BioInvasions Records (2022) Volume 11, Issue 4: 1067–1077

Rapid Communication

First reports of the Sohal surgeonfish, *Acanthurus sohal* (Forsskål, 1775) (Actinopterygii, Acanthuridae), and the Violet-eyed swimming crab, *Carupa tenuipes* Dana, 1852 (Decapoda, Brachyura, Portunidae), from North African waters

Ola Mohamed Nour[1], Sara A.A. Al Mabruk[2,3], Zeinab Khodary[1], Bruno Zava[4,5], Alan Deidun[6] and Maria Corsini-Foka[7,*]

[1]*Department of Biology and Geology, Faculty of Education, Alexandria University, 21526 Alexandria, Egypt*
[2]*Higher institute of Science and Technology, Cyrene, Libya*
[3]*Marine Biology in Libya Society, El Bayda, Libya*
[4]*Wilderness studi ambientali, via Cruillas 27, 90146 Palermo, Italy*
[5]*Museo Civico di Storia Naturale di Comiso, Via degli Studi 9, 97013 Comiso (RG), Italy*
[6]*Department of Geosciences, University of Malta, Msida MSD 2080, Malta*
[7]*Institute of Oceanography, Hydrobiological Station of Rhodes, Hellenic Centre for Marine Research. Cos Street, 85100 Rhodes, Greece*
**Corresponding author*
E-mail: *mcorsini@hcmr.gr*

Citation: Nour OM, Al Mabruk SAA, Khodary Z, Zava B, Deidun A, Corsini-Foka M (2022) First reports of the Sohal surgeonfish, *Acanthurus sohal* (Forsskål, 1775) (Actinopterygii, Acanthuridae), and the Violet-eyed swimming crab, *Carupa tenuipes* Dana, 1852 (Decapoda, Brachyura, Portunidae), from North African waters. *BioInvasions Records* 11(4): 1067–1077, https://doi.org/10.3391/bir.2022.11.4.24

Received: 22 April 2022
Accepted: 15 July 2022
Published: 12 October 2022

Handling editor: Melih Ertan Çınar
Thematic editor: Amy Fowler

Abstract

On March 25, 2022, one specimen of the Sohal surgeonfish *Acanthurus sohal* and one of the Violet-eyed swimming crab *Carupa tenuipes* were collected for the first time off the north coastline of Egypt and Libya, respectively. The native range of both species includes the Red Sea, and here, they are reported for the first time from the southern Mediterranean Sea. The second record of the Lessepsian migrant *Pteragogus trispilus* from Libyan waters, also caught on March 25, 2022, is furthermore included.

Key words: Non-Indigenous Species (NIS), Lessepsian migration, human-mediated transport, Egypt, Libya, Mediterranean Sea

Introduction

Knowledge of the diversity, distribution and abundance of non-indigenous species (NIS) in the Mediterranean Sea, in particular of biota of Indo-Pacific origin, has increased in recent years in both southern and eastern data-deficient regions of the basin, including the waters off Egypt, Libya and the Palestinian territories (Abd Rabou 2019; Bariche et al. 2019; Al Mabruk et al. 2021a, b; Corsini-Foka et al. 2021; Deef 2021; Fitori et al. 2021; Nour et al. 2021 and references therein, 2022a, b; Adel et al. 2022). This data gap has been partly bridged by the recent intensification of research and monitoring projects in the region (Bakhoum 2019; Farrag et al. 2019; Ragheb et al. 2019; Akel 2020; Abd Rabou et al. 2020 and references therein) as well as by the increasing awareness of and interest in the marine environment and its protection by citizens and fishers. The latter phenomenon has translated itself into increased citizen-scientist based collaborations through social media platforms and emerging technologies,

