Mediterranean Marine Science

Vol 12, No 2 (2011)

Aliens in Egyptian Mediterranean waters. A check-list of Erythrean fish with new records

Y. HALIM, S. RIZKALLA

doi: [10.12681/mms.46](https://doi.org/10.12681/mms.46)

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net

Research Article

Aliens in Egyptian Mediterranean waters. A check-list of Erythrean fish with new records

Y. HALIM[1] and S. RIZKALLA[2]

[1] Department of Oceanography, Faculty of Science, Alexandria University
[2] National Institute of Oceanography and Fisheries, Alexandria

Corresponding author: youssefhalim@gmail.com

Received: 21 January 2011; Accepted: 5 October 2011; Published on line: 25 November 2011

Abstract

The historical role of the Suez Canal as a pathway for migrations between the Red sea and the Mediterranean is recalled. A check-list of 42 immigrant Erythrean fish in Egyptian Mediterranean waters is given. The list comprises four new records. 17 of the immigrant species are commercially exploited, whereas 15 are known from single records. While the Erythrean fish as invasive species are beneficial to local fisheries, in our view, they do not have an important impact upon the ecosystem.

Keywords: Suez Canal; Invasive species; Ecosystems; Impacts; Benefits; Biodiversity.

Introduction

The biodiversity of the East Mediterranean has been considerably altered since the opening of the Suez Canal in 1869. As a narrow and shallow water course, it stands as a channel between two marine basins (GRUVEL, 1936). Its biological role however, is out of proportion to its size, although as a habitat and a pathway it remained long inhospitable to marine organisms. Two opposite salinity barriers, the abnormally high salinity of the Bitter Lakes, south, and the Nile dilution, north, stood on their way. With the continuous dissolution of the salt beds in the Lakes and the cessation of the Nile flood, both barriers became weaker. MORCOS (1980) compared the water masses in the Canal in 1955 to the records made in 1871, two years after its opening and found that salinity dropped from about 65 ppm to about 45ppm. Nevertheless, the circulation pattern remained unchanged, the residual current tending to flow from the Red Sea to the Mediterranean for ten months, reversing its flow in August-September. This pattern, added to their greater tolerance to high salinity, favours the northward migration of Erythrean organisms.

The process of immigration into and through the Canal remained incremental but slow, as documented by the early surveys of its ichthyofauna. Some ten years after its opening, KELLER (1882) found 12 fish species in the Canal and shortly after, KRUKENBERG (1888) recorded 15 species (for KRUKENBERG 1888 see NORMAN, 1927). TILLIER in 1902 published a detailed account of the ichthyofauna of the Canal based on a survey extending over several years. He recorded 80 species of which about 40 occurred in the Canal, the others presumably venturing in and out.

NORMAN (1927), working on the collection made by the Cambridge Expedition to the Suez Canal in 1924, reported the occurrence of 45 fish species, 24 originated from the Red Sea and 21 from the Mediterranean. From his records and from more recent observations, it appears that 13 of the Red Sea species had already established viable populations in the Mediterranean . On the other hand, five the Mediterranean species such as *Engraulis encrassicholus* (Linnaeus, 1758)*, Hippocampus brevirostris* (Schinz, 1822), *Serranus cabrilla* (Linnaeus, 1785)*, Gobius ocheticus* (Norman, 1926) and *Epinephelus aeneus* (Geoffroy Saint-Hilaire, 1817), succeeded in crossing the Bitter Lakes establishing in the Gulf of Suez.

The important changes that took place in the Levantine basin following the completion of the High Aswan Dam in 1965-67 have created more favourable conditions for the settlement and spread of Erythrean fish and invertebrates in the Mediterranean basin (HALIM *et al.,* 1995; HALIM, 2004). Instead of reaching a plateau as POR (1978) assumed, the process appears to be accelerating.

