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VERSITA

RESEARCH NOTE

First occurrence of native cymothoids parasites on introduced rabbitfishes in the Mediterranean Sea

Esmail Shakman[1], Ragnar Kinzelbach[1], Jean Paul Trilles[2] and Michel Bariche[3]*

[1]General and Systematic Zoology, Universitätsplatz 2, D-18055, Rostock University, Germany; [2]Equipe Adaptation Ecophysiologique et Ontogenèse, UMR 5119 (CNRS-UM2-IFREMER), Université de Montpellier 2, CC 092, Place E. Bataillon, 34095 Montpellier, France; [3]Department of Biology, Faculty of Arts and Sciences, American University of Beirut, PO Box 11-0236, Beirut, Lebanon

Abstract

This paper presents the first record of two native Mediterranean cymothoid species caught attached to introduced Lessepsian rabbitfishes. This is also the first record of cymothoids from the coastal waters of Libya. *Anilocra physodes* was collected from *Siganus luridus* while *Nerocila bivittata* was found on both *Siganus rivulatus* and *S. luridus*. Rabbitfishes in the southern central Mediterranean have acquired native Mediterranean cymothoids but do not seem to be infested along the Levantine coast.

Keywords

Isopoda, Cymothoidae, *Anilocra physodes*, *Nerocila bivittata*, rabbitfish, Mediterranean Sea, Libya

The term "Lessepsian migration" describes the introduction of organisms from the Red Sea into the Mediterranean by way of the Suez Canal (Por 1978). Since its opening in 1869, many changes have occurred in the eastern Mediterranean ecosystem, where several hundred Indo-Pacific organisms have subsequently founded populations (Galil 2008). *Siganus rivulatus* Forsskål, 1775 and *S. luridus* (Rüppell, 1829) are two Lessepsian rabbitfishes (Siganidae) that are well established in the Mediterranean and are considered successful immigrants (Ben-Tuvia 1985, Papaconstantinou 1990, Bariche *et al*. 2004). Both species were reported along the Levantine coast as early as 1927 for *S. rivulatus* and 1956 for *S. luridus* but were not present along the northern coast of Africa during the same period (Steinitz 1927, Ben-Tuvia 1964, Tortonese 1970). The first rabbitfishes were later recorded off the coast of Libya and Tunisia early in the 1970s (Tortonese 1970, Ktari-Charkroun and Bouhlal 1971, Ktari and Ktari 1974). They have since become common and have acquired economic importance along the Egyptian and Libyan coasts (Hamza *et al*. 2000, Shakman and Kinzelbach 2007).

Cymothoidae (Crustacea, Isopoda) are a family of ectoparasitic isopods that are usually found on marine, brackish and freshwater fishes. They are often attached to the body or settled inside gill chambers, buccal cavity or body pouches (Brusca 1981, Trilles 1994, Lester and Roubal 1995, Cassier *et al*. 1998). Interest in eastern Mediterranean cymothoids has increased in the last decade and about 20 species have been confirmed along the Levantine basin to date (Horton 2000; Öktener and Trilles 2004; Bariche and Trilles 2005, 2006, 2008; Horton *et al*. 2005; Trilles and Bariche 2006). The situation is similar along the Mediterranean coasts of Africa, where various cymothoid species have recently been identified as well. In total, 15 species have been reported from Morocco, 16 from Algeria, 11 from Tunisia, 4 from Egypt but none from Libya (Trilles 1994; Horton 2000; Horton *et al*. 2005; Ramdane *et al*. 2007a, b; in press). The cymothoid fauna of the entire area can be considered largely understudied, particularly along the southeastern Mediterranean coast where introduced species prosper. So far three exotic cymothoids, namely *Cymothoa indica* Schioedte et Meinert, 1884, and *Anilocra pilchardi* Bariche et Trilles, 2006, both Lessepsian migrants, and *Ceratothoa collaris* Schioedte et Meinert, 1883, an exotic from the Atlantic Ocean, have been recorded from Lebanon (Bariche and Trilles 2006, 2008; Trilles and Bariche 2006).

