Occurrence of *Echeneibothrium* (Platyhelminthes, Cestoda) in the calico scallop *Argopecten* gibbus from North Carolina

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Scallops are known hosts for larval parasites (Cheng 1967). Nematode and trematode parasites have been described in the calico scallop *Argopecten gibbus*, a bivalve native to the Atlantic coast (Cummins et al. 1981). Larval cestodes of the genera *Parachristianella*, *Tylocephalum*, *Rhinebothrium*, and *Polycephala* have also been described in *Argopecten irradians* populations from the Gulf of Mexico (Cake 1977).

During the course of a study describing gametogenesis and reproductive periodicity in the North Carolina population of *A. gibbus*, a larval cestode was found in specimens collected in late 1990 and early 1991. The objectives of this report are to identify the cestode, and to describe alterations in intestinal morphology and percent dry weight of the gonadal tissues ("gonadal index") of *A. gibbus*, which coincided with infection by this cestode.

Materials and methods

Calico scallops were collected by personnel of the North Carolina Division of Marine Fisheries or by commercial fishermen at 1–3 mo intervals from January 1990 to February 1991. Collection sites were located 10–20 km offshore (33–35° lat., 76–77° long.) from Cape Lookout, North Carolina at depths of 30–40 m. The scallops were placed on ice, transported to the lab, and the tissue processed within 24 h.

Gonads were removed and fixed in a seawater Bouin's solution for 12–24 h. After dehydration in a graded ethanol series, the gonads were embedded in paraffin and sectioned at 7 µm. Tissues were stained with either hematoxylin and eosin Y or Mallory's trichrome stain (Humason 1962).

Dry weights of tissues were determined by separating gonads, adductor muscle, and the remaining tissues, and drying each tissue to constant weight in an oven at 60°C (~48 h). Dry weight of the gonad was expressed as a percentage of the total dry weight to obtain the gonadal index. An analysis of variance (ANOVA) was used to test for differences in the gonadal indices of scallops from parasitized and nonparasitized groups in the same stages of gametogenesis.

Results

Encysted parasites, identified by Dr. Thomas C. Cheng (Medical Univ. South Carolina, Charleston) as the plerocercoid stage of the cestode *Echeneibothrium* sp., were found within the connective tissue of the gonads in calico scallops collected only during November 1990 and February 1991 (Fig. 1). Levels of

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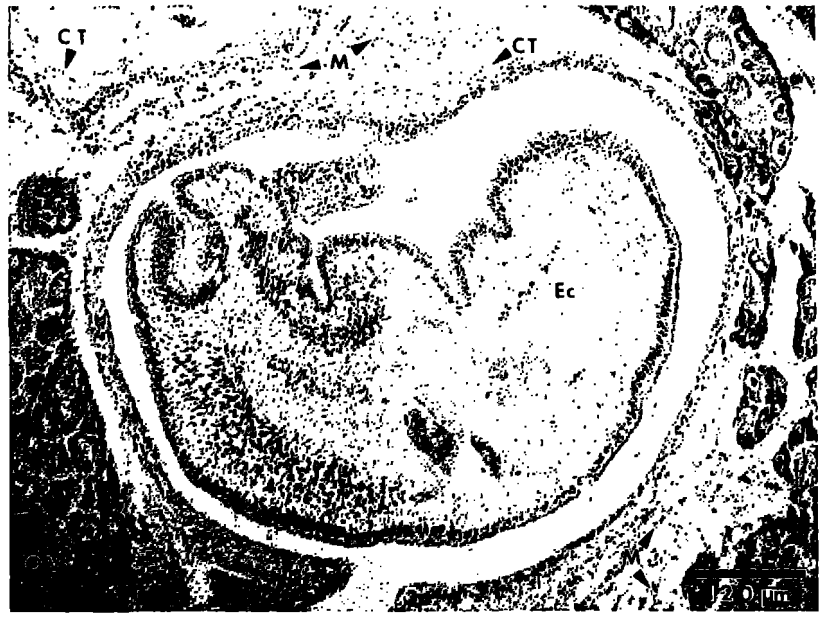

Figure 1
Longitudinal section of *Echeneibothrium* (**Ec**) in the gonad of *Argopecten gibbus*. Numerous macrophagous hemocytes (**M**) surround the connective tissue capsule (**CT**) and nearby tissue. **OV** = ovarian acini containing developing eggs. Mallory's trichrome stain.

infestation appeared low, with 1–2 larvae observed per cm^2 section of gonadal tissue. Encysted larvae appeared surrounded by a connective tissue capsule of host origin and were located immediately subjacent to the wall of the gut. Each larva measured ~600 µm in length.

The presence of these organisms was accompanied by morphological changes in the intestinal wall tissue of *A. gibbus* in the vicinity of the cyst. The wall of the intestine normally consisted of a columnar ciliated epithelium separated by a basement membrane from a thin underlying layer of connective tissue (Fig. 2). Debris and sand particles were prominent features within the lumen of the intestine. Hemocytes were present in the sinus surrounding the intestinal loop, but were not normally present in great numbers between the gonadal acini at this stage of gametogenesis.

In contrast, the intestinal epithelium of parasitized scallops appeared to have undergone cellular change in which the normal ciliated columnar epithelium had been replaced by a stratified squamous epithelium, or undifferentiated cells. The lumen of the intestine contained sloughed epithelial cells and what appeared to be cellular debris and intact hemocytes (Fig. 3). In addition, hemocytes were abundant within the connective tissues of the gut wall and surrounding the acini of the gonads, although the germinal epithelium appeared identical to non-parasitized tissue and eggs did not differ significantly in diameter.

