

P A R T . I .

" STUDIES ON Trypanosoma IN SOME LOWER VERTEBRATES "

INTRODUCTION

Flagellates of the genus Trypanosoma are all parasitic and may comprise of amastigote, promastigote, epimastigote, sphaeromastigote and trypomastigote forms at some stage of their life cycles. Among these, trypomastigotes are the typical forms occurring in blood of vertebrate hosts.

According to Baker (1969) the trypomastigotes bear flagellum and are slender individuals with kinetoplast and basal body situated near the posterior end. Flagellum emerges through a short pocket, which is detectable only in electron micrographs. Flagellum proceeds through body surface and on account of its undulation a fin-like expansion of body is drawn out to form what is known as undulating membrane.

Most of the trypanosomes have been known only in peripheral blood of vertebrates and it is thought possible that an invertebrate host exists for every one of them with the possible exception of Trypanosoma equiperdum which is transferred directly from horse to horse during the sexual act.

Trypanosomes have been recorded from almost every class of vertebrates and these have been accorded considerable importance because of the fact that some of these are known to cause severe illness, as in the case of some mammalian hosts including man.

The present work was undertaken as it was felt that the study of trypanosomes in India has so far been inadequate, and a survey is likely to yield interesting results.

REVIEW OF LITERATURE

A. Trypanosoma in Fishes of fresh water

Piscine haemoflagellates were first observed

by Valentin (1841) in the blood of a trout, Salmo fario. It is uncertain to the genus whether they belonged to Trypanosoma or a Trypanoplasma. Remak (1842) detected a definite fish Trypanosoma in the blood of pike, Esox lucius (cited by Lom, 1979).

According to Wenyon (1926), Mitrophanov in Europe described for the first time in 1883 two named species from fish of Trypanosoma, viz., Trypanosoma carassii and Trypanosoma cobitis from Carassius carassius and Misgurnus fossilis respectively. Since then many investigators encountered fish trypanosomes from fresh water in various parts of the world.

Danilewsky (1885) recorded the occurrence of trypanosomes in fresh water fishes of Europe. Laveran & Mesnil (1901) named Remak's trypanosome as Trypanosoma remaki in Esox lucius from France. These authors, in 1904, also described Trypanosoma abramidis, Trypanosoma tincae and Trypanosoma danilewskyi in fishes of France and Europe. Léger (1904) described Trypanosoma barbatulae in Nemachilus (=Cobitis) barbatula from Europe. Castellani & Willey (1905-1906) described Trypanosoma sp. in Mystus (=Macrones) cavasius and Trypanosoma saccobranchi and Trypanosoma sp. in Heteropneustes (=Saccobranchus) fossilis collected from Sri Lanka. Montel (1905) described Trypanosoma clariae in Clarias macrocephalus of North Viet Nam. Petrie (1905) observed Trypanosoma sp. in Carassius auratus from England. Neave (1906) found Trypanosoma sp. from Bageus bayard (= Bagrus bayad), Lynodontis schal (=Synodontis schall) and Mugil sp. of Sudan. Brumpt (1906) described nine species of Trypanosoma viz., Trypanosoma barbi, Trypanosoma percae, Trypanosoma acerinae, Trypanosoma phoxini, Trypanosoma langeroni, Trypanosoma scardinii, Trypanosoma leucisci, Trypanosoma elegans, Trypanosoma squalii in fishes of France. Dutton et al., (1906, 1907) reported Trypanosoma sp. from Clarias angolensis collected near

Kinshasa in the Zaire. Botelho (1907) described Trypanosoma rhamdiae and Trypanosoma macrodonis from Brazilian fishes. Wenyon (1909) reported Trypanosoma sp. from Tilapia zilli, Hynodontis (=Synodontis) schall, Clarias anquillaris, Chrysichthys auratii, Channa (=Ophiocephalus) obscurus, Bageus bayard and Mugil sp. in the Sudanese Nile. Rodhain (1908) recorded Trypanosoma sp. from Labeo macrostoma, Labeo zalzifer and Malapterurus electricus at Ubangi, Zaire ^{(cited by Wenyon, 1926).} Minchin (1909) observed trypanosomes in fresh water fishes of England. Bouet (1909) described Trypanosoma toddi from Clarias anquillaris in the then French West Africa. Neumann (1909) described Trypanosoma triqlae and Trypanosoma scorpaenae in fishes of Europe. Zupitza (1909) found trypanosomes in fishes from Cameroons. Leboeuf & Ringenback (1910) described Trypanosoma simondi and Trypanosoma synodontis in fishes collected at Stanley Pool, Zaire. Mathis & L  ger (1910, 1911) described two forms of Trypanosoma clariae, Trypanosoma pelligrini and Trypanosoma roulei from fishes of Tonkin. Coles (1914) reported trypanosomes from fishes of England. L  ger & L  ger (1914) described Trypanosoma sp. from Tilapia lata in the river Niger of the then French West Africa. Fantham (1919) found Trypanosoma sp.

from Clarias gariepinus at Natal, South Africa. Kudo (1921) reported Trypanosoma remaki in Lucius reticulatus collected near New York City. Tanabe (1924) observed Trypanosoma sp. in fishes of Japan. Hoare (1932) described Trypanosoma mukasai in Haplochromis nubilis, Haplochromis serranus, Haplochromis cinereus and Haplochromis humilior in Lake Victoria, Uganda. Pearse (1933) described Trypanosoma ophicephali in Channa (=Ophiocephalus) striatus from Thailand. ^{and Fantham & Porter} Fantham et al., (1942), (1947) observed a variety of Trypanosoma percae from fishes of Quebec, Canada. Dias (1952, 1955) described Trypanosoma andrade silvae, Trypanosoma tobeyi, Trypanosoma napolesi, Trypanosoma rebeloi and Trypanosoma serranoi from Clarias gariepinus, Clarias angolensis and Tilapia mossambica of Mozambique. Baker (1960) reported Trypanosoma mukasai in Tilapia nilotica, Tilapia esculenta, Tilapia variabilis, Tilapia leucosticta, Bagrus sp., Mormyrus sp., Haplochromis sp. and Astatoreochromis sp. of Lake Victoria, Africa. He also reviewed the taxonomy of the trypanosomes of African fresh water fishes and considered Trypanosoma toddi, Trypanosoma mukasai and Trypanosoma tobeyi as valid species. Qadri (1962) described Trypanosoma winchesiense from Cyprinus carpio of England. Bykhovskaya Pavlovskaya et al., (1962) listed trypanosomes of fishes in Russia. Bray (1964) also listed trypanosomes

from African fresh water fishes. Becker (1967) described Trypanosoma occidentalis from Cottus gulosus, Cottus rhotheus and Gasterostens aculeatus the fresh water teleosts in Washington State. He listed 71 species of trypanosomes from fresh water fishes of which 38 species from Europe and Asia, 11 species from Africa, 20 species from South America and 2 species from Australia and Newzealand. Abolarin (1970) reported Trypanosoma toddi from Soles, parasitising African fresh water fishes with a list of many host records. Daly & Degiusti (1971) described Trypanosoma catostomi in Catostomus catostomus commersoni from Flemings Creek, Michigan. Vinnichenko, et al., (1973) described Trypanosoma anura, Trypanosoma amurensis, Trypanosoma dogieli, Trypanosoma latinucleata, Trypanosoma siluri, Trypanosoma striata and Trypanosoma sinipercae from river Amur's basin. Froes, et al., (1978) described three species of Trypanosoma from fresh water fishes of Brazil. These authors, in 1979, also described trypanosomes from fishes of Brazil. Lom (1979) reviewed the trypanosomes of fishes and listed 107 named species and 28 unnamed species of Trypanosoma from fresh water fishes. Grogl, et al., (1980) described Trypanosoma magdalenae from a fresh water teleost, Patania kraussi. Lainson (1981) redescribed Trypanosoma bourouli Neiva & Pinto, 1926 in the fish Sybranchus marmoratus collected from Pará State, North Brazil.

B. Trypanosoma in Anura.

Anuran trypanosomes were first observed by Gluge (1842) in the blood of frog, Rana esculenta. Mayer (1843) described various forms of the same parasite from European frogs (Rana spp.) under the names of Amoeba rotatorium, Paramecium loricatum and Paramecium costatum. Gruby (1843) also studied the above parasites and created the genus Trypanosoma (type species Trypanosoma sanguinis Gruby, 1843). Amoeba rotatorium was identical with Trypanosoma sanguinis which now became a synonym of Trypanosoma rotatorium and considered as type species of the genus. Lankester (1871) recorded Undulina ranarum from the blood of frog and this was now considered Trypanosoma ranarum (Lankester). Dutton & Todd (1903) reported Trypanosoma sanguinis, Trypanosoma mega, and Trypanosoma karyozeukton in the blood of African frogs. Sergent & Sergent (1904) described Trypanosoma inopinatum from Rana esculenta of Algiers. Laveran & Mesnil (1904) reviewed earlier work on trypanosomes of Amphibia and concluded that Trypanosoma rotatorium of frogs appeared to be a species of wide geographical distribution throughout the world. Dutton, et al., (1907) also reported Trypanosoma karyozeukton from Bufo regularis, Rana mascarensis, Rana occipitalis and Rana

oxyrhynchus from Africa. Franca & Athias (1906) studied trypanosomes of Rana esculenta and observed Trypanosoma loricatum costatum, Trypanosoma rotatorium and Trypanosoma inopinatum Sergent & Sergent, 1904 along with two new species viz., Trypanosoma undulans and Trypanosoma elegans. Same authors in 1907 recorded Trypanosoma rotatorium in Hyla arborea. Wenyon (1909) found several types of trypanosomes in Bufo regularis in Sudan. Bouet (1909) reported trypanosomes in Bufo regularis of the then French West Africa. Mathis & L  ger (1911b) described Trypanosoma chattoni from Bufo melanostictus of Viet Nam. Stevenson (1911) observed that trypanosomes rotated rapidly on its long axis and concluded that the name rotatorium was given for this characteristic movement. Macfie (1914) recorded Trypanosoma rotatorium, Trypanosoma mega and a possibly new trypanosome from Bufo regularis in Nigeria. Trypanosomes were also reported from Japan and adjacent countries by Koidzumi (1911), Ogawa (1913) and Ogawa & Uegaki (1927) in anurans. Martin, et al., (1909) found Trypanosoma mega, Trypanosoma rotatorium and Trypanosoma elegans in the blood of Bufo regularis of Zaire. Kudo (1922) described Trypanosoma parvum and Trypanosoma rotatorium from North American frogs. Tanabe (1931)

described four morphological types of Trypanosoma rotatorium from Rana nigromaculata in Korea. Fantham, et al., (1942) described Trypanosoma lavalia, Trypanosoma gaumontis and Trypanosoma montrealis from Bufo americanus in Canada. These authors also reported the occurrence of Trypanosoma rotatorium and Trypanosoma inopinatum from frogs of Canada in the same year. Nigrelli (1945) also reported Trypanosoma rotatorium from North American amphibians. Hoare (1932) found a Trypanosoma in a small frog, Hyperolius sp. caught on Bugala Island, Uganda and considered as Trypanosoma rotatorium. Diamond (1950) described Trypanosoma pipientis in the leopard frog, Rana pipiens. Diamond (1958, 1965) listed 26 species of anuran trypanosomes as distinct species. Mohammed & Mansour (1959a, b) described the polymorphic forms of Trypanosoma rotatorium in Egyptian toads. Bardsley (1969) found Trypanosoma rotatorium in the Bull-frog, Rana catesbeiana. Woo (1969) described Trypanosoma canadensis in amphibian of Southern Ontario. * Bardsley & Harmsen (1973) reviewed the literature of anuran trypanosomes and listed 34 valid species except for Trypanosoma aurorae Lehmann, 1959, which is nomen nudum. Miyata (1976) described three morphological forms of Trypanosoma rotatorium collected from tadpoles and adult frogs in Mogi, near Nagasaki City. Werner & Walewski (1976) described Trypanosoma pseudopodium in Bufo americanus collected from Michigan. Baker (1977) described some trypanosomes of African Anuran.

* Ayala (1970) described Trypanosoma bufophlebotomi in Bufo boreas halophilus collected from California.

Miyata(1978) described 14 types of anuran trypanosome which was detected from 10 species of frog captured in Kyushu and Ryukyu islands. This author described Trypanosoma rotatorium, Trypanosoma loricatum and Trypanosoma chattoni as known species and six new species viz., Trypanosoma nagasakiense, Trypanosoma ishigakiense, Trypanosoma miyagii, Trypanosoma tsukamotoi, Trypanosoma rugosae and Trypanosoma tsunozomiyatai and other five types which were not identified as distinct species or known species. He stated that the number of known anuran trypanosomes became 40 species by the addition of 6 new species, however, much more species might be described in near future in various parts of the world, because some more trypanosomes figured in various literature under the name Trypanosoma rotatorium or Trypanosoma sp., were not identical with one of those known species morphologically.

C. Trypanosoma in Chelonia and Ophidia

Chelonian Trypanosoma was first encountered by Kunstler(1883) in the blood of mud-tortoise. Laveran & Mesnil (1902) described Trypanosoma damoniae from a tortoise, Damonia reevesii of Far East. Dutton & Todd(1903) and Dutton, et al., (1907) noted the presence of trypanosomes in different tortoises of Gambia. Robertson(1908) described

Trypanosoma vittatae from Emyda vittata collected from Sri Lanka. Trypanosoma vittatus Robertson (cited by Klinke & Elkan, 1965) was also reported from Lissemys punctata granosa. Bouet (1909) reported Trypanosoma pontyi from a tortoise of Africa. Joyeux (1913) described Trypanosoma sp. from Pelusios sinuatus of Guinea. Combes (1919) described Trypanosoma lerovi in Kinixys homeana in Mali. Wenyon (1926) reviewed the reptilian trypanosomes of Order Chelonia. Roudabush & Coatney (1937) described Trypanosoma chrysemydis from Chrysemys belli marginata in United States of America. Floch & Abonnec (1942) described Trypanosoma testudinis and Trypanosoma platemysi from Testudo esculenta and Platemys platicephala respectively collected from South America. Dias (1951) described Trypanosoma sheppardi and Trypanosoma neitzi from Pelusios sinuatus zuluensis in the then Portuguese Africa. Walliker (1965) reviewed the literature of reptilian trypanosomes and listed 12 chelonian trypanosome of which two were reported as Trypanosoma sp.

Ophidian Trypanosoma was first detected by Dutton, et al., (1907) in puff-adder snake, Bitis arietans of Gambia. Wenyon (1908, 1909) described

described Trypanosoma erythrolampri and Trypanosoma najae from Erythrolamprus aesculapii and Naja nigricollis of South America and Sudan respectively. Bouet (1909) reported Trypanosoma clozeli from Tropidonotus ferox of Western Africa. Mathis & Léger (1909) described Trypanosoma primeti from Tropidonotus piscator of Indo China. Brumpt (1914) described Trypanosoma brazili from Helicops modestus of Brazil. Macfie (1919) described Trypanosoma voltariae from Naja nigricollis of Ghana. Pessôa (1928) described Trypanosoma phylodriasi from Philodri nattereri of Brazil. Arantes & Fonseca (1931) described Trypanosoma butantanense and Trypanosoma merremii from Ophis merremii of Brazil. Fonseca (1935) again reported Trypanosoma mattagrossense from Cyclogras gigas of Brazil. Schwetz (1944) found Trypanosoma sp. in Graya ornata. Fantham & Porter (1950) described Trypanosoma psammophis and Trypanosoma sebae in Psammophis sibilans and Python sebae of South Africa. Walliker (1965) reviewed the reptilian trypanosomes and listed fifteen snake trypanosomes of which three were reported as Trypanosoma sp.

WORK DONE IN INDIA.

A. Trypanosoma in fresh water fishes

Lingard (1904) recorded Trypanosoma sp. from fishes viz., Puntius (=Barbus) carnaticus, Channa

(=Ophiocephalus) striatus and Ryncobdella aculeata collected from river at Pune, Maharashtra. He (1904) also described Trypanosoma sp. from Channa striatus, Mystus seenghala, Mystus tengara and Trichogaster fasciatus collected from Jamuna river, Uttar Pradesh.

de Mello & Valles (1936) described Trypanosoma clariae batrachi from Clarias batrachus obtained from Goa.

