavan kulam, 7.3.87.

Distribution : India : Southern Karnataka, Kerala, Tamil Nadu, Sri Lanka.-

Mystus cavasius (Hamilton)

1822. *Pi.nelodus cavasius* Hamilton, *Fish Ganges*, p. 303, 379, pl. 11, Fig. 67. (Type locality : Gangetic Provinces).

Material : 1 ex., 140.0 mm. SL., Theni river, 9.11.86; 1 ex., 115.0 mm. SL., Vaigai Dam, 9.11.86.

Distribution : India : Throughout India. Pakistan, Bangladesh, Burma, Thailand.

Mystus montanus (Jerdon)

1849. *Baqarusmontanus* Jerdon, *Madras J. Lit. & Sci.*, 15 (2), p. 338. (Type locality : Manantody river, Wynaad).

Material : 1 ex., 78.0 mm. SL., Vaigai Dam, 9.11.86.

Distribution : India : Manantody river, Wynaad, Cauvery headwaters.

Mystus vittatus (Bloch)

1797. *Silurus vittatus* Bloch, *Ichthyol. Hist. Nat.*, 11, p. 40, pl. 371, Fig. 2. (Type locality : Tranquebar, South India).

Material : 2 exs., 90-110 mm. SL., Vaigai Dam, 9.11.86; 1 ex., 75.0 mm. SL., Periyakulam, 11.11.86.

Distribution : India : Throughout India. Pakistan, Burma, Thailand, Bangladesh, Sri Lanka.

Ompok bimaculatus (Bloch)

1797. *Silurus bimaculatus* Bloch, *Syst. Ichts.*, 11, p. 17, pl. 369. (Type locality : Malabar).

Material : 1 ex., 110.0 mm. SL., Vaigai dam, 13.11.86; 1 ex, 240.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India. Pakistan, Nepal, bangladesh, Sri lanka, Thailand, Malaya, Vietnam, East Indies, Yunnan.

Wallago attu (Bloch)

1801. *Silurus attu* Schneider, *Syst. Ichth.*, p. 378, pl. 75. (Type locality : Malabar).

Material : 1 ex., 190.0 mm. SL., Vaigai Dam, 9.11.86; 1 ex., 215.0 mm. SL., Theni river, 9.11.86; 1 ex., 246.0 mm. SL., Vaigai Dam, 13.11.86; 1 ex., 280.0 mm. SL., Vaigai Dam, 14.3.87.

Distribution : India : Throughout India. Pakistan, Burma, Bangladesh, Sri Lanka.

Gambusia affinis patruelis (Baird & Girard)

1853. *Heterandia patruelis* Baird & Girard, *Proc. Acad. nat. Sci. Philad.*, 6, p. 390. (Type locality : Rio Sabinal, Texas).

Material : 1 ♂ ex., 17.0 mm. SL., Veerapandi, 10.11.86; 1 ♀ and 8 ♂, ex., 12-21 mm. SL., Berijam Lake, 15.11.86; 5 ♀ and 7 ♂ exs., 20-27 mm. SL., Kodaikanal Lake, 17.11.86; 48 ♀ and 14 ♂ exs., 23-27 mm. SL., Berijam Lake, 22.3.87.

Distribution : India : Throughout India. Pakistan, Burma, Bangladesh, Sri Lanka.

Channa orientalis (Schneider)

1810. *Channa orientalis* Schneider, *Syst. Ichth.*, p. 496, pl. 90, Fig. 2. (Type locality : Not given).

Material : 1 ex., 64.0 mm., SL., Sathiyar Dam, 8.3.87.

Distribution : India : Throughout India. Pakistan, Afghanistan, Bangladesh, Sri Lanka, Burma, Thailand, Malaya Archipelago, Vietnam.

Channa striatus (Bloch)

1793. *Ophiocephalus striatus* Bloch, *Naturq. Ausland. Fisches*, 2, p. 141, pl. 359. (Type locality : Malabar).

Material : 1 ex., 44.0 mm. SL., Periyakulam, 11.11.86.

Distribution : India : Throughout India. Pakistan, Bangladesh, Sri Lanka, Burma, Thailand, Malaya, S. China, Philippines.

Etroplus maculatus (Bloch)

1785. *Chaetodon maculatus* Bloch, *Syst. Ichth.*, pl. 427, Fig. 2. (Type locality : Not given).

Material : 1 ex., 55.0 mm. SL., Vaigai Dam, 9.11.86; 1 ex., 46.0 mm. SL., Pickup site Vaigai Dam, 11.11.86.

Distribution : India : Tamil Nadu, Kerala, S. Kanara, Sri Lanka.

Sarotherodon mossambica (Peters)

1852. *Chromis mossambicus* Peters, *Monatsb. Akad. Wiss., Berlin*, p. 681. (Type locality Zambesi river, S. Africa).

Material : 1 ex., 133.0 mm. SL., Sathiyar Dam, 6.11.86; 7 exs., 22-65 mm. SL., Vaigai Dam, 8.11.86; 2 exs. 102-131 mm. SL., Theni river, 9.11.86; 2 exs., 46-52 mm. SL., Periyakulam, 11.11.86; 5 exs., 124-154 mm. SL., Parapalar Dam, 12.11.86; 5 exs., 44-63 mm. SL., Vaigai Dam, 12.11.86; 6 exs., 110-124 mm. SL., 22.11.86; 6 exs., 52-73 mm. SL., Kodavanaru, 23.11.86; 13 exs., 39-45 mm. SL., Sathiyar Dam, 8.3.87.

Distribution : East Africa to Natal. Widely introduced in India and Pakistan.

Rhinomugil corsula (Hamilton)

1822. *Mugil corsula* Hamilton, *Fish Ganges*, p. 221, 381, pl. 8, Fig. 97. (Type locality : Rivers of Gangetic Provinces, in Southern parts of Bengal).

Material : 2 exs., 115-170 mm. SL., Vaigai Dam, 9.11.86; 2 exs., 157-162 mm. SL., Vaigai Dam, Pick up site, 11.11.86; 1 ex., 147.0 mm. SL., Vaigai Dam, 13.11.86.

Distribution : India : Gangetic Province and Southern parts of Bengal, Chilka Lake, Krishnagiri and Sathanur Reservoir across Penniar and Cauvery rivers.

Glossogobius giuris (Hamilton)

1822. *Gobius giuris* Hamilton, *Fish Ganges*, p. 51, 336, pl. 33, Fig. 15. (Type locality : Ponds and freshwaters of Gangetic Provinces).

Material : 5 exs., 94-205 mm. SL., Vaigai Dam, 9.11.86; 5 exs., 80-144 mm. SL., Vaigai Dam, 11.11.86; 4 exs., 170-225 mm. SL., Sathiyar Dam, 8.3.87.

Distribution : India : Throughout India, Pakistan, Burma, Bangladesh, Sri Lanka. This species has a wide range from the East Coast of Africa to Japan, Australia and S. Pacific.

ACKNOWLEDGEMENT

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SUMMARY

The paper deals with 34 species belonging to 9 families, which were collected from Anna and Madurai Districts, Tamil Nadu. *Puntius arenatus* (Day) is reported for the first time from Vaigai Dam.

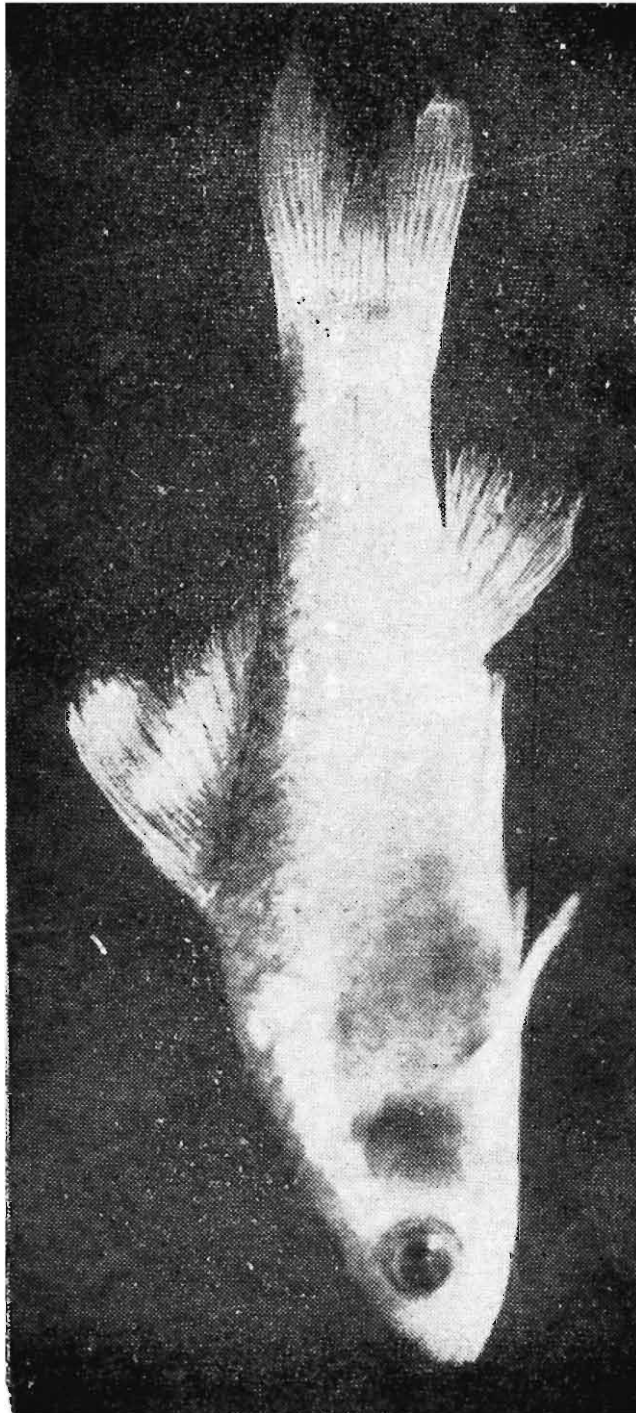
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Records of the Zoological Survey of India

T. J. INDRA

PLATE I



Puntius arenatus (Day)—Lateral view

**NOTES ON THE INDIAN SPECIES OF *ANISOLABIS* FIEBER
(DERMAPTERA : ANISOLABIDIDAE)**

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In India genus *Anisolabis* Fieber, is represented by two species viz., *A. gaudens* Burr and *A. deplanata* Srivastava, of which the taxonomic position of the former is doubtful since it is known by females. Besides a new species *A. bhowmiki* is described here.

It is proposed to synonymise *Aborolabis martensi* brindle under *Anisolabis deplanata* Srivastava owing to their identical description.

According to Srivastava (1985) the record of *A. maritima* Bonelli from South India (Burr, 1914 ; Steinmann, 1981) are based on either females or nymphs, are doubtful.

Genus *Anisolabis* Fieber

1853. *Anisolabis* Fieber, *Lotos*, 3 : 257 (Type species—*Forficula maritima* Bonelli in Gene, 1832, by subsequent designation of Scudder, 1876, *Proc. Boston Soc. nat. Hist.*, 18 : 289).

Diagnostic characters. — Parameres elongated, three to four times longer than broad, parallel sided or slightly dilated in middle or base, apically rounded, virga present or absent.

Distribution. — All regions.

Remarks. — The interpretation of the genus in the present work is after Burr, 1915.

Key to the species

1(2). Size larger (17.7 mm or more)	<i>A. gaudens</i> Burr
2(1). Size smaller (7.8 — 10.3 mm)	
3(4) Sides of abdominal segments 5th to 9th in males acute angled posteriorly and with an oblique carina on 6th to 8th or 9th	<i>A. deplanata</i> Srivastava
1(3) Sides of abdominal segments 5th to 9th in males obtuse angled posteriorly and ecrinate	<i>A. bhowmiki</i> sp. n.

Anisolabis bhowmiki sp. n.

(Figs. 1-6)

♂ : General colour blackish brown, mouth parts, one or two ante-apical antennal segments yellow ; legs yellow with basal half of femora banded with blackish brown.

Head slightly longer than broad, shining, frons convex, sutures obsolete, hind margin with slight emargination in middle. Eyes small, about $1/2$ as long as the post-ocular length. Antennae (partly broken, on the right side 5 basal and on the left 15 segments remaining) with basal segment stout, gently expanded apically, slightly shorter than the distance between antennal bases ; 3rd long and cylindrical longer than 4th and 5th ; 4th slightly shorter than 5th, subclavate, stouter ; 5th slightly stouter than 4th, subclavate ; 6th almost equal to 3rd but stouter, narrowed

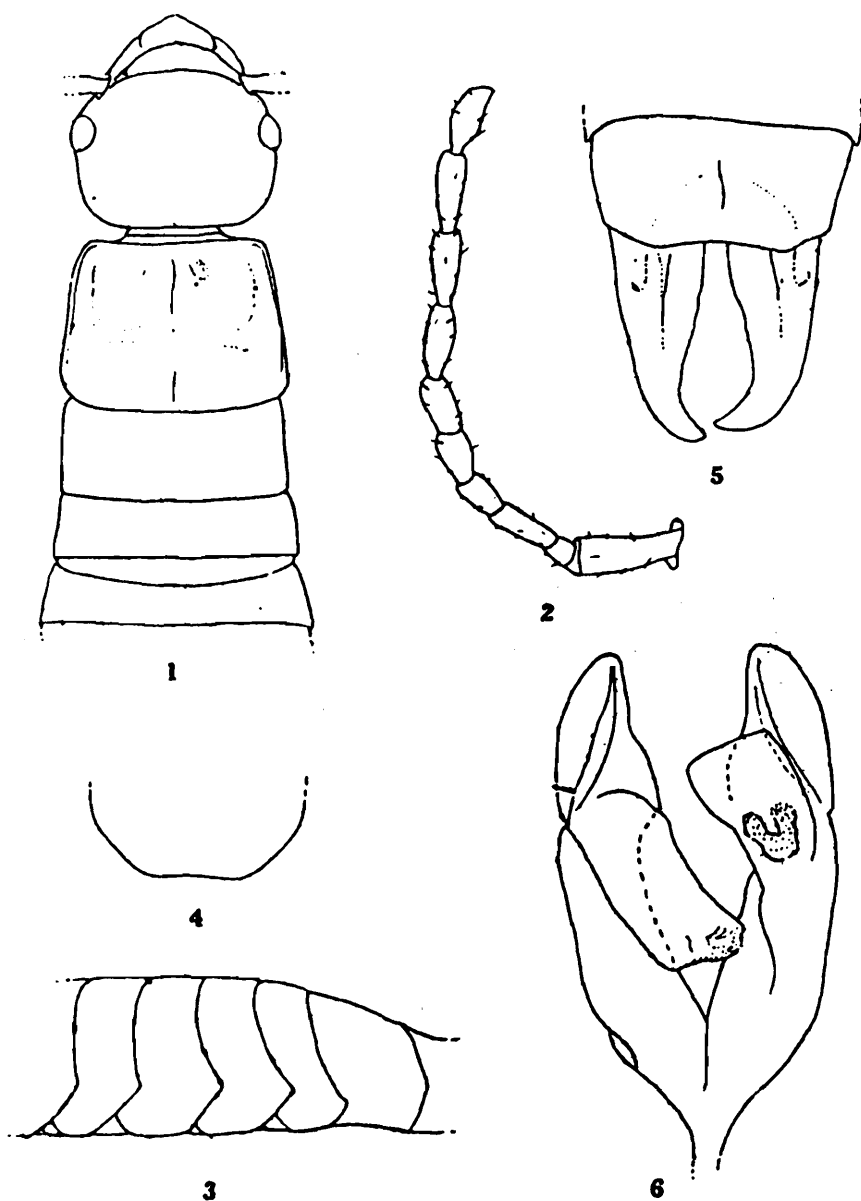


Fig. 1-6 : *Anisolabis bhowmiki* sp. n., Holotype , (1) Anterior portion of body; (2) Left antenna, enlarged ; (3) Sides of abdominal segments ; (4) Posterior margin of penultimate sternite ; (5) Ultimate tergite and forceps ; (6) Genitalia.

basally and gently expanded apically ; remaining gradually increasing in length and thinning. Pronotum transverse, gently widened posteriorly, all margins straight, sides gently reflexed, median sulcus faint, prozona weakly raised, hardly differentiated from weakly depressed metazona. Mesonotum and metanotum transverse, former with hind margin truncate and latter concave. Elytra and wings absent. Legs typical for the genus. Abdomen gently expanded in middle, convex, lateral tubercles on 3rd and 4th tergites obsolete, sides of segments 5th to 9th obtuse angled posteriorly, ocarinate, rugulosely punctulate. Penultimate sternite obscurely punctulate, transverse, hind margin scarcely emarginate in middle. Ultimate tergite transverse, smooth, shining, sloping backwards, median sulcus distinct, hind margin trisinate, laterally oblique. Forceps subcontiguous, expanded at base, tapering apically, left branch almost straight, right bent in basal half, apices gently hooked and pointed, trigonal above in basal 1/3, afterwards depressed, internal margin finely serrated. Genitalia as seen in the Fig. 6.

♀ : Unknown.

Measurements (in mm) :

	Holotype
	♂
Length of body	9.0
Length of forceps	1.3

Material examined. — Holotype , India : West bengal, Darjeeling District, Sonada, Alt. 1971 m, 24. iii. 1978 (A. R. Bhowmik) ; genitalia mounted between two coverslips and pinned with the specimen ; deposited in the Zoological Survey of India, Calcutta. The species is named after the collector.

Remarks. — This species comes very close to *Anisolabis deplanata* Srivastava, by its small size but differs in having the sides of abdominal segments 5th to 9th obtuse angled and ecarinate. Besides the shape of parameres in the described species is distinctive in being slightly expanded basally.

***Anisolabis gaudens* Burr** (Figs. 7-8)

1904. *Anisolabis gaudens* Burr, *Trans. R. Ent. Soc. Lond.*, 1904 : 291, (♀ not ♂ ; Bhutan) ; 1910, *Fauna Brit. India, Dermaptera* : 87 ; 1911, *Genera Insect.*, 122 : 30 ; 1913, *Rec. Indian Mus.*, 8(2) : 138 ; Kapoor, 1968, *Agra Uni. J. Res. (Sci.)*, 16(1) : 12 ; Biswas, Lahiri and Ghosh, 1973, *Proc. zool. Soc., Calcutta*, 26 : 29 (3 nymphs, not ; Meghalaya) ; Srivastava, 1976, *Rec. zool. Surv. India, Occ. pap.*, 2 : 21 ; 1985, *Rec. zool. Surv. India*, 82(1-4) : 44.

Brief description. - ♂ : Unknown.

♀ : General colour shining blackish, head clear brick red ; antennae with two segments reddish. Build stout.

Head about as long as broad, convex, sutures faint ; antennae 15-segmented, 4th and 5th almost globular ; eyes black, smaller than genae. Pronotum transverse, gently expanded posteriorly with margin subtruncate. Elytra and wings absent. Legs normal. Abdomen smooth, gently widened posteriorly. Penultimate sternite with posterior margin rounded in middle. Ultimate tergite weakly transverse,

gently narrowed in middle. Forceps with branches simple, straight, contiguous, trigonal near base, tapering, apices pointed, gently incurved and crossing, inner margin unarmed.

Measurements (in mm) :

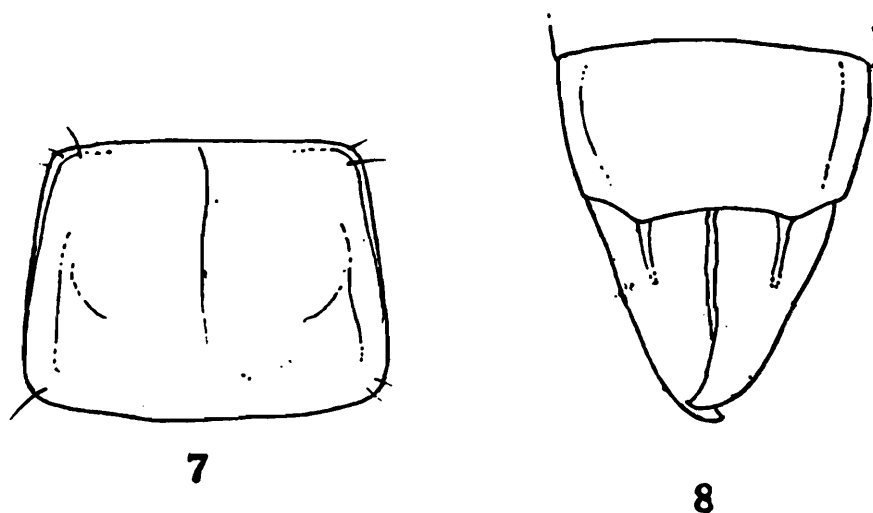
	♀
Length of body	14.5
Length of forceps	2.6

Material examined.— India : Arunachal Pradesh, Siang District, Rotung, 427 m, 1 ♀ (Det. by M. Burr), 25. xii. 1911, under bark (S. W. Kemp).

Distribution.— India : Arunachal Pradesh and Sikkim (Pedong).

Remarks.— The original description of the species was based on 1 ♂ (not ♂ as stated) from Bhutan, Pedong. But Pedong is now included under Sikkim.

The above specimen was referred doubtfully to this species by Burr (1913).



Anisolabis gaudens Burr, (7) Pronotum ; (8) Ultimate tergite and forceps ;

***Anisolabis deplanata* Srivastava** (Figs. 9-12)

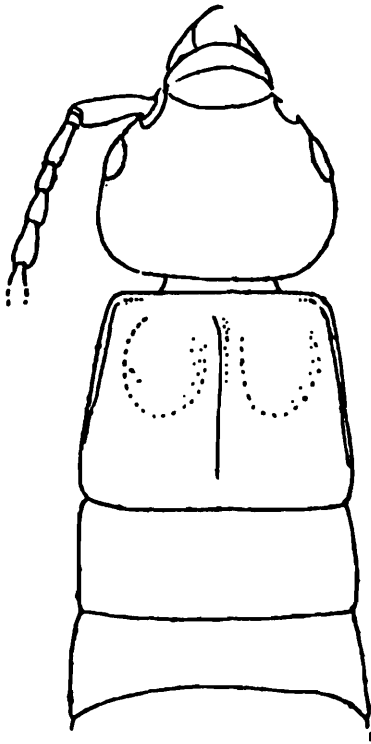
1985. *Anisolabis deplanata* Srivastava, *Rec. zool. Surv. India*, **82**(1-4) : 42, Fig. 1-6 (Holotype ♂, Paratype 1 ♂ ; India : Arunachal Pradesh, Tirap District ; Paratype 1 ; West Bengal, Darjeeling District).

1987. *Aborolabis martensi* Brindle, *Courier Forsch.-Inst. Senckenberg.*, **93** : 336, Figs. 12, 17 (Holotype ♂, Paratype 1 ♀, Nepal, Gorkha District)—Syn. n.

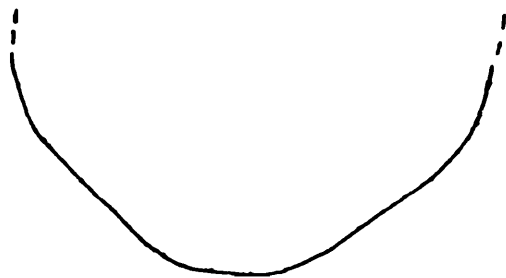
Brief description.— o : General colour dark brownish black, antennal segments 2nd and 12th onwards two or three segments dirty white, pronotum laterally yellow ; legs yellow but femora banded with black in basal half. ,

Head longer than broad, frons convex, sutures obsolete. Antennae 13-segmented. Eyes about 1/2 as long as the post-ocular length. Pronotum about as long as broad

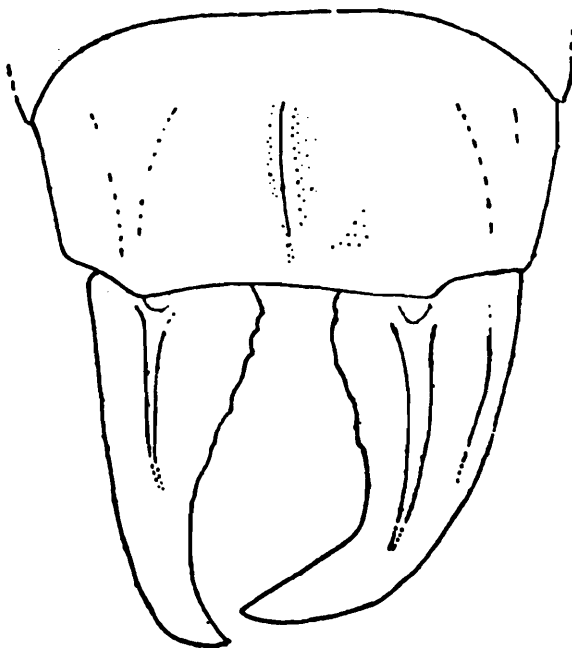
or gently transverse, all margins straight. Legs typical. Abdomen spindle shaped, sides of segments 6th to 8th or 9th with a ridge. Penultimate sternite with posterior margin rounded. Ultimate tergite transverse, obscurely punctulate. Forceps



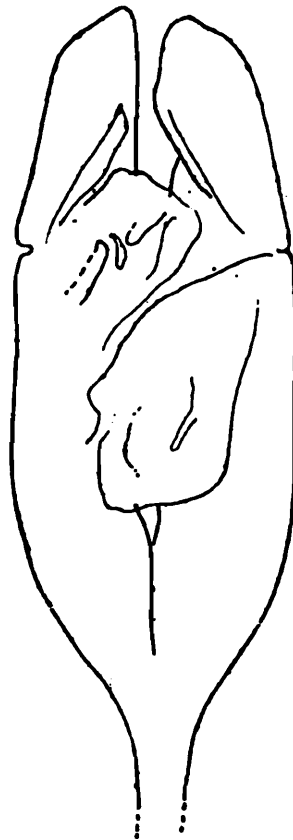
9



10



11



12

Anisolabis deplanata Srivastava, Holotype

(9) Anterior portion of body ; (10) Posterior margin of penultimate sternite ;
(11) Ultimate tergite and forceps ; (12) Genitalia.

subcontiguous, trigonal in basal $1/3$, at base wide, tapering apically and incurved. Genitalia (fig. 12) with parameres three times longer than broad.

♀ : As male but branches of forceps simple and straight.

Measurements (in mm):-

	♂	♀
Length of body	6.9 - 7.5	7.5
Length of forceps	0.7 - 1.0	1.5

Material examined.- India : Arunachal Pradesh, Tirap District, Hornbill, Holotype ♂, Paratype 1♂, 11. iv. 1981 (S. Biswas) ; West Bengal, Darjeeling District, Sivoke, Paratype 1♂, 10. iv. 1978 (A. R. Bhowmik), of *Anisolabis deplanata* Srivastava.

Distribution.- India (Arunachal Pradesh and West Bengal) and Nepal (Gorkha District).

Remarks.- In lacking the inner tooth of parameres the inclusion of *Aborolabis martensi* Brindle under *Aborolabis* Srivastava does not seem to be correct. The description of this species and *Anisolabis deplanata* Srivastava agree so closely that the former is considered here as the synonym of the latter.

SUMMARY

Notes on two species of *Anisolabis* Fieber, known from India, besides the description of a new species, *A. bhowmiki* are provided. A key for their separation is also given.

ACKNOWLEDGEMENTS

My thanks are due to the Director, Zoological Survey of India, Calcutta for necessary facilities during the course of present work.

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**RECORDS OF CULICINE MOSQUITOES FROM BASTAR DISTRICT
(MADHYA PRADESH), INDIA. (DIPTERA : CULICIDAE), PART—II.
GENUS AEDOMYIA, ARMIGERES, COQUILLELTIDIA,
HEIZMANNIA, MANSONIA AND MIMOMYIA**

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INTRODUCTION

Except a short record by Hussainy (1981) and subsequent publication by Rajput and Kulkarni (1984), Bastar district of Madhya Pradesh remained unknown for their Culicine fauna. Genus *Aedomyia*, *Coquillettidia*, *Heizmannia* and *Mimomyia* included in the present communication is the first record for the Bastar district, while under the genus *Armigeres* and *Mansonia*, only *Armigeres subalbatus*, *Mansonia annulifera* and *M. uniformis* could be recorded by earlier workers. The present communication deals with the additional records of 10 species of mosquitoes under 6 genera viz., *Aedomyia*, *Armigeres*, *Coquillettidia*, *Heizmannia*, *Mansonia* and *Mimomyia* collected during the period from 1980 to 1982.

The classification and nomenclature, used here is mainly based on the synoptic catalogue mosquitoes of the world (Knight and Stone, 1977; Knight, 1978). Identification was done mainly on adult characters. Genital characters of males and the characters of immature stages were also taken into consideration whenever those forms were available. The description of the study area, climate, topography and materials & methods have already been included in part-I (Rajput and Kulkarni, 1984).

SYSTEMATIC ACCOUNT

Genus *Aedomyia* Theobald

1. *Aedomyia catasticta* Knab

1909. *Aedomyia catasticta* Knab, *Ent. News.* 20 : 387.

1977. *Aedomyia catasticta* : Knight and Stone : 69.

