# STUDIES ON PARASITES OF INDIAN FISHES, I, PROTOZOA MYXOSPORIDIA TOGETHER WITH A CHECK LIST OF PARASITIC PROTOZOA DESCRIBED FROM INDIAN FISHES.[1]

By

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(Plate I.)

In the course of investigations on parasitic incidence in Indian fresh and brackish-water food fishes, 15 species, with a new genus of Myxosporidians, were observed. These are described below. A check list of the myxosporidia and other parasitic protozoa so far described from Indian fishes is also given including those recorded by Southwell (1915), Southwell and Prashad (1918), Halwani (1930), Ray (1933), Setna and Bana (1935), deMello and Vales (1936), Chakravarty (1939, 1943), Ganapati (1941), Setna (1942) and Chakravarty and Basu (1948).

The fishes were obtained from various ponds and from market samples. Occasional collections made from the river Hoogly and Chilka lake were also examined. The parasites were studied fresh and with the vital stains Methylene Blue (0·5 per cent.) and Neutral Red (0·5 per cent.). For permanent preparations smears were fixed with Bouin's fluid (aquous), methyl alcohol, or by heating slightly over the spirit lamp. They were stained with Delafield's haematoxylin and eosine, or Heidenhain's iron-alum haematoxylin. Satisfactory results were generally obtained. Five per cent. potassium hydroxide solution was used to extrude the polar filament.

The following table shows the incidence of infection found during the investigations.

TABLE I.

| Host. | Number examined. | Number infected. | Parasite. | Habitat. |
|---|---|---|---|---|
| 1. *Barbus sarana* (Ham.). | 3 | 3 | *Myxobolus branchhialis* sp. nov. | Gills. |
| 2. *Barbus ticto* (Ham.). | 15 | 1 | *Myxobolus barbi*, sp. nov. | Skin. |

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Table I—*contd.*

| Host. | Number examined. | Number infected. | Parasite. | Habitat. |
|---|---|---|---|---|
| 3. *Cirrhina mrigala* (fingerlings). (Ham.). | 100 | 40 | *Chloromyxum mrigalae*, sp. nov. | Gall bladder. |
| ,, ,, | 100 | 50 | *Myxobolus indicum*, sp. nov. | Muscles, skin, Liver. |
| ,, ,, | 190 | 67 | *Myxobolus sphericum*, sp. nov. | Scales. |
| 4. *Cirrhina reba* (Ham.). | 4 | 1 | *Thelohanellus mrigalae*, sp. nov. | Skin on the head. |
| ,, ,, | 40 | 12 | *Chloromyxum mrigalae*, sp. nov. | Gall bladder. |
| 5. *Chela bacaila* (Ham.). | 50 | 1 | *Thelohanellus gangeticus* sp. nov. | Muscles. |
| 6. *Labeo calbasu* (Ham ). | 14 | 1 | *Thelohanellus calbasui* sp. nov. | Scales. |
| 7. *Lates calcarifer* (Bl.). | 20 | 6 | *Henneguya latesi*, sp. nov. | Gills and mouth cavity. |
| 8. *Ophicephalus gachua* (Ham.). | 8 | 3 | *Unicauda ophicephali* sp. nov. | Gills. |
| 9. *Odontamblyopus* (Ham.) *rubicandus.* | 50 | 15 | *Neohenneguya tetraradiata* gen. et. sp. nov. | Gills. |
| 10. *Strongylura strongylura* (v. Hass). | 2 | 2 | *Kudoa chilkaensis* sp. nov. | Muscles. |
| 11. *Therapon jarbua* (Forsk.). | 4 | 1 | *Sphaeromyxa theraponi*, sp. nov. | Gall bladder. |
| 12. *Xenentodon cancila* (Ham.). | 1 | 1 | *Chloromyxum* sp. nov. | ,, |

**Chloromyxum mrigalae**, sp. nov.

During the months of September and October 1950 the gall bladder of *Cirrhina reba* and *C. mrigala* obtained from the Research Station tank No. 2 were found to be infected with a new species of *Chloromyxum*. The size of infected specimens of *C. reba* observed ranged from 4 to 8 cms. and those of *C. mrigala* from 5 to 7 cms. The scales and the muscles of these fishes also carried a heavy infection of *Myxobolus sphericum* sp. nov. and *M. indicum* sp. nov. respectively (See pages 68 and 69). The guts of the infected fishes, which were comparatively weak and emaciated, were found to be empty.

*Trophozoite.*—The young trophozoite (6·3μ in diameter) is circular and has a few refringent granules in its endoplasm. The ectoplasm is hyaline and the endoplasm is vacuolated. The trophozoite moves with the help of the blunt pseudopodia. The mature trophozoite (19·8-23μ in diameter) is more or less globular in shape and has 8-12 spores in various stages of development.

*The spore.*—It is spherical with thin and smooth shell valves. The sutural line is distinct and slightly curved. The four polar capsules which are spherical, are equal in size and each opens out by a small duct. In the front view all the capsules are not seen in the same plane, but one of them is slightly below the other three. The sporoplasm fills nearly half of the extra-capsular cavity. There is only one sporoplasm nucleus which is situated in the centre of the spore.

*Measurements of the spore.*—Diameter 9—10μ. Diameter of the polar capsule 2·7-3·6μ.

*Chloromyxum* sp. The gall bladder of one specimen of *Xenentodon cancila* (11·9 cms. long) obtained from the Belghuria fish farm pond 'C' on 4th October 1950 carried a mild infection of *Chloromyxum* sp. Unfortunately permanent preparations could not be made, but the observations made on the fresh spores are as follows. The spore is spherical, 7·2 μ in diameter, the shell being smooth and the sutural line slightly raised. The polar capsules are spherical and 2·7μ in diameter.

*Remarks.*—There are at present, including the above two additions, 49 species of *chloromyxum* besides the two species *C. diploxys* (Gurley) and *chloromyxum* sp. Awerinzew (listed by Kudo in 1933). The last two species do not appear to deserve recognition because *C. diploxys* has two polar capsules situated at two poles (which is not a generic character for *chloromyxum*) and is recorded from an insect, while the spore of *Chloromyxum* sp. Awarinzew has not been described so far.

Meglitsch (1937) recorded *Chloromyxum* sp. from the gall bladders of *Aplodinotus grunniens, Helioperca incisor* and *Ictiobus babalus.* In 1947 he listed the species of *Chloromyxum* as follows to supplement the earlier list of Kudo (1933).

50. *C.* sp. Meglitsch 1937 } Not *C. opladeli nar C. thompsoni.*
51. *C.* sp. *Meglitsch*, 1937 }
52. *C. gibbosum* Herrick, 1941.
53. *C. opladeli* Meglitsh, 1942% *C.* sp. Meglitsch 1937.
54. *C. thompsoni* Meglitsch 1942=*C.* sp. Meglitsch 1937.

It is not clear on what basis he retained the two species numbered 50 and 51, as no description of *Chloromyxum* species was given by him in 1937 In the absence of any description, these two species can not be recognised.

For facilitating the future work these 49 species of *Chloromyxum* are divided into the following four groups based on the characters of the shell valves. It may be stated that due to non-availability of literature detailed information could not be gathered for eleven of these species and hence they could not be grouped.

