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Research Article

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New records of Decapod Crustaceans (Decapoda: *Pontoniinae* and *Inachidae*) associated with sea anemones in Turkish waters

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Abstract

Three anemone-associated decapod crustaceans, two shrimp species, *Periclimenes amethysteus* and *P. aegylios* (Caridea: Palaemonidae: Pontoniinae), and the crab *Inachus phalangium* (Brachyura: Inachidae), all collected from the Dardanelles, are reported for the first time from Turkish coasts. Another inachid crab, *Macropodia czernjawskii*, is also reported for the first time to occur in association with the sea anemone *Anemonia viridis*. *Periclimenes scriptus* was the fifth decapod species recorded associated with sea anemones within the framework of the present study, and while this species has already been reported from Turkish waters, this is the first time it is recorded from the Dardanelles (the Turkish Straits System).

Keywords: *Inachus, Macropodia, Periclimenes,* sea anemone, symbiosis, Dardanelles, Turkish Straits System.

Introduction

The phenomenon of symbiosis between cnidarian hosts and crustacean associates is widespread in tropical marine waters, in both the Indo-West Pacific (e.g., Bruce, 1976; Fautin *et al.,* 1995) as well as the tropical Western Atlantic (e.g. Nizinski, 1989; Spotte, 1998). Additionally, a limited number of cnidarian–crustacean associations are also known from subtropical-lower boreal (e.g. Wirtz & Diesel, 1983; Calado *et al.*, 2007) or temperate waters (Jonsson *et al.,* 2001), in the Eastern Atlantic. The most well-known representatives of such symbioses in the area are sea-anemones and shrimps of the genus *Periclimenes* and brachyuran crabs from the genus *Inachus* (e.g. Calado *et al.*, 2007), in addition to the 'classic' example of symbiosis of a hermit crab with a sea anemone (Ross & Sutton, 1960).

A short study on the sea-anemone associated fauna in the straits system of the southern Marmara Sea revealed four new records for the Dardanelles, of which three are new for Turkish marine waters, and one has never been observed in immediate contact with a sea-anemone. These new records are reported here, with remarks on shrimp and crab species morphology, coloration, behaviour and habitat.

Material and Methods

SCUBA observations and sampling were performed in Turkish marine waters of the southern Dardanelles, in September 19-23, 2011. Sea anemones were investigated for associated shrimps and crabs in two habitats and localities – the *Posidonia* beds off Dardanos (40° 04′ 21″ N, 26° 20′ 39″ E) at depths of 7–9 m, and a flat bottom in Çanakkale harbour (40° 10′ 18″ N, 26° 23′ 42″ E) at depths 6.5–6.9 m. Shrimps and crabs were photographed and/or video-recorded *in situ*. Collected specimens were preserved in 80% ethanol and deposited in the authors' collections.

Systematics

Family Palaemonidae

Subfamily Pontoniinae Kingsley, 1879
Genus *Periclimenes* Costa, 1844

Periclimenes aegylios Grippa & d'Udekem d'Acoz, 1993

(Figs 1, 2A-D)

Periclimenes sagittifer aegylios Grippa & Udekem d'Acoz, 1996: 409, Figs 1, 2b, pl. 1b.

Periclimenes sagittifer aegylios.—Udekem d'Acoz, 1996: 143 (full synonymy).

Periclimenes aegylios.—Udekem d'Acoz, 1999: 99.

