International Journal of Ecotoxicology and Ecobiology
2016; 1(1): 13-19
http://www.sciencepublishinggroup.com/j/pst
doi: 10.11648/j.ijee.20160101.12

Puffer Fish Catch in the Egyptian Mediterranean Coast "The Challenged Invaders"

Alaa A. K. El-Haweet[1], Mahmoud M. S. Farrag[2, *], El-SayedKh. A. Akel[3], Mohsen A. Moustafa[2]

[1]College of Fisheries Technology and Aquaculture, Arab Academy for Science, Technology and Maritime transportation, Alexandria, Egypt

[2]Zoology Department, Faculty of Science, Al-Azhar University (Assiut Branch), Assiut, Egypt

[3]Fisheries Division, National Institute of Oceanography & Fisheries, Alexandria, Egypt

Email address:

m_mahrousfarrag@yahoo.com (M. M. S. Farrag)

*Corresponding author

To cite this article:

Alaa A. K. El-Haweet, Mahmoud M. S. Farrag, El-SayedKh. A. Akel, Mohsen A. Moustafa. Puffer Fishes Catch in the Egyptian Mediterranean Coast "The Challenged Invaders". *International Journal of Ecotoxicology and Ecobiology*. Vol. 1, No. 1, 2016, pp. 13-19.
doi: 10.11648/j.ijee.20160101.12

Received: May 24, 2016; **Accepted**: June 3, 2016; **Published**: June 20, 2016

Abstract: Catch per unit effort (CPUE) and distribution of puffer fishes along the Egyptian Mediterranean coast were detected using commercial fishing operation during 2011 and 2012. Puffer fish were mainly caught by bottom long-lines followed by otter bottom trawls and occasionally by other gears (seiners, trammel and gill nets). The average (CPUE) from long-lines was 78.82 and 53.13 kg/day/boat during 2011& 2012, respectively, with a maximum of 101.7kg in autumn 2011 and 87.7kg in winter 2012; while the bottom trawler had an average CPUE equal to 8.70 and 16.77 kg/day/boat during 2011& 2012, respectively, with a maximum of 16.6kg and 31.3kg in the spring of 2011 & 2012, respectively. The percentage of puffer catch in relation to total catch of otter bottom trawl was 4.86% and 5.5% of the total catch of bottom trawlers during 2011, 2012, respectively. During the time of this study, five puffer fish species were identified; *Lagocephalus sceleratus*; *L. suezensis*; *L. guentheri*; *L. lagocephalus* and *Sphoeroidespachygaster*. They spread along the coast in various habitats (sandy, rocky and muddy) up to 150 m depth. *L. sceleratus* was the dominant, representing 97.8% by weight and 83.2% by number of the puffer fish catch with a length range of 5 to 83 cm. The present observation of some tropical puffer fishes reflected the change in the Mediterranean Sea biodiversity, which may affect the ecosystem and commercial fisheries, emphasizing the continuous investigation for the alien species to set up a special management plan for its exploitation.

Keywords: Puffer fish, CPUE, *Lagocephalus sceleratus*, Mediterranean Sea, Egypt

1. Introduction

The Mediterranean Sea is one of the hotspots for marine bio-invasions, with increasing rates of invaders being reported [1]. The pathways of invasion are Suez Canal, GibraltarStrait, ship ballast water and others. In eastern Mediterranean, about 85 fish species have entered through the Suez Canal [2,3].

Puffer fish is attracting the public attention since its migration to the Mediterranean Sea, with a rapid distribution along different Mediterranean basins. This creates some negative effects to the fisheries activities in the area with social impact due to its poisoning effect. It is distributed in tropical and subtropical areas of the Atlantic, Indian and PacificOceans. Few studies were conducted on its occurrence in the eastern Mediterranean Sea and up to the gulf of Gabes (Tunisia) [4,5,6,7,8,9] with no mention of Egyptian coast that logically the main country closed to Suez canal which is the main pass way for many puffer fishes immigration from red Sea [10]. Until now, just few researches were conducted on puffer fish from the Red Sea focusing on its toxicology [11,12,13]. Even, after its migration to Mediterranean Sea, few studies were published [14,15,16] with no regarding its fisheries status. Although the Egyptian law has prohibited the fishing of puffer fishes since 2008; they are distributed along the Egyptian Mediterranean coast; illegally caught and marketed [10]. So, the monitoring of their catch and distribution is necessary for the management process, whether they are newcomers or native, dangerous or not. The

present study aims to describe the fisheries status of puffer fish species in the Egyptian Mediterranean waters in relation to the ecosystem.