Material examined, 6 ♀♀, 28 ♂♂ : *Dongariguda* — 1 ♂ (10 Apr. '81) from herb vegetation, *Jagdalpur*—1 ♂ (18 Jan. '82) from human dwelling, 1 ♂ (24 Feb. '81) reared from lerva from pond, *Kangoli* — 22 ♂♂ (21 Nov. '81) from herbs,

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Kurandi—2 ♀♀, 3 ♂♂ (27 Mar. '80 — 11 Sept. '80) from bovine bait, 4 ♀♀ (25 Feb. '80) from human bait.

Genus *Armigeres* Theobald

2. *Armigeres subalbatus* (Coquillett.)

1889. *Culex subalbatus* coquillett. *Proc. U. S. nat. Mus.* 21 : 302.

1977. *Armigeres subalbatus* : Knight and Stone : 172.

Material examined. — 57 ♀♀, 25 ♂♂ : Aghanpur — 4 ♀♀ (11 Aug. '81 — 3 Dec. '81) from herbs. Chindawada — 1 ♀ (28 Jan. '82) from cattle shed. Darbha — 1 ♀ (22 Sept. '80), 3 ♀♀ (2 Mar. '81 — 18 Aug. '81) from bovine bait ; 7 ♀♀ (17 Mar. '80 — 13 Oct. '80), 9 ♀♀ (17 Mar. '81 — 15 Sept. '81) from human bait. Gumiyapal— 2 ♀♀, 1 ♂ (17 Sept. '80) larvae reared from discarded pitcher. Jadgalpur — 1 ♀ (10 Jan. '81) from herb vegetation. Kakalgur — 1 ♂ (10 Feb. '81) from herbs. Kotamsar — 1 ♀ (5 Feb. '81) from human bait. Kurandi — 2 ♀♀ (13 Nov. '80 — 11 Dec. '80), 4 ♀♀ (29 Jan. '81 — 12 Mar. '81) from bovine bait ; 1 ♀ (13 Nov. '80), 4 ♀♀ (26 Feb. '81 — 1 May '81) from human bait ; 2 ♀♀ (11 Feb. '81) from herb vegetation. Orcha — 2 ♀♀ (30 Nov. '81) from bovine bait. Pakhanjore — 8 ♀♀, 9 ♂♂ (27 Aug. '81 — 28 Nov. '81) from herb vegetation. Pandripani—1 ♀, 3 ♂♂ (14 Sept. '81) reared from larvae from bamboo cut ; 1 ♀ (18 Jan. '82) from herb vegetation. Rajur — 1 ♀, 4 ♂♂ (23 Sept. '81) reared from larvae from log—hole. Sargipal—2 ♀♀, 1 ♂ (23 Nov. '80) from shrub vegetation. Tokapal — 2 ♀♀, 2 ♂♂ (23 Sept. '81) reared from larvae from bamboo cut ; 2 ♂♂ (11 Jan. '82) from herb vegetation.

3. *Armigeres theobaldi* Barraud

1934. *Armigeres theobaldi* Barraud, *Monog. Cul.* 1 : 320.

1977. *Armigeres theobaldi* : Knight and Stone : 172.

Material examined. — 18 ♀♀, 2 ♂♂ : Adawal — 1 ♀, 1 ♂ (20 Oct. '80) from herb vegetation. Bastar — 1 ♀ (20 Nov. '80) from herb vegetation. Darbha — 2 ♀♀ (1 Aug. '80 — 22 Sept. '80), 2 ♀♀ (18 Aug. '81) from bovine bait ; 2 ♀♀ (21 Jul. '80), 4 ♀♀ (18 Aug. '81) from human bait, 1 ♀ (12 Nov. '80), 1 ♀ (17 Feb. '81) from herb vegetation. Kakalgur— 1 ♀ (29 Jul. '80) from herb vegetation. Kotamsar — 1 ♀ (14 Apr. '80) from bovine bait. Kumarawand — 1 ♀ (10 Nov. '81) from herb vegetation. Kurandi— 1 ♀ (25 Sept. '80) from herb vegetation. Rajur — 1 ♀ (11 Jan. '82) from shrub vegetation.

Genus *Coquillettidia* Dyar

4. *Coquillettidia crassipes* (Van der Wulp)

1981. *Culex crassipes* Van der Wulp, *Bijd. Fauna Mid. Sumatra, Dipt.* : 9.

1977. *Coquillettidia crassipes* : Knight and Stone : 290.

Material examined. — 2 ♀♀, 4 ♂♂ : Bastar—1 ♀, 2 ♂♂ (20 Nov. '80). Gumiyapal— 1 ♂ (17 Nov. '81). Kachora—1 ♀ (9 Nov. '81). Pandripani—1 ♂ (14 Dec. '81). All the specimens were collected from herb vegetation.

Genus **Heizmannia** Ludlow5. **Heizmannia complex** (Theobald)

1910. *Bolbodeomyia complex* Theobald, *Rec. Indian Mus.* 4 : 31.

1977. *Heizmannia complex* : Knight and Stone : 182.

Material examined—3 ♀♀, 4 ♂♂ : *Dhaniyalur*—3 ♀♀, 4 ♂♂ (16 Jul. '81) larvae reared from tree hole.

Genus **Mansonia** Blanchard6. **Mansonia annulifera** (Theobald)

1901. *Panoplitus annulifera* Theobald, *Monog. Cul.* : 183.

1977. *Mansonia annulifera* : Knight and Stone : 297.

Material examined—2 ♀♀ : *Kurandi*—1 ♀ (11 Dec. '80) from bovine bait. *Tahakapal*—1 ♀ (21 Jan. '82) from cattle shed.

7. **Mansonia indiana** Edwards

1930. *Mansonia indiana* Edwards, *Bull. Ent. Res.* 21 : 541.

1977. *Mansonia indiana* : Knight and Stone : 297.

Material examined.—48 ♀♀, 2 ♂♂ : *Aghanpur*—2 ♂♂ (1 Sept. '80) from herb vegetation. *Darbha*—14 ♀♀ (7 Jul. '80 — 1 Aug. '80) from bovine bait ; 9 ♀♀ (8 Sept. '81 — 17 Nov. '81) from human bait, 3 ♀♀ (16 Feb. '81) from herb vegetation. *Karanji*—2 ♀♀ (12 Nov. '80), 4 ♀♀ (6 Jan. '81) from bovine bait ; 3 ♀♀ (19 Sept. '81) from herb vegetation. *Kurandi*—3 ♀♀ (27 Mar. '80 — 25 Apr. '80), 5 ♀♀ (13 Nov. '81) from bovine bait ; 4 ♀♀ (6 Jul. '82) from herbs. *Sargipal*—1 ♀ (23 Nov. '80) from herb vegetation.

8. **Mansonia uniformis** (Theobald)

1901. *Panoplitus uniformis* Theobald, *Monog. cul.* 2 : 180.

1977. *Mansonia uniformis* : Knight and Stone : 297-298.

Material examined.—362 ♀♀, 37 ♂♂ : *Aghanpur* — 7 ♀♀ (26 Sept. '81) from herb vegetation ; 2 ♀♀ (21 Nov. '81) from cattle shed. *Balenga* — 1 ♀ (22 Jul. '81) from herb vegetation. *Bastar* — 2 ♀♀, 1 ♂ (20 Nov. '80) from herb vegetation. *Darbha* — 32 ♀♀ (7 Jul. '80 — 13 Oct. '80), 61 ♀♀ (16 Feb. '81 — 15 Sept. '81) from bovine bait, 34 ♀♀ (17 Mar. '80 — 16 Dec. '80), 54 ♀♀, 14 ♂♂ (16 Feb. '81 — 15 Sept. '81) from human bait ; 5 ♀♀, 1 ♂ (19 Sept. '81) from herb vegetation. *Dhaniyalur*—1 ♀ (11 Jul. '80) from herb vegetation. *Jagdalpur* — 3 ♀♀ (12 Nov. '80) from herbs. *Karanji* — 2 ♀♀ (12 Nov. '81) from bovine baits, 2 ♀♀ (6 Jan. '82) from human bait. *Kotamsar*—1 ♀ (27 Jun. '80) from bovine bait. *Kumarawand*—2 ♀♀ (10 Nov. '81 — 3 Dec. '81) from herb vegetation. *Kurandi* — 89 ♀♀, 19 ♂♂ (27 Mar. '80-29 Dec. '80), 6 ♀♀, 1 ♂ (29 Jan. '81 — 26 Mar. '81) from bovine bait ; 34 ♀♀, 1 ♂ (25 Apr. '80 — 29 Dec. '80), 16 ♀♀ (29 Jan. '81 — 1 May '81) by human bait. *Sargipal*—7 ♀♀ (23 Nov. '80) from shrub vegetation. *Tokapal*—1 ♀ (23 Sept. '81) from shrub vegetation.

Genus **Mimomyia** (Theobald)9. **Mimomyia chamberlaini** (Ludlow)1904. *Ficalbia chamberlaini* (Ludlow), *Can. Ent.* **36** : 297.1977. *Mimomyia chamberlaini* : Knight and Stone : 285.

Material examined.—6 ♀♀ : Jagdalpur—6 ♀♀ (18 Jan. '81 — 17 Apr. '81) reared from larvae from weedy ponds.

10. **Mimomyia luzonensis** (Ludlow)1905. *O'Reillia luzonensis* (Ludlow), *Can. Ent.* **37** : 101.1977. *Mimomyia luzonensis* : Knight and Stone : 284.

Material examined—7 ♀♀, 5 ♂♂ : Bastar — 1 ♀ (22 Dec. '81) from herb vegetation, Bhond—1 ♂ (15 Dec. '81) from tree hole. Bringpal—1 ♀, 1 ♂ (14 Dec. '81 — 18 Jan. '82) from pit shelter. Darbha—2 ♀♀ (18 Nov. '80 — 17 Feb. '81) from pit shelters. Dhaniyalur—1 ♂ (16 Jun. '82) from burrow. Dongariguda—1 ♂ (9 Nov. '81) Kumarawand—1 ♂ (21 Nov. '81) from dried leaves. Potanar—2 ♀♀ (21 Jan. '82) from dried well. Takaraguda—1 ♀ (15 Dec. '81) from a tree hole.

SUMMARY

The present communication deals with the distribution record of *Aedomyia catasticta*, *Armigeres subalbatus*, *A. theobaldi*, *Coquillettidia crassipes*, *Heizmannia complex*, *Mansonia annulifera*, *M. Indiana*, *M. uniformis*, *Mimomyia chamberlaini* and *M. luzonensis* from Bastar district of Madhya Pradesh. Except *Armigeres subalbatus*, *Mansonia annulifera* and *M. uniformis* all are recorded for the first time from this district.

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**A REVIEW OF INDIAN CHLOROCYPHIDAE (INSECTA : ODONATA)
WITH ADDITIONAL NOTES ON TAXONOMY AND DISTRIBUTION
FOR SOME SPECIES AND DESCRIPTION OF
A NEW SUBSPECIES**

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INTRODUCTION

Fraser's (1934) account of Indian Chlorocyphidae preceeded and followed by number of important revisional contribution on the group including those of Cowley (1937), Fraser (1949, 1957), Laidlaw (1917, 1950) and Montgomery (1967). Our knowledge about the Indian fauna of the group has also been augmented through the works of Bhasin (1953), Chhotani et.al. (1983), Kumar (1973), Kumar and Prasad (1977, 1981), Lahiri (1977, 1979, 1985), Lahiri and Sinha (1985), Prasad (1976), Prasad and Singh (1976), Rao and Lahiri (1983) and Singh and Prasad (1976).

Data on material collected in course of a number of recent surveys sponsored by the Zoological Survey of India, Calcutta have been reported in the present account of the family together with a review of the Indian species of the group and description of a new subspecies.

Fraser (1949) and Laidlaw (1950) proposed a number of new genera for various species or species groups of the genera *Rhinocypha* Rambur and *Libellago* Selys. These new genera have not, however been generally accepted and here also, the two genera, viz. *Rhinocypha* Rambur and *Libellago* Selys have been used in the broader sense of the term.

SYSTEMATIC ACCOUNT

A list of Chlorocyphid species and subspecies known from Indian union.

Fraser (1934) reported 25 Chlorocyphid species and subspecies from various parts of Indian union including one each belonging to the genera *Calocypha* Fraser and *Chlorocypha* Fraser, four to the genus *Libellago* Selys and the rest to the genus *Rhinocypha* Rambur. However, Singh and Prasad (1976) and Lahiri and Sinha (1985) suppressed *R. bifasciata* Selys and *R. bifenestrata* Fraser under *R. trifasciata* Selys and *R. cuneata* Selys respectively. Chhotani et. al. (1983) treated *Libellago andamanensis* Fraser as a subspecies of *L. limeata* (Burmeister). Lahiri (1987) raised *R. perforata beatifica* Selys to species status. In the present paper a new subspecies viz. *R. hilaryae miaoa* has been added to Indian Chlorocyphid

fauna which thus, at present, comprises of the following 24 species and subspecies.

1. *Calocypha laidlawi* (Fraser)
2. *Chlorocypha vittata* (Selys)
3. *Libellago lineata andamanensis* Fraser
4. *L. I. blanda* (Selys)
5. *L. I. indica* (Fraser)
6. *L. l. lineata* (Burmeister)
7. *Rhinocypha beatifica* Selys
8. *R. biforata abbreviata* Fraser
9. *R. b. beelsoni* Fraser
10. *R. b. delimbata* Selys
11. *R. bisignata* Selys
12. *R. cuneata* Selys
13. *R. fenestrella* Rambur
14. *R. hilaryae miaoa* subsp. nov.
15. *R. ignipennis* Selys
16. *R. immaculata* Selys
17. *R. perforata limbata* Selys
18. *R. quadrimaculata hemihyalina* Fraser
19. *R. q. quadrimaculata* Selys
20. *R. spuria* Selys
21. *R. trifasciata* Selys
22. *R. trimaculata* Selys
23. *R. unimaculata* Selys
24. *R. vitrinella* Fraser

Genus *Libellago* Selys 1840

Libellago lineata indica (Fraser)

1919. *Micromerus lineatus indicus* Fraser, *Rec. Indian Mus.*, **16** : 197.

1934. *Libellago lineata indica* Fraser, *Fauna British India, Odonata*, **2** : 63 ; Cowley, 1937, *Trans. R. ent. Soc., London*, **86** : 4.

Material examined : 9 exs ; 1 ♂, 1 ♀, Madhya Pradesh, Bastar, Chitnakut, Jagdalpur, 2.xi.1979, coll. S. Ahmed and party ; 1 , Kerala, Prema, 800 ft., foot of Annamalai Hills (W), 12-14. viii. 1929, coll. H. S. Pruthi; 6 exs., MAHARASHTRA, coll. A.R. Lahiri and party; 2 ♂♂, 3 ♀♀, Mula river bank, 23 kms. N.W. of Ahmednagar, 15.iv.1983; 1 , Ambarali, 17.iv.1983.

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 14.0-16.0, 15.0 ; Length of hind wing : 20.0, 20.0-22.0; number of antenodal veins : forewing : 6-7, 5-7; hindwing : 5-6, 5-7; number of postnodal veins : forewing : 10-11, 9-12; hindwing : 10-11, 9-11.

Note : The subspecies has here been recorded for the first time from North India (Madhya Pradesh). The males studied vary from the description of the species provided by Fraser (1934) in having longer hindwing.

Distribution : India : Madhya Pradesh, Maharashtra, Kerala, Tamil Nadu. Outside India : Ceylon.

Libellago lineata lineata (Burmeister)

1839. *Calopteryx lineata* Burmeister, *Handh. Ent.*, 2 : 826.

1934. *Libellago lineata lineata* (Burmeister), Fraser, *Fauna British India, Odonata*, 2 : 60 ; Cowley, 1937. *Trans. R. ent. Soc., London*, 86 : 4 ; Bhasin, 1953, *Indian Forest Leaflet*, 121 : 69 ; Prasad and Singh, 1976, *Rec. zool. Surv. India*, 70 : 130.

Material examined : 16 exs.; 15 exs., TRIPURA; 14 exs., coll. M.S. Shishodia and party; 7♂♂, 6♀♀, Garjee, Udaipur (6♂♂, 6♀♀, 7.xi.1974; 1 ♂, 5.xi.1974); 1 ♂, Pratapgarh, Agartala 29.x.1971; 1 ♀, Pratapgarh, Agartala, coll. J.K. Jonathan and Party, 15.v.1978; 1 ♀, MANIPUR, 3 kms N.W. of Moreh (Alt. 2000'), coll. M.S. Shishodia and party, 25.ix.1975.

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 13.0-15.0, 12.0-13.0 ; Length of hindwing : 17.0-18.0, 18.0-20.0; number of antenodal veins : forewing : 4-6, 5-9; hindwing : 5-7, 5-7; number of postnodal veins : forewing 10-12, 7-10; hindwing : 9-12, 8-11.

Note : This subspecies has been recorded here for the first time from Manipur and Tripura states of the Indian union. Specimens studied exhibit lower range in respect of nodal index and measurements of body parts as compared to the description of the species provided by Fraser (1934).

Distribution : India : Assam, Himachal Pradesh, Manipur, Tripura, Uttar Pradesh, West Bengal. Outside India : Burma, Thailand, Vietnam, Malay peninsula, Borneo, Indonesia.

Genus *Rhinocypha* Rambur 1842

***Rhinocypha bisignata* Selys**

1853. *Rhinocypha bisignata* Selys, *Syn. Cal.*, : 62 ; Laidlaw, 1917, *Rec. Indian Mus.*, 13 : 26, 38 ; Fraser, 1934, *Fauna British India, Odonata*, 2 : 49 ; Rao and Lahiri, 1983, *J. Bombay nat. Hist. Soc.* 79 : 557.

1949. *Heliocypha bisignata* (Selys) : Fraser, *Bull. Inst. Roy. Sc. nat. belg.*, 25 : 16 ; Laidlaw, 1950, *Trans. R. ent. Soc. Lond.*, 101 : 272 ; Montgomery, 1967, *Dt. ent. Zeit.*, 14 : 332.

Material examined : 7 exs.; 1 ♂, MAHARASHTRA, Poona, Lonavala, 16.x.1965, coll. B.S. Lamba; 1 ♂, ANDHRA PRADESH, Cuddapa dist., Kodar, 15-18.vii.1929, coll. H.S. Pruthi ; 3 ♂♂, TAMIL NADU; 1 ♂, Sagol Eru stream (5 miles from Diguvametta) foot of Annamalai Hills (E), 21.viii.1929, coll. H.S. Pruthi ; 1 ♂, Silent valley expedition, 25.i.1980, coll. S.K. Bhattacharjee and party; 1 ♂, Karapara expedition, Periyar, Palam, 20.xii.1980, coll. R.S. Pillai and party; 2 ♂♂, KERALA, Kattayam dist., Elappara, 29.xii.1970, coll. A.N.T. Joseph.

Measurements (in mm) and Nodal index (for male); Length of abdomen : 19.0-21.0; Length of hindwing : 24.0-26.0; number of antenodal veins : forewing : 12-14; hindwing : 11-15 ; number of postnodal veins : forewing : 24-28, hindwing : 23-27.

Note : The species has here been recorded from a number of additional localities of South India.

Distribution : India : Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh.

Rhinocypha hilaryae miaoa subsp. nov.

(Plate I, Figs. 1 and 2)

Material examined : Holotype ♂ and Allotype ♀, INDIA : ARUNACHAL PRADESH : tirap district : Horn bill, ca, 30 kms north east of Miao, 12.xii.1983, coll. S. Biswas and party Registration Nos. 3903/H₁₃ and 3904/H₁₃ respectively). Paratypes : 1 ♂, and 2 ♀♀, same data as holotype (Registration Nos. 3905/H₁₃, 3906/H₁₃ and 3907/H₁₃).

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 20.0-22.0, 20.0 ; length of hindwing : 24.0-25.0, 27.0-28.0; number of antenodal veins : forewing : 13-15, 12-18; hindwing : 13-15, 11-18; number of postnodal veins : forewing : 24-27, 22-30, hindwing : 22-24, 20-26.

Note : The nominate form of this newly proposed subspecies was described from Maymyo in Upper Burma and after a lapse of nearly 40 years it was reported by Asahina (1970) from Putao, situated further north of the type-locality. Asahina (op.cit.) did not mention about any variation of his material from the nominate form and in addition illustration of wing markings provided for his material by Asahina is remarkably similar to that provided by Fraser (1927) thereby indicating that the 'Upper Burma' population of the species is characterised by a reasonably homogenous pattern of body markings, wing colouration and measurements.

The specimens under study however, inspite of their general resemblance to *R. hilaryae* Fraser, differ from its aforementioned Burmese population in a number of important respects in size, body markings and above all the male wing colour pattern in particular. Due to such distinctive features, a new subspecies is established herein to accommodate the present material. *R. hilaryae miaoa* subsp. nov. is briefly described below by indicating its differences from the nominate form.

Male

1. Hindwing shorter (24.0-25.0 mm vs 27.0 mm) with but little corresponding variation in the length of abdomen (20.0-22.0 mm vs 21.0-22.0 mm).

2. Labium and labrum black without marking (vs labium black, lateral lobes creamY white; labrum azure blue, its anterior border and base narrowly black, that basal black with a median point).

3. Synthorax : with following additional bluish markings on black ground colour) a fine antehumeral stripe lost or represented just by a broken segment in the upper half; humeral stripe broken to form an isolated segment at upper end; a streak at upper part of 1st lateral suture and a similar but transverse streak along the upper edge of mesepimeron; laterally the major part of mes- and metepimeron bluish but this is longitudinally divided by a broad black stripe running accross the 2nd lateral suture (vs laterally an irregular thick interrupted stripe extending the whole length of the thorax, rather zigzagged anteriorly, and broadened into an elongate triangular spot on metepimeron.)

4. Forewing entirely hyaline (vs extreme apices bordered or clouded with black).

5. Apical opaque black mark in hindwing limited to the level of middle of pterostigma (*vs* continued as a narrow border along hind edge of wing for about its apical fourth).

6. Hindwing marked only with two out of three rows of vitreous spots present in *R. h. hilaryae* Fraser, the one lying between MA and Cu₂ and 'confluent with the narrow opaque black borders' being absent.

7. In hindwing the vitreous spot lying between IR₂ and R₄₊₅ is much elongated being the longest (*vs* shortest) of the series with inner end lying 6-7 cells proximal (*vs* 6-7 cells distal) to nodus.

8. The opaque black fascia at a short distance proximal to pterostigma in hindwing vestigial.

Female

1. Hindwing shorter (27.0-mm *vs* 30.0-32.0 mm) with but little corresponding variation in the length of abdomen (20.0 mm *vs* 21.0-22.0 mm).

2. Labium black, unmarked (*vs* marked as in the male).

3. Labrum black, either unmarked (in the allotype) or marked with a pair of large oblong greenish spots (*vs* marked as in the male).

4. Antehumeral stripe on synthorax as in complete as stated for male (*vs* complete).

5. Humeral stripe on synthorax as stated for male above (*vs* incomplete below).

6. Synthorax laterally also marked as stated for male above (*vs* as in male).

Distribution : India : Arunachal Pradesh.

***Rhinocypha ignipennis* Selys**

1879. *Rhinocypha ignipennis* Selys, *Bull. Acad. Belg.*, **47** : 389 ; Laidlaw, 1917, 1917, *Rec. Indian Mus.*, **13** : 26, 35 ; Fraser, 1934, *Fauna Brit. India, Odonata*, **2** : 23 ; Cowley, 1937, *Trans. R. ent. Soc., London*, **86** : 4.

Material examined : 1 ♂, MEGHALAYA, Khasi hills, Shillong, 15.xi.1930, coll. H.S. Rao.

Measurements (in mm) and Nodal index (for male) : Length of abdomen : 22.0 ; length of hindwing : 25.0 ; number of antenodal veins : forewing : 15, hindwing : 14 ; number of postnodal veins : forewing : 35 ; hindwing : 34-36.

Note : The single male under study varies from the description of the species provided by Fraser (1934) in respect of length of abdomen.

Distribution : India : Meghalaya. Outside India : Burma.

***Rhinocypha quadrimaculata* Selys**

(Plate I, Figs. 3 and 4)

1853, *Rhinocypha quadrimaculata* Selys, *Syn. Cal.*, : 60 ; Fraser, 1934, *Fauna British India, Odonata*, **2** : 14 ; Cowley, 1937, *Trans. R. ent. Soc., London*, **86** : 6 ; Bhasin, 1953, *Indian Forest Leaflet*, **121** : 69 ; Kumar and Prasad, 1977, *Orient. Ins.*, **11** : 551 ; Prasad, 1976, *Rec. zool. Surv. India*, **71** : 100 ; Prasad and Singh, 1976, *Rec. zool. Surv. India*, **70** : 128 ; Lahiri, 1985, *Rec. zool. Surv. India*, **82** : 61.

Aristocypha quadrimaculata (Selys) : Laidlaw, 1950, *Trans. R. ent. Soc. London*, **101** : 273; Montgomery, 1967, *Dt. ent. Zeit.*, **14** : 331.

Material examined : 106 exs. ; 41 exs., WEST BENGAL, Darjeeling; 39 exs., coll. H. S. Sharma and party; 20 ♂♂, 2 ♀♀, Singla (1 ♂, 13.iv.1973; 16 ♂♂, 8.iv.1973; 3 ♂♂, 20.iv.1973; 2 ♀♀, 7.iv.1973); 1 ♂, 1 ♀, Karmata vill., 19.iv.1973; 9 ♂♂, 6 ♀♀, Rayang, 30.iii.1973; 2 ♂♂, Teesta, 24.v.1979, coll. M. S. Shishodia and party; 33 exs., SIKKIM, Rangpo; 30 exs., coll. P. Halder and party (17 ♂♂, 12 ♀♀, 5.vii.1979; 1 ♂, 6.vii. 1979); 3 exs, coll H. S. Sharma and party (1 ♂, 6.iv.1973, 1 ♂, 9.iv.1973, 1 ♀, 7.iv.1973); 7 ♂♂, HIMACHAL PRADESH, Mandi, river side, 23.ix.1980, coll. H. K. Bhowmik and party; 7 exs., MANIPUR; 3 exs., Moreh, coll. P.T Cherian and party (1 ♂, Lockchou river bank, 22.ii.1975, 2 ♂♂, near forest office, 24.ii.1975); 4 exs., coll. M.S. Shishodia and party (1 ♂, Burma border east, alt. 2000 m., 21.ix.1975, 3 ♂♂, Moreh, alt. 2000 m., 25.ix.1975); 18 exs., ARUNACHAL PRADESH ; 16 exs., Tirap district ; 13 exs., Namdhapa, coll. S. Biswas and party; 1 ♂, Gibbons land, 10 kms post on Miao Vijaynagar road, 2.iv.1981; 10 ♂♂, 2 ♀♀, Miao (4 ♂♂, 2 ♀♀, 30.xi.1982, 3 ♂♂, 1.xii.1982, 2 ♂♂, 3.xii.1982, 1 ♂, 4.i.1983); 1 ♂, 2 ♀♀, Nampong camp, alt. 350 m., 28.x.1971, coll. G. S. Arora and party; 1 ♂, on way to Mori, Upper Subansiri district, 25.x.1981, coll. S.K. Gupta and M. Prasad; 1 ♂, Kameng division, Denling, alt. 229 m., 5.v.1966, coll. A.N.T. Joseph; 17 ex., WEST BENGAL, coll. H.S. Sharma and party; 3 ♂♂, 5 ♀♀, 1 km. west of Forest Rest House, Reyang, 30.iii.1973; 6 ♂♂, 2 ♀♀, 4 kms. southeast of Goke Forest Rest House, Singla, 7-20.iv.1973.

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 17.0-21.0, 16.0-20.0 ; length of hindwing : 19.0-25.0, 24.0-28.0; number of antenodal veins : forewing : 15-25, 16-22; hindwing : 13-21, 12-18; number of postnodal veins : forewing : 26-41, 24-33, hindwing : 23-40, 20-30.

Note : In general built, body and wing markings *R. quadrimaculata* Selys closely resembles *R. spuria* Selys. As pointed out by Fraser (1934), the minor differences in respect of thoracic markings between the two species also are inconsistent because "Teneral specimens (of *R. quadrimaculata*) have markings very similar to those of *R. spuria*" Fraser (Loc. cit.) stressed on a few points (p. 14) to serve as distinctive features between the two species. But a careful study of a fairly large collection of *R. quadrimaculata* Selys under study shows that such characters are also variable and overlapping or nearly so between the two species as would be evident from measurements of body parts and nodal index recorded here for the two species. The nature of the apical vitreous spot of hind wing of *R. quadrimaculata* Selys male is also variable in the specimens studied in being square or elongated in shape and overlapping IR₃ by 1 or 2 cells on posterior margin.

Presence of considerable infraspecific variation in the population of same locality (Figs. 3 and 4; Table 1) rules out the possibility of such variation conditioned geographically. However, effect of season, in this respect, can not be properly judged since, the available material does not contain seasonal representative all round the year from any of the localities.

R. quadrimaculata Selys is however a smaller species than *R. spuria* Selys. The two species constantly differ from each other in the following points as is evident from present study : (i) abdomen in male is never more than 21.0 mm. in

R. quadrimaculata Selys but always more than 23.0 mm. in *R. spuria* Selys; (ii) *R. spuria* Selys have a wider mesothoracic triangle than *R. quadrimaculata* Selys (0.75 mm. vs 0.50 mm. and 0.50 mm. vs 0.25 mm. for males and females respectively at about middle); (iii) *R. spuria* Selys also have a longer discoidal cell and longer median space than *R. quadrimaculata* Selys (Table I).