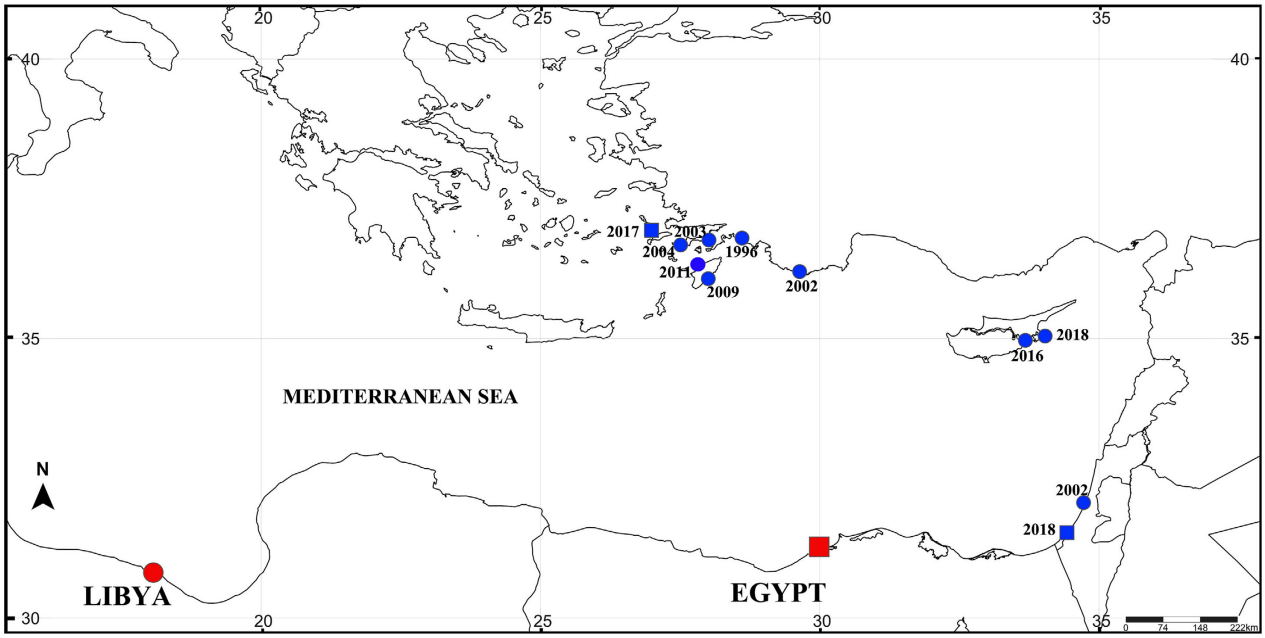

Figure 1. Distribution of records of *Carupa tenuipes* (bullets) and *Acanthurus sohal* (squares) in the Mediterranean Sea. *Carupa tenuipes*: published records (blue bullets) [Galil 2004; Yokes and Galil 2006; Yokes et al. 2007; Pancucci-Papadopoulou et al. 2009; Savva and Kleitou 2017; Katsanevakis et al. 2020; Kondylatos et al. 2020] and present study record at Bin Jawad, Gulf of Sirte, Libya (red bullet). *Acanthurus sohal*: published records (blue squares) [Giovos et al. 2018; Bariche et al. 2019] and present study record at Miami Beach, off Alexandria, Egypt (red square).

including smartphones, social media networks and Geographic Information Systems (Newman et al. 2012; Al Mabruk et al. 2021a, b; Nour et al. 2021, 2022a).

The first occurrence of the Sohal surgeonfish *Acanthurus sohal* (Forsskål, 1775) in Mediterranean Egyptian waters and of the Violet-eyed swimming crab *Carupa tenuipes* (Dana, 1852) in Libya is hereby reported, updating their distribution along the Mediterranean coasts. The native range of both species includes the Red Sea, and their introduction pathway to North African waters is briefly discussed. A brief note on the second finding of the Lessepsian migrant *Pteragogus trispilus* Randall, 2013 in Libya is also included.

Materials and methods

Photos of an unknown fish, caught on 25 March 2022, were sent to one of the authors (OMN) by a fisherman for identification. The fish, an acanthurid, was caught by angling at about 7 m of depth, over a rocky substrate at Miami Beach, off Alexandria, Egypt (31°16′21.7″N; 29°59′27.0″E) (Figure 1). The surface seawater temperature and salinity, measured with a conductivity meter (WTW Cond 3110, Tetracon 325), were 16 °C and 38.5‰, respectively. The sample was subsequently deposited within the collections of the Biological Museum of the Department of Biological and Geological Sciences, Faculty of Education, Alexandria University and, to date, is preserved frozen. The fish specimen was identified following Randall (1956), Khalaf and Disi (1997), Sommer et al. (1996) and Carpenter et al. (1997).

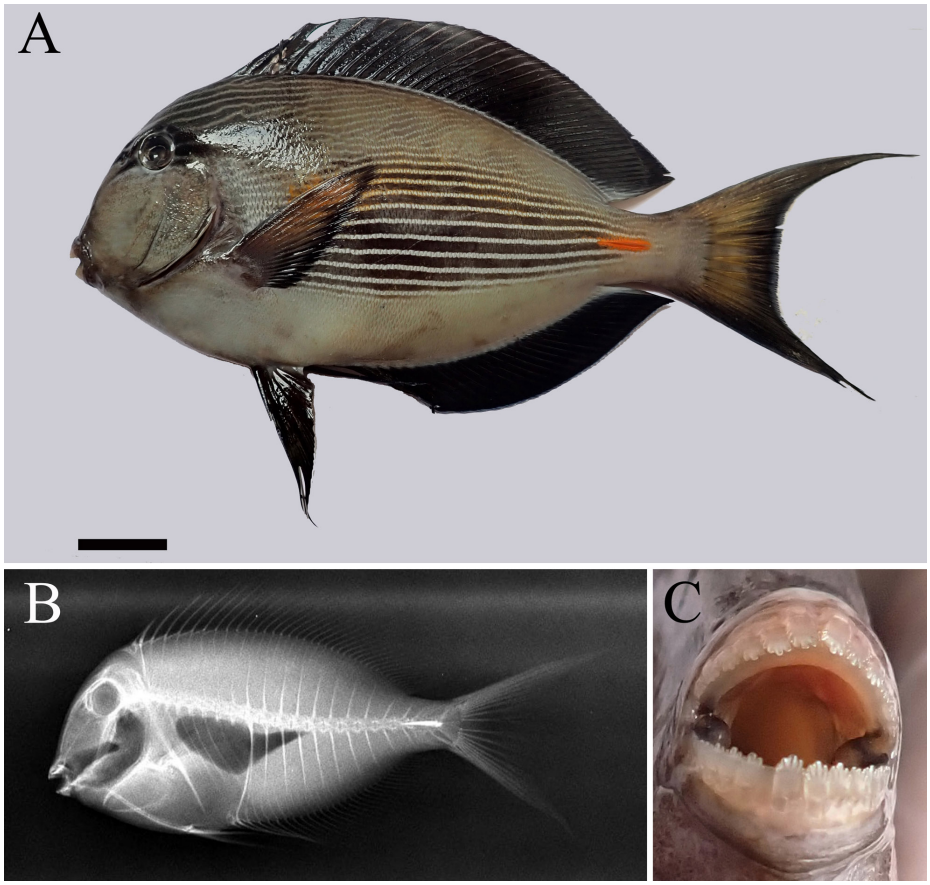

Figure 2. *Acanthurus sohal* (Forsskål, 1775) from off Alexandria, Egypt. A: freshly-thawed specimen (Black bar: 20 mm), B: X-rays, C: mouth (Photos by Ola Mohamed Nour).

