FISH MYXOSPORIDIA FROM PLYMOUTH.

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(With 6 Text-figs.)

During the summer of 1914 and during the months January to April, 1920, I have been able to investigate the Myxosporidian parasites of fish occurring at Plymouth, and I am glad to take this opportunity of thanking the Ray Lankester Trustees for their grant in aid of this research, and also to express my gratitude for the very valuable and kind assistance afforded me by the Director, Dr E. J. Allen, and staff of the Marine Biological Station at Plymouth, where the researches were carried out. The assistant Mr Smith helped me very considerably in the identification of the fish examined.

I have been unable as yet to work out the material fully, especially the interesting developmental stages, and as it may be some time before I am able to do this, it may be useful to give a list of the forms found in fish met with at Plymouth, and to describe briefly some new forms.

Quite a number of new hosts were found and it is a matter of difficulty at present to decide whether a parasite found in a new host is a new species or not. The same difficulty occurs of course in other groups of parasites, notably Trematoda and Anoplura, and while some species are certainly found in many different hosts, others apparently are very restricted in their choice of hosts, even when abundant opportunities occur for infection. In this paper a very conservative attitude has been adopted with regard to possible new species. When a form has been found with spores which agreed with a published description, the parasite has been given the name of the earlier described species, although found in a different host. The plasmodial stages do not show sufficiently clear distinctions to serve for specific or even generic characteristics, except in rare cases like the pigmented plasmodium of *Chloromyxum*.

Some of the forms described under pre-existing names may be found subsequently to be distinct species, but with our present defective knowledge of life histories in this group it is better to describe the same species as occurring in different hosts rather than create new specific names which might have to be abandoned later. Some species like *Chloromyxum leydigi* have been recorded already from many different hosts, and it will be seen that a form indistinguishable from *Myxidium incurvatum* is here recorded from several different hosts. On the other hand, there appear to be some species which

are more restricted in occurrence. One case is that of *Sphaeromyxa ovata* which occurred in all of the three specimens of *Onos tricirratus* examined, but in only one of 46 specimens of *Onos mustela* which came from the same locality. In the one case in which it did occur, it was present in very small numbers only, as though it had not been able to establish a strong infection. It has been held that these spores are abnormal spores of *Sphaeromyxa balbianii*, but the spores are very dissimilar and were not found together by me. Another example of restriction in distribution is shown by *Myxidium incurvatum*, which was found in five out of 19 specimens of *Blennius pholis*, but not in one of 30 specimens of *Gobius* (various species) taken from the same rock pools. Yet *Myxidium incurvatum* is found in a large number of different hosts, and the Gobies must sometimes take up spores of this and other species. It can be suggested at least that not all species of fish are equally susceptible, and it appears likely that some species of Myxosporidia are specific to certain hosts, but their mere occurrence in different hosts cannot be taken as proof of specific difference, without some accompanying difference in form, size of spore, or other characteristic feature. Therefore it will be found that in this paper specimens have been identified as far as possible with pre-existing species, and also as far as possible with the species mentioned by Labbé in *Das Tierreich*. It would be a convenience to parasitologists if in the case of parasites a trinomial system of nomenclature for animals and plants could be used, indicating the specific character of the parasite and also the host from which it was obtained.

In the following list the fish hosts have been named for the sake of uniformity according to Dr Smitt's edition of Fries, Ekström and Sundevall's *Scandinavian Fishes*.

Host	Examined	Negative	Infected	Parasite
Agonus cataphractus ...	2	2	0	
Anguilla vulgaris	1	1	0	
Blennius gattorugine ...	5	5	0	
Blennius ocellaris	2	1	1	*Myxidium incurvatum* Thél. + *Ceratomyxa arcuata* Thél.
Blennius pholis	19	14	5	*Myxidium incurvatum* Thél.
Bothus maximus	14	13	1	*Myxidium incurvatum* Thél.
Callionymus lyra	15	0	15	*Myxidium incurvatum* Thél. (13). *M. incurvatum* + *Ceratomyxa arcuata* Thél. (2).
Capros sanglier	1	0	1	*Ceratomyxa lata* sp. n.
Clupea pilchardus	17	6	11	Plasmodium only (1). *Ceratomyxa truncata* Thél. + *Coccomyxa morovi* Léger and Hesse.
Cottus bubalis	3	0	3	*Ceratomyxa dubia* sp. n. (3). *Plistophora typicalis* Gurley in liver (1). *Chloromyxum quadratum* Thél. in muscles (1).
Gadus luscus	6	6	0	

