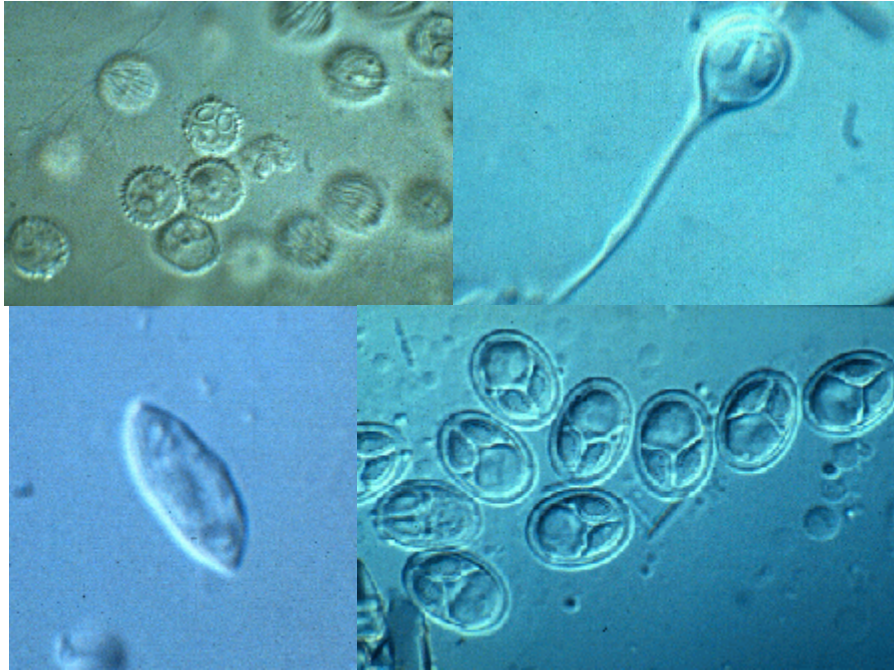


MYXOZOANS



Clockwise from the top-left are *Chloromyxum* sp., *Henneguya* sp., *Myxobolus* sp., and *Myxidium* sp.

A recent addition to the phylum Cnidaria is the ex. protozoan Phylum Myxozoa. Myxozoan parasites consist of more than 1250 described species, the majority of which occur in freshwater, brackish and marine fishes. They also parasitize polychaetes and oligochaetes.

Myxozoans are now classified among the metazoa, most closely related to parasitic Hydrozoans based on ribosomal DNA sequence analysis (Siddall et al. 1995). Morphological links to the metazoa include the fact that myxozoans are multicellular and have structures homologous to cnidarian structures. Ejectable organelles (polar filaments) resemble cnidarian nematocysts, and sporoplasms of the myxosporea resemble cnidarian ameboid cells.

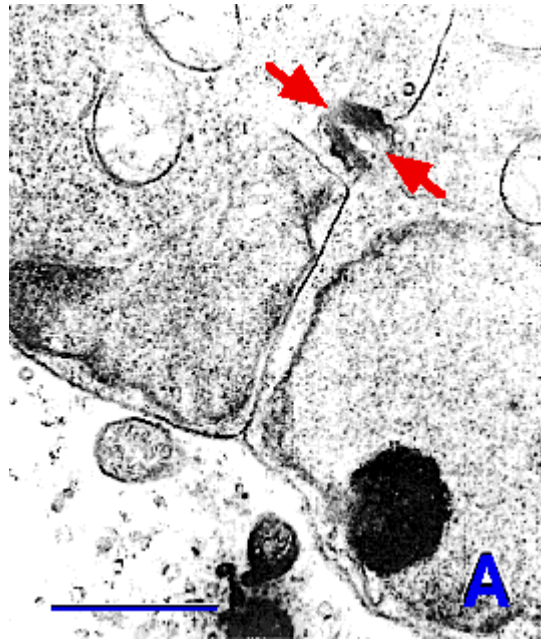
Point: How systematics of a group changes in a decade. In Ruppert and Barnes (1994), Myxozoa are the protozoan, spore-forming Phylum Microsporidia (parasitic protozoa having spores with polar filament and encased in several valves-page66). In Brusca and Brusca (2002), Myxozoa are presented as parasitic cnidarians, closely related to hydrozoans, page 246-247.

