Journal of *Marine Science and Engineering*

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Protect the Natives to Combat the Aliens: Could *Octopus vulgaris* Cuvier, 1797 Be a Natural Agent for the Control of the Lionfish Invasion in the Mediterranean Sea?

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Citation: Crocetta, F.; Shokouros-Oskarsson, M.; Doumpas, N.; Giovos, I.; Kalogirou, S.; Langeneck, J.; Tanduo, V.; Tiralongo, F.; Virgili, R.; Kleitou, P. Protect the Natives to Combat the Aliens: Could *Octopus vulgaris* Cuvier, 1797 Be a Natural Agent for the Control of the Lionfish Invasion in the Mediterranean Sea? *J. Mar. Sci. Eng.* **2021**, *9*, 308. https://doi.org/10.3390/jmse9030308

Academic Editor: Gualtiero Basilone

Received: 14 February 2021
Accepted: 9 March 2021
Published: 11 March 2021

Biological invasions constitute a major threat to native ecosystems and to global biodiversity [1,2]. The Mediterranean Sea, a biodiversity hotspot hosting about 17,000 species, is facing an unprecedented challenge due to the invasion of nonindigenous species (NIS) and is considered to be the most bioinvaded marine region in the world [3,4]. Although the number of recorded NIS has reached about 1000 so far, only a fraction of those have been documented to cause adverse impacts to the environment, pose a threat to human health and/or result in economic losses and increased management efforts [5–8].

Among NIS, the lionfish *Pterois miles* (Bennett, 1828) raised the concern of the regional scientific community of the Mediterranean Sea because of its rapid invasion and population expansion during the last decade [9,10]. The lionfish is native to the Indian Ocean and abundant in the Red Sea, with a geographical distribution that extends southwards to the eastern parts of South Africa, the Arabian Sea, the Persian Gulf, the Gulf of Oman, the Laccadive Sea, the Bay of Bengal, the Andaman Sea and the Indonesian region [11]. This taxon, together with other congeneric species, is involved in an ongoing invasion in the western Atlantic, where it is causing significant ecological and socioeconomic impacts [12–14]. The lionfish was reported for the first time in the Mediterranean Sea off Israel in 1991 [15], and following a twenty-year gap in observations it was sighted off nearby Lebanon in 2012 [16]. Then, within two years, a plethora of records followed from the entire Levantine Sea [17–21]. Its population expansion and establishment in the Mediterranean Sea were finally evident in several areas of the southern and central Aegean Sea and the eastern parts of the Ionian Sea, even reaching areas of the central Mediterranean Sea since 2015 [22–31]. Such timing accounts for one of the fastest fish invasions ever reported in the region.

The biological and ecological traits of lionfishes favor their invasion successes and impacts to the recipient ecosystems. They are coastal fish species that thrive in a wide range of depths [32–34] and usually hide in crevices or caves, thus making commercial fisheries techniques challenging [35]. They can also occur in unstable environmental conditions such as in areas with low salinity and/or characterized as turbid with high sediment

loads [36,37], and are generalist predators [38–40]. Lionfishes have a reproductive strategy that enables them to mature in less than a year [35]. The production of over two million eggs per year [41], and the planktonic larvae phase with an ability to drift for approximately 20–35 days before settlement, are additional traits that facilitate their dispersion across long distances [42]. Finally, they possess venomous dorsal, pelvic and anal spines that act as a protection from predators [26].

During a recreational scuba dive at the Cyclops dive site (Famagusta, Cyprus; 34.98584 N, 34.07787 E) on 09/02/2021 at 10:30 a.m., a lionfish (~25 cm in total length) was spotted by one of the coauthors of this note (M. S.-O.) at a depth of approximately 5 m near a small ledge. Soon after, a large *Octopus vulgaris* Cuvier, 1797 approached the lionfish and captured it by attaching its two arms along the lionfish's body. It slowly hauled it toward its mouth until it finally covered it with all its arms and web. The octopus did not release its prey, despite several attempts to escape. It then moved to the bottom of the ledge and first hid in a small crevice before moving to a bigger crevice. During this last phase, the lionfish was not moving anymore, suggesting that the toxin produced by the octopus was presumably already acting (Figure 1; Electronic Supplementary Material).