Material: Southern Dardanelles, Turkey, scuba, coll.: H.B Özalp & Z. Ďuriš:—off Dardanos, 19 Sept. 2011, 5.6 m, coralligenous *Posidonia oceanica* meadows, from sea anemone *Anemonia viridis*; 1♀ov (coll.# 02 Tr2011).—Çanakkale Harbour, 20 Sep. 2011, flat sandy-

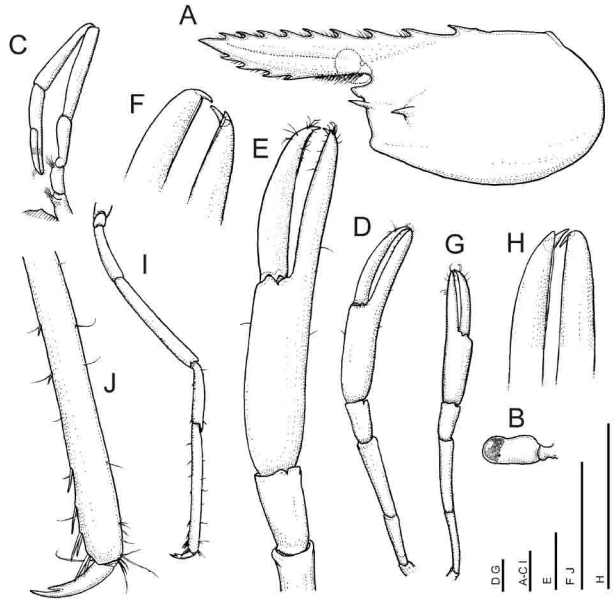

Fig. 1: *Periclimenes aegylios* Grippa & d'Udekem d'Acoz, 1996, ovigerous female, CL 5.0 mm. A, carapace and rostrum, lateral. B, eye, dorsal. C, first pereiopod and 4th thoracic sternum (shaded). D, major second pereiopod. E, same, distal segments, dorsal. F, same, tip of fingers. G, minor second pereiopod, dorsal. H, same, tip of fingers. I, third pereiopod. J, same, dactylus and propodus. Scale bars - 1 mm.

clay bottom, 6.5–6.9 m, from sea anemone *Condylactis aurantiaca*: 2♀♀ov., 1♀, 1♂ (coll.## 08-12 Tr2011).

Remarks: The present specimens morphologically (Fig. 1) agree with the original description of the species (Grippa & Udekem d'Acoz, 1996). The species shares the short (about 2–2.5 times longer than wide distally) carpi of the unequal second pereiopods with another Mediterranean anemone-associated congener, *P. amethysteus* (Risso, 1827) and with the eastern Atlantic *P. sagittifer* (Norman, 1861), whilst a further Mediterranean anemone representative of the genus, *P. scriptus* (Risso, 1822) (see below), has the second chelipeds equal, with quite elongated carpi, more than three times longer than wide distally (Noël, 1992; Grippa & Udekem d'Acoz, 1996).

In addition to these characters, the present specimens possess a low median tubercle on the fourth thoracic sternite (Fig. 1C – hatched part), and an additional, subdistal, dorsally (medially) situated tooth or prominent tubercle on the distal end of the fingers of the second pereiopods (Fig. 1H). The eyes have a small additional pigment spot dorsally on the eyestalk–corneal border (Fig. 1B).

Colour: It is the remarkable colour pattern with elongated "V"-shaped figure dorsally on anterior abdominal segments (Fig. 2A-D) that easily allows to distinguish *P. aegylios* from the other species *in situ* (Grippa & Udekem d'Acoz, 1996). The cornea of the specimens examined was greyish when alive.

Host and habitat: The present specimens were found associated with the sea anemones *Anemonia viridis* (Forskål, 1775) [syn. *A. sulcata* (Pennant, 1777)] in the coralligenous bottom on the *Posidonia oceanica* meadows, and with *Condylactis aurantiaca* (Delle Chiaje, 1925) (Fig. 2B, C) on a flat sandy-clay bottom, each at depths of 5.6–6.9 m. Both sea anemone species were also reported in the original paper (Grippa & Udekem d'Acoz, 1996). According to Udekem d'Acoz (1996), it is possible that this species has already been reported, under the name of *P. sagittifer*, from the sea anemone *Cribrinopsis crassa* (Andres, 1884) by Svoboda & Svoboda (1975). Six specimens of *P. aegylios* were found in association with *C. aurantiaca* anemones (50 anemone specimens examined). All *Anemonia viridis* surveyed (20 specimens) only had a single specimen of *P. aegylios*.