2. Materials and Methods

The present study area was extended from Al-Arish (34º 12' 36" E and 31º 15' 00" N) to Sallum (25º 08' 42" E and 31º 30' 00" N) along the Egyptian Mediterranean coast. Six fishing ports as landing sites were chosen for collecting fisheries data and puffer fish samples, which contain a majority of the Egyptian fishing fleet using different gear types that catch puffer fish along the coast (Fig.1). Moreover, several commercial fishing cruises and fishermen interviews were conducted during 2011 and 2012. For each fishing cruise, thetrip duration, fishing grounds (depth and type of bottom), gear used, fishing time and landing quantity were recorded. The catch of one hundred bottom long-liners, 60 bottom trawlers and few seiners, trammel and gill nets boatswere used to describe the catch per unit effort (CPUE) for each fishing gear (kg/day/boat), geographical distribution, abundance, habitats and species compositions (in weight and numbers).

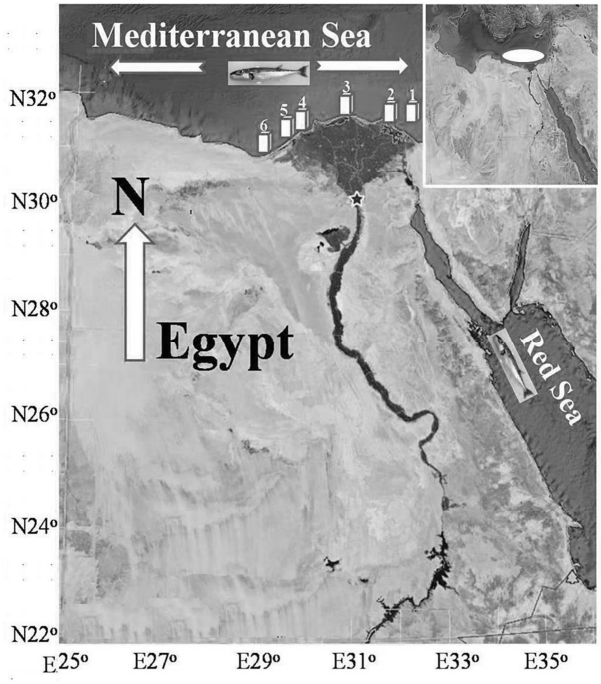

Fig. 1. *The study area along the Egyptian Mediterranean coast and fishing ports {(1) Port Said; (2) Ezbet- ElBorg (Damietta); (3) El-Burullus; (4) El-Maadia; (5) Abu-Qir, (6) Alexandria (Anfoushy)}.*

A total of 2087 specimens from different puffer fish species were collected randomly from the catch of different fishing gear types. All sampled fishes were taxonomically identified to the species level and measured to the nearest centimetre (cm) and weighed to the nearest gram (g). Fish were identified according to [16,17,18].

3. Result

3.1. Fishing Gears

The present investigation revealed that puffer fish was mainly caught by bottom long-line followed by bottom otter trawl. It accidentally appeared in the catch of purse seine, trammel and gill nets. The features of gears catching puffer fish especially bottom long lines and bottom trawler are typical Mediterranean form, however this study reported a modification for the long-line created by Egyptian fishermen for catching puffer fish, they added a specific steel part (20 cm) attached to the branch lines before hooks to avoid the cutting of the branched line by the fish sharp teeth (Fig. 2).

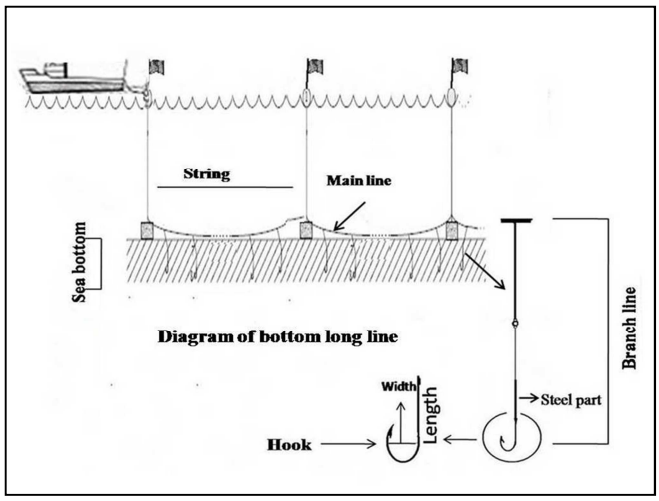

Fig. 2. *Diagram of modified bottom long-lines with steel part used for catching puffer fishes in the Egyptian Mediterranean waters*

