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## Updated checklist of bony fishes along the Libyan coast (southern Mediterranean Sea)

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### 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' (Elbarassi *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-

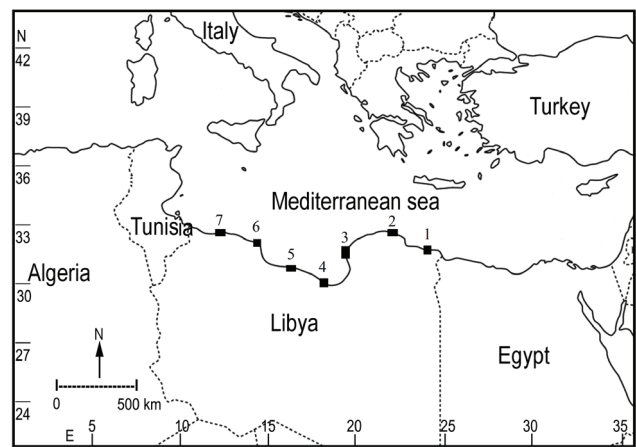
ogy Department of the Faculty of Science, University of Benghazi. A total of 12 surveys were carried out on-board local fishing vessels from December 2009 to December 2013, and fishery landings and local fish markets were periodically monitored during the same period. The study area included the major 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

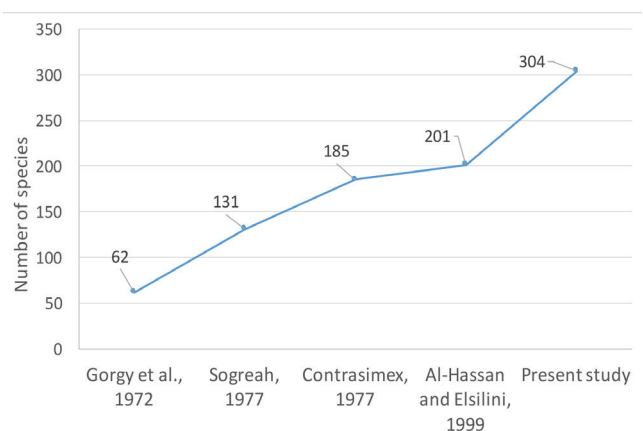


**Fig. 1:** Map showing the study area and locations where both fishery surveys and fishermen interviews were performed along the Libyan coast (1, Tobruk; 2, Derna; 3, Benghazi; 4, Raslanof; 5, Sirte; 6, Musrata; 7, Tripoli).

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 sev-

(continued on page 102)



**Fig. 2:** Number of species included in the previous checklists of Libyan fishes and in the present study.

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

(continued)

Table 1 (Continued)

|                                                                 | Common name                | Origin | Reference* |
|-----------------------------------------------------------------|----------------------------|--------|------------|
| <b>Stomiidae</b>                                                |                            |        |            |
| <i>Chauliodus sloani</i> Bloch & Schneider, 1801                | Sloane's viperfish         | N      | PS         |
| <i>Stomias boa boa</i> (Risso, 1810)                            | Boa dragonfish             | N      | PS         |
| <b>AULOPIFORMES</b>                                             |                            |        |            |
| <b>Aulopidae</b>                                                |                            |        |            |
| <i>Aulopus filamentosus</i> (Bloch, 1792)                       | Royal flagfin              | N      | HE         |
| <b>Chlorophthalmidae</b>                                        |                            |        |            |
| <i>Chlorophthalmus agassizi</i> Bonaparte, 1840                 | Shortnose greeneye         | N      | HE         |
| <b>Synodontidae</b>                                             |                            |        |            |
| <i>Saurida lessepsianus</i> Russell, Golani & Tikochinski, 2015 |                            | L      | HE         |
| <i>Synodus saurus</i> (Linnaeus, 1758)                          | Atlantic lizardfish        | N      | HE         |
| <b>Paralepididae</b>                                            |                            |        |            |
| <i>Arctozenus risso</i> (Bonaparte, 1840)                       | Spotted barracudina        | N      | PS         |
| <i>Lestidiops jayakari</i> (Boulenger, 1889)                    | Pacific barracudina        | N      | PS         |
| <i>Paralepis coregonoides</i> (Risso, 1820)                     | Sharpchin barracudina      | N      | PS         |
| <b>Evermannellidae</b>                                          |                            |        |            |
| <i>Evermannella balbo</i> (Risso, 1820)                         | Balbo sabretooth           | N      | PS         |
| <b>MYCTOPHIFORMES</b>                                           |                            |        |            |
| <b>Myctophidae</b>                                              |                            |        |            |
| <i>Benthoosema glaciale</i> (Reinhardt, 1837)                   | Glacier lantern fish       | N      | PS         |
| <i>Ceratoscopelus maderensis</i> (Lowe, 1839)                   | Madeira lantern fish       | N      | PS         |
| <i>Diaphus holti</i> Tåning, 1918                               | Small lantern fish         | N      | PS         |
| <i>Diaphus rafinesquii</i> (Cocco, 1838)                        | White-spotted lantern fish | N      | PS         |
| <i>Electrona risso</i> (Cocco, 1829)                            | Electric lantern fish      | N      | PS         |
| <i>Gonichthys cocco</i> (Cocco, 1829)                           | Cocco's lanternfish        | N      | PS         |
| <i>Hygophum benoiti</i> (Cocco, 1838)                           | Benoit's lanternfish       | N      | PS         |
| <i>Hygophum hygomii</i> (Lütken, 1892)                          | Bermuda lantern fish       | N      | PS         |
| <i>Lampanyctus crocodilus</i> (Risso 1810)                      |                            | N      | PS         |
| <i>Lampanyctus pusillus</i> (Johnson 1890)                      |                            | N      | PS         |
| <i>Lobianchia dofleini</i> (Zugmayer, 1911)                     | Dofleini's lantern fish    | N      | PS         |
| <i>Myctophum punctatum</i> Rafinesque, 1810                     | Spotted lanternfish        | N      | PS         |
| <i>Notoscopelus bolini</i> Nafpaktitis, 1975                    |                            | N      | PS         |
| <i>Symbolophorus veranyi</i> (Moreau, 1888)                     | Large-scale lantern fish   | N      | PS         |
| <b>LAMPRIFORMES</b>                                             |                            |        |            |
| <b>Lophotidae</b>                                               |                            |        |            |
| <i>Lophotus lacepede</i> (Giorna, 1809)                         | Crested oarfish            | N      | PS         |
| <b>Trachipteridae</b>                                           |                            |        |            |
| <i>Trachipterus trachipterus</i> (Gmelin, 1789)                 | Mediterranean dealfish     | N      | PS         |
| <i>Zu cristatus</i> (Bonelli, 1819)                             | Scalloped ribbonfish       | N      | PS         |
| <b>GADIFORMES</b>                                               |                            |        |            |
| <b>Macrouridae</b>                                              |                            |        |            |

