MIMACHLAMYS VARIA (MOLLUSCA, BIVALVIA) EPIBIONTIC ON *GALATHEA STRIGOSA* (DECAPODA, GALATHEIDAE) IN THE NORTH ADRIATIC SEA

BY

PAOLO G. ALBANO[1,3]) and FLAVIO FAVERO[2])

[1]) Department of Experimental Evolutionary Biology, University of Bologna, c/o Prof. B. Sabelli, via Selmi, 3, I-40126 Bologna, Italy

[2]) Fossalta (Ferrara), Italy

ABSTRACT

Fifty-six specimens of *Mimachlamys varia* epibiontic on a single specimen of *Galathea strigosa* are reported from the North Adriatic Sea. Their size suggests the specimens are from a few days to a maximum of 3 months old after metamorphosis. The main advantage for the epibiont is a suitable hard substratum for settling on an otherwise unsuitable soft substratum, while the main disadvantage is that the periodic moultings of the crab allow only a few months of settling. However, *Mimachlamys* is able to release its byssus, swim, and settle elsewhere. Due to the small size of the epibionts, neither advantages nor disadvantages for the basibiont could be recognized.

RIASSUNTO

Su un esemplare di *Galathea strigosa* proveniente dal Mar Adriatico settentrionale sono stati rinvenuti 56 esemplari di *Mimachlamys varia*. La loro taglia suggerisce che questi esemplari siano di età compresa tra pochi giorni e massimo 3 mesi dalla metamorfosi. I vantaggi e gli svantaggi di questa epibiosi sono discussi. Il principale vantaggio per l'epibionte consiste nell'aver trovato un substrato rigido per svilupparsi in un ambiente dominato da inadatti substrati mobili. Il principale svantaggio per l'epibionte è la muta periodica di *Galathea* che dopo pochi mesi lo costringe a trovare un nuovo substrato, cosa che *Mimachlamys* è in grado di fare rilasciando il bisso e nuotando altrove. Data la piccola taglia degli epibionti, non si individuano particolari vantaggi o svantaggi per *Galathea*.

INTRODUCTION

Mimachlamys varia (Linnaeus, 1758) (Mollusca, Bivalvia, Pectinidae) is a common marine species reported from the Mediterranean Sea and in the north-eastern Atlantic, from Scandinavia southward to Senegal. It lives from the intertidal

[3]) e-mail: pgalbano@iperbole.bologna.it

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to the upper circalittoral and is generally associated with hard substrata on which it settles by a bissus. *M. varia* usually attains a maximum size of 50 mm, but larger specimens are reported.

Galathea strigosa (Linnaeus, 1761) (Crustacea, Decapoda, Galatheidae) is reported from the Mediterranean Sea and in the north-eastern Atlantic from Scandinavia southward to Morocco (Baba et al., 2008). In the Mediterranean Sea, it is a common species in the lower infralittoral and upper circalittoral. It is associated with hard substrata where it hides in crevices (d'Udekem d'Acoz, 1999).

Epibiosis is a non-symbiontic, facultative association between an epibiont, an organism growing attached to a living substratum, and a basibiont, a substratum organism which is host to the epibiont (Wahl, 1989). Such an association usually includes benefits and disadvantages both for the epibiont and the basibiont.

The aim of this study is to describe the epibiontic association between *M. varia* and *G. strigosa*, and to discuss hypotheses on advantages and disadvantages for both the epibiont and the basibiont.

To our knowledge, this is the first record of molluscan epibiosis on *Galathea strigosa*.

MATERIAL AND METHODS

The studied specimen of *Galathea strigosa* was found by the second author on 15 August 2005 while SCUBA diving at a depth of 23 meters on the wreck "Quintino Sella", 12 nautical miles [approx. 22 km] off Lido di Venezia, in the northern Adriatic Sea. The specimen was hiding in a hole of the wreck and was collected in order to keep it in an aquarium for live observation. However, it died soon after surfacing. The specimen was dried and mounted on a cardboard support to allow easier handling and observation.

The molluscan epibionts were identified and measured. Since they could hide deeply between setae or other exoskeleton microsculpture items, their size could not always be measured precisely. Moreover, extremely juvenile *Mimachlamys* specimens were observed and at this stage identification is very difficult. Identification was based on a growth series that could be built from detached specimens. However, it is tentative for the smallest specimens. Information on the biology of Pectinidae was, for the most part, obtained from Shumway (1991). In the text that follows, only notes specifically about *Mimachlamys varia* have been cited in detail. The position of the epibionts on the crab's body was described following the descriptive terminology for crustaceans by Moore (1969).

Taxonomy follows Fransen & Türkay (2009) for *Galathea strigosa* and Dijkstra (2009) for *Mimachlamys varia*. Fish taxonomy follows the WoRMS database (http://www.marinespecies.org).