## Group I.

Shell striated without posterior cilia.

| | | |
|---|---|---|
| *C. protei* | *C. truttae* | *C. cristatum* |
| *C. dubium* | *C. thymalli* | *C. koi* |
| *C. misgurni* | *C. fujitai* | *C. granulosam* |
| *C. trijugum* | *C. catostomi* | *C. wardi* |
| *C. salvelini* | *C. giganteum* | *C. quadriforme.* |
| *C. opladeli* | *C. sphaericum* | *C. parasiluri* |
| *C. cyprini* | *C. sphyrnae* | |

## Group II.

Shell striated with posterior cilia.

| | | |
|---|---|---|
| *C. leydigi* | *C. ovatum* | *C. oviforme* |
| *C. pristiophori* | *C. scyliorhinum* | |

## Group III.

Shell smooth with posterior cilia.

| | |
|---|---|
| *C. caudatum* | *C. magnum* |

## Group IV.

Shell smooth without posterior cilia.

| | | |
|---|---|---|
| *C. fluviatile* | *C. mucronatum* | *C. chitosens.* |
| *C. levigatum* | *C. mrigalae* | *Chloromyxum* sp. |

Species about which no information could be obtained are :—

*C. incertum*, *C.* sp. of Zandt, *C. bora*, *C. legeri*, *C.* sp. of Touraine, *C. oncorrhynchi*, *C. tanakai* *C. barbi*, *C. esocinum* and *C. rutili.*

Thus it will be seen that *Chloromyxum mrigalae* sp. nov. and *Chloromyxum* sp. belong to the group IV, but they differ from all the described species in the shape and size of the spores. In *C. chitosenese* Fujita (1923) the polar capsules are unequal, in *C. levigatum* Jameson (1931) the spore is somewhat oval and the polar capsules are long and narrow while in *C. mucronatum* Gurley (1893) the spore is sub-globular and mucronate anteriorly. In *C. fluviatile* Thelohan, the spore is spherical with a well marked ridge, and the polar capsule is slightly pyriform. In *C. mrigalae* sp. nov. and *Chloromyxum* sp. described here the spores are smooth. The polar capsules are spherical and the sutural ridges are absent. *C. mrigalae* and *Chloromyxum* sp. differ in the size of the spores. The other species of *Chloromyxum* described from India is *C. amphipnoui* Ray, 1933 from the gall bladder of *Amphipnous cuchia* and *Heteropneustes fossilis.* The spore of this species is circular in front view and ovoidal in side view. The shell valve is thin and striated and the dimensions as given by Chakravarty are, length and breadth 8·24—10·3μ ; polar capsule 4·1—5·2×3·1-4μ.

**Kudoa chilkaensis,** sp. nov.

On 11th May 1951 two specimens of *Strongylura strongylura* (36·5 and 42·0 cms. in length) were obtained from Chilka lake at Balugaon. On examination these fishes were found to be infected with small cysts (0·6-0·8m.m. in diameter). These cysts were attached to muscles and the peritoneum in the oesophageal region. They were referable to a new species of myxosporida *viz., Kudoa chilkaensis* sp. nov.

The smear preparations only showed the mature spores and not the vegetative forms.

*The spore.*—In the front view the posterior region of the spore is convex and the anterior end is attenuated. The lateral sides of the anterior half are slightly straight. In the anterior view the spore is rectangular in shape with rounded ends. The shell valves are four in number and are thin and smooth. On fixation they get distorted very easily. The sutural line is indistinct and in some spores does not seem to be complete in the anterior view. The nuclei of the shell valve cells are round and situated at the four corners. The four polar capsules are long, pyriform and convergent. Their anterior ends slightly project out of the shell valve as seen in *K. funduli* (Hahn). The polar capsules are straight as in *K. funduli* and not curved as in the *K. clupeidae* (Hahn). The nucleus of the polar capsule cell is situated at the posterior margin of the polar capsule. The sporoplasm is granular and fills most of the extra capsular cavity. Only one nucleus is seen situated in the centre of the sporoplasm.

*Measurements of the spore.*—Length, 5·5μ ; breadth 7·2μ ; thickness 5·8μ ; polar capsule 3·5×1·0—1·5μ ; length of the polar filament 10·0μ.

*Remarks.*—This species resembles *K. clupeidae* in the size of the spore but the polar capsules are of different sizes in the two species. In the shape of the spore it resembles *K. funduli* but in the latter species the spore is more oval as compared to that of *K. chilkaensis.* Meglitsch (1948) has listed the points of difference between *K. funduli* and *K. clupeidae.* The present form differs from both of them in the points listed above.

Meglitsch (1947) created the new genus *Kudoa* for those forms of Chloromyxidae which are histozoic and with the spores quadrate or stellate in shape in the anterior view. He transferred eight species of *Chloromyxum* to the new genus *Kudoa.* The present species is the ninth one and the first to be described from India. The other species are described from North and South America, South Africa, Australia and Europe.

**Myxobolus branchialis,** sp. nov.

(pl.I, figs. 6—7.)

Three specimens of *Barbus sarana* (11·3-14·8 cms. in length) bought from the local market on 10th November, 1949 had small white cysts on their gill filaments, which were brought to my notice by Mr. A David of this Station. On examination, the cysts were found to contain a new species of *Myxobolus* described here as *Myxobolus branchialis* sp. nov.

*The trophozoite.*—It is circular and contains only one spore. The protoplasm is finely granular and is surrounded by a thin layer of ectoplasm.

*The spore.*—It is more or less oval in front view and fusiform in side view. The shell valves are smooth, symmetrical and moderately thick. The sutural ridge is prominent. The two polar capsules are convergent, unequal, and oval in shape with the anterior end slightly pointed. The polar filaments are also unequal. The nucleus of polar capsule cell is oval and is situated near the posterior end of the polar capsule. The sporoplasm fills most of the extra capsular cavity and has one nucleus in the centre. The iodinophilous vacuole is oval and posterolateral in position.

*Measurements of the spore.*—Length, 6·4-7μ; breadth, 4·5-5μ; thickness, 3·2-4·0μ; polar capsule, 3·5×1·5μ and 1·5×1·0μ; length of the polar filament, 24·0-27·2μ, and 12·0-14·5μ, iodinophilous vacuole 1·7×2·3μ.

Size of the cyst 0·27-0·45mm. Diameter of the trophozoite 13·5μ.

*Remarks.*—This species resembles *M. inaequalis*, *M. musculi*, *M. aureatus*, *M. mrigali* and *M. calbasui* in having unequal polar capsules and the absence of the inter capsular ridge, but it differs from them in the dimensions and shape of the spore and the relative size of the ploar capsules.

**Myxobolus indicum,** sp. nov.

(pl.I, figs. 8—9.)

The muscles, liver and the intestinal wall of over 50 per cent. of specimens of *Cirrhina mrigala* obtained from the Research Station tank number 2 in September, 1950 were found to be heavily infected with small cysts (0·5-0·7mm. in diameter) of a species of *Myxobolus*. At first this was identified as *M. calbasui* Chakravarty (1939) but detailed examination showed it to be a different species of *Myxobolus* and is described here as *M. indicum* sp. nov.

These fishes were also heavily infected on the under side of their scales with *Myxobolus sphaericum* sp. nov. (see page 69).