(continued)

Table 1 (Continued)

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

(continued)

Table 1 (Continued)

|                                                      | Common name                    | Origin | Reference* |
|------------------------------------------------------|--------------------------------|--------|------------|
| <i>Atherina hepsetus</i> Linnaeus, 1758              | Mediterranean sand smelt       | N      | HE         |
| <i>Atherinomorus forskalii</i> (Rüppell, 1838)       | Red Sea hardyhead silverside   | L      | HE         |
| <b>CYPRONODONTIFORMES</b>                            |                                |        |            |
| <b>Cyprinodontidae</b>                               |                                |        |            |
| <i>Aphanius fasciatus</i> (Valenciennes, 1821)       | Mediterranean banded killifish | N      | HE         |
| <b>BELONIFORMES</b>                                  |                                |        |            |
| <b>Scomberesocidae</b>                               |                                |        |            |
| <i>Scomberesox saurus</i> (Walbaum, 1792)            | Atlantic saury                 | N      | HE         |
| <b>Belonidae</b>                                     |                                |        |            |
| <i>Belone belone</i> (Linnaeus, 1761)                | Garfish                        | N      | HE         |
| <b>Hemiramphidae</b>                                 |                                |        |            |
| <i>Hemiramphus far</i> (Forsskål, 1775)              | Black-barred halfbeak          | L      | PS         |
| <i>Hyporhamphus picarti</i> (Valenciennes, 1847)     | African halfbeak               | N      | HE         |
| <b>Exocoetidae</b>                                   |                                |        |            |
| <i>Cheilopogon heterurus</i> (Rafinesque, 1810)      | Mediterranean flyingfish       | N      | HE         |
| <i>Hirundichthys rondeletii</i> (Valenciennes, 1847) | Black wing flyingfish          | N      | PS         |
| <i>Parexocoetus mento</i> (Valenciennes, 1847)       | African sailfin flyingfish     | L      | HE         |
| <b>BERYCIFORMES</b>                                  |                                |        |            |
| <b>Trachichthyidae</b>                               |                                |        |            |
| <i>Hoplostethus mediterraneus</i> Cuvier, 1829       | Mediterranean slimehead        | N      | HE         |
| <b>Holocentridae</b>                                 |                                |        |            |
| <i>Sargocentron rubrum</i> (Forsskål, 1775)          | Redcoat                        | L      | HE         |
| <b>ZEIFORMES</b>                                     |                                |        |            |
| <b>Zeidae</b>                                        |                                |        |            |
| <i>Zeus faber</i> Linnaeus, 1758                     | John dory                      | N      | HE         |
| <b>SYNGNATHIFORMES</b>                               |                                |        |            |
| <b>Fistulariidae</b>                                 |                                |        |            |
| <i>Fistularia commersonii</i> Rüppell, 1838          | Bluespotted cornetfish (L)     | L      | PS         |
| <b>Centriscidae</b>                                  |                                |        |            |
| <i>Macroramphosus scolopax</i> (Linnaeus, 1758)      | Longspine snipefish            | N      | HE         |
| <b>Syngnathidae</b>                                  |                                |        |            |
| <i>Hippocampus guttulatus</i> Cuvier, 1829           | Long-snouted seahorse          | N      | HE         |
| <i>Hippocampus hippocampus</i> (Linnaeus, 1758)      | Short snouted seahorse         | N      | HE         |
| <i>Nerophis ophidion</i> (Linnaeus, 1758)            | Straightnose pipefish          | N      | PS         |
| <i>Syngnathus abaster</i> Risso, 1827                | Black-striped pipefish         | N      | HE         |
| <i>Syngnathus acus</i> Linnaeus, 1758                | Greater pipefish               | N      | HE         |
| <i>Syngnathus phlegon</i> Risso, 1827                |                                | N      | PS         |
| <i>Syngnathus typhle</i> Linnaeus, 1758              | Broadnosed pipefish            | N      | HE         |
| <b>SCORPAENIFORMES</b>                               |                                |        |            |
| <b>Sebastidae</b>                                    |                                |        |            |
| <i>Helicolenus dactylopterus</i> (Delaroche, 1809)   | Blackbelly rosefish            | N      | HE         |

(continued)

