Updated checklist of bony fishes along the Libyan coasts (Southern Mediterranean Sea)

HOUSSEIN ELBARAASI, BAHRIA ELABAR, SALAMA ELAABIDI, ASMA BASHIR, OSAMA ELSILINI, ESMAIL SHAKMAN, ERNESTO AZZURRO

doi: 10.12681/mms.15570

To cite this article:

ELBARAASI, H., ELABAR, B., ELAABIDI, S., BASHIR, A., ELSILINI, O., SHAKMAN, E., & AZZURRO, E. (2019). Updated checklist of bony fishes along the Libyan coasts (Southern Mediterranean Sea). Mediterranean Marine Science, 20(1), 90–105. https://doi.org/10.12681/mms.15570
Updated checklist of bony fishes along the Libyan coast (southern Mediterranean Sea)

Houssein ELBARAASI1, Bahria ELABAR1, Salama ELAABIDI1, Asma BASHIR1, Osama ELSILINI1, Esmail SHAKMAN2 and Ernesto AZZURRO3, 4

1Department of Zoology, Faculty of Science, University of Benghazi, Benghazi, Libya
2Zoology Department, Tripoli University, Tripoli, Libya
3ISPRA, Institute for Environmental Protection and Research, Livorno, Italy
4Stazione Zoologica Anton Dohrn, Villa Comunale, Naples, Italy

Corresponding author: albrasi2000@gmail.com

Handling Editor: Paraskevi KARACHLE

Received: 24 December 2017; Accepted: 30 October 2018; Published on line: 30 April 2019

Abstract

Here, we provide an updated review of both native and nonindigenous ichthyofauna occurring in the waters of Libya, one of the largest and less-studied marine areas of the Mediterranean basin. With respect to the most recent information, the list of Libyan bony fishes was updated with 104 species for a total of 304 listed taxa. Out of these species, 271 are native, 6 are endemic to the Mediterranean, 22 are nonindigenous and of Lessepsian origin, and 5 are a range of expanding taxa from Gibraltar. Information on the distribution and abundance of Lessepsian fishes along the Libyan coast was gained through both field surveys and interviews with local small-scale fishermen, which contributed to filling large information gaps in this area. This combined approach allowed us to gather a more complete representation of nonindigenous species along the Libyan coast and indicated three assessment areas, corresponding to the eastern, central and western sectors of the country, which should be considered in future monitoring programs.

Keywords: Osteichthyes; Nonindigenous fishes; Mediterranean Sea; Local Ecological Knowledge.

Introduction

Among all Mediterranean countries, Libya provides one of the largest, more interesting and less-studied marine areas of the basin (Coll et al., 2010; 2013). The approximately 2000 km of coastline is characterized by low levels of anthropogenic pressure (Badalamenti et al., 2011), relatively little contamination (Galgani et al., 2014) and an increasing number of new species that are conquering these waters as well as other sectors of the eastern Mediterranean Sea (Bariche, 2012; Golani et al., 2017; Elbaraasi et al., 2013).

The current information on Libyan fish biodiversity is particularly limited (Bilecenoglu et al., 2002), representing a significant gap in knowledge for Mediterranean sciences. The relevance of this ‘Libyan gap’ (Elbaraasi et al., 2014) is recognized as a serious constraint for the assessment of the biodiversity of this basin (Coll et al., 2010), which encompasses approximately 7% of the total marine fish species in the world (Abdul Malak et al., 2011).

So far, Libyan fishes have been the subject of a number of studies since the pioneer investigation of Vinci-guerra in 1881. Gorgy et al. (1972) listed a total of 62 taxa; a few years later, Sogreah (1977) presented a list of 131 species, and Contransime (1977) reported 185 bony fishes, whereas the more complete checklist of bony fishes is so far the one reported by Al-Hassan & Elsilini (1999), who reported 201 species. Recently, Shakman & Kinzelbach (2007) provided a useful list of 16 exotic fishes of Lessepsian origin occurring in Libyan waters, and Belhassan et al. (2017) reported new data on the species composition and relative abundance of ten exotic fishes in eastern Libya.

Here, our aim is to provide an updated checklist of the marine bony fishes of Libya, which will be based on both the revision of the available literature and new field surveys. For the new immigrants that have recently been recorded in these waters, their establishment and geographical origin will be examined and discussed.

Methods

Data and samples were collected within the framework of a 5-year research project carried out by the Zool-
ogy Department of the Faculty of Science, University of Benghazi. A total of 12 surveys were carried out on-board local fishing vessels from December 2009 to December 2013, and fishery landings and local fish markets were periodically monitored during the same period. The study area included the major fishing ports of Libya (Fig. 1) and the cities of Tobruk, Derna, Benghazi, Raslanof, Sirte, Musrata and Tripoli. In these areas, commercial fishing is mainly represented by bottom trawlers, operating either over coastal or deep-water habitats. Small-scale fisheries mostly operate with artisanal gears such as trammel nets, various types of gillnet, mid-water and bottom longlines, and encircling nets.

Some fishermen actively contributed to this research, and in some cases, they provided voucher specimens and/or photographic documentation of species perceived as rare or new in the fishing area. Taxonomical identification was mostly performed according to Fisher et al. (1987), Nelson (2006), and, in some cases, specific literature. Specimens were preserved and finally deposited in the zoological collection of the Aquaculture and Fishery Laboratory - Zoology Department - Faculty of Science, University of Benghazi. Information collected by field surveys was compared to information extracted from a comprehensive bibliographic search performed on both scientific and gray literature. Scientific names were checked according to Eschmeyer et al. (2016) and listed in alphabetic order within each family. The year of the first Mediterranean record of Lessepsian species was based on Azzurro et al. (2014) and Golani et al. (2017). An expert evaluation of nonindigenous species (NIS) abundances was performed by the authors from data collected by both field surveys and interviews with local fishermen. These interviews were performed by showing pictures of NIS and asking fishermen to express the perceived abundance of species in six ranks of abundance, according to the approach given by Azzurro et al. (2011) and Boughedir et al. (2015): 0 = absent or not recorded; 1 = single record (caught only once); 2 = rare (caught once a year); 3 = occasional (caught sometimes in the fishing period); 4 = frequent (caught once a month or less in the fishing period); and 5 = common (caught regularly in the fishing period). When doubts arose on the correct identification of the species, the data collected from the interview were discarded. For each survey location, the ‘Lessepsian score’ was expressed as the sum of the ranks of each species recorded in the area.

The geographical origin of the Libyan bony fishes was based on Froese & Pauly (2016) and, in some cases, on species-specific literature. A cluster representation of survey locations according to the ranked abundance of Lessepsian species was performed with the software Past 3 (Hammer et al., 2001) and was based on Euclidean distances.