The smears of the cysts showed only the mature spores suggesting that the infection was fairly advanced. The spore is oval in front view and lenticular in side view. The shell valves are moderately thick, symmetrical and smooth. The polar capsules are unequal and divergent. The longer one is pyriform and the smaller one is more or less spherical. The posterior ends of the polar capsules are at differ levels and not at the same level as in *M. calbasui*. The sporoplasm is granular and fills most of the extra capsular space. One sporoplasm nucleus is present in the centre of the spore. The iodinophilous vacuole varies from round to oval in shape and is situated near the posterior end.

*Measurements of the spore.*—Length, 9·5-10·8μ; breadth, 7·5-8·2μ thickness 5·5μ; polar capsules, 2·7-3·6×1·8μ and 1·8×1·0μ; diameter of the iodinophilous vacuole 2·5μ.

*Remarks.*—The other species of *Myxobolus* described from the muscles of *mrigala* is *M. calbasui*. Inspite of the same host and the habitat the two species differ in the shape and size of the spore and the polar capsules. The anterior end is pointed in *M. calbasui* but is round in *M. indicum*. The shell is thicker in *M. calbasui* as compared to the present species. This species resembles *M. mrigalae* Chakravarty (1939) in the size of the spore but the triangular thickenings on the sutural ridge in *M. mrigalae* are absent in *M. indicum*.

## Myxobolus sphericum, sp. nov.

(pl.I, figs. 10—11.)

The inner side of the scales of over 65 per cent of the specimens of *Cirrhina mrigala* obtained from the Research Station tank number 2 in September 1950 were heavily infected with the cysts of a new species of *Myxobolus* described here as *M. sphericum* sp. nov. The size of the infected fish ranged between 4·8-8·7 cms. The largest number of cysts present on a fish (5·4 cms.) was sixty. The infected scales were raised along their posterior margin and in some cases the scales had fallen off. The infection was all over the body but absent on the head. The infected scales were thinner and devoid of chromatophores but not perforated like scales of *C. mrigala* infected with *M. mrigalae* as reported by Chakravarty (1939). Only mature spores were present in the cysts.

*The spore.*—It is oval in front view and lenticular in side view. The anterior end is wider than the posterior end, unlike in many other species where the greatest width is in the middle of the spore. The shell valves are moderately thick, smooth and symmetrical. The sutural ridge is prominent and has four thickenings along its posterior margin but the sutural line is not clear. The polar capsules are spherical, equal and convergent. They open outside by small ducts. A small triangular intercapsular ridge is present between the openings of the two capsules. The nucleus of the polar capsule cell is small, elliptical and is situated near the posterior end of the capsule. The iodinophilous vacuole is prominent and oval in shape. The sporoplasm is granular. The sporoplasm nucleus is situated anterior to the vacuole.

*Measurements of the spore.*—Length, 9-9·5μ ; breadth, 7·2μ ; thickness 5·0-5·5μ ; polar capsule 2·8-3·6μ in diameter; iodinophilous vacuole 2·0-2·7μ in diameter.

*Remarks.*—In the shape of the spore this species resembles *M. elongatus* Fujita (1924) but the two species differ in the size of the spores, shape of the polar capsules as also the habitate. A ' rim ' is present in the posterior region upto the polar capsule in *M. elongatus* which is absent in *M. sphericum*. The other species of *Myxobolus* described from the scales of *C. mrigala* is *M. mrigalae* but it differs from the present new species in the absence of the inter-capsular ridge and in the shape and size of the spore. The polar capsules are unequal in *M. mrigalae* but they are equal in *M. sphericum*.

**Myxobolus barbi,** sp. nov.

(pl.I, figs. 12—13.)

Small white cysts were present on the skin of one out of 15 specimens of *Barbus ticto* obtained from tank 'F' at the Belghuria fish farm in June 1950. The cysts, whitish in colour, were covered by thin fibrous tissue. Only mature spores were present in the cysts.

*The spore.*—It is perfectly oval in front view and lenticular in side and anterior view. The shell valves are thick. The sutural ridge is prominent but the sutural line is indistinct. The polar capsules are pyriform, equal and convergent and their ducts open out close together. A small inter-capsular ridge is present between the openings of the polar capsules. The sporoplasm fills most of the extra-capsular cavity. The iodinophilous vacuole is round. The capsulogenous nuclei are very small and situated near the posterior end of the capsule. One abnormal spore had a small prolongation on one side near the posterior end. The size of this spore was similar to that of the normal spore.

*Measurements of the spore.*—Length, 12·6-13·5μ; breadth, 9·0μ, thickness 5·5-6·3μ polar capsules 3·6-4·5μ×2·7μ. Thickness of the shell 0·8μ.

*Remarks.*—In the shape of the spore this species resembles *M. gigas* Auerbach but differs from it in the size of the spore and character of the sutural ridge. In size the new species resembles *M. catostomi* Fantham *et al.* (1939) but the two species differ in the character of the sutural ridge. The sutural ridge of *M. catostomi* has folds, where as, it is smooth in *M. barbi.* sp. nov.

There are at present 112 species of Myxobolus of which only ten are described from India. These species of *Myxobolus* can be divided into the following four groups based on the characters of the spores and the polar capsules.

## Group I.

### Polar capsules equal, with Inter-capsular ridge.

| | | |
|---|---|---|
| *M. mulleri* | *M. pfeifferi* | *M. exiguus* |
| *M. obesus* | *M. cycloides* | *M. gigas* |
| *M. scardinii* | *M. bramae* | *M. cyprinicola* |
| *M. balleri* | *M. squamae* | *M. pleuronectidae* |
| *M. discrepans* | *M. notropis* | *M. catostomi* |
| *M. elongatus* | *M. squamosus* | *M. sphericum* |
| *M. barbi* | | |

## Group II.

POLAR CAPSULES EQUAL, INTER-CAPSULAR RIDGE NOT PRESENT.

| | | |
|---|---|---|
| *M. ellipsoides* | *M. oviformis* | *M. lintoni* |
| *M. globosus* | *M. transovalis* | *M. anurus* |
| *M.* sp. Gurley 1894 | *M. cyprini* | *M. neurobius* |
| *M. aeglefini* | *M. physophilus* | *M. chondrophilus* |
| *M. macrocapsularis* | *M. sandrac* | *M. cordis.* |
| *M.* sp. Wagner | *M. permagnus* | *M. rotundus* |
| *M. minutus* | *M. minutus* | *M. magnus* |
| *M. carassii* | *M. funduli* | *M. nodularis* |
| *M. hylae* | *M. miyairii* | *M. koi* |
| *M. orbiculatus* | *M. mesentericus* | *M. cunhai* |
| *M. pygocentris* | *M. noguchii* | *M. stokesi* |
| *M. peocilichthidis* | *M. dentium* | *M. percae* |
| *M. rhinichthidis* | *M. couesii* | *M. hyborhynchi* |
| *M. subcircularis* | *M. nemachili* | *M. subepithelialis* |
| *M. osburni* | *M. conspicuus* | *M. granäis* |
| *M. associatus* | *M. teres* | *M. ovatus* |
| *M. angustus* | *M. vastas* | *M. gravidus* |
| *M. compressus* | *M. mutabilis* | *M. mutabilis* |
| *M. nodosus* | *M. obliquus* | *M. bellus* |
| *M. lutzi* | *M. intestinalis* | *M. congesticius* |
| *M. transovalis* | *M. capsulatus* | *M. moxostomi* |
| *M. bengalensis* | *M. clarii* | *M. catlae.* |

## Group III.

POLAR CAPSULES UNEQUAL INTER-CAPSULAR RIDGE NOT PRESENT

| | | |
|---|---|---|
| *M. inaequalis* | *M. musculi* | *M. aurealus* |
| *M. ovoidalis* | *M. destruent* | *M. calbasui* |
| *M. mrigali* | *M. branchialis* | *M. indicus.* |
| *M. uniporus* | | |

## Group IV,

POLAR CAPSULES UNEQUAL INTER-CAPSULAR RIDGE PRESENT.