Table 1 (Continued)

|                                                          | Common name                | Origin | Reference* |
|----------------------------------------------------------|----------------------------|--------|------------|
| <b>Scorpaenidae</b>                                      |                            |        |            |
| <i>Scorpaena elongata</i> Cadenat, 1943                  | Slender rockfish           | N      | HE         |
| <i>Scorpaena loppei</i> Cadenat, 1943                    | Cadenat's rockfish         | N      | HE         |
| <i>Scorpaena maderensis</i> Valenciennes, 1833           | Madeira rockfish           | N      | PS         |
| <i>Scorpaena notata</i> Rafinesque, 1810                 | Small red scorpionfish     | N      | HE         |
| <i>Scorpaena porcus</i> Linnaeus, 1758                   | Black scorpionfish         | N      | HE         |
| <i>Scorpaena scrofa</i> Linnaeus, 1758                   | Red scorpionfish           | N      | HE         |
| <b>Dactylopteridae</b>                                   |                            |        |            |
| <i>Dactylopterus volitans</i> (Linnaeus, 1758)           | Flying gurnard             | N      | HE         |
| <b>Triglidae</b>                                         |                            |        |            |
| <i>Chelidonichthys cuculus</i> (Linnaeus, 1758)          | Red gurnard                | N      | HE         |
| <i>Chelidonichthys obscurus</i> (Walbaum, 1792)          | Longfin gurnard            | N      | HE         |
| <i>Eutrigla gurnardus</i> (Linnaeus, 1758)               | Grey gurnard               | N      | HE         |
| <i>Lepidotrigla cavillone</i> (Lacepède, 1801)           | Large-scaled gurnard       | N      | HE         |
| <i>Lepidotrigla dieuzeidei</i> Blanc & Hureau, 1973      | Spiny gurnard              | N      | PS         |
| <i>Trigla lyra</i> (Linnaeus, 1758)                      | Piper gurnard              | N      | HE         |
| <i>Trigloporus lastoviza</i> (Bonnaterre, 1788)          | Streaked gurnard           | N      | HE         |
| <b>Famiy Peristediidae</b>                               |                            |        |            |
| <i>Peristedion cataphractum</i> (Linnaeus, 1758)         | African armoured sear-obin | N      | HE         |
| <b>PERCIFORMES</b>                                       |                            |        |            |
| <b>Moronidae</b>                                         |                            |        |            |
| <i>Dicentrarchus labrax</i> (Linnaeus, 1758)             | European seabass           | N      | HE         |
| <i>Dicentrarchus punctatus</i> Bloch, 1792               | Spotted seabass            | N      | HE         |
| <b>Polyprionidae</b>                                     |                            |        |            |
| <i>Polyprion americanus</i> (Bloch & Schneider, 1801)    | Wreckfish                  | N      | HE         |
| <b>Serranidae</b>                                        |                            |        |            |
| <i>Anthias anthias</i> (Linnaeus, 1758)                  | Swallowtail seaperch       | N      | HE         |
| <i>Cephalopholis taeniops</i> (Valenciennes, 1828)       |                            | A      | BE         |
| <i>Epinephelus aeneus</i> (Geoffroy Saint-Hilaire, 1817) | White grouper              | N      | HE         |
| <i>Epinephelus caninus</i> (Valenciennes, 1843)          | Dogtooth grouper           | N      | HE         |
| <i>Epinephelus costae</i> (Steindachner, 1878)           | Goldblotch grouper         | N      | HE         |
| <i>Epinephelus fasciatus</i> (Forsskal, 1775)            | Blacktip grouper           | N      | HE         |
| <i>Epinephelus marginatus</i> (Lowe, 1834)               | Dusky grouper              | N      | HE         |
| <i>Hyporthodus haifensis</i> (Ben-Tuvia, 1953)           | Haifa grouper              | N      | HE         |
| <i>Mycteroperca rubra</i> (Bloch, 1793)                  | Mottled grouper            | N      | PS         |
| <i>Serranus cabrilla</i> (Linnaeus, 1758)                | Comber                     | N      | HE         |
| <i>Serranus hepatus</i> (Linnaeus, 1758)                 | Brown comber               | N      | HE         |
| <i>Serranus scriba</i> (Linnaeus, 1758)                  | Painted comber             | N      | HE         |
| <b>Callanthiidae</b>                                     |                            |        |            |
| <i>Callanthias ruber</i> (Rafinesque, 1810)              | Parrot seaperch            | N      | HE         |
| <b>Apogonidae</b>                                        |                            |        |            |
| <i>Apogon imberbis</i> (Linnaeus, 1758)                  | Cardinal fish              | N      | HE         |

(continued)

Table 1 (Continued)

