Unidentified Kidney Coccidia and Others

I. Causative Agent and Disease

Coccidiasina is a subclass within the class Conoidasida in the phylum Apicomplexa. These protozoa are intracellular parasites of vertebrates as well as invertebrates. Some members of two suborders, Adeleorina and Eimeriorina, parasitize bivalve molluscs in the kidneys (*Pseudoklossia glomerata, P. pectinis, P. pelseneeri, Klossia tellinae*), germ cells of the ovarian tubules (*Merocystis tellinovum*), developing ova (unidentified coccidia), connective tissues (unidentified coccidian sporocysts) and sometimes visceral ganglia (*P. glomerata*). Coccidia of bivalve molluscs are of two types: those that complete part of their life cycle in bivalves and presumably require an alternate host because certain developmental stages have not been observed; and those organisms that complete their entire life cycle within their bivalve hosts where all developmental stages have been described. Depending on the species of bivalve host, tissue degeneration and necrosis from the intracellular development of these parasites ranges from minor in developing ova to severe kidney damage or parasitic castration of females when infecting germ cells. Severe kidney tubule infestation of an unidentified coccidian in Canadian bay scallops reportedly resulted in systemic dissemination of the parasite into various other tissues. No mortality directly related to coccidian parasitism in bivalves has been documented in feral populations but has been reported in scallops during at least one situation of recirculating hatchery culture.

II. Host Species

Coccidia have been described infecting *Tapes* and *Tellina* clams in the Mediterranean Sea, England and Scotland, *Pectin* scallops and the European flat oyster in France, cockles in Spain, blacklipped oysters in Australia and in blue mussels, bay scallops and the eastern oyster on the Atlantic coast of North America and on the Pacific coast in the native littleneck clam in Washington State and in blue mussels, native littleneck and Japanese littleneck (Manila) clams in British Columbia, Canada. In Alaska, an unidentified kidney coccidian (possibly multiple species) has been found in 12-33% of examined blue mussels, basket cockles and native littleneck clams. Also, varying prevalences of littleneck clams from all Alaskan locations (total prevalence ~ 62%) have been parasitized by a sporocyst stage of another unidentified coccidian disseminated throughout all connective tissues. A light intensity of similar sporocysts have also been found in the connective tissues surrounding the gut of a single butter clam.

III. Clinical Signs

The kidney coccidian in native littleneck clams from Washington State reportedly causes behavioral modification such that live parasitized clams are found on the surface of the sand substrate (“kick-outs”) rather than buried underneath. Otherwise there are no other gross clinical signs of disease or mortality in the other reported infestations. Routine histological examination detects these coccidia within their respective target host tissues with varying degrees of cell damage or host response ranging from none to significant in the case of certain kidney coccidia.

IV. Transmission

Transmission of these coccidia is likely horizontal via ambient seawater but many may require at least one alternate host to complete their life cycles. The typical life cycle producing the developmental stages of coccidia can be divided into three phases: asexual merogony (schizogony) where multiplication occurs inside the specific host target cells producing trophozoites giving rise to schizonts containing merozoites that infect other cells to continue merogony or to begin gamogony; sexual gamogony (anisogomy) where merozoites, upon entering host cells, transform into gamonts of macrogametes (female) and biflagellated microgametes (male) that join to form a zygote or oocyst; and asexual sporogony where oocyst cytoplasm divides to contain sporoblasts that develop into sporocysts each containing sporozoites that, when liberated from the oocyst, infect cells to start the entire cycle anew. For most coccidia in bivalve molluscs gamogony and sporogony occur in the bivalve host with merogony presumably occurring in other hosts that have not been identified. The few remaining reported coccidia apparently complete all developmental phases in the bivalve host.

V. Diagnosis

Large mature macrogamonts may be observed in squash preparations of kidney tissues while all intracellular developmental stages may be observed by histological examination. The kidney coccidian of the Alaskan littleneck clam appears identical to one reported in the same clam species in Washington State and is likely an undescribed species based on: the apparent completion of its entire life cycle in the clam; the production of a thick-walled spore in addition to a thin-walled oocyst; and the presence of tetrazoic (4 sporozoites) sporocysts instead of dizoic sporocysts. Large sporocysts of another unidentified coccidian disseminated throughout the connective tissues of Alaskan littleneck clams typically contain elongate sporozoites (28 µm by 4 µm). Generic and species identification of coccidia are based primarily on the structure of oocysts and sporocysts as well as the number of sporocysts contained by the oocyst.

