

First record of an invasive shrimp from the family Processidae (Crustacea, Decapoda) in the Mediterranean Sea

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Handling Editor: Argyro Zenetos

Received: 17 July 2014; Accepted: 19 August 2014; Published on line: 2 October 2014.

Abstract

This is the first recording on the genus *Nikoides* Paulson, 1875 in the Mediterranean Sea, with remarks on taxonomy and ecology.

Keywords: Decapoda; Processidae, *Nikoides sibogae*, alien species, Mediterranean Sea, Levantine Basin, Suez Canal.

Introduction

The introduction of tropical species into the Mediterranean Sea has been ongoing since the opening of the Suez Canal in 1869. This Lessepsian migration, a term coined in memory of the French engineer Ferdinand De-Lesseps (Por, 1971), does not show any sign of abating. More than 430 marine alien species have been recorded along the coasts of Israel (Katsanevakis *et al.*, 2013). These newly established species can have an enormous impact on ecosystem functioning, especially through competition with native species, which can lead to physical habitat alterations and influence the food provision (Katsanevakis *et al.*, 2014; Spanier & Galil, 1991; Ruiz *et al.*, 1997; Galil, 2011).

Within the Crustacea, the decapod species are the most successful taxonomic group. More than 70 species have been recorded in the Eastern Mediterranean Sea, most of them introduced through the Suez Canal. At least 33 Lessepsian decapods are known along the coasts of Israel (Galil & Shlagman, 2011), with new records added constantly. Out of the known Lessepsian decapods nine species are shrimps which belong to the infraorder Caridea (Galil & Shlagman 2011; Galil & Mendelson 2013; Karhan *et al.*, 2013; Rothman *et al.*, 2013).

The family Processidae, with currently 6 known genera and 69 species (De Grave & Fransen, 2011; De Grave & Felder, 2012; Hendrickx, 2012; Ayón-Parente *et al.*, 2012; Komai & Fujita, 2014), has only one known genus in the Mediterranean Sea- *Processa* Leach, 1815, and three known species along the coasts of Israel (d'Udekem d'Acoz, 1999; Galil & Shlagman, 2011).

Here we report the occurrence of the first Indo-Pacific representative of the family Processidae: *Nikoides sibogae* De Man, 1918 in the Mediterranean Sea.

Materials and Methods

During 2012 a scientific survey was conducted along the Mediterranean coast of Israel (Fig. 1), by four nocturnal trawling cruises: Nizzanim, coast of Israel: (31°44.270N 34°32.630E-31°47.573N 34°34.768E), depth 32 m, sand-mud bottom, 24 June 2012, 1 ovigerous female (ovf), pocl 12.0 mm (TAU AR 29080); Nizzanim, coast of Israel: (31°47.520N 34°34.663E-31°44.209N 34°32.637E), depth 32 m, sand-mud bottom, 27 June 2012, 1 m and 1 ovf, pocl 13.1-13.8 mm (TAU AR 29223); Haifa bay, coast of Israel: (32°52.440N 34°57.800E-32°51.280N 35°00.200E), depth 24 m, sand bottom, 07 November 2012, 1 ovf, pocl 10.0 mm (TAU AR 29111); Haifa bay, coast of Israel: (32°53N 34°58E-32°54N 35°00E), depth 32 m, sand bottom, 18 November 2012, 2 m, 9 f, 12 ovf and 1 unknown, pocl 8.3-12.9 mm (TAU AR 29116, OUMNH.ZC.2014-01-022).

Average egg size of the 15 ovf specimens is 0.45 mm in diameter.

The specimens are deposited in the Steinhardt Museum of Natural History and National Research Center, Tel Aviv University, Israel (TAU) and in the Oxford University Museum of Natural History, United Kingdom (OUMNH.ZC).

In a few specimens several pereopods and pleopods are missing, but they are otherwise in good condition and their identity can be unequivocally asserted. One specimen lacks its second pleopods, making its sex unknown.

Size was expressed as post-orbital carapace length (pocl), measured as the distance from the posterior orbital edge to the mid-dorsal posterior border of carapace, with a digital caliper to the nearest 0.1 mm.