Later, POR himself reviewed his earlier statement (POR, 1990). TORTONESE (1964) estimated the Indo-Pacific immigrant fish species to be about 30 for a Mediterranean total of about 550. BEN-TUVIA (1985) listed 41 species including the records of MOUNEIMNE (1977). In their Atlas of Exotic fish species in the Mediterranean, GOLANI *et al.* (2002) reported 59 exotic species for an estimated Mediterranean total of 650, which is almost 10% of the population. The rate of fish invasion has continued unabated since 2002 (GOLANI *et al.,* 2002). By 2007, 18 new alien fish species have been recorded and many have extended their area of distribution (GOLANI *et al*., 2007). By 2010, their number in the updated CIESM check list (GOLANI *et al.*, 2010) had reached 23. A further 17 alien species recorded in 2009 figure on the list but with no indication about biogeographic affinity. The check list of ZENETOS *et al*. (2010) comprises 92 alien species of Indo-Pacific origin in the East Mediterranean.

As to Egyptian waters, the check list of EL SAYED (1994) included 31 Erythrean fish species out of a total of 257. After EL SAYED (1994) and taking into account earlier records (NORMAN, 1927; MILLER & FOUDA, 1986) and more recent ones (RIZKALLA, 1997; ALLAM *et al.*, 1999; GAMEE, 2005), Erythrean fish accounted for 38 species. Two species reported from Egyptian waters by TORTONESE (1951), *Glaucostegus halav*i (Forsskål, 1775) and *Carcharhinus melanopterus* (Quoy & Gaimard, 1824) have been omitted as their occurrence has not been confirmed.

The present work adds four new records of Erythrean fishes being present along the Mediterranean Egyptian coasts, bringing the list to a total of 42 species. Information on their contribution to fishery is also given.

Material and Methods

The present check-list of Erythrean fish species in Egyptian waters combines dispersed records reported by several authors over the years but it also includes recent, unpublished records made by the second author (S. RIZKALLA). Species are sorted according to the observed abundance and the frequency of appearance in the fish market. Species which have established successful viable populations are grouped under "A" and "B". Species under A are of commercial value and appear on the fish market, with the exception of the toxic *Lagocephalus sceleratus.* "Single record" species are put under "C" since the frequency of the presence in the fish market tends to be a function of their economic value. The less valuable species are frequently overlooked, though some might be fairly common. On the other hand the three groups should not to be considered as rigid categories. Some species from group B such *Fistularia commersonii* and *Hemiramphus far* are on their way to develop growing populations and will soon need to be included under A. Three species (*Herklotsichthys punctatus, Siganus luridus* and *Callionymus filamentosus)* have been placed under category "A" following the survey of AKEL (2005) in Abu Qir bay. Two species namely *Glaucostegus halav*i (Forsskål, 1775) and *Carcharinus melanopterus* reported from Egyptian waters by TORTONESE (1951) have been omitted from the check list as their occurrence in Egyptian waters has not been confirmed.

Nomenclature follows the World Register of Marine Species (APPELTANS *et al*, 2011).

Results

The Erythrean fish species recorded from Egyptian Mediterranean waters until 2010 are given on Table 1. Apart from nine species, all of them are demersal, feeding on benthic crustacea, bivalves and other fish, excepting the herbivorous *Siganus* spp. The nine pelagic fish comprise two plankton feeders, *Dussumieria elopsoides* and *Hemiramphus far, and* seven carnivores or omnivores, namely, *Etrumeus teres, Fistularia commersoni, Sphyraena chrysotaenia, Sphyraena flavicauda, Parexocoetus mento, Scomberomorus commerson* and *Tylosurus choram*

As a rule, the new-comers to the Mediterranean tended to extend east rather than west from the Canal in the pre-High Dam times, a trend which is expected to change. Nevertheless, some Red Sea immigrants are now common hundreds of kilometres west of Alexandria. This is the case with *L. sceleratus* and *F. commersonii* (unpublished records). On the other hand, some Erythrean fish proved to be highly euryhaline, tolerant to a wide salinity range being able to penetrate the low brackish Delta lakes as well as the hypersaline Bardawil lagoon (Table 2, Fig. 1).

Sebastapistes nuchalis (Günther, 1874), which was excluded from the checklist of GOLANI *et al.* (2002) on the grounds that its single record in Cyprus was based on a misidentification, is now included again in the list of alien Mediterranean species from a single record of EL SAYED, 1994.

New records. Four new Indo-Pacific species were encountered in samples collected by the second author (S.R.) from trawlers, beach-seiners and purse-seiners from 2001 to 2009. Their description agrees with GOLANI *et al.* (2010).

