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STUDIES ON THE HAEMATOZOA OF CATFISHES FROM INDIA

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INTRODUCTION

Considerable attention has been paid to the haematozoa of man and domestic animals due to their medical and veterinary inportance. But little work has been done on the blood parasites of cold blooded animals.

The catfishes are the scale-less fishes which come under the order siluriformes, comprising of 30 families with about 2000 species distribued from South America, Africa, Europe, Asia to Japan (Jayaram, 1977). Of which, 13 families comprising of 46 genera are found in Indian subcontinent. Of these representatives of 10 families, Ariidae, Plotosidae, Siluridae, Clariidae, Heteropneustidae, Amblycipidae, Sisoridae, Bagridae, Schilbeidae and Pangasiidae have been examined for the protozoan parasites and the rest Olyridae, Chacidae and Akysidae have not been studied due to nonavailability of material.

Valentin (1841) was the first who detected a haemoflagellate from a fish-European brown trout. Since then, a number of workers have contributed much in this field and the following are considered as pioneers from abroad :

Minchin (1909), Henry (1910, 13), Hoare (1930), Laird (1951, 52), Saunders (1958, 60, 66), Noble (1968) Becker (1970, 77) and Lom (1979).

In India, Lingard (1904) was the first who recorded a trypanosome from fish and subsequently, de Mello and Valles (1936), Qadri (1955, 62), Hassan and Qasim (1962),

Misra, Haldar and Chakravarty (1969, 72), Haldar, Misra and Chakravarty (1971), Ray Chaudhury and Misra (1973), Misra, Chandra and Chaudhury (1973), Tandon and Joshi (1973), Tandon (1977), Tandon and Chandra (1977 ab), Mandal (1975, 78a b), Saratchandra and Narsimhmurti (1978), Mukherjee and Halder (1979) and Gupta and Jairajpuri (1981) did some work on the haematozoa of fishes.

A consolidated account of the haematozoa of particular groups of fishes is still lacking except that of Mandal (1979) who dealt with the blood inhabiting forms of the fishes belonging to the genus *Mystus* Scopoli. The present communication gives a detailed account of the haematozoa of Indian catfishes, mainly based on the author's own observations or as described by the other workers.

Six genera, *Trypanosoma*, *Cryptobia* (=*Trypanoplasma*) *Haemogregarina*, *Dactylosoma*, *Babesiosoma*, *Mesnilium* and *Haematractidium* have been recorded from different groups of fishes. However, the genera *Trypanosoma*, *Cryptobia* (=*Trypanoplasma*), *Dactylosoma* and *Haematractidium* only have been recorded from Indian Cat fishes.

The material for the present study is mainly brought from different parts of India particularly from West Bengal, Orissa, Assam, Uttar Pradesh, Bihar and Goa, and the potential sources were the markets of different places visited by the author or to contact the fishermen at the time of catch. The usual methods for preparing blood smears are followed after pancturing the branchial blood vessels of the fishes. Stains like Wright, Leishman or Giemsa were used for routine staining. Organ imprints were made only when the host was positive for haematozoa. The other procedures are vividly enumerated by Mandal (1979) and followed.

While describing a parasite, for the sake of convenience, the host family was given first followed by the specific name. The number of individuals examined and the number infected is shown in parenthesis. In addition, a table has been appended showing the number of hosts examined, number infected together with the name of the parasite.

The type materials will be deposited to the collection of Zoological Survey of India, Calcutta.

Family ARIIDAE

Five genera of fishes, *Arius*, *Osteogenious*, *Batrachocephalus*, *Ketengus* and *Hemipimelodus* have been examined. Although *Arius* is represented by 20 species only *A. sona* (Ham.) and *A. dussumeiri* Valenciennes have been examined. *Batrachocephalus* represented by single species, *B. meno* has been examined. *Ketengus* is having single species *K. trypis*. *Hemipimelodus* is also represented monotypically in India and both are not examined due to the nonavailability of material.

Host : *Arius sona* (Ham.) (20 : 5)
Loc. Kakdwip, 24 Parganas, West Bengal

Parasite : **Haematractidium** sp.

The smaller ring form measured 2.25 μm in diameter and had a centrally placed nucleus. The elongated form had two nuclei and measured 6.0 X 2.5 μm (vide Mandal *et al.*, in Press).

Host : *A. dussumeiri* (Valenciennes) 20 : 0
Loc. Kakdwip, 24 Paraganas, West Bengal
Host : *B. meno* (Ham.). 15 : 0
Loc. Calcutta market

Family PLOTOSIDAE

Of the two species *P. canius* Ham. and *P. anguilaris* Ham only one, *P. canius* has been examined.

Host : *Plotosus canius* Ham. (40 : 1)
Loc. Canning, 24 Parganas, West Bengal

An undetermined parasite was encountered intraerythrocitically on one occasion and the infection was very light. The length of the parasite was 6 μm. The nucleus was divided into two lobes and showed inter connecting bridge.

The identification is only possible subject to the availability of more material.

Family SILURIDAE

Three genera *Silurus*, *Ompok*, and *Wallago*, are included in the family. Of which, *Ompok pabda* (Ham.). *O. pabo* (Ham.) and *Wallago attu* (Schneider) have been examined.