This is the first record of occurrence of this species in the states of Arunachal Pradesh and Manipur of Indian union.

Distribution : India : Arunachal Pradesh, Assam, Himachal Pradesh, kashmir, Manipur, Sikkim, Uttar Pradesh, West Bengal. Outside India : Burma, Nepal.

Rhinocypha spuria Selys

1879. *Rhinocypha spuria* Selys, *Bull. Acad. Belg. (2)*, **47** : 388 ; Fraser, 1934, *Fauna Brit. India, Odonata*, **2** : 12 ; Cowley, 1937, *Trans. R. ent. Soc., London*, **86** : 6 ; Bhasin, 1953, *Indian Forest leaflet*, **121** : 69.

1950. *Aristocypha spuria* (Selys) : Laidlaw, *Trans. R. ent. Soc., London*, **101** : 273.

Material examined : 5 exs., ARUNACHAL PRADESH, Tirap district, namdhapa, Miao, coll. S. Biswas and party (3 ♂♂, 30.xi.1982, 2 ♀♀, 1.xi.1982).

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 23.0-24.0, 18.0 ; length of hindwong : 26.0-28.0, 27.0 ; number of antenodal veins : forewing : 16-22, 16-18; hindwing : 16-23, 14-15; number of postnodal veins : forewing : 29-44, 14-15; hindwing : 30-41, 22-26.

Note : The species has here been recorded for the first time from Arunachal Pradesh.

Distribution : India : Arunachal Pradesh, Meghalaya, Nagaland. Outside India Burma.

Rhinocypha trifasciata Selys

1853. *Rhinocypha trifasciata* Selys, *Syn. Cal.*, : 61 ; Laidlaw, 1917, *Rec. Indian Mus.*, **13** : 25, 34 ; Fraser, 1934, *Fauna Brit. India, Odonata*, **2** : 31 ; Cowley, 1937, *Trans. R. ent. Soc., London*, **86** : 6 ; Bhasin, 1953, *Indian Forest Leaflet*, **121** : 69 ; Singh and Prasad, 1976, *Orient. Ins.*, **10** : 553 ; Kumar and Prasad, 1977, *Orient. Ins.*, **11** : 549 ; Prasad and Singh, 1976, *Rec. zool. Surv. India*, **70** : 129.

1879. *Rhinocypha bifasciata* Selys, *Bull. Acad. Belg. (2)*, **57** : 386 ; Fraser, 1934, *Fauna Brit. India. Odonata*, **2** : 29.

Material examined : 4 exs.; 2 ♂♂, UTTAR PRADESH, Garhwal district, jarmola to Naitwar, coll. D. R. Mondal, 25.ix.1972; 1 ♂, HIMACHAL PRADESH, Solan, Patror, coll. O. B. Chhotani and G.S. Arora, 4.ix.1969; 1 ♂, JAMMU, Udampur district, Kata Nala, coll. Raj Tilak, 20.xi.1964.

Measurements (in mm) and Nodal index (for male) : Length of abdomen : 23.0; length of hindwing : 27.0 ; number of antenodal veins : forewing : 19-25½ ; hindwing : 19-23; number of postnodal veins : forewing : 34-37; hindwing : 31-34.

Note : The species has here been recorded for the first time from Jammu and Kashmir state of the Indian union.

Distribution : India : Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, West Bengal.*

Rhinocypha unimaculata Selys

1853. *Rhinocypha unimaculata* Selys, *Syn. Cal.*, : 61 ; Laidlaw, 1917, *Rec. Indian Mus.*, 13 : 26, 35 ; Fraser, 1934, *Fauna British India, Odonata*, 2 : 27 ; Cowley, 1937, *Trans. R. ent. Soc., London*, 86 : 4 ; Bhasin, 1953, *Indian Forest Leaflet*, 121 : 69 ; Jumar, 1973, *Orient. Ins.*, 7 : 94 ; Prasad and Singh, 1976, *Rec. zool. Surv. India*, 71 : 129.

1949. *Paracypha unimaculata* : (Selys) Fraser, *Bull. Inst. Roy. Sc. nat. Belg.*, 25 : 11 ; Laidlaw, 1950, *Trans. R. ent. Soc., London*, 101 : 272 ; Montgomery, 1967, *Dt. ent. Zeit.*, 14 : 332.

Material examined : 21 exs.; 11 exs., WEST BENGAL : Darjeeling, coll. H.S. Sharma and party; 9 exs., Singla : 1 ♂, 16.iv.1973; 5 ♂♂, 18.iv.1973; 3 ♂♂, 19.iv.1973; 2 ♂♂, Teesta, 24.v.1973; 6 ♂♂, 3 ♀♀, SIKKIM, Rangpo, 5.vii.1979, coll. P. Halder and party ; 1 ♂, UTTAR PRADESH, Kumaon hills, Almora district, 29.v.1930, coll. H.S. Prathi.

Measurements (in mm) and Nodal index (for males and females respectively); Length of abdomen : 21.0-28.0, 22.0 ; length of hindwing : 28.0-33.0, 30.0-32.0 ; number of antenodal veins) forewing : 15-22, 17-22 ; hindwing : 15-22, 15-20 ; number of postnodal veins : forewing : 32-48, 31-38 ; hindwing : 32-44, 30-37.

Note : The males under study vary from the description of the species provided by Fraser (1934) in having longer abdomen and hindwing.

This is the first record of occurrence of this species in Sikkim state of the Indian union.

Distribution : India : Sikkim, Uttar Pradesh, West Bengal. Outside India : Nepal

SOME NOTES ON THE DISTRIBUTION OF INDIAN CHLOROCYPHID SPECIES (Table II)

Montane and submontane areas with subtropical or temperate vegetation appears to be the preferred habitat of Chlorocyphid species in general. Majority (nearly 80% of the total) Indian representative of the family are noticed to be distributed either in the foothills of the Himalayas or the states of Eastern India - but in contrast, plains of Northern India is practically devoid of any Chlorocyphid fauna. Peninsular India and the Andaman and the nicobar islands possess their own exclusive species composition which however, accounts for a rather insignificant part (12½% and 8% respectively) of the total Chlorocyphid fauna of the Indian union. One of the South Indian species is known also from Ceylon while out of the 19 species known from North India two extend to Tibet, two to Nepal and eight to Burma or other Indo-Chinese countries. Out of these eight species one extends as far as Malay peninsula and another right upto Indonesia. Distribution of some species, e.g. those belonging to Sl. No. 6, 9 and 21 is patchy or discontinuous. *Rhinocypha quadrimaculata* Selys appears to be the most widely distributed Chlorocyphid species in North India while *R. bisignata* Selys is so in South India.

*Its earlier record of distribution in Assam is erroneous because the actual locality 'Gopaldhara' is situated in (northern) West Bengal.

	<i>Rhinocypha quadrimaculata</i> Selys													<i>Rhinocypha spuria</i> Selys.			
	ex. 1	ex. 2	ex. 3	ex. 4	ex. 5	ex. 6	ex. 7	ex. 8	ex. 9	ex. 10	ex. 11	ex. 12	Mean	ex. 1	ex. 2	ex. 3	Mean
Median space	♂ 2.6	2.8	2.5	2.6	3.0	2.6	2.5	3.0	3.2	3.0	2.9	2.8	2.79	3.6	3.5	3.0	3.36
	♀ 2.7	2.7	2.7	2.7	2.43	2.61	3.78	2.7	2.88	2.7	2.25	2.7	2.73	3.06			2.83
Discoidal cell	♂ 2.0	2.1	2.3	1.7	2.5	2.3	1.9	2.2	2.3	2.2	2.3	2.2	2.17	2.9	2.7	2.5	2.70
	♀ 1.98	1.8	1.98	1.89	1.98	1.53	2.16	2.07	2.16	2.07	1.71	1.98	1.94	2.07	2.07		2.07
Hind wing	♂ 19.0	22.0	25.0	24.0	24.0	23.0	24.0	22.0	23.0	24.0	23.0	24.0	23.08	28.0	28.0	26.0	27.33
	♀ 26.0	27.0	24.0	28.0	26.0	27.0	30.0	27.5	26.0	24.0	27.0	27.0	26.87	27.0	27.0		27.0
Abdomen	♂ 21.0	17.0	21.0	20.0	20.0	21.0	20.0	21.0	18.0	19.0	20.0	20.0	19.83	23.0	24.0	23.0	23.33
	♀ 20.0	20.0	16.0	22.0	19.0	18.0	20.0	20.0	18.0	18.0	18.0	19.0	19.0	18.0	18.0		18.0

Table II. Comparative measurements of body parts (in mm) of *Rhinocypha quadrimaculata* Selys and *R. spuria* Selys.

R. quadrimaculata Selys = Moreh, Feb. 75 (♂ exs. 1 and 2) : Darjeeling district : Reyang, November, 1973 (♂ exs. 5, 9, 12; ♀ exs. 1, 2, 6, 7, 12); Singla, April, 1973 (♂ exs. 3, 4, 6, 7, 8, 10, 11; ♀ exs. 4, 11) : Sikkim : Rongpo, July, 1979 (♀ exs. 5, 11) : Tirap district : Nampong, October, 1971 (♀ exs. 5, 10) : Miao, November, 1982 (♀ ex. 3).

R. spuria Selys = Tirap district : Maao, November, 1982 (♂ exs. 1, 2, 3; ♀ exs. 1, 2).

Serial No.	Name of the species	INDIA						And. & Nic. Is.	OUTSIDE INDIA
		S. India	North India						
			Himalayas			Rest of North India			
			Western (J. & K.)	Central (U.P., H.P.)	Eastern (N. Beng., Sik., Ar. Pr.)				
1.	<i>Calocypha laidlawi</i> Fraser	+	-	-	-	-	-	-	
2.	<i>Chlorocypha vittata</i> (Selys)	-	-	-	-	Mizoram	-	Burma	
3.	<i>Libellago lineata andamanensis</i> Fraser	-	-	-	-	-	+	-	
4.	<i>L. I. blanda</i> (Selys)	-	-	-	-	-	+	-	
5.	<i>L. I. indica</i> (Fraser)	+	-	-	-	Madhya Pradesh	-	Ceylon	
6.	<i>L. I. lineata</i> (Burmeister)	-	+	-	-	Assam, Manipur	-	Burma, Thailand, Vietnam, Malay peninsula, Borneo, Indonesia	
7.	<i>Rhinocypha beatifica</i> Selys	-	-	-	-	Nagaland Meghalaya	-	-	
*8.	<i>R. biforata abbreviata</i> Fraser	-	-	-	-	? Assam	-	-	
*8.	<i>R. b. beelsoni</i> Fraser	-	+	-	-	Assam	-	Burma	
*10.	<i>R. b. delinbata</i> Selys	-	-	-	-	Assam, Manipur, Meghalaya	-	Burma, Vietnam	
11.	<i>R. bisignata</i> Selys	+	-	-	-	-	-	-	
***12.	<i>R. cuneata</i> Selys	-	-	-	+	-	-	Tibet	
**13.	<i>R. fenestrella</i> Rambur	?	?	?	?	?	-	Burma, Indonesia	
14.	<i>R. hilaryae miaoa</i> subsp. nov.	-	-	-	+	-	-	-	
15.	<i>R. ignipennis</i> Selys	-	-	-	-	Meghalaya	-	Burma	
16.	<i>R. i.n.naculata</i> Selys	-	-	-	-	Meghalaya	-	-	
*17.	<i>R. perforata linbata</i> Selys	-	-	-	-	? Assam	-	Burma, Malay Penisnula	
18.	<i>R. quadri.naculata he.nihyalina</i> Fraser	-	-	-	-	Meghalaya ? Nagaland	-	-	
19.	<i>R. q. quadri.naculata</i> Selys	-	+	+	+	Assam, Manipur, Meghalaya	-	Bruma, Nepal Nepal	
20.	<i>R. spuria</i> Selys	-	-	-	+	meghalaya, Nagaland	-	Burma	
***21.	<i>R. trifasciata</i> Selys	-	+	-	+	-	-	-	
22.	<i>R. tri.naculata</i> Selys	-	-	-	-	Assam	-	Tibet	
*23.	<i>R. unimaculata</i> Selys	-	+	-	+	-	-	Nepal	
24.	<i>R. vitrinella</i> Fraser	-	-	-	-	Assam, Meghalaya	-	-	

Table II. Chart showing distribution of Indian Chlorocyphid Species.

* Recorded from erstwhile 'Assam' Province—hence exact distribution in the newly erected states out of said province uncertain.

** Fraser (1934) recorded this species from India on the strength of a specimen present in British Museum collection without a specific locality record.

*** Earlier record of distributio in 'Assam' is erroneous since the actual locality 'Gopaldhara' is situated in the Darjeeling district of West Bengal.

SUMMARY

The known Chlorocyphid species from the Indian union have been listed together with illustration of the comparative features of *Rhinocypha quadrimaculata* Selys and *R. spuria* Selys, description of a new subspecies viz. *R. hiliaryae miaoa* and additional records of distribution for *Libellago I. indica* Fraser), *L. I. lineata* (Burmeister), *R. bisignata* Selys, *R. ignipennis* Selys, *R. q. quadrimaculata* Selys, *R. spuria* Selys, *R. trifasciata* Selys, *R. unimaculata* Selys.

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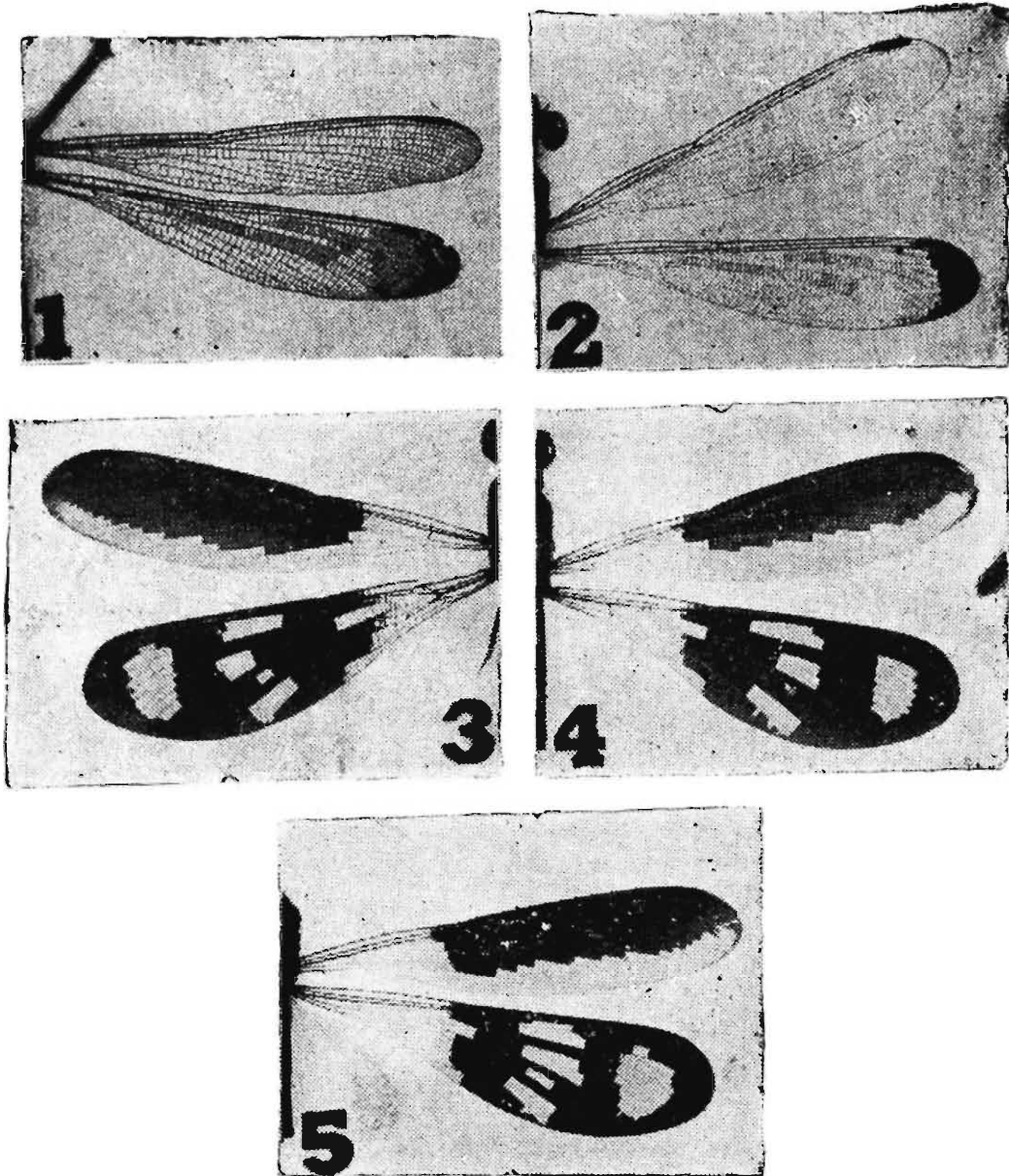
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A. R. LAHIRI & C. SINHA

PLATE I



Figs. 1-5. *Rhinocypha* spp. (Male) ; Fore-and Hind-wings.
Figs. 1 and 2. *Rhinocypha hilaryae* subsp. nov., Holotype and
Paratype (hornbill ca. 90 km. north of Miao).
Figs. 3 and 4. *Rhinocypha quadrimaculata* Selys (Miao).
Fig. 5. *Rhinocypha spuria* Selys (Miao).

**ON SOME NEW SPECIES OF *CHEIRACANTHIUM* C.L., KOCH AND
SIMALIO SIMON (ARANEAE : CLUBIONIDAE) FROM
COASTAL ANDHRA PRADESH, INDIA.**

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INTRODUCTION

The first record of Indian Clubionid spiders was made in India by Cambridge in 1874 and thereafter through a series of publications of Thorell (1881, 91, 95 and 97), Cambridge (1885), Simon (1885, 86, 89, 97, 98 and 1906), Strand (1907), Gravely (1921, 31), Reimoser (1934), Caporiacco (1935) and Dyal (1935) as many as 59 species belonging to 14 genera were known. Recently Tikader (1962), Singh (1970), Patel & Patel (1973), Tikader (1975, 76, 77, 81), Tikader & Biswas (1981) and Biswas (1984) added another 13 species from India raising the total number of species to 72 from 14 different genera. Lahore now being in Pakistan, Dayal's 4 species are not included in the above number.

Very recently Tikader & Majumder (1985) described 12 new species from 5 different genera, out of which the genus *Eutichurus* Simon was recorded for the first time from India. This brings the total number of species upto 84 belonging to 15 different genera. While examining the spider collections made by one of us (TSR) from Coastal Andhra Pradesh, we came across two new species from *Cheiracanthium* C.L. Koch. and one from *Simalio* Simon of this family are described and illustrated here.

All the type specimens will in due course be deposited in the National Collections of Zoological Survey of India, Calcutta.

1. *Cheiracanthium sambii* sp. nov. (Fig. 1, a-e)

General : Cephalothorax and legs yellowish, abdomen chalk white. Total length 11.75 mm. Carapace 4.80 mm long, 3.35 mm wide ; abdomen 7.15 mm long, 4.00 mm wide.

Cephalothorax : Yellowish, longer than wide, narrowing anteriorly, clothed with pubescence and hairs. Cephalic region high anteriorly, centre of the thorax provided with very light reddish fovea, radiating streaks originate from the fovea. Eyes in two rows, anterior and posterior, all pearly white. The anterior row slightly recurved and slightly shorter than the posterior row; anterior medians slightly

larger than the anterior laterals. The posterior row recurved and posterior medians slightly larger than the posterior laterals. Both the laterals close to each other and remote from the medians. Ocular quad almost square as in Fig. 1a. Clypeus narrow. Sternum oval, pointed behind, yellowish in colour. Labium and maxillae longer than wide, reddish brown with pale distal ends and provided with scopulae ; labium convergent apically and maxillae slightly constricted at the middle and wider anteriorly. Sternum, labium and maxillae as in Fig. 1b. Chelicerae strong and stout, reddish brown with scopulated fange groove ; the inner and outer margins of fang furrow provided with three teeth each as in Fig. 1e. Legs long, strong and stout, clothed with spines and hairs. Tibiae I and II provided with four and two pairs of ventral spines resp. and metatarsae of all legs provided with three pairs of ventral spines. Tarsi usually short provided with two claws and thick claw tufts. Leg formula 1 4 2 3.

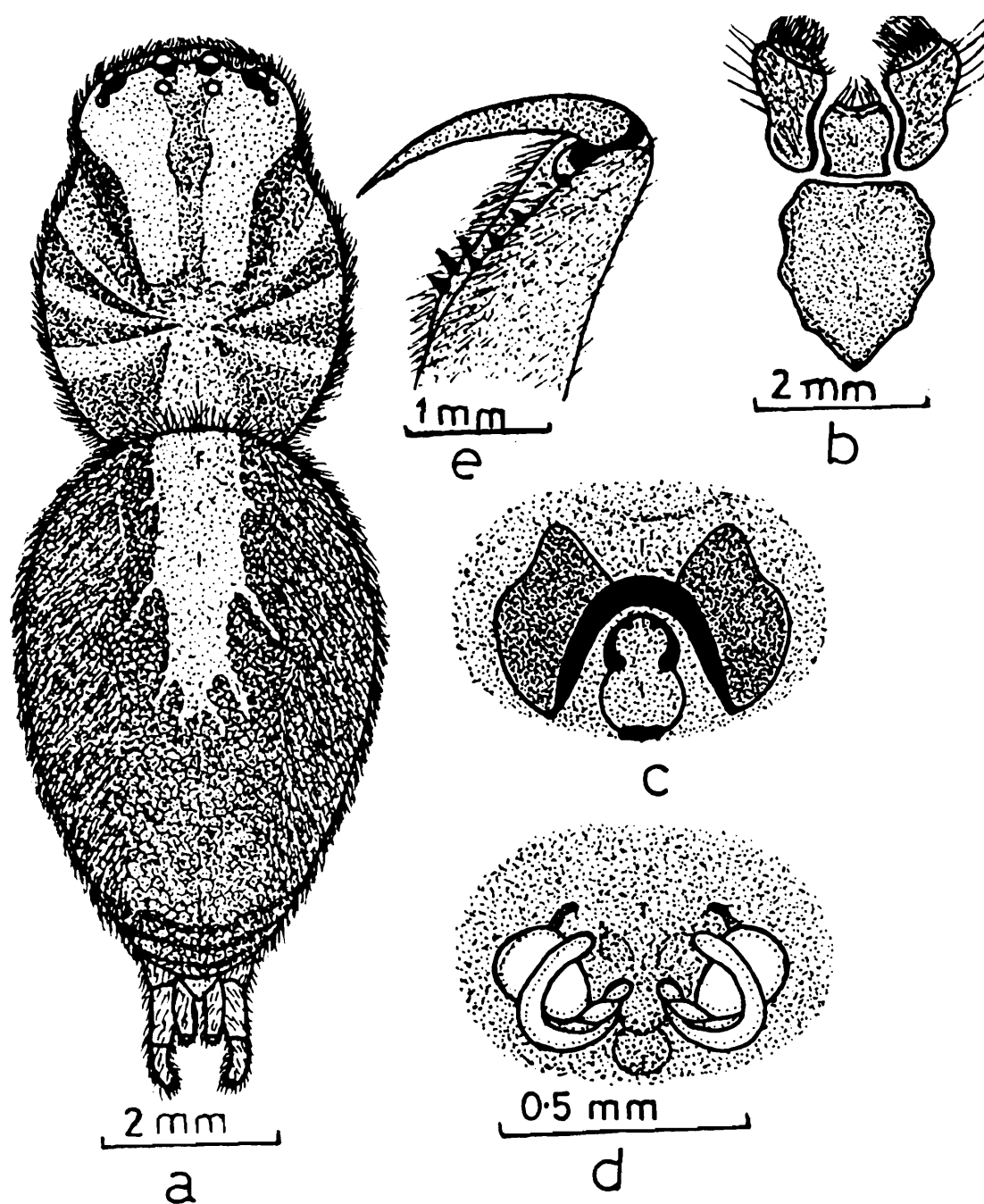


Fig. 1. *Cheiracanthium sambii* sp. nov. : a. Dorsal view of female (legs omitted) ; b. Sternum, labium and maxillae ; c. Epigyne ; d. Internal genitalia ; e. Left chelicera-ventral view.

Male : Unknown.

Abdomen : Oval, chalk white, longer than wide, clothed with pubescence and hair. Anterior mid-dorsal region provided with a lens shaped brown marking as in Fig. 1, a. Ventral side lighter than the dorsal, a brown band is extending from the epigastric furrow to the spinnerets. Epigyne and internal genitalia are as in Fig. 1, c and d.

Holotype : 1 ♀ in spirit.

Type-Locality : Tenali, Dist. Guntur, 20. i. 1986. Coll. T. S. Reddy.

Diagnosis : This species resembles to *Cheiracanthium murina* Thorell but it is separated as follows : (i) Ocular quad almost square but in *C. murina* ocular quad wider than long, narrower anteriorly. (ii) Inner and outer margins of fang furrow provided with three teeth each but in *C. murina* inner and outer margins of fang furrow provided with three and two teeth respectively. (iii) Anterior mid-dorsal side of abdomen provided with a lens shaped brown marking but in *C. murina* anterior mid-dorsal side of abdomen without such lens shaped marking. (iv) Epigyne and internal genitalia are also structurally different.

This species also resembles to *C. seshii* sp. nov. but it is separated as follows : (i) Anterior median eyes are larger than all other eyes but in *C. seshii* anterior median eyes are not larger than all other eyes. (ii) Dorsum of abdomen without sigillae but in *C. seshii* dorsum of abdomen provided with two pairs of sigillae. (iii) Abdomen antero-laterally not notched and postero-laterally not provided with any muscular corrugations but in *C. seshii* abdomen antero-laterally notched and postero-laterally provided with muscular corrugations. (iv) Epigyne and internal genitalia are also structurally different.

2. *Cheiracanthium seshii* sp. nov. (Fig. 2, a-e)

General : Cephalothorax reddish brown, legs and abdomen yellowish brown. Total length 8.80 mm. Carapace 3.90 mm long, 2.90 mm wide ; abdomen 5.30 mm long, 3.10 mm wide.

Cephalothorax : Longer than wide, narrow anteriorly, clothed with pubescence and hair. Cephalic region high anteriorly, center of the thorax provided with very light fovea, radiating streaks originate from the fovea. Eyes in two rows, all pearly white. The anterior row slightly recurved. The posterior row slightly procurved and slightly longer than the anterior row. The laterals are close to each other and remote from the medians. Ocular quad wider than long with parallel sides as in Fig. 2 a. Sternum oval, yellowish, clothed with hairs. Labium and maxillae reddish brown, longer than wide, distal ends provided with scopulae ; labium convergent apically and maxillae slightly constricted at the middle and wider anteriorly. Sternum, labium and maxillae as in Fig. 2 b. Chelicerae strong, reddish brown, scopulated fang groove, inner and outer margins of fang furrow provided with three teeth each as in Fig. 2 e. Legs long, strong and stout, clothed with hairs and long spines. Tibiae and metatarsi I and II provided with two and three pairs of ventral spines resp. ; tibiae and metatarsi III and IV provided with one and three pairs of ventral spines respectively. Tarsi of all the legs usually short, provided with two

claws and thick claw tufts. Leg formula 1 4 2 3.

Male : Unknown.