RESULTS

The carapace of the specimen of *Galathea strigosa* is (with rostrum) 97 mm in length. Sixty-five specimens of bivalves were found attached to its body (table I). Most of these (N = 56, or 86.1%) are juvenile specimens identified as *Mimachlamys varia* (fig. 1). A few other bivalves are present and these include 5 juvenile specimens of *Anomia* sp. (Anomiidae) and 4 juvenile specimens of *Modiolarca subpicta* (Cantraine, 1835) (Mytilidae). Two specimens of the latter are so young that identification is only tentative. This paper concentrates on *Mimachlamys varia*, being the dominant epibiontic species.

TABLE I
List of molluscan epibionts found on *Galathea strigosa* (Linnaeus, 1761)

Galathea body part	Molluscan species	Number of specimens	Size range [mm]
Right cheliped	*Modiolarca subpicta* (Cantraine, 1835)	1	1.4
	Mimachlamys varia (L., 1758)	12	0.9-3
	Anomia sp.	1	2
Left cheliped	*Modiolarca subpicta*	1	1
	Mimachlamys varia	15	0.5-3
	Anomia sp.	1	1
Rostrum	*Mimachlamys varia*	3	0.5-2.5
Carapace	*Mimachlamys varia*	3	0.5-2.5
Right first walking leg	*Modiolarca subpicta*	1	1
	Mimachlamys varia	4	1-1.7
	Anomia sp.	1	1.2
Right second walking leg	*Mimachlamys varia*	2	1-1.3
Right third walking leg	*Modiolarca subpicta*	1	0.4
	Mimachlamys varia	1	0.5
Left first walking leg	*Mimachlamys varia*	1	1
Left second walking leg	*Mimachlamys varia*	3	0.7-1.5
Left third walking leg	*Mimachlamys varia*	3	0.5-2.5
	Anomia sp.	2	1.7-2
Abdomen, telson	*Mimachlamys varia*	2	0.3-1
Bivalves detached from crab, position on the body could not be ascertained	*Mimachlamys varia*	7	2.2-5.4