Host : *Ompok pabda* (Hamilton (30 :))
Loc. Calcutta market
Host : *Ompok pabo* (Hamilton (10 : 0)
Loc. Calcutta market
Host : *Wallago attu* (Schneider (30 : 2)
Loc. : Champahati, 24 Parganas, West Bengal

Parasite : **Trypanosoma tandoni** Mandal, 1980
(Fig. 1)

Description : The trypanosomes are monomorphic, elongated and attenuated at both ends. Generally "S" shaped. Length of the cell body 23.5 μm (range 20μm-27.5 μm), length of the free flagellum 14.5 μm (range 11.5-18.5 μm), distance from anterior end of the body to the anterior end of nucleus 10.0 μm (range 9.00-11.00 μm), length of the nucleus 2.5 μm (range 2.25-3.00 μm) width of the nucleus, 0.75 μm (range 0.5-1.30 μm) distance from posterior end of the nucleus to the Kinetoplast 7.00 μm (range 6.00-8.5 μm) ; length of the Kinetoplast 7.00 μm (range 1.00-1.75 μm), width of the Kinetoplast 0.85 μm (range 0.5 μm-1.00 μm) ; distance from Kinetoplast to the posterior tip 1.5 μm (range 0.5-2.00 μm), width of the undulating membrane 0.6 μm (range 0.3-0.95 μm), maximum width of the cell body 1.5 μm (range 1.3-1.8 μm). No polymorphism was noted and no division stages were found in the blood or any other organ smear preparations.

Cytoplasm : The cytoplasm stain faint blue with Giemsa. Numerous granules are localized in the cytoplasm, concentrated at the boder opposite the undulating membrane in a linear fashion. Sometimes a few small vacuoles (2-5) in number were found on the cytoplasm anterior to the nucleus.

Nucleus : Sausage shaped, placed almost at the middle of the body. Sometimes shifted a little towards the post-

terior end. It stains deep blue but does not occupy the entire width of the body. The Chromatin material is uniformly distributed. No karyosome was observed.

Kinetoplast : Almost naviculoid in shape, sometimes oval form has also been encountered in the preparations. It stains very deep with any stain used and does not exceed the width of the cytoplasomic mass where it is situated.

Flagellum and undulating membrane : Appears from the base of the Kinetoplast and trails anteriorly bordering the undulating membrane. It extends beyond the body as a distinct long free flagellum and perform a clear lashing movement when the organism is observed in citrate preparation. The undulating membrane stains very faint, having 5-9 folds and can easily be separated from the body cytoplasm by its light colour bordered by thick flagellum.

Family CLARIIDAE

Single genus *Clarius*, monotypically represented *C. batrachus* (Linnaeus).

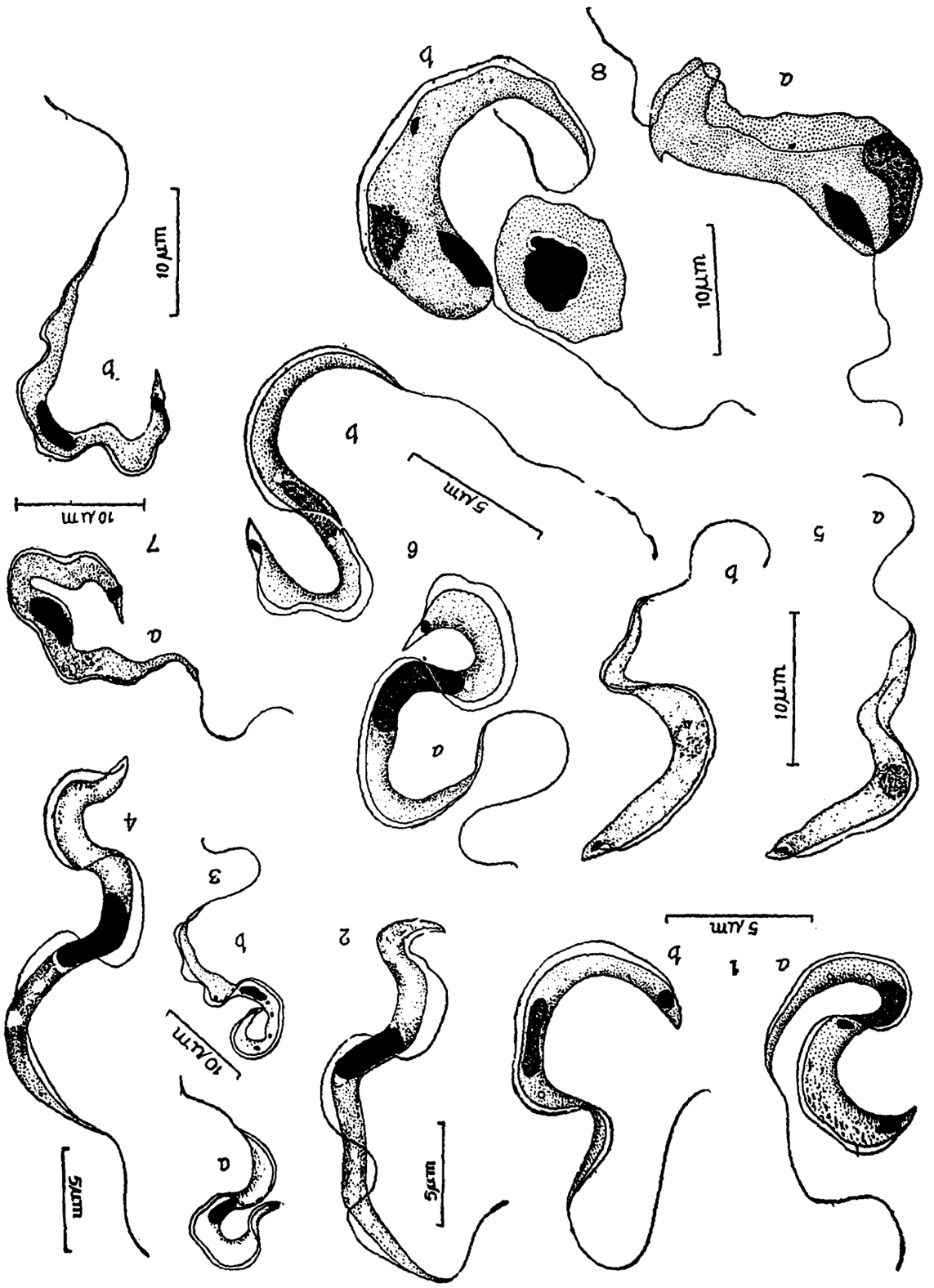
Host : *Clarius batrachus* (Linnaeus) 45 : 15/45 : 3
Loc. Calcutta market