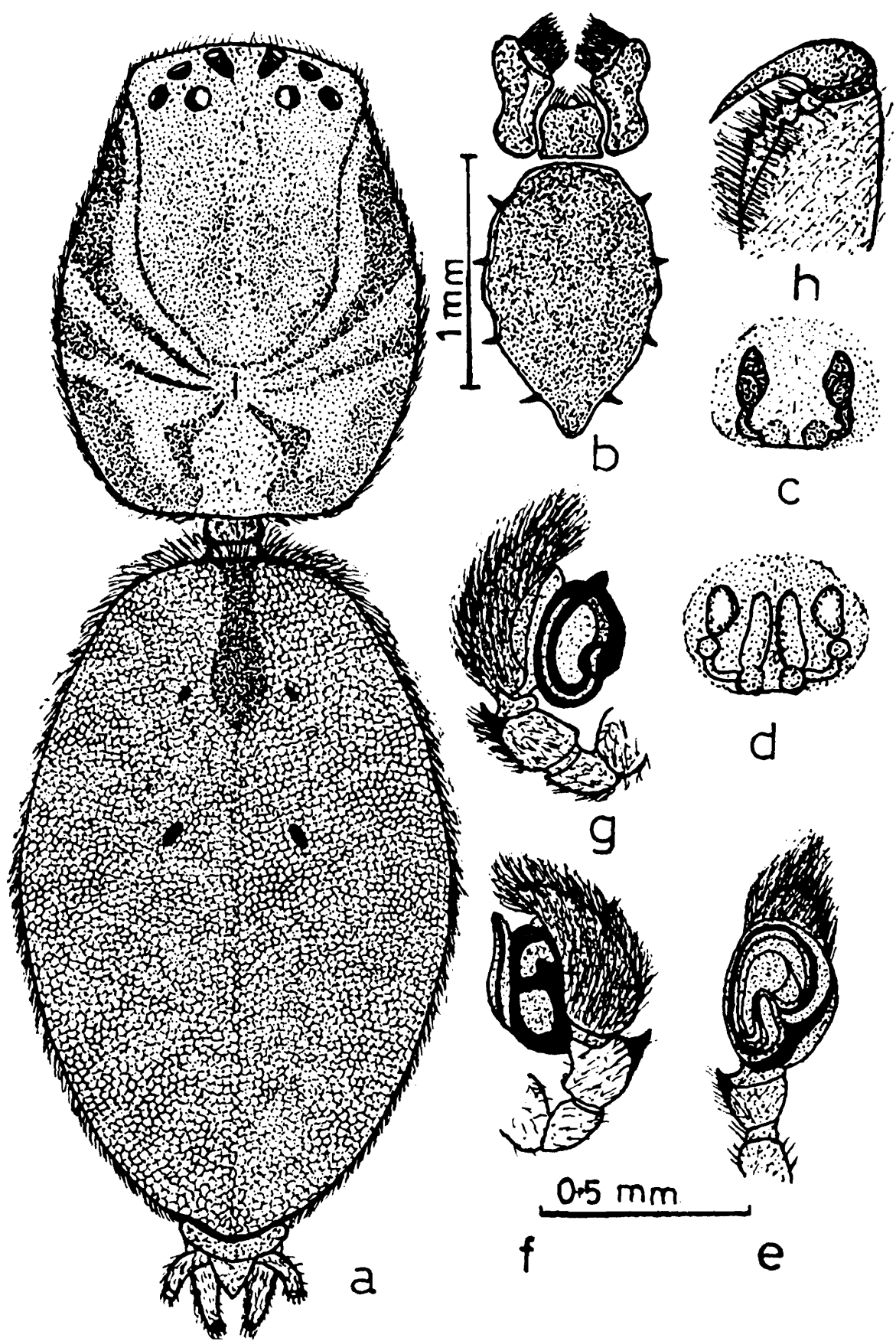


Fig. 2. *Cheiracanthium seshii* sp. nov. : a. Dorsal view of female (legs omitted) ; b. Sternum, labium and maxillae ; c. Epigyne ; d. Internal genitalia ; e. Left chelicera-ventral view.

Abdomen : Yellowish brown longer than wide, clothed with pubescence and hair. Dorsum of abdomen provided with two pairs of sigillae. Anterior mid-dorsal side provided with a lens shaped brown marking. Abdomen antero-laterally notched and postero-laterally provided with muscular corrugations as in Fig. 2 a. Ventral side pale in colour. Epigyne and internal genitalia are as in Fig. 2 c. and d.

Holotype : 1 ♀ in spirit.

Type-Locality : Palasa, Dist. Srikakulam, 13.x.1986. Coll. T. S. Reddy.

Diagnosis : This species resembles to *Cheiracanthium murina* Thorell but it is separated as follows : (i) Ocular quad wider than long with parallel sides but in *C. murina* ocular quad wider than long and narrower anteriorly. (ii) Chelicerae strong, inner and outer margins of fang furrow provided with three teeth each but in *C. murina* chelicerae strong, inner and outer margins of fang furrow provided with three and two teeth respectively. (iii) Dorsum of abdomen provided with two pairs of sigillae and antero-laterally notched and postero-laterally provided with muscular corrugations but in *C. murina* dorsum of abdomen not provided with sigillae and not provided with antero-lateral notch and not any postero-lateral muscular corrugations. (iv) Epigyne and internal genitalia are also structurally different.

3. *Simalio aurobindoi* sp. nov. (Fig. 3, a-h)

General : Cephalothorax and legs yellowish brown, abdomen pale yellow. Total length 5.20 mm. Carapace 1.90 mm long, 1.50 mm wide ; abdomen 3.10 mm long, 1.80 mm wide.

Cephalothorax : Longer than wide, narrow anteriorly, clothed with thin pubescence, provided with inconspicuous fovea situated just below the median half of the cephalothorax. Eyes in two rows ; the anterior row of eyes usually shorter, slightly recurved, medians blackish, slightly smaller than the laterals and equidistant. The posterior row usually longer than the anterior, slightly procurved, medians larger than all other eyes, widely separated from each other and closer to the laterals. Clypeus narrow. Ocular quad wider than long, much wider behind than in front as in Fig. 3 a. Sternum, oval, yellowish, pointed behind, clothed with hairs. Labium nearly as long as wide, yellowish with pale distal end and provided with scopulae. Maxillae longer than broad, yellowish, slightly depressed at the middle, clothed with fine hairs, distal end pale and provided with scopulae. Sternum, labium and maxillae as in Fig. 3 b. Chelicerae moderately strong, pale yellow, inner and outer margins of fang furrow provided with two and three teeth resp. as in Fig. 3 h. Legs short and strong, coxae long, trochanters and patellae shorter. Femora, tibiae and metatarsi relatively long. Femora I and II provided with three apical and one median spines, III and IV with three apical and two median spines on the dorsal side. Patellae of all legs provided with two basal, one retrolateral and one apical median spines. Tibiae I and II apically provided with one pair and one antero-retrolateral spines and metatarsi II with antero-prolateral spine on ventral side. Tibiae III and IV provided with one and two pairs of dorsal spines, metatarsi III with three pairs and IV with four pairs of dorsal spines. Tibiae III and IV with one median ventral spine, metatarsi III and IV with one median and one pair of apical ventral spines. Leg formula 4 1 2 3.

Male : Male is similar to the female and slightly smaller. Total length 3.85 mm. Tibiae of male palp provided with retrolateral apophysis, which is short and blunt, tegulum without apophysis, embolus short and narrow, cymbium without spur. Male palps in Fig. 3 e, f and g.

Abdomen : Oval, light yellowish-brown, longer than wide, broader anteriorly and narrow posteriorly. Dorsum of abdomen anteriorly provided with two pairs of sigillae. Anterior portion of abdomen provided with a lens-shaped pale brown marking clothed with hairs and anteriorly with a cluster of semierect setae as in Fig. 3 a. Ventral side pale in colour. Epigyne with 'U' shaped elongated plate as in Fig. 3 c. Internal genitalia as in Fig. 3 d.

Holotype : 1 ♀, **paratype :** 5 ♀, **allotype :** 1 ♂ in spirit.

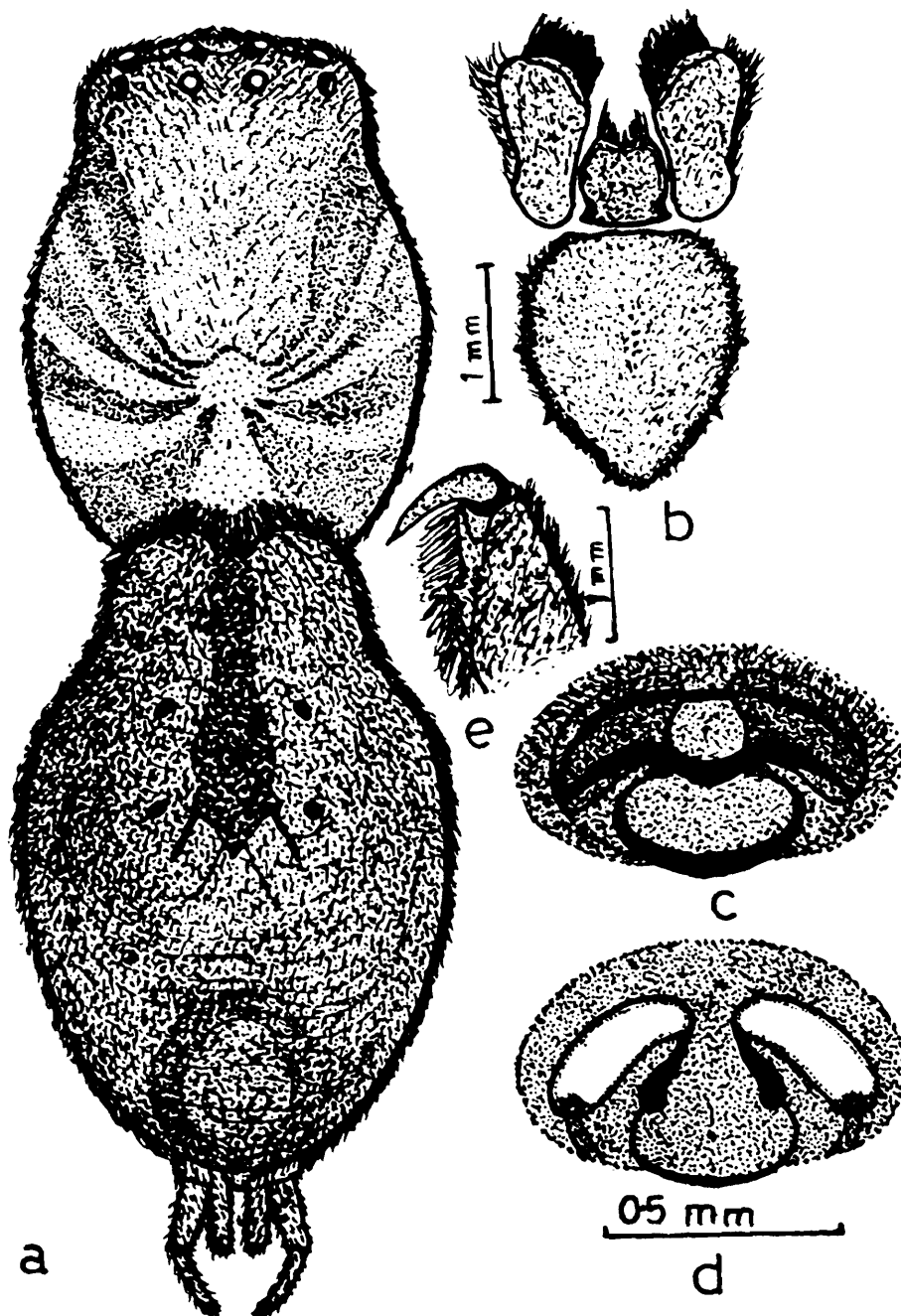


Fig. 3. *Simalio aurobindoi* sp. nov. : a. Dorsal view of female (legs omitted) ; b. Sternum, labium and maxillae ; c. Epigyne ; d. Internal genitalia ; e. Right male palp-ventral view ; f. Right male palp-inner view ; g. Right male palp - outer view ; h. Left chelicera - ventral view.

Type-Locality : Valiveru, Dist. Guntur, 20.iv.1986. Coll. T.S. Reddy.

Diagnosis : This species resembles to *Simalio biswasi* Tikader and Majumder but it is separated as follows : (i) Labium nearly as long as wide, yellowish with pale distal end and provided with scopulae but in *S. biswasi* labium moderately elongated more or less parallel and not scopulated anteriorly. (ii) Femora I and II provided with three apical and one median spins on the dorsal side but in *S. biswasi* femora I and II provided with two pairs of dorsal spines. (iii) Tibiae I and II provided with one pair of ventral spines apically and one retrolateral spine anteriorly but in *S. biswasi* tibiae I and II provided with two pairs of ventral spines. (iv) Epigyne and internal genitalia are also structurally different.

SUMMARY

Three new species of the genera *Cheiracanthium* Koch and *Simalio* Simon (family : Clubionidae) viz., *Cheiracanthium sambii*, *C. seshii* and *Simalio aurobindoi* are described and illustrated from Guntur and Srikakulam Districts of Coastal Andhra Pradesh, India.

ACKNOWLEDGEMENTS

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ON A COLLECTION OF BOMBYLIIDAE (DIPTERA) FROM INDIA AND PAKISTAN

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INTRODUCTION

In course of arranging family-wise the large dipterous collections of various old surveys present in the Diptera Section of the Zoological Survey of India, 97 examples of bombyliid flies were sorted out. These include specimens from different parts of India and Pakistan. Some of these specimens are affected by the silt deposition of flood of the River Varuna in Varanasi in 1943 (but not damaged and properly cleaned for study). The present collection represents 22 species in 8 genera of 2 subfamilies. Two species from India and one species from Pakistan are described as new, one species is recorded for the first time from India, and a several species have extended their range into different Indian provinces from their previous distributional records. After the publication of 'Fauna' by Brunetti (1920), Nurse (1922) described 7 species and Kapoor *et al.* (1978) described 5 species from India. Recently Zaitzev (1988 a, b, c) described 9 species from India and 6 species from Sri Lanka, and recorded 2 species from the Indian part, totalling the Indian species to 118. He (1988 a) also provided key to a group of *Exoprosopa* Macquart species from India and Sri Lanka. With the description of 2 new species and record of 1 species from the Indian part the number of Indian bombyliid species now stands 121. The 'types' of all the new species are deposited in the Zoological Survey of India, Calcutta.

The Bombyliidae or bee-flies are predominatly present in arid and semi-arid parts of the World (Bowden, 1975). The adults feed on nectar and pollen grain of flowers, and are of importance as they help to a certain extent in pollination. The larvae of bombyliids are known to be parasitic on larvae or pupae of other endopterygote insects viz., Lepidoptera, Hymenoptera, Diptera and Coleoptera, or predacious on egg pods of acridids (Orthoptera). The adults are commonly found in dry areas, or sandy woodlands and less commonly occur in the wet forested areas.

SYSTEMATIC ACCOUNT

Subfamily BOMBYLIINAE

1. *Bombylius ardens* Walker

1849. *Bombylius ardens* Walker, *List Dipt. Colln. Br. Mus.* 2 : 284.

1920. *Dischistus ardens* : Burnett, *Fauna Br. India, Dipt.* 2 : 274.

1975. *Bombylius ardens* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 171.

Material examined : 1 ♂ INDIA : KARNATAKA, North Kanara District, Castle Rock, 11-26.x.1961, S. Kemp.

Distribution : INDIA : Karnataka (New record).

Remarks : This species is recognised by the first posterior cell of wing open ; hyaline wing, dark brown at base and slightly so along borders which is oblique and slants posteriorly towards base; black body covered with long, bright hairs.

2. *Systoechus socius* (Walker)

1852. *Boobylius socius* Walker, *Insecta Saundersiana* 1 : 201.

1909. *Systoechus socius* : Brunetti, *Rec. Indian Mus.* 2 : 458.

Material examined : 3 ♂♂, 2 ♀♀ INDIA : PUNJAB, Muree Sub Division, Tret, 3306 ft. (1002 m.), 5.x.1928, H.S. Pruthi.

Distribution : INDIA : West Bengal, Sikkim, Uttar Pradesh, Punjab (New record), Kashmir, Karnataka, Tamil Nadu; SRI LANKA: NEPAL: PAKISTAN.

Remarks : This species can be recognised by the underside of head moderately pubescent, pubescence of the body pale yellow to bright yellow, femora blackish and abdominal spines black. This species resembles *S. nivialis* Brunetti, the pubescence of which is nearly white.

Subfamily ANTHRACINAE

3. *Petrorossia ceylonica* (Brunetti)

1909. *Argyra.noeba ceylonica* Brunetti, *Rec. Indian Mus.* 2 : 471.

1920. *Aphoebantus ceylonicus* : Brunetti, *Fauna Br. India, Dipt.* 2 : 257.

1975. *Petrorossia ceylonica* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 173.

Material examined : 1 ♂, INDIA : S. ANDAMAN, Worigtung, 50 ft. (15 m.), 24.iii.1964, B.S. Lamba.

Distribution : INDIA : West Bengal, Bihar, Uttar Pradesh, Andaman Is. (New record); SRI LANKA.

Remarks : This species is identified by the second longitudinal vein with a strong loop near tip of wing, clear wing with costal and subcostal cell yellowish; oblong abdomen furry, yellowish with middle part longitudinally blackish.

4. *Anthrax distigma* Wiedemann

1828. *Anthrax distigma* Wiedemann, *Aussereurop. zweifl. Insekt.* 1 : 309.

1857. *Anthrax argyropyga* Doleschall, *Natuurk. Tijdschr. Ned-indië* 14 : 401.

1867. *Anthrax tripunctata* Wulp, *Tijdschr. Ent.* 11 : 109.

1882. *Anthrax tripunctata* : Osten-Sacken, *Ann. Mus. Genev.* 21 : 433.

1898. *Spogostylum distigma* : Coquillett, *Proc. U.S. Natl. Mus.* 21 : 318.

1907. *Argyra.noeba distigma* : de Meijere, *Tijdschr. Ent.* 50 : 241.

1988. *Anthrax distigma* : Zaitzev, *Rev. Ent. URSS* 67 : 867.

Material examined : 9 ♂♂, 10 ♀♀ INDIA : ARUNACHAL PRADESH, Subansiri District, Tamen, 305-457 m., 18-20.v.1966. A.N.T Joseph.

Distribution : INDIA : West Bengal, Sikkim, Bihar, Uttar Pradesh, Arunachal Pradesh, Tamil Nadu, Karnataka ; BANGLADESH : BURMA ; SRI LANKA ; INDONESIA (Java, Sumatra) ; SULAWESI : PHILIPPINES.

Remarks : Distal margin of dark wing band limited to enclosing anterior cross-vein and bases of discal and fourth posterior cell ; spot on fork of second longitudinal vein and that at base of third posterior cell quite isolated from the band itself and of almost same size; spot at base of second posterior cell small, indistinct or absent, are the major diagnostic features of *distigma*.

5. *Villa aperta* (Walker)

1852. *Anthrax aperta* Walker, *Insecta Saundersiana* 1 : 180.

1975. *Villa aperta* : Bowden, *Catalog Dipt. Orint. Reg., Hawaii* 2: 177.

Material examined : 1 ♂, INDIA : ARUNACHAL PRADESH, Kameng District, Dirong Dzong Jungle; 1601 m., 20.vii.1961, S. Biswas.

Distribution : INDIA : Uttar Pradesh, Himachal Pradesh, Meghalaya, Arunachal Pradesh.

Remarks : This species is characterized by the pubescence on sides of abdomen entirely snow-white, except for few bunches of scales on each side near tip; legs blackish.

6. *Villa baluchianus* (Brunetti)

1920. *Anthrax baluchianus* Brunetti, *Fauna Br. India, Dipt.* 2 : 250.

1975. *Villa baluchianus* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 177.

Material examined : 3 ♂♂ PAKISTAN : North West Frontier Province, Chitral, Lutokh Valley, Izh, viii.1929, B.N. Chopra.

Distribution : INDIA : Kashmir; PAKISTAN.

Remarks : This species can be recognised by the costal cell of wing yellowish. ground colour of abdomen blackish; pubescence on sides of abdomen not arranged as in *aperta* and generally yellowish-grey; legs all blackish.

7. *Villa claripennis* : Brunetti)

1909. *Anthrax hottentota* L. var. *claripennis* Brunetti, *Rec. Indian Mus.* 2 : 452.

1975. *Villa claripennis* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 177.

Material examined : 2 ♂♂, 1 ♀ PAKISTAN : North West Frontier Province, Chitral. 1 ♀, 20-28.vi.1929 ; Lutokh Valley, Izh. 1 ♂, viii.1929 ; Mastuj Valley, Buni, 1 ♂, viii.1929, coll. B.N. Chopra.

Distribution : INDIA : Uttar Pradesh (W. Himalayas); PAKISTAN : N.W. Frontier Province (New record) :

Remarks : The characteristic features of this species are : Wing clear, hyaline with subcostal cell yellowish-brown bifurcation of second and third longitudinal vein is exactly over anterior cross-vein, blackish dorsum of thorax with minute elongate yellow scale-like pubescence, frons wholly black haired.

8. *Villa fuscolimbata* (Brunetti)

1917. *Anthrax fuscolimbata* Brunetti, *Rec. Indian Mus.* **12** : 75.

1975. *Villa fuscolimbata* : Bowden, *Catalog Dipt. Orient. Reg., Hawii* **2** : 177.

Material examined : 1 ♀, INDIA : TAMIL NADU, Anamalai Hills, Cinchona, 3500 ft. (1060 m.), iv.1957, P.S.N.

Distribution : INDIA : Himachal Pradesh, Uttar Pradesh, Tamil Nadu.

Remarks : This species can be recognised by its clear wing with the brown suffusion on anterior part limited to subcostal cell or little below it, anterior cross-vein situated just above middle of discal cell, abdomen black with transverse bands of small yellowish-grey or whitish scales, thorax black and more or less covered with small impressed yellow scales, frons covered with yellowish impressed scales and blackish pubescence.

9. *Villa* sp. nr. *manifesta* (Walker)

Material examined : 1 ♂. INDIA : UTTAR PRADESH, Dehra Dun District, below Bhatta, 4 miles below Mussoorie, 16.vi.1930, B.N.C., in khud.

Distribution : INDIA : Uttar Pradesh.

Remarks : This species comes close to *manifesta* by wing with deep brownish-black costa and open anal cell. But the clear part of wing of this species is with tint brown suffusion, pubescence of thorax and abdomen wholly blackish and not very densely pubescent. These differences may deserve a separate specific status for the species under consideration. But I preferred to wait for more material for better comparative study before coming to a conclusive opinion.

10. *Villa paniscus* (Rossi)

1790. *Bibio paniscus* Rossi, *Fauna Etrusca* **2** : 256.

1820. *Anthrax cingulatus* Meigen, *Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten* **2** : 145.

1834. *Anthrax binaculatus* Macquart, *Nouvelles suites à Buffon, for.nant avec les oeuvres de cet auteur, un cours complet d' Histoire naturelle* **1** : 403.

1849. *Anthrax hottentottus*, Walker, *List Dipt. Colln. Br. Mus.* **2** : 259.

1920. *Anthrax paniscus* : Brunetti, *Fauna Br. India Dipt.* **2** : 248.

1975. *Villa paniscus* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* **2** : 177.

Material examined : 2 ♂♂, INDIA : ARUNACHAL PRADESH, Kameng District, Dun Bridge, 1524 m., 1 ♀. 1.v.1966, A.N.T. Joseph ; TAMIL NADU, Anamalai Hills, Cinchona, 3500 ft. (1060 m.), 1 ♀. iv.1957, P.S.N.

Distribution : INDIA : Uttar Pradesh, Arunachal Pradesh, Tamil Nadu (New record) ; EUROPE.

Remarks : This species can be recognised by its clear wing little iridescent, base

and fore margin yellowish-brown down to first longitudinal vein or a little further, basal part of vein blackish-brown ; abdomen black with sides of first two segments brownish, first four segments covered with coppery pubescence, sides of seventh segment with whitish pubescence ; thorax dull black with coppery scaly pubescence.

11. **Exoprosopa (Exoprosopa) andamanica** sp. nov.

(Test-fig. 1)

Moderately large, about 12 mm., largely yellowish-brown with yellowish and blackish pubescence.

Male : *Head* broader than long ; frons light brown, covered with short yellowish, squamiferous scales, interspersed with longer blackish hair-like pubescence ; frons at level of antennae slightly more than one-third as wide as head, narrowing towards vertex ; ocellar triangle small. *Antenna* with apical two segments nut-brown, 1st antennal segment about thrice as long as 2nd, 2nd about as broad as long, 3rd segment elongated, about as long as 1st one ; style narrow-cylindrical, about 0.7 time as long as third segment and distinctly demarcated from it ; 1st antennal segment with long black bristles and 2nd with shorter bristles, 3rd segment bare. *Proboscis* dark brown, strong, slightly longer than head and bifid apically. *Eyes* blackish-brown, facets very small and uniform ; occiput blackish with whitish squamiferous scales on sides and blackish pubescence throughout.

Thorax somewhat quadrate, little broader than head, ground colour blackish ; dorsum somewhat bare, only with yellowish pubescence near posterior margin ; fringe of light brown bristly hairs on anterior margin and shoulders, continued posteriorly with whitish setae ; groups of long, black bristles directed backwards from posterior callus and above wing base ; underside of thorax with moderate amount of greyish hairs. *Scutellum* brownish with yellowish pubescence near antero-median part, blackish pubescence on sides and little below the former one, posterior margin with row of strong blackish bristles directed backwards.

Legs long, slender, yellowish-brown ; fore legs practically bare, posterior ones minutely pubescent and with distinct blackish bristles, which are stronger on hind pair.

Wing (Fig. 1) clear hyaline with yellow spots in larger area, first longitudinal vein feebly curved apically, Rs vein arises a little before r-m cross-vein, apical loop of 2nd longitudinal vein moderately strong, r-m cross-vein joins discal cell at middle of its length, 1st basal cell about 1.25 times longer than 2nd basal cell, 1st posterior cell and anal cell open, 2nd posterior cell slightly wider apically than at base, pattern of wing spots as shown in Fig. 1. *Haltere* yellowish with a small apical brown spot.

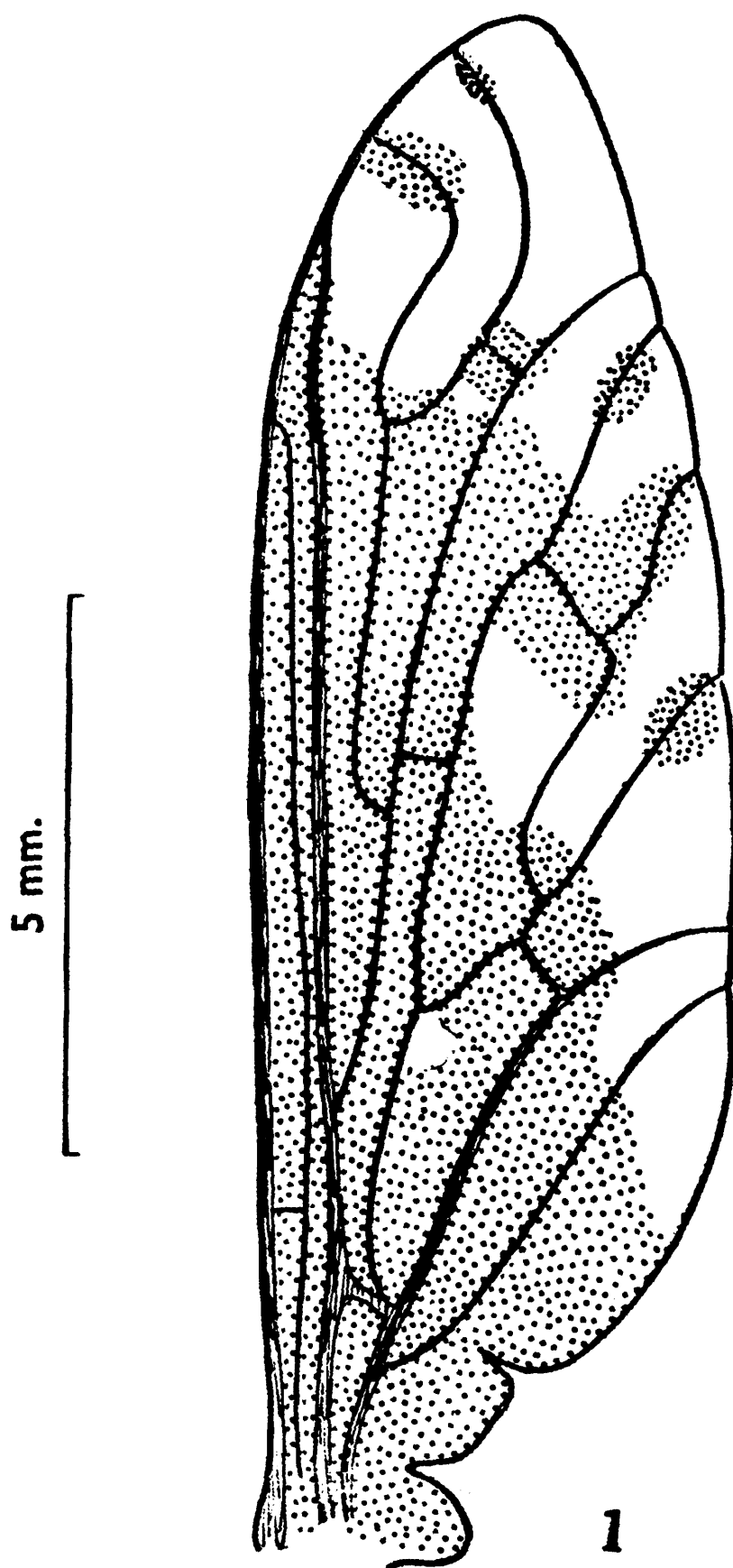
Abdomen elongate-oblong, ground colour yellowish brown ; a broad triangular median black spot on 2nd segment, which slightly shorter and narrower on 3rd segment, more area of 4th and 5th segments blackish ; dorsum with sparsely arranged short, depressed blackish setae, some yellowish setae here and there, a bunch of yellowish-brown elongate hairs at sides of 1st segment. *Venter* covered with whitish setae.

Length : Body-12.0 mm. ; wing-13.0 mm.

Female : Similar to male but abdomen comparatively darker.

Holotype ♂, INDIA : ANDAMAN Is., S. Andaman, Waraftur's Creek, Baratang, 13.iii.1964, B.S. Lamba ; *Paratype* ♀, same data as holotype except 17.iii.1964 (Z.S.I. Regn. No. 7489/H₆ and 7490/H₆).

This species resembles only with *E. insulata* (Walker) in having isolated spots in



Text-fig. 1. Right wing of *Exoprosopa andamanica* sp. nov.

clear part of wing. It can be separated from the latter by having additional subapical transverse band joining baso-costal oblique wing band, wing spots yellowish, and ground colour of abdomen and legs yellowish.

