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# ILLUSTRATIONS OF FISH PATHOGENS IN HUBEI PROVINCE

Edited by the Hubei Provincial Research Institute of Aquatic Biology*

## Order: Myxosporidia

Myxosporidians are parasites of fishes, amphibians and reptiles. Statistics indicate that more than 700 species of myxosporidians have already been discovered, and the vast majority of these are parasitic in fishes. Therefore, myxosporidians can be regarded as a type of parasite that is characteristically found in fishes. On two previous occasions (from 1959 to 1960 and again in 1962) the Institute of Aquatic Biology of the Chinese Academy of Sciences carried out systematic surveys of the fish parasites occurring in Huama Lake in Hubei Province. In the course of these studies 97 species of myxosporidians were discovered. It can be expected that our understanding of the biology and pathology of these myxosporidians, which occur so extensively in our country and are represented by such an abundance of diverse types, will continue to be

*Formerly known as the Institute of Aquatic Biology of the Chinese Academy of Sciences.

enriched and improved as surveys and other research work on them expand and achieve greater depth. /p. 58

Morphology Myxosporidians are a comparatively minute type of parasite. During their growth process, all myxosporidians, without exception, produce spores. These spores, which are of varying shapes and sizes, are composed of two-valved spore cases with specialized protoplasm. The area where the two valves join is known as the sutural line. A raised structure is produced along this sutural line, either as a thickening or a projection; since this structure has a ridgelike appearance, it is referred to as the sutural ridge. The plane of the spore in which the sutural ridge is lacking is called the valvular plane, while the plane that features the sutural ridge is known as the sutural plane. Structures of varying types may be seen in the different types of myxosporidians. For example, some of these spores, including Mitraspora, Myxidium, and Chloromyxum, have striated shell-valves; other forms, such as Myxosoma, Myxobolus, and Thelohanellus, have plicate or rugulate shell-valves; and still others, including Henneguya and Hoferellus as well as Mitraspora, have shell-valves that are prolonged posteriorly into a caudal process. The interior of these spores includes two types of structures known as the polar capsules and the sporoplasm. The number of polar capsules also varies in different types of myxosporidians, ranging from one to four, and they may be either of equivalent or unequal size. These polar capsules may be situated either at the anterior end of the spores or at both ends. Spores that have a pair of polar capsules - for instance, Myxobolus and Myxosoma - possess a V-shaped or U-shaped endoprocess on the anterior side of the interval between the polar capsules; this process is referred to as the intercapsular appendix. Inside the polar capsules are spirally coiled polar filaments. Young spores

generally have six nuclei. Two of these are the so-called "polar capsule nuclei" that form the polar capsules; another two are the nuclei that form the two-valved spore membrane; and the remaining two, known as the germinal vesicles, stay within the germ plasm. In addition, an iodinophilous vacuole can also be found in the sporoplasm of some types of myxosporidians.

Research Method The data and illustrations appearing in this paper are all based on materials that had been fixed with 4% formalin and then cleared using 10% glycidol. Measurement of the size of these myxosporidians was accomplished by adopting the techniques used by previous investigators. However, in determining the length of the polar capsules, only the actual length of the polar capsule itself was measured; that is to say, the section that extends outside of the [spore case]* was disregarded when ascertaining a polar capsule's length. Text Figure 14 shows the method that was employed.

Life History Judging from the literature, there is still a fair amount of controversy concerning the life history of myxosporidians. This is especially true as regards the changes that the nuclei undergo, as no unified view has yet been attained. Some workers maintain that, for the main part of their life cycle, myxosporidian cells have the haploid number of chromosomes. Other researchers believe, however, that [myxosporidian cells] are diplonts, while still other reports indicate that their life cycles include two meiotic divisions and two zygote stages. Moreover, the papers that contend that the myxosporidian life cycle only involves one zygote, also show disagreement over whether meiosis takes place immediately prior to fertilization or subsequent to it. In view of the fact that the authors have not found any materials that are

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*Translator's note: Brackets indicate inferences.

appropriate for resolving these issues, they are not being addressed in the study presented here. In the future, after we have had additional opportunity [to examine] the leading hypotheses that are being put forward in the literature published abroad, we will finally make a contribution to this debate by advancing some views of our own.

As far as is now known, the majority of myxosporidians have a rather low chromosome count. Diplonts possess four chromosomes, while haplonts have two. This circumstance is useful for investigating their life history. Nevertheless, the fact remains that the nuclei of these spores are quite small, so small, in fact, that it is difficult to accurately distinguish them with the optical microscopes currently available. In the last analysis, this is the main reason that so much controversy has arisen over this topic.

1. One hypothesis is that the myxosporidian life history involves two stages of fertilization and two periods of zygote formation.

Included among the researchers who have advanced this view are Awerinzew (1908, 1909), Auerbach (1910, 1912), Mercier (1909), Naville (1928, 1930), Parisi (1913), and Prashad (1918). This approach was most clearly expressed by Naville, whose detailed study on Myxobolus guyenoti produced the life history illustrated in Text Figure 15.

In the sporoplasm of mature spores (34)*, two haploid nuclei fuse to form a synkaryon, and then, at the proper time, the sporoplasm changes in such a way that an active plasmodium (1) is produced. This plasmodium leaves the spore case and penetrates the epithelial cells of the host's tissue, where it lives and grows by absorbing the nutrients in the cells of the host. While this is

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*The numbers in parentheses, here and below, refer to the numbers in Text Figure 15.

taking place, the nucleus undergoes schizogony; that is, the diploid nucleus* multiplies by means of extensive division (2) at this time. Subsequently, the resulting nuclei undergo what is called "premeiosis" (3) and /p. 60 "reduction division", in which the number of chromosomes is reduced from four to two (5, 6). Finally these haploid nuclei each undergo a single "heteropolar division" (7) to produce two gametes, a larger one referred to as a macrogamete (8, 9) and a smaller one known as a microgamete (16, 17), and then /p. 61 zygotes (10-12) are formed from these macrogametes and microgametes by fertilization. These zygotes also may proliferate by division (12-15) until a large number of them have been formed, and then sporonts (18-20) are once again produced. These sporonts assume two different forms. One of these forms is a monosporont, a case in which a single spore is produced (27-32), whereas the other form consists of a bisporont, i.e., a case in which two spores are generated (21-26). Naville believed that, during the course of the formation of these spores, a mononuclear sporont initially undergoes unequal division, which gives rise to a large germinative nucleus and a small vegetative nucleus. The latter nucleus then divides one time to produce two [nuclei], but subsequently no additional fission takes place. Finally, [these nuclei] probably produce the spore's external membrane and then disappear. The germinative nucleus undergoes fission one time, dividing into two [nuclei]. One of these nuclei then continues to divide two or three times, forming either four or eight diploid nuclei, and these then produce the nuclei [that generate] the polar capsules and the spore membrane. The other nucleus undergoes meiotic division to produce either two or four haploid sporoplasmic nuclei (26, 32, 33), and then, finally, two of the sporoplasmic nuclei fuse to form a zygote. At this time

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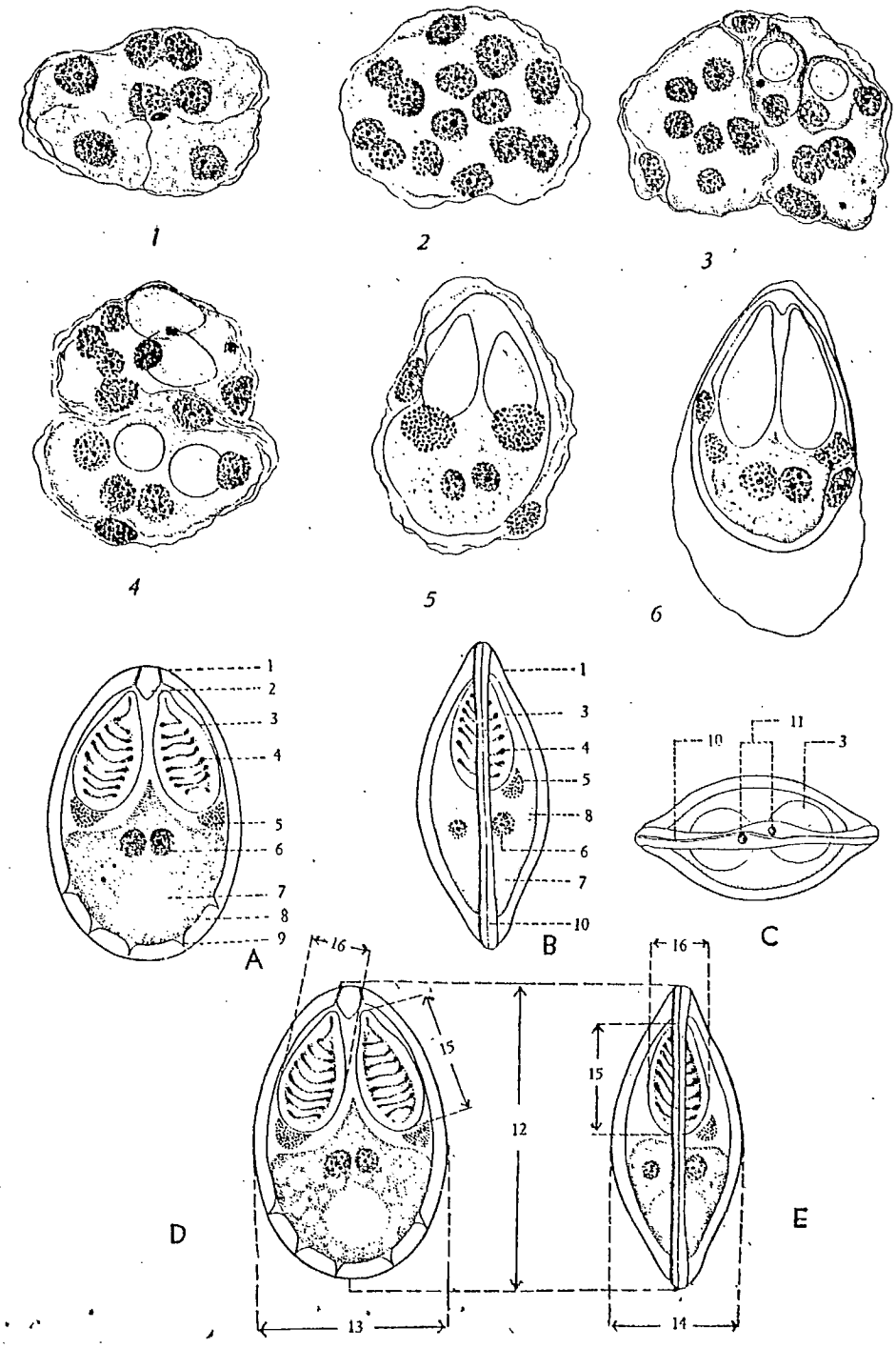
*Translator's note: Literally, "diploid chromosome nucleus."

the spore also reaches maturity (34). /p. 59




Text Figure 14 Sporulation in Myxosporidians and Their Structure, As Well As the Measurement Methods Employed

(Explanation of Text Figure 14)

1: stage where the sporoplasm possesses seven cell nuclei (After Keysselitz)

2: stage where the mass of sporoplasm possesses 14 cell nuclei (After Keysselitz)

3-4: stage where two spores are initially formed from one sporont (After Kudo)

5: shows how [the cell material] is distributed when one sporont is forming a spore and six cell nuclei

6: shows how [the cell material] is distributed when one sporont is forming a spore and cell nuclei, as well as the condition of the spore membrane

A, D: spore viewed from the valvular plane aspect

B, E: spore viewed from the sutural plane aspect

C: spore in apical view

1: spore case

2: intercapsular appendix

3: polar capsule

4: polar filament

5: polar capsule nucleus

6: germinal vesicle

7: iodinophilous vacuole

8: sporoplasm

9: plication

(Explanation of Text Figure 14, cont.)

10: striation

11: apertures for extrusion of the polar filaments

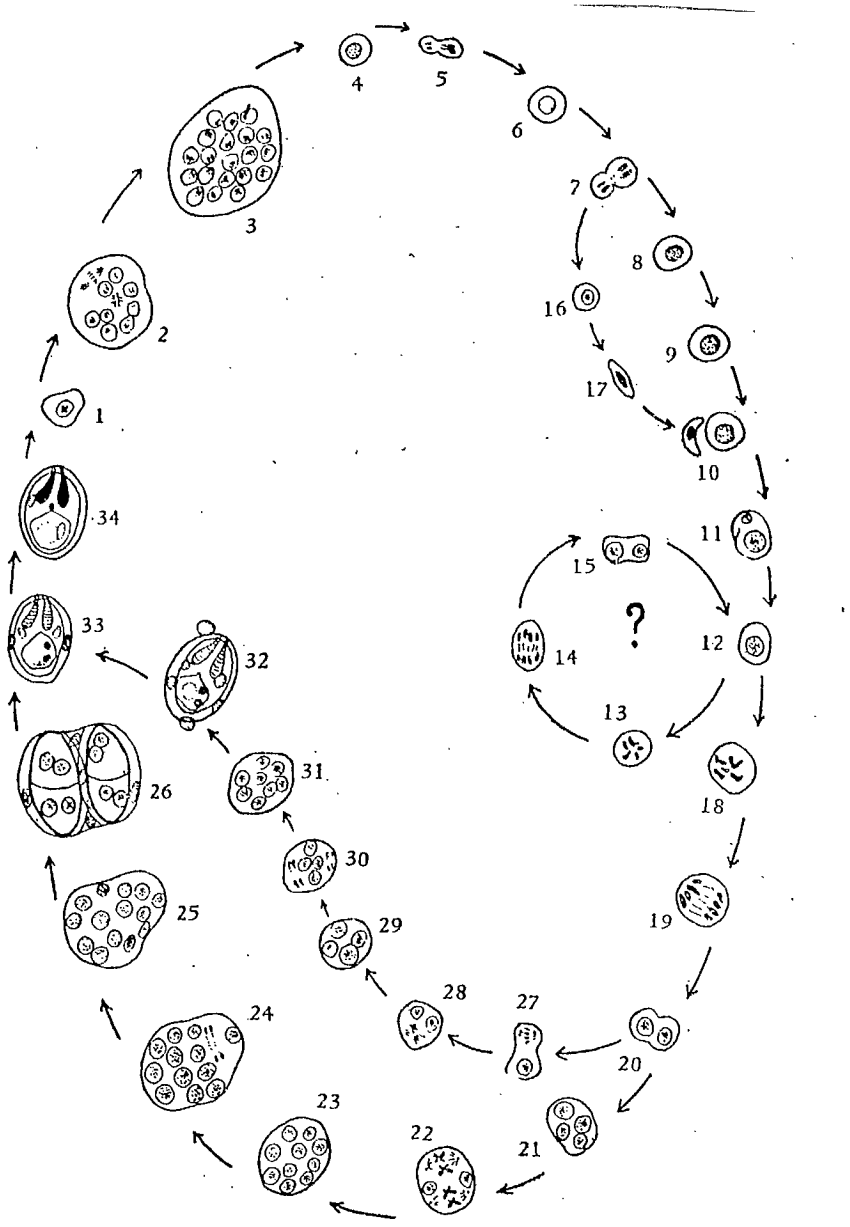
12: length of spore

13: breadth of spore

14: thickness of spore

15: length of polar capsule

16: breadth of polar capsule




**Text Figure 15** The Life History of *Myxobolus guyenoti*

(Explanation of Text Figure 15)

1: zygote plasmodium

2: multiplication of nuclei and sporoplasm

3-4: premeiosis

5-6: reduction division

7: heteropolar division

8-9: formation of macrogametes and microgametes

10-12: a fertilized zygote

13-15: possible multiplication of zygotes

16-17: formation of macrogametes and microgametes

18-20: formation of a sporont

21-26: formation of a bispore

27-32: formation of a monospore

33: a binucleate spore

34: spore with a synkaryon

(After Naville, 1928)

2. Another hypothesis is based on plasmogamy. /p. 61

[According to this hypothesis], when the plasmodium of a new zygote that has penetrated a host proceeds to grow and multiply within the host epithelial cells, it eventually reaches the point where a sporont is formed. When this occurs, and especially in cases where gametes are formed, a type of heteropolar meiosis takes place, producing a microgamete nucleus and a macrogamete nucleus. Surrounding each of them is a thick, dense layer of cytoplasm. When these nuclei come together, [their] cytoplasm[s] blend together, if only barely, but the nuclei remain independent and do not fuse. This "plasmogamy hypothesis" has been advocated by Dunkerley (1915), Debaisieux (1925), Erdmann (1927) and Kudo (1917, 1943), among others. The other processes [involved in this hypothesis] are the same as those discussed below.

3. A third hypothesis denies that sporonts are formed by the fusion of nuclei, and it also rejects the existence of plasmogamy.

According to this view, a given germinative nucleus, out of several that are present, will differentiate and undergo reduction division, and this in turn will produce two or four isogamete nuclei having the haploid number of chromosomes. The main proponents of this hypothesis include Georgévitch (1914, 1916, 1935, 1936), Mavor (1916), Davis (1916, 1923) and Noble (1941, 1943).

Noble (1941, 1943) investigated the life histories of Ceratomyxa blennius and Myxidium gasterostei. [Since] his views on this subject are essentially the same as those advanced by Georgévitch, we will now discuss the life history of Myxidium gasterostei. This life history is illustrated in Text Figure 16.

A plasmodium that has left a mature spore still retains a pair of isogamete

nuclei (16)* that possess a haploid chromosome set. After [the plasmodium] has penetrated the epithelial cells of the host's tissues, the [two isogamete nuclei] unite to form a zygote (1). After [this zygote] has absorbed nutrients from the host, its cytoplasm grows larger while at the same time its diploid nucleus constantly divides mitotically (2-7). Some of the expanded cells [that result from this mitosis] begin to produce sporonts. At the outset their nucleus divides unequally to form a large germinative nucleus and a small vegetative nucleus (8). The vegetative nucleus proceeds to divide into two, but then it abruptly ceases dividing and does not participate in the formation of a spore (9). The germinative nucleus, meanwhile, proceeds to divide twice to form four nuclei, two of which are germinative nuclei and two of which are spore-membrane nuclei. The latter nuclei then undergo one further division to produce four spore-membrane nuclei [that lead to the formation] of bisporonts. One of the germinative nuclei also divides twice to form four polar capsule nuclei, which subsequently give rise to polar capsules, while the other germinative nucleus undergoes reduction division to produce four haploid nuclei (12), which ultimately form the sporoplasmic nuclei of a pair of spores (13, 14).

On considering the hypotheses that have been put forward by the researchers cited above, it is the present authors' opinion that the viewpoint expressed, for instance, by Georgévitch and Noble, makes more sense than the others. To suppose that fertilization takes place twice and that two zygote stages occur within a single generation is to suppose a course of development that goes beyond what is normally seen in organisms, and any such notion will

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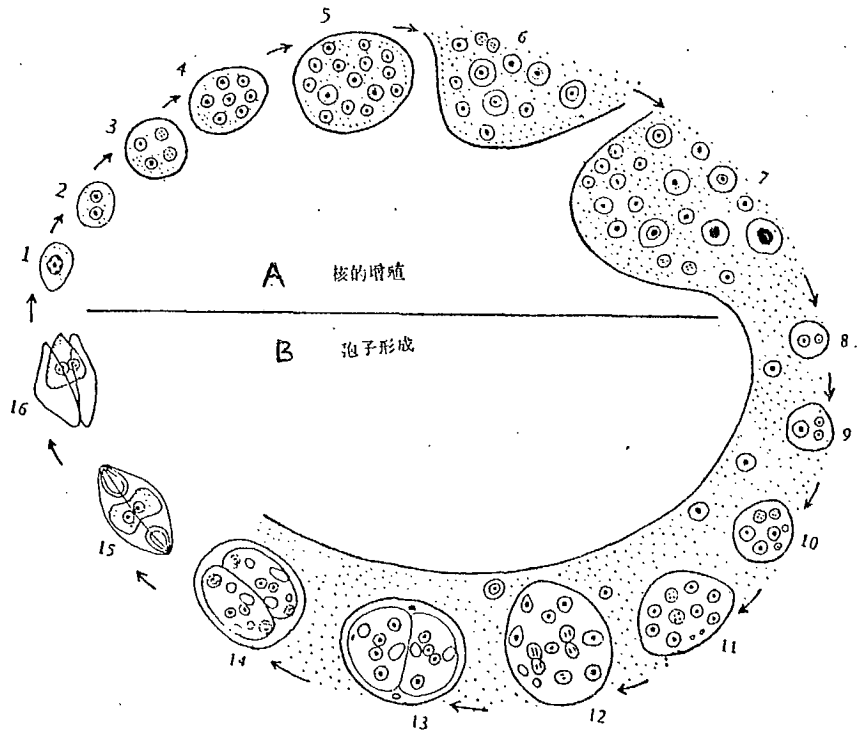
*The numbers in parentheses, here and below, refer to the numbers in Text Figure 16.

naturally be viewed as lacking in credibility. Other hypotheses - for example, the one involving plasmogamy - also seem to go to unnecessary lengths. Since a sporont is itself a syncytium type [of sporozoan], it is completely understandable that [its] sporoplasm may separate [and/or] fuse as a consequence of physiological effects, fixation with pharmaceutical chemicals, etc. What is more, [if it is supposed that] these two haploid nuclei eventually /p. 62 fuse to form a zygote, then what, in the last analysis, would be the significance of plasmogamy anyway? All in all, this would seem to be a very dubious hypothesis.




**Text Figure 16** The Life History of Myxidium gasterostei

(Explanation of Text Figure 16)

A: multiplication of nuclei

B: sporogony

1: zygote plasmodium

2-7: multiplication of cytoplasm and nuclei

8: appearance of the sporont; within it are a small vegetative nucleus and a large germinative nucleus

9: binary fission of the vegetative nucleus; after this there no further division takes place, and the resulting [nuclei] do not participate in spore formation

10: division of the germinative nuclei into five [nuclei]

11: division of the germinative nuclei into nine [nuclei]

12: division of the germinative nuclei into four spore-membrane nuclei, four polar capsule nuclei, and four haploid nuclei

13-14: formation of a bisporont

15: the mature spore

16: a plasmodium on the verge of being liberated

(After Noble, 1941)

The Relationship Between Myxosporidians and Their Hosts As has already been discussed above, myxosporidians can be considered to be a characteristic parasite of fishes. Present knowledge indicates that nearly every species of fish is infected [with myxosporidians]. Sometimes a dozen or more species of these parasites may be found [in an individual fish]; in fact, several different species of myxosporidians are frequently encountered even within a single tissue or organ of a fish. Some types of myxosporidians do not have very stringent requirements for selection of their hosts, whereas other species not only exhibit strict host selectivity but also require a specific infection site. With still other types of myxosporidians, the infective characteristics that they display will depend upon the age of their host. For example, Myxidium ophiocephali and Chloromyxum ellipticum both exhibit a fairly high infection rate in fishes during their summer* and fry stages of development, but these parasites are seldom seen in mature fishes. As fishes grow older, on the other hand, a gradual increase can be noted in the types of myxosporidians that parasitize them. For example, during their summer and fry stages of development the silver carp Hypophthalmichthys molitrix molitrix (Cuvier et Valenciennes) and the variegated carp Aristichthys nobilis (Richardson) show fairly extensive infection by Myxobolus dispar on their gills, as large numbers of cysts are frequently formed, even though the actual quantity and the number of different types of myxosporidian parasites may both be quite low. However, after the silver carp and the variegated carp have attained maturity, very few Myxobolus dispar parasites may be found on their

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*Translator's note: Literally, the "summer-flower" or "summer-blossom" stage. (This suggests an early stage of development that carps would attain in the summer when they are being bred in ponds. The "flower" part of the term suggests a variegated sort of coloration.)

gills, but a steady increase can be observed in the number of different species of myxosporidians that are discovered within their bodies. The facts outlined in the above discussion indicate that fish not only have the power to clear myxosporidians from their body, but that these parasites also can increase in number as fishes become older.

Not enough is currently known with any assurance about the degree to which myxosporidians harm fishes. However, it is common knowledge that "twist-disease" and one form of "dizziness disease" can be attributed to the /p. 63 species Myxosoma cerebralis. Myxobolus pfeifferi, moreover, is able to induce "boil disease" in fish. Judging from the author's materials, it is evident that infection of a fish by parasites such as Myxobolus dispar, Sphaerospora amurensis, and Myxosoma varius can be fatal if they are present in large numbers. Furthermore, a parasite that invades the epithelial cells of the intestines - for example, Thelohanellus rohitae, which attacks the common carp Cyprinus carpio carpio (Linnaeus) - can cause death by destroying the host's digestive functions. Other parasites, including forms that infect the intestinal walls and organs such as the gall bladder, liver, and kidney, also damage tissue to one extent or another and thereby impair the health of fish.

Systematic Position According to the taxonomic scheme set out by Kudo, the order Myxosporidia is divided into three suborders, namely, the Eurysporea, the Sphaerosporea, and the Platysporea. All of the above suborders are represented by the myxosporidians that were discovered in the authors present investigations. These parasites are described below, grouped according to suborder.

**Suborder: Eurysporea**

**Family: Wardiidae**

**Genus: Mitraspora Fujita, 1912**

1. Mitraspora cyprini Fujita, 1912 (Plate XV, Figs. 1-5)

Sites of Infection and Host: The ureter and urinary bladder of the crucian carp Carassius auratus auratus (Linnaeus).

The trophozoites are irregular masses of protoplasm. Their ectoplasm is relatively transparent, while their endoplasm exhibits two to four spores and granules of varying sizes. The trophozoites are 25.0 μm long and 24.0 μm wide.

Viewed from the valvular plane aspect as well as from the sutural plane aspect, the spores appear bell-shaped, being somewhat sharply pointed at their anterior end and having a rather straight posterior margin. Distinct striations, measuring approximately 5.0 μm in length, ornament the spore. The sutural ridge is straight and conspicuous, and it evenly divides a pair of symmetrical polar capsules. The length of the spores is 9.8 (9.0 - 10.8) μm; their breadth, determined from the sutural plane aspect*, is 7.4 (7.2 - 7.8) μm, while their breadth is 6.0 μm when measured from the valvular plane aspect**. The polar capsules are pyriform or oval; their length is 4.0 (3.6 - 4.2) μm and their breadth is 3.0 (2.4 - 3.2) μm. The spore case is thin and transparent, and running over its surface are 9 or 10 distinct, parallel lines which extend posteriorly to form thicker, more prominent striations. The sporoplasm contains a conspicuous iodinophilous vacuole and two circular germinal vesicles.

Mitraspora cyprini is a type of myxosporidian that is found rather frequently in the urinary bladder of Carassius auratus. It has also

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*Translator's note: Sic. Apparently this is equivalent to "front view".
**Translator's note: Sic. Apparently this is equivalent to "side view" or "profile".

been discovered in breeding ponds, including those at Huanggang and Xiaogan.

2. Mitraspora sinensis Lee & Nie, 1965 (Plate XV, Figs. 6-11)

Sites of Infection and Host: The kidney, ureter and urinary bladder of Pseudobagrus fulvidraco (Richardson).

Amoeboid trophozoites are very commonly encountered. A certain number of spores are seen in the body [of the host], with their length measuring 21.8 (19.2 - 24.0) μm and their width 17.9 (14.8 - 21.6) μm.

Viewed from the valvular plane aspect, the spores have an oval-to-circular shape; from the sutural valve aspect, their shape is elliptical; and in apical view, their shape is spherical. The sutural ridge is straight and raised. The surface of the spore is provided with eight parallel lines, which appear to form two concentric rings when seen in apical view and in sutural-plane view. Each of the lines prolongs posteriorly to produce a striation that extends about 3 or 4 μm, with the ends of these striations showing a slight swelling. The spores are 8.3 (7.2 - 9.0) μm long; their breadth is 7.1 (6.6 - 7.8) μm when measured from the sutural plane aspect and 6.2 - 7.2 μm when measured from the valvular plane aspect. The two pyriform polar capsules occupy approximately one-half of the spore's length. These polar capsules are 3.5 (3.0 - 3.6) μm long and 2.6 (2.4 - 3.0) μm wide. Within the sporoplasm are a conspicuous iodinophilous vacuole and a* circular germinal vesicle.

Mitraspora sinensis was found in the body of a Pseudobagrus fulvidraco fish from the Xiaogan district. Although the rate of infection shown by this parasite is not very great, the severity of its infections is fairly heavy.

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*Translator's note: Sic; should be two?

**Suborder: Sphaerosporea** /p. 64

**Family: Sphaerosporidae**

**Genus: Sphaerospora** Thélohan, 1892

3. Sphaerospora branchialis Lee & Nie, 1965 (Plate XV, Figs. 12-18)

Site of Infection and Host: The gill filaments of Cyprinus carpio.

No young amoeboid trophozoites have been found as yet. This organism does not form cysts when it parasitizes the gill filament tissues of its host. When a host has become infected by this parasite, it will frequently occur that all of the gill filaments of the host will become filled up with mature spores and with multinucleate masses of protoplasm that exhibit varying stages of development.

The spores have a spheroidal shape when viewed from either the valvular plane aspect or the sutural plane aspect. Four or five rather indistinct lines can be seen on the surface of the spores. The sutural ridge is straight and raised, and it extends between a pair of polar capsules. Immature spores are still enveloped by a thin, transparent membrane. The spores are 7.4 (7.0 - 8.2) μm long, 7.4 (6.8 - 8.2) μm broad, and approximately 7.0 μm thick. Two pyriform polar capsules are present; they are situated at the anterior end of the spore, and account for approximately one-half of its total length. The polar filaments are coiled, with four or five volutions. The polar capsules are 3.4 (3.0 - 3.6) μm long and 2.7 (2.4 - 3.0) μm broad. Not much sporoplasm is observed, and no iodinophilous vacuole. Two circular germinal vesicles can be seen.

Sphaerospora branchialis was discovered on the gills of a Cyprinus carpio fish from Wangtian Lake in the Huanggang area. The extent of its infection with this parasite was comparatively heavy.

4. Sphaerospora amurensis Achmerov, 1960 (Plate XV, Figs. 19-26; Plate XVI, Fig. 27)

Sites of Infection and Hosts: The gill filaments of the grass carp Ctenopharyngodon idellus (Cuvier et Valenciennes) and the black carp Mylopharyngodon piceus (Richardson).

No trophozoites have been discovered as yet. This organism does not form cysts when it parasitizes the gill tissues of its host. When a host has become infected by this parasite, all of its gill filaments will be filled up with spores.

The spores appear either spherical or fusiform when viewed from the sutural plane aspect, and the sutural ridge is very prominent. Observed from the valvular plane aspect, the spores have a spherical shape and are [usually] smooth and non-striate, although at times some plications can be seen. The length of the spores is 8.7 (8.4 - 9.8) μm; their width, as measured from the valvular plane [aspect], is 7.2 - 7.8 μm; and their thickness is 7.5 (7.2 - 9.6) μm. Two pyriform polar capsules are present, and they occupy approximately one-half of the spore's length. The polar capsules are 3.5 (3.0 - 4.2) μm long and 3.2 (2.8 - 3.2) μm broad. The polar filaments are coiled, displaying three or four volutions. Two germinal vesicles are observed; they have a circular outline and are positioned close to each other. No iodinophilous vacuole occurs within the sporoplasm.

This myxosporidian is found in both the Xiaogan and Jingzhou districts.

5. Sphaerospora hupehensis Lee & Nie, 1965 (Plate XVI, Figs. 28-31)

Site of Infection and Hosts: The gill filaments of Acanthorhodeus fishes.