3.2. Catch Per Unit Effort (CPUE).

The average annual CPUE of bottom long-line was estimated as 78.82 and 53.13 kg/day/boat during 2011 & 2012, respectively, with a maximum value of (101.7kg) in autumn 2011 and (87.7kg) in winter 2012; whereas the lowest one was in summer (48.4 & 27.2 during 2011 & 2012, respectively). The bottom trawl has a less annual CPUE, 8.70±16.61 and 16.77±25.08 kg/day/boat in 2011 & 2012, respectively with the maximum value in spring (16.6kg) and the lowest in autumn (5.3kg) during 2011; while in 2012; the maximum was recorded in spring (31.3kg) and the lowest in summer (4.8kg) as shown in Fig. 3. Other nets occasionally caught puffer fish with few individuals per day. By applying significance test between the different values of CPUE of the two methods, the significance difference was observed where $t = -2.759$ at $p < 0.05$and $t = -3.64$ at $p < 0.05$ for 2011 and 2012, respectively.

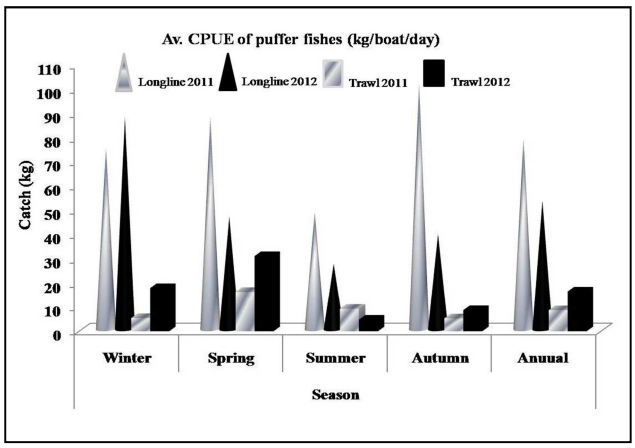

Fig. 3. *Seasonal variations in average catch per unit effort (CPUE) (Kg/day/boat) of puffer fish by long-liners and trawlers (2011 & 2012).*

3.3. Puffer Fish Catch in Relation to the Catch of Bottom Trawl

The percentage of puffer catch in relation to total catch of otter bottom trawl was estimated from the investigated boats. The total catch of trawlers nets was used where these nets characterized by havingregular catch without selectivityofspecies or size. The puffers constituted 4.86% and 5.5% of the total catch of bottom trawlers during 2011,2012 respectively (Fig.4).

3.4. Length Frequency Distribution

Length range of puffer fish catch differed according to fishing gears (Fig. 5). For the long-line catch, the length range varied from 13 to 83 cm with the two modes, the small one at 21cm and the larger one at 51 cm. While for the bottom trawl catch, the minimumlength was 5cm and the maximum was 72 cm, with two modes at 18 and 48 cm (i.e. smaller than the long- line range). The length range of puffer fish in other nets catch (few specimens) was 5 to 25cm.