Parasite (i) **Trypanosoma batrachi** Qadri, 1973
(ii) **Trypanosoma maguri** Tandon and Joshi, 1973

Trypanosoma batrachi Qadri, 1962
(Fig. 2)

Description : The trypanosome is monomorphic. Length of the cell body 25.5 μm (range 22.00-29.00 μm) ; breadth of the cell body 2.00 μm (range 1.5-3.5 μm) ; length of the free flagellum 12.00 μm (range 9.00-14.00 μm), length of the nucleus 2.5 μm (range 2.00-3.00 μm), breadth of the nucleus 1.35 μm (1.00-1.5 μm), length of the Kinetoplast 1.00 μm (range 1.00-1,50 μm).

Cytoplasm : Granular with many vacuoles of different sizes, sometimes the volution granules form a compact mass and appear very deep in the stained preparation.



Figs. 1a—8b : 1a, b. *Trypanosoma tandoni* Mandal, 1980, 2. *T. batrachi* Qadri, 1962, 3a, b. *T. maguri* Tandon & Joshi, 1973, 4. *T. danilewskyi saccobranchi* Qadri, 1962, 5a, b. *T. mukundi* Roychaudhury and Misra, 1973, 6b, b. *T. bengalensis* Mandal, 1979, 7a, b. *T. vittati* Tandon & Joshi, 1973, 8a, b. *Trypanoplasma indica* (Mandal, 1979).

Nucleus : Situated a little towards posterior half of the body elongated and uniformly compact and occupies almost the whole breadth of the body where it is situated. The ends of the nucleus are surrounded by a clear halo.

Kinetoplast : Oval, or round or bean-shaped, compact, situated, posteriorly sometimes the length exceeded the width where it is situated.

Flagellum and undulating membrane : The organism has got a long flagellum and trails along body margin after forming the undulating membrane which can be differentiated from the body cytoplasm. It extends beyond the body as free end and performs a lashing movement in citrate preparation. The undulating membrane stains very deep and showed 3-6 folds.

Remarks : Stumpy forms as observed by the author, were not observed.

Trypanosoma maguri Tandon and Joshi, 1973
(Fig. 3)

Description : The trypanosome is polymorphic, attenuated at both ends. The large and small forms have been encountered in the preparation. Large forms : Length of the cell body 25.5 μ (range 18.00-3 .5 μ), length of the free flagellum 15 μ (range 9.00-21.5 μ), breadth of the cell body 2.00 μ (range 1.5-3.00 μ) breadth of the nucleus 1.25 μ (range 0.7-1.5 μ) ; length of the Kinetoplast 0.75 μ (range 0.5-1.5 μ), width of the Kinetoplast 0.5 μ (range 0.3-1.5 μ).

Small form : Length of the cell body 5.00 μ (range 3.00-6.5 μ), breadth of the cell body 1.2 μ (range 1.00-2-2 μ) ; length of nucleus 1.5 μ (range 1.00-2.00 μ) ; width of the nucleus 1.00 μ (range 0.5-1.5 μ) ; length of the Kinetoplast 0.5 μ (range 0.8-1.00 μ) width of the Kinetoplast 0.3 μ.

Cytoplasm : Granular and the granules are distributed throughout the body. Stray small vacuoles are also found. The granular disposition is well marked at the border opposite the undulating membrane.

Nucleus : Oval or reniform, almost placed at the middle of the body or slightly behind the middle. The chromatin granules are densly concentrated and do not form any Karyosomal mass.

Kinetoplast : Ovoidal or reniform appears reddish purple with Leishman stain. Sometimes a hole was found around the Kinetoplast.

Flagellum and undulating membrane : The flagellum is thick and conspicuous but the undulating membrane is difficult to differentiate from the body.

Remarks : de Mello and Valles described a trypanosome from *Clarias batrachus* as *Trypanosoma clariae* Montel (1905) var. *batrachi* var. nov. in 1936.

Subsequently two more species, *I. batrachi* Qadri, 1962 and *I. maguri* Tandon and Joshi, 1973 have been described after obtaining the specimens from the same host material of this subcontinent. While describing these two, the authors have not mentioned the work of de Mello and Valles.

A detailed examination of the material by the author and a perusal of the literature showed that *T. batrachi* and *T. maguri* are different from *Trypanosoma cleariae batrachi* (= *Trypanosoma clariae* var. *batrachi*, de Mello and Valles, 1936).