Results and Discussion

The high diversity of the Mediterranean Sea is well reflected by the richness of marine species that live in Libyan waters and by the wide range of marine habitats that characterize this country (Ben-Abdallah et al., 2011). Our revision reports a total of 304 bony fishes belonging to 22 orders and 97 families (Table 1). With respect to the most recent appraisal given by Al-Hassan & Elsilini (1999), we added 104 new species, which is more than one-third of those previously stated. This represents a significant update to the inventory of bony fishes of Libya that contributes to the information generated by historical studies (Fig. 2), filling an important gap in knowledge (Elbarassi et al., 2014) of marine biodiversity in Libya. According to the geographical origin, our update includes 271 native species; 6 endemic species; 22 Lessepsians; and 5 of Atlantic Ocean origin (Fig. 3). The Zilli’s tilapia Tilapia zilli, mentioned by Al-Hassan & Elsilini (1999), was not considered in the present checklist because it was already removed from the exotic species list of the Mediterranean (Golani et al., 2017) for its freshwater habits.

Our findings also provided a significant update on exotic fish occurring in Libyan waters. We know that several

(continued on page 102)
Table 1. The checklist of bony fishes of the Libyan coast on the Mediterranean (N = Native; E = Endemic of the Mediterranean Sea; A = Atlantic Ocean origin; L = Lessepsian species).

| Common name | Origin                        | Reference* |
|-------------|-------------------------------|------------|
| **ANGUILLIFORMES** |                                |            |
| Anguilla anguilla (Linnaeus, 1758) | European eel | N          | HE         |
| **Muraenidae** |                                |            |
| Gymnothorax unicolor (Delaroche, 1809) | Brown moray | N          | HE         |
| Muraena helena Linnaeus, 1758 | Mediterranean moray | N          | HE         |
| **Ophichthidae** |                                |            |
| Dalophis imberbis (Delaroche, 1809) | Armless snake eel | N          | PS         |
| Echelus myrus (Linnaeus, 1758) | Painted eel | N          | HE         |
| Ophisurus serpens (Linnaeus, 1758) | Serpent eel | N          | PS         |
| **Congridae** |                                |            |
| Ariosa balearicum (Delaroche, 1809) | Bandtooth conger | N          | HE         |
| Conger conger (Linnaeus, 1758) | European conger | N          | HE         |
| Gnathodus mystax (Delaroche, 1809) | Thinlip conger | N          | PS         |
| **CLUPEIFORMES** |                                |            |
| Clupeidae |                                |            |
| Alosa alosa (Linnaeus, 1758) | Allis shad | N          | PS         |
| Alosa fallax (Lacepède, 1803) | Twaite shad | N          | PS         |
| Herklotsichthys punctatus (Rüppell, 1837) | Spotback herring | L          | PS         |
| Sardina pilchardus (Walbaum, 1792) | European pilchard | N          | HE         |
| Sardinella aurita Valentines, 1847 | Round sardinella | N          | HE         |
| Sardinella maderensis Lowe, 1838 | Madeiran sardinella | N          | HE         |
| Sprattus sprattus (Linnaeus, 1758) | European sprat | N          | PS         |
| Etrumeus golanii (DiBattista, Randall & Bowen, 2012) | Round herring | L          | SH         |
| **Engraulidae** |                                |            |
| Engraulis encrasiculus (Linnaeus, 1758) | European anchovy | N          | HE         |
| **OSMERIFORMES** |                                |            |
| Argentinidae |                                |            |
| Argentina sphyraena (Linnaeus, 1758) | Argentine | N          | HE         |
| Glossanodon leioglossus (Valenciennes, 1848) | Smalltoothed argentine | N          | PS         |
| **STOMIGIFORMES** |                                |            |
| Gonostomatidae |                                |            |
| Cyclothone braueri Jespersen & Tåning, 1926 | Garrick | N          | PS         |
| Cyclothone pygmaea Jespersen & Tåning, 1926 | E           | PS         |
| Gonostoma denudatum Rafinesque, 1810 | N           | PS         |
| **Sternopychidae** |                                |            |
| Argyroplectus hemigymnus Cocco, 1829 | Half-naked hatchetfish | N          | PS         |
| Maurolicus muelleri (Gmelin, 1789) | Silvery lightfish | N          | HE         |
| **Phosichthyidae** |                                |            |
| Ichthyococcus ovatus (Cocco, 1838) | Lightfish | N          | PS         |
| Vinciguerra attenuata (Cocco, 1838) | Slender lightfish | N          | PS         |
| Vinciguerra poweriae (Cocco, 1838) | Power's deep-water bristle-mouth fish | N          | PS         |

(continued)
| Order | Family | Common name | Origin | Reference* |
|-------|--------|-------------|--------|------------|
| **Stomiidae** | Chauliodus sloani | Bloch & Schneider, 1801 | Sloane’s viperfish | N | PS |
| | Stomias boa boa (Risso, 1810) | | Boa dragonfish | N | PS |
| **AULOPIFORMES** | Aulopidae | Aulopus filamentosus | Royal flagfin | N | HE |
| | Chlorophthalmidae | Chlorophthalmus agassizi | Shortnose greeneye | N | HE |
| | Synodontidae | Saurida lessepsianus | | | |
| | | Russell, Golani & Tikochinski, 2015 | | L | HE |
| | | Synodus saurus (Linnaeus, 1758) | Atlantic lizardfish | N | HE |
| | Paralepididae | Arctozenus risso (Bonaparte, 1840) | Spotted barracudina | N | PS |
| | | Lestidiops jayakari (Boulenger, 1889) | Pacific barracudina | N | PS |
| | | Paralepis coregonoides (Risso, 1820) | Sharpchin barracudina | N | PS |
| | Evermannellidae | Evermannella balbo (Risso, 1820) | Balbo sabretooth | N | PS |
| **MYCTOPHIFORMES** | Myctophidae | Benthosema glaciale (Reinhardt, 1837) | Glacier lantern fish | N | PS |
| | | Ceratoscopelus maderensis (Lowe, 1839) | Madeira lantern fish | N | PS |
| | | Diaphus holti (Tåning, 1918) | Small lantern fish | N | PS |
| | | Diaphus rafinesquii (Cocco, 1838) | White-spotted lantern fish | N | PS |
| | | Electra risso (Cocco, 1829) | Electric lantern fish | N | PS |
| | | Gonichthys coco (Cocco, 1829) | Cocco’s lanternfish | N | PS |
| | | Hygophum benoiti (Cocco, 1838) | Benoit’s lanternfish | N | PS |
| | | Hygophum hygomii (Lütken, 1892) | Bermuda lantern fish | N | PS |
| | | Lampanyctus crocodilus (Risso 1810) | | N | PS |
| | | Lampanyctus pusillus (Johnson 1890) | | N | PS |
| | | Lobianchia dolfini (Zugmayer, 1911) | Dolfine’s lantern fish | N | PS |
| | | Myctophum punctatum Rafinesque, 1810 | Spotted lanternfish | N | PS |
| | | Notothenia bohni Nafpaktitis, 1975 | | N | PS |
| | | Symbolophorus veranyi (Moreau, 1888) | Large-scale lantern fish | N | PS |
| **LAMPRIFORMES** | Lophotidae | Lophotus lacepede (Giorna, 1809) | Crested oarfish | N | PS |
| | Trachipteridae | Trachipterus trachypterus (Gmelin, 1789) | Mediterranean dealfish | N | PS |
| | | Zu cristatus (Bonelli, 1819) | Scalloped ribbonfish | N | PS |
| **GADIFORMES** | Macrouridae | | | | |