12. *Exoprosopa* (s. str.) *brahma* Schiner

1868. *Exoprosopa brahma* Schiner, In : *Reise der osterreichischen Fregatta Novara, Dipt.* : 118.

1975. *Exoprosopa (Exoprosopa) brahma* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 181.

1988. *Exoprosopa brahma* : Zaitzev, *Entomol. Review* : 7.

Material examined : 18 ♀♀ INDIA : PONDICHERRY, Karaikal, ii.1985 & ii.1960, P.S.N.

Distribution : INDIA : Karnataka, Pondicherry (New record) ; SRI LANKA.

Remarks : This species can be recognised by its sooty brown wing with front margin darker and more reddish, first posterior cell closed at very margin of wing and without distinct petiole, with eight isolated black spots ; the second abdominal segment with basal band of whitish pubescence and scutellum and antennae reddish-yellow. Zaitzev (1988a) recorded this Sri Lankan species from Karnataka of India.

13. *Exoprosopa (Exoprosopa) flexuosus* sp. nov. (Text-Fig. 2)

Large, about 14.8 mm. long, dark tan with brownish pubescence.

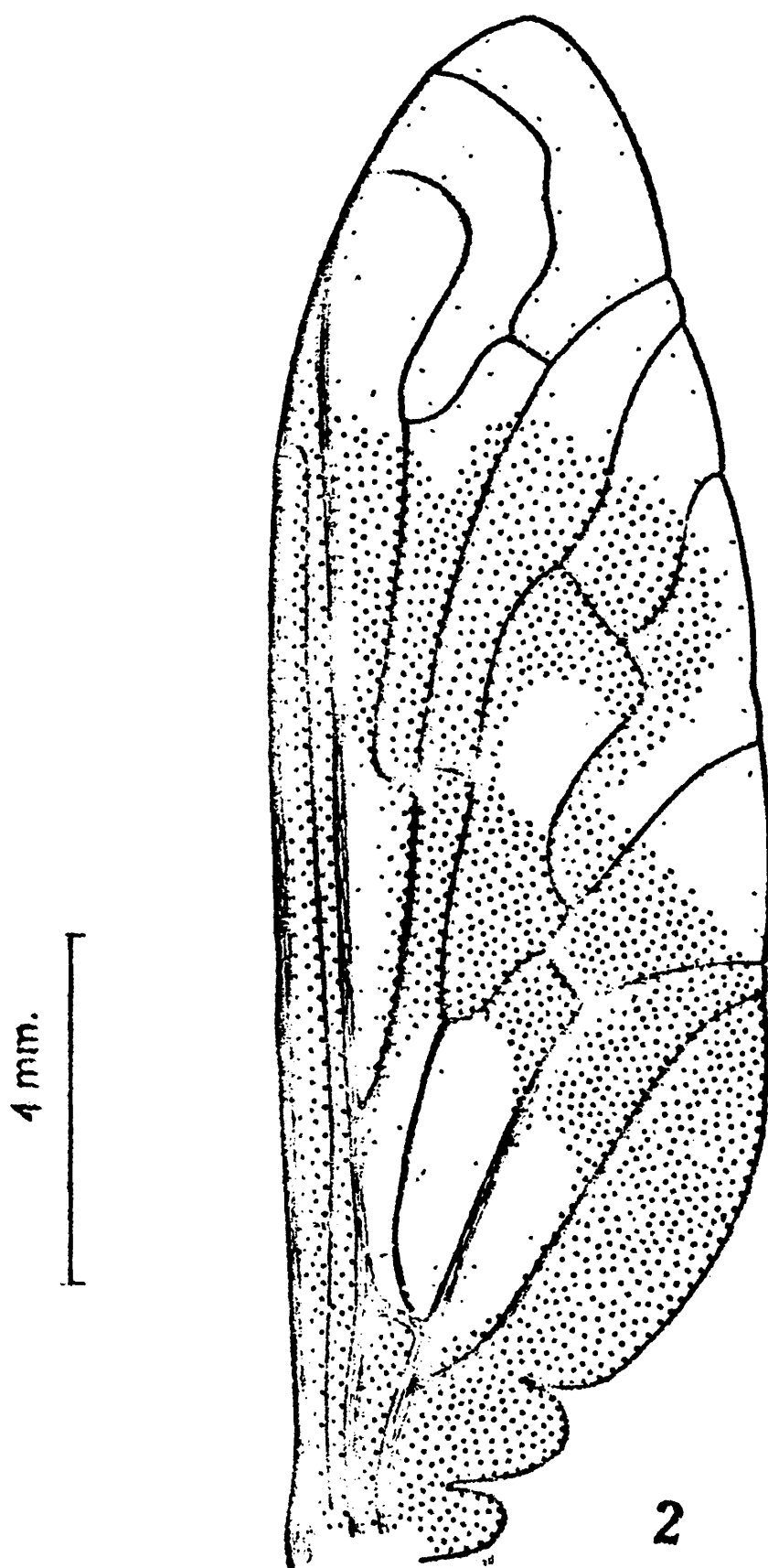
Female : *Head* dark brown, broader than long ; frons brownish, covered with short golden-yellow pubescence ; frons at level of antennae one-third as wide as head, narrowing towards vertex ; ocelli on a minute protuberance. Antennae nut-brown. 1st antennal segment more than twice as long as 2nd, 2nd broader than long, 3rd segment long, more than 1.5 times as long as 1st and 2nd together ; style elongated, narrow-cylindrical, demarcated from 3rd segment ; 1st antennal segment with long black bristles and 2nd segment with shorter bristles, 3rd segment bare. Proboscis black, strong, about as long as head and bifid apically. Eyes blackish brown, facets very small and uniform ; occiput blackish with short darker pubescence.

Thorax somewhat quadrate, little broader than head, blackish-brown, fringe of light brown bristly hairs on anterior margin and shoulders ; dorsum covered with moderately close, short brown pubescence ; 6-7 long, black bristles directed backwards on the posterior callus ; underside of thorax with moderate amount of greyish hairs. Scutellum deep reddish-brown, covered with pubescence as on dorsum of thorax, posterior margin with a row of strong blackish bristles directed backwards.

Legs long, slender, deep reddish-brown ; fore legs practically bare, posterior ones minutely pubescent and with distinct blackish bristles, which are stronger on the hind pair.

Wing (Fig. 2) : Ground colour smoky pale yellow, costa reaching near apex and ending between 2nd and 3rd longitudinal vein, first longitudinal vein feebly curved apically, Rs vein arises immediately before r-m cross-vein, 2nd longitudinal vein take a strong loop before joining wing margin, r-m vein joins discal cell at middle of

its length, 1st basal cell about 1.25 times longer than 2nd basal cell, 1st posterior cell and anal cell open. Two dark brown broad transverse bands leaving three clear spaces within basal two-thirds : base of wing orange-yellow up to 2nd basal cell, extending anteriorly along costa above bifurcation of 2nd and 3rd longitudinal vein,



Text-fig. 2. Right wing of *Exoprosopa flexuosus* sp. nov.

and posteriorly along anal vein up to its apex ; first dark band about as wide as half (basal) of discal cell and 2nd band about as wide as apical third of discal cell to basal half 2nd posterior cell ; three clear spaces : first below radius almost up to origin of 2nd longitudinal vein, 2nd about half as wide as 1st basal cell and extending up to anal vein, and third in the apical half of discal cell. Haltere dark brown.

Abdomen subconical, ground colour deep brown with posterior margin of all segments blackish, dorsum with short depressed brownish pubescence, a bunch of yellowish-brown elongate hairs at sides of first segment. Venter covered with short lighter hairs.

Length : Body—14.8 mm. ; wing—16 mm.

Male : Unknown.

Holotype ♀ , PAKISTAN, North West Frontier Province, Izh, Lutkoh Valley, Chitral, viii.1929, B.N. Chopra (Z.S.I. Regn. No. 7491/H₆).

This species comes close to *E. flammea* Brunetti, described originally by a female specimen. It can be separated from the latter by the difference of dark wing bands, especially the clear spaces, first posterior cell open, r-m cross-vein joins discal cell before middle of its length; ground colour of body, legs and pubescence darker.

14. *Exoprosopa* (s. str.) *insulata* Walker

1852. *Anthrax (Litorhynchus) insulata* Walker, *Insecta Saundersiana* 1 : 172.

1909. *Exoprosopa insulata* : Brunetti, *Rec. Indian Mus.* 2 : 446.

1975. *Exoprosopa (Exoprosopa) insultata* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 181.

Material examined : 2 ♀ ♀ INDIA : UTTAR PRADESH, Garhwal District, Mopata, 4700 ft. (1424 m.), 3.ix.1958, B.S. Lamba.

Distribution : INDIA : Bihar, Meghalaya, Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Karnataka, Tamil Nadu ; SRI LANKA ; NEPAL.

Remarks : Characteristic features of this species are : abdomen and antennae black, dorsum of abdomen with white scale-spots ; first posterior cell of wing broadly open at margin, dark pattern of wing extending beyond middle of discal and anal cell, with several isolated dark spots on clear part, alula well developed.

15. *Exoprosopa* (s. str.) *lateralis* Brunetti

1909. *Exoprosopa lateralis* Brunetti, *Rec. Indian Mus.* 2 : 467.

1975. *Exoprosopa (Exprosopa) lateralis* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 181.

Material examined : 2 ♀ ♀ INDIA : ORISSA, Jeypore, 1775 ft. (538 m.), x.1958, P.S.N.

Distribution : INDIA : West Bengal, Orissa (New record), Karnataka.

Remarks : This species can be recognised by the brownish wing with a pattern of broad darker mark, first posterior cell open and the second posterior cell about twice as wide at base as tip ; thorax blackish with long bright reddish-yellow bristly hairs on anterior margin, below shoulders and on posterior calli; abdomen blackish with the sides more or less broadly reddish-yellow.

16. **Exoprosopa** (s. str.) **siva** Nurse
(Text-figs. 3, 4)

1922. *Exoprosopa siva* Nurse, *J. Bombay nat. Hist. Soc.* **28** : 654.

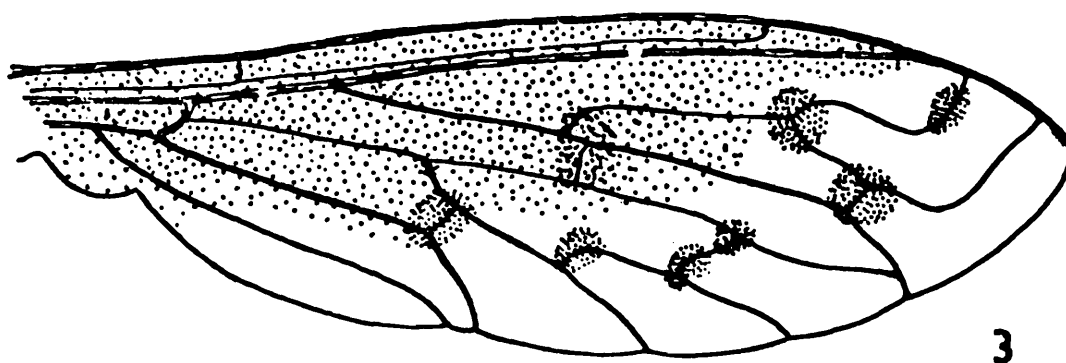
1975. *Exoprosopa* (*Exoprosopa*) *siva* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* **2** : 182.

1988. *Exoprosopa siva* : Zaitzev, *Entomol. Review* : 7.

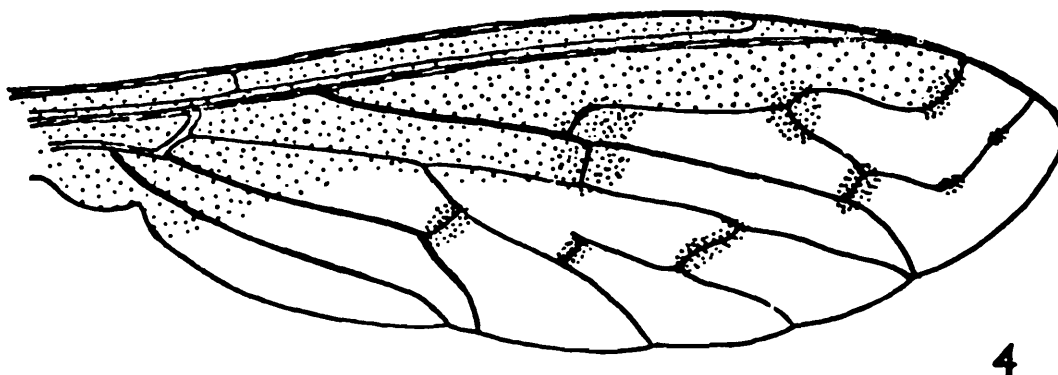
Material examined : 7 ♂♂, 6 ♀♀ INDIA : ORISSA, Jeypore, 1775 ft. (538 m.), x.1958, P.S.N. ; HIMACHAL PRADESH, Kangra Valley, Stn. 27, 1950, ZSI & PU coll.

Distribution : INDIA : Maharastra, Karnataka, Orissa (New record), Himachal Pradesh (New record).

Remarks : This species can be diagnosed by its blackish body with spots of pure white scales present along sides of 3rd and 6th abdominal tergites and on middle of 4th and 7th abdominal tergites ; wing with baso-costal dark oblique band and some isolated dark spots in the clear space, first posterior wing cell closed (Fig. 3). But in the specimens from Kangra Valley (2 male and 3 female) the first posterior wing cell is just open (Fig. 4).



5 mm.



Text Figs.: 3 and 4 : 3. Right wing *Exoprosopa siva* Nurse ; 4, Right wing of variant form of *E. siva*.

17. *Exoprosopa* (s. str.) *tamerlan* Portschinsky

1887. *Exoprosopa tamerlan* Portschinsky, *Horae Soc. ent. ross.* **21** : 185.

1909. *Exoprosopa flavipennis* Brunetti, *Rec. Indian Mus.* **2** : 465.

1975. *Exoprosopa* (*Exoprosopa*) *ta.nerlan* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* **2** : 182.

Material examined : 1 ♂ INDIA : ORISSA, Jeypore, 1775 ft. (538 m.), x.1958, P.S.N.

Distribution : INDIA : Bihar, Orissa (New record) ; PAKISTAN ; IRAN ; SOVIET UNION (Turkemenistan).

Remarks : This species apparently resembles *lateralis* Brunetti and can be distinguished by its first posterior wing cell closed. The wing of this species is almost entirely bright yellow to beyond middle and a narrow band in apical half.

18. *Litorhina* lar (Fabricius) (Text-Fig. 5)

1781. *Bibio lar* Fabricius, *Spec. Insect* **2** : 414.

1828. *Anthrax lar* : Wiedemann, *Aussereurop. zweifl. Insekt.* **1** : 268.

1840. *Litorhynchus collaris* (nec. Wiedemann) : Macquart, *Dipteres exotiques nouveaux ou peu connus* **2** (1) : 80.

1840. *Litorhynchus lar* : Oldroyd, *Ann. Mag. nat. Hist.* (11) **5** : 202.

1841. *Anthrax rugicollis* Saunders, *Trans. Ent. Soc. Lond.* **3** : 59.

1920. *Exoprosopa lar* : Brunetti, *Fauna Br. India, Dipt.* **2** : 194.

1909. *Exoprosopa collaris* (nec. Wiedemann) : Brunetti, *Rec. Indian Mus.* **2** : 444.

1975. *Litorhynchus lar* : Bowden, *Catalog Dipt. Orient. Reg. Hawai* **2** : 80.

1989. *Litorhina lar* : Evenhuis, *Catalog Dipt. Australian Oceanian Reg.* : 373.

Material examined : 1 ♂ INDIA : KARNATAKA, Kaddur District, Bababudan Hills, Jungle between Kemmangundi & Kalhattigiri, 4500-6155 ft. (1363-1865 m.), 17.xii.1928, H.S. Rao.

Distribution : INDIA : Bihar, Uttar Pradesh, Madhya Pradesh, Gujarat, Kerala, Karnataka ; SRI LANKA.

Remarks : This species can be recognised by its wing (Fig. 5) clear with a broad basal and median transverse band, the latter sometimes reaching hind border, both bands joined on the costa ; abdomen black with sides reddish.

19. *Ligyra flaviventris* (Doleschall)

1875. *Anthrax flaviventris* Doleschall, *Natuurk. Tijdschr. Ned. indie* **14** : 400.

1909. *Hyperalonis flaviventris* : Osten-Sacken, *Berl. Ent. Zeitschr.* **24** : 112.

1909. *Hyperalonis flaviventris* : Burnetti, *Rec. Indian Mus.* **2** : 441.

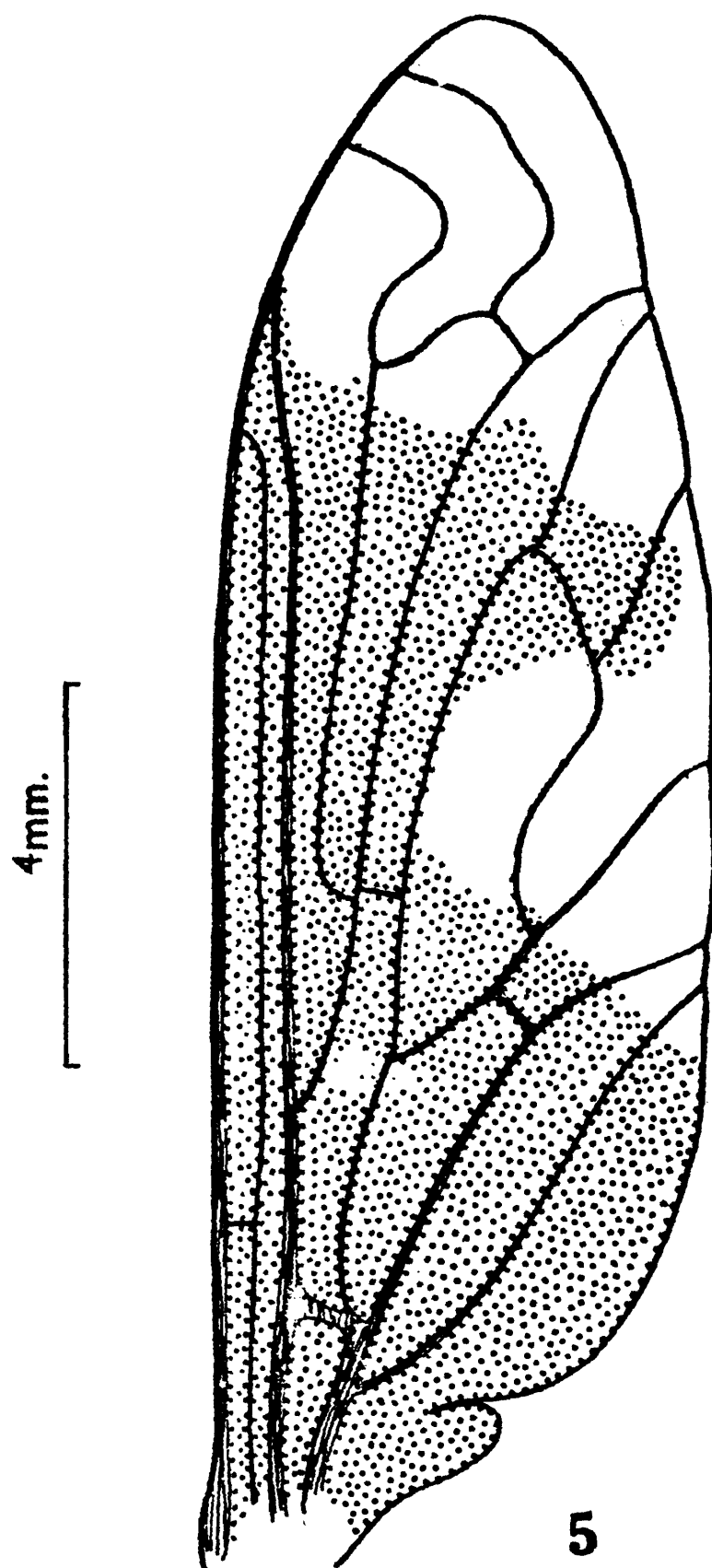
1975. *Ligyra flaviventris* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* **2** : 183.

Material examined : 1 ♂ , 1 ♀ INDIA : ANDAMAN Is., S. Andaman, Wraftur's Creek, Baratung, 13.iii.1964, B.S. Lamba.

Distribution : INDIA : Kerala, Andaman Is. (New record) ; BURMA ; MOLUCCAS.

Remarks : This species is characterised by the wing with apical part and a

considerable portion of the posterior half clear but the demarcation line with the darker part is less-defined ; blackish thorax bearing dense, long, fiery-orange bristly hairs along anterior margin ; blackish abdomen with a bunch of long fiery-orange hairs on sides of first and second segments, continued posteriorly with shorter setae, median stripe of pubescence on venter bright reddish-yellow:



Text-fig. 5. Right wing of *Litorhina lar* (Fabricius)

20. *Ligyra oenomaus* (Rondani)

1875. *Hyperalonia oenomaus* Rondani, *Annali Mus. civ. Stor. nat. Giac.no Doria* 7 : 453.

1909. *Hyperalonia oenomaus* : Brunetti, *Rec. Indian Mus.* 2 : 442.

1975. *Ligyra oenomaus* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 184.

Material examined : 1 ♀ INDIA : ARUNACHAL PRADESH, Kameng District, Tipi, 213 m., 3.v.1966, A.N.T Joseph.

Distribution : INDIA : Arunachal Pradesh, Assam, Sikkim, West Bengal (Darjeeling District) ; PHILIPPINES ; MALAYASIA.

Remarks : This species resembles closely with *L. flaviventris*, but can be distinguished by its blackish antennae, median ventral stripe of pubescence snow-white, and the darker part of wing with an iridescent violet tinge.

21. *Ligyra peninsularis* sp. nov.

(Text-fig. 6)

Moderately large, about 10.6 mm. blackish with grey or whitish pubescence.

Male : *Head* broader than long ; frons blackish, covered with whitish, short squamiferous scales, interspersed with longer blackish hair-like setae ; frons at level of antennae more than one-third as wide as head, narrowing towards vertex ; ocellar triangle small, protuberance-like. Antenna with basal two segments yellowish-brown and apical segment dark brown, 1st antennal segment more than twice as long as 2nd, 2nd about as broad as long, 3rd segment elongated, about as long as 1st and 2nd together ; style narrow-cylindrical, about 0.6 time as long as 3rd segment and distinctly demarcated from it ; 1st antennal segment with long black bristles and 2nd with shorter bristles, 3rd segment bare. Proboscis a dark brown, strong, little longer than head and bifid apically. Eyes dark brown peripherally with inner part blackish, facets very small and uniform. Occiput blackish with whitish setae.

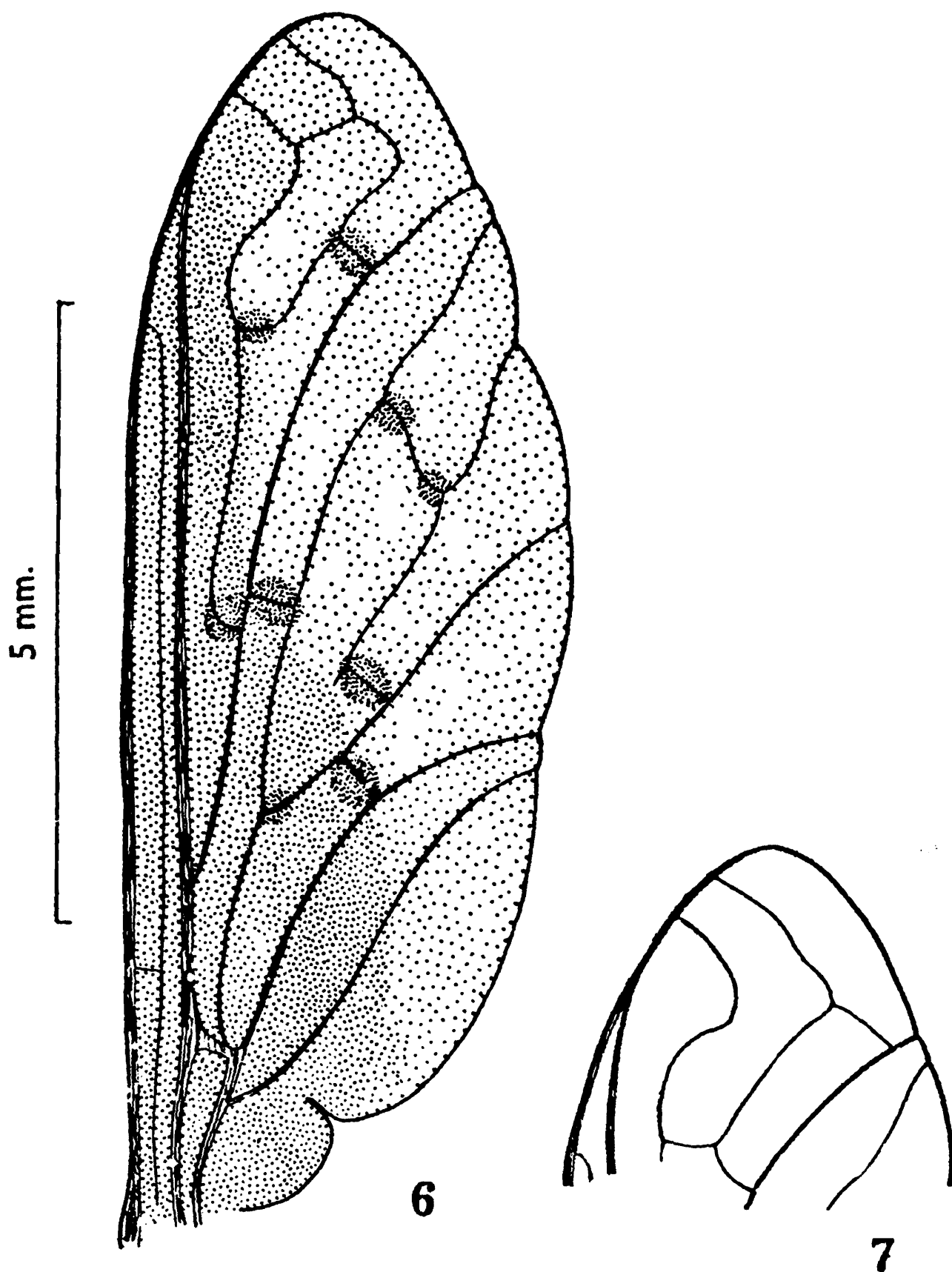
Thorax broader than long, little broader than head, blackish ; dorsum with scanty whitish pubescence ; fringe of whitish bristly hairs on anterior margin and shoulders, continued posteriorly with shorter setae ; groups of long, black bristles directed backwards from posterior callus and above wing base ; underside of thorax with moderate amount of greyish hairs. Scutellum blackish with apical half brownish, whitish squamiferous scales on sides, posterior margin with a row of strong blackish bristles directed backwards.

Legs long, slender, yellowish-brown ; fore legs practically bare, posterior ones minutely pubescent and with distinct blackish bristles, which are stronger on the hind pair.

Wing (Fig. 6) moderately dark brown, darker on anterior half, with isolated darker spots ; first longitudinal vein feebly curved apically, Rs vein arises a little before r-m cross-vein, apical loop of 2nd longitudinal vein rather strong ; a cross-vein between 2nd and 3rd longitudinal veins, a little away from apex divide first submarginal cell ; r-m cross-vein joins discal cell at middle of its length, 1st posterior cell 1.3 times longer than 2nd basal cell, 1st posterior cell and anal cell open, 2nd posterior cell slightly wider basally than at apex ; wing spots arranged as shown in

Fig. 6. Haltere yellowish-brown.

Abdomen elongated, sides rather parallel, ground colour blackish, segments apically yellow-bordered, dorsum mostly bare ; 1st segment with a sparsely arranged row of long whitish hairs along posterior margin, 2nd segment with densely arranged squamiferous scales near anterior border, other segments with less amount of



Text-figs. 6 and 7 : Right wing of *Ligyra peninsularis* sp. nov. ; 7. Apical part of right wing of *L. aurantiaca* (Guerin-Meneville) showing submarginal cells.

scales near anterior and posterior borders, a bunch of whitish elongate hairs at sides of 1st segment and continued to 2nd segment, sides of other segments and apical margin of 7th segment with long blackish hairs. Venter covered with whitish squamiferous scales and some long silvery hairs.

Length : Body-10.6 mm. ; wing-11.0 mm.

Female : Unknown.

Holotype ♂, INDIA : PONDICHERRY, Karikal, ii.1960, P.S.N. (Z.S.I. Reg. No. 7492/H₆)

This species comes close to the Indian species, *L. aurantiaca* (Guerin-Meneville) in having blackish-brown wing fading to dark grey towards hind border ; but it can be differentiated from the latter in having several isolated dark spots on the wing. This species resembles also with *L. suffusipennis* (Brunetti) in having isolated darker spots on the wing ; but it can be differentiated from *suffusipennis* by its wing not uniformly dark brown throughout, the shapes and arrangement of isolated spots different and the edges of which are rather well-defined. This species in the present account is placed under *Ligyra* Newman for possessing four submarginal cells of wing. But it is strikingly different from the known oriental species of the genus by having the first submarginal cell is divided by a sub-apical cross-vein, instead of the division of third or posterior one (Fig. 7). This species may deserve a different generic status. But no attempt is made here to erect a separate genus for this species.

