Rapid Communication

A record of Arcania brevifrons Chen, 1989 (Crustacea; Decapoda; Leucosiidae) from the Mediterranean coast of Israel

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Abstract

Two adult specimens of Arcania brevifrons, a leucosiid crab native to the Indo-West Pacific Ocean, were recently collected off the southern Israeli coast, at the southeastern Mediterranean Sea. Molecular analyses based on the mitochondrial barcoding gene cytochrome oxidase sub unit I (COI) revealed two closely related haplotypes and suggest the species has entered the Mediterranean on at least two separate occasions. This is the fourth Erythraean leucosiid species recorded in the Mediterranean Sea. The presence of an ovigerous female may indicate the existence of an established population.

Key words: Erythraean invasion, Mediterranean, Suez Canal, Red Sea, non-indigenous species, barcoding

Introduction

The Levantine shelf biota has an increasing component of Erythraean aliens (Galil et al. 2016b). Of the 41 non-indigenous decapod species recorded from the Israeli coast, all but two, the vessel-transported Atlantic blue crab Callinectes sapidus Rathbun, 1896 (Portunidae) and the Atlantic brown shrimp Penaeus aztecus Ives, 1891 (Penaeidae) have been introduced through the Suez Canal. Three Erythraean leucosiid crabs have established populations in the Mediterranean Sea: Myra subgranulata Kossmann, 1877, first recorded in 1929 off Jaffa (Monod 1930), Ixa monodi Holthuis and Gottlieb, 1956 in 1955 off Mersin, Turkey (Holthuis and Gottlieb 1956), Coleusia signata (Paulson, 1875) in 1953 Tel Aviv, Israel (Holthuis and Gottlieb 1958) – all three species have since spread across the Levant – from Egypt to Greece (http://www.ciesm.org/atlas/appendix2.html, viewed 21 July 2017).

Five species of the genus Arcania Leach, 1817 have been recorded in the Red Sea or in nearby waters: A. brevifrons Chen, 1989, A. erinacea (Fabricius, 1787), A. gracilis Henderson, 1893, A. septemspinosa (Fabricius, 1787) and A. tuberculata Bell, 1855 (Galil 2001; Naderloo and Sari 2005; Galil et al. 2012).

Here, we report the occurrence of a previously unrecorded Arcania species off the Mediterranean coast of Israel. Its colour pattern and shape of the vulvae identify it as A. brevifrons Chen, 1989, previously recorded from the Red Sea (Galil 2001). Mitochondrial cytochrome oxidase sub unit I (COI) were compared with leucosiid sequences in BoLD system and confirm the species’ placement in Arcania. The new find is the fourth introduced leucosiid species recorded in the Mediterranean Sea.

Material and methods

Sampling was carried out off Ashdod, Israel by a commercial 240 hp bottom trawler (net opening 12 m wide, 1.2 m high, mesh at cod-end 42 mm, net equipped with two sweeplines for 70 m effective width). Trawling was conducted on 11 December, 2016, at 60 m depth, on silt and clay sediment.
The specimens were transported to the National Institute of Oceanography, Haifa, photographed, measured and tissue samples removed for DNA extractions. The Israeli specimens were photographed using Nikon SMZ1000 stereomicroscope with DeltaPix camera. MNHN specimens were photographed using Canon EOS 60D, with a 50 mm objective and Kenko extension tubes (20 and 36 mm). The specimens, preserved in 70% EtOH, are deposited in the Crustacea collection at the Steinhardt Museum of Natural History, Tel Aviv University, Israel (SMNH).

Molecular analysis
DNA extraction
Total genomic DNA was extracted from ethanol-preserved leg muscles, using the QIAamp® DNA Micro Kit (QIAGEN), following the manufacturer’s instructions.

PCR amplification
For each amplification, 2 µl of diluted DNA (1:10) from each specimen were added to a PCR reaction mixture in a total solution volume of 50 µl that consisted of VWR® Taq DNA Polymerase 2X Master Mix and 0.1 µM of forward and reverse primers, LCO1490f (5’-GGTCAACAAATCATAAAGATATTGG-3’) and HCO2198r (5’-TAAACTTCAGGGTACCAAAAAATCA-3’), following Folmer et al. (1994). The thermocycle profile consisted of 94 °C for 2 minutes, 35 cycles of 94 °C for 30 s, 52 °C for 40 s, and 72 °C for 1 minute, with a final extension at 72 °C for 10 minutes (Ivanova et al. 2007). The PCR products were screened on 1.5% agarose gel. The same PCR primers were then used for direct sequencing of the PCR products (Macrogen Inc., South Korea).