(continued)
| Common name                        | Origin | Reference |
|------------------------------------|--------|-----------|
| Coelorinchus caelorhincus (Risso, 1810) | Hollowsnout grenadier | N | HE |
| Hymenocephalus italicus Giglioli, 1884 | Glasshead grenadier | N | HE |
| Nezumia aequalis (Günther, 1878)   | Common Atlantic grenadier | N | HE |
| Trachyrincus scabrus (Rafinesque, 1810) | Roughsnout grenadier | N | PS |
| **Morididae**                      |        |           |
| Gadella maraldi (Risso, 1810)      | Gadella | N | HE |
| **Gadidae**                        |        |           |
| Gadilus argentus Guichenot, 1850   | Silvery pout | N | HE |
| Merlangius merlangus (Linnaeus, 1758) | Whiting | N | HE |
| Micromesistius poutassou (Risso, 1827) | Blue whiting | N | PS |
| Trisopterus luscus (Linnaeus, 1758) | Pouting | N | PS |
| Trisopterus minutus (Linnaeus, 1758) | Poor cod | N | HE |
| **Lotidae**                        |        |           |
| Gaidropsarus biscayensis (Collett, 1890) | Mediterranean bigeye rockling | N | HE |
| Gaidropsarus mediterraneus (Linnaeus, 1758) | Shore rockling | N | HE |
| Molva macrophthalmus (Rafinesque, 1810) | Spanish lin | N | HE |
| **Phycidae**                       |        |           |
| Phycis blennoides (Brünnich, 1768) | Greater forkbeard | N | HE |
| Phycis phycis (Linnaeus, 1766)     | Forkbeard | N | HE |
| **Merlucciidae**                   |        |           |
| Merluccius merluccius (Linnaeus, 1758) | European hake | N | HE |
| **OPHIDIIFORMES**                  |        |           |
| Ophidiidae                         |        |           |
| Ophidion barbatum Linnaeus, 1758    | Snake blenny | N | HE |
| Ophidion rochel Müller, 1845       |              | N | HE |
| **Carapidae**                      |        |           |
| Carapus acus (Brünnich, 1768)     | Pearl fish | N | HE |
| **BATRACHOIDIFORMES**              |        |           |
| Batrachoididae                     |        |           |
| Halobatrachus didactylus (Bloch & Schneider, 1801) | Lusitanian toadfish | N | PS |
| **LOPHIIFORMES**                   |        |           |
| Lophiidae                          |        |           |
| Lophius budegassa Spinola, 1807    | Blackbellied angler | N | HE |
| Lophius piscatorius Linnaeus, 1758 | Angler | N | HE |
| **GOBIESOCIFORMES**                |        |           |
| Gobiesocidae                       |        |           |
| Diplocogaster bimaculata (Bonnaterre, 1788) | Two-spotted clingfish | N | HE |
| Gouania willdenowi (Risso, 1810)   | Blunt-snouted clingfish | N | PS |
| **ATHERINIFORMES**                 |        |           |
| Atherinidae                         |        |           |
| Atherina boyeri Risso, 1810        | Big-scale sand smelt | N | HE |

(continued)
Table 1 (Continued)

| Common name                     | Origin                  | Reference |
|--------------------------------|-------------------------|-----------|
| Atherina hepsetus Linnaeus, 1758| Mediterranean sand smelt| N         |
| Atherinomorus forskali (Rüppell, 1838) | Red Sea hardyhead silverside | HE |
| **CYPRONODONTIFORMES**          |                         |           |
| Cyprinodontidae                 |                         |           |
| Aphanius fasciatus (Valenciennes, 1821) | Mediterranean banded killifish | N |
| **BELONIFORMES**                |                         |           |
| Scomberesocidae                 |                         |           |
| Scomberesox saurus (Walbaum, 1792) | Atlantic saury | N |
| Belonidae                       |                         |           |
| Belone belone (Linnaeus, 1761)  | Garfish                | N         |
| Hemiramphidae                   |                         |           |
| Hemiramphus far (Forsskål, 1775) | Black-barred halfbeak   | L         |
| Hyporhamphus picartii (Valenciennes, 1847) | African halfbeak | N |
| **BERYCIFORMES**                |                         |           |
| Trachichthyidae                 |                         |           |
| Hoplostethus mediterraneus Cuvier, 1829 | Mediterranean slimehead | N |
| Holocentridae                   |                         |           |
| Sargocentron rubrum (Forsskål, 1775) | Redcoat               | L         |
| **ZEIFORMES**                   |                         |           |
| Zeidae                          |                         |           |
| Zeus faber Linnaeus, 1758       | John dory              | N         |
| **SYNGNATHIFORMES**             |                         |           |
| Fistulariidae                   |                         |           |
| Fistularia commersonii Rüppell, 1838 | Bluespotted cornetfish (L) | L |
| Centriscidae                    |                         |           |
| Macroramphosus scolopax (Linnaeus, 1758) | Longspine snipefish | N |
| Syngnathidae                    |                         |           |
| Hippocampus guttulatus Cuvier, 1829 | Long-snouted seahorse | N |
| Hippocampus hippocampus (Linnaeus, 1758) | Short snouted seahorse | N |
| Nerophis ophidion (Linnaeus, 1758) | Straightnose pipefish | N |
| Syngnathus abaster Risso, 1827  | Black-striped pipefish | N |
| Syngnathus acus Linnaeus, 1758  | Greater pipefish       | N         |
| Syngnathus phlegeth Risso, 1827 | Broadnosed pipefish    | N         |
| Syngnathus typhle Linnaeus, 1758 |                        |           |
| **SCORPAENIFORMES**             |                         |           |
| Sebastidae                      |                         |           |
| Helicolemus dactylopterus (Delaroche, 1809) | Blackbelly rosefish | N |