Say goodbye to a phylum:

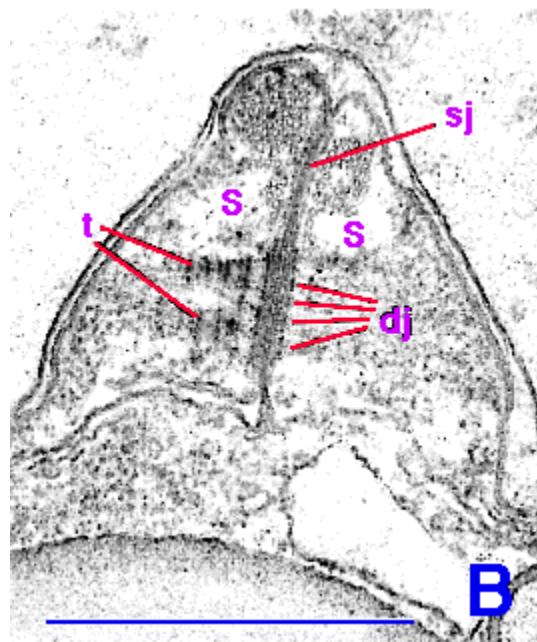
Myxozoa are Cnidarians

Here's why:

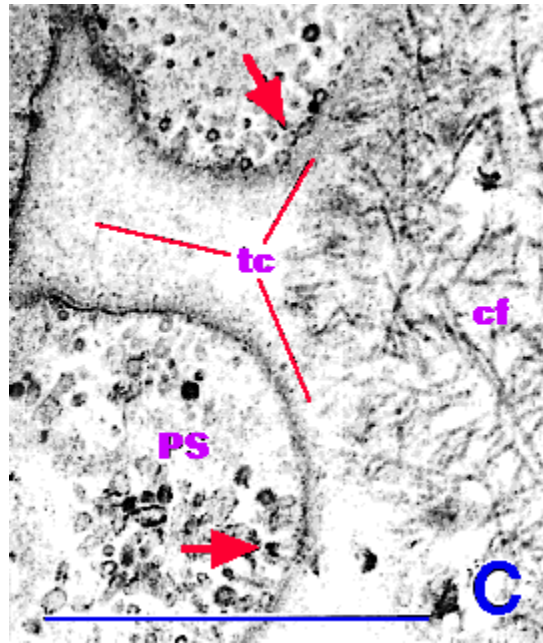
Metazoan characteristics of the myxozoan *Thelohanellus nikolskii*.



A. Intercellular cytoplasmic communication seen between arrows. Scale bar=1um



B. Septate (**sj**) and desmosomal (**dj**) junctions with characteristic tonofilaments (**t**) between adjacent sporogenic cells (**s**). Scale bar = 1 um



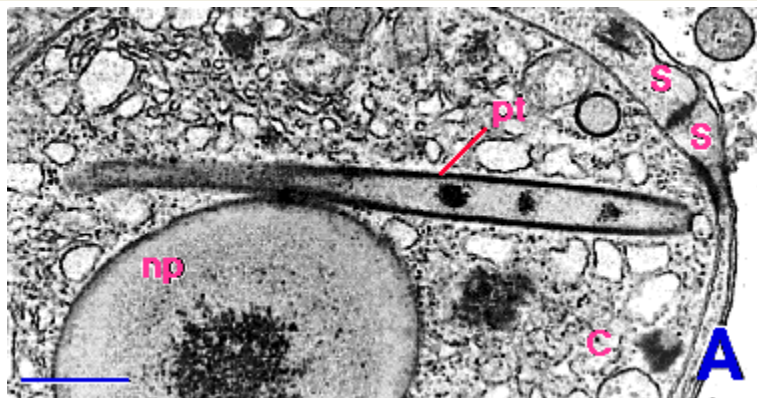
C. Extracellular production of cross-linked collagen (**cf**) by a pansporoblast (**PS**), arrow indicates active exocytosis of tropocollagen (**tc**). Scale bar = 1 um