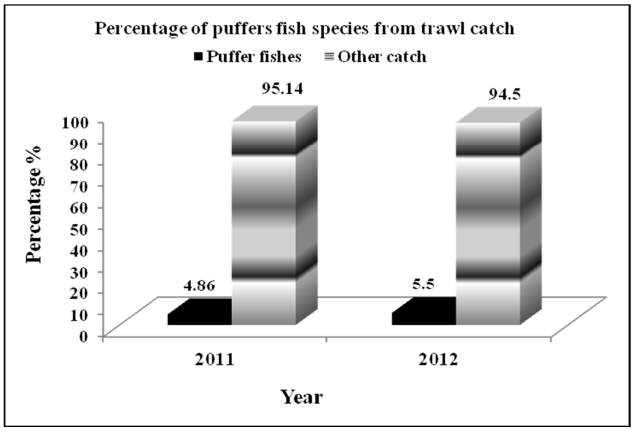

Fig. 4. *Percentage of pufferfishes in relation to catch of bottom trawlers.*

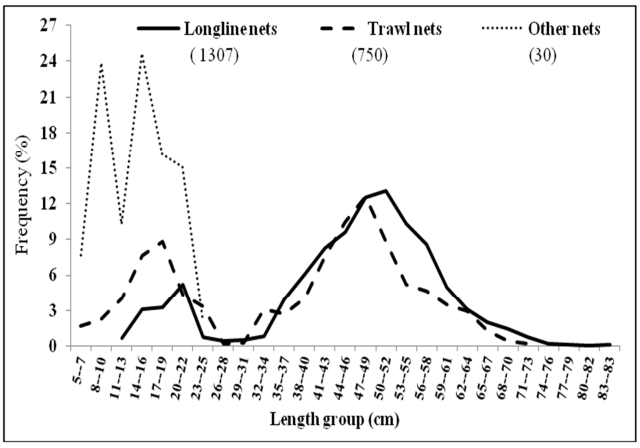

Fig. 5. *Length frequency distribution of puffer fish from the Egyptian Mediterranean waters according to fishing gears.(The number of specimens between brackets).*

3.5.Species Composition

The present puffer fishes were identified into five species,*Lagocephalus sceleratus*, *L. suezensis*, *L. guentheri*, *L.lagocephalus and Sphoeroides pachygaster*; their catch composition and variations in relation to different fishing gears were estimated by number and weight according to the collected samples (Figs. 6 A, B). *L. sceleratus* was the dominant species by weight and number (97.79% and 83.18%, respectively), while the least abundant species was *S. pachygaster* (0.02% by weight) and *L. Lagocephalus*(0.05% by number).

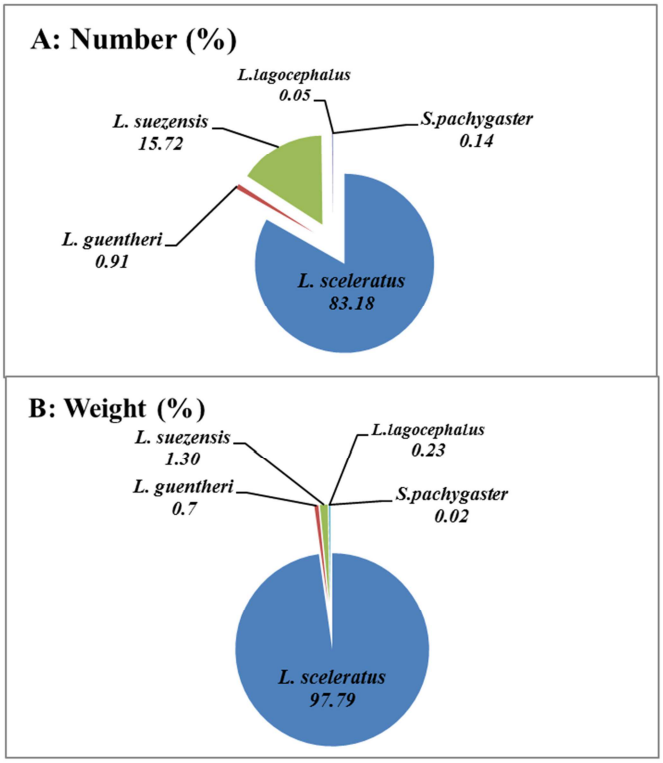

Fig. 6. *Species composition (in%) of puffer fishes according to A: Number and B: weight from the Egyptian Mediterranean waters during the study period.*

3.6. Distribution of Pufferfish

Distribution and abundance of various puffer fish species are illustrated in Fig. (7). During the fishing survey along the coast passing to around fifteen fishing stations,*L. sceleratus* was the most abundant species caught from different habitat types (sandy, rocky and muddy bottom) along the whole coast of Egypt (from Al-Arish to Sallum and mainly from Alexandria to Sallum) at depth up to 150 m, but they were more abundant in sandy grounds near the edges of the rocky areas in shallow depths (20-50m). *L. suezensis* was caught closed to western region of delta area from sandy bottom at depths less than 40m. *L. guentheri* was caught occasionally from western coast region from sandy and rocky bottom up to 50 m depth. Single specimen of *L. lagocephalus* was caught from the muddy area off Al-Arish city. Few individuals of *S. pachygaster* were caught from the sandy bottom off Alexandria at a depth exceeding 150 m.