Qadri (1951) reported Trypanosoma sp. in Channa striatus collected from Hyderabad, Andhra Pradesh. Qadri (1955) described Trypanosoma striati from Channa striatus caught in Hyderabad, Andhra Pradesh. The same author again (Qadri, 1962) reported Trypanosoma batrachi and Trypanosoma danilewskyi saccobranchi in Clarias batrachus and Heteropneustes (= Saccobranchus) fossilis caught in Hyderabad, Andhra Pradesh. Hasan & Qasim (1962) described Trypanosoma punctati in Channa punctatus also caught from Hyderabad, Andhra Pradesh. Ray Chaudhuri & Misra (1973) described Trypanosoma elongatus and Trypanosoma mukundi from Channa punctatus and Heteropneustes fossilis obtained from the local markets and from the lakes and ponds in and around Calcutta, West Bengal. Misra, et al., (1973) described Trypanosoma gachuii in Channa gachua collected from ponds in and around Calcutta, West Bengal. Tandon & Joshi (1973) described Trypanosoma vittati and Trypanosoma maguri from Mystus vittatus and Clarias batrachus obtained in

Calcutta markets, West Bengal. Pandey & Pandey (1974) described Trypanosoma baigulensis from two different fishes viz., Cirrhina reba and Osteobrama cotio collected at Nainital, Uttar Pradesh. Tandon & Joshi (1974) observed Trypanosoma sp. in the blood of Channa punctatus, Clarias batrachus, Mystus seenghala and Heteropneustes fossilis collected from Lucknow, Uttar Pradesh. Mandal (1975, 1977, 1978, 1979, 1980) described seven species of Trypanosoma viz., Trypanosoma arneti, Trypanosoma pancali, Trypanosoma choudhuryi, Trypanosoma cancili, Trypanosoma anabasi, Trypanosoma bengalensis and Trypanosoma tandoni from Mastocembelus armatus, Mastocembelus pancalus, Telapia mossambica, Xenentodon cancila, Anabus testudineus, Mystus bleakeri and Wallago attu respectively collected from Champahati, Bagmari, Canning and Raidigi, 24-Parganas, West Bengal. Joshi (1976, 1978) described Trypanosoma mrigali, Trypanosoma seenghali, Trypanosoma batai and Trypanosoma stigmai from Cirrhina mrigala, Mystus seenghala, Labeo bata and Barbus stigma collected from Gomati river and Chinhat Lake, Lucknow, Uttar Pradesh. Tandon & Chandra (1977) found Trypanosoma sp. in the blood of Clarias batrachus, Macrones seenghala, Mastocembelus armatus, Mystus seenghala and Wallago attu collected from Lucknow, Uttar Pradesh. Joshi (1979) described the presence of Trypanosoma sp. in the blood of Notopterus notopterus, Puntius stigma, Labeo

bata, Mystus aor, Channa gachua, Heteropneustes fossilis
Wallago attu, Mystus seenghala, Mastocembelus armatus,
Clarias batrachus and Channa punctatus collected from
Lucknow, Uttar Pradesh. Joshi & Dabrol (1979) found
Trypanosoma sp. in Heteropneustes fossilis collected at
Lucknow, Uttar Pradesh. Mukherjee & Halder (1979) found
Trypanosoma sp. in the blood of Nandus nandus collected
from Kalyani, Nadia, West Bengal. Narasimhamurti &
Saratchandra (1980) described Trypanosoma channai and
Trypanosoma qadrii in Channa punctatus and Clarias batra-
chus collected from ponds in and around Visakhapatnam
and Srikakulam, Andhra Pradesh. Sinha (1980) reported
Trypanosoma sp. in the blood of Lepidocephalus guntea
collected from ponds of Bongaon, 24-Parganas, West Bengal.
Gupta & Jairajpuri (1981) described Trypanosoma tricho-
gasteri from Trichogaster fasciata collected from Aligarh,
Uttar Pradesh. Joshi (1982, 1983) described Trypanosoma
aori and Trypanosoma rupicoli in Mystus aor and Nemacheilus
rupicola from Gomoti river, Lucknow and Kosi river near
Kosi station, 11 kms. North of Almora, Uttar Pradesh.
Nandi. et al., (1983) listed 20 named species of Trypanosoma
and 32 unnamed species of Trypanosoma from Indian fresh
water fishes.

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B. Trypanosoma in Anura.

According to Wenyon (1926) anuran trypanosomes were first recorded by Donovan in Bufo melanostictus, Rana hexadactyla and Rana cyanophlyctis. Berestneff (1903) described Trypanosoma sp. from Rana tigrina and Rana limnocharis collected from Bombay. Patton (1908) found Trypanosoma rotatorium in Rana tigrina and Trypanosoma inopinatum (=hendersoni) in Rana tigrina as well as Rana hexadactyla from South India. Scott (1926, 1927) reported Trypanosoma rotatorium in the blood of Rana tigrina. Pujati (1953) recorded Trypanosoma rotatorium from Rana cyanophlyctis and Rana tigrina from South India. Damayanthi & Rao (1979) reported Trypanosoma ranarum in the heart muscle of some frogs of Warangal, Andhra Pradesh. The occurrence of this parasite was also observed in tadpoles by these authors. Ray & Nandi (1978) recorded Trypanosoma rotatorium in Rana limnocharis from West Bengal. Ray (1979a, b, 1980) reported Trypanosoma rotatorium, Trypanosoma chattoni, Trypanosoma karyozeukton, Trypanosoma loricatum, Trypanosoma malabarica and Trypanosoma systema in Bufo melanostictus, Bufo stomaticus, Microhyla ornata, Rana cyanophlyctis, Rana hexadactyla, Rana limnocharis, Rana malabarica, Rana tigrina, Rhacophorus maculatus, Rhacophorus malabaricus and Uperodon systema collected from different parts of India. Sinha (1981) reported Trypanosoma rotatorium from Manipur toads (Bufo

melanostictus). Ray & Choudhury (1980, 1981) observed Trypanosoma rotatorium in Rana tigrina collected from West Bengal. Ray & Choudhury (1983) described nine species of Trypanosoma viz., Trypanosoma rotatorium, Trypanosoma loricatum, Trypanosoma karyozeukton, Trypanosoma chattoni, Trypanosoma inopinatum, Trypanosoma ranarum, Trypanosoma taprobanica, Trypanosoma malabarica and Trypanosoma systema in Indian anurans collected from different districts of West Bengal, Orissa, Bihar, Assam, Andaman Islands, Tripura, Andhra Pradesh, Kerala and Nova Goa.

C. Trypanosoma in Chelonia and Ophidia.

Sinha (1978) described Trypanosoma gangetica from a fresh water turtle, Trionyx gangeticus collected from Bongaon, 24-Parganas, West Bengal.

Haq & Mohiuddin (1956) described an unnamed species of Trypanosoma from Xenchrophis (= Natrix) piscator. Sinha & Mandal (1976) described Trypanosoma enhydris from a fresh water snake, Enhydris enhydris collected from Chakdah, Nadia, West Bengal.

MATERIALS

The following hosts were examined for Trypanosoma infection in their peripheral blood.

1. Clarias batrachus (Linnaeus)

It is popularly known as 'Magur' in Bengal. It belongs to Family Clariidae under Order Cypriniformes. It is found in fresh and brackish waters of plains of India and can live in mud. It possesses accessory respiratory organs and is able to breathe even when it is out of water. Body is elongate, greyish-black with a laterally compressed head. Dorsal fin is more than two thirds of the length of body. This fish is recommended by dieticians as food for patients during the period of convalescence.

Thirty specimens were collected from ponds and ditches of Chakdah, Nadia, West Bengal and examined. Five of these fishes were found to harbour Trypanosoma in their peripheral blood.

2. Tilapia mossambica (Peters)

This fish popularly known as 'American Koi' belongs to Family Cichlidae under Order Perciformes. It is an exotic species introduced in India

in 1952 by the Central Marine Research Station, Mandapam. Body is compressed and dull brownish-olive or blackish in colour. Dorsal and caudal fins are with yellow edges.

Twenty five specimens were collected from ponds of Bongaon, 24-Parganas, West Bengal and examined. Two of these were found positive for Trypanosoma infection.

3. Lepidocephalus guntea (Hamilton)

It is popularly known as 'Gule' belonging to Family Cobitiidae under Order Cypriniformes. It is found all over India except for Malabar Coast and South of Krishna. Body is compressed and dirty yellow in colour. A light band extends from centre of snout to a black ocellus. Numerous rows of dark spots are present on dorsal and caudal parts of body and often there are two rows of such spots on anal fin. Lateral line is absent.

Twenty of these specimens were collected from ponds of Bongaon, 24-Parganas, West Bengal for studying Trypanosoma and two of these were found positive for the parasite.

4. Xenentodon cancila (Hamilton)

This fish is commonly known as 'Kekle' in Bengal. It belongs to Family Belontiidae under Order Belontiiformes. It is a fresh water species found throughout India. Body is stout almost cylindrical and upper part is green while lower part is whitish. It has silvery streak with dark margin from orbit to middle of caudal base.

Twenty specimens were captured from ponds of Bongaon, 24-Parganas, West Bengal and examined. Three of these were found to harbour Trypanosoma in their peripheral blood.

5. Channa gachua (Hamilton)

This fish is known as 'Cheng' in Bengal belonging to Family Ophiocephalidae under Order Ophiocephaliformes. It is found in fresh waters throughout greater parts of India. Body is brown with dark bands running forwards from dorsal ridge to just below lateral line.

Twelve specimens were collected from Baruipur, 24-Parganas, West Bengal and examined. Two specimens were found infected with

Trypanosoma in its blood.

6. Mastocembelus armatus (Lacepède)

This fish is popularly known as 'Baam' in Bengal. It belongs to Family Mastocembelidae under Order Mastocembeliformes. It is found in fresh and brackish waters in plains and hills of India. Upper part of body is brownish in colour and the lower part is pale. Black or dark-brown irregular zigzag pattern is present in between lateral line and dorsal ridge.

Fifteen specimens were collected from Chakdah, Nadia, West Bengal and examined for Trypanosoma. Only two of these specimens were positive for the parasite.

7. Mastocembelus pancalus (Hamilton)

It is popularly known as 'Pankal' in Bengal. It belongs to Family Mastocembelidae under Order Mastocembeliformes. It is found in large rivers and estuaries. It is greenish-olive along black and yellowish colour below with yellowish spots along sides.

Fifteen specimens were collected from ponds of Baruipur, 24-Parganas, West Bengal and examined. Two of these were found positive for Trypanosoma in their peripheral blood.

8. Bufo melanostictus Schneider

This toad is popularly known as "Kuno" in Bengal. It belongs to Family Bufonidae under Order Anura. It is found in damp places all over the country. Adult one has uniform brownish or greyish-olive above. Crown of head is deeply concave. Parotid glands are elongate and longer than head. Upper parts are densely covered with tubercles and warts. Tympanum is well developed. Legs are short. Length of hind limb is not much more than that of the body.

Four specimens were collected and blood smears were drawn by Mr. Ekendar Singh of Manipur. Two of these specimens were found to harbour Trypanosoma.

9. Lissemys punctatus (Bonnaterre)

It is popularly known as mud-turtle. It belongs to Family Trionychidae under Order Chelonia. The animal is timid and lives in ponds. Body is olive-brown above with large well-defined spots.

First marginal bone is much longer than the second.

Entoplastral callosity is usually small in adult.

Head and carapace bear yellow spots. It is distributed in the Ganges, and the Indus and in their tributaries.

Twelve mud turtles were collected at different times from Bongaon, 24-Parganas, West Bengal and examined. Five of these animals were found to harbour Trypanosoma.

10. Trionyx gangeticus Cuvier

It is a common turtle found in the Gangetic river system. It belongs to Family Trionychidae under Order Chelonia. Its carapace and plastron are covered with soft skin. Snout ends in a proboscis. Jaws are concealed under fleshy lips. Ears are hidden and tail is short. Head is provided with a black longitudinal streak between the eyes extending to the nape. Dorsal part is olivaceous, while ventral part is yellowish.

Fifteen specimens were collected from the Ichamati river of Bongaon, 24-Parganas, West Bengal and examined. Two of these specimens were found positive for Trypanosoma.

11. Enhydris enhydris (Schneider)

This snake is popularly known as 'metuli' in Bengal. It belongs to Family Colubridae under Order squamata. It is an aquatic and non-poisonous snake but is often found on land in the vicinity of water. It is brown or grey or olivaceous in colour above and bounded on either side by a pale stripe which is most distinct on the hinder part of the body. Head is indistinctly variegated with grey or with an indistinct dark stripe on each side of the eye. It is distributed in North Eastern India and is very common in Bengal. It chiefly feeds on fishes.

Fifty snakes were collected at different times from the ponds and ditches of Chakdah, Nadia, West Bengal and examined. Thirty of these were found to harbour Trypanosoma in their peripheral blood.

METHODS

The following methods were adopted for the preparation of blood smears from different specimens.

In fishes, blood was collected from branchial blood vessels or caudal veins with the help of a sterilised needle.

In amphibians, blood smears were drawn by puncturing the facial vein at the angle of mouth.

In turtles, blood was collected by pricking the limbs and sometimes by puncturing the heart directly when the animals are killed.

In snakes, blood was collected by clipping the tail region or from the facial vein.

Blood smears were stained with Leishman's and Giemsa's stains. For staining with Giemsa's stain the air dried slides were fixed in acetone-free methyl alcohol for five minutes and allowed to dry. For Leishman's stain separate fixation was not necessary, since the solution itself acted as fixatives.

Measurements of trypanosomes were made from fixed and stained materials and Camera lucida drawings were made.

Nuclear index (NI) and kinetoplasmic index (KI) were calculated to determine the position of nucleus and the kinetoplast after the methods advocated by Dias & Freitas (1943) and Keymer (1967) respectively for the parasites.

OBSERVATIONS

Trypanosoma in Fishes

Parasite No.1.

Trypanosoma clariae Montel

(Figs. 1 - 12)

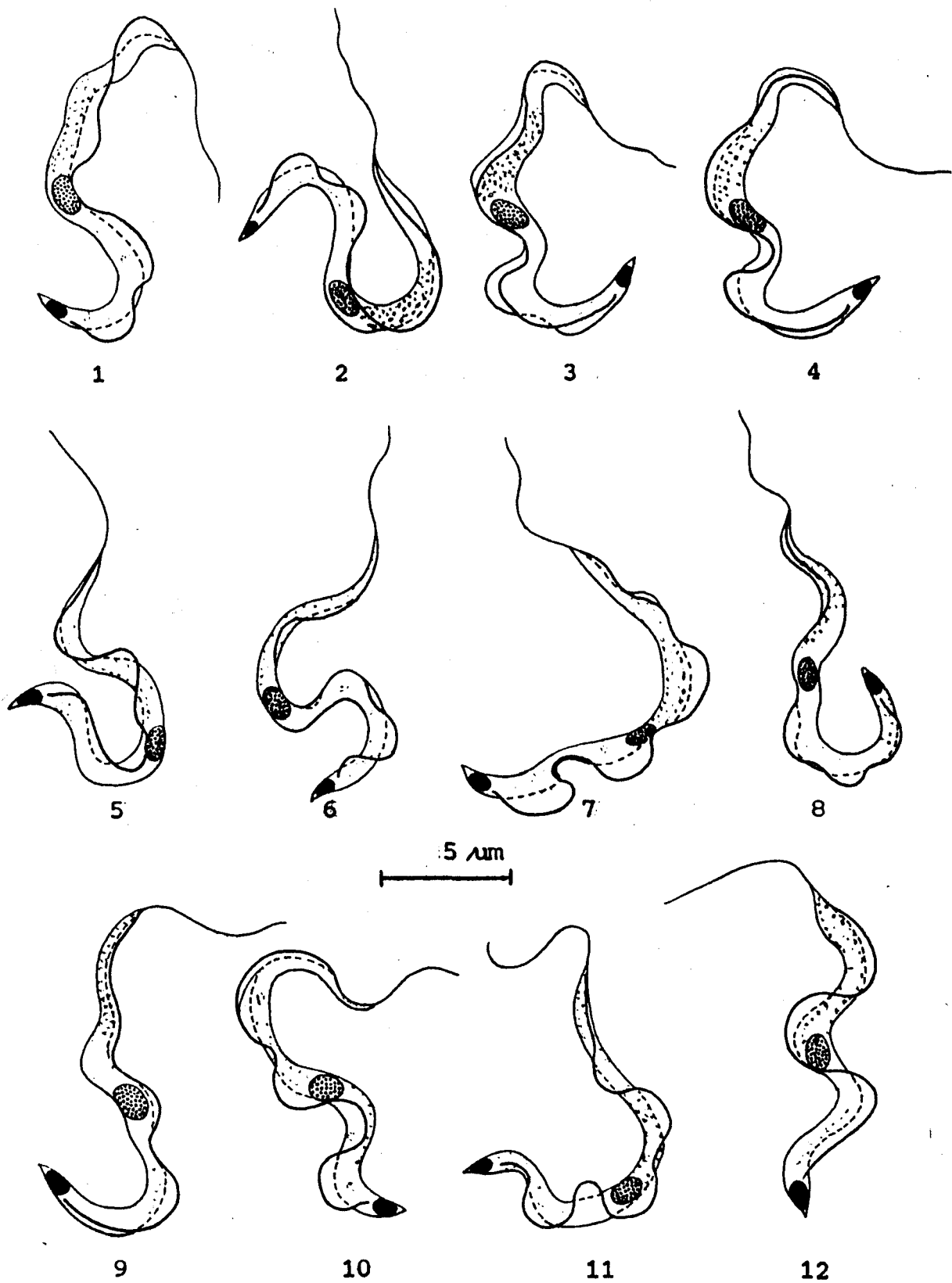
1905. Trypanosoma clariae Montel, C.r.Soc.Biol., 58 :1016;
 Mathis & L  ger, 1910, C.r.Soc.Biol., 69 : 349;
 Mathis & L  ger, 1911, C.r.Soc.Biol., 71: 185.

Occurrence

The parasite was encountered in peripheral blood plasma of Clarias batrachus (Linnaeus) collected from Chakdah, Nadia, West Bengal, India.

Morphology

Trypomastigotes were only found in blood plasma. These showed a single morphological type. These (Figs.1-12) were slender, elongate with pointed extremities. Narrow cell body was widest at its middle part. Cytoplasm stained light blue and contained 3 - 4 vacuoles. Volutin granules were found towards anterior part of cell body. Nucleus was oval, sub-terminal and stained light purple. A karyosome was not observed. Kinetoplast was terminal, conical and stained deep purple. A flagellum emerged from base of kinetoplast forming an undulating membrane with 3 - 4 folds. Free part of flagellum was short.



FIGURES. 1 - 12. Camera lucida drawings of Trypanosoma clariae Montel (1905), showing trypomastigote forms.

Dimensions:

Measurements of forty trypanosomes were given in the following table 1.

TABLE 1

Measurements (in micrometers, μm) of Trypanosoma clariae Montel, 1905.