*M. dispar.*

No detailed information could be obtained due to the non-availability of literature on the following species :

*M. guyenoti*, *M. kudoi*, *M. gibbosus* *M. bilineatum*, *M. variabilis*, *M. hungaricus* *M. heterocapsulatus*, *M. lobatus*, *M. kubanicum* and *M. kostiri.*

Information for the following species is incomplete and it has not been possible to classify them in any of the above groups.

*M.* sp. Gurley, *M.* sp. Gurley, *M.* sp. Lebzelter, *M.*, sp. Miyairi, *M. sphaeralis*, *M.* sp. Southwell, M. sp. Splenodre, *M.* sp. Kudo.

The species under the above groups can further be divided into sub-groups on the basis of the characters of the shell valves and the sutural ridge.

TABLE II.

*Measurements in microns of the spores of* Myxobolus *species described from India.*

| | Length. | Breadth. | Thickness. | Polar capsule. |
|---|---|---|---|---|
| *M. clarii* Chakravarty (1943) | 11·3-12·4 | 10·3 | 6·18 | 6·18×3·09 equal. |
| *M. catlae* Chakravarty (1943) | 14·5-16·5 | 6·18 | 5·15 | 10·3-12·36× 2·06-3·1 equal. |
| *M. calbasui* Chakravarty (1939) | 12·45-15 | 8·2-10 | 6·18 | 6·18×4·12 and 4·12—3·09 unequal. |
| *M. mrigalae* Chakravarty (1939). | 7·2-8·4 | 7·2-8·4 | 6·18 | 5·15×3·09 and 3·09 ×2·06 unequal. |
| *M. bengalensis* Chakravarty and Basu (1948). | 8·56-9·36 | 6·42-6·8 | 4·28 | 4·28-5·8×2·5-3·2 equal |
| *M. nodularis* Southwell and Prashad (1918). | 9 | 7·2 | — | 3·4 long equal. |
| *M. branchialis* sp. nov. | 6·4-7 | 4·5-5 | 3·2-4 | 3·5×1·5 and 1·4×1 unequal. |
| *M. barbi* sp. nov. | 12·6-13·5 | 9 | 6·3 | 3·6-4·5×2·7 equal. |
| *M. indicum* sp. nov | 9·5-10·8 | 7·5-8·5 | 5·5 | 2·7-3·6×1·8 and 1·8 ×1·2 unequal. |
| *M. sphericum* sp. nov. | 9—9·5 | 7·2 | 5·5-5 | Diameter 2·8-3·6 equal. |

**Henneguya latesi**, sp. nov.

(pl.I, figs. 14-15.)

The gills and the wall of the mouth cavity of *Lates calcarifer*, were infected with small cysts of Myxosporidia. The infected fishes (20·4—48 cms. long) were apparently healthy and the protozoan infection did not seem to harm the fishes to any appreciable extent. The only other Myxosporidian described from *L. calcarifer* is *Leptotheca latesi* Chackravarty, (1943) from the gall bladder. The fishes were obtained from the Chilka Lake and the local market.

The cysts contained only mature spores and no vegetative stages were observed.

*The spore.*—In the front view it is pyriform and pointed posteriorly the anterior end being broad and more or less flattened. In the sutural

view the spore is fusiform. The shell valves are thin and symmetrical. Posteriorly there are two very thin prolongations, which are fused for some distance from the base. The polar capsules are pyriform and slightly convergent. The polar filament is seen coiled within them but could not be extruded on the application of 5 per cent. KOH solution. The nuclei of the polar capsule cells are elliptical and situated near the posterior margin of the polar capsule. The sporoplasm is granular and fills most of the extra-capsular cavity. The iodinophilous vacuole is situated near the posterior end, in front of which one or two sporoplasm nuclei can be seen.

*Measurements of the spore.*—Length (excluding the posterior prolongation) 9·0—10·8 μ; breadth, 6·3—8·2 μ; thickness, 5·4 μ; polar capsule, 3·6×2 μ; length of the posterior prolongations, 17·2—25·4 μ; diameter of the iodinophilous vacuole, 1·5 μ; ratio of the length of the spore to the length of the posterior prolongation nearly 1 : 2.

*Remarks.*—In the size of the spore this species resembles *H.zschokkei* (length 10 μ and breadth 7 μ) and *H.salmonis* (length 10—11·6 μ and breadth 5—7·7 μ) but differs from them in the length of the posterior prolongation and size of the polar capsules. It resembles *H.otolithi* and *H.nigris* in the shape of the spore but differs from them in the size of the spore and the posterior prolongations.

So far only three species of *Henneguya* have been described from Indian fishes.

TABLE III.

*Measurements in microns of the spore of* Henneguya *species described from India.*

| | Total length (including the tail). | Length. | Breadth. | Thickness. | Polar capsule. | Posterior prolongation. |
|---|---|---|---|---|---|---|
| *H. ophicephali*, Chakravarty (1939). | 41·5—52·5 | .. | 6·8—7·21 | 4·12 | 6·18—9·27 ×2·06—3 and 5·15—8·24×2·06—3 | 20—32 |
| *H. otolithi* Ganapati (1941). | .. | 10—12 | 6—8·5 | 4·5 | 3·4×2—2·5 | 35—40 |
| *H. latesi* sp. nov. | 26·2—35·5 | 9—10·8 | 6·3—7·2 | 5·4 | 3·6×2 | 17·2—25·4 |

At present 56 species are included under *Henneguya*. It has not been possible to divide these species into groups as has been done for other genera in this paper. More information about spore character of various species is required before any grouping can be successfully attempted.

## Unicauda ophicephali, sp. nov.

The gills of *Ophiocephalus gachua* obtained from the local market in September 1948 and July 1949 were found to be infected with white

spherical cysts 1—1·5 mm. in diameter. The highest number of the cysts present in one fish (13·7 cms. long) was five. The fishes were apparently in good health.

The cysts had only the mature spores and no young trophozoites were seen.

*The spore.*—It is long, conical and tapering posteriorly and round anteriorly. The shell valves are thick and smooth, and the sutural line and the sutural ridge are prominent and straight. The nuclei of the shell valve cells are elliptical and situated near the middle of the spore. The caudal prolongation is long, thick and tapering posteriorly. The polar capsules are pyriform, convergent and slightly unequal. The nuclei of the polar capsule cells are oval and situated near the inner margin of the polar capsule. The sporoplasm is granular and fills most of the extra-capsular cavity. One or two sporoplasm nuclei are present anterior to the iodinophilous vacuole.

*Measurements of the spore.*—Length, 19·8—26·4 μ; breadth, 5·4—7.2 μ; thickness, 4·5—5 μ; length of the polar capsules, 7·2—8·1 μ, and 5·5—7·2 μ respectively; breadth of the polar capsule, 2—3 μ; length of the caudal prolongation 20·5—23·8 μ; diameter of the iodinophilous vacuole 0·8 μ.