No trophozoites have been discovered as yet. Large numbers of these spores occur within the gill filament tissues of the parasitized host; no cysts are observed, however.

Seen from the valvular plane aspect, the spores have a circular or oval outline, and bear four to six striations that are arranged in an arc-shaped pattern. Eight to ten small processes appear on each of the striations. In sutural plane aspect, the spores are walnut-shaped, with their anterior end being somewhat pointed and the sutural ridge being straight and conspicuous. The length of the spores is 7.8 (6.6 - 9.0) μm, their breadth is 7.4 (6.6 - 8.4) μm; and their thickness is approximately 7.5 μm. Two pyriform polar capsules are present, and they account for about one-half of the spore's total length. The length of these polar capsules is 3.3 (2.4 - 3.6) μm, and their width is 2.8 (2.4 - 3.0) μm. The polar filaments are coiled, with five or six volutions. Two circular germinal vesicles are [usually] observed, although only one may be seen in some instances.

Sphaerospora hupehensis has been found in fishes from Huangsha Lake in the Huanggang district.

**Family: Chloromyxidae** /p. 65

**Genus: Chloromyxum** Mingazzini, 1890

6. Chloromyxum ellipticum Lee & Nie, 1965 (Plate XVI, Figs. 32-42)

Sites of Infection and Hosts: The gall bladders of Carassius auratus, Mylopharyngodon piceus, Ctenopharyngodon idellus, Squaliobarbus curriculus (Richardson), the bream Parabramis pekinensis (Basilewsky), Aristichthys

nobilis, Hypophthalmichthys molitrix, etc.

The amoeboid trophozoites are variable in size and they also show rather major differences in shape. These trophozoites are 18.3 (9.6 - 25.8) μm long and 16.0 (8.4 - 22.0) μm wide. The trophozoites are disporous to polysporous, and they also contain numerous granules that diffract light fairly strongly.

Viewed from the valvular plane aspect, the spores have an elliptical shape, exhibiting a somewhat pointed anterior end and a bluntly rounded posterior tip. In apical view and counter-apical view* the spores appear circular. The surface of the shell is conspicuously striated, with the lines being arranged so as to form a "U". Four pyriform polar capsules are present; these polar capsules are similar in size and are positioned at the anterior end of the spore, accounting for approximately one-third to one-half of the spore's length. The sporoplasm is homogeneous and compact; two circular germinal vesicles appear within it, and they are positioned either close to one another or somewhat apart. This species of Chloromyxum has been discovered in the gall bladders of seven fish species, and no significant differences have been noted in the shape or size of these myxosporidians. The results of the authors' measurements of this parasite are presented in Table 5.

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*Translator's note: Literally, "opposite-apical" view. It would seem that this could be interpreted as "bottom view" - i.e., the view of the spore from the end opposite its apex.

## Table 5 Chloromyxum ellipticum

| 寄 A主 | B部位 | C 孢子长×孢子宽(微米) | D 极囊长×极囊宽(微米) | E 孢子厚度(微米) |
|---|---|---|---|---|
| F 鲫 | M胆 | 8.0×7.2(7.2—8.4×6.0—8.4) | 3.6×2.3(3.6—3.8×1.2—2.8) | 6.0 |
| G青 鱼 | M胆 | 7.0×5.9(6.6—7.8×5.4—6.0) | 2.5×1.6(2.4—2.8×1.4—1.8) | 4.8—6.0 |
| H草 鱼 | M胆 | 7.5×5.5(7.2—8.4×5.0—6.0) | 2.9×1.9(2.4—3.6×1.4—2.4) | 5.4 |
| I赤眼鳟 | M胆 | 7.4×5.6(7.0—10.8×5.4—6.0) | 3.0×1.7(2.4—3.6×1.6—1.8) | 5.4 |
| J长春鳊 | M胆 | 8.0×6.3(7.4—8.8×5.4—7.2) | 3.3×1.7(2.8—3.6×1.6—1.8) | 5.4—6.0 |
| K 鳙 | M胆 | 8.0×5.8(7.4—8.6×5.4—6.0) | 3.0×2.2(3.0—3.4×2.0—2.4) | 5.4 |
| L 鲢 | M胆 | 7.4×5.6(7.2—7.8×5.4—6.0) | 2.6×1.7(2.0—3.0×1.4—1.8) | 6.0 |

A: host

B: site of infection

C: the spore's length x its breadth (μm)

D: the polar capsules' length x their breadth (μm)

E: thickness of the spore (μm)

F: Carassius auratus

G: Mylopharyngodon piceus

H: Ctenopharyngodon idellus

I: Squaliobarbus curriculus

J: Parabramis pekinensis

K: Aristichthys nobilis

L: Hypophthalmichthys molitrix

M: gall bladder

Chloromyxum ellipticum is a widely distributed parasite, as it has been found in breeding ponds in the Jingzhou, Xiaogan and Huanggang districts. Moreover, the infection rate of this organism is fairly high, and the magnitude of its infections is also serious.

7. Chloromyxum hupehensis Lee & Nie, 1965 (Plate XVI, Figs. 43-47)

Site of Infection and Host: The gall bladder of Pseudorasbora parva (Temminck et Schlegel).

The amoeboid trophozoites are pale yellow masses of protoplasm; they contain four to six spores, and measure 15-20 μm in diameter.

The spores have an elliptical shape, and their surface bears prominent striations. The length of these spores is 6.0 μm and their breadth is 5.9 (5.4 - 6.0) μm; measured from the sutural plane aspect, they are approximately 5.4 μm wide. Four pyriform polar capsules that are similar to one another can be seen grouped at the anterior end of the spore; they are relatively large, extending 2.8 (2.6 - 3.0) μm in length and 1.7 (1.6 - 1.8) μm in width. The sporoplasm is homogeneous and compact. The polar capsules' nuclei and the germinal vesicles are not easily discerned in mature spores.

This parasite was discovered in the body of a Pseudorasbora parva fish from Huangsha Lake in the Huanggang district.

**Suborder: Platysporea** /p. 66

**Family: Myxidiidae**

**Genus: Myxidium Bütschli, 1882**

8. Myxidium leiberkuehni Bütschli, 1882 (Plate XVI, Figs. 48-57)

Sites of Infection and Host: The kidney and urinary bladder of Cyprinus carpio.

The cysts are circular or elliptical; they are surrounded by several layers of the host's tissues, and they contain not only spores but also yellow or black-coloured granules. The cysts are 47-150 μm in diameter.

Viewed from the sutural plane aspect, the spores appear fusiform. One

side sometimes will appear raised and the other a trifle sunken when the spores are observed from valvular plane aspect. Frequently 7-10 striations occur on the surface. The length of the spores is 14.0 (13.6 - 16.8) μm, and their breadth is 5.2 (4.8 - 6.0) μm. Measured from the sutural plane aspect, the width of the spores is about 4.0μm. The polar capsules are either oval or pyriform in shape. The polar filaments are distinct and have five to seven coils. The length of the polar capsules is 4.3 (3.6 - 4.8) μm long and their breadth is 2.9 (2.8 - 3.0) μm. The distance between the polar capsules is 3.0 - 3.6 μm. The germinal vesicles are conspicuous.

This parasite has been found in the bodies of Cyprinus carpio from the Huanggang and Xiaogan districts.

9. Myxidium polymorphum Nie & Lee, 1964 (Plate XVII, Figs. 58-83)

Site of Infection and Hosts: The gall bladder of Mylopharyngodon piceus, Ctenopharyngodon idellus, Opsariichthys uncirostris bidens Günther, Hemiculter leucisculus (Basilewsky), Parabramis pekinensis, the triangular bream Megalobrama terminalis (Richardson), Aristichthys nobilis, Hypophthalmichthys molitrix, Pseudorasbora parva, and Macropodus chinensis (Bloch), among others.

The spores have an elongated elliptical shape. Viewed from the sutural plane aspect, the sutural ridge is either straight (Plate XVII, Fig. 67) or somewhat in S-form. The spore's surface is marked with six to eight striations; these striations are arranged in a manner that follows the turns in the shell-valves, so that they exhibit a variety of shapes. The polar capsules are pyriform or circular, and the polar filaments have four or five coils. This parasite exhibits a very wide distribution, as it has been discovered in the gall bladders of ten different species. The data obtained in measurements of

these spores show some variation depending upon the host. Data on the dimensions of these spores and their polar capsules are presented in Table 6.

Myxidium polymorphum has been found in the Jingzhou, Xiaogan and Huanggang districts.

**Table 6** Myxidium polymorphum

| 寄A主 | B部位 | C 孢子长×孢子宽（微米） | D 极囊长×极囊宽（微米） | 极囊间距(微米)E |
|---|---|---|---|---|
| F 青 鱼 | P 胆 | 12.3×5.3(11.4—13.2×5.0—6.0) | 2.8×2.5(2.4—3.3×2.4—3.0) | 4.7(4.2—5.2) |
| G 草 鱼 | P 胆 | 12.6×4.9(10.8—13.2×4.8—5.4) | 2.9×2.6(2.4—3.4×2.4—3.0) | 5.0(4.8—5.4) |
| H南方马口鱼 | P 胆 | 12.1×5.4(11.8—13.0×5.4—5.8) | 2.5×2.0(2.4—3.0×1.8—2.4) | 4.9(4.8—5.0) |
| I 鲦 条 | P 胆 | 13.0×5.4(12.0—14.4×4.8—6.0) | 3.4×2.8(3.0—3.6×2.4—3.0) | 5.0(4.2—6.0) |
| J 长春鳊 | P 胆 | 14.0×5.3(13.2—14.4×4.8—6.0) | 3.5×2.9(3.2—3.8×2.4—3.6) | 5.8(5.4—6.4) |
| K 三角鲂 | P 胆 | 12.3×5.3(12.0—13.2×4.8—5.4) | 2.7×2.6(2.4—3.0×2.4—2.8) | 5.0(4.8—6.0) |
| L 鳙 | P 胆 | 12.9×5.6(12.0—13.2×4.8—6.0) | 2.6×2.5(2.4—3.0×2.4—2.6) | 5.3(4.8—6.2) |
| M 鲢 | P 胆 | 13.1×5.1(12.0—14.4×4.8—6.0) | 2.6×2.4(2.4—3.0×2.4—2.8) | 5.8(5.4—6.0) |
| N 麦穗鱼 | P 胆 | 13.0×5.6(12.0—14.2×5.4—6.0) | 3.3×2.5(3.0—3.6×2.4—2.6) | 5.4(4.8—7.0) |
| O 圆尾斗鱼 | P 胆 | 12.4×5.2(11.4—13.2×4.8—6.0) | 3.0×2.8(2.4—3.6×2.4—3.0) | 4.4(3.6—6.0) |

A: host

B: site of infection

C: the spore's length x its breadth (μm)

D: the polar capsules' length x their breadth (μm)

E: distance between the polar capsules (μm)

F: Mylopharyngodon piceus

G: Ctenopharyngodon idellus

H: Opsariichthys uncirostris bidens

I: Hemiculter leucisculus

J: Parabramis pekinensis

K: Megalobrama terminalis

(Explanation of Table 6, cont.)

L: Aristichthys nobilis

M: Hypophthalmichthys molitrix

N: Pseudorasbora parva

O: Macropodus chinensis

P: gall bladder

10. Myxidium spinosum Lee & Nie, 1965 (Plate XVII, Figs. 84-88)

Sites of Infection and Hosts: The kidney, ureter and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

The trophozoites are pale yellow, amoeboid masses of protoplasm measuring 19.8 (14.4 - 21.2) μm in length and 17.3 (13.2 - 27.6) μm in breadth. /p. 67 Within each of the trophozoites are one, two or even more spores. The pseudopodia are short and leaflike.

Viewed from the valvular plane aspect, the spores are heart-shaped or elliptical. The surface of the spores is marked with eight rows of small, regularly arranged spines; these spines are positioned in a criss-crossed fashion with respect to their neighbouring ones. As a result of this, the pattern displayed by any three given spines in every two rows resembles that represented by the Chinese character "品". The spines are slightly expanded at their tips, and their length is approximately 0.8 μm. From the sutural plane aspect, [the spores] are circular or fusiform, and the sutural ridge is straight and conspicuous. The spores are 8.0 (6.4 - 8.4) μm long, 9.0 (7.2 - 10.8) μm wide, and 6.0 - 6.8 μm thick. Two polar capsules with a pyriform shape are observed, grouped together at the anterior end of the spore. The

apertures of these polar capsules, however, are inclined toward the two ends [of the spore]. The length of the polar capsules is 3.1 (2.4 - 3.6) μm and their breadth is 3.0 (2.4 - 3.6) μm. The polar filaments exhibit four or five coils. The sporoplasm takes up approximately one-half of the spore's length. Two circular germinal vesicles can be seen.

Myxidium spinosum has been found in the Huanggang and Xiaogan districts.

11. Myxidium ophiocephali (Chen & Hsieh, 1961) (Plate XVIII, Figs. 89-95)

Alternate name: Zschokkella ophiocephali Chen & Hsieh, 1961.

Sites of Infection and Hosts: The gall bladder and intestines of Aristichthys nobilis and Hypophthalmichthys molitrix.

Cysts have not been discovered yet. The trophozoites exhibit a variety of shapes, having a circular outline in some cases and an oval or elongated elliptical one in others. They measure 55.2 (33.6 - 79.2) μm in length and 29.7 (10.8 - 42.0) μm in breadth. The number of spores occurring within each of the trophozoites is variable, ranging from four to six on the one hand to several dozen or even several hundred spores at the other extreme. Pseudopodia can be seen in in vivo observations.

The spores are rectangular with bluntly rounded ends. The sutural ridge is either straight (Plate XVII, Fig. 93) or in S-form (Plate XVII, Figs. 89 and 94), and the striations on the spore's surface extend either parallel or obliquely in relation to the sutural ridge. The length of the spores is 13.1 (12.0 - 14.4) μm and their breadth is 5.2 (4.8 - 6.0) μm. The polar capsules are spherical, and their apertures are located at the ends of the spores. The polar filaments are coiled, exhibiting five volutions. The polar capsules are

4.7 (4.6 - 4.8) μm long and 4.5 (4.2 - 4.8) μm wide, and the distance between them is approximately 5.0 μm. The sporoplasm is compact, and occasionally two circular germinal vesicles (Plate XVII, Fig. 92) can be observed.

Myxidium ophiocephali was initially discovered by CHEN Qi-liu and his colleagues in kidney tissue of the snakeheaded fish Ophiocephalus argus argus Cantor. They identified this organism as Zschokkella ophiocephali. However, the present authors have conducted a detailed comparison between the specimens that they have found in the gall bladder, intestines, and other tissues of Aristichthys nobilis and Hypophthalmichthys molitrix, and the specimens that [CHEN et al.] observed infecting the bodies of Ophiocephalus argus, and the results of these studies indicated that there were no significant differences between these specimens as regards their shape and size. Based on the principal characteristics of the genus Zschokkella, it is the writers' view that this parasite is more plausibly classified as a member of Myxidium.

This organism shows a fairly wide distribution, as it can be found in all three [of the] districts [considered here], i.e., Jingzhou, Xiaogan and Huanggang.

12. Myxidium macrocapsulare Auerbach, 1910 (Plate XVIII, Figs. 96-98)

Site of Infection and Host: The gall bladder of Pseudobagrus fulvidraco.

The spores have an elongated elliptical shape with slightly pointed ends. The sutural ridge is prominent, as are the protruding striations that run parallel to it. The spores are 11.7 (11.4 - 12.0) μm long and 5.8 (5.4 - 6.0) μm wide. The polar capsules are relatively large and have an oval or spheroidal shape, with their apertures occurring at the ends of the spore. The polar filaments are coiled, with five volutions. The polar capsules

measure 3.7 (3.6 - 3.8) μm in length and 3.5 (3.4 - 3.6) μm in breadth, and they are separated by a distance of 2.8 (2.4 - 3.0) μm. The sporoplasm is meager but compact. Two circular germinal vesicles are present; these are positioned either relatively close together or somewhat apart from each other.

This parasite has only been encountered in the Xiaogan district.

13. Myxidium rhinogobides Nie & Lee, 1964 (Plate XVIII, Figs. 99-102)

Site of Infection and Hosts: The liver of fishes in the family Gobiidae.

The spores have an elongated elliptical shape, with one end being /p. 68 somewhat sharply pointed. Viewed from the sutural plane aspect, the sutural ridge exhibits somewhat of an S-shape. When the spores are viewed from the valvular plane aspect, four or five striations that fail to extend to the spores' tips can be seen (Figs. 99 and 102). The length of the spores is 14.0 (13.2 - 14.4) μm, their breadth is 7.0 (6.2 - 7.2) μm, and their thickness is approximately 6.5 μm. The polar capsules are more or less round and the polar filaments are coiled, with five to seven volutions. The polar capsules measure 4.9 (4.8 - 5.0) μm in length and 4.7 (4.2 - 4.8) μm in width, and they are separated by a distance of about 2.4 μm.

This parasite was discovered in the internal organs of a Rhinogobio typus* fish from the reservoir of the Bailian River at Xishui.

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*Translator's note: This is a guess, based on the name that has been given to this parasite and a similarity between one of its primary Chinese characters and the Chinese name of Rhinogobio typus.

## Genus: Zschokkella Auerbach, 1910

14. Zschokkella carassii Nie & Lee, 1964 (Plate XVIII, Figs. 103-106)

Sites of Infection and Hosts: The gall bladder and ureter of Carassius auratus and Cyprinus carpio.

The trophozoites are quite large, and the pseudopodia can be seen in living trophozoites. After [the trophozoites] have been fixed, their ectoplasm is very transparent, but numerous wrinkles are produced by the fixing process; these wrinkles appear to be a decorative pattern, much like the border around a pillow (Plate XVIII, Fig. 105). The endoplasm [is composed of] fine granules, and it contains numerous spores. The trophozoites are 2.8 m long and 0.8 - 1.0 $\mu$m wide.

Seen from the valvular plane aspect, the spores have a reniform shape, while in sutural plane aspect they appear elliptical. The sutural ridge is conspicuous and in S-form; it wraps around the spores, extending from one of their ends to the other. The spore's surface is provided with striations that run parallel to the sutural ridge. The length of the spores is 14.6 (13.2 - 15.6) $\mu$m, their breadth is 8.6 (8.4 - 9.0) $\mu$m, and their thickness averages 7.8 $\mu$m. The polar capsules are spheroidal, and the polar filaments are coiled, exhibiting five volutions. Moreover, the apertures of the polar capsules are not situated at the tips of the spores. The distance between the polar capsules ranges from 2.4 - 3.6 $\mu$m. Two germinal vesicles are observed; these vesicles are circular, but their positions are variable.

Zschokkella carassii have been found in the bodies of Carassius auratus and Cyprinus carpio fishes from the Jingzhou and Huanggang districts. However, neither the rate nor magnitude of infection with this parasite is very high.

15. Zschokkella minuta Nie & Lee, 1964 (Plate XVIII, Figs. 107-110)

Site of Infection and Host: The gall bladder of Cyprinus carpio.

When viewed from the valvular plane aspect, the spores exhibit a semi-circular shape (Plate XVIII, Figs. 108 and 109); from the sutural plane aspect, however, their shape is reniform. Eight or nine distinct striations occur on the surface of the spore. The length of the spores is 7.9 (7.8 - 8.9) μm, their breadth is 5.0 (4.8 - 6.0) μm, and their thickness is approximately 4.8 μm. The two polar capsules are more or less round, and the polar filaments are coiled, with four or five volutions. Both the length and breadth of the polar capsules are about 2.4 μm, while the distance between these capsules is about 1.0 μm. The sutural ridge is prominent and S-shaped; it wraps around the spores, extending from one of their ends to the other.

Zschokkella minuta has only been found in the body of one Cyprinus carpio fish from the Xiaogan district.

## Genus: Sphaeromyxa Thélohan, 1892

16. Sphaeromyxa sabrazesi Laveran & Mesnil, 1900 (Plate XVIII, Figs. 111 and 112)

Site of Infection and Host: The gall bladder of the long-tailed anchovy Coilia ectenes Jordan et Seale.

No cysts have been discovered as yet. The spores are banana-shaped, with their median parts being slightly curved, their ends somewhat narrower, and their surface smooth. The length of the spores ranges between 16.8 and 19.4 μm and their breadth is 4.0 - 4.2 μm. The pair of polar capsules have an elongated oval shape, and the polar filaments are ribbon-like and coiled, exhibiting three or four volutions. The polar capsules measure 4.8 - 5.4 μm in

length and 2.0 - 3.0 μm in breadth, and they are separated by a distance of 4.8 - 6.0 μm. The sporoplasm is relatively abundant, and two circular germinal vesicles can be seen positioned close to each other. Although this species of Sphaeromyxa is observed fairly commonly in marine fishes, this marks the first time it has been discovered in a freshwater fish. The parasite described here was found in the body of a single Coilia ectenes anchovy from Huangsha Lake in the Huanggang district. Neither the rate nor the magnitude of infection with this organism is very high. /p. 69

**Family: Myxosomatidae**

**Genus: Myxosoma** Thélohan, 1892

17. Myxosoma bibullatum Kudo, 1934 (Plate XVIII, Figs. 113-115)

Sites of Infection and Host: The gills, heart, kidney and gall bladder of Carassius auratus.

Seen from the valvular plane aspect, the spores have an elliptical shape, with a thick spore case; the spores are smooth at their anterior end, and they exhibit six or seven V-shaped plications at their posterior end. The intercapsular appendix is comparatively prominent. When the spores are viewed from the sutural plane aspect, they appear fusiform, and the sutural ridge is straight and distinct. The spores are 14.1 (13.2 - 15.6) μm long and 11.2 (9.6 - 12.0) μm wide. The two polar capsules are shaped like eggplants and are slightly different in size; situated at the anterior end of the spore, they account for approximately half of its total length. Their anterior ends, moreover, are positioned rather close together, while their posterior ends diverge away from each other somewhat. The length of the polar capsules is 6.3 (6.0 - 7.0) μm and their breadth is 3.5 (3.0 - 3.6) μm. Two noticeable

germinal vesicles occur within the sporoplasm, but no iodinophilous vacuole is observed.

Myxosoma bibullatum is a parasite that is frequently encountered in the internal organs of Carassius auratus. It is especially prevalent in this fish's heart.

18. Myxosoma notropis Fantham, Porter & Richardson, 1939 (Plate XIX, Figs. 116-123)

Sites of Infection and Host: The intestines, gall bladder, liver, kidney and heart of Carassius auratus.

This parasite frequently forms elliptical cysts in the epithelial tissues of the intestinal wall (Plate XIX, Fig. 120). These cysts are white, and they are enveloped by multiple layers of connective tissue. The cysts measure 1 to 3 $\mu$m in length and 0.5 - 2 $\mu$m in width.

When viewed from the valvular plane aspect, the spores appear broader anteriorly and narrower posteriorly, with bluntly rounded ends. Seen from the sutural plane aspect, the spores are fusiform, with the sutural ridge appearing rather thick and extending either straight or somewhat undulatingly. The length of the spores is 13.7 (12.0 - 15.6) $\mu$m, their breadth is 8.6 (7.8 - 9.0) $\mu$m, and their thickness is 6.4 $\mu$m. The polar capsules have an elongated pyriform shape and are of similar size, measuring 5.3 (4.8 - 6.0) $\mu$m in length and 3.0 (2.6 - 3.6) $\mu$m in width. The sporoplasm is thick and dense, and lacks an iodinophilous vacuole. Two circular germinal vesicles are present, however, and they are often positioned close to one another. The surface of the spores possesses V-shaped plications; these folds vary in number, but usually more than seven of them can be seen.

This species of Myxosoma is found on a rather frequent basis in the various internal organs of Carassius auratus. It was discovered in all three districts [that were covered] in the present investigation, i.e., Huanggang, Xiaogan, and Jingzhou.

19. Myxosoma cerebralis (Hofer, 1903) . (Plate XIX, Figs. 124-127)

Alternate names: Myxobolus cerebralis Hofer, 1903; Lentospora cerebralis (Hofer) Plehn, 1905.

Sites of Infection and Host: The heart, kidney, intestines, swim bladder, urinary bladder, and spinal cord of Carassius auratus.

Seen from the valvular plane aspect, the spores have an elliptical to circular shape, and two to four V-shaped plications can often be observed at their posterior end. The spores appear fusiform from the sutural plane aspect, with the sutural ridge being straight and conspicuous. The spores are 8.9 (8.4 - 9.6) μm long, 8.5 (8.4 - 9.0) μm wide, and approximately 6.0 μm thick. The two pyriform polar capsules occupy about one-half of the spore's length; they are positioned fairly close together at their anterior ends, but they diverge from each other posteriorly, in a manner reminiscent of the character "人". The polar capsules measure 4.6 (4.2 - 4.8) μm in length and 2.5 (2.4 - 2.6) μm in breadth. The nuclei of the polar capsules have a circular or triangular shape and appear to be closely appressed to the bottoms of the capsules at their sides. Within the sporoplasm are two circular germinal vesicles; no iodinophilous vacuole is observed.

This species of Myxosoma is encountered fairly often in the Xiaogan and Jingzhou districts. During the present investigation, however, no evidence of "dizziness disease" was found. /p. 70

20. Myxosoma pfrille Fantham, Porter & Richardson, 1939 (Plate XIX, Figs. 128-132)

Site of Infection and Host: The bases of the gill filaments of Cyprinus carpio.

The cysts have a circular or elliptical shape, and infect the host either between its gill filaments or within the gill filaments' tissues. These cysts range in length between 310.0 - 330.3 μm and in width from 255.0 - 325.0 μm.

Viewed from the valvular plane aspect, the spores are elliptical, and at their posterior end there are four or five V-shaped plications. The intercapsular appendix, moreover, is fairly noticeable. Viewed from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and distinct. The length of the spores is 12.9 (12.0 - 14.4) μm, their breadth is 9.5 (8.4 - 10.2) μm, and their thickness is approximately 7.0 μm. The polar capsules are pyriform and of equivalent size; they are arranged parallel to one another at the anterior end of the spore. The polar filaments show five coils, and the polar capsules are 5.6 (5.0 - 6.0) μm long and 3.6 μm broad. The nuclei of the polar capsules have a semilunar or triangular shape, and they appear to be closely appressed to the bottoms of the capsules. No iodinophilous vacuole is observed in the sporoplasm; however, two circular germinal vesicles can be seen, and they are positioned fairly closely together. This parasite has only been found on the gills of Cyprinus carpio fishes from Wangtian Lake in the Huanggang district.

21. Myxosoma sinensis Nie & Lee, 1964 (Plate XIX, Figs. 133-141)

Sites of Infection and Host: The gall bladder, intestinal wall, spleen, kidney and urinary bladder of Cyprinus carpio.

The cysts are white and have a circular or elliptical shape; the larger ones are 1.0 - 1.5 mm in diameter, while the smaller ones are 150-260 μm long and 120-310 μm wide.

Seen from the valvular plane aspect, the spores have an elongated oval or an oval-to-circular shape, with their anterior end being either somewhat pointed or bluntly rounded. The posterior end of the spores frequently bears plications, which vary in number. Viewed from the sutural plane aspect, the spores are either fusiform or elongated oval in outline; as a rule, the sutural ridge is straight, but in some cases it assumes a curved form. The spores are 10.0 (8.0 - 12.0) μm long, 8.6 (8.4 - 9.6) μm wide, and approximately 6.0 μm thick. The two pyriform polar capsules occupy about one-half of the spore's length, and the polar filaments are coiled, with six volutions. The length of the polar capsules is 4.7 (4.2 - 5.0) μm and their breadth is 2.9 (2.4 - 3.0) μm. The sporoplasm is homogeneous and does not contain an iodinophilous vacuole. However, two circular germinal vesicles are present, and they are positioned either close together or apart from each other.

This type of myxosporidian is commonly encountered in the internal organs and tissues of Cyprinus carpio. It was discovered in all three of the regions surveyed during this investigation, i.e., in the Xiaogan, Jingzhou, and Huanggang districts.

22. Myxosoma varia (Achmerov) Nie & Lee, 1964 (Plate XX, Figs. 142-147)

Alternate name: Myxobolus varius Achmerov, 1960.

Sites of Infection and Hosts: The body surface, gills, intestines, gall bladder, kidney, spleen and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

No trophozoites have been discovered as yet, as only some scattered spores have been discovered to date in the hosts' tissues (Plate XX, Fig. 145). No encystment has been observed.

Viewed from the valvular plane aspect, the spores have an elliptical shape, with bluntly rounded ends; occasionally four or five V-shaped plications can be seen in the posterior end of the spore. Viewed from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and prominent. The spores are 10.3 (9.6 - 11.0) $\mu$m long and 6.8 (6.0 - 7.2) $\mu$m wide. Two polar capsules are present; they are either pyriform or oval in form and are arranged parallel to one another at the anterior end of the spore; these polar capsules account for two-fifth's of its total length, as they measure 3.7 (3.6 - 3.8) $\mu$m in length and 2.3 (2.2 - 2.4) $\mu$m in breadth. No iodinophilous vacuole occurs within the sporoplasm, but two circular germinal vesicles are present.

Myxosoma varia most readily infects Aristichthys nobilis and Cyprinus carpio during their summer and fry stages of development. This myxosporidian was discovered in breeding ponds in all three of the regions that were studied in the current investigation, i.e., in the Xiaogan, Huanggang and Jingzhou districts.

23. Myxosoma lieni Nie & Lee, 1964 (Plate XX, Figs. 148-152)

Sites of Infection and Host: The intestines, gall bladder, spleen, muscles and urinary bladder of Hypophthalmichthys molitrix.

The trophozoites have a light yellow coloration and vary in size. Two to many spores are contained within them (Plate XX, Fig. 148).

The spores have a more or less circular shape. Whether seen in /p. 71 apical view or from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and conspicuous. The diameter of the spores ranges from 7.2 - 7.4 μm, and their thickness is 4.8 - 5.0 μm. The two pyriform polar capsules are grouped at the anterior end of the spore, taking up approximately one-half to two-thirds of its total length. The polar filaments are coiled, with five volutions. The length of the polar capsules is 3.8 (3.6 - 4.2) μm while their width is 2.8 (2.6 - 3.0) μm. The sporoplasm is homogeneous and compact and lacks an iodinophilous vacuole. Two circular germinal vesicles are present, however, and they are often positioned close together.

Myxosoma lieni has been found in the Huanggang, Xiaogan and Jingzhou regions, among others. Infection by this myxosporidian is fairly common in Hypophthalmichthys molitrix fishes; it occurs with an especially high frequency in the fry stage and in adults.

24. Myxosoma ophiocephali Chen & Hsieh, 1960 (Plate XX, Figs. 153-155)

Site of Infection and Host: The gill filaments of Ophiocephalus argus.

The cysts have a circular or elliptical form. In addition to spores, these cysts contain a black-coloured granular material. The cysts range in diameter from 60.0 to 63.0 μm.

Seen from the valvular plane aspect, the spores exhibit an elongated oval

or pyriform shape, with their anterior end being pointed and their posterior end being bluntly rounded. Viewed from the sutural plane aspect, the spores appear fusiform, and their sutural ridge is straight and prominent. The length of the spores is 12.5 (12.0 - 13.6) μm, their breadth is 7.1 (6.6 - 7.4) μm, and their thickness is approximately 5.4 μm. A pair of pyriform polar capsules are observed, and the polar filaments are coiled with seven volutions. The polar capsules measure 6.5 (6.0 - 7.2) μm in length and 2.4 μm in breadth. No iodinophilous vacuole occurs within the sporoplasm. The germinal vesicles are small and circular, although at times it may be difficult to see them.