	Range	Average
Total length of body (including free flagellum).	27.5 - 37.5	30.7
Length of cell body.	20 - 24.5	23
Width of cell body.	1.1 - 2	1.4
Posterior extremity to posterior kinetoplast.	0.01 - .03	.02
Anterior kinetoplast to posterior nucleus.	6.3 - 8.9	7.7
Anterior nucleus to anterior end.	7.7 - 9.9	8.6
Length of free flagellum.	7.5 - 10	8
Length of nucleus.	1.38 - 1.99	1.77
Width of nucleus	.45 - 1.2	.95
Length of kinetoplast.	.77 - 1.2	1
Width of kinetoplast.	.33 - .4	.38
Nuclear index (posterior end to centre of nucleus // nucleus to anterior end).	.91 - 1.04	1.02
Kinetoplastic index (posterior end to centre of nucleus // centre of kinetoplast to centre of nucleus).	1.04 - 1.06	1.05

Discussions

Different species of Clarias have been reported to harbour Trypanosoma in their peripheral blood plasma. Montel (1905) reported for the first time the occurrence of a trypanosome in Clarias macrocephalus of North Viet Nam and named the parasite Trypanosoma clariae. * Dutton et al., (1906, 1907) described trypanosomes in Clarias angolensis collected from Kinshasa in the Zaire which existed in three varieties of different size and assigned no name to them. Wenyon (1909) reported Trypanosoma sp. in the blood of Clarias anguillaris which abounded in the Nile river and in Lake Ambodi of Sudan. He did not give any description and measurements of the parasite. Bouet (1909) found a trypanosome in the same fish and suggested that it might be the ~~same~~ same parasite as that from Clarias angolensis and therefore, no detailed account was given. He also described Trypanosoma toddi a parasite from Clarias anguillari in the then French West Africa which Baker (1960) considered a valid species. Zupitza (1909) also described an unnamed species of Trypanosoma in Clarias sp. from Cameroon. Mathis & Léger (1910, 1911) described two forms of Trypanosoma clariae Montel, 1905 and named Trypanosoma clariae var parva and Trypanosoma clariae var magma in the blood of Clarias macrocephalus from Tonkin. Trypanosoma clariae parva was small, narrow with pointed ends. Cytoplasm was granulated. Nucleus was large and lay at middle. Kinetoplast was rounded and near the posterior part of cell body. These form measured 39 μm in total length and 2.75 μm in breadth.

* He did not give measurements and adequate description of the parasite.

authors gave any adequate description of the parasite.

The parasite under report resembles the small form of trypanosomes described by Mathis & L  ger (1910, 1911) and is identified as Trypanosoma clariae Montel (1905). The only difference is that the large forms (Trypanosoma clariae var magna) were not found in the present study as described by these authors.

Diagnosis

Family Trypanosomatidae Doflein, 1901; emend Grobber, 1905.

Single nucleus and a kinetoplast ; flagellum arising from base of kinetoplast.

Genus. Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus; flagellum forming outer margin of undulating membrane along anterior end.

Specific characters

parasite in the present study measuring $27.5 \mu\text{m} - 37.5 \mu\text{m} \times 1.1 \mu\text{m} - 2 \mu\text{m}$ including free flagellum. Cytoplasm containing volutin granules; kinetoplast terminal ; nucleus oval, sub-central.

The present parasite is referred to as Trypanosoma clariae Montel (1905)

Host. Clarias batrachus (Linnaeus)

Site of infection . Blood plasma.

Locality: Chakdah, Nadia, West Bengal, India.

Trypanosoma in Fishes

Parasite

No.2.

Trypanosoma mukasai Hoare

(Figs. 1 - 12)

1932. Trypanosoma mukasai Hoare, Parasitology, 24 : 210 ; Baker, 1966, Parasitology, 50 : 515.
1977. Trypanosoma choudhuryi Mandal, Acta Protozool., 16 : 1.

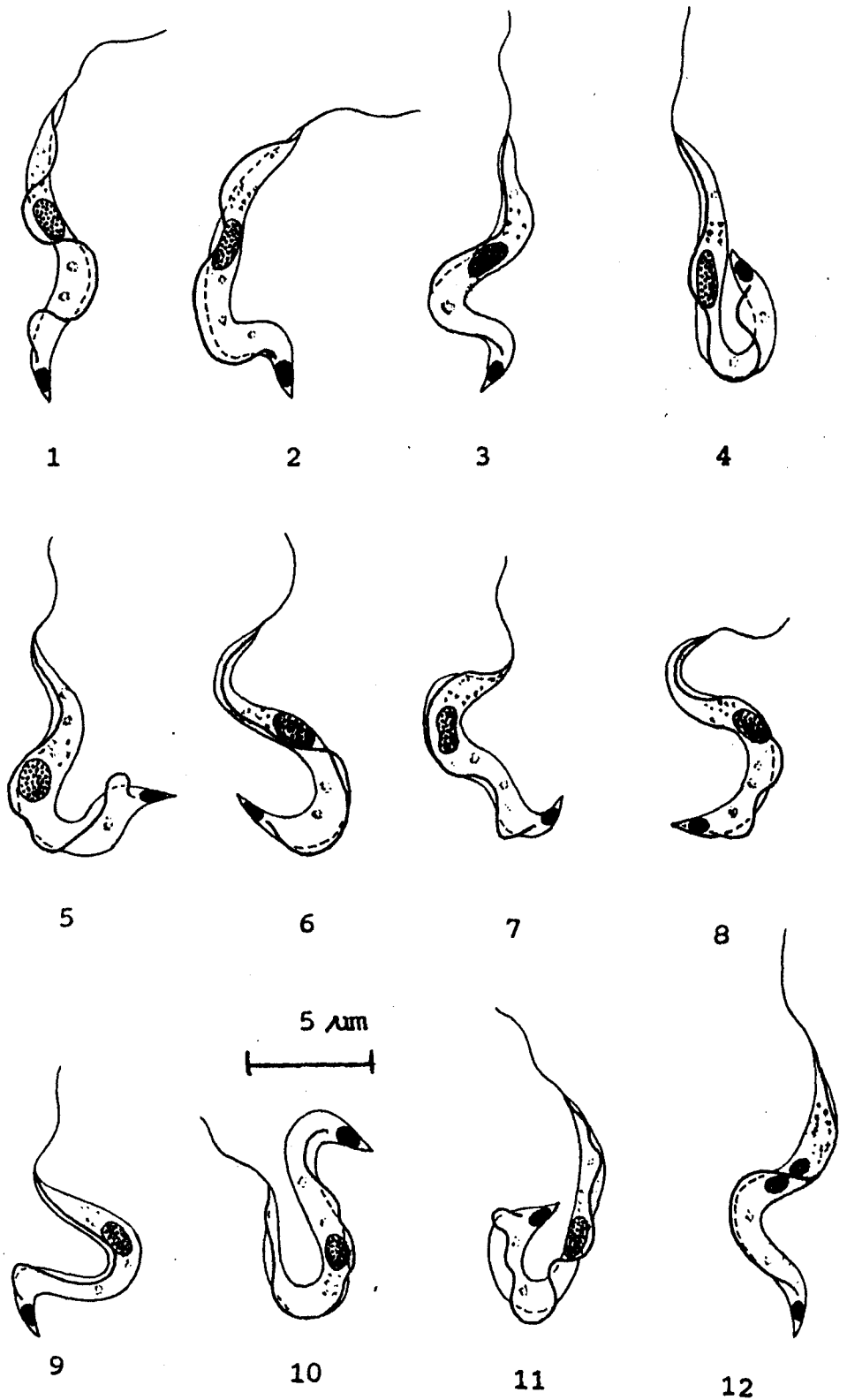
Occurrence

The parasite was found in peripheral blood smears of Tilapia mossambica (Peters) collected from Bongaon, 24-Parganas, West Bengal, India.

Morphology

Trypomastigotes showed a single morphological type in blood plasma. These (Figs.1-12) were small and slender with bluntly pointed extremities. Cytoplasm was light purple and contained a few volutin granules and vacuoles. Nucleus was oval, sub-central and stained purple in colour. It lay towards the anterior part. A karyosome was not found. Kinetoplast was small, sub-terminal, dot-like and deep purple in colour. Flagellum arose from base of kinetoplast forming an undulating membrane with 2 - 3 folds. Free part of flagellum was short at the anterior tip.

Dividing forms of these trypomastigotes were not seen except for one individual (Fig. 12) where the cell body contained nuclei but the kinetoplast remained undivided.



FIGURES. 1 - 12. Camera lucida drawings of Trypanosoma mukasai Hoare (1932), showing trypomastigote forms.

FIG. 12. Dividing form of trypomastigote showing two nuclei.

Dimensions

Morphometric measurements (in micrometers, μm) of thirty trypomastigote forms of Trypanosoma mukasai Hoare, 1932 were given in table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	18.9 - 24.1	21.4
Length of cell body.	14.3 - 18.8	16.2
Width of cell body.	1.2 - 2.2	1.5
Posterior end to posterior kinetoplast.	.01 - .5	.2
Anterior kinetoplast to posterior nucleus.	5.5 - 7.9	7
Anterior nucleus to anterior end.	4.4 - 8.8	5.8
Length of free flagellum.	4.4 - 5.8	5.1
Length of nucleus.	1.7 - 2.4	1.9
Width of nucleus.	.6 - 1.2	1
Length of kinetoplast.	.7 - 1.1	.9
Width of kinetoplast.	.2 - .6	.3
Nuclear index (posterior end to centre of nucleus / centre of nucleus to anterior end.	1.1 - 1.35	1.3
Kinetoplastic index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.02 - 1.12	1.04

Discussion

Trypanosomes have been recorded in different species of Tilapia from Africa and India. Wenyon (1909) described an unnamed species of Trypanosoma in Tilapia zilli of the Nile river in Sudan. L  ger & L  ger (1914) found trypanosomes in Tilapia lata from the river Niger in the then French West Africa but assigned no specific name to the parasite. These authors believed that the trypanosomes were identical with those described by Wenyon (1909) from Tilapia zilli. After a lapse of many years, Dias (1955) described three species of trypanosomes viz., Trypanosoma napolesi, Trypanosoma rebeloi (in which were included the trypanosomes described by Wenyon, 1909 in Tilapia zilli) and Trypanosoma serranoi (in which were included the trypanosomes which Neave, 1906 reported from Synodontis schall) from Tilapia mossambica in Mozambique.

Baker (1960) reviewed the trypanosomes of African fresh water fishes and considered Dias's three species as variants of a single species and regarded them as synonyms of Trypanosoma mukasai Hoare (1932). Baker (1960) also reported the occurrence of Trypanosoma mukasai Hoare (1932) from Tilapia nilotica, Tilapia esculenta, Tilapia variabilis and Tilapia leucosticta of George and Victoria lakes of East Africa. Mandal (1977) described Trypanosoma choudhuryi in Tilapia mossambica collected from Champhahati, 24-Parganas, West Bengal, India.

The present parasite under discussion is identified as Trypanosoma mukasai Hoare (1932) as redescribed by Baker (1960) from different species of Tilapia on the basis of the morphological characters described above.

Trypanosoma choudhuryi Mandal (1977) resembles very much the small forms of Trypanosoma mukasai Hoare (1932) in its morphology and dimensions. Therefore, Trypanosoma choudhuryi Mandal (1977) and the present parasite are both identified as Trypanosoma mukasai Hoare (1932). The only difference is that the large forms were not found in the present study nor were these reported in Trypanosoma choudhuryi Mandal (1977).

A comparative study on the measurements of these trypanosomes is given in table 2 which reveals that differences in dimensions, which almost overlap each other, are minor in nature and not sufficient for considering Trypanosoma choudhuryi Mandal (1977) and the present parasite as valid species distinct from Trypanosoma mukasai Hoare (1932).

TABLE 2

Comparative measurements (in micrometers, μm) of Trypanosoma mukasai Hoare (1932), Trypanosoma choudhuryi Mandal (1977) and the present parasite.

	<u>Trypanosoma mukasai</u> Hoare (1932) as described by Baker (1960)	<u>Trypanosoma choudhuryi</u> Mandal (1977)	The present parasite.
	Range Small forms	Range Large forms	Range
TL.	22 - 35	45 - 62	23 - 37.8
BL.	16 - 27	33 - 54	16.5-25.3
BW.	1 - 2.7	2 - 6	1.5-1.8
FF.	5 - 12	7 - 17	6.5 - 12.5
PK.	0 - 2	.5 - 2	.8 - 2.5
NL.	1.7-3.5	3 - 5.5	3.5 -5.2
NW.	.75-1.7	1.5 - 5.7	1 - 2.5
KN.	5 - 17	14 - 29	5.5-9.5
NA.	4.5-11.5	13 - 19	4.5-8.5
KL.	.25-1.5	.5 - 1.5	1 - 1.5
KW.	.25 - 1	.5 - 1	1 - 1.05

Abbreviations:

TL= total length of the body including free flagellum; BL=length of cell body excluding free flagellum; BW =width of the cell body; FF =length of free flagellum; PK = the distance from posterior end to kinetoplast; NL=length of nucleus; NW =width of nucleus; KN =anterior kinetoplast to nucleus; NA =anterior nucleus to anterior end; KL =length of kinetoplast; KW=width of kinetoplast.

Diagnosis

Family Trypanosomatidae Doflein, 1901; emend Grobben, 1905.

Single nucleus and a kinetoplast; flagellum arising from base of kinetoplast.

Genus Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus; flagellum forming outer margin of undulating membrane extending along anterior end.

Specific characters

Measuring $18.9 \mu\text{m} - 24.1 \mu\text{m} \times 1.2 \mu\text{m} - 2.2 \mu\text{m}$ in total length including free flagellum; kinetoplast sub-terminal; nucleus towards anterior part of body. The present parasite is referred to as Trypanosoma mukasai Hoare (1932).

Host. Tilapia mossambica (Peters)

Site of infection. Blood plasma.

Locality: Bongaon, 24-Parganas, West Bengal, India.

Trypanosoma in Fishes

Parasite No.3.

Trypanosoma n.sp. (a)

(Figs. 1 - 5)

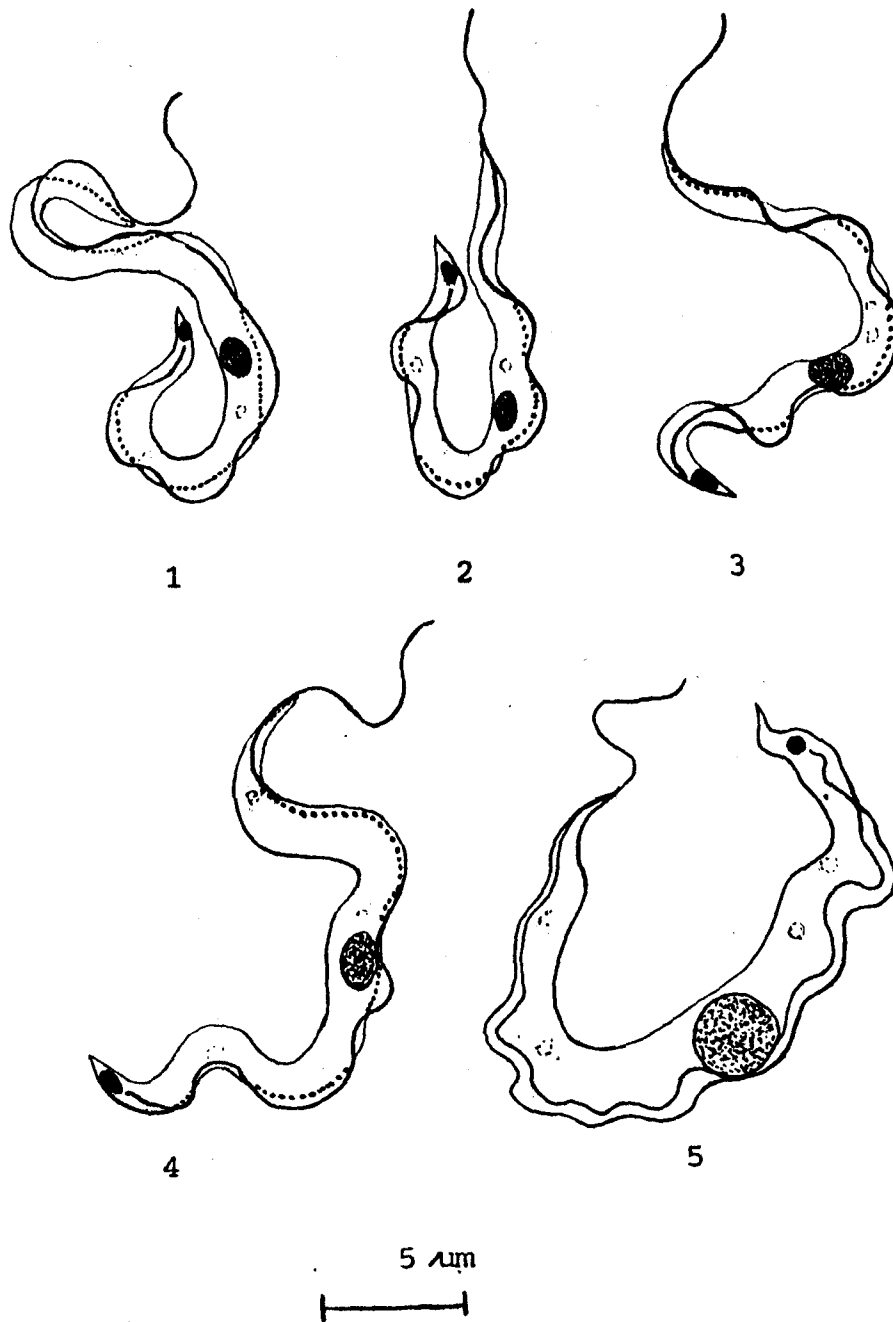
Occurrence

The parasite was encountered in peripheral blood smears of Lepidocephalus Guntea (Hamilton) collected from Bongaon, 24 -Parganas, West Bengal, India.