On 25 March 2022 a crab specimen was collected at Bin Jawad, Gulf of Sirte, Libya (30°48′43.8″N; 18°04′13.5″E) (Figure 1) by gill nets at 8–10 m of depth, over a rocky substrate, along with three specimens of an unknown fish. The surface seawater temperature and salinity were 16.24 °C and 38.71 psu, respectively (https://myocean.marine.copernicus.eu/data). This crab and the fish specimens were originally discarded by fishers but were subsequently noted and photographed by a citizen on the rocky coast. The citizen directly contacted one of the authors (SAAA) and sent photos via Facebook messenger for identification. The crab and one fish specimen were delivered to SAAA, and they are currently preserved frozen. Apel and Spiridonov (1998) and Galil (2004) were used for the crab identification, while the fish species was determined following Randall (2013).

Measurements of the above samples were taken with a caliper to the nearest 0.1 mm.

Results

The fish specimen caught off Alexandria was identified as *Acanthurus sohal* (Figure 2).

Description (Figure 2A): body oval, tall and compressed, head rounded, large caudal spine positioned approximately in the middle of each side of caudal peduncle, caudal fin very lunate. Dorsal IX, 31; Anal III, 29; Pectoral 17;

Table 1. Morphometric measurements (mm) of the *Acanthurus sohal* specimen from off Alexandria, Egypt.

Measurements	mm	Measurements	mm
Total length	189	Pre dorsal fin length	35.4
Fork length	155	Pre pectoral fin length	35
Standard length	135	Pre pelvic fin length	40.8
Head length	36	Pre anal fin length	62
Preorbital length	16	Caudal peduncle length	17.7
Post orbital length	11	Caudal peduncle depth	16
Snout length	26.2	Caudal fin concavity	32.3
Eye diameter	8	Caudal spine length	12.3
Upper jaw length	6.3	Pelvic fin length	39.2
Body depth	64.6	Pectoral fin length	40.8
		Length of longest dorsal ray	24.6

Pelvic I, 5; caudal 14; 22 vertebrae (Figure 2B). Anterior gill rakers 15, posterior gill rakers 14. Teeth spatulate with denticulations, 14 in upper jaw and 13 visible in lower jaw (Figure 2C).

Colour of freshly-thawed specimen (Figure 2A): background of body pale creamy with 13 blackish stripes visible along the sides, under the lateral line; undulate horizontal blackish lines on upper head and under the dorsal fin spines; undulate oblique pale lines distinguishable above lateral line under the dorsal fin rays; a light blue line at base of dorsal and anal fins and on the outer margin of caudal fin; head, under the eye, and belly uniform creamy. Dorsal, anal, and pelvic fins blackish, pectoral fin yellowish with black upper rays and distal margin; caudal fin pale creamy at base, then yellowish with blackish margins; a yellow-orange spot on pectoral region; the spine sheath and socket on caudal peduncle bright orange.

On the basis of the main measurements (in mm) of the specimen (Table 1), the following proportions were obtained: head length 3.8, body depth 2.1, caudal fin concavity 4.2, snout length 5.2, longest dorsal ray 5.5, pectoral fin length 3.3, pelvic fin length 3.4, all in standard length; preorbital length 2.3, postorbital length 3.3, diameter of eye 4.5, length of caudal spine 2.9, caudal peduncle depth 2.3, upper jaw length 5.7, all in head length. The fish was an immature male, and its stomach was empty.

The crab from the Gulf of Sirte was identified as *Carupa tenuipes* (Figure 3A, B). It was a female with a carapace length of 20.8 mm and a carapace width of 29 mm. The main morphological characteristics observed in the specimen were the following: carapace transverse, moderately convex, smooth, anterolateral borders moderately oblique consisting of seven teeth including the outer orbital angle; front cut into four shallow lobes. The carapace and pereiopods were of nearly uniform, bright orange-red colour in the freshly caught sample. The fingers were dark brown distally and along their inner margins (Figure 3A, B).

The fish collected in the Gulf of Sirte, lightly damaged, was identified as *Pteragogus trispilus*, and its total length was 96 mm (Figure 4).

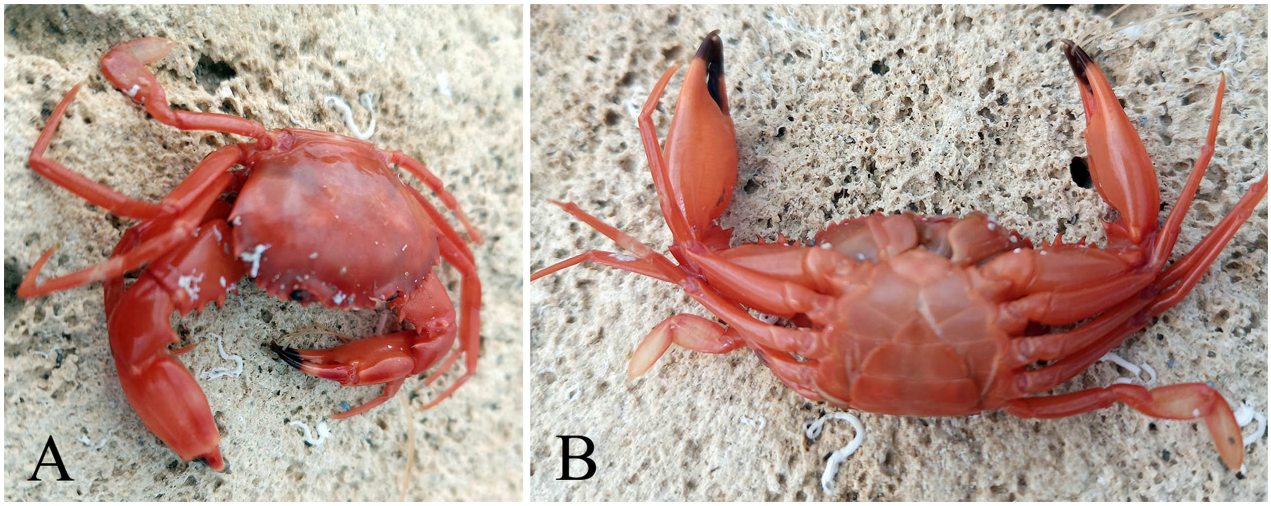

Figure 3. The freshly caught female *Carupa tenuipes* Dana, 1852, carapace length 20.8 mm, from the Gulf of Sirte, Libya. A: dorsal view, B: ventral view. Photos by Anwer Abdelsallam Saleh.