cnidarian characters

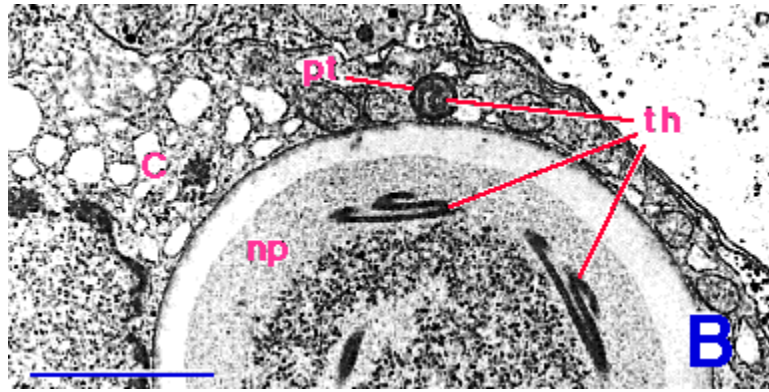
Cnidarian characteristics of the myxozoan *Thelohanellus nikolskii*.

Structures seen in the development of the so-called "polar capsule" of *Thelohanellus nikolskii* labeled in accordance with the homologous structure in cnidarian nematocysts.

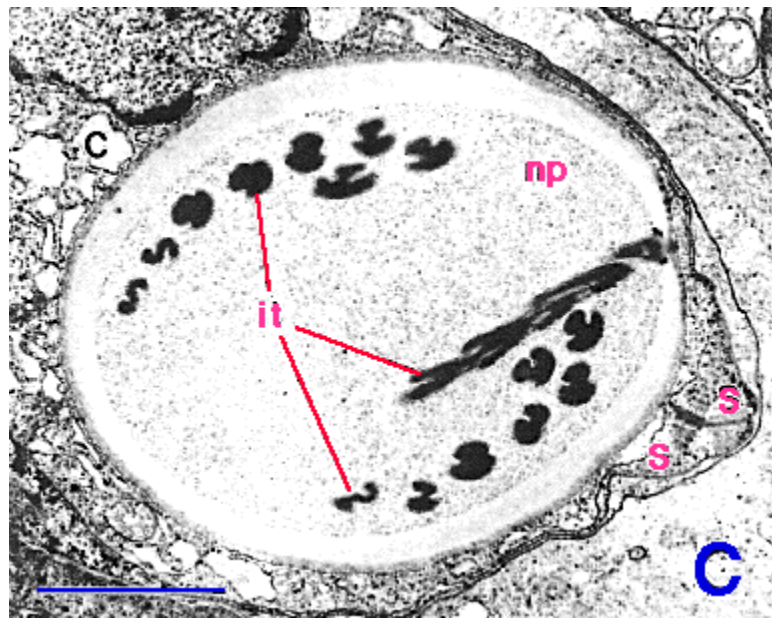
Figures **A** through **D** represent the earliest stage in cellular ontogeny through to that of the mature nematocyst respectively.



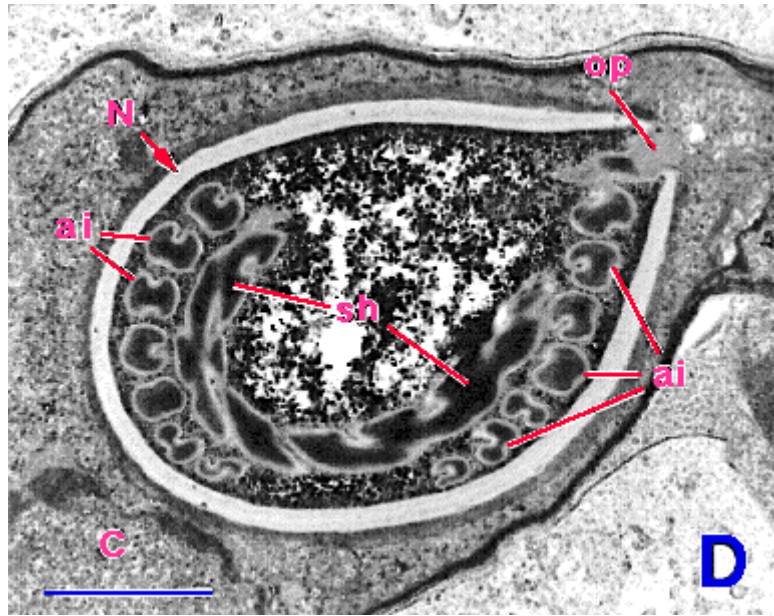
c, cnidocyte; **pt**, preinverted tubule; **np**, nematocyst primordium; **s**, differentiating sporogenic cells. Scale bar = 1 um.