Sequence analyses
Forward and reverse sequences of the PCR products were aligned and corrected using DNA baser 4.12.0 (DNA Baser Sequence Assembler v4 [2013], Heracle BioSoft, http://www.DnaBaser.com) and BioEdit (Hall 1999). The corrected COI sequences were compared to the BoLD (Barcode of Life Data Systems) identification system (http://www.boldsystems.org/views/idrequest.php) and to the NCBI data base (http://blast.ncbi.nlm.nih.gov/Blast.cgi).

Results
Molecular analysis
The two COI sequences from Israel present two different but closely related haplotypes (differing in 9/597 nucleotides; 98.49% identity), indicating that both specimens belong to a single taxon and that more than a single founder was introduced to the Mediterranean Sea. Sequences were uploaded to http://www.boldsystems.org with BoLD ID: BIM 527-17 and BIM 526-17 for our specimen no AP-043 and AP-042, respectively, and to the NCBI (accession numbers: MF488953 for AP-042 and MF488954 for AP-043). This is the first BoLD record for A. brevifrons. Comparison of the two Israeli specimens to the most similar sequences in the BoLD database revealed 96.31–95.41%, 90.17–89.14% and 89.54–88.51% to COI sequences of a single “private” voucher (details unavailable) and to two published sequences of Arcania sp. (both from Mozambique, MAINBAZA cruise vouchers MNHN-IU-2008-12673 (= MNHN-B31784) and MNHN-IU-2008-12677 (= MNHN-B31788), respectively, Muséum national d’Histoire Naturelle, Paris), support the placement of the Mediterranean specimens in the genus Arcania as presently defined (Galil 2001). Due to various logistical reasons we were unable to sequence the tissues of additional specimens of A. brevifrons we used for our morphological study. Nevertheless, we felt it was useful to have the present Mediterranean material barcoded for the record and possible future comparisons.

Systematics
LEUCOSIOIDEA Samouelle, 1819
Leucosiidae Samouelle, 1819
Arcania Leach, 1817
Arcania brevifrons Chen, 1989
(Figures 1–3)
Arcania brevifrons Chen, 1989: 204, figs 31f, 32e–f, pl. 5, fig. 6; Galil 2001: 172, fig. 1A, 4A; Kumar et al. 2013: 543.

Material examined: Israel. Off Ashdod, 31º49.81′N; 34º30.296′E to 31º46.03′N; 34º27.592′E, 60 m, 11 December 2016, 1 female ovigerous cl 30.0 mm (SMNH AR29689); same data, 1 female cl 27.7 mm (SMNH AR29707).

Comparative material: Philippines. MUSORSTOM 3 stn 141, 11º44.6′N; 122º45.3′E to 31º46.03′N; 34º27.592′E, 60 m, 11 December 2016, 1 female ovigerous cl 30.0 mm (SMNH AR29689); same data, 1 female cl 27.7 mm (SMNH AR29707).

Material examined: Madagascar. CREVETTIERE 1973 NW coast, 12º49.5′S; 48º30.0′E, 55 m, 02 August 1973, coll. A. Crosnier, det. H. Chen, 1 female cl 20 mm, badly damaged, holotype [MNHN-IU-2008-10961 (= MNHN-B18079)]; 1 male immature cl 10 mm, 1 female immature cl 11 mm, paratypes [MNHN-IU-2008-10961 (= MNHN-B18080)] same data as holotype.

Material examined: Fiji. MUSORSTOM 10, stn CP 1323, 17º16.1′S; 177º45.7′E, 143–173 m, 07 August 1998, coll. Bouchet, Richer, 3 females cl 28.6, 25.1, 17.9 mm MNHN-IU-2016-10932 (= MNHN-B27434). BORDAU 1 stn CP
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Figure 1. *Arcania brevifrons* Chen, 1989. SMNH AR29689, ovigerous female, cl 30.0 mm, Ashdod, Israel. A. habitus, dorsal view, B. habitus, ventral view. Photographed by G. Paz.