Family Fistularidae (Cornetfishes)

Fistularia commersonii Rüppell, 1835 (Fig. 2).

A relatively large number of specimens (48-103 cm in total length) were caught in 2001 by trawlers west of Alexandria. The species is so far absent from the eastern zone.

Family Nemipteridae (Whiptail breams, Threadfin breams)

Nemipterus randalli Russell, 1986 (Fig. 3).

Table 1
Check-list of Erythrean fish in Egyptian Mediterranean waters.

Species	**Collection date**	**Source**
A. Abundant and marketable		
Alepes djedaba (Forsskål, 1775)	1992	EL SAYED, 1994
Callionymus filamentosus Valenciennes, 1837	1994	RIZKALLA, 1997
Dussumieria elopsoides Bleeker, 1849	1971	AL KHOLY & EL WAKEEL, 1975
Equulites klunzingeri (Steindachner, 1898)	1924	NORMAN, 1927
*Etrumeus teres (*DeKay, 1848)	1992	EL SAYED, 1994
Herklotsichthys punctatus (Rüppell, 1837)	1975	BEN TUVIA, 1977b
Himantura uarnak (Forsskål, 1775)	1983	ALLAM *et al*., 1989
**Lagocephalus sceleratus* (Gmelin, 1789)	2008	This work
Saurida undosquamis (Richardson, 1848)	1965	EL ZARKA & KOURA, 1965
Scomberomorus commerson (Lacepède, 1800)	1992	EL SAYED, 1994
Siganus luridus (Rüppell, 1829)	unkn	GEORGE, 1972
Siganus rivulatus Forsskål, 1775	1958	PANSA & SASTRY, 1958
Sphyraena chrysotaenia Klunzinger, 1884	1978	RIZKALLA, 1985
Sphyraena flavicauda Rüppell, 1838	1998	ALLAM *et al.,* 1999
Terapon puta (Cuvier, 1829)	1973	BEN-TUVIA, 1977b
Upeneus moluccensis (Bleeker, 1855)	unkn	BEN-TUVIA, 1966
Upeneus pori (Ben-Tuvia & Golani, 1989)	unkn	BAYOUMI, 1972
B. Multiple records		
Apogonichthyoides pharaonis (Belloti, 1874)	1994	RIZKALLA, 1997
Atherinomorus lacunosus (Forster, 1801)	unkn	TILLIER, 1902
Crenidens crenidens (Forsskål, 1775)	unkn	KELLER, 1882
Epinephelus malabaricus Bloch & Schneider, 1801	1992	EL SAYED, 1994
**Fistularia commersonii* Rüppell, 1838	2001	This work
Hemiramphus far (Forsskål, 1775)	unkn	BEN-TUVIA, 1975
Liza carinata (Valenciennes, 1836)	1924	NORMAN, 1927
**Nemipterus randalli* Russell, 1986	2009	This work
Sargocentron rubrum (Forsskål, 1775)	1992	EL SAYED, 1994
Stephanolepis diaspros Fraser-Brunner, 1940	1994	RIZKALLA, 1997
C. Single records		
Coryogalops ochetica (Norman, 1927)	1924	NORMAN, 1927
Cynoglossus sinusarabici (Chabanaud, 1931)	1992	EL SAYED, 1994
Oxyurichtys petersi (Klunzinger, 1871)	1994	RIZKALLA, 1997
Parexocoetus mento (Valenciennes, 1847)	1992	EL SAYED, 1994
Pelates quadrilineatus (Bloch, 1790)	unkn	BEN-TUVIA, 1977a
**Pempheris vanicolensis* Cuvier, 1831	2007	This work
Platycephalus indicus (Linnaeus, 1758)	unkn	KREFFT, 1963
Pomadasys stridens (Forsskål, 1775)	1973	BEN-TUVIA, 1977b

Continued

Table 1 (Continued)

Species	**Collection date**	**Source**
Pteragogus pelycus Randall, 1981	1999	GAMEE, 2005
Rastrelliger kanagurta (Cuvier, 1816)	1992	EL SAYED, 1994
Sebastapistes nuchalis (Günther, 1874)	1992	EL SAYED, 1994
Silhouettea aegyptia (Chabanaud, 1933)	1986	MILLER & FOUDA, 1986
Sillago sihama (Forsskål, 1775)	1992	EL SAYED, 1994
Spratelloides delicatulus (Bennett, 1832)	1992	EL SAYED, 1994
Tylosurus choram (Rüppell, 1837)	1992	EL SAYED, 1994