Morphology

Trypomastigotes were only found in blood plasma which showed a single morphological type. These were elongate, slender (Figs. 1 - 4) or broad (Fig.5). The posterior end is narrowly pointed while the anterior tip is bluntly pointed. Cytoplasm was homogeneous, non-granular and contained a few vacuoles. It stained light blue in colour. Nucleus was either oval (Figs. 1 - 4) or sub-spherical and pink in colour. A karyosome was not observed. Kinetoplast lay almost at the posterior end (Figs.1 - 4) or away from the posterior part of the cell body (Fig. 5). * Flagellum arose near kinetoplast and trailed anteriorly along undulating membrane forming 4 - 8 folds. Free part of flagellum was present at the anterior tip.

*Kinetoplast was conical (Figs. 1 - 4) or dot-like (Fig.5) and stained deep purple in colour.



FIGURES. 1 - 5. Camera lucida drawings of Trypanosoma n.sp. (a).

Figs. 1 -4. Slender trypomastigote forms.

Fig. 5. Broad trypomastigote form.

Dimensions

Measurements (in micrometers, μm) of twenty trypomastigotes of Trypanosoma n.sp. (a) were given in table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	38 - 50	43.5
Length of cell body.	28 - 41	38
Width of cell body.	2.2 - 3.4	2.7
Posterior end to posterior kinetoplast.	.8 - 3	1.5
Anterior kinetoplast to posterior anterior nucleus.	10.5-15.4	13
Anterior nucleus to anterior end.	12.8 -19	15
Length of free flagellum.	7 - 10	8.5
Length of nucleus.	1.5 - 3.3	2.2
Width of nucleus.	1.2 - 3.3	1.6
Length of kinetoplast.	.5 - 1.1	.8
Width of kinetoplast.	.4 - .6	.4
Nuclear index (posterior end to centre of nucleus / nucleus to anterior end).	.93 - 1.02	1.01 1.04
Kinetoplastic index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.08 - 1.21	1.14

Discussion

Parasite under discussion possesses an undulating membrane and a posterior kinetoplast. So it has been placed under genus Trypanosoma. Sinha (1980) reported Trypanosoma sp. from Lepidocephalus guntea collected at Bongaon, 24-Paraganas, West Bengal, India. The same parasite is described here from the same host fish and considered a new species ^{Trypanosoma n.sp.(a)} on the basis of the morphological characters described above.

The problem of new speciation remains complicated for the trypanosomes from fishes as also pointed out earlier by various investigators (Baker, 1960; Becker, 1967, 1970, 1977; Joshi, 1978, 1982; Mandal, 1979). Recently Froes et al., (1978, 1979) and Grogl et al., (1980) considered species specificity and varying morphometric characteristics to create new speciation.

25 species of Trypanosoma have been recorded so far from Indian fresh water fishes. Among the known monophic forms, Trypanosoma n.sp. (a) resembles to some extent Trypanosoma ophicephali Pearse (1933), Trypanosoma punctati Hasan & Qasim, (1962), Trypanosoma elongatus Raychaudhuri & Misra (1973) and Trypanosoma qadrii Narasimhamurti & Saratchandra (1980) due to body configuration but differs in the following morphometric measurements and in host range given below (measurements in micrometers, μm).

<u>Trypanosoma</u> <u>ophicephali</u>	<u>Trypanosoma</u> <u>punctati</u>	<u>Trypanosoma</u> <u>elongatus</u>	<u>Trypanosoma</u> <u>qadrii</u>	<u>Trypanosoma</u> <u>n.sp. (a)</u>
1. 33.6	34	43 - 44.5	20 - 32	28 - 41
2. 7.7	14.6	17 - 18.5	5 - 14	7 - 10
3. 5.2	2.7	6 - 6.5	2.5 - 4	1.5 - 3.3
Host				
<u>Channa</u> <u>striatus</u>	<u>Channa</u> <u>punctatus</u>	<u>Channa</u> <u>punctatus</u>	<u>Clarias</u> <u>batrachus</u>	<u>Lepidocephalus</u> <u>guntea</u>
Locality				
(Siam) Thailand.	Hyderabad India.	Calcutta India.	Visakhapath- nam, India.	Bongaon India.

Thus, Trypanosoma n.sp. (a) does not fit in other known species, and can not be considered as identical.

Abbreviations. 1. = Body length; 2. length of free flagellum
3. Length of nucleus.

Diagnosis

Family Trypanosomatidae Doflein, 1901; emend Grobben, 1905

Single nucleus and a kinetoplast;
flagellum arising from base of kinetoplast.

Genus. Trypanosoma Gruby, 1843

Kinetoplast posterior to nucleus;
flagellum forming outer margin of undulating membrane extending along anterior end.

Specific characters

Trypanosoma sp. n. measuring 38 μ m

Trypomastigotes measuring 38 μ m
- 50 μ m X 2.2 μ m - 3.4 μ m in total
length including free flagellum;
Cytoplasm non-granular; nucleus oval
or spherical; kinetoplast terminal or
subterminal; undulating membrane forming
4 - 8 folds.

For the present the parasite is referred
to as Trypanosoma n.sp. (a)

Host. Lepidocephalus guntea (Hamilton)

Site of infection. Blood plasma.

Locality: Bongaon, 24-Parganas, West Bengal, India.

Trypanosoma in Fishes

Parasite No.4.

Trypanosoma cancili Mandal

(Figs. 1 - 4)

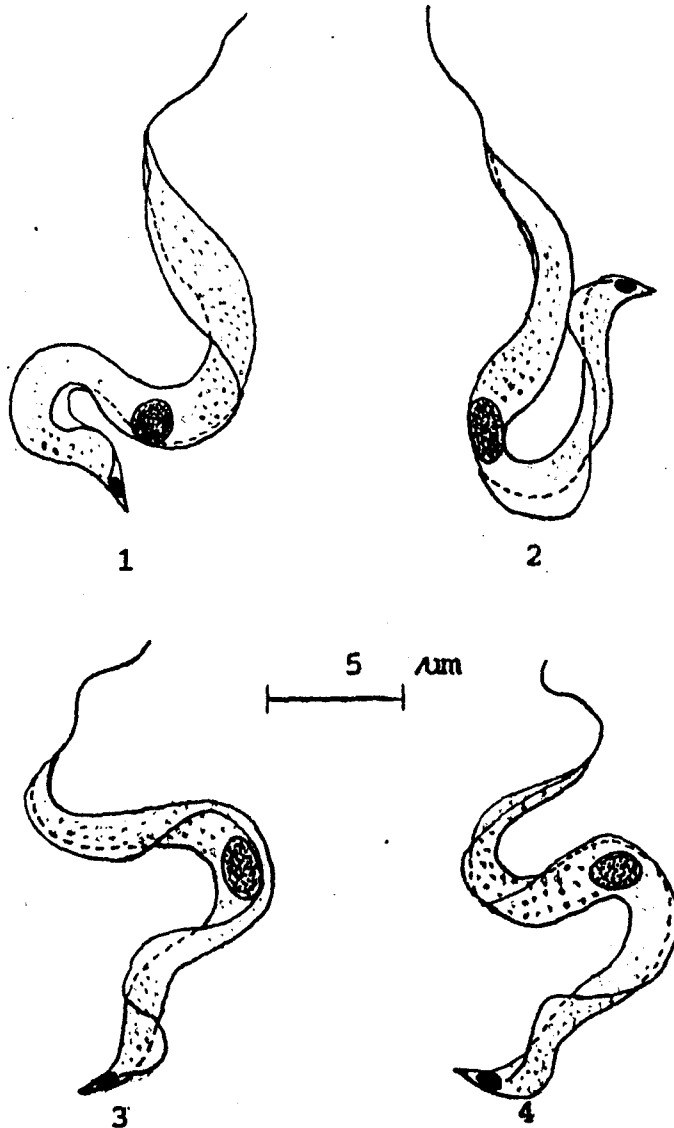
1978. Trypanosoma cancili Mandal, Angew. Parasitol., 19 : 158.

Occurrence

The parasite was found in peripheral blood smears of Xenentodon cancila (Hamilton) collected from Bongaon, 24-Parganas, West Bengal, India.

Morphology

Trypomastigotes were only present in blood plasma and showed a single morphological type. These (Figs.1-4) were long, slender, elongate and both the extremities were pointed. Cytoplasm was basophilic and contained volutin granules. Nucleus was oval, sub-central and light pink in colour. No karyosome was observed. Kinetoplast was sub-terminal, small and stained deep purple. Flagellum emerged from the base of kinetoplast forming an undulating membrane with 1 - 2 folds. Free part of flagellum was present at the anterior tip.



FIGURES. 1 - 4. Camera lucida drawings of Trypanosoma cancelli Mandal (1978) showing trypomastigote forms.

DIMENSIONS

Measurements (in micrometers, μm) of thirty trypomastigotes of Trypanosoma cancili Mandal, 1978 were given in the following table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	30 - 37	33.3
Lengthh of cell body.	26 - 33	28.4
Width of cell body.	1.8-2.7	2.2
Posterior end to posterior kinetoplast.	.4 - .7	.5
Anterior kinetoplast to posterior nucleus.	10 - 14	11.8
Anterior nucleus to anterior end.	9.5 - 14.5	12.4
Length of free flagellum.	4.4 - 6.8	4.8
Length of nucleus.	1.6 - 3.2	2.6
Width of nucleus.	1.2 - 1.7	1.5
Length of kinetoplast.	.8 - 1.1	.9
Width of kinetoplast.	.4 - .6	.5
Nuclear index (posterior end to centre of nucleus / centre of nucleus to anterior end).	1.01 - 1.08	1.04
Kinetoplastic index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.06 - 1.109	1.07

Discussion

The parasite is placed under the genus Trypanosoma on account of an undulating membrane and a posterior kinetoplast.

Mandal (1978) described Trypanosoma cancili from Xenentodon cancila collected at Raidighi, 24-Parganas, West Bengal, India. Parasite under discussion is also reported from the same host and is identified as Trypanosoma cancili Mandal (1978) on the basis of the following characters.

Parasite is monomorphic, slender and attenuated at both ends. Cytoplasm is strongly basophilic and contained vacuoles. Nucleus is ovoid and almost central. Kinetoplast is oval and stains deep purple. Free part of flagellum is present.

However, the following differences are also noted which are given in the following table 2 (measurements in micrometers, μm).

TABLE 2

	<u>Trypanosoma cancili</u> Mandal (1978) Range	Present parasite. Range
Total length.	27 - 40.3	30 - 37
Length of cell body.	18.5-28.5	26 - 33
Width of cell body.	- -	1.8- 2.7
Length of free flagellum.	8.5 -11.8	4.4 - 6.8
Length of nucleus.	2.5 - 3.5	1.6 - 3.2
Width of nucleus.	1.3 - 2.8	1.2 - 1.7

Posterior end to kinetoplast.	1 - 2.5	1.2-1.8
Kinetoplast to posterior nucleus.	8.5 - 10.5	10 - 14
Anterior nucleus to anterior end.	7.5 - 10.5	9.5 -14.5
Host locality.	Raidighi, 24-Parganas, West Bengal.	Bongaon, 24-Parganas, West Bengal.

Above differences are minor in nature and not sufficient for considering the present parasite as new one. However, the range of dimensions of Trypanosoma cancili is amended in this study and shown in table 3.

Therefore, the parasite under report is identified and described as Trypanosoma cancili Mandal, 1978 subject to the above amendment.

TABLE 3

	<u>Range</u>
Total length including free flagellum.	27 - 40.3
Length of cell body.	18.5-33
Width of cell body.	1.8-2.7
Length of free flagellum.	4.4-11.8
Length of nucleus.	1.6 - 3.5
Width of nucleus.	1.2 - 2.8
Posterior end to kinetoplast.	1 - 2.5
Kinetoplast to posterior nucleus.	8.5 - 14
Nucleus to anterior end.	7.5 - 14.5
Nuclear index.	1.01- 1.08
Kinetoplasmic index.	1.06- 1.09.

Diagnosis

Family Trypanosomatidae Doflein, 1901; emend Grobben, 1905.

Single nucleus and a kinetoplast;
flagellum arising from base of kinetoplast.

Genus Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus;
flagellum forming outer margin of undulating membrane extending along anterior end.

Specific characters

Trypomastigotes exhibiting a single morphological type ; 30 - 37 μm X 1.8 - 2.7 μm in total length; kinetoplast sub-terminal; nucleus sub-central; cytoplasm basophilic; The present parasite is referred to as Trypanosoma cancili Mandal (1978).

Host. Xenentodon cancila (Hamilton)

Site of infection. Blood plasma.

Locality : Bongaon, 24-Parganas, West Bengal, India.

Trypanosoma in Fishes:

Parasite No.5.

Trypanosoma gachuii Misra, Chandra & Choudhury

(Figs. 1 - 4)

1973. Trypanosoma gachuii Misra, Chandra & Choudhury,
Arch. Protistenk., 115 : 18.

Occurrence

The parasite was found in peripheral blood smears of Channa gachua (Hamilton) collected from Baruipur, 24-Parganas, West Bengal, India.

Morphology

Trypomastigotes were only found in peripheral blood plasma and showed a single morphological type. These (Figs. 1 - 4) were slender with an anterior blunt end. Cytoplasm was homogeneous, non-granular and light blue in colour. Nucleus was elongate or oval and pink in colour. No karyosome was observed. Kinetoplast was terminal, small, oval and stained deep purple. Flagellum emerged near kinetoplast and trailed anteriorly along the border of undulating membrane forming 1 - 2 folds. Free part of flagellum was present at the anterior tip.

Dimensions

Measurements (in micrometers, μm) of thirty trypomastigote forms of Trypanosoma gachuii Misra, Chandra & Choudhury, 1973 were given in table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	24.5 - 29	26.5
Length of cell body.	16.5 - 18	16.5
Width of cell body.	1 - 1.4	1.2
Posterior end to posterior kinetoplast.	.1 - .5	.2
Anterior kinetoplast to posterior nucleus.	6 - 8	7
Anterior nucleus to anterior end.	5 - 7.5	6
Length of free flagellum.	7 - 9.5	8.4
Length of nucleus.	1.6 - 2	1.8
Width of nucleus.	.5 - .8	.6
Length of kinetoplast.	.6 - .9	.7
Width of kinetoplast.	.4 - .6	.5
Nuclear index (posterior end to centre of nucleus / centre of nucleus to anterior end).	1.2 - 1.3	1.2
Kinetoplastic index (posterior end to centre of nucleus // centre of kinetoplast to centre of nucleus).	1.06 - 1.1	1.07

Discussion

Several species of trypanosomes have been described from the Family Ophiocephalidae. Lingard(1904) reported for the first time the occurrence of a Trypanosoma sp. from Channa(= Ophiocephalus) striatus of Pune. He did not give any measurements and description of the parasite. Wenyon (1909) found a trypanosome in Channa obscurus of the river Nile from Sudan. Mathis & Léger(1911) also reported Trypanosoma sp. in Channa maculatus of Tonkin. * After a lapse of many years, Qadri(1951) found a trypanosome in Channa striatus collected from Hyderabad, Andhra Pradesh, India and later named as Trypanosoma striati in 1955. Hasan & Qasim(1962), Raychoudhury & Misra(1973) and Narasimhamurthi & Sartchandra(1980) described Trypanosoma punctati, Trypanosoma elongatus and Trypanosoma channai from Channa punctatus while Misra, et al., (1973) described Trypanosoma gachuii from Channa gachua respectively. Trypanosoma sp. was also reported from India by Tandon & Joshi(1974) and Joshi(1979) from Channa punctatus and Joshi(1979) from Channa gachua. None of these authors gave any description of the parasite.

The parasite under report resembles short slender form of Trypanosoma gachuii Misra, Chandra & Choudhury(1973) and accordingly the trypanosome in this study is identified as Trypanosoma gachuii Misra, Chandra & Choudhury(1973

* Pearse(1933) described Trypanosoma ophicephali in Channa striatus from Thailand.

Short slender form is elongated with pointed extremities. Cytoplasm contains a few vacuoles and granules. Nucleus is oval and sub-central. Kinetoplast is terminal or sub-terminal. The long slender form of Trypanosoma gachuii is not found in the present study. The following differences are also noted which are given in table 2 (measurements in micrometers, μm).

	<u>TABLE 2</u> <u>Trypanosoma gachuii</u>		Present parasite
	Misra, Chandra & Choudhury (1973)		Range
	Range short slender	Range Long slender	
TL.	34.4 - 38.9	51.1 - 54.4	24.5 - 29
BL.	23.3 - 26.4	38.4 - 44.4	16.5-18
BW.	2.2 - 2.7	2.5 - 5.6	1 - 1.4
FF.	10 - 12.5	10 - 12.2	7 - 9.5
NL.	2 - 2.8	2.2 - 3.3	1.6 -2
NB.	2 - 2.7	2.2 - 3.3	.5 - .8
Host Locality.	Local markets of Calcutta, West Bengal, India.		Baruipur, 24- Parganas, West Bengal, India.

Above differences are not sufficient for considering the present parasite as new one. Therefore, the parasite under report is identified and described as Trypanosoma gachuii Misra, Chandra & Choudhury (1973)

Diagnosis

Family Trypanosomatidae Doflein, 1901; emend
Grobben, 1905.

Single nucleus and a kinetoplast;
flagellum arising from base of kinetoplast.

Genus Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus ;
flagellum forming outer margin of undul-
ating membrane extending along anterior
end.

Specific characters

In this study, the trypomastigotes measuring
24 μ m - 29 μ m X 1 μ m - 1.4 μ m in total
length including free flagellum; kinetoplast
sub-terminal or terminal; nucleus elongate
and sub-central.

The present parasite is referred to as
Trypanosoma gachuii Misra, Chandra & Choudhury
(1973).

HOST. Channa gachua (Hamilton)

Site of infection. Blood plasma.