Host	Examined	Negative	Infected	Parasite
Gadus merlangus	8	4	4	*Myxidium sphaericum* Thél. (3). *Ceratomyxa arcuata* Thél. (1).
Gadus minutus	5	4	1	*Sphaeromyxa longa* sp. n. + *Myxidium sphaericum* Thél.
Gadus pollachius	13	13	0	
Gastraea spinachia ...	1	1	0	
Gobius flavescens	4	4	0	
Gobius minutus	11	11	0	
Gobius paganellus	15	15	0	
Labrus (Crenilabrus) melops	4	4	0	
Labrus mixtus	1	1	0	
Lepidorhombus whiff (megastoma)	2	1	1	Plasmodia only.
Lophius piscatorius ...	4	2	2	*Ceratomyxa appendiculata* Thél. (?)(2). All four with *Glugea lophii* on nerves.
Merlucius merluccius ...	1	1	0	
Molua molva	1	0	1	*Ceratomyxa* sp.? No free spores seen.
Mustelus vulgaris	5	4	1	*Chloromyxum leydigi* Ming. Plasmodia only.
Nerophis lumbriciformis ...	9	9	0	
Onos mustela	46	44	2	*Sphaeromyxa balbianii* Thél. (1). *Sphaeromyxa ovata* sp. n. rare spores (1).
Onos tricirratus	3	0	3	*Sphaeromyxa ovata* sp. n.
Pholis gunnellus	1	1	0	
Platophrys laterna ...	2	1	1	*Myxidium incurvatum* Thél. + *Ceratomyxa arcuata* Thél.?
Pleuronectes flesus ...	8	7	1	*Myxidium intermedium* sp. n.
Pleuronectes limanda ...	15	10	5	*Ceratomyxa sphaerulosa* Thél.
Pleuronectes microcephalus	3	0	3	*Ceratomyxa lata* sp. n.
Pleuronectes platessa ...	8	8	0	
Ramphistoma belone ...	1	1	0	
Rhina squatina	3	3	0	
Roccus labrax	1	0	1	*Ceratomyxa arcuata* Thél.
Scomber scombrus ...	15	3	12	Plasmodia only.
Scylliorhinus canicula ...	5	5	0	
Scylliorhinus stellaris ...	5	3	2	*Chloromyxum leydigi* Ming.
Solea variegata	3	2	1	Plasmodia only. *Ceratomyxa* sp.?
Solea vulgaris	2	2	0	
Squalus acanthias ...	5	0	5	*Chloromyxum leydigi* Ming.
Syngnathus typhle... ...	5	5	0	
Trigla gurnardus	13	13	0	
Zeus faber	7	7	0	

DESCRIPTION OF SPECIES.

Ceratomyxa lata sp. n. (Fig. 1). Host: *Capros sanglier*. Habitat: Gall bladder. Spore: $19\mu \times 7\mu$, crescentic in shape, ends rounded, polar capsules large, not marginal. The proportions and shape of this form distinguish it from any other, the nearest to it being *C. coris* Georg. (from *Coris julis*), which is less crescentic in form and from a different host and locality. A similar form was found in *Pleuronectes microcephalus*, and is given provisionally the same name.

Ceratomyxa dubia sp. n. (Fig. 2). Host: *Cottus bubalis*. Habitat: Gall bladder. Spore: 17·5μ × 8μ. Polar threads 30μ long. This form approaches *Leptotheca* in proportions, but sporoplasm does not fill spore, and the organism is therefore named as a Ceratomyxa, but is, like *C. coris* Georg. and to a less extent *C. lata*, an intermediate form between these two closely related genera.