c, cnidocyte; **pt**, preinverted tubule; **np**, nematocyst primordium; **th**, tubular thread; Scale bar = 1 μ m.



c, cnidocyte; **np**, nematocyst primordium; **it**, inverted tubule; **s**, differentiating sporogenic cells. Scale bar = 1 μ m.



c, cnidocyte; **ai**, atrichous izorhiza, **sh**, shaft of atrichous izorhiza; **op**, opercular cap of atrichous izorhiza; **N**, mature nematocyst; Scale bar = 1 μ m.

Phylogenetic Analyses of Myxozoan placement

from combined morphological and 18S rDNA characters



References:

Siddall, M. E., Martin, D.S., Bridge, D., Cone, D.M., Dessler, S.S. 1995. The demise of a phylum of protists: Myxozoa and other parasitic Cnidaria. *Journal of Parasitology* 81: 961-967

WHO CARES?

Examples with *Myxobolus cerebralis* and *Kudoa* spp.

Myxobolus cerebralis

Parasite of fresh water salmonids, preys on the host's cartilage. The fish becomes deformed, the infection results in inflammation which puts pressure on nerves and disrupts balance. The fish swims in circles – condition known as **whirling disease**. When the fish dies, *Myxobolus cerebralis* spores are released from the decaying fish and can survive up to 30 years in sediment. Spores are consumed by the oligochaete *Tubifex* until the intermediate host is consumed by a new host fish (Brusca and Brusca 2002).

Kudoa spp.

Members of the genus *Kudoa* primarily infect muscle tissue of marine fishes and are often associated with post-mortem degeneration of the tissue. This softening of flesh is most likely a result of the release of proteolytic enzymes by the parasite. The parasite infects muscle tissue of the fish host and in some cases causes unsightly white cysts and softening of flesh in fillets. In extreme cases infections of the parasite can result in post mortem myoliquefaction where the muscle tissue takes on a jelly-like condition (Fig. 1). This is of concern to the marine fish aquaculture industry where a decrease in flesh quality may represent a significant loss of revenue. About 45 species in *Kudoa* have been described, and infections occur in various commercially important fishes around the world (e.g. tuna, mahi mahi, mackerel, Pacific hake, English sole).

