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On some Indo-Pacific boring endolithic *Bivalvia* species introduced into the Mediterranean Sea with their host – spread of *Sphenia rueppelli* A. Adams, 1850

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Abstract

The study of the endolithic molluscs found on/in living alien *Spondylus* shells collected in the Gulf of Iskenderun (Turkey) brought to light three more alien *Bivalvia* species, namely *Petricola hemprichi*, *Gastrochaena cymbium* and *Sphenia rueppelli*. The presence of *Sphenia rueppelli* deserves attention as it constitutes the first record of this species as living in the Mediterranean Sea. The definitive establishment and spread of these bivalves in the basin seems to be also attested by careful analysis of specimens sampled in other southern Turkish localities and previously retained in local private collections. The present records raise some questions on the vector of arrival of the species in the Mediterranean Sea, which could be strictly connected with their hosts.

Keywords: Alien *Bivalvia*; S. Turkey; *Sphenia rueppelli*.

Introduction

The Gulf of Iskenderun appears to be a hotspot area for alien marine species. ALBAYRAK (2010) has reported that 9 of the 63 *Bivalvia* species (14,3%) in soft substrata of the Gulf are alien. The majority are of Indo-Pacific origin and have arrived either as Lessepsian immigrants (progressive penetration via the Suez Canal) or transferred by ships. This is mainly due to the high

levels of shipping transport in the area. Iskenderun is in fact not only one of Turkey's largest ports on the Mediterranean Sea but serves also as an important naval training base. Other ports located in the Iskenderun Gulf include Dörtyol, at the head of the Gulf, a port and oil terminus and Yumurtalik, at a distance of about 40 km from the centre of Adana, whose harbour is heavily visited by recreational boats during the summer.

One of the most invasive species in

the Gulf of Iskenderun is *Spondylus spinosus* Schreibers, 1793 whose most probable vector of introduction is assumed to be shipping via the Suez Canal. *Spondylus spinosus* was first sighted in the Mediterranean Sea in 1988, off Haifa, attached to rocky sea beds at depths of 2-25m together with *Chama pacifica* Broderip, 1834 and other Spondylidae (MIENIS *et al.*, 1993), and then rapidly spread to Lebanon, Syria, Turkey and Cyprus (ENGL & ÇEVIKER, 1999; ZIBROWIUS & BITAR, 2003; KATSA-NEVAKIS *et al.*, 2009) soon becoming one of the top invasive species in the Mediterranean (STREFTARIS & ZENETOS, 2006). Dense populations of up to 15 specimens per m² (MIENIS *et al.*, 1993) and stable-reproducing populations (MIENIS *et al.*, 1993; ENGL & ÇEVIKER, 1999) suggest a definitive establishment of the species in the Mediterranean Sea. A congeneric species, *Spondylus multisetosus* Reeve, 1856 has been reported as common in the Iskenderun area since 1992. Even if it was sometimes suspected to be a variant of the established species *Spondylus spinosus* ÇEVIKER, 2001), the two 'morphotypes' are here treated as different species.

Methodology

During a diving expedition in August 2009 in Dörtyol, Hatay (36° 50' 43" N

36° 13' 22" E) the shallow water rocky substrata were found to be dominated by *Spondylus* spp (*S. spinosus*, *S. multisetosus*) and *Chama pacifica*. A number of *Spondylus spinosus* and *S. multisetosus* specimens were detached and brought to the laboratory for further examination. In most of them, the thick upper shell (left valve) showed holes and signs of infestation by boring organisms. Endolithic bivalves were extracted from the shells of Spondylids and then identified to species level, revealing to be three further alien species: *Petricola hemprichi*, *Gastrochaena cymbium* and *Sphenia rueppelli*. In addition, local amateur collectors were asked for further material, resulting in the discovery of further additional specimens from Iztuzu, Dalyan, Mugla (36° 50' 03" N 28° 38' 33" E) SW Turkey and Yumurtalik, Adana (36° 46' 0 N 35° 46' 60" E). Voucher specimens have been deposited in the Hellenic Centre for Marine Research, mollusc collection.

