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BONAMIA EXITIOSA AND ITS INFECTION OF *CRASSOSTREA VIRGINICA* IN THE EASTERN USA: AN ADVISORY

September 11, 2013

The last 14 months have seen the first two reports of the parasite *Bonamia exitiosa* infecting the eastern oyster, *Crassostrea virginica*. Hatchery-produced seed oysters from Core Sound, North Carolina were found to be infected in July 2012, and cultured seed from Stage Harbor, Chatham, Massachusetts collected in June 2013 were infected with what is presumed to be the same parasite. While *B. exitiosa* does not appear to be a serious pathogen of *C. virginica*, its emergence in *C. virginica* warrants attention from pathologists, resource managers, and the aquaculture community. Here is what we presently know about this organism.

Who is *Bonamia exitiosa*? *B. exitiosa* is a protistan parasite infecting oyster tissues. It was first observed in the oyster *Ostrea chilensis* from New Zealand, in which it is a serious pathogen. Because of the damage it causes in some hosts, *B. exitiosa* has been placed on the World Organisation for Animal Health (OIE) list of notifiable pathogens (http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2013/).

Distribution. While *B. exitiosa* was originally described from New Zealand[1], it is now known to occur widely, in Australia, South America, eastern and western North America, North Africa, and Europe. Along the Atlantic coast of the USA south of Cape Hatteras, the non-commercial crested oyster *Ostrea stentina* (= *Ostreola equestris*) is a host[2,3]. The European flat oyster *Ostrea edulis*, which is established in New England, is infected by *B. exitiosa* in some European systems[4].

Effects on oyster hosts. Parasites in the genus *Bonamia* are often referred to as "microcell haplosporidians"[5], which emphasizes their distinctiveness from familiar haplosporidians like *Haplosporidium nelsoni* (MSX) and *H. costale* (SSO). They are tiny parasites (2-3 μm) that specifically infect and proliferate in oyster hemocytes, or blood cells. Transmission occurs directly from oyster to oyster (unlike MSX and SSO) and infections produce inflammation that, in advanced cases, can be highly disruptive of host tissue structure and function. Associated mortality in susceptible hosts like *Crassostrea ariakensis* can exceed 90%[6]. Only small *C. virginica* seed (< 20 mm) have been found infected, and while

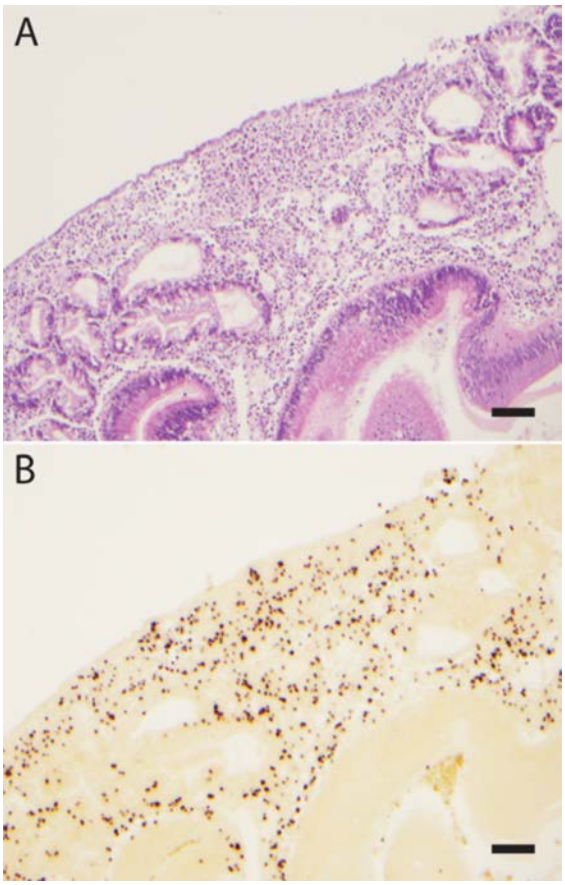

Fig. 1. Heavy *Bonamia exitiosa* infection of *Crassostrea virginica* from North Carolina. **A**. Inflammation of oyster tissues as viewed histologically. **B**. *In situ* hybridization to the same section showing abundant *B. exitiosa* cells (dark spots) associated with oyster hemocytes. Scale bars = 50 μm. Images: N. Stokes.

prevalence of *B. exitiosa* in *C. virginica* may be high, as in the North Carolina case (93.8%), most infections have been light, and no mortality has been reported.

Environmental influences. Research on *B. exitiosa* in *C. ariakensis* indicated that the parasite was limited by salinities under 20 ppt[7,8,9]. Based on its infection of oysters in cool temperate as well as sub-tropical systems, it must be viewed as tolerating a wide temperature range.

Detection. Due to its small size, *B. exitiosa* is difficult to detect microscopically, especially when infections are light. Use of a polymerase chain reaction assay (PCR) assay[10] is recommended for general surveillance. *In situ* hybridization[3] may be used to confirm infection. Control material is available from the VIMS Shellfish Pathology Laboratory. Because even the newer small-subunit ribosomal DNA-based PCR assays above cannot distinguish *B. exitiosa* from other closely related parasites, DNA sequencing of internal transcribed spacer (ITS) region sequences (still pending for the Massachusetts case) is necessary for definitive identification of *B. exitiosa* in new hosts and locations.

Management. We recommend that screening for *B. exitiosa* (preferably by PCR) be conducted in *C. virginica* seed and broodstock destined for interstate transfer, particularly when originating from the Southeast or New England, and that oysters positive for *B. exitiosa* not be transferred to areas free of the parasite. Determination of the distribution of *B. exitiosa* in wild and cultured *C. virginica* populations in the eastern USA should be a priority.

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