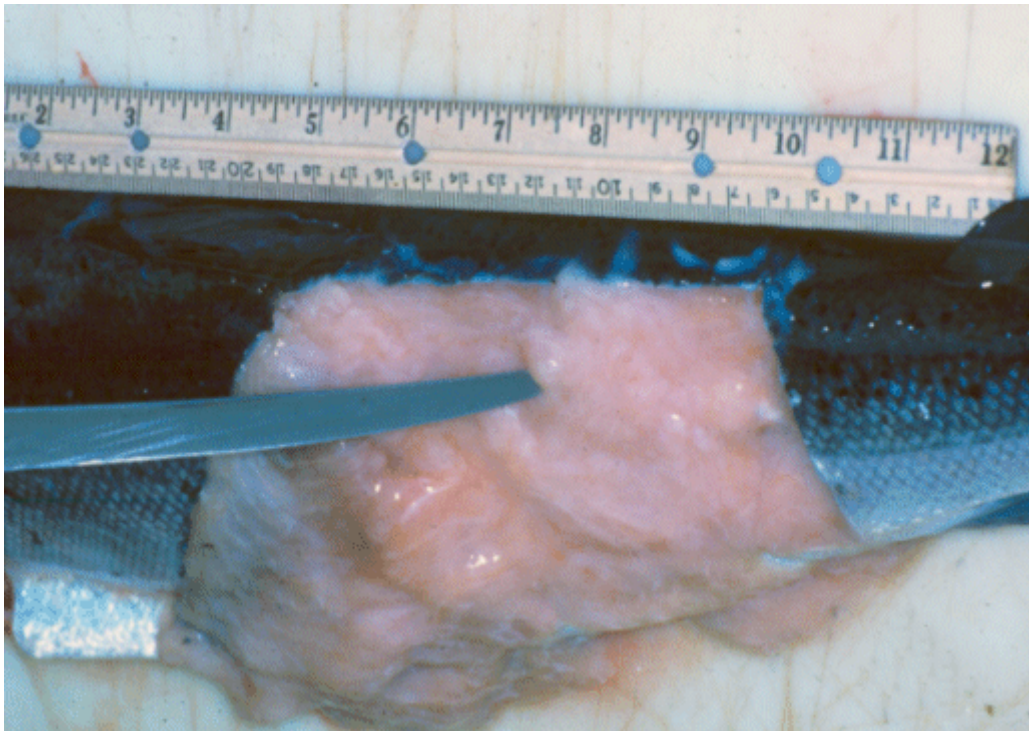


Figure 1. Post mortem myoliquefaction in Atlantic salmon by *Kudoa thyrsites* (held for 6 days on ice).

The spores of *K. thyrsites* are stellate in shape, with 4 valves and 4 polar capsules (Fig. 2). Upon infection by the actinosporean stage the sporoplasm migrates to a muscle fiber where formation of the pseudocyst takes place. Within these pseudocysts are the developing spore stages. In lighter infections the pseudocysts are isolated from the immune system within the muscle fiber. The intensity of *K. thyrsites* infections is also correlated positively with the severity of flesh softening in Atlantic salmon fillets (St-Hilaire et al. 1997).

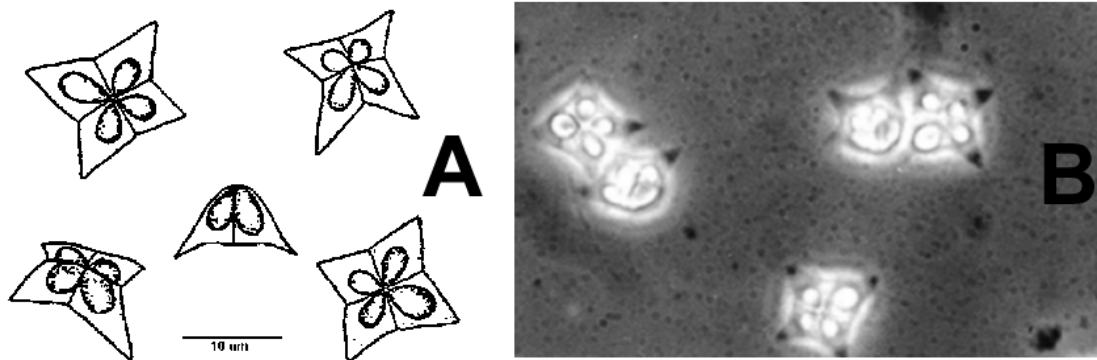


Figure 2. Morphology of *Kudoa thyrsites* spores A) Line drawing showing spores at various angles, note the 4 valves and 4 polar capsules. B) Wetmount preparation of *K. thyrsites* spores.

Detection

Detection of the parasite is accomplished via wetmount preparations of muscle tissue and observation of stellate spores. The more sensitive PCR test may be most useful for lightly infected tissues where detection by wetmount is problematic. St-Hilaire et al. (1997) reported a nondestructive sampling method by examining wetmount preparations of the hyohyoid ventralis muscle of the operculum of Atlantic salmon (Fig 3).

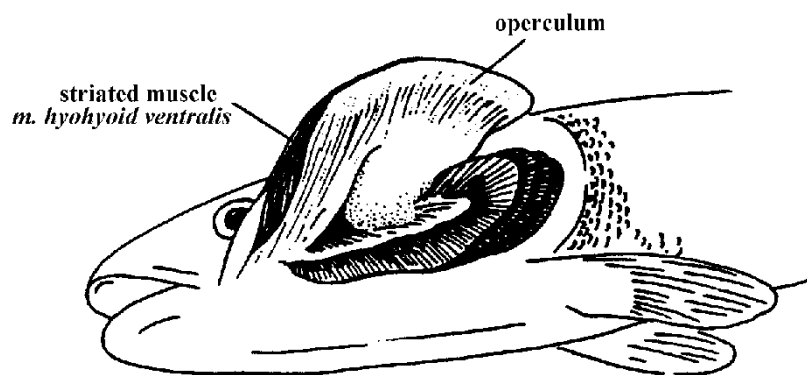


Figure 3. Sampling of the hyohyoid ventralis muscle as a means of non lethal detection of *K. thyrsites*. Illustration from St-Hilaire et al. (1997)