Locality : Baruipur, 24-Paraganas, West Bengal, India.

Trypanosoma in Fishes

Parasite No.6

Trypanosoma armeti Mandal

(Figs. 1 - 3)

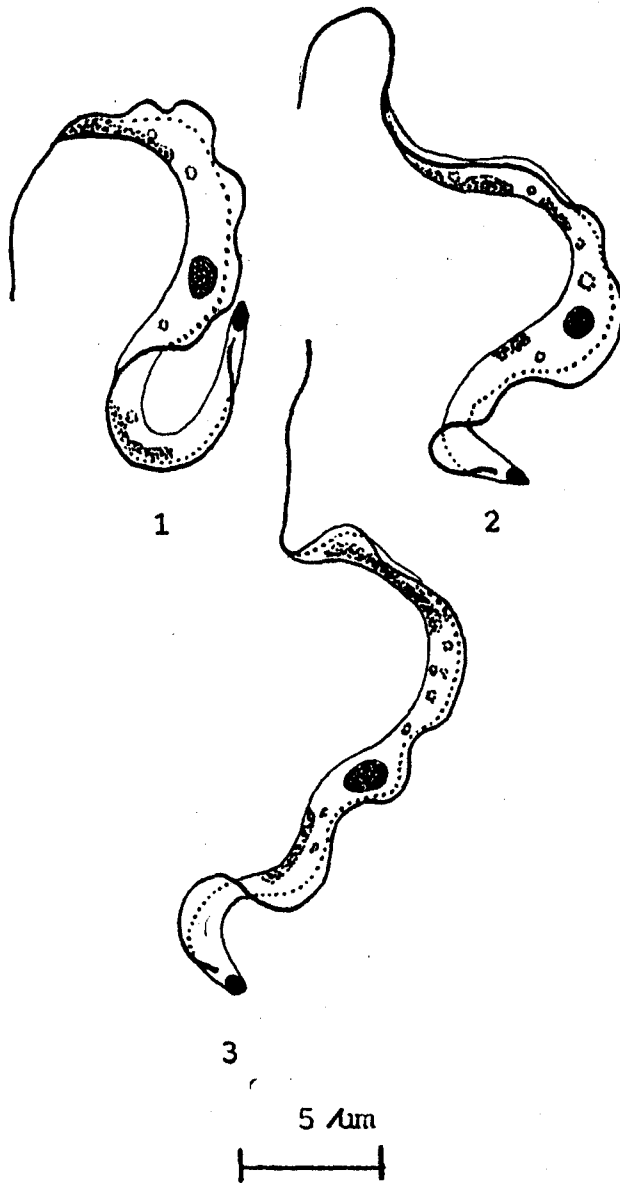
1975. Trypanosoma armeti Mandal, Angew. Parasitol.,
16 : 87.

Occurrence

The parasite was encountered in peripheral blood smears of Mastocembelus armatus (Lacepède) collected from Chakdah, Nadia, West Bengal, India.

Morphology

Trypomastigotes were only found in blood plasma. These exhibited a single morphological type. These (Figs. 1 - 3) were long, slender and both the extremities were bluntly end. Cytoplasm was light blue in colour and contained volutin granules. A few vacuoles were also present. Nucleus was oval and stained light pink in colour. A karyosome was not observed. Kinetoplast was terminal, dot-like or conical and stained deep purple. Flagellum emerged near kinetoplast and formed an undulating membrane with 3 - 5 folds. Free part of flagellum was present at the anterior tip.



FIGURES. 1 - 3. Camera lucida drawings of Trypanosoma armeti Mandal (1975), showing trypomastigote forms.

Dimensions

Morphometric measurements (in micrometers, μm) of twenty trypomastigote forms of Trypanosoma arneti Mandal, 1975 were given in table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	32 - 40	35
Length of cell body.	24 - 31	27.2
Width of cell body.	1.8 - 2.3	2
Posterior end to posterior kinetoplast.	.01 - .2	.1
Anterior kinetoplast to posterior nucleus.	9.5 - 10.8	10.5
Anterior nucleus to anterior end.	13 - 14.6	13.8
Length of free flagellum.	6.5 - 8.8	7.3
Length of nucleus.	1.4 - 2	1.6
Width of nucleus.	.9 - 1.1	1
Length of kinetoplast.	.7 - 1.1	.8
Width of kinetoplast.	.3 - .5	.4
Nuclear index (posterior end to centre of nucleus / centre of nucleus to anterior end).	.79 - .84	.82
Kinetoplasmic index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.03 - 1.06	1.04

Discussion

Mandal (1975) recorded the occurrence of two species of Trypanosoma viz., Trypanosoma arneti and Trypanosoma pancali from Mastocembelus armatus and Mastocembelus pancalus collected at Champahati, 24-Parganas, West Bengal, India.

Tandon & Chandra (1977) and Joshi (1979) reported Trypanosoma sp. in Mastocembelus armatus collected from Lucknow, Uttar Pradesh. These authors did not give any adequate description of the parasite.

The parasite is reported from Mastocembelus armatus and is identified as Trypanosoma arneti Mandal (1975) on the basis of the following characters.

Parasite is long, slender with blunt extremities. Cytoplasm is granular and contained vacuoles. Nucleus is ovoid and does not cover the whole width of the body. Kinetoplast is terminal or sub-terminal.

The only difference is that the stumpy forms were not found in the present study. Differences in dimensions which almost overlap each other and in host locality noted in the following table 2 may be minor in nature and can not be considered as separate species. Therefore, the parasite under report is identified as Trypanosoma arneti Mandal (1975) (measurements in micrometers, μm).

TABLE 2

	<u>Trypanosoma arneti</u> Mandal (1975)	Present parasite
	Stumpy	Slender
Total length including free flagellum.	48 - 50	53 - 57
		32 - 40

Length of the cell body.	38 - 40	42 - 45	24-31
Width of the cell body.	4 - 5.5	3 - 4.5	1.8 - 2.3
Length of free flagellum.	10 - 11	11 - 12	6.5 - 8.8
Length of nucleus.	4 - 5	5 - 5.5	1.4 - 2
Width of nucleus.	3 - 3.5	2 - 2.5	.9 - 1.1
Length of kinetoplast.	1 - 1.5	.79 - 1	.7 - 1.1

Diagnosis:

Family Trypanosomatidae Doflein, 1901;
emend Grobben, 1905.

Single nucleus and a kinetoplast;
flagellum arising from base of
kinetoplast.

Genus Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus;
flagellum forming outer margin of
undulating membrane extending along
anterior end.

Specific characters

Trypomastigotes measuring $32\mu\text{m} - 40\mu\text{m} \times 1.8\mu\text{m} - 2.3\mu\text{m}$ in total length including free flagellum.

Cytoplasm containing volutin granules, kinetoplast terminal, nucleus sub-central.

The present parasite is referred to as Trypanosoma armeti Mandal, 1975.

Host. Mastocembelus armatus (Lacepède)

Site of infection. Blood plasma.

Locality: Chakdah, Nadia, West Bengal, India.

Trypanosoma in Fishes:

Parasite No.7

Trypanosoma pancali Mandal

(Figs. 1 - 3)

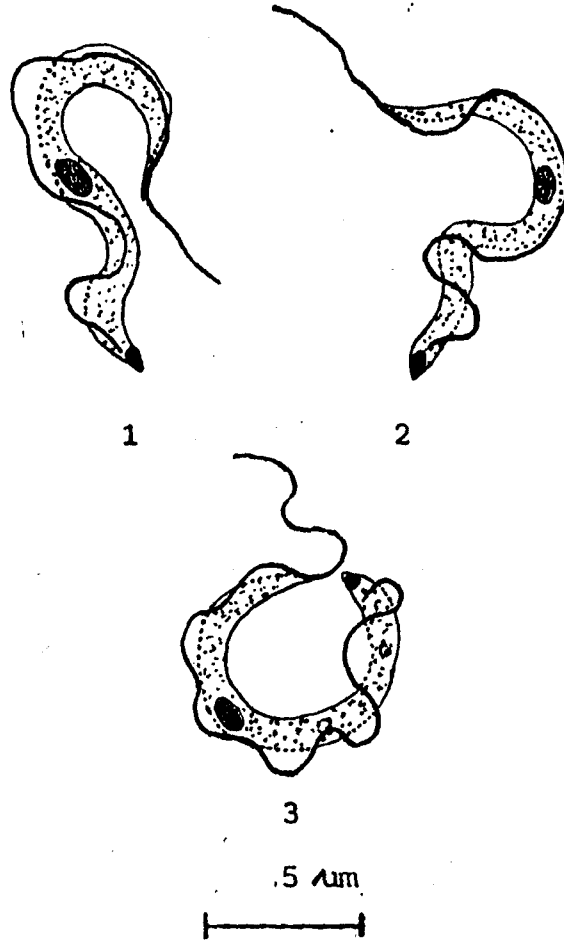
1975. Trypanosoma pancali Mandal, Angew. Parasitol.,
16 : 87.

Occurrence

The parasite was found in peripheral blood smears of Mastocembelus pancalus (Hamilton) collected from Baruipur, 24-Parganas, West Bengal, India.

Morphology

Trypomastigotes were only present in blood plasma and exhibited a single morphological type. These (Figs. 1 - 3) were slender, elongate and attenuated at both ends. Cytoplasm was alveolar, blue in colour and contained volutin granules. Nucleus was oval, sub-central and light pink in colour. A karyosome was not found. Kinetoplast was small, round or conical, terminal and stained deep purple. Flagellum originated near kinetoplast forming an undulating membrane with 3 - 7 folds. Free part of flagellum was present at the anterior tip.



FIGURES. 1 - 3 . Camera lucida drawings of Trypanosoma
pancali Mandal (1975), showing trypomastigote forms.

Dimensions

Morphometric measurements (in micrometers, μm)
of thirty trypomastigote forms of Trypanosoma pancali Mandal, 1975
were given in table 1.

TABLE 1

	Range	Average
Total length including free flagellum.	24.5 - 32.5	27.2
Length of cell body.	19.5 - 25.5	21.7
Width of cell body.	1.2 - 2.3	1.6
Posterior end to posterior kinetoplast.	.01 - .05	.03
Anterior kinetoplast to posterior nucleus.	7.5 - 10.5	8.8
Anterior nucleus to anterior end.	8 - 11.5	9.5
Length of free flagellum.	4.5 - 7.8	5.7
Length of nucleus.	1.2 - 1.6	1
Width of nucleus.	.6 - 1.1	.7
Length of kinetoplast.	.4 - .7	.5
Width of kinetoplast.	.3 - .5	.3
Nuclear index (posterior end to centre of nucleus / centre of nucleus to anterior end).	.97 - 1.1	1
Kinetoplastic index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.04 - 1.08	1.06

Discussion

Parasite under report is placed in the genus Trypanosoma on account of an undulating membrane and a posterior kinetoplast.

Mandal (1975) described a dimorphic (Trypanosoma arneti) and a monomorphic (Trypanosoma pancali) trypanosome from Mastocembelus armatus and Mastocembelus pancalus collected at Champahati, 24-Parganas, West Bengal, India, respectively. The present parasite is also reported from Mastocembelus pancalus and is identified as Trypanosoma pancali Mandal (1975) on the basis of the following characters.

Parasite is slender, elongate and attenuated at both ends. Cytoplasm contains volutin granules. Nucleus is either oval or sausage-shaped and occupies almost the entire width of the body. Kinetoplast is terminal or sub-terminal. undulating membrane forms 3-7 folds.

However, the following differences are also noted which are given in table 2. (measurements in micrometers, μm)

TABLE 2

	<u>Trypanosoma</u> <u>cancili</u> Mandal (1975)	Present parasite
Total length including free flagellum.	35 - 40	24.5 - 32.5
Length of body.	22- 26	19.5 - 25.3
Length of free flagellum.	13 - 14	4.5 - 7.8
Host locality.	Champahati, 24-Parganas.	Baruipur, 24-Parganas.

Above differences are minor in nature and not sufficient for considering the present parasite as new one. Therefore, the parasite under report is identified and described as Trypanosoma pancali Mandal (1975).

Diagnosis

Family Trypanosomatidae Doflein, 1901;
emend Grobben, 1905.

Single nucleus and a kinetoplast;
flagellum arising from base of
kinetoplast.

Genus Trypanosoma Gruby, 1843.

Kinetoplast posterior to nucleus;
flagellum forming outer margin of
undulating membrane extending along
anterior end.

Specific characters

Monomorphic; measuring $24.5 \mu\text{m}$ -
 $32.5 \mu\text{m}$ X $1.2 \mu\text{m}$ - $2.3 \mu\text{m}$ with a free
flagellum ($4.5 \mu\text{m}$ - $7.8 \mu\text{m}$); cytoplasm
alveolar containing volutin granules
and few vacuoles. Nucleus oval,
sub-central, kinetoplast terminal.
The present parasite is referred to
as Trypanosoma pancali Mandal, 1975.

Host. Mastocembelus pancalus (Hamilton)

Site of infection. Blood plasma.

Locality: Baruipur, 24-Parganas, West Bengal, India.

Trypanosoma in Anura

Parasite No.8.

Trypanosoma rotatorium (Mayer)

(FIGS. 1 - 7)

1843. Amoeba rotatoria Mayer, 'Spicilegium observationum anatomicarum de organo electrico in Ralis anelicticis et de Haematozois', Bonnae; Chaussat, 1850, Des hematozoaires (Ph.D. Thesis, Paris).
1885. Trypanosoma ranarum Danilewsky, Biol. Zbl., 5 : 529; 1889, La parasitologie comparee du Sang 1. Nouvelles recherches Sur les parasites du sang des Oiseaux, Kharkoff, Partim.
1885. Trypanosoma ranarum Danilewsky, Ibid.; 1889, Ibid.
1885. Trypanosoma sanguinis Danilewsky, Ibid. ; 1889, Ibid.
1888. Trypanosoma snaguinis ranarum Shalashnikov, Arkh. Vet. Nauk.S. Peterburg., 1 : 65.
1889. Trypanomonodes ranarum Danilewsky, La parasitologie comparee du sang 1. Nouvelles recherches Sur les parasites du sang des Oiseaux, Kharkoff, Partim.
1889. Trypanosoma costatum Danilewsky, Ibid.
1889. Trypanosoma costatum ranarum Danilewsky, Ibid.
1901. Trypanosoma rotatorium Laveran & Mesnil, C.r. Séanc. Soc. Biol. Paris, 53 : 678; Wenyon, 1926, Protozoology Vol.1., 590; Pujati, 1953, Doriana, 1 : 1 ; Ray, 1979a, Proc. 2nd Natl. Cong. Parasitol., p.13; 1979b, 'Studies on the Haemato-

- zoa of Indian Amphibians, Ph.D. Thesis, Cal. Univ.,; 1980, Indian J. Parasitology, 3 (suppl), :87; Ray & Choudhury, 1980, Proc. Sym. Host as an environment, Z.S.I., p.92 ; 1981, Proc. 6th Int. Cong. Protozool., p.308; Sinha, 1981, Proc. 68th. Ind. Sci. Cong., p.30; Ray & Choudhury, 1983, Zool. Surv. India, Tech. Monogr. no. 8. P.1.
1907. Trypanosoma loricatum Dutton, Todd & Tobey, Ann. trop. Med. Parasit., 1 : 287, Partim.
1908. Trypanosoma sp. Patton, A Rep. King. Inst. Prev. Med. Guindy (1907), 1 : 3; Berestneff, 1903, Arch. Protistenk., 2: 34; Scott, 1926, Proc. Zool. Soc. London, 1 : 231; 1927, Proc. zool. Soc. London, 2 : 173; Wenyon, 1926, Protozoology, Vol. 1, p.588.
1908. Trypanosoma hylae Franca, Archs R. Inst. Bact., 2: 271, Partim.
- 1911b. Trypanosoma borreli Mathis & Leger, C.r. Séanc. Soc. Biol., 70 : 956, Partim.

Occurrence

The parasite was encountered in peripheral blood smears of Bufo melanostictus Schneider a common toad, collected from Manipur, India.

Morphology

Trypomastigote forms of parasite were found in blood plasma. These exhibited four morphological types.

Type. I.

These (Figs. 1 - 2) may be described as thin slender with a long free flagellum. These were thin, narrow, slender and both the extremities were pointed .

Posterior part of cell body stained deep blue and anterior part took light blue. Cytoplasm was homogeneous and less vacuolated. Nucleus was circular and situated towards posterior part of cell body and stained pink in colour.. A karyosome was not observed. Kinetoplast was small, round, deep purple in colour and adhered behind the nucleus. Flagellum rose from the base of kinetoplast and formed well-developed undulating membrane with 4 - 6 folds. Free part of flagellum was long.

Type. II.