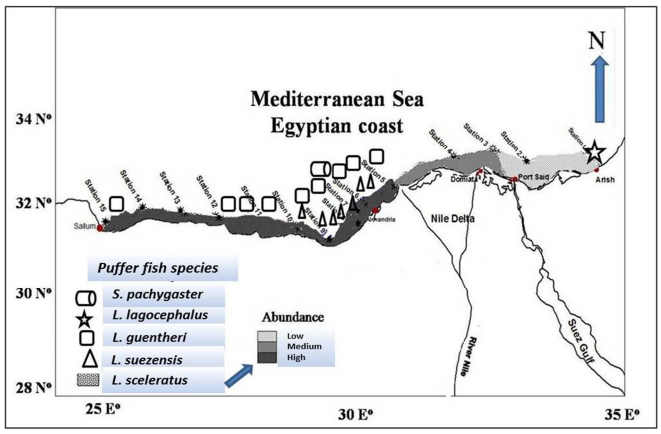

Fig. 7. *Distribution and abundance of puffer fish species along the Egyptian Mediterranean waters during the study period.*

4. Discussion

The rate of bio-invasion in the Mediterranean Sea has increased considerably with time. Several new alien species were establishing large populations in the recent years. They are regularly captured and they constitute an important share of the commercial catch with other economically important species such as *Nemipterus japonicas, Saurida undosquamis* and *Etrumeus teres* in Egypt [19, 20].The alien species reached more than 790 kinds in the whole Mediterranean Sea, with some invaders from the Red Sea, creating very successful colonizers in marine ecosystems [21]. Invasions of non-native species in the ocean can profoundly reshape indigenous communities, impact conservation strategies and affect human health and the economy [22]. The establishment of these species and other non-indigenous species in the Eastern Mediterranean, signify the good conditions for growth, reproduction and survival of tropical species and offer the aliens various advantages when competing with native species[23,24].

Puffer fish are one of these invaders that became an ecological and economical issue, as the cases of tetrodotoxin poisoning that have been reported in the eastern Mediterranean by [6]. Occasionally, accidental intoxications, including some deaths, have been reported in Egypt due to the consumption of puffer fish. The present study investigate the fishery status of the puffer fish, particularly its catch which is prohibited by the Egyptian law (GAFRD, Ministry of Agriculture, 2008) and its marketing that is banned by the Ministry of Commerce (2013);however, they are fished and marketed illegally, mainly the common species *L. sceleratus*.

The present results revealed that puffer fish is mainly caught by the bottom long-lines, which are baited by sepia, octopus, carangid fish to attract puffer fishes to eat; this indicates its carnivorous behaviour; it is worthy mentioned that the branch line of long lines is made from nylon and not jointed directly to hook but connected with modified steel wire (15 -20 cm), particularly for puffers to avoid the cutting of branch line and lose of hooks by the action of their sharp teeth. The use of the steel wire offersthis fishing method high efficiency to catch large quantities of puffer fish especially larger size without damage the fishing lines. These observations may explain the effect of power teeth of large individuals of puffer fishes (particularly highly distributed *L. sceleratus*) on fishing gears, valuable baits and suspended fishes in other nets,explaining the complaints of local fishermen from Turkey [25], where reported that five minutes of recreational fishing resulted in 3 broken fishing lines, ten missing hooks and the capture of one kg of *L. sceleratus*. Moreover, other reported that 52 long-line hooks were found in 33 stomachs, confirming the preference of puffer fish for the long-line method and its capability to cut the hooks if the steel part is not attached[9].

The bottom otter trawler came next to bottom long-liners catching puffer fishes in the Mediterranean coast of Egypt, this may attributed to that the main fishing ground for the Egyptian trawlers off Nile Delta region where asthis area is flat and suitable for trawl operations in agreement with [26]. According to present work and [9], the puffer fish prefer the sandy bottom which is the suitable fishing ground for both fishing methods in Egypt. In addition, the area of Nile delta is distinguished by its muddy bottom which is characterized by abundance of puffer fishes but less than sandy bottom confirming the second choiceof trawl after bottom long lines which operates in sandy and rocky habitats.

The occasionally catch of puffer fishes by other fishing gears, as the purse seine that targets mainly pelagic fish species, is rare, while puffer fish is demersal. Regarding gill nets, the little catch of puffer fish may be related to the way of starching the net in the water column facing the sharp teeth of puffer fish which can cut its monofilament panel. At any time the fishermen feel the presence of puffer fish; they quickly leave the fishing ground saving their nets. Only small sized individuals are usually caught by gill nets due to their small teeth which cannot cut the nets, this was in agreement with [27] and [25]. Moreover, the large puffer fish with large heads not gilling by small mesh size of this net.

