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An updated Checklist of Marine fishes from Syria with an emphasis on alien species

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Abstract

An updated checklist of marine ichthyofauna recorded to date from Syrian marine waters, including 298 species (belonging to 220 genera, 111 families, 36 orders, and 3 classes) is presented. Sparidae is the dominant family (28 species), followed by Blenniidae (15 species), while 55 families are represented by 1 species. The Chondrichthyes present in Syria were cross-checked for the first time. The status, frequency, main fishing gear targeting common species, in addition to the fishing method by which the rare species were caught, are also provided. *Four species are recorded herein for the first time: Stomias boa boa* (Risso, 1810), *Hymenocephalus italicus* Giglioli, 1884, *Scarus ghobban* Forsskal, 1775, and *Nettastoma melanurum* Rafinesque, 1810. This inventory includes 56 Lessepsian migrant species, with 16 of them being considered very common and of positive economic importance. *Alien species have been grouped into three categories, namely, established (49 species), casual (2 species) and single records (5 species).* Twenty-eight species were excluded from this list, due to lack of reliable documentation on their presence

Keywords: Marine fishes; checklist; Syria; Eastern Levant; Mediterranean.

Introduction

The Syrian coast lies at the edge of the eastern Mediterranean, between Turkey to the north and Lebanon to the south, facing the island of Cyprus. The Eastern Mediterranean Sea is characterized by high salinities and high temperature. In the Mediterranean, salinity exhibits an eastward increase, from approximately 37.5‰ in the west to 39.5‰ in the east; temperature increases from west to east, ranging from 15 to 26°C (Skliris, 2014; EEA, 2006).

The Mediterranean Sea has a long history of bioinvasions. During the last few decades, many new species have been discovered in the Mediterranean Sea. The upward trend in new arrivals since 1950, which culminated during the 2001-2010 period (Zenetos *et al*., 2017), appears to be decreasing (Zenetos, 2017). The main reasons for new arrivals are associated with Lessepsian migration, Atlantic influx, intentional or unintentional introduction as well as climate change. By 2016, the total number of reported multicellular alien species reached 821 (Zenetos *et al*., 2017). Lessepsian migration encompasses almost all marine taxa, including more than six hundred species (Zenetos *et al*., 2010). By 2017, the number of alien fish species reached 102 (Fricke *et al*., 2017).

Gruvel (1931) was the first specialist to report on the marine ichthyofauna of the Eastern Mediterranean Sea. Fourty years later, a local study was carried out on the marine ichthyofauna from the Syrian coast (Anonymous, 1976). Unfortunately, there are no preserved specimens of the species pertaining to these studies. During the last three decades, several studies have been carried out sporadically, and all recorded species have been documented with voucher specimens, photographs, and scientific publications.

Two major comprehensive field studies were carried out within the framework of a master's degree. The first one was on Osteichthyes (Sbaihi, 1994) and the second on Chondrichthyes (Ali, 2003). Several other studies have been carried out in the area in recent years (Saad, 2005; Ghanem *et al*., 2012; Hallom *et al*., 2014; Sabour *et al.,* 2014; Galiya *et al.,* 2015; Capape & Ali, 2017; Ali *et al*., 2017a, b), with some published in Arabic (with abstracts in English or French).

Most of the fish species that entered Syrian waters in the last decades are Lessepsian migrants. Scientific research curried out along the Syrian coast, combined with reports by fishers, within the context of local ecological knowledge, confirm that several alien species are

successfully established in the area, with some of them becoming invasive alien species (Ali *et al.,* 2017a; Ali *et al*., 2017b). Saad (2005) recorded 37 lessepsian fish species, while Ibrahim *et al*. (2010) reported 42 alien species.

The current work provides a validated updated checklist of Syrian ichyofauna that could serve as a baseline for future monitoring and assessment of potential biodiversity changes in this area.