Results

Petricola hemprichi (Issel, 1869)

Petricola hemprichi (Fig. 1) is a species of Indo-Pacific origin that was reported from the Suez Canal and Port Said in the early 1900s (TILLIER & BAVAY 1905). The species was also stated to be common in



Fig. 1: *P. hemprichi* (left); *P. lithophaga* (middle); *P. lajonkairii* (right).

Alexandria (FARAG *et al.* 1999), where it is eaten. As this statement was not confirmed, ZENETOS *et al.* (2004) did not include it in the Atlas. However, empty shells were found in 2002 at Great Bitter Lake at 1 m depth [HOFFMAN *et al.*, 2006 as *Choristodon hemprichii* (Issel, 1869)] and further specimens were reported in the holes of shells of *Spondylus spinosus* from a 7 m depth at Karatas, SE Turkey in August 1999 (ÇEVIKER & ALBAYRAK, 2006). The distinctive characteristics between *Petricola hemprichi* and two similar species of *Petricola* present in the Red Sea and Suez Canal are provided in ÇEVIKER & ALBAYRAK (2006). *Petricola hemprichi* has a distinct shape in comparison to the Mediterranean native *Petricola lithophaga* (Philippon, 1788) and *Petricola lajonkairii* (Payraudeau, 1826) (Fig. 1). For full description see ÇEVIKER & ALBAYRAK (2006).

Material examined:

Two individuals and one loose valve were collected in December 2006 in Iztuzu, Dalyan, Mugla, SW Turkey (colln D. Çeviker).

Four living specimens were present in holes in valves of *Spondylus* spp. (Fig. 2) collected in August 2009, at Dörtyol, Hatay (colln P. Ovalis). Findings of the present work confirm the establishment of *Petricola hemprichi* in the Iskenderun Gulf and SW Turkey.

Sphenia rueppelli A. Adams, 1850

Sphenia rueppelli (Fig. 3) originates in the Indian Ocean. Despite its presence in the Suez Canal (MOAZZO, 1939), the species was never previously collected alive from the Mediterranean Sea, where it was known only from a single valve collected in 1978 in Netanya (Israel) (BARASH & DANIN,



Fig. 2a, b: *Petricola hemprichi* in *Spondylus multisetosus* shell (Photo: P. Ovalis).



Fig. 3: *Sphenia rueppelli* collected in Dörtyol (Photo: P. Ovalis).

1986). This led ZENETOS *et al.* (2004) to consider the species as unlikely to be established in the Mediterranean. The distinguishing characteristics with the Mediterranean native *Sphenia binghami* Turton, 1822 are given in ZENETOS *et al.* (2004).

Material examined:

Nine living specimens of *S. rueppelli* were collected in October 1998 in Yumurtalik, Adana (colln D. Çeviker).

Five living specimens were found in August 2009 in Dörtyol Hatay (colln P. Ovalis)

***Gastrochaena cymbium* Spengler, 1783**

Gastrochaena cymbium (Fig. 4) is of Indo-Pacific origin. By 1933 it had been recorded in the Suez Canal (MOAZZO, 1939) and it is currently very common in the far eastern Mediterranean (BARASH & DANIN, 1973; MIENIS, 2002) attached to shells of *Cardita* and *Glycymeris* in Haifa Bay (BARASH & DANIN, 1977). Other records include S. Turkey: 1990 (NIEDERHÖFER *et al.*, 1991); Lebanon (LAKKIS & NOVELLAKKIS 2005); and the Saronikos Gulf (TENEKIDES, 1989).

The flask shell (*Gastrochaena*) has been encountered on 52 species of bivalves, 2 species of scaphopods, 12 species of gastropods and on corals, a sharktooth, bones

and stones along the Mediterranean coast of Israel (MIENIS, 2002). Shell differences among the native *Gastrochaena dubia* (Pennant, 1777) and the alien *Gastrochaena cymbium* were illustrated in DELONGUEVILLE & SCAILLET (2005) on the basis of specimens recorded on living *Hexaplex pecchiolanus* (d'Ancona, 1871).

Material examined:

More than 30 specimens were collected in October 1993 nested in several empty shells and living mollusc specimens from Yumurtalik (colln D. Çeviker).

Seven living specimens were collected in August 2009 in valves of *Spondylus spinosus* and *S. multisetosus* from Dörtyol (colln P. Ovalis).