Fisheries biologists and management agencies have recognized the importance of reliable quantitative information on the discrepancies between landings and actual catches of a species [28, 29, 30]. The present results emphasize that puffer fish is catching regularly as a considerable amount by long line and trawl in the Egyptian fleet; however no information or fisheries statistics is officially available. This attributed to that the catch of tetraodontids converted at many times to discards that can be thrown back into the Sea or hidden due to (illegal landing and its toxicity). Hence, it is important to study the by-catch and discard (puffer fishes and others) to be used in the field of fisheries assessment. The present average annual CPUE (kg /day /boat) was higher for long-lines than bottom trawls, indicating the high efficiency of the first method to catch puffer fish and its fishing ground is suitable habitats for puffer fish that could use as an indicator of stock abundance [31].The seasonal variations in CPUE reflected the abundance of puffer fish during winter and autumn in offshore rocky habitats, which are the fishing grounds of long-lines;though during spring and summer they are plentiful in shallow sandy areas, which are the fishing grounds of trawls. The lower CPUE in summer for both fishing gears may be related to the smaller lighter fishes that are available in the fishing ground, while the larger and heavier fishes are caught in late autumn up to early spring. [32] reported that *L. sceleratus* is classified as a sea grass resident with an intermediate affinity to the *Posidonia oceanica* habitats particularly at smaller size in the summer season, while larger and heavier individuals are caught over rocky bottoms by long-lines. This may indicate the ontogenetic shifting of puffer fish habitats from offshore rocky to shallow sandy at a depth up to 40m in relation to the puffer fish reproductive seasons (spring and summer).

In the present work, the proportion of puffer fishes catch to total catch of each fishing gear was calculated for bottom trawler only because this net is responsible for the bulk of discards including puffer fishes and others as supported by [33,34]. In fact the otter bottom trawl has less selectivity unlike longlines which can be controlled by fishermen (biased to area, species and size). The present percentage of puffer catch in relation to total catch of estimated bottom trawlers from the Egyptian Mediterranean waters reflects the importance of these fishes in the catch of bottom trawler especially in the Egyptian Mediterranean water.

Length range of puffer fish catch differed according to fishing gears, the presence of larger lengthsin long lines catch followed by bottom trawl indicates the majority of long lines catching larger individuals which lead to large quantityas in agreement with present CPUE. In addition to that, long line operates in wide area especially sandy and edge of rocks that are suitable for puffer fishes unlike bottom trawl that doesn't operate in all areas in Egypt beside its operations in shallower area in which small sized fishes are found.

The present catch composition of puffer fishes by species illustrate that*L. sceleratus* is the dominant species in agreement with its distribution behavior where *L. sceleratus* was the most abundant species caught from different habitat types (sandy, rocky and muddy bottom) along the whole coast of Egypt at depth up to 150 m.While other species showed lower distribution along the coast and mostly caught by bottom trawler with few individuals in agreement with [16].

In conclusion, the present investigation revealed that some of alien immigrants have successfully adapted to the different topography and environments of the Egyptian Mediterranean coast like puffer fish including many Red Sea immigrants supporting the Lessepsian colonization and a tropicalization of the area. Continuous monitoring and investigation of the recent ecological situations of the coast is necessary to manage wanted and unwanted populations in the Egyptian coast; which is a great challenge in case of puffer fish. National efforts are needed to alert fishermen and the public about the toxicity of puffer fish.

Acknowledgement

Authors would like to thank the General Authority for Fish Resources Development (GAFRD), Ministry of Agriculture, Egypt, for facilitating the sample collection of illegible puffer fish catch.

References

[1] A. Zenetos, S. Gofas, C. Morri, D. Rosso, D. Violanti, J. E. Garcia Raso, M. E. Cinar, A. AlmogI-Labin, A.S. Ates, E. Azzurro, E. Ballesteros, C.N.Bianchi,, M. Bilecenoglu, M.C. Gambi, A. Giangrande, C. Gravili, O. Hyams-kaphzan, P.K. Karachle, S. Katsanevakis, L. Lipej, F. Mastrototaro, F. Mineur,, M. A Pancucci-Papadopoulou, A. Ramos Espla, C. Salas, G. San Martin, A. Sfriso, N. Streftaris, and M.Verlaque, "Alien species in the Mediterranean Sea by 2012. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part 2. Introduction trends and pathways" Mediterranean Marine Science, 13:pp328-352, 2012.