Myxosoma ophiocephali has been discovered in both the Xiaogan and Huanggang districts.

**Family: Myxobolidae**

**Genus: Myxobolus** Bütschli, 1882

25. Myxobolus diversus Nie & Lee, 1964 (Plate XX, Figs. 156-160)

Sites of Infection and Host: The gall bladder, intestines, spleen, kidney, muscles and urinary bladder of Carassius auratus.

The cysts are of different sizes, with the smaller ones containing no more than a few spores and the larger ones attaining a diameter of as much as 200 μm.

The spores are highly variable in form, but they usually display a shape similar to that of a muskmelon. Viewed from the valvular plane aspect, the anterior end of the spores is more sharply pointed than their posterior end, and V-shaped plications of varying numbers are frequently observed. Seen from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and thick. The spores measure 15.4 (13.2 - 16.8) μm in

length, 9.0 (7.8 - 9.6) μm in breadth, and 6.6 - 7.2 μm in thickness. The two polar capsules differ from each other in size and are situated at a position more than one-third of the length of the spore at its anterior end. The larger polar capsule is 5.8 (4.8 - 6.6) μm long and 3.4 (3.0 - 3.6) μm wide, while the smaller polar capsule is 2.8 (2.4 - 3.0) μm long and 1.6 (1.2 - 1.8) μm wide. A conspicuous iodinophilous vacuole and two circular germinal vesicles can be seen in the sporoplasm.

This species of Myxobolus is most frequently found in the internal organs and tissues of Carassius auratus. It was encountered in all of the regions surveyed in the present investigation, i.e., in the Huanggang, Jingzhou and Xiaogan districts.

26. Myxobolus rutilus Nie & Lee, 1964 (Plate XX, Figs. 161-163)

Alternate name: Myxobolus sp. Lom, 1960.

Sites of Infection and Host: The gall bladder, liver, kidney, muscles and urinary bladder of Carassius auratus.

The cysts are circular and usually contain only a small number of spores. The length of the cysts is 19.2 μm, and their width is also 19.2 μm.

Viewed from the valvular plane aspect, the spores either appear oval or have a shape resembling that of a melon seed. Moreover, they may be either smooth or plicate. Seen from the sutural plane aspect, the spores have a shortened fusiform shape, and the sutural ridge is conspicuous and straight. The length of the spores is 8.5 (8.0 - 9.0) μm, their breadth is 6.8 (6.0 - 7.8) μm, and their thickness is 4.8 - 5.0 μm. Two pyriform polar capsules of more or less equal size are present; as a rule, they occupy more than one-half of the spore's length. The polar filaments have three or four coils. The

polar capsules measure 4.8 (4.6 - 5.0) μm in length and 2.5 (2.4 - 2.8) μm in breadth. A prominent iodinophilous vacuole and two circular germinal /p. 72 vesicles can be seen within the sporoplasm.

This species is one of the most commonly observed types of myxosporidian in the internal organs of Carassius auratus. It was discovered in all of the areas included in the present investigation, i.e., in the Huanggang, Jingzhou, and Xiaogan regions.

27. Myxobolus musculi Keysselitz, 1908 (Plate XX, Figs. 164-168)

Sites of Infection and Host: The intestines, gall bladder, liver, kidney, heart, swim bladder and urinary bladder of Carassius auratus.

The trophozoites form cysts of varying sizes that are surrounded by comparatively thick connective tissue. Inside these cysts are not only spores but also a large number of yellow or black granules of differing sizes. The length of these cysts is 125.8 (32.7 - 393.0) μm, and their width is 59.3 (36.7 - 147.0) μm.

When viewed from the valvular plane aspect, these spores are oval, with their anterior end being somewhat pointed and their posterior end being bluntly rounded. Seen from the sutural plane aspect, the spores have an elongated fusiform shape, and the sutural ridge is straight and conspicuous. The spores are 10.7 (9.6 - 12.0) μm long, 8.3 (7.2 - 8.4) μm broad, and approximately 6.0 μm thick. The two polar capsules are unequal in size and have the shape of an eggplant; they take up about two-thirds of the spore's length. The larger polar capsule is 7.2 (6.2 - 8.4) μm long and 3.4 (2.6 - 3.6) μm wide, while the smaller one measures 5.9 (4.8 - 6.0) μm in length and 2.6 (2.2 - 3.0) μm in breadth. The polar filament of the larger polar capsule

has five or six coils, while that of the smaller polar capsule shows four or five coils. There is relatively little sporoplasm. The iodinophilous vacuole is very prominent, and there are two germinal vesicles that are positioned close together.

Myxobolus musculi is one of the most frequently observed species of myxosporidian in the internal organs of Carassius auratus. It has been found in all of the areas studied in the current investigation, i.e., in the Huanggang, Jingzhou and Xiaogan regions, with the highest infection rate being recorded in the Huanggang district.

28. Myxobolus carassii Klokaceva, 1914 (Plate XX, Figs. 169-170; Plate XXI, Figs. 171-177)

Site of Infection and Host: The kidney of Carassius auratus.

The spores are elliptical when viewed from the valvular plane aspect, and their surface is either smooth or provided with V-shaped plications. Seen from the sutural plane aspect, the spores are fusiform, and the sutural ridge is straight and conspicuous. The length of the spores is 14.1 (13.2 - 15.6) μm, their breadth is 10.1 (8.4 - 10.8) μm, and their thickness is approximately 6.2 μm. There are two polar capsules that are shaped like eggplants and are more or less equal in size; arranged in a manner suggestive of the character "八", these polar capsules extend slightly less than one-half of the spore's length. The polar capsules are 6.1 (6.0 - 6.4) μm long and 3.2 (3.0 - 3.6) μm wide, and the polar filaments are coiled, with eight or nine volutions. The nuclei of the polar capsules are triangular and appear to be closely appressed to the bottoms of the capsules. In the sporoplasm are a rather large iodinophilous vacuole and a pair of circular germinal vesicles.

Although Myxobolus carassii has been discovered in both the Huanggang and Xiaogan regions, the rate of infection shown by this parasite is not very high.

29. Myxobolus bilis Achmerov, 1960 (Plate XXI, Figs. 178-181)

Sites of Infection and Host: The gall bladder, intestines, kidney, swim bladder, and urinary bladder of Carassius auratus.

The cysts are more or less circular in shape and contain black and brown granules in addition to spores. The length of the cysts is 39.6 - 49.3 μm and their breadth is 32.4 - 47.3 μm.

When viewed from the valvular plane aspect, the spores are circular or broadly oval, and their surface is either smooth or provided with a number of V-shaped plications. From the sutural plane aspect, the spores appear to be shaped like melon seeds, and the sutural ridge is straight and conspicuous. The length of the spores is 9.0 (8.4 - 9.6) μm, their breadth is 8.5 (8.4 - 9.0) μm, and the thickness is approximately 6.0 μm. The polar capsules are of equal size, oval in form, and arranged in a pattern reminiscent of the character "ノ乀". The length of the polar capsules is 5.1 (4.8 - 6.0) μm and their breadth is 3.1 (3.0 - 3.6) μm. The polar filaments are coiled, with five or six volutions. The sporoplasm is homogeneous and possesses one iodinophilous vacuole and a pair of circular germinal vesicles.

Myxobolus bilis is also one of the most frequently seen myxosporidians in the internal organs and tissues of Carassius auratus. This parasite was discovered in breeding ponds in all three of the regions that were the principal focus of the present investigation.

30. Myxobolus velatus Lee & Nie, 1965 (Plate XXI, Figs. 182-186)

Sites of Infection and Host: The body surface and gills of Carassius auratus.

The cysts are circular or elliptical and infect the host between /p. 73 its gill lamellae. These cysts measure 163 (126-257) μm in length and 119.4 (78.7 - 220.5) μm in breadth.

When viewed from the valvular plane aspect, the spores have a broadly oval shape, with their anterior end being somewhat pointed and their posterior end showing a blunt rounding. Their posterior end, moreover, not only displays four or five V-shaped plications, but also a thin membrane that is suspended from it and seems to provide the spore with a decorative border of sorts. Viewed from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and conspicuous. The length of the spore proper is 9.4 (8.4 - 9.6) μm, while its width is 8.2 (7.4 - 8.4) μm and its thickness ranges between 6.0 and 7.0 μm. The thin membrane at the posterior end of the spores is 1.3 (1.2 - 1.8) μm long and 5.9 (5.8 - 6.6) μm wide. There are two pyriform polar capsules of more or less equal size, and they frequently occupy one-half of the spore's length. The polar filaments have eight or nine coils. The length of the polar capsules is 5.0 (4.8 - 5.4) μm and their breadth is 3.1 (3.0 - 3.4) μm. The sporoplasm is homogeneous and compact, and it possesses a iodinophilous vacuole that is not very prominent and a pair of circular germinal vesicles.

Myxobolus velatus, too, is among the most commonly seen myxosporidians in the gill tissues of Carassius auratus. Ordinarily, however, neither the rate nor magnitude of infection by this organism is very high.

31. Myxobolus egregius Lee & Nie, 1965 (Plate XXI, Figs. 187-189)

Sites of Infection and Host: The gall bladder, intestines and kidney of Carassius auratus.

No cysts have been discovered as yet. When viewed from the valvular plane aspect, the spores have an oval shape, and frequently five to seven V-shaped plications can be seen. From the sutural plane aspect, the spores have the form of Chinese dumplings, with one side exhibiting a slight inward concavity. The spores measure 20.0 (18.8 - 21.6) μm in length, 13.6 (13.2 - 15.6) μm in breadth, and 10.8 μm in thickness. The two polar capsules are small, oval, and unequal in size, and they occupy about one-fourth of the spore's length. The polar filaments are coiled, with three or four volutions. The larger polar capsule is 5.7 (5.0 - 6.0) μm long and 3.9 (3.6 - 4.2) μm wide, while the smaller one is 3.9 (3.6 - 4.8) μm long and 2.7 (2.4 - 3.0) μm wide. The sporoplasm is very abundant, and it is provided with a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

This species of Myxobolus has been discovered in the Jingzhou and Xiaogan districts, but neither its infection rate nor the magnitude of its infections are very great.

32. Myxobolus gigi (Fujita 1927) Schulman, 1962 (Plate XXI, Figs. 190-193)

Sites of Infection and Host: The gills and gall bladder of Carassius auratus.

No cysts have been found to date. Viewed from the valvular plane aspect, the spores have an elongated elliptical shape, and they are smooth as no plications can be seen. Observed from the sutural plane aspect, the spores

are fusiform, and the sutural ridge is straight and prominent. The spores are 14.5 (13.2 - 14.8) μm long, 7.2 (6.8 - 7.4) μm broad, and 5.0 - 5.4 μm thick. The polar capsules, which have an elongated elliptical shape, are usually unequal in size, and they are arranged tightly parallel to one another. The polar filaments are ribbon-like and coiled, displaying three or four volutions. The larger polar capsule measures 6.1 (6.0 - 6.6) μm in length and 2.5 (2.4 - 3.0) μm in breadth, while the smaller one is 5.0 (4.8 - 5.2) μm long and 2.3 (2.2 - 2.4) μm broad. Within the sporoplasm can be found an iodinophilous vacuole that extends up to about 3.6 μm in diameter, and a pair of circular germinal vesicles.

Myxobolus gigi was discovered on the bodies of three Carassius aratus fishes in the Xiaogan and Huanggang districts.

33. Myxobolus kubanicum I. & B. Bychowsky, 1940 (Plate XXI, Figs. 194-195; Plate XXII, Figs. 195a-200)

Sites of Infection and Host: The fins, gills, kidneys, swim bladder, and urinary bladder of Carassius auratus.

Viewed from the valvular plane aspect, the spores have an obovate or rectangular form, and three or four V-shaped plications can often be seen. Viewed from the sutural plane aspect, the spores appear fusiform, with the sutural ridge being straight and conspicuous. The length of the spores is 10.3 (9.6 - 11.0) μm, their width is 7.6 (7.2 - 8.0) μm, and their thickness is 5.4 - 6.0 μm. There are two polar capsules of equivalent size that occupy approximately one-third of the spore's length; they are 3.7 (3.6 - 3.8) μm long and 2.5 (2.4 - 2.6) μm broad. The nuclei of the polar capsules are triangular, and they appear to be closely appressed to the bottoms of the capsules. The

sporoplasm takes up approximately two-thirds of the spore's [total length], and it contains an iodinophilous vacuole and two circular germinal vesicles.

This species of Myxobolus is a parasite that is encountered rather frequently, both on the inside and the exterior of the bodies of Carassius auratus fishes. Moreover, it is distributed over a fairly broad area. /p. 74

34. Myxobolus nemachili Weiser, 1949 (Plate XXII, Figs. 201-208)

Sites of Infection and Host: The gill filaments and urinary bladder of Carassius auratus.

The cysts are circular or elliptical, and they infect the host between two gill filaments. These cysts are 12 μm long and 8.1 μm wide.

Seen from the valvular plane aspect, the spores have an elliptical shape, and they are either smooth or provided with numerous V-shaped plications. Viewed from the sutural plane aspect, the spores have a lenticular shape, and their sutural ridge is straight and prominent. The length of the spores is 11.4 (10.8 - 12.0) μm, their breadth is 8.5 (8.4 - 9.0) μm, and their thickness is 5.4 - 6.0 μm. The polar capsules have an elongated oval shape and are more or less equal in size. They extend approximately one-half of the spore's length, as they are 4.6 (4.2 - 4.8) μm long and 2.8 (2.4 - 3.2) μm wide. A distinct iodinophilous vacuole occurs within the sporoplasm, along with a pair of circular germinal vesicles.

This species of Myxobolus is one of the more commonly seen types of myxosporidian on the gills of Carassius auratus. It was found in C. arautus fish in all of the major areas investigated in this study, i.e., in the Huanggang, Xiaogan, and Jingzhou districts.

35. Myxobolus koi Kudo, 1919 (Plate XXII, Figs. 209-212)

Site of Infection and Hosts: The gill filaments of Cyprinus carpio and Carassius auratus.

No trophozoites have been found as yet. The cysts are white, and they ordinarily infect the host between its gill lamellae. These cysts are either oval or elliptical, and they measure 0.2 - 0.3 μm in length and 0.2 μm in width.

Viewed from the valvular plane aspect, the spores have an elongated oval shape; their anterior end is pointed and their posterior end is bluntly rounded, while their surface is either smooth or provided with V-shaped plications. Seen from the sutural plane aspect, the spores appear to have the shape of eggplants, with one side protruding rather conspicuously in an arched curve, and the sutural ridge is straight and distinct. The length of the spores is 13.2 (12.6 - 14.4) μm, their breadth is 7.1 (6.0 - 7.8) μm, and their thickness is about 6.0 μm. The two polar capsules are bottle-shaped and more or less equal in size; they occupy two-thirds of the spore's length, and are 7.2 (6.0 - 8.4) μm long and 2.5 (2.4 - 3.0) μm broad. The sporoplasm is homogeneous and has a conspicuous iodinophilous vacuole that measures 2.4 - 3.0 μm in diameter. There are two germinal vesicles that have a circular outline.

Myxobolus koi is one of the most commonly encountered types of myxosporidian in the gill tissues of Cyprinus carpio. During the present investigation it was discovered in both the Huanggang and Xiaogan districts.

36. Myxobolus toyamai Kudo, 1915 (Plate XXII, Figs. 213-216)

Site of Infection and Hosts: The gill filaments of Cyprinus carpio and Carassius auratus.

The cysts have an oval or elliptical shape and are white or pale yellow in colour. Larger cysts can be seen with the unaided eye, while the smaller ones may contain no more than a dozen or so spores. Generally speaking, the cysts range from 300-500 μm in diameter.

Seen from the valvular plane aspect, the spores exhibit the shape of either an eggplant or a bottle gourd, with their anterior end being sharply pointed and curving somewhat toward the side, while their posterior end shows a blunt rounding. The spores measure 14.0 (13.2 - 15.6) μm in length, 5.5 (4.8 - 6.0) μm in breadth, and 4.4 - 5.4 μm in thickness. The two polar capsules are pyriform and greatly different in size. The smaller polar capsule is positioned anterior to the larger one, and it takes up very little space. The larger polar capsule is 5.7 (4.8 - 7.2) μm long and 2.8 (2.4 - 3.6) μm wide, while the smaller polar capsule is 3.2 (2.4 - 3.6) μm long and 0.8 (0.6 - 1.0) μm wide. In the spore's young stage of development, the two polar capsules can be clearly seen. But as the spore continues to develop, one of the polar capsules expands while the other one terminates its growth. In some specimens, however, polar capsules that are of similar size and shape may be observed. The sporoplasm is homogeneous and compact, and two circular germinal vesicles are present. These germinal vesicles are usually positioned close to each other.

This parasite is one of the most commonly seen types of myxosporidian on the gills of Cyprinus carpio, and it exhibits a fairly wide distribution. During the current investigation, it was discovered in both the Xiaogan and Huanggang districts.

37. Myxobolus acinosus Nie & Lee, 1964 (Plate XXII, Figs. 217-220)

Site of Infection and Host: The gill filaments of Cyprinus carpio.

The cysts are oval-to-circular or elliptical in shape, white in colour, and very dissimilar in size, with the larger ones extending more than /p. 75 300 μm in diameter and the smaller ones containing only 20-30 spores.

Viewed from the valvular plane aspect, the spores have a grape-like shape, with their anterior end being sharply pointed and their posterior end bluntly rounded. In some specimens, however, the anterior end of the spore may curve toward one side somewhat, while V-shaped plications can often be observed at the posterior end. The spores have a comparable appearance when viewed from the sutural plane aspect, and the sutural ridge is straight and conspicuous. The length of the spores is 10.0 (9.6 - 10.8) μm long, 5.6 (5.4 - 6.0) μm wide, and 4.8 μm thick. The shape and size of the two polar capsules are markedly different. The smaller polar capsule is situated anterior to the larger one, which measures 4.6 (3.8 - 4.8) μm in length and 2.4 μm in width. The polar filaments are coiled, showing six volutions. The sporoplasm is homogeneous and compact, and it contains a distinct iodinophilous vacuole together with two circular germinal vesicles. These germinal vesicles are frequently positioned close together. Within a given cyst, spores that bear polar capsules of a similar size and shape might also be encountered.

Myxobolus acinosus was discovered on the gills of only a single Cyprinus carpio fish in the Xiaogan region.

38. Myxobolus vastus Kudo, 1934 (Plate XXII, Figs. 221-224; Plate XXIII, Figs. 225-228)

Sites of Infection and Hosts: The gall bladder, intestines, liver, kidney, heart and ureter of Cyprinus carpio and Squaliobarbus curriculus.

When viewed from the valvular plane aspect, the spores have an obovate shape, with their anterior end being somewhat expanded. The spores appear fusiform when seen from the sutural plane aspect, and their sutural ridge is straight and distinct. The length of the spores is 10.2 (9.6 - 10.8) μm, their breadth is 8.2 (7.2 - 8.6) μm, and their thickness is approximately 6.0 μm. The two polar capsules are of similar size and shape, and they diverge [from one another] in a manner somewhat reminiscent of the character "ノ乀". The polar capsules occupy slightly less than one-half of the spore's total length. These polar capsules are 4.4 (4.2 - 4.8) μm long and 2.7 (2.4 - 3.0) μm wide, while the polar filaments are coiled, exhibiting five or six volutions. The nuclei of the polar capsules are triangular in shape and differ in size, with one of them being large and the other one being small. They appear to be closely appressed to the bottoms of the polar capsules. The sporoplasm is abundant and contains a large and prominent iodinophilous vacuole, whose diameter is approximately 3.6 μm. The two circular germinal vesicles are positioned close to each other.

Myxobolus vastus is one of the more commonly seen types of myxosporidian in Cyprinus carpio, both in the internal and external tissues of this fish. This parasite, moreover, shows a broad distribution. It was discovered in [all] of the areas that were the focus of the present investigation - areas, that is, such as the Huanggang district, the Xiaogan district, etc.

39. Myxobolus obliquus Kudo, 1934 (Plate XXIII, Figs. 229-231a)

Sites of Infection and Host: The nasal cavity and kidney of Cyprinus carpio.

No cysts have been found to date. When viewed from the valvular plane aspect, the spores are circular or oval-to-circular in shape, and extending around them are a number of V-shaped plications. When seen from the sutural plane aspect, the spores display a lenticular form, and their sutural ridge is straight and conspicuous. The spores measure 9.3 (7.8 - 9.6) $\mu$m in length, 8.8 (7.2 - 9.6) $\mu$m in width, and 6.0 - 6.8 $\mu$m in thickness. Two pyriform polar capsules are observed. These polar capsules are of similar size and diverge from one another, in a pattern suggestive of the character "/ \". The polar capsules occupy about one-half of the spore's length, as they are 4.7 (4.2 - 5.0) $\mu$m long and 3.1 (3.0 - 3.4) $\mu$m broad. The sporoplasm is homogeneous and extends about one-half of the spore's [length]. The iodinophilous vacuole is large and noticeable, having a diameter of 3.0 $\mu$m. Two circular germinal vesicles are also present.

Myxobolus obliquus was discovered on the body of a single Cyprinus carpio in both the Huanggang and Xiaogan districts.

40. Myxobolus obovoides Lee & Nie, 1965 (Plate XXIII, Figs. 236-239)

Sites of Infection and Host: The gills and urinary bladder of Cyprinus carpio.

The cysts are circular or elliptical and measure 157.5 $\mu$m in length and 131.5 $\mu$m in width. They were discovered between the fish's gill lamellae.

When viewed from the valvular plane aspect, the spores are circular or heart-shaped, and they display four or five V-shaped plications at their

posterior end. Seen from the sutural plane aspect, the spores have a lenticular shape, and the sutural ridge is straight and thick. The length of the spores is 12.2 (11.8 - 13.2) $\mu$m, their breadth is 11.5 (10.8 - 12.0) $\mu$m, and their thickness is approximately 7.4 $\mu$m. The two oval polar capsules are large and thick and more or less equal in size; they occupy about one-half of the spore's length, and they diverge from one another to a slight extent. The polar filaments are coiled, with five volutions, while the nuclei of the polar capsules have a triangular shape and appear to be closely appressed to the bottoms of the capsules. The length of the polar capsules is 6.1 (6.0 - 6.6) $\mu$m and their breadth is 4.7 (4.6 - 4.8) $\mu$m. Within the sporoplasm are a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

This parasite was found on the gills of a single Cyprinus carpio fish from Huangsha Lake in the Huanggang district. /p. 76

41. Myxobolus microlatus Lee & Nie, 1965 (Plate XXIII, Figs. 240-243)

Sites of Infection and Host: The gall bladder and kidney of Cyprinus carpio.

The cysts are spheroidal, and they are surrounded by a comparatively large amount of connective tissue. In addition to spores, the cysts contain yellow- or black-coloured granules of varying sizes. The length of the cysts is 56.4 $\mu$m while their breadth is 54.0 $\mu$m.

Viewed from the valvular plane aspect, the spores have an oblate shape, with their width being greater than their length. The anterior end of the spores is smooth, while their posterior end exhibits four to six V-shaped plications. The intercapsular appendix is indistinct. When seen from the sutural plane aspect, the spores have an elliptical shape, and the sutural

ridge is narrow and straight. The length of the spores is 7.0 (6.0 - 7.8) μm, their breadth is 8.0 (7.4 - 8.4) μm, and their thickness is 6.0 μm. The two polar capsules have a pyriform shape and in most cases differ in size, although sometimes they may be more or less equivalent in this regard. Arranged in a pattern suggestive of the character "/\", the polar capsules take up more than approximately one-half of the spore's length. The larger polar capsule is 4.0 (3.6 - 4.8) μm long and 2.5 (2.4 - 3.0) μm wide, while the smaller polar capsule is 3.2 (3.0 - 3.6) μm long and 2.2 (2.0 - 2.4) μm wide. The sporoplasm is homogeneous, and it contains an iodinophilous vacuole that is not very discernible, as well as two circular germinal vesicles.

Myxobolus microlatus is one of the more commonly seen types of myxosporidian in the kidney tissues of Cyprinus carpio fishes, and it exhibits a fairly wide distribution. It was discovered in [all of the regions] that were studied in the present investigation - i.e., the Jingzhou district, the Huanggang district, etc.

42. Myxobolus opsariichthyi Lee & Nie, 1965 (Plate XXIII, Figs. 232-235)

Sites of Infection and Hosts: The gills, kidney, liver, intestines, spleen and urinary bladder of Opsariichthys uncirostris bidens and Zacco platypus (Schlegel).

No cysts have been discovered as yet. The spores appear elliptical when viewed from the valvular plane aspect, and they may be either smooth or marked with V-shaped plications. When viewed from the sutural plane aspect, the spores have a lenticular shape, and the sutural ridge is straight and conspicuous. The spores are 10.7 (9.4 - 12.0) μm long, 8.4 (6.0 - 9.6) μm wide, and

6.0 - 6.2 μm thick. The two polar capsules are oval and resemble each other in size. Grouped together at the anterior end of the spore, the polar capsules account for something less than one-half of the spore's length. The length of the polar capsules is 4.7 (4.2 - 4.8) μm and their breadth is 3.0 (2.8 - 3.6) μm. The iodinophilous vacuole inside the sporoplasm is large and quite prominent.

This parasite was discovered when fishes in the Xiaogan and Huanggang districts were being investigated. The rates of infection by this organism were found to be fairly high.

43. Myxobolus acanthogobii Hoshina, 1952 (Plate XXIII, Figs. 244-249)

Sites of Infection and Hosts: The gills, intestines, kidney, spleen and swim bladder of Ctenopharyngodon idellus and Mylopharyngodon piceus.

The cysts differ considerably [in shape and size]. As a rule they are circular or elliptical, and they range between 115.2 (42.0 - 147.0) μm in length and 54.4 (31.5 - 99.7) μm in breadth. Spreading out over the external surface of the spores is an extensive membrane that is thin to the point of being translucent. This membrane is separated [from the spore's surface] by a distance of approximately 2.4 μm. Viewed from the valvular plane aspect, the spores are circular to elliptical, and their anterior half appears to be smooth while their posterior half is provided with two to four V-shaped plications. Seen from the sutural plane aspect, the spores have a convex lenticular form, with one side projecting outward to some extent, and the sutural ridge is either straight or curved. The length of the spores is 10.0 (9.6 - 10.8) μm, their breadth is 9.0 (7.8 - 9.6) μm, and their thickness is 5.8 - 6.6 μm. The two polar capsules are similarly pyriform and also have more or less the same

size. Extending 3.8 (3.6 - 4.8) $\mu$m in length and 3.0 (2.8 - 3.6) $\mu$m in width, these polar capsules account for less than one-half of the spore's length. The nuclei of the polar capsules have a triangular shape and appear to be closely appressed to the bottoms of the capsules. Within the sporoplasm are a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

This is one of the more commonly encountered species of Myxobolus in both the internal and external tissues of Ctenopharyngodon idellus and Mylopharyngodon piceus. The distribution of this parasite, moreover, is quite broad. In the current investigation this organism was discovered in all of the regions principally studied - i.e., in the Jingzhou, Xiaogan and Huanggang districts - and its infection rate reached as high as 80%.

44. Myxobolus clarii Chakravarty, 1943 (Plate XXIII, Figs. 250-254)

Sites of Infection and Hosts: The body surface, intestines, liver and spleen of Mylopharyngodon piceus and Hypophthalmichthys molitrix.

Viewed from the valvular plane aspect, the spores have a broadly oval shape, with their anterior end projecting in some cases and their posterior end showing three to five V-shaped plications. Viewed from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight /p. 77 and noticeable. The length of the spores is 12.9 (12.0 - 13.0) $\mu$m, their width is 10.8 (9.6 - 12.0) $\mu$m, and their thickness is approximately 7.2 $\mu$m. The two polar capsules are large and pyriform. Taking up more than two-thirds of the spore's length, these polar capsules are 7.9 (6.6 - 8.4) $\mu$m long and 4.7 (4.6 - 5.0) $\mu$m wide. The polar filaments are coiled, with five to seven volutions. The nuclei of the polar capsules are triangular and appear to be closely appressed to the bottoms of the capsules. The sporoplasm is relatively meager,

but it contains a conspicuous iodinophilous vacuole and two circular germinal vesicles.

This species of Myxobolus was discovered on the bodies of one Mylopharyngodon piceus fish and one Hypophthalmichthys molitrix fish from Wangtian Lake in the Huanggang district.

45. Myxobolus mylopharyngodoni Nie & Yin, 1958 (Plate XXIII, Fig. 255; Plate XXIV, Figs. 256-257)

Site of Infection and Host: The gills of Mylopharyngodon piceus.

The cysts are circular or elliptical. Ordinarily they are not very bulky, and they measure 107.6 (94.5 - 120.7) μm in length and 84.7 (78.7 - 105.0) μm in breadth. Not many spores are contained within these cysts, either.

Seen from the valvular plane aspect, the spores have an elliptical form, and their surfaces are smooth, as no plications are observed. Viewed from the sutural plane aspect, the spores have a pyriform shape, and their sutural ridge is straight and prominent. The length of the spores is 13.4 (13.2 - 14.4) μm, their breadth is 11.2 (10.8 - 12.0) μm, and their thickness is 8.4 - 9.6 μm. The two polar capsules are pyriform and differ markedly in size. The larger of the polar capsules is exceptionally big, nearly extending the entire length of the spore, as it is 9.5 (9.0 - 10) μm long and 7.9 (7.8 - 8.2) μm wide. The polar filament of this capsule is flattened and smooth, appearing much like a ribbon, and it coils up within the polar capsule, displaying seven to nine volutions. The smaller of the polar capsules is quite small, and it is arranged at an oblique angle at the anterior end of the spore. This polar capsule measures 3.0 (2.6 - 3.6) μm in length and 2.2 (2.0 - 2.4) μm in breadth, and its polar filament has two coils. The sporoplasm is squeezed to

one side by the larger polar capsule, so that it has somewhat of a crescentic shape. Nevertheless, the single iodinophilous vacuole is very prominent, as are the two circular germinal vesicles.

Myxobolus mylopharyngodoni was discovered in all of the numerous breeding ponds that were investigated in the Huanggang region. The rates of infection by this parasite, however, were not very high.

46. Myxobolus tumides Nie & Yin, 1958 (Plate XXIV, Figs. 258-259)

Sites of Infection and Host: The gill filaments and intestines of Mylopharyngodon piceus.

The spores appear elliptical from the valvular plane aspect, with their transverse axis being obviously greater than their longitudinal axis. The surface of the spores, moreover, is smooth, as no plications can be seen, and the intercapsular appendix is U-shaped. In apical view, the spores are shaped either like a dumbbell or the figure "8", with their two ends being slightly pointed and their median section sinking inwards. Viewed from the sutural plane aspect, the spores appear lenticular. The length of the spores is 12.8 (12.0 - 14.4) μm, their breadth is 18.5 (16.8 - 19.6) μm, and their thickness is approximately 8.4 μm. The two polar capsules are very large, have a pyriform shape, and differ somewhat in size. They occupy a very substantial portion of the spore. The larger of the polar capsules extends 9.8 (9.6 - 10.6) μm in length and 8.5 (8.2 - 9.0) μm in breadth, while the smaller one is 8.4 (7.8 - 8.8) μm long and 7.2 (6.8 - 7.8) μm wide. The polar filaments are thick but smoothly flattened, and they coil up inside the polar capsules, displaying seven to nine volutions. The nuclei of the polar capsules are triangular and positioned near the bottoms of the capsules. The sporoplasm is

meager, and the iodinophilous vacuole is large and conspicuous. Two circular germinal vesicles are [usually] present, but sometimes only one is observed.