However, from the description of de Mello and Valles it appears that this is monomorphic. But *T. clariae* Montel, 1905 as redescribed by Mathis and Leger, 1911 from Tonkin (vide Wenyon, C. M. 1926. *Protozoology* Vol. II p. 1400) after obtaining the host *Clarias macrocephalus*, is dimorphic viz. 'var *parva*' and 'var *magna*' measuring the length of the cell body 39 μm and 64 μm and length of the free flagellum 9 μm and 11 μm respectively.

de Mello and Valles gave the measurements of this specimen as follows : Length of cell body varies from 12.5 μm-30.00 μm and the flageller length varies from 9 μm-32 μm. Though the authors described a subspecies '*batrachi*' as monomorphic while species was dimorphic. But it is premature at this stage to comment further as the present author is not having any material of this particular subspecies.

Thus *Clarius batrachus* has one subspecies, *T. clariae butrachi* de Mello and Valles 1936 and two species, viz. *T. batrachi* Qadri, 1962 and *T. maguri* Tandon and Joshi, 1973.

Family HETEROPNEUSTIDAE

Single genus *Heteropnoustus*, monotypically represented viz., *H. fossilis* (Bl.).

Host : *Heteropneustus fossilis* (Bl.) (30 : 10/30 : 12/30)

Loc. : Calcutta Market.

Parasites (i) **Trypanosoma danilewskyi saccobranchi** Qadri, 1962.

(ii) **Trypanosoma mukundi** Raychaudhury and Misra, 1973.

Trypanosoma danilewskyi saccobranchi Qadri, 1962.

(Fig. 4)

Description : The trypanosome is monomorphic more pointed at the anterior end. Length of the cell body 29.5 μm (range 27.30-33.5 μm) ; breadth of the cell body 1.2 μm (range 1.00-1.5 μm), length of the free flagellum 13.5 μm (range 11.00-15.5 μm), length of the nucleus 3.00 μm (range 2.00-3.5 μm) ; breadth of the nucleus 0·5 μm (range 0.7-1.00 μm) ; length of the Kinetoplast 0.5 μm (range 0.75-1.5 μm) :

Cytoplasm : Granular with large vacuoles situated mostly at the anterior region of the body. The granules are uniform but in some species it is found to concentrate more towards the side opposite to undulating membrane.

Nucleus : Compact, elongated situated at the posterior half of the body not always occupying the entire width of the body. The vacuoles are always situated at both ends of the nucleus.

Kinetoplast : Very densely stainted either elongated, round or bar like, sometimes occupies the entire width of the body.

Flagellum and undulating membrane : Flagellum very thick and prominent trails along the margin of the body and forms a narrow undulating membrane. It extends as free flagellum for about half the length of the boby. The undulating membrane showed 6-9 folds.

Remarks : Roychaudhury and Misra (1973) described the species viz. *T. mukundi* from *Heteropneustus fossilis* after obtaining the parasite in 3 examples of fish out of 10 examined.

Trypanosoma mukundi Roychaudhury and Misra, 1973

(Fig. 5)

Description : This blood parasite was found to occur in two forms, a 'slender' form with a free flagellum and a 'stumpy' form with a relatively short flagellum.

Slender form : The slender trypomastigote form is fusiform in shape with a long free flagellum. The posterior end is abruptly pointed while the anterior tip is narrowly pointed. The nucleus is elongate to elongate-oval in shape and placed more or less centrally, slightly towards the posterior half. The nucleus stains deep purple with Giemsa. It is not a homogenous mass but was granulated and had a distinct nuclear membrane. A halo around the nucleus is absent. The nucleus usually adheres to the cell wall of the parasite. No distinct karyosome was observed.

Cytoplasm stains light blue with Giemsa and is granulated. In some forms a few small vacuoles were observed in the posterior half of the cell body. Volutin granules within the cytoplasm were not seen. The narrow cell body is widest at its middle part where the nucleus is situated. The Kinetoplast is small and round, usually with a halo and stains deep purple. It is not located at the posterior tip but slightly subterminal. A distinct flagellum arises from the side of the Kinetoplast and forms the undulating membrane with 4-6 attachments with the cell body and leaves the body as a free flagellum at the anterior tip. The undulating membrane stains light pink with Giemsa.

Stumpy form : This form resembles the slender form in structural morphology but differs in shape, size, number of attachments of undulating membrane and in the length of the free flagellum as stated by the authors. The posterior tip of the parasite is narrowly pointed.

The nucleus is round to ovoid and the Kinetoplast is nearer to the nucleus than in the slender form. The undulating membrane touches the cell body at 6-9 points indicating that this from is more active than the others, as was observed under the phase contrast microscope in the live condition. The free flagellum is distinct but short.

No intermediate froms were seen.

Measurements :

	Slender form	*Stumpy form*
Total length of the parasite including (free flagellum)	32·5-43-5 μm	22·0-28·5 μm
Length of the cell body	24·0-28·5 μm	18·0-23·5 μm
Breadth of the cell body	2·0-2·5 μm	1·9-2·5 μm
Length of the free flagellum	9·0-15·5 μm	4·0-6·5 μm
Length of the nucleus	2·25-3·75 μm	2·25-3·75 μm
Breadth of the nucleus	1·75-2·25 μm	1·75-2·25 μm
Diameter of the Kinetoplast	0·75 μm	0·75 μm

Family AMBLICEPIDAE

Single genus *Amblyceps* and monotypically represented, *A. mangois* (Hamilton) in India.

Host : *Amblyceps mangois* (Hamilton) 5 : 0.

Loc. : Calcutta market.