Figure 2. *Arcania brevifrons* Chen, 1989. SMNH AR29689, ovigerous female, cl 30.0 mm, Ashdod, Israel. Cephalothorax frontal view. Photographed by N. Mollaret.

1437, 17°11′S; 178°46′W, 160–177 m, 02 March 1999, coll. P. Bouchet et al., 1 female cl 26.4 mm MNHN-IU-2016-10933 (= MNHN B27435).

**Description:** Carapace globose, nearly rounded in adult female (Figure 1A, B), dorsal surface densely, uniformly covered with columnar granules. Front divided into 2 triangular lobes by wide triangular gap, lobes squat, minutely granulate. Margins of carapace with 11 spines: one spine each on subhepatic, anterolateral, midlateral, posterolateral and posterior margins, single spine on intestinal region. Anterolateral spines smallest; midlateral, posterolateral, intestinal spines

Figure 3. *Arcania brevifrons* Chen, 1989. Right vulva. A. SMNH AR29689, ovigerous female, cl 30.0 mm, Ashdod, Israel. B. MNHN-IU-2014-11970 (= MNHN-B18472), female, cl 28.6 mm, NW coast, Madagascar. Photographed by N. Mollaret.
the characteristic shape of the vulvae, an essential Madagascar revealed close similarity, including in the latter in its G1 distally bent at right angle (sinuously Naruse, 2014, but can be easily distinguished from brevifrons to that of the gonopods (Figure 3A, B).

Comparison with specimen s collected in Fiji and adult female collected off the Israeli coast. However, with carapace length one third as long as that of the condition and the paratypes are immature individuals brevifrons legs pale orange (Figure 1).

Cheliped merus red-orange, fingers pale, ambulatory patterned with reddish lines, abdomen bone coloured; irregular network of dark reddish lines medially on lateral margins, setose. Extreme on posteriormost legs. Dactylus keeled on mesial, sparser on lower margins, granulation most prominent on posteriormost legs. Dactylus keeled on mesial, lateral margins, setose.

Colour in life: Carapace dorsally dark pink with irregular network of dark reddish lines medially on patterned with reddish lines, abdomen bone coloured; cheliped merus red-orange, fingers pale, ambulatory legs pale orange (Figure 1).

Remarks: Unfortunately, the holotype of A. brevifrons preserved in the MNHN is in poor condition and the paratypes are immature individuals with carapace length one third as long as that of the adult female collected off the Israeli coast. However, comparison with specimens collected in Fiji and Madagascar revealed close similarity, including in the characteristic shape of the vulvae, an essential diagnostic feature, with a taxonomic value comparable to that of the gonopods (Figure 3A, B). Arcanita brevifrons is morphologically similar to A. tropicalis Naruse, 2014, but can be easily distinguished from the latter in its G1 distally bent at right angle (sinuously curved in A. tropicalis), the shape of the vulvae, and the colour pattern (cf. Naruse 2014: fig. 18a).

Distribution: Originally described from the Philippines (Chen 1989), it has been recorded in the Red Sea, Seychelles, Madagascar, Mozambique Channel, Pakistan, India, Indonesia, Fiji (Galil 2001, Kumar et al. 2013). Newly recorded in the Mediterranean Sea.

Discussion

The Suez Canal is the most significant introduction pathway into the Mediterranean Sea (Galil et al. 2016a, 2017). The Canal’s typical cross-sectional area that was 3600 m² in 2000, is at present 5200 m². The last expansion increased its depth to 24 m to allow passage of vessels up to draught of 66 ft, and the Suez Canal Authority is already conducting feasibility studies with the aim to increase its depth in order to allow passage of vessels with draught to 72 ft (http://www.suezcanal.gov.eg, viewed June 3, 2017). The implications of a deeper, wider canal on transport of Erythrean biota through the Canal are obvious: “a steeply increasing invasion of Red Sea animals into the Mediterranean can be expected” (Thorson 1971: 846). Although no concerted effort was undertaken to study the Erythrean bioinvasion, seven non-indigenous decapod species have been newly recorded between 2008 and 2015 along the Israeli coastline, all but one introduced through the Suez Canal (De Grave et al. 2012; Karhan et al. 2013; Galil and Mendelson 2013; Rothman et al. 2013; Levitt et al. 2014; Günül et al. 2016; Galil et al. 2016a).

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