Following introduction to a new environment, a reduction of the parasite community of the invader and perhaps acquisition of native parasites may occur (Torchin *et al*. 2002 and references therein included). With the exception of two uniden-

*Corresponding author: michel.bariche@aub.edu.lb

Table I. Cymothoids collected from the Libyan coast

ZSRO	Cymothoid	Sex	Status	L_T	W_D	Date	Host	Infection site	Locality
ISO 001	*A. physodes*	♂	–	27.18	7.73	Nov. 2005	*S. luridus*	caudal peduncle	Musrata
ISO 002	*N. bivittata*	♀	Non ovigerous	17.04	8.3	Aug. 2005	*S. luridus*	caudal fin	Tripoli
ISO 003	*N. bivittata*	♀	Ovigerous	23.05	11.92	Jul. 2005	*S. luridus*	caudal fin	Musrata
ISO 004	*N. bivittata*	♀	Ovigerous	27.32	15.5	May 2005	*S. luridus*	pectoral fin	Tripoli
ISO 005	*N. bivittata*	♀	Non ovigerous	21.22	13.84	Mar. 2005	*S. luridus*	caudal fin	Musrata
ISO 006	*N. bivittata*	♀	Non ovigerous	20.97	10.98	Mar. 2005	*S. luridus*	caudal fin	Tubruk
ISO 007	*N. bivittata*	♀	Ovigerous	22.21	11.50	Apr. 2005	*S. luridus*	behind pectoral fin	Tripoli
ISO 008	*N. bivittata*	♀	Non ovigerous	18.45	9.25	Feb. 2006	*S. rivulatus*	pectoral fin	Tubruk

L_T – total length (mm), W_D – body width (mm).

tified exotic *Nerocila* sp. (Bariche and Trilles 2005), however, no native Mediterranean cymothoid has ever been reported on a Lessepsian immigrant fish. This paper presents the first occurrence of Mediterranean native cymothoid on Lessepsian rabbitfishes and provides a discussion related to the impoverishment of the parasite fauna during the process of introduction and adaptation to the new environment. This paper is also the first contribution to the Libyan cymothoids fauna. Biological studies on rabbitfishes were carried out in the south central Mediterranean along the Libyan coast. *Siganus rivulatus* (n = 180) and *S. luridus* (n = 195) were both collected from three different localities using trammel nets (inner mesh 26 mm, outer mesh 120 mm). While being processed, all fishes were investigated for the possible presence of ectoparasites. Sexes were determined following Raibaut and Trilles (1993). Prevalence (P), intensity (I) and abundance (A) were calculated according to Bush *et al*. (1997). All collected cymothoids were identified and preserved in 70% alcohol and deposited at the Zoological Collection of the University of Rostock (ZSRO, ISO 001 to ISO 008), Germany.

Two cymothoid species belonging to the subfamily Anilocrinae were collected on the bodies of rabbitfishes from Tripoli and from Musrata and Tubruk, along the Libyan coast. These were *Anilocra physodes* (Linnaeus, 1758) and *Nerocila bivittata* (Risso, 1816), both native to the Mediterranean Sea. One individual of *A. physodes* was collected on *Siganus luridus* (P = 0.51%, I = 1, A = 0.51%) and seven *N. bivittata* specimens were collected from both *S. luridus* (P = 3.08%, I = 1, A = 3.08%) and *S. rivulatus* (P = 0.55%, I = 1, A = 0.55%). Information regarding the ectoparasites and their hosts is summarized in Table I.

Both cymothoid species can be found throughout the Mediterranean with *A. physodes* having a wider distribution in the eastern Atlantic (Trilles 1994). *A. physodes* is a ubiquitous species which has been recorded on several native fishes, mainly Labridae, Sparidae and Centracanthidae, while *N. bivittata* is usually found on a wide range of Mediterranean fishes belonging to various families such as Sparidae, Sciaenidae, Serranidae and Mugilidae (Körner 1982; Trilles 1994; Charfi-Cheikhrouha *et al*. 2000; Öktener and Trilles 2004; Bariche and Trilles 2005; Ramdane *et al*. 2007a, b; Alas *et al*. 2008). The occurrence of both *A. physodes* and *N. bivittata* is remarkable, as no Lessepsian fish has previously been reported as a host for Mediterranean cymothoids. In fact, autochthonous cymothoids have never been collected from rabbitfishes along the coast of Lebanon despite several thousand fish collected and processed between 1998 and 2000 and despite the large-scale survey (2003–2005) of the cymothoid fauna of Lebanon (M. Bariche unpublished data). The situation is probably similar elsewhere in the Levantine basin, where the two Lessepsian fish have established large populations.

Both *N. bivittata* and *A. physodes* are typically Mediterranean species, rarely encountered in the nearby Atlantic. The single record of *A. physodes* on *S. luridus* and of *N. bivittata* on *S. rivulatus* might be considered as accidental until addi-

tional specimens are collected. Both cymothoid species are known to infest a wide variety of fishes and one cannot exclude the possibility of a resettlement after capture (Trilles 1994, Bariche and Trilles 2005). This is not the case of *N. bivittata* as six specimens were collected from various localities and dates and female cymothoids are usually considered sedentary on their host which clearly showed an adaptation to the Lessepsian host (Table I).