(continued)
| Common name          | Origin | Reference* |
|----------------------|--------|------------|
| Scorpaenidae          |        |            |
| Scorpaena elongata    | N      | HE         |
| Scorpaena loppei      | N      | HE         |
| Scorpaena maderensis  | N      | PS         |
| Scorpaena notata      | N      | HE         |
| Scorpaena porcus      | N      | HE         |
| Scorpaena scrofa      | N      | HE         |
| Dactylopteridae       |        |            |
| Dactylopterus volitans| N      | HE         |
| Triglidae             |        |            |
| Chelidonichthys cuculus| N      | HE         |
| Chelidonichthys obscurus| N      | HE         |
| Eutrigla gurnardus    | N      | HE         |
| Lepidotrigla callione | N      | HE         |
| Lepidotrigla dieuzeidei| N      | PS         |
| Trigla lyra           | N      | HE         |
| Trigloporus lastoviza | N      | HE         |
| Family Peristediidae  |        |            |
| Peristedion cataphractum| N      | HE         |
| PERCIFORMES           |        |            |
| Moronidae             |        |            |
| Dicentrarchus labrax  | N      | HE         |
| Dicentrarchus punctatus| N      | HE         |
| Polyprionidae         |        |            |
| Polyprion americanus  | N      | HE         |
| Serranidae            |        |            |
| Anthias anthias       | N      | HE         |
| Cephalopholis taeniops| A      | BE         |
| Epinephelus aeneus    | N      | HE         |
| Epinephelus caninus   | N      | HE         |
| Epinephelus costae    | N      | HE         |
| Epinephelus fasciatus | N      | HE         |
| Epinephelus marginatus| N      | HE         |
| Hyporthodus haifensis | N      | HE         |
| Mysteropecora rubra   | N      | PS         |
| Serranus cabrilla     | N      | HE         |
| Serranus hepatus      | N      | HE         |
| Serranus scriba       | N      | HE         |
| Callanthiidae         |        |            |
| Callanthias ruber     | N      | HE         |
| Apogonidae            |        |            |
| Apogon imberbis       | N      | HE         |

(continued)
| Common name | Origin | Reference |
|-------------|--------|-----------|
| Pomatomus saltatrix (Linnaeus, 1766) | Bluefish | N HE |
| Echeneis naucrates (Linnaeus, 1758) | Live sharksucker | N HE |
| Remora remora (Linnaeus, 1758) | Shark sucker | N HE |
| Alectis alexandrina (Geoffroy Saint-Hilaire, 1817) | Alexandria pompano | N PS |
| Alepes djedaba (Forsskål, 1775) | Shrimp scad | L PS |
| Campoglycyra glaycos (Lacepède, 1801) | Vadigo | N PS |
| Caranx crysos (Mitchill, 1815) | Blue runner | N HE |
| Caranx hippos (Linnaeus, 1766) | Crevale jack | N HE |
| Caranx rhonchus (Geoffroy Saint-Hilaire, 1817) | False scad | N HE |
| Lichia amia (Linnaeus, 1758) | Leerfish | N HE |
| Naucrates ductor (Linnaeus, 1758) | Pilotfish | N PS |
| Pseudocaranx dentex (Bloch & Schneider, 1801) | White trevally | N HE |
| Seriola dumerili (Risso, 1810) | Greater amberjack | N HE |
| Seriola fasciata (Bloch, 1793) | Lesser amberjack | A SH |
| Seriola rivoliana (Valenciennes, 1833) | Longfin yellowtail | A SH |
| Trachurus trachurus (Linnaeus, 1758) | Atlantic horse mackerel | N HE |
| Trachurus picturatus (Bowdich, 1825) | Blue jack mackerel | N HE |
| Trachurus mediterraneus (Steindachner, 1868) | Mediterranean horse mackerel | N HE |
| Trachinotus ovatus (Linnaeus, 1758) | Pompano | N HE |
| Coryphaena hippurus (Linnaeus, 1758) | Common dolphinfish | N HE |
| Brama brama (Bonnaterre, 1788) | Atlantic pomfret | N PS |
| Lobotes surinamensis (Bloch, 1790) | Tripletai | N PS |
| Pomadasys incisus (Bowdich, 1825) | Bastard grunt | N HE |
| Boops boops (Linnaeus, 1758) | Bogue | N HE |
| Crenidens crenidens (Forsskål, 1775) | Karanteen seabream | L HE |
| Dentex dentex (Linnaeus, 1758) | Common dentex | N HE |
| Dentex macrophtalmus (Bloch, 1791) | Large-eye dentex | N HE |
| Dentex gibbonus (Rafinesque, 1810) | Pink dentex | N HE |
| Diplodus annularis (Linnaeus, 1758) | Annular seabream | N HE |
| Diplodus cervinus (Lowe, 1838) | Zebra seabream | N HE |
| Diplodus puntazzo (Walbaum, 1792) | Sharpsnout seabream | N HE |
| Diplodus sargus (Linnaeus, 1758) | White seabream | N HE |