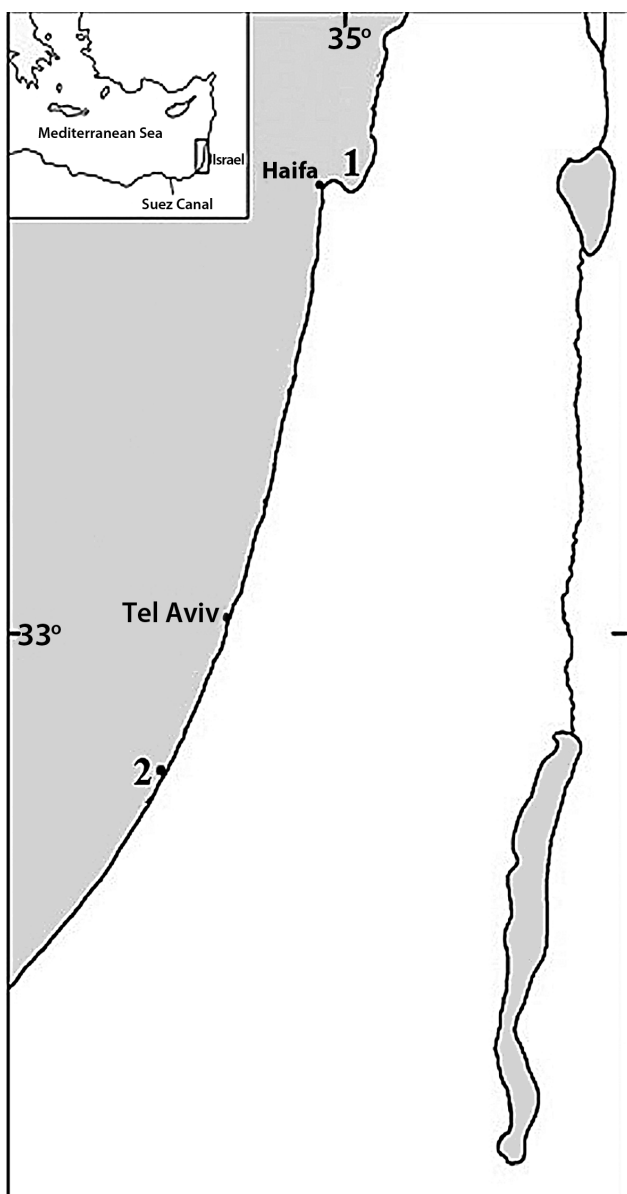


Fig. 1: Collection sites. 1. Haifa Bay, Israel; 2. Nizzanim, Israel.



Fig. 2: *Nikoides sibogae* De Man, 1918, Haifa Bay, Israel. Colors faded following preservation in ethanol. Photographed by Rittner O.

Results

Nikoides sibogae De Man, 1918 (Fig. 2, Fig. 3A-J)

The diagnosis of the Israeli specimens is as follows: Rostrum long, laterally compressed, apex bifid. Antennular peduncle with stylocerite truncate. Outer spine of scaphocerite small, not reaching level of distal margin of blade. Pereiopods slender and long, propodus of fifth pereiopod with small terminal spine. Ischium of third and fourth pereiopods with two spines. Merus of third pereiopod with four spines. Fifth abdominal somite with posteriorly pointed pleuron. Sixth abdominal somite with posterolateral lobe bidentate. Telson with 2 pairs of dorsolateral teeth. This corresponds closely to the diagnosis in Hayashi (1975) for the species, and also distinguishes the species from the only other Atlantic species of the genus, the Western Atlantic *Nikoides schmitti* (see Almeida & Bezerra, 2011).

Nikoides sibogae (Fig. 2) can be easily distinguished from all other Mediterranean and indeed East Atlantic Processidae, as the species harbours an exopod on the first pair of pereiopods (Fig. 3C), which distinguishes it from the genus *Processa*.

Discussion

The current study records the genus *Nikoides* in the Mediterranean Sea. Like most of the other species in the family, *Nikoides sibogae* is a nocturnal shrimp common on soft-bottom and sea-grass meadows (Hayashi, 1975; Noël, 1986). However, little is known about its ecology and life-cycle.

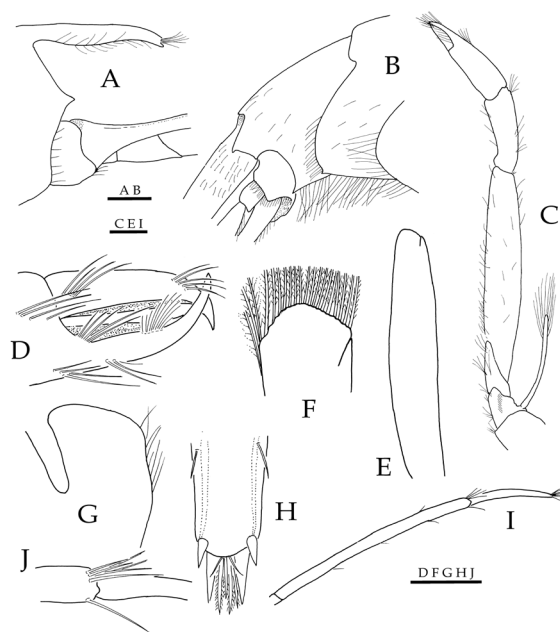


Fig. 3: *Nikoides sibogae* De Man, 1918 (OUMNH.ZC.2014-01-022), ovigerous, pocl 10.7 mm, Haifa Bay (Israel): A- carapace, frontal margin; B- posterior pleonites; C- first pereiopod; D- first pereiopod, chela; E- scaphocerite; F- same, distal; G- stylocerite; H- telson, distal margin; I- fifth pereiopod, propodus and dactylus; J- same, detail of propodal-dactylar joint. Scale bars indicate 1mm.