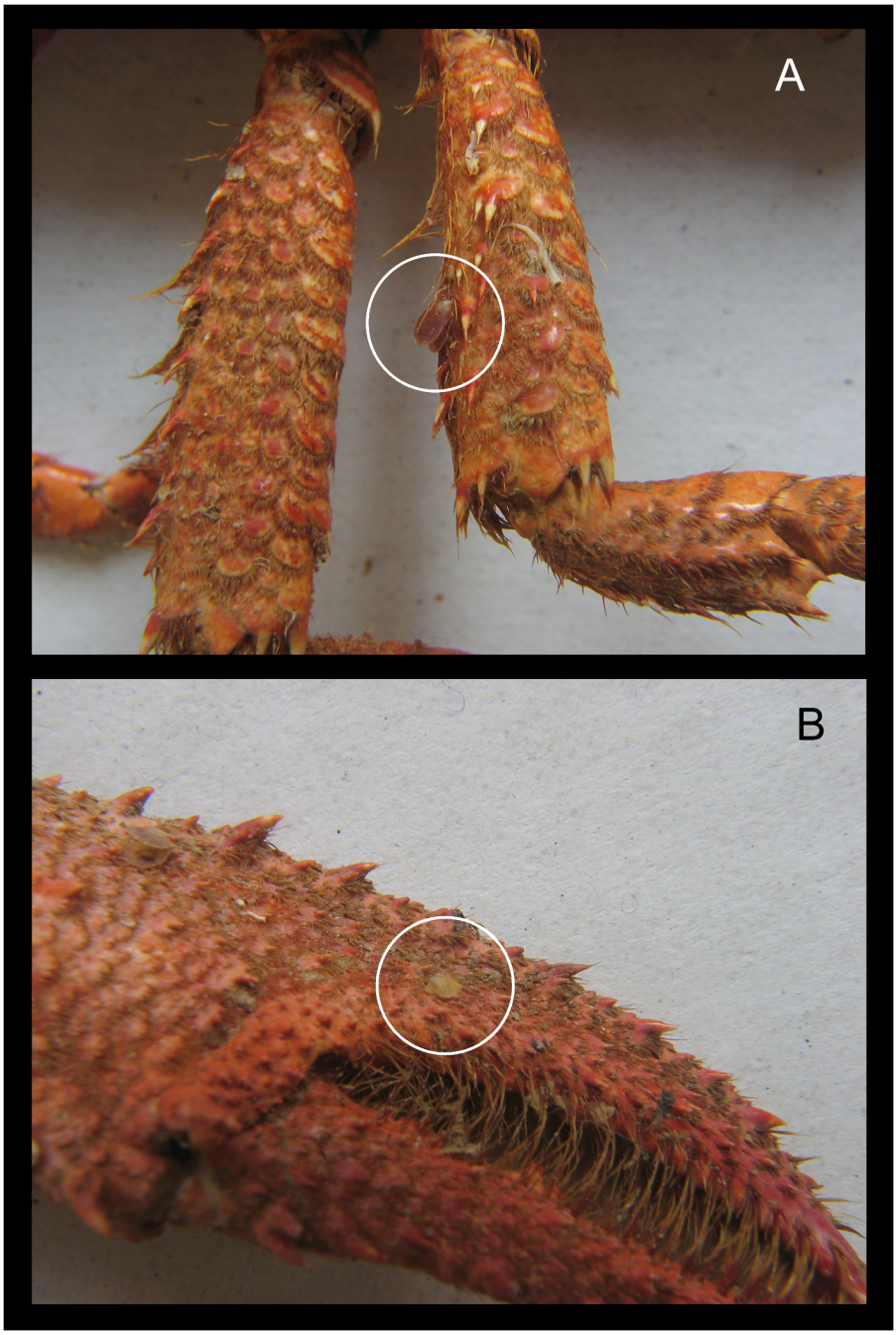

Fig. 1. *Mimachlamys varia* (Linnaeus, 1758) epibiont on *Galathea strigosa* (Linnaeus, 1761); Quintino Sella wreck, North Adriatic Sea. A, left third walking leg, bivalve size: 2.5 mm; B, left cheliped, bivalve size: 2 mm. This figure is published in colour in the online edition of this journal, which can be accessed via http://www.brill.nl/cr

DISCUSSION

With the exception of a single specimen of 5.5 mm, all *Mimachlamys* specimens are equal to or below 3 mm in length (fig. 2). Cancelo et al. (1992) report specimens of a mean size of 6.5 mm being obtained in a hatchery from spat after 3 months of growth. All epibionts found on *Galathea* are, therefore, just a few weeks old following metamorphosis. The smallest specimens may even be just a few days old.

Pectinidae have planktonic larvae. This enhances their dispersal potential. It has been suggested that scallop larvae may be gregarious, that settlement patterns may depend on the distribution of suitable primary settlement sites like on hydroids and bryozoans, and that density-dependent mechanisms can affect recruitment success. Most Pectinidae begin their post-larval life as byssally-attached juveniles. This is the stage observed and described here. Later, some species release their byssus and start a free life. However, this is not expected for *Mimachlamys varia*, which, although it is capable of releasing its byssus and performing active swimming movements, generally remains attached throughout life (Brand, 1991).

Epibiosis of Pectinidae on decapod crustaceans is poorly recorded in the literature. Coan et al. (2000) record occasional epibiosis of *Leptopecten latiauratus* (Conrad, 1837) from off California on pelagic red crabs, *Pleuroncodes planipes* (Stimpson, 1860). T. R. Waller (pers. comm., August 2009) reports about specimens of *Delectopecten*, probably *Delectopecten vancouverensis* (Whiteaves,

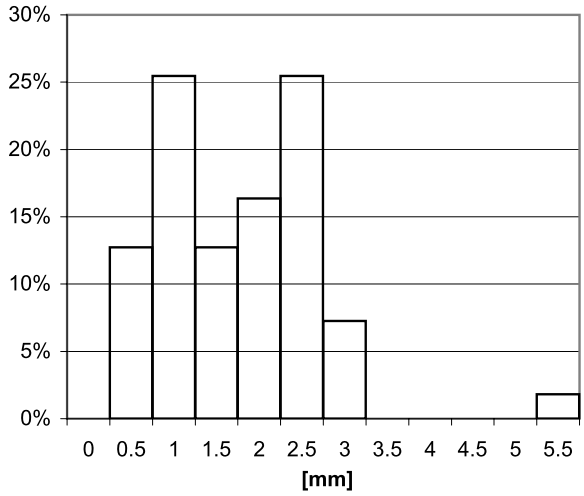

Fig. 2. Size-frequency distribution of *Mimachlamys varia* (Linnaeus, 1758) found on *Galathea strigosa* (Linnaeus, 1761).

1893), on tanner crabs (*Chionoecetes bairdi* M. J. Rathbun, 1924) that were caught by commercial fishermen about 30 miles west of Coos Bay, Oregon, at depths of 300 to 350 fathoms [approx. 450-525 m]. The juvenile scallops, which were up to 14 mm in diameter, were byssally attached in indentations on the carapaces of the crabs.