(unkn=collection date not reported)

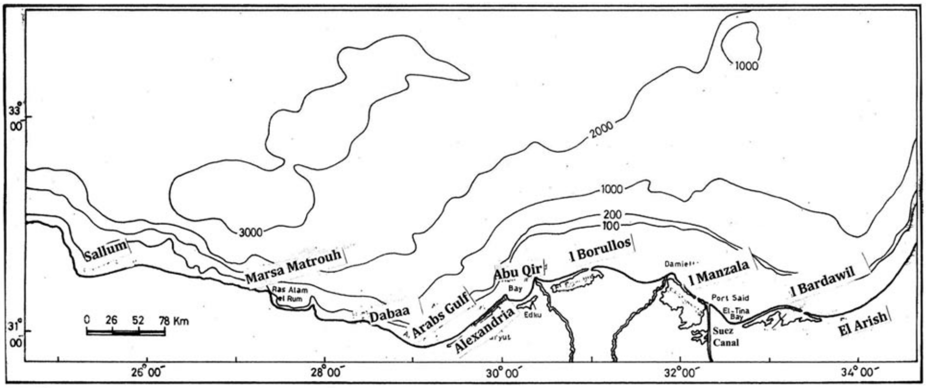

Fig. 1: The Egyptian Mediterranean Coast. Note the Suez Canal and the coastal lagoons. (after Google Earth).

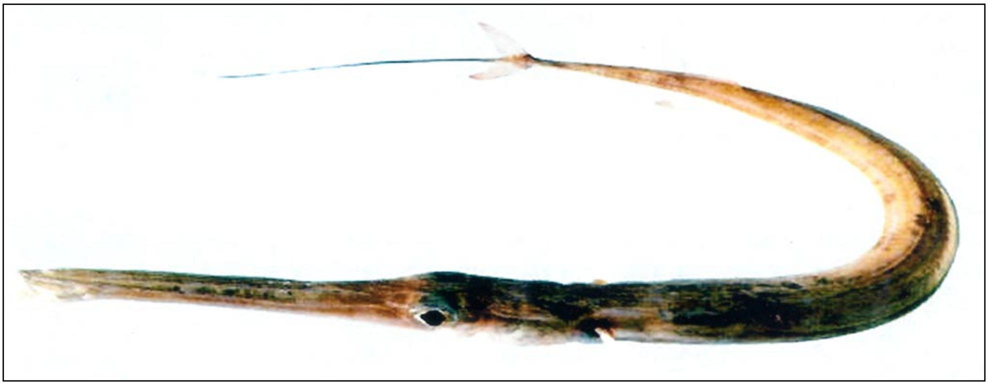

Fig. 2: *Fistularia commersonii.*

Specimens of this species (11.0-14.0 cm in total length) were found in 2009 in the catch of trawlers in Abu Qir Bay at 39-47 m of depth. Additional specimens (7.0- 10 cm in length) were captured off Rosetta at less than 50 m.

Family Pempheridae (Sweepers)

Pempheris vanicolensis Cuvier, 1831 (Fig. 4).

One specimen of 10 cm in total length was caught by day-light purse-seine in coastal waters off Abu Qir in 2007.

Family Tetraodontidae (Pufferfishes)

Lagocephalus sceleratus (Gmelin, 1789) (Fig. 5).

Specimens of this species were first caught off Alexandria at a depth of about 80m in 2008. Additional specimens were later caught

Fig. 3: *Nemipterus randalli.*

Fig. 4: *Pempheris vanicolensis.*

Fig. 5: *Lagocephalus sceleratus.*

Table 2
Erythrean fish in the northern lagoons of Egypt.