N. sibogae has been recorded from Papua New Guinea, Japan, Vietnam, Zanzibar, Seychelles, Bikini Atoll, Marshall Islands, Indonesia, Persian Gulf, Singapore (Hayashi, 1975; Noël, 1986; Manning & Chace, 1971; De Grave & Ashelby, 2011). Although it is a widespread species in the Indo-Pacific there are no records of this species from the Red Sea.

The majority of the studied specimens are females, of which more than half were found with fertilized eggs, thus indicating a well-established population in the area. Environmental conditions such as temperature and larval food supply are well-known factors in the regulation of decapod crustacean reproduction (Bauer, 2004). The sea surface temperature (SST) range in the native habitat of *N. sibogae*, in the Indo-Pacific Ocean, is between 28–30°C (Webster *et al.*, 1996), while in the Levant Basin it can reach as low as 16°C in winter and as high as 30°C in summer (Shenkar & Loya, 2008). During the months in which this survey was conducted SST averaged 22.5°C (± 3.4) in June and 24.9°C (± 1.0) in November (data taken from the Department of Marine Geology and Coastal Processes, Israel Oceanographic and Limnological Research).

During the current study we were unable to determine the annual reproduction cycle as specimens were sampled only during the transitional seasons. The ability of introduced species to alter their reproductive period is a crucial factor in determining their success in the introduced area (Shenkar & Loya, 2008). Acquiring additional data on the reproductive cycle of *N. sibogae* is vital in order to understand its potential to establish and expand its distribution in the Mediterranean Sea in the future.

Whether *N. sibogae* has been introduced to the Mediterranean by human-mediated transport (e.g., barge hulls and/or ballast water), or aquarium shops, remains unknown. Combining genetic data with field observations may contribute to our understanding of the introduction route of *N. sibogae*.

Introduced caridean shrimp may become food for fish (Reaka-Kudla, 2000), introduce bacteria and other parasite microorganisms and alter native populations through competitive displacement (Bauer, 2004; Galil, 2007).

In view of the ongoing increase of introduced decapods in the Eastern Mediterranean (Galil & Mendelson, 2013; Karhan *et al.*, 2013; Rothman *et al.*, 2013), it is crucial to increase the body of knowledge regarding the infraorder Caridea, which is able to inhabit a wide range of habitats worldwide and successfully invade new environments.

Acknowledgement

We are grateful to N. Stern and S. B.-S. Rothman for obtaining the samples and N. Paz for editorial assistance. This research was supported by the Israeli Taxonomy Initiative and by the Zoological Museum of Tel Aviv University and grant number 321547 of FP7 Marie Curie CIG to N. Shenkar.