Behaviour: All shrimps were found as a single symbiotic specimen on their host. Disturbed shrimps freely climbed onto the tentacles and crossed the oral disk (Fig. 2C), then again hiding under the marginal tentacles of the anemone (Fig. 2B). When their host contracted into the sand, shrimps remained a while on the bottom and then walked towards the nearest sea anemone immediately climbing on its oral disc or under its tentacles, without any previous acclimation to the new host specimen.

Distribution: *Periclimenes aegylios* was originally reported from Giglio Island off western Italy, and mentioned also from the Mediterranean coast of France, Balearic Islands, the Gulf of Naples in western Italy, Tremiti Island off eastern Italy, Rovinj and Krk in Croatia, and "from unspecified localities in Spain and Grece" (see Grippa & Udekem d'Acoz, 1996). The present records from the south Dardanelles are the first from Turkish marine waters, and also the easternmost report from the Mediterranean.

Periclimenes amethysteus (Risso, 1827)

(Fig. 2E, F)

Periclimenes amethysteus.— Zariquiey Álvarez, 1968: 179 (key), 180, Figs 2d, 75c-f, 76e.—Holthuis, 1977: 48 (early synonymy).—Lagardère, 1971: 69 (key), 71, Figs 123–125.— Noël, 1992: 62 (key).—Grippa & Udekem d'Acoz, 1996: 403, 409 (key), Fig. 2d, pl. 1a.

Material: Southern Dardanelles, Turkey, 5 Sep. 2011, scuba, flat sandy-clay bottom, depth 2 m, from sea anemone *Condylactis aurantiaca*; photographed by H.B. Özalp, not collected.

Remarks: A single specimen observed (not collected) definitely belongs to this species as it displays the typical coloration described by Grippa & Udekem d'Acoz (1996). While the species coloration pattern can present some limited variation among specimens and during maturation (Noël, 1983), it is stable and species-specific; in some cases it is the only usable *in situ* feature to distinguish between the eastern Atlantic anemone-associated *Periclimenes* species (Grippa & Udekem d'Acoz, 1996).

Colour: The colour pattern of the specimen observed

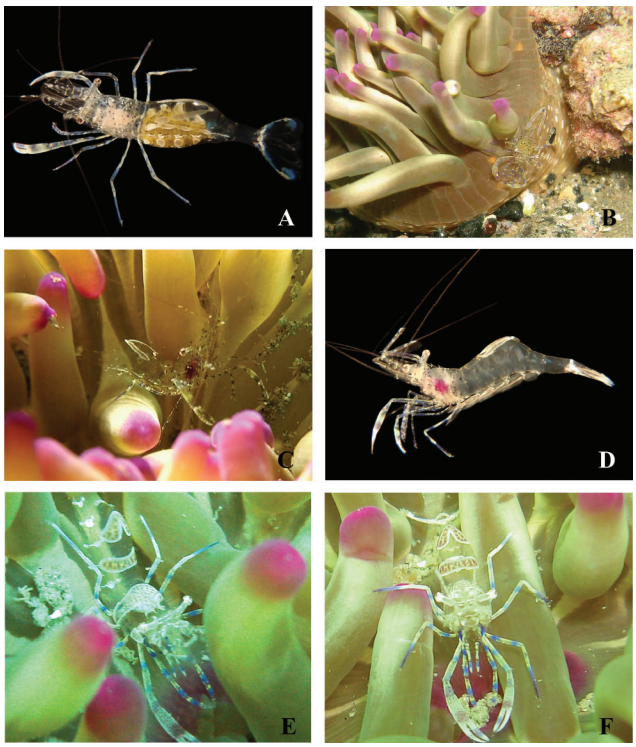

Fig. 2: *Periclimenes aegylios* Grippa & d'Udekem d'Acoz, 1996 (A-D) and *Periclimenes amethysteus* (Risso, 1827) (E, F). A, ovigerous female, color pattern. B, same, on sea anemone *Condylactis aurantiaca* (Delle Chiaje, 1925). C, male on *C. aurantiaca.* D, male, color pattern.