Family SISORIDAE

Having 12 genera *Bagarius*, *Batasio*, *Conta*, *Erethistoides*, *Euchislogelanis*, *Exostoma*, *Gagala*, *Glypothorax*, *Hora*, *Mycrsglnis*, *Pseudochemeis* and *Sisor*. Only *Bagarius bagarius* (Ham.) has been examined.

Host : *Bagarius bagarius* (Ham.) 20 : 0

Loc. : Kakdwip, 24-Parganas, West Bengal

Genus **Batasio** Blyth

Three species, *Batasio batasio* (Hamilton), *B. tengara* (Hamilton) and *B. trayancoria* Hora and Law. Only *B. batasio* has been examined.

Host : *Batasio batasio* (Hamilton) 5 : 0

Loc. : Calcutta market.

Family Bagridae

Comprises 5 genera *Rita*, *Chandramara*, *Horabagrus*, *Mustus* and *Aorichthys*.

Genus **Rita** Bleeker

Having 4 species *R. chrysea* Day, *R. gogra* (Sykes), *R. kuternee* (Sykes) and *R. rita* (Hamilton), only 3 species *R. chrysea*, *R. kuternee* and *R. rita* have been examined.

Host : *Rita chrysea* Day 15 : 0

Loc. : Balugaon, Orissa

Host : *R. kuturnee* (Sykes) 10 : 0

Loc. : Parlakhemindi, Orissa

Host : *R. rita* (Hamilton) 20 : 0

Loc. : Calcutta market

Genus **Mystus** Scopoli

Having 38 species and 13 are found in India, of which, 6 species, *M. bleekeri*, *M. cavasius* (Hamilton), *M. gulio* (Hamilton), *M. vittatus* (Bloch), *M. tengara* (Hamilton) and *M. menoda* (Hamilton) have been examined.

Host : *Mystus bleekeri* (Day) 30. 4

Loc. : Canning, W. Bengal

Parasite : **Trypanosoma bengalensis** Mandal, 1979

Trypanosoma bengalensis Mandal, 1979

(Fig. 6)

Description : Monomorphic, elongated and atenuated at both ends. Length of the cell body 15·5 μm (range 14·00-17·5 μm), length of the free flagellum 10·5 μm (range 8·5-12·5 μm), distance from anterior end of the body to the anterior end of the nucleus 7·5 μm (range 5·5-8·5 μm) length of the nucleus 2·5 μm (range 2·00-3·00 μm), width of the nucleus 0·5 μm, distance from posterior end of the nucleus to the Kinetoplast 5·00 μm (range 4·5-5·5 μm), diameter of the Kinetoplast 0·75 μm (range 0·5 μm-1·00 μm), distance from Kinetoplast to the post. tip 1·00 μm (1·00-1·5 μm), width of the undulating membrane 0·5 μm, maximum width of the cell body 1·75 (range 1·5-2·00 μm).

Cytoplasm : Granular, granules are arranged along the border opposite the undulating membrane. Two large vacuoles are found at both the extremities of the nucleus.

Nucleus : Bean-shaped, centrally placed, in some specimens it is shifted a little towards the posterior end. It never exceeds the width of the body.

Kinetoplast : Round, stains very deep and does not exceed the width of the body where it is situated.

Flagellum and undulating membrane : The flagellum arises from the Kinetoplast and trails along the border forming on undulating membrane and extends beyond the body as free flagellum. The undulating membrane stains light blue having 3-7 folds. The flagellum is very slender.

Host : *M. vittatus* (Bloch) (40 : 4/40 : 3/40 : 1/40).

Loc. : Taldi, West Bengal, for *T. vittati* and *Cryptobia india* and *Dactylosoma* sp. Champahati, 24-Parganas, W. Bengal.

Parasites : (i) **Trypanosoma vittati** Tandon and Joshi, 1973
(ii) **Cryptobia indica** Mandal, 1979
(iii) **Dactylosoma** sp.

Trypanosoma vittati Tandon and Joshi, 1973

(Fig. 7)

Description : Monomorphic, configuration varies from C to S. Length of the cell body 25.5 μm (range 20.00-35.5 μm), length of the free flagellum 12.5 μm (range 8.5-14.00 μm), distance from anterior end of the body to the anterior end of the nucleus 10.5 μm (range 9.5-12.5 μm), length of the nucleus 3.00 μm (range 2.00-4.5 μm), width of the nucleus 1.2 μm (range 0.7-1.4 μm ; distance from posterior end of nucleus to the Kineroplast 9.00 (8.5-11.5 μm), length or width of the Kinetoplast 1.5 μm, distance from Kinetoplast to the posterior tip 2.25 μm (range 2.00-3.00 μm) ; width of the undulating membrane 0.5-1.5 μm.

Cytoplasm : Uniformly granular, a little dense towards the portion anterior to the nucleus. Sometimes a few stray small vacuoles are seen throughout the body.

Nucleus : Bean-shaped, almost situated at the middle, compact with chromatin material, occasionally a clear area is vissible at both extremities of the nucleus. The nucleus does not exceed the width of the body.

Kinetoplast : Almost round, deep with any stain used. It sometimes exceeds the width of the body where it is situated.

Flagellum and undulating membrane : Undulating membrane distinct clearly out lined, can be differentiated easily from the body cytoplasm and bordered by the thick flagellum throughout the length of the body. The flagellum extends as free portion, very distinct and can be stained with any Romonowsky type of stain.