(continued)
| Common name | Origin | Reference* |
|-------------|--------|------------|
| Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817) | Common two-banded seabream | N | HE |
| Lithognathus mormyrus (Linnaeus, 1758) | Sand steenbras | N | HE |
| Oblada melanura (Linnaeus, 1758) | Saddled seabream | N | HE |
| Pagellus acarne (Risso, 1827) | Axillary seabream | N | HE |
| Pagellus bellottii (Steindachner, 1882) | Red Pandora | N | HE |
| Pagellus bogaraveo (Brünnich, 1768) | Blackspot seabream | N | HE |
| Pagellus erythrinus (Linnaeus, 1758) | Common Pandora | N | PS |
| Pagrus auriga (Valenciennes, 1843) | Redbanded seabream | N | HE |
| Pagrus caeruleostictus (Valenciennes, 1830) | Bluespotted seabream | N | HE |
| Pagrus pagrus (Linnaeus, 1758) | Red porgy | N | HE |
| Sarpa salpa (Linnaeus, 1758) | Salema | N | HE |
| Sparus aurata (Linnaeus, 1758) | Gilthead seabream | N | HE |
| Spondyliosoma cantharus (Linnaeus, 1758) | Black seabream | N | HE |
| Centracanthidae | Curled picarel | N | HE |
| Centracanthus cirrus Rafinesque, 1810 | | | |
| Spicara flexuosa (Rafinesque 1810) | | | |
| Spicara maena (Linnaeus, 1758) | Blotched picarel | N | HE |
| Spicara smaris (Linnaeus, 1758) | Picarel | N | HE |
| Sciaenidae | Meagre | N | PS |
| Argyrosomus regius (Asso, 1801) | | | |
| Sciaena umbra Linnaeus, 1758 | Brown meager | N | HE |
| Umbrina cirrosa (Linnaeus, 1758) | Shi drum | N | HE |
| Umbrina canariensis (Valenciennes, 1843) | Canary drum | N | HE |
| Mullidae | Red mullet | N | HE |
| Mullus barbatus Linnaeus, 1758 | | | |
| Mullus surmuletus Linnaeus, 1758 | Surmullet | N | HE |
| Upeneus moluccensis (Bleeker, 1855) | Goldband goatfish | L | PS |
| Upeneus porti Ben-Tuvia & Golani, 1989 | Por’s goatfish | L | PS |
| Pempheridae | Vanikoro sweeper | L | PS |
| Pempheris rhomboidea Kossmann & Räuber, 1877 | | | |
| Kyphosidae | Bermuda sea chub | A | EL |
| Kyphosus sectatrix (Linnaeus, 1758) | | | |
| Cepolidae | Red bandfish | N | HE |
| Cepola macrophthalmalma (Linnaeus, 1758) | | | |
| Mugilidae | Thicklip grey mullet | N | HE |
| Chelon labrosus (Risso, 1827) | | | |
| Liza aurata (Risso, 1810) | Golden grey mullet | N | HE |
| Liza carinata (Valenciennes, 1836) | Keeled mullet | L | PS |
| Liza ramada (Risso, 1827) | Thinlip grey mullet | N | HE |
| Liza saliens (Risso, 1810) | Leaping mullet | N | HE |
| Mugil cephalus Linnaeus, 1758 | Flathead grey mullet | N | PS |
| Common name | Origin | Reference* |
|-------------|--------|------------|
| Oedalechilus labeo (Cuvier, 1829) | Boxlip mullet | N | PS |
| Chromis chromis (Linnaeus, 1758) | Damselfish | N | HE |
| Coris julis (Linnaeus, 1758) | Mediterranean rainbow wrasse | N | HE |
| Ctenolabrus rupestris (Linnaeus, 1758) | Goldsinny-wrasse | N | PS |
| Labrus bergylta Ascanius, 1767 | Ballan wrasse | N | HE |
| Labrus merula Linnaeus, 1758 | Brown wrasse | N | HE |
| Labrus mixtus Linnaeus, 1758 | Cuckoo wrasse | N | HE |
| Labris viridis Linnaeus, 1758 | | N | HE |
| Symphodus cinereus (Bonnaterre, 1788) | Grey wrasse | N | HE |
| Symphodus doderleini (Jordan, 1890) | | E | PS |
| Symphodus mediterraneus (Linnaeus, 1758) | Axillary wrasse | N | HE |
| Symphodus ocellatus (Linnaeus, 1758) | | N | HE |
| Symphodus roissali (Risso, 1810) | Five-spotted wrasse | N | HE |
| Symphodus rostratus (Bloch, 1791) | | N | HE |
| Symphodus tinca (Linnaeus, 1758) | East Atlantic peacock wrasse | N | HE |
| Thalassoma pavo (Linnaeus, 1758) | Ornate wrasse | N | HE |
| Xyrichtys novacula (Linnaeus, 1758) | Pearly razorfish | N | HE |
| Sparisoma cretense (Linnaeus, 1758) | Parrotfish | N | HE |
| Echithys vipera (Cuvier, 1829) | Lesser weever | N | HE |
| Trachinus araneus Cuvier, 1829 | Spotted weever | N | HE |
| Trachinus draco Linnaeus, 1758 | Greater weever | N | HE |
| Trachinus radiatus Cuvier, 1829 | Starry weever | N | HE |
| Uranoscopus scaber Linnaeus, 1758 | Stargazer | N | HE |
| Clinitrauchus argentatus (Risso, 1810) | Cline | N | HE |
| Blennius ocellaris Linnaeus, 1758 | Butterfly blenny | N | HE |
| Lipophrys trigloides (Valenciennes, 1836) | | N | HE |
| Parablennius incognitus (Bath, 1968) | | N | HE |
| Parablennius sanguinolentus (Pallas, 1814) | Rusty blenny | N | PS |
| Salaria basilisca (Valenciennes, 1836) | | E | HE |
| Salaria pavo (Risso, 1810) | Peacock blenny | N | HE |
| Callionymus lyra Linnaeus, 1758 | Dragonet | N | HE |
| Callionymus maculatus (Rafinesque, 1810) | | N | HE |
| Synchiropus phaeon (Günther, 1861) | Phaeton dragonet | N | PS |

(continued)
## Table 1 (Continued)

| Common name | Origin | Reference* |
|-------------|--------|------------|
| **Gobiidae** | | |
| Deltentosteus quadrimaculatus (Valenciennes, 1837) | Four spotted goby | N  PS |
| Gobius bucchichi Steinachner, 1870 | Bucchich’s goby | N  HE |
| Gobius cobitis Pallas, 1814 | Giant goby | N  HE |
| Gobius cruentatus Gmelin, 1789 | Red-mouthed goby | N  HE |
| Gobius niger (Linnaeus, 1758) | Black goby | N  HE |
| Gobius paganellus Linnaeus, 175 | Rock goby | N  PS |
| Pomatoschistus marmoratus (Risso, 1810) | Marbled goby | N  HE |
| Pomatoschistus minutus (Pallas, 1770) | Sand goby | N  PS |
| Pomatoschistus tortonesei (Miller, 1969) | Tortonese’s goby | E  HE |
| **Siganidae** | | |
| Siganus luridus (Rüppell, 1829) | Dusky spinefoot | L  HE |
| Siganus rivulatus (Forsskål & Niebuhr, 1775) | Marbled spinefoot | L  HE |
| **Luvaridae** | | |
| Luvarus imperialis Rafinesque, 1810 | Luvar | N  PS |
| **Sphyraenidae** | | |
| Sphyraena sphyraena (Linnaeus, 1758) | European barracuda | N  HE |
| Sphyraena viridensis Cuvier, 1829 | Yellowmouth barracuda | N  HE |
| Sphyraena chrysootaenia Klunzinger, 1884 | Obtuse barracuda | L  PS |
| Sphyraena flavicauda Rüppell, 1838 | Red barracuda | L  PS |
| **Gempylidae** | | |
| Ruvettus pretiosus Cocco, 1833 | Oilfish | N  PS |
| **Trichiuridae** | | |
| Lepidopus caudatus (Euphrasen, 1788) | Silver scabbardfish | N  HE |
| Trichiurus lepturus Linnaeus, 1758 | Largehead hairtail | N  PS |
| **Scombridae** | | |
| Acanthocybium solandri (Cuvier, 1832) | Wahoo | N  PS |
| Auxis rochei (Risso, 1810) | Bullet tuna | N  HE |
| Auxis thazard (Lacepède, 1800) | Frigate tuna | N  PS |
| Euthynnus alletteratus (Rafinesque, 1810) | Little tunny | N  HE |
| Katsuwonus pelamis (Linnaeus, 1758) | Skipjack tuna | N  HE |
| Orycopsis unicolor (Geoffroy Saint-Hilaire, 1817) | Plain bonito | N  HE |
| Sarda sarda (Bloch, 1793) | Atlantic bonito | N  HE |
| Scomber colias Gmelin, 1789 | Atlantic chub mackerel | N  HE |
| Scomber scombrus Linnaeus, 1758 | Atlantic mackerel | N  HE |
| Scomberomorus commerson (Lacepède, 1800) | Narrow-barred Spanish mackerel | L  PS |
| Thunnus alalunga (Bonnaterre, 1788) | Albacore | N  PS |
| Thunnus thynnus (Linnaeus, 1758) | Atlantic bluefin tuna | N  HE |
| **Xiphiidae** | | |
| Xiphius gladius Linnaeus, 1758 | Swordfish | N  PS |
| **Istiophoridae** | | |
| Kajikia albida (Poey, 1860) | Atlantic white marlin | N  PS |