Species/Lake	Burullus	Manzalla	Bardawil
Herklotsichthys punctatus			BEN-TUVIA (1975)
Hemiramphus far	HOSNY & HASHEM (1996)	WAHBY & BISHARA (1977)	
Terapon puta			BEN-TUVIA (1977b)
Pelates quadrilineatus		HOSNY (1987)	BEN-TUVIA (1977a)
Crenidens crenidens		KELLER (1882)	LOURIE & BEN-TUVIA (1970)
Liza carinata		WAHBY & BISHARA (1977)	
Silhouettea aegyptia			MILLER & FOUDA (1986)

off Lake Borullos in the mid-delta at depths from 50-100m (total length range 51-73 cm.). *L. sceleratus* is now common off the Delta and the Sinai. Proven to be toxic due to tetrodotoxin and is banned.

Discussion

The spread of non-native species into the Mediterranean and their impacts on the host environment is of much concern to ecologists everywhere. In most definitions the term "invasive aliens" is associated with adverse effects, threatening native biological diversity, the ecological stability of the invaded ecosystems and the resulting economic consequences. Some authors consider the spread of "invasive" species and climate change as the two major threats to biodiversity in the marine environment (DUKES, 2003). This ignores other potential impacts such as overharvesting of resources, destruction of habitats or the introduction of harmful pollutants.

The terminology used by invasion ecologists reflects their pre-conceived options, ranging from neutral to quasi-hostile, sometimes emotionally charged attitudes. The history of invasion biology (1958-2005) has been reviewed by DAVIS & THOMPSON (2000) and DAVIS (2006). Depending on the author, a species in the invasion literature might be referred to as non-indigenous, introduced, imported, non-native, immigrant, colonizer, alien, exotic or invasive. A list of the "100 Worst Invasives" in the Mediterranean has been compiled by STREFTARIS & ZENETOS (2006).

On the other hand, it should not be forgotten that the spread of new species to new habitats is and has always been a natural and continuous process over the ages. Man has only accelerated this process. The Mediterranean Sea in particular has seen successive waves of introductions. Its fauna and flora consist of a mosaic of formerly alien species of different biogeographic affinities, reflecting its eventful geological history.

OCCHIPINTI-AMBROGI & SAVINI (2003) discussing three case studies such as the lagoon of Venice, the Black Sea and the spread of the alien alga *Caulerpa taxifolia* in the West Mediterranean, concluded that stress on the marine environment favours the spread of alien species. Invasions are facilitated either in strongly depleted environments subject to anthropogenic stress or in inherently unstable and variable environments having empty niches. However, the case of the Erythrean invasions in the Levantine basin and the waters beyond does not fit entirely with the above hypothesis. Successful invasions also occur in undisturbed environments.

The Suez Canal has created a gradient in the biodiversity between the highly rich Red Sea -Indo-Pacific and the impoverished Levantine fauna (HALIM *et al.,* 1995)

In Egyptian waters, the reported impact of immigrant fish species is based on assumptions while the benefits are largely economic. In certain cases in our view there is no evidence of measurable conflict. The Erythrean fish *Siganus luridus* and *S. rivulatus* which are voracious feeders on green algae (MOHAMED, 1991), do not appear to be in competition with the indigenous *Diplodus vulgaris* and *D. sargus* as happens elsewhere (IDIL *et al.,* 2007). In Egyptian waters the last two species are omnivorous, feeding on microcrustaceans, bivalves, fish fry and green algae (WASSIF, 1973). *Merluccius merluccius*, once abundant on the shelf fishing grounds, appears to have been displaced from its coastal habitat to deeper waters. It is presumably unable to coexist with demersal Erythrean invaders. It is not clear whether this is due to competition for food or to predation on its fry and youngs (unpublished observations).

The most severe case of adverse impact on human health is that of the puffer fish, *Lagocephalus sceleratus*. First recorded in Gokova Bay, on the south-eastern Aegean Sea coast of Turkey in 2003 (AKYOL *et al.*, 2005), it rapidly extended to Egyptian waters where it became abundant in the fish catch. Although sold beheaded and eviscerated, it soon proved to be a serious hazard to consumers, causing paralysis of the mouth and limbs. Four lethal cases occurred in Alexandria following consumption of *L.sceleratus* due to tetrodotoxin, a poisonous substance. The species figures on the list of the 100 worst invasives (STREFTARIS & ZENETOS, 2006). With the exception of the latter case and of the few instances of native species displacement or regression, the Erythrean immigrants are economically important for Egyptian fisheries.