References

- Almeida, A.O., Bezerra, L.E.A., 2011. *Nikoides schmitti* Manning & Chace, 1971 (Caridea: Processidae) in the South Atlantic Ocean, with an updated list and key for processid shrimps of Brazil. *Zootaxa*, 2864, 34–42.
- Ayón-Parente, M., Hendrickx, M.E., Ríos-Jara, E., 2012. Notes on two species of *Processa* (Decapoda: Processidae) from the Mexican Pacific. *Nauplius*, 20 (1), 63–73.
- Bauer, R.T., 2004. *Remarkable shrimps: Adaptations and natural history of the carideans*. University of Oklahoma Press, Norman, 282 pp.
- De Grave, S., Ashelby, C.W., 2011. Notes on some shrimp species (Decapoda: Caridea) from Qatar, with an annotated checklist of marine caridean species known from the Persian Gulf. *Marine Biodiversity Records*, 4, e20.
- De Grave, S., Fransen, C.H.J.M., 2011. Carideorum catalogus: The recent species of the dendrobranchiate, stenopodidean, procarididean and caridean shrimps (Crustacea: Decapoda). *Zoologische Mededelingen*, 85 (9), 195–589.
- De Grave, S., Felder, D.L., 2012. The genus *Processa* in the vicinity of Carrie Bow Cay (Belize) with description of a new species (Crustacea: Decapoda: Processidae). *Zootaxa*, 3436, 41–50.
- d'Udekem d'Acoz, C., 1999. Inventaire et distribution des crustacés décapodes de l'Atlantique nord-oriental, de la Méditerranée et des eaux continentales adjacentes au nord de 25°N. *Patrimoines Naturels (M.N.H.N./P.N.)*, 40, 1–383.
- Galil, B.S., 2007. Seeing red: Alien species along the Mediterranean coast of Israel. *Aquatic Invasions*, 2, 281–312.
- Galil, B.S., 2011. The alien Crustaceans in the Mediterranean Sea: An historical review. p. 377–401. In: *In the wrong place-alien marine Crustaceans: Distribution, biology and impacts*, Galil B.S., Clark P.F., Carlton J.T. (Eds). Springer, 16. Berlin.
- Galil, B.S., Mendelson, M., 2013. A record of the moon crab *Matuta victor* (Fabricius, 1781) (Crustacea: Decapoda: Matutidae) from the Mediterranean coast of Israel. *BioInvasions Records*, 2, 69–71.
- Galil, B.S., Shlagman, A., 2011. An annotated list of the Decapod Crustacea of the Mediterranean coast of Israel – Half a century later. p. 269–282. In: *Studies on Malacost-raca: Lipke Bijdeley Holthuis Memorial Volume*, Fransen C.H.J.M., De Grave S., Ng P.K.L. (Eds). Crustaceana Monographs 14. Brill, Leiden, Boston.
- Hayashi, K.I., 1975. The Indo-West Pacific Processidae (Crustacea, Decapoda, Caridea). *Journal of the Shimonoseki University of Fisheries*, 24, 47–145.
- Hendrickx, M.E., 2012. Distribution and abundance of the pelagic processid, *Processa pippinae* Wicksten & Méndez, 1985 (Decapoda, Caridea, Processidae), collected during the TALUD XIV cruise in the Gulf of California, Mexico, and description of a new genus. *Crustaceana*, 85, 463–472.
- Karhan, S.Ü., Yokes, M.B., Clark, P.F., Galil, B.S., 2013. First Mediterranean record of *Actaea savignii* (H. Milne Edwards, 1834) (Crustacea: Decapoda: Brachyura: Xanthidae), an additional Erythraean alien crab. *BioInvasions Records*, 2, 145–148.
- Katsanevakis, S., Gatto, F., Zenetos, A., Cardoso, A.C., 2013. How many marine aliens in Europe?. *Management of Biological Invasions*, 4 (1), 37–42.

- Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppäkoski, E., Çinar, M. E., *et al.*, 2014. Impacts of invasive alien marine species on ecosystem services and biodiversity: A pan-European review. *Aquatic Invasions*, 9 (4), in press.
- Komai, T., Fujita Y., 2014. New records of the caridean shrimp genus *Processa* Leach, 1815 (Crustacea: Decapoda: Processidae) from Japan, with descriptions of two new species. *Zootaxa*, 3794 (2), 263-278.
- Manning, R.B., Chace Jr., F.A., 1971. Shrimps of the family Processidae from the northwestern Atlantic Ocean (Crustacea: Decapoda: Caridea). *Smithsonian Contributions to Zoology*, 89, 1-41.
- Noël, P., 1986. Crustacés Décapodes: Processidae de l'Indo-Ouest-Pacifique. p. 261-301. In *Résultats des Campagnes MUSORSTOM. I & II. Philippines (1976, 1980). Mémoires du Muséum national d'Histoire naturelle (A)*, Crosnier A. (Ed). Zoologie, 133.
- Por, F.D., 1971. One hundred years of Suez Canal—A century of Lessepsian migration: Retrospect and viewpoints. *Systematic Biology*, 20, 138-159.
- Reaka-Kudla, M.L., 2000. Crustaceans. p. 915-943. In: *Encyclopedia of biodiversity*, Levin S. (Ed). Academic Press, 1. New York.
- Rothman, S. B.-S., Shlagman, A., Galil, B.S., 2013. *Saron marmoratus*, an Indo-Pacific marble shrimp (Hippolytidae: Decapoda: Crustacea) in the Mediterranean Sea. *Marine Biodiversity Records*, 6, 1-3.
- Ruiz, G.M., Carlton, J.T., Grosholz, E.D., Hines, A.H., 1997. Global invasions of marine and estuarine habitats by non-indigenous species: Mechanisms, extent, and consequences. *American Zoologist*, 37, 621-632.
- Shenkar, N., Loya, Y., 2008. The solitary ascidian *Herdmania momus*: Native (Red Sea) versus non-indigenous (Mediterranean) populations. *Biological invasions*, 10, 1431-1439.
- Spanier, E., Galil, B.S., 1991. Lessepsian migration: A continuous biogeographical process. *Endeavour*, 15, 102-106.
- Webster, P.J., Clayson, C.A., Curry, J.A., 1996. Clouds, radiation, and the diurnal cycle of sea surface temperature in the tropical Western Pacific. *Journal of Climate*, 9, 1712-1730.