|                                                           | Common name                  | Origin | Reference* |
|-----------------------------------------------------------|------------------------------|--------|------------|
| <b>Pomatomidae</b>                                        |                              |        |            |
| <i>Pomatomus saltatrix</i> (Linnaeus, 1766)               | Bluefish                     | N      | HE         |
| <b>Echeneidae</b>                                         |                              |        |            |
| <i>Echeneis naucrates</i> (Linnaeus, 1758)                | Live sharksucker             | N      | HE         |
| <i>Remora remora</i> (Linnaeus, 1758)                     | Shark sucker                 | N      | HE         |
| <b>Carangidae</b>                                         |                              |        |            |
| <i>Alectis alexandrina</i> (Geoffroy Saint-Hilaire, 1817) | Alexandria pompano           | N      | PS         |
| <i>Alepes djedaba</i> (Forsskål, 1775)                    | Shrimp scad                  | L      | PS         |
| <i>Campogramma glaycos</i> (Lacepède, 1801)               | Vadigo                       | N      | PS         |
| <i>Caranx crysos</i> (Mitchill, 1815)                     | Blue runner                  | N      | HE         |
| <i>Caranx hippos</i> (Linnaeus, 1766)                     | Crevalle jack                | N      | HE         |
| <i>Caranx rhonchus</i> Geoffroy Saint-Hilaire, 1817       | False scad                   | N      | HE         |
| <i>Lichia amia</i> (Linnaeus, 1758)                       | Leerfish                     | N      | HE         |
| <i>Naucrates ductor</i> (Linnaeus, 1758)                  | Pilotfish                    | N      | PS         |
| <i>Pseudocaranx dentex</i> (Bloch & Schneider, 1801)      | White trevally               | N      | HE         |
| <i>Seriola dumerili</i> (Risso, 1810)                     | Greater amberjack            | N      | HE         |
| <i>Seriola fasciata</i> (Bloch, 1793)                     | Lesser amberjack             | A      | SH         |
| <i>Seriola rivoliana</i> (Valenciennes, 1833)             | Longfin yellowtail           | A      | SH         |
| <i>Trachurus trachurus</i> (Linnaeus, 1758)               | Atlantic horse mackerel      | N      | HE         |
| <i>Trachurus picturatus</i> (Bowdich, 1825)               | Blue jack mackerel           | N      | HE         |
| <i>Trachurus mediterraneus</i> (Steindachner, 1868)       | Mediterranean horse mackerel | N      | HE         |
| <i>Trachinotus ovatus</i> (Linnaeus, 1758)                | Pompano                      | N      | HE         |
| <b>Coryphaenidae</b>                                      |                              |        |            |
| <i>Coryphaena hippurus</i> (Linnaeus, 1758)               | Common dolphinfish           | N      | HE         |
| <b>Bramidae</b>                                           |                              |        |            |
| <i>Brama brama</i> (Bonnaterre, 1788)                     | Atlantic pomfret             | N      | PS         |
| <b>Lobotidae</b>                                          |                              |        |            |
| <i>Lobotes surinamensis</i> (Bloch, 1790)                 | Tripletai                    | N      | PS         |
| <b>Haemulidae</b>                                         |                              |        |            |
| <i>Pomadasys incisus</i> (Bowdich, 1825)                  | Bastard grunt                | N      | HE         |
| <b>Sparidae</b>                                           |                              |        |            |
| <i>Boops boops</i> (Linnaeus, 1758)                       | Bogue                        | N      | HE         |
| <i>Crenidens crenidens</i> (Forsskål, 1775)               | Karanteen seabream           | L      | HE         |
| <i>Dentex dentex</i> (Linnaeus, 1758)                     | Common dentex                | N      | HE         |
| <i>Dentex maroccanus</i> (Valenciennes, 1830)             | Morocco dentex               | N      | HE         |
| <i>Dentex macrophthalmus</i> (Bloch, 1791)                | Large-eye dentex             | N      | HE         |
| <i>Dentex gibbosus</i> (Rafinesque, 1810)                 | Pink dentex                  | N      | HE         |
| <i>Diplodus annularis</i> (Linnaeus, 1758)                | Annular seabream             | N      | HE         |
| <i>Diplodus cervinus</i> (Lowe, 1838)                     | Zebra seabream               | N      | HE         |
| <i>Diplodus puntazzo</i> (Walbaum, 1792)                  | Sharpsnout seabream          | N      | HE         |
| <i>Diplodus sargus</i> (Linnaeus, 1758)                   | White seabream               | N      | HE         |

(continued)

Table 1 (Continued)

|                                                         | Common name                | Origin | Reference* |
|---------------------------------------------------------|----------------------------|--------|------------|
| <i>Diplodus vulgaris</i> (Geoffroy Saint-Hilaire, 1817) | Common two-banded seabream | N      | HE         |
| <i>Lithognathus mormyrus</i> (Linnaeus, 1758)           | Sand steenbras             | N      | HE         |
| <i>Oblada melanura</i> (Linnaeus, 1758)                 | Saddled seabream           | N      | HE         |
| <i>Pagellus acarne</i> (Risso, 1827)                    | Axillary seabream          | N      | HE         |
| <i>Pagellus bellottii</i> (Steindachner, 1882)          | Red Pandora                | N      | HE         |
| <i>Pagellus bogaraveo</i> (Brünnich, 1768)              | Blackspot seabream         | N      | HE         |
| <i>Pagellus erythrinus</i> (Linnaeus, 1758)             | Common Pandora             | N      | PS         |
| <i>Pagrus auriga</i> (Valenciennes, 1843)               | Redbanded seabream         | N      | HE         |
| <i>Pagrus caeruleostictus</i> (Valenciennes, 1830)      | Bluespotted seabream       | N      | HE         |
| <i>Pagrus pagrus</i> (Linnaeus, 1758)                   | Red porgy                  | N      | HE         |
| <i>Sarpa salpa</i> (Linnaeus, 1758)                     | Salema                     | N      | HE         |
| <i>Sparus aurata</i> (Linnaeus, 1758)                   | Gilthead seabream          | N      | HE         |
| <i>Spondylusoma cantharus</i> (Linnaeus, 1758)          | Black seabream             | N      | HE         |
| <b>Centracanthidae</b>                                  |                            |        |            |
| <i>Centracanthus cirrus</i> Rafinesque, 1810            | Curled picarel             | N      | HE         |
| <i>Spicara flexuosa</i> (Rafinesque 1810)               |                            | N      | HE         |
| <i>Spicara maena</i> (Linnaeus, 1758)                   | Blotched picarel           | N      | HE         |
| <i>Spicara smaris</i> (Linnaeus, 1758)                  | Picarel                    | N      | HE         |
| <b>Sciaenidae</b>                                       |                            |        |            |
| <i>Argyrosomus regius</i> (Asso, 1801)                  | Meagre                     | N      | PS         |
| <i>Sciaena umbra</i> Linnaeus, 1758                     | Brown meager               | N      | HE         |
| <i>Umbrina cirrosa</i> (Linnaeus, 1758)                 | Shi drum                   | N      | HE         |
| <i>Umbrina canariensis</i> (Valenciennes, 1843)         | Canary drum                | N      | HE         |
| <b>Mullidae</b>                                         |                            |        |            |
| <i>Mullus barbatus</i> Linnaeus, 1758                   | Red mullet                 | N      | HE         |
| <i>Mullus surmuletus</i> Linnaeus, 1758                 | Surmullet                  | N      | HE         |
| <i>Upeneus moluccensis</i> (Bleeker, 1855)              | Goldband goatfish          | L      | PS         |
| <i>Upeneus pori</i> Ben-Tuvia & Golani, 1989            | Por's goatfish             | L      | PS         |
| <b>Pempheridae</b>                                      |                            |        |            |
| <i>Pempheris rhomboidea</i> Kossman & Räuber, 1877      | Vanikoro sweeper           | L      | PS         |
| <b>Kyphosidae</b>                                       |                            |        |            |
| <i>Kyphosus sectatrix</i> (Linnaeus, 1758)              | Bermuda sea chub           | A      | EL         |
| <b>Cepolidae</b>                                        |                            |        |            |
| <i>Cepola macrophthalma</i> (Linnaeus, 1758)            | Red bandfish               | N      | HE         |
| <b>Mugilidae</b>                                        |                            |        |            |
| <i>Chelon labrosus</i> (Risso, 1827)                    | Thicklip grey mullet       | N      | HE         |
| <i>Liza aurata</i> (Risso, 1810)                        | Golden grey mullet         | N      | HE         |
| <i>Liza carinata</i> (Valenciennes, 1836)               | Keeled mullet              | L      | PS         |
| <i>Liza ramada</i> (Risso, 1827)                        | Thinlip grey mullet        | N      | HE         |
| <i>Liza saliens</i> (Risso, 1810)                       | Leaping mullet             | N      | HE         |
| <i>Mugil cephalus</i> Linnaeus, 1758                    | Flathead grey mullet       | N      | PS         |