It is obvious that the focus in most of

the "invasion" literature is on the unwanted effects, any beneficial outcome being minimized or overlooked (GALIL, 2007). A parallel list of species without important adverse effects upon the biodiversity and the environmental stability could be sought.

Among the ecological benefits derived from immigration and settlement of Erythrean fish in Egyptian waters and possibly in the Levantine basin at large are the enrichment in species and the ensuing improvement of biodiversity. This leads to a more efficient use of the resources presumably leading to an improvement of the ecosystem stability.

The economic returns are undeniable. Among the "100 Beneficial Invasives" should be included the species listed under A in Table 1. The Erythrean *Scomberomorus commerson* increased in the catch from 550 ton/year in 2000 to 1500 ton/year in 2007, valued at about 15 million LE. Likewise the *Siganus* spp increased in the catch from 600 t/y to 1146 and the Synodontids from 1300 to 2000 t/y in the same period, the native and non-native species included (GAFRD, 2009). Several examples can be given demonstrating that the increased species richness has been of economic benefit.

An objective approach to the issue of non-native species migration to new environments and its consequences has to recognize that the problem is case-specific.

Acknowledgement

The authors are grateful to Alexander Youssef Halim (UCLA) for his assistance in finalizing this paper.

References

AKEL, E.H.KH., 2005. A comparative study on the catch characteristics of purse-seine operating during the day time in Abu-Qir and El-Mex Bays, Alexandria (Egypt). *Egyptian Journal of Aquatic Research,* 31 (2): 357-372.

AKYOL, O., ÜNAL, V., CEYHAN, T. & BILECENOĞLU, M., 2005. First confirmed record of the silverside blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), in the Mediterranean Sea. *Journal of Fish Biology*, 66: 1183-1186.

AL-KHOLY, A.A. & El-WAKEEL, S.K. (eds), 1975. Fisheries of the South-Eastern Mediterranean Sea along the Egyptian coast. Soviet-Egyptian Expedition 1970-1971. *Bulletin of the National Institute of Oceanography & Fisheries,* 5, 279 pp.

ALLAM, S.M., 1989. *Revision of the order Hypotremata along the Mediterranean coast off Alexandria with special reference to the family Dasyatidae*. Ph.D. Thesis, Faculty of Science, University of Alexandria, Egypt.

ALLAM, S.M., FALTAS, S.N. & RAGAB, E., 1999. Food and feeding habits of barracuda in the Egyptian Mediterranean waters off Alexandria. *Bulletin of the National Institute of Oceanography & Fisheries*, 25: 395-410.

APPELTANS, W., BOUCHET, P., BOXSHALL, G.A., FAUCHALD, K., GORDON, D.P., *et al.* (eds) (2011). *World Register of Marine Species*. Accessed at http://www.marinespecies.org on 2011-10-05.

BAYOUMI, A.R., 1972. Recent biological investigations in the Red Sea along the A.R.E. coasts. 1. On some demersal fishes of economic importance from the Red Sea with notes on migration of fish through the Suez Canal. *Bulletin of the National Institute of Oceanography & Fisheries*, 2: 159-183.

BEN-TUVIA, A., 1966. Red Sea fishes recently found in the Mediterranean. *Copeia*, 2: 254-275.

BEN-TUVIA, A., 1975. Mugilid fishes of the Red Sea with a key to the Mediterranean and Red Sea species. *Bamidgeh*, 27 (1): 14-20.

BEN-TUVIA, A., 1977a. New records of Red Sea immigrants in the eastern Mediterranean. *Cybium*, 3: 95-102.

BEN-TUVIA, A., 1977b. Occurrence of Red Sea fishes *Herklotsichhys punctatus, Autisthes puta* and *Rhonciscus stridens* in the eastern Mediterranean. *Israel Journal of Zoology,* 25: 212-213.

BEN-TUVIA, A., 1985. The impact of the Lessepsian (Suez Canal) fish migration on the Eastern Mediterranean ecosystem. p.367-375.In: *Mediterranean Marine Ecosystems*. M. Moraitou-Apostolopoulou & V. Kiortsis (Eds). Plenum Press, New York.