in situ showed the typical, robust, "Y"-like dorsal figure on the third abdominal segment, and wide, diffusely spotted, transverse bands posteriorly on the carapace and on the second abdominal segment (Fig. 2E, F), as shown also by Grippa & Udekem d'Acoz (1996: pl. 1, Fig. a). The cornea of the eyes of the specimen observed was whitish.

Host and habitat: The present specimen was found associated with the sea anemone *Condylactis aurantiaca* (Fig. 2E,F) at a depth of 6–7 m. The specimen was alone on its host. The shrimp species is known from depths of 1–10m, usually from *Posidonia oceanica* meadows, associated also with sea anemones *Anemonia viridis* and *Aiptasia mutabilis* (Gravenhorst, 1831) (Svoboda & Svoboda, 1975; Grippa & Udekem d'Acoz, 1996).

Distribution: Known from the Western Mediterranean and the Adriatic Sea (Noël, 1983), and Crete, the Aegean Sea (Koukouras *et al.,* 1992; Grippa & Udekem d'Acoz, 1996). Not previously reported from Turkish waters.

Periclimenes scriptus (Risso, 1822)

(Fig. 3)

Periclimenes scriptus.—Holthuis, 1949: 242, Fig. 4.—1977: 48 (early synonymy).—Zariquiey Álvarez, 1968: 179 (key), 180, Figs 3a, 76a-d.—Lagardère, 1971: 69 (key), 71, Figs 119–122.—Grippa & Udekem d'Acoz, 1996: 403, 409 (key), Fig. 2a, pl. 1d.—Udekem d'Acoz, 1999: 101.—Udekem d'Acoz, 2005: 367, Fig. 1.

Periclimenes (Periclimenes) scriptus.—Noël, 1992: 62 (key).

Material: Southern Dardanelles, Çanakkale Harbour, Turkey, 20 Sep. 2011, scuba, flat sandy-clay bottom, 6.5 m, from sea anemone *Condylactis aurantiaca*, coll.: H.B. Özalp & Z. Ďuriš; 1♀ov. (coll.# 07 Tr2011).

Remarks: The species differs from other eastern Atlantic and Mediterranean anemone-associated congeners (see above) by the elongated carpi of the second pereiopods, usually up to four times longer than wide distally (Fig. 3D-F). The second chelipeds of the single specimen are almost equal in their size and shape which also coincides with previous reports (Holthuis, 1949; Zariquiey Álvarez, 1968; Lagardère, 1971; Grippa & Udekem d'Acoz, 1996; Udekem d'Acoz, 2005). The rostrum of the only available specimen (Fig. 3A) is more slender than those of *P. aegylios* specimens mentioned above, being more than four times longer than maximum height (with teeth) in *P. scriptus* (Fig. 3A) but distinctly shorter, a little more than three times longer than high in *P. aegylios* (Fig. 1A). The number of rostral teeth in the specimen examined (rostral formula 2 + 6/2) is at the lower limit compared to published reports (e.g.: Holthuis, 1949; Udekem d'Acoz, 2005), usually with 2–3 postrostral teeth and with 6–7 dorsal and 2–3 ventral teeth. Also, the pereiopods in the present specimen (Fig. 3C-H) are more slender than those of *P. aegylios* (Fig. 1C-J). The present specimen has a similar median tubercle on the fourth thoracic sternite (Fig. 2C, shaded part) as shown