(continued)

Table 1 (Continued)

|                                                   | Common name                  | Origin | Reference* |
|---------------------------------------------------|------------------------------|--------|------------|
| <i>Oedalechilus labeo</i> (Cuvier, 1829)          | Boxlip mullet                | N      | PS         |
| <b>Pomacentridae</b>                              |                              |        |            |
| <i>Chromis chromis</i> (Linnaeus, 1758)           | Damselfish                   | N      | HE         |
| <b>Labridae</b>                                   |                              |        |            |
| <i>Coris julis</i> (Linnaeus, 1758)               | Mediterranean rainbow wrasse | N      | HE         |
| <i>Ctenolabrus rupestris</i> (Linnaeus, 1758)     | Goldsinny-wrasse             | N      | PS         |
| <i>Labrus bergylta</i> Ascanius, 1767             | Ballan wrasse                | N      | HE         |
| <i>Labrus merula</i> Linnaeus, 1758               | Brown wrasse                 | N      | HE         |
| <i>Labrus mixtus</i> Linnaeus, 1758               | Cuckoo wrasse                | N      | HE         |
| <i>Labrus viridis</i> Linnaeus, 1758              |                              | N      | HE         |
| <i>Symphodus cinereus</i> (Bonnaterre, 1788)      | Grey wrasse                  | N      | HE         |
| <i>Symphodus doderleini</i> (Jordan, 1890)        |                              | E      | PS         |
| <i>Symphodus mediterraneus</i> (Linnaeus, 1758)   | Axillary wrasse              | N      | HE         |
| <i>Symphodus ocellatus</i> (Linnaeus, 1758)       |                              | N      | HE         |
| <i>Symphodus roissali</i> (Risso, 1810)           | Five-spotted wrasse          | N      | HE         |
| <i>Symphodus rostratus</i> (Bloch, 1791)          |                              | N      | HE         |
| <i>Symphodus tinca</i> (Linnaeus, 1758)           | East Atlantic peacock wrasse | N      | HE         |
| <i>Thalassoma pavo</i> (Linnaeus, 1758)           | Ornate wrasse                | N      | HE         |
| <i>Xyrichtys novacula</i> (Linnaeus, 1758)        | Pearly razorfish             | N      | HE         |
| <b>Scaridae</b>                                   |                              |        |            |
| <i>Sparisoma cretense</i> (Linnaeus, 1758)        | Parrotfish                   | N      | HE         |
| <b>Trachinidae</b>                                |                              |        |            |
| <i>Echiichthys vipera</i> (Cuvier, 1829)          | Lesser weever                | N      | HE         |
| <i>Trachinus araneus</i> Cuvier, 1829             | Spotted weever               | N      | HE         |
| <i>Trachinus draco</i> Linnaeus, 1758             | Greater weever               | N      | HE         |
| <i>Trachinus radiatus</i> Cuvier, 1829            | Starry weever                | N      | HE         |
| <b>Uranoscopidae</b>                              |                              |        |            |
| <i>Uranoscopus scaber</i> Linnaeus, 1758          | Stargazer                    | N      | HE         |
| <b>Clinidae</b>                                   |                              |        |            |
| <i>Clinitrachus argentatus</i> (Risso, 1810)      | Cline                        | N      | HE         |
| <b>Blenniidae</b>                                 |                              |        |            |
| <i>Blennius ocellaris</i> Linnaeus, 1758          | Butterfly blenny             | N      | HE         |
| <i>Lipophrys trigloides</i> (Valenciennes, 1836)  |                              | N      | HE         |
| <i>Parablennius incognitus</i> (Bath, 1968)       |                              | N      | HE         |
| <i>Parablennius sanguinolentus</i> (Pallas, 1814) | Rusty blenny                 | N      | PS         |
| <i>Salaria basilisca</i> (Valenciennes, 1836)     |                              | E      | HE         |
| <i>Salaria pavo</i> (Risso, 1810)                 | Peacock blenny               | N      | HE         |
| <b>Callionymidae</b>                              |                              |        |            |
| <i>Callionymus lyra</i> Linnaeus, 1758            | Dragonet                     | N      | HE         |
| <i>Callionymus maculatus</i> (Rafinesque, 1810)   |                              | N      | HE         |
| <i>Synchiropus phaeton</i> (Günther, 1861)        | Phaeton dragonet             | N      | PS         |