Remarks : Mandal (1979) has discussed the validity of *T. vittati* Tandon and Joshi as well as about its pleomorphic nature. Tandon and Joshi, 1973 described this species after obtaining the host materials from Gomati River, Lucknow, U. P. with the parasite obtained from fish out of 12 examined.

Cryptobia indica Mandal, 1979 [= **Trypanoplasma indica** (Mandal, 1979)]

(Fig. 8)

Description : Monomorphic, broad, sickle-shaped, measuring 28.5 μm (range 25.00-30.00 μm) in length and 8.5 μm (range 6.00-10.0 μm) in width. The nucleus measures 7.5 μm (range 5.00-8.5 μm) in length and 3.00 μm (range 2.5-3.5 μm) in width. Kinetoplast measures 5.5 (range 5.00-6.00 μm) in length and 1.5 μm (range 0.75-2.00 μm) in width. Length of the anterior flagellum 25.00 μm (range 21.00-30.00 μm), width of the undulating membrane 0.25 μm ; length of the trailing flagellum 10.5 μm (range 9.00-12.00 μm).

Cytoplasm : Stains faint blue having fine granules all over the body, less so at the posterior region.

Nucleus : Situated anteriorly, reniform or ovoidal in shape and loosely packed with large irregular chromatin masses.

Kinetoplast : Large, oblong or reniform in shape situated close to the ventral surface towards the anterior end and stained deep pink with any Romonoswky type of stain. Most cases it lies opposite to nucleus.

Flagellum and undulating membrane : Anterior flagellum long and moves freely when alive. Posterior flagellum trails along the margin of the body forms an undulating membrane and extends as free portion.

Dactylosoma sp.

Description : An organism with granular cytoplasm and a clear nucleus was encountered intraerythrocitically and placed under the genus *Dactylosoma* Labbe, 1894. The merozoites are 5 in number and arranged in the form of fan. Further specimens are needed for specific determination (Vide Mandal, 1979) of the parasite.

Remarks : While describing *C. indica* from *M. vittatus* after obtaining the specimens from blood, a search was made to trace the organism from the gut but could not be detected.

Lom (1979) was of openion that the individual occurring in the bloodstream should be considered as the genus *Trypanoplasma* Laveran and Mesnil and the form found in the gut would come under the genus *Cryptobia* Leidy. Therefore *Cryptobia indica* Mandal, 1979 should be considered as *Trypanoplasma indica* (Mandal).

Host : *M. cavasius* (Hamilton) 30 : 0

Loc. : Calcutta, market.

Host : *M. gulio* (Hamilton) 60 : 0

Loc. : Calcutta market

Host : *M. tangara* (Hamilton) 10 : 0

Loc. : Calcutta market

Host : *M. menoda* (Hamilton) 5 : 0

Loc. : Calcutta market

Genus **Aorichthys** Wa

Having 2 species, *A. aor* (Hamilton) and *A. seenghala* (Sykes) and both the species have been examined.

Host : *Aorichthys aor* (Hamilton) 15 : 1

Loc. : Calcutta market

Parasite : **Trypanosoma** sp.

Description : Monomorphic, configuration mostly like 'S'. Length of the cell body 32·5 μm (range 30·00-38·5 μm), length of the free flagellum 14·00 μm (range 12·00-18·00 μm), length of the nucleus 2·5 μm (range 12·00-3·5 μm).

Cytoplasm : Granular, deeply stained with Romonoswky type of stains. The granules are uniformly distributed throughout the length of the body.

Kinetoplast : Oval, deeply stained and appears as dark pink and does not exceed the entire width of the body.

Flagellum and undulating membrane : Flagellum arises from the kinetoplast and trails along the border forming an undulating membrane and extends beyond the body as free flagellum. The undulating membrane has 4-9 folds.

Host : *A. seenghala* (Sykes) 16 : 0

Loc. : Calcutta market

Joshi (1976) described *T. seenghala* after obtaining the specimens from *M. seenghala* (=*A. seenghala*). Whereas Tandon and Chandra (1977 a, b) detected *Trypanosoma* sp., from *M. seenghala* (=*A. seenghala*) in 40 examples out of 1158 fishes examined at Lucknow, U. P. Out of 16 examples examined from Calcutta market, the author could not detect any parasite. However, the description given below for *T. seenghali* is based upon Joshi (1976).

Trypanosoma seenghali Joshi, 1976

Description : Shape : The body is elongated and slender, tapering at both ends, posterior extremity generally ends sharply.

Cytoplasm : It is finely granulated, the distribution of granules is not even, as few forms have less granules in the posterior part of the body. Granules take dark azurophilic stain. Vacuoles are not present in these forms.

Nucleus : Oval or round, occupies most of the body width. It stain pinkish purple. The nuclear chromatin is not very dense. Karyosome absent. Nucleus is generally situated in the anterior half, but may be present in the posterior half of the body.

Kinetoplast : Small, round or oval and stains purple-blue and placed a little away from the posterior end.

Blepharoplast : Not distinct in any form.

Flagellum : It directly arises from the Kinetoplast and runs along the border of the undulating membrane, before becoming free. It may be long or short. A marked variation in the free flagellar length of few forms is noted.

Undulating membrane : Very distinct. No granules or myonemes are present.

Dimensions : The dimensions of both the smallest and the largest forms of *T. seenghali* are given in the next page.