*Remarks.*—This species resembles *U. oviperda* (Cohn) in the shape of the spore, but in the latter species the posterior prolongation is shorter. The length of the spore is similar in *U. ophicephali* and *U. acerinae* (Schroeder) of Nemeczek (1911) but the form of the spore differs in these two species.

Chakravarty (1939) described *Henneguya ophicephali* from the gills and muscles of *Ophiocephalus punctatus* and therein he described two types of spores. "In the spores obtained from the gills, the tail was found bifurcated and devaricated (Pl. 9 Fig. 25 and Pl. 10 Fig. 26) while in those from the muscles the bifurcations are approximated (Pl. 10 Fig. 29—30)" (Chakravarty 1939, p. 175). In 1944 Davis divided the genus *Henneguya* in three genera *Henneguya, Unicauda* and *Myxobilatus.* The form described by Chakravarty from the muscles comes under *Unicauda.* The species described herein from the gills of *O. gachua* is similar to that described by Chakravarty (1939) from the muscles, so *Hennguya ophicephali* Chakravarty becomes synonym (in part) of *U. ophicephali* sp. nov.

Davis (1944) has listed ten species under *Unicauda.* But the review of the literature shows that the following species can also be transferred to *Unicauda. Henneguya acerinae* (Schroeder) described by Nemeczek in 1911 and by Jirovec (1942) have one posterior prolongation only. The measurements of the spore given by these two authors are very much similar. It is proposed that this species be transferred to *Unicauda* as *U. nemeczeki* nom. nov. *H. oviperda* (Cohn), and *H. limatula* Maglitsch, (1937) are also transferred to *Unicauda* because the spores have single caudal prolongation.

At present there are 14 species of *Unicauda* which can be divided into the following three groups :

### GROUP I.

POSTERIOR PROLONGATION NEARLY AS LONG AS THE MAIN BODY OF THE SPORE.

*U. strongylura* and *U. ophicephali.*

### GROUP II.

POSTERIOR PROLONGATION SHORTER THAN THE MAIN BODY OF THE SPORE.

*U. oviperida, U. crassii* and *U. fontinalis.*

### GROUP III.

POSTERIOR PROLONGATION LONGER THAN THE MAIN BODY OF THE SPORE.

*U. clavicauda, U. crassicauda, U. monura, U. brachura, U. spatulata, U. limatula U. nemeczeki, U. plasmodia* and *U. macrura.*

## **Neahenneguya tetraradiata,** gen. *et.* sp. nov.

The gills of 15 out of 50 *Odontamblyopus rubicundus* obtained from the river Hooghly on 1st February 1950 were found to be infected with small cysts (diameter 0·5 mm.), which could be easily removed. There was no pathological effect on the gills to any appreciable extent. On close examination the cysts were found to belong to a new genus and species of myxosporidia designated as *Neohenneguya tetraradiata.* gen. *et* sp. nov.

*The trophozoite.*—The young trophozoite is irregular in shape and has one developing spore in it. The protoplasm is not properly differenciated into the ecto and endo-plasm.

*The spore.*—It is fusiform with two long thin prolongations at either end. The prolongations are equal in length. The shell valves are thin, smooth and slightly unequal in size. The sutural line is thin and the sutural ridge is not distinct. The polar capsules are spherical and tendem in position in the front view. They are situated a little posterior to the anterior end of the spore. The openings of the capsules are in different directions. The anterior capsule opens on the front side and posterior capsule opens on the sutural side. The polar filament is long and thin. The iodinophilous vacuole is situated near the end, opposite to the polar capsule end. The sporoplasm between the polar capsule and the vacuole is granular and has one or two nuclei. The polar capsule cell nucleus is not seen.

*Measurements of the spore.*—Length (excluding the prolongations), 16·2—21·6 μ ; breadth and thickness 5·4 μ ; diameter of the polar capsule 2—2·7 μ ; diameter of the iodinophilous vacuole 1·5—2·5 μ ; length of the prolongations 63—72 μ.

The present form belongs to the family Myxobolidae as it possesses the iodinophilous vacuole and two polar capsules. The caudal prolongations indicate its affinity to *Henneguya* Thelohan but the presence of the prolongations at the anterior end also, and the opening of the polar capsules at the sides instead of at the anterior end show that it is different from this genus. The aforesaid characters justify the creation of a new genus for the reception of the present form. The generic diagnosis is given below.

*Neohenneguya* nov. gen. Myxobolidae in which the spore is fusiform with two equal prolongations at each of its anterior and posterior end. The polar capsules are spherical with their openings in different directions. Histozoic, on the gill of estuarine fish. Type species: *N. tetraradiata* sp. nov.

### Thelohanellus mrigalae, sp. nov.

Out of four *Cirrhina mrigala* fingerlings (3—4 cms. long) obtained from the fry market one had three cysts (0·75 mm. in diameter) on its head, two between the eyes and one near the snout. The infected fish was kept under observation for 12 days along with others in the laboratory aquarium but no additional specimen was observed to be infected. Smears of the cysts showed only the spores.

*The spore.*—In the front view the spore is oval with the lateral sides more or less parallel, and a slight knob like projection at the anterior end. In the sutural view the spore is pyriform. The shell-valves are thick, symmetrical and smooth. The sutural line is prominent. The polar capsule is oval and occupies nearly half of the spore cavity. The polar capsule cell is elliptical and situated just posterior to the polar capsule. The sporoplasm fills nearly the whole of the extra-capsular cavity. It has only one nucleus, behind which the iodinophilous vacuole is situated.

*Measurements of the spore.*—Length, 10·8—12 μ; breadth, 6·3—7·2 μ; thickness, 4·5—5·4 μ; polar capsule, 5·4—7·2 μ×3·6—5·0 μ.

*Remarks.*—In size it resembles the spore of *T. oculileucisci* but differs from it in shape. The shape of the spore is somewhat like that of *T. catlae* Chakravarty and Basu (1948) but differs from it in the size of the spore and shape of the polar capsule.

### Thelohanellus calbausi, sp. nov.

One *Labeo calbasu* (18·6 cms.) obtained from Sheoraphulli market in February 1949 had two white cysts (1·5 and 2 mm. in diameter) on the scales on the lateral sides of the fish. At the place of attachment of the cyst the scale was perforated. In *mrigala* also the scale becomes perforated when infected by *Myxobolus mrigalae* Chakravarty. When the smears of the cysts were prepared, only the mature spores were seen.

*The spore.*—It is more or less oval, the anterior end is less broad than the posterior end. In the side view it is pyriform. The shell is thin smooth and the sutural valves are equal. The sutural line is distinct

but there is no sutural ridge. The polar capsule is oval with the anterior end drawn into a small duct. The capsulogenous cell nucleus is elliptical and is situated near the posterior end. The sporoplasm is granular and has two big round nuclei in the middle of the spore. The nuclei of the shell valve cells are also seen along the lateral margin in the region of the polar capsule.

*Measurements of the spore.*—Length 9—10·8 μ; breadth 7·2 μ; thickness 5·5 μ; polar capsule 5·4×3·4 μ diameter of the sporoplasm nucleus 1·2 μ.

*Remarks.*—This species resembles *T. mrigalae* sp. nov. in the size but differs from it in the shape of the spore. In shape of the spore it resembles *T. seni* Southwell and Prashad (1918) except that the spore of the latter species has a thickened sutural ridge.