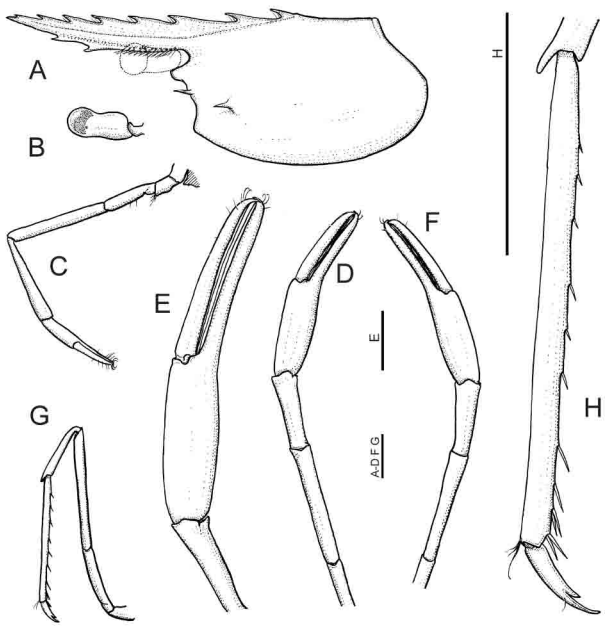

Fig. 3: *Periclimenes scriptus* (Risso, 1822), ovigerous female, CL 4.7 mm. A, carapace and rostrum, lateral. B, eye, dorsal. C, first pereiopod and 4th thoracic sternum (shaded). D, left second pereiopod, dorsal. E, same, distal segments. F, right second pereiopod, dorsal. G, third pereiopod. H, same, dactylus and propodus. Scale bars - 1 mm.

for *P. aegylios* (above). The eyes have a small additional pigment spot dorsally on the eyestalk–corneal border (Fig. 3B), similar to that mentioned above for *P. aegylios*.

Colour: The colour pattern of the present specimen was faded, but displayed the typical "Y"-like dorsal figure (rather than "V" –shaped) on the anterior abdominal segments, as shown also by Grippa & Udekem d'Acoz (1996: pl. 1, Fig. c). The cornea of the eyes of the specimen examined was reddish when alive.

Host: The present specimen was found associated with the sea anemone *C. aurantiaca*, at a depth of 6.5 m. The specimen was alone on its host, hidden on the side wall under the anemone tentacles. Svoboda & Svoboda (1975) regarded this anemone species as the exclusive host of the shrimp species.

Distribution: Although reported from the tropical Eastern Atlantic, Grippa & Udekem d'Acoz (1996) and Udekem d'Acoz (1996) questioned most previous reports of *P. scriptus* from tropical West Africa. Udekem d'Acoz (2005) records the species from mainland Portugal. The specimen reported by Holthuis (1949) from the Canary Islands, however, seems likely to be the present species. *Periclimenes scriptus* is widely distributed in the entire Mediterranean Sea, being the most common representative of the genus in the Mediterranean western and central basins (for references see: Grippa & Udekem d'Acoz, 1996; Udekem d'Acoz, 1996). The present record confirms previous reports of the species from Greek and Turkish waters (Koukouras *et al*., 1992; Ateş *et al.,* 2010), but is the first from the Turkish Straits System of the southern Marmara Sea.

Infraorder Brachyura
Family Inachidae MacLeay, 1938
Genus *Inachus* Weber, 1795

***Inachus phalangium* (Fabricius, 1775)**
(Fig. 4A-D)

Inachus phalangium.—Monod, 1956: 531 (synonymy).—Zariquiey Álvarez, 1968: 470 (key), 472, Fig. 159c. —Christiansen, 1969:102, Fig. 42, map 35.—Noël, 1992: 134 (key).—Koukouras *et al.,* 1992: 225, 231.—Udekem d'Acoz, 1999: 195.

Material: Southern Dardanelles, Dardanos, Turkey, 19 Sept. 2011, scuba, 5.6–6 m, *Posidonia oceanica* beds, from the sea anemone *Anemonia viridis,* coll.: H.B. Özalp & Z. Ďuriš; 7 spms – 4♂♂, 3♀♀ (coll.# 14&15 Tr2011).