(continued)
| Common name                  | Origin                | Reference |
|-----------------------------|-----------------------|-----------|
| Tetrapturus belone          | Mediterranean spearfish | E        |
| Centrolepidae               |                       |           |
| Centrolephus niger          | Rudderfish            | N        |
| Stromateidae                | Blue butterfish       | N        |
| Caproidae                   | Boarfish              | N        |
| Stromateus fiatola          |                       |           |
| Capros aper                 |                       |           |
| Centrolophidae              |                       |           |
| Centrolophus niger          |                       |           |
| Stromateus fiatola          |                       |           |
| Capros aper                 |                       |           |
| Pleuronectiformes           |                       |           |
| Citharidae                  |                       |           |
| Citharus linguatula         | Spotted flounder      | N        |
| Scophthalmidae              |                       |           |
| Lepidorhombus bosci         | Four-spot megrim      | N        |
| Lepidorhombus whiffagonis   | Megrin                | N        |
| Scophthalmus maximus        | Turbot                | N        |
| Scophthalmus rhombus        | Brill                 | N        |
| Bothidae                    |                       |           |
| Arnoglossus imperialis      | Imperial scaldfish    | N        |
| Arnoglossus kessleri        | Scaldback             | N        |
| Arnoglossus laterna         | Mediterranean scaldfish | N   |
| Arnoglossus rueppellii      | Rüppell’s scaldback   | N        |
| Bothus podas                |                       |           |
| Pleuronectidae              |                       |           |
| Platichthys flesus          | European flounder     | N        |
| Soleidae                    |                       |           |
| Buglossidium luteum         | Solenette             | N        |
| Dicologlossa cuneata        | Wedge sole            | N        |
| Microchirus ocellatus       | Four eyed sole        | N        |
| Microchirus variegatus      | Thickback sole        | N        |
| Monochirus hispidus         | Whiskered sole        | N        |
| Pegusa lascaris             | Sand sole             | N        |
| Solea aegyptiaca            | Egyptian sole         | N        |
| Solea solea                 | Common sole           | N        |
| Synaptura lusitanica        | Portuguese sole       | N        |
| Synapturichthys kleini      | Klein’s sole          | N        |
| Cynoglossidae               |                       |           |
| Symphurus ligulatus         | Elongate tonguesole   | N        |
| Symphurus nigrescens        | Tonguesole            | N        |
| Tetraodontiformes           |                       |           |
| Balistidae                  |                       |           |
| Balistes capriscus          | Grey triggerfish      | N        |
| Monacanthidae               |                       |           |

(continued)
Table 1 (Continued)

| Common name                      | Origin | Reference*  |
|----------------------------------|--------|-------------|
| Stephanolepis diaspros (1940)    |        | HE          |
| Lagocephalus lagocephalus (1758) | N      | PS          |
| Lagocephalus sceleratus (1789)   | L      | PS          |
| Lagocephalus suezensis (1953)    | L      | PS          |
| Sphoeroides pachygaster (1848)   | A      | SH          |
| Mola mola (1758)                 | N      | PS          |
| Ranzania laevis (1776)           | N      | PS          |

* HE= Al-Hassan and Elsilini; 1999; PS = Present study; SH= Shakman et al., 2017; EL= Elbaraasi et al., 2013; BE= Ben Abdallah et al., 2007.

Several of these species have caused significant ecological and socioeconomic impacts in the Mediterranean (Otero et al., 2013; Katsanevakis et al., 2014), but this phenomenon is probably underestimated in several countries of the southern Mediterranean rim (Coll et al., 2013). Out of a total of 304 species registered by the present study, 22 (7%) were of Lessepsian origin. These are distributed in 8 total orders: Perciformes (11 species); Tetraodontiformes (3 species); Beloniformes and Clupeiformes (2 species), including the recently recorded species Etrumeus golanii (Shakman et al., 2017); and Syngnathiformes, Atheriniformes, Aulopiformes, and Beryciformes (1 species).

With respect to the most recent inventory (Shakman & Kinzelbach, 2007), the importance of Lessepsian fish species in Libya has significantly increased. According to our findings and by considering all survey locations, 1 species (S. diaspros) was reported as ‘rare’; 3 species (P. mento, S. rubrum, L. carinata) were considered ‘occasional’; 7 species (A. forskali, H. far, S. commerson, U. pori, P. rhomboidea, L. suezensis, L. sceleratus) were ‘frequent’; and 10 species (S. lessepsianus, H. punctatus, S. luridus, S. rivulatus, S. obtusata, S. pinguis, A. djedaba, U. moluccensis, C. crenidens, F. commersonii) were ‘common’.

Fig 3: Ichthyofauna of Libya: Number of species according to their geographical origin.

Fig 4. Abundance of Lessepsian fishes along the study locations in Libya. The percentage of Lessepsian fishes distributed in each class of abundance (defined in six different ranks) is calculated for each location.
were indicated as ‘common’. Remarkably, the common lionfish *Pterois miles* was not recorded by the present investigation. Taking into account the efforts posed in this study in terms of the number of surveys and the number of interviewed fishermen, it is highly probable that this species was unnoticed because it is very rare along the Libyan coast. Indeed, despite some punctual observations of the lionfish that have been recently reported to the west of Libya (from Tunisia and southern Italy, see Azzurro et al. 2017), to the best of our knowledge, the species has not been reported on the Mediterranean coast of Egypt. Considering the increasing success of the lionfish and its rapid geographical expansion, further investigation is needed to detect its expected occurrence and spread.