Myxobolus tumides was discovered in the Huanggang and Jingzhou regions.

47. Myxobolus obliquoides Nie & Yin, 1958 (Plate XXIV, Figs. 260-262)

Sites of Infection and Host: The gills and spleen of Mylopharyngodon piceus.

Seen from the valvular plane aspect, the spores have an elliptical shape, with their transverse axis being greater than their longitudinal axis. The apical tip of the anterior end of the spore is inclined toward one side; the surface of the spore is smooth, as no plications can be seen; and the intercapsular appendix is triangular. Viewed from the sutural plane aspect, the spores display either a figure "8" type of shape or a shape suggestive of a bottle gourd. The spores measure 10.8 (10.0 - 12.0) $\mu$m in length, 16.6 (15.6 - 18.8) $\mu$m in breadth, and approximately 8.5 $\mu$m in thickness. The two polar capsules are pyriform and of different sizes, although together they occupy practically the entire spore. The larger polar capsule runs parallel to the spore's longitudinal axis and extends 9.0 (8.8 - 9.6) $\mu$m in length and 7.5 (7.4 - 8.4) $\mu$m in breadth, while the smaller polar capsule intersects the longitudinal axis and is 7.1 (7.0 - 7.2) $\mu$m long and 5.6 (5.4 - 6.0) $\mu$m broad. The polar filaments are coiled, with six or seven volutions. The nuclei of the polar capsules are triangular and are positioned near the bottoms of the capsules. The sporoplasm is meager, and it only occupies a small part of the spore. The iodinophilous vacuole, however, is large and conspicuous, as its diameter comes to about 3.6 $\mu$m, and a pair of circular germinal vesicles are also present. These vesicles are frequently positioned close to /p. 78

each other.

This parasite was only found in two Mylopharyngodon piceus fishes in the Huanggang district.

48. Myxobolus artus Achmerov, 1960 (Plate XXIV, Figs. 263-265)

Sites of Infection and Host: The intestines of Ctenopharyngodon idellus.

The cysts are white and have a circular or elliptical shape. As a rule not many cysts are produced within the host's tissues. These cysts range in length from 42.0 - 89.2 μm and in breadth from 31.5 - 73.5 μm, and they contain not only spores but also numerous granules of a blackish-brown colour.

Viewed from the valvular plane aspect, the spores appear elliptical, with their longitudinal axis being shorter than their transverse axis; plications that are not very distinct can be seen in the posterior end of the spores. Viewed from the sutural plane aspect, the spores have a rhombic shape (Plate XXIV, Fig. 265), with one side protruding outward to a slight extent. In apical view, the spores have a fusiform shape. The length of the spores is 5.0 (4.8 - 6.0) μm, their breadth is 7.8 (6.6 - 8.4) μm, and their thickness is approximately 4.8 μm. The two oval polar capsules are more or less equal in size, and they are arranged in a pattern reminiscent of the character "ノ乀". These polar capsules measure 3.1 (3.0 - 3.2) μm in length and 2.0 (1.4 - 2.4) μm in breadth. The sporoplasm is meager but homogeneous, and it occupies one-half of the spore. The iodinophilous vacuole is conspicuous and has a diameter of about 1.5 μm. Two rounded germinal vesicles can be seen, at varying positions [within the sporoplasm].

This species is among the most commonly encountered myxosporidians in the intestinal tissues of Ctenopharyngodon idellus fishes, and it is prevalent over

a very wide region. Myxobolus artus was discovered in all three of the regions - i.e., Jingzhou, Xiaogan and Huanggang - that were the principal focus of the current investigation, and parasitism by this organism was detected at the summer stage, the fry stage, and the adult stage of the fishes' development.

49. Myxobolus lomi Donec & Kulakowskaja, 1962 (Plate XXIV, Figs. 266-267)

Sites of Infection and Host: The gall bladder, intestines, and kidney of Ctenopharyngodon idellus.

The cysts, which are white, have an elongated elliptical shape and are provided with a relatively thick membrane. These cysts are 2.5 mm long and 0.8 mm wide. Ordinarily cysts that can be seen with the naked eye are formed on the intestinal walls.

Seen from the valvular plane aspect, the spores have the shape of melon seeds, with their anterior end being abruptly contracted to produce a narrow but blunt apical tip, and their posterior end being provided with V-shaped plications. Viewed from the sutural plane aspect, the spores appear fusiform, and their sutural ridge is straight and distinct. The length of the spores is 11.2 (10.8 - 12.0) $\mu$m, their breadth is 7.9 (7.2 - 9.6) $\mu$m, and their thickness is approximately 6.0 $\mu$m. The two polar capsules are bottle-shaped and occupy about three-fifths of the spore's length; they diverge from one another, in a pattern suggestive of the character "ハ". The polar capsules are 5.2 (4.8 - 6.0) $\mu$m long and 2.5 (2.4 - 3.0) $\mu$m wide. The nuclei of the polar capsules are triangular, and they are positioned near the bottoms of the capsules. The sporoplasm is homogeneous and compact, while the iodinophilous vacuole is large and conspicuous, with a diameter measuring 3.6 $\mu$m. The germinal vesicles are

difficult to observe.

Myxobolus lomi is a type of myxosporidian that is encountered fairly frequently in the internal organs of Ctenopharyngodon idellus, and it exhibits a broad distribution. During the present investigation, this parasite was discovered in both the Jingzhou and Huanggang regions.

50. Myxobolus tricostatus Lee & Nie, 1965 (Plate XXIV, Figs. 268-274)

Site of Infection and Host: The gill filaments of Ctenopharyngodon idellus.

The spores appear oval-to-circular when seen from the valvular plane aspect. In this view, their anterior end sometimes exhibits a three-toothed structure (Plate XXIV, Fig. 268), and the spore's surface is either smooth or marked with V-shaped plications. Seen from the sutural plane aspect, the spores have an oval shape, and their sutural ridge is distinctive, as it is comparatively broad. Generally speaking, another ridge of a thickness resembling that of the sutural ridge can be seen running along each of the latter's sides. As a consequence, three conspicuous ridge lines, one of them actually being the sutural ridge, can be seen rising above the spore's surface. The spores are 9.3 (8.4 - 10.8) $\mu$m long, 8.5 (7.2 - 9.0) $\mu$m wide, and 6.0 - 7.2 $\mu$m thick. The two pyriform polar capsules are of an equivalent size and take up approximately one-half of the spore's length. The polar capsules measure 4.5 (3.6 - 4.8) $\mu$m in length and 2.9 (2.4 - 3.0) $\mu$m in breadth. Contained in the sporoplasm are a prominent iodinophilous vacuole and a pair of circular germinal vesicles.

Myxobolus tricostatus was only discovered on the gills of a single Ctenopharyngodon idellus fish in the Huanggang district.

51. Myxobolus microsporus Lee & Nie, 1965 (Plate XXIV, Figs. 275-280)

Sites of Infection and Host: The gills, kidney, spleen and urinary bladder of Ctenopharyngodon idellus. /p. 79

Viewed from the valvular plane aspect, the spores have an oval shape, with their anterior end being relatively pointed and their posterior end being bluntly rounded; moreover, three to five V-shaped plications can often be seen. Viewed from the sutural plane aspect, the spores have an elongated oval form, and their sutural ridge is straight and conspicuous. The length of the spores is 10.8 (10.2 - 12.0) $\mu$m, their breadth is 7.1 (6.2 - 8.2) $\mu$m, and their thickness is 5.4 $\mu$m. The two pyriform polar capsules differ in size. The larger polar capsule is 5.1 (5.0 - 5.6) $\mu$m long and 3.0 (2.8 - 3.6) $\mu$m wide, while the smaller one is 2.5 (2.4 - 2.6) $\mu$m long and 1.4 (1.2 - 1.8) $\mu$m wide. The nuclei of the polar capsules are prominent, and they appear to be closely appressed to the bottoms of the capsules. Fairly large granules can often be seen within the sporoplasm. The iodinophilous vacuole in the sporoplasm is distinct and has a diameter of about 2.6 $\mu$m. Two circular germinal vesicles are present, and they are either positioned close together or somewhat apart from each other.

This species of Myxobolus was discovered in a number of breeding ponds, but only in the Jingzhou district. Furthermore, the magnitudes of infection by this organism were not very severe.

52. Myxobolus pseudoparvus Lee & Nie, 1965 (Plate XXIV, Figs. 281-285)

Sites of Infection and Host: The gills, intestines, gall bladder, liver, spleen, ureter, and urinary bladder of Ctenopharyngodon idellus.

[When viewed from the valvular plane aspect,] the spores have a circular

or oval-to-circular appearance, and they either possess a smooth surface or are marked with four to six V-shaped plications at their posterior end. Seen from the sutural plane aspect, the spores are lenticular, and their sutural ridge is straight and conspicuous. The length of the spores is 8.2 (7.6 - 8.4) $\mu$m, their breadth is 7.4 (7.2 - 8.2) $\mu$m, and their thickness is 6.6 $\mu$m. The two pyriform polar capsules are of equivalent size and they occupy less than about one-half of the spore's length. The polar filaments are coiled, with five volutions. The length of the polar capsules is 3.4 (3.0 - 3.8) $\mu$m and their breadth is 2.5 (2.4 - 2.6) $\mu$m. The sporoplasm is homogeneous; the iodinophilous vacuole is distinct; and the germinal vesicles are circular.

This species is one of the more commonly encountered types of myxosporidian in both the internal and external tissues of Ctenopharyngodon idellus fishes. Parasitism by this organism was discovered in all of the breeding ponds in the three districts that provided the principal focus of this study.

53. Myxobolus exiquus Thélohan, 1895 (Plate XXIV, Figs. 286-290)

Sites of Infection and Hosts: The gills, kidney, and sex glands of Hemiculter leucisculus, Culter erythropterus Basilewsky, Erythroculter dabryi (Bleeker), Erythroculter ilishaeformis (Bleeker), etc.

The cysts are comparatively small, as their diameters are 20-30 $\mu$m.

Viewed from the valvular plane aspect, the spores are elliptical, and their surface is either smooth or bears three or four V-shaped plications. Seen from the sutural plane aspect, the spores are fusiform, and the sutural ridge is straight but narrow. The spores are 8.5 (7.8 - 9.0) $\mu$m long, 6.8 (6.0 - 7.2) $\mu$m wide, and 4.2 - 4.8 $\mu$m thick. The two polar capsules are pyriform and similar in size. Arranged somewhat apart from each other, they

usually take up less than one-half of the spore's length. The length of the polar capsules is 3.2 (2.4 - 3.6) $\mu$m and their breadth is 2.2 (1.8 - 2.4) $\mu$m. Within the sporoplasm are a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

Myxobolus exiquus exhibits a very wide distribution, and it was found in all three of the regions investigated here - i.e., in the Jingzhou, Xiaogan and Huanggang districts. The magnitudes of the infections by this parasite were not very heavy, however.

54. Myxobolus cyprini Doflein, 1898 (Plate XXV, Figs. 291-293)

Site of Infection and Host: The anterior intestine of Erythroculter ilishaeformis.

The spores appear oval when seen from the valvular plane aspect, and two or three V-shaped plications occur in their posterior end. When viewed from the sutural plane aspect, the spores have a fusiform shape, and the sutural ridge is straight and prominent. The length of the spores is 11.9 (11.4 - 12.0) $\mu$m, their breadth is 8.8 (8.4 - 9.6) $\mu$m, and their thickness is approximately 6.8 $\mu$m. The two polar capsules have eggplant-like shapes; positioned parallel to one another in one half of the spore, they measure 5.6 (5.2 - 6.0) $\mu$m in length and 3.2 (3.0 - 3.6) $\mu$m in breadth. The polar filaments are coiled and exhibit seven volutions. The sporoplasm is homogeneous and contains two circular germinal vesicles together with a conspicuous iodinophilous vacuole.

This species of Myxobolus was only found in the intestines of a single Erythroculter ilishaeformis fish in the Xiaogan district. The extent of infection, however, was not very severe.

55. Myxobolus acanthorhodi Nie & Lee, 1964 (Plate XXV, Figs. 294-296)

Sites of Infection and Host: The kidney and spleen of Acanthorhodeus macropterus (Bleeker)*.

The cysts are small and circular. As a rule, those that appear in the kidney of the host have no more than a few spores that can be seen clustered together. The diameter [of the cysts] is approximately 100 μm.

Seen from the valvular plane aspect, the spores have an elongated /p. 80 elliptical shape, whereas from the sutural plane aspect they appear fusiform, with a sutural ridge that is straight and conspicuous. The length of the spores is 11.8 (9.6 - 12.0) μm, their breadth is 6.5 (6.0 - 7.8) μm, and their thickness is 5.0 - 6.0 μm. The two polar capsules are shaped like eggplants and they differ in size. The larger of the polar capsules is 6.4 (6.0 - 7.2) μm long and 2.5 (2.4 - 3.0) μm wide, while the smaller one is 5.6 (4.8 - 6.0) μm long and 2.2 (1.8 - 2.4) μm wide. The sporoplasm is meager and homogeneous, and the iodinophilous vacuole is extremely prominent. Two circular germinal vesicles are present, and they are either positioned close together or slightly apart from each other. In its early stages of development, this organism exhibits a bundle of large, regular cilia located in the posterior end of the spore. Once the organism has attained maturity, however, these cilia either show pronounced withering or they disappear completely.

This species of Myxobolus was only encountered in a single Acanthorhodeus macropterus fish from Huangsha Lake in the Huanggang district.

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*Translator's note: A guess; the Chinese name of this fish, dacipangpi, could be Acanthorhodeus macropterus or Acanthorhodeus tabiro Jordan et Thompson, whose Chinese names are similar; or it could be a completely different species of Acanthorhodeus, probably one that is "large" in some major respect. (This note applies to all references to Acanthorhodeus macropterus in this translation.)

56. Myxobolus elaiodes Nie & Lee, 1964 (Plate XXV, Figs. 297-299)

Sites of Infection and Hosts: The kidney and muscles of Acanthorhodeus macropterus, Acanthorhodeus hypselonotus Bleeker, sicibiangou*, etc.

The cysts are circular and relatively small, measuring no more than about 15.0 μm in diameter.

Seen from the valvular plane aspect, the spores have an oval shape, and their posterior end bears four V-shaped plications. The spores appear fusiform when viewed from the sutural plane aspect, and the sutural ridge is straight and narrow. The spores are 9.5 (9.0 - 11.4) μm long, 5.8 (5.4 - 6.0) μm wide, and 4.8 - 5.0 μm thick. The two polar capsules are pyriform and unequal in size; the larger polar capsule is 4.4 (3.6 - 4.8) μm long and 2.4 (2.2 - 2.6) μm wide, while the smaller one is 3.0 (2.4 - 3.6) μm long and 1.9 (1.5 - 2.0) μm wide. Within the sporoplasm are a distinct iodinophilous vacuole and a pair of circular germinal vesicles. This species of Myxobolus, too, displays ciliary appendages at the posterior end of the spore during its earlier stages of development. These [appendages] are 1.6 (1.4 - 1.8) μm long and 7.0 (6.0 - 7.2) μm broad. After the organism has matured, however, the ciliary appendages completely vanish.

This parasite was only encountered in the bodies of sicibiangou fishes and in two species of Acanthorhodeus from Huangsha Lake in the Huanggang district.

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*Translator's note: Chinese name of unidentified fish. Literally, "pseudo - spine [or thorn] - bream - goby".

57. Myxobolus vesiformis Nie & Lee, 1964 (Plate XXV, Figs. 300-304)

Site of Infection and Hosts: The gill filaments of Acanthorhodeus macropterus.

Viewed from the valvular plane aspect, the spores have a pyriform shape, with their anterior end being sharply pointed and their posterior end bluntly rounded; the surface of the spore is either smooth or displays two or three V-shaped plications. Seen from the sutural plane aspect, the spores have a leaflike appearance, with their sutural ridge being thin and straight. The length of the spores is 12.3 (10.8 - 15.8) $\mu$m, their breadth is 6.4 (6.0 - 7.4) $\mu$m, and their thickness is approximately 5.0 $\mu$m. The two polar capsules are of equivalent size and are arranged parallel to each other; they occupy more than one-third of the spore's length. The polar capsules are 4.9 (4.6 - 6.0) $\mu$m long and 2.0 (1.8 - 2.4) $\mu$m wide. The sporoplasm is homogeneous and compact; [it contains] a distinct iodinophilous vacuole, and [normally] two circular germinal vesicles are present, although sometimes only one such vesicle is observed.

This species of Myxobolus was discovered in a single Acanthorhodeus macropterus fish from Huangsha Lake in the Huanggang district.

58. Myxobolus symmetricus Nie & Lee, 1964 (Plate XX, Figs. 305-310)

Sites of Infection and Hosts: The gills, intestines, kidney, spleen and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

The cysts are circular or oval, and they measure 20.0 - 35.0 $\mu$m in diameter.

Seen from the valvular plane aspect, the spores appear either obovoid, oval, or elliptical, with their surface being smoother or provided with three

to six V-shaped plications in the posterior end. Viewed from the sutural plane aspect, the spores have a fusiform shape, and their sutural ridge is straight and thick. The length of the spores is 10.5 (9.6 - 10.8) μm, their breadth is 8.2 (7.2 - 8.4) μm, and their thickness is 5.8 - 6.0 μm. The two polar capsules are pyriform, more or less equal in size, and arranged parallel to one another; they extend for more than about one-half of the spore's length. The polar filaments possess five to seven coils. The polar capsules measure 5.7 (5.0 - 6.0) μm in length and 3.2 (3.0 - 3.6) μm in width. The nuclei of the polar capsules are small, looking something like periods*, and they appear to be appressed to the bottoms of the capsules. There is little sporoplasm, but [it contains] a distinct iodinophilous vacuole and two circular germinal vesicles.

Myxobolus symmetricus is one of the most commonly encountered types of spore in the internal organs and tissues of Aristichthys nobilis and Hypophthalmichthys molitrix. A. nobilis and H. molitrix fishes bred in ponds everywhere show infection by this parasite. It was discovered /p. 81 in all of the regions covered by the present investigation - i.e., in the Xiaogan, Huanggang, and Jingzhou districts.

59. Myxobolus dispar Thélohan, 1895 (Plate XXV, Figs. 311-326)

Sites of Infection and Hosts: The gills, gall bladder, kidney, swim bladder, and urinary bladder of Hypophthalmichthys molitrix, Cyprinus carpio, and Aristichthys nobilis.

The cysts are white and have a circular or elliptical shape. These cysts

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*Translator's note: Presumably the type of period that is used in Chinese - i.e., a small, hollow circle.

have relatively thick walls, and they measure 220.9 (131.2 - 309.0) μm in length and 86.7 (47.2 - 131.2) μm in width. They infect the host either in its gill filaments or between its gill lamellae.

Seen from the valvular plane aspect, the spores appear either oval-to-circular, oval, obovoid, or elliptical, and their surface is either smooth or provided with two to eleven V-shaped plications. The intercapsular appendix, moreover, is fairly distinct. Seen from the sutural plane aspect, the spores have a lenticular shape, and their sutural ridge is straight and conspicuous. The length of the spores is 10.5 (9.6 - 12.0) μm, their breadth is 8.2 (7.2 - 9.6) μm, and their thickness is 6.0 (5.4 - 6.6) μm. The two polar capsules are pyriform and of different sizes; they are separated from each other by a certain distance, with a conspicuous intercapsular appendix being situated between them. The polar filaments are coiled and have four or five volutions. The nuclei of the polar capsules are conspicuous, and they are positioned near the bottoms of the capsules. The larger of the polar capsules is 4.9 (4.8 - 5.4) μm long and 3.4 (3.0 - 3.6) μm wide, while the smaller one is 3.8 (3.5 - 4.2) μm long and 2.5 (1.8 - 3.0) μm wide. The sporoplasm is homogeneous and is provided with a noticeable iodinophilous vacuole and a pair of circular germinal vesicles, which are usually situated close to each other.

Myxobolus dispar is one of the most commonly encountered types of myxosporidian in the bodies of Aristichthys nobilis and Hypophthalmichthys molitrix, both in their internal and external tissues. The distribution of this organism is extensive, too, and it was discovered in all three of the areas that provided the main focus of the present study - i.e., the Huanggang, Xiaogan, and Jingzhou districts. What is more, M. dispar exhibited a quite high rate of infection in A. nobilis and H. molitrix, and these infections were

of a serious magnitude.

60. Myxobolus aristichthydis Nie & Yin, 1958 (Plate XXVI, Figs. 327-330)

Sites of Infection and Host: The heart, kidney, intestines and urinary bladder of Aristichthys nobilis.

The cysts are white and have a circular or oval shape, with their diameter being approximately 0.55 μm. As a rule, the cysts are formed in the connective tissues of the heart and in the heart muscles.

Viewed from the valvular plane aspect, the spores appear oval or elliptical, and their surface is either smooth or provided with a small number of V-shaped plications. Seen from the sutural plane aspect, the spores have a lenticular shape, whereas in apical view they are circular. The sutural ridge of the spore is straight and thick, with its breadth being approximately 1.2 μm. The spores are 17.0 (14.4 - 18.6) μm long, 13.4 (13.2 - 14.2) μm broad, and 10.0 - 12.0 μm thick. The two polar capsules differ considerably with respect to both their size and shape. The larger one virtually fills up the greater part of the spore, and its polar filament exhibits eight or nine coils. The smaller polar capsule, meanwhile, is squeezed to one side, and its polar filament has two to four coils. The length of the larger polar capsule is 11.2 (9.6 - 12.0) μm and its breadth is 8.5 (7.8 - 9.6) μm, while the length of the smaller polar capsule is 3.7 (3.6 - 4.8) μm and its breadth is 1.8 (1.2 - 2.0) μm. The nuclei of the polar capsules are reniform or triangular, and they appear to be appressed to the lower part of the capsules. The sporoplasm is meager but compact; it contains a conspicuous iodinophilous vacuole and two circular germinal vesicles.

Myxobolus aristichthydis is one of the more easily encountered types of myxosporidian in the bodies of Aristichthys nobilis, both in their internal tissues and organs and in their external ones. Under ordinary circumstances, this organism exhibits a lower infection [rate] in A. nobilis fishes during their summer and fry stages of development, and a higher infection [rate] after the fishes have matured. During the present investigation, this parasite was discovered only in the Huanggang region.

61. Myxobolus cyprinicola Reuss, 1906 (Plate XXVI, Figs. 331-339)

Sites of Infection and Hosts: The fins, gills, intestines, gall bladder, kidney, swim bladder, swim bladder, sex glands, and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

The cysts are circular or elliptical and they contain not only spores but also black- or yellow-coloured granules. Although these cysts do vary in their diameter and overall size, they generally exhibit a diameter in the 40-42 $\mu$m range.

Seen from the valvular plane aspect, the spores have an oval or elliptical shape. The surface of the spores may be entirely smooth, or several V-shaped plications may be present in their posterior end. Viewed from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and conspicuous. The length of the spores is 10.2 (9.6 - 11.2) $\mu$m, their breadth is 7.4 (7.2 - 7.8) $\mu$m, and their thickness is 5.4 - 6.0 $\mu$m. The two polar capsules are of similar size and shape and show a parallel arrangement. They occupy slightly less than one-half of the spore's length, as they are /p. 82 4.8 (4.2 - 5.0) $\mu$m long and 2.9 (2.6 - 3.2) $\mu$m wide. Within the sporoplasm are a prominent iodinophilous vacuole and a pair of circular germinal vesicles.

Myxobolus cyprinicola is one of the most common types of myxosporidian spore that is seen in Aristichthys nobilis and Hypophthalmichthys molitrix fishes, both inside their bodies and on their exteriors. It shows a very wide distribution, and it was discovered in all three of the areas that were the primary concern of the current study. The rate of infection by this parasite in A. nobilis and H. molitrix fishes was found to be as high as 90%.

62. Myxobolus ellipsoides Thélohan, 1892 (Plate XXVI, Figs. 340-345)

Sites of Infection and Hosts: The gall bladder, intestines, liver, spleen, muscles, kidney and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

The cysts are circular and are 50.4 μm long and 46.8 μm broad. The walls of the cysts are fairly thick, measuring approximately 4.8 - 6.0 μm.

Seen from the valvular plane aspect, the spores have an elliptical shape, and their surface is either smooth or bears V-shaped plications. Seen from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and prominent. The length of the spores is 11.0 (9.6 - 12.0) μm, their breadth is 7.3 (7.0 - 7.8) μm, and their thickness is approximately 6.0 μm. The two pyriform polar capsules are arranged parallel to each other, and lying between them is a conspicuous intercapsular appendix. These polar capsules take up about one-half of the spore's length. The polar filaments are coiled, with five volutions. The polar capsules measure 4.9 (4.8 - 5.4) μm in length and 3.0 (2.4 - 3.2) μm in width. Within the sporoplasm are a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

This species is one of the most readily encountered types of myxosporidian parasite in the internal organs of Aristichthys nobilis and Hypophthalmichthys

molitrix, and it shows a wide distribution. M. ellipsoides was discovered in all three of the districts that were concentrated upon in this investigation.

63. Myxobolus atypicus Nie & Lee, 1964 (Plate XXVI, Figs. 346-350)

Sites of Infection and Hosts: The gills, intestines, gall bladder, spleen, kidney, ureter, and urinary bladder of Aristichthys nobilis and Hypophthalmichthys molitrix.

The cysts are more or less circular in shape and measure 288.7 μm long by 210.0 μm wide. Within the cysts are not only spores but also clumpy material with a black or yellow coloration.

Seen from the valvular plane aspect, the spores appear elliptical, whereas they look fusiform when seen from the sutural plane aspect and in apical view. The sutural ridge is thick and straight and approximately 1.0 m thick. The spores are 14.7 (13.2 - 16.8) μm long, 10.5 (8.4 - 10.8) μm wide, and 7.0 - 8.4 μm thick. The two polar capsules are pyriform, and they differ considerably in size. These capsules, moreover, are arranged parallel to each other, and a V-shaped intercapsular appendix is positioned between them. The larger polar capsule is 8.4 (7.4 - 9.6) μm long and 5.8 (5.4 - 6.0) μm wide, and its coiled polar filament shows six or seven turns. The smaller polar capsule is 5.0 (3.6 - 5.4) μm long and 3.0 (2.4 - 3.6) μm wide, and its polar filament shows three to five coils. Within the sporoplasm are an iodinophilous vacuole, which has a diameter of 3 μm, and two circular germinal vesicles.

This species of Myxobolus was discovered in all of the breeding ponds that were examined in the Jingzhou, Xiaogan and other regions included in the present study.

64. Myxobolus nobillis Lee & Nie, 1965 (Plate XXVI, Figs. 351-355)

Sites of Infection and Hosts: The gill filaments and urinary bladder of Hypophthalmichthys molitrix and Aristichthys nobilis.

The cysts are white and circular, and they have very thick walls. The diameter of these cysts is approximately 120 μm.

Viewed from the valvular plane aspect, the spores have an oval-to-circular outline, with their anterior end being pointed and their posterior end showing a blunt rounding. The surface of the spores is smooth, as no plications can be seen. Seen from the sutural plane aspect and in apical view, the spores have a fusiform shape, and their sutural ridge is thick and prominent. The length of the spores is 12.7 (12.0 - 14.0) μm, their breadth is 10.6 (10.2 - 12.0) μm, and their thickness is 6.6 - 6.8 μm. The two pyriform polar capsules are unequal in size, and they extend parallel to each other, with that a conspicuous V-shaped intercapsular appendix being situated between them. The larger of the polar capsules measures 7.4 (7.2 - 7.5) μm in length and 5.4 (4.8 - 5.8) μm in breadth, and its polar filament is coiled, with nine volutions. The smaller polar capsule is 3.7 (3.2 - 4.5) μm long and 2.3 (2.2 - 2.5) μm wide, and its polar filament coils with five volutions. The nuclei of the polar capsules are plainly visible, and they appear to be closely appressed to the bottoms of the capsules. The sporoplasm contains two circular germinal vesicles and an iodinophilous vacuole that has a diameter of 4.0 μm.

Myxobolus nobillis is a type of myxosporidian that is commonly encountered in the bodies of Aristichthys nobilis and Hypophthalmichthys molitrix fishes, both in their internal and external tissues. These parasites are especially prevalent in the connective tissue of H. molitrix. M. nobillis was discovered during the present investigation in both the Jingzhou and Huanggang districts.

65. Myxobolus drjagini (Achmerov, 1954) Schulman, 1962 /p. 83

(Plate XXVII, Figs. 356-360)

Alternate names: Disparospora drjagini Achmerov, 1954; Disparospora hypophthalmichthydis Dogeil & Achmerov, 1960.

Sites of Infection and Host: The kidney and swim bladder of Hypophthalmichthys molitrix.

The cysts are white and have a circular or elliptical shape. They can be seen by the naked eye, as their diameter is in the 0.2 - 1.0 mm range.

Viewed from the valvular plane aspect, the spores are elliptical or obovoid, with their anterior end being broadened and their posterior end being somewhat narrowed. The spore's surface is either smooth or bears four or five V-shaped plications, and the intercapsular appendix is conspicuous and V-shaped. The length of the spores is 12.3 (10.8 - 13.2) $\mu$m, their breadth is 9.0 (7.5 - 9.6) $\mu$m, and their thickness is 6.0 - 6.5 $\mu$m. The two polar capsules are pyriform and differ in size. As a rule, the larger polar capsule is positioned in the anterior end of the spore at an inclined angle, and its coiled polar filament shows six or seven turns. This larger polar capsule measures 5.6 (5.4 - 6.0) $\mu$m long by 3.5 (3.4 - 3.6) $\mu$m wide. The smaller polar capsule, meanwhile, extends more or less parallel to the longitudinal axis of the spore, and it measures 3.2 (3.0 - 3.6) $\mu$m long by 1.6 (1.4 - 2.4) $\mu$m broad. The nuclei of the polar capsules are conspicuous, and they appear to be appressed to bottoms of the capsules. The sporoplasm is homogeneous and compact; it possesses an iodinophilous vacuole that has a diameter of 3.6 - 4.2 $\mu$m, and a pair of circular germinal vesicles.

This type of myxosporidian is among those that are commonly encountered in the bodies of Hypophthalmichthys molitrix fishes, particularly in their

connective tissues.

66. Myxobolus abitus Nie & Lee, 1964 (Plate XXVII, Figs. 361-366)

.Sites of Infection and Hosts: The gills, kidney, and mucus on the body surface of Hypophthalmichthys molitrix and Aristichthys nobilis.

Seen from the valvular plane aspect, the spores have an elliptical shape, with their transverse axis being greater than their longitudinal axis, and their surface is smooth. In apical view, as well as from the sutural plane aspect, the spores appear fusiform, with their sutural ridge being straight and narrow. The spores are flattened, and they extend 7.4 (7.2 - 8.6) $\mu$m in length, 8.6 (8.4 - 9.6) $\mu$m in breadth, and about 4.8 $\mu$m in thickness. The two polar capsules are pyriform and of different sizes, and a conspicuous U-shaped intercapsular appendix is positioned between them. The distance between the polar capsules comes to approximately 6.0 $\mu$m. The larger polar capsule is 4.5 (4.0 - 4.8) $\mu$m long and 3.0 (2.6 - 3.4) $\mu$m broad, while the smaller one measuring 3.5 (2.8 - 3.8) $\mu$m in length by 2.2 (2.0 - 2.4) $\mu$m in width. The sporoplasm is homogeneous, and it contains a prominent iodinophilous vacuole and two circular germinal vesicles.