Materials and Methods

The current updated checklist is based on information collected from taxonomic studies, which were carried out in Syrian marine waters, using various types of fishing gear (183km), between latitudes 34.63333333° & 35.96666667° N; and longitudes 35.50000000 ° & 35.95000000° E (Fig. 1).

Only documented records that have been confirmed by preserved samples, photographs, and scientific publications, are included on this list. The presence of each species has been validated by checking at least one published scientific paper. The main sources used were University theses, articles, conference proceedings, and reports of scientific missions. The preserved specimens were deposited in the Ichthyological Collection of the Marine Sciences Laboratory (M.S.L.), Faculty of Agriculture at Tishreen University, Syria, under catalogue numbers, or in other laboratories at the same University. Records based only on human observation, without actual evidence of their presence, were excluded and considered incomplete records, as further verification is required.

The previous checklist published by Saad (2005) was used as a baseline for the Osteichthyes. However, the taxonomical categories have been updated, new records were added, and synonymized taxa were re-assessed in the light of recently published studies. The Chondrichthyes species were checked for the first time.

The orders and families are arranged in accordance with Weigmann, 2016; Last *et al.*, 2016; Nelson *et al*., 2016; Van Der Laan *et al*., 2014, and the version of Catalog of Fishes database [Catalog of fishes classification, 2018. https:// www.calacademy.org/ scientists/catalog-of-fishes-classification, (accessed 10 January 2018)]. Within each family, species were classified in alphabetical order.

Single records are reported with the date of first detection and location. Abundance categorization for the Syrian coasts as follows: in Chondrichthyes, "rare" corresponds to 1-30 annual findings, "frequent" corresponds to 31- 350 annual findings and "common" corresponds to more than 350 annual findings. In Osteichthyes, "rare" corresponds to 1- 700 annual findings, "frequent" corresponds to 701- 3000 annual findings and "common" corresponds to more than 3000 annual findings. This scale is used for both the native and alien species. Alien species were grouped into three categories, namely, established (at least two records in the area spread over time and space), casual (only one record, but older than two years) and single records (recent records < two years).

Results and Discussion

The results of all documented records of ichthyofauna species from Syrian marine waters are listed in Table 2. Further details on alien species are provided in Table 3.

A total of 298 documented species have been recorded from Syrian waters (40 Elasmobranchii; 2 Holocephali and 256 Actinopterygii), belonging to 36 orders, 111 families (Table 1). Among the families of Elasmobranchii, Dasyatidae was the most diverse (5 species), followed by Rajidae (4 species).Among the families of Actinopterygii, Sparidae and Blenniidae (28 and 15 species, respectively) were the most diverse, while 17 families were represented by two species and 55 families by only one species.