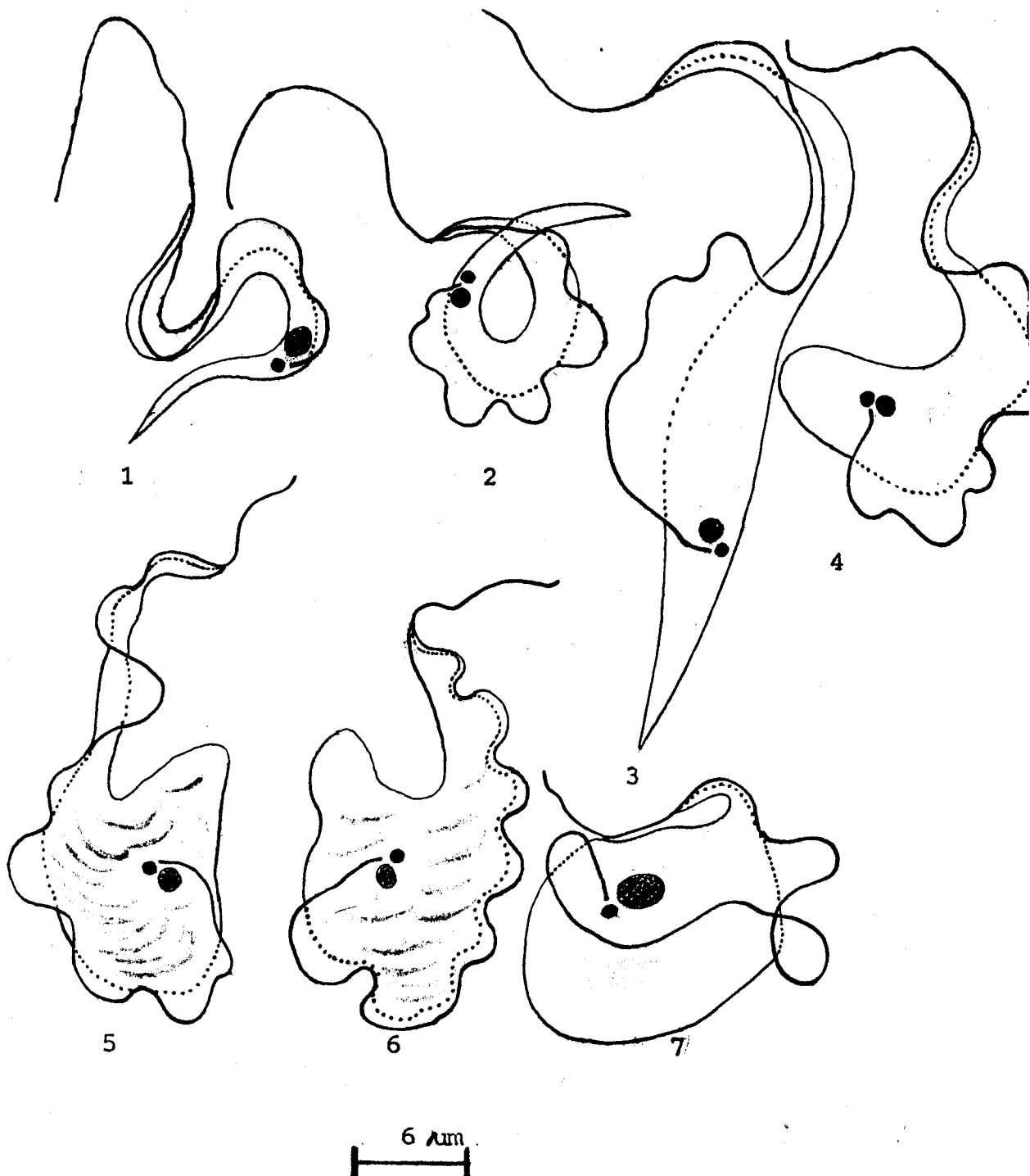
This may be regarded as broad slender form (Fig.3). It was long, broader, slender and both the extremities were pointed. Cytoplasm was homogeneous, basophilic and non-granular. Nucleus was round, light purple in colour and was very close to kinetoplast. A karyosome was not found. Kinetoplast was dot-like deep pink in colour and situated away from posterior part. Flagellum rose from base of kinetoplast and formed an undulating membrane with 5 - 7 folds. Free part of flagellum was present.

Type. III.

These were regarded as leaf-like forms (Figs. 4-6). These were with a broad posterior end and a narrow pointed anterior end. Cytoplasm was basophilic and in some individuals (Figs. 5 - 6) several pellicular striations of myonemes were present. Nucleus was round, light purple in colour and adhered to kinetoplast. A karyosome was not present. Kinetoplast was dot-like, deep purple in colour and situated away from posterior part of cell body. Flagellum emerged from base of kinetoplast and formed undulating membrane with 7 - 8 folds. Free part of flagellum was present.

Type. IV.

This was described as round form (Fig. 7). It was round or oval in shape. Cytoplasm was homogeneous, non-granular, non-vacuolated and stained light blue in colour. Nucleus was oval, sub-central and light pink in colour. A karyosome was not found. Kinetoplast was small, conical, deep purple and lying away from posterior tip. Flagellum rose from base of kinetoplast forming irregular undulating membrane with one or two folds. Free part of flagellum was present.



FIGURES. 1 - 7. Camera lucida drawings of Trypanosoma rotatorium (Mayer, 1843).

Figs. 1 - 2. Thin slender trypomastigote forms.

Fig. 3. Broad slender trypomastigote form.

Figs. 4 - 6. Leaf-like trypomastigote forms.

Figs. 5 - 6. showing myonemes.

Fig. 7. Round form of trypomastigote form.

Measurements (in micrometers, μm) of Trypanosoma rotatorium (Mayer, 1843).

Type. I. Thin slender forms.

	Range.	Average.
Total length of body including free flagellum.	45 - 58	51.8
Length of cell body.	23 - 36	34
Width of cell body.	2.5- 5	4
Length from posterior extremity to posterior border of kinetoplast.	5 - 9.8	7.7
Length from anterior border of kinetoplast to posterior nucleus.	.1 - .4	.2
Length from anterior border of nucleus to anterior extremity.	16 - 25	20.7
Length of free flagellum.	16.8 - 22.8	20
Length of nucleus.	1 - 1.6	1.2
Width of nucleus.	.8 - 1.4	.9
Length of kinetoplast.	.4 - .9	.6
Width of kinetoplast.	.4 - .8	.5
Nuclear Index (posterior end to centre of nucleus/centre of nucleus to anterior extremity).	.31 - .43	.41
Kinetoplastic Index (posterior end to centre of nucleus /centre of kinetoplast to centre of nucleus)	7.5 - 8.3	7.6

Measurements (in micrometers, μm) of Trypanosoma rotatorium
(Mayer, 1843)

Type. II. Broad slender form.

Total length of body including free flagellum.	62.4
Length of cell body.	49.2
Width of cell body.	6.6
Posterior extremity to posterior kinetoplast.	11.4
Anterior kinetoplast to posterior nucleus.	.2
Anterior nucleus to anterior extremity.	36
Length of free flagellum.	12.2
Length of nucleus.	1.2
Width of nucleus.	1.2
Length of kinetoplast.	.4
Width of kinetoplast.	.4
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity.).	.34
Kinetoplastic Index (posterior end to centre of nucleus ; / centre of kinetoplast to centre of nucleus.	12.8

Measurements (in micrometers, μm) of Trypanosoma rotatorium
(Mayer, 1843).

Type. III. Leaf-like forms.

	Range.	Average.
Total length of body including free flagellum.	45 - 49.5	47
Length of cell body.	37 - 40	38
Width of cell body.	14 - 17	15.5
Posterior extremity to posterior kinetoplast.	6.8-7.8	6.9
Anterior kinetoplast to posterior nucleus.	1.2 - 1.6	1.3
Anterior nucleus to anterior extremity.	29 - 33	31
Length of free flagellum.	7 - 9.5	8
Length of nucleus.	.9 - 1.4	1.1
Width of nucleus.	.8 - 1.3	1
Length of kinetoplast.	.2 - .4	.3
Width of kinetoplast.	.1 - .3	.2
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity).	.27 - .31	.28
Kinetoplasmic Index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	4.2 - 5.05	4.5

Measurements (in micrometers, μm) of Trypanosoma rotatorium
(Mayer, 1843).

Type. IV. Round form.

Total length of body including free flagellum.	32.4
Length of cell body.	22.8
Width of cell body.	15.6
Posterior extremity to posterior kinetoplast.	6
Anterior kinetoplast to posterior nucleus.	.36
Anterior nucleus to anterior extremity.	11.6
Length of free flagellum.	9.6
Length of nucleus.	2.5
Width of nucleus.	1.6
Length of kinetoplast.	.4
Width of kinetoplast.	.2
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity).	.62
Kinetoplasmic Index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	4.4

Discussion

The present parasite is placed under genus Trypanosoma on account of undulating membrane and a posterior kinetoplast. Parasite has been described as Trypanosoma rotatorium (Mayer, 1843) because of the following characters.

Parasite is polymorphic, showing four morphological types viz., thin slender, broad slender, leaf-like and round forms. Poor stainability of nucleus is a most characteristic feature of Trypanosoma rotatorium is also noticed which was reported earlier by many workers (Dutton, et al., 1907; Balfour, 1908; Stevenson, 1911; Macfie, 1914; Mohammed & Mansour, 1959).

Morphological variation due to polymorphism in rotatorium from different species of anuran hosts is also pointed out by Fantham, et al., 1942 and Mohammed & Mansour, 1959.

Therefore, the parasite under report is identified as Trypanosoma rotatorium (Mayer, 1843).

Diagnosis

Family. Trypanosomatidae Doflein, 1901; emend Grobben, 1905.

Single nucleus and a kinetoplast; flagellum arising from base of kinetoplast.

Genus. Trypanosoma Gruby, 1843.

Polymorphic; kinetoplast posterior to nucleus; flagellum forming undulating membrane.

Specific characters.

Trypomastigotes exhibiting four morphological types. Type. I. Thin slender forms measuring $45 \mu\text{m} - 58 \mu\text{m} \times 2.5 \mu\text{m} - 5 \mu\text{m}$.

Type. II. Broad slender form measuring $62.4 \mu\text{m} \times 6.6 \mu\text{m}$

Type. III. Leaf-like forms measuring $45 \mu\text{m} - 49.5 \mu\text{m} \times 14 \mu\text{m} - 17 \mu\text{m}$.

Type. IV. Round form measuring $32.4 \mu\text{m} \times 15.6 \mu\text{m}$.

In all trypomastigote forms nucleus stains poorly.

The present parasite is referred to as Trypanosoma rotatorium (Mayer, 1843)

Host. Bufo melanostictus Schneider

Site of infection. Peripheral blood.

Locality : Manipur, India.

Trypanosoma in Chelonia

Parasite No.9.

Trypanosoma vittatae Robertson

(FIGS. 1 - 8)

1908. Trypanosoma vittatae Robertson, Spolia. Zeylan., 5 :
178 ; 1909, Q.J.microsc.Sci., 53 :665.

Occurrence

The parasite was found in peripheral blood smears of Lissemys punctatus (Bonnaterre) a mud-turtle, collected from Bongaon, 24-Parganas, West Bengal, India.

Morphology

In blood plasma, trypomastigotes exhibited three morphological types.

Type. I.

These may be regarded as thin slender forms (Figs. 1 - 3). These were slender, elongate and curved. Anterior tip was pointed while posterior tip was either pointed or blunt. Cytoplasm was basophilic and contained a few vacuoles. Nucleus was sub-central, oval or circular, light pink in colour and lying towards posterior part of body. A karyosome was sometimes present (Fig.2). Kinetoplast was small, dot-like, deep purple and located terminally or sub-terminally. Flagellum rose from base of kinetoplast and formed an undulating membrane with 3 -5 folds. Free part of flagellum was present at the anterior

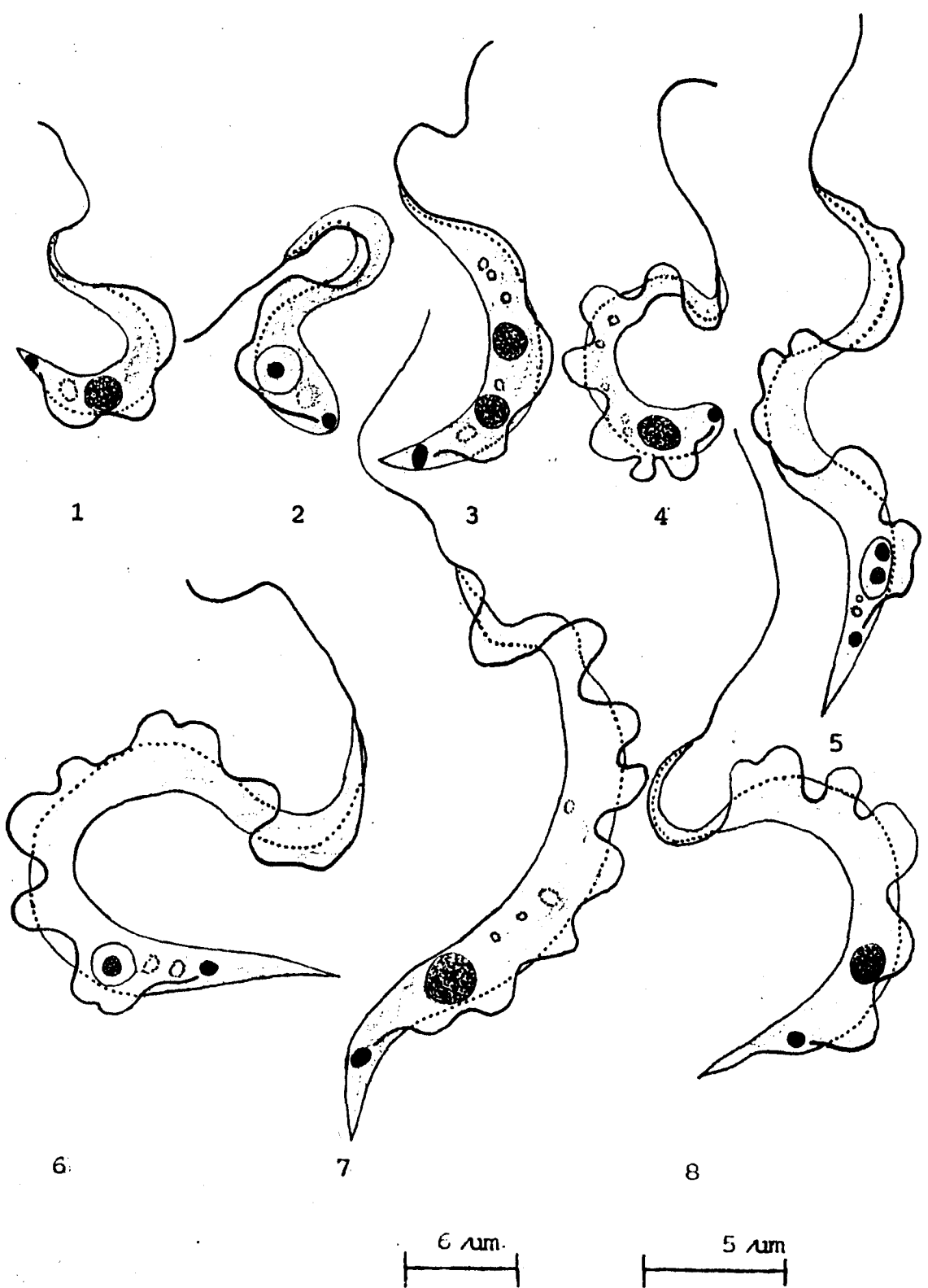
tip. In one case, a trypomastigote (Fig.3) was found to contain two nuclei and a single kinetoplast.

Type. II.

These were described as intermediate forms (Figs. 4 - 5). These were larger than the thin forms having a slender elongate body. Both the extremities were pointed. Cytoplasm was homogeneous, basophilic and contained a few vacuoles. Nucleus was oval and light purple in colour and lay posteriorly. Karyosomes were sometimes present (Fig.5). Kinetoplast was small, dot-like, sub-terminal and deep purple in colour. Flagellum emerged from near the kinetoplast forming an undulating membrane with 6 - 10 folds. Free part of flagellum was present at the anterior tip.

Type. III.

These should be regarded as broad slender form (Figs.6-8). These were large, slender, elongate and with pointed extremities. Cytoplasm was homogeneous, basophilic, and contained a few vacuoles. Nucleus was sub-spherical, sub-central, light purple in colour and lay posterior part of cell body. A karyosome was sometimes present (Fig.5). Kinetoplast was small, ~~dot-like~~ dot-like, sub-terminal and deep purple in colour. Flagellum emerged from base of kinetoplast and formed undulating membrane with 6 -10 folds. Free flagellum was also present at the anterior tip.



FIGURES. 1 - 8. Camera lucida drawings of Trypanosoma vittatae Robertson (1908).

Figs. 1 - 3. Thin slender trypomastigote forms.

Fig. 3. Slender trypomastigote showing two nuclei.

Figs. 4 - 5. Intermediate forms of trypomastigotes.

Figs. 6 - 8. Broad slender trypomastigote forms.

Measurements (in micrometers, μm) of Trypanosoma vittatae
Robertson, 1908.

Type. I, Thin slender forms.

	Range.	Average.
Total length of body including free flagellum.	23.9 - 30.6	27.4
Length of cell body.	17.4 - 23	19
Width of cell body.	1.4 - 6.2	3.1
Posterior extremity to posterior kinetoplast.	.05 - .8	.4
Anterior kinetoplast to posterior nucleus.	1.4 - 2.5	2.1
Anterior nucleus to anterior extremity.	11.5 - 20	14.5
Length of free flagellum.	6 - 12.6	8.4
Length of nucleus.	1.6 - 3	2.2
Width of nucleus.	1.2 - 2.1	1.6
Length of kinetoplast.	.4 - 1.1	.7
Width of kinetoplast.	.2 - .5	.3
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity).	.21 - .28	.27
Kinetoplasmic Index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.08 - 1.2	1.1

Movement of Parasite

In citrate solution, parasites showed
wriggling movement.

Measurements (in micrometers, μm) of Trypanosoma vittatae
Robertson, 1908.

Type. II. Intermediate forms.

	Range.	Average.
Total length of body including free flagellum.	35 - 42	38.9
Length of cell body.	23 - 33	28.1
Width of cell body.	2.4 - 3.5	2.6
Posterior extremity to posterior kinetoplast.	.01-3.4	1.8
Anterior kinetoplast to posterior nucleus.	1.2 - 2.4	1.4
Anterior nucleus to anterior extremity.	18 - 23.5	21
Length of free flagellum.	8 - 12	10.4
Length of nucleus.	1.4 - 2.9	1.6
Width of nucleus.	1.4 - 2	1.5
Length of kinetoplast.	.4 - .7	.5
Width of kinetoplast.	.3 - .5	.4
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity.	.12 - .32	.2
Kinetoplastic Index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus).	1.09 - 1.9	1.7

Movement of parasite

In citrate solution, parasites showed
wriggling movement.

