MYTILUS (MOLLUSCA, BIVALVIA) EPIBIONTIC ON THE FISH PARASITE *MOTHOCYA EPIMERICA* (CRUSTACEA, ISOPODA) IN THE SEA OF MARMARA, TURKEY*

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Abstract *Veliger and pediveliger stages of* Mytilus cf. galloprovincialis *are observed attached to the pleonites of the parasitic isopod* Mothocya epimerica *living in the branchial chamber of the fish,* Atherina boyeri. *The bivalves are attached by byssus threads to the isopod and to each other. It is suggested that this is an accidental association that comes about by the intake of drifting post larval stages whose byssus becomes entangled with the appendages of the isopod. While epibiontic bivalves are known to attach to the exoskeletons of decapod crustaceans this is the first record of attachment to parasitic isopods.*

Key words *Epibiosis; bivalve; isopod; Sea of Marmara*

INTRODUCTION

Mothocya Hope, 1851 is a genus of parasitic isopods found attached within the branchial chamber and mouths of fishes (see Bruce, 1986 for a taxonomic review). *Mothocya epimerica* Costa, 1851 is associated with the sand smelt, *Atherina boyeri*, Risso, 1810 (Fig. 1A) to which they attach by means of hooked claws on their legs. Female isopods brood their young in a swollen marsupium and may reach a centimeter in length (Fig. 1B). The fish, also known as the Black Sea Silverfish, is an inhabitant of estuaries, lagoons and lowered salinity waters in the north-east Atlantic and throughout the Mediterranean and Black Seas . This fish is of commercial importance and the effects and ecology of the parasites have been the subject of a number of studies (Trilles 1994; Bello et al 1997; Charfi-Cheikhrouha et al 2000; Öktener and Sezgin 2000; Leonardos and Trilles 2003). *Mothocya epimerica* was first recorded from Turkish waters, in the Sea of Marmara (Öktener & Sezgin, 2000) and during continuing investigations of this infestation Ahmet Öktener observed small bivalves attached to the pleon of the isopod (Fig. 1B, B*).

Associations between bivalves and crustaceans are well documented (Li et al, 2013) ranging from obligate (commensal) relationships such as that between *Lepton squamosum* and *Upogebia* to epibiosis exemplified by *Mimachlamys varia* attaching to *Galathea strigosa* (Albano & Favaro, 2011) and *Semimytilus algosus* to *Emerita analoga* (Villegas et al, 2005) where the relationship is not one of commensalism. The majority of instances involve either Decapoda or Stomatopoda while those involving the orders of smaller Crustacea within the Epicaridea are rare. A notable exception is that of *Arculus sykesi* attached to the Tanaidacean *Apseudes* (Warén & Carrozza, 1994). The majority of commensal bivalves belong to the superfamily Galeommatoidea while the range of epibiontic taxa is much greater and includes many epibyssate forms within the Mytliodea, Pectinoidea and Anomioidea. Bivalves commensal or epibiontic with parasitic crustaceans have not been previously reported.

This paper determines the identity of the bivalves and discusses this novel association.

MATERIALS AND METHODS

The fish samples were collected by trawl and local gears from Bandırma Bay in 2014.

The body surfaces, buccal cavities and branchial chambers of the each fish were examined for isopod parasites. The parasites were dislodged from their host and preserved directly in a labelled tube with 70% ethanol. The identification, classification and current nomenclature of both isopod and fish follow Trilles (1968), Trilles (1994),