One other important result of this study was that the occurrence and abundance of Lessepsian fish in Libya are unevenly distributed across the different geographical sectors (Table 2, Fig 4). Indeed, 98% of the reported Lessepsian species occurred on the eastern coast, 91% on the central coast, and only 56% in the western sector. These differences, which are well represented by the Lessepsian score (Fig 5a), produced a clear west-east gradient, with a higher representation (in terms of both distribution and abundance) of Lessepsian fish along the eastern coast than along the western coast. Interestingly, the cluster obtained by the ranked abundances (Fig 5b) perfectly matched the geographical arrangement of survey locations across the western, central and eastern coasts of the country. Therefore, at least three assessment areas, corresponding to the eastern, central and western sectors of the country, should be considered in monitoring programs, which focus on the distribution and abundance of Lessepsian species. Considering the rapid evolution of the Lessepsian phenomenon along the Libyan coast and the longitudinal gradients, monitoring activities should be ideally performed on all these subsectors on a periodic basis. Recent studies provide increasing evidence on the effectiveness of involving local communities in order to provide a complementary knowledge to traditional surveys and enforce early detection systems (e.g., Azzurro et al., 2018). In this regard, we provided a good example to show how local stakeholders, especially small-scale fishermen, can be involved in the process of knowledge building. The used approach, which combined fishermen knowledge with field surveys, was of great help in filling large information gaps along the Libyan coast, and its use can be certainly advised, especially in data-poor coastal ecosystems (Beaudreau & Levin, 2014), such as the southern Mediterranean Sea.

Nevertheless, some groups of small and cryptic species with no commercial importance such as gobidae, blennidae, trypterigidae and gobiesoscidae remain underrepresented in this study, and further investigation is expected to enrich our knowledge of fishes along the Libyan coast.

![Fig. 5: A upper) Lessepsian score according to survey locations. An east-west gradient is apparent; B lower) Cluster representation of survey locations according to the ranked abundance of Lessepsian species and based on Euclidean distances: Eastern, central and western survey locations clustered together.](image-url)
This work is part of Bahria Elabar’s MSC thesis. The work was funded partly by the Zoology Department, Faculty of Science, University of Benghazi. All our gratitude goes to the fishermen from the study areas for their valuable help and collaboration. Special thanks go to Marine Fisheries World Ltd. and Amoaj Alkehir Ltd. for their support in the field surveys and samples collections. Many thanks go to Dr. Ahmad F. Mahjoub (University of Sirte) for his help. We wish to thank Osama Elkhader and Saad Muftah Elyamni for their help in field surveys. Finally, this work is dedicated to the everlasting memory of Osama Bogarah (Manager of Marine Fisheries World Ltd.).

Table 2. Abundance of Lessepsian fish species on the Libyan coast estimated by both scientific surveys and interviews with local fishermen.

| Species          | Eastern Region | Mid Region | Western Region |
|------------------|----------------|------------|----------------|
|                  | Tobruk  | Derna  | Benghazi | Raslanof | Sirte | Musrata | Tripoli |
| A. forskalii     | frequent | frequent | frequent | occasional | occasional | rare | rare |
| S. lessepsianus  | common | common | common | frequent | frequent | rare | rare |
| P. mento         | frequent | frequent | occasional | occasional | occasional | - | - |
| H. far           | common | common | frequent | frequent | occasional | occasional | occasional |
| S. rubrum        | frequent | frequent | occasional | occasional | occasional | - | - |
| H. punctatus     | common | common | common | frequent | occasional | - | - |
| L. carinata*     | occasional | occasional | occasional | - | rare | - | - |
| S. luridus       | common | common | common | common | common | common | common |
| S. rivalatus     | common | common | common | common | common | common | common |
| S. flavicuda*    | common | common | common | occasional | occasional | occasional | occasional |
| S. chrysotaenia* | common | common | common | frequent | occasional | occasional | occasional |
| S. commerson     | frequent | frequent | frequent | frequent | frequent | frequent | frequent |
| A. djedaba       | common | common | common | frequent | frequent | occasional | occasional |
| U. pori          | frequent | frequent | frequent | occasional | occasional | - | - |
| U. moluccensis   | common | common | common | frequent | occasional | occasional | occasional |
| C. crendens      | common | common | common | frequent | occasional | occasional | occasional |
| P. rhomboidea    | common | common | frequent | frequent | occasional | - | - |
| F. commersonii   | common | common | common | common | frequent | frequent | frequent |
| S. diaspros      | occasional | rare | rare | rare | rare | rare | rare |
| L. suezensis*    | frequent | frequent | frequent | frequent | occasional | - | - |
| L. scleratus     | frequent | frequent | frequent | frequent | occasional | - | - |

*For species with difficult taxonomical identification, estimation was based on scientific surveys only.

Acknowledgements

References

Abdul Malak, D., Livingstone, S., Pollard, D., Polidoro, B., Cuttelod A. et al., 2011. Overview of the Conservation Status of the Marine Fishes of the Mediterranean Sea. Gland, Switzerland and Malaga, Spain, IUCN VII, 61pp.

Al-Hassan, L.A.J., El-Silini, O.A., 1999. Check-list of bony fishes collected from the Mediterranean coast of Benghazi, Libya. Revista de Biologia Marina y Oceanografía, 34 (2), 291-301.

Azzurro, E., Moschella, P., Maynou, F., 2011. Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. PLoS One, 6 (9), e24885.

Azzurro, E., Tuset, V.M., Lombarte, A., Maynou, F., Simberloff, D. et al., 2014. External morphology explains the success of biological invasions. Ecology letters, 17 (11), 1455-1463.

Azzurro, E., Stancanelli, B., Di Martino, V., Bariche, M., 2017. Range expansion of the common lionfish Pterois miles
(Bennet, 1828) in the Mediterranean Sea: an unwanted new guest for Italian waters. *Bioinvasions Records*, 6, 95-98.

Azzurro, E., Bolognini, L., Dragičević, B., Drakulović, D., Dulčić, J. *et al.*, 2018. Detecting the occurrence of indigenous and non-indigenous megafauna through fishermen knowledge: A complementary tool to coastal and port surveys. *Marine pollution bulletin* (in press) doi: 10.1016/j.marpolbul.2018.01.016.

