Gill and Gut Parasitic Copepods

I. Causative Agent and Disease

Parasitic copepods are arthropods belonging to the subphylum Crustacea, class Maxillopoda and subclass Copepoda. Copepods parasitizing bivalve molluscs are mostly within the order Cyclopoida and can be divided into two basic groups; obligate endoparasites inhabiting the alimentary tract including the more common species of *Mytilicola* (*intestinalis, orientalis, porrecta*) and ectoparasites inhabiting the mantle and gill tissues including several species within the genera *Conchyliurus, Modiolicola, Myicola, Myocheres, Ostrincola, Pseudomyicola* and *Paranthessius.* An exception to the latter group is *Pseudomyicola spinosus* that apparently is able to move back and forth between the gill/mantle areas and the alimentary tract of bivalve hosts. *Mytilicola* has been implicated in causing intestinal damage, poor growth and mortality in European mussels but conclusive evidence is lacking regarding its true pathogenicity. Most ectoparasitic copepods appear to be commensals but their attachment to gill surfaces may cause localized tissue damage. When found within the GI tract, *P. spinosus* may damage mucosal epithelial cells followed by perforation, subsequent invasion into connective tissues and encapsulation of the parasite by host granulomatous tissues.

II. Host Species

Mytilicola intestinalis is apparently limited to Europe occurring in mussels, clams, cockles and the flat oyster in waters from Denmark to Italy including the British Isles and Ireland but not the Baltic. *Mytilicola orientalis* was introduced to the Pacific Northwest and Canada with seed oysters from Japan. It occurs in the European flat, Pacific and native oysters and several other species of marine bivalves and has recently been introduced into France. *Mytilicola porrecta* occurs in ribbed and hooked mussels and may also occur in other bivalves in the Gulf of Mexico. External parasitic copepods have been reported in the mantle and on the gills of various bivalve species from Europe and from the Atlantic, Gulf and Pacific coasts of North America, including British Columbia, Canada. In Alaska, unidentified parasitic copepods have occurred on the gills and in the alimentary tracts of Pacific oysters, basket cockles, blue mussels, rock scallops and native littleneck clams. Many of these copepods have been present both externally and internally appearing more like *Pseudomyicola* rather than *Mytilicola.*

III. Clinical Signs

Copepod infestations are mostly found by routine histological examination. There are no clinical signs of external or internal copepod infestation except in European reports attributing poor growth and mortality in mussels to infestations by *M. intestinalis.* Infestations in the GI tract may cause metaplasia (columnar epithelium reduced to low cuboidal or squamous) of mucosal epithelium and in rare cases erosion and perforation from the appendages with or without host encapsulation by hemocytes.

IV. Transmission

Parasitic copepods of bivalve molluscs have a direct life cycle involving copulation of two adult sexes and the production of eggs that hatch directly in

ambient seawater or, as with endoparasitic species, the egg cases are released with feces to seawater. The hatched nauplii may undergo molts into other naupliar stages or into metanauplii and finally to one or more copepodid stages. One of the copepodid stages is usually the initial parasitic stage that either attaches to the external target host tissue or, in the case of endoparasitic forms, is drawn into the GI tract by filter feeding of the mollusc host. Other parasitic instars may occur until the copepod becomes an adult. However, the number of molts and specific stages vary depending on the species of parasitic copepod and remain unknown for many.

V. Diagnosis

Specific diagnosis is based on observing external copepods attached to gills and mantle tissues or by dissecting reddish colored elongate worm-like copepods from the stomach and intestine of internally infested bivalves. Enzymatic digestion also may be used for quantification. The body of *Mytilicola* sp. is about 5 to 12 mm long (depending on species), relatively dedifferentiated with reduced limbs and body segmentation and overall is less recognizable as compared to other ectoparasitic genera that resemble free living copepods. Species is determined by various external morphological features (body length or size, mouth parts and antennae) of female copepods since the occurrence of males is generally transient. Histological examination of a parasitic copepod demonstrates general features of a complex body structure with carapace, segments, appendages, GI tract, gonads and striated musculature.

VI. Prognosis for Host

The effects of ectoparasitic copepods on their hosts have been minimal and generally considered harmless, unless the parasites are present in great numbers. The pathogenicity of endoparasitic copepods in bivalve molluscs has been enigmatic with many reports indicating no pathogenicity. Other investigators indicate poor growth and bivalve mortality caused by erosion of the mucosal epithelium with perforation and encapsulation of the parasites in surrounding connective tissues. Internal copepods may also cause apparent occlusion of the large ducts connecting the stomach and digestive diverticulae. *Mytilicola* sp. occurs more commonly in larger host animals inhabiting the bottoms of sheltered areas and rarely occurs in bivalves less than 10 mm in length and in Pacific oysters less than or equal to 20 mm. In Alaska, there has been no bivalve mortality or poor body condition associated with the presence of parasitic copepods.

VII. Human Health Significance

There are no zoonotic human health concerns with the occurrence of parasitic copepods in the tissues of bivalve molluscs.