[2] M. Bariche. and P. Heemstra, First record of the blackstrip grouper *Epinephelus fasciatus* (Teleostei: Serranidae) in theMediterranean Sea. Marine Biodiversity Records, 5, e1. 2012.

[3] R. Fricke, D. Golani, B. and Appelbaum-Golani, "First record of the Indian Ocean anchovy *Stolephorus insularis* Harden-berg, 1933 (Clupeiformes: Engraulidae) in the Mediterranean. BioInva sion Records, 1: 303-306, 2012.

[4] B. Zava, G. D'Anna, D. Giordano, G. B.,Giusto, G. Monteverde, C. Pipitone,and F.Fiorentino,"Notebiologichesu *Lagocephalus lagocephalus* (L.1758) (OsteichthyesTetraodontida) delleacquesiciliane. *Biologia* Marina Mediterranea, 12 (1): 614-617, 2005.

[5] M. Bilecenoglu, M. Kaya, and S. Akalin, "Range expansion of silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), to the northern Aegean Sea" Aqua. Invas., 1 (4): 289-291, 2006.

[6] Y. Bentur, J. Ashkar, Y. Lurie, Y. Levy, Z. S. Azzam, M. Litmanovich, M. Golik, B.Gurevych, D.Golani, A. Eisenman,"Lessepsian migration and tetrodotoxin poisoning due to *Lagocephalus sceleratus*in the eastern Mediterranean" Toxicon, 52 (8), 964-968, 2008.

[7] R. Zouari-Ktari, M. N. Bradai. and A. Bouain, "The feeding habits of the Lessepsian fish *Stephanolepis diaspros* (Fraser-Brünner, 1940) in the Gulf of Gabès (eastern Mediterranean Sea)" Cahiers de Biologie marine, 49:329-335, 2008.

[8] G. Minos, T. Karidas, M. Corsini-Foka, and P.S. Economidis, "New data on the geographical distribution of the invasive *Lagocephalus sceleratus* (Gmelin, 1789) in North Aegean". In: Proceedings of the 14th Panhellenic Conference of Ichthyologists, 6-9 May 2010, Piraeus, Greece, pp 283-286, 2010.

[9] S. Kalogirou, "Ecological characteristics of the invasive pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) in Rhodes, Eastern Mediterranean Sea". A case study. Mediterranean Marine science, 14 (2): pp251-260., 2013.

[10] M. M. S. Farrag, "Fisheries and Biological studies on Lessepsian pufferfish, *Lagocephalus sceleratus* (Gmelin, 1789) (Family: Tetraodontidae) in the Egyptian Mediterranean waters" PhD Thesis, Faculty of science, Al-Azhar University, (Assuit), Egypt, 2014

[11] A. S. Mohamed, "Ecotoxicological studies on puffer fishes in the North western part of the Red Sea" Ph.D. Thesis, Tanta University, Egypt. 167pp, 2003.

[12] M. M. Sabrah, A. A. El-Ganainy, and M. A. Zaky, "Biology and toxicity of the pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) from the Gulf of Suez. Egyptian Journal of Aquatic Research, 32 (1): pp 283-279, 2006.

[13] H. M. O. Abd-El hameed, Toxicicological studies on puffer fishes, *Lagocephalus sceleratus* and *Amblyrhnchotes hypselogenion* family Tetradontidae. In Suez Gulf, Red Sea. M. Sc. Thesis, Faculty of Science, Suez Canal University, Egypt, 2011.

[14] M. M. S. Farrag, T.B.H. Soliman, E. Kh.A. Akel, A.A.K. El-Haweet and M. A. Moustafa, "Molecular phylogeny and biometrics of lessepsian puffer fish Lagocephalus sceleratus (Gmelin, 1789) from Mediterranean and Red Seas, Egypt" Egyptian journal of aquatic research, 41, pp. 323-335, 2015.. DOI: 10.1016/j.ejar.2015.08.001

[15] M.M.S. Farrag, A. A. K. El-Haweet, E.Kh.A. Akel and M. A. Moustafa, "Stock Status of Puffer Fish *Lagocephalus sceleratus* (Gmelin, 1789) Along the Egyptian Coast, Eastern Mediterranean Sea" American Journal of Life Sciences. Special Issue: New Horizons in Basic and Applied Zoological Research, Vol. (3), 1-6; 83-93, 2015.