Remarks: All 7 available specimens were easily identified, as they display widely flattened rostral lobes, with a narrow slit between them (Fig. 4C,D). The gastric region of the carapace bears only two tubercles in a transverse line on each side of the median line anterior to a quite prominent median spine (Fig. 4C). The cardiac region has three small tubercles. The tubercles on the pterygostomial and sub-branchial regions are less prominent, compared to previous reports (Zariquiey Álvarez, 1968; Christiansen, 1969; Noël, 1992).

Host and habitat: The present specimens were found associated with the sea anemone *A. viridis* (Fig. 4A,B) on a coralligenous bottom in a *Posidonia* meadow at depths of 5.6–6m. This species has also been previously reported from the anemone *Aiptasia* spp. (e.g. Wirtz & Diesel, 1983).

Behaviour: Each specimen of *I. phalangium* was collected from a different anemone host specimen, however, direct *in situ* observations revealed the occurrence of 2–3 specimens on the same anemone host. Diesel (1988) reported that off southern France in almost 80 % of the cases a single crab occupies its anemone host.

The crabs observed in this study usually hid themselves under the marginal tentacles of the anemone (or sat on the tentacles), always turning their fronts and first pereiopods outwards. Crabs which had moved a short distance from the anemone were able to freely re-enter the range of the anemone tentacles whenever disturbed, apparently without any harm. According to Breton *et al.* (2004), these crabs benefit from contacts with anemones due to reducing the attractiveness for predatory fish. Most observed crab specimens were also covered, at least partly, by sponges for camouflage purposes, as reported e.g., by Wirtz & Diesel (1983), Breton *et al.* (2004), or Martinelli *et al.* (2006).

Distribution: *Inachus phalangium* is a Mediterranean-Lusitanian species commonly found in shallow waters. It is distributed from the Cape Verde Islands to the British Isles and western Norway in the Eastern Atlantic (Monod, 1956; Christiansen, 1969). In the Mediterranean, it was reported from the Western and Central basins, and from Alexandria in the Eastern Basin (Holthuis & Gottlieb, 1958; Zariquiey Álvarez, 1968; Christiansen, 1969). The present record is the first from the northern part of the Eastern Mediterranean Basin and, in particular, from Turkish marine waters. However, Holthuis (1961) mentioned two early reports (end of the 19th Century) of an inachid crab under the name '*Stenorhynchus phalangium'* from the southern Bosporus, from the eastern Sea of Marmara, from the south-western part of Çanakkale, and off Izmir, but thought to be *Macropodia rostrata* (Linnaeus, 1761). *Inachus phalangium* is the seventh species within this genus in Turkish waters, in addition to *I. aguiarii* de Brito Capello, 1876, *I. communissimus* (Rizza, 1839), *I. dorsettensis* (Pennant, 1777), *I. leptochirus* Leach, 1817, *I. parvirostris* (Risso, 1816), and *I. thoracicus* Roux, 1830 (see Ateş *et al.,* 2010).

Genus *Macropodia* Leach, 1814

***Macropodia czernjawskii* (Brandt, 1880)**
(Fig. 4E, F)

Macropodia czerniavskii.—Forest, 1964: 348, 351–354.—Zariquiey Álvarez, 1968: 478 (key), 479, Figs 161a, 162d.—Noël, 1992: 136 (key).

Macropodia czernjavskii.—Ng *et al.,* 2009: 112.

Macropodia czernjawskii.—Koukouras *et al.*, 1992: 225.—Ateş *et al.,* 2010: 217.—Udekem d'Acoz, 1999: 199.

Material: Southern Dardanelles, Dardanos, Turkey, 20 Sept. 2011, scuba, 6 m, *Posidonia oceanica* beds, from the sea anemone *Anemonia viridis*, coll.: H.B. Özalp & Z. Ďuriš; 1 ♀ov (coll.# 13-Tr2011).