Figure 4. *Pteragogus trispilus* Randall, 2013, total length 96 mm, from the Gulf of Sirte, Libya. Black bar: 10 mm. Photo by Sara A.A. Al Mabruk.

Discussion

The native range of the Sohal surgeonfish, *A. sohal*, includes the Red Sea and the northwestern Indian Ocean, namely the Gulf of Aden, the Gulf of Oman and the Persian Gulf (Golani and Fricke 2018). This surgeonfish feeds on benthic algae, prevalently on *Sargassum* sp. and filamentous green algae (Randall 1956). It reaches 27 cm in standard length and is found along the seaward edges of reefs exposed to wave surge at depths up to 10 m; it is prevalently solitary, but can be observed in groups, and shows aggressive and territorial behaviour (Randall 1956; Khalaf and Disi 1997; Debelius 2011). In its native range, this herbivorous fish defends its algal-covered territory against benthic algae-feeding intruders that threaten its food resources, mostly other Acanthuridae as well as members of the families Scaridae and Pomacentridae (Alwany et al. 2005; Alwany and Sarhan 2012). Reducing grazing pressure by herbivorous intruders, *A. sohal* plays an important role in maintaining a balance among various species and between algal and coral communities (Alwany and Sarhan 2012). The species is caught through nets, traps and occasionally through trawling (Sommer et al. 1996; Carpenter et al. 1997) and has a limited commercial

value (Khalaf and Disi 1997), while it is valuable in the aquarium trade (Giovos et al. 2018). In the Mediterranean, *A. sohal* was first observed in 2017 in the shallow waters off Kalymnos Island, southeastern Aegean, Greece (Giovos et al. 2018) and later, in 2018, it was detected in waters off the coast of Gaza, Palestine (Bariche et al. 2019). Description, colour, proportions of main measurements, meristics and depth at which the *A. sohal* specimen was caught from Alexandria agree with those given by Randall (1956), Khalaf and Disi (1997) and Bariche et al. (2019) and corresponded to a sub-adult specimen (cf. Randall 1995).

The present record of *A. sohal* is the first for both the Mediterranean Egyptian waters and the North African waters, while it is the third one for the whole Mediterranean basin. As *A. sohal* is native to the Red Sea, this record strongly suggests that the species has been introduced following the Lessepsian migration process, as already indicated by Bariche et al. (2019). The Sohal surgeonfish *A. sohal* is the second *Acanthurus* sp. recorded from Mediterranean Egyptian waters, following *Acanthurus xanthopterus* (Valenciennes, 1835) recently reported for the first time from the Mediterranean basin (Adel et al. 2022). Since *A. xanthopterus* is not listed amongst the Red Sea ichthyofauna, Adel et al. (2022) discussed different pathways of its introduction into the Mediterranean other than Lessepsian migration, such as an accidental or deliberate release from the aquarium/pet industry, as well as other human-mediated pathways of introduction including shipping and drilling platforms. Although a second specimen of *A. xanthopterus* was observed in December 2021, also caught within the waters off Alexandria, Egypt (Ola M. Nour *pers. obs.*), the occurrence of the species in the area is still considered casual (cf. Zenetos et al. 2022). As for the NIS of siganids, the monitoring of feeding habits and behaviour of acanthurids introduced into the Mediterranean is imperative, since they could compete for food with native herbivorous, such as *Sarpa salpa* (Linnaeus, 1758) (Yapici 2021).

The portunid *C. tenuipes*, commonly named the violet-eyed swimming crab due to the colour of its eyes whilst alive, is a predatory carnivorous brachyuran (Monteforte 1987) widely distributed across the Indo-Pacific, from the Red Sea to Japan, Australia, Polynesia, and Hawaii. In its native range, the species inhabits reef areas as well as rocky, vegetated coastal waters, crevices of coral reefs and coral rubble, from intertidal areas to a depth of 80 m (Apel and Spiridonov 1998). The species, a Lessepsian migrant introduced into the Mediterranean via the Suez Canal (Galil et al. 2020), has been repeatedly recorded in Turkey since 1996 (Yokes and Galil 2006; Yokes et al. 2007). Furthermore, *C. tenuipes* has been reported from Israel in 2002 (Galil 2004), Greece in 2009 (Pancucci-Papadopoulou et al. 2009) and Cyprus in 2016 (Savva and Kleitou 2017) (Figure 1).

The specimen of *C. tenuipes* reported in the present study was collected in shallow waters over a rocky seabed, as in other Mediterranean regions. It

is a species with nocturnal habits (Yokes and Galil 2006) that can adapt to diversified habitats in a new colonized environment (Pancucci-Papadopoulou et al. 2009). In fact, in the eastern Mediterranean, *C. tenuipes* has been generally reported from 0.5 m to 25–30 m of depth, over rocky seabeds and under stones (Yokes and Galil 2006; Yokes et al. 2007; Pancucci-Papadopoulou et al. 2009; Kondylatos et al. 2020), over biogenic rubble and rocky substrates (Galil 2004; Yokes and Galil 2006) as well as in marine caves (Yokes and Galil 2006; Bianchi et al. 2022).