This parasite was discovered in the gill filaments and bodies of two Hypophthalmichthys molitrix fishes in the Huanggang district.

67. Myxobolus cheni Schulman, 1962 (Plate XXVII, Figs. 367-368)

Sites of Infection and Host: The intestines, gall bladder, kidney and urinary bladder of Hypophthalmichthys molitrix.

Seen from the valvular plane aspect, the spores have an elliptical shape, while they are fusiform when viewed from the sutural plane aspect. The surface

of the spores is smooth, as no plications can be seen. The spores are 9.2 (8.4 - 9.6) $\mu$m long, 5.7 (5.4 - 6.0) $\mu$m wide, and 4.0 - 4.8 $\mu$m thick. Two polar capsules are present; these have a pyriform shape and are equivalent in size, and their posterior end generally extends beyond one-half of the spore's length. The polar capsules measure 4.0 (3.6 - 4.8) $\mu$m long by 2.2 (2.0 - 2.4) $\mu$m broad. The iodinophilous vacuole within the sporoplasm is large and conspicuous, and two circular germinal vesicles are found, although sometimes only one might be observed.

This species of Myxobolus was initially discovered by Schulman on the gills of the mullet Mugil cephalus Linnaeus and the red-eye mullet Liza so-iuy (Basilewsky). The current finding of M. cheni in the internal organs of Hypophthalmichthys molitrix fishes represents the discovery of a new host for this parasite, and it underscores the very extensive [distribution] of this organism. During the current investigation, M. cheni was found in Hypophthalmichthys molitrix fishes that were reared in ponds from all three of the districts studied.

68. Myxobolus minutus Nemaczek, 1911 (Plate XXVII, Figs. 369-374)

Sites of Infection and Host: The gills, intestines, gall bladder, kidney, liver, spleen, ureter, and urinary bladder of Hypophthalmichthys molitrix.

The trophozoites are small and irregular in shape, and their size is approximately two or three times that of the spores. Within the trophozoites are two to four mature spores along with some granules. Seen from the valvular plane aspect, the spores have a circular shape, with their anterior end being slightly wider than their posterior end; and the surface of the spores is smooth, as no plications can be seen. Viewed from the sutural plane aspect,

the spores appear lenticular, and the sutural ridge is thick and straight. The length of the spores is 7.4 (7.0 - 8.2) μm, their breadth is 6.5 /p. 84 (6.0 - 7.2) μm, and their thickness is 4.6 - 4.8 μm. The two pyriform polar capsules are similar in size and are arranged in a parallel pattern, with a conspicuous intercapsular appendix being positioned between them. The polar capsules take up less than one-half of the spore's total length. The length of the polar capsules is 3.0 (2.8 - 3.6) μm and their breadth is 2.2 (2.0 - 2.4) μm. The nuclei of the polar capsules are small and noticeable, and they appear to be appressed to the bottoms of the capsules. Within the sporoplasm is a distinct iodinophilous vacuole and a pair of germinal vesicles.

This organism is one of the more commonly encountered types of myxosporidian in the body of Hypophthalmichthys molitrix, both in its internal and external tissues. The distribution of this parasite is very broad, too. It was discovered in all three of the regions that were the primary focus of the current study - i.e., in the Huanggang, Xiaogan, and Jingzhou districts.

69. Myxobolus parvus Schulman, 1962 (Plate XXVII, Figs. 375-379)

Sites of Infection and Host: The intestines, kidney, spleen, and urinary bladder of Hypophthalmichthys molitrix.

The trophozoites consist of finely granular masses of protoplasm and have a diameter of approximately 20.0 μm. Their peripheries are relatively transparent, and they contain 4-16 spores.

The spores are quite small. Viewed from the valvular plane aspect, they are either circular or transversely elliptical; when seen from the sutural plane aspect or in apical view, however, they appear fusiform, with their sutural ridge being straight and narrow. The spores are 5.5 (5.0 - 6.6) μm

long, 5.9 (5.4 - 6.6) μm wide, and 3.6 - 4.0 μm thick. The two pyriform polar capsules are more or less equal in size and are arranged in the anterior half of the spore, either in a parallel fashion or in a pattern suggestive of the character "/\". These polar capsules measure 2.5 (2.4 - 3.0) μm in length by 1.8 (1.6 - 2.0) μm in breadth. The sporoplasm is homogeneous and occupies one-half of the spore's length. The iodinophilous vacuole is small but distinct, and sometimes the germinal vesicles may be obscure.

This species of Myxobolus is also among the more frequently seen types of myxosporidian in the internal tissues of Hypophthalmichthys molitrix fishes. It was discovered in all of the breeding ponds in the three districts that were primarily studied during the present investigation.

70. Myxobolus gourdiformis Lee & Nie, 1965 (Plate XXVII, Figs. 380-384)

Sites of Infection and Host: The gills and anterior intestine of Hypophthalmichthys molitrix.

The cysts are elliptical, and they are located in the intestinal tissues. Rather thick connective tissue surrounds the cysts, which are 105 μm long and 68.2 μm wide.

Seen from the valvular plane aspect, the spores have an elliptical shape, and their surface is marked with seven to nine V-shaped plications. Viewed from the sutural plane aspect, the spores have the shape of a bottle gourd, and the sutural ridge is straight and conspicuous. The length of the spores is 12.7 (12.0 - 13.2) μm, their breadth is 8.9 (8.4 - 9.6) μm, and their thickness is 7.2 - 7.4 μm. The two polar capsules are pyriform and differ in size; they are arranged parallel to each other, and positioned between them is

a conspicuous intercapsular appendix. The larger of the polar capsules is 4.8 (3.6 - 5.4) μm long and 3.5 (3.0 - 3.6) μm broad, and its polar filament is coiled, with six or seven volutions. The smaller polar capsule measures 3.9 (3.6 - 4.2) μm long by 2.9 (2.4 - 3.2) μm broad, and its coiled polar filament has five or six turns. The sporoplasm takes up a sizeable part of the spore's length, and the iodinophilous vacuole is distinct, extending about 3.6 μm in diameter. Two circular germinal vesicles can be seen, positioned close together.

Myxobolus gourdiformis was discovered in the gills and the tissues of the intestinal tract of two Hypophthalmichthys molitrix fishes from the Huanggang and Jingzhou districts.

71. Myxobolus nephroides Lee & Nie, 1965 (Plate XXVII, Figs. 385-388)

Sites of Infection and Host: The kidney, intestines, gall bladder and spleen of Hypophthalmichthys molitrix.

Although this parasite does not form cysts in the kidney, gall bladder, and spleen, it usually does produces them on the mesentery. These cysts, however, are of a comparatively small size, as they measure about 50 μm in diameter.

Viewed from the valvular plane aspect, the spores have an oval-to-circular appearance, with their anterior end being slightly smaller; 9-11 V-shaped plications can be seen on their surface. Seen from the sutural plane aspect as well as in apical view, the spores have a fusiform shape, and their sutural ridge is straight and prominent. The spores are 9.5 (9.0 - 9.8) μm long, 8.8 (8.4 - 9.0) μm wide, and approximately 7.0 μm thick. The two polar capsules are pyriform and of unequal sizes; at their anterior end they are

positioned close together, but posteriorly they diverge in a pattern reminiscent of the character "/\". The large polar capsule measures 5.1 /p. 85 (4.8 - 5.4) μm in length and 3.4 (3.0 - 3.6) μm in width, while the smaller one is 3.2 (2.8 - 3.6) μm long and 2.0 (1.6 - 2.2) μm broad. The sporoplasm contains an iodinophilous vacuole that has a diameter of 2.4 μm, and two circular germinal vesicles.

This parasite shows a wide distribution. It was found in all three of the districts that the present study concentrated upon.

72. Myxobolus squamosus Kudo, 1934 (Plate XXVII, Figs. 389-392; (Plate XXVIII, Figs. 393-395)

Sites of Infection and Host: The gills, kidney, gall bladder, and intestines of Pseudorasbora parva.

The cysts are white and have an oval-to-circular shape, with their diameter coming to 0.3 - 1.5 μm.

Viewed from the valvular plane aspect, the spores are elliptical, and their surface bears four to seven V-shaped plications. Viewed from the sutural plane aspect, the spores have a fusiform shape, and their sutural ridge is straight and conspicuous. The length of the spores is 9.4 (8.4 - 9.6) μm, their breadth is 7.5 (7.2 - 8.4) μm, and their thickness is approximately 4.8 μm. The two pyriform polar capsules are equivalent in size, and they extend less than one-half of the spore's length. The polar capsules measure 3.5 (3.0 - 3.6) μm long by 2.3 (1.8 - 2.4) μm broad. The sporoplasm occupies a large proportion [of the spore's total length]. The iodinophilous vacuole is distinct, and the two circular germinal vesicles are positioned close to each other.

This species of Myxobolus is a type that is often encountered in the bodies of Pseudorasbora parva fishes, both in their internal tissues and their external ones. Its distribution is quite widespread; in fact, wherever this particular fish can be found, so, too, can this parasite.

73. Myxobolus miyairii Kudo, 1919 (Plate XXVIII, Figs. 396-403)

Sites of Infection and Hosts: The body surface, gills, mesentery, intestines, kidney, spleen and swim bladder of the catfish Silurus asotus (Linnaeus) and Erythroculter ilishaeformis.

The cysts are circular and have a diameter of 79.4 μm.

Seen from the valvular plane aspect, the spores have an elongated elliptical form, and varying numbers of V-shaped plications occur in their posterior end. Viewed from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and narrow. The length of the spores is 12.7 (12.0 - 13.2) μm, their breadth is 5.4 (4.8 - 6.0) μm, and their thickness is approximately 4.2 μm. The two polar capsules are club-shaped and similar in size; they are arranged parallel to each other at the anterior end of the spore, and they take up less than about one-half of the spore's length. The polar capsules measure 5.6 (5.0 - 6.0) μm in length and 1.6 (1.4 - 1.8) μm in breadth. The nuclei of the polar capsules are crescentic-shaped, and they are located near the bottoms of the capsules. The sporoplasm is homogeneous, and it possesses a fairly large iodinophilous vacuole and two circular germinal vesicles.

This is one of the most readily seen types of myxosporidian in the internal organs of Silurus asotus. It was found in all of the districts that were the focus of this investigation - i.e., in the Jingzhou, Xiaogan and

Huanggang areas.

74. Myxobolus physophilus Reuss, 1906 (Plate XXVIII, Figs. 404-408)

Alternate names: Myxobolus macrocapsularis Reuss, 1906; M. macrocapsularis Schulman, 1962. [Page] 105, Fig. 233.

Sites of Infection and Host: The fins and urinary bladder of Pseudobagrus fulvidraco.

The cysts are white and variable in size, with the smaller ones resembling broken grains of rice and the larger ones suggesting peas. Frequently a number of cysts will cluster together, with the result that collectively they assume an external shape similar to that of a bunch of flowers (see Plate XXVIII, Fig. 406).

Viewed from the valvular plane aspect, the spores have the shape of melon seeds. Their anterior end is narrow and pointed yet blunt [at the tip], while their median part is the broadest and their posterior end not only exhibits several V-shaped plications, but also has an extensive, translucent enveloping membrane (Plate XXVIII, Fig. 408). Seen from the sutural plane aspect, the spores appear fusiform, and their sutural ridge is straight and conspicuous. The spores are 13.2 (12.6 - 14.4) μm long, 8.4 (7.2 - 9.4) μm wide, and 6.0 μm thick. The two polar capsules are club-shaped, and they extend parallel to each other over three-fifths of the spore's total length. The length of these polar capsules is 6.5 (6.0 - 7.2) μm and their breadth is 3.0 (2.6 - 3.6) μm. The sporoplasm is homogeneous; [it contains a] distinct iodinophilous vacuole and two circular germinal vesicles, whose positions [within the sporoplasm] are variable.

In the early part of its mature period, this species of Myxobolus

possesses a translucent enveloping membrane, whose anterior side is closely appressed to the spore and whose posterior end elongates and expands. The length of this membrane ranges from 3.6 - 4.2 μm while its width is 9.6 - 12.0 μm.

This parasite was only discovered in the Xiaogan district. /p. 86

75. Myxobolus aureatus Ward, 1934 (Plate XXVIII, Figs. 409-411)

Sites of Infection and Host: The gills and kidney of Pseudobagrus fulvidraco.

The cysts have an elongated oval shape, and surrounding them is a vesicular sort of translucent membrane. Innumerable spores are contained in these cysts, which measure 188 - 266.4 μm in length and 144.3 - 188.7 μm in width.

Seen from the valvular plane aspect, the spores have the shape of a muskmelon, with their anterior end being narrow and pointed and their posterior end showing a blunt rounding. In apical view, the spores are elliptical, while from the sutural plane aspect they appear leaflike, with their sutural ridge being straight and conspicuous. The spores are 12.9 (12.0 - 14.4) μm long, 5.6 (5.4 - 6.0) μm wide, and 5.4 - 6.0 μm thick. The two polar capsules are club-shaped, and they are arranged parallel to each other in the anterior end of the spore, extending 5.8 (5.4 - 6.0) μm in length and 2.5 (2.4 - 3.0) μm in breadth. The sporoplasm contains a distinct iodinophilous vacuole and two circular germinal vesicles.

This species of Myxobolus is fairly commonly seen in the bodies of Pseudobagrus fulvidraco fishes, both in their internal and external tissues. This organism is also distributed over a wide range of regions.

76. Myxobolus muelleri Bütschli, 1881 (Plate XXVIII, Figs. 412-415)

Sites of Infection and Host: The gills, kidney, spleen and brain of Pseudobagrus fulvidraco.

When viewed from the valvular plane aspect, the spores have an elongated oval shape, and their surface is either smooth or marked with a small number of plications. Seen from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and narrow. The length of the spores is 11.5 (10.8 - 12.0) μm, their breadth is 7.0 (6.0 - 8.4) μm, and their thickness is 4.5 - 5.0 μm. The polar capsules are pyriform and of equivalent size; they are arranged either parallel to each other or in a pattern suggestive of the character "ノ\". The polar capsules measure 4.9 (4.2 - 6.0) μm in length and 2.3 (2.2 - 2.4) μm in breadth. Within the sporoplasm are a conspicuous iodinophilous vacuole and a pair of circular germinal vesicles.

This species of Myxobolus is among the most frequently seen types of myxosporidian in the bodies of Pseudobagrus fulvidraco, both in their internal and their external tissues. Its distribution also encompasses a wide area.

77. Myxobolus vescus Achmerov, 1960 (Plate XXVIII, Figs. 416-419)

Sites of Infection and Host: The gills and kidney of Pseudobagrus fulvidraco.

Viewed from the valvular plane aspect, the spores have the shape of muskmelons, and two to four V-shaped plications occur in their posterior end. Seen from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and narrow. The spores are 9.9 (8.4 - 10.8) $\mu$m long, 5.3 (4.8 - 6.0) $\mu$m wide, and approximately 3.6 - 4.8 $\mu$m thick. The polar capsules are long and narrow and more or less equal in size, and they show a parallel arrangement. Extending about three-fifths of the spore's length, the polar capsules measure 5.3 (4.8 - 5.8) $\mu$m in length and 1.9 (1.8 - 2.2) $\mu$m in width. The sporoplasm is meager, and it contains an iodinophilous vacuole that is either circular or oval, along with a pair of circular germinal vesicles.

Schulman considered Myxobolus vescus to be a synonym of Myxobolus physophilus, which was described above. If one considers these organisms from the morphological standpoint, the similarity between them is indeed quite striking. However, when these spores are assessed from a size standpoint, it is clear that those that have been assigned to M. vescus are much smaller than those designated as M. physophilus. For this reason the present writers believe that these parasites should be regarded as two different species.

This species of Myxobolus is also one of the more commonly observed types of myxosporidian in the internal organs of Pseudobagrus fulvidraco, and it is distributed over a broad range of regions. During the current investigation it was discovered in both the Jingzhou and Xiaogan districts.

78. Myxobolus pseudorasborae Achmerov, 1960 (Plate XXVIII, Fig. 420; Plate XXIX, Figs. 421-426)

Sites of Infection and Host: The gall bladder, kidney, and swim bladder of Pseudobagrus fulvidraco.

Viewed from the valvular plane aspect, the spores have an oval or pumpkin-seed shape, with their anterior end being somewhat pointed and their posterior end being bluntly rounded. Viewed from the sutural plane aspect, the spores have an elongated fusiform shape, and the sutural ridge is straight and /p. 87 distinct. The length of the spores is 14.9 (13.8 - 16.8) μm, their breadth is 7.8 (7.2 - 8.4) μm, and their thickness is 4.8 - 6.0 μm. The two polar capsules are club-shaped and arranged in the anterior end of the spore, in either a parallel pattern or with one of them being positioned anterior to the other. The polar filaments are coiled, showing seven volutions. The length of the polar capsules is 8.0 (6.6 - 9.2) μm and their breadth is 2.7 (2.3 - 3.4) μm. The sporoplasm is relatively meager, and it occupies less than one-half of the length of the spore. It is provided with a conspicuous iodinophilous vacuole and two circular germinal vesicles.

This species of Myxobolus was initially discovered by Achmerov on the fins of Pseudorasbora parva. The organisms described here were found by the authors on the bodies of Pseudobagrus fulvidraco fishes. Since their shapes and sizes show no significant differences from those of M. pseudorasborae, the authors are treating them as belonging to this species.

This parasite is fairly often encountered in the bodies of Pseudobagrus fulvidraco. As a rule, however, the rate of infection with this organism is not very high.

79. Myxobolus heterocapsularis Chen & Hsieh, 1960 (Plate XXIX, Figs. 427-430)

Site of Infection and Host: The gills of Ophiocephalus argus.

No cysts have been discovered to date. Seen from the valvular plane aspect, the spores have an oval shape, and frequently V-shaped plications can be seen at their margins. Viewed from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and conspicuous. The length of the spores is 13.2 (12.0 - 14.4) $\mu$m, their breadth is 10.2 (9.6 - 10.8) $\mu$m, and their thickness is approximately 7.0 $\mu$m. Two polar capsules are observed; they are of unequal size, and they are positioned in the anterior end of the spore, diverging from each other in a pattern more or less suggestive of the character "/\". The larger polar capsule is 7.6 (7.2 - 9.0) $\mu$m long and 4.6 (4.2 - 4.8) $\mu$m wide, and its polar filament has 9-10 coils. The smaller polar capsule measures 5.6 (4.8 - 6.0) $\mu$m long by 3.2 (2.8 - 3.6) $\mu$m broad, and its coiled polar filament has six or seven turns. The nuclei of the polar capsules are triangular, and they appear to be closely appressed to the exterior of the capsules at their bottom. Within the sporoplasm are a distinct iodinophilous vacuole and two circular germinal vesicles.

This parasite was discovered on the gills of only one Ophiocephalus argus fish from Wangtian Lake in the Huanggang district.

## Genus: Neomyxobolus Chen & Hsieh, 1960

80. Neomyxobolus phiocephali Chen & Hsieh, 1960 (Plate XXIX, Figs. 431-433)

Site of Infection and Host: The kidney of Ophiocephalus argus.

Viewed from the valvular plane aspect, the spores display a somewhat large, semilunar shape, with their anterior end being truncated and their transverse axis being greater than their longitudinal axis. Viewed from the sutural plane aspect, the spores have a more or less elliptical shape, and their sutural ridge is broad and conspicuous. In addition to the usual sutural ridge, these spores also possess another ridge that is positioned in the vicinity of the sutural ridge. This other ridge shows little difference from the sutural ridge as far as its thickness is concerned. The length of the spores is 7.6 (7.5 - 7.9) $\mu$m and their breadth is 9.3 (9.0 - 10.1) $\mu$m. The polar capsules are nearly circular in outline and similar in size, and their apertures are situated on the left and right sides of the anterior end of the spore. These polar capsules measure 2.9 (2.6 - 3.2) $\mu$m in length and 2.9 (2.6 - 3.1) $\mu$m in breadth, and their polar filaments are coiled, showing four or five volutions. The nuclei of the polar capsules are small, looking something like periods, and they are positioned near the lower part of the capsules. The sporoplasm is homogeneous and compact, and it occupies approximately one-half of the spore's length. Within the sporoplasm are an iodinophilous vacuole and two circular germinal vesicles.

This species of Neomyxobolus was discovered in both the Huanggang and Xiaogan districts. Generally speaking, however, the severity of the infections by this organism is not very great.

**Genus:** Thelohanellus Kudo, 1933

81. Thelohanellus fuhrmanni (Auerbach, 1909) (Plate XXIX, Figs. 434-436)

Alternate names: Myxobolus fuhrmanni Auerbach, 1909; Thelohanellus carassii Achmerov, 1960; T. nikolskii Achmerov, 1955.

Sites of Infection and Host: The body surface, gills, kidney, swim bladder, and urinary bladder of Carassius auratus. /p. 88

No cysts have been found as yet. Viewed from either the valvular or the sutural plane aspect, the spores exhibit an elongated olive-like shape, with their anterior end being more finely pointed than their posterior end. In apical view, the spores have a circular outline, with their surface being smooth and lacking plications. The sutural ridge is straight and prominent. The spores are 17.9 (15.6 - 18.8) $\mu$m long, 9.0 (7.8 - 12.0) $\mu$m wide, and approximately 8.0 $\mu$m thick. The polar capsule is pyriform, and its anterior end has no distinctive structure. The polar filament is ribbon-like and coiled, with five or six volutions. The length of the polar capsule is 7.5 (7.2 - 7.8) $\mu$m and its breadth is 4.7 (4.6 - 5.0) $\mu$m. The nucleus of the polar capsule is large and triangular, and it is positioned near the bottom of the capsule. The sporoplasm is homogeneous and compact, and the iodinophilous vacuole is conspicuous, measuring 3.6 - 4.8 $\mu$m. Two circular germinal vesicles are [usually] present, although sometimes only one is observed.

This species of Thelohanellus is seen fairly often in the bodies of Carassius auratus, both in their internal tissues and their external ones. C. auratus fishes from all areas of Hubei Province have been found to be parasitized by this organism, although the magnitude of these infections is not very great.

82. Thelohanellus gangeticus Tripathi, 1953 (Plate XXIX, Figs. 437-439)

Site of Infection and Host: The kidney of Carassius auratus.

No cysts have been found to date. When viewed from either the valvular or the sutural plane aspect, the spores have the shape of an elongated egg-plant, with their anterior end being slightly curved to one side. The spores measure 14.8 (14.4 - 15.6) μm in length, 5.4 (4.8 - 6.0) μm in breadth, and approximately 4.8 μm in thickness. The polar capsule is bottle-shaped and its anterior end is a trifle expanded; its length is 6.1 (6.0 - 6.1) μm and its width is 2.5 (2.4 - 3.0) μm. The polar filament has six or seven coils. The nucleus of the polar capsule is conical, and it appears to be closely appressed to the bottom of the capsule. The sporoplasm is either homogeneous or provided with rather large granules. The iodinophilous vacuole is conspicuous, and there are two germinal vesicles, which are circular and positioned either close together or somewhat apart.

In this study, Thelohanellus gangeticus was found in the kidney of only one Carassius auratus fish in the Jingzhou district.

83. Thelohanellus rohitae (Southwell & Prashad, 1918 (Plate XXIX, Figs. 440-442)

Alternate names: Myxobolus rohitae Southwell & Prashad, 1918; Thelohanellus dogeili Achmerov, 1955.

Sites of Infection and Host: The body surface, nasal cavity, ureter and urinary bladder of Cyprinus carpio.

The cysts are variable in size and either white or wax yellow in colour. As a rule relatively thick cysts are formed inside the gills, with the larger

cysts measuring 0.5 - 1.5 μm in diameter and the smaller ones being 0.2 - 0.5 μm.

When viewed from either the valvular or the sutural plane aspect, the spores have an elongated oval shape, with their posterior end being bluntly rounded and their anterior end gradually tapering to a fine point. Their sutural ridge is straight and prominent, and their surface is smooth, as no plications are observed. The length of the spores is 28.5 (26.4 - 30.0) μm, their breadth is 8.8 (7.2 - 9.6) μm, and their thickness is 7.2 μm. One club-shaped polar capsule is present. This polar capsule occupies about two-thirds to three-fourths of the spore's length, as it extends 18.8 (16.2 - 19.2) μm in length and 6.8 (6.6 - 7.2) μm in breadth. The nucleus of the polar capsule is triangular. There is comparatively little sporoplasm, and it contains an iodinophilous vacuole and two circular germinal vesicles.

In some cysts, it often occurs that the outer surface of the spores is enveloped by a colourless, transparent spore membrane, whose length is 40.4 (39.6 - 42.0) μm and width is 11.0 (9.6 - 14.4) μm. Furthermore, some abnormal spores may also be present; their abnormality is manifested by the existence of two polar capsules of differing sizes (see Plate XXIX, Fig. 442).

The Thelohanellus dogeili spores that Achmerov discovered on the gills of red-finned carps* from Heilongjiang are shorter than the spores that have been regarded as T. rohitae, but their other features - notably their shape and the structure of their polar capsule - are identical in every respect. On this

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*Translator's note: Literal translation of "hongqili". If there is no typographical error here, this would be the name of an unidentified species of carp. However, the last Chinese character in this combination could easily be a misprint, in which case the intended word would likely have been "hongqibo" - the name, that is, of Culter erythropterus. This latter interpretation receives some support from the authors' subsequent remarks concerning Achmerov (see T. hovorkae below).

account the present writers consider these two species names to be synonymous.

This species of Thelohanellus is one of the more commonly encountered types of myxosporidian on the bodies of Cyprinus carpio. When fishes have been heavily infected by this parasite, they may develop "hard-scale disease", or their internal tissues may undergo pathological changes, etc. This organism is very widely distributed, as it has been found everywhere. /p. 89

84. Thelohanellus hovorkae Achmerov, 1960 (Plate XXX, Figs. 443-447)

Alternate names: T. dogeili Schulman, 1962, pp. 127 and 128, Fig. 294 (Non Achmerov, 1955, T. dogeili); T. catlae Schulman 1962, Fig. 295, partim (Non T. catlae Chakravarty, 1948).

Sites of Infection and Host: The gills, gall bladder, and urinary bladder of Cyprinus carpio.

The cysts are white and of different sizes, with their diameters ranging from 95.0 - 130.0 μm.

Seen from either the valvular or the sutural plane aspect, the spores have an oval shape, with their anterior end being somewhat pointed and their posterior end showing a blunt rounding. Their sutural ridge is straight and prominent. The length of the spores is 20.4 (18 - 22.8) μm, their breadth is 9.8 (7.2 - 12.0) μm, and their thickness is 7.0 - 10.0 μm. The polar capsule is spheroidal, and its apical end either lacks any distinctive alteration or displays a triangular enlargement. This polar capsule measures 10.8 (7.2 - 14.4) μm long by 8.9 (7.2 - 10.8) μm broad. The polar filament is smooth and flattened, appearing like a ribbon, and it is coiled, with 10-12 volutions. The nucleus of the polar capsule is triangular, and it is positioned near the bottom of the capsule. A few granules of a comparatively large size are

found in the sporoplasm. The iodinophilous vacuole is large and conspicuous, as its diameter extends 5.0 - 6.0 μm. Also present [as a rule] are a pair of circular germinal vesicles; sometimes, however, only one germinal vesicle is observed.

Schulman (1962) combined into the single species Thelohanellus dogeili five types of spores that had been identified by other workers - namely, the T. amurensis and T. nikolskii spores that Achmerov (1955) discovered in Culter erythropterus fishes from Heilongjiang, as well as the T. carassii and T. hovorkae spores that he discovered in 1960, and the species T. cyprini that was erected by Hoshina and Hosoda in 1957. In the opinion of the present authors, Schulman's decision was very misguided. This is because, in our view, the spores that Achmerov assigned the name of T. dogeili should in fact have been identified as T. rohitae (this has been pointed out above); as a result, the putative species "T. dogeili" has no true basis and should not have been considered to exist. For Schulman to compound this error by also identifying another type of spore as "T. dogeili" (from his illustrations it seems obvious that his material was T. hovorkae, a species that was discovered by Achmerov in 1960) amounts to an even more obvious mistake.

Based on our detailed analyses of the morphologies of the several types of spores mentioned above, it is the authors' conclusion that T. amurensis and T. nikolskii are in fact the same species. Moreover, in consideration of the rules of priority [for biological nomenclature], T. amurensis and T. nikolskii ought to be regarded as synonyms of T. fuhrmanni. In our opinion, T. carassii is also synonymous with T. fuhrmanni, but T. hovorkae is a legitimate species, as its morphology differs from that of T. fuhrmanni in a variety of respects, particularly the shape of its polar capsule. As for the T. saurogobii spores

that were described by Achmerov (1960), the writers consider them to be synonymous with T. acuminatus.

T. hovorkae is one of the more frequently encountered types of myxosporidian in the bodies of Cyprinus carpio, both internally and externally. Its distribution, moreover, is widespread. It was found in all three of the districts that were primarily examined in the current study - i.e., in the Huanggang, Xiaogan and Jingzhou districts.

85. Thelohanellus sagittarius Lee & Nie, 1965 (Plate XXX, Figs. 448-452)

Site of Infection and Host: The kidney of Cyprinus carpio.

The cysts are circular or elliptical and measure 60-80 μm in diameter. The outer surface of the cysts is surrounded by fairly thick connective tissue.

Seen from the valvular plane aspect, the spores have an elongated oval shape, with their anterior end being pointed and their posterior end bluntly rounded. The posterior part of the spore's surface bears six V-shaped plications. Viewed from the sutural plane aspect, the spores appear fusiform, and their sutural ridge is straight and distinct. The length of the spores is 20.0 (19.2 - 20.6) μm, their breadth [measured from the valvular plane aspect] is 9.6 (8.0 - 10.2) μm, and their breadth measured from the sutural plane aspect is 8.0 μm. One polar capsule with an elongated pyriform shape is observed. The anterior end of this polar capsule expands, assuming a triangular form, and the polar filament of the capsule has eight or nine coils. The polar capsule measures 10.6 (9.6 - 12.0) μm in length by 7.2 (6.6 - 8.0) μm in width. The two nuclei of the polar capsule are relatively large and have a

triangular shape; they appear to be closely appressed to the bottom of the polar capsule at its sides. Within the sporoplasm can be seen two circular germinal vesicles and one prominent iodinophilous vacuole.

This species of Thelohanellus has been discovered in both the Huanggang and Xiaogan districts. However, neither the rate of infection nor the severity of infection demonstrated by this parasite is very high. /p. 90

86. Thelohanellus pyriformis Nie & Lee, 1964 (Plate XXX, Figs. 453-455; Plate XXXI, Fig. 456)

Alternate names: T. catlae Schulman 1962, Fig. 295, partim (Non T. catlae Chakravarty 1949, Figs. 19-23).

Sites of Infection and Host: The gall bladder and swim bladder of Ophiocephalus argus.