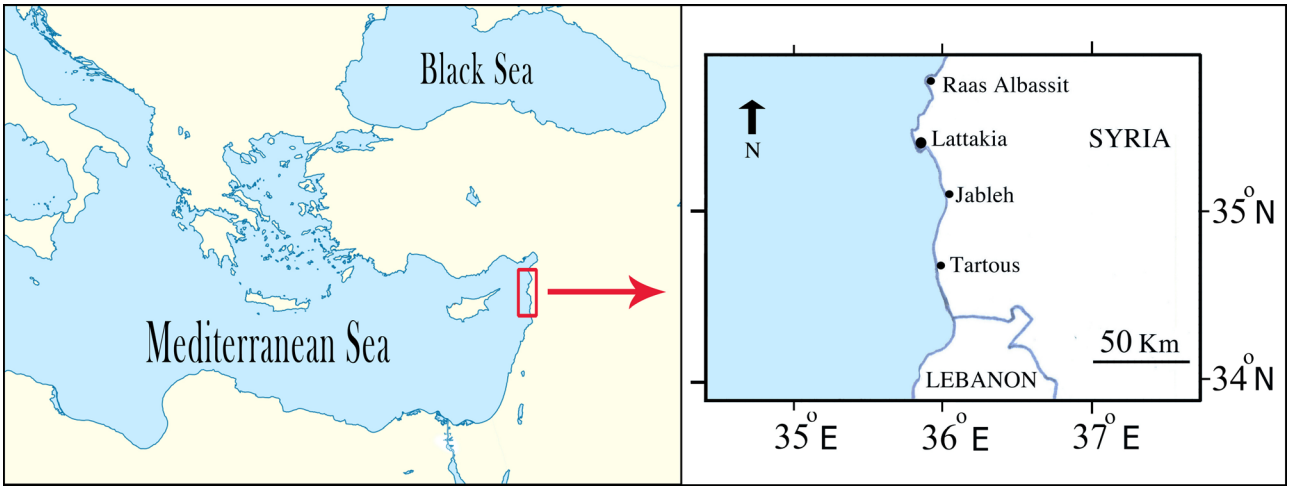

Fig. 1: Map of the Mediterranean showing the study area (Syrian coast).

Fifty-six species are Lessepsian migrants (have entered the Levantine Sea via the Suez Canal).

The number of species recorded along the Syrian coast is lower than the number of species recorded in the waters of neighbouring countries. Golani (2005) reported 402 fish species from Israel, while 441 species were recorded along the Levant coasts of Turkey (Bilecenoğlu *et al*., 2014) and 364 along the Mediterranean coast of Egypt (Akel & Karachle, 2017). This could be attributed to the limited number of taxonomic studies that have been carried out in Syria, as well as the lack of sampling efficiency of the fishing gear used. Moreover, the deep–sea species of this region have not been studied sufficiently. This leads us to the hypothesis that many species are yet unreported in Syrian waters.

While compiling the checklist, some taxonomical corrections were made. For example, *Saurida lessepsianus* Russell *et al*. (2015), was previously misidentified as *Saurida undosquamis* (Richardson, 1848) (Russell *et al.*, 2015). *Pteragogus trispilus* Randall, 2013 was primarily identified as *Pteragogus pelycus* Randall, 1981. Also, *Etrumeus golanii* DiBattista, Randall & Bowen, 2012, *Atherinomorus forskalii* (Rüppell, 1838), and *Pempheris rhomboidea* Kossmann & Räuber, 1877, were previously misidentified as *Etrumeus sadina* (Mitchill, 1814), *Atherinomorus pinguis* (Lacepède, 1803) and *Pempheris vanicolensis* Cuvier, 1831, respectively.

The classification of many species was updated and revised; previous literature reported that Rhinopristiformes are represented in Syrian marine waters by one family (Rhinobatidae), which was represented by one genus (Rhinobatos) and two species, namely, *Rhinobatos rhinobatos* (Linnaeus, 1758) and *R. cemiculus* (Ali, 2003; Saad *et al.*, 2004; Saad *et al*., 2006). In this work, Rhinopristiformes are represented by two families, Rhinobatidae and Glaucostegidae, each being represented by one genus and one species (Table2); *Rhinobatos cemiculus* had been moved to Glaucostegidae as *Glaucostegus cemiculus*, according to Last *et al.* (2016) and Weigmann (2016). *Centrophorus acus* Garman, 1906, and *Centrophorus machiquensis* Maul, 1955, which were recorded by Ali (2003), are not included on this list, because these two species were considered as synonyms of *Centrophorus granulosus* (Bloch & Schneider, 1801) by Weigmann (Weigmann, 2016).

Four species from Syrian waters are reported for the first time in this work. These are: *Hymenocephalus italicus* Giglioli, 1884, *Nettastoma melanurum* Rafinesque, 1810, *Scarus ghobban* Forsskal, 1775, and *Stomias boa boa* (Risso, 1810) (Fig. 2). All specimen measurements for these records were carried out using a digital calliper to the nearest 0.1 mm; weights were measured to the nearest 0.1 g, and the specimens were preserved in 10% buffered formalin at the Ichthyological collection of the M.S.L.