It is probable that this small sized Lessepsian migrant crab (maximum carapace width = 42.6 mm) had already extended its distribution to the area under study, but remained undetected for various reasons. These include the scarcity of systematic surveys in Libyan waters, its nocturnal habits that make observations and collections difficult, a low population density, as well as its non-commercial value and its consequent discarding in fishery activities, as in the case hereby described. Nevertheless, it must be noted that the location of the finding reported in the current study, Bin Jawad, is close to Al Sidrah Port, a very important oil depot. Thus, *C. tenuipes* could have arrived into Libyan waters aided by a secondary vector of introduction, including human-mediated transport from eastern Mediterranean regions, where it is established (Çinar et al. 2021; Kondylatos et al. 2020; Zenetos et al. 2022), as has been observed in New Zealand (cf Yeo et al. 2011). The present first finding of *C. tenuipes* in North Africa and Libya adds another species to the previously known NIS brachyuran diversity of the country, represented namely by the crabs *Eucrate crenata* (De Haan, 1835 [in De Haan, 1833–1850]), *Percnon gibbesi* (H. Milne Edwards, 1853), *Plagusia squamosa* (Herbst, 1790), *Portunus segnis* (Forskål, 1775), *Callinectes sapidus* Rathbun, 1896 and *Thalamita poissonii* (Audouin, 1826) (Shakman et al. 2019; Mahklouf and Shakman 2021; Corsini-Foka et al. 2021; Al Mabruk and Crocetta 2022). Further monitoring in the region will characterize the status of the *C. tenuipes* population in this area of colonization.

Also noteworthy is the finding of the Lessepsian migrant *P. trispilus* in the Gulf of Sirte, a region significantly far from the Al-Bardi site, Libya, at the border between Libya and Egypt, where it was first recorded in 2021 (Fitori et al. 2021), as well as from off the Gulf of Tunis, Tunisia, where it was first reported in 2016 (Hamed et al. 2018) and from the island of Malta (Borg and Evans 2022). This small Lessepsian migrant labrid has extended its range to all the eastern Mediterranean coasts (Galil et al. 2020). Beyond the above first record of *P. trispilus* at the easternmost extremity of Libya, to date the species was undetected along the remaining extended Libyan coasts, due most likely to a lack of systematic surveys or monitoring for research purposes. The finding hereby reported could indicate that the species has already colonized other coastal regions of the country.

The first record of *C. tenuipes* and *A. sohal* in North African waters, and the second record of *P. trispilus* from Libya, described here show the

importance of citizen scientists, including sensitized fishers, in the detection of marine NIS in various areas of the Mediterranean Sea through the use of new technologies and platforms. This is especially significant given that the Mediterranean is one of the global regions most impacted by bioinvasions, with citizen science reports helping to address lacunae on the knowledge of NIS distribution.

The tropical enrichment of the Mediterranean through the introduction of novel marine species of Red Sea and Indo-Pacific origin through the Suez Canal is "the most remarkable biogeographic phenomenon of today" (Por 2009). This unstoppable process has been favoured by various factors including the successive enlargements and deepening of the Suez Canal, while the increasing temperatures of the basin permit the further expansion westwards and northwards of the introduced species (Galil et al. 2017).

Acknowledgements

Authors warmly thank Khaled Shela and Anwer Abdelsallam Saleh for providing pictures, data and the specimens of *Acanthurus sohal* and *Carupa tenuipes* and *Pteragogus trispilus* respectively. They also thank the veterinarian Dr Ahmed Shawky (Caesar Vet Center, Alexandria) for his kind help on X-rays analysis of *A. sohal* and Dr Danilo Scannella (IRBIM CNR, Italy) for technical support. Ola Mohamed Nour acknowledges the financial support of the PADI Foundation (project number 47796). The authors wish to thank the Editor and the anonymous reviewers for their helpful suggestions on the first version of the manuscript.

Authors' contributions

Conceptualization, methodology, validation, data curation, investigation, writing – original draft, OMN, SAAA, ZK, BZ, MCF and AD; Writing – review and editing, BZ, MCF and AD; Supervision, MCF; Resources, AD. All authors participated and commented in various aspects of discussing the results to achieve the final manuscript. The authors read and approved the final manuscript.

References

Abd Rabou AFN (2019) On the occurrence and health risks of the Silver-cheeked Toadfish (*Lagocephalus sceleratus* Gmelin, 1789) in the marine ecosystem of the Gaza Strip, Palestine. *Biodiversitas* 20: 2620–2627, https://doi.org/10.13057/biodiv/d200926

Abd Rabou AFN, Al Agha MR, Abd Rabou MA, Abualtayef MT, Elnabris KJ, Elkahlout KE, El Bashiti TA, Abu Amra HE, Attallah AJ, Abu Hatab HG, Aboutair MA (2020) On the Ocean Sunfishes (*Mola mola*, Linnaeus 1758) By-caught off the Mediterranean coast of the Gaza Strip, Palestine. *Biomedical Journal of Scientific and Technical Research* 29: 22624–22632, https://doi.org/10.26717/BJSTR.2020.29.004831

Akel EHKh (2020) Fisheries status of the trawlers by-catch from Alexandria, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries* 24: 83–106, https://doi.org/10.21608/ejabf.2020.78754

Adel M, Nour OM, Al Mabruk SAA, Zava B, Deidun A, Corsini-Foka M (2022) The yellowfin surgeonfish *Acanthurus xanthopterus* Valenciennes, 1835 (Actinopterygii: Perciformes: Acanthuridae) from Mediterranean Egyptian waters. *Mediterranean Marine Science* 23: 134–139, https://doi.org/10.12681/mms.28131