Measurements (in micrometers, μm) of Trypanosoma vittatae
Robertson, 1908.

Type. III. Broad slender forms.

	Range.	Average.
Total length of body including free flagellum.	54 - 70.8	60.3
Length of cell body.	37 - 44.5	41.1
Width of cell body.	2.2 - 6	3.3
Posterior extremity to posterior kinetoplast.	3.8 - 6.6	5.2
Anterior kinetoplast to posterior nucleus.	2.6 - 4.8	4
Anterior nucleus to anterior extremity.	24.9 - 31.5	27.8
Length of free flagellum.	12.4 - 23.4	18
Length of nucleus.	1.1 - 3.5	2.4
Width of nucleus.	1 - 2.1	1.7
Length of kinetoplast.	.7 - 1.3	1
Width of kinetoplast.	.2 - .5	.3
Nuclear Index (posterior end to centre of nucleus / centre of nucleus to anterior extremity).	.29 - .43	.39
Kinetoplasmic Index (posterior end to centre of nucleus / centre of kinetoplast to centre of nucleus.).	2.01 - 2.2	2

Movement of parasite

In citrate solution, parasites showed
wriggling movement.

Discussion

Parasite under discussion belongs to genus Trypanosoma on account of an undulating membrane and a posterior kinetoplast and has been identified as Trypanosoma vittatae Robertson, 1908 on the basis of the following characters.

Parasite is polymorphic, showing three distinct morphological types viz., small, intermediate and large forms. These also come close to the measurements as described by Robertson. However, the following differences are also noted with the present parasite.

For example, myonemes of large forms are not present and divisional stages are only encountered in small forms as in the present case.

Differences noted above are minor in nature and not sufficient for considering the present parasite as new one. Hence, parasite under report is identified as Trypanosoma vittatae.

This is the first record of Trypanosoma vittatae from a host other than Emyda vittata.

Diagnosis

Family. Trypanosomatidae Doflein, 1901; emend Grobben, 1905.

Single nucleus and a kinetoplast;
flagellum arising from base of kinetoplast.

Genus Trypanosoma Gruby, 1843.

Polymorphic ; kinetoplast posterior to nucleus; flagellum forming undulating membrane.

Specific Characters.

Trypomastigotes exhibiting three morphological types. Type. I. Thin slender forms measuring $23.9 \mu\text{m} - 30.6 \mu\text{m} \times 1.4 \mu\text{m} - 6.2 \mu\text{m}$ including free flagellum.

Type. II. Intermediate forms measuring $35 \mu\text{m} - 42 \mu\text{m} \times 2.4 \mu\text{m} - 3.5 \mu\text{m}$ including free flagellum.

Type. III. Broad slender forms measuring $54 \mu\text{m} - 70.8 \mu\text{m} \times 2.2 \mu\text{m} - 6 \mu\text{m}$ including free flagellum.

The present parasite is referred to as Trypanosoma vittatae Robertson, 1908.

Host. Lissemys punctatus (Bonnaterre)

Site of infection. Peripheral blood plasma.

Locality : Bongaon, 24-Parganas, West Bengal, India.

APPENDIX(6 - i)

C. K. SINHA and A. K. MANDAL

Trypanosoma enhydris sp. n. from a Fresh Water Snake
Enhydris enhydris (Schneider)

Synopsis. The description of a new species of Trypanosome, *Trypanosoma enhydris* sp. n. (*Trypanosomatidae*) from a fresh water snake, *Enhydris enhydris* collected from West Bengal, India is incorporated in the paper. Its affinities with the known species of the genus and differences to consider it as new species are also incorporated.

This is the first instalment of the series deals with the haemoflagellates of some Indian reptiles. It includes the description of a new species of trypanosome from a fresh water snake *Enhydris enhydris* (Schneider). The snakes were captured from Chakdah, Nadia, West Bengal, India during the month of March to June 1975, and brought to the laboratory for examination. Out of the 50 snakes examined 30 were found positive for trypanosome. Blood films were obtained by clipping the tail and stained with Giemsa's, Leishman's stain and Wright stain. Tissues fixed in Bouins Duboscq Brasil's fluid for studying endogenous stage. No tissue phase is seen in the preparation. However, observation to note down the tissue phase, intermediate vector along with some cross transmission experiments are being carried out in the laboratory. The results of which will be published in due course. Drawings were made with the help of a camera lucida with the uniform magnification 1600 X. Measurements were made from camera lucida drawing along a line drawn from the anterior to the posterior end through the middle of the parasite. Estimated parasitemia 2-5 trypanosomes per cubic mm of blood films. The slides will be deposited to the National collection of the Zoological Survey of India.

Description

Trypanosoma enhydris sp. n.

Holotype: Z. S. I. Registration No 1835

Type Host: *Enhydris enhydris* (Schneider)

Type Locality: Chakdah, Nadia, West Bengal, India.

The trypanosoma is polymorphic. Three distinct forms viz. small with free flagellum of considerable length, intermediate with a long free flagellum and a large form with a short flagellum are seen in the peripheral blood. Some undergoing division along with the epimastigote forms have also been encountered.

In the citrate solution, they were found sluggish and sometimes form a knot. Measurements of the organism are given in Table 1.

Table 1
Measurements of *Trypanosoma enhydris* sp. n. (in microns)

Form	Small	Intermediate	Large
Length from posterior end to the kinetoplast	8.5 (7.5-9)*	16 (15.5-17.5)	39 (38-49)
Length from kinetoplast to the nucleus	2.15 (2-3.5)	2.5 (2-3)	1.5 (1-2)
Length of the nucleus	1.75 (1.50-2.50)	2 (2-2.5)	6 (5-7)
Length from nucleus to anterior end of body	15 (14-16.5)	18.5 (17-19.5)	60 (55-62)
Length of the free flagellum	13 (12-14)	15 (14.5-17.5)	10 (9-11)
Length of the kinetoplast	0.86 (0.5-1)	0.85 (55-1.5)	1.5 (1-2)
Width of the kinetoplast	0.45 (0.40-0.86)	0.65 (55-0.86)	0.40 (0.40-0.42)
Width of cell body	2 (1.5-2.4)	5 (4-5.5)	27 (24-30)

* Mean and range (in parantheses).

Small form

Slender, elongated and sharply pointed at both ends (Fig. 1). Their number varies from 5 to 1" in the films. Cytoplasm homogenous with scattered small vacuoles. It is deeply stained with Giemsa and more towards the border opposite to undulating membrane. Cytoplasm towards periphery stains faintly and become almost without any stain at the posterior extremity. No myonemes or granular arrangements are found on the cytoplasm.

Nucleus exhibits a round or oval shape situated almost at the middle. The chromatin granules are arranged towards the distinct nuclear membrane sometimes leaving a decided gap at the centre.

Kinetoplast almost subspherical situated slightly posterior to the nucleus and appeared as a black dot with a halo around, hardly conical form with deep stain is noticed in the preparation.

Flagellum originates from the base of the kinetoplast, trails anteriorly bordering the undulating membrane and extends beyond the body as free flagellum.

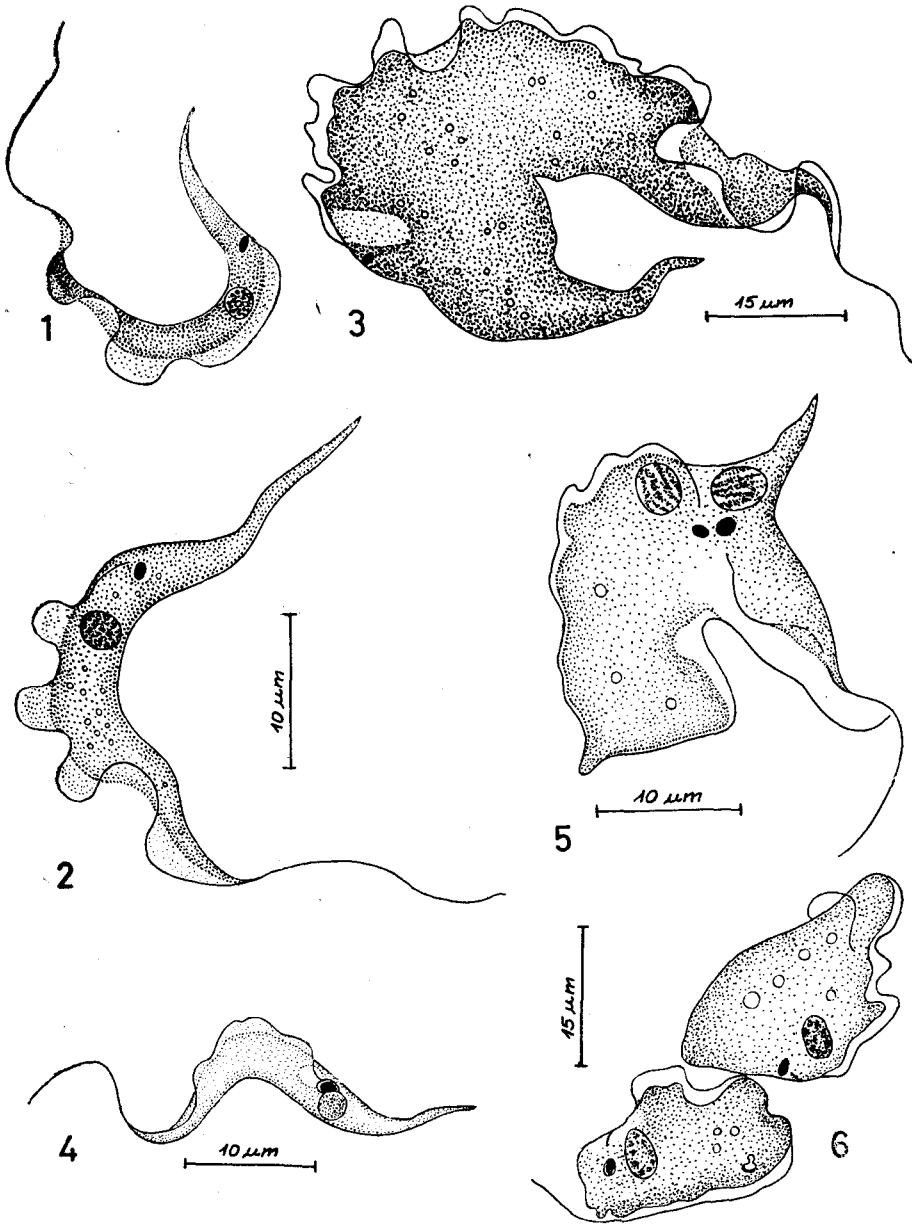


Fig. 1-6. *Trypanosoma enhydris* sp. n. 1 — Small form, 2 — Intermediate form, 3 — Large form of *T. enhydris* in peripheral blood, 4 — Epimastigote form of *T. enhydris* in the peripheral blood, 5 — Trypanosome (divisional stage) with two nuclei and two kinetoplast, 6 — Two daughter individual after division. (Figs. 1, 2, 4, 5 are in one, and Figs 3, 6 in other magnification)

The undulating membrane is conspicuous with three or four folds and stains light red with Giemsa. The body margin bordering the undulating membrane is evenly curved and does not follow the undulations of the membrane.

Intermediate form

This form (Fig. 2) resembles the small one morphologically but varies in size (Table 1) and the number of folds in the undulating membrane. The folds touch the body five or six times. They are in great abundance in the peripheral blood approximately 15–20 in each film.

Large form

They are few in number sometimes about 3 to 5 in one film; heavily stained body with a narrow undulating membrane and a short free flagellum (Fig. 3).

Cytoplasm coarse, vacuolated and takes a deep stain. Nucleus oval, stains very light with faintly granular chromatin materials.

Kinetoplast adheres to the nucleus and stains deeply. The folds of the undulating membrane waved 12 to 14 times bordered by the thick flagellum with a short free portion at the anterior end.

In addition to these, some epimastigote forms (Fig. 4) are also encountered in the peripheral blood where a dark blue kinetoplast is located at the anterior end very close to the nucleus. This form measures about 23 μm to 27 μm (mean 25 μm) by 3.5 μm to 4.5 μm (mean 4 μm) with a free flagellum 9 μ to 10 μ in length. Moreover, some divisional stages with two kinetoplasts and two nuclei almost divided with their cytoplasm (Fig. 5) have been found in the peripheral blood along with some daughter trypanosomes (Fig. 6).

Diagnosis of *Trypanosoma enhydris* sp. n.

The described haemoflagellate is polymorphic; small, intermediate and large; measuring 40 μm by 2 μm , 54 μm by 5 μm , and 116 μm by 27 μm respectively in total length including the free flagellum.

Cytoplasm homogeneous with few vacuoles and without any volutin granules. Kinetoplast always away from posterior end, nucleus sub-central and situated at the middle of the cytoplasm; undulating membrane distinct, prominently bordered by the thick flagellum with considerable free end. The body cytoplasm does not participate in forming the folds of undulations.

Discussion

Walliker (1965) reviewed the reptilian trypanosomes and listed fifteen snake trypanosomes of which three were reported as *Trypanosoma* sp.

The species under report resembles *Trypanosoma primetti* Mathis et Legger, 1909 (Host: *Torpidonotus* = *Natrix piscator*) due to body configuration and shape, but the former is polymorphic and the latter is dimorphic.

Moreover, the total length of the polymorphic forms including the free flagellum, measure about 40 μm by 2 μm , 54 μm by 5 μm , and 116 μm by 27 μm , of the species encountered; whereas in *Trypanosoma primetti* the dimorphic forms measure 57 μm by 7 μm and 105 μm by 14 μm .

Another species of trypanosome from *Natrix piscator* was reported in Pakistani Science congress by Haq and Mohiuddin (1956), without giving any detail account. So the specimen dealt herewith could not be possible to compare with that species. However, efforts were made to inoculate the present trypanosome to *Natrix piscator* in the laboratory but were unsuccessful. Simultaneously the present trypanosome was inoculated to infection free *Enhydris enhydris*, the natural host and found to be positive after 3 to 5 days.

These experiments led us to conclude that the present trypanosome is quite different from those of the species occurring in *Natrix piscator*. In addition, the present species does not approaches any other known trypanosomes hence it is described as new and designated as *Trypanosoma enhydris* sp. n. The specific name of the parasite was given after the specific name of the host.

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RÉSUMÉ

L'article s'agit de la description d'une nouvelle espèce, *Trypanosoma enhydris* (*Trypanosomatidae*), recueillie d'un serpent, *Enhydris enhydris* (Schneider), qui vit dans l'eau douce du Bengale occidental de l'Inde. Son affinité avec les espèces connues du genre et ses caractères très distingués sont aussi mentionnés.

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APPENDIX(6 - ii)

C. K. SINHA

Trypanosoma gangetica sp. n. from a Fresh Water Turtle *Trionyx gangeticus* Cuvier

Synopsis. The paper deals with a new species of monomorphic Trypanosome, *Trypanosoma gangetica* sp. n. (*Trypanosomatidae*) from a soft leathery turtle *Trionyx gangeticus* Cuvier collected from West Bengal, India. The morphology of the haemoflagellate has been described and it is compared with other known chelonian trypanosomes to consider it as new species.

Trypanosomes have been reported from the peripheral blood of different species of chelonians. Laveran and Mesnil (1902) described *Trypanosoma damoniae* from the tortoise *Damonia reevesii*. Dutton and Todd (1903) and Dutton et al. (1907) noted the presence of trypanosomes in different tortoises of Gambia. Bouet (1909) reported *Trypanosoma pontyi* from a tortoise *Sternotherus derbianus* of Africa. *Trypanosoma chelodina* was recorded from *Chelodina longicollis* by Johnson (1907) from Australia. Walliker (1965) reviewed the occurrence of reptilian trypanosomes and enlisted twelve chelonian trypanosome of which two were reported as *Trypanosoma* sp. In India, studies on chelonian trypanosomes have not so far been recorded.

The turtles *Trionyx gangeticus* Cuvier, were collected from local markets of Bongaon, West Bengal, India in March 1975 with a view to study haematozoa. Fifteen turtles were examined and five were positive for a haemoflagellate of the genus *Trypanosoma* in the circulating blood. No ecto-parasitic infestation was noticed. Thin blood films were drawn and stained with Giemsa and Leishman stain. Drawings and measurements were made with the aid of camera lucida, along a line drawn from posterior to anterior end of the flagellate at the uniform magnification of 1500 X.

Results

Trypanosoma gangetica sp. n.Type Host: *Trionyx gangeticus* Cuvier

Type Locality: Bongaon, 24 Parganas, West Bengal, India.