## **Thelohanellus gangeticus.** sp. nov.

During the course of studies of the spawning grounds of the carps in the Ganges river near Nimtita one small specimen of *Chela bacaila* (4·6 cms. long) was obtained which showed a tumorous growth on the body in its pectoral region. This specimen was kindly handed over to me by Sri S. J. Karamchandani of this Station for study. Other specimens examined at the Research Station from the local ponds were free from the infection.

A piece of this tumour was examined under the microscope which showed many spores of *Thelohanellus*, described here as *T. gangeticus* sp. nov.

No vegetative stages of the parasite were seen in the smear preparation. The spore is elongated and thin and the two lateral sides nearly straight. The posterior end is slightly flattened with rounded ends. The anterior end is truncated, and from the side the spore appears pyriform. A sutural ridge is present but the sutural line is not clear. The polar capsule is pyriform with a thin neck. The sporoplasm fills nearly half of the extra-capsular cavity. The iodinophilous vacuole is small and varies in position. In some spores it is in the centre of the spore whereas in others it is near the posterior end. There is only one sporoplasm nucleus and the protoplasm around it is dense. Some spores are arched at the anterior end in the front view, but in other respects they are simlar to the typical spores described above.

*Measurements of the spore.*—Length, 16·2—17·5 μ; breadth 5·4 μ; thickness 3·5 μ; size of the polar capsule 7·2×2·5 μ.

*Remarks.*—This species resembles *T. pyriformis* in the shape and the length of the spore to a certain extent, but the two species differ in the breadth of the spore. The present species is characteristic in having its posterior end slightly flattened and not round or oval as in other species.

So far 15 species of *Thelohanellus* have been described. Of these six species are from India. Eleven species have the length of the spore more than 15 μ except the four—*T. seni*, *T. oculileucisci*, *T. mrigalae*, and *T. calbasui* in which the spore length is between 10—15 μ.

TABLE IV.

*Measurements in microns of the spore of* Thelohanellus *species described from India.*

| | Length. | Breadth. | Thickness. | Polar capsule. |
|---|---|---|---|---|
| *T. seni,* (Southwell and Prashad 1918). | 12·48—14·94 | 8·56 | .. | 6·42×4·0 |
| *T. rohitae* (Southwell and Prashad 1918). | 30—33 | 10—13 | .. | 16·2×7—8·24 |
| *T. catlae* (Chakravarty and Basu 1948.) | 19·26—21·4 | 10·7—12·4 | 12·48 | 10·71—13·9× 9·63—11·77 |
| *T. mrigalaei* sp. nov. . | 10·8—12 | 6·3—7·2 | 4·5 | 5·4—7·2× 3·6—5 |
| *T. calbasui* sp. nov. . | 10·5—11 | 6·3 | 3·6 | 5·4×3·6 |
| *T. gangeticus* sp. nov. . | 16·2—17 | 5·4 | 2·7—3 | 7·2×2·5 |

## **Sphaerymyxa pultai,** sp. nov.

Twelve out of 50 specimens of *Odontamblyopus rubicundus* caught from the river Hooghly near the Research Station showed infection in the gall bladder by a new species of *Sphaeromyxa* which is described here as *S. pultai* sp. nov. The fishes were obtained during the months of October and December, 1950 and March 1951. No appreciable difference was noticed in the seasonal intensity of the infection. The bile in all the infected fishes was viscous and whitish in colour.

*Vegetative stage.*—The young trophozoite is circular (4·5 μ in diameter) with two big circular nuclei (1·8 μ in diameter). The protoplasm is clear and hyaline. The mature trophozoite is mono or di-sporous. The endoplasm is vacoulated surrounded by a thin layer of ectoplasm. The monosporous form measures 12·6—13·9 μ and the di-sporous trophozoite measures 19—27·3 μ. There are 6—8 nuclei in the mature trophozoite.

*The spore.*—It is long with truncate ends. The two sides are slightly curved in the front and the sutural views. The shell is thin and smooth. The sutural line is more or less parallel to the long axis of the spore. There is no sutural ridge. The polar capsules are long, pyriform and with truncate ends. The nucleus of the polar capsule cell is round and situated just behind the polar capsule. The sporoplasm is granular and does not fill the whole of the extra-capsular cavity. Two round sporoplasm nuclei are situated in the middle of the spore.

*Measurements of the spore.*—Length, 28·8—30·0 μ; breadth and thickness 5—5·5; diameter of the sporoplasm nucleus 1—1·3 μ.

*Remarks.*—This species resembles *S. gibbonsia* Noble in the size of the spore, but the spore in the latter species is more arched in the front view. In the shape of the spore *S. pultai* sp. nov. resembles *S. balbianii*

Thelohan, but in the latter species the shell valve is striated and also the size of the spores in the two species are different. In *S. ovale* the spore is oval in shape and smaller in size than the present species.

### **Sphaeromyxa theraponi,** sp. nov.

One out of 4 specimens of *Therapon jarbua* obtained from Port Canning on 4th December 1950, showed an infection in the gall bladder by a new species of *Sphaeromyxa* which is described here as *S. theraponi* sp. nov. The bile was slightly viscous and the colour of the bile was yellowish. The intensity of infection was not very heavy. Only mature spores were found.

*The spore.*—It is arched in the front view, one side being more arched than the other. Some spores, abnormal in shape are deeply arched and appear 'V' shaped. In the sutural view the spore is more or less 'S' shaped and the two polar capsules open in different directions. The shell valve is thin and smooth. The sutural line is 'S' shaped, thin and distinct. The sutural ridge is absent. The polar capsules are small and pyriform, with truncate ends. The sporoplasm fills most of the extra-capsular cavity.

*Measurements of the spore.*—Length (distance between the ends of the two polar capsules in the front view) 19·8 μ; breadth and thickness 5·4 μ; polar capsules 7·2 × 2·7 μ.

*Remarks.*—This species has its spore arched in the front view and sutural line is 'S' shaped. In this character it resembles *S. incurvata*, *S. hellandi*, *S. exneri* and *S. reinhardti* but it differs from them in the size of the spore.

There are 15 species of *Sphaeromyxa* described so far. On the basis of the shape of the spore these are divided into the following four groups:

| GROUP I. | GROUP II. |
|---|---|
| SHELL STRIATED. | SHELL SMOOTH, SPORE ELONGATED IN FRONT VIEW. |
| *S. balbianii*<br>*S. curvaula* | *S. ovale*, *S. arcuata*, *S. paltai*, and *S. longa*<br>*S. gasterostei*. |
| **GROUP III.** | **GROUP IV.** |
| SHELL SMOOTH, SPORE CURVED IN FRONT VIEW AND THE SUTURAL LINE 'S' SHAPED. | SHELL SMOOTH, SPORE CURVED IN THE FRONT VIEW, AND THE SUTURAL LINE STRAIGHT. |
| *S. incurvata*, *S. hellandi*, *S. exneri*, *S. reinhardti*, and *S. theraponi*. | *S. sabrazesi*, *S. lateralis* and *S. gibbonsia*. |

The two new species of *Sphearomyxa* described here are the only ones so far recorded from India. They can easily be distinguished from others by the shape and size of the spore.

## Check List of Parasitic Protozoa Described from Indian Fishes.

### SPOROZOA.

### *TELOSPORIDIA.*

COCCIDIA

Eimeriidae.