Al Mabruk SAA, Crocetta F (2022) *Thalamita poissonii* in Libya. In: Tiralongo F, Akyol O, Al Mabruk SA, Battaglia P, Beton D, Bitlis B, Borg JA, Bouchoucha M, Çinar ME, Crocetta F, Dragičević B, Jdulčić JD, Evangelopoulos A, Jevans J, Fortič A, Gauff RP, Georgiadis CG, Gökoğlu M, Daniele Grech D, Guy-Haim T,Huseyinoglu MF, Lombardo A, Marletta G, Mastrototaro F, Montesanto F, Nunes F, Özgül A, Öztürk B, Rammou D-L, Scuderi D, Terbiyik Kurt T, Trainito E, Trkov D, Ulman A, Ünal V, Velasquez X (2022) New Alien Mediterranean Biodiversity Records (August 2022). *Mediterranean Marine Science* 23: 725–747, https://doi.org/10.12681/mms.31228

Al Mabruk SAA, Zava B, Abdulghani A, Corsini-Foka M, Deidun A (2021a) The first record of the Pharaoh cardinal fish *Apogonichthyoides pharaonis* (Actinopterygii: Perciformes: Apogonidae) from Libyan waters. *Acta Ichthyologica et Piscatoria* 51: 113–118, https://doi.org/10.3897/aiep.51.63504

Al Mabruk SAA, Zava B, Nour OM, Corsini-Foka M, Deidun A (2021b) Record of *Terapon jarbua* (Forsskål, 1775) (Terapontidae) and *Acanthopagrus bifasciatus* (Forsskål, 1775) (Sparidae) in the Egyptian Mediterranean waters. *BioInvasions Records* 10: 710–720, https://doi.org/10.3391/bir.2021.10.3.21

Alwany MA, Sarhan HM (2012) Territoriality of *Acanthurus sohal* on reefs in Ras Mohamed National Park, Red Sea. *Catrina* 7(1): 33–40

Alwany MA, Thaler E, Stachowitsch M (2005) Territorial behaviour of *Acanthurus sohal* and *Plectroglyphidodon leucozona* on the fringing Egyptian Red Sea reefs. *Environmental Biology of Fishes* 72: 321–334, https://doi.org/10.1007/s10641-004-2587-0

Apel M, Spiridonov VA (1998) Taxonomy and zoogeography of the portunid crabs (Crustacea: Decapoda: Brachyura: Portunidae) of the Arabian Gulf and adjacent waters. *Fauna of Arabia* 17: 159–331

Bakhoum S (2019) Fish assemblages in surf zone of the Egyptian Mediterranean coast off Alexandria. *Turkish Journal of Fisheries and Aquatic Sciences* 19: 351–362, https://doi.org/10.4194/1303-2712-v19_4_09

Bariche M, Sayar N, Balistreri P (2019) Records of two non-indigenous fish species *Synanceia verrucosa* Bloch and Schneider, 1801 and *Acanthurus sohal* (Forsskål, 1775) from the Gaza strip (eastern Mediterranean Sea). *BioInvasions Records* 8: 699–705, https://doi.org/10.3391/bir.2019.8.3.27

Bianchi CN, Gerovasileiou V, Morri C, Froglia C (2022) Distribution and ecology of decapod crustaceans in Mediterranean marine caves: a review. *Diversity* 14: 176, https://doi.org/10.3390/d14030176

Borg JA, Evans J (2022) First record of *Pteragogus trispilus* (Actinopteri, Labridae) from Malta. In: New Alien Mediterranean Biodiversity Records (2022). *Mediterranean Marine Science* 23, https://doi.org/10.12681/mms.28737

Carpenter KE, Krupp F, Jones DA, Zajonz U (1997) FAO species identification field guide for fishery purposes. Living marine resources of Kuwait, eastern Saudi Arabia, Bahrain, Qatar, and the United Arab Emirates. FAO, Rome, 293 pp

Corsini-Foka M, Abdulghani A, Al Mabrouk SAA, Abdulrraziq AA, Ibrahim SM, Scannella D, Zava B, Deidun A, Gianguzza P (2021) Invasive portunid crabs in Libyan waters: first record of *Callinectes sapidus* and range expansion of *Portunus segnis*. *BioInvasions Records* 10: 885–893, https://doi.org/10.3391/bir.2021.10.4.13

Çinar ME, Bilecenoğlu M, Yokeş MB, Öztürk B, Taşkin E, Bakir K, Doğan A, Açik Ş (2021) Current status (as of end of 2020) of marine alien species in Turkey. *PLoS ONE* 16: e0251086, https://doi.org/10.1371/journal.pone.0251086

Debelius H (2011) Red Sea reef guide. IKAN-unterwasserarchiv, Frankfurt, Germany, 321 pp

Deef LEM (2021) First record of two squirrelfishes, *Sargocentron spinosissimum* and *Sargocentron tiereoides* (Actinopterygii, Beryciformes, Holocentridae) from the Egyptian Mediterranean coast. *Acta Ichthyologica et Piscatoria* 51: 107–112, https://doi.org/10.3897/aiep.51.63216

Farrag MMS, El-Naggar HA, Abou-Mahmoud MMA, Alabssawy AN, Ahmed HO, Abo-Taleb HA, Kapiris K (2019) Marine biodiversity patterns off Alexandria area, southeastern Mediterranean Sea, Egypt. *Environmental Monitoring and Assessment* 191: 367, https://doi.org/10.1007/s10661-019-7471-7

Fitori A, Mahdy A, Said REM, Al-Faturi A (2021) The first record of the lessepsian migrant *Pteragogus trispilus* Randall, 2013 (Osteichthyes: Labridae) off the Libyan coast, east Mediterranean Sea. *Egyptian Journal of Aquatic Research* 47: 381–385, https://doi.org/10.1016/j.ejar.2021.09.009