(continued)

Table 1 (Continued)

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

(continued)

Table 1 (Continued)

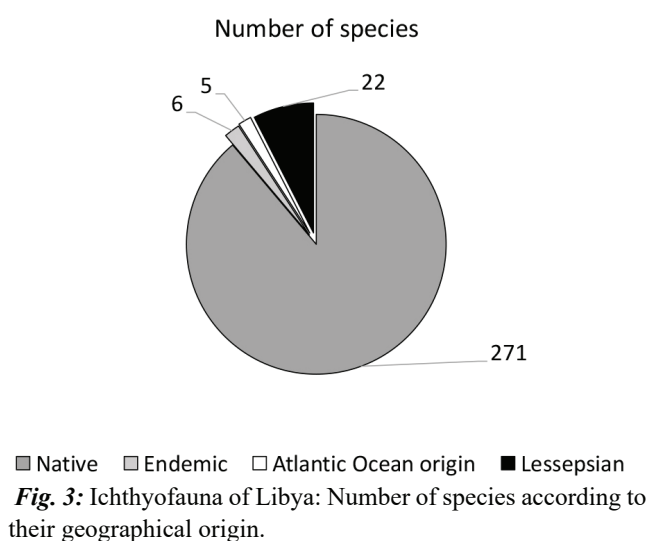
|                                                                 | Common name             | Origin | Reference* |
|-----------------------------------------------------------------|-------------------------|--------|------------|
| <i>Tetrapturus belone</i> Rafinesque, 1810                      | Mediterranean spearfish | E      | PS         |
| <b>Centrolophidae</b>                                           |                         |        |            |
| <i>Centrolophus niger</i> (Gmelin, 1789)                        | Rudderfish              | N      | PS         |
| <b>Stromateidae</b>                                             |                         |        |            |
| <i>Stromateus fiatola</i> Linnaeus, 1758                        | Blue butterfish         | N      | PS         |
| <b>Caproidae</b>                                                |                         |        |            |
| <i>Capros aper</i> (Linnaeus, 1758)                             | Boarfish                | N      | PS         |
| <b>PLEURONECTIFORMES</b>                                        |                         |        |            |
| <b>Citharidae</b>                                               |                         |        |            |
| <i>Citharus linguatula</i> (Linnaeus, 1758)                     | Spotted flounder        | N      | HE         |
| <b>Scophthalmidae</b>                                           |                         |        |            |
| <i>Lepidorhombus boschii</i> (Risso, 1810)                      | Four-spot megrim        | N      | HE         |
| <i>Lepidorhombus whiffiagonis</i> (Walbaum, 1792)               | Megrim                  | N      | HE         |
| <i>Scophthalmus maximus</i> (Linnaeus, 1758)                    | Turbot                  | N      | PS         |
| <i>Scophthalmus rhombus</i> (Linnaeus, 1758)                    | Brill                   | N      | HE         |
| <b>Bothidae</b>                                                 |                         |        |            |
| <i>Arnoglossus imperialis</i> (Rafinesque, 1810)                | Imperial scaldfish      | N      | PS         |
| <i>Arnoglossus kessleri</i> (Schmidt, 1915)                     | Scaldback               | N      | PS         |
| <i>Arnoglossus laterna</i> (Walbaum, 1792)                      | Mediterranean scaldfish | N      | HE         |
| <i>Arnoglossus rueppelii</i> (Cocco, 1844)                      | Rüppell's scaldback     | N      | HE         |
|                                                                 | Common name             | Origin | Reference* |
| <i>Arnoglossus thori</i> (Kyle, 1913)                           | Thor's scaldfish        | N      | HE         |
| <i>Bothus podas</i> (Delaroche, 1809)                           | Wide-eyed flounder      | N      | HE         |
| <b>Pleuronectidae</b>                                           |                         |        |            |
| <i>Platichthys flesus</i> (Linnaeus, 1758)                      | European flounder       | N      | PS         |
| <b>Soleidae</b>                                                 |                         |        |            |
| <i>Buglossidium luteum</i> (Risso, 1810)                        | Solenette               | N      | PS         |
| <i>Dicologlossa cuneata</i> (Moreau, 1881)                      | Wedge sole              | N      | HE         |
| <i>Microchirus ocellatus</i> (Linnaeus, 1758)                   | Foureyed sole           | N      | HE         |
| <i>Microchirus variegatus</i> (Donovan, 1808)                   | Thickback sole          | N      | PS         |
| <i>Monochirus hispidus</i> (Rafinesque, 1814)                   | Whiskered sole          | N      | HE         |
| <i>Pegusa lascaris</i> (Risso, 1810)                            | Sand sole               | N      | HE         |
| <i>Solea aegyptiaca</i> (Chabanaud, 1927)                       | Egyptian sole           | N      | HE         |
| <i>Solea solea</i> (Linnaeus, 1758)                             | Common sole             | N      | HE         |
| <i>Synaptura lusitanica lusitanica</i> (de Brito Capello, 1868) | Portuguese sole         | N      | HE         |
| <i>Synapturichthys kleinii</i> (Risso, 1827)                    | Klein's sole            | N      | HE         |
| <b>Cynoglossidae</b>                                            |                         |        |            |
| <i>Symphurus ligulatus</i> (Cocco, 1844)                        | Elongate tonguesole     | N      | HE         |
| <i>Symphurus nigrescens</i> (Rafinesque, 1810)                  | Tonguesole              | N      | HE         |
| <b>TETRAODONTIFORMES</b>                                        |                         |        |            |
| <b>Balistidae</b>                                               |                         |        |            |
| <i>Balistes capriscus</i> Gmelin, 1789                          | Grey triggerfish        | N      | HE         |
| <b>Monacanthidae</b>                                            |                         |        |            |