Remarks: As discussed by Zariquiey Álvarez (1968) and Noël (1992), *M. czernjawskii* can be distinguished from other Mediterranean species by the following characters: (1) tip of the rostrum curved slightly downward, reaching half of the fifth antennal segment; (2) basal segment of the antennal peduncle armed by two sharp spines interspaced by two smaller ones; (3) both protogastric tubercles fused into a single, strong, obtuse tubercle;(4) merus of walking legs with a small dorsodistal spine. All these features are present in the single specimen, an ovigerous female (Fig. 4E), collected during this study.

Habitat and behaviour: The present specimen was found on a *Posidonia oceanica* leaf surrounded by the tentacles of *A. viridis*, at a depth of 6 m. *Macropodia czernjawskii* has not been reported before in association with any sea anemone, and the present case could be regarded as an accidental association. Nevertheless, when disturbed, the specimen took shelter amongst the tentacles of the anemone (Fig. 4F) and was apparently able to walk freely and unharmed among the tentacles of its temporary host. Despite not being a "typical crustacean" occuring in association with sea anemones, the species evidently possesses the ability to protect itself from the stinging cells of the anemone. It is not clear if this ability is a result of acclimation procedures, as known from Indo-West Pacific clown-fish (e.g. Fautin, 1991) and pantropical anemone shrimps (e.g. Levine & Blanchard, 1980) or the Mediterranean inachid crab, *Inachus phalangium* (Diesel, 1988; Breton *et al.*, 2004). *Macropodia czernjawskii* can be found at depths of 0.5-80 m (Noël, 1992).

Distribution: *Macropodia czernjawskii* is a purely Ponto-Mediterranean species, thus, occurring only in the Mediterranean and Black Seas.

It occurrs in the whole Mediterranean (Noël, 1992), previously reported from Spain, the Balearic Islands, France, Italy (Naples), as well as the Black Sea (Zariquiey Álvarez, 1968). The species was already reported from the Turkish Aegean Sea (Ateş *et al.,* 2010), but never in association with a sea anemone.

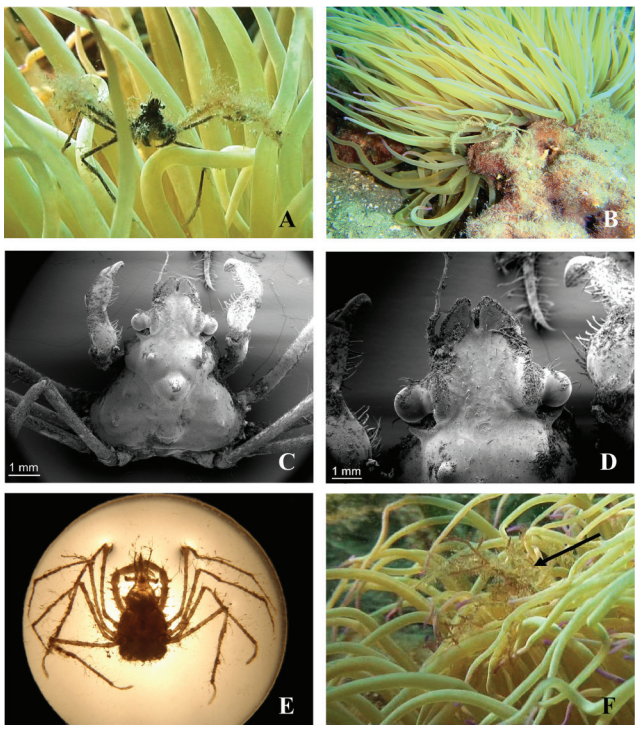

Fig. 4: *Inachus phalangium* (Fabricius, 1775) (A-D) and *Macropodia czernjawskii* (Brandt, 1880) (E, F). Specimens on sea anemone *Anemonia viridis* (Forskål, 1775) (A, B, F). C, carapace, dorsal aspect. D, rostrum, dorsal. E, total view, dorsal aspect. F, arrow points to crabs' body, lateral view.