DAVIS, M.A., 2006. Invasion biology 1958-2005: the pursuit of science and conservation. p.35-64.In: *Conceptual ecology and invasion biology: reciprocal approaches to nature.* M.W. Cadotte, S.M. McMahon & T. Fukami (Eds). Springer, London.

DAVIS, M.A. & THOMSON, K., 2000. Eight Ways to be a Colonizer, two ways to be an Invader. A proposed Nomenclature Scheme for Invasion Ecology. *Bulletin of the Ecological Society of America*, 81 (3): 226-230.

DUKES, J., 2003. Hotter and weedier? Effects of climate change on the success of invasive species. In: *Global climate change and biodiversity.* R.E. Green, M. Hartley, L. Miles, J. Scharlemann, A . Watson & O. Watts (Eds). Tyndall Center for Climate Change Research, Norwich.

EL SAYED, R.S., 1994. Check-list of Egyptian Mediterranean fishes. *Bulletin of the National. Institute of Oceanography & Fisheries*, 1-77.

EL-ZARKA, S. & KOURA, R., 1965. Seasonal fluctuations in the production of the important food fishes of the U.A.R. waters of the Mediterranean Sea. *Notes and memoirs - Alexandria Institute of Hydrobiology & Fisheries*, No.74, 67 pp.

GAFRD, 2009. General Authority for Fish Resources Development Fisheries. Statistics Yearbook. Development

GALIL, B.S., 2007. Loss or gain? Invasive aliens and biodiversity in the Mediterranean Sea. *Marine Pollution Bulletin*, 55 (7-9): 413-422.

GAMEE, F.M., 2005. *Taxonomical and biological studies on some representatives of Family Labridae in the Egyptian Mediterranean waters off Alexandria*. PhD Thesis, Faculty of Science, Alexandria University, 235 pp.

GEORGE, C.J., 1972. Notes on the breeding and movements of the rabbitfishes, *Siganus rivulatus* (Forsskål) and *S. luridus* Ruppell, in the coastal waters of the Lebanon. *Annali Del Museo Civico Di Storia Naturale Di Genova*, 79: 32-44.

GOLANI, D., ORSI-RELINI, L., MASSUTI, E. & QUIGNARD, J.-P., 2002. *CIESM Atlas of Exotic species in the Mediterranean. Vol.1. Fishes*. F. Briand (Ed). Monaco, 254 pp.

GOLANI, D., ORSI-RELINI, L., MASSUTI, E., QUIGNARD, J.-P. & DULCIC, J., 2007. Fish invasion of the Mediterranean. Retrospective and prospective. *Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee*, 38: 10.

GOLANI, D., ORSI-RELINI, L., MASSUTI, E., QUIGNARD, J.-P., DULCIC, J. & AZZURRO, E., 2010. *CIESM Atlas of Exotic Fishes in the Mediterranean Sea*. http//www.ciesm.org/atlas/appendix1and 2, html.

GRUVEL, A., 1936. Contribution à l'étude de la bionomie générale et de l'exploitation de la faune du Canal de Suez. *Mémoires présentés a l'institut d'Égypte,* 29: 1-229.

HALIM, Y., 2004. The Nile and the Levantine Pump. p.73-82. In: *Proceedings "Isotopes in Environmental Studies. Aquatic Forum" IAEA Monaco, 25-29 October 2004*.

HALIM, Y., MORCOS, S.A., RIZKALLA, S. & EL SAYED, M.KH., 1995. The impact of the Nile and the Suez Canal on the living resources of the Egyptian Mediterranean waters (1958-1986). p.19-57. In: *Effects of riverine inputs on coastal ecosystems and fisheries resources, FAO Fisheries Technical Paper* No.349. FAO, Rome.

HOSNY, C.F.H., 1987. *Studies on fish population in Lake Manzala*. Ph.D. Thesis. Faculty of Science, Alexandria University, Egypt, 319 pp.

HOSNY, C.F.H. & HASHEM, M.T., 1996. Fukanet in the beach area of Lake Borullos, Egypt. *Bulletin Faculty of Science*, *Alexandria* University, 1: 57-69.

IDIL OZ, M., OKU, E. & YÜKSEK, A., 2007. Notes on the Erythrean alien fish of Datça-Bozburun Peninsula. A specially protected area in the southeastern Aegean Sea (Turkey). *Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee*, 38: 563.