Data regarding cymothoid infestation on rabbitfishes is scarce in the Indo-West Pacific. The only available record concerns *Nerocila sigani* Bowman et Tareen, 1983 collected on *Siganus canaliculatus* (as *S. oramin*) from Kuwait (Bowman and Tareen 1983). Although *S. canaliculatus* is not present in the Red Sea, it seems likely to suspect that the parasite could also infest *S. luridus* and/or *S. rivulatus*, both found in the Red Sea and western Indian Ocean (Woodland 1990). *Nerocila sigani*, however, was never collected from the Mediterranean despite the fact that rabbitfishes individuals from the Red Sea are continuously crossing the Suez Canal as shown by the lack of genetic bottlenecks for both species in the new environment (Hassan *et al*. 2003, Azzurro *et al*. 2006). *Nerocila sigani* may not have found an adequate environment in the eastern Mediterranean. Other explanations may include that Lessepsian rabbitfishes are not potential hosts for *N. sigani* in the Indian Ocean or that *N. sigani* might be present in the Mediterranean as well as in the Red Sea but not yet collected. Interestingly, both *S. rivulatus* and *S. luridus* have acquired native Mediterranean parasites, particularly the congeneric *N. bivittata*. Gruvel has collected *N. bivittata* in 1932 from an unknown fish in the Great Bitter Lake (Suez Canal), which is midway between the Mediterranean and the Red Sea (Trilles 1975). Other introduced Lessepsian cymothoids from the Indo-Pacific have recently been recorded in the Mediterranean. *Cymothoa indica* and *Anilocra pilchardi* were collected from the eastern Mediterranean and were considered the first Lessepsian cymothoids known to the Mediterranean Sea (Bariche and Trilles 2006, Trilles and Bariche 2006). *C. indica* is an example of a Lessepsian parasite-host complex and seemed to infest particularly the Lessepsian *Sphyraena chrysotaenia*, while *A. pilchardi* was found on various native Clupeidae as well as on some Sparidae and Engraulidae (Bariche and Trilles 2006, Trilles and Bariche 2006).

The success of an introduction might be partly related to being relatively free of the effects of natural enemies such as parasites and predators (Torchin *et al*. 2002, 2003; Colautti *et al*. 2004). The Lessepsian rabbitfishes in the eastern Mediterranean displayed relatively low parasite diversity when compared to the Red Sea population (Diamant and Paperna 1986, Diamant 1989, Pasternak *et al*. 2007). In fact, from the approximately 40 species of parasitic taxon recorded from rabbitfishes in the northern Red Sea, only a dozen species immigrated with *S. rivulatus* and were found on Mediterranean individuals and only one hemiurid digenean was acquired in the Mediterranean. The release from natural enemies certainly contributed to the success of rabbitfishes in the new environment. However, the relatively long time of residence of rabbitfishes in the Mediterranean, in addition to the large population sizes, their schooling behavior and their presence all year round close to shore, makes them good potential candidates for an autochthonous cymothoid life cycle. Rabbitfishes are so well adapted to the new environment that they can be considered "naturalized" and thus part of the eastern Mediterranean ichthyofauna. However, the degree of infestation detected along the Libyan coast seems to be low and might be regionally limited to the southeastern central Mediterranean. Due to some adverse environmental conditions, rabbitfishes would have acquired native Mediterranean cymothoids, in the central Mediterranean and not along the Levantine coast, despite the presence of *A. physodes* and *N. bivittata* in the easternmost part of the Mediterranean (Bariche and Trilles 2005).

Why native cymothoids have not been found on rabbitfishes along the Levantine coast is unknown. Are environmental variables or biotic interactions occurring in the easternmost part of the Mediterranean suitable for the presence of the two cymothoids but not adequate enough to make them thrive? Have some negative effects related to parasite-host associations delayed rabbitfish invasion in the southeastern Mediterranean coast as opposed to the Levantine coast? Is the release from natural controls in a direct relationship with the success of rabbitfishes in the Mediterranean? Is there another reason?

Although marine invasion rates have been increasing noticeably, relatively few studies consider associated parasitic fauna introduced with the hosts (e.g. Zibrowius 1992, Ruiz *et al.* 1997, Streftaris and Zenetos 2006, Galil 2008). In an area highly affected by introductions such as the eastern Mediterranean, the role of parasites in marine invasions remain relatively unexplored despite the well known direct (growth, reproduction, survivorship) and indirect effects (interacting with predation and/or competition) on community structure that are likely to facilitate the success or failure of the invasion (Torchin *et al*. 2002). Introduced parasites, particularly those displaying monoxenic life cycles, might result in new parasite-host combinations, leading to negative effects on the ecology of the concerned host species and eventually creating potential threats to local fisheries, fish farming, and the Mediterranean ecosystem as a whole.

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