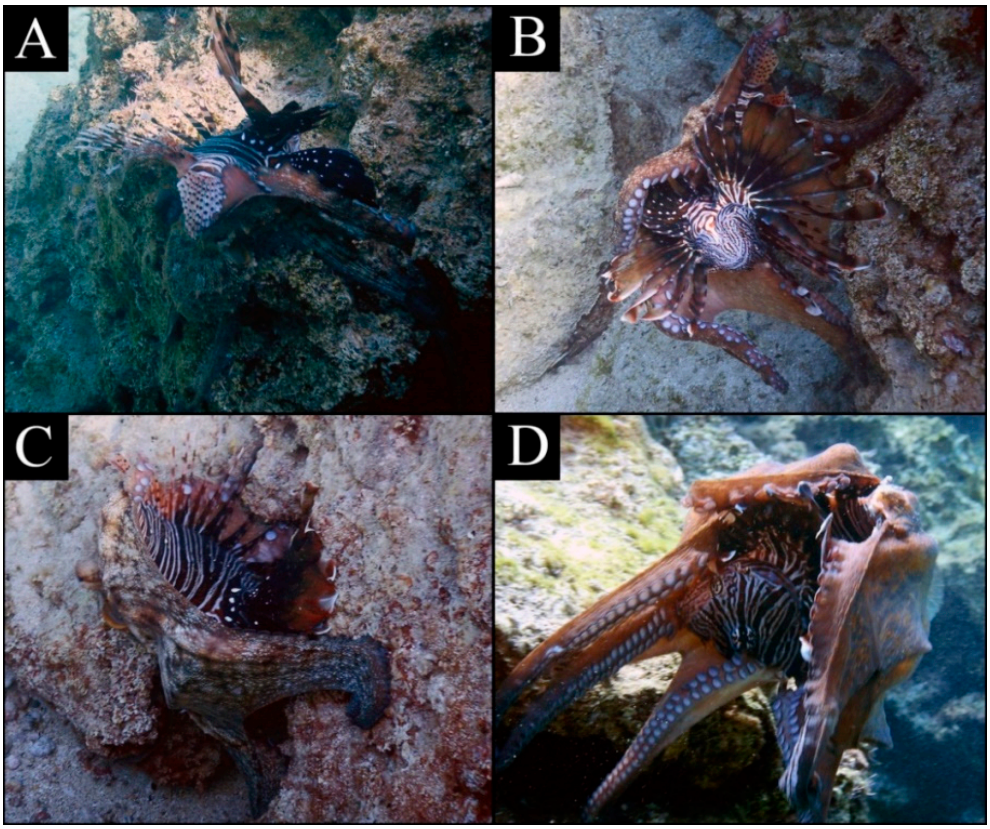

Figure 1. *Octopus vulgaris* Cuvier, 1797 preying on a lionfish in Famagusta (Cyprus). (**A**) The octopus soon after the catch. (**B**) The octopus enveloping the lionfish with all the arms and the web, moving to the bottom of the cliff. (**C**) The octopus hiding in a small crevice. (**D**) The octopus while moving to a bigger crevice. Photos by Maria Shokouros-Oskarsson.

To our knowledge, this is the first reliable evidence of lionfish predation in the Mediterranean Sea. In fact, only Turan et al. [43] reported and pictured a dusky grouper *Epinephelus marginatus* (Lowe, 1834) as "capturing and digesting a lionfish" (see [43]: Figure 8). However, the figure in the study of Turan et al. [43] clearly shows a grouper preying/feeding on a small native scorpaenid species of the genus *Scorpaena* Linnaeus, 1758.

Several species have been documented to prey on lionfishes in their native ranges, including groupers, cornetfishes, sharks, spotted moray eels and sea eagles [44–47], but information on predation from the invaded areas has only been rarely documented [48–50].

This is most likely because native predators are not yet adapted to this new potential prey. Lack of natural competitors might also be attributed to the higher growth rates and larger sizes of individuals in the invaded regions compared to those residing in the native ones, but also to the overfishing of top predators [35,51,52].

Octopus vulgaris, and octopuses in general, are well-known opportunistic predators with a broad generalist diet, including species with venomous spines [53–58]. At the same time, octopuses are also a target fishery species, with catches and landings strongly decreasing in several countries of the Mediterranean Sea [58]. Kleitou et al. [51] recently proposed the protection of native top predators as one of the possible ways to combat NIS establishment in the Mediterranean Sea; a proposal that is in line with our observation. Although more research would be needed to prove that such an observation is not a casual event, and that *O. vulgaris* may act as a natural predator of lionfishes in the Mediterranean Sea, the present study provides valuable information for future directed studies with the aim to improve the knowledge on NIS spread and developing control efforts. In addition, it suggests that proper fisheries management of *O. vulgaris* in the Mediterranean Sea could serve to control this and other NIS in the future.

Supplementary Materials: The following are available online at https://www.mdpi.com/2077-1312/9/3/308/s1, Video S1: *Octopus vulgaris* Cuvier, 1797 preying on a lionfish in Famagusta (Cyprus).

Author Contributions: Conceptualization, F.C. and P.K.; resources, F.C.; data curation, F.C. and P.K.; writing—original draft preparation, F.C. and P.K.; writing—review and editing, M.S.-O., N.D., I.G., S.K., J.L., V.T., F.T., R.V. All authors have read and agreed to the published version of the manuscript.

Funding: P.K. was funded by the LIFE financial instrument of the European Union – RELIONMED project [Grant Agreement LIFE16 NAT/CY/000832].

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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