No cysts have been found as yet. Seen from either the valvular or the sutural plane aspect, the spores exhibit a pyriform or eggplant-like shape. The spore's surface is smooth, as no plications can be seen, and the sutural ridge is thick and straight. The length of the spores is 20.6 (18.8 - 24.0) μm, their breadth [measured from the valvular plane aspect] is 11.8 (10.6 - 12.0) μm, and their breadth measured from the sutural plane aspect is 10.0 μm. The polar capsule is bottle-shaped; it is positioned obliquely at the anterior end of the spore, and measures 10.3 (9.6 - 12.0) μm long by 6.4 (5.8 - 6.6) μm broad. The polar filament is ribbon-like and coiled, with 9-11 volutions. The polar capsule contains two nuclei of different sizes; they are situated near the bottom of the capsule at its sides. Within the sporoplasm are a relatively large granule, a conspicuous iodinophilous vacuole, and two germinal vesicles; however, sometimes only one germinal vesicle is seen.

This species of Thelohanellus was found in both the Huanggang and Xiaogan districts, but the magnitude of its infections was not high.

## Genus: Hoferellus Berg, 1896

87. Hoferellus sinensis Lee & Nie, 1965 (Plate XXXI, Figs. 457-463)

Sites of Infection and Host: The kidney and urinary bladder of Misgurnus anguillicaudatus (Cantor).

No cysts have been discovered as yet. Sometimes, however, trophozoites can be seen. These trophozoites often contain not only spores but also granules of varying sizes. The trophozoites are 14.0 μm long and 10.0 μm wide. From either the valvular or the sutural plane aspect, the spores exhibit a spheroidal shape, and their sutural ridge is straight and elevated. The spore's surface displays annular striations that are arranged on a quadrant basis. Each of these striations extend toward the posterior part of the spore; they are somewhat coarse at their tips, and their length does not exceed 3.0 μm. The posterior margins of the spores are either arcuate or truncated, and their outer margins exhibit angular projections; these are even more distinct when the spore is viewed from the sutural plane aspect. The spores are 7.9 (7.2 - 8.4) μm long, 7.0 (6.8 - 7.2) μm wide, and 5.8 - 6.0 μm thick. Two pyriform polar capsules are present, and they take up approximately one-half of the spore's length. The polar capsules measure 3.3 (3.0 - 3.6) μm in length and 2.5 (2.0 - 3.0) μm in breadth. Within the sporoplasm is a prominent iodinophilous vacuole with a diameter of 3.6 μm; two germinal circular vesicles are also found [as a rule], although sometimes only one germinal vesicle is observed.

What is especially interesting to note here is that the position of the

polar capsules frequently varies in different [spores]. Sometimes the polar capsules are arranged in a manner similar to that seen in the genus Myxobolus, while in other cases they may intersect the sutural ridge at an oblique angle. Not only this, but quite a few instances are also observed where the polar capsules are positioned at the sides of the sutural ridge, much in the way they occur in the genus Mitraspora. Examination of a total of 35 spores revealed that 9 of them (25.7%) had polar capsules that were positioned alongside the sutural ridge; 11 of them (31.4%) had polar capsules that intersected the sutural ridge at an oblique angle; and 15 of them (42.9%) had polar capsules that were divided lengthwise by the sutural ridge, which is consistent to what is seen in the genus Hoferellus. Since the majority of this material fits the latter description, the writers are referring these spores to Hoferellus.

This parasite was only found in a single Misgurnus anguillicaudatus fish from the Xiaogan district.

## Genus: Henneguya Thélohan, 1892

88. Henneguya zikawiensis Sikama, 1938 (Plate XXXI, Figs. 464-468)

Sites of Infection and Host: The gills, gall bladder, intestines and heart of Carassius auratus.

The cysts are white and of different sizes and shapes, and they usually infect the host between its gill filaments. The external form of the cysts somewhat resembles that of white sesame. As for their size, the maximum diameter of the cysts ranges between 1.0 - 3.0 $\mu$m. /p. 91

Viewed from the valvular plane aspect, the spores have an obovoid shape, and their surface is either smooth or marked with some plications. Viewed

from the sutural plane aspect, the spores appear oval. Sometimes folds that are arranged in a conspicuous reticulate pattern can be seen (Plate XXXI, Fig. 466), and the sutural ridge is straight and distinct. The length of the spore proper is 9.5 (8.4 - 10.8) $\mu$m, its breadth is 8.0 (7.2 - 9.6) $\mu$m, and its thickness is 6.0 - 6.6 $\mu$m. The [two]* polar capsules are pyriform and take up approximately one-half of the spore's length, measuring 4.5 (4.2 - 4.8) $\mu$m long by 3.0 (2.4 - 3.6) $\mu$m broad. Their coiled polar filaments have four or five turns. Within the sporoplasm is a conspicuous iodinophilous vacuole and two circular germinal vesicles. The caudal prolongation[s] are long and thin, and they either separate or stay together as they extend 12.0 - 38.4 $\mu$m.

This species of Henneguya is observed fairly often in the bodies of Carassius auratus, both in their internal and their external tissues. In addition, the distribution of this organism is very broad, as it was found in all of the districts investigated here - i.e., in Huanggang, Xiaogan, and Jingzhou.

89. Henneguya sinensis Chen & Hsieh, 1960 (Plate XXXI, Figs. 469-470)

Site of Infection and Host: The swim bladder of Ophiocephalus argus.

The cysts vary considerably in both their shape and size, as their diameters fall within a range of 47.3 - 275.0 $\mu$m.

Seen from the valvular plane aspect, the spores have an elongated elliptical shape, with their anterior end being somewhat truncated; their surface is smooth, as no plications are observed. Viewed from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and

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*Translator's note: Inference; as often occurs in Chinese, the text does not specify whether this is singular or plural.

narrow. The length of the spore proper is 12.7 (10.8 - 13.2) μm, their breadth [measured from the valvular plane aspect] is 4.7 (4.0 - 5.4) μm, and their breadth measured from the sutural plane aspect is 4.0 - 4.5 μm. The two polar capsules are elongated club-shaped, and they measure 5.2 (4.8 - 6.6) μm in length and 1.7 (1.4 - 1.8) μm in width. The caudal prolongation[s] that are produced by the spore case are fairly broad while they remain in the vicinity of the body of the spore, but they gradually contract as they proceed posteriorly. The length of this caudal prolongation comes to 21.6 - 30.0 μm. Ordinarily they separate as they extend.

This organism is frequently found in the internal and external tissues of Ophiocephalus argus; it is especially prevalent in the soft connective tissues of the intratubular walls of the host's swim bladder. Henneguya sinensis shows a very wide distribution, and it was discovered in all of the localities that were investigated in the current study.

90. Henneguya giga Chen & Hsieh, 1960 (Plate XXXI, Figs. 471-473)

Site of Infection and Host: The swim bladder of Ophiocephalus argus.

The cysts are circular or oval and measure 130 - 370 μm in diameter. The outer surface of the cysts is surrounded by relatively thick connective tissue.

Viewed from the valvular plane aspect, the spores have an elongated oval outline, and their surface is either smooth or provided with V-shaped plications. Seen from the sutural plane aspect, the spores are fusiform, and their sutural ridge is straight and conspicuous. The length of the spore proper is 11.0 (10.2 - 13.2) μm, its breadth [measured from the valvular plane aspect] is 5.5 (4.6 - 6.0) μm, and its breadth measured from the sutural plane aspect is 3.6 - 4.8 μm. The two polar capsules are bottle-shaped, and they are arranged

parallel to each other in the anterior end of the spore. The length of the polar capsules is 5.5 (4.6 - 6.0) μm and their breadth is 1.7 (1.2 - 2.0) μm. The caudal prolongation[s] that are produced by the extension of the posterior end of the spore do not bifurcate. However, at a position that roughly corresponds to one-half of its total length, the caudal prolongation[s] curve upward in a sickle- or hook-like manner. The length of these caudal prolongation[s] is 20 to 30 μm. Within the sporoplasm can be seen a distinct iodinophilous vacuole and two circular germinal vesicles.

Henneguya giga is also among the most commonly encountered types of myxosporidian in the internal tissues and organs of Ophiocephalus argus, and its distribution, too, is very widespread. During the present investigation, this parasite was discovered in both the Huanggang and Xiaogan districts.

91. Henneguya rhinogobii Lee & Nie, 1965 (Plate XXXI, Figs. 474-476)

Site of Infection and Host: The mesenteron of Rhinogobio typus.*

Viewed from the valvular plane aspect, the spores have an elongated elliptical shape, and their surface is smooth, lacking plications. Viewed from the sutural plane aspect, the spores appear fusiform, and their sutural ridge is straight and conspicuous. The length of the spore proper is 16.2 (15.0 - 16.8) μm, its breadth is 5.0 (4.8 - 5.4) μm, and its thickness is 4.8 μm. The two polar capsules are club-shaped and arranged parallel to each other in the anterior end of the spore. The polar capsules measure 6.2 (5.8 - 7.2) μm in length and 1.7 (1.4 - 2.0) μm in width, and their polar filaments are coiled, with six volutions. The caudal prolongation[s] that are formed by [the

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*Translator's note: A guess; see the note on p. 31 of the translation.

extension of] the posterior end of the spore case show no curvature, and they separate at an area corresponding to approximately two-thirds of their length. These caudal prolongation[s] are 34 - 45.6 μm long. A noticeable iodinophilous vacuole and two circular germinal vesicles appear within the sporoplasm. /p. 92

This species of Henneguya was found only in the Silurian System at Bailianhe, Xishui County.

## EXPLANATIONS OF PLATES

### Plate XV

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Figs. 1-5. Mitraspora cyprini

1, 3, 4. Spore viewed from the sutural plane aspect, showing the parallel striations on the surface of the spore and the striations in its posterior end

2. Valvular plane aspect

5. Trophozoite with four spores

Figs. 6-11. Mitraspora sinensis

6. Sutural plane aspect, showing the sutural ridge and the parallel striations on the spore

7. Optical section

8. Sutural plane aspect, showing the spore's striations

9. Counter-apical view, showing the sutural ridge and the striations on the spore

10. A trophozoite with numerous spores

11. Valvular plane aspect

Figs. 12-18. Sphaerospore branchialis

12. Sutural plane aspect, showing the striations on the spore's surface and its external membrane

(Explanation of Plate XV, cont.)

13. Optical section, viewing the spore from the sutural plane aspect

14. Sutural plane aspect, showing how the spore's striations are arranged

15. Optical section, viewing the spore from the valvular plane aspect

16. Optical section, viewing the spore from the sutural plane aspect

17. Counter-apical view

18. Apical view, showing the spore's striations and its external membrane

Figs. 19-26. Sphaerospora amurensis

19. Valvular plane aspect, showing the spore and its external membrane

20. Sutural plane aspect, showing the spore and its external membrane

21. Sutural plane aspect, showing the plications on the spore's surface

22, 24. Sutural plane aspect

23. Optical section, viewing the spore from the sutural plane aspect; shows the spore's internal structure and its external membrane

25. Shows the trophozoites of two spores

26. Shows a spore in its early stage of development

## Plate XVI



Fig. 27. Sphaerospora amurensis, showing how it infects the tissues of the host

Figs. 28-31. Sphaerospora hupehensis

28. Optical section, viewing the spore from the sutural plane aspect

29. Sutural plane aspect, showing the sutural ridge and the punctae-like striations on the spore's surface

30. Valvular plane aspect

31. Spore viewed from the apical-sutural plane aspect, showing the sutural ridge, the polar capsules, and the spore's striations

Figs. 32-42. Chloromyxum ellipticum

32, 35, 39, 40. A specimen that had parasitized a Hypophthalmichthys molitrix fish

32. Spore viewed from an oblique sutural plane aspect

35. Valvular plane aspect

39. Valvular plane aspect

40. Counter-apical view

33. A specimen that had parasitized a Parabramis pekinensis fish; shows the spore in its early stage of development, from the valvular plane aspect

(Explanation of Plate XVI, cont.)

34, 41. A specimen that had parasitized a *Ctenopharyngodon idellus* fish

34. Valvular plane aspect

41. Apical view

36, 38. A specimen that had parasitized a *Squaliobarbus curriculus* fish.

37. Specimen[s] that had parasitized *Carassius auratus* and *Aristichthys nobilis* fishes

42. A trophozoite that bears seven spores

Figs. 43-47. *Chloromyxum hupehensis*

43. Spore viewed from an oblique sutural plane aspect

44. Spore viewed from the front-sutural plane aspect

45. Counter-apical view

46. Spore viewed from an oblique valvular plane aspect

47. Shows a trophozoite that bears five spores

Figs. 48-57. *Myxidium lieberkuehni*

48. Shows the two spores produced by a sporont

49, 52, 53, 57. Valvular plane aspect, showing the striations on the spore's surface

50, 55. Sutural plane aspect, showing the sutural line and the spore's striations

51, 54, 56. Optical section

## Plate XVII



Figs. 58-83. Myxidium polymorphum

58-60. A specimen that had parasitized a Mylopharyngodon piceus fish

58. Valvular plane aspect

59. Optical section

60. Sutural plane aspect

61-65. A specimen that had parasitized a Ctenopharyngodon idellus fish

61, 63, 65. Sutural plane aspect

62. Optical section

64. Valvular plane aspect

66, 67. A specimen that had parasitized a Opsariichthys uncirostris bidens fish

66. Valvular plane aspect

67. Spore viewed from the front-sutural plane aspect

68, 69. A specimen that had parasitized a Hemiculter leucisculus fish, showing the spore from the valvular plane aspect

70, 71. A specimen that had parasitized a Parabramis pekinensis fish

70. Sutural plane aspect

71. Valvular plane aspect

72-74. A specimen that had parasitized a Megalobrama terminalis fish

(Explanation of Plate XVII, cont.)

72, 73. Sutural plane aspect

74. Optical section

75-77. A specimen that had parasitized a *Aristichthys nobilis* fish

75. Valvular plane aspect

76. The spore in its early stage of development

77. Sutural plane aspect

78, 79. A specimen that had parasitized a *Hypophthalmichthys molitrix* fish

78. Valvular plane aspect

79. Sutural plane aspect

80. A specimen that had parasitized a *Pseudorasbora parva* fish, viewed from the sutural plane aspect

81-83. A specimen that had parasitized a *Macropodus chinensis* fish

81. Spore viewed from an oblique sutural plane aspect

82. Valvular plane aspect

83. Optical section

Figs. 84-88. *Myxidium spinosum*

84. Sutural plane aspect

85, 87. Valvular plane aspect, showing the polar capsules, germinal vesicles, and the small spines on the spore's surface

(Explanation of Plate XVII, cont.)

86. Spore viewed from the apical-sutural plane aspect, showing the arrangement of the polar capsules and the spine's on the spore's surface

88. Shows a trophozoite that bears three spores

## Plate XVIII

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Figs. 89-95. Myxidium ophiocephali

89. Sutural plane aspect, showing the sutural line and how the striations are arranged on the spore's surface

90, 91. Valvular plane aspect

92. Optical section

93. Spore viewed from the front-sutural plane aspect

94. Sutural plane aspect

95. Shows a trophozoite that bears 10 spores

Figs. 96-98. Myxidium macrocapsulare

96. Optical section, viewing the spore from the valvular plane aspect

97. Spore viewed from the front-sutural plane aspect

98. Sutural plane aspect, showing the sutural line and the striations on the surface of the spore

Figs. 99-102. Myxidium rhinogobides

99, 102. Valvular plane aspect, showing the striations on the surface of the spore

100. Spore viewed from the front-sutural plane aspect, showing the sutural line and the parallel striations on the surface of the spore

(Explanation of Plate XVIII, cont.)

101. Optical section

Figs. 103-106. Zschokkella carassii

103, 106. Sutural plane aspect, showing the S-shaped sutural line and the striations on the spore's surface

104. Valvular plane aspect

105. Shows a trophozoite that bears numerous spores

Figs. 107-110. Zschokkella minuta

107. Sutural plane aspect, showing the S-shaped sutural line and the striations on the spore's surface

108, 109. Valvular plane aspect

110. Sutural plane aspect, showing the striations on the surface of the spore and how they intersection the sutural line

Figs. 111, 112. Sphaeromyxa sabrazesi

111, 112. Optical section of the spore, revealing its internal structure

Figs. 113-115. Myxosoma bibullatum

113. Sutural plane aspect

114, 115. Valvular plane aspect

## Plate XIX

/p. 300

Figs. 116-123. Myxosoma notropis

116-118, 122, 123. Valvular plane aspect

119, 121. Sutural plane aspect

120. A cyst that had infected the host on its mesentery

Figs. 124-127. Myxosoma cerebralis

124, 126, 127. Shows the spore from the valvular plane aspect

125. Sutural plane aspect

Figs. 128-132. Myxosoma pfrille

128-130. Valvular plane aspect

131. Shows a cyst that had formed at the base of the gill filaments of the host

132. Sutural plane aspect

Figs. 133-141. Myxosoma sinensis

133, 135, 139-141. Valvular plane aspect

134, 137, 138. Sutural plane aspect

136. Shows a cyst that had been formed among the gill filaments of the host

## Plate XX



Figs. 142-147. Myxosoma varia

142, 144, 147. Valvular plane aspect

143. Sutural plane aspect

146. An abnormal spore

145. Shows how [the spore] infected the gill tissues of the host

Figs. 148-152. Myxosoma lieni

148. A trophozoite; shows two mature spores and [a] spore in the early stages of development

149, 151. Valvular plane aspect

150. Sutural plane aspect

152. Optical section, viewing the spore from the counter-apical aspect

Figs. 153-155. Myxobolus ophiocephali

153. Valvular plane aspect, showing the spore's polar capsules, germinal vesicles, and V-shaped plications

154. Sutural plane aspect

155. A cyst

Figs. 156-160. Myxobolus diversus

156, 158, 159. Valvular plane aspect

157. Sutural plane aspect

160. An abnormal spore

Figs. 161-163. Myxobolus rutilus

161. Valvular plane aspect

(Explanation of Plate XX, cont.)

162. Shows a trophozoite that bears numerous spores

163. Sutural plane aspect

Figs. 164-168. Myxobolus musculi

164, 166, 167. Valvular plane aspect

165. Sutural plane aspect

168. Shows two trophozoites in the process of developing and forming a cyst

Figs. 169, 170. Myxobolus carassii

169. Valvular plane aspect

170. Sutural plane aspect

## Plate XXI



Figs. 171-177. Myxobolus carassii

171-174, 176, 177. Valvular plane aspect

175. Sutural plane aspect

Figs. 178-181. Myxobolus bilis

178, 180. Valvular plane aspect

179. Sutural plane aspect

181. A cyst

Figs. 182-186. Myxobolus velatus

182, 183, 185. Valvular plane aspect, showing the polar capsules, germinal vesicles, iodinophilous vacuole, and the thin membrane at the posterior end of the spore

184. Sutural plane aspect

186. A cyst that had infected the gill filaments of the host

Figs. 187-189. Myxobolus egregius

187. Sutural plane aspect

188, 189. Valvular plane aspect

Figs. 190-193. Myxobolus gigi

190, 191, 193. Valvular plane aspect

192. Sutural plane aspect

Figs. 194, 195. Myxobolus kubanicum, viewed from the valvular plane aspect

## Plate XXII



Figs. 195a - 200. Myxobolus kubanicum

195a, 197, 199. Valvular plane aspect

196, 200. Sutural plane aspect

Figs. 201-208. Myxobolus nemachili

201-205, 208. Valvular plane aspect

206, 207. Sutural plane aspect

Figs. 209-212. Myxobolus koi

209, 210. Valvular plane aspect

211, 212. Sutural plane aspect

Figs. 213-216. Myxobolus toyamai

213, 215. Valvular plane aspect

214. Sutural plane aspect

216. Shows a cyst that had infected the host among its gill filaments

Figs. 217-220. Myxobolus acinosus

217. Valvular plane aspect, showing a larger polar capsule and a smaller one

218. Valvular plane aspect, showing two polar capsules of equivalent size

219. Sutural plane aspect

220. A cyst

Figs. 221-224. Myxobolus vastus, viewed from the valvular plane aspect

## Plate XXIII



Figs. 225-228. Myxobolus vastus

225. Valvular plane aspect

226, 227. Sutural plane aspect

228. A cyst

Figs. 229-231a. Myxobolus obliquus

229, 231. Valvular plane aspect

230, 231a. Sutural plane aspect

Figs. 232-235. Myxobolus opsariichthyi

232, 234, 235. Valvular plane aspect

233. Sutural plane aspect

Figs. 236-239. Myxobolus obovoides

236. Sutural plane aspect

237, 238. Valvular plane aspect

239. A cyst

Figs. 240-243. Myxobolus microlatus, viewed from the valvular plane aspect

Figs. 244-249. Myxobolus acanthogobii

244, 249. Valvular plane aspect, showing the spore and its external membrane

245, 247. Valvular plane aspect

246, 248. Sutural plane aspect

Figs. 250-254. Myxobolus clarii

250, 252-254. Valvular plane aspect

251. Sutural plane aspect

Fig. 255. Myxobolus mylopharyngodoni, viewed from the sutural plane aspect

## Plate XXIV



Figs. 256, 257. Myxobolus mylopharyngodoni

256. Valvular plane aspect

257. A cyst

Figs. 258, 259. Myxobolus tumides

258. Valvular plane aspect

259. Counter-apical view

Figs. 260-262. Myxobolus obliquoides

260. Valvular plane aspect

261. Counter-apical view

262. Sutural plane aspect

Figs. 263-265. Myxobolus artus

263. Valvular plane aspect

264. Apical view

265. Sutural plane aspect

Figs. 266, 267. Myxobolus lomi

266. Valvular plane aspect

267. Sutural plane aspect

Figs. 268-274. Myxobolus tricostatus*

268, 270, 272, 274. Valvular plane aspect

269. Sutural plane aspect, showing three costa-like angular processes

271. Counter-apical view

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*Translator's note: Inference; the text says "Myxobolus tricostalus".

(Explanation of Plate XXIV, cont.)

273. Shows one-half of the spore, depicting its sutural ridge and one of the costa

Figs. 275-280. Myxobolus microsporus

275-277, 279, 280. Valvular plane aspect

278. Sutural plane aspect

Figs. 281-285. Myxobolus pseudoparvus

281, 282, 284, 285. Valvular plane aspect

283. Sutural plane aspect

Figs. 286-290. Myxobolus exiquus

286, 288-290. Valvular plane aspect

287. Sutural plane aspect

## Plate XXV



Figs. 291-293. Myxobolus cyprini

291, 292. Valvular plane aspect

293. Sutural plane aspect

Figs. 294-296. Myxobolus acanthorhodi

294. Valvular plane aspect

295. Valvular plane aspect, showing the cilia in the posterior end of the spore

296. Sutural plane aspect

Figs. 297-299. Myxobolus elaiodes

297, 298. A specimen that had parasitized an Acanthorhodeus* fish

297. Valvular plane aspect, showing the cilia in the posterior end of the spore

298. Sutural plane aspect

299. A specimen that had parasitized a gongshi sicibianggou** fish, viewed from the valvular plane aspect

Figs. 300-304. Myxobolus vesiformis

300, 301, 303, 304. Valvular plane aspect

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*Translator's note: Inference; no specific name is shown. Actually the characters that are used in the text here would normally be taken to indicate the fish belonged to the genus Rhodeus, whose Chinese name is almost the same as the name used for Acanthorhodeus fishes. However, from the description of M. elaiodes that appears in the text, it would seem that the intended reference here is to an Acanthorhodeus fish.

**Translator's note: Chinese name of an unidentified fish. Literally, "pseudo - spine [or thorn] - bream - goby", preceded by "Gong's", which normally would be a phonetic rendering of the initial part of the surname of the person after whom the fish was named.

(Explanation of Plate XXV, cont.)

302. Sutural plane aspect

Figs. 305-310. Myxobolus symmetricus

305, 306, 308-310. Valvular plane aspect

307. Sutural plane aspect

Figs. 311-326. Myxobolus dispar

311-314. A specimen that had parasitized a Cyprinus carpio fish, shown from both the valvular and sutural plane aspects

315-320. Specimens that had parasitized Aristichthys nobilis and Hypophthalmichthys molitrix fishes, shown from both the valvular and sutural plane aspects

321-326. A specimen that had parasitized a Aristichthys nobilis fish in its intestinal and other tissues, shown from both the valvular and sutural plane aspects

## Plate XXVI



Figs. 327-330. Myxobolus aristichthydis

327-329. Valvular plane aspect

330. Sutural plane aspect

Figs. 331-339. Myxobolus cyprinicola

331-333, 336-339. Valvular plane aspect

334. Sutural plane aspect

335. A cyst

Figs. 340-345. Myxobolus ellipsoides

340, 345. Sutural plane aspect

341-344. Valvular plane aspect

Figs. 346-350. Myxobolus atypicus

346, 349. Valvular plane aspect

347, 350. Sutural plane aspect

348. A cyst

Figs. 351-355. Myxobolus nobillis

351. Apical view, showing the sutural ridge, sutural line, and the apertures of the polar capsules

352-354. Valvular plane aspect

355. Sutural plane aspect

## Plate XXVII



Figs. 356-360. Myxobolus drjagini

356-358, 360. Valvular plane aspect

359. Sutural plane aspect

Figs. 361-366. Myxobolus abitus

361-364. Valvular plane aspect

365. Counter-apical view

366. Apical view

Figs. 367, 368. Myxobolus cheni

367. Sutural plane aspect

368. Valvular plane aspect

Figs. 369-374. Myxobolus minutus

369, 371, 372. Valvular plane aspect

373, 374. Sutural plane aspect

370. Shows how these spores infect a host within its gill filaments

Figs. 375-379. Myxobolus parvus

375, 377, 378. Valvular plane aspect

376. Counter-apical view

379. A trophozoite

Figs. 380-384. Myxobolus gourdiformis

380, 381. Sutural plane aspect

382. Optical section, viewing the spore from the counter-apical aspect

383, 384. Valvular plane aspect

Figs. 385-388. Myxobolus nephroides

(Explanation of Plate XXVII, cont.)

385, 386. Valvular plane aspect

387. Counter-apical view

388. Sutural plane aspect

Figs. 389-392. Myxobolus squamosus

389-391. Valvular plane aspect

392. Sutural plane aspect

## Plate XXVIII



Figs. 393-395. Myxobolus squamosus

393. Shows a cyst that had parasitized the host on its gills

394, 395. An abnormal spore, viewed from the valvular plane aspect

Figs. 396-403. Myxobolus miyairii

396-398, 400-403. A specimen that had parasitized a Silurus asotus fish

396, 397, 402, 403. Valvular plane aspect

398. Apical view

400. Sutural plane aspect

401. A cyst

399. A specimen that had parasitized a Erythroculter ilishaeformis* fish, viewed from the valvular plane aspect

Figs. 404-408. Myxobolus physophilus

404, 407, 408. Valvular plane aspect

405. Sutural plane aspect

406. Shows a cyst that had formed on a fin of the host

408. Shows the membrane that envelopes these spores

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*Translator's note: Inference; one of the characters in this fish's name is missing here, but the omission appears to be a typographical error.

(Explanation of Plate XXVIII, cont.)

Figs. 409-411. Myxobolus aureatus

409. Shows a cyst that had formed within the gill* filaments of the host

410. Valvular plane aspect

411. Sutural plane aspect

Figs. 412-415. Myxobolus muelleri

412, 413, 415. Valvular plane aspect

414. Sutural plane aspect

Figs. 416-419. Myxobolus vescus

416, 417. Valvular plane aspect

418. Sutural plane aspect

419. A trophozoite; one mature spore can be seen

Fig. 420. Myxobolus pseudorasborae, viewed from the valvular plane aspect

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*Translator's note: Inference; there seems to be a typographical error here, too.

## Plate XXIX



Figs. 421-426. Myxobolus pseudorasborae

421-424, 426. Valvular plane aspect

425. Sutural plane aspect

Figs. 427-430. Myxobolus heterocapsularis

427. Sutural plane aspect

428-430. Valvular plane aspect

Figs. 431-433. Neomyxobolus ophiocephali

431. Spore viewed from the apical-sutural plane aspect

432. Optical section, viewing the spore from the valvular plane aspect

433. Spore viewed from an oblique sutural plane aspect

Figs. 434-436. Thelohanellus fuhrmanni

434, 435. Valvular plane aspect

436. Sutural plane aspect

Figs. 437-439. Thelohanellus gangeticus

437. Sutural plane aspect

438, 439. Valvular plane aspect

Figs. 440-442. Thelohanellus rohitae

440. Valvular plane aspect, showing the spore and its external membrane

441. A cyst that had infected the host beneath its scales

442. Valvular plane aspect, showing a smaller polar capsule and a larger one

## Plate XXX



Figs. 443-447. Thelohanellus hovorkae

443. Sutural plane aspect, showing the spore and its external membrane

444. Valvular plane aspect

445. A cyst

446. Sutural plane aspect

447. Valvular plane aspect

Figs. 448-452. Thelohanellus sagittarius

448, 450. Sutural plane aspect

449, 452. Valvular plane aspect

451. Valvular plane aspect, showing the spore and its external membrane

Figs. 453-455. Thelohanellus pyriformis, viewed from the valvular plane aspect

## Plate XXXI



Fig. 456. Thelohanellus pyriformis, viewed from the sutural plane aspect

Figs. 457-463. Hoferellus sinensis

457. Spore viewed from an oblique sutural plane aspect, showing the obliquely inclined sutural ridge and the striations on the spore's surface

458. Valvular plane aspect

459. Sutural plane aspect, showing two symmetrical polar capsules that are evenly divided by the sutural ridge

460. Valvular plane aspect, showing the thinner and the more prominent striations that occur on the spore's surface

461. A trophozoite that bears one spore

462. Spore viewed from the apical-sutural plane aspect

463. Sutural plane aspect

Figs. 464-468. Henneguya zikawiensis

464, 465, 467. Valvular plane aspect

466. Sutural plane aspect, showing the plications on the surface of the spore

468. Sutural plane aspect

Figs. 469, 470. Henneguya sinensis

469. Valvular plane aspect

(Explanation of Plate XXXI, cont.)

470. Sutural plane aspect

Figs. 471-473. Henneguya giga

471. Valvular plane aspect

472. Sutural plane aspect

473. A cyst

Figs. 474-476. Henneguya rhinogobii

474. Sutural plane aspect

475, 476. Valvular plane aspect

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*Translator's note: Under the romanization system that used to be commonly used in China, these authors' names would have been spelled as CHEN Ch'i-liu and HSIEH Hsing-jen respectively.