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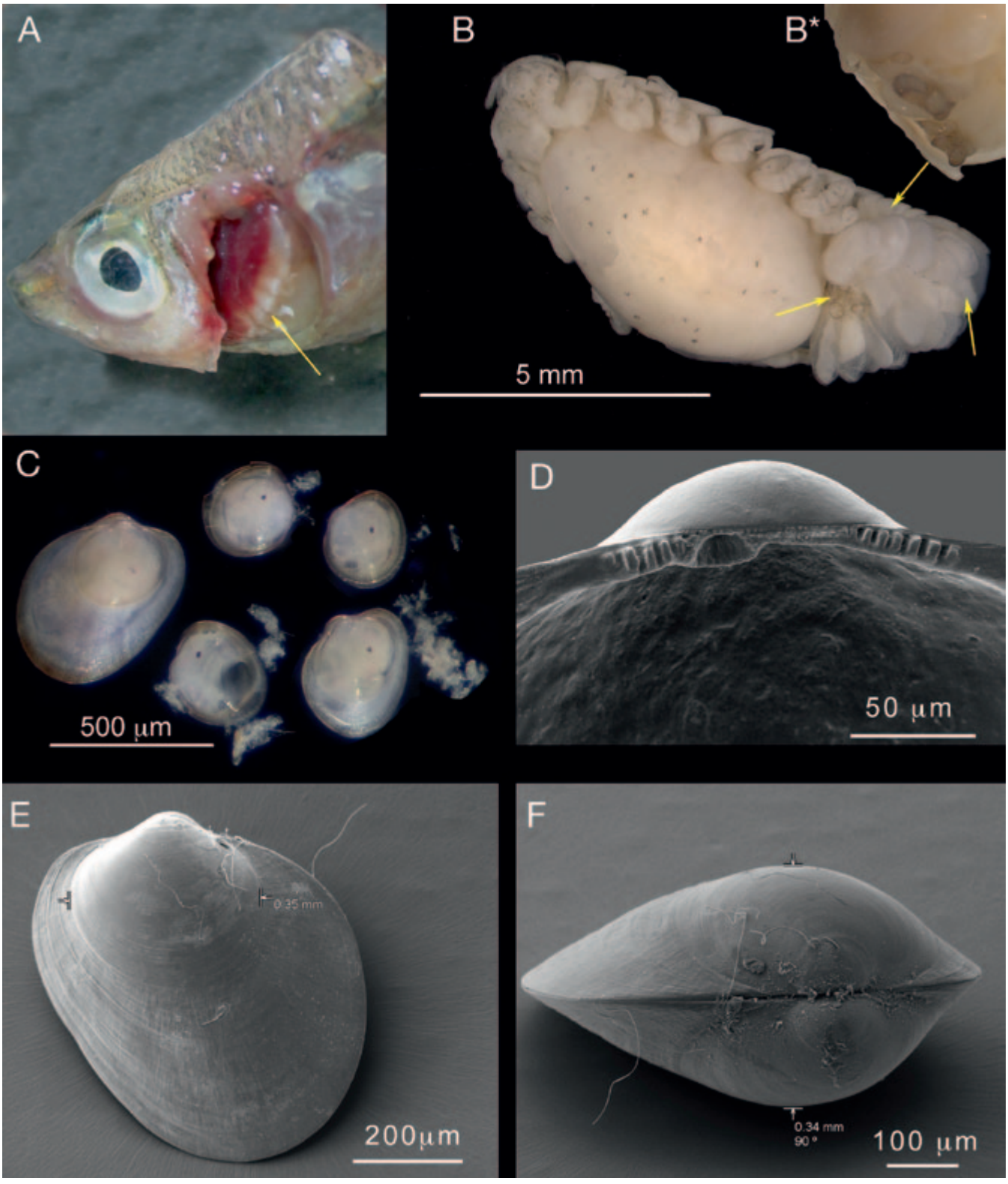

Figure 1A Head of *Athernia boyeri* with branchial chamber exposed to show presence of the parasitic isopod *Mothocya epimerica* [arrowed]: **B**, Ventral view of a *Mothocya* showing attached bivalves and sites of attached bivalves [arrows]: **B*** margin of a second specimen with nine specimens attached: **C**, Photomicrographs of the group of mytilids removed from the pleon of *Mothocya* seen in Fig. 1B: **D**, Scanning electron micrograph of the hinge of a mytilid pediveliger, the far right individual in Fig. 1C: **E–F**, Scanning electron micrograph of the largest pediveliger seen in Fig. 1C, lateral and dorsal views.

Bruce (1986) and WoRMS (2014). Examination of the parasite specimens confirmed that they were *Mothocya epimerica* according to the general body shape, maxillule with 4 terminal spines, maxilla with two curved spines on medial and lateral lobes, mandible palp article 3 without setae, antennule and antenna with 8 articles, maxilliped article 3 with 4 recurved spines, all agreeing with the drawings given by Trilles (1968, 1994) and Bruce (1986).

The bivalves were preserved in 70% ethanol and prepared for scanning electron micrography by critical point drying, coating with gold and examination in a Jeol Neoscope. Photomicrographs of the isopod and bivalves were made with the aid of AutoMontage computer aided stacking software.