Badalamenti, F., Ben Amer, I., Dupuy De La Grandrive, R., Foulquie, M., Milazzo, M. *et al.*, 2011. *Scientific field survey report for the development of Marine Protected Areas in Libya*. 31pp.

Bariche, M., 2012. *Field identification guide to the living marine resources of the Eastern and Southern Mediterranean*. FAO Species Identification Guide for Fishery Purposes. Rome, FAO, 610 pp.

Bariche, M., Kazanjian, G., Azzurro, E., 2013. A lag of 25 years: evidence from an old capture of *Fistularia commersonii* Ruppell, 1838 from Lebanon (Mediterranean Sea). *Journal of Applied Ichthyology*, 30 (3), 535-536.

Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S. *et al.*, 2010. The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities. UNEP/MAP RAC/SPA, RAC/SPA, Tunis, 100 pp.

Beaudreux, A.H., Levin, P.S., 2014. Advancing the use of local ecological knowledge for assessing data-poor species in coastal ecosystems. *Ecological Applications*, 24 (2), 244-256.

Belhassan, A.M.A., Ali, R.A.S., Ali, A.M., El-Mor, M.E., 2017. Ent origins from Libya (Mediterranean Sea). *Rostocker Meeresbiologische Beiträge* 71, 6, 95-98.

Ben Abdallah, A., Ben Souissi, J., Méjri, H., Capapé, C., Golani, D., 2007. First record of *Cephalopholis taeniops* (Valenciennes) in the Mediterranean Sea. *Journal of Fish Biology*, 71 (2), 610-614.

Ben Abdallah, A., Al-Turky, A., Nafii, A., Shakman, E., 2011. A new record of a Lessepsian fish, *Lagocephalus suezensis* (Actinopterygii: Perciformes: Kyphosidae), in the coastal water of the Tripolitanian coast. Final Report. Part V: 1-44, and final report: Introduction and General Conclusions: 1-30.

Ben Abddallah, A., Al-Turky, A., El-Silini, O., Bashir, A.E., Azzurro, E., 2014. *Fistularia commersonii* Rüppell, 1838 in the Mediterranean Sea: filling the Libyan gap. *Journal of Applied Ichthyology*, 30 (5), 1047-1049.

Bilecenoglu, M., Taskavak, E., Mater, S., Kaya, M., 2002. Checklist of the marine fishes of Turkey. *Zootaxa*, 113, 1-194.

Boughdir, W., Rifi, M., Shakman, E., Maynou, F., Ghanem, R. *et al.*, 2015. Tracking the invasion of *Hemiramphus far* and *Saurida undosquamis* along the southern Mediterranean coasts: A Local Ecological Knowledge study. *Mediterranean Marine Science*, 16 (3), 628-635.

Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., Aguzzi, J. *et al*. 2010. The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. *PLoS ONE* 5 (8), e11842.

Contransimex, C., 1977. Final report concerning the results of the fisheries oceanographic survey, carried out by the Romanian researcher teams on board “Delta Dunarii” and “Gilort” in the eastern territorial waters of the Libyan Arab Republic between Ras Azzaz and Ras Kirkurra. II: 173-563.

Eschmeyer, W.N., Fricke, R., van der Laan R. (Eds), 2016. *Catalog of Fishes: Genera, Species, References. Electronic version*. http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. (Accessed 15 December 2016).

Elbarassi, H., Bograra, O., Elsilini, O., Bojwari, J., 2013. First record of the Bermuda sea chub, *Kyphosus saltatrix* (Actinopterygii: Perciformes: Kyphosidae), in the coastal water of Libya. *Acta Ichthyologica et Piscatoria*, 43 (3), 251-253.

Elbarassi, H., Bashir, A.E., Azzurro, E., 2014. *Fistularia commersonii* Rüppell, 1838 in the Mediterranean Sea: filling the Libyan gap. *Journal of Applied Ichthyology*, 30 (5), 1047-1049.

Fischer, W., Sheneider, M., Bauchet, M.L., 1987. *Mediterranee et Mer Noire Zone*. Des Nations Unies Pour L’Alimentation et L’Agriculture. FAO et CEE Rev. 1, Rome, Vol: II, 1288 pp.

Froese, R., Pauly, D. (Eds), 2016. *FishBase*. http://www.fishbase.org. (Accessed 20 June 2016).

Galigani, F., Chiffouleau, J.F., Barrah, M., Drebika, U., Tomasi-no, C. *et al.*, 2014. Assessment of heavy metal and organic contaminants levels along the Libyan coast using transplanted mussels (*Mytilus galloprovincialis*). *Environmental Science and Pollution Research*, 21,(19), 11331-11339.

Golani, D., Massuti, E., Orsi-Relimi, L., Quignard, J.P., Dulcic, J. *et al.*, 2017. CIESM atlas of exotic fish species. http://www.ciesm.org/atlases/appendix1.html (Accessed 28 September 2018).

Gorgy, S.A., Mugahid, A., Ali, R., 1972. Survey of the Libyan territorial waters and the adjacent international waters in the central Mediterranean. *Communication présentée au 23e Congrès-Assemblée Pleniere CIESM*, Athens 3-11 (4), 72 J.

Hammer, Ø., Harper, D.A.T., Ryan, P.D., 2001. *PAST-Paleontological statistics*. https://folk.uio.no/ohammer/past/ (Accessed March 2018).

Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppäkoski, E., Činár, M.E. *et al.*, 2014. Impacts of invasive alien marine species on ecosystem services and biodiversity: a pan-European review. *Aquatic Invasions*, 9 (4), 391-423.

Nelson, J., 2006. *Fishes of the World*. 4th edition. Wiley, Inc., 601pp.

Otero, M., Cebrian, E., Francour, P., Galil, B., Savini, D., 2013. *Monitoring Marine Invasive Species in Mediterranean Marine Protected Areas (MPAs): A strategy and practical guide for managers*. Malaga, Spain, IUCN, 136 pages.

Shakman, E.A., Kinzelbach, R., 2007a. Commercial fishery and fish species composition in coastal waters of Libya. *Rostocker Meeresbiologische Beiträge*, 18, 63-78.

Shakman, E.A., Kinzelbach, R., 2007b. Distribution and characterization of Lessepsian migrant fishes along the coast of Libya. *Acta Ichthyologica et Piscatoria*, 37 (1), 7-15.

Shakman, E., Ben Abdallah, A., Talha, F., Al-Faturi, A., Bariche, M., 2017. First records of seven marine organisms of different origins from Libya (Mediterranean Sea). *Bioinvasions Records*, 6 (4), 377-382.

Sogreah, E., 1977. *Trawl fishing ground survey off the Tripolitanian coast*. Final Report. Part V: 1-44, and final report: Introduction and General Conclusions: 1-30.