22. *Ligyra tantalus* (Fabricius)

1794. *Anthrax tantalus* Fabricius, *Ent. Syst.* 4 : 260.
 1828. *Anthrax tantalus* : Wiedemann, *Aussereurop zweifl. Insekt.* 1 : 255.
 1840. *Exoprosopa tantalus* : Macquart, *Dipteres exotiques nouveaux ou peu connus* 2(1) : 37.
 1857. *Anthrax coeruleopenmis* Doleschall, *Natuurk. Tijdschr. Ned. Indie* 14 : 400.
 1875. *Hyperalonia tantalus* : Rondani, *Annali Mus. civ. Stor. nat. Giacomo Doria* 7 : 453.
 1907. *Exoprosopa tantalus* : de Meijere, *Tijdschr. Ent.* 50 : 239.
 1909. *Hyperalonia tantalus* : Brunetti, *Rec. Indian Mus.* 2 : 438.
 1975. *Ligyra tantalus* : Bowden, *Catalog Dipt. Orient. Reg., Hawaii* 2 : 184.

Material examined : 1 ♀ INDIA : ARUNACHAL PRADESH, Kameng District, Tipi, 6.v.1966, A.N.T Joseph.

Distribution : INDIA : Arunachal Pradesh, Assam, West Bengal (Darjeeling District), Uttar Pradesh ; NEPAL ; CHINA ; TAIWAN ; MALAYSIA ; INDONESIA ; SULAWESI.

Remarks : This species can be recognised by its entirely dark brown wing with iridescent violet tinge and posterior part hardly lighter, second posterior cell distinctly broader at base than at tip ; antennae blackish ; blackish thorax bearing bright yellowish-orange hairs on anterior margin and above wing base ; abdomen blackish with whitish scaly pubescence on sides of sixth and seventh segments, and median stripe of pubescence on venter white.

SUMMARY

97 examples of Bombyliidae from India and Pakistan, of old surveys, are worked out. These represent 22 species in 8 genera of 2 subfamilies. 2 species viz., *Exoprosopa andamanica* and *Ligyra peninsularis*, and 1 species viz., *Exoprosopa flexuosus* are described as new, from India and Pakistan respectively. 1 species viz., *Bombylius ardens* Walker is recorded for the first time from India and several new records within the Indian territory are noted.

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**ON THE OCCURRENCE OF *DJOMBANGIA PENETRANS* BOVIEN, 1926
(CESTODA : CARYOPHYLLIDEA : LYTOCESTIDAE) IN WEST
BENGAL, INDIA AND NOTES ON ITS DIAGNOSTIC CHARACTERS**

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INTRODUCTION

The genus *Djombangia* was erected by Bovien (1926) with *D. penetrans* as its type species, collected from the intestine of a siluroid fish *Clarias batrachus* (L.) at Java. The present study is based on four specimens of *D. penetrans* collected from the junction of duodenum and intestine of *Clarias batrachus* (L.) from Malda, West Bengal in March, 1984. The study of these specimens revealed interesting intraspecific variations and the species is redescribed in the present communication. Classification is based on Mackiewicz (1972). All measurements are in millimeters.

SYSTEMATIC ACCOUNT

- Class CESTOIDEA Rudolphi, 1808
.Subclass CESTODA Carus, 1863
Order CARYOPHYLLIDEA Van Beneden (in
 Carus, 1863)
Family LYTOCESTIDAE Wardle and McLeod, 1952
 (=LYTOCESTINAE Hunter, 1927)
Genus **djombangia** Bovien, 1926

***Djombangia penetrans* Bovien, 1926**

.(Figs. 1 and 2)

1974. *Djombangia indica* Satpute and Agarwal, *Indian J. Exptt. Biol.* **12** : 373-375.

1977. *Djombangia caballeroi* Sahay and Sahay, *Excerta Parasitologica En Memoria Del Doctor Eduardo Caballero Y Caballero*, 371-376.

1985. *Djombangia clariae* Kundu, Bhattacharya and Datta, *Bull. Zool. Surv. India*, **7** (2-3) : 151-154.

Diagnostic character : Body white, divisible into scolex, neck and body proper, covered with thick tegument except in the region of scolex, measures $9.7-13.47 \times 2.97-4.18$. Head or anterior part globular or triangular with terminal introvert, $0.55-1.32 \times 0.82-1.10$, profusely supplied with glandular cells along the margin which concentrate below the apex in a semilunar fashion resulting in formation of some evagination or sucker. Neck muscular, $0.66-1.21 \times 0.27-0.82$, contractile in nature. Body proper oval or leaf-shaped with rounded posterior end ; pretesticular

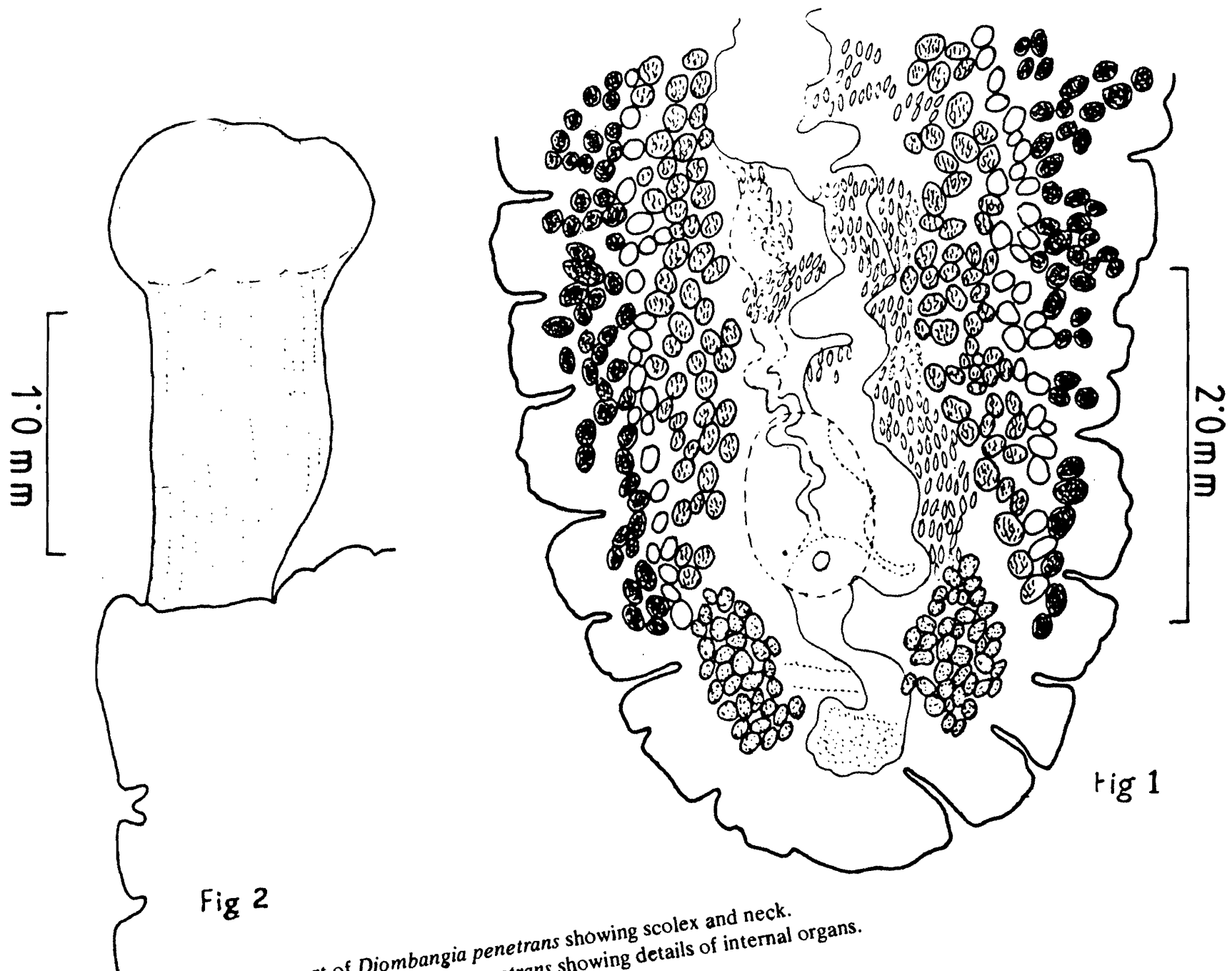


Fig. 1 : Anterior part of *Djombangia penetrans* showing scolex and neck.
Fig. 2 : Posterior part of *Djombangia penetrans* showing details of internal organs.

region $0.44-1.21 \times 1.76-2.31$ and uterotesticular region $5.28-8.36 \times 2.97-4.18$.

After fixing in A F A under cover slip pressure it contracts due to which deep denticulations appear in the margin of the body. Testes follicular, numerous, distributed in lateral medullary field, from behind neck to anterior level of ovary which is follicular bilobed on two sides of median line, two lobes measure $0.69-0.93 \times 0.33-0.44$ and $0.71-0.93 \times 0.33-0.49$ respectively and connected by wide strips of isthmus measuring $0.49-0.66 \times 0.11-0.16$. Uterus extends from testicular zone to posterior extremity of ovary. Shell gland mass well developed, located posterior to ovary Vitelline follicles measure $0.06-0.13 \times 0.06-0.11$, distributed in cortical region out side testes and extend from behind neck to anterior margin of ovary except in one specimen where it extends upto middle of ovary. Common atrium situated near hind end of body. Eggs operculate, elliptical and measure $.066-.088 \times .044-.044$. The spines mentioned by Bovien (1926) not clearly discernible. Measurements of different body organs of all the four specimens are included in Table I

Host : *Clarias batrachus* (L.)

Locality : Malda (West Bengal) ; Date of Coll. : 20.3.1984

Deposited in the National Zoological Collection, Zoological Survey of India, Calcutta, Registration No. W 7610/1—W 7613/1.

REMARKS

Parasites of the genus *Djombangia* Bovien, 1926 are characterised by their peculiar shape, globular head, short neck and disposition of the uterus. The body is broad and fleshy. The head of the parasites of this genus generally penetrate through and projects outside the intestinal wall. From the shell gland mass the uterus ascends and reaches up to the neck and then it descends to open through the female opening at posterior end.

Variations in the present specimens from those of *D. penetrans* Bovien, 1926 are mainly in structures of sucker. The comparison of the present specimens with the type specimen and those of other species described so far from India are based on literature and presented in Table II. From this table it is apparent that all the Indian species including the present specimens differ in minor characters from *D. penetrans* Bovien, 1926. The difference in the cirrus sac, location of the genital atrium, the structure of the sucker and the length of the neck in various species described so far from India are of such minor nature that they do not warrant erection of a new species. Chakraborty and Tandon (1988) referred their specimen to *D. indica* Satpute and Agarwal, 1974 as it is having prominent cirrus sac, post-ovarian vitelline follicles and receptaculum seminis. Mackiewicz (1981) remarked that *D. indica* is described from flattened specimens, and the correct assessment of its status could be done only after comparison with *D. caballeroi* Sahay and Sahay, 1977. In the light of the present studies it is concluded that there are variations in the structure of different organs in the species belonging to the genus *Djombangia* Bovien, 1926 (Table II) as such the species described so far from India are considered to be synonym of *D. penetrans* Bovien, 1926.

TABLE—I
MEASUREMENTS AND VARIATIONS OF 4 MATURE SPECIMENS

	<i>Specimens</i>			
	1	2	3	4
Length of parasites	13.47	11.78	11.11	9.07
Maximum breadth	4.18	4.01	3.3	2.97
Hold fast length	0.55	0.88	1.32	0.66
Hold fast breadth	1.1	0.82	0.77	0.82
Neck length	1.21	1.05	0.66	0.99
Neck breadth	0.82	0.60	0.27	0.33
Pretesticular body length	1.21	0.82	0.44	0.88
Pretesticular body breadth	2.31	1.76	1.98	1.76
Utrrotesticular region length	8.36	8.25	7.37	5.28
Uterotesticular region length	3.18	4.01	3.3	2.97
Ovary length (Right lobe)	0.93	0.88	0.69	0.71
Ovary breadth (Right lobe)	0.44	0.44	0.33	0.33
Number of ovarian follicles (Right lobe)	30	—	—	—
Ovary length (left lobe)	0.93	0.91	0.71	0.77
Ovary breadth (Left lobe)	0.44	0.49	0.38	0.33
Number of ovarian follicles (Left lobe)	33	—	—	—
Ovarian Isthmus length	0.66	0.49	0.49	0.55
Ovarian Isthmus breadth	0.16	0.16	0.13	0.11
Size of Testes (Based on 3 exs.)	0.16×0.16	0.15×0.16	0.16×0.16	0.16×0.16
	0.16×0.16	0.19×0.16	0.16×0.14	0.16×0.16
	0.16×0.16	0.17×0.16	0.16×0.16	0.14×0.15
Size of Vitalline follicles (Based on 3 exs.)	0.11×0.11	0.13×0.11	0.11×0.11	0.09×0.09
	0.11×0.11	0.13×0.11	0.11×0.09	0.08×0.08
	0.11×0.11	0.11×0.11	0.11×0.11	0.06×0.06
Size of Eggs (Based on 10 exs.)	0.05-0.09×0.03-0.05	0.05-0.08×0.03-0.04	0.05-0.09×0.03-0.04	0.05-0.08×0.03-0.04
	(0.072×0.041)	(0.068×0.038)	(0.066×0.036)	(0.063×0.035)

TABLE—II
MORPHOLOGICAL VARIATIONS OF DIFFERENT SPECIES OF GENUS *DJOMBANGIA* BOVIEN, 1926 OCCURRING IN
CLARIAS BATRACHUS (LINN.) AND *HETEROPNEUSTES FOSSILIS* (BL.)

	<i>Djombangia penetrans</i> Bovien, 1926.	<i>D. indica</i> Satpute & Agarwal, 1974	<i>D. caballeroi</i> Sahay & Sahay, 1977	<i>D. clariae</i> Kundu, Bhattacharya & Datta, 1985	<i>D. penetrans</i> Bovien, 1926 (Present study)
Body	9-10×3	7.3-13.8×1.8-4.3	7.86-8.12×2.70-2.76	14.035×5.087	9.7-13.47×2.97-4.18
Cirrus sac	Not well defined	Very prominent	Well defined	Discernible	Not well defined.
Cenital atrium	Near ovarian Isthmus.	Opposite uterovaginal aperture.	Anterior to Cirrus sac	In front of ovarian isthmus.	Near the hind end not anterior to Cirrus sac.
Sucker	Circular, at the tip of scolex.	Distinct, at the tip of hold fast.	Slit like groove at the tip of hold fast.	Evagination at the tip of scolex.	Very feeble evagi- nation at the tip of scolex.
Neck	Continuous with scolex and body.	Short neck, not marked off from the scolex and body.	Neck marked off from the scolax by a line.	Neck is not short, not marked off from the scolex by a line.	Neck continuous with scolex and body.
Eggs	Eggs with spinous shell eva 62-75 uu×30-40 u spinous projection—4 u.	Eggs operculated bearing spinous projections on the surface 64-81 u × 43-58 u spinous projection—3 u.	Eggs non operculated and smooth 0.08×0.04	Eggs non operculated and smooth 82-96×41.	Eggs operculate 0.067×0.037.
Host	<i>Clarias batrachus</i>	<i>Clarias batrachus</i>	<i>Heteropneustes fossilis</i>	<i>Clarias batrachus</i>	<i>Clarias batrachus</i>

SUMMARY

Djombangia penetrans Bovien, 1926 has been redescribed based on the specimens collected from the fish *Clarias batrachus* (L.) from Malda, West Bengal, India. The present specimens differ in minor morphological characters from the type specimens. All the other species of the genus *Djombangia* Bovien, 1926 described so far from India have been considered synonyms of *D. penetrans* Bovien, 1926.

ACKNOWLEDGEMENT

The author is thankful to the Director, Zoological Survey of India for necessary facilities. The author also expresses his sincere thanks to Dr. R. P. Mukherjee and Dr. C.B. Srivastava, Scientists 'SD' for critically going through the manuscript and to Shri I.B. Datta of Zoological Survey of India for his help in the preparation of this paper. He would also like to thank Dr. J.S. Mackiewicz, Biological Sciences, State University of New York, Albany, Ny 12222 (U.S.A.) for his suggestions.

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ON THE GENUS *STRIGILLA* IN INDIA (MOLLUSCA : BIVALVIA : TELLINIDAE).

A. DEY

Zoological Survey of India
Calcutta

INTRODUCTION

Members of the genus *Strigilla* have been recorded from eastern Atlantic, western Atlantic, eastern Pacific and Indo-pacific regions, Admans and Adam 1858, Bertin 1878, Dall 1901, Boss 1966, 1969, Afshar 1969). From the western Atalantic coast Boss (1969) recognised four subgenra viz. i) *Strigilla* s.st. ii) *Aeretica* Dall iii) *Simplistrigilla* Olsson iv) *Pisostrigilla* Olsson. In India, the genus is represented by only one species, viz. *Strigilla* (*Aeretica*) *splendida* (Anton). Since the species is less known, an attempt is made to present an account of its habitat and morphology.

MATERIAL AND METHODS

Morphological examinations of shells was carried out with the help of magnifying glass (IOX) or under a binocular microscope. The measurements are given in millimeters (mm). Three specimens, one largest, one smallest and one average were selected for measurements. Shell measurements are given in terms of maximum length (Length), maximum width (Width) and maximum thickness (Height). All these measurements were taken with the help of a dial caliper.

The burrowing process was studied by keeping the live specimens in an enamel tray filled with a layer of sand, mud and water from same locality. Burrowing time was recorded with the help of a stop watch.

The population density was estimated with the help of a square steel frame of half a meter length. The frame was inserted deep into substratum and the mud/sand within the frame was scooped and sieved through a net having 1 mm mesh.

***Strigilla* (*Aeretica*) *splendida* (Anton)** (Pl. I, figs. 1-4; Pl. II, figs. 1-3)

1839. *Tellina splendida* Anton, *Verz. Conch.*, p. 5, (type locality, Isle of Samar, Philippines).

1908. *Strigilla denestriata* Preston, *Rec. Indian Mus.*, 2 : 210, (type locality, Andaman : Holotype, ZSI Regd. no. M 4065/1).

Material examined : i) 1 ex. Andaman ii) 20 exs. Digha coast, W. Bengal iii) 208 exs. Kakdwip, W. Bengal iv) 20 exs. Bakkhali, W. Bengal v) 10 exs., Halliday Island, Sundayban, W. Bengal vi) 20 exs., Saimari, Sundarban, W. Bengal vii) 4 exs.,

Kakinda Bay, Andhra Pradesh.

Description : Shell medium, orbicular, moderately strong or very thin, delicate, inequivalve, the right valve more convex than the left. Shell white with yellow or rosy suffused. Umbo acuminate, elevated and anterior in position. Anterior margin rounded; ventral margin convex; anterior dorsal margin straight and abruptly sloping; posterior dorsal margin straight and gradually sloping; posterior margin rounded. Sculptured with oblique scissulation on the posterior part of the both the valves but anterior and with fine closely spaced concentric striae. Ligament sunken and small, flexure not conspicuous; lunule moderate and partly situated on the left valve; umbonal ridge obsolete (Plate-I).

In the left valve the cardinal complex consists of a narrow, elongated, laminate bifid anterior tooth and a thin laminate posterior tooth, closely depressed to the calcareous element of the ligament; laterals pointed and posterior proximal to the cardinal complex. In the right valve the cardinal complex consist of a small, thin, anterior and strong bifid posterior tooth with a large posterior lobe; laterals strong, socketed above with anterior proximal and posterior distal to the cardinal complex.

Muscle scars moderately impressed. Adductor scars elongate and narrow. Cruciform scars close to the ventral boundary and rounded. Pallial sinus discrepant in two valves. Sinus rising abruptly and convex shaped, falls obliquely to the pallial line without touching the anterior adductor scar, but more close to the anterior adductor scar in the case of right valve (Plate-II).

Remarks : *S. (Aeretica) splendida* (Anton) can be distinguished by its sculpture which has oblique scissulation on the posterior part, but fine closely spaced concentric striae on the anterior part. The colour of the shell very variable. The specimens from Andaman are rosy suffused and thick, while the specimens from Digba and other places are very thin, white, yellowish, or with pinkish umbonal region.

Preston (1908) described a new species *S. denestriata* from Andaman (Pl. I, Figs 3 & 4). After a through examination of the type specimen, it is synonymised with *S. splendida* as the former resembles the latter in its sculpture, cardinal complex, adductor muscle impressions, pallial line and pallial sinus (Pl-II, Fig. 1).

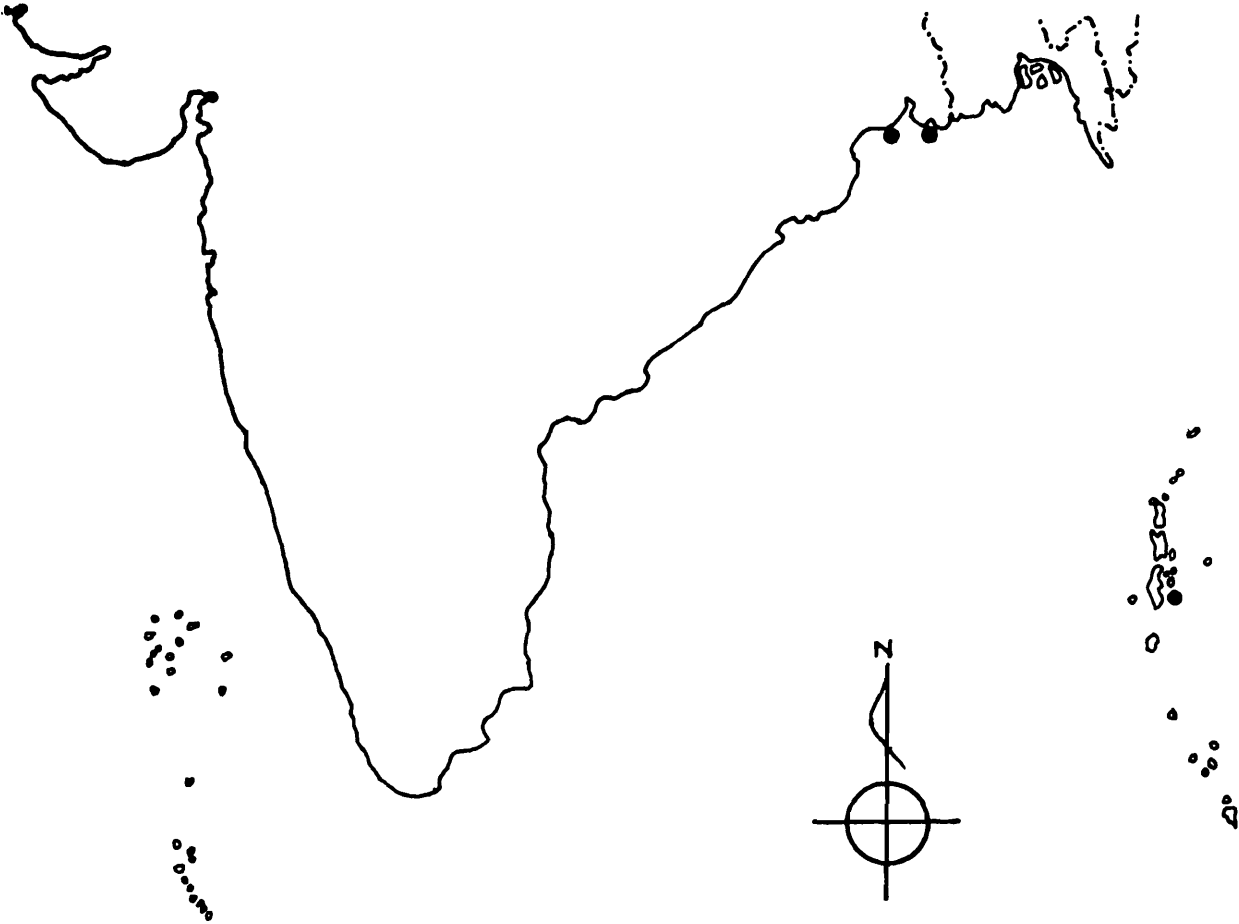
Measurements (in mm) :

Length	Height	Width
20.24	17.81	Andamans
17.90	16.42	8.0
10.34	8.28	3.88 Digba, W Bengal

Range : India to Philippines.

Distribution : India : Andaman and Nicobar Islands, Andhra Pradesh, West Bengal.

Elsewhere : Indonesia : Sumatra; Philippines : Isle of Luzon, Isle of Samar, Mindanao.



MAP OF INDIA SHOWING THE DISTRIBUTION OF
STRIGILLA (A) SPLENDIDA (ANTON)

S. (A.) splendida (Anton) has been recorded from the sandy beds along the coasta of Andaman and Nicobar Islands, Andhra Pradesh and West Bengal (Map-I). A total of 283 specimens (one from Andaman, 20 from Digha, 208 from Kakdwip, 20 from Bakkhali, 20 from halliday Island, 10 from Saimari (West Bengal) and 4 from Kakinada Bay (Andhra Pradesh) were examined. though the specimens were morphologically close to each other variations in shell length, height, width, colour have been noted with the change of locality. The specimens collected from Andaman were 17.90 to 20.24 in length and greyish white in colour, while those collected from Digha, Kakdwip, Bakkhali, Halliday, Saimari were 10.30 mm to 16.90 and yellowish or pinkish in colour.

They are equally apt to make their way deep into the soil, be it sand or clay. The foot was soon protruded and extended forward. The posterior end of the animal was pushed into the soil, through repeated jerking moments. The entire process was completed within 30-60 seconds. Inside the soil the animals were seen to position themselves in vertical direction and the siphons were extruded out.

Population density was observed in Muriganga (Kakdwip), Bakkhali and Digha. The population varied from 1.6 to 22.8 nos/sq meter on an average. The maximum population was observed during June/July and minimum during February/March.

The breeding season varied from March to May when the salinity content is higher.

General morphology

The mantle is a thin and transparent structure covering the whole visceral mass. It is united dorsally and fused ventrally in the cruciform muscles region, where it is thickened at the edge. The foot is large, elongated and pointed at the posterior end. The anterior and posterior adductor muscles are well developed. The pedal retractors are inserted into the foot. The foot and viscera posses many intrinsic adductor muscle fibres, while special siphonal muscles and cruciform muscles are posteriorly developed. The cruciform muscles consist of two compact bundles of transverse running fibres which stretch diagonally between the shell valves running through one another in the middle of their length.

The otenidia and palps are paired structures situated in the mantle cavity. The labial palps are trigonal and smaller than the ctenidia, having 19 folds in each. The ctenidium consists of a very large inner end and smaller, upturned demibranch. The ctenidium lacks the anterior portion in the case of outer demibranch and the inner demibranch extends dorsally and superficially over the pericardium. Centrally and along most of the ctenidial length, the outer demibranch is present and it consists of a single dorsally upturned direct lamella (Pl. III).

The siphons are separate, elongate and have constricted tips. The length of incurrent siphon is more than the body in a few cases (Pl. III).

The oesophagus is straight, long and leads directly to stomach. Stomach consists of two portions, the median globular portion and the ventral posterior portion, the style sac united with the midgut. The midgut terminated at the beginning of the rectum and enters into the pericardium, continuous around the dorsal surface of the posterior adductor muscle and terminated at the anus near the opening of excurrent siphon.

The kidney lies in between the heart and the posterior adductor muscle. The pericardium is located dorsally between the kidney and digestive diverticula. The heart consists of two large thin walled auricles connected with muscular ventricle which is transversed by the rectum (Boss, 1966). The nervous system is similar to that noted in other lamellibranchs. Gonads embedded into the foot and surrounds much of style sac and midgut.

SUMMARY

In India the genus *Strigilla* is represented by a single species *S. (Aeretica) splendida* (Anton). The Members of this are distributed along the east coast and in Andaman and Nicobar Islands. It is recognised by its oblique incised rugose sculpture on the middle which is diverticulate on both posterior and anterior ends.

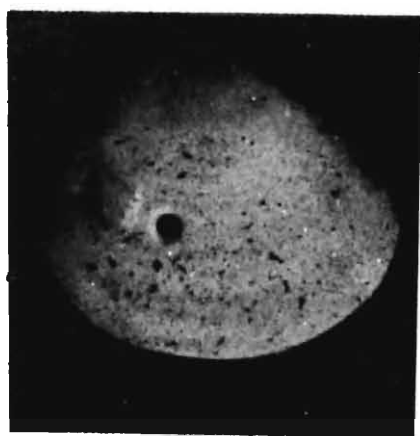
The species was found burrowing in sand as well as muddy stretches of sea and estuary, particularly where the clay contains high percentage of organic carbon. The population density was however, observed to be higher in the muddy areas of estuaries than that of sandy coastal areas.