Particulars	*Smallest form* (*μm*)	*Largest form* (*μm*)	*Mean & range* (*μm*)
Length of free flagellum	9.7	10.0	8.50 (4.5-12.0)
Length of body	17.8	28.0	24.50 (17.8-28.0)
Total length	27.5	38.0	33.0 (27.5-38.0)
Width of body at the centre	1.5	2.2	1.71 (1.2-2.5)
Width of the undulating membrane	1.3	1.8	1.40 (0.9-2.1)
Long axis of nucleus	2.2	3.0	2.76 (1.5-3.5)
Short axis of nucleus	1.7	2.0	1.0 (1.2-2.3)
Distance of nucleus from flagellar end	11.6	12.6	11.43 (8.5-15.0)
Length of kinetoplast	0.9	1.0	0.95 (0.3-1.2)
Width of kinetoplast	0.6	0.8	0.56 (0.3-1.0)
Distance of kinetoplast from and flagellar end	0.8	1.8	1.20 (0.4-2.0)
Nuclear index	1.7	0.7	0.88 (0.7.1.8)

Remarks : While describing the species the author has not mentioned about the Trypanosome (unnamed) described by Lingard, 1904 from the same host.

Family Schilbeidae

Seven genera *Ailia*, *Silonia*, *Proeutrosiichthys*, *Futropiichths*, *Neotropius*, *Clupisoma* and *Pseudeutropius* are included. Among them *Ailia coila*, *Clupisoma garua*, and *Entropiichthys vacha* (Ham.) have been examined.

1. *Host* : *Ailia coila* (Hamilton) 20 : 0
   Loc. : Calcutta market.
2. *Host* : *Clupisoma garua* (Hamilton) 3 : 0
   Loc. : Chaibasa, Bihar.
3. *Host* : *Eutropiichthys vacha* (Hamilton) 25 : 0
   Loc. : Calcutta market.

Family Pangasiidae

Includes one genus *Pangasius* and monotypically represented by *P. pangasius* (Ham.) which was examined.

Host : *Pangasius pangasius* (Ham.) 30 : 0

Host specificity, prevalence and pathogenicity.

The genera *Trypanosoma*, *Trypanoplasma*, *Dactylosoma* and *Haematractidium* have so far been reported from Indian catfishes. From the information available so far, as well as from the present study it is clear that these parasites are not restricted to any particular host. The work on this aspect along with the prevalence and incidence of infection have not been taken up so far on a large scale. However, some studies on the effects of *Trypanosoma* and *Trypanoplasma* on the hosts have recently been carried out. Lom (1973) while discussing the host specificity of Trypanosomes in fishes stated that no strain appeared to be specific for a particular host from which it was recorded. Khan (1976) conducted some experiments after taking a few morphologically similar Trypanosomes of fish from seven species of marine Teleosts and found that no marine fish species tested was insusceptable to Trypanosomes isolated from different hosts. Becker (1977) has opined that the host parasite relationship of haematozoa particularly the Trypanosome is eurihospitalic. Mandal (1979) while dealing with the haematozoan parasites of fishes belonging to the genus *Mystus* Scopoli found that the host species like *M. vittatus* and *M. bleekeri* have parasites whereas the *M. cavasius* and *M. qulio* did not have them though they were collected from the same ecological niche. Of course, the role played by the vactor like leeches was also taken into account.

Lom (1979) wrote a chapter on the biology of trypanosomes and trypanoplasma of fish in 'The Biology of Kinetoplastida' where he discussed in detail the different aspects of trypanosomal and trypanoplasmal infection in fishes. He has also agreed that most of the blood inhabiting forms are generally transmitted by the vectors like the leeches. Further the author remarks that the prevalence and transmission depends on the bottom, pelagic or littoral forms. The fish living near bottom or littoral vegetation are more exposed to leeches than the pelagic one. The incidence of infection also depends upon temperature, season or the age of the fish.

Becker (1977) stated that slow moving stream bordered by aquatic vegetation provides a favourable habitat for production of many fishes along with the leech species. The fishes examined from such areas will surely reveal a high incidence of infection. Mandal (1978c) found that the percentage of trypanosomal infection varies with the herbivorous, omnivorous or carnivorous habit of fish. The lowest percentage of infection was noticed in the carnivorous fishes and the highest in the harbivorous fish. The same author further noted that the factors like the bottom dwelling habit with limited mobility, the surface feeding habit and the mucus on the body of some fishes are equally important while considering the variations in percentage of infection. The bottom dwelling habit with limited mobility in fishes may increase the incidence of infection as the vector gets more opportunities to take blood meal. While on the other hand, the surface feeding habit and the mucus on the body prevent the vector in taking blood from the fish which leads to decline the incidence of haematozoan infection.

Regarding the pathogenicity of haematozoans of fishes a little work has been done so far. Some of them are found to be non-pathogenic and Lom (1979) stated that in most cases the fishes pass without any sign of infection. However, the trypanosome causes a disease commonly known as piscine trypanosomiasis which incurs heavy annual loss of fish, a potential source of animal protein for consumption.

So far little attention has been paid, to study the pathogenesis of this disease. Recently Kipp (1968), Smirnova (1970) outside India have worked on these aspects. In our country, Tandon and Joshi (1973) did some work after obtaining the trypanosome from *Clarius batrachus* (46.6%) and *Mystus vittatus* (8.3%). The percentage of infection is mentioned in the parenthesis. They observed some pathological symptoms specially in the blood of the infected fish. The percentage of haemoglobin was reduced along with a decrease in the number of erythrocytes and leucocytes. They have also noted some abnormal cells and macrophages in the circulation of the infected fishes.