(continued)

Table 1 (Continued)

|                                                          | Common name               | Origin | Reference* |
|----------------------------------------------------------|---------------------------|--------|------------|
| <i>Stephanolepis diaspros</i> Fraser-Brunner, 1940       | Reticulated leatherjacket | L      | HE         |
| <b>Tetraodontidae</b>                                    |                           |        |            |
| <i>Lagocephalus lagocephalus</i> (Linnaeus, 1758)        | Oceanic puffer            | N      | PS         |
| <i>Lagocephalus sceleratus</i> (Gmelin, 1789)            | Silver-cheeked toadfish   | L      | PS         |
| <i>Lagocephalus suezensis</i> (Clark & Gohar, 1953)      |                           | L      | PS         |
| <i>Sphoeroides pachygaster</i> (Müller & Troschel, 1848) | Blunthead puffer          | A      | SH         |
| <b>Molidae</b>                                           |                           |        |            |
| <i>Mola mola</i> (Linnaeus, 1758)                        | Ocean sunfish             | N      | PS         |
| <i>Ranzania laevis</i> (Pennant, 1776)                   | Slender sunfish           | N      | PS         |

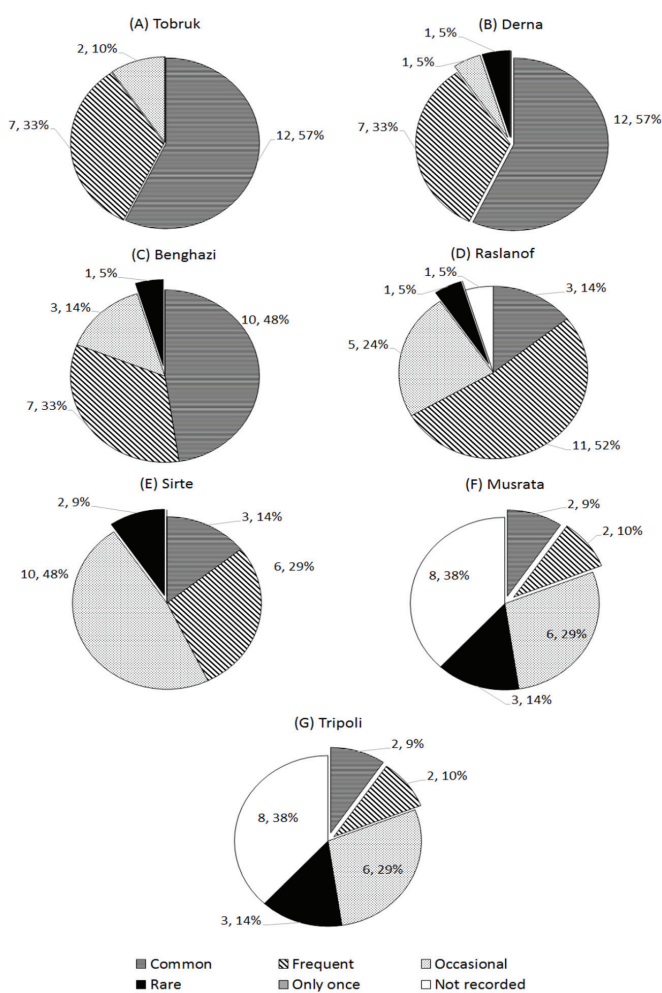
\* HE= Al-Hassan and Elsilini; 1999; PS = Present study; SH= Shakman *et al.*, 2017; EL= Elbaraasi *et al.*, 2013; BE= Ben Abdallah *et al.*, 2007.



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

(continued from page 91)

eral 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. forskalii*, *H. far*, *S. commerson*, *U. pori*, *P. rhomboidea*, *L. suezensis*, *L. sceleratus*) were