Differences in the gonadal dry weight indices were also observed among parasitized and non-parasitized

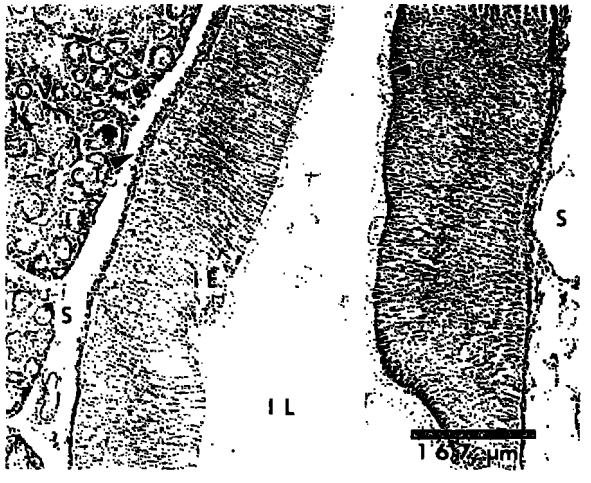

Figure 2

Cross-section of intestinal loop through gonad of unparasitized *Argopecten gibbus*. Note the ciliated columnar epithelium (**IE**). Few macrophagous hemocytes are present in the hemolymph sinus (**S**) surrounding the intestine, and the lumen (**IL**) contains only a slight amount of particulate matter. **OV** = ovarian acini, **C** = cilia, **CT** = connective tissue. Mallory's trichrome stain.

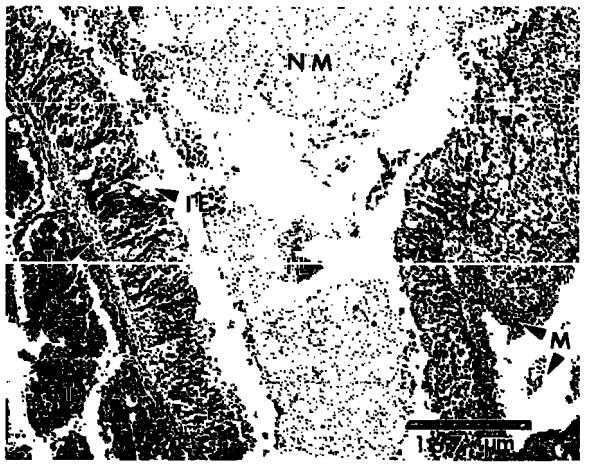

Figure 3

Cross-section of intestinal loop through gonad of a parasitized *Argopecten gibbus*. Note that the epithelium (**IE**) shows a loss of integrity, and the cells are more squamous than columnar. Ciliation has disappeared. The sinus surrounding the intestine contains numerous macrophagous hemocytes (**M**). The lumen (**IL**) is filled with non-cellular debris (**NM**). **T** = testicular acini, **CT** = connective tissue. Mallory's trichrome stain.

A. gibbus. The gonadal indices of non-parasitized *A. gibbus* during late gametogenesis and spawning were significantly higher (ANOVA, p=0.0001) than those of parasitized individuals in the same gametogenic state (Table 1).

Discussion

Past reports of larval *Echeneibothrium* hosts have been limited to species of *Venerupis staminea*, inhabiting the west coast of North America (Sparks & Chew 1966). Therefore, this report presents the first evidence for the occurrence of this genus in a bivalve from the east coast of North America, and the first indication of a scallop host. It is presently unclear how *Echeneibothrium* has

Table 1

Tukey's Studentized Range Test of mean gonadal indices (GI) among uninfected (January–April 1990) and infected (November 1990 and February 1991) *Argopecten gibbus* in the same reproductive state. Means not significantly different are underlined.

	Pairwise comparisons of GI					
	Feb '90	Mar	Jan	Apr	Feb '91	Nov
Mean	21.15	17.13	15.93	14.74	9.93	6.11
SD	±6.10	±2.96	±3.05	±4.28	±1.97	±2.08

migrated to eastern coastal waters. It is possible that parasitized intermediate and/or final host species either were introduced or migrated into the area.

Invasion of molluscan gonadal tissue by parasitic flatworms has been described as a secondary invasion, with the hepatopancreas (digestive gland) serving as the primary site. The resulting damage to the gonad, including atrophy and eventually destruction of the germinal epithelium, is believed to be a combination of mechanical pressure and nutrient deprivation (Cheng 1967). However, within the gonads of parasitized *Argopecten gibbus*, these changes were not apparent. Developing and mature eggs in the acini were identical in morphology to the eggs seen in non-parasitized tissue, and did not differ significantly in diameter (Singhas 1992). The only obvious difference was the higher numbers of hemocytes surrounding the germinal epithelium in infected scallops. The most extensive tissue damage in parasitized *A. gibbus* occurred in the epithelium of the intestinal loop. This damage consisted of alterations in intestinal epithelial cell shape and structural integrity, similar to those described by Cheng (1967) for hepatopancreatic tissue.

Failure of the local commercial crop of *A. gibbus* coincided with the appearance of *Echeneibothrium* in 1991 (P. Phalen, N.C. Div. Mar. Fish., Morehead City NC 28557-0769, pers. commun.). It is uncertain if the *Echeneibothrium* infestation contributed directly to this failure, because this species is known to undergo dramatic fluctuations in number (Moyer & Blake 1986). However, the commercial failure of *A. gibbus* in Florida during January–February 1991 was attributed to a Protoctistan parasite, *Marteilia* sp. (Blake & Moyer, 1992). Parasitism may therefore be an important factor in the population biology of *A. gibbus*, and merits further investigation.

Acknowledgments

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