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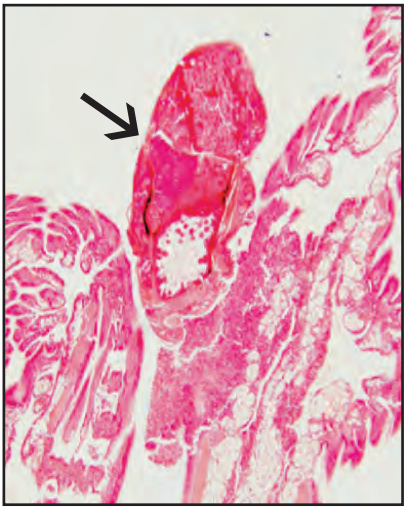
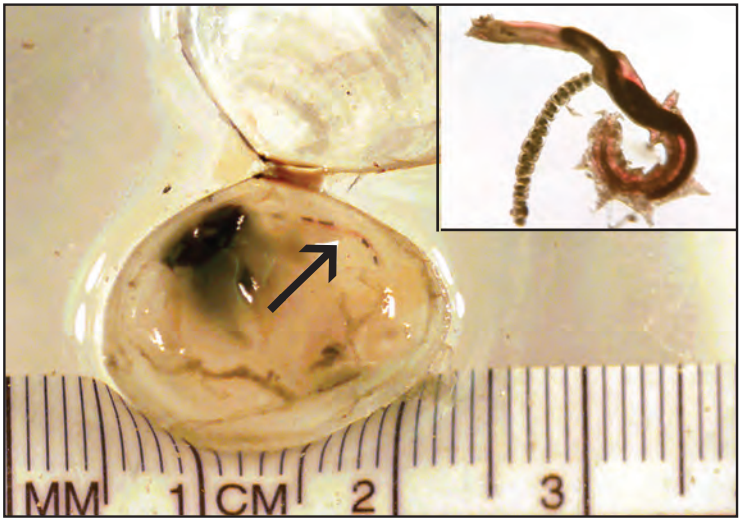
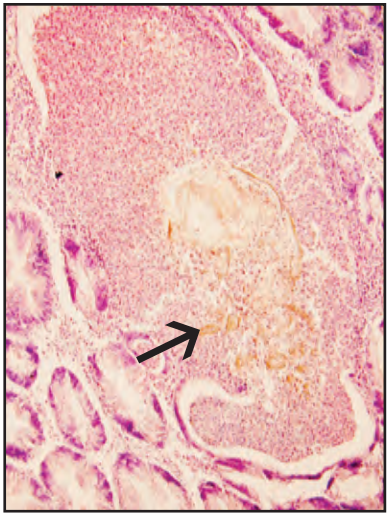


Histological section of Pacific oyster with a parasitic copepod (arrow) attached to the gill tissues causing localized inflammation

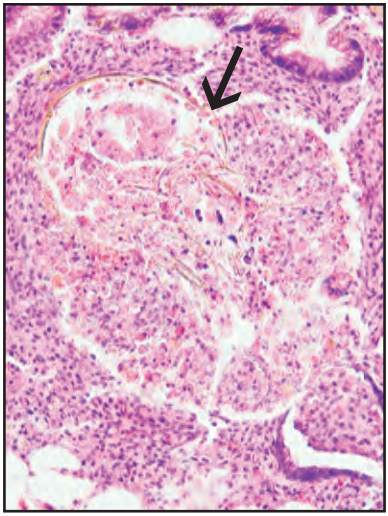
Histological section of Pacific oyster with a parasitic copepod in the intestinal lumen



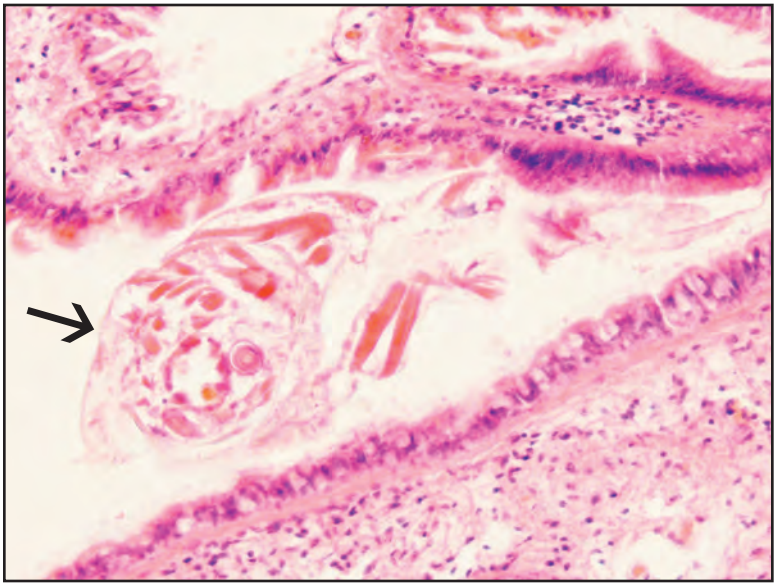
Mytilicola sp. in gut (arrow and inset) of the clam *Macoma balthica* (Photo: Dorothy Howard, NOAA Cooperative Oxford, MD Laboratory)



Histological section of dead parasitic copepod (arrow) surrounded by host inflammatory cells after penetrating into the connective tissues from digestive gland tubules in Pacific oyster



Similar dead parasitic copepod (arrow) surrounded by host inflammatory cells in connective tissue of digestive gland of blue mussel



Histological section of a parasitic copepod (arrow) on the mantle tissues of weather-vane scallop