Galil BS (2004) *Carupa tenuipes* Dana, 1851: an Indo-Pacific swimming crab new to the Mediterranean (Decapoda, Brachyura, Portunidae). *Crustaceana* 77: 249–251, http://www.jstor.org/stable/20105703

Galil BS, Marchini A, Occhipinti-Ambrogi A, Ojaveer H (2017) The enlargement of the Suez Canal - Erythraean introductions and management challenges. *Management of Biological Invasions* 8: 141–152, https://doi.org/10.3391/mbi.2017.8.2.02

Galil BS, Mienis HK, Hoffman R, Goren M (2020) Non-indigenous species along the Israeli Mediterranean coast: tally, policy, outlook. In: Kovalenko KE, Pelicice FM, Kats LB, Kotta J, Thomaz SM (eds), Aquatic Invasive Species III, Hydrobiologia, 19 pp, https://doi.org/10.1007/s10750-020-04420-w

Giovos I, Bernardi G, Romanidis-Kyriakidis G, Marmara D, Kleitou P (2018) First records of the fish *Abudefduf sexfasciatus* (Lacepède, 1801) and *Acanthurus sohal* (Forsskål, 1775) in the Mediterranean Sea. *BioInvasions Records* 7: 205–210, https://doi.org/10.3391/bir.2018.7.2.14

Golani D, Fricke R (2018) Checklist of the Red Sea fishes with delineation of the Gulf of Suez, Gulf of Aqaba, endemism and Lessepsian migrants. *Zootaxa* 4509: 1–215, https://doi.org/10.11646/zootaxa.4509.1.1

Hamed O, Miled-Fathalli N, Chakroun-Marzouk N (2018) First record of the Lessepsian migrant *Pteragogus trispilus* Randall, 2013 (Osteichthyes: Labridae) off the Tunisian coasts, Central Mediterranean Sea. *Cahiers de Biologie Marine* 59: 115–119, https://doi.org/10.21411/CBM.A.EE765A73

Katsanevakis S, Poursanidis D, Hoffman R, Rizgalla J, Rothman SB-S, Levitt-Barmats Y, Hadjioannou L, Trkov D, Garmendia JM, Rizzo M, Bartolo AG, Bariche M, Tomas F, Kleitou P, Schembri PJ, Kletou D, Tiralongo F, Pergent C, Pergent G, Azzurro E, Bilecenoglu M, Lodola A, Ballesteros E, Gerovasileiou V, Verlaque M, Occhipinti-Ambrogi A, Kytinou E, Dailianis T, Ferrario J, Crocetta F, Jimenez C, Evans J, Ragkousis M, Lipej L, Borg JA, Dimitriadis C, Chatzigeorgiou G, Albano PG, Kalogirou S, Bazairi H, Espinosa F, Ben Souissi J, Tsiamis K, Badalamenti F, Langeneck J, Noel P, Deidun A, Marchini A, Skouradakis G, Royo L, Sini M, Bianchi CN, Sghaier Y-R, Ghanem R, Doumpas N, Zaouali J, Tsirintanis K, Papadakis O, Morri C, Çinar ME, Terrados J, Insacco G, Zava B, Soufi- Kechaou E, Piazzi L, Ounifi Ben Amor K, Andriotis E, Gambi MC, Ben Amor MM, Garrabou J, Linares C, Fortič A, Digenis M, Cebrian E, Fourt M, Zotou M, Castriota L, Di Martino V, Rosso A, Pipitone C, Falautano M, García M, Zakhama-Sraieb R, Khamassi F, Mannino AM, Ktari MH, Kosma I, Rifi M, Karachle PK, Yapıcı S, Bos AR, Balistreri P, Ramos Esplá AA, Tempesti J, Inglese O, Giovos I, Damalas D, Benhissoune S, Huseyinoglu MF, Rjiba-Bahri W, Santamaría J, Orlando-Bonaca M, Izquierdo A, Stamouli C, Montefalcone M, Cerim H, Golo R, Tsioli S, Orfanidis S, Michailidis N, Gaglioti M, Taşkın E, Mancuso E, Žunec A, Cvitković I, Filiz H, Sanfilippo R, Siapatis A, Mavrič B, Karaa S, Türker A, Monniot F, Verdura J, El Ouamari N, Selfati M, Zenetos A (2020) Unpublished Mediterranean records of marine alien and cryptogenic species. *BioInvasions Records* 9: 165–182, https://doi.org/10.3391/bir.2020.9.2.01

Khalaf MA, Disi AM (1997) Fishes of the Gulf of Aqaba. Marine Science Station, Aqaba, Jordan, 252 pp

Kondylatos G, Crocetta F, Corsini-Foka M, Froglia C (2020) Crustacea Decapoda from the Rhodes Island area (eastern Mediterranean): new records and an updated checklist. *Diversity* 12: 246, https://doi.org/10.3390/d12060246

Mahklouf MH, Shakman EA (2021) Invasive alien species in Libya. In: Pullaiah T, Ielmini MR (eds), Invasive Alien Species: Observations and Issues from Around the World. Volume 1: Issues and Invasions in Africa. Wiley-Blackwell, pp 173–195, https://doi.org/10.1002/9781119607045.ch6

Monteforte M (1987) The decapod reptantia and stomatopod crustaceans of a typical high island coral reef complex in French Polynesia (Tiahura, Moorea Island): zonation, community composition and trophic structure. *Atoll Research Bulletin* 309: 1–37, https://doi.org/10.5479/si.00775630.309.1

Newman G, Wiggins A, Crall A, Graham E, Newman S, Crowston K (2012) The future of citizen science: emerging technologies and shifting paradigms. *Frontiers in Ecology and the Environment* 10: 298–304, https://doi.org/10.1890/110294