Discussion

A variety of marine bivalve molluscs are endolithic, living inside rock, coral, animal shells, or in the pores between mineral grains of a rock. The endolithic life habit has evolved several times in the Bivalvia, e.g., in the families Modiolopsidae, Arcidae, Mytilidae (subfamily Lithophaginae), Tridacnidae, Petricolidae, Gastrochaenidae, Myidae, Pholadidae and Teredinidae (CARTER & STANLEY, 2004). A substantial lateral asymmetry of the shell is observed in boring en-



Fig. 4: *Gastrochaena cymbium* Dörtyol (Photo: P. Ovalis).

dolitic bivalves like members of the Petricolidae that bore in rock or mineralised biogenic substrata (SAVAZZI, 2005).

Petricola (Petricolidae) are nonspecialized borers in peat, firm mud, and soft rock (ANSELL, 1970). They resemble burrowing forms in the importance of the hydrodynamic role of the body fluids (ANSELL & NAIR, 1969). Findings of the present work confirm the establishment of *Petricola hemprichi* in the Iskenderun Gulf and S. Turkey. Indeed, in May 2005 one valve of *Sphenia rueppelli* associated with *Spondylus* was found at Yumurtalik (R. Scaillet and C. Delongeville pers. Comm).

Sphenia (Myidae) are small bivalves that live, attached by byssus threads, on substrata that provide shelter and protection against direct wave action. *Sphenia* live within madreporic rocks, shells on beaches, under stones and are subject to numerous deformities. *Sphenia antillensis* Dall & Simpson, 1901 lives where there is some disturbance of the bottom deposits and the water contains a small amount of suspended material (NARCHI & DOMANESCHI, 1993). The present findings of *Sphenia rueppelli* confirm not only its northward expansion but most likely its establishment in S. Turkey.

Gastrochaena (Gastrochaenidae) are specialized for boring by having a closed mantle cavity, a large pedal gape, and a truncate foot, allowing them to press the foot and shell against the burrow wall (ANSELL & NAIR, 1969). When it bores into shells the species forms a sectioned calcareous case to protect itself (OLIVER, 1992). In literature they are recorded as boring in limestone, in encrusting coralines, and on old oyster shells, maerl and shell gravel. ALBANO (2003) suggests that the species should be named as *Cucurbitula cymbium* (Spengler, 1793).

All three mollusc species reported in

this work were found in holes and crevices of *Spondylus* spp. occurring in areas where there was some disturbance of the bottom deposits and water transparency was low due to high percentage of Particulate Organic Matter. The establishment and spread of *Spondylus spinosus* is well documented in the Levantine Sea, Iskenderun Bay included (ZENETOS *et al*, 2004). The occurrence of *Petricola* and *Gastrochaena* in the wider Iskenderun Gulf is documented in this work along with the spread of *Sphenia rueppelli*. However, to date, the vector of introduction of the three aforementioned species has been assumed to be Lessepsian migration. The present findings of the three species so closely related in life habit with the alien *Spondylus* spp raises new questions on the means of arrival of these species in the Mediterranean basin. It is herein suggested that the three endolithic species were most likely introduced attached to the shells of other introduced Indo-Pacific mollusca such as the bivalve *Chama pacifica*. Their spread and establishment was further facilitated in the 1990s following the invasion of *Spondylus* spp., the shells of which form excellent substrates not only for some Lessepsian immigrants but also for quite a number of local Mediterranean species. Nineteen species of molluscs of Mediterranean origin and sixteen Lessepsian invasive molluscs (*Gastrochaena cymbium* included) are reported on about 20 *Spondylus* shells coming from the Gulf of Iskenderun (DELONGUEVILLE & SCAILLET, 2006a). Another alien bivalve in the Mediterranean whose presence is directly related to that of *Spondylus spinosus* is *Afrocardium richardi* (Audouin, 1826) (DELONGUEVILLE & SCAILLET, 2006b).

Other documented cases of Indo-Pacific species introduced with hosts include the parasitic barnacle *Heterosaccus dollfusi* Boschma, 1960, introduced with its host, the

swimming crab, *Charybdis longicollis* Leene, 1938 (INNOCENTI & GALIL, 2007) and three parasitic copepods on immigrant and native clupeid fish caught in Egyptian coastal waters off Alexandria (EL-RASHIDY & BOXSHALL, 2010)

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