VI. Prognosis for Host

The effects of coccidia on host bivalve molluscs is variable ranging from no effect to significant kidney necrosis and parasitic castration in females. In Alaska, moderate host inflammatory infiltration with minor kidney necrosis caused by infestation has been observed in two basket cockles. However, generally these parasites have appeared harmless in wild as well as cultured bivalve species.

VII. Human Health Significance

There are no zoonotic human health concerns regarding these coccidian parasites in bivalve mollusc tissues.

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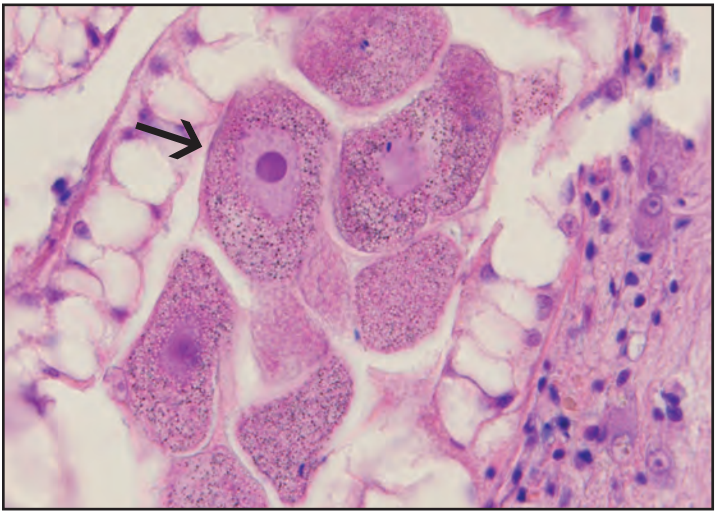
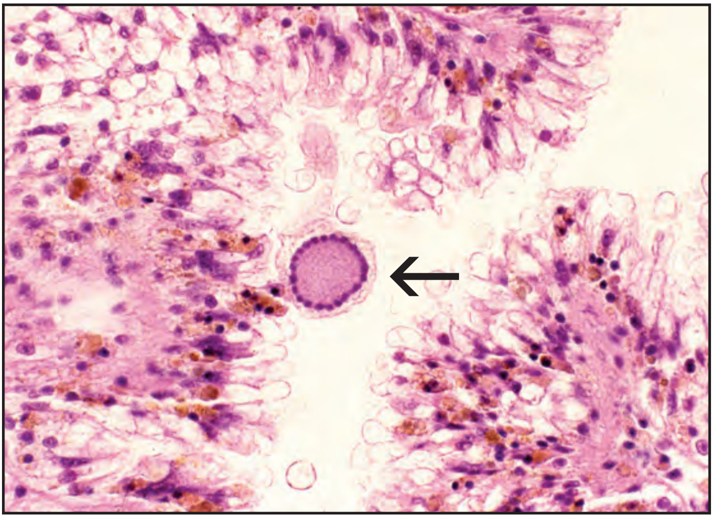
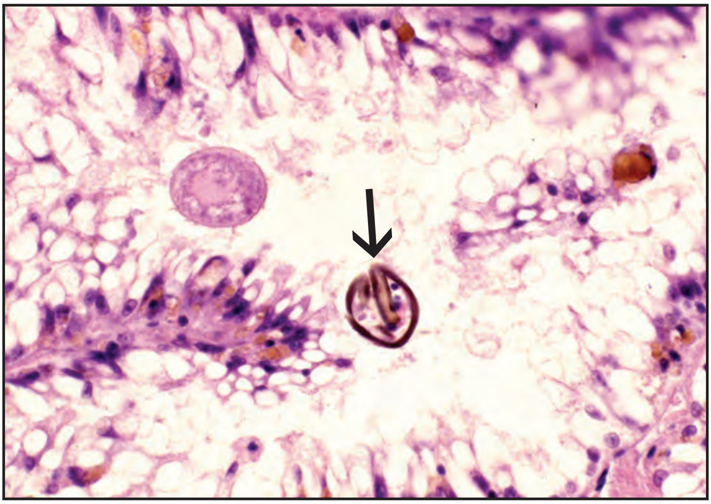