**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.

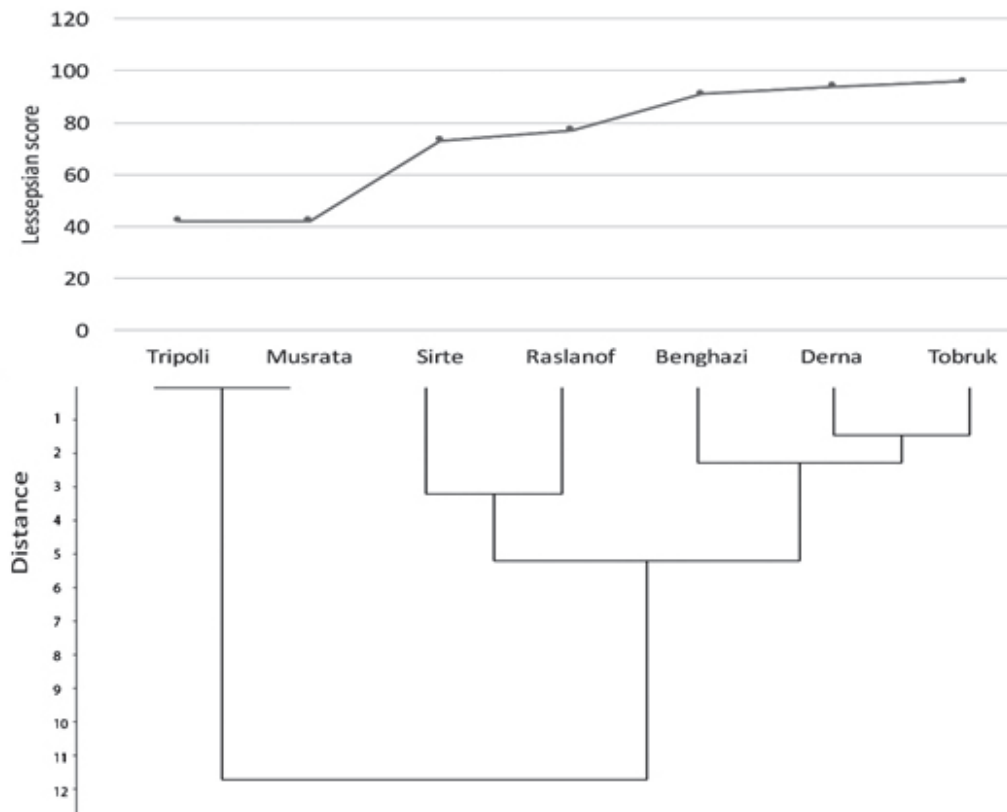
'frequent'; and 10 species (*S. lessepsianus*, *H. punctatus*, *S. luridus*, *S. rivulatus*, *S. obtusata*, *S. pinguis*, *A. djedaba*, *U. moluccensis*, *C. crenidens*, *F. commersonii*)

were 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 gobiidae, blennidae, trypterigidae and gobiesocidae 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.

**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    |
| <i>A. forskalii</i>     | frequent       | frequent   | frequent   | occasional | occasional | rare           | rare       |
| <i>S. lessepsianus</i>  | common         | common     | common     | frequent   | frequent   | rare           | rare       |
| <i>P. mento</i>         | frequent       | frequent   | occasional | occasional | occasional | -              | -          |
| <i>H. far</i>           | common         | common     | frequent   | frequent   | occasional | occasional     | occasional |
| <i>S. rubrum</i>        | frequent       | frequent   | occasional | occasional | occasional | -              | -          |
| <i>H. punctatus</i>     | common         | common     | common     | frequent   | occasional | -              | -          |
| <i>L. carinata*</i>     | occasional     | occasional | occasional | -          | rare       | -              | -          |
| <i>S. luridus</i>       | common         | common     | common     | common     | common     | common         | common     |
| <i>S. rivulatus</i>     | common         | common     | common     | common     | common     | common         | common     |
| <i>S. flavicauda*</i>   | common         | common     | common     | occasional | occasional | occasional     | occasional |
| <i>S. chrysotaenia*</i> | common         | common     | common     | frequent   | occasional | occasional     | occasional |
| <i>S. commerson</i>     | frequent       | frequent   | frequent   | frequent   | frequent   | frequent       | frequent   |
| <i>A. djedaba</i>       | common         | common     | common     | frequent   | frequent   | occasional     | occasional |
| <i>U. pori</i>          | frequent       | frequent   | frequent   | occasional | occasional | -              | -          |
| <i>U. moluccensis</i>   | common         | common     | common     | frequent   | frequent   | occasional     | occasional |
| <i>C. crenidens</i>     | common         | common     | common     | frequent   | frequent   | occasional     | occasional |
| <i>P. rhomboidea</i>    | common         | common     | frequent   | frequent   | frequent   | -              | -          |
| <i>F. commersonii</i>   | common         | common     | common     | common     | common     | frequent       | frequent   |
| <i>S. diaspros</i>      | occasional     | rare       | rare       | rare       | rare       | rare           | rare       |
| <i>L. suezensis*</i>    | frequent       | frequent   | frequent   | frequent   | occasional | -              | -          |
| <i>L. scleratus</i>     | frequent       | frequent   | frequent   | frequent   | occasional | -              | -          |

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

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## 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 Oceanografia*, 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* Rüppell, 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.
- Beaudreau, 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. Species Composition, Relative Abundance and Length-Weight Relationship of Ten Exotic Fishes from Eastern Libya Mediterranean Sea Coast. *Journal of Global Scientific Research* 2, 13-23.
- 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., Nafti, A., Shakman, E., 2011. A new record of a Lessepsian fish, *Lagocephalus suezensis* (Actinopterygii: Tetraodontiformes: Tetraodontidae), in the south Mediterranean (Libyan coast). *Acta Ichthyologica et Piscatoria*, 41 (1), 71-72.
- Bilecenoglu, M., Taskavak, E., Mater, S., Kaya, M., 2002. Checklist of the marine fishes of Turkey. *Zootaxa*, 113, 1-194.
- Boughedir, 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 Karkura*. 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).
- Elbaraasi, 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. *Mediterranean 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).
- Galgani, F., Chiffolleau, J.F., Barrah, M., Drebiha, U., Tomasino, 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., Massutí, E., Orsi-Relini, L., Quignard, J.P., Dulcic, J. *et al.*, 2017. CIESM atlas of exotic fish species. <http://www.ciesm.org/atlas/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 Plénière CIESM*, Athens 3-11 (4), 72 J.
- Hammer, Ø., Harper, D.A.T., Ryan, P.D., 2001. *PAST-Palaeontological statistics*. <https://folk.uio.no/ohammer/past/> (Accessed March 2018).
- Katsanevakis, S., Wallentinus, I., Zenetos, A., Leppäkoski, E., Çinar, M.E. *et al.*, 2014. Impacts of invasive alien marine species on ecosystem services and biodiversity: a pan-European review. *Aquatic Invasions*, 9 (4), 391-423.
- Nelson, J., 2006. *Fishes of the World*. 4<sup>th</sup> 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.