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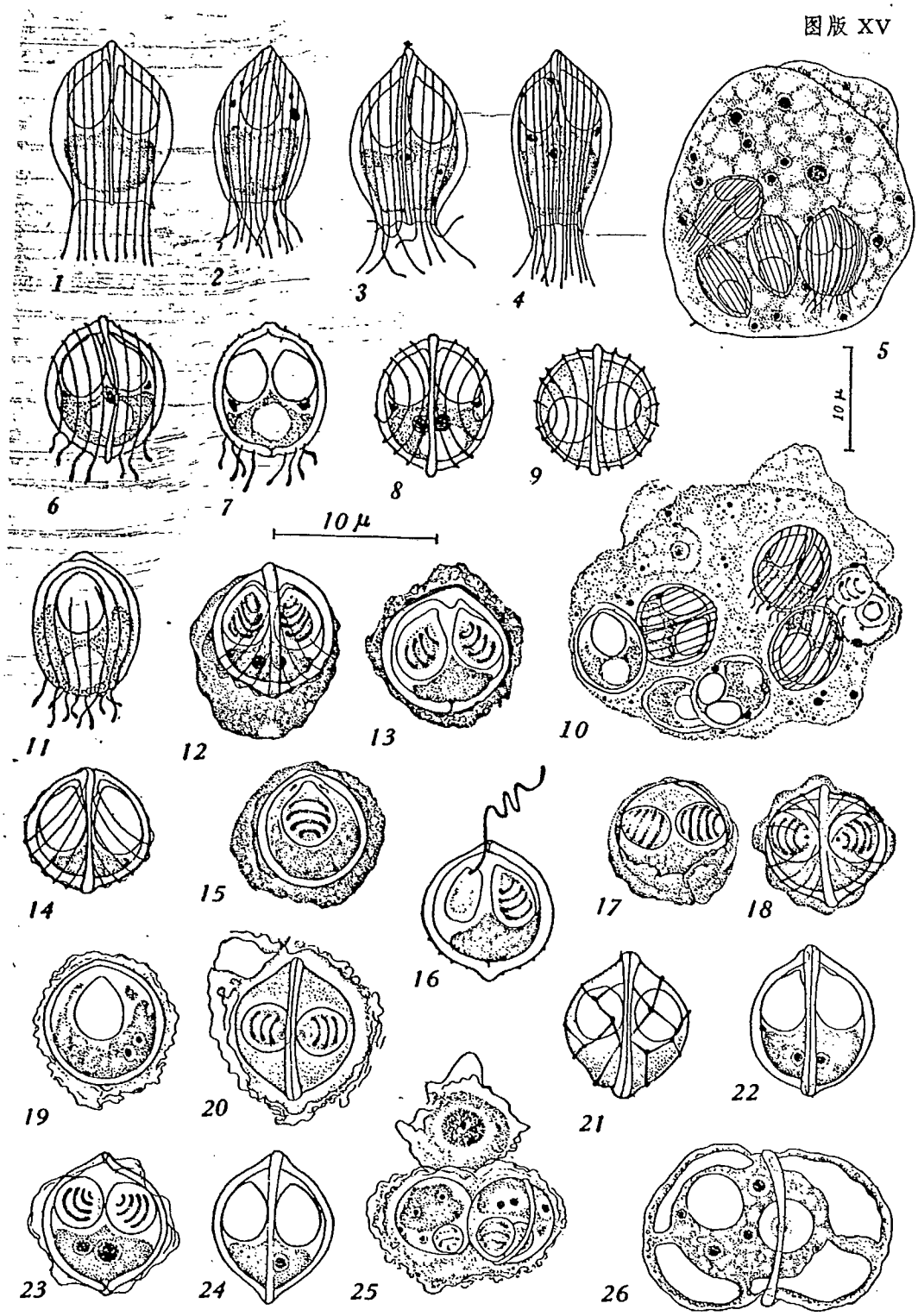
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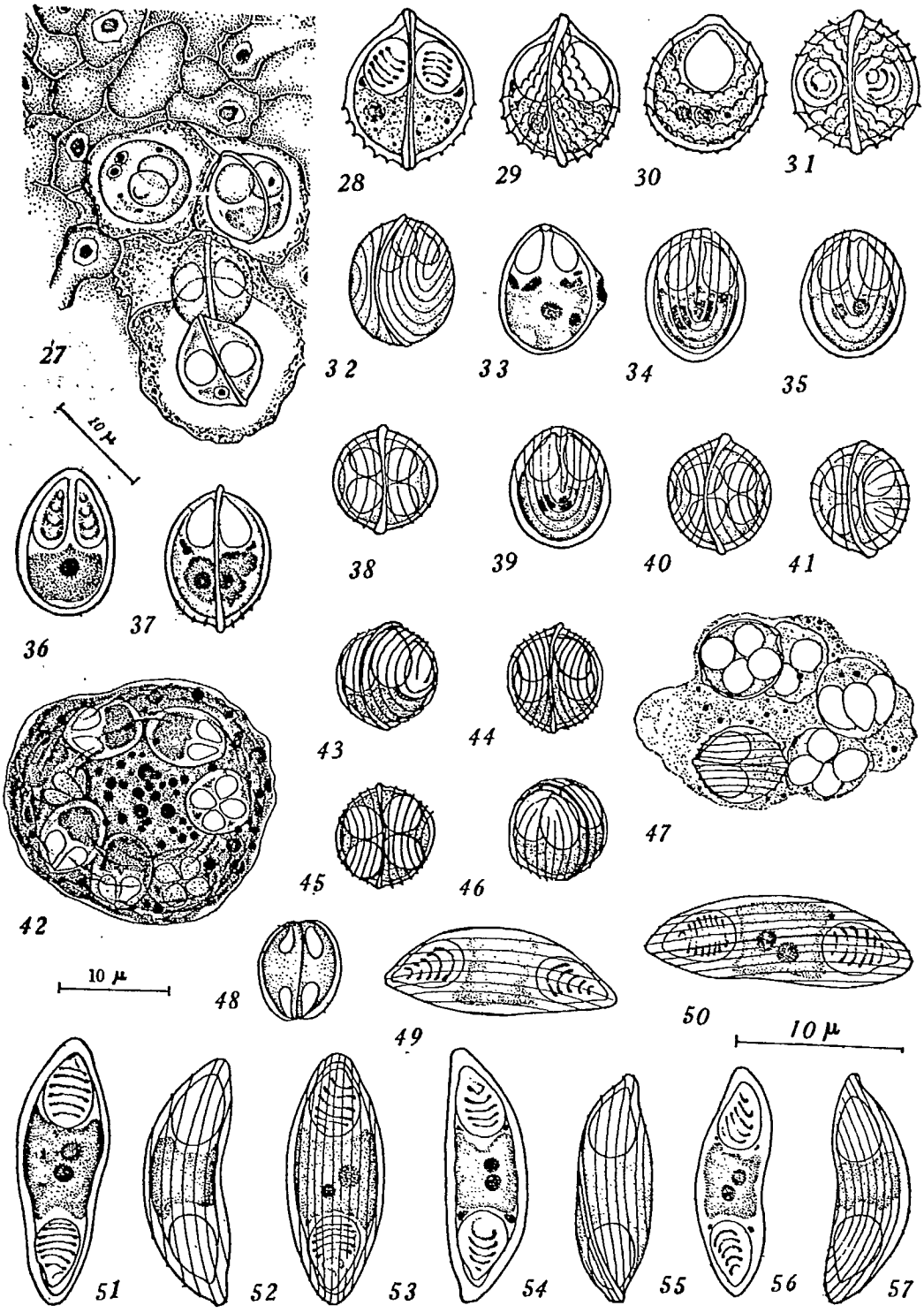
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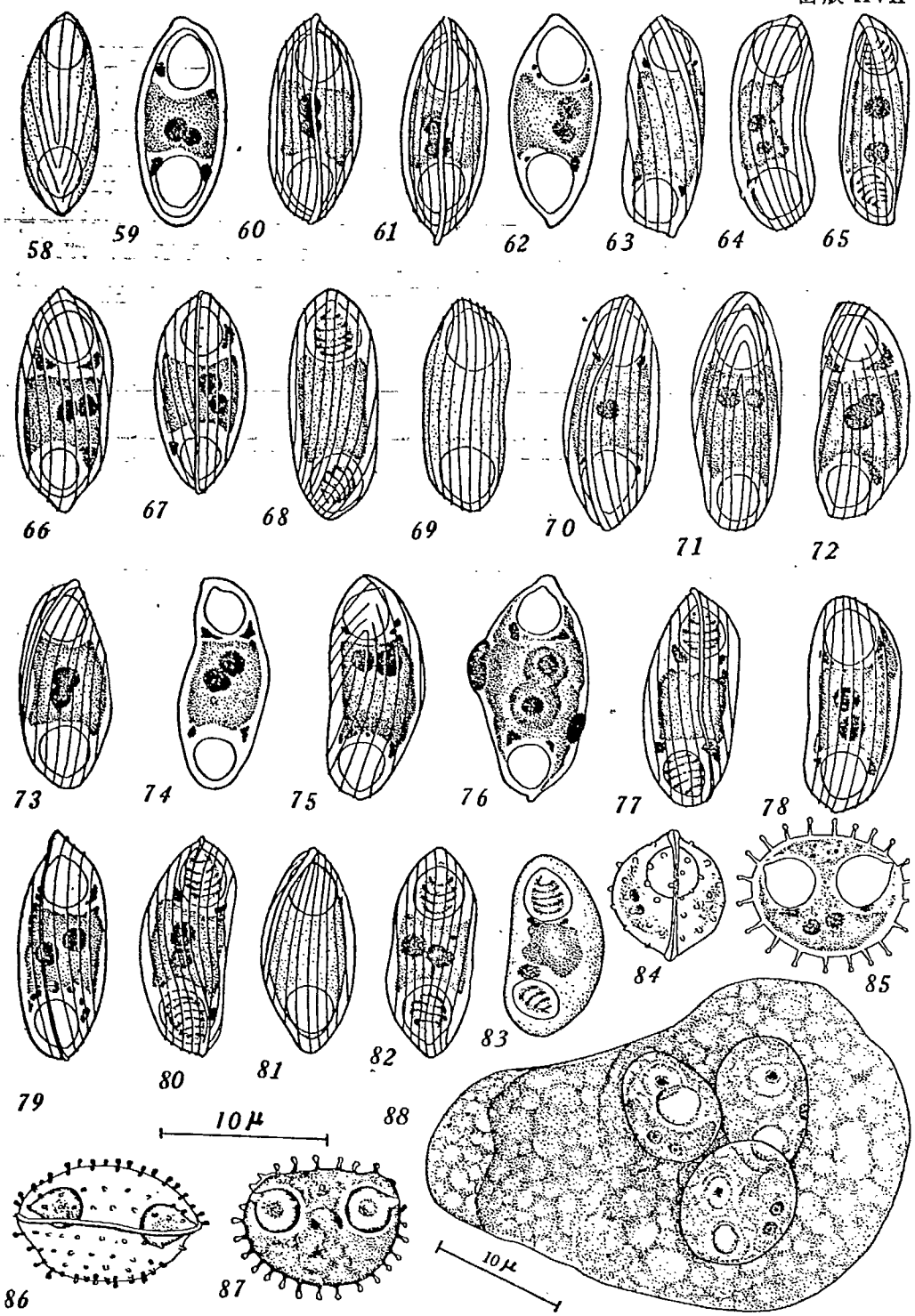
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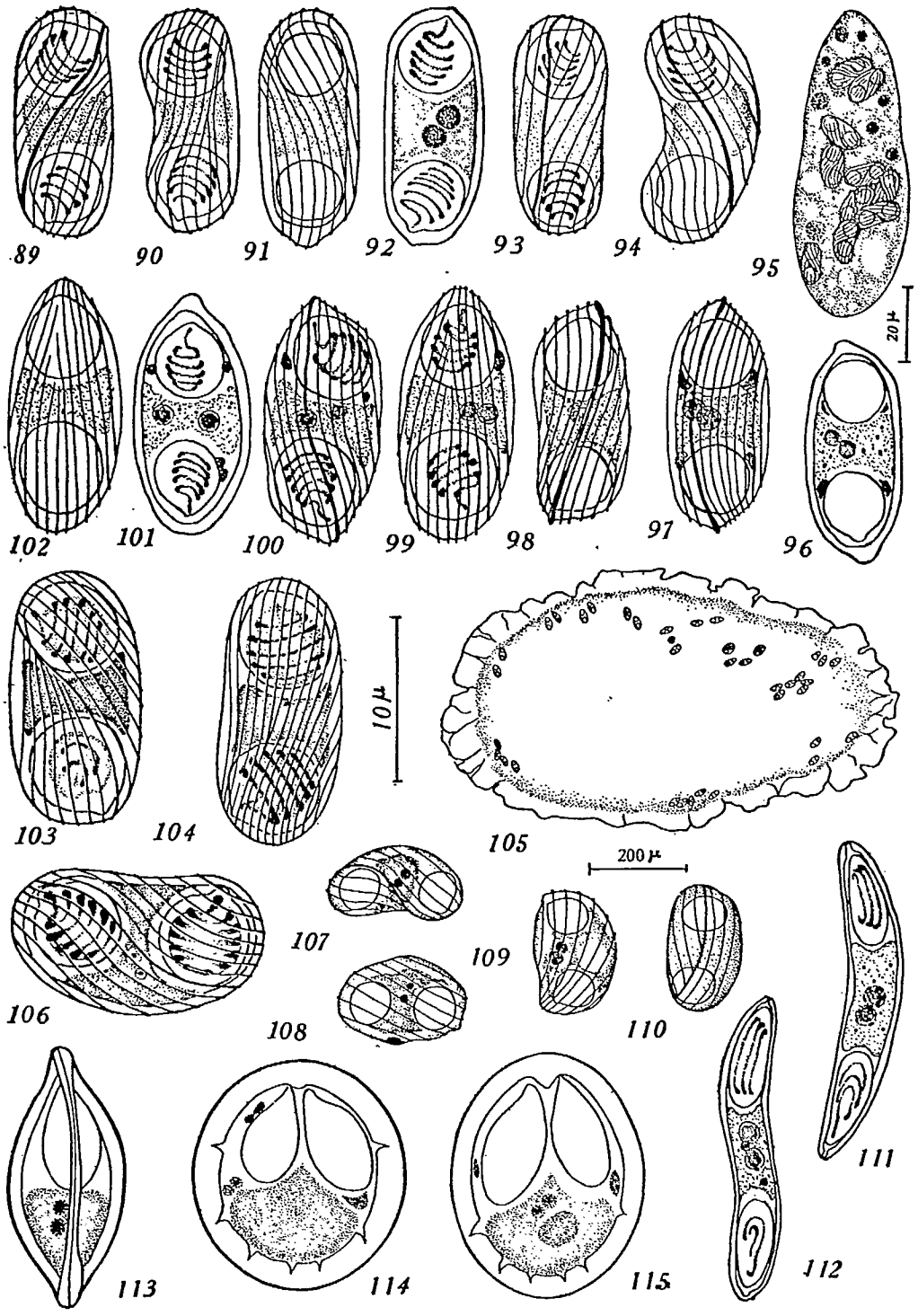
87
10μ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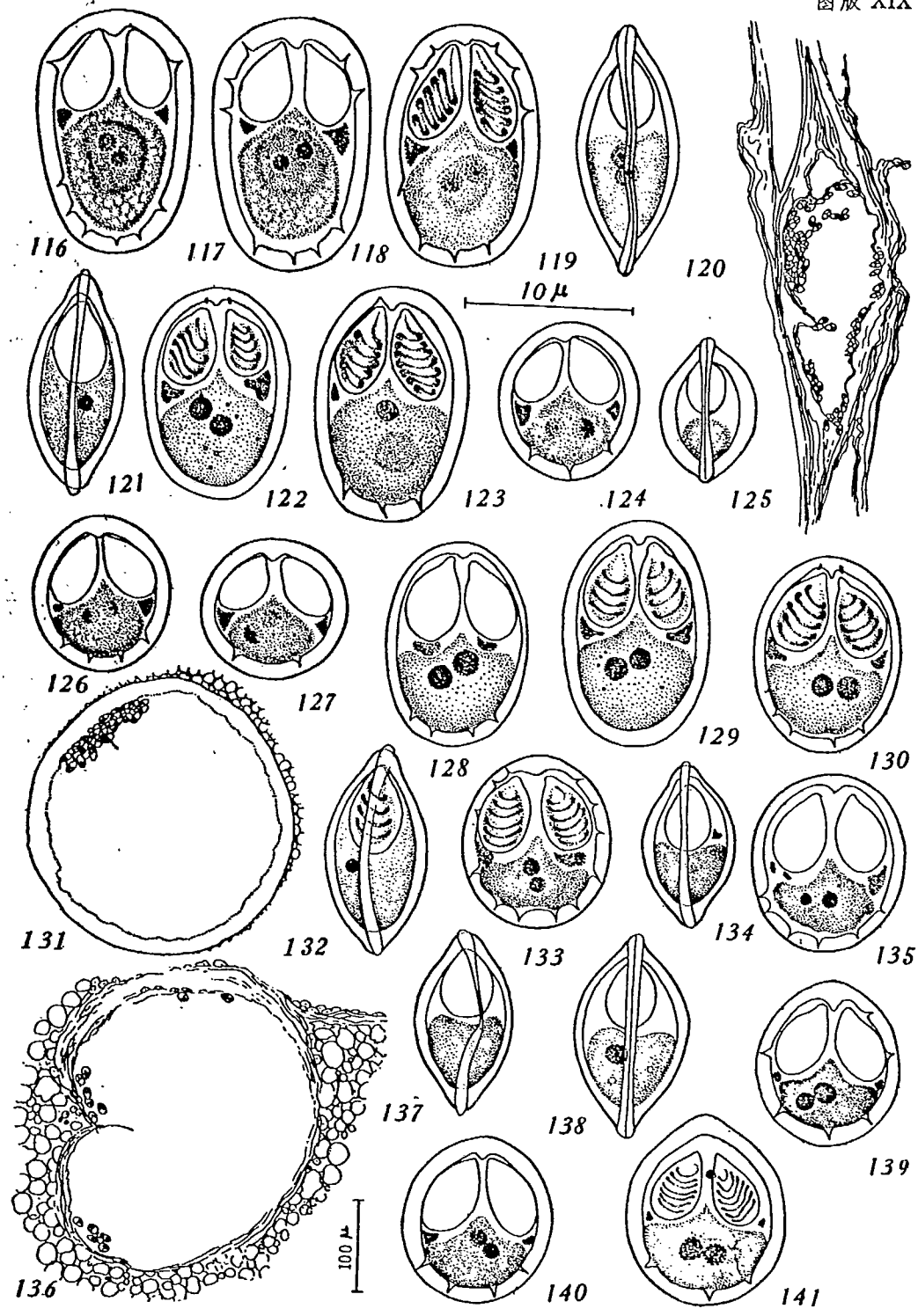
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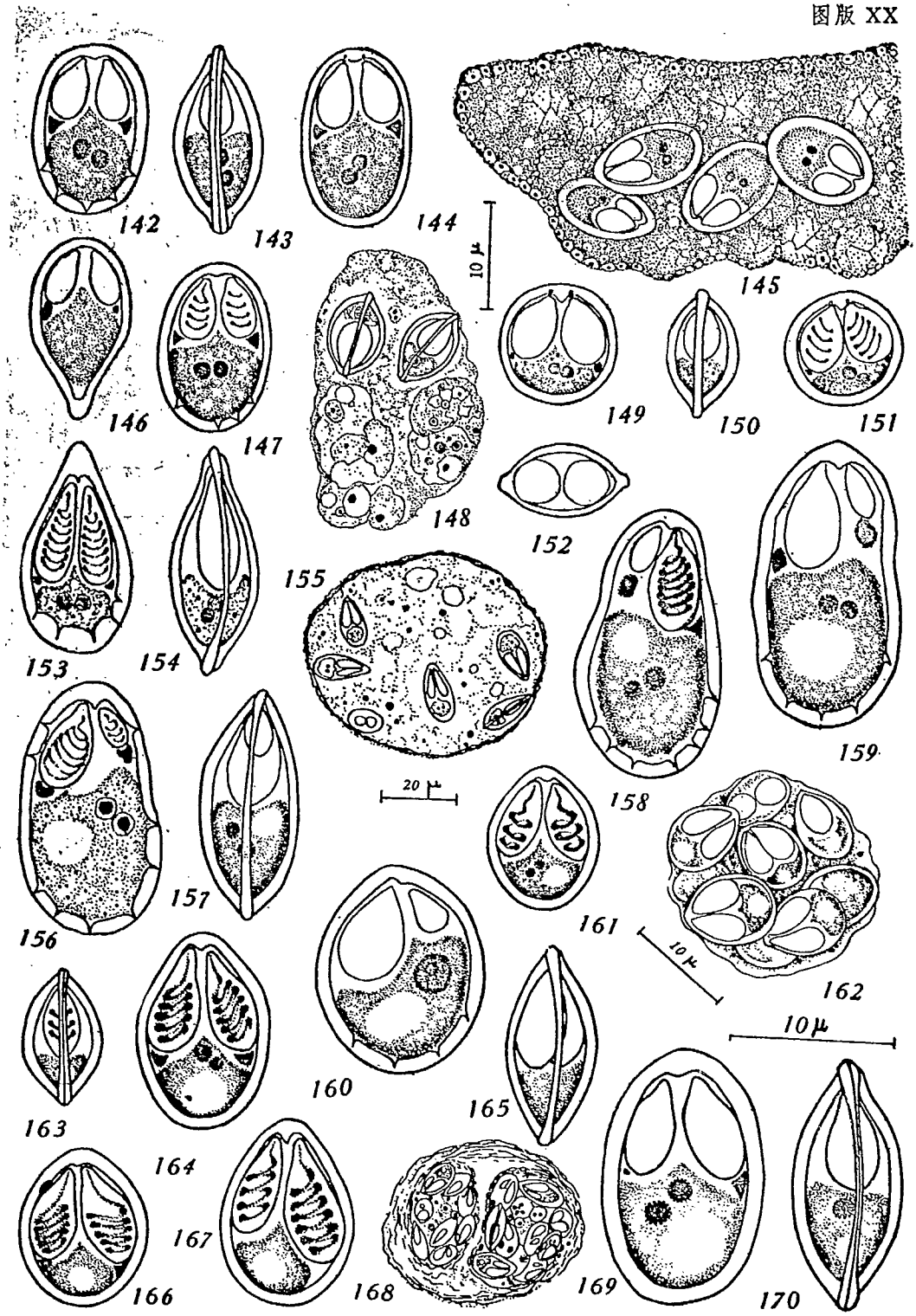
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170
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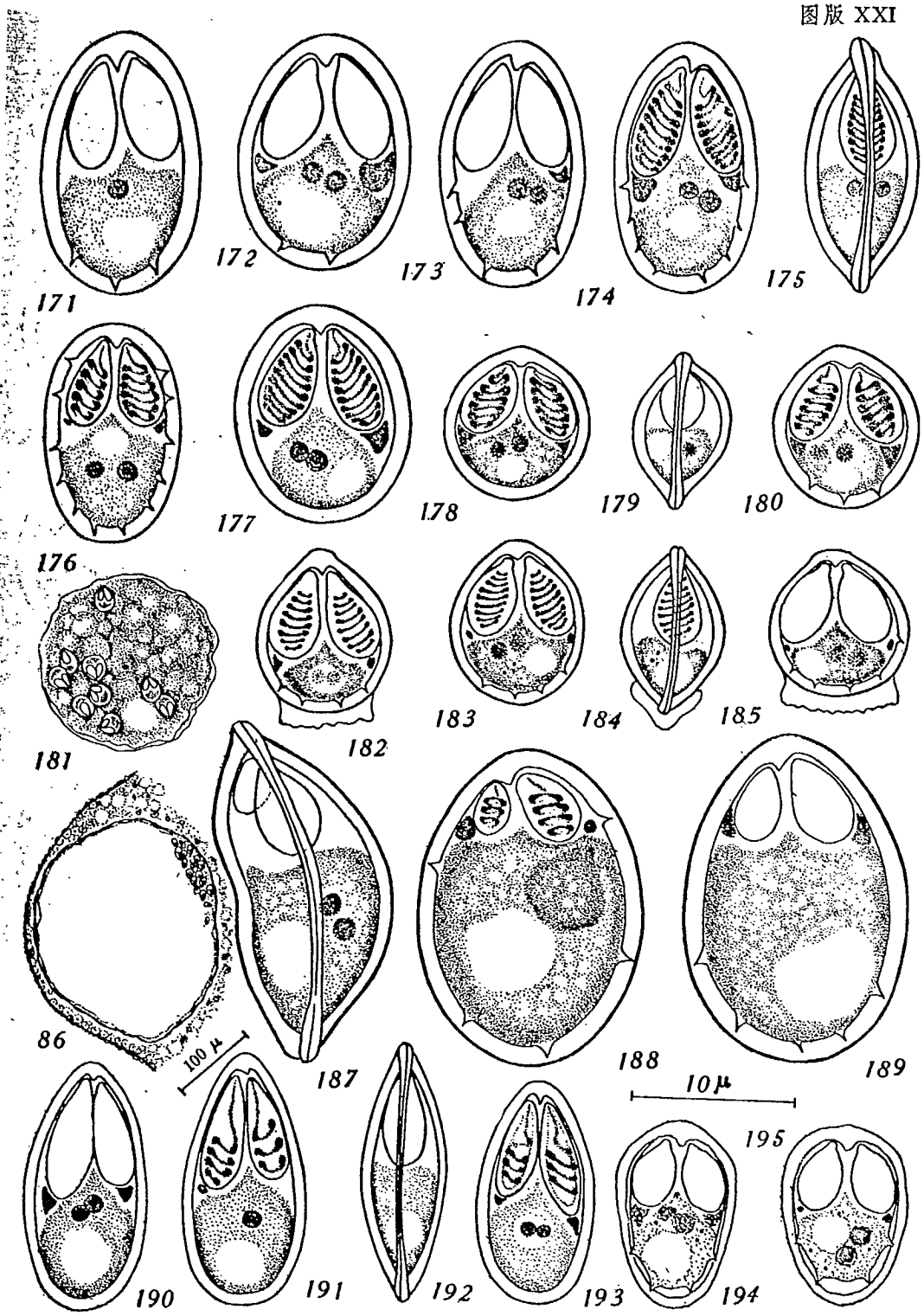
20 μ
10 μ
10μ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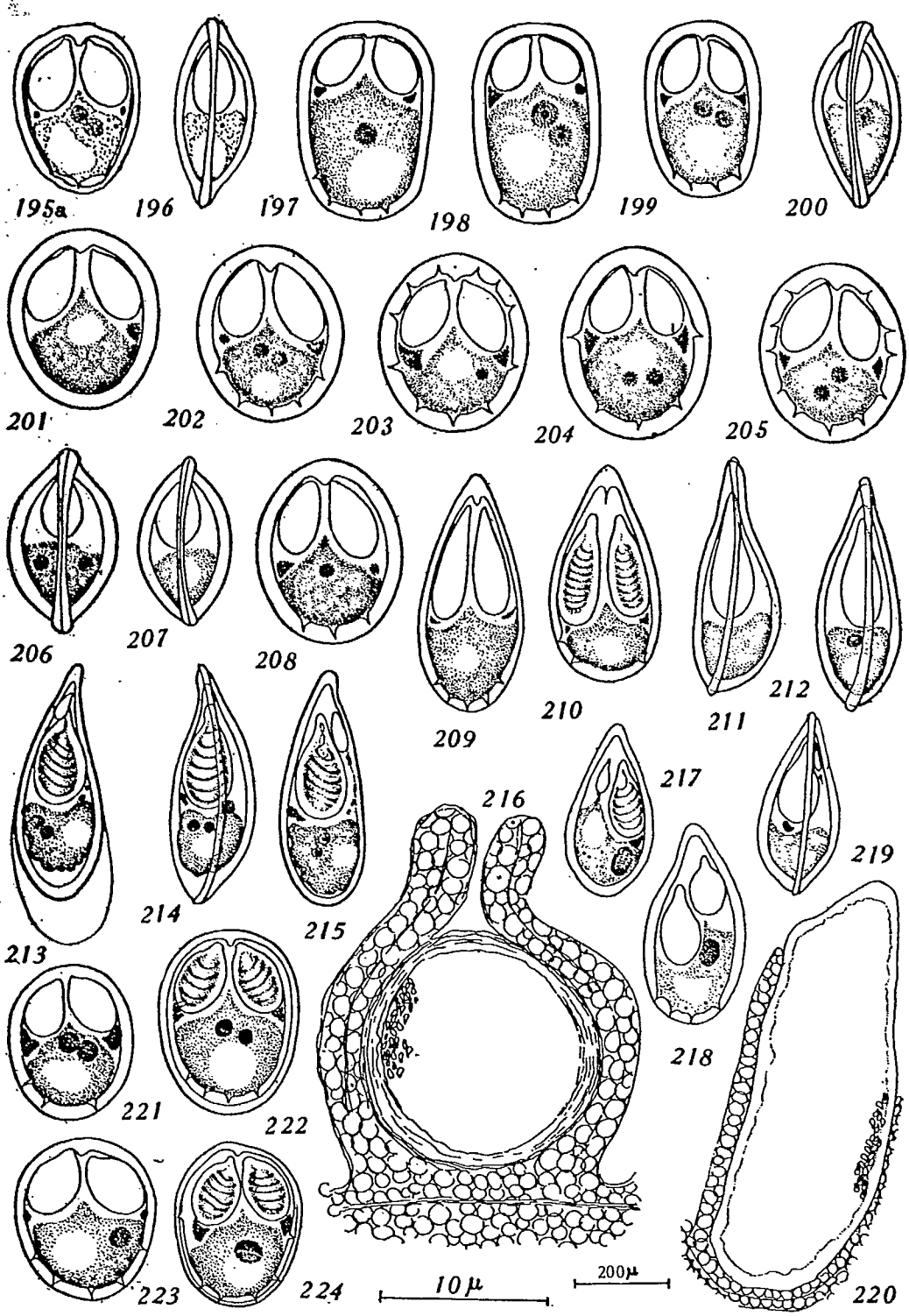
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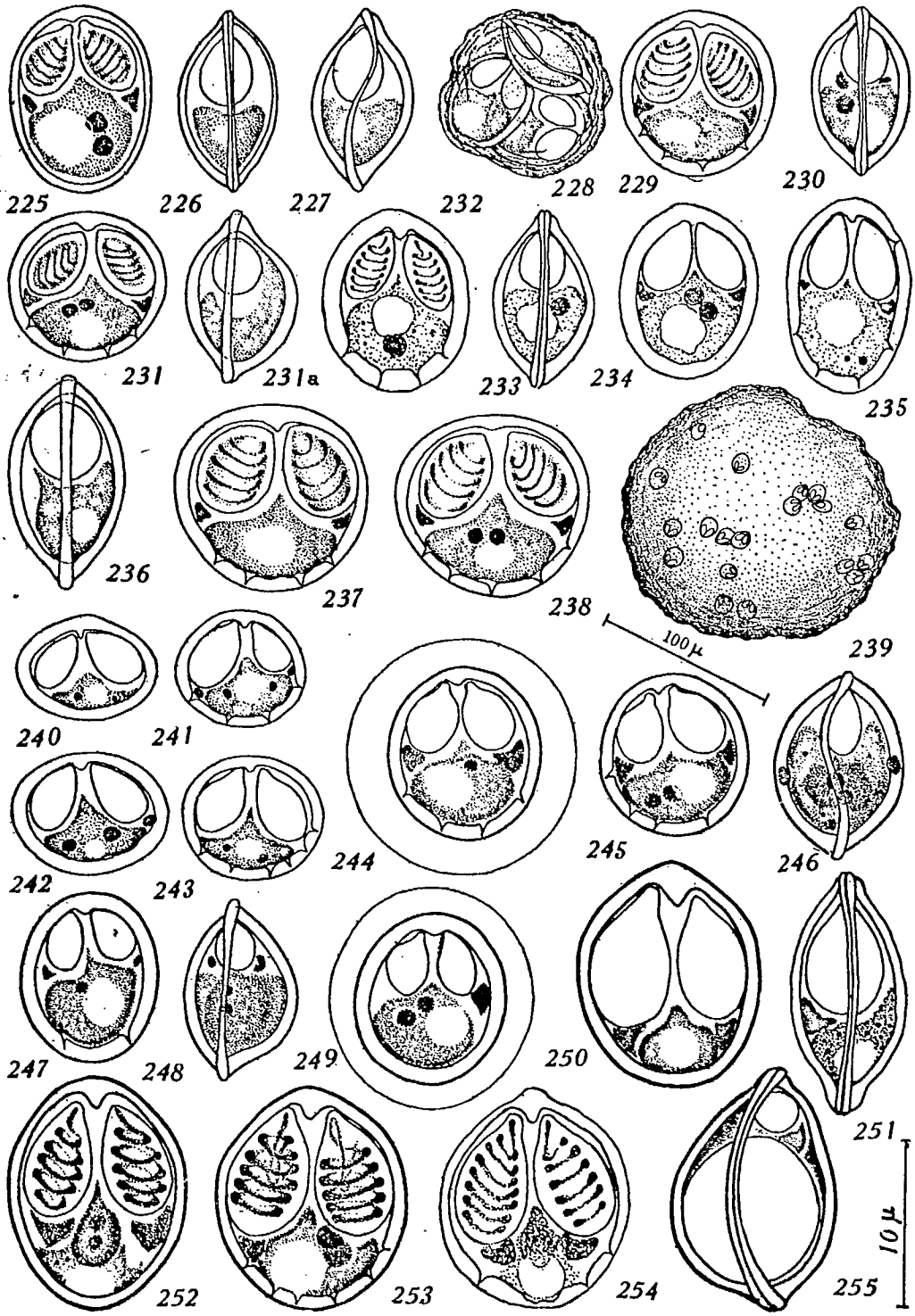