Nour OM, Al Mabruk SAA, Zava B, Deidun A, Corsini-Foka M (2021) Records of new and rare alien fish in North African waters: the burrowing goby *Trypauchen vagina* (Bloch and Schneider, 1801) and the bartail flathead *Platycephalus indicus* (Linnaeus, 1758) in Egypt and the cobia *Rachycentron canadum* (Linnaeus, 1766) in Libya. *BioInvasions Records* 10: 914–923, https://doi.org/10.3391/bir.2021.10.4.16

Nour OM, Al Mabruk SAA, Adel M, Corsini-Foka M, Zava B, Deidun A, Gianguzza P (2022a) First occurrence of the needle-spined urchin *Diadema setosum* (Leske, 1778) (Echinodermata, Diadematidae) in the south Mediterranean Sea. *BioInvasions Records* 11: 199–205, https://doi.org/10.3391/bir.2022.11.1.20

Nour OM, Al Mabruk SAA, Zava B, Gianguzza P, Corsini-Foka M, Deidun A (2022b) New entry of *Naso annulatus* (Quoy & Gaimard, 1825) and further records of *Scatophagus argus* (Linnaeus, 1766) and *Charybdis* (*Charybdis*) *natator* (Herbst, 1794) in the Mediterranean Sea. *BioInvasions Records* 11(3) (*in press*)

Pancucci-Papadopoulou MA, Corsini-Foka M, Tsiamis C, Kalogirou S (2009) First occurrence of the alien brachiuran *Carupa tenuipes* Dana 1851 in Rhodes island (SE Aegean Sea). *Aquatic Invasions* 4: 713–714, https://doi.org/10.3391/ai.2009.4.4

Por FD (2009) Tethys returns to the Mediterranean: Success and limits of tropical re-colonization. In: Krupp F, Musselman JL, Kotb MMA, Weidig I (eds), Environment, Biodiversity and Conservation in the Middle East. Proceedings of the First Middle Eastern Biodiversity Congress, Aqaba, Jordan, 20-23 October 2008. *BioRisk* 3: 5–19, https://doi.org/10.3897/biorisk.3.30

Ragheb E, Akel EHKh, Rizkalla SI (2019) Analyses of the non-target catch from the Egyptian Mediterranean trawlers, off Port Said. *Egyptian Journal of Aquatic Research* 45: 239–246, https://doi.org/10.1016/j.ejar.2019.07.003

Randall JE (1956) A revision of the Surgeon Fish Genus *Acanthurus*. *Pacific Science* 10: 159–235, https://doi.org/10.2307/1439239

Randall JE (1995) Coastal fishes of Oman. University of Hawaii Press, Honolulu, 439 pp

Randall JE (2013) Seven new species of labrid fishes (*Coris*, *Iniistius*, *Macropharyngodon*, *Novaculops*, and *Pteragogus*) from the western Indian Ocean. *Journal of the Ocean Science Foundation* 7: 1–43, https://doi.org/10.5281/zenodo.1041964

Savva I, Kleitou P (2017) On three alien species from Cyprus (eastern Mediterranean Sea). In: Gerovasileiou V, Akel E, Akyol O, Alongi G, Azevedo F, Babali N, Bakiu R, Bariche M,

Bennoui A, Castriota L, Chintiroglou C, Crocetta F, Deidun A, Galinou-Mitsoudi S, Giovos I, Gökoğlu M, Golemaj A, Hadjioannou L, Hartingerova J, Insacco G, Katsanevakis S, Kleitou P, Korun J, Lipej L, Michailidis N, Mouzai Tifoura A, Ovalis P, Petović S, Piraino S, Rizkalla S, Rousou M, Savva I, Şen H, Spinelli A, Vougioukalou K, Xharahi E, Zava B, Zenetos A, New Mediterranean Biodiversity Records (July, 2017). *Mediterranean Marine Science* 18: 355–384, https://doi.org/10.12681/mms.13771

Shakman E, Eteayb K, Taboni I, Ben Abdalha A (2019) Status of marine alien species along the Libyan coast. *Journal of the Black Sea/Mediterranean Environment* 25(2): 188–209

Sommer C, Schneider W, Poutiers J-M (1996) FAO species identification field guide for fishery purposes. The living marine resources of Somalia. FAO, Rome, 376 pp

Yapici S (2021) A risk screening of potential invasiveness of alien and neonative marine fishes in the Mediterranean Sea: implications for sustainable management. *Sustainability* 13: 13765, https://doi.org/10.3390/su132413765

Yeo DCJ, Carlton JT, Teo SLM, Ng PKL (2011) An incoming flood on a cryptic stage: understanding alien crustacean invasions in Southeast Asia. In: Galil BS, Clark PF, Carlton JT (eds), In the wrong place - alien marine crustaceans: distribution, biology and impacts. *Invading Nature - Springer Series in Invasion Ecology* 6: 30–417, https://doi.org/10.1007/978-94-007-0591-3_14

Yokes MB, Galil BS (2006) New records of alien decapods (Crustacea) from the Mediterranean coast of Turkey, with a description of a new palaemonid species. *Zoosystema* 28(3): 747–755

Yokes, MB, Karhan SÜ, Okus E, Yüksek A, Aslan-Yilmaz A, Yilmaz IN, Demirel N, Demir V, Galil BS (2007) Alien crustacean decapods from the Aegean coast of Turkey. *Aquatic Invasions* 2: 162–168, https://doi.org/10.3391/ai.2007.2.3.2

Zenetos A, Albano PG, López Garcia E, Stern N, Tsiamis K, Galanidi M (2022) Established non-indigenous species increased by 40% in 11 years in the Mediterranean Sea. *Mediterranean Marine Science* 23: 196–212, https://doi.org/10.12681/mms.29106