KELLER, C., 1882. Die fauna in Suez Canal und die diffusion der Mediterranean und Erythraischen Tierwelt. *Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesamten naturwissenschaften,* 28 (3): 1-28.

KREFFT, G., 1963. *Platycephalus indicus* (L.1758), ein neues faunenelement der agyptyschen Mittelmeerkuste. *Archive fur fischereiwissenschaft*, 14 (3): 148-152.

LOURIE, A. & BEN-TUVIA, R., 1970. Fishes *Pelates quadrilineatus* (Bloch) and *Crenidens crenidens* (Forsskal) in the Eastern Mediterranean. *Israel Journal of Zoology*, 19 (4): 203-207.

MILLER, P.J. & FOUDA, M., 1986. Notes on the biology of a Red Sea goby *Silhouettea aegyptia* (Chabanaud, 1933) (Teleostei,Gobiidae). *Cybium*, 10 (4): 395-409.

MOHAMED, N.I., 1991. *Biological and biochemical studies of some Siganid fishes from the Mediterranean waters off Alexandria*. M.Sc.Thesis Faculty of Science, Alexandria University, 215 pp.

MORCOS, S.A., 1980. Seasonal changes in the Suez Canal following its opening in 1869: newly
discovered hydrographic records of 1870-1872. p.290-305.In: *Oceanography: The Past*. Sears M. & Merriman D. (Eds). Springer-Verlag, Berlin.

MOUNEIMNE, N., 1977. Liste des poissons de la côte du Liban (Méditerranée orientale). *Cybium,* 1: 37-66.

NORMAN, J.R., 1927. Zoological results of the Cambridge Expedition to the Suez Canal. *Transactions of the Zoological Society of London*, 22: 375-389.

OCCHIPINTI-AMBROGI, A. & SAVINI, D., 2003.Biological invasions as a component of global change in stressed marine ecosystems. *Marine Pollution Bulletin*, 46: 542-551.

PANSE, V.G. & SASTRY, K.V.R., 1958. *Sample surveys for improvement of fishery statistics in Egypt*. FAO, Rome, 96 pp.

POR, F.D., 1978. *Lessepsian Migration*. *Ecological Studies*, Vol. 23. Springer-Verlag, Berlin, 228 pp.

POR, F.D., 1990. Lessepsian Migration. An appraisal and new data. *Bulletin de l'Institut Oceanographique*. *Monaco*, 7: 1-10.

RIZKALLA, S.I., 1985. *Fishery biology stud-*

ies on Family Sphyraenidae in the Egyptian Mediterranean waters. M.Sc. Thesis. Faculty of Science, University of Alexandria.

RIZKALLA, S.I., 1997. New records of Lessepsian fishes found in the Egyptian Mediterranean waters. p.464-470. In: *Proceedings of the 7th International Conference on "Environmental Protection is a Must",* Alexandria, Egypt..

STREFTARIS, N. & ZENETOS, A., 2006. Alien Marine species in the Mediterranean - the 100 "Worst Invasives" and their impact. *Mediterranean Marine Science*, 7 (1): 87-118.

TILLIER, J.B., 1902. Le Canal de Suez et sa faune ichthyologique. *Memoires. Societe Zoologique de France*, 15 (3): 279-318.

TORTONESE, E., 1951. I caratteri biologici del Mediterraneo orientale e i probleme relativi. *Attualita Zoologiche*, 7: 207-251.

TORTONESE, E., 1964. The main biogeographical features and problems of the Mediterranean fish fauna. *Copeia*, 1: 98-107.

WAHBY, S.D. & BISHARA, N.F., 1977. Physical and chemical factors affecting fish distribution in Lake Manzala, Egypt. *Acta Ichthyologica & Piscatoria*, 7 (1): 15-29.

WASSIF, E.A., 1973. *Study of the biology of the genus Diplodus sargus (L.) and related species of the family Sparidae in the Mediterranean*. M.Sc. Thesis, Faculty of Science, Alexandria University, 159 pp.

ZENETOS, A., GOFAS, S., VERLAQUE, M., CINAR, M.E., BIANCHI, C.N. *et al*., 2010. Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive. Part I. Spatial Distribution. *Mediterranean Marine Science,* 11 (2): 381-493.