200μ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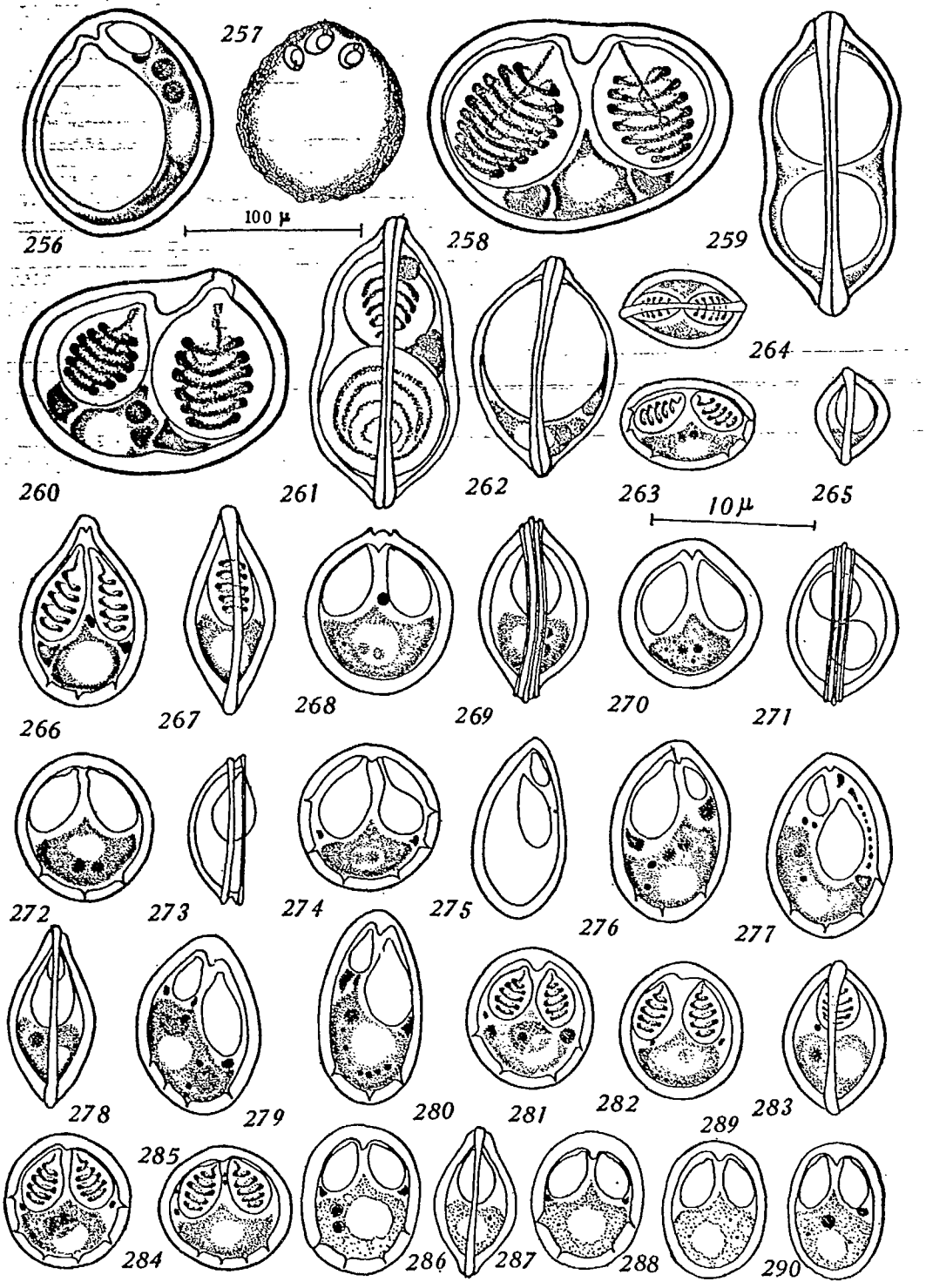
100 μ
10 μ
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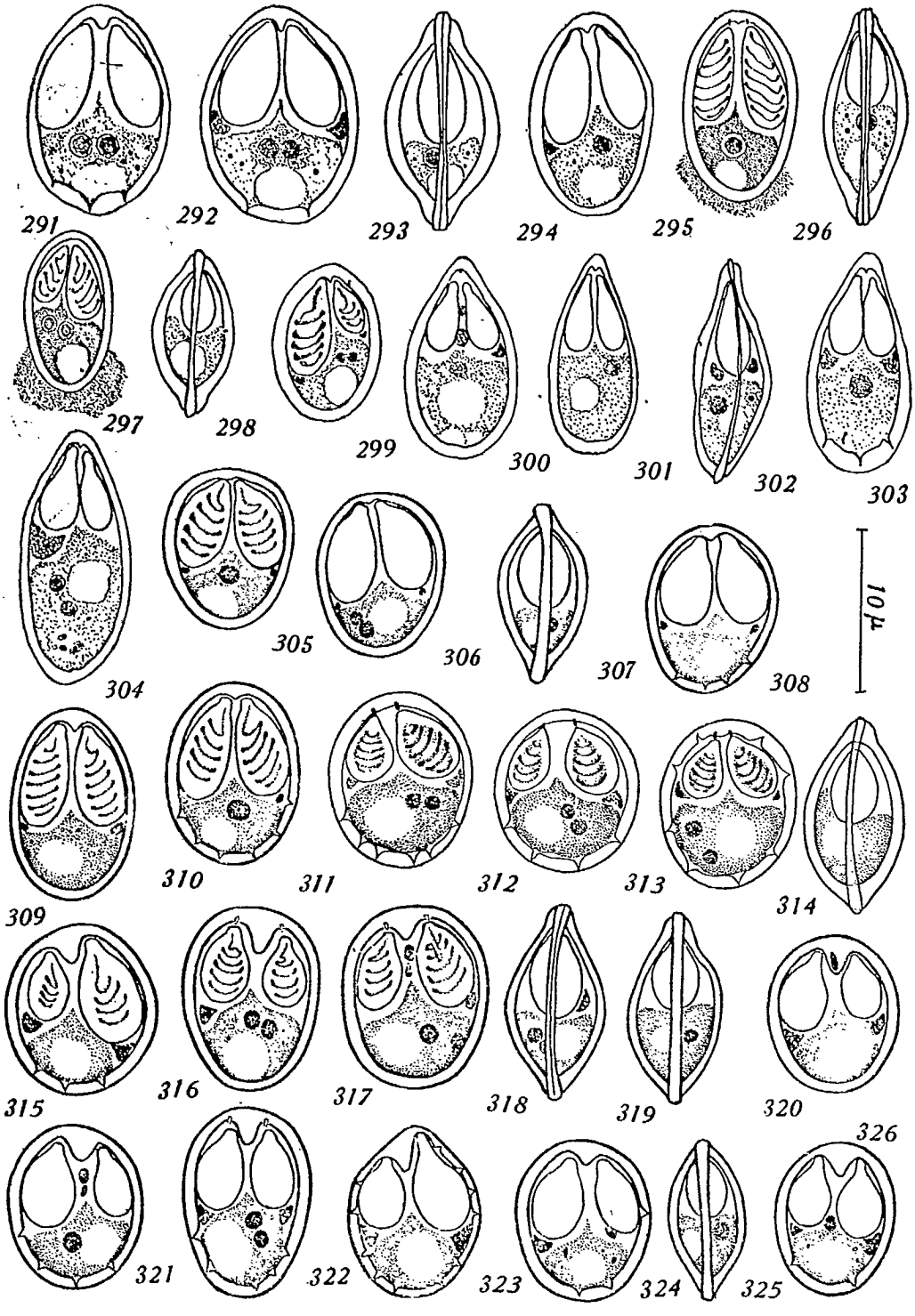
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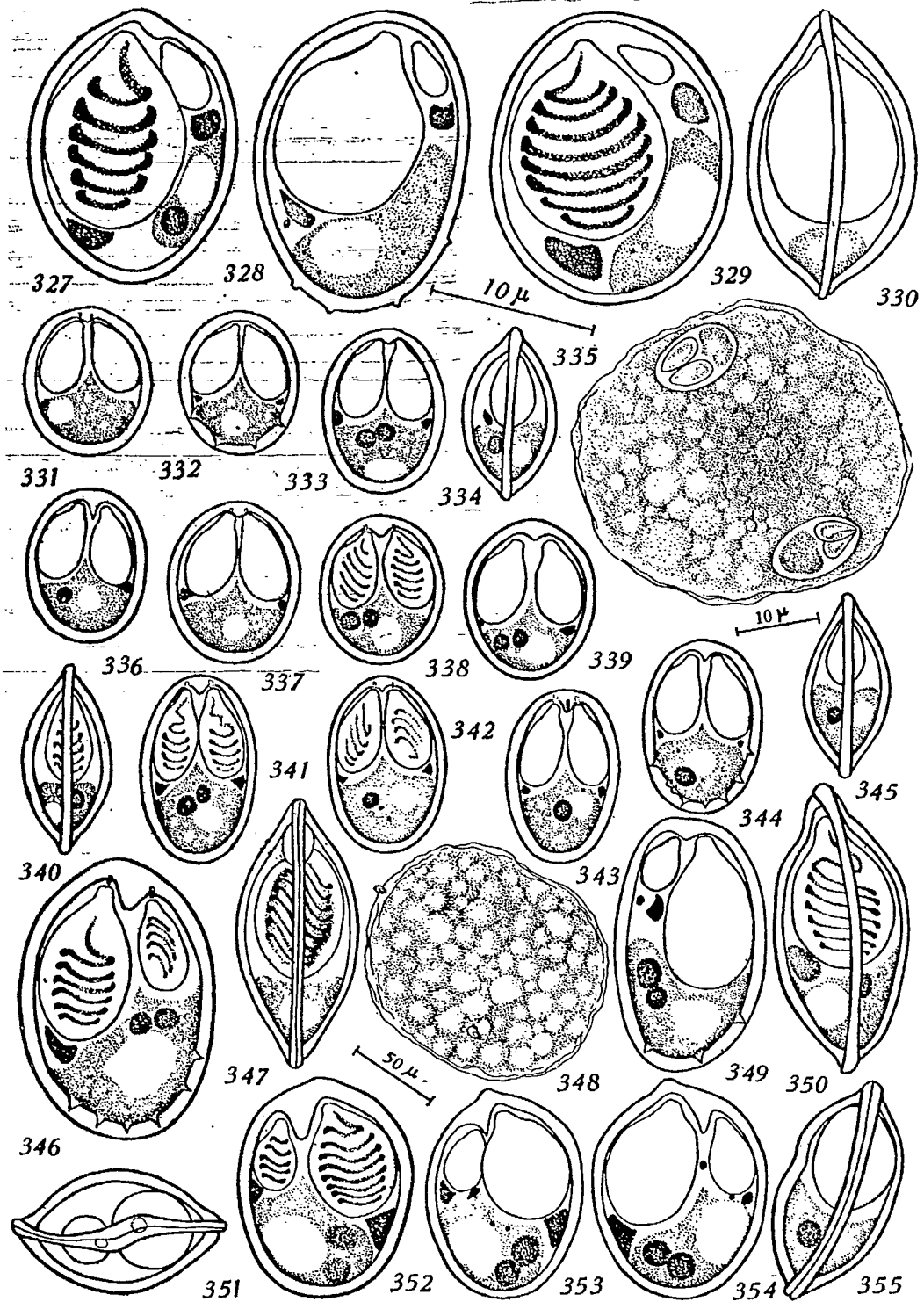
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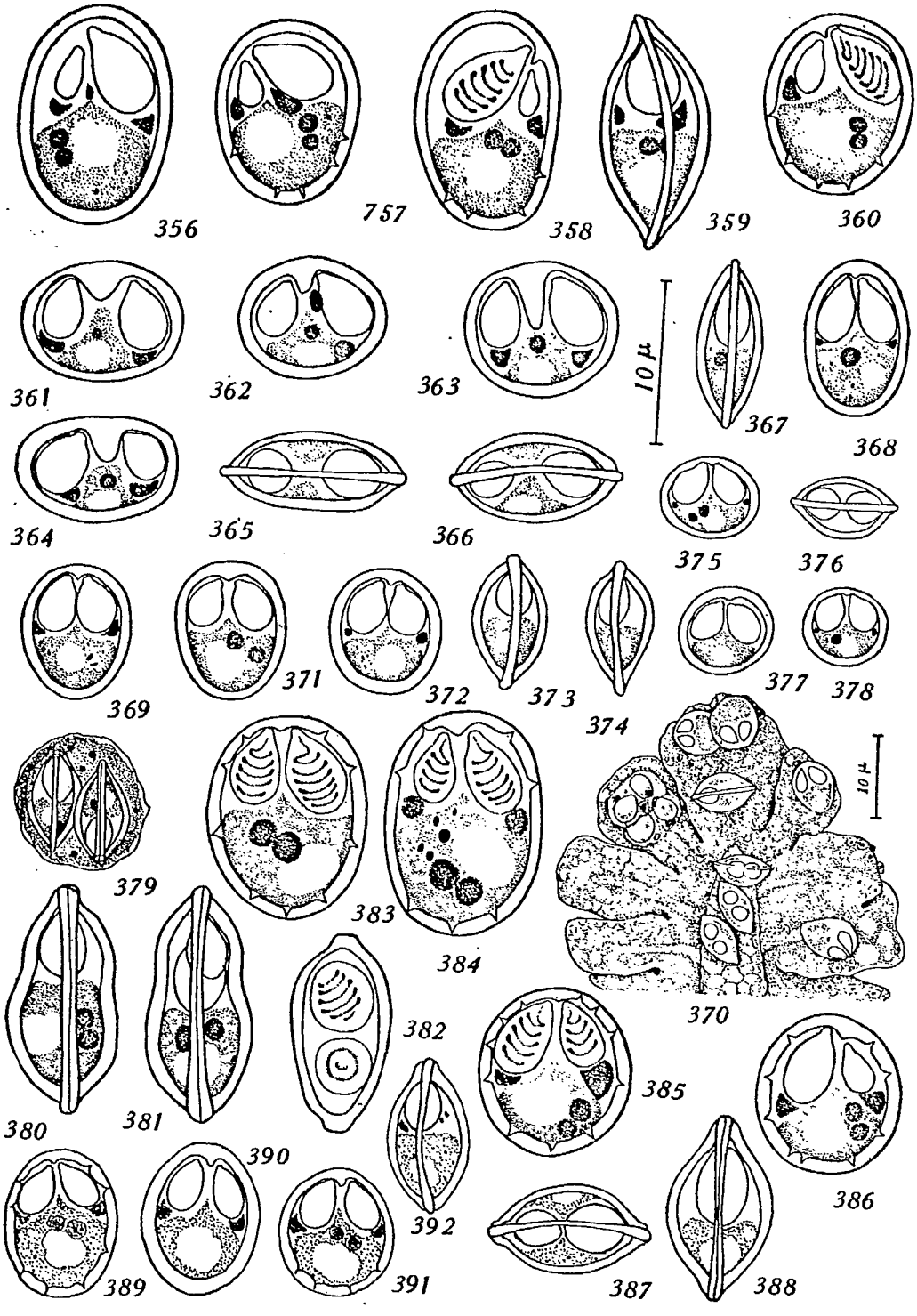
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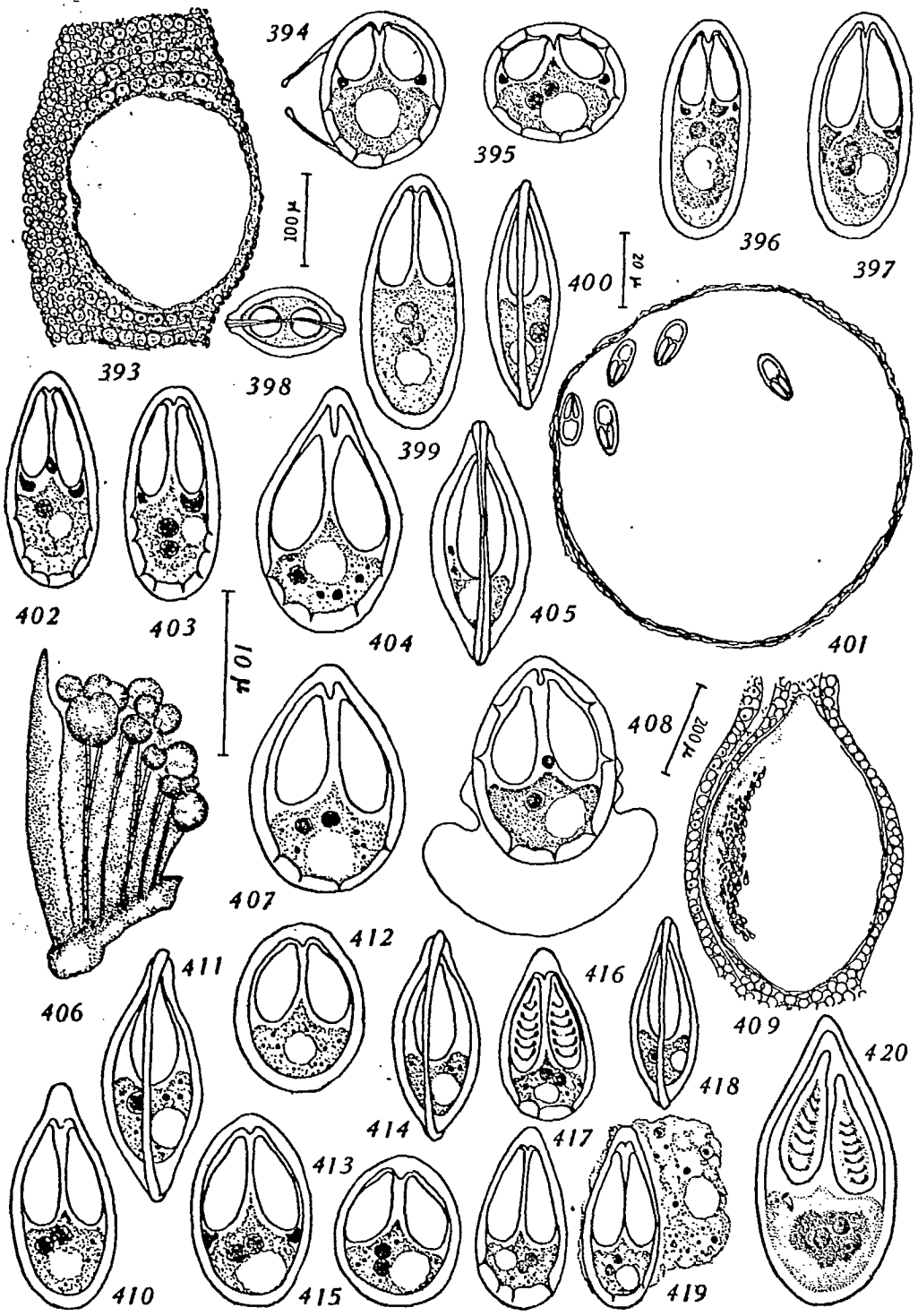
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100 μ
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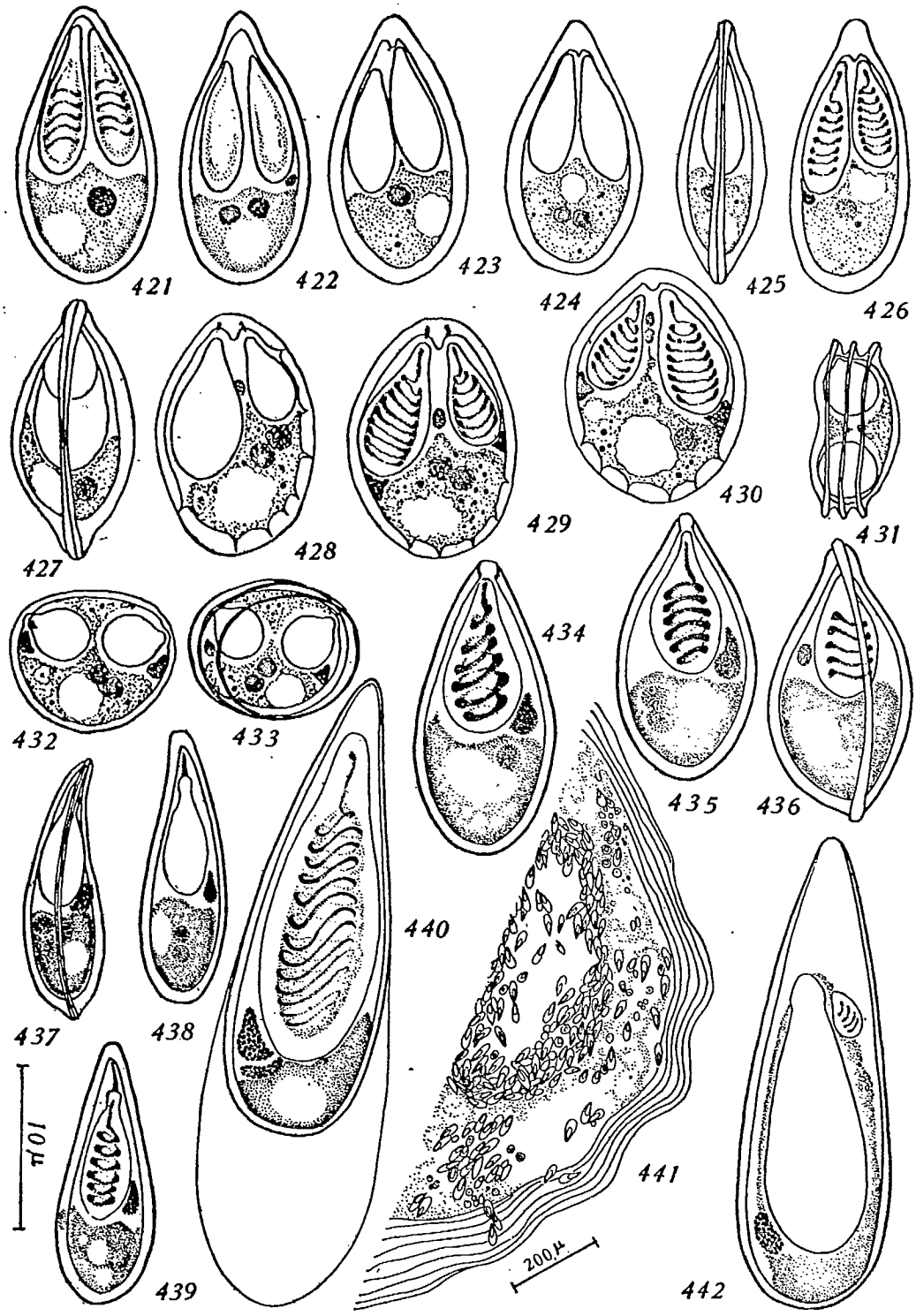
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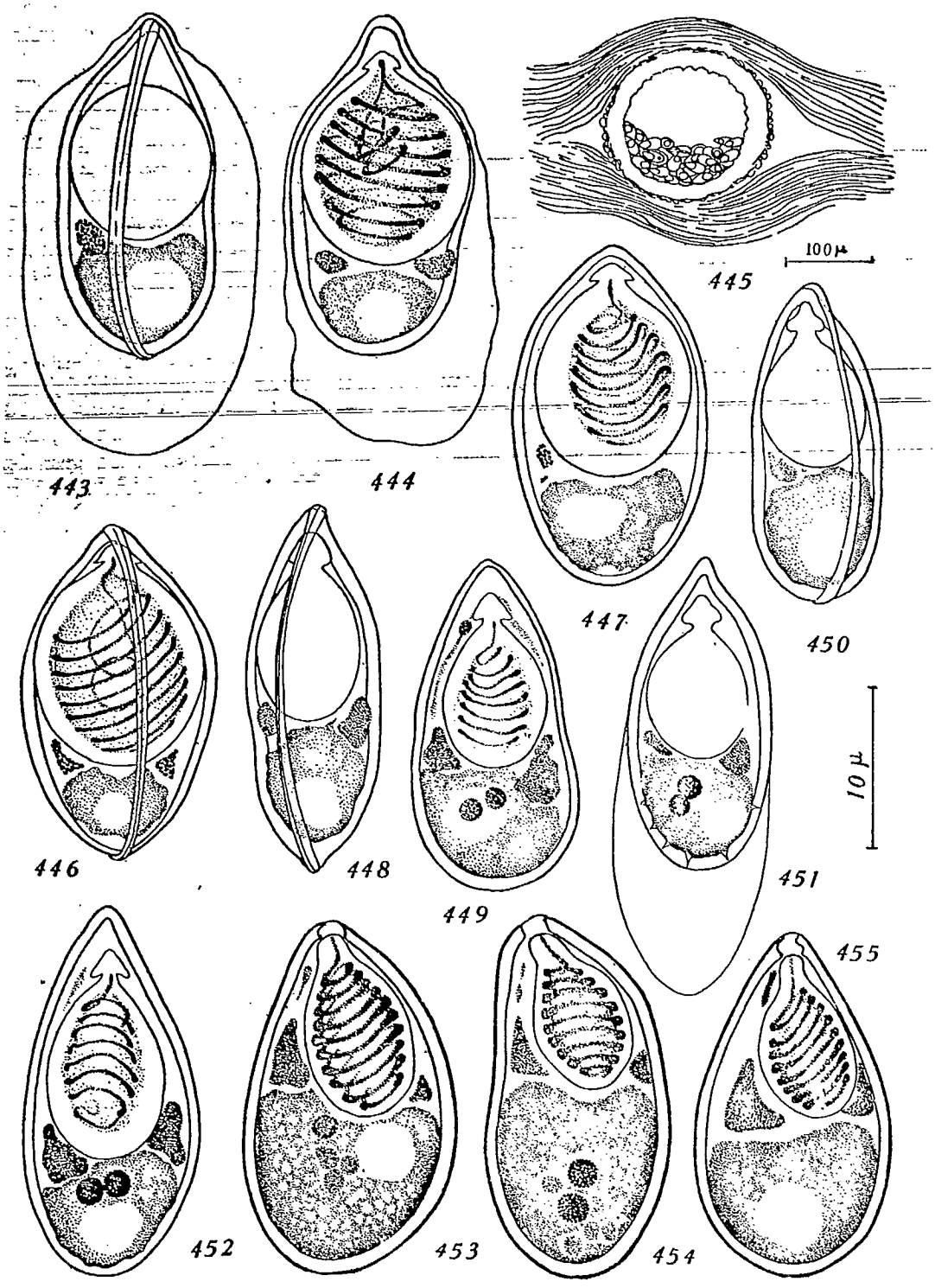
100μ
10 μ
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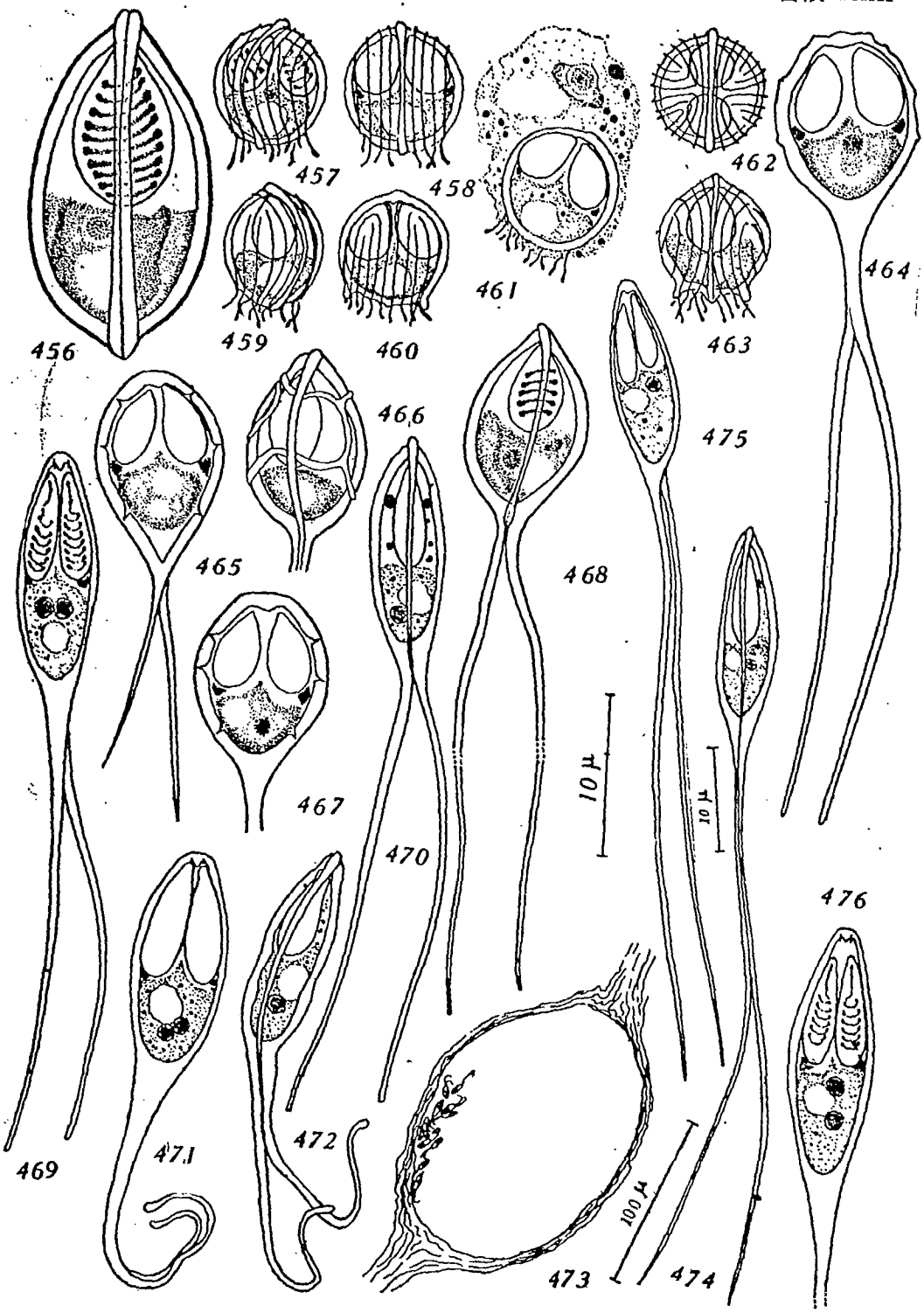
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10 μ
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