ACKNOWLEDGEMENTS

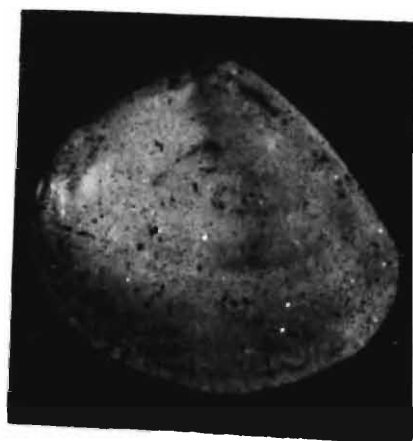
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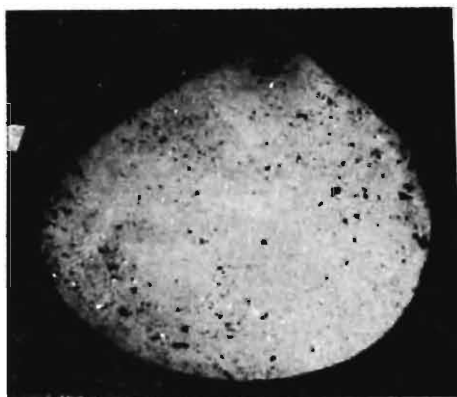


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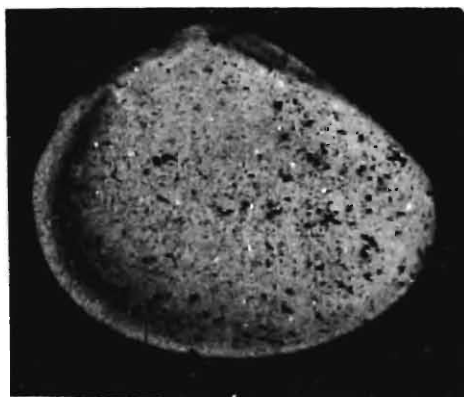


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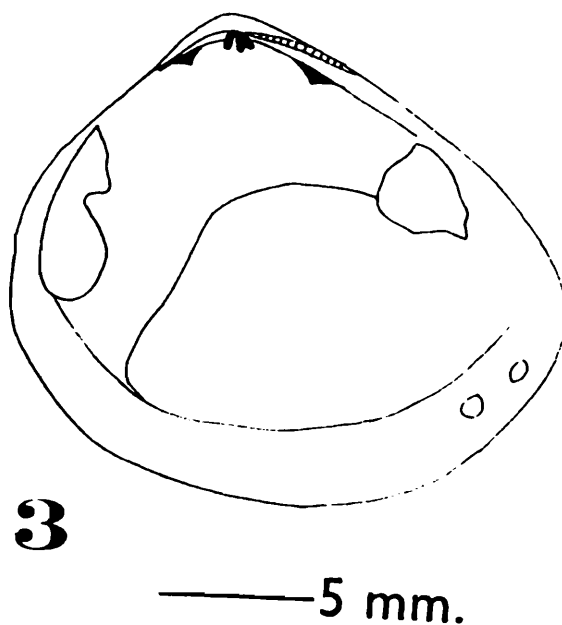
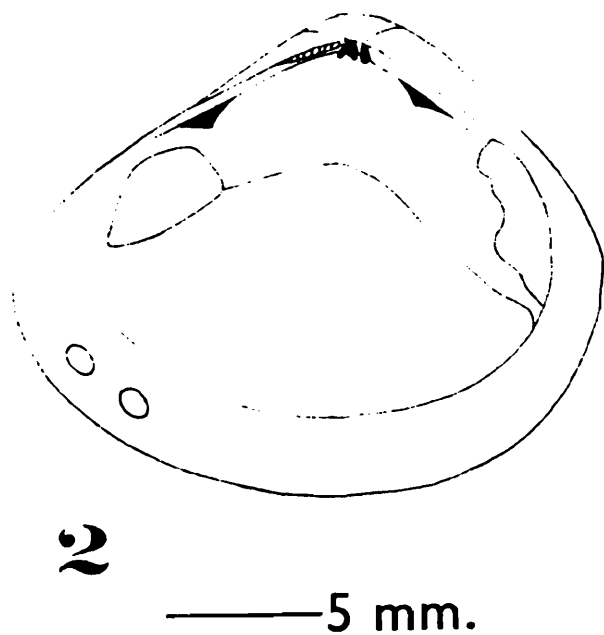
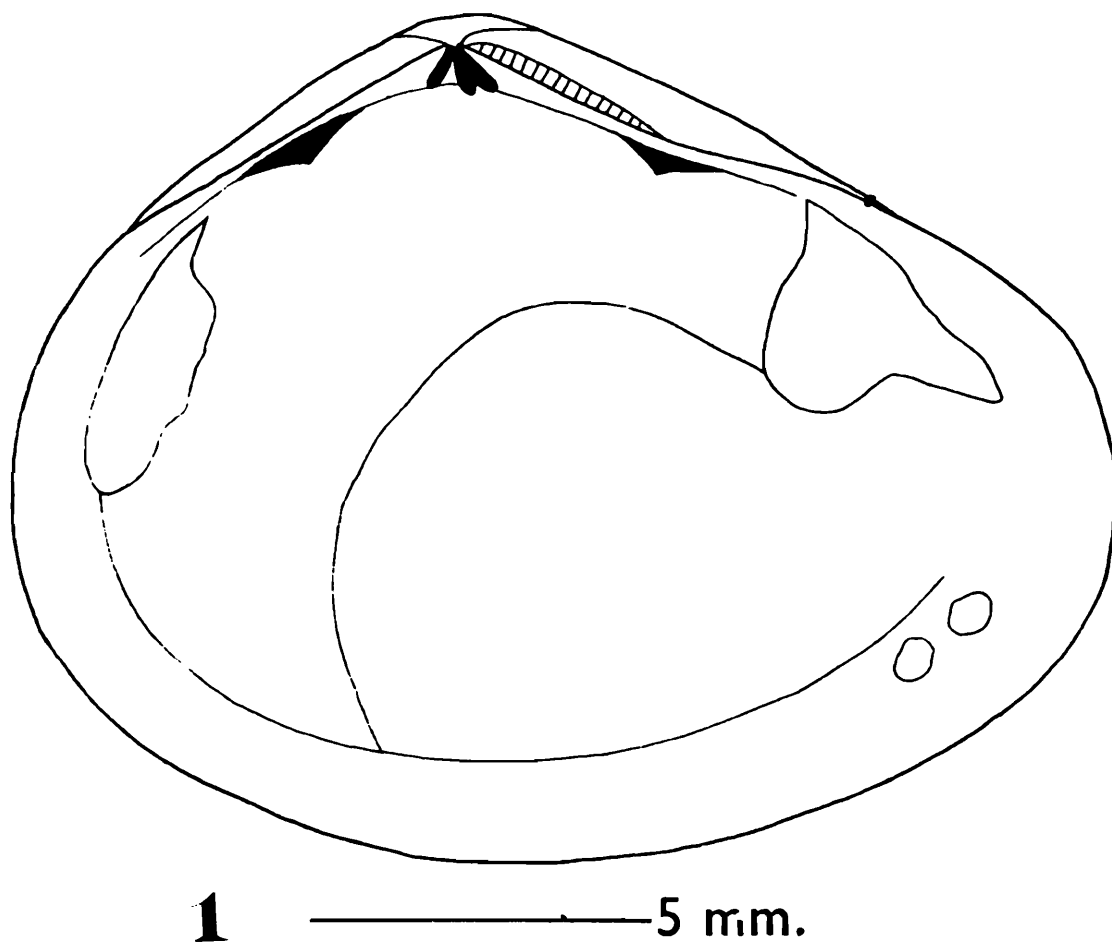


4



PLATE—I

- Fig. 1. External view of left valve of *Strigilla (Aeretica) splendida* (Anton).
Fig. 2. Internal view of right valve of *Strigilla (Aeretica) splendida* (Anton).
Fig. 3. External view of right valve of *Strigilla denestriata* Preston (Type).
Fig. 4. Internal view of right valve of *Strigilla denestriata* Preston (Type).



PLATE—II

Diagrammatic illustrations of the internal surface of the valves showing the cardinal complex, adductor muscles impressions, cruciform muscles impressions, pallial line and pallial sinus.

Fig. 1. *Striailla denestriata* Preston (Type), right valve.

Fig. 2. *Strigilla (Aeretica) splendida* (Anton), right valve.

Fig. 3. *Stioilla (Aeretica) splendida* (Anton), right valve.

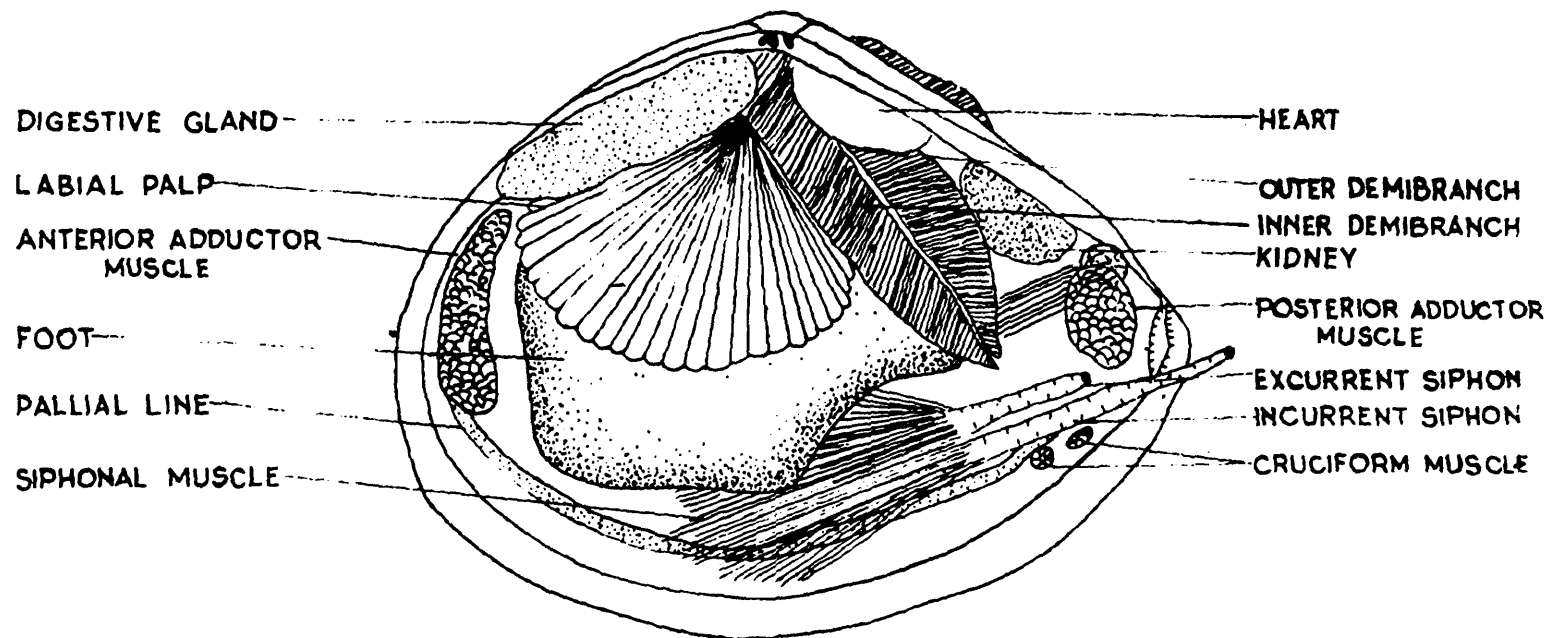


PLATE: III. Semidiagrammatic illustration of the anatomy of
Strigilla (~~Aeretica~~) Splendida (Anton)

PLATE—III

Semidiagrammatic illustration of the anatomy of *strigilla (Aeretica) splendida* (Anton).

DESCRIPTION OF MALE SPIDER *ULOBORUS DANOLIUS* TIKADER (ARANEAE : ULOBORIDAE)

U.A. GAJBE

Central Regional Station, Zoological Survey of India, Jabalpur (M.P.)

A male spider of *Uloborus danolius* Tikader (Family : Uloboridae) is described and illustrated for the first time. Tikader (1969) described *Uloborus danolius* on the basis of female specimens collected from Danoli Village, Ratnagiri district of Maharashtra. So far the male of this species was remained unknown.

***Uloborus danolius* Tikader** (Figs. 1-3)

1969. *Uloborus danolius* Tikader, *Proc. Indian Acad. Sci.*, **70**(3) : 129.

1977. *Uloborus danolius* : Tikader, *Rec. zool. Surv. India*, **72** : 162.

1981. *Uloborus danolius* : Tikader & Biswas, *Rec. zool. Surv. India, Occ. paper*, No. **30** : 15.

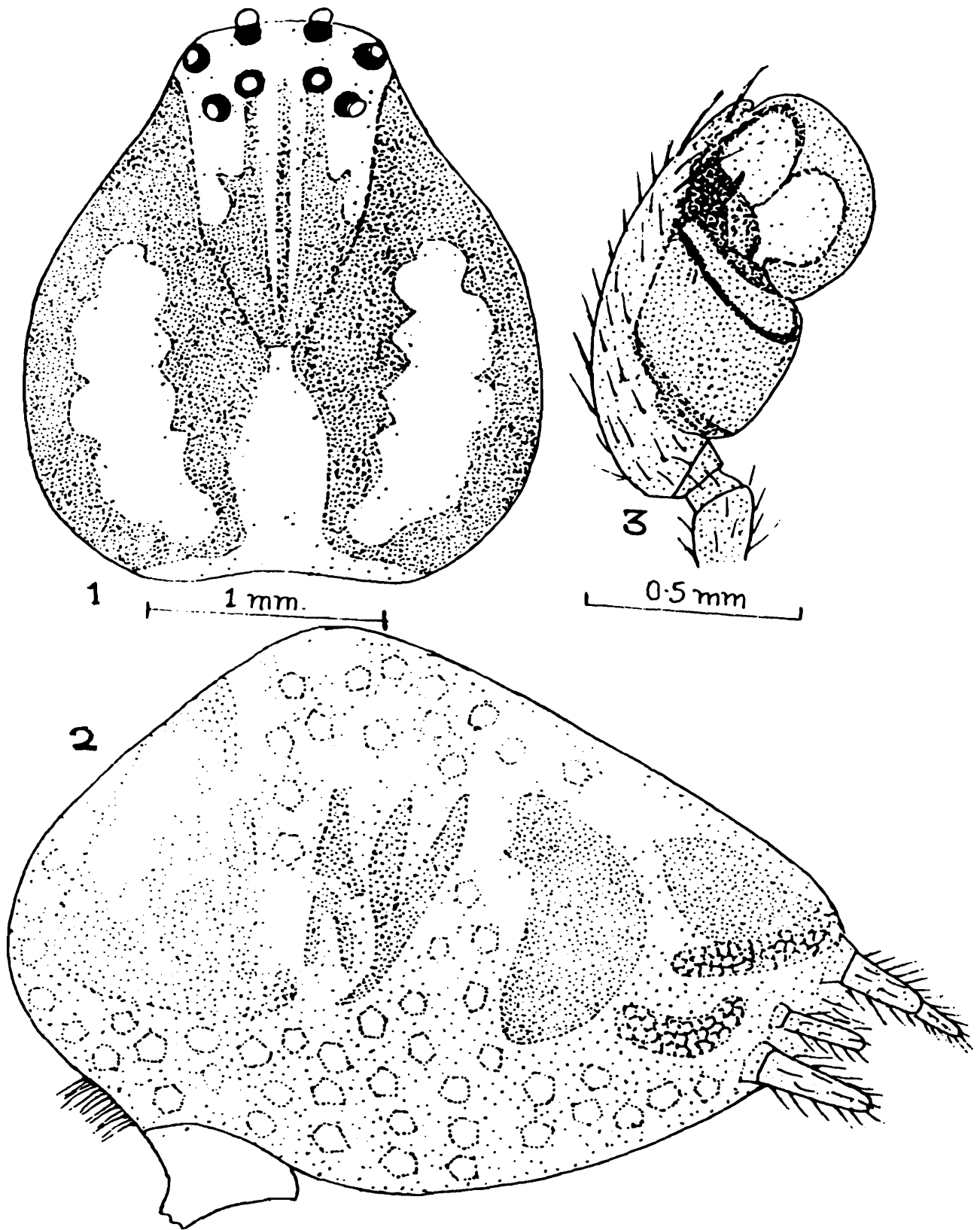
Specimen examined : 16 ♀♀, 10 ♂♂, Kachari Savanga Village, Katol Tahsil, Nagpur district, Maharashtra. Coll. U.A. Gajbe, 8.IV.1986.

General : Cephalothorax and legs light yellowish-green. Abdomen yellowish green. Total length 4.80 mm. Carapace 2.40 mm. long, 2.10 mm. wide ; abdomen 3.60 mm. long, 2.30 mm. wide.

Cephalothorax : Slightly longer than wide, narrow in front, two conspicuous longitudinal deep brown broad patches on the cephalothorax (Fig. 1). Eyes in two rows, anterior row slightly longer than the posterior row. Anterior row of eyes slightly recurved, anterior medians larger than the laterals and closer to each other than to adjacent laterals. Posterior row of eyes almost equal in size, posterior medians slightly closer to adjacent laterals than to each other. Median ocular quadrangle longer than wide and wider behind than in front. Clypeus narrow, length of clypeus is little smaller than the diameter of anterior median eyes. Sternum heart-shaped pointed behind and rebordered at coxae of all legs and deep brown in colour. Legs long and strong, clothed with hairs and conspicuously banded with transverse black patches. Leg I and IV longer than II and III. Male palp as in Fig. 3.

Abdomen : Longer than wide, high and broad in front clothed with pubescence and decorated with brownish patches and fine net like structure as in Fig. 2. Anterior dorsal side of abdomen provided with a hump, Mid-ventral side provided with longitudinal deep brown band extending from epigastric fold to above the calamistrum.

Distribution : INDIA : Maharashtra ; Danoli, Dist. Ratnagiri (Type-locality), Poona, Nagpur ; West Bengal : Calcutta ; Car-Nicobar.



Figs. 1-3. *Uloborus danolius* Tikader.

1. Dorsal view of Cephalothorax, legs omitted. 2. Lateral View of abdomen. 3. Male Palp (Ventral view).

REFERENCES

Tikader, B.K. 1969. Two new spiders of the genus *Uloborus* of the family Uloboridae from India, *Proc. Indian Acad. Sci.*, **70**(3) : 127-130.

**RECORD OF CULICINE MOSQUITOES FROM BASTAR DISTRICT
(MADHYA PRADESH), INDIA. (DIPTERA : CULICIDAE.)
PART III. GENUS AEDES.**

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INTRODUCTION

Genus *Aedes* is medically very important since it includes vectors of some fatal viruses like dengue & Chickungunya in India. Some of the aedine species are also known to transmit Zika, Reo, and Tembusu viruses in Malaysia and *Dirofilaria* in Japan & Thailand.

The Bastar district of Madhya Pradesh remained poorly known for his aedine mosquito fauna. The only mosquito record presented by Hussainy (1981) includes four species viz., *Aedes albopictus*, *A. scatophagoides*, *A. w-albus* and *A. vittatus*, from this area.

The present communication deals with the distribution records of some 24 species collected from Bastar district (Madhya Pradesh). This study was made during the period from year 1980 to 1982. The description of study area, climate, topography, and materials & methods used, have already been presented in Part I (Rajput and Kulkarni, 1984).

For identification mainly the adult characters were used. Genital characters of males and the characters of immatures were also taken into consideration whenever those forms were available. The identification was done with the help of Barraud (1934), Huang (1977 ; 1979) and Reinert (1973). Besides, some other papers were also consulted. The classification and nomenclature used here is mainly based on synoptic catalogue of the mosquitoes of the World (Knight & Stone, 1977 ; Knight, 1978).

SYSTEMATIC ACCOUNT

Genus *Aedes* Meigen

Subgenus *Aedimorphus* Theobald

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1. *Aedes alboscuteUellatus* (Theobald)

1905 a. *Lepidotomyia alboscuteUellatus* Theobald, *Ann. hist. nat. Mus. Hung.* 3 : 80.

1977. *Aedes alboscuteUellatus* : Knight and Stone : 73.—

Material examined : 192 ♀♀ : *Bhond* — 1 ♀ (1 Sept. '81) from herb vegetation. *Darbha* — 1 ♀ (1 Aug. '80) from human bait. *Dhaniyalur* — 1 ♀ (12 Jun. '81) from herb vegetation. *Karanji* — 82 ♀♀ (11 Aug. '81 — 8 Sept. '81) from bovine bait ; 14 ♀♀ (11 Aug. '81 — 8 Sept. '81) from human bait. *Kumarawand* — 1 ♀ (22 Aug. '81) from herb vegetation. *Kurandi* — 6 ♀♀ (4 Jul. '80 — 26 Aug. '80) from bovine bait ; 29 ♀♀ (4 Jul. '80 — 30 Oct. '80) from human bait. *Rajur* — 1 ♀ (21 Jul. '80) from herb vegetation ; 1 ♀ (10 Aug. '81) reared from larva from paddy field. *Telengarapur* — 33 ♀♀ (12 Jul. '80) bovine bait, 22 ♀♀ (12 Jul. '80) from human bait.

2. *Aedes caecus* (Theobald)

1901 a. *Culex caecus* Theobald, *M. C.* 1 : 413.

1977. *Aedes caecus* : Knight and Stone : 74.

Material examined : 7 ♀♀, 4 ♂♂ : *Dhaniyalur*—7 ♀♀, 4 ♂♂ (13 Aug. '81) reared from larvae from cart-track.

3. *Aedes jamsei* (Edwards)

1914. *Ochlerotatus jamsei* Edwards, *Bull. Ent. Res.* 5 : 77.

1977. *Aedes jamsei* : Knight and Stone : 77.

Material examined : 195 ♀♀ : *Chapar-Bhanpuri* — 4 ♀♀ (28 Aug. '81) from herb vegetation. *Darbha*—1 ♀ (17 Jun. '80) from herb vegetation. *Dhaniyalur*—1 ♀ (11 Aug. '80) from shrubby vegetation. *Dongariguda* — 1 ♀ (26 Jul. '80), 1 ♀ (23 Jul. '81) from herb vegetation. *Gumiyapal*—1 ♀ (24 Jul. '81) from shrubby vegetation. *Kakalgur*—1 ♀ (29 Jul. '81) from herb vegetation. *Karanji*—28 ♀♀ (27 Jul. '81 — 25 Aug. '81) from human bait. *Kotamsar*—69 ♀♀ (5 May '80 — 27 Jun. '80), 2 ♀♀ (26 May '81) from bovine bait, 63 ♀♀ (5 May '80 — 27 Jun. '80), 7 ♀♀ (26 May '81 — 3 Nov. '81) from human bait. *Kumarawand* — 4 ♀♀ (22 Aug. '81) from herb vegetation. *Kurandi* — 3 ♀♀ (4 Jul. '80) from bovine bait and 8 ♀♀ (4 Jul. '80) from human bait. *Tekameta* — 1 ♀ (31 Jul '81) from herb vegetation.

4. *Aedes pallidostriatus* (Theobald)

1907. *Culex pallidostriatus* Theobald, *M. C.* 4 : 410.

1977. *Aedes pallidostriatus* : Knight and Stone : 80.

Material examined : 3 ♀♀, 2 ♂♂ : *Darbha* — 1 ♂ (5 Aug. '81) reared from larvae from rock pool. *Kurandi* — 1 ♀ (4 Jul. '80) from bovine bait ; 2 ♀♀ (4 Jul. '80) from human bait. *Telengarapur*— 1 ♂ (4 Aug. '80) from herb vegetation.

5. *Aedes pipersalatus* (Giles)

1901. b. *Stegomyia pipersalatus* Giles, in Theobald, *M.C.* 2 : 316.

1977. *Aedes pipersalatus* : Knight and Stone : 80.

Material examined : 349 ♀♀, 27 ♂♂ : *Adawal* — 1 ♀ (30 Sept. '81) from herb vegetation. *Balenga* — 2 ♀♀ (15 Sept. '81) reared from larva from rainy pit.

Bhond — 3 ♀♀, 1 ♂ (25 Aug. '81 — 15 Sept. '81) from herb vegetation. *Bringpal* — 2 ♂♂ (31 Aug. '81) reared from larvae from paddy field. *Chapar-Bhanpuri* — 3 ♀♀ (5 Sept. '81) from herb vegetation. *Darbha* — 12 ♀♀ (20 Jul. '81 — 18 Aug. '81) from bovine bait ; 1 ♀ (12 Nov. '80) from herb vegetation. *Dhaniyalur* — 1 ♀ (13 Aug. '81) from herb vegetation. *Dongariguda* — 1 ♀ (20 Aug. '81) from shrubby vegetation. *Gumiyapal* — 1 ♀ (3 Sept. '81) from herb vegetation. *Kachora* — 1 ♀ (4 Sept. '81) from herb vegetation ; 18 ♀♀, 20 ♂♂ (25 Sept. '81) reared from larvae from paddy fields. *Karanji* — 240 ♀♀ (7 Jul. '81 — 8 Sept. '81) from bovine bait ; 25 ♀♀ (27 Jul. '81 — 8 Sept. '81) from human bait. *Keslur* — 1 ♀ (31 Aug. '81) from herb vegetation. *Kotamsar* — 4 ♀♀ (24 Oct. '80 — 5 Nov. '80), 2 ♀♀ (3 Nov. '81) from bovine bait. *Kumarawand* — 1 ♀ (5 Sept. '81) from herb vegetation. *Kurandi* — 8 ♀♀ (4 Jul. '80 — 13 Nov. '80) from bovine bait ; 3 ♀♀ (4 Jul. '80 — 13 Nov. '80) from human bait. *Lendra* — 1 ♀ (7 Sept. '81) from herb vegetation. *Neganar* — 3 ♀♀ (19 Aug. '81) reared from larvae from paddy fields. *Pakhanjore* — 1 ♀ (27 Aug. '81) from herb vegetation, 7 ♀♀ (20 Nov. '81 — 22 Nov. '81) from cattle shed. *Pandripani* — 2 ♀♀ (17 Aug. '81) reared from larvae from paddy field. *Rajur* — 4 ♀♀ (10 Aug. '81 — 7 Sept. '81) reared from larvae from paddy fields. *Takaraguda* — 1 ♀, 1 ♂ (22 Jul. '81 — 15 Sept. '81) from herb vegetation. *Tekameta* — 1 ♀, 2 ♂♂ (28 Aug. '81 — 9 Sept. '81) from herb vegetation. *Telengarapur* — 1 ♀ (31 Aug. '81) from herb vegetation. *Tokapal* — 1 ♂ (23 Sept. '81) from shrubby vegetation.

6. *Aedes taeniorhynchoides* (Christophers)

1911. *Leslieomyia taeniorhynchoides* Christophers, *Paludism* 2 : 68.

1977. *Aedes tdeniorhynchoides* : Knight and Stone : 82.

Material examined : 50 ♀♀ : *Karanji* — 1 ♀ (11 Aug. '81), from bovine bait. *Kotamsar* — 26 ♀♀ (5 May '80 — 27 Jun. '80) from bovine bait ; 9 ♀♀ (20 May '80) from human bait. *Kurandi* — 8 ♀♀ (15 May '80 — 4 Jul. '80) from bovine bait ; 4 ♀♀ (4 Jul. '80) from human bait. *Telengarapur* — 2 ♀♀ (12 Jul. '80) from human bait.

7. *Aedes trimaculatus* (Theobald)

1905. b. *Leslieomyia trimaculatus* Theobald, *Ann. Mus. Nat. Hung.* 3 : 86.

1977. *Aedes trimaculatus* : Knight and Stone : 83.

Material examined : 6 ♀♀, 1 ♂ : *Kurandi* — 5 ♀♀ (4 Jul. '80 — 27 Oct. '80) from bovine bait ; 1 ♀ (17 Jul. '80) from human bait. *Pandripani* — 1 ♂ (14 Sept. '81) reared from larvae from cart-track.

8. *Aedes vexans* (Meigen)

1830. *Culex vexans* Meigen, *Syst. Bechr.* 6 : 241.

1977. *Aedes vexans* : Knight and Stone : 83.

Material examined : 15 ♀♀, 10 ♂♂ : *Adawal* — 1 ♀ (30 Sept. '81) from herb vegetation. *Dhaniyalur* — 1 ♀ (26 Dec. '81) from herb vegetation. *Dongariguda* — 1 ♀, 1 ♂ (9 Jul. '81) from shrubby vegetation. *Kachora* — 2 ♂♂ (6 Aug. '81 — 20 Aug. '81) from herb vegetation. *Kotamsar* — 2 ♀♀ (7 Jun. '80) from bovine bait. *Kumarawand* — 10 ♀♀, 7 ♂♂ (22 Aug. '81 — 21 Nov. '81) from herb vegetation.

Subgenus **Christophersiomyia** Barraud9. **Aedes thomsoni** (Theobald)

1905. *Stegomyia thomsoni* Theobald, *Gen. Ins. Fam. Culicidae* : 19.

1977. *Aedes thomsoni* : Knight and Stone : 87.

Material examined : 33 ♀♀ : *Darbha* — 2 ♀♀ (17 Mar. '80), *Kotamsar* — 7 ♀♀ (5 May '80 — 27 Jun. '80), *Kurandi* — 24 ♀♀ (4 Jul. '80 — 17 Jul. '80). All the specimens were collected from human baits.