*Eimeria*

| | |
|---|---|
| *E. harpodoni,* Setna & Bana, 1935 | *Harpodon nehereus.* |
| *E. southwelli* Halwani, 1930 | *Aetobatis narinari.* |
| *Eimeria* sp. Setna & Bana, 1935 | *Trichurus savala.* |
| *Eimeria* sp. Setna & Bana, 1935 | *Plotosus cannius.* |
| *Eimeria* sp. Setna & Bana, 1935 | *Sillago sihama.* |

Haemogregerinide.

*Haemogregarina*

| | |
|---|---|
| *H. thyrsoideae* deMello & Vales, 1936 | *Thyrsoidea macrurus.* |
| *Haemogregarina* sp. Plinner, 1914 | *Colisa fasciatus.* |

### *CNIDOSPORIDIA.*

Myxosporidia Butschli, 1881.

*Unipolaria* Tripathi, 1948.

CERATOMYXOIDEA Tripathi, 1948.

Ceratomyxidae Doflein, 1899.

*Ceratomyxa* Thelohan, 1892.

| | |
|---|---|
| *C. hilsae* Chakravarty, 1939 | *Hilsa ilisha.* |
| *C. gobioidesi* Chakravarty, 1939 | *Odontamblyopus rubicundus.* *Colisa fasciatus.* |
| *C. scatophagi* Chakravarty, 1943 | *Scatophagus argus.* |

*Leptotheca* Thelohan, 1895.

| | |
|---|---|
| *L. latesi* Chakravarty, 1943 | *Lates calcarifer.* |
| *L. macronesi* Chakravarty, 1943 | *Mystus gulio.* |
| *Sphaerospora* sp. Southwell & Prashad, 1918 | *Barilius barna.* |

Chloromyxidae Thelohan, 1892.

*Chloromyxum* Mingazzini, 1890.

| | |
|---|---|
| *C. amphipnoui* Ray, 1933 | *Amphipnous cuchia.* *Heteropneustes fossilis.* *Amblypharyngodon mola.* |
| *C. mrigalae* sp. nov | *Cirrhina mrigala, C. reba.* |
| *Chloromyxum* sp. | *Xenentodon cancila.* |

*Kudoa* Meglitsch, 1947.

| | |
|---|---|
| *K. chilkaensis* sp. nov. | *Strongylura strongylure.* |

MYXOBOLOIDEA Tripathi, 1948.

Myxobolidae Thelohan, 1892.

*Myxobolus* Butschli, 1882.

| | |
|---|---|
| *M. bengalensis* Chakravarty & Basu, 1948 | *Catla catla.* |
| *M. branchialis* sp. nov. | *Barbus sarana.* |
| *M. barbi* sp. nov. | *Brabus ticto.* |
| *M. calbasui* Chakravarty, 1939 | *Labeo calbasu, L. rohita, Cirrhina mrigala.* |
| *M. clarii* Chakravarty, 1943 | *Clarius batrachus.* |
| *M. catlae* Chakravarty, 1943 | *Catla catla, Labeo rohita* and *Cirrhina mrigala.* |

| | |
|---|---|
| *M. indicum* sp. nov. | *Cirrhina mrigala.* |
| *M. mrigalae* Chakravarty, 1939 | *Cirrhina mrigala.* |
| *M. nodularis* Southwell & Prashad, 1918 | *Rasbora daniconius.* |
| *M. sphericum* sp. nov. | *Cirrhina mrigala.* |
| *Henneguya* Thelahan, 1892. | |
| *H. latesi* sp. nov. . | . *Lates calcarifer.* |
| *H. ophicephali* Chakravarty, 1939 | *Ophicephalus punctatus.* |
| *H. otolithi* Ganapati, 1941 . | *Otolithus ruber, O. maculatus.* |
| *Unicauda* Davis, 1944. | |
| *U. ophicephali* sp. nov. | . *Ophicephalus gachua. O. punctatus.* |
| *Neohenneguya* gen. nov. | |
| *N. tetraradiata* sp. nov. | . *Odontamblyopus rubicundus.* |
| THELOHANELLIDAE Tripathi, 1948. | |
| *Thelohanellus* Kudo, 1933. | |
| *T. calbasui* sp. nov. . . . . | . *Labeo calbasu.* |
| *T. catlae* Chakravarty & Basu, 1948 . . | . *Catla catla.* |
| *T. gangeticus* sp. nov. . . | . *Chela bacaila.* |
| *T. mrigalae* sp. nov. . . . | . *Cirrhina mrigala.* |
| *T. rohitae* (Southwell & Prashad, 1918) . . | *Labeo rohita.* |
| *T. seni* (Southwell & Prashad, 1918) . | *Catla catla.* *Labeo rohita.* |
| *Bipolaria* Tripathi, 1948. | |
| MYXIDIIDAE Thelohan, 1892. | |
| *Myxidium* Butschli, 1882. | |
| *M. heteropneustesi* Chakravarty, 1943 | . *Heteropneustes fossilis.* |
| *M. leiberkuhni* Butschli, 1881 | *Anabas testudineus.* |
| *M. procerum* var. *calcariferi* Chakravarty, 1943 | . *Lates calcarifer.* |
| *M. glossogobi* Chakravarty, 1939 . | . *Glossogobius giuris.* |
| *Sphaeromyxa* Thelohan, 1892. | |
| *S. pultai* sp. nov. . . . . | *Odontamblyopus rubicundus.* |
| *S. theraponi* sp. nov. . . . . | *Therapon jarbua.* |
| *Zschokkella* Auerbach, 1910 | |
| *Z. fossilae* Chakravarty, 1943 . | . *Heteropneustes fossilis.* |
| *Z. ilishae* Chakravarty, 1943 . . | . *Hilsa ilisha.* |

*Note.*—Setna (1942) has given a list of 18 species of Elasmobranch fishes which are infected by Myxosporidian parasites and in order to complete this list the table given by Setna is queted below.

| Host | Number of species from each host | Genus | Seat of infection |
|---|---|---|---|
| 1. *Carcharinus pleurotaenia* | 1 | *Ceratomyxa* | Gall bladder |
| 2. *Cestraction blochii* . . | 2 | *Ceratomyxa* *Chloromyxum* | do. |
| 3. *Cestracion zygaena* . . | 3 | *Ceratomyxa* *Ceratomyxa* *Chloromyxum* | do. |

| Host | Number of species from each host | Genus | Seat of infection |
|---|---|---|---|
| 4. *Chiloscyllium griseum* | 1 | *Chloromyxum* | Gall bladder |
| 5. *Carcharinus menisorrah* . | 2 | *Ceratomyxa*<br>*Ceratomyxa* | do. |
| 6. *Carcharinus limbatus* . | 5 | *Leptotheca*<br>*Chloromyxum*<br>*Ceratomyxa*<br>*Ceratomyxa* | do. |
| 7. *Hemigaleus balfouri* . | 3 | *Ceratomyxa*<br>*Ceratomyxa*<br>*Chloromyxum* | do. |
| 8. *Pristis cuspidatus* . . | 2 | *Chloromyxum*<br>*Ceratomyxa* | do. |
| 9. *Rhynchobatus djeddensis* . | 2 | *Chloromyxum*<br>*Ceratomyxa* | do. |
| 10. *Scoliodon sorrakowah* . | 3 | *Chloromyxum*<br>*Ceratomyxa*<br>*Leptotheca* | do.<br>Kidney |
| 11. *Scoliodon* sp. . . | 2 | *Chloromyxum*<br>*Ceratomyxa* | Gall bladder |
| 12. *Scoliodon walbeehmi* . | 3 | *Ceratomyxa*<br>*Ceratomyxa*<br>*Chloromyxum* | do. |
| 13. *Scoliodon palasorrah* . | 2 | *Ceratomyxa*<br>*Chloromyxum* | do. |
| 14. *Carcharinus bleekeri* . | 3 | *Ceratomyxa*<br>*Ceratomyxa*<br>*Chloromyxum* | do. |
| 15. *Hypoprion macloti* . . | 2 | *Ceratomyxa*<br>*Ceratomyxa* | do. |
| 16. *Carcharinus melanopterus* | 2 | *Ceratomyxa*<br>*Chloromyxum* | do. |
| 17. *Trygon bleekeri* . . | 1 | *Chloromyxum* | do. |
| 18. *Rhynoptera javanica* . | 1 | *Chloromyxum* | do. |

ALPHABETICAL LIST OF THE HOSTS.