Trypanosoma gangetica sp. n. showed monomorphic form and were abundant in the blood film. All the forms were long and slender. This form (Fig. 1 1-4) of flagellate is elongated with sharply pointed ends, Cytoplasm is homogenous and stains light pink with Giemsa. It contains 7-10 vacuoles. Nucleus is round or oval in shape. It always lies at the middle of the body with a distinct nuclear membrane. Kinetoplast is a spherical dot like structure situated away from the posterior part of the nucleus and takes deep stain with Giemsa and Leishman. Flagellum is found to emerge from the kinetoplast and has 6 to 8 attachments with the undulating membrane proper and leaves it as a distinct free flagellum. A well stretched form exhibits the maximum width of the

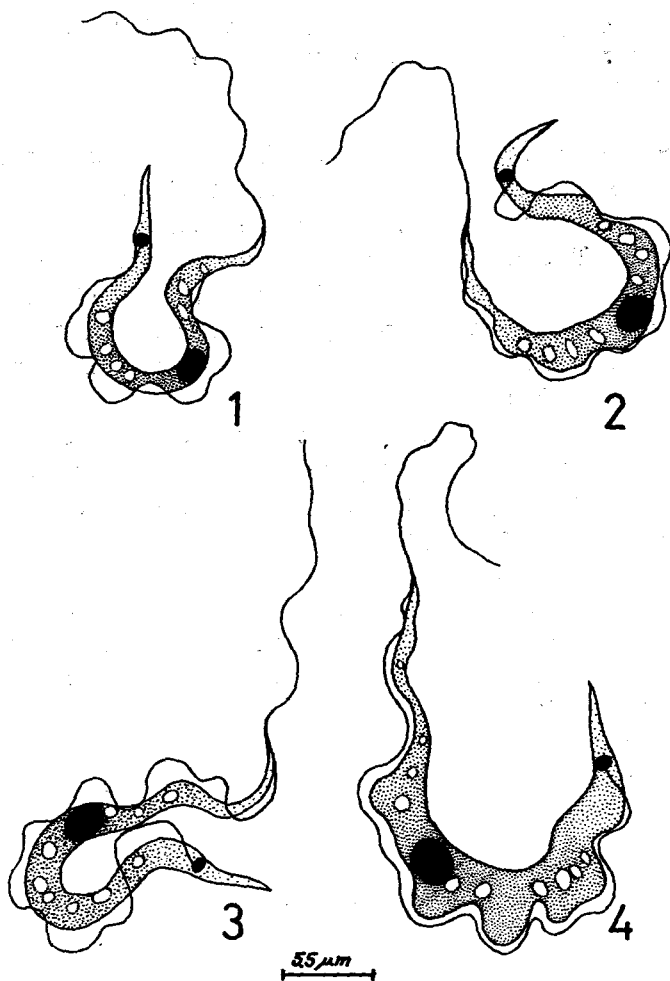


Fig. 1. 1-4. *Trypanosoma gangetica* sp. n. Camera lucida drawings. 1-3—Long slender form, note the distinct free flagellum and the vacuoles. 4—Well stretched condition of the long slender form

Table 1

Measurements of *Trypanosoma gangetica* sp. n. (in μm)

Characters	Range	Mean
Total length of the parasite (including free flagellum)	53.4–58.0	55.7
Length of the cell body	33.7–36.7	34.7
Breadth of the cell body	1.8–4.8	2.45
Length of the free flagellum	19.2–21.9	20.9
Length of the nucleus	2.2–2.4	2.3
Breadth of the nucleus	1.3–1.8	1.5
Length of the kinetoplast	0.6–0.9	0.8
Breadth of the kinetoplast	0.7–1.0	0.8
Post-kinetoplast distance	4.1–4.6	4.38
Anterior edge of kinetoplast to posterior edge of nucleus	12.1–14.50	13.55
Anterior edge of nucleus to anterior end of cell body	12.8–14.80	13.7

cell body (Fig. 1-4). No divisional phase has been observed so far (Table 1).

Diagnosis of *Trypanosoma gangetica* sp. n.

The described haemoflagellate is monomorphic measuring 55.7 μm by 2.45 μm in total length including the free flagellum. Cytoplasm is homogenous having 7–10 vacuoles and without any volutin granules. Kinetoplast is always away from the posterior part of the nucleus. Nucleus is always centrally situated in the cell body. A prominent undulating membrane with 7–8 folds. The body cytoplasm does not enter inside the fold of it. A long free flagellum measuring 19.2 μm is also the characteristic feature of this parasite.

Discussion

Trypanosomes appeared to be non-pathogenic to their host. The peculiarity of the present species of trypanosome described in the paper is that it has a long free flagellum measuring 19.2–21.9 μm and mean length being 20.9 μm . Generally vertebrate trypanosomes reveal more than one morphological feature in the peripheral blood. Robertson (1908, 1909) discovered *Trypanosoma vittatae* in the soft tortoise *Emyda vittata* which was polymorphic. The parasite under report lacks this feature.

Trypanosoma vittatus was also recorded by Robertson (Klinke & Etken, 1965) from a tortoise *Lissemys punctata granosa* from Ceylon. The parasite

was 70 μm long and is different from the present form. The species under report draws a close affinity with *Trypanosoma chrysemidis* Roudabush and Coatney (1937) from *Chrysemys belli marginata* but it differs in many respects. *T. chrysemidis* measures 46.8–50.0 μm by 3.15–4.05 μm . Moreover, it has got a short free flagellum measuring 13.05 μm . However, this flagellate differs from all other known chelonian trypanosomes. Considering all these aspects the trypanosome from *Trionyx gangeticus* Cuvier, has been assigned a new species status and named *Trypanosoma gangetica* sp. n. This turtle is recorded for the first time as a host for trypanosome. The holotype and paratypes of *Trypanosoma gangetica* sp. n. will be deposited in the national zoological collection of Zoological Survey of India, Calcutta in due course.

ACKNOWLEDGEMENTS

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ZUSAMMENFASSUNG

Trypanosoma gangetica sp. n. wird von einer Süßwasser Schildkröte *Trionyx gangeticus* Cuvier beschrieben. Die Morphologie des Parasiten und seine Beziehungen zu anderen bekannten Arten wird diskutiert.

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CHECK-LIST OF Trypanosoma FOUND IN SOME LOWER
VERTEBRATES IN INDIA.

(* indicates new species described in the thesis)

(** indicates known species reported here)

Family. Trypanosomatidae Doflein, 1901; emend
Grobben, 1905.

Genus. Trypanosoma Gruby, 1843.

Trypanosoma in Fresh water fishes.

1. Trypanosoma sp. Lingard, 1904

In the blood of Channa striatus,

collected from Jamuna river,

Uttar Pradesh and also from

Pune, Maharashtra.

Qadri, 1951.

In the blood of same host fish,

collected from Hyderabad, Andhra

Pradesh.

2. Trypanosoma sp. Lingard, 1904.

In the blood of Puntius

carnaticus, collected from Pune,

Maharashtra.

3. Trypanosoma sp. Lingard, 1904.

In the blood of Ryncobdella aculeata ,
collected from Pune, Maharashtra.

4. Trypanosoma sp. Lingard, 1904.

In the blood of Trichogaster fasciatus ,
collected from Jamuna river, Uttar Pradesh.

5. Trypanosoma sp. Lingard, 1904.

In the blood of Mystus seenghala ,
collected from Jamuna river, Uttar Pradesh.
Tandon & Joshi, 1974; Tandon & Chandra, 1977;
Joshi, 1979. In the blood of the same
host fish , collected from Lucknow, Uttar
Pradesh.

6. Trypanosoma sp. Lingard, 1904.

In the blood of Mystus tengara ,
collected from Jamuna river, Uttar Pradesh.

7. Trypanosoma sp. Tandon & Joshi, 1974 ; Joshi, 1979.

In the blood of Channa punctatus ,
collected from Lucknow, Uttar Pradesh.

8. Trypanosoma sp. Tandon & Chandra, 1977; Joshi, 1979.

In the blood of Mastocembelus ,
armatus , collected from Lucknow, Uttar
Pradesh.

9. Trypanosoma sp. Tandon & Joshi, 1974; Tandon & Chandra, 1977; Joshi, 1979.
In the blood of Clarias batrachus,
collected from Lucknow, Uttar Pradesh.
10. Trypanosoma sp. Tandon & Chandra, 1977; Joshi, 1979.
In the blood of Cirrhina mrigala ,
collected from Lucknow, Uttar Pradesh.
11. Trypanosoma sp. Tandon & Chandra, 1977 ; Joshi, 1979.
In the blood of Wallago attu, collected
from Lucknow, Uttar Pradesh.
12. Trypanosoma sp. Joshi, 1979.
In the blood of Notopterus notopterus,
collected from Lucknow, Uttar Pradesh.
13. Trypanosoma sp. Joshi, 1979.
In the blood of Puntius stigma, collected
from Lucknow, Uttar Pradesh.
14. Trypanosoma sp. Joshi, 1979.
In the blood of Labeo bata, collected
from Lucknow, Uttar Pradesh.
15. Trypanosoma sp. Joshi, 1979.
In the blood of Mystus aor, collected
FROM Lucknow, Uttar Pradesh.
16. Trypanosoma sp. Joshi, 1979.
In the blood of Channa gachua, collected
from Lucknow, Uttar Pradesh.

17. Trypanosoma sp. Mukherjee & Haldar, 1979.
In the blood of Nandus nandus, collected from Kalyani, Nadia, West Bengal.
18. Trypanosoma sp. Sinha, 1980.
In the blood of Lepidocephalus guntea, collected from Bongaon, 24-Parganas, West Bengal.
19. Trypanosoma clariae batrachi de Mello & Valles, 1936.
In the blood of Clarias batrachus, collected from Goa.
20. Trypanosoma striati Qadri, 1955.
In the blood of Channa striatus, collected from Hyderabad, Andhra Pradesh.
21. Trypanosoma batrachi Qadri, 1962.
In the blood of Clarias batrachus, collected from Hyderabad, Andhra Pradesh.
22. Trypanosoma danilewski var saccobranchi Qadri, 1962.
In the blood of Heteropneustes fossilis, collected from Hyderabad, Andhra Pradesh.
23. Trypanosoma punctati Hasan & Qasim, 1962.
In the blood of Channa punctatus, collected from Hyderabad, Andhra Pradesh.
24. Trypanosoma elongatus Raychaudhuri & Misra, 1973.
In the blood of Channa punctatus, collected from local market of Calcutta, West Bengal.

- ** 25. Trypanosoma gachuii Mishra, Chandra & Choudhury, 1973.
In the blood of Channa gachua, collected from local markets of Calcutta, West Bengal. Reported here from the same host fish, collected from Baruipur, 24-Parganas, West Bengal.
26. Trypanosoma mukundi Raychaudhuri & Misra, 1973.
In the blood of Heteropneustes fossilis, collected from local markets of Calcutta, West Bengal.
27. Trypanosoma vittati Tandon & Joshi, 1973.
In the blood of Mystus vittatus, collected from Calcutta, West Bengal.
28. Trypanosoma maguri Tandon & Joshi, 1973.
In the blood of Clarias batrachus, collected from Calcutta, West Bengal.
29. Trypanosoma baigulensis Pandey & Pandey, 1974.
In the blood of Cirrhina reba and Osteobrama cotio, collected from Nainital, Uttar Pradesh.
- **30. Trypanosoma armeti Mandal, 1975.
In the blood of Mastocembelus armatus, collected from Champahati, 24-Parganas, West Bengal.
Reported here from the same host fish, collected from Chakdah, Nadia, West Bengal.

**31. Trypanosoma pancali Mandal, 1975

In the blood of Mastocembelus pancalus,
collected from Champahati, 24-Parganas,
West Bengal.

Reported from the same host fish, collected
from Baruipur, 24-Parganas, West Bengal.

32. Trypanosoma mrigali Joshi, 1976

In the blood of Cirrhina mrigale, collected
from Gomati river, Lucknow, Uttar Pradesh.

33. Trypanosoma seenghala Joshi, 1976.

In the blood of Mystus seenghala, collected
from Gomoti river, Lucknow, Uttar Pradesh.

** 34. Trypanosoma cancili Mandal, 1978.

In the blood of Xenentodon cancila, collected
from Raidighi, 24-Parganas, West Bengal.

Reported from the same host fish, collected
from Bongaon, 24-Parganas, West Bengal.

35. Trypanosoma anabasi Mandal, 1978.

In the blood of Anabas testudineus, collected
from Canning, 24-Parganas, West Bengal.

36. Trypanosoma batai Joshi, 1978.

In the blood of Labeo bata, collected from
Gomati river and Chinhat Lake, Lucknow,
Uttar Pradesh.

37. Trypanosoma stigmati Joshi, 1978.

In the blood of Barbus stigma, collected from Gomati river and Chinhat Lake, Lucknow, Uttar Pradesh.

38. Trypanosoma bengalensis Mandal, 1980

In the blood of Mystus bleekeri, collected from Canning, 24-Parganas, West Bengal.

39. Trypanosoma tandoni Mandal, 1980.

In the blood of Wallago attu, collected from Champahati, 24-Parganas, West Bengal.

40. Trypanosoma channai Narasimhamurti & Saratchandra, 1980.

In the blood of Channa punctatus, collected from Visakhapathnam and Srikakulum, Andhra, Pradesh.

41. Trypanosoma gadrii Narasimhamurti & Saratchandra, 1980.

In the blood of Clarias batrachus, collected from Visakhapathnam and Srikakulum, Andhra Pradesh.

42. Trypanosoma trichogasteri Gupta & Jairajpuri, 1981.

In the blood of Trichogaster fasciata, collected from Aligarh, Uttar Pradesh.

43. Trypanosoma aori Joshi, 1982.

In the blood of Mystus aor, collected from Gomoti river, Lucknow, Uttar Pradesh.

44. Trypanosoma rupicoli Joshi, 1983.

In the blood of Nemacheilus rupicola collected from Kosi river near Kosi station, Uttar Pradesh.

**45. Trypanosoma clariae Montel, 1905.

In the blood of Clarias batrachus, collected from Chakdah, Nadia, West Bengal.

**46. Trypanosoma mukasai Hoare, 1932.

In the blood of Tilapia mossambica, collected from Bongaon, 24-Parganas, West Bengal.

*47. Trypanosoma n.sp. (a)

In the blood of Lepidocephalus guntea, collected from Bongaon, 24-Parganas, West Bengal.

Trypanosoma in Anura

1. Trypanosoma sp. Donovan (cited by Wenyon, 1926).

In the blood of Bufo melanostictus.

Locality not stated.

2. Trypanosoma sp. Donovan (cited by Wenyon, 1926)

In the blood of Rana hexadactyla.

Locality not stated.

3. Trypanosoma sp. Berestneff, 1903.

In the blood of Rana tigrina, collected from Bombay, Maharashtra.

4. Trypanosoma sp. Berestneff, 1903.

In the blood of Rana limnocharis, collected from Bombay, Maharashtra.

5. Trypanosoma sp. Patton, 1908 (Cited by Wenyon, 1926)

In the blood of Rana hexadactyla.

Locality not stated.

6. Trypanosoma sp. Scott, 1926 & 1927.

In the blood of Rana tigrina.

Locality not stated.

7. Trypanosoma rotatorium (Mayer, 1843) Berestneff, 1903;

Patton, 1908, ; Scott, 1926, 1927; Ray, 1979a, b;

Ray & Nandi, 1978. In the blood of Rana limnocharis, collected from different parts of India.

8. Trypanosoma rotatorium (Mayer, 1843) Wenyon, 1926; Ray, 1979

a, b, 1980; Sinha, 1981. In the blood of

Bufo melanostictus, collected from some

parts of India. Berestneff, 1903; Patton, 1908;

Scott, 1926, 1927; Pujati, 1953; Ray, 1979 a, b, 1980 ; Ray &

Choudhury, 1980, 1981, 1983. In the blood of Rana tigrina,

collected from different parts of India.

Pujati, 1953; Ray, 1979 a, b, 1980.

In the blood of Rana cyanophlyctis,

collected from some parts of India.

Ray, 1979 a, b, 1980.

In the blood of Bufo stomaticus, Rhacophorus maculatus and Rhacophorus malabaricus, collected from different parts of West Bengal and other states.

8. Trypanosoma loricatum (Mayer, 1843) Ray, 1979b, 1980.

In the blood of Rana limnocharis, collected from Balitha and Bishnupur, Bankura, West Bengal.

9. Trypanosoma ranarum (Lankester, 1871) Damayanthi & Rao, 1979.

In the blood of Rana sp. and Tadpoles, collected from Warangal, Andhra Pradesh.

Ray & Choudhury, 1983.

In the blood of Rana tigrina, collected from Bankura, West Bengal.

10. Trypanosoma karyozeukton Dutton & Todd, 1903.

Ray, 1979b, 1980; Ray & Choudhury, 1983.

In the blood of Rana hexadactyla, collected from Salikona, Hooghly, West Bengal.

11. Trypanosoma inopinatum Sergent & Sergent, 1904.

Patton, 1908; Ray & Choudhury, 1983.

In the blood of Rana hexadactyla, collected from South India, and Bankura, West Bengal.

Patton, 1908; Ray & Choudhury, 1983.

In the blood of Rana tigrina, collected from South India and Bankura, West Bengal.

12. Trypanosoma chattoni Mathis & Léger, 1911.
 Ray, 1979a,b, 1980; Ray & Choudhury, 1983.
 In the blood of Bufo melanostictus,
Bufo stomaticus, Rana limnocharis,
Rana tigrina, Rhacophorus maculatus,
Rhacophorus malabaricus, Microhyla
ornata, collected from Volpoi, Mollem
 and Bondla, Goa.
13. Trypanosoma taprobanica Ray & Choudhury, 1983.
 In the blood of Kaloula pulchra
taprobanica, collected from Santaldi,
 Purulia, West Bengal.
14. Trypanosoma malabarica Ray & Choudhury, 1983.
 In the blood of Rana malabarica,
 collected from Volpoi, Goa.
15. Trypanosoma systema Ray & Choudhury, 1983.
 In the blood of Uperodon systema
 Midnapore, West Bengal.

Trypanosoma in Chelonia

1. Trypanosoma gangetica Sinha, 1978.
 In the blood of Trionyx gangeticus
 collected from Bongaon, 24-Parganas,
 West Bengal.

**2. Trypanosoma vittatae Robertson, 1908

In the blood of Lissemys punctatus
collected from Bongaon, 24-Parganas,
West Bengal.

Trypanosoma in Ophidia

1. Trypanosoma sp. Haq & Mohiuddin, 1956.

In the blood of Xenchrophis piscator.

Locality not stated.

2. Trypanosoma enhydris Sinha & Mandal, 1976.

In the blood of Enhydris enhydris

collected from Chakdah, Nadia,

West Bengal.