Hymenocephalus italicus: three specimens were captured (only one specimen was deposited, 123.8 mm TL; 2323 M.S.L.) during a trawling expedition, on 11 December 2017; the depth ranged between 470 and 610 m; capture location from 35.46666667 N, 35.65000000 E to 35.38333333 N, 35.68333333 E.

Nettastoma melanurum: two specimens were captured (only one specimen was deposited, 398.1 mm TL; 2324 M.S.L.) during a trawling expedition, on 11 December 2017; the depth ranged between 470 and 610 m; capture location from 35.46666667 N, 35.65000000 E to 35.38333333 N, 35.68333333 E.

Scarus ghobban: On 1 October 2013, the first specimen was captured (34.86666667 N, 35.80000000 E) on sandy bottom, at a depth of35 m, using a bottom cage, and deposited (193.0 mm, TL; 2275 M.S.L.) (Ahmad Soliman, personal communication). Another specimen was

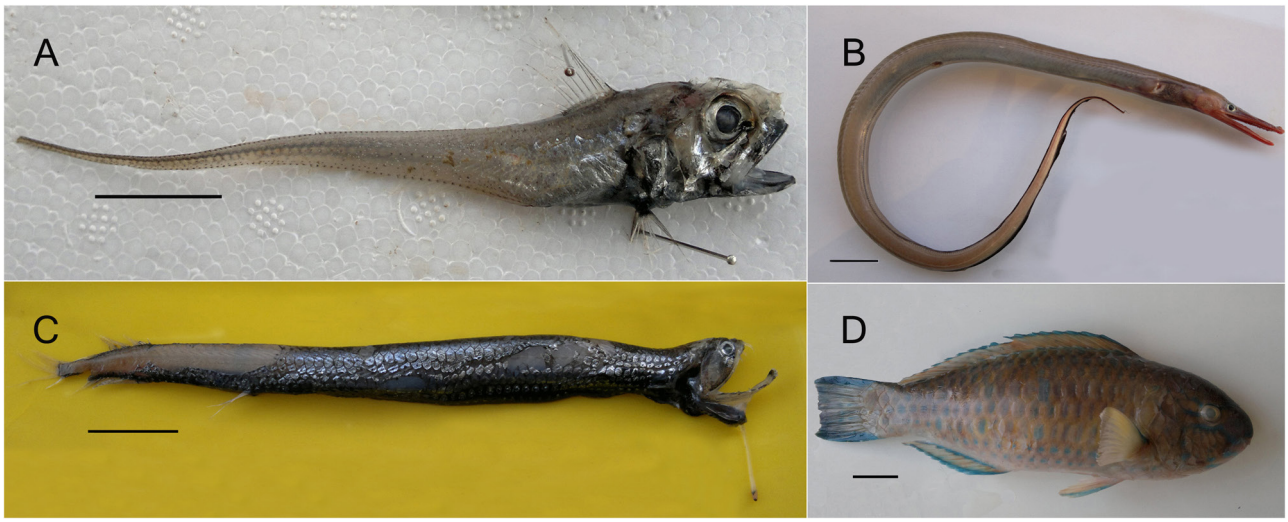

Fig. 2: The specimens of the new records from the Syrian coast, A: *Hymenocephalus italicus*; B: *Nettastoma melanurum*; C: *Stomias boa boa*; D: *Scarus ghobban*. Scale bar = 20 mm.

captured on 2 June 2015 (35.10000000 N, 35.81666667 E), using a bottom trawl net at a depth of 40 m. Since 2016, this species occurs frequently in fishery production.

Stomias boa boa: two specimens (185.3 mm, 176.7 mm, TL; 2319 and 2320 M.S.L., respectively) were captured on 2 November 2017, during a trawling expedition that started from Latakia city and ended opposite Banias city (between 35.51666667 N, 35.65000000 E and 35.25000000 N, 35.75000000 E) at depth of about 550 m, on a bottom ranging from sandy to muddy.