1. *Aetobatis narinari* (Euphrasen) . . . Myliobatidae.
   *Emeria Southwelli* (Intestine)
2. *Amblypharyngodon mola* (Ham). . . . . Cyprinidae.
   *Chloromyxum amphipnoui* (Gall bladder)
3. *Amphipnous cuchia* (Ham.) . . . Amphipnoidae.
   *Chloromyxum amphipnoui* (Gall bladder)

4. *Anabas testudineus* (Bl.) . . . Anabantidae.
   *Myxidium leiberkuhni* (Gall bladder)

5. *Barbus* (*Puntius*) *sarana* (Ham.) . Cyprinidae.
   *Myxobolus branchialis* (Gills)

6. *Barbus* (*Puntius*) *ticto* (Ham.) . . . . Cyprinidae.
   *Myxobolus barbi* (Skin)

7. *Barilius barna* (Ham.) . . . . Cyprinidae.
   *Sphaerospora* sp. (Under the scale)

8. *Catla catla* (Ham.) . . Cyprinidae.
   *Myxobolus catlae* (Gills)
   *M. bengalensis* (Gills)
   *Thelohanellus catlae* (Gills)
   *T. seni* (Gills)

9. *Chela bacaila* (Ham.) . Cyprinidae.
   *Thelohanellus gangeticus* (Skin and muscles)

10. *Cirrhina mrigala* (Ham.) . . Cyprinidae.
    *Chloromuxum mrigalae* (Gall bladder)
    *Myxobolus calbasui* (Gills)
    *M. catlae* (Gills)
    *M. indicum* (Muscles)
    *M. mrigalae* (Scales)
    *M. Sphericum* (Scales)

11. *Cirrhina reba* (Ham.) . . . . . Cyprinidae.
    *Chloromyxum mrigalae* (Gall bladder)

12. *Clarias batrachus* (L.) . . . . . Clariidae.
    *Myxobolus clarii* (Gall bladder, liver, ovary (Bl. schn.) testis, and fat bodies)

13. *Coilia fasciatus* (Bl. Schn.) . . . . Osphronemidae.
    *Haemogregarina* sp. (Blood)

14. *Glossogobius giuris* (Ham.) . . . Gobiidae.
    *Myxidium glossogobi* (Gall bladder)

15. *Harpodon nehereus* (Ham.) . Synodidae.
    *Eimeria harpodoni* (Intestine)

16. *Heteropneustes fossilis* (Bl.) . . . . Heteropneustidae.
    *Chloromyxum amphipnoui* (Gall bladder)
    *Myxidium heteropneustesi* (Gall bladder)
    *Zschokkella fossilae* (Gall bladder)

17. *Hilsa ilisha* (Ham.) . . . . . Clupeidae.
    *Ceratomyxa hilsae* (Gall bladder)
    *Zschookkella ilishae* (Gall bladder)

18. *Labeo calbasu* (Ham.) . . . . . Cyprinidae.
    *Myxobolus calbasui* (Gall bladder)
    *Thelohanellus calbasui* (Skin)

19. *Labeo rohita* (Ham.) . . . Cyprinidae.
    *Myxobolus calbasui* (Gall bladder)
    *Myxobolus catlae* (Gills)
    *Thelohanellus rohitae* (Gills)
    *T. Seni* (Median & caudal fin)

20. *Lates calcarifer* (Bl.) . . . . Percidae.
    *Leptotheca latesi* (Gall bladder)
    *Myxidium procerum* var *calcariferi* (Gall bladder)
    *Henneyguya latesi* (Gills and skin)

21. *Mystus gulio* (Ham.) . . . . . Bagridae.
    *Leptotheca macronesi* (Gall bladder)

22. *Ophicephalus gachua* (Ham.) . . . . . Ophicephalidae.
*Unicauda ophicephali* (Gills)

23. *Ophicephalus punctatus* (Bl.) . . . . . Ophicephalidae.
*Henneguya ophicephali* (Gills)
*Unicauda ophicephali* (Muscles)

24. *Otolithus maculatus* (Kuhl. & Hass.) and

25. *Otolithus rubber* (Bl. Schn.) . . . Scieanidae.
*Henneguya otolithi* (Heart)

26. *Odontamblyopus rubicundus* (Ham.) . . . Gobiidae.
*Ceratomyxa gobioidesi* (Gall bladder)
*Neohenneguya tetraradiata* (Gills)
*Sphaeromyxa pultai* (Gall bladder)

27. *Plotosus canius* (Ham.) . . Plotossidae.
*Eimeria* sp. (Intestine)

*Rasbora daniconius* (Ham.) . . . . . Cyprinidae.
*Myxobolus nodularis* (Muscles)

29. *Scatophagus argus* (Bl.) . . . . . Percidae.
*Ceratomyxa scatophagi* (Gall bladder)

30. *Sillago sihama* (Forsk.) . . Trachinidae.
*Eimeria* sp. (Intestine)

31. *Strongylura strongylura* (v. Hass.) . . . . Scombresocedae.
*Kudoa chilkaensis* (Muscle)

32. *Therapon jarbua* (Forsk.) . . . . . Percidae.
*Sphaeromyxa theraponi* (Gall bladder)

33. *Thyrsoidea macrurus* (Blkr.) . . . . Muraenidae.
*Haemogregarina thyrsoideae* (Blood)

34. *Xenentodon cancila* (Ham.) . . . . Scombresocidae.
*Chloromyxum* sp. (Gall bladder)

So far only 39 species of Myxosporidia are described from 29 species of Indian fishes excluding the list of 18 species of Elasmobranch fishes given by Setna in 1942. Of these 29 species, 11 species are from Cyprinidae, which are mostly cultured in ponds specially in Bengal. Among the Clupeids, myxosporidia have been described only from one species *i.e.*, *Hilsa ilisha*. It may be added here that our knowledge of the incidence of myxosporidian infection in riverine and marine fishes is very poor. Again, in the case of recorded species there is a vast field for the study of systematics, geographical and seasonal distribution of the parasites and their effect on the hosts, so that their full significance in relation to fish and fishery may be elucidated.

## SUMMARY.

Fifteen new species and one new genus of Myxosporidian parasites are described from fresh-water and estuarine fishes of India.

A check list of the Protozoan parasites from Indian fishes is also given.

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