Taxonomically closely related families like Anomiidae are also reported as epibionts on crabs (e.g., Mori & Manconi, 1990; Dvoretsky & Dvoretsky, 2008). Anomiidae belong to the same order, Pterioida, as Pectinidae. They attach themselves to hard substrata by a calcified byssus that passes from the inside of the left (upper) valve through a hole in the right (lower) valve (Tebble, 1976). A characteristic of this family is that the shell assumes the outline or impression of the object on which it lies. Mytilidae are reported as epibionts on crabs as well (Villegas et al., 2006; Dvoretsky & Dvoretsky, 2008) and they belong to the same subclass Pteromorphia (taxonomy according to Schiaparelli, 2009). They attach themselves to the substratum by a slender brown byssus. Anomiidae and Mytilidae were observed on the studied *G. strigosa* specimens, too, but the abundance of *M. varia* is striking. Rodhouse & Burnell (1979) have observed that, under natural conditions, juvenile *M. varia* show preference for dark sites (e.g., cracks in rocks and the insides of empty shells). The habit of *Galathea* to live in crevices may enhance the settlement of *M. varia* larvae on their body.

The North Adriatic Sea has a dynamic soft substratum where no, or only a few, hard substrata are available for larvae to settle. In these conditions, biogenic substrata are commonly used by hard-bottom colonizers. This is certainly the main advantage for *M. varia*, which found in the carapace of *G. strigosa* a suitable substratum to settle upon. However, since *M. varia* settles on a wide array of other abiotic substrata, this association is facultative and not species-specific (Wahl & Mark, 1999). Moreover, most *Mimachlamys* specimens were observed between spines or spicules. The rough surface of the carapace of *Galathea* probably enhances the settlement of *Mimachlamys* larvae. Ridges, spines, tubercles, and fine spiculae create a rather rough surface that may offer protection to juvenile *Mimachlamys* and be suitable for byssus attachment (those structures may create a sheltered micro-environment with low water movement, which enhances larvae settling).

Galathea does not have a terminal moult, but adults of *G. strigosa* probably have only one or two moults each year (C. Froglia, September 2009, pers. comm.). Therefore, *Mimachlamys* loose their substratum every few months. This may lead specimens to detach themselves from their host and swim in search of a new substratum, or to die when the old exoskeleton becomes buried in the sediment.

The estimated age of specimens is less than three months. This is consistent with the periodic *Galathea* moultings, which constitute the main disadvantage for the epibiont. Settling necessarily is for only a few months, and it does not allow bivalve specimens to become adult on that substratum. Survival of a *Mimachlamys* is dependent on its ability to release its byssus, swim to a suitable new substratum, and form a new byssus, the latter being an ability that has already been observed in *M. varia* (cf. Brand, 1991). Since *Galathea* lives on hard substrata, *Mimachlamys* may find a new suitable substratum within a short swim.

When it comes to predation, it is not easy to draw conclusions whether this epibiosis brings advantages or disadvantages to the epibiont. Juvenile specimens of *Mimachlamys* on inorganic substrata may be actively predated by small crabs, starfish, and gastropods. Living on a *Galathea* certainly greatly reduces the risk of attack by those species, which are not expected to crawl on a so large and active living crab. On the other hand, *Galathea* is predated by fish, like *Phycis phycis* Linnaeus, 1766 (for Greece, Papaconstantinou & Caragitsou, 1989), *Raniceps raninus* (Linnaeus, 1758), *Zeugopterus regius* (Bonnaterre, 1788), *Zeugopterus punctatus* (Bloch, 1787) (for Scotland, Nickell & Sayer, 1998), *Scorpaena notata* Rafinesque, 1810 (for the Ligurian Sea, Relini et al., 2002), and *Epinephelus marginatus* (Lowe, 1834) (for the Balearic Islands, Reñones et al., 2002). Therefore, *Mimachlamys* would also be predated upon at the same time.

When it comes to *Galathea strigosa*, it is difficult to imagine any advantage of having *M. varia* as epibionts. The number and size of attached specimens is not enough to provide any camouflage and this kind of camouflage may anyway better be avoided, since adult *Mimachlamys* have many predators that may feed on *Galathea* as well (e.g., octopuses).

In the specific case described here, there probably are not even disadvantages, due to the small size of the attached bivalves. Periodic moulting does not permit *Mimachlamys* to grow to any significant size, and so it cannot induce any increase in weight, or reduce buoyancy, or increase surface friction. Moulting is, therefore, the main mechanical defense against any serious colonization from epibionts. *Mimachlamys* are suspension feeders and do not parasitize in any way on their host. Moreover, the position of *Mimachlamys*, sparsely settled on the carapace, does not suggest any case of commensalism, which has been reported for a few other species of bivalves on crustaceans (e.g., *Arculus sykesi* (Chaster, 1895), Leptonidae, on *Tuberapseudes echinatus* (G. O. Sars, 1886), Tanaidacea, Apseudidae; cf. Warén & Carrozza, 1994). However, in that case, bivalves were fixed with their byssus near the gills, where enhanced water movement brings more food to the bivalve, which may be a benefit.

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