Myxidium intermedium sp. n. (Fig. 3). Host: *Pleuronectes flesus*. Habitat: Gall bladder. Spore: 12μ × 6–7μ, broad ~-shaped like *M. incurvatum* Thél.,

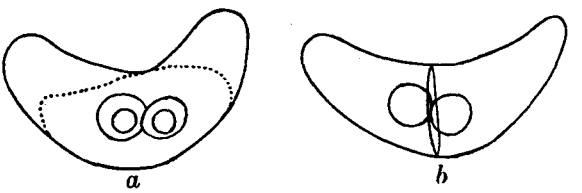

Fig. 1. *Ceratomyxa lata* sp. n. × 1900. (*a*) Spore showing extent of sporoplasm. (*b*) Spore showing sutural line.

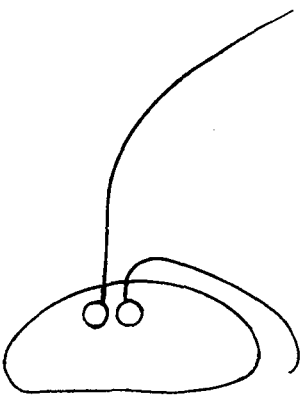

Fig. 2. *Ceratomyxa dubia* sp. n. × 1900. Polar filaments extruded.

Fig. 3. *Myxidium intermedium* sp. n. × 1500.

but larger and from a different host, no Myxidium having been recorded from *Pleuronectes*. Size alone is not a reliable guide to species as there is apparently great variation amongst specimens from different localities, though not much in any one infection. Auerbach gives the size of *Myxidium bergense* spore as 16·2–19μ long × 7–9μ wide, but specimens from *Gadus virens* caught at Millport on the Clyde, which I have carefully drawn with camera lucida and compared with a Zeiss 1/100 mm. scale drawn under the same conditions, are all very near to the measurements 12·5μ × 5μ.

Sphaeromyxa longa sp. n. (Fig. 4). Host: *Gadus minutus*. Habitat: Gall bladder. Spore: $20\mu \times 5\mu$, similar in form to that of *S. balbianii* Thél., but much longer and from a different host. This form was compared with *S. balbianii* which was obtained from *Onos mustela* and the *S. balbianii* spores were consistently smaller, $16\mu \times 5\mu$. There was very little variation in the size of spores in either case when carefully measured, not more than $1{\cdot}5\mu$ in length. *S. longa* was found in association with *Myxidium sphaericum* Thél., the spores of *S. longa* being more numerous than those of *M. sphaericum*.

Sphaeromyxa ovata sp. n. (Fig. 5). Host: *Onos tricirratus*. Habitat: Gall bladder. Spore: $13\mu \times 6{\cdot}5\mu$, oval with round ends, some slightly curved in one plane, polar capsules large, terminal. This form resembles *Cystodiscus*

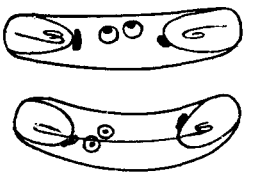

Fig. 4. *Sphaeromyxa longa* sp. n. ×1500.

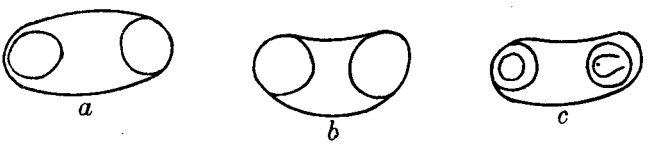

Fig. 5. *Sphaeromyxa ovata* sp. n. ×1900.

Fig. 6. *Chloromyxum quadratum.* (*a*) Spore from above. (*b*) Spore with polar filaments extruded. ×1900.

immersus Lutz parasitic in Amphibia, but *C. immersus* is said to be 9–10μ wide. Occasionally an abnormal spore of *S. ovata* can be found measuring $10\mu \times 8\mu$, which is nearer the proportions of *C. immersus*, but is smaller. Georgevitch describes this form as a polymorph of *S. balbianii*, but no spores of *S. balbianii* were found in the three specimens of *Onos tricirratus* containing *S. ovata*. One out of 46 specimens of *Onos mustelus* showed a slight infection by this parasite, spores being very rare. This specimen was not infected with *S. balbianii*.

Chloromyxum quadratum Thél. A figure of *Chloromyxum quadratum* from the muscles of *Cottus bubalis* is subjoined to show the extruded polar filaments and the four polar nuclei (Fig. 6).

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