Subgenus **Diceromyia** Theobald10. **Aedes micropterus** (Giles)

1901. *Culex micropterus* Giles, *Journ. Bomb. Nat. Hist. Soc.* 13 : 609

1977. *Aedes micropterus* : Knight and Stone : 88.

Material examined : 18 ♀♀, 4 ♂♂ : *Adawal* — 1 ♀ (26 Sept. '80) from herb vegetation. *Bringpal* — 1 ♂ (29 Jun. '81) from herb vegetation. *Darbha* — 3 ♀♀ (1 Aug. '80 — 22 Sept. '80) from bovine bait ; 1 ♀ (21 Jul. '80) from human bait, 1 ♀ (18 Aug. '81) reared from larvae from tree hole. *Dhaniyalur* — 4 ♀♀, 1 ♂ (12 Jul. '81 — 13 Aug. '81) from herb vegetation ; 1 ♀, 1 ♂ (2 Aug. '81) reared from larvae from tree holes. *Dongariguda* — 1 ♀, 1 ♂ (31 Mar. '81 — 9 Jul. '81) from shrubby vegetation. *Kotamsar* — 1 ♀ (27 Jun. '80) from bovine bait. *Kurandi* — 3 ♀♀ (17 Jul. '80 — 26 Aug. '80) from bovine bait ; 1 ♀ (17 Jul. '80) from human bait. *Pandripani* — 1 ♀ (17 Aug. '81) from herb vegetation.

Subgenus **Finlaya** Theobald11. **Aedes albolateralis** (Theobald)

1908. *Stegomyia albolateralis* Theobald, *Rec. Ind. Mus.* 2 : 289.

1977. *Aedes albolateralis* : Knight and Stone : 90.

Material examined : 119 ♀♀ : *Darbha* — 60 ♀♀ (7 Jul. '80 — 22 Sept. '80), 8 ♀♀ (20 Jul. '81 — 15 Sept. '81) from bovine bait ; 28 ♀♀ (7 Jul. '80 — 8 Sept. '80), 18 ♀♀ (20 Jul. '81 — 15 Sept. '81) from human bait. *Kotamsar* — 2 ♀♀ (27 Jul. '80 — 24 Oct. '80) from bovine bait. *Kurandi* — 1 ♀ (26 Aug. '80) from bovine bait ; 2 ♀♀ (4 Jul. '80 — 17 Jul. '80) from human bait.

12. **Aedes assamensis** (Theobald)

1908. *Stegomyia assamensis* Theobald, *Rec. Ind. Mus.* 2 : 290.

1977. *Aedes assamensis* : Knight and Stone : 91.

Material examined : 89 ♀♀, 48 ♂♂ : *Aghanpur* — 1 ♂ (11 Aug. '81) reared from larvae from discarded tin, *Bhond* — 39 ♀♀, 32 ♂♂ (26 Jun. '81 — 15 Sept. '81) reared from larvae from tree holes. *Darbha* — 2 ♀♀ (22 Sept. '80), 1 (20 Jul. '81) from bovine bait, 1 ♀ (1 Aug. '80), 9 ♀♀ (20 Jul. '81 — 15 Sept. '81) from human bait ; 1 ♀ (18 Aug. '81) reared from larvae from discarded pitcher. *Dhaniyalur* — 1 ♀, 10 ♂♂ (30 Jul. '81 — 13 Aug. '81) reared from larvae from tree hole, 3 ♂♂ (13 Aug. '81) larvae reared from discarded container. *Kakalgur* — 1 ♀ (10 Feb. '81) from herb vegetation. *Kurandi* — 17 ♀♀ (18 May '80 — 4 Sept. '80) from bovine bait ; 17 ♀♀ (18 May '80 — 4 Jun. '80) from human bait. *Retawand* — 1 ♂ (9 Jul. '80) from herb vegetation. *Telengarapur* — 1 ♀ (12 Jul. '80) from human bait.

13. *Aedes gubernatoris* (Giles)

1901. *Culex gubernatoris* Giles, *Journ. Bomb. Nat. Hist. Soc.* 13 : 607.

1977. *Aedes gubernatoris* : Knight and Stone : 96.

Material examined : 40 ♀♀, 5 ♂♂ : *Bhond* — 12 ♀♀, 5 ♂♂ (24 Jun. '81 — 15 Sept. '81) reared from larvae from tree holes. *Darbha* — 7 ♀♀ (27 Jul. '80 — 22 Sept. '80), 6 ♀♀ (18 Aug. '81 — 15 Sept. '81), from bovine bait ; 6 ♀♀ (20 Jun. '81 — 15 Sept. '81) from human bait. *Kotamsar* — 1 ♀ (24 Oct. '80) by human bait. *Kurandi* — 5 ♀♀ (17 Jul. '80) from bovine bait ; 3 ♀♀ (17 Jul. '80 — 3 Oct. '80) from human bait.

14. *Aedes pseudotaeniatus* (Giles)

1901. *Culex pseudotaeniatus* Giles, *Journ. Bomb. Nat. Hist. Soc.* 13 : 607.

1977. *Aedes pseudotaeniatus* : Knight and Stone : 102.

Material examined : 43 ♀♀, 36 ♂♂ : *Darbha* — 2 ♀♀ (1 Aug. '80 — 22 Sept. '80) from human bait, 41 ♀♀, 36 ♂♂ (29 Aug. '81 — 5 Aug. '81) reared from larvae from rock pools.

Subgenus *Neomelaniconion* Newstead

15. *Aedes lineatopennis* (Ludlow)

1905. *Taeniorhynchus lineatopennis* Ludlow, *Can. Ent.* 36 : 133.

1977. *Aedes lineatopennis* : Knight and Stone : 120.

Material examined : 25 ♀♀ : *Adawal* — 1 ♀ (30 Sept. '81) from herb vegetation. *Chapar-Bhanpuri* — 1 ♀ (5 Sept. '81) from herb vegetation. *Dongariguda* — 1 ♀ (30 Sept. '81) from herb vegetation. *Kachora* — 1 ♀ (6 Aug. '81) from shrubby vegetation. *Karanji* — 7 ♀♀ (11 Aug. '81 — 30 Oct. '81) from bovine bait ; 3 ♀♀ (25 Aug. '81 — 30 Oct. '81) from human bait. *Kotamsar* — 1 ♀ (3 Nov. '81) from human bait. *Kumarawand* — 2 ♀♀ (19 Sept. '81 — 26 Sept. '81) from herb vegetation. *Kurandi* — 5 ♀♀ (17 Jul. '80 — 3 Oct. '80) from bovine bait ; 1 ♀ (4 Jul. '80) from human bait. *Takaraguda* — 1 ♀ (1 Aug. '81) from herb vegetation. *Tekameta* — 1 ♀ (9 Sept. '81) from herb vegetation.

Subgenus *Stegomyia* Theobald

16. *Aedes aegypti* (Linnaeus)

1762. *Culex aegypti* Linnaeus, *Hasselquist's Reise nach Palestina* : 470.

1977. *Aedes aegypti* : Knight and Stone : 154.

Material examined : 1 ♀ : *Jagdalpur* — 1 ♀ (11 Oct. '81) reared from larvae from discarded motor tyre.

17. *Aedes albopictus* (Skuse)

1894. *Culex albopictus* Skuse, *Ind. Mus. Notes* 3 : 20.

1977. *Aedes albopictus* : Knight and Stone : 156.

Material examined : 1762 ♀, 1175 ♂♂ : *Adawal* — 3 ♀♀, 2 ♂♂ (30 Aug. '80 — 2 Oct. '80), 2 ♀♀, 6 ♂♂ (9 Jun. '81 — 30 Sept. '81) from herb vegetation ; 42 ♀♀, 73 ♂♂ (20 Aug. '81 — 25 Sept. '81) reared from larvae from discarded earthen pitchers. *Aghanpur* — 1 ♀ (11 Aug. '81) from herb vegetation ; 11 ♀♀,

16 ♂♂ (5 Sept. '80), 77 ♀♀, 59 ♂♂ (11 Aug. '81 — 26 Sept. '81) reared from larvae from discarded motor tyres ; 2 (11 Aug. '81) reared from larvae from discarded tin, 7 ♀♀, 5 ♂♂ (5 Sept. '81) reared from larvae from insect hole in a wooden log. *Balenga* — 1 ♀, 2 ♂♂ (15 Sept. '81) reared from larvae from plastic container. *Bastar* — 3 ♀♀ (28 Aug. '80 — 20 Nov. '80) from herb vegetation, *Bhond* — 27 ♀♀, 25 ♂♂ (24 Jun. '81 — 15 Sept. '81) reared from larvae from (tree holes, 14 ♀♀, 14 ♂♂ (15 Sept. '81) reared from larvae from discarded container. *Bringpal* — 3 ♀♀, 2 ♂♂ (29 Jun. '81 — 14 Sept. '81) from herb vegetation, 4 ♀♀, 4 ♂♂ (20 Jul. '81) reared from larvae from discarded tub, 7 ♀♀, 9 ♂♂ (31 Aug. '81) reared from larvae from tree hole ; 23 ♀♀, 13 ♂♂ (31 Aug. '81 — 14 Sept. '81) reared from larvae from log hole ; 24 ♀♀, 17 ♂♂ (24 Sept. '81) reared from larvae from discarded earthen container. *Chapar* — *Bhanpuri* — 71 ♀♀, 49 ♂♂ (28 Aug. '81) reared from larvae from discarded pitcher. *Chindawada* — 1 ♂ (29 Aug. '81) from herb vegetation ; 3 ♀♀, 1 ♂ (15 Jul. '81) reared from larvae from rock pools, 74 ♀♀, 60 ♂♂ (15 Jul. '81 — 10 Sept. '81) reared from larvae from broken pitcher. *Darbha* — 8 ♀♀ (7 Jul. '80 — 30 Oct. '80), 2 ♀♀ (7 May '81) from bovine bait ; 2 ♀♀ (7 Jul. '80), 13 ♀♀ (2 Mar. '81 — 15 Sept. '81) from human bait ; 3 ♀♀, 1 ♂ (17 Jun. '80 — 12 Nov. '80) from herb vegetation ; 2 ♀♀, 1 ♂ (5 Aug. '81) reared from larvae from tree hole ; 9 ♀♀, 8 ♂♂ (18 Aug. '81 — 16 Sept. '81) reared from larvae from a log hole ; 26 ♀♀, 22 ♂♂ (18 Aug. '81) reared from larvae from discarded pitcher, 2 ♀♀ (16 Sept. '81) larvae collected from a lichen, 9 ♀♀, 1 ♂ (16 Sept. '81) reared from larvae from rock pool. *Daurgaon* — 1 ♂ (5 Sept. '81) from herb vegetation ; 16 ♀♀, 14 ♂♂ (15 Sept. '81) reared from larvae from a discarded pitcher. *Dhaniyalur* — 1 ♀ (11 Jul. '80), 1 ♀ (30 Jul. '81) from herb vegetation ; 40 ♀♀, 22 ♂♂ (2 Jul. '81 — 13 Aug. '81) reared from larvae from a tree hole ; 79 ♀♀, 59 ♂♂ (16 Jul. '81 — 13 Aug. '81) reared from larvae from discarded pitcher. *Dongariguda* — 1 ♀ (30 Aug. '80), 8 ♀♀, 1 ♂ (23 Jul. '81 — 9 Nov. '81) from herb vegetation ; 80 ♀♀, 31 ♂♂ (20 Aug. '81) reared from larvae from discarded pitchers. *Gumiyapal* — 2 ♀♀ (24 Jul. '81) from herb vegetation ; 17 ♀♀, 26 ♂♂ (17 Sept. '80) reared from larvae from discarded pitchers. *Jadgalpur* — 8 ♀♀, 1 ♂ (10 Apr. '81 — 12 Nov. '81) from herb vegetation ; 239 ♀♀, 135 ♂♂ (13 Jul. '81 — 12 Nov. '81) reared from larvae from discarded motor tyres ; 64 ♀♀, 44 ♂♂ (27 Aug. '81 — 10 Oct. '81) reared from larvae from discarded containers. *Kachora* — 1 ♀ (25 Sept. '81) from herb vegetation ; 93 ♀♀, 64 ♂♂ (9 Jul. '81 — 4 Sept. '81) reared from larvae from discarded pitchers. *Kakalgur* — 14 ♀♀, 5 ♂♂ (29 Aug. '81 — 10 Sept. '81) reared from larvae from discarded pitchers ; 8 ♀♀, 3 ♂♂ (10 Sept. '81) reared from larvae from tree hole. *Karanji* — 2 ♀♀ (27 Jul. '81 — 11 Aug. '81), from bovine bait ; 3 ♀♀ (11 Aug. '81) from human bait ; 1 ♀, 1 ♂ (24 July '80 — 12 Sept. '81) from herb vegetation. *Keslur* — 1 ♀ (28 Jul. '80) from shrubby vegetation ; 19 ♀♀, 13 ♂♂ (17 Aug. '81 — 31 Aug. '81) reared from larvae from discarded pitcher. *Kotamsar* — 10 ♀♀ (5 May '80 — 27 Jun. '80) from bovine bait ; 39 ♀♀ (5 May '80 — 27 Jun. '80) from human bait ; 1 ♀, 1 ♂ (28 Jun. '80) from herb vegetation. *Kumarawand* — 4 ♀♀, 2 ♂♂ (5 Sept. '81 — 10 Nov. '81) from shrubby vegetation. *Kuranai* — 3 ♀♀ (16 Jun. '80 — 4 Sept. '80) from bovine bait ; 19 ♀♀ (15 May '80 — 26 Aug. '80), 2 ♀♀ (26 Mar. '81 — 1 Apr. '81) from human bait ; 1 ♀, 1 ♂ (30 Aug. '80 — 11 Feb. '81) from herb vegetation. *Lendra* — 6 ♀♀, 1 ♂ (24 Aug. '81) reared from larvae from discarded pitcher. *Pandripani* — 3 ♀♀, 1 ♂ (17 Aug. '81 — 16 Nov. '81) from herb vegetation. 22 ♀♀, 10 ♂♂ (17 Aug. '81 — 14 Sept. '81) reared from

larvae from bamboo-cuts, 5 ♀♀, 6 ♂♂ (14 Sept. '81) reared from larvae from log hole. *Potanar* — 1 ♂ (3 Sept. '81) from herb vegetation ; 56 ♀♀, 61 ♂♂ (28 Aug. '81 — 17 Sept. '81) reared from larvae from discarded pitchers ; 11 ♀♀, 17 ♂♂ (3 Sept. '81 — 17 Sept. '81) reared from larvae from tree hole. *Rajur* — 24 ♀♀, 12 ♂♂ (10 Aug. '81 — 7 Sept. '81) reared from larvae from broken bottle ; 13 ♀♀, 9 ♂♂ (23 Sept. '81) reared from larvae from log hole ; 27 ♀♀, 9 ♂♂ (23 Sept. '81) reared from larvae from tree hole. *Retawand* — 3 ♀♀, 4 ♂♂ (7 Jul. '81) reared from larvae from discarded pitchers. *Tahakapal* — 36 ♀♀, 13 ♂♂ (10 Jul. '81) reared from larvae from tar barrel, 78 ♀♀, 49 ♂♂ (3 Sept. '81 — 17 Sept. '81) reared from larvae from discarded pitchers, *Takaraguda* — 3 ♀♀ (17 Jun. '81 — 15 Nov. '81) from herb vegetation ; 58 ♀♀, 32 ♂♂ (7 Jul. '81 — 18 Aug. '81) reared from larvae from discarded pitcher. *Tandpal* — 1 ♀, 1 ♂ (3 Sept. '81 — 17 Sept. '81) from herb vegetation ; 22 ♀♀, 18 ♂♂ (10 Jul. '81) reared from larvae from tree hole ; 39 ♀♀, 35 ♂♂ (21 Aug. '81 — 3 Sept. '81) reared from larvae from log hole. *Tekameta* — 2 ♀♀ (21 Nov. '81) from herb vegetation ; 47 ♀♀, 39 ♂♂ (3 Jul. '81 — 9 Sept. '81) reared from larvae from discarded pitchers. *Telengarapur* — 5 ♀♀ (12 Jul. '80) from human bait ; 1 ♀♀, 2 ♂♂ (31 Aug. '81) reared from larvae from tree hole, *Tokapal* — 12 ♀♀, 10 ♂♂ (7 Sept. '81) reared from larvae from log hole ; 36 ♀♀, 30 ♂♂ (7 Sept. '81 — 23 Sept. '81) reared from larvae from bamboo cuts.

18. *Aedes flavopictus* Yamada

1921. *Aedes flavopictus* Yamada, *Ann. Zool. Jap.* 10 : 52.

1977. *Aedes flavopictus* : Knight and Stone : 160.

Material examined : 1 ♂ : Tekameta 1 ♂ (3 Jul. '81) reared from larva from discarded pitcher.

19. *Aedes novalbopictus* Barraud

1931. *Aedes novalbopictus* Barraud, *Ind. Journ. Med. Res.* 19 : 224.

1977. *Aedes novalbopictus* : Knight and Stone : 162.

Material examined : 2 ♂♂ : Kotamsar - 2 ♂♂ (7 Jun. '80) from bovine bait.

20. *Aedes pseudalbopictus* Borel

1928. *Aedes pseudalbopictus* Borel, *Arch. des. Inst. Pasteur d'Indochine* : 85.

1977. *Aedes pseudalbopictus* : Knight and Stone : 163.

Material examined : 1 ♂ : Darbha - (18 Nov. '80) from herb vegetation.

21. *Aedes subalbopictus* Barraud

1931. *Aedes subalbopictus* Barraud, *Ind. Journ. Med. Res.* 19 : 225

1977. *Aedes subalbopictus* : Knight and Stone : 165.

Material examined : 6 ♀♀, 2 ♂♂ : Dhaniyalur - 6 oo, 2 ♂♂ (2 Jul. '81) reared from larvae from tree hole.

22. *Aedes unilineatus* (Theobald)

1906. *Quasistegomyia unilineatus* Theobald, *2nd Rept. Wellc. Res. Lab.* : 70.

1977. *Aedes unilineatus* : Knight and Stone : 166.

Material examined : 2 ♀♀, 4 ♂♂ : Tandpal - 2 oo, 4 ♂♂ (21 Aug. '81) reared from

larvae from log hole.

23. *Aedes vittatus* (Bigot)

1861. *Culex vittatus* Bigot, *Ann. Soc. Ent. France* 4(1) : 227.

1977. *Aedes vittatus* : Knight and Stone : 166.

Material examined : 222 ♀♀, 207 ♂♂ : *Bringpal* - 3 ♀♀, 3 ♂♂ (20 Jul. '81) reared from larvae from discarded tub, *Chindawada* - 23 ♀♀, 39 ♂♂ (15 Jul. '81) larvae reared from rock pools. *Darbha* - 1 ♀ (17 Mar. '81) from bovine bait ; 3 ♀♀ (7 Jul. '80 - 1 Aug. '80), 4 ♀♀ (20 Jul. '81 - 18 Aug. '81) from human bait, 4 ♀♀, 2 ♂♂ (29 Aug. '80), 47 ♀♀, 66 ♂♂ (5 Aug. '81 - 16 Sept. '81) reared from larvae from rock pools. *Jagdalpur* - 3 ♂♂ (10 May '81) from herb vegetation ; 6 ♀♀ (27 Aug. '81) reared from larvae from discarded enamel tray. *Karanji* - 2 ♀♀ (27 Jul. '81) from bovine bait ; 4 ♀♀ (27 Jul. '81) from human bait, 13 ♀♀, 21 ♂♂ (11 Aug. '81) reared from larvae from rock pools. *Kotamsar* - 3 ♀♀ (20 May '80 - 27 Jun. '80) from bovine bait ; 1 ♀ (24 Oct. '80) from human bait. *Kurandi* - 1 ♀, 1 ♂ (15 May '80 - 4 Jun. '80) from bovine bait ; 21 ♀♀, 3 ♂♂ (15 May '80 - 17 Jul. '80) from human bait. *Tandpal* - 70 ♀♀, 66 ♂♂ (21 Aug. '81 - 17 Sept. '81) reared from larvae from log hole. *Telengrapur* - 3 ♀♀ (12 Jul. '80) from bovine bait ; 8 ♀♀, 1 ♂ (12 Jul. '80) from human bait ; 1 ♀ (31 Aug. '81) from herb vegetation ; 4 ♀♀, 2 ♂♂ (20 Jul. '81) reared from larvae from rock pools.

24. *Aedes w-albus* (Theobald)

1905. *Stegomyia walbus* Theobald, *Ann. Mus. Nat. Hung.* 3 : 74.

1977. *Aedes w-albus* : Knight and Stone : 166.

Material examined : 107 ♀♀, 43 ♂♂ : *Adawal* - 1 ♀ (9 Nov. '81) from herb vegetation. *Bringpal* - 1 ♀ (21 Jul. '80) from herb vegetation ; 1 ♀ (31 Aug. '81) reared from larva from tree hole. *Darbha* - 2 ♀♀ (7 Jul. '80) from bovine bait ; 13 ♀♀, 1 ♂ (17 Jun. '80 - 18 Nov. '80), 2 oo (7 May '81 - 18 Aug. '81) from shrubby vegetation. *Dhaniyalur* - 2 ♀♀ (4 Apr. '81 - 30 Jul. '81) from herb vegetation ; 35 ♀♀, 27 ♂♂ (2 Jul. '81 - 13 Aug. '81) reared from larvae from tree holes. *Dharampura* - 2 ♀♀ (14 Jul. '81) larvae reared from Ant-well. *Karanji* - 1 ♀ (11 Aug. '81) from bovine bait, 4 ♀♀ (11 Aug. '81 - 25 Aug. '81) from human bait. *Kotamsar* - 1 ♀, 7 ♂♂ (7 Jun. '80) from bovine bait ; 26 ♀♀, 1 ♂ (14 Apr. '80 - 27 Jun. '80), 4 ♀♀ (8 Apr. '81 - 26 May '81) from human bait ; 4 ♀♀ (28 Jun. '80) from herb vegetation, *Kurandi* - 6 ♀♀ (4 Jul. '80), 1 ♀ (1 May '81) from human bait. *Pandripani* - 1 ♀ (21 Jul. '80), 2 ♀♀ (17 Aug. '81) from herb vegetation. *Retawand* - 3 ♂♂ (9 Jul. '80) from herb vegetation. *Tahakapal* - 1 ♀ (10 Jul. '81) reared from larvae from tar barrel. *Tekameta* - 1 ♀ (9 Sept. '81) from herb vegetation.

SUMMARY

The present paper describes the distribution record of *Aedes alboscuteallatus*, *A. pipersalatus*, *A. taeniorhynchoides*, *A. trimaculatus*, *A. vexans*, *A. thomsoni*, *A. micropterus*, *A. gubernatoris*, *A. assamensis*, *A. pseudotaeniatatus*, *A. albolateralis*, *A. lineatopennis*, *A. aegypti*, *A. albopictus*, *A. flavopictus*,

A. noalbopictus, *A. pseudalbopictus*, *A. subalbopictus*, *A. unilineatus*, *A. vittatus* and *A. w-albus* from Bastar district, Madhya Pradesh. Out of the 24 recorded species, only *Aedes albopictus*, *A. vittatus* and *A. w-albus* was collected by earlier workers. *A. scatophagoides* reported earlier, was absent from the present collection.

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**ON THE FIRST RECORD OF INFANTICIDE IN THE HOOLOCK
GIBBON — *HYLOBATES HOOLOCK* IN THE WILD.**

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A detailed study on the socio-eco-behavioural aspects of the hoolock gibbon was undertaken in the Garo Hills district of Meghalaya, N.E. India. Data was collected every minute on the minute in three family groups of gibbons, using focal, instantaneous and scan sampling methods (Altmann, 1974).

Observations made on one of the family groups of gibbons which comprised of an adult male, an adult female and a sub-adult male is presented here. During the course of the study, coitus was observed and thereafter the adult female became pregnant. After the completion of the gestation period this female gibbon was due anytime. As per earlier records on gestation period in gibbons, we reached the site well in time to record the birth of a gibbon, in the wild.

On 16th October 1985 everything was normal, the usual territorial calls made, the feeding and locomotion done, except that the adult pregnant female rested more than usual. It was still another week for the baby to be born.

As was the practice, the next day quite early in the morning, long before sunrise we approached the roosting tree of the night before to begin our data collection for the day. To our great surprise we saw that the baby had already been born and the adult female was carrying it in its ventrum. That day the awakening time was recorded as 0540 hrs — when the family moved to the fruiting tree for its first feeding bout.

After the feeding, they joined together in their chorus call. Response was heard from the neighbouring family groups. Once the morning call was over the adult male started to move towards a single solitary adult female which had moved into the buffer zone of the territory only a day before. She had always been keeping a distance from the members of this family group.

The adult male brachiated, swung and leaped for nearly 200 m. to reach this solitary female. All the other members of the family were passive in the same tree from where the first call of the day was made.

Soon after reaching the tree where the single female was sitting, the adult male started to self groom, self play, and do things in a way that looked like he was

attracting the attention of the female. She, however, was oblivious to all this and at one time showed her disinterest by moving to the next tree. After spending nearly 40 minutes, the adult male returned to his own group — when the family joined together in a second chorus call, which lasted for a very short period.

All this time the new born infant was with the mothers She was taking care of, suckling the baby and grooming it. The infant was always in the ventro-ventrum position grasping its mother.

At 0814 hrs, the sub-adult approached the mother and the infant, and took the infant from the mother. She gave it willingly. The sub-adult also held the baby in its ventrum and started to groom the little one sitting next to the mother in the same tree.

Around this time, the adult male once again left the group and moved towards the single female (which did not belong to the family group) which was sitting passively. When the adult male approached her this time, she did not show any antagonism but in fact joined in play behaviour-though no contact play was observed. After nearly half an hour the adult male returned to its own family group.

The whole family then moved towards where *Bauhinia purpurea* was and the second feeding bout of the day was observed, which lasted for nearly 15 min. Thereafter, all the members became passive and this resting phase lasted for a little over half an hour. Both during this feeding and resting the new born infant was with the sub-adult.

At 1010 hrs a third chorus cell was made by the group which lasted for about 15 min. Around this time, the single solitary female started moving away from the territory — all the while being keenly watched by the adult male of the group.

At 1030 hrs the new born infant made crying sounds “cuon-cuon” as though it was hungry or in pain. Neither the adult female (mother) nor the adult male (father) responded to this cry. Both were sitting on different branches of the same tree and were either passive or self-grooming. The infant went on crying incessantly for nearly an hour, the parents not being bothered at all.

At 1127 hrs the adult male moved and approached the tree where the subadult was sitting with the infant. The adult female was still passive. At 1131 hrs the adult male snatched the infant from the subadult and started to manipulate the infant quite roughly. He carried the infant by its feet, dangling the little body and sometimes holding it with one hand by its neck. The male also made deep throated growls towards the infant and once in a while towards the adult female (mother) and the subadult. The infant's cry increased and it was in pain as though injured. At 1145 hrs the infant still crying, the adult male snapped at it and nipped the baby on its body. Then dangling the infant in one of its hands, the adult male moved away from the other members of the group.

After reaching a tree 150 m away the adult male held the baby in its feet and pulled at the little ones hands and then suddenly started biting the infant near its naval. The infant's cry reached a peak when it was dropped to the ground. The infant came crashing down to lie at the foot of the tree on which the adult male was sitting. It was at this time, that the adult female gave a deep throated growl first at the infant and then at the adult male.

All this while the subadult was keenly observing the sequence of events. After a couple of minutes the sub-adult moved down halfway and looked at the infant but showed no indication of retrieving it. The infant was rolling on the ground, crying in pain, and except for watching/observing no other movement was made by the adult pair.

At 1305 hrs. the adult male made the first movement and brachiated towards a feeding tree and started feeding on the figs there. The adult female and sub-adult were in the same tree as before looking down at the infant once in a while.

At 1347 hrs the sub-adult, and at 1450 hrs. the adult female moved towards the feeding tree where the adult male was feeding. Soon after reaching the fig tree the sub-adult started feeding while the adult female started to feed only at 1509 hrs. This fig tree was nearly 200 m away from the infant. Finally the group stopped feeding at 1525 hrs and moved towards the resting tree after traversing for over 250-300 m, where they settled for the night.

Once all movement had stopped we waited for nearly 15 minutes, before we moved towards the infant. The infant was unconscious. There were 3-4 major and 5-6 minor wounds on its body. The abdominal muscles and part of the intestines were hanging out. Most of the minor wounds were covered with clotted blood. We confirmed that the infant was a male.

We took all measures to save the infant's life but due to inadequate hospital/medical facilities in the remote area that we were, the infant breathed his last at 2330 hrs. The body is preserved and kept in the museum of the Eastern Regional Station, Zoological Survey of India at Shillong, Meghalaya.

In this volume there is an excellent review article on 'Infanticide in Animals and Man : Comparative assessment in evolutioning context with a new theory by Dr. M.L. Roonwal. Here it has pointed out that no examples exist, and no cases of infanticide are known in the Family Hylobatidae. We were not able to send our finding to Dr. Roonwal before he passed away.

We, therefore, dedicate this article in his memory.

SUMMARY

Infanticide is reported for the first time in gibbons. A newly born male of *Hylobates hoolock* was snatched by the father (adult male) and after inflicting fatal injuries, threw the baby to the ground resulting in its death. No cannibalism was observed.

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