[16] M.M.S. Farrag, A. A. K. El-Haweet, E.Kh.A. Akel and M. A. Moustafa, "Occurrence of puffer fishes (Tetraodontidae) in the eastern Mediterranean, Egyptian coast - filling in the gap" BioInvasions Records, 5 (1): 47–54, 2016.DOI: http://dx.doi.org/10.3391/bir.2016.5.1.09.

[17] P. J. P. Whitehead, M. L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese, "Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vols. I-III: 1473 p., 1986.

[18] D. Golani, L.Orsi-Relini, E. Massutí,J. P. Quignard,"CIESM Atlas of Exotic Species in the Mediterranean" *Vol.1.Fishes.* [F. Briand, ed.]. 256 pp. CIESM Publishers, Monaco.,2002

[19] A. El- Haweet, "Biological studies of the invasive species *Nemipterus japonicus* (Bloch, 1791) as a Red Sea immigrant into the Mediterranean. Egyptian Journal of Aquatic Research,. 39: 267–274, 2013.

[20] M. M. S. Farrag, A. G. O. Osman,E. H. Kh Akel, and M. A. Moustafa,"Catch and effort of night purse seine with emphasize to Age and Growth of lessepsian *Etrumeus teres* (Dekay, 1842), Mediterranean Sea, Egypt"Egyptian Journal of Aquatic Research., 40, 181–190, 2014.

[21] M. Oral, "Alien Fish Species in the Mediterranean - Black Sea Basin". Journal of Black Sea/ Mediterranean Environment, 16 (1): pp 87-132, 2010.

[22] G. Rilov, J. A. Crooks, "Biological Invasions in Marine Ecosystems – Ecological, Management, and Geographic Perspectives" Springer-Verlag, Berlin. 641 pp, 2009.

[23] IUCN - ISSG, Aliens. 27:1-30, 2008.

[24] G. Bernardi, D. Golani, E. Azzurro, "The genetics of Lessepsian bioinvasions". Fish Invasion in. Mediterranean. Sea, 71-84, 2010.

[25] M. Bilecenoglu, "Alien marine fishes of Turkey - an updated review. p. 189-217. In: *Fish Invasions of the Mediterranean Sea: Change and Renewal*. D. Golani, Appelbaum-Golani, B. (Eds) Pensoft Publishers, Sofia-Moscow, 2010.

[26] M. A. Ibrahim, I.A. Soliman, "Check-list of the bony fish species in the Egyptian waters of Egypt" Bulletin of National Institute of Oceanography & Fisheries, A.R.E., 22:43-57 p, 1996.

[27] P. Katikou, D. Georgantelis, N. Sinouris, A. Petsi, and T. Fotaras, "First report on toxicity assessment of the Lessepsian migrant pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) from European waters (Aegean Sea, Greece)" Toxicon, 54 (1): pp50-55., 2009.

[28] D. L. Alverson, M. H. Freeberg, S. A. Murawski and J. G. Pope, "Global assessment of fisheries bycatch and discards" *FAO Fisheries Paper No. 339*. Rome: FAO., 1994 A.

[29] G. Stratoudakis, R. Fryer, R. Cook, and G. Pierce, "Fish discarded from Scottish demersal vessels: estimators of total discards and annual estimates for targeted gadoids" ICES Journal of Marine Science, 56,592–605, 1999a.

[30] G. Stratoudakis, R. Fryer, and R. Cook, "Discarding practices for commercial gadoids in the North Sea" Canadian Journal of Fisheries and Aquatic science, 55: 1632-1644, 1999b.

[31] R. J. H. Beverton, and S. J. Holt, "On the dynamics of exploited fish population" U. K. Ministry of Agriculture, Fish. and Food, Fish. Inves. Ser. 2 (19), 533p. 1957.

[32] S. Kalogirou, M. Corsini-Foka, A. Sioulas,H. Wennhage, L. Pihl,"Diversity, structure and function of fish assemblages associated with *Posidonia oceanica* beds in an area of the eastern Mediterranean Sea and the role of non-indigenous species". Journal of Fish Biology, 77:2338-2357, 2010.

[33] K. I. Stergiou, A, Economou, C. Papaconstantinou, N. Tsimenides, and S. Kavadas, "Estimates of discards in the Hellenic commercial trawl fishery" Rapp. Commun. Int. Mer. Medit., 35: 490–491, 1998.

[34] S. J. Hall, "The Effects of Fishing on Marine Ecosystems and Communities" Blackwell Science, London, 274 pp, 1999.