Results

Numbers and distribution of bivalves on the isopod One hindred and fifty fish were examined, of these ten were infested each with a single isopod. Of the ten isopods examined five were found to have bivalves attached. The number of bivalves attached to each isopod were 4, 4, 5, 8 and 9. No bivalves were found attached to the gills, or in the branchial chamber of *Atherina*.

Description of the bivalves The attached bivalves are very small, ranging from 350–690 µm. The smaller specimens consist of the prodissoconch only, with a Prodissoconch 1 of 110 µm (Fig. 1F) and a Prodissoconch 2 of 340–350 µm (Fig. 1E). Prodissoconch 1 is D-shaped while P2 is ovate with low umbos. The larger specimens consist of the larval shell with a small growth increment of the dissoconch (Fig. 1E, F). They are mytiliform in outline and the obliquely developing dissoconch is tinged blue in colour (Fig. 1C). The hinge line of the pediveliger consists of 5 anterior and 6 posterior taxodont teeth separated by an edentulous space incorporating a small ligament pit (Fig. 1D). Byssus threads were present, binding the bivalves together and attached to the pleonites of the isopod.

In all the examined specimens a pigment "eye" spot was visible as were the beginnings of the ctenidium and foot (Fig. 1C). This and the presence of byssus threads suggests that these are newly settled veligers or pediveligers.

Identity of the bivalves The general features of these veligers and pediveligers fit well with those of the Mytilidae (Le Pennec, 1980). The fauna of the Sea of Marmara is relatively impoverished compared to that of the adjacent Aegean Sea with only three Mytilidae recorded, *Mytilus galloprovincialis* Lamarck, 1819, *Mytilaster lineatus* (Gmelin, 1791) and *Modiolarca subpicta* (Cantraine, 1835) (Demir, 2003).

Information on the veligers of these species is scant except for *Mytilus*. From juvenile shells of *Modiolarca* illustrated in Oliver et al (2010) the P2 is over 500 µm in diameter. From a specimen of *M. lineatus* from Italy in the collection of the National Museum of Wales the P2 is 190 µm. Fully developed veligers of *M. galloprovincialis* were reported to be between 230–250 µm by Le Pennec (1980) but the size at maturity is known to vary with environmental parameters, primarily temperature (Le Corre et al, 2013). Lower temperatures are known to delay settlement and produce larger P2 shells with sizes ranging from 242–384 µm (Le Corre et al, 2013). The Sea of Marmara is warm temperate suggesting that the P2 size should be at the lower end of the scale and not the observed large size of 340–350 µm. Salinity is also known to affect the growth of larval mussels (His, Robert & Dinet, 1989) and the lowered salinity, experienced in the Sea of Marmara, may extend larval duration and result in a larger P2 but this has not been studied.

The general appearance of these specimens suggests that they are veliger and pediveligers of *Mytilus galloprovincialis.*

The possibility that these bivalves were true commensal forms was considered initially but as they are not adult this was rapidly discounted. Mytilids are rarely commensal and none are known from Crustacea. Only *Modiolarca* species are associated with sessile invertebrates where they embed themselves in the tests of tunicates.

Discussion

The observed association is considered here to be accidental and is a result of the feeding behaviour of the fish. *Atherina boyeri* feeds on small invertebrates either from the zooplankton or surface benthos, its preferences depending on seasonal availability (Bartulović et al, 2004; Vizzini & Mazzola, 2005). Feeding on either can bring the fish into contact with mytilid veligers and

pediveligers although bivalves are not reported from stomach contents (Bartulović et al, 2004). Mytilids are not only present in the plankton as developing veligers but are also found as drifting pediveligers supported by byssus threads (Lane et al, 1985). This latter behavior we believe could lead to entanglement on the isopod. We propose that during feeding the drifting bivalves are taken into the mouth of the fish but some pass into the branchial cavity where their passage is interrupted by the disproportionately large isopod. The wafting of the pleopods carries the bivalves to the pleon where the byssus threads become entangled and new threads are produced. We do not consider that primary settlement has taken place on the isopod. Bivalves are not attached to the gills or walls of the branchial cavity of the fish probably because there is no site for entanglement.

We do not know how long the *Mytilus* remain attached to the isopod or if they survive for any length of time. Byssate bivalves settling on decapod exoskeletons are considered to be temporary as they are shed when the crustacean moults (Albano & Favero, 2011). Although one may suggest that there is an element of dispersion facilitated by attaching to such a mobile host there is no evidence that the mussels are actively seeking out this relationship and that it is no more than accidental.

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