Twenty eight species were excluded from this work as they were not substantially documented. These include 24 species (table 4) whose record by Foulquie & Dupuy de la Grandrive (2003) was based only on information provided by fishermen, with no further documentation, while another four species, namely, *Phycis blennoides* (Brünnich, 1768), *Blennius ocellaris* Linnaeus, 1758, *Campogramma glaycos* (Lacepède, 1801) and *Epinephelus caninus* (Valenciennes, 1843), reported in previous studies, are not included in this updated checklist, because there are no preserved specimens of these species, and subsequent studies have not confirmed their presence in Syrian waters.

Fourteen species of Atlantic origin, which were reported as alien (Saad, 2005), were removed from the alien species list because their presence can be explained by natural range expansion via Gibraltar rather than human-mediated introductions according to Zenetos *et al*. (2012).

In this work only two species [*T. sinuspersici* Olfers, 1831, and *Hydrolagus mirabilis* (Collett, 1904)] were considered as casual records. *Squalus megalops* (Macleay, 1881), *Torpedo sinuspersici* Olfers, 1831, and *Siganus javus* (Linnaeus, 1766) have been discussed in the previous literature and considered as casual or questionable records for various reasons (Zenetos *et al*., 2005; 2010; 2011). *Squalus megalops* is distributed throughout the Mediterranean Sea (Ebert & Stehmann, 2013); it has been recorded in the Mediterranean Sea (Muñoz-Chápuli & Ramos,1989), in the Eastern Mediterranean (Ali, 2003), and along the Tunisian coast (Marouani *et al*., 2012). According to the literature, there are unresolved taxonomic problems associated with these species. Marouani *et al*. (2012) reported that Duffy & Last (2007) and Last & Stevens (1994) suggested that it may belong to a species complex, and stated that records of *Squalus megalops* outside Australia need to be confirmed. *Torpedo sinuspersici:* a single record (Ali, 2003), the discovery was made on 19 May 2002; one specimen was captured at a depth of about 260 m, 700 m opposite the Jableh city coast, and preserved at the M.S.L. (395 mm T.L, 1270 g. T.W., 236 M.S.L.). No additional records since 2002. Thus, continued monitoring of this species is necessary to confirm its presence or absence. Unlike the situation of *Himantura uarnak* (Gmelin 1789), which was found in 2008 (Ali *et al*., 2010), additional occurrences were reported on 15 April 2012 (Ali *et al*., 2013c) and 20 April 2015.

Sixteen of the alien fish species are considered very common and of positive economic importance: *Alepes djedaba, Atherinomorus forskalii, Dussumieria elopsoides, Fistularia commersonii, Hemiramphus far, Herklotsichthys punctatus, Liza carinata, Parupeneus forsskali, Sargocentron rubrum, Saurida lessepsianus, Scomberomorus commerson, Siganus luridus, Siganus rivulatus, Sphyraena chrysotaenia, Upeneus moluccensis, Upeneus pori.*

On the other hand, *Callionymus filamentosus, Lagocephalus Sceleratus, Lagocephalus spadiceus, Lagocephalus suezensis, Silhouettea aegyptia, Plotosus lineatus, Pterois miles* and *Stephanolepis diaspros* are of no economic importance. Some of them are considered pests; by-catch that is discarded. For example, *Lagocephalus sceleratus*, *Plotosus lineatus* and *Pterois miles*, despite being relatively new invaders (first records from the Syrian coast 2014, 2015, 2016, respectively), have become abundant and well-established. They have dramatic effects on native fish species, including the destruction of ecosystems and negative economic impacts on fisheries and tourism, as they present a potential risk to humans. Fishermen have to avoid these species, because they contain tetrodotoxin. Since the arrival of *L. sceleratus* along the Syrian coast, it has caused several fatalities, as well as damage to fishing gear.

To conclude, a total of 298 species have been recorded until November 2017, 56 of which have been classified as alien species (19.1%). The true number of fish is likely to be much higher considering that 28 are reported but undocumented (Foulquie & Dupuy de la Grandrive, 2003) and many more are already present in neighbouring countries (Bilecenoğlu *et al*., 2014).

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