Discussion

Decapod crustacean diversity of the Aegean Sea is actually well known due to a series of studies devoted to the whole area (e.g. Koukouras *et al.,* 1992; Udekem d'Acoz, 1994, 1995; Zenetos *et al.,* 2011) or, in particular, in Turkish waters (e.g. Kocataş, *et al.,* 2004; Ateş *et al.,* 2005, 2007, 2010; Yokes & Galil, 2006; Yokes *et al.,* 2007; Cinar *et al.,* 2011). In total, 244 decapod species are currently known from Turkish waters (Ateş *et al.,* 2010). Of these, only a single true anemone-associated species is known, the pontoniine shrimp *Periclimenes scriptus*. Together with the present confirmation of the occurrence of *P. scriptus* in the eastern Aegean Sea or, more exactly, in the Dardanelles two other anemone-associated species, *P. aegylios* and *P. amethysteus*, are reported here from the same area, thus, providing new regional records. The inachid crab, *Inachus phalangium,* is another decapod species not previously reported from Turkish waters. This symbiotic species is a model object of a wide series of recent ecological and behavioural studies, as reviewed by Melzer & Mayer (2010). Another inachid crab mentioned in this study, *Macropodia czernjawskii*, has already been known from those waters (Ateş *et al.,* 2010). However, it is reported for the first time associated with a sea anemone, despite this association being occasional or accidental. Wirtz (1997), as well as Calado *et al.* (2007), have pointed out that only a few species form lasting associations with anemones, while several others are facultative symbionts or short-term visitors. *Macropodia czernjawskii* may be regarded as one of these short-term visitors. Some other Mediterranean crabs were reported recently by Calado *et al.* (2007) and Melzer & Mayer (2010) in a similar occasional association with *Anemonia viridis* e.g., *Eriphia verrucosa* (Forskål, 1775)*, Ilia nucleus* (L.,

1758), *Maja squinado* (Herbst, 1787) [under the name *M. brachydactyla* Balss, 1922], *Pilumnus hirtellus* (Linnaeus, 1761), *Pilumnus villosissimus* (Rafinesque, 1814), and *Necora puber* (Linnaeus, 1767).

Two of the anemone-associated decapods mentioned above, *P. aegylios* and *I. phalangium*, were observed *in situ* to change their host anemones, *Condylactis aurantiaca* and *Anemonia viridis* (respectively), without subsequent acclimation actions. An initial acclimation period is generally considered as necessary for symbionts when making first contact with the anemone, or after a long period outside of their host. This was described for tropical anemone shrimps (Levine & Blanchard, 1980; Crawford, 1992), as well as for the Indo-West Pacific clown fish *Amphiprion* spp. (e.g. Fricke, 1974; 1975; Fautin, 1991).

In conclusion, three decapod crustacean species, sea anemone symbionts, are reported here as new species for Turkish marine waters. However, the safe, although occasional, association of *Macropodia czernjawskii* with *Anemonia viridis*, as well as the direct movement of the anemone shrimp *P. aegylios* from its anemone to another one, are the most surprising observations made during this study. *Macropodia czernjawskii* is clearly a non-anemone crab which has not been reported before in association with sea anemones. The direct change of host anemone by a symbiotic shrimp without its re-acclimation has been mentioned before (e.g. Melzer & Mayer, 2010). The anemone mucus is generally suggested as the key matter used by symbionts to cover their own body as a chemical protection to ensure safe contact with their anemone host. It is evident that, in the present cases, the protection ensured by the mucus of the actual or previous host is not strongly specimen-specific, and such a chemical protection of a symbiotic shrimp is quite acceptable for a new host specimen. Thus, the protection mechanism might be effective at the specific (regarding the host) level at least.

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