Tandon and Chandra (1977 a, b) studied the serum cholesterol and serum alkaline phosphatase levels in some naturally infected fishes. It was found that the reduction of serum cholesterol level was the highest (42.3%) in the spiny eel, *Mastacembelas armatus* and the lowest in the carp *Cirrhina mrigala* (4.46%). Catfishes like *Hateropneustes fossilis* showed a loss of 9.83% while *Clarius batrachus* showed 12.46%, *Mystus seenghala* 11.65% and *Wallago attu* 12.05%.

The trypanosomes are known to consume large quantities of sugar from blood resulting on complete consumption of carbohydrate reserve, thereby causing strain on the liver—a chief centre of cholesterol metabolism. The trypanosomal infection disturbed the cholesterol metabolism—leads to hypocholesterolemia in the infected fishes. The same author stated that the alkaline phosphates level of *Cirrhina mrigala* reduced to 69.91% and in *M. armetus* it was found as 10.94% whereas in *Clarius batrachus* it goes down to 40.68% and in *M. seenghala* was 8.82%. The minimal level was observed in *W. attu* which was about 3.91%.

They further observed that the metabolic activity is reduced due to trypanosome infection in fishes. The alkaline phosphatase of active fish, *Clarius batrachus* reduced to 40.68% the herbivorus carp, *Cirrhina mrigala* showed a loss 69.91% and the hardy fish, *Wallago attu* suffered a minimal loss of 3.91% due to trypanosomal infection in the blood stream.

As regards the Trypanoplasmosis due to *Trypanoplasma* infection Walis and Wolf (1955) Makeyeva (1956) Britchuk (1969) Migala (1967, 71) did some work while Nowichi (1940) questioned about the pathogenic potency of *Trypanoplasma.* However, the same was not accepted by the others. On the other hand Lom (1979) was of the opinion that the pathogenic changes of trypanoplasmosis is still not available. In the present investigation no difference was noticed between the infected and uninfected fishes in blood cell count where as in the infections with *Dactylosoma* and *Haematractidium*

it was found that in both cases there was dislocation of the erythrocyte nuclei along with some hypertrophy of the infected cells.

Table I. Showing the number of fishes examined and number parasitised along with the name of the parasite.

	Name of fish	No. examined	No. infected	Name of the parasite
1.	*Arius sagar* (Ham.)	20	5	*Haematractidium* sp. Mandal *et al.*
2.	*Plotosus canius* (Ham.)	40	1	Undermined
3.	*Ompok pabda* (Hamilton)	30	0	
4.	*Ompok pabo* (Hamilton)	10	0	
5.	*Wallago attu* (Schneider)	32	2	*Trypanosoma tandoni* Mandal 1980
6.	*Clarius batrachus*	45	15	*Trypanosoma batrachi* Qadri, 1962
7.	*Clarius batrachus*	45	3	*Trypanosoma maguri* Tandon & Joshi, 1973
8.	*Heteropneustes fossilis*	30	10	*Trypanosoma danilewski saccobranchi* Qadri, 1962
9.	*Heteropneustes fossilis*	30	12	*Trypanosoma mukundi* Raychaudhury & Misra, 1973
10.	*Amblyceps mangois*	5	0	
11.	*Rita chrícia* (Day)	15	0	
12.	*Rita kuturnee* (Sykes)	10	0	
13.	*Rita rita* (Hamilton)	20	0	
14.	*Batasio batasio* (Hamilton)	5	0	
15.	*Mystus bleekeri* (Day)	34	0	*Trypanosoma bengalensis* Mandal, 1979 (b)
16.	*Mystus vittatus* (Bloch)	40	4	*Trypanosoma vittati* Tandon & Joshi, 1973

Cont.

	Name of fish	No. examined	No. infected	Name of the parasite
17.	*Mystus vittatus* (Bloch)	40	3	*Cryptobia indica* Mandal, 1979= *Trypanoplasma indica* Mandal, 1979
18.	*Mystus vittatus* (Bloch)	40	1	*Dactylosoma* sp. Mandal
19.	*Mystus clavasius*	30	0	
20.	*Mystus qulio* (Hamilton)	60	0	
21.	*Mystus tangera* (Ham.)	10	0	
22.	*Mystus menoda* (Ham.)	5	0	
23.	*Aorichthys aor.* (Ham.)	15	1	*Trypanosoma* sp.
24.	*Aorichthys seenghala* (Sykes)	6	0	*Trypanosoma seenghali* Joshi, 1976 from Lucknow, U.P.
25.	*Alilia coila* (Hamilton)	20	0	
26.	*Clupisoma garua*	3	0	
27.	*Eutropiichthys vacha* (Hamilton)	35	0	
28.	*Pungasius pungasius* (Ham.)	30	0	

SUMMARY

Of the 13 families of catfishes occurring in Indian subregion, 10 families, Ariidae, Plotosidae, Siluridae, Clariidae, Heteropneustidae, Amblycipidae, Sisoridae, Bagridae, Schilbeidae and Pangasiidae have been studied for haematozoan parasites so far. Three genera, *Trypanosoma*, *Cryptobia* (=*Trypanoplasma*) and *Dactylosoma* have been recorded. A total 8 species of trypanosomes with one *Trypanosoma* sp., have been described from these catfishes. An undetermined parasite has also been recorded from the estuarine catfish, *Plotosus canius*.

A comment on the pathogenicity of these parasites has been added. The possible mode of transmission of these parasites and the role of vector have been discussed.

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