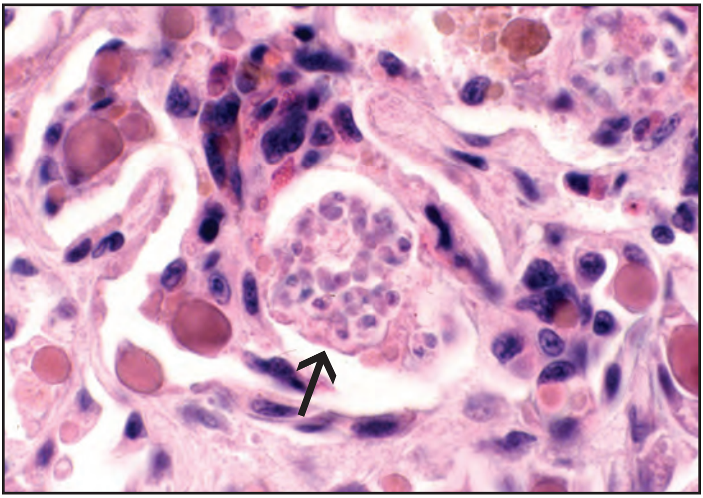
Histological section of gamonts (arrow) of a *Pseudoklossia*-like coccidian in the kidney of native littleneck clam



Microgamont (arrow) of a *Pseudoklossia*-like coccidian in the kidney of native littleneck clam



Resting spore (arrow) of *Pseudoklossia*-like coccidian in the kidney of native littleneck clam



Oocyst (arrow) of *Pseudoklossia*-like coccidian in the kidney of basket cockle

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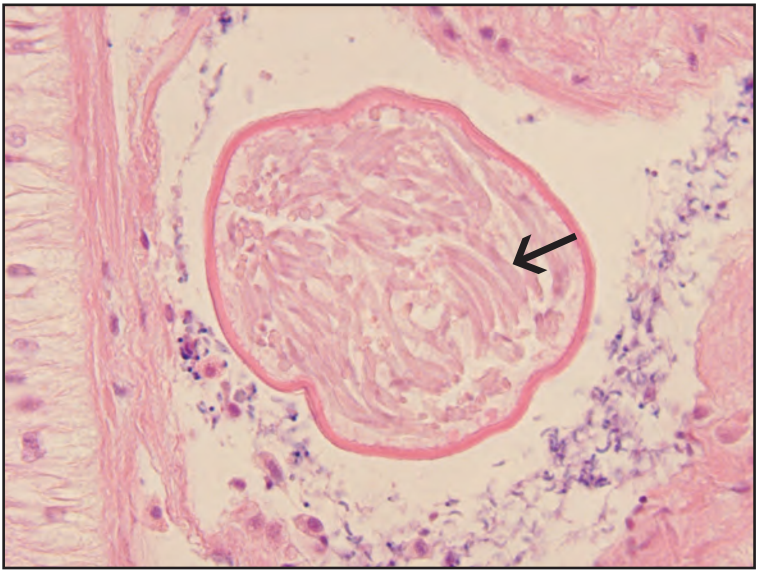
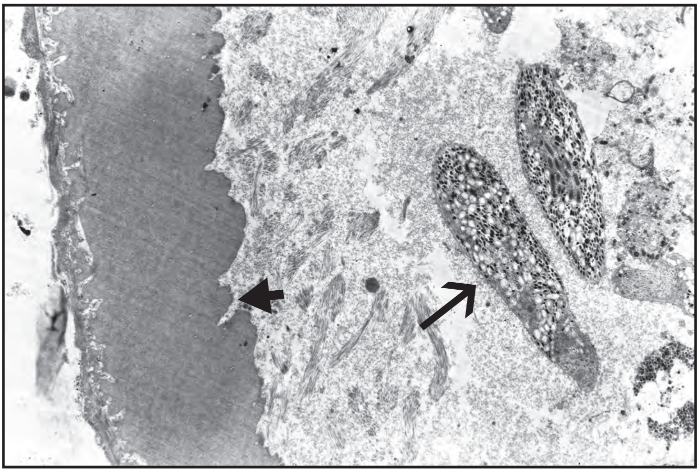


Histological section of sporocyst containing elongate sporozoites (arrow) of an unidentified coccidian in the connective tissue of native littleneck clam



Ultrastructural detail of littleneck clam sporozoites (arrow) and sporocyst wall (arrowhead), TEM

Typical Coccidia Life Cycle