

**Rapid Communication****Much can change in a year: the Massawan mantis shrimp, *Erugosquilla massavensis* (Kossmann, 1880) in Sicily, Italy**Paola Gianguzza<sup>1</sup>, Gianni Insacco<sup>2</sup>, Bruno Zava<sup>2,3</sup>, Alan Deidun<sup>4</sup> and Bella S. Galil<sup>5,\*</sup><sup>1</sup>Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università di Palermo, Via Archirafi 22, I-90123 Palermo, Italy<sup>2</sup>Museo Civico di Storia Naturale, via degli Studi 9, 97013 Comiso (Ragusa), Italy<sup>3</sup>Wilderness Studi Ambientali, Via Cruillas, 27, 90146 Palermo, Italy<sup>4</sup>Department of Geosciences, Faculty of Science, University of Malta, campus Msida, Malta<sup>5</sup>The Steinhardt Museum of Natural History, Tel Aviv University, Tel Aviv, IsraelAuthor e-mails: [paola.gianguzza@unipa.it](mailto:paola.gianguzza@unipa.it) (PG), [g.insacco@comune.comiso.rg.it](mailto:g.insacco@comune.comiso.rg.it) (GI), [wildernessbz@hotmail.com](mailto:wildernessbz@hotmail.com) (BZ), [alan.deidun@um.edu.mt](mailto:alan.deidun@um.edu.mt) (AD), [galil@post.tau.ac.il](mailto:galil@post.tau.ac.il) (BG)

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**OPEN ACCESS****Abstract**

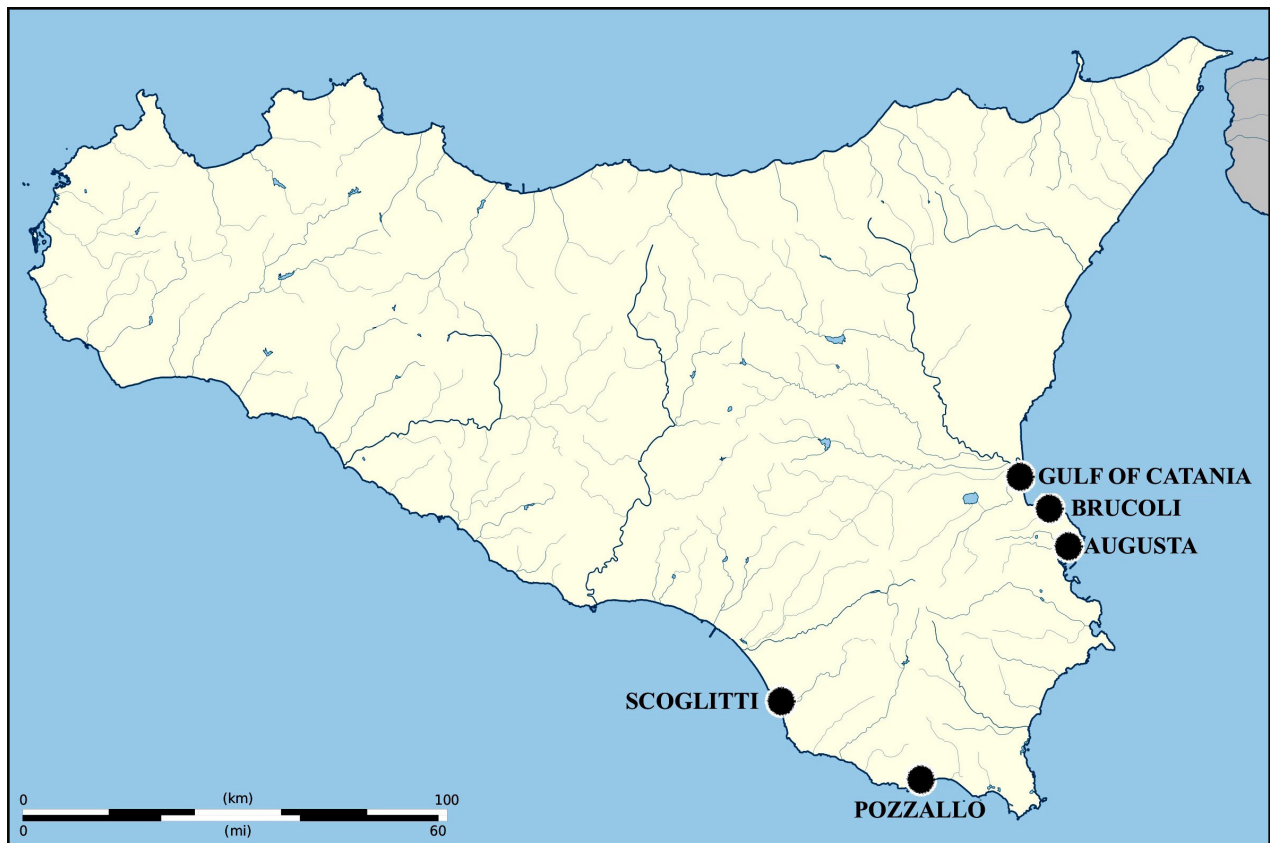
A flourishing population of the Massawan mantis shrimp, *Erugosquilla massavensis*, an Erythraean species, is recorded off Sicily, Italy, one year after the very first specimen was collected off the eastern coast of the island. The species is already established as a minor, albeit valuable, fishery resource. Once its population increases, however, it may compete with the native Mediterranean spot-tail mantis shrimp, *Squilla mantis*. This article presents the results of a joint effort between members of the Museo Civico di Storia Naturale of Comiso and local fishermen to monitor non-indigenous species in Sicilian waters.

**Key words:** invasive alien species, distribution, population dynamics, fishery resource, *Squilla mantis*, competition**Introduction**

*Erugosquilla massavensis* (Kossmann, 1880), native to the Red Sea, was first recorded in the Mediterranean Sea in 1933, off Alexandria, Egypt (Steuer 1936, as *Squilla africana* Calman, 1917), and thereafter spread throughout the Levantine Basin and the south-central Mediterranean (for detailed chronological distribution see Ounifi Ben Amor et al. 2015; Corsini-Foka et al. 2017).

Lewinsohn and Manning (1980: 1–2) had anticipated the spread of *E. massavensis* by several decades when they wrote “... we can foresee no barriers other than temperature, especially along the northern Mediterranean, which might keep it from spreading throughout the sea, and it will be interesting to follow the further spread of this species, if that occurs.”

The first specimen in Italian waters was captured in May 2017 off Brucoli, along the south-eastern coast of Sicily, while trawling for red mullet, seabream, bogue, and spottail mantis shrimp (Corsini-Foka et al.



**Figure 1.** Map of Sicily, Italy, with the locations where *Erugosquilla massavensis* (Kossmann, 1880) were collected in 2017–2018 (see Supplementary material Table S1 for details).

2017). In August 2017 a few more specimens were captured off the Province of Syracuse, and in September 2017, a single specimen was captured off Scoglitti, Province of Ragusa, along the southern coast of Sicily. One year later, *E. massavensis* specimens were collected along the eastern and southeastern coasts of the island in numbers large enough to elicit commercial interest. This article presents the results of a joint effort between members of the Museo Civico di Storia Naturale of Comiso and local fishermen to monitor non-indigenous species in Sicilian waters.

### Materials and methods

Specimens were obtained from fishermen through the Museo Civico di Storia Naturale of Comiso (MCSNC), which has engaged in an effort to monitor rare and alien species. The specimens were collected in 2017–2018 in the Gulf of Catania, off Augusta, Siracusa, and Brucoli along the eastern coast of Sicily, and off Scoglitti, and Pozzallo along the southern coast of Sicily (Supplementary material Table S1, Figure 1). With the exception of three specimens (14, 15, 78, Table S1) collected using a traditional trammel net (“impardata”) deployed on sandy bottoms at water depths shallower than 20 m, specimens were hauled in by trawlers operating on sandy-mud bottoms at depths greater than 20 m. The specimens were measured and weighed (total length, carapace length, wet weight), their sex determined

and some females were examined for gonad maturity using female gonadal development stages (immature (I), premature (II), mature (III), post-mature (IV)) (Wortham-Neal 2002; Vila et al. 2013). Some specimens were photographed, preserved in 80% ethanol, and deposited at the Natural History Museum of Comiso, Ragusa, Sicily, (specimens 1–14, Table S1).

## Results

Of the 140 specimens collected between August 1<sup>st</sup>, 2017 and September 19<sup>th</sup>, 2018 (Table S1), 54 were females. The largest male (TL 15.5 cm, 52 gr) and female (TL 15.5 cm, 48 gr) specimens were collected in the Gulf of Catania on August 24<sup>th</sup>, 2018. The smallest mature female (TL 10.3 cm, 13 gr) was collected in the Gulf of Catania on August 13<sup>th</sup>, 2018. Of the 52 females examined for gonadal maturity, 11 were immature (10.0–13.8 cm TL), 26 premature (10.4–15.5 cm TL) and 15 mature (10.3–15.3 cm TL).

## Discussion

The reproductive biology of the *E. massavensis* population studied off the Egyptian coast is characteristic of an opportunistic species, with protracted reproductive period that lasts (for females) from February to August, a high fecundity (number of ripe ova 80372, 217344 in females of 18.1, 29.7 mm CL, respectively), and an early onset of sexual maturity (females at 15 mm CL) (Sallam 2005). Ovarian maturity can be established by assessing their color visible through the cuticle of the abdominal tergites (El-Sherif et al. 2012). Our results indicate possibly a later onset of reproductive activity in the Gulf of Catania, with the smallest mature (phase III) female having a CL of 23 mm.

Off the Israeli coastline in the early 1960s, *E. massavensis* was the sole stomatopod species collected at 9–18 m, whilst the native spot-tail mantis shrimp, *Squilla mantis* (Linnaeus, 1758) was the sole stomatopod at depths greater than 70 m, whereas at 35–42 m both species were found (Gilat 1964). Already in the late 1970s, along the same coastline, *E. massavensis* was the only stomatopod collected up to 45 m (Lewinsohn and Manning 1980; Galil and Lewinsohn 1981; Tom and Galil 1991), and both species were only found concurrently at 70 m depth (Lewinsohn and Manning 1980). By that time, *E. massavensis* was the dominant stomatopod in the southeastern Mediterranean upper shelf (Lewinsohn and Manning 1980; Abdel-Salam and Hamdi 2015). It appears that along the Levantine coast of Turkey too, competitive displacement has modified the bathymetric ranges of the populations of the Erythraean and indigenous stomatopod species (Özcan et al. 2008). In 2007, specimens of *E. massavensis* were collected at depths of 150–200 m off the southern Aegean coast of Turkey (Özcan et al. 2008), and in 2014 at 180 m, off Abu Qir, Egypt (Abdelsalam 2014). The incursion of *E. massavensis* and other Erythraean species into the lower



**Figure 2.** *Erugosquilla massavensis* (Kossmann, 1880) offered for sale on the Catania fish market, 29 August 2018. Photo L. Molino.

continental shelf and upper slope reveals their capacity to tolerate lower temperatures and this phenomenon has largely been underrated (Galil et al. 2018). It seems that the climatic niche of *E. massavensis* is wider than accounted for and the species may pose a higher invasion risk in the Central Mediterranean Sea than previously anticipated. Still, it is noteworthy the the average sea surface temperature (SST) in the Gulf of Catania in the months of August and September rose between 2016 and 2018 from 26.34 °C to 26.97 °C and 25.55 °C to 26.46 °C, respectively (*vide* A. A. Gauci). Recent records of Erythraean NIS from the Sicilian shelf, such as *Siganus rivulatus* Forsskål and Niebuhr, 1775 and *Trachysalambria palaestinensis* (Steinitz, 1932), highlight the increasing vulnerability of Sicily to thermophilic invasive species (Insacco and Zava 2016; Insacco et al. 2017).

The species is currently established as a minor fishery resource in Sicily: in August 2018 it was sold, mixed with *S. mantis*, for 5–10 euro/kg at the Catania fish market (Figure 2). Gruvel (1936) had already noted that *E. massavensis* was common in the Egyptian fish markets of Suez and Ismailia, as it is indeed today in Port Said (Abdelsalam 2014). The species was the most abundant Erythraean demersal species (26.6%) along the Egyptian Mediterranean shelf (Bakhoum et al. 2013). It is rarer in the markets of Israel, Cyprus and Turkey, but may increase in importance as its populations expand (<https://www.sealifebase.ca/summary/Erugosquilla-massavensis.html>). Given its high fecundity and predaceous diet, were its population to expand, it may pose a threat to the native biota on shelf and shelf/slope ecotone habitats.

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### Supplementary material

The following supplementary material is available for this article:

**Table S1.** List of specimens of *Erugosquilla massavensis* (Kossmann, 1880) collected between August 2017 and September 2018 off Sicily, Italy, including date, sex, gonadal development (GD